Item	Report	IMPORTANT NOTE
3308	Export cables, cable route survey report	This document describes the scope and the delivery format of cable route surveys for PART 1, PART 2 and PART 3. PART 1 is the only part, that concerns the connections between the offshore wind farms, Bornholm I and Bornholm II and the energy island of Bornholm.

SCOPE OF SERVICES

Project		Energy islands					
Assignment		Cable route surveys, Denmark					
Document Title		Scope of Services, LOT 1					
Document No.		21/04393-2					
Audience		Tenderers					
Version	**Document status**	**Prepared by**		**Reviewed by**		**Approved by**	
		Name	**Date**	**Name**	**Date**	**Name**	**Date**
1	Template	JCO	2019-03-01	RNY	2019-03-11	JHA	2019-03-11
2	For tender	JCO/NHW	2021-09-10	CNY/POPBES/JOH	2021-09-14	JRA	2021-09-16

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1. Introduction

1.1 Background and the project

Following a decision in the Danish Parliament June 2020 Denmark is on the path to establish offshore energy infrastructure in the Danish North Sea and in the Danish Baltic Sea to connect respectively 3 GW and 2 GW offshore wind energy to the Danish mainland and to neighbouring countries via offshore energy hubs, called *Energy islands*. Figure 1-1 illustrate the regional locations of the project.

Figure 1-1. Project locations for the North Sea and the Baltic Sea. YELLOW SYMBOLS mark the "Energy islands" as a new, artificial island in the North Sea and the existing island, Bornholm, in the Baltic Sea.

The *Energy island* in the North Sea consists of a new, artificial island located ca. 90 km west of the Danish west coast offshore the peninsula Jutland. In the Baltic Sea the *Energy island* is the existing island of Bornholm.

For the subsea cables connecting the energy islands to the Danish power grid it is required to survey cable routes

- In the Baltic Sea connecting two offshore wind farms with Bornholm.
- In the Baltic Sea connecting Bornholm with the island of Sjælland.
- In the North Sea connecting the artificial island with Jutland.

The further development, construction and operation of the subsea cables will be done by

- A *concessionaire,* identified by a tender from the Danish Energy Agency for the cables connecting two offshore wind farms with Bornholm.
- *Energinet,* for the cables connecting Bornholm with the island of Sjælland.
- *Energinet,* for the cables connecting the artificial island with Jutland.

1.2 Site investigations

Following the political decision the Danish Energy Agency has instructed the Client to initiate site investigations, environmental and metocean studies for the abovementioned main project elements.

On the basis of the instruction from the Danish Energy Agency the Client requests the Consultant to carry out a geophysical survey and geotechnical investigations for the cable routes in 2022 and 2023 for the project parts listed in Table 1-1.

The purpose of the present assignment is to provide cable route survey for

- CONTRACT LOT 1 regarding scope in the Baltic Sea

The area of investigation subject to the present assignment is defined by the cable RPL and the cable route survey corridor (see Figure 1-2). A detailed definition of the area of investigation is provided in chapter 5.

Table 1-1. Overview of baseline project parts and contract lots included in the present assignment.

Part	Site	Region	Route length (*)	Corridor width (*)	Contract lot
1a	Bornholm to OWF I + II	Baltic Sea	70km	2000m	1
1b	Bornholm to Sjælland	Baltic Sea	8 km	1500m	1
2	Bornholm to Sjælland (SE)	Baltic Sea	100km	1500m	1
3	Bornholm to Sjælland (DK)	Baltic Sea	95km	1500m	1
4	Artificial island to Jutland (landfall 1)	North Sea	100km	2000m	2
5	Artificial island to Jutland (landfall 2)	North Sea	140km	1500m	2
6	Artificial island to Jutland (landfall 3)	North Sea	150km	1500m	2
(*) Approximative figures – see Chapter 5 for details.					

Table 1-2 Overview of possible variations to baseline project parts and contract lots in the present assignment

Part	Site	Region	Route length (*)	Corridor width (*)	Contract lot
1b**	Possible variation	Baltic Sea	+ 35km	± 500m	1
2**	Possible variation	Baltic Sea	+ 35km	± 500m	1
3**	Possible variation	Baltic Sea	- 65km	± 500m	1
5**	Possible variation	North Sea	- 70km	± 500m	2
6**	Possible variation	North Sea	- 150km	± 500m	2
(**) The Cable routes are subject to change with variations of the approximate figures stated in this row					

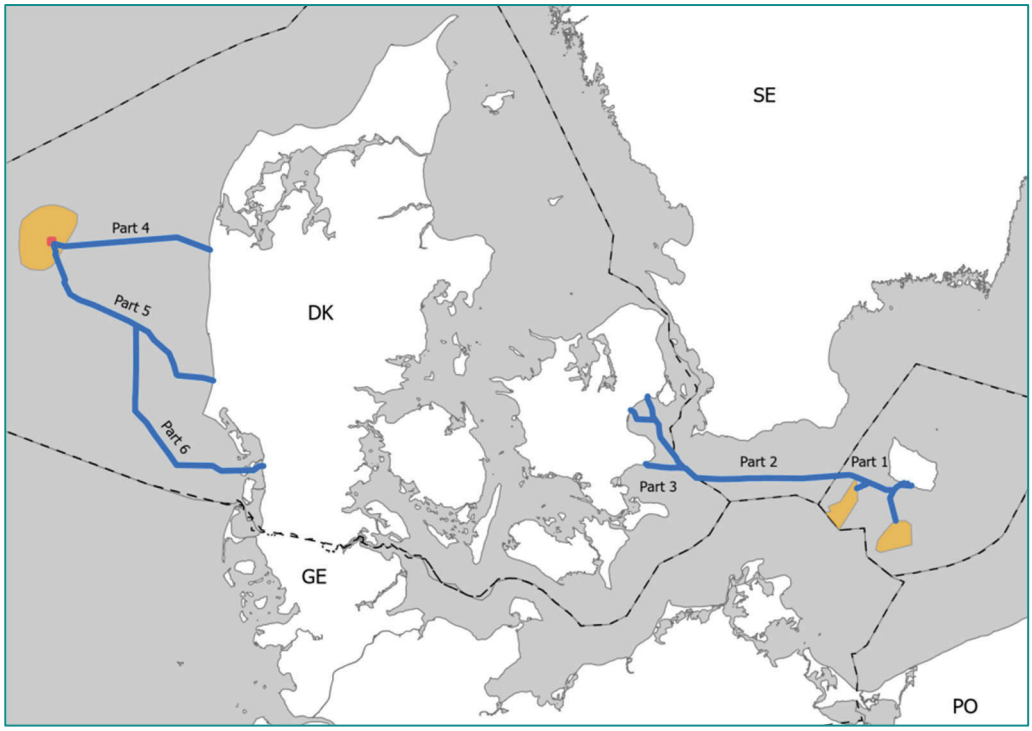

Figure 1-2 *Overview of the project parts. **BLUE LINE**: Cable routes for survey. **ORANGE POLYGONS**: OWF development. Details provided in Chapter 5.*

2. Scope of services

To support the development of the project the Consultant must provide a seabed survey covering the area of investigation described in chapter 5.

2.1 Scope of Assignment

To accommodate the abovementioned purposes the assignment includes the following work packages:

- Work Package A – Offshore Cable Route Survey > 10m MSL(*)
  A geophysical survey must be performed with commencement in 2022 and completion as soon as possible. The survey has full coverage in the cable corridor. The survey must map the bathymetry, the static and dynamic elements of the seabed surface and upper soil stratification to ca. 10m below seabed.

- Work Package B – Nearshore and Landfall Survey < 10m MSL(*)
  Same scope as Work Package A performed for shallow water and intertidal parts of the cable route. Work Package B also contains a few limited onshore activities for mapping of landfall.

  (*) Splitting Work Packages A and B at 10m water depth is based on the Clients anticipations regarding selection of survey vessels. The Consultant may chose to separate the work packages at another water depth. Chapter 5 provide bathymetrical information based on archive sources.

- Work Package C – Geotechnical investigations.
  Upon completion and interpretation of the Work Packages A and B, a geotechnical campaign must be performed to provide the soil parameters of the interpreted soil strata.

- Work Package D – Crossings survey
  A dedicated ROV based survey with cable- and pipeline tracking sensors must be performed to map existing third party utilities, that cross or intersect the area of investigation. The survey determines the horizontal location as well as the depth of burial of the third party utility.

  Work Package E – Hydrographical survey 2023
  OPTION applicable for Part 4,5 and 6 only
  A repeated hydrographical survey with full coverage of the area of investigation must be performed in 2023 Q3 to investigate dynamic seabed conditions. The scope and work is requested as an option.

2.2 Purpose of assignment

The results of the survey should be able to be used as basis for

- Initial marine archaeological site assessment.
- Planning of environmental investigations.
- Assessment of subsea cable burial design.

- Assessment of installation conditions for subsea cables.
- Site information enclosed the tender for the offshore wind farm concession.

This document - including enclosures - describes the requirements to the fulfilment of the assignment.

3. Time schedule

3.1 Requirements to time schedule Baltic Sea (Contract Lot 1)

It is requested that the services are performed – as much as possible - with respect to the following schedule requirements:

Part 1 and Part 3 - Work Packages A to D

1. All deliverables are provided in revidsed issue before 2022-12-31.
   Note: Preceeded by a draft delivery, client review and revisiononary amendments.
2. Permit for survey is available from be 2022-03-01.
3. Marine operations with seismic spread allowed from 01 April to 31 October.

Part 2 - Work Packages A to D

4. All deliverables are provided in revidsed issue before 2023-10-31.
   Note: Preceeded by a draft delivery, client review and revisiononary amendments.
5. Permit for survey is available from 2023-03-01.
6. Marine operations with seismic spread allowed from 01 May to 31 July.

3.2 Contract milestones

As part of the Consultants tender response, the Consultant supplied milestone dates for the performance of the Scope of Services based on the template displayed in Figure 3-1.

Together with the Consultants detailed time schedule (Gantt style) the provided milestone dates constitutes the contracted time schedule. It appear from Table 3-1, that some selected milestones are subject to liquidated damages (LD) as described in the Service Agreement.

Table 3-1. Overview of contract milestones subject to liquidated damages.

Milestone	WP	Event	Project Part	Contract Lot
101	(all)	Premob deliverables provided	1	1
102	A	Survey commenced	1	1
111	A	Report provided, revised issue	1	1
201	(all)	Premob deliverables provided	2	1
202	A	Survey commenced	2	1
211	A	Report provided, revised issue	2	1
301	(all)	Premob deliverables provided	3	1
302	A	Survey commenced	3	1
311	A	Report provided, revised issue	3	1

Item	Event	Note	Due date	LD	Milestone
1	Commencement of contract		2021-12-07		
2	Project execution and QHSE plans provided				
3	Kick-off meeting				
4	Premob deliverables provided	3, 4		YES	**101**
5	**Work Package A - Offshore cable route survey**				
6	WP A - Survey commenced	1,3		YES	**102**
7	WP A - All marine operations completed				**103**
8	**Work Package B - Nearshore and landfall survey**				
9	WP B - Survey commenced	1			**104**
10	WP B - All marine operations completed				**105**
11	**Work Package C - Geotechnical investigations**				
12	WP C - Investigations commenced	1			**106**
13	WP C - All marine operations completed				**107**
14	**Work Package A to C - Reporting**				
16	WP A to C - Report provided, draft issue	2			**110**
17	WP A to C - Report, Client review		(4 weeks)		
18	WP A to C - Report provided, revised issue	2,3		YES	**111**
25	**Work Package D - Crossing survey**				
26	WP D - Survey commenced	1			**112**
27	WP D - All marine operations completed				**113**
28	WP D - Report provided, draft issue	2			**114**
29	WP D - Report, Client review		(2 weeks)		
30	WP D - Report provided, revised issue	2			**115**
19	**Work Package E - Hydrographical survey**				
20	WP D - Survey commenced	1	NA		
21	WP D - All marine operations completed		NA		
22	WP D - Report provided, draft issue	2	NA		
23	WP D - Report, Client review		(2 weeks)		
24	WP D - Report provided, revised issue	2	NA		
Note 1	Event has occurent at first day with working time recorded as OPERATIONAL TIME.				
Note 2	Event has occured when report, including all charts and all digital deliverables have arrived at the Clients office in Fredericia, Denmark.				
Note 3	Milestones marked with "YES" in the table column "LD" are subject to potential delay damages acc. to contract.				
Note 4	Premobilization deliverables must be provided within 20 calendar days of contract signature. Premobilization deliverables include evidence for meeting the insurrance requirements and the performance guarantee. See the Consultancy Agreement for detailed requirements.				

Figure 3-1. Template for contract milestones that must be completed by Consultant as part of his proposal. The milestones subject to liquidated damages (LD) are indicated here and described in the Servcie Agreement. The template displayed here apply for part 1. Similar templates apply for part 2-6.

4. Requirements

For the area of investigation described in section 5 the Consultant must provide data acquisition, seabed sampling and testing, laboratory analyses, data processing, data interpretation and reporting.

4.1 Functional

To meet the purposes of the Scope of Services for the offshore survey, the Consultant must carry out a detailed mapping of the seabed surface within the surveyed area in order to provide:

- Accurate bathymetric data and charts in the surveyed area.
- The morphology and natural features of the seabed surface such e.g. as mega-ripples, sand-waves, boulders, outcropping geology, seaweed and reefs.
- Possible man-made features such as wrecks, debris, fishing gear, trawl marks, anchor scars, objects of potential archaeological interests.
- Outline habitat and biotope mapping including ground truthing.
- Identification of features of potential conservation interest including but not limited to; sandbanks, gravel reef, cobble reef, rocky reef and biogenic reef structures.

The sub-surface of the seabed must be investigated to provide:

- The soil stratification and seismic units to 10m below seabed.
- The soil types, geotechnical properties and thermal properties of the soil units down to 6m below seabed.

At the landfall location the beach area behind the shoreline must be mapped:

- To provide a DTM that connects the marine bathymetry to the onshore topography.
- To chart any obstacles or infrastructure in the beach area.

4.2 Technical Requirements

To meet the functional requirements the following technical requirements shall apply for the scope of services:

- Multi-Beam Echo-Sounding for bathymetric mapping, complete coverage within corridor.
- Side Scan Sonar for mapping of the seabed surface. The coverage must have overlap to cover nadir of adjacent survey lines.
- Magnetometer for screening for larger ferrous objects and crossing cables and pipelines.
- Sub-bottom profiling with s single-channel seismic system able to provide a high resolution mapping of the shallow geology. The system must be able to penetrate to 10m below seabed in sandy geological environment.
- Grab sampling to support the interpretation of the seabed surface geology.

Onshore survey activities shall include land surveying carried out from the low water mark (defined as Mean Low Water Spring mark) and further towards land to cover the full survey corridor.

The Geotechnical investigations shall include the following offshore in-situ activities:

- Core sampling of the seabed with a suitable corer device, 6m below seabed.
- CPT tests of the seabed, 6m below seabed.
- Geotechnical laboratory tests and tests of soil samples thermal properties.

4.3 Data processing, Interpretation and Reporting

The Consultant shall process and interpret all data acquired during surveying as well as carry out all necessary reporting according to the requirements specified in the documents

- Enclosure 1 - Technical Specifications and
- Enclosure 2 - Standards of Deliverables.

4.4 UXO risk mitigation

Some parts of the areas of investigation are likely to be located in areas with elevated probability for encountering UXO objects. The Client has not yet conducted a UXO desk study.

Therefore the Consultant shall include in his Project and QHSE plan a procedure to mitigate the UXO risk relating to direct seabed interactions (e.g. grab sampling, seabed coring, CPT).

The Client accepts that this risk can be minimized within the principles of ALARP if seabed interactions are localized within 5 m of geophysical survey lines free of any anomalies.

4.5 HSE requirements

To manage the Health, the Safety and the Environmental under the assignment a number of requirements attached as Enclosure 3 must apply for Consultants provision of the services.

4.6 Quality requirements

To manage the Quality under the assignment a number of requirements attached as Enclosure 4 must apply for Consultants provision of the services.

5. Area of Investigation – Part 1

This section describes the parameters that define the area of investigation for Part 1:

- Overview of the marine routes.
- The landfall locations.
- The survey corridor.

The area of investigation (AOI) for the present assignment is determined on the basis of the cable *Route Position List (RPL)* . The RPL coordinates are found in Annex 1 found at the end of this document.

The cumulated length of the cable route for survey is ca. 75km.

The Nominal width of the cable route survey corridor is 1500m.

An ESRI Shape-file with a polygon for the survey corridor is included in Annex 2.

On overview of the cable route is shown in Figure 5-1 where the BLUE POLYLINE displays the cable route. It is apparent that

- The Landfall is located on the south shore of Bornholm near the site *Boderne*.
- The survey corridor is split in three, connecting to Bornholm I & and II respectively and extending westward to the DK-SE EEZ
- The survey corridor is widening in the shallow sections
- The western extension of the survey corridor crosses a mayor vessel traffic route
- Primary port of interest is Rønne Habour

At time of contract signature, the Client will confirm the area of investigation.

For convenience, the coordinates of the Bornholm I & II OWF is included in Annex 3.

5.1 Background information related to the cable route

Figure 5-2 display the cable route and the survey corridor in more detail from Landfall to the Bornholm OWF site.

The survey corridor terminates at ca. 300m onshore, at boundary to the OWF site and at the DK-SE EEZ

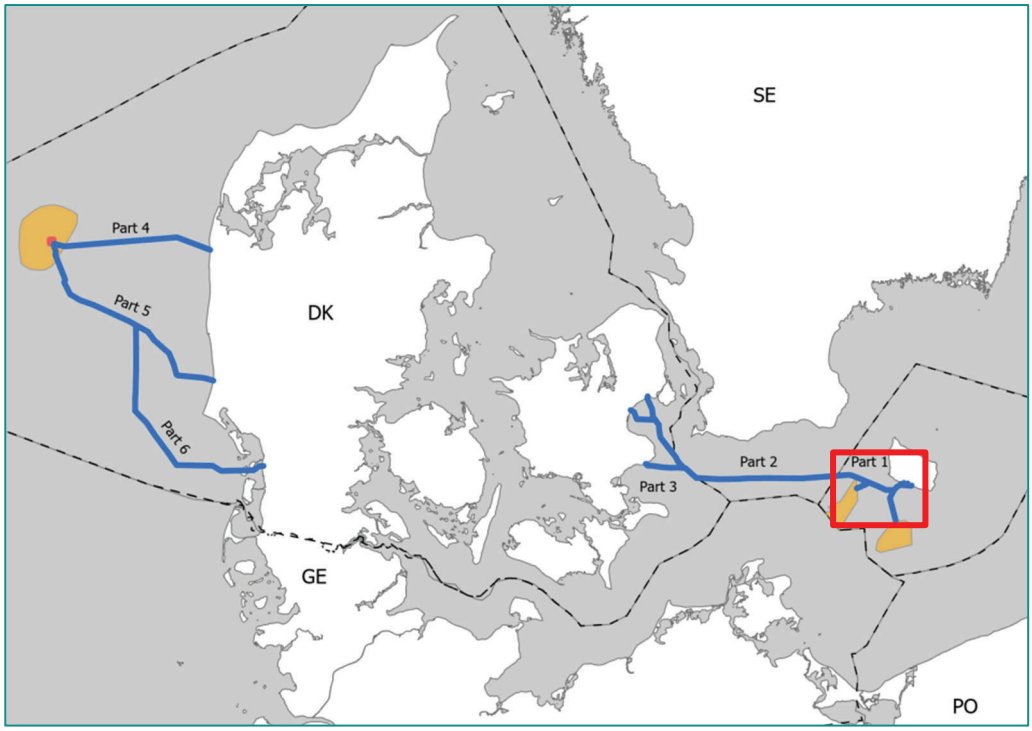

*Figure 5-1. Overview of the project parts. **BLUE LINE**: Cable routes for survey. **ORANGE POLYGONS**: OWF development. **RED BOX**: Indication of location of Figure 5-2.*

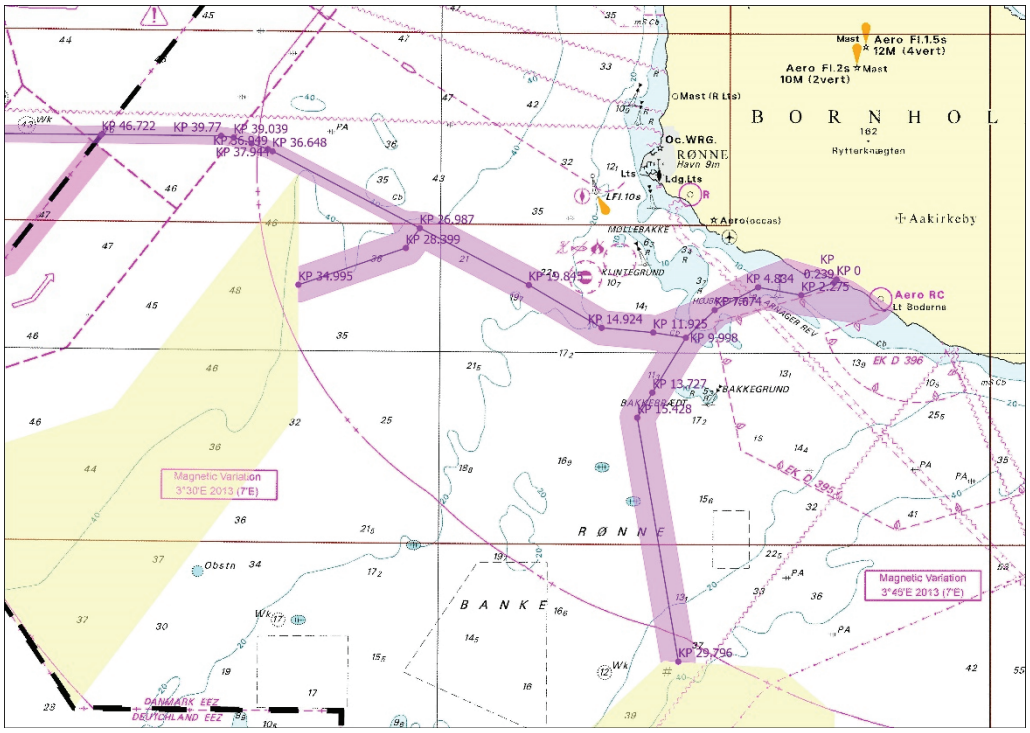

*Figure 5-2. Overview of the cable route and survey corridor for part 1 from Bornholm OWF 1 and 2 to Bornholm: **PURPLE LINE**: Cable Route. **POINTS**: Route Positions with KP values. **PURPLE POLYGON**: Survey corridor. EEZ boundary: **Dashed BLACK LINE***

5.2 Landfall

The landfall is located in the area west of Boderne with KP0 placed on the beach site. The survey corridor is extended onshore from the shoreline to ca. 300m inland.

The survey corridor is extended to cover multiple potential landfalls and reaches a maximum width in the nearshore section of 7000m.

The area behind the beach is primarily consisting of fields and forestry.

5.3 Water depths

The Client expects that the water depths in the area of investigation are ranging between 0m MSL at landfall to 40m MSL at the OWF site.

Figure 5-2 illustrates the bathymetry in the area of investigation based on a Admirality charts.

The shallow water conditions associated nearshore is illustrated in Figure 5-2 The Client anticpates that the cable route survey from KP0 to ca. KP 5 is performed with nearshore or intertidal vessels (Work Package B).

According to public tide tables for Rønne Habour, the sea level is seen[1] to vary within plus-minus 2cm from MSL.

5.4 Seabed surface geology

The seabed surface in the area of investigation is expected to consist primarily of sand and sedimentary bedrock.

Surface soil units of sand, Till/diamicton and Quaternary clay and silt are also likely to be encountered. Towards the DK-SE EEZ muddy conditions are expected.

[1] See tables at the Danish Meteorologial Institue: https://www.dmi.dk/hav-og-is/temaforside-tidevand/tidevandstabeller-for-danmark/

6. Area of Investigation – Part 2

This section describes the parameters that define the area of investigation for Part 2:

- Overview of the marine routes.
- The survey corridor.

The area of investigation (AOI) for the present assignment is determined on the basis of the cable *Route Position List (RPL)* . The RPL coordinates are found in Annex 1 found at the end of this document.

The cumulated length of the cable route for survey is ca. 95km.

The Nominal width of the cable route survey corridor is 1500m.

An ESRI Shape-file with a polygon for the survey corridor is included in Annex 2.

On overview of the cable route is shown in Figure 6-1 where the BLUE POLYLINE displays the cable route. It is apparent that

- The cable route enters Swedish waters at KP 0
- The cable route terminates at the boundary to danish waters at KP 95
- The survey corridor is currently offset Baltic Pipe by 700m
- The eastern section of the survey corridor crosses a mayor vessel traffic route
- Primary ports of interest could be Rønne Habour and Ystad Harbour

At time of contract signature, the Client will confirm the area of investigation.

For convenience, the coordinates of the Bornholm I & II OWF is included in Annex 3.

6.1 Background information related to the cable route

Figure 6-2 display the cable route and the survey corridor in more detail from through Swedish waters.

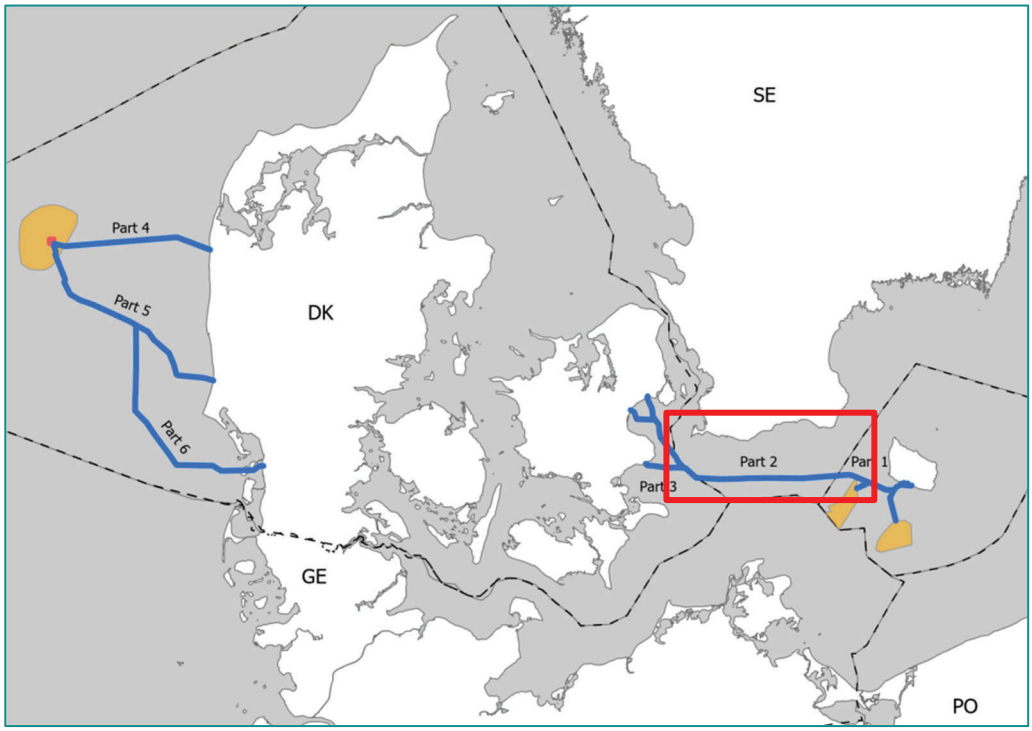

*Figure 6-1. Overview of the project parts. **BLUE LINE**: Cable routes for survey. **ORANGE POLYGONS**: OWF development. **RED BOX**: Indication of location of Figure 6-2.*

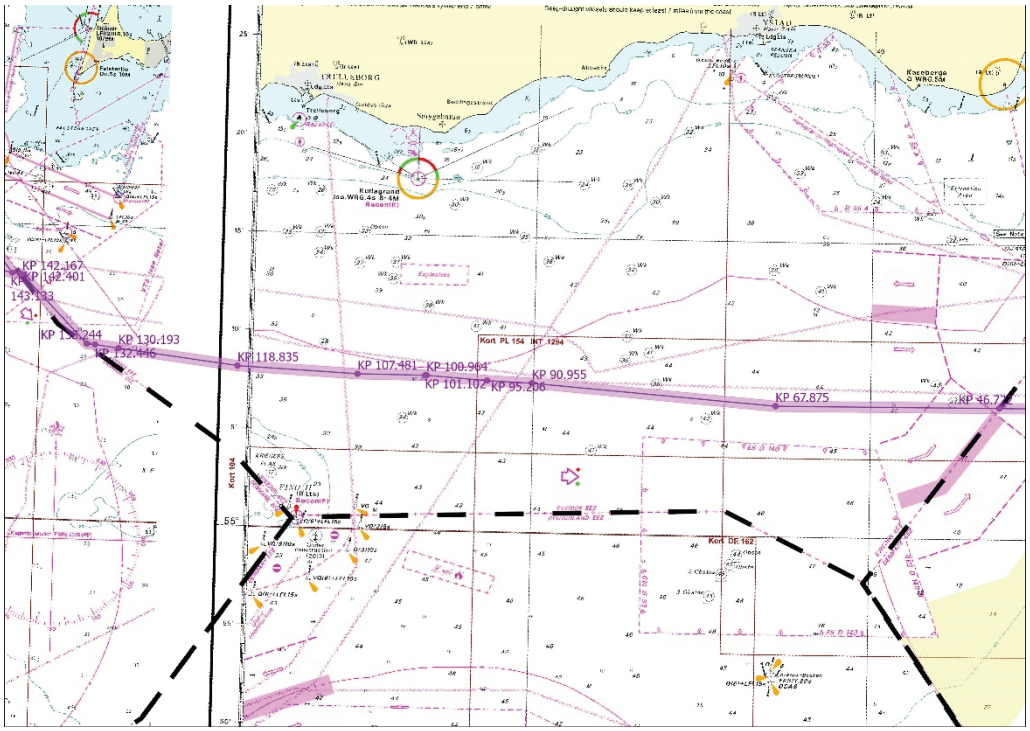

*Figure 6-2. Overview of the cable route and survey corridor for part 2 through Swedish waters: **PURPLE LINE**: Cable Route. **POINTS**: Route Positions with KP values. **PURPLE POLYGON**: Survey corridor. EEZ boundary: **Dashed BLACK LINE***

6.2 Landfall

Part two does not include a landfall survey

6.3 Water depths

The Client expects that the water depths in the area of investigation are ranging between 25m MSL at landfall to 40m MSL at the OWF site.

Figure 6-2 illustrates the bathymetry in the area of investigation based on a Admirality charts.

No shallow water conditions are anticipated by the Client associated with Part 2.

According to public tide tables for Rønne Habour, the sea level is seen[1] to vary within plus-minus 2cm from MSL.

6.4 Seabed surface geology

The seabed surface in the area of investigation is expected to consist primarily of sand and muds.

Surface soil units of sand, Till/diamicton and Quaternary clay and silt are also likely to be encountered.

7. Area of Investigation – Part 3

This section describes the parameters that define the area of investigation for Part 3:

- Overview of the marine routes.
- The landfall locations.
- The survey corridor.

The area of investigation (AOI) for the present assignment is determined on the basis of the cable *Route Position List (RPL)* . The RPL coordinates are found in Annex 1 found at the end of this document.

The cumulated length of the cable route for survey is ca. 95km.

The Nominal width of the cable route survey corridor is 1500m.

An ESRI Shape-file with a polygon for the survey corridor is included in Annex 2.

On overview of the cable route is shown in Figure 7-1 where the BLUE POLYLINE displays the cable route. It is apparent that

- Three separate landfalls are included.
- The survey corridor is split in three, connecting the cable route to landfalls at Rødvig, Karlslunde and Avedøre respectively
- The Eastern extension of the survey corridor crosses a mayor vessel traffic route
- The Eastern extension of the survey corridor terminates at the DK-SE EEZ
- Primary port of interest is Køge Habour

At time of contract signature, the Client will confirm the area of investigation.

For convenience, the coordinates of the Bornholm I & II OWF is included in Annex 3.

7.1 Background information related to the cable route

Figure 7-2 display the cable route and the survey corridor in more detail from Landfall to the Bornholm OWF site.

The survey corridor terminates ca. 300m onshore on all sites and at the DK-SE EEZ Boundary

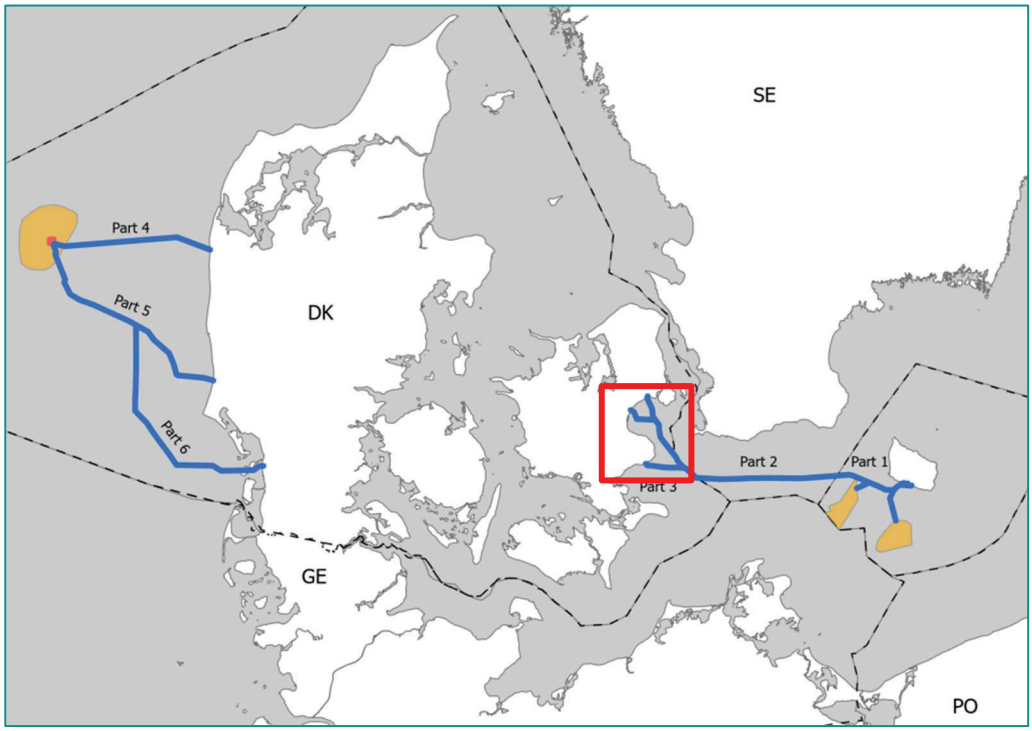

Figure 7-1. *Overview of the project parts. **BLUE LINE**: Cable routes for survey. **ORANGE POLYGONS**: OWF development. **RED BOX**: Indication of location of Figure 7-2.*

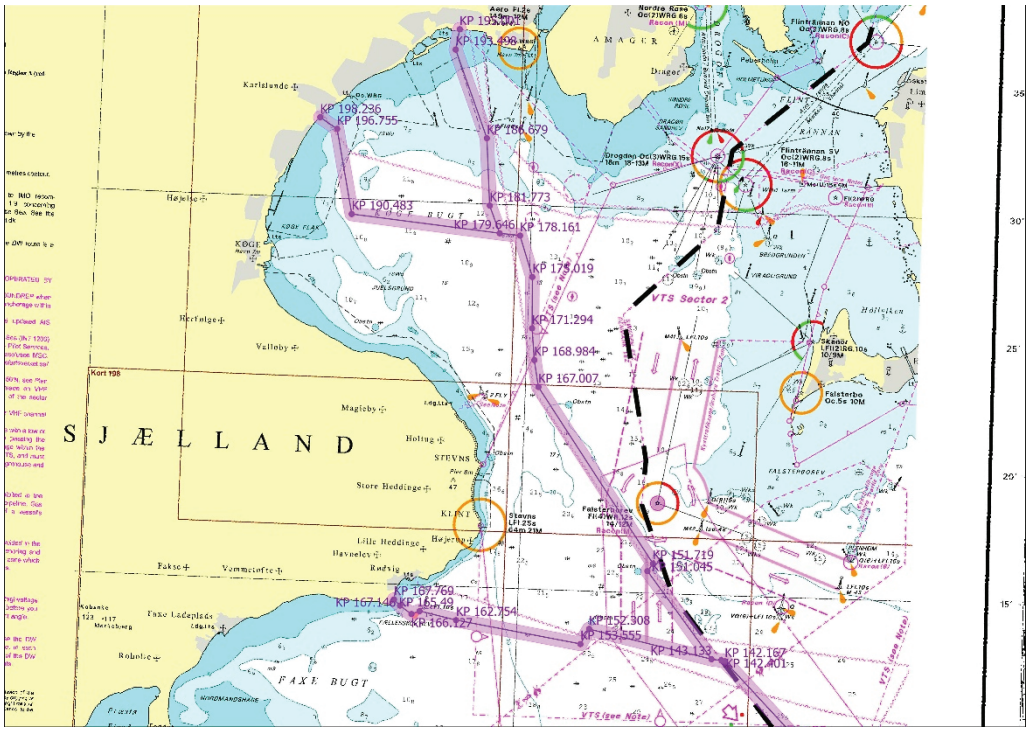

Figure 7-2. *Overview of the cable route and survey corridor for part 3 from Danish EEZ to Landfall: **PURPLE LINE**: Cable Route. **POINTS**: Route Positions with KP values. **PURPLE POLYGON**: Survey corridor. EEZ boundary: **Dashed BLACK LINE***

7.2 Landfall

Three multiple landfalls are to be surveyed; Rødvig, Karlslunde and Avedøre.

The Rødvig landfall is located in the area west of Boderne with KP 167 placed on the beach site. The survey corridor is extended onshore from the shoreline to ca. 300m inland.

The area behind the beach is consisting primarily of fields.

The Karlslunde landfall is located in an area between residental buildings, but with fields and forestry in connection to the beach. KP 198 is placed on the beach site. The survey corridor is extended onshore from the shoreline to ca. 300m inland.

The Avedøre landfall is located on the beach just east of Ishøj docks. with KP 195 placed on the beach site. The survey corridor is extended onshore from the shoreline to ca. 300m inland.

The area behind the beach is primarily consisting of fields and of very shallow inland bogs.

7.3 Water depths

The Client expects that the water depths in the area of investigation are ranging between 25m MSL at the boundary of the DK-SE EEZ to 0m MSL at the landfall sites. .

Figure 5-2 illustrates the bathymetry in the area of investigation based on a Admirality charts.

The shallow water conditions associated with nearshore survey are illustrated in Figure 5-2 The Client anticpates that nearshore or intertidal vessels are used for the cable route survey from KP 167 to KP 165 at the Rødvig Landfall, from KP 198 to KP 190 at the Karlslunde landfall, and from KP 195 to KP 180 at the Avedøre landfall (Work Package B)

According to public tide tables for Køge Habour, the sea level is seen[2] to vary within plus-minus 6cm from MSL.

7.4 Seabed surface geology

The seabed surface in the area of investigation is expected to consist primarily of sand and muds.

Surface soil units of Till/diamicton and Quaternary clay and silt are also likely to be encountered. Towards the DK-SE EEZ muddy conditions are expected.

[2] See tables at the Danish Meteorologial Institue: https://www.dmi.dk/hav-og-is/temaforside-tidevand/tidevandstabeller-for-danmark/

Annex 1 – Export cable route position list (RPL)

Table A1-1. Coordinates for definition of the cable Route Position List. Revision 04, 2021-09-09. Datum = ETRS89, Projection = UTM 33N. KP0 is located at the landfall and at intersections of route.

KP	EASTING [meter]	NORTHING [meter]	LATITUDE [DD mm.mmmm]	LONGITUDE [DD mm.mmmm]
LOT 1 Part 1				
Route section 1				
0	491090.93	6099105.29	55°2.3212' N	014°51.6356' E
0.239	490943.97	6098917.40	55°2.2197' N	014°51.498' E
2.275	489045.36	6098180.25	55°1.82' N	014°49.7172' E
4.834	486528.33	6098639.66	55°2.064' N	014°47.3533' E
7.674	484016.96	6097313.19	55°1.3443' N	014°45.0002' E
9.998	482332.00	6095712.52	55°0.4778' N	014°43.4248' E
13.727	480392.85	6092527.15	54°58.756' N	014°41.6187' E
15.428	479508.56	6091074.48	54°57.9706' N	014°40.7959' E
29.796	481892.90	6076906.01	54°50.3367' N	014°43.0839' E
Route section 2				
9.998	482332.00	6095712.52	55°0.4778' N	014°43.4248' E
11.925	480428.91	6096014.51	55°0.6364' N	014°41.6382' E
14.924	477442.77	6096288.63	55°0.7766' N	014°38.8353' E
19.845	473198.12	6098780.06	55°2.1073' N	014°34.8388' E
26.987	466867.52	6102084.64	55°3.8661' N	014°28.873' E
28.399	466054.55	6100929.74	55°3.2401' N	014°28.1175' E
34.995	459816.79	6098784.98	55°2.0558' N	014°22.2773' E
Route section 3				
26.987	466867.52	6102084.64	55°3.8661' N	014°28.873' E
36.648	458301.48	6106553.44	55°6.2367' N	014°20.7867' E
36.949	458026.42	6106673.82	55°6.3002' N	014°20.527' E
37.944	457089.33	6107009.95	55°6.4766' N	014°19.6427' E
39.039	456047.03	6107346.33	55°6.6525' N	014°18.6594' E
39.77	455323.12	6107444.04	55°6.7013' N	014°17.9777' E
46.722	448371.45	6107517.45	55°6.7003' N	014°11.4389' E

Table A1-2. Coordinates for definition of the cable Route Position List.
Revision 04, 2021-09-09. Datum = ETRS89, Projection = UTM 33N.
KP0 is located at the landfall and at intersections of route.

KP	EASTING [meter]	NORTHING [meter]	LATITUDE [DD mm.mmmm]	LONGITUDE [DD mm.mmmm]
LOT 1 Part 2				
Route section 1				
46.722	448371.45	6107517.45	55°6.7003' N	014°11.4389' E
67.875	427218.93	6107733.24	55°6.6575' N	013°51.5436' E
90.955	404241.49	6109903.66	55°7.593' N	013°29.8949' E
95.206	399997.86	6110150.79	55°7.6759' N	013°25.8982' E
100.964	394261.99	6110652.94	55°7.8751' N	013°20.492' E
101.102	394124.53	6110662.39	55°7.8785' N	013°20.3625' E
107.481	387746.24	6110802.36	55°7.8697' N	013°14.3597' E
118.835	376418.97	6111572.46	55°8.1229' N	013°3.6862' E
130.193	365180.35	6113213.77	55°8.8315' N	012°53.0694' E
132.446	362954.20	6113565.69	55°8.9844' N	012°50.9649' E
133.244	362161.84	6113654.08	55°9.0188' N	012°50.2169' E
142.167	356095.38	6120197.75	55°12.4407' N	012°44.3102' E
142.401	355866.33	6120247.63	55°12.4636' N	012°44.0929' E

Table A1-3. Coordinates for definition of the cable Route Position List.
Revision 04, 2021-09-09. Datum = ETRS89, Projection = UTM 33N.
KP0 is located at the landfall and at intersections of route.

KP	EASTING [meter]	NORTHING [meter]	LATITUDE [DD mm.mmmm]	LONGITUDE [DD mm.mmmm]
LOT 1 Part 3				
Route section 1				
142.401	355866.33	6120247.63	55°12.4636' N	012°44.0929' E
143.133	355140.74	6120345.19	55°12.5034' N	012°43.4063' E
152.308	346230.72	6122534.62	55°13.5213' N	012°34.9413' E
153.555	345608.46	6121454.16	55°12.9276' N	012°34.3903' E
162.754	336574.63	6123186.57	55°13.6864' N	012°25.8195' E
165.49	333919.18	6123845.50	55°13.9882' N	012°23.2939' E
166.127	333322.51	6123622.92	55°13.8562' N	012°22.7394' E
167.146	332502.95	6124229.85	55°14.1665' N	012°21.9455' E
167.769	332066.03	6124673.76	55°14.3966' N	012°21.5178' E
Route section 2				
143.133	355140.74	6120345.19	55°12.5034' N	012°43.4063' E
151.045	350482.95	6126740.52	55°15.8654' N	012°38.815' E
151.719	350875.62	6127288.03	55°16.1675' N	012°39.168' E
167.007	342552.12	6140111.50	55°22.9196' N	012°30.8836' E
168.984	342254.03	6142065.86	55°23.9666' N	012°30.5354' E
171.294	342095.69	6144370.80	55°25.205' N	012°30.3072' E
175.019	342121.24	6148095.21	55°27.2116' N	012°30.2048' E
178.161	341218.07	6151105.39	55°28.8155' N	012°29.2457' E
179.646	339742.60	6151272.35	55°28.8765' N	012°27.8405' E
190.483	328995.65	6152667.25	55°29.4094' N	012°17.5974' E
196.755	327929.71	6158847.65	55°32.7153' N	012°16.3562' E
198.236	326706.68	6159682.31	55°33.1388' N	012°15.1632' E
Route section 3				
179.646	339742.60	6151272.35	55°28.8765' N	012°27.8405' E
181.773	339013.32	6153270.25	55°29.9382' N	012°27.0794' E
186.679	338811.68	6158171.62	55°32.5741' N	012°26.717' E
193.498	336544.22	6164602.68	55°35.9925' N	012°24.3349' E
195.001	336833.40	6166078.24	55°36.7931' N	012°24.5576' E

Annex 2 – Area of investigation – ESRI Shape-file

SN2022_008_KP_ROUTE_LIN.shp	Route center line
SN2022_008_SURVEYS_POL.shp	Route corridor

Annex 3 – Bornholm OWF coordinates

Table A2-1. Coordinates for definition of the offshore wind farm area of investigation. Revision 04, 2021-09-09. Datum = ETRS89, Projection = UTM 33N

POINTID	EASTING [meter]	NORTHING [meter]	LATITUDE [DD mm.mmm]	LONGITUDE [DD mm.mmm]
1	438 848	6 085 950	54° 55,008' N	14° 2,759' E
2	442 635	6 085 900	54° 55,008' N	14° 6,304' E
3	441 494	6 089 210	54° 56,785' N	14° 5,196' E
4	449 026	6 091 630	54° 58,139' N	14° 12,225' E
5	459 856	6 105 370	55° 5,606' N	14° 22,258' E
6	459 773	6 091 350	54° 58,047' N	14° 22,299' E
7	446 750	6 074 200	54° 48,728' N	14° 10,285' E

POINTID	EASTING [meter]	NORTHING [meter]	LATITUDE [DD mm.mmm]	LONGITUDE [DD mm.mmm]
1	490 998	6 073 870	54° 48,714' N	14° 51,596' E
2	490 487	6 061 450	54° 42,017' N	14° 51,143' E
3	471 025	6 058 420	54° 40,339' N	14° 33,042' E
4	468 094	6 060 170	54° 41,272' N	14° 30,303' E
5	469 981	6 066 000	54° 44,422' N	14° 32,024' E
6	470 209	6 066 260	54° 44,563' N	14° 32,234' E
7	474 267	6 070 700	54° 46,970' N	14° 35,993' E
8	481 015	6 076 960	54° 50,364' N	14° 42,264' E
9	487 876	6 076 510	54° 50,134' N	14° 48,674' E

TECHNICAL REQUIREMENTS

Project		Energy Islands					
Assignment		Cable route surveys, Denmark					
Document Title		Scope of Services – Enclosure 1 – Technical Requirements					
Document No.		21/04393-3					
Audience		Tenderers					
Version	**Document status**	**Prepared by**		**Reviewed by**		**Approved by**	
		Name	**Date**	**Name**	**Date**	**Name**	**Date**
2	For tender	JCO/NHW	2021-09-09	CNY/POP BES/JOH	2021-09-04	JRA	2021-09-16

Table of Contents

1. Introduction

In the document “Scope of Services” the objectives and the general outcome of the survey activities are described.

This specification, when read in conjunction with the Agreement, referenced standards, specifications and other listed documentation, defines the minimum technical, functional and procedural requirements for the Services associated with the project.

The Consultant shall take responsibility to ensure all survey operations are conducted safely and with full regard to national, international and area specific environmental considerations.

1.1 Constraints

The Client’s approval of the Consultant’s time schedule, organisation plan, list of subcontractors, list of equipment, etc., shall not relieve the Consultant of any responsibility for the performance of his obligations.

The Consultant shall perform the Services in accordance with best professional standards and practice within the industry plus in accordance with equipment and software manufacturer’s recommendations and descriptions.

The presence of and the inspection and supervision by the Client at the worksite as well as any approval, consent, comments and the like given to the Consultant by or on behalf of the Client shall not relieve the Consultant from his obligations and responsibilities.

All data and reports that are a result of the Services are confidential and cannot be distributed to third parties without written permission from the Client.

2. Geodetic Reference system

The survey data is acquired, processed, reported and charted with respect to the following geodetic requirements:

Baltic Sea (Lot 1):

- Datum: ETRS89
- Projection UTM 33N
- Offshore datum: Mean Sea Level (MSL). Use model DTU21MSL
- Onshore datum: DVR90
- Vertical reference for reporting: Offshore datum

North Sea (Lot 2):

- Datum: ETRS89
- Projection UTM 32N
- Offshore datum: Mean Sea Level (MSL). Use model DTU21MSL
- Onshore datum: DVR90
- Vertical reference for reporting: Offshore datum

All vertical information are provided as *depths* relative to MSL such that water depths are positive *downwards*.

Work Package B include onshore surveying activites near the landfall with the provisioin of a terrestrial DTM (see section 3.2)

Although onshore, the DTM must be reported in the vertical reference system mentioned above to evaluate the combined bathymetrical/topographical DTMS coherent and seamlessly.

3. Work packages and quantities

A number of Work Packages are defined to organize the different requirements in the document “Scope of Services”:

- Work Package A - Offshore Cable Route Survey > 10m MSL (*)
- Work Package B - Nearshore and Landfall Survey < 10m MSL (*)
- Work Package C - Geotechnical investigations
- Work Package D - Crossing survey
- Work Package E - Hydrographical survey

(*) Splitting Work Packages A and B at 10m water depth is based on the Clients anticipations regarding selection of survey vessels. The Consultant may chose to separate the work packages at another water depth.

This chapter describes the general technical requirements for work packages A- E.

3.1 Work Package A – Offshore Geophysical Survey > 10m LAT

Within the survey corridor the following requirements must be fulfilled by the survey:

- Multibeam Echosounding survey with full bathymetric coverage. The data quality must accommodate the preparation of digital elevation models (DTMs) of the bathymetry with 25cm spatial resolution.
- Dual frequency side scan sonar with > 200% coverage to ensure overlap with the nadir of adjacent survey lines. Detection of all objects > 0.5m.
- Single magnetometer or gradiometer towed after vessel, all survey lines.
- Sub-bottom profiling: One high resolution and relative high frequency single channel system, all survey lines.
- Horizontal positioning uncertainty < 0.5m for vessels.
- Horizontal positioning uncertainty < 2.0m for towed equipment.

As a part of the Work Package A grab samples are acquired with a spatial density of

- Approximative 1 (One) grab samples pr. 1 (one) route km.

Is taken to provide in-situ information of the seabed surface to support the interpretation of bathymetric and side scan sonar data. The requested amount of grab samples are subject to change according to seabed sediment complexity. The quantities of grab samples are included in the pricelist.

All samples must be subject to laboratory tests:

- Particle size, Sieve analysis
- Particle size, Hydrometer analysis
- Organic content, Loss on ignition

It must be expected that the quantities are varied and adapted to the encountered conditions.

3.2 Work Package B – Nearshore and Landfall Survey < 10m MSL

3.2.1 Onshore activities

To ensure overlap between onshore terrain datum and the marine datum applied for the intertidal and offshore survey the beach area must be surveyed from the Mean Low Water Spring mark (MLWS) and further onshore towards the limits of the route.

At the landfall the onshore survey activities must cover the beach area and the surroundings behind the beach within the limitations of the area of investigation (see the document "Scope of Service", chapter 5).

The following is provided for the onshore area of investigation:

1. A digital terrain model (DTM) that connects the land topography with the marine bathymetry.

2. The DTM must have a resolution such that contour curves with 0.50m equidistance can be extracted.

3. Infrastructure, obstacles and geological surface units must be mapped.

4. A number of 3 geodetic benchmark points at each landfall site must be established with elevations determined relative to the following systems:

    a. Offshore datum.
    b. Onshore datum.
    c. Ellipsoid height.

5. The benchmark points must be located in the area of the landfall site and have a quality such that they can exist for at least five years.

3.2.2 Intertidal and nearshore activities

The nearshore and intertidal survey area extends from the Mean High Water Spring mark (MHWS) and off shore to the water depth that at least can be surveyed by nearshore or offshore vessels from Work Package A.

The survey area of the intertidal activities must have sufficient overlap with survey activities related to Work Package A to provide a coherent and connected bathymetric DTM.

The intertidal and nearshore survey area must be mapped using the following methods:

- Multibeam Echosounding survey with full bathymetric coverage. The data quality must accommodate the preparation of digital elevation models (DTMs) of the bathymetry with 25cm spatial resolution.
- Dual frequency side scan sonar with > 200% coverage to ensure overlap with the nadir of adjacent survey lines. Detection of all objects > 0.5m.
- Single magnetometer or gradiometer towed after vessel, all survey lines.
- Sub-bottom profiling: One high resolution and relative high frequency single channel system, all survey lines.
- Horizontal positioning uncertainty < 0.5m for vessels.
- Horizontal positioning uncertainty < 2.0m for towed equipment.

As a part of the Work Package B grab samples are acquired with a spatial density of

- Approximative 2 (Two) grab samples pr. 1 (one) route km.

Is taken to provide in-situ information of the seabed surface to support the interpretation of bathymetric and side scan sonar data. Amount of grab samples are subject to change according to seabed sediment complexity. The quantities of grab samples are included in the pricelist.

All samples must be subject to laboratory tests:

- Particle size, Sieve analysis
- Particle size, Hydrometer analysis
- Organic content, Loss on ignition

It must be expected that the quantities are varied and adapted to the encountered conditions.

3.3 Work Package C – Geotechnical Investigations

The Scope of Service must include geotechnical investigations with Cone Penetration Testing (CPT) and core sampling with either a Vibrocore system or equivalent system. The quantities requested by the Client is

- Approximative 1 (one) CPT and 1 (one) vibrocorer pr. 1 (one) route km.

At each location subject to geotechnical investigations both a CPT test and a core sample must be performed. The distance between the CPT test and the core sampling must be less than 10m and no closer than 5 meters.

The target depth of the geotechnical investigations should alternate between 3m and 6m below seabed.

The quantities of the geotechnical cores, the laboratory classification tests and the CPTs are included in the pricelist.

It must be expected that the quantities are varied and adapted to the encountered conditions.

Geotechnical classification tests must be performed on soil samples extracted from the cores. Section 8.12 provides a detailed description of the required laboratory analyses.

3.4 Work Package D – Crossing Survey

All existing 3rd party utilities that intersects the survey corridor must be subject to an inspection survey that maps the intersecting utility

- Completely within the survey corridor and
- Additionally 500 m (along-track the intersectiong utility) to either side of the survey corridor.

The Consultant must perform crossing survey of all utilities intersecting the area of investigations. The pricelist include a preliminary quantity that will be modified based on the Consultants utility desk study (see section 8.9.2).

If the Consultant identifies other potential crossings as part of his preparation or during the preliminary interpretation of the geophysical survey data these must be investigated as well. The inspection of the object and surrounding seabed must include the following:

- High-resolution still images.
- High-resolution multibeam echosounding performed from surface vessel.
- High-resolution acoustic profiling performed from subsea ROV.
- Tracking of the objects lateral and vertical position as well as the burial of the object with a suitable cable- or pipe-tracking system.

Furthermore Work Package D include processing and reporting of the acquired data as described in section 8.14 and specified in the document “Standards of Deliverables”, Section 4.

As part of the premobilization activities the Consultant performs a desk study to identify all known and potential utilities, that cross the area of investigation (cable corridor). See section 8.9.2.

To be able to submit a tender response and to setup a plan, the Clients has provided preprinted quantities for the number of crossings in the pricelist. The quantities shall be modified to reflect the actual survey crossings.

3.5 Work Package E – Hydrographical Survey

A repeated hydrographical survey within the area of investigation is performed in 2023.

- Full bathymetric coverage within the area of investigations.
- Acceptable sounding density is 4 (four) soundings pr. square meter.
- The survey area of Work Package D is identical to the survey area of Work Package A and B.

Work Package D must provide a study comparing the bathymetric datasets from 2022 (Work Package A and B) and 2023 (Work Package E) with the purpose to conclude on dynamical conditions of the seabed.

Work Package E is an option for contract parts 4, 5 and 6.

3.6 All work packages: Reporting and data delivery

All work packages include

- processing and interpretation of the acquired data as described in chapters 9 and 10.
- preparation of reports and charts as described in chapter 11.

4. Planning and variations

As an integrated part of the Scope of Services the Consultant must carry out planning related to the Scope of Services. The planning work must include:

- Preparation of survey line plans for Work Packages A and B.
- Planning of grab sampling for Work Package A and for Work Package B.
- Planning of geotechnical sampling and laboratory analyses for Work Package C.
- Preparation of survey line plans for Work Package D
- Preparation of survey line plans for Work Package E.

4.1 Survey line and infill planning

Before commencement of the marine activities the Consultant must prepare a survey line plan that meets the technical requirements for Work Packages A, B, D and E. The survey line plan is subject to Client approval before commencement.

The survey line plans must accommodate that the quality requirements described in section 8 are met.

On a continuous basis and during the execution of the survey the Consultant must monitor the quality of the acquired data and assess if the requirements are met. If the requirements are not met the Consultant must plan infill lines and progress with supplementary survey activities.

Additional survey lines may be instructed by the Client Representative and agreed as variation orders to the contract.

4.1.1 Local extension of survey corridor width

On a continuous basis and during the execution of the survey the Consultant must carry out a preliminary data interpretation to analyse if the survey corridor contains challenges that can obstruct the planning and installation of export cables.

Such challenges can for example be, but not limited to, environmental sensitive areas such as reefs, geological hazards, wrecks, debris, or potential UXO objects.

If such locations occur the Consultant must propose a plan to adjust the route locally to mitigate the encountered constraint including a corresponding survey corridor.

The program must be planned together with and approved by the offshore Client Representative.

Local extensions of the survey corridor shall be agreed as variation orders to the contract.

4.2 Planning of grab sampling

For Work Package A and B the Consultant must prepare a program for grab sampling on basis of a preliminary interpretation of the geophysical data.

The program for grab sampling will primarily be related to selecting the geographical locations for sampling. The locations shall be selected such that seabed surface units of variable sonar reflectivity are sampled.

Adjusting the quantities of the seabed sampling will not constitute a variation order but would be commercially regulated by the rates stated in the Price List.

The program must be reviewed and approved by the offshore Client Representative.

4.3 Planning of vibrocore sampling and CPT testing

For Work Package C the Consultant must prepare a program for geotechnical seabed tests. The plan propose the geographical locations of the tests and the target depths.

Ideally, the Consultant plan the locations for geotechnical investigations based on a preliminary interpretation of the centreline survey data from the geophysical survey (Work Package A and B).

Alternatively, the Client accepts, that a plan for geotechnical investigations is developed from archive data assuming that this would allow for a faster commencement of the geotechnical offshore work.

Principles for planning the geotechnical tests and cores will be addressed at the kick-off meeting.

Adjusting the quantities of the seabed sampling will not constitute a variation order but would be commercially regulated by the rates stated in the Price List.

4.4 Programme for laboratory analyses

The Consultant must prepare a plan for laboratory analyses of the acquired soil samples from sampling with grab and Vibrocore.

The program must be adapted to the encountered conditions. Therefore a geological and lithological description of the cores and samples must be carried out as an integrated part of the recovery of the samples.

The program must be approved by the offshore Client Representative. Principles for laboratory program planning – including types and quantities - will be addressed at the kick-off meeting. Adjusting the quantities of the laboratory analyses will not constitute a variation order but would be commercially regulated by the rates stated in the Price List.

5. Permissions and consenting processes

The following permits and consenting processes are required ahead of the marine activities:

1. Danish Energy Agency, Permission for site investigations
2. Danish Geodata Agency, Permission for survey
3. Danish Maritime Agency, Risk Assessment of traffic safety
4. Danish Maritime Agency, Notice to Mariners

The Client is responsible for acquiring #1 and #2 and part one of #3.

The Client expects that the permit from the Danish Energy Agency, would prohibit seismic survey operations during November to March. Geotechnical investigation and survey with multibeam echosounder or side scan sonar are expected to be permitted without restrictions.

The Consultant is responsible for completion of part two of #3 and submission of #4 before commencement of the marine activities.

6. Vessels

6.1 General requirements

Based on the Consultant's experience and detailed operational knowledge, it's the responsibility of the Consultant to select the proper number of vessels necessary for performing the Scope of Services.

It is required that the vessels for Work Package A have full processing and interpretation capabilities on-board.

The Client assumes that vessels used for operations in the offshore sector, will be operated on a 24 hour basis while vessels used for operations in the shallow water sector, will be operated on a 12 hour basis.

Based on the Consultants experience and availability of appropriate vessels, it's the responsibility of the Consultant to propose and carry out most favourable mode of operations.

The vessels shall have been purpose built or suitably converted to undertake the specified work in the designated geographic area.
The vessels shall be able to operate under the meteorological and oceanographic conditions within the limitations stated by the Consultant in his tender.

The vessel(s) shall be equipped with adequate communication equipment for telephone communication plus continuously high-speed internet connections with a speed of at least 1 Mbit/s for digital data distribution.

The vessels used for Work Package A and B shall be proven to be acoustically quiet to enable good quality acoustic data to be acquired. The acoustic noise signature shall be acceptable outside the acoustic frequency range of the survey equipment to be deployed from the vessels.

Vessel deck areas used for survey operations shall have good lighting and be free of trip hazards. All are-as of the vessel used for the survey equipment deployment/recovery shall be either visible from the bridge, or good quality closed-circuit television pictures of such areas shall be provided on the bridge at all times of such operations.

6.2 DP Requirements for Work Package D

All offshore vessels used for Work Package D must be of DP class 2 and be designed, equipped and operated in accordance with IMO MSC Circ.645 "Guidelines for Vessels with Dynamic Positioning Systems".

DP operators shall be trained in accordance with NMD Guideline No 23: "Certification of DP-Operators" or equivalent.

Means for voice communication (Clear coms) must be available to enable necessary information to be passed between DP controls and all other parties directly involved in or responsible for the operation. All essential communication systems should be provided with 100% backup, either through duplication or provision of an alternative system.

6.3 AIS

The vessels shall be equipped with AIS. The AIS transponder on board the vessels shall automatically, and with the required accuracy and update rate, provide other vessels and authorities with relevant information about the vessels and their navigation.

6.4 Offshore Client Representative

The Client will employ a Client Representative to provide offshore presence during the mobilisation and operation at any vessel offered by the Consultant.

The specific roles and responsibilities of the offshore Client Representatives will be addressed at the project kick-off meeting.

On the offshore vessels, operated at 24 hours basis, the Consultant must allow for two (2) Client Representatives.. If vessels are operated at 12 hours basis, the Consultant must allow for one (1) Client Representative.

As a minimum the Client Representative cabin shall be a single cabin and fitted with telephone, at least 1 Mbit/s internet connections and adequate offline facilities for evaluation of the results.

6.5 Fisheries Liaison Officer

The Client will investigate and decide on the level of Fisheries Liaison.

In case of significant fishing activities in the area of investigation the Client will employ a Fisheries Liaison Officer (FLO) that will be deployed and accommodated on a relevant survey vessel. Alternatively Onshore based FLO services could be decided.

6.6 Marine Mammal Observer

It is required to provide Marine Mammal Observer (MMO) and PAM (Passive Acoustic Monitoring) for work packages A and B.

The detailed requirements will be defined by the Danish Energy Agency as part of the survey permit.

7. Personnel and crew

The manning of the survey team is the responsibility of the Consultant. The Consultant must provide sufficient competent supervisory, technical and other personnel to properly perform the service.

The Consultant may not replace key personnel without written approval from the Client. All marine personnel should be qualified in accordance with the requirements of the flag of registration.

The master and other principal vessel officers must be fluent in written and spoken English. All personnel sailing on the vessels are expected to be medically fit and the Consultant is required to ensure that regular medical examinations are undertaken.

The Party Chief shall be the Consultant's nominated offshore Survey Representative and shall liaise directly with the offshore Client Representative.

8. Equipment and Methods

The Consultant's equipment, materials, supplies and tools shall be of first-class quality and shall be in good and safe operational condition, approved for use in the survey area. The Consultant shall maintain and repair all equipment and tools and maintain adequate stock levels and spare parts and spare equipment in order to ensure timely operations.

All equipment shall be installed and operated in such a way no interferences or disturbances between the various equipment units or the vessel and the equipment units occur.

All equipment and instruments must be able to operate under the meteorological and oceanographic limitations stated by the Consultant in his tender.

As a minimum but not limited to, the vessels shall be equipped with the equipment specified below.

8.1 Vessel Positioning System

The positioning of the vessels shall be determined with a highly accurately Global Navigation and Satellite System (GNSS) positioning system(s). Positioning shall be carried out such that coordinates are derived with sufficient accuracy to meet the objectives and needs of the project as specified in section 3.1.

As part of the mobilisation and acceptance test in the port(s) of mobilisation, the GNSS antennas position determined by the GNSS-system(s) shall be compared with the GNSS antennas position determined by land survey methods.

At least two independent vessel positioning systems need to be available. Furthermore the vessel(s) shall be equipped with motion sensor and gyro.

The vessel gyro shall meet the following specifications:

- Dynamic heading accuracy of ± 0.2° or better
- Static heading accuracy of ± 0.05° or better

The horizontal and vertical accuracy of the vessel position shall be better than 0.5m.

8.1.1 Intertidal vessels(s)

For the vessel(s) provided for intertidal activities (Work Package B) the vessel position must be derived by use of an RTK-based GNSS-system or equivalent. The horizontal and vertical accuracy of the vessel position shall be better than 0.25m.

8.2 Towed Equipment Positioning System(s)

All towed equipment shall be positioned relative to the vessel by highly accurately positioning systems, e.g. Ultra-Short BaseLine (USBL) systems, with a horizontal accuracy better than 2m.

The relative positions of all the towed equipment in relation to the vessel shall be interfaced to the positioning computer to provide orientations and distances for computation of offset positions from the GNSS antenna(s) as well as absolute positions. Mini-beacons must be provided to support the positioning of towed equipment, CPT and coring equipment.

The relative as well as the absolute positions of the towed equipment shall be stored in the positioning database.

The tow cable winch shall be remotely controlled from the geophysical survey instrument room and fitted with a remote alarm.

Layback of the towed equipment shall be measured by a calibrated meter on the deployment pulley and by USBL. Alterations to the tow cable length during surveying shall automatically be recorded in the acquisition system.

8.3 Bathymetric System(s)

8.3.1 Work Package A and B

The bathymetric data shall be acquired with a multi-beam echo-sounding (MBES) system and provide a spatial density that at least has 16 depth soundings pr. square meter.

The data quality must accommodate the preparation of digital elevation models (DTMs) of the bathymetry with 25cm spatial resolution without extrapolation.

The data shall be acquired in *equal distance* mode.

The MBES system shall record backscatter images.

The bathymetric system shall be supplied with ability to compensate for motion such as Pitch, Roll, Yaw and Heave.

8.4 Sound Velocity Profiler

The speed of sound in water shall be measured in the survey area at intervals not exceeding 6 hours.

The measurement shall be made using calibrated sound velocity profiler. Measurements shall be taken at suitable intervals from the sea surface to the seabed.

A second set of readings shall be taken from the seabed to the sea surface and the speed of sound computed from the measured values.

It's the responsibility of the Consultant to ensure the required vertical as well as horizontal resolutions are achieved and maintained during all periods of surveying. If so needed, the Consultant must apply and operate a moving sound velocity profiler system, which allows continuous monitoring of the entire water column. If also so needed to be able to achieve the required resolutions, acoustic ray bending algorithms shall be applied for depth and position calculations.

8.5 Dual Frequency Side Scan Sonar System(s)

A dual channel side scan sonar system shall be provided. The Consultant shall propose an instrument with operating HF and LF frequencies that will optimize the performance with respect to coverage and resolution in relation to the objectives of this survey.

Objects larger than 0.5m along the shortest axis must be resolved in the sonar images.

The applied operational range of the side scan sonar system shall be selected to ensure as high resolution as possible plus to ensure side scan sonar overlap to cover nadir regions of adjacent survey lines (i.e. Coverage > 200%).

The Client anticipates that the side scan sonar system shall be installed and operated in a terrain following mode at a fixed height above seabed at 8-12% of the operational range. The Consultant may propose other configurations if this are a benefit for the survey.

The towing system shall be designed and operated to ensure the side scan sonar system is adequately decoupled from vessel's heave, pitching and rolling motion.

The survey speed at which side scan sonar surveys are undertaken shall normally be maintained at 4.0 knots (±10%).

8.6 Sub-bottom profiler system

The sub-bottom system shall be able to in details to map at least the uppermost 10m of seabed sediments and sedimentary bedrock in a variety of geological conditions.

One high-frequency single-channel sub-bottom profiler system must be provided (e.g. Innomar SES-2000 or similar) to map shallow geology including layer interfaces to 10m below seabed with a vertical resolution better than 0.3m.

To achieve this the Consultant must provide a system that is optimized for the above-mentioned objective regarding:

- Altitude of towfish with seismic system
- Ping rate
- Signal frequency

8.7 Magnetometer

A marine magnetometer (e.g. Geometrics G-882 or similar) must be towed behind the vessel.

The magnetometer must be towed in a distance from the vessel such that the instruments are free of the vessel magnetic noise.

The seabed altitude of the magnetometer must be recorded with an altimeter.

The following requirements must apply for the magnetometer:

- Magnetometer seabed altitude: ≤ 5 m
- Magnetometer measurement sensitivity: 0.01 nT
- Magnetometer sampling frequency: 1 – 20 Hz (selectable)
- Noise level ≤ 2 nT
- All measurements must be recorded digitally.

8.8 Grab sampling – Work Package A and B

An appropriate numbers of Ground Truth Sampling, e.g. grab samples or similar, must be carried out to be able to, in conjunction with the results from the side scan sonar and bathymetric system(s) to characterize the seabed according to industry standard.

The locations for grab sampling must be selected together with the Client's Representative on basis of a preliminary interpretation of the swathe bathymetric and side scan sonar results.

The Grab Sampling shall be carried out not more than 5m from the designated position. The accuracy of the positioning of the Ground Truth Sampling shall be better than 2m.

If less than 5 kg of geological sample material is obtained, the Client Representative may instruct up to two (2) additional attempts on each site, without any extra costs.

Samples shall be preserved. After a preliminary visual geological description of the soil, the samples shall be carefully sealed and stored on the vessel for potential later transportation to an onshore laboratory for potential further testing.

All grab samples must be subject to a geological characterization according t*o*

- A guide to engineering geological soil description. G. Larsen et. al. DGF-Bulletin 1. Danish Geotechnical Society.

Among other things this requirement means that samples must be described regarding:

- Lithology
- Depositional environment
- Geological age

A selected number of grab samples must be subject to the following geotechnical classification tests:

- Particle size, Sieve analysis
- Particle size, Hydrometer analysis
- Organic content, Loss on ignition

8.9 Geotechnical data acquisition

Shallow geotechnical investigations including sampling with Vibrocore and Cone Penetration Tests (CPT) must be carried out within the survey corridor and coincide with a survey line from the Geophysical Seabed Survey.

The locations of the geotechnical investigations must be decided together with the Client Representative and shall be based on a preliminary interpretation of the sub-bottom profiling (see section 4.3).

At each location subject to geotechnical investigation one CPT test and one core sample must be performed.

In general the target penetration depth below seabed of the CPT and the vibrocore sampling shall be at least 3m or at least 6m.

A subset of the core sampling positions must be performed with a target penetration depth to 6m below seabed. This would be required especially on crossing of traffic corridors, in areas with increased seabed dynamics (sand waves) or if the sub-bottom profiling data require verification of the soil conditions deeper than 3m below the seabed.

8.9.1 UXO risk management

To mitigate the potential threat from Un-Exploded Ordnances (UXO) and other Man-Made-Objects (MMO's) the geotechnical test positions shall be localized within 5 m of geophysical survey lines free of any anomalies.

8.9.2 Utility desk study

It is the responsibility of the Consultant to ensure that the geotechnical investigations are carried out with sufficient safety distance to subsea utilities. Therefore - as a part of the mobilization the Consultant must undertake a desk study to map out known utilities along the route such as but not limited to oil and gas pipelines, power cables (both operational and dead) and telecommunication cables.

8.10 CPT

The Consultant shall provide, maintain and operate equipment for in-situ CPT-testing plus evaluate and report the testing carried out.

The equipment specified for CPT shall be in accordance with IRTP (2001), *International Reference Test Procedure (IRTP) for the Cone Penetration Test (CPT)* and the *Cone Penetration Test with pore pressure (CPTU)*, Report of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), 2001.

All CPTs shall be performed with conical (60 degree) electrical cones which permits simultaneous measurement of the cone tip resistance, local sleeve friction and pore pressure.
The pore pressure filter and transducer position shall be at the cone shoulder, although cones with the pore pressure element on the cone face should be available on site, if required.

Sufficient calibrated piezocones (10cm^2 type) shall be on board the survey vessel.

The CPT system must be able to provide at least 75 kN of thrust.

A selection of cones shall be mobilised with pore pressure sensors mounted on the shoulder and cone face. All assigned field cones shall be newly calibrated before start of the Services and copies of the calibration documentation shall be available to the Client as part of the list of pre-survey deliverables.

The penetrometer shall be positioned in such a way as to provide the perfect verticality of push rods.

The porous filter shall be accurately vacuum deaerated and positioned in order to ensure self-saturation.

The CPT units shall be controlled from the deck of the investigation vessel.

The CPTs shall be carried out not more than 5m from the designated position. The accuracy of the positioning of the CPTs shall be better than 2m.

Re-testing

The CPTs shall be carried out from the seabed to the target depth or refusal. If less than the target depth penetration is obtained, the Client Representative may instruct up to additional two (2) re-attempts on each site, without any extra costs.

The seabed elevation at the test location shall be recorded by pressure transducers mounted on the subsea rig and corrected for specific gravity of the water column at the location.

Settlement due to the net weight of the subsea rig shall be registered.

Field checks on site of cones and the data acquisition system shall be performed as part of the mobilization and every time a new cone is used.

Before conducting each CPT, the tip and friction sleeve readings must be zeroed and the pore pressure reading checked to comply with the water depth. Zero readings shall be reported.

The cone shall be pushed into the soil at a constant rate of 20mm per second.

During CPT operations and before start of the penetration of the push rods into the soil, the Survey Consultant shall record simultaneous, continuously and in real-time the following data in digital and graphical format and in strict accordance with the ISSMGE guidelines:

- A full record of the individual test offsets and zeros shall be kept to check that the tool is still in calibration.
- Water depth at time of test.
- The tip resistance at the penetrating probe.
- The local sleeve friction.
- The pore pressure at the cone shoulder starting from the elevation of the working platform.

The raw measured results shall be stored on digital format, and backed up for subsequent processing and interpretation.

8.11 Vibrocore sampling

The Consultant shall provide, maintain and operate equipment for Vibrocore sampling (in short – just core sampling) plus evaluate and report the sampling carried out.

Core sampling equipment capable of coring the seabed to the target depth shall be used. The sample diameter shall be at least 70 mm or more.

Sufficient lifting cable and power umbilical shall be provided to ensure safe operation of the system in all water depths in the survey areas.

The core sampling equipment shall be capable of collecting samples from clay, silt, gyttja or other organic formations with undrained shear strength of 2-200kN/m^2 as well as from less consolidated sea bottom sediments and consolidated sand.

To ensure maximum core recovery in the varying formations, core catchers of different stiffness and tightness shall be available.

To ensure all coring systems and deck handling equipment are operable, the coring systems must be tested in the harbour during mobilisation and the Client Representative shall have the opportunity to witness the test.

The core samples shall be carried out not more than 5m from the designated position. The accuracy of the positioning of the cores shall be better than 2m.

The seabed elevation at the test location shall be recorded, preferably by pressure transducers mounted on the core rig, and corrected for specific gravity of the water column at the location. Penetration rate shall be recorded continuously on the vessel during coring.

Possible settlement, due to the net weight of the corer shall be recorded.

Seabed sampling on a site shall be made in such a way that at least 2m penetration and maximum recovery is obtained unless local seabed and soil conditions dictate otherwise.

Re-testing

If less than the target depth penetration is obtained, the Client Representative may instruct up to additional two (2) re-attempts on each site, without any extra costs.

Samples shall be preserved in the core barrel liner. Liner with samples shall be cleaned and cut into one metre lengths. After a preliminary soil description of the one metre sample, the sample shall be carefully sealed and stored in boxes on the vessel for later transportation to the onshore laboratory for further testing.

Samples must at all times be handled so risk of disturbance is minimized.

8.12 Geotechnical laboratory works – Work Package C

As a part of the Geotechnical Investigations (Work Package C) laboratory tests on extracted soil samples must be performed.

As an integrated part of the handling of all cores and samples the materials must on recovery from the seabed be subject to a visual geological description and denomination by geologist. The characterization must include photographs of samples and characterization of colour and smell.

The soil sample description must include a

- Lithological description
- Description of the depositional environment
- Description of the depositional age

Geological description shall be in accordance with

- A guide to engineering geological soil description. G. Larsen et. al. DGF-Bulletin 1.

All cores must be subject to test with Pocket penetrometer or vane shear strength determination on fine grained cohesive materials. Furthermore the thermal conductivity must be determined with a hand held instrument on selected samples of the cores.

The laboratory tests shall contain:

1. Natural Moisture content
2. Particle size analyses (sieve)
3. Particle size analyses (hydrometer)
4. Particle density
5. Organic content (loss on ignition)
6. Density, wet and dry
7. Density, Bulk density of intact core
8. Density, relative on sand.
9. Atterberg Limit Test (plasticity)
10. Thermal conductivity
11. C14-dating of organic samples

The laboratory tests shall be carried out in accordance with ASTM standards or equivalent standards.

The cores must be properly stored and archived in at least 2 year after demobilization. The stored samples must be clearly labelled with “PROPERTY OF ENERGINET”.

8.13 Onshore investigations

At the landfall site it is required to perform onshore surveying activities for the onshore zone of the area of investigation (see “Scope of Services”, Figure 5.11) in order to

- Establish a DTM for the onshore zone that can be merged with the offshore bathymetrical DTM.
- Establish or determine three (3) geodetic benchmark points.
- Map the surface geology or land use category, major obstacles and infrastructure.

The geodetic benchmark points must be of sufficient quality to be usable for at least three years.

The onshore surveying activities may be performed using an airborne drone. In this case the Consultant is responsible for establishing the necessary permits and for using authorized drone operators.

8.14 ROV and Cable/Pipe tracking system

It is the assessment of the Client that to complete the crossing survey activities in work package D a ROV must be equipped with the types of instruments that are listed in Table 8-1.

The ROV shall be

- Feasible for operating with the subsea conditions that must be expected in the areas of investiga-tion, such as sea current, rugged seabed and water depths

- Able to provide a stable platform for the measuring equipment. The performance shall be suffi-ciently documented by the Provider.

The ROV must be a flying type ROV.

Technical solutions may vary from the setup only if the Consultants tender describes an alternative solution that contain complete information on that the listed purposes are met at the same level.

Table 8-1 Overview of setup of cable tracking measurement system.

Instrument	Purpose
Altimeter	To measure the height of the ROV reference point above the seabed surface.
USBL-system	To obtain a position of the ROV reference point.
Gyro-system	To measure the ROV orientation in 3D space. Data shall be used for quality check of the tracking results and to allow for possible corrections.
Cable and pipe detection system	To record the lateral and vertical distance from the ROV reference point to the top or center of the target.
Acoustic Profiler	To provide a high resolution DTM of the seabed surface relative to the ROV.
Video camera	To allow for recording of relevant and interesting observa-tions along the route.
Still image camera	To acquire high-resolution visual images of the seabed

The cable and pipe detection system shall be

- Able to perform within the Scope of Services. This could e.g. be a Orion system (Optima Ranging) or a Teledyne TSS440, TSS350 or an alternative measurement system.

- Capable of detecting both active and inactive cables as well as pipelines. The specific methodology is to be decided on the time of survey.

Under these conditions the cable and pipe detection system must be able to produce the Depth of Burial (DOB) as the vertical distance from the top of the buried cable or pipeline to either

- The level of the undisturbed seabed or equivalently to

- The level of the seabed adjacent to the installation trench assuming the trench is not completely filled with sediments.

The ROV must be equipped with at least one video camera for recording of any identified events. The video camera shall be mounted central on the ROV platform to record with focus directly on the top cen-tre of the cable and pipe locations.

The camera for obtaining still images must be pointing vertical downwards. Digital images must be geo-referenced, of high resolution and acquired along the entire length of both cables and pipelines.

The video recording must be acquired along the entire width of the cable corridor with a local extension of 500m for both cables and pipelines. The video recordings must be KP-referenced and supplemented with a KP-reference table of relevant events identified along the targets.

The cable and pipe detection system must measure the distance to the cable or pipeline with an accuracy of ±10% of the burial depth.

The horizontal positioning of the ROV used for the cable and pipe detection system must have accuracy better than 2.0 m.

Calibration procedures described by the instrument manufacturer (e.g. background and sea-water com-pensation and target scaling for TSS440 or other instruments) must be performed

9. Data Processing

The Consultant shall process all data acquired during the survey operations.

The data processing shall improve the subsequent interpretation and ensure the highest possible quality and resolution of the digital deliverables.

Requirements to data formats and specific deliverables are described in the “Standards of Deliverables”.

According to the Service Agreement the Consultant is obligated to amend any non-conformances of the provided services.

Therefore the Consultant shall include safe storage of all digital hydrographical, geophysical, geotechnical and other data that has been acquired as a part of the project.

10. Data Interpretation

To meet the objectives of the assignment plus the requirements for charting, reporting and digital deliverables, the Consultant shall interpret all the acquired and processed data to meet the highest possible quality.

The Consultant must carry out a number of integrated interpretations using both the geophysical and geotechnical data.

10.1 Geophysical anomalies

When processing of the geophysical data is completed then the data must be analysed to identify anomalies in Multi-beam Echo-sounding, Side Scan Sonar, Sub-Bottom Profiling and Magnetometer.

After the identification of the anomalies they have to be analysed and compared to be interpreted e.g. as man-made-objects or as natural seabed features.

Detailed requirements for the deliverables from the interpretations are listed in the document "Standards of Deliverables".

10.2 Integrated seabed surface interpretation

An integrated data analysis of the geophysical and the geotechnical data must be carried out to identify and interpret the following seabed surface themes:

1. Seabed Surface Features including morphological units such as dynamic seabed, biology, scars from man-made activities, gas escape features, slopes, scour patterns, erosion and deposition features and boulders.The Consultant must propose criteria for interpretation of survey data as individual boulders or areal boulder zones. The Client anticipates that "large" boulders are always individually picked in data.
2. Seabed Surface Geology including lithological zones, zones of different boulder coverage, outcropping till and others. The Client requests consistency between the geophysical data, the grab samples and the geotechnical investigations in the results of the interpretation of the Seabed Surface Geology.
3. Debris and Man-Made-Objects including wrecks, cables, pipelines, potential UXO objects, fishing gear and others.

The integrated interpretation of the abovementioned theme #1, #2 and #3 must be done such that full class coverage is obtained within the area of investigation.

Detailed requirements for the deliverables from the interpretations are listed the document "Standards of Deliverables".

10.3 Geology

Seismic data acquired with the sub-bottom profiler system must be interpreted for all survey lines.

The seismic lines must be interpreted to be used for assessment of:

- Morphological features below the seabed, e.g. stone and bubble reefs.
- Depth, thickness and distribution of geological layers.

- Geological hazardous features below seabed, e.g. soft seabed, shallow gas, pock-marks, boulders and peat.

The interpretation of seismic units shall be in accordance with

- A guide to engineering geological soil description. G. Larsen et. al. DGF-Bulletin 1.

The seismic data shall be interpreted to achieve consistency

- With the ground-truthing information from the geotechnical investigations and the surface geophysical results.
- Between along route survey lines and cross-lines.

Adjacent survey lines must be compared and seismic reflectors must be correlated and joined to form a set of interpretation points, such that layer surface grids and isopachs grids can be derived coherently for the area of investigation.

Detailed requirements for the deliverables from the interpretations are listed the Standards of Deliverables".

11. Reporting requirements

During the various stages of the assignment the Consultant has to deliver a number of plans, reports and digital deliverables.

Table 11-1 provides a schematic and staged overview of the outputs that must be provided as an integrated part of performing the Scope of Services.

Section 11 gives in conjunction with the document "standards of Deliverables" a description of the requirements that apply to the deliverables.

Furthermore - in order for the Client to complete his part of the application for permissions the Consultant must upon request and without delay provide the Client with any supplementary relevant master data or metadata relating the vessels, instruments, crew or other parameters related to the survey.

For the provision of the draft deliverables indicated in Table 11-1 the Client will use the time indicated in the document "Scope of Services", section 3 for Client review. Hereafter, the Consultant will finalize revised deliverables based on the Client's comments and feedback.

Table 11-1. Schematic overview of the various deliverables that must be provided during the assignment.

Event	Deliverable	Document reference	WP
Contract Kick-off meeting	Project Execution Plan HSE Management Plan Quality Management Plan	Section 11.1	A – E
Mobilization start Mobilization end	Acceptance Test Report	Section 11.2	A – E
Survey operations	Daily Progress Reports Weekly Management Reports Monthly HSE Reports Interim delivery packages #1 and #2	Section 11.3 Section 11.4 Section 11.5 Section 11.6	A – E
De-Mobilization end	Operational Report	Section 11.7	A – E
Provision of **Draft** deliverables	Cable Route Survey Report Hydrographical Report Crossing Report Digital Deliverables	Section 11.8 Section 11.9 Section 11.11 Section 11.11	A – C E D A – E
Provision of **Revised** deliverables	Do.	Do.	A – E

11.1 Project Execution and QHSE plan's

As a part of his project mobilization prior to marine activities the Consultant must prepare and forward three plans to the Client:

- A plan for Project Execution
- A plan for Quality Plan
- A plan for Health, Safety and Environment (HSE)

The Consultant shall forward the plans to the Client in due time for the Client to review before the kick-off meeting. The Client request reception at least three days in advance.

The Project Execution Plan shall at least include the following parts:

1. Program planning.
    a. A high-level description of main activities and their order of performance.
    b. Technical method statement regarding marine operations (e.g. LARS activities).
    c. Description of survey line plan and how the plan accommodates that the quality requirements described in Chapter 8 are met. The survey line plan must be provided in an ESRI digital format.
    d. Description of how to plan the scope of the geotechnical investigations (CPT and vibrocoring) and grab sampling.

2. Plan for technical quality assurance and quality control.
    a. Plan for nomenclature and denomination of survey lines, tracks, locations, grabs, cores and CPT tests.
    b. Plan for nomenclature and denomination of digital deliverables.

3. Plan for the execution of the acceptance tests including pass criteria
    a. Template for the acceptance test reports for instruments applied for the execution of the Services.

4. Templates for all requested reporting incl. digital deliverables.

5. Utility desk study (see section 8.9.2).

The HSE management plan shall fulfil the requirements specified in the document:

- Scope of Services - Enclosure 3 - HSE requirements

The Quality management plan shall fulfill the requirements in the document:

- Scope of Services - Enclosure 4 - Quality requirements

Based on the Client's comments the Consultant shall forward a final Project Execution Plan to the Client for approval.

No quality related services must be commenced prior to the approval of the Project Execution Plan by the Client. This means that the plan needs to be approved prior to commencing offshore activities.

11.2 Acceptance Test Reports

The vessels are mobilized when all equipment are tested and calibrated and the data acquisition can begin.

As part of the mobilization of the vessels, the final testing and calibrating shall be witnessed by the Client Representative and reported by the Consultant in an Acceptance Test Report for each vessel to be applied for execution of the services.

The Client Representative and the Consultant's party chief shall by signing the Acceptance Test Report agree that the vessels are mobilized and ready for survey.

11.3 Daily Progress Reports

Daily Progress Reports for a vessel shall be prepared and submitted from start of mobilization and uninterrupted until end of demobilization.

The Daily Progress Reports must include information regarding:

- Survey status: Completed quantities (current day and cumulated) and remaining quantities.
- Time break down: Mobilization, Operation, Standby, Transit, etc. (current day and cumulated).
- Weather observations (sea state, wind and visibility).
- Weather forecast – next 24 hours.
- Instrumental deviations from normal operation (break downs, calibration issues, etc.).
- QHSE incidents.

The Daily Progress Report must be submitted by e-mail to the Client before 09.00 am the following day.

The final format of the Daily Progress Report should be addressed at the project kick-off meeting and agreed with the Client.

11.4 Weekly Management Reports

From commencement to completion of contract, weekly management reports shall be prepared and submitted by the Consultants contract manager.

The weekly management reports shall cover the previous week’s services plus the actual status of the project as on Sunday at 24:00 hrs. UTC. Among many other subjects, the weekly management reports shall include an updated list of the projects actual deviations from the Agreement.

The weekly management reports shall be comprehensive and cover all relevant topics to be able for the Client’s project management to maintain an overview plus manage the project.

The weekly management reports shall be used as a basis for the Client's informing of and dialogues with authorities and other stakeholders about the progress and status of the project.

Distribution of the Weekly Management Reports shall be agreed on the project kick-off meeting.

11.5 Monthly HSE reports

On a monthly basis the Consultant is required to submit work hour statistics to the Client. The requirements to the HSE report is described in the document "HSE requirements", section 1.21.

The specific format of delivery is discussed and agreed at the project kick-off meeting.

11.6 Interim delivery packages #1 to #2

* * * * * SECTION 11.6 NOT APPLICABLE * * * * *

To support interfacing activities that rely on the survey results from Work Package A and B the following intermediate deliverables are provided:

- Interim delivery package #1: Survey data for environmental investigations
- Interim delivery package #2: Survey data for archaeological assessment

11.6.1 Interim delivery package #1 for environmental investigations

* * * * * SECTION 11.6.1 NOT APPLICABLE * * * * *

The Client needs to commence marine, environmental investigations early in 2022 with third party suppliers. To aid the planning and execution of these investigations the following products are required as digital and preliminary results:

- Bathymetry
- Backscatter
- Seabed surface classification, Geology
- Seabed surface classification, Morphology
- Seabed surface classification, Substrate type (*)
- Grab samples, geological classification and laboratory tests

(*) See Annex 2 of the document "Standards of Deliverables".

Requirements to the digital formats of the products are described in the document "Standards of Deliverables".

11.6.2 Interim delivery package #2 for marine archaeological assessment

* * * * * SECTION 11.6.2 NOT APPLICABLE * * * * *

The Client needs to commence marine archaeological site assessment early in 2021 with designated museums. To aid the planning and execution of these investigations the following products are required as digital and preliminary results:

- Bathymetry
- Side Scan Sonar
- Magnetometry
- Seabed surface classification, Geology

- Sub-bottom geology, horizon elevation grids
- Sub-bottom geology, layer isochore grids

The sub-bottom geology grids are in particular relevant for the archaeologists ability to evaluate soil units with potential stone age heritage potential.

Requirements to the digital formats of the products are described in the document “Standards of Deliverables”.

11.7 Operational Report

Within four weeks after demobilisation the Consultant must submit an Operational Report that documents vessels, instruments and equipment, methods and procedures, etc. An Operational Report shall be provided for each work package.

The Operational Report must cover the operations of all on- and offshore resources. The Acceptance tests reports must be attached the Operational Report.

Requirements to the Operational Report are described in the document “Standards of Deliverables”.

11.8 Cable Route Survey Report

The Consultant must submit a Cable Route Survey Report by the time indicated in the contracted time schedule.

In general, the Cable Route Survey Report inclusive charts and digital deliverables shall provide and integrated presentation of the results and findings of the survey Work Packages A, B and C.

The Cable Route Survey Report shall be interpretive and provide a detailed assessment of the seabed and sub-seabed conditions by correlating the results gained from the various instruments during the survey activities.

The preparation of the Route Survey Report must follow the requirements described in the document “Standards of Deliverables”.

Throughout the preparation of the Cable Route Survey Report, charts and the digital data deliverables, the Consultants Reporting Manager shall maintain a regular dialogue with the Client.

After receiving the Route Survey Report, charts and the digital data deliverables the Client will use four weeks for reviewing and commenting on the delivery.

Hereafter the Consultant must amend the Cable Route Survey Report including charts and digital deliverables according to the feedback from the Client.

11.9 Hydrographical report

The report presents the results of the hydrographical survey – Work Package D - and include a study of the seabed changes based on an analysis of differences between the bathymetric datasets acquired from both Work Package A and B in relation to Work Package D.

Further requirements to the Benthic Report are described in the document “Standards of Deliverables”.

11.10 Crossing report

Together with the Cable route survey report the Provider must issue a separate Crossing report that documents the findings of Work Package D.

The purpose of the Crossing report is to provide a basis for Energinet to negotiate potential crossing agreements with third party asset owners and have full documentation of all crossings within the area of investigation.

Further requirements are described in the document “Standards of Deliverables”,

11.11 Digital deliverables

Together with the reports a number of digital deliverables must be supplied. Digital deliverables include the measured data from the various geophysical and hydrographical sensors as well as GIS deliverables.

The digital deliverables must be provided for all work packages.

The format and specifications of these deliverables must follow the requirements described in the document “Standards of Deliverables”.

12. Meetings

12.1 Kick-off meeting

The Consultant must facilitate a project kick-off meeting at his own premises where at least the following topics will be a part of the agenda:

- Mobilization and acceptance test criteria
- Project execution plan and Daily Progress Reports
- Principles for planning and adjusting the program of work
- Project Deliverables
- Time Schedule
- Organisation, roles and responsibilities
- QHSE
- Commercial matters
- Contractual matters

The project kick-off meeting shall be scheduled prior to the mobilization of the marine resources.

12.2 Weekly Management Meetings

From commencement of the services and uninterrupted until the completion of the services, every Tuesday morning and based on the previous days weekly management and technical reporting, management web-meetings between the Consultants and the Client's project management incl. reporting manager shall be held.

The Consultant shall facilitate the web-meetings.

The Consultant shall minute the meetings and not later than 24 hours after ending of the meeting, the minutes shall be distributed as on the project kick-off meeting.

12.3 Monthly Status Meeting

The Consultant must participate in monthly status meetings that will be hosted and every second month by the Client in Frederica, Denmark and every second month by the Consultant.

The purpose of the Status Meeting is to address the status and progress, the data quality, the deliverables as well as the commercial and contractual status of the contract. Furthermore relevant technical key topics may be addressed depending on current project phase.

The Consultant shall at least be represented by two persons of whom the Consultants project manager is one of them.

Unless otherwise agreed the Monthly Status meetings shall be held until revised issues of the Geophysical Survey Report and the Benthic report have been accepted by the Client.

STANDARDS OF DELIVERABLES

Project	Energy Island
Assignment	Cable route survey
Document Title	Scope of Services - Enclosure 2 - Standards of Deliverables
Document No.	21/04393-4
Audience	Tenderers

Version	Document status	Prepared by		Reviewed by		Approved by	
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4	Template	XMLRA	2020-05-04				
5	For tender	NHW	2021-08-23	JCO	2021-09-09	JRA	2021-09-16

Table of Contents

1. Introduction

This document specifies a set of base requirements that must apply for the deliverables supplied to the Client by Consultants.

The concept of "minimum requirements" is used to express a set of general requests for the deliverables supplied to the Client. This concept does not relieve any Consultant from producing deliverables that meet the general industry standard.

The Consultant can only deviate from these specifications upon agreement with the Client.

All reports including all attached charts, profiles, enclosures and annexes must be provided in English language and as standard PDF files.

The Scope of Service does not require that any deliverable is provided as printed paper reports

2. Operational Report

The Operational Report must in general describe how the survey was completed. As such the Operational report must at least include the following:

a. Executive summary.
b. Description of any QHSE events
c. Project introduction and background.
d. Description of the applied vertical and horizontal reference systems.
e. Description of all applied vessels.
f. Detailed description of all instruments and measurement equipment.
g. Documentation of the calibration and system tests (enclose Acceptance Test Reports).
h. Definition of area of investigation. For Cable Route Surveys applied Route Position Lists shal be enclosed.
i. Description of planned offshore scope suchs as survey line plans and seabed test locations.
j. Description of completed offshore scope including cumulative quantities.
k. Documentation of the spatial accuracies achieved for the different systems including multi-beam echo-sounding system, subsea positioning systems, ROV operational systems and geotechnical systems.
l. Description of data processing and interpretation methods.
m. Description of norms and standards applied for the various work packages.
n. Description of the cumulative time breakdown from the start of the mobilization to the end of the demobilization.

An Operational Report is provided for each individual work package.

3. Cable Route Survey Report

The Cable Route Survey Report must present the results of the survey, the achieved data quality and the interpreted data products.

The report must at least include the following:

a. Executive Summary.
b. Project introduction and background.
c. Description of area of investigation.
d. Applied geodetic system including both location and vertical elevation.
e. Summary of the vessels and instrumental spread.
f. Assessment of the achieved data quality.
g. Presentation of survey results for the seabed surface:
    a. Bathymetry
    b. Seabed surface geology
    c. Geotechnical properties
    d. Seabed surface morphology
    e. Seabed surface features.
h. Presentation of survey results for the seabed geology including:
    a. A summary of the regional geological history based on desk study.
    b. A presentation of the identified seismic reflectors including statistics on reflector depth below seabed and reflector elevation relative to applied vertical datum.
    c. Geotechnical sample interpretations, relating to the soil parameters from the CPT tests and the lithological descriptions and laboratory analysis of the vibracores.
    d. An interpretation of the soil units associated with the identified reflectors. The interpretation include expectations to sedimentology, depositinal environment as wells as age of sediment deposition, also reflecting the geotechnical samples. Nomenclature and conventions according to /1/.
j. Presentation of the survey results for the onshore activities (WP B) with DTM, benchmark and surface mapping.
    a. Phographic images of the benchmarks (overview and detail)
    b. 3D geocentric, Cartesian coordinates (X, Y , Z)
    c. Geographic coordinates (Longitude, Latitude)
    d. Project coordinates (Easting, Northing)
    e. Elevation relative to offshore vertical reference, DVR90 (Danish onshore datum and Ellipsoid).
k. Detailed route analysis from “start” to “end” of route with description of hydrographic, morphological, geological/geotechnical, archaeological and environmental challenges to the route. Must be KP referenced.
l. Summary of archaeological findings and anomalies with archaeological potential.
m. Overview of the digital deliverables.

3.1 Charts

The Cable Route Survey Report must as a minimum be enclosed the following charts:

Overview / North Up charts:

a. Overview chart showing coastlines, EEZ, large scale bathymetric features and area of investigations.
b. Chart showing actual performed survey lines and seabed sampling positions.
c. Bathymetry chart with contour lines and presented as color shaded relief maps.

Allignment charts with KP markings including the below information:

d. Bathymetry as color shaded relief, with contours
e. Side Scan Sonar mosaic image, High frequency
f. Seabed surface classification, Geology
g. Seabed surface classification, Morphology.
h. Seabed objects, identified objects and lineaments (swathe bathymetric and side scan sonar objects, lineaments, magnetic objects, etc.).
i. Seabed features chart, with all identified seabed features including, morphological, archaeological, seabed obstructions and infrastructure.
j. Sub-seabed geology profiles, interpreted horizons related to seabed level.
    a. Integrated Geotechnical profiles showing lithological profiles based on the core samples together with the strength parameters from the CPT tests and geotechnical properties from the laboratory analyses.

The Alignment charts must be organized such that the results of the onshore survey activities (Work Package B) are covered by the chart series.

For all charts/alignment charts, the Consultant shall propose for Client approval the formats of the maps. This should at least include content, symbology, paper size, map scale and layout.

4. Crossings report

The Crossing Report must present the results of from Work Package D .

The Crossing Report must at least include the following:

a. Executive Summary.
b. Project introduction and background.
c. Summary of the vessel(s) and technical setup related to Work Package D.
d. Description of the identified crossing utilities: Type, Owner, Location, Burial, Bathymetry, Geotechnical seabed conditions, etc.
e. Description of the digital deliverables.
f. The Utility desk study completed as a part of the Project Execution Plan must be attached as an Annex.

The Crossing Report must be enclosed a number of charts and must as a minimum be enclosed the following charts:

g. Overview map showing coastlines, EEZ, the cable routes with KP markings, locations of the investigate crossing utilities.

For each crossing utility that has been surveyed:

h. Alignment chart showing the detailed results of the ROV investigations with cable- and pipe-tracking equipment: Depth of Burial, Bathymetry, seabed surface features, seabed surface geology, seabed subsurface geology, Man-Made-Objects, boulders, etc.

For all charts/alignment charts, the Consultant shall propose for Client approval the formats of the maps. This should at least include content, symbology, paper size, map scale and layout.

5. Hydrographical Report

The Hydrographical Report must present the results of the bathymetrical survey performed in 2023, the achieved data quality and the interpreted data products.

The report must at least include the following:

a. Executive Summary.
b. Project introduction and background.
c. Description of area of investigation.
d. Applied geodetic system including both location and vertical elevation.
e. Summary of the vessels and instrumental spread.
f. Assessment of the achieved data quality.
g. Presentation of survey results.
h. Analysis of seabed changes comparing bathymetrical data (Work Package A and B) with data acquired with Work Package D.
i. Overview of the digital deliverables.

5.1 Charts and drawings

The Hydrographical Report must as a minimum be enclosed the following charts:

j. Overview map showing coastlines, EEZ, large scale bathymetric features and area of investigations.
k. Map showing actual performed survey lines.
l. Map with bathymetry with contour lines and presented as color shaded relief maps.
m. Map with seabed surface change, Work Package A/B with D.

For all maps the Consultant shall propose for Client approval the formats of the maps. This should at least include content, symbology, paper size, map scale and layout.

6. Digital deliverables

6.1 General structure

This section describes the digital deliverables that must be provided as a part of the delivery.

The digital deliverables are specified below as a numbered list such that each deliverable has a unique ID. This ID must be used in referencing the specific deliverable during the project execution.

The package of digital deliverables must be provided with a suitable spreadsheet that lists the individual deliverables including the following information:

- Unique deliverable ID number
- Deliverable name
- Deliverable type
- Revision number
- Date of issue
- Data file format

The digital deliverables are provided on external hard drives in two (2) copies.

6.2 GIS deliverables

A number of the digital deliverables must be delivered for ESRI ArcGIS using the Clients template as described in Annex 1. The template is referred to as a *Template Survey Geodatabase* or as TSG.

In the list below describing the requirements for the digital deliverables references will be made to specific data objects in the TSG.

Multiple deliverables are required to be loaded to the same TSG data object. For instance it is required that vessel tracks and instrument-specific tracks are stored in the same object (TRACKS_LIN). To distinguish between the different input data, the attributes must be configured to reflect the different sources.

For the geophysical survey data (MBES, SSS, MAG and SBP) targets are required at two levels:

- As anomalies (the ANOMALY data objects).
- As interpreted targets (the MMO and the SEABED_FEATURE data objects).

In this context *anomalies* should not be interpreted – these are considered as data markers only. Interpretation of *targets* should be performed taking all swathe data into consideration. The data objects MMO and SEABED_FEATURES include attributes to store interpretation, certainty and anomaly reference.

The Consultant may propose changes to the TSG code lists (ESRI *Domains*).

6.3 Bathymetric data

The results of the bathymetric survey must be delivered as processed and despiked data with the following deliverables:

1. Un-gridded soundings, (X,Y,Z) values in ASCII format.
2. Gridded soundings, 0.25m resolution, (X,Y,Z) values in ASCII format.
3. Gridded soundings, 0.25m resolution, GeoTIFF grid format.
4. Gridded soundings, 1.00m resolution, (X,Y,Z) values in ASCII format.
5. Gridded soundings, 1.00m resolution, GeoTIFF grid format.
6. Gridded soundings, 5.00m resolution, (X,Y,Z) values in ASCII format.
7. Gridded soundings, 5.00m resolution, GeoTIFF grid format.
8. Bathymetric contour curves with 50cm interval, as TSG object CONTOURS_LIN
9. Vessel tracks, as TSG object TRACKS_LIN, indicate equipment carrier and equipment type in attributes.
10. Bathymetry - TVU 1.00 m resolution, (X,Y, TVU) values in ASCII format
11. Bathymetry - TVU 1.00 m resolution, GeoTIFF grid format
12. Bathymetry - THU 1.00 m resolution (X,Y,THU) values in ASCII format
13. Bathymetry - THU 1.00 m resolution, GeoTIFF grid format
14. Bathymetry - Backscatter 32bit Geotiff (amplitude populated channels).
15. Sound velocity profiles (SVP) in native format
16. MBES Anomaly target list, as TSG object MBES_ANOMALY_PTS, anomaly characteristics provided in attributes.

The GeoTIFF grid format must satisfy the following requirements:

- GeoTIFF Grids are stored in a ESRI file geodatabase.
- *Spatial Reference* has been configured.
- *Calculate Statistics* has been performed.
- *Build Pyramids* has been performed.

Deliverable item 1 (ungridded soundings) is delivered as data files corresponding to the data acquisition along the vessel tracks. The filenames reflect the vessel track ID's are corresponding one-to-one with contents of deliverable 9.

6.3.1 Work Package B – Nearshore and Landfall Survey

The results of the topographic onshore survey must be delivered as processed and despiked data with the following deliverables:

17. Gridded soundings, 0.25m resolution, (X,Y,Z) values in ASCII format.
18. Gridded soundings, 0.25m resolution, GeoTIFF grid format.
19. Topographic contour curves with 50cm interval, as TSG object CONTOURS_LIN

6.3.2 Work Package D – Hydrographical survey

The delivery package for the hydrographical survey is similar to the abovementioned list with the following exeptions:

- Items 2 and 3: Provided with 0.50m resolution.
- Item 14 is excluded.
- Imte 16 is excluded.

6.4 Side scan sonar data

The results of the SSS data must be supplied as:

20. Raw side scan data as XTF-files with corrected navigation, High frequency.
21. Raw side scan data as XTF-files with corrected navigation, Low frequency.
22. Navigation files, CSV-format.
23. SSS instrument tracks, as TSG object TRACKS_LIN, indicate equipment carrier and equipment type in attributes.
24. SSS Anomaly target list, as TSG object SSS_ANOMALY_PTS, anomaly characteristics provided in attributes.
25. SonarWiz project

6.5 Magnetometer data

The results of the MAG data must be supplied as:

26. MAG measurements, CSV-format, with the following data columns
    a. Date (YYYY-MM-DD)
    b. Time (HH:MM:SS)
    c. Location ID (Unique location ID number)
    d. Magnetometer line ID (Unique line number)
    e. Survey line Heading
    f. Total field (Raw magnetic measurement, nT)
    g. Residual field (Residual magnetic field, nT)
    h. Easting1, Northing1 (Measured coordinates, meters)
    i. Easting2, Northing2 (Processed coordinates, meters, filtered coordinates and reduced for obvious noise)
    j. Lay-back (Instrument lay-back distance, meters)
    k. Altitude (Instrument altitude above seabed,meters)
27. MAG instrument tracks, as TSG object TRACKS_LIN, indicate equipment carrier and equipment type in attributes.
28. MAG Anomaly target list, as TSG object MAG_ANOMALY_PTS, anomaly characteristics provided in attributes.
29. Oasis montaj Project – if available.

The magnetic residual field (item g above) is the result of a process where the measured Total magnetic field (item f above) is subtracted medium- and long-wavelength signals caused by the geomagnetic field, ionospheric and sources and regional geological sources.

The magnetic Residual field must be processed to reflect any ferrous or magnetic objects on the seabed or with shallow burial within the seabed e.g. wrecks and large debris, subsea cables and pipelines or other Man-Made ferrous objects.

6.6 Sub-bottom profiling data

The results of the seismic data acquisition must be supplied as:

30. Processed SBP and UHRS recordings, SEGY format. Processing include at least that
    a. SEGY headers are configured with geometry
    b. Traces are corrected for motion
    c. Traces are aligned with datum
31. Processed SBP and UHRS recordings, as image-files (Tiff or PNG)
32. SBP and UHRS instrument tracks, as TSG object TRACKS_LIN, indicate equipment carrier and equipment type in attributes.
33. SBP and UHRS Anomaly target list, as TSG object SBP_ANOMALY_PTS, anomaly characteristics provided in attributes.
34. Interpretation of the processed seismic data. These data include interpretation points for digitized horizons identified in the seismic recordings. The data must be delivered as a point list file in CSV-format with the following data columns:

d.	PointID	Unique identification number
e.	Survey line ID	Unique survey line identification
f.	SEGY_Name	Filename of SEGY file
g.	KP	Km point
h.	Easting, Northing	Coordinates, meters
i.	TWT	Two-way-time, millisec
j.	Elevation	Elevation, LAT, meters
k.	Depth BSB	Depth Below Seabed, meters, based on constant velocity
l.	Type	The interpretation points must be assigned a "type value" to identify the observed layer boundaries, etc.

35. Generated **elevation grids** relative to vertical datum for each interpreted horizon in 5 m resolution as
    a. GeoTIFF grid
    b. An (X,Y,Z) values in ASCII format (Z as the horizon elevation in meter)

36. Generated **depth below seabed** (BSB) grids for each interpreted horizon in 5 m resolution as
    a. GeoTIFF grid
    b. An (X,Y,Z) values in ASCII format (Z as the horizon depth BSB in meter)

37. Generated **Isochore** (layer thickness) grids for each interpreted soil unit in 5 m resolution as
    a. GeoTIFF grid
    b. An (X,Y,Z) values in ASCII format (Z as the layer thickness in meter)

6.7 Grab sampling

The results of the ground truth sample data must be delivered as:

38. Grab sample positions, as TSG object GEOTECHNIC_PTS, indicate sampling characteristics in attributes.
39. Grab sample classification, MS-Excel spread sheet with the following data columns:
    l. Unique sampling ID
    m. Geological description of the recovered sample,
        i. Lithology
        ii. Depositional environment
        iii. Depositional age
40. Grab sample laboratory analysis, overview table and result tables, MS-Excel spread sheet.

6.8 Geotechnical data

The results for the geotechnical investigations must be delivered as:

41. Vibrocore and CPT sample positions, as TSG object GEOTECHNIC_PTS, indicate sampling characteristics in attributes.
42. Geotechnical laboratory test, overview table and result tables, MS-Excel spread sheet.
43. All CPT tests, Vibrocore, Piston core and laboratory test results provided as an AGS 4 data file (see e.g. www.agsdataformat.com).

6.9 Integrated seabed surface interpretation

The acquired data must be used for an integrated interpretation of the following themes related to the seabed:

- Seabed Surface Geology.
- Seabed Surface Features.
- Sebaed Substrate type (see Annex 2)
- Debris and Man-Made Objects.

The Client assumes that the most feasible solution for interpretation of

- boulders on the seabed is performed using automatic boulder interpretation methods.
- seabed surface geology, features and susbtrate type is performed with backscatter images.

The results of the interpretation must be provided as:

44. Seabed Surface Geology, as TSG object SEABED_GEOLOGY_POL, indicate surface geological unit in attributes.
45. Seabed Surface Features, as TSG object SEABED_SURFACE_PTS, indicate surface forms in attributes.
46. Seabed Surface Features, as TSG object SEABED_SURFACE_LIN, indicate surface forms in attributes.

47. Seabed Surface Features, as TSG object SEABED_SURFACE_POL, indicate surface forms in attributes.
48. Seabed Substrate type, as TSG object SEABED_SUBSTRATE_POL, indicate substrate type in attributes (see Annex 2).

The polygon deliverables 44 and 47 must have full coverage within the survey area.

49. Man-Made-Objects, as TSG object MMO_PTS, indicate MMO type in attributes.
50. Man-Made-Objects, as TSG object MMO_POL, indicate MMO type in attributes.
51. Man-Made-Objects, as TSG object MMO_LIN, indicate MMO type in attributes.

6.10 Reports, Charts and Annexes

A PDF copy of all reports including all attached charts, profiles, enclosures and annexes must be provided as a part of the digital deliverables:

52. Operational Report.
53. Geophysical Survey Report.
54. Crossings Report
55. Hydrographical Report

The Consultant may use suitable subdivision to reflect substructure with e.g. charts, annexes or enclosures.

7. References

/1/ A guide to engineering geological soil description. G. Larsen et. al. DGF-Bulletin 1. Danish Geotechnical Society.

Annex 1 – Requirements to TSG

Annex 2 – Substrate type classification

The substrate type map is divided into the following substrate types, cf. the Danish Råstof-bekendtgørelsen (BEK no. 1680 of 17/12/2018, Phase IB):

Substrate type 1 - Sand, silt and mud: Areas consisting of fine-grained soft bottom or solid sand bottom (possibly with dynamic bottom shapes (sand ripples etc.)) with varying amounts of shells and gravel. Sand is defined as grain sizes in the range of 0.06-2.0 mm.
Typically, substrate type 1 is subdivided into substrate type 1a (silty, soft bottom), 1b (solid sandy bottom) and 1c (clay bottom), which is not stated in the "Råstofbekendtgørelsen". It is a standard substrate type subdivision used in a wide range of marine raw material investigations, Natura 2000 projects etc. The subdivision is approved by MST (MST = Danish Environmental Protection Agency).

Substrate type 2 - Sand, gravel and pebbles: Areas consisting of a mixture of coarse sand and gravel with a grain size of approx. 2-20 mm and pebbles with sizes of approx. 2-10 cm. The substrate type also contains some larger stones from approx. 10 cm and larger, covering from 1-10% of the seabed.
Substrate type 2 can be subdivided into substrate types 2a and 2b, respectively. According to the "Råstofbekendtgørelse", these two types constitute the same substrate type, but on the basis of their different characteristics a division can be made. Substrate type 2a consists mainly of coarse sand, gravel and pebbles. This type of substrate typically consists of only a few larger stones over 10 cm. Substrate type 2b consists of 1-10% larger stones typically on a coarse sandy bottom.

Substrate type 3 - Sand, gravel and pebbles, and larger stones: Areas consisting of mixed substrates with sand, gravel and pebbles with a varying amount of larger stones from approx. 10 cm covering 10-25% of the seabed. The substrate type differs from substrate type 2 by containing a greater number of stones from ca. 10 cm and upwards. The stones are usually scattered, and only in one layer.

Substrate Type 4 - stony areas and stone reefs with 25-100% of larger stones: Areas dominated by stones from approx. 10 cm and up - from dense irrigation to actual stone reefs with or without cavities. There may also be varying amounts of sand, gravel and pebbles, as well as biogenic reefs or limestone reefs in this substrate type. The stones can be in one layer, or form actual stone reefs, which rise above the surrounding bottom with several layers (cavity forming).

Table 1. Substrate classes.

Class	Description of substrate class
1a	Sand, silty, soft bottom
1b	Sand, solid sandy bottom
1c	Clay bottom
2a	Sand, gravel and pebbles – few larger stones
2b	Sand, gravel and pebbles – seabed cover of larger stones 1% to 10%
3	Sand, gravel and pebbles – seabed cover of larger stones 10% to 25%
4	Stony areas and stone reefs - seabed cover of larger stones 25% to 100%

Enclosure 3 – HSE requirements

Excluded.

Enclosure 4 – Quality requirements

Excluded.