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Status Final

Search Area 6/7 Geophysical Survey
Lot 1: Seabed Survey

Annex 5 - Section IV

Scope of Work

Colophon

Project name	Geophysical Survey Search Area 6/7 – Lot1
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1 Introduction

1.1 Glossary

Item	Description
IA	Investigation Area
GDB	Geodatabase
MBES	Multibeam Echo Sounder
SVP	Sound Velocity Profiler
SSS	Sidescan Sonar
MAG	Magnetometer
SBP	Sub-bottom Profiler
UXO	Unexploded Ordnance
MRU	Motion Reference Unit
GNSS	Global Navigation Satellite System
SVS	Sound Velocity Sensor
USBL	Ultra-Short baseline
BS	Backscatter
WC	Water column Data
CTD	Conductivity – Temperature – Density
SAS	Synthetic Aperture Sonar
HF	High Frequency
LF	Low Frequency
QA	Quality Assurance
QC	Quality Control
PPP	Precise Point Positioning
DGNSS	Differential GNSS
CRP	Central Reference Point
C-O	Computed - Observed
UHRS	Ultra-High Resolution Seismic
CR	CLIENT REPRESENTATIVE

1.2 Scope of this document

This document and its appendices detail the scope of WORK as part of the CONTRACT that CLIENT has awarded to CONTRACTOR for carrying out a geophysical investigation in Search area 6/7 (Sa 6/7).

1.3 Background

The Ministry of Economic Affairs and Climate Policy is responsible for the legislative framework for the development of offshore wind farms in the Netherlands. Within this framework (a) (concession) tender(s) for permit for construction and operation of (a) wind farm(s) will be organized under the current regulation. As part of the tender documentation, the participants will receive an information package in which detailed information on the offshore site is included. Detailed information on the soil conditions at the site will be part of this information package.

Information on the soil conditions at the site is to be developed through a sequence of commissions for geological, geophysical, geotechnical and morphodynamical studies. Information will be presented as factual data, integrated and interpreted data (an Integrated Ground Model) and will be comprehensively reported.

The Geophysical Survey follows and receives information from the Geological, Archaeological and UXO Desk Studies, and it is expected to precede and supply information to a geotechnical investigation, an Integrated Ground Model (IGM, integrating the results of Geological, Geophysical and Geotechnical investigations) and a morphodynamical investigation. The Integrated Ground Model is to be of sufficient precision to allow Offshore wind farm developers who want to participate in upcoming tenders in the Netherlands to make initial plans and costings for foundation design and cable installation.

This assignment is concerned with the geophysical investigation component, contributing to the information package to be provided to participants.

1.4 Site description and investigation area

Search Area 6/7 (Sa 6/7) is being investigated for the offshore wind development of the Netherlands. The geophysical survey will focus on the West of Search Area 6/7, hereafter often called the Investigation Area (IA). For this scope of work, it is the intention to obtain a single, comprehensive set of geophysical data, reports, drawings and a preliminary ground model (PGM) for the Investigation Area (IA).

Within the Dutch Shelf of the North Sea, several search areas have been selected with potential for the development of offshore wind. Search area 6/7 (Sa 6/7) is located approximately 94 km off the northwest coast of the Netherlands and covers an area of approximately 4639 km^2. At the time of writing this document, there are no designated wind farm zones in this area.

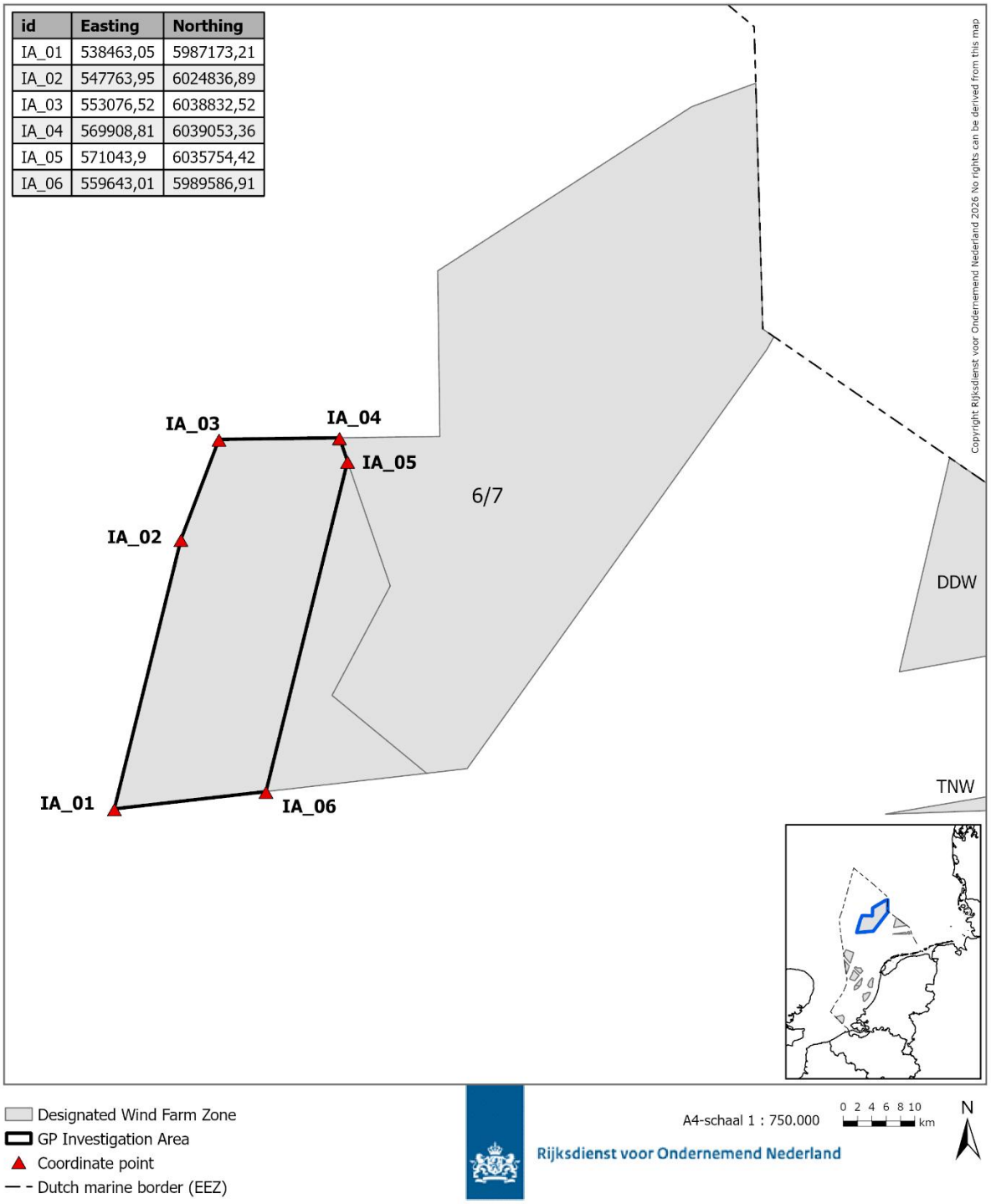
Search area 6/7 is located within the northern part of the Dutch North Sea. General characteristics of the investigation area are shown in the table below, alongside Figure 1. A GIS dataset of Sa 6/7 and the IA can be found in the GIS examples and project files attached in this tender package. **After contract award, CONTRACTOR must request cable and pipeline data themselves from Rijkswaterstaat, since this is not public information any longer.**

Table 1: Characteristics of the investigation area

Characteristics	
Water depth	Approximately 40-50 m ALAT
Distance from shore	Approximately 94-170 km

Area 6/7 - GP Investigation Area

id	Easting	Northing
IA_01	538463,05	5987173,21
IA_02	547763,95	6024836,89
IA_03	553076,52	6038832,52
IA_04	569908,81	6039053,36
IA_05	571043,9	6035754,42
IA_06	559643,01	5989586,91



Deze kaart is gebaseerd op informatie beschikbaar in augustus 2026. Hoewel de grootst mogelijke zorg is besteed aan het samenstellen van de kaart, kan de Rijksdienst voor Ondernemend Nederland niet verantwoordelijk worden gesteld voor welke schade dan ook, voortvloeiend uit onnauwkeurigheden en/of verouderde informatie. De besluiten over windenergie gebieden zijn nog niet definitief.

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Figure 1: Investigation area within windfarm zone Search area 6/7. The IA covers part of the Western part of Search area 6/7 (phase 1).

SI units (ISO/IEC 8000) are applicable for any activities carried out in the Search areas.

The chart datum is Approximate Lowest Astronomical Tide (ALAT). All positioning data shall be collected in the European Terrestrial Reference System 1989 (ETRS89) and projected using ETRS89 Transverse Mercator Coordinate Reference System (UTM Zone 31N), with EPOCH 1 January 2027. The reference for this system is EPSG Projection code 25831 - ETRS89 / UTM zone 31N.

The requirements for GIS metadata which all Contractors shall comply with is shown in Appendix A. As RVO will make this data publicly available, the metadata needs to be in line with the General Data Protection Regulation (GDPR) (in Dutch: AVG) requirements.

1.5 Two Scopes of Work for geophysical survey campaigns

The Contacting Authority has chosen to split the planned geophysical survey campaign for the IA into two Scopes of Work (SoW)/Lot(s):

- Lot 1 (this SoW): SoW for Seabed Survey (SS) focuses on a Seabed Survey in Sa 6/7 west (Sa 6/7-GP-Lot1).
- Lot 2 (separate SoW): for 3D-UHRS survey, including MBES, focuses on a full coverage 3D-UHRS survey in Sa 6/7 west (Sa 6/7-GP-Lot2).

With two scopes, the Contracting Authority aims to provide an opportunity for various contractors to bid for one or both of these SoWs, considering the overall planning of soil investigations in relation to the Dutch offshore wind RoadMap. More information on the current RoadMap can be found on *https://energietransitie.nl/soorten- energie/windenergie/windenergie-op-zee/doelstellingen-windenergie-op-zee.*

This SoW document covers Lot 1: Seabed Survey. Both lots cover the same IA, with different geophysical scopes, as summarised in the table below.

Table 2. Division over Lots of geophysical surveys.

Investigation Area	Sa 6/7-GP-Lot1	Sa 6/7-GP-Lot2
Seabed survey (SSS, SBP, MBES, Backscatter, Magnetometer)	**All sensors**	**MBES only**
Seabed Grab Sampling	**200**	**-**
3D-UHRS	-	**Full Investigation Area**

1.6 Aims of the geophysical surveys

The aim of the geophysical investigations is to obtain seabed and sub-seabed information, contribute to the geological understanding of Sa 6/7. This information is in turn expected to be suitable for the planning and preparation of geotechnical investigations for the subsequent integration into a ground model to progress the basic/FEED design and installation requirements for offshore wind farms, including, but not limited to, foundations and cables.

The CONTRACTOR is expected to provide:

- A high resolution bathymetric dataset;

- Sub-seabed sub-bottom profiler (SBP) data;
- SBP interpretation as input to a Preliminary Ground Model (PGM) of the site, including as a minimum;
    - Estimated elevation (depth in meters below LAT) and depth below seabed for a set of interfaces between principal geological formations or other horizons of interest; see stratigraphy model for an overview of Formations and units expected across the site (reference to Geological Desk Study);
    - The locations of visible structural features or geohazards within the shallow geological succession including but not limited to faulting, accumulations of shallow gas, organic sediments/peat, buried/infilled channels, depth to hard ground/bedrock, soft sediments, salt diapir (deformation), structures associated with sub-glacial processes or glaciotectonism;
    - Comprehensive packaging of the Lot 1 seabed survey results, including but not limited to the MBES and SBP;
    - Co-creation and providing assistance where required to the Lot 2 CONTRACTOR, who will integrate the datasets;
    - Correlation with existing geophysical and geotechnical interpretation as available.
- A comprehensive Final Interpretation Report on the survey results obtained, describing the Preliminary Ground Model (PGM);
- A preliminary zonation of the site for input into the specification and scope for a geotechnical sampling and testing program to follow the completion of the geophysical survey;

The output of the investigation shall be delivered in formats defined in this scope of work and accompanying documents, including digital raw & processed data, metadata, Seismic Interpretation System Package, Geographic Information System project files, chart data, and reports.

The Geophysical Survey, and the resultant preliminary ground model, follows and receives information from the Geological, Archaeological and UXO Desk Studies, and it is expected to precede and supply information to a geotechnical investigation, an Integrated Ground Model (IGM, integrating the results of Geological, Geophysical and Geotechnical investigations) and a morphodynamical investigation.

It is expected that the IGM (to be developed under a separate, later commission following geotechnical data acquisition) will be a revision and significant enhancement of the PGM. It is expected to include a refinement of data processing of sub-seabed data, ground-truth calibration of geophysical estimated depths from the GP survey, rationalisation of geotechnical and geophysical observations, refinement of the preliminary litho-stratigraphic model to include geotechnically relevant structures and the development of a 3D distribution of geotechnical parameters.

1.7 Special Considerations

CONTRACTOR shall consider that time-sharing arrangements on the survey plans (timing and location at the site where the survey is carried out) shall be made with other contractors working in the vicinity of/ at the site and/or third parties using the space if required. It is expected that simultaneous operations (SIMOPS) might occur within the Investigation Area. This includes Notice to Mariners 7 day look ahead, as well as all shipping traffic through IMO and all other third party operations. SIMOPS and all relevant stakeholder communications are expected to be managed by the CONTRACTOR.

CONTRACTOR shall consider arrangements for permits to use the survey equipment within the investigation area and shall adhere to requirements of environmental and other required permits.

CONTRACTOR shall consider the close vicinity of the NL/DE maritime boundary and the shipping lanes as well as the active cables crossing the site.

1.8 Co-creation

The CLIENT wishes to collaborate with the CONTRACTOR as one team for the duration of the project. This does not mean an adaptation of responsibilities by the CONTRACTOR. In this context, the following opportunities are anticipated:

- Teamwork between RVO, CONTRACTOR, and other RVO contractors to achieve optimum results;
- Acquisition of geophysical data to support and provide clearance for a geotechnical campaign;
- Development of a Preliminary Ground Model;
- Open and transparent correspondence during SIMOPS and data integration including but not limited to other parties contracted by the CLIENT (e.g. GP Lot 2 CONTRACTOR);
- Dissemination activities such as webinars and answering questions from the market;
- Reduction of environmental impact for survey operations.

1.9 Timing of the investigations

- The geophysical survey for Sa 6/7-GP-Lot1 is expected to be conducted from Q1 2027 onwards. The key desired/ultimate dates are indicated in Annex [4]:
- Issue Final Interpretation Report:
    - Desired date set by client (incl WoW) = 31-10-2028
    - Ultimate date set by client (incl WoW) = 31-12-2028
- CONTRACTOR shall provide a project schedule in the Project Execution Plan (PEP), in which all aspects of the survey are fully covered and the survey time (as indicated by the CONTRACTOR in Annex [4]) is justified based on the speed of the surveying (km^2/day), expected weather downtime, crew change duration, technical maintenance, etc.

1.10 Available information

CONTRACTOR will thoroughly scrutinise the complete Tender package. Tenderer will get the opportunity to ask questions during the time set aside for the Memorandum of Information (MOI) as described in the Tender Document.

1.10.1 *WFZ specific information*

CLIENT has performed and will perform other studies on Sa 6/7. The following relevant desk studies are available on https://offshorewind.rvo.nl

- The CLIENT has performed and published a Geological Desk Study (GDS) containing information on the expected stratigraphic units, geological structures and possible influence on the design and the construction of offshore wind farms in the IA.
- Alongside the GDS, a UXO Desk Study has been published as well.

Both and future reports can be found on the offshore wind RVO website *https://offshorewind.rvo.nl/page/view/cbc43dd1-913d-4478-b284-f210753bcdcc/soil-search-area-67*.

The CLIENT will endeavour to give results of other studies earlier to the winning CONTRACTOR.

1.10.2 *Other information*

Further, for information, the results of the geophysical and geotechnical surveys carried out for all other Dutch WFZ's are available at https://offshorewind.rvo.nl/. It should be noted that this scope of work deviates from those of previous investigations *and may introduce additional requirements.*

2 Scope of Work

2.1 General scope of work

This scope of work for Sa 6/7-GP-Lot1 covers the aforementioned IA.

2.1.1 *Activities Lot 1*

The below text contains a summary of the activities the CONTRACTOR will carry out under the CONTRACT Scope of Work.

- **Preparation**:
  - All preparatory works required for the geophysical surveys, including preparation of all documentation and plans which need to be provided and approved by CLIENT before the works can start, without which, the vessel cannot complete mobilization and leave port;
  - Permit to perform survey works with the proposed equipment within the investigation area.
- **Data Acquisition & Processing**:
  - High resolution bathymetric and backscatter survey (snippets, and water column when required)
  - High resolution side scan sonar survey
  - Magnetometer survey
  - Shallow Penetration Sub-Bottom Profiler (SBP) survey
- **Data Interpretation:**
  - Produce derived interpretation products including:
  - Seabed feature maps (SSS/ MBES),
  - Sediment classification boundaries (MBES/ SSS),
  - An integrated contact database (MBES/ SSS/ MAG),
  - Tracing of main seismic horizons including the resultant gridded surfaces (depth & thickness maps),
  - Tracing and mapping of relevant subsurface features (e.g. channel features, faults, strong reflectors potentially pointing to presence of peat, shallow gas, gravel/till, etc),
- **Quality Assurance and Quality Control**
  - CONTRACTOR shall deliver a Quality Management Plan with requirements as described in Annex 5 Section VI and the Tender Document. The QMP and subsequent revisions will be adhered to throughout the WORK.
  - CONTRACTOR maintain an updated Project Execution Plan. The PEP and subsequent revisions will be adhered to throughout the WORK.
- **Reporting:**
  - Create final data package with QA and metadata elements.
  - Present the results in clear reports, maps, and drawings, detailed in 2.6.4.
  - Provide zonation and extents of seabed & sub-seabed geological units as guidance for design of a geotechnical investigation campaign.
  - Provide input for a morphodynamical study (e.g. bathymetry, seabed sediment classification, observed bedforms, etc.).
  - Provide input for preliminary routing design (e.g. seabed sediment classification, observed bedforms, boulders & debris >0.3m, boulder fields, etc.).
  - Provide input for an archaeological study (e.g. observed wrecks, debris fields, or paleo landforms, etc.).
- **Delivery**
  - Products of the survey are to be delivered as a coherent and integrated data package with complete descriptive documentation.

This scope of work is designed to provide a minimum acceptable specification and contains important requirements throughout the document.

The description of the survey goals should inform the CONTRACTOR in preparing their proposal which should clearly describe their suggested specification, including the survey geometry, in order to

achieve the survey goals as well as their planned survey setup including communication protocols, back-up systems, and power supply.

It should be recognised that the results of the survey are to be integrated with other geophysical investigations and made available to multiple parties as part of the information package associated with the overall tender process described in the Introduction. The deliverable products of the survey must allow third parties receiving the data package to evaluate, reprocess, reinterpret, or otherwise rework the data to fit the needs of their processes. To this end, it is emphasised that raw data, open formats, positioning information, reporting, and metadata are essential elements of the deliverable package.

2.1.2 *Deliverables*

The survey data represents a significant collection of elements which are to be arranged in a coherent format. The specifications of raw, processed, and interpreted deliverables from individual survey elements are described within their respective sections (see sections 2.3 and 2.4).

Three integrated deliverables are required:

1. a GIS project (*ESRI ArcGIS geodatabase exported as MapPackage is preferred)* containing *all* processed and integrated elements that may be represented in GIS;
2. a single Seismic Interpretation System project (e.g. IHS Kingdom, or a comparable system, after consultation with and approval from the CLIENT) containing *all* the subsurface data elements, and
3. an integrated Final Interpretation Report, which can be used as input to the PGM.

The contents of these integrated deliverables are to be supplemented by raw data suitable to allow reprocessing, intermediate processed data as specified for each data element, final data, interpreted data, metadata, and reporting.

2.2 Preparation

2.2.1 *Scrutiny of available information*

CONTRACTOR shall scrutinise the information that has been made available by CLIENT. The CONTRACTOR will warrant that it is not aware of any error, fault, inconsistency, or other defect in the data. As explained in the tender document, during the tender process CONTRACTOR can ask questions and clarifications during the Memorandum of Information period. Information that is relevant for carrying out the WORK shall be considered while preparing the WORK. The CONTRACTOR will satisfy itself based on the provided information, public domain information, and experience as state of the art service provider as to the extent and nature of the work including, but not limited to, the services, personnel, materials, equipment, vessels, consumables, spare parts and facilities required for to execute the work.

2.2.2 *Design Requirements of the Survey Layout and Configuration*

It is anticipated that the acquisition of geophysical, hydrographic, and environmental datasets may involve one or more passes across the IA. The CONTRACTOR shall select their optimal survey layout and acquisition configuration (*e.g.,* single, or multiple passes, single- or multi-vessel solution) to achieve the survey objectives and data quality requirements.

CONTRACTOR is required to determine an effective logistical solution with regards to the requirements of each measurement type within the IA boundary.

The chosen survey geometry should be dutifully documented and included in the package of deliverables for CLIENT. The following criteria represent layout requirements for the proposal, covering the entire IA:

2.2.2.1 Main survey

- Multi-Beam Echo Sounder (MBES) bathymetry and backscatter, Side-Scan Sonar (SSS), magnetometry (MAG), shallow penetration, and high-resolution Sub Bottom Profiler (SBP[1]) are to be acquired with isotropic parallel primary lines at not greater than 90 m line spacing. A line spacing should be chosen by the CONTRACTOR to achieve the required data quality and sufficient coverage on all sensors without relying on infill.
- Inlines shall be oriented at CONTRACTOR's discretion considering technical and quality considerations for all sensors, survey efficiency, representative tidal current speed and direction, the results of the geological desk study, and interfaces at the survey boundaries.
- Cross lines are to be acquired at a maximum spacing of 420 m
- Minimum length of any line or line segment shall be 500 m.
- Every Inline or line segment shall have at least two Cross line intersections, with each cross line intersection being located within 420 m of each inline end.
- A dual magnetometer system (transverse gradiometer) is preferable over a single magnetometer system, and use of a separate tow point is preferred rather than being piggybacked from the SSS (as specified in Section 2.4.8).

2.2.2.2 Multiple vessels

Multiple vessels may be used by the CONTRACTOR to acquire the required datasets (MBES/SSS/MAG/SBP), albeit that strong preference is given to a minimum number of vessels in order to reduce the SIMOPS, data integration, noise and environmental impact. Acceptable solutions include but are not limited to the use of the following configurations:

- One- or multiple-vessel solution each with a single pass to cover the MBES/SSS/MAG/SBP/ surveys concurrently.
- One- or multiple-vessel solution with multiple passes to cover the MBES/SSS/MAG/SBP/ surveys consecutively.

Whatever the number of deployed vessels or passes, all recorded data should be delivered in one coherent and logically ordered dataset. All data must be referenced to a common vertical datum.

Vessel specification sheets including instrumentation certificates, towing diagram, instrument settings and appropriate procedures are required to be produced, maintained, and followed where multiple vessels and/or multiple personnel rosters contribute to the same measurement type. Annex 3b/c shall be filled in, and vessel and equipment spec sheets, certificates etc. shall be included in an appendix of the PEP for reference.

Equipment interference must be minimised in all cases, shall be proactively monitored, and reported, and shall not impact the data quality. The mitigation measures for potential sources of interference should be described in the proposal.

A minimum overlap between the area covered by each vessel of at least 500 m is required. Acquisition parameters for each sensor, on each vessel, shall be meticulously recorded. For consistent backscatter data, changes to the MBES acquisition parameters should be avoided.

2.2.3 *Permits and notifications*

CONTRACTOR shall obtain and manage all necessary permissions other than the Flora & Fauna environmental exemption (underwater noise in Dutch waters), and/or notifications, to perform the survey (including all permissions and fees necessary for access and safety arrangements to harbours and offshore positions). CLIENT shall arrange for environmental exemption, on the basis of the documentation provided by the tenderers, and CONTRACTOR shall work within the requirements of this permit throughout survey activity. In this aspect attention is drawn to the vicinity of the shipping

[1] Sub Bottom Profiler (SBP) refers in this document to systems with shallow penetration i.e. Pinger, Chirp or parametric or equivalent systems

lanes. The latter may warrant different permits which are under the responsibility of the CONTRACTOR.

Operation of an Acoustic Deterrent Device (ADD) "Pinger" during all offshore works is mandatory to CONTRACTOR. Specifications of the active sources for sub-bottom profiler devices (all sources for SBP) shall not vary during the project from those supplied to the CLIENT for application of the ecological exemption (underwater noise). Furthermore, a soft start procedure for the SBP devices should be in place before the start of the survey.

2.2.4 *UXO assessment and measures*

The general risk regarding the presence of UXO (unexploded ordnance) will be assessed and reported in a desk study, available on the RVO offshore wind website. The acquisition and processing of the magnetic data, sidescan data, and selection of any pUXO which might be observed within the data, should be performed by the CONTRACTOR in accordance to the CS-OOO guidelines both with regards to data acquisition and data processing.

2.2.5 *Project Plans*

CONTRACTOR shall prepare all project plans as required by the CONTRACT. The technical proposal includes a Project Execution Plan, HSE management plan and Quality Management Plan. Along with the filled in annexes, these plans will form the first version of the Project Documentation. The Project Documentation shall include planning for the execution of operations, quality management and safety management. The organisation of these elements shall follow the requirements set in the tender document and scope of work. Elements can be according to the CONTRACTOR's normal working practice, but the planning material must include (but not be limited to) the following for every data type to be acquired:

- Project Execution Plan (PEP):
    - Line plans, method statements and safe systems of work;
    - Company standard operating procedures, including but not limited to: lifting plans, crew changes, personnel transfer, deck arrangements, towing configuration, i.e. battery change out, performing surveys with all sensors, processing data from all sensors, positioning, etc.
    - Mobilisation, equipment verification tests, parameter optimization;
    - Operational QAQC procedures (can reference to QMP, QAQC workflow in PEP);
    - Data acceptance criteria per sensor;
    - Data acceptance criteria per block. A minimum of 100 m overlap between blocks is required. Seamless overlap of blocks and integration to be responsibility of contractor. (see 2.6.5 for definition of blocks)
    - Data processing sequences (see sections 2.3 and 2.5)
    - Spares inventory management;
    - Preliminary project schedule;
    - Project & task specific risk assessment including mitigating measures
- HSE management plan, compliant with Annex [5], Section V HSE Requirements including but not limited to:
    - A comprehensive HSE and Emergency Response Procedure;
- Quality Management Plan, compliant with Annex [5] Section VI including but not limited to:
    - Management systems;
    - Meetings;
    - Data management, transfer overview and data workflow (see also delivery section and Quality Management Requirements);
    - Plans to interface between CONTRACTOR's offshore team, CONTRACTOR's onshore management, offshore CLIENT representative and CLIENT's onshore team, e.g. document and data sharing platforms.

CONTRACTOR shall only commence the WORK when all project plans have been reviewed by CLIENT and all comments made by the CLIENT are resolved and approved. For all revisions a document version with track changes on, a document review form (DRF) and a final version are expected to be provided for ease of reviewing changes. The following review schedule is to be adhered to:

- The CLIENT will strive to complete its review of the first version within three weeks;
- The CONTRACTOR will implement changes and answer comments in the DRF within 2 weeks;
- The CLIENT will strive to complete its review of the 2nd version, within 2 weeks;
- The CONTRACTOR will implement changes and answer comments in the DRF within 1 week.

The cycle described by the last two points will continue until the document is accepted.

Generic descriptions in the project plans which will be updated upon /after award of the contract shall be highlighted and provided with an (explicit) time bound plan providing insight into when generic information will be replaced. Project specific information will be of added value.

The preparation of Project Documentation is expected to include an onshore based Technical Kick-Off Meeting (TKOM) and Hazard Identification and Risk Assessment meeting (HIRA, refer to Annex [5] - section V HSE Requirements) as physical meetings prior to a Vessel Kick-Off Meeting (VKOM) to be held as mobilisation starts.

The Technical kick-off meeting is held at least 3 weeks prior to the planned mobilisation date. The TKOM is minimal a 2 day in person meeting at either CLIENT's or CONTRACTOR's office.

The TKOM shall at least address following topics (with the final agenda being agreed between CLIENT and CONTRACTOR before the TKOM):

- Project Execution Plan to include
    - Crew changes planned
    - Mobilization and demobilization ports agreed
    - Port agency, harbour master, customs control, fire brigade details confirmed (clearance for hot works) and arrival plans communicated
- Project schedule/planning
- Initial sensor/survey configuration
- Line plan
- Offshore data QC
- Data acceptance criteria per sensor
- Offshore testing phase/survey parameter optimisation
- De- and Mobilisation acceptance
- Technical mitigation plan (equipment breakdown/ positioning loss/ data quality degradation)/ etc.

Offshore equipment verification and parameter testing shall be required and agreed with onboard client representative and used as input to finalised production procedures, to be completed after the offshore testing phase. It is a requirement that all parameter/filter testing carried out is delivered as a field report to the client for data quality approval with data examples shown off before and after settings & filters are applied.

2.3 Data acquisition

2.3.1 *Mobilisation and demobilisation*

Mobilisation of the vessel(s) to the site will be considered completed when:

- all necessary survey and project documentation (Annex [5] - section V HSE Requirements, Annex [5] – section VI Quality, 2.2.5 & 2.6.2), equipment, spares, and personnel are accepted as operational, and all these aspects are optimised to the specification agreed by the CLIENT and approved by the CLIENT.

- All equipment, including spares, has been calibrated and validated;

- And alongside & offshore testing has been conducted to an agreed plan to demonstrate sensor settings are optimised to meet the survey requirements set out in this Scope of Work (SoW).

All required verifications, optimisations and calibrations of vessel and equipment (defined during TKOM) need to be documented, agreed, and signed off by both the RVO onshore Quality Expert Support (QES), and offshore Client Representative (CR).

Where the final configuration of any survey equipment is not pre-defined in plans, (*e.g., where on-site configuration or optimisation is required)* ALL deployed options and spares are to be verified as operational during the mobilisation phase.

The harbour to be used for mobilisation of survey vessel(s), equipment and personnel is chosen by the CONTRACTOR with approval of the CLIENT. The harbour which will be used for subsequent port calls and crew changes is also to be chosen by the CONTRACTOR with approval of the CLIENT. Crew changes shall be organised at least every 28 days in a port within one day of sailing from the concession, or the closest suitable port.

Demobilisation of the vessel will be authorised when all the data required have been acquired and have passed field QA/QC criteria to the satisfaction of the offshore CLIENT representative and onshore QES.

2.3.2 *Testing, calibration, and verification*

Following equipment verification, a testing phase shall be implemented to establish the appropriate configuration and parameterisation of data acquisition equipment and finalisation of the survey QA parameters. A testing programme shall be agreed as part of the planning phase and should include the collection of data properly representative of the range of ground conditions at the site.

Provision shall be made for tests to be evaluated, agreed, and signed off by both the RVO onshore QES, and offshore CLIENT representative.

Acceptance by CLIENT of data acquisition configuration is expected to take place as soon as possible after mobilisation and testing (within 2 working days). Production data acquired prior to acceptance of the data acquisition configuration is acquired at the CONTRACTOR'S risk.

A draft Mobilisation and Testing report (including calibration, verification, and testing phase results) is to be provided within one calendar week of acceptance of the data acquisition configuration. This report is to be delivered both separately and included as an appendix to the Field (Operations) Report when this becomes available.

Examples of tests to conduct during testing phase (complete list shall be agreed on during TKOM):

- MBES – test multiple pulse width and gain settings for backscatter (if applicable). Perform an absolute depth check; the CONTRACTOR will propose a location and method to perform the depth check. Furthermore, Patch and Wet test are required.
- SSS – perform a rub test. Resolve subtle details on outer swath in High-Frequency channel. Carry out a verification exercise to demonstrate positioning accuracy.
- MAG – spanner test. Carry out a verification exercise to demonstrate positioning accuracy and detection of distinct fero-magnetic objects, proof the background noise is not larger then 2 nT.
- SBP – test multiple pulse width and types, frequency selection.

- Navigation – test correct navigation string is applied to each sensor, check measured layback where relevant[2]. Verify/ update geodetics in the navigation software.
- Positioning – verification of obtained x/y accuracy & absolute heights by all GNSS using an official datum point. The datum point to be proposed by the CONTRACTOR. INS, Gyro, and motion sensor calibrations. Verification of the vessel's sound velocity profilers and sensors. Direct comparison of primary and secondary DGNSS systems. USBL calibration/verification.
- General – describe the timing/firing sequence, and steps taken to maximize lateral resolution and avoid interference between sensors. Establish/ verify the vessel geometry. Dimensional control survey/ verification.

The position test required for the SSS and MAG sensors shall be performed over a CONTRACTOR surrogate item. The item will have a weight of 25 kg (unless otherwise agreed, subject to the UXO desk study). The high level surrogate test procedure is as follows. The test procedure may need to be adopted to meet the results of the UXO desk study:

- A suitable testing area of 20 x 50 m shall be identified at the project site;
- The test area shall be surveyed using all survey sensors;
- The test item shall be deployed away from any other observable magnetic anomalies;
- The position of the test item shall be recorded using the vessel's MBES;
- 5 survey lines shall be planned and sailed. One line shall cross over the item while the two winglines will be planned at either side of the centreline at the planned linespacing. The centreline will be surveyed at a flying height of 4 m, 5 m, and 7 m.

The test will be considered successful if the sidescan sonar and multibeam data can still resolve the object on the winglines. The object should be detected on the centerline at a flying height of 4 m, the remaining altitudes are meant to give an insight into the decay of the signal. A spare surrogate item should be available on board.

Note on expected SBP tests:

- Frequencies 6kHz, 8kHz, 10kHz and 12kHz with 1 and 2 pulses are to be tested during sea trials over same set of lines at site and optimum settings for frequency, gain and power output are to be selected and agreed/signed off with onboard CLIENT REPRESENTATIVE as chosen parameters to be used throughout the survey.
- For each of these different tests, data is to be provided to the onboard CLIENT REPRESENTATIVE for assessment of signal-to-noise ratio, avoidance of amplitude clipping, penetration, and resolution.
- Fully idented traces, including merging with navigational data, should be delivered. Export of acquisition data in SEG-D format, and of idented traces in SEG-Y format.
- The method and the velocity used for converting SBP interpretation in time to depth must be described and provided as SEG-Y if appropriate.
- An SBP Processing Report should be delivered with all QC processing parameters, such that the work can eventually be reproduced.

For any equipment requiring factory calibration (e.g. SVP/ SVS) a calibration certificate will be provided proofing the equipment has been calibrated within the last 12 months at the time of mobilisation. At any point during the project execution, the calibration certificate shall not be older than 12 months.

2.3.3 *Lost Equipment*

CONTRACTOR shall be responsible at his own cost for marking the location of, and recovery of, equipment dropped or lost during the execution of the project. CONTRACTOR shall mark the positions

[2] CONTRACTOR is encouraged to apply assessment methodology as described in this document: Guidelines for the GNSS positioning in the oil & gas industry, International Marine Contractors Association, Report 373-19, February 2021

of equipment on or below the seabed with marker buoys if necessary and recover the equipment at the earliest possible opportunity.

CONTRACTOR is responsible for ensuring all necessary reporting to the relevant authorities is performed.

All reasonable possible attempts should be made to recover lost equipment.

For any non-electronic lost equipment not being recovered, a fee of €500 per piece is due to be paid by CONTRACTOR to an NGO selected by CLIENT for the purpose to support marine environmental protection.

For any other lost equipment not being recovered with circuit boards, hazardous fluids, or batteries inside, a fee of €5000 per piece is due to be paid by CONTRACTOR to an NGO selected by CLIENT for the purpose to support marine environmental protection.

2.3.4 *Positioning*

Navigational accuracy, tidal height accuracy, frequency and method of navigation checks and positioning specifications shall be stated in project documentation. Navigation checks and positioning calibrations shall be completed prior to leaving harbour at mobilisation. The combined precision and accuracy of the navigational positioning capability and post-processing methods must be sufficient to allow horizontal positions of moving survey hardware to be determined to within ±1 m, with height values within ±0.1 m. Static measurements shall have DGPS positioning to ±0.1m in all 3 dimensions. Equipment must be positioned using DGPS (or better) for surface and DGPS (or better) and USBL (ultra short base line) for subsurface gear.

USBL system accuracy: ≤0.5 % of Slant Range

Accurate positioning is essential. Coverage requirements dictate the course of MBES and SSS data acquisition, while pre-plot line-plans are the primary target for positioning of MAG and SBP data acquisition.

The position of both the survey vessel and the equipment shall be monitored continuously during the execution of the works. Preferably RTK positioning is used for planimetric and altimetric positioning. In case this would not be available, DGNSS or PPP is to be used. All positioning should be tidal corrected.

An independent secondary system will be provided, maintained, and operated during the survey. The secondary system is available as a backup to the primary system and can be used for online quality assurance of the primary system. When the primary and secondary system diverge, the survey shall be suspended. As a prudent practice, RINEX corrections will be recorded for the duration of the survey to allow for post-processing if required.

PPS timing will be supplied to all sensors requiring a timestamp. The pulses will be derived from the same single source.

The Gyro, INS, and motion reference units will provide the vessel's heading, heave, pitch and roll corrections. The sensors are to be aligned with the vessel's axes' and calibrated.

All sensors or to be positioned relative to the vessel's zero point (CRP).

- Gyro static accuracy: equal to or less than 0.5°
- Gyro repeatability: equal to or les then 0.25°
- Gyro resolution: equal to or less than 0.1°
- Surface X/Y positioning: equal to or less than 0.2 m accuracy
- Surface z positioning: equal to or less than 0.3 m accuracy

The exact position of the measurements must be recorded with an acoustic tracking system such as an USBL, giving the position of the equipment underwater relative to central reference point (CRP).

The acoustic underwater positioning system must be used to provide X, Y and Z offset to all seabed deployed systems. The offset to each sensor is used in real time to provide an absolute position coordinate and logged together with all raw data relative to a common DGPS time base, synchronised using a Pulse Per Second signal (PPS).

The CONTRACTOR must calibrate or verify the system(s) in the work area or at similar water depth and demonstrate the validity of the calibration procedures prior to initiating survey work.

2.3.5 *High Resolution Bathymetric Survey*

The objective of the High-Resolution Bathymetry Survey is to contribute to the model of the seabed including:

- seabed elevations / depths relative to ALAT and MSL;
- identification and mapping of static (and potentially mobile) bedforms;
- identification and mapping of potential hazards to the development of offshore wind farm infrastructure at the site;
- identification and mapping of natural and anthropogenic seabed features and objects;
- classification and mapping of seabed sediments.

Required elements

The High-Resolution Bathymetry Survey must include:

- Area-wide bathymetric measurement
- Sound velocity measurements (sound velocity sensor performing real time measurements at the receiver and min. 2 daily vertical profiles a day)
- Multi-spectrum Backscatter intensity measurement as input for seabed analysis (snippets)
- Water Column Data over wrecks

Specifications

Acquisition of high-resolution bathymetric data using a Multi-Beam Echo Sounder (MBES) with at least 120% coverage of the IA.

Data will be acquired to exceed IHO Standard S-44 Edition 6[3] Special Order standard according to specifications issued by the International Hydrographic Association (IHO). The system shall be capable of providing a minimum of 6 soundings per 0.5x0.5 m cell when deployed on-site, with object detection to >1m. The CONTRACTOR shall define the technology and line spacing employed to meet these requirements based on existing water depth information. Compliance with IHO Standard S-44 Edition 6 Special Order uncertainty thresholds must be demonstrated in the Field (Operations) Report.

The following IHO S-44, ed-6 Matrix Code is to be used: Ba9, Bc10, Bd8, Be6, Bg9, Bh9 + 6 Pings/0.5x0.5m.

MBES data must be recorded with optimised settings for backscatter and bathymetrical analyses of the seafloor. Guidance on best practice and optimised settings for backscatter surveys can be found in the GEOHAB backscatter report[4]. While conducting the backscatter measurements, the CONTRACTOR will:

- Survey using a fixed frequency, gain, and pulse length;
- All used acquisition parameters will be recorded, and any changes will be documented;
- Acoustic saturation of the backscatter dataset should be avoided;
- No filters can be applied during data recording which lead to significant loss of data or to loss of data quality;

[3] https://iho.int/uploads/user/pubs/Drafts/S-44_Edition_6.0.0-Final.pdf

[4] Lurton, X.; Lamarche, G. (Eds) (2015) Backscatter measurements by seafloor-mapping sonars. Guidelines and Recommendations. 200p. http://geohab.org/wp-content/uploads/2014/05/BSWGREPORT-MAY2015.pdf

- At the start of each survey phase the acoustic absorption value is to be determined and delivered including the related CTD profiles. The absorption value is to be calculated using the Francois & Garisson equation.

Prior to the start of the survey, the CONTRACTOR will sail a single line of at least 1 km across the area. While sailing this line the acquisition parameters will be optimised.

It should be noted that the quality of the bathymetrical data holds priority over the backscatter data, however, the CLIENT is aware that both datasets can be recorded at high quality simultaneously.

Guidance

The system should incorporate a sound velocity probe to monitor the speed of sound in water in real time at the receiver to provide a constant comparison against a vertical Sound Velocity Profile (SVP) through the entire water column. The sound velocity sensor (SVS) incorporated into the MBES system should have an accuracy of better than ±0.05 m/s.

Vertical SVPs to measure the speed of sound in water should be obtained once per tide at a depth which is representative of the area being surveyed. SVP acquisition intervals may be increased with the agreement of the offshore CLIENT REPRESENTATIVE. Measurements should be made using a calibrated velocimeter or calculated using temperature, pressure, and salinity measurements, to create a static vertical SVP. Measurements should be taken continuously between the sea surface and the seabed in a vertical profile. The accuracy of the recorded depths should be within 0.5 m. The sound velocity measurements should have an accuracy of 0.05 m.

Reported water depths from MBES must be sound velocity corrected and reduced to ALAT by applying the latest ALAT model for the Dutch North Sea (NLLAT2018[5]). Bathymetry relative to MSL shall be derived *from* the ALAT referenced data, for MSL reduction the latest DTU21[6] Mean Sea Level model shall be used. The methods for reduction shall be comprehensively explained in detail in the project plan and the final report.

Backscatter/snippets data from seabed returns should be logged and processed for use in seabed characterisation together with side-scan sonar data as appropriate. Seabed analysis should be carried out by an experienced analyst who is demonstrably familiar with the specific methodology used. The methods shall be comprehensively described in detail in the project plan and the Final Interpretation Report in which the seabed characterization and grab sample results will be implemented where possible.

Upon request, water column backscatter data will be recorded of encountered wrecks and obstacles for delivery to the CLIENT.

Data Processing

Data shall be reduced to datum, then gridded to produce a raster Digital Terrain Model (DTM) of the seabed at 0.25 x 0.25 m resolution or better. Grids at 1.0 x 1.0 m and 0.25 x 0.25 m are required.

The reduction method and vertical and horizontal datums used must be compliant with Sections 2.4 and 2.4 and IHO standards and guidance (IHO, 2005[7]; IHO, 2020[8]). Details of the vertical reduction process (MSL and ALAT) must be included in the Final (Operations) Report and demonstrated to meet or exceed the requirements of the specified standards and guidelines, using appropriate illustrations.

[5] https://english.defensie.nl/documents/2026/03/26/nllat2018

[6] https://ftp.space.dtu.dk/pub/DTU21/ Please note that DTU is in the TOPEX and mean tide system for use with satellites. DTU21 needs to be updated to ETRS89 ellipsoid and Tide Free system for consistency.

[7] IHO. 2005. Manual on Hydrography (C-13). International Hydrographic Bureau, Monaco, 1st ed. (corrections to February 2011), 36 pp.

[8] IHO. 2020. IHO Standards for hydrographic surveys (S-44). IHO Publications No. 44. International Hydrographic Bureau, Monaco, 6.1.0 ed., 49 pp

Full QA/QC must be carried out in order to generate statistical proof that the survey meets the requirements. A statistical description of Total Horizontal Uncertainty (THU) and Total Vertical Uncertainty (TVU) must be generated with the resulting values being demonstrated to meet or exceed the 'Special Order' minimum requirements described in the IHO Standard S-44 Edition 6 according to the matrix codes referenced above. A quantitative assessment of the feature detection thresholds for the survey must also be included and demonstrated to meet or exceed the Special-Order minimum requirements.

Offshore MBES Processing Requirements:

- Track processing/de-spiking & sound velocity corrections.
- Bathymetry data, reduced to MSL and ALAT.
- Bathymetric data cleaned on a line-by-line basis using area-based cleaning tools: Point cloud data to be shown to onboard CLIENT REPRESENTATIVE for cumulative coverage assessment line to line and across the site
- Manually delete largest residual outliers; line-by-line basis /using area-based cleaning tools which will also consider soundings/spikes/anomalies from adjacent lines
- Processing filters to be used to effectively removes spikes. The effectiveness /choice of the filters will be chosen dependent on geology/ environmental constraints. Filters are only to be applied offline to prevent data degradation to the backscatter data
- Review the final soundings. Remove any residual noise
- Final deliverables to be in line with Table 3.

Interpretation

MBES Contact picking should be carried out based on gridded data and point cloud data to support the interpretation of SSS Contacts.

MBES Contacts must be identified and should be listed separately in a spreadsheet, along with a description of the Contact length, width, and depth/height where appropriate. A target confidence will be attributed to each selected target based on the following key:

- 1 – Single detection on one line with one sensor
- 2 – Detected on multiple lines at least twice using one sensor
- 3 – Detected on multiple lines using at least two sensors
- 4 – All of the above plus historical data records

The CONTRACTOR can expand on this classification as they see fit.

Contacts must be classified *at minimum* into the following categories:

- Wreck-associated, correlated to local wreck registers, if available, and associated magnetometer/SSS Contacts;
- Debris-associated, correlated to associated magnetometer/SSS Contacts;
- Possible pipeline (with appropriate ID to indicate where multiple Contacts are thought to be associated with the same pipeline);
- Possible cable (with appropriate ID to indicate where multiple Contacts are thought to be associated with the same cable);
- Mounds;
- Depressions;
- Trawl marks (if these are reasonably identifiable individually, otherwise trawl mark zones suffice)
- Faults
- Fluid emissions
- Boulders.

Deliverables

The following deliverables including their metadata are required at minimum:

Table 3: MBES deliverables

MBES deliverables						
Item ID	**Measurement**	**Module R = Raw P = Processing I = Interpretation**	**Description**	**Resolution**	**Format**	**Load into GIS-database**
a1	**MBES**	**R**	MBES output files	n/a	Native data format & .gsf	N
a2			MBES backscatter output files	n/a	Native data format & .gsf	N
a3		**P**	Despiked, cleaned, positioning corrected soundings as x,y,z, per line, full density		Ascii+prj	N
a4			Despiked, cleaned, positioning corrected MBES backscatter data as x,y,z, per line, full density		Ascii+prj	N
a5			Subset of a2 for repeat lines		Ascii+prj	N
a6			Speed of sound in seawater vertical dip data profiles	n/a	.xlsx, PDF, Ascii+prj	N
a7			MBES tracks (navigation) data, Survey line ID and fix point index 0	n/a	.gdb, Ascii+prj	Y
a8			Gridded bathymetry, relative to LAT	0.25 m	Ascii+prj	N
a9			Gridded bathymetry, relative to MSL	0.25 m	Ascii+prj	N
a10			Gridded bathymetry, relative to LAT	0.25 m	Encoded Geotiff	Y
a11			Gridded bathymetry, relative to MSL	0.25 m	Encoded Geotiff	Y
a12			Gridded bathymetry, relative to LAT	1.0 m	Ascii+prj	N
a13			Gridded bathymetry, relative to MSL	1.0 m	Ascii+prj	N
a14			Gridded bathymetry, relative to LAT	1.0 m	Encoded Geotiff	Y
a15			Gridded bathymetry, relative to MSL	1.0 m	Encoded Geotiff	Y

MBES deliverables						
Item ID	**Measurement**	**Module R = Raw P = Processing I = Interpretation**	**Description**	**Resolution**	**Format**	**Load into GIS-database**
a16			Height adjusted gridded bathymetry relative to LAT	1.0 m	.gdb	Y
a17			Height adjusted gridded bathymetry relative to LAT	0.25 m	netCDF*	Y
a18			Tile map index [polygon]	n/a	.gdb	Y
a19			Total Vertical Uncertainty (TVU) gridded XYZ	0.25 m	Ascii+prj	N
a20			Total Horizontal Uncertainty (THU) gridded XYZ	0.25 m	Ascii+prj	N
a21			Total Vertical Uncertainty (TVU) raster	0.25 m	Encoded Geotiff	Y
a22			Total Horizontal Uncertainty (THU) raster	0.25 m	Encoded Geotiff	Y
a23			Bathymetric contours, typically 1 m interval.	n/a	.gdb	Y
a24			Backscatter data, gridded xyz	1.0 m	Ascii+prj	N
a25			Backscatter data, geo-referenced raster	1.0 m	Encoded Geotiff	Y
a26			Bathymetry slope in degrees, xyz	0.25 m	Ascii+prj	N
a27			Bathymetry slope in degrees Georeferenced raster	0.25 m	Encoded Geotiff	Y
a28			Water column data over wrecks and obstacles	n/a	native	N
a29			Timestamp indexed text file of tidal correction	1 minute	.txt	N
a30		I	MBES Contact list:	n/a	.xlsx	N
a31			MBES Contact list [pnt]:	n/a	.gdb	Y

Notes on MBES deliverables:

Raw:

- Raw output files from the MBES instrument are required as native data format of the used sensor/hydrographic survey software.

Processed:

- MBES backscatter data, to be delivered as native file and in a standard format to be agreed (xtf of gsf).
- MBES trackplot (fix point and line).
- The bathymetry at a resolution of 0.25 x 0.25 m or better reduced to datums and produced by gridding the swath bathymetry data to a regular grid, as a single or tiled set of xyz text files (*.xyz/*.pts) without overlaps together with projection information saved in a .prj file; ***and*** a single or tiled raster/grid without overlaps.
- Bathymetry contours at an appropriate interval for the topographic complexity, the grid vertical accuracy/precision and the depth range (typically 1 m).
- MBES backscatter image at an appropriate resolution, produced by gridding the swath bathymetry backscatter data to a regular grid, as: a single or tiled set of xyz text files (*.xyz/*.pts) without overlaps together with projection information saved in a .prj file; ***and*** a single or tiled raster/grid without overlaps.
- Bathymetry Total Vertical Uncertainty (TVU) and Total Horizontal Uncertainty (THU) grids at an appropriate resolution, as: a single or tiled set of xyz text files (*.xyz/*.pts) without overlaps together with projection information saved in a .prj file; ***and*** a single or tiled raster/grid without overlaps.
- Height adjusted bathymetry grid to remove survey artefacts of overlapping and crossing survey lines. This grid shall **NOT** be used for any depth related analyses but for **surface analyses only**. (Geotiff and *NetCDF-4 classic grid data format)
- The bathymetry slope in degrees calculated from the height adjusted bathymetry grid as a single or tiled set of xyz text files (*.xyz/*.pts) without overlaps together with projection information saved in a .prj file; ***and*** a single or tiled raster/grid without overlaps.
- A timestamp indexed text file of the tidal correction.
- Water column data over wrecks and other obstacles shall be supplied.

Interpreted:

- Multi Beam Echo Sounder data series should have a Contact table and associated point, line, and polygon spatial data files with columns for:
    - unique ID;
    - Contact classification (wreck, boulder, debris, *etc.*);
    - X co-ordinate (centre);
    - Y co-ordinate (centre);
    - dimension(s);
    - brief description;
    - where relevant, associated wreck number or cable/pipeline ID;
    - where relevant, Z value in m ALAT (highest point extracted from water column or bathymetry data);
    - Confidence level;
    - Target dimensions

  and columns as appropriate to relate the Unique Contact ID where multiple sensors have detected the same feature.

- All raster deliverables for single-variable data should be supplied as single-band files with actual cell values encoded (e.g. elevation, intensity).
- The processed data files should be of a maximum file size which can still be reasonably managed by a standard PC. The CONTRACTOR will propose a maximum file size in their project documentation for acceptance by the CLIENT.

2.3.6 *High resolution Side-Scan Sonar survey*

The objective of the Side Scan Sonar (SSS) Survey is to contribute to the model of the seabed including:

- identification and mapping of static (and potentially mobile) bedforms;
- identification and mapping of potential hazards or influences on the development of offshore wind farm infrastructure at the site;
- identification and mapping of natural and anthropogenic seabed features and objects;
- classification and mapping of seabed sediments and morphologies.

The Side Scan Sonar survey should be run simultaneously with MBES acquisition.

Required elements

The SSS Survey must include:

- survey-wide continuous (≥200%) high frequency (HF) Side Scan Sonar coverage;
- mosaic produced at no greater than 0.3 x 0.3 m grid pitch.

Required Specifications

The SSS survey should be carried out using simultaneous multiple channel, multiple frequency side scan sonar with at least two frequencies of LF ≥600 kHz and HF ≥900 kHz.

The line spacing should be defined to ensure that the SSS survey shall provide at least 200% coverage of the IA with frequency sufficient to resolve all objects larger than 0.3 m in their longest dimension.

Instrument gain should be managed to allow SSS data to contribute optimally to the seabed classification operations.

Evaluation of proposals will be made with reference to the following method preferences:

The side-scan sonar tow fish should be towed at the optimum altitude for the water depth encountered. The towing altitude is normally expected to be between 8% and 15% of the selected sonar range. The slant range used should be set to yield 200% coverage of the survey area with ≥600 kHz data. No blank nadir is to appear in the mosaic. Proposals that exploit instrumentation which eliminates a nadir gap without requiring overlap, while maintaining or improving object detection performance, are encouraged.

Scale ranges, depth of tow and tow speed should be determined on site to attain optimum resolution and area coverage.

Guidance

Interference in the SSS data from other equipment (*e.g*. magnetometer altimeter) should be minimised and should not impact on the SSS data quality and interpretability. Seabed features should be correlated with visual observations where provided by the CLIENT.

Proposals involving innovative SSS or SAS instrumentation, which meet the baseline specification, are encouraged.

SSS data should be corrected for the sound velocity based on the SVP profiles taken to correct the multibeam data.

Data Processing

Data shall be bottom tracked and corrected for: slant range, navigation errors; tow-fish skew/vessel speed, absorption of sound by seawater, and geometric spreading to produce the SSS mosaic. The bathymetry elevation data should be used for topographic corrections such that the corrections are carried out based on 3D positioning. The data should be mosaicked to 0.25 x 0.25 m or better and the final mosaic should be arranged so that the nadir of a line is layered behind the data of an adjacent line. Empirical Gain Normalisation tables are required. Automatic Gain Control is not to be used. Clipping of outer ranges is to be agreed and any infill determined on a line by line basis by onboard CLIENT REPRESENTATIVE if thermocline or other environmental constraints are present.

Interpretation

SSS Contact picking must be carried out, with interpreted contacts classified according to SSDMv2 standards. SSS contacts should be picked on scan plots and referenced to accurately positioned MBES features where possible. A target confidence will be attributed to each selected target based on the following key:

- 1 – Single detection on one line with one sensor
- 2 – Detected on multiple lines at least twice using one sensor
- 3 – Detected on multiple lines using at least two sensors
- 4 – All of the above plus historical data records

The inspection should target the features *at minimum*:

- Wrecks;
- Both linear and point debris ≥ 0.3 m in any dimension;
- Locations of Boulders ≥ 0.3 m in any dimension,
- Perimeters of boulder fields where number density is > 10 per 100x100 m area, to be classified as:
    - Low density:10 – 50 boulders
    - Medium density: 50 - 100 boulders
    - High density: 100 + boulders
    - Class A: 50% of the boulders within the filed are larger than 0.3 m;
    - Class B: 50% of the boulders within the field are larger than 0.5 m
    - Class C: 50% of the boulders within the field are larger than 1.5 m;
    - Class D: 50% of the boulders within the field are larger than 2.5 m.
- Other seabed objects ≥ 1.0 m in any dimension with measured length, width, and height;
- Seabed features (ridges/sand waves);
    - Pockmarks/depressions;
    - Gas plumes;
    - Cables;
    - Pipelines; and
    - Trawl scars and regions of trawl scars.

Where a class of Contact feature (as described above) is not detected within the IA, reporting of the search for and conclusions of the absence of such features is required.

The thresholds indicated are nominal, and a higher threshold and/or mapping of discrete areas of anomalously high Contact density may be appropriate if feature densities are high, subject to approval by the CLIENT. Proposed identification thresholds should be indicated within the CONTRACTOR's Project Documentation for approval by the CLIENT.

Deliverables

The following deliverables and their metadata are required at minimum:

Table 4: SSS deliverables

SSS deliverables						
Item ID	**Measurement**	**Module R = Raw P = Processing I = Interpretation**	**Description**	**Resolution**	**Format**	**Load into GIS-database**
b1	**SSS**	**R**	Raw XTF/JSF, nav corrected - High Frequency	n/a	.xtf/.jsf	N
b2			Raw XTF/JSF, nav corrected - Low Frequency	n/a	.xtf/.jsf	N
b3		**P**	SSS tracks (navigation - xyz) data, Survey line ID included as attribute	n/a	.gdb	Y
b4			SSS tracks (navigation - xyz) data, fix point included as attribute	n/a	.gdb	Y
b5			High frequency processed sidescan data, geo-referenced Mosaic tiles	0.25 m	RGB Geotiff	Y
b6			Low frequency processed sidescan data, geo-referenced Mosaic tiles	0.25 m	RGB Geotiff	Y
b7			Tile index	n/a	.gdb	Y
b8			Processed SSS data, corrections applied, including navigational information (x,y positioning and heading of tow-fish)	n/a	Xtf of HF and LF	N
b9		**I**	SSS Contact list	n/a	.xlsx	N
b10			SSS Contact list [pnt]	n/a	.gdb, .shp	Y
b11			SSS Contact list [lin]	n/a	.gdb, .shp	Y
b12			SSS linear features (scars, sand wave crests etc) [lin]	n/a	.gdb, .shp	Y
b13			SSS area features (boulder fields, bedform classification, trawl scars etc) [pgn]	n/a	.gdb, .shp	Y
b14			Sidescan sonar contact report containing information and images	n/a	.docx	N
b15			Sidescan sonar contact report containing information and images	n/a	.pdf	N
b16			Sidescan sonar contact images	0.3 m	.gdb	Y

Notes on Sidescan Sonar deliverables

Raw:

- Side-Scan Sonar data in the form of raw, un-mosaiced data files (*e.g.* *.xtf or .jsf files)

Processed:

- SSS trackplot (fix point and line).
- Single or tiled Side-Scan Sonar mosaic at 0.25 m cell size without overlaps in raster format (*e.g.* *.tif).

Interpreted:

- Side-Scan Sonar data series should have a Contact table and associated point, line, and polygon spatial data files with columns for:
    - Unique ID;
    - Contact classification with SSDMv2 code (wreck, boulder, debris, *etc.*);
    - X co-ordinate – easting and longitude (centre);
    - Y co-ordinate – northing and latitude (centre);
    - Location of targets >0.3m (not dimensioned)
    - Dimensions for object >0.3 m in any dimension;
    - Brief description;
    - File name of processed sidescan sonar line;
    - Where relevant, associated wreck number or cable/pipeline ID;
    - Confidence level (see "interpretation")

  and columns as appropriate to relate the Unique Contact ID where multiple sensors have detected the same feature.
- Comprehensive Side Scan Sonar contact report containing information and waterfall images for all identified SSS Contacts in Microsoft Word and Adobe pdf formats.

2.3.7 *Grab Sampling*

The objective of the seabed sediment sampling campaign is to collect grain size data to calibrate the seabed classification and interpretation, and to inform the seabed mobility study.

Required Specifications

The overarching goal of the choice and setup of the sampling equipment is to sample as much sediment as possible with minimal disruption. At least two types of gear should be available onboard. One sampler targeting finer sediments and one targeting coarser sediments.

Each grab sample will be positioned using a USBL system and recorded in the onboard survey system.

The sampling scope contains the following elements:

- Preliminary field analysis
- Sample conservation and storage
- Onshore analysis of sediment composition and grain size distribution
- USBL positioning.

The grab samples will provide a ground truth for the seabed classification and are thus to be conducted after the geophysical acquisition of a survey area is complete, and a preliminary seabed classification has been conducted. The sample stations are to be distributed to adequately sample the anticipated distribution of the seabed sediments and the seabed morphology indicated in the geological desk study. A sample location plan shall be proposed by the CONTRACTOR and agreed by the CLIENT.

Guidance

The key components of a grab are:

- The type of grab
- The weight of the grab
- The bucket dimensions

- The maximum penetration into the substrate
- The system to allow examination of the volume upon recovery
- Additional weight systems
- And the positioning system

All these aspects should be documented by the CONTRACTOR. The most appropriate grab should be identified considering the capabilities of the survey vessel, the environment, and the objective of the sampling campaign.

It is expected that the sample handling equipment will be either a van Veen Grab or a similar sampling device for sampling only the surface layer.

Data Processing

Samples are to be conserved and stored for onshore analysis using appropriate protocols to be proposed by the CONTRACTOR and approved by the CLIENT.

A field description must be reported in an appropriate format for use in geological, chemical and biological investigations.

Each retrieved sample is to be:

- Logged and photographed by a qualified CONTRACTOR's geologist
- Recorded in the station log
- Sufficient sample of wet weight should be stored in a zip-lock back to allow fine fraction analysis following EN ISO 17892-4. The bag should be labelled with the station ID and the sample ID. The sample shall be described in accordance to EN ISO 14688.
- The sample is to be photographed with a label, scale, and Munsell colour chart. The photography will have a quality, focus, colour, and resolution (at least 1080p) adequate to resolve millimetre scale features. The sample should then be double bagged and again labelled.
- Sub-samples are to be labelled in an adequate manner.
- The sample is to be refrigerated.

Upon return to the shore, the samples are to be send to a lab for further analysis.

All onshore laboratory testing shall be conducted at an approved geotechnical laboratory. Grain size distribution analysis shall follow EN ISO 17892-F. All soil testing shall be conducted, where applicable, respectively to Eurocode EN 1977-2, ISO 19901-8, or CLIENT approved equivalent.

Organic content shall be analysed by dichromate or loss on ignition when samples show signs of organic material. Samples to be analysed for organic content shall be suggested by the CONTRACTOR and approved by the CLIENT.

Deliverables

The following deliverables and their metadata are required at minimum:

Table 5: Grab sample deliverables

Grab samples deliverables						
Item ID	**Measurement**	**Module R = Raw P = Processing I = Interpretation**	**Description**	**Resolution**	**Format**	**Load into GIS-database**
c1	**Grab**	**R**	Conserved sediment samples	n/a	n/a	N
c2		**P**	Station log	n/a	xlsx	N
c3			Station log	n/a	.gdb	Y
c4			Sample log	n/a	xlsx	N
c5			Sample photographs	n/a	PNG	N
c6		**I**	Laboratory report (included as section in final interpretation report)	n/a	PDF	N
c7			Laboratory test results	n/a	.ascii	N

Notes on Grab sample deliverables

Raw:

- Sample

Processed:

- The station log contains the following information:
    - Date of sampling
    - Position of the station (easting/northing & latitude/ longitude)
- Seabed depth to ALAT and MSL
    - Number of samples taken
    - Sample ID numbers (including subsamples)
    - Observed lithology
    - Estimated amount of sample recovered per sample
    - Planned station position
    - GNSS position of the grab deployment
    - USBL position of each individual sample
    - Photograph of each recovered sample
- The sample logs contain all information described under data processing.

Interpreted:

As a final deliverable a laboratory report is expected containing the following information per sample:

- Determining the sediment texture
- Determining the sediment composition
- The mean grain size

- The grain size distribution
- The kurtosis
- The skewness
- The carbonate content
- Organic content
- And the mass properties

The report will be attached to the CONTRACTORS interpretative report and will be taken into account during the seabed sediment classification.

2.3.8 *Magnetometry survey*

The objective of the Magnetometry (MAG) Survey is to contribute to the model of the seabed including:

- identification and mapping of natural and anthropogenic seabed features and objects.

The primary purpose of this survey will be the identification/confirmation of the positions of all pipelines and possibly electrical and communications cables. It is acknowledged that a magnetometer survey along widely spaced lines will not be suitable for a comprehensive UXO survey. However, sampling, coring and later geotechnical investigations may use the magnetometry data for UXO clearance in restricted area proximal to the sensor track. Therefore, signal to noise performance, sensitivity and sensor altitude should be maintained at levels described below.

The magnetometer shall be deployed in the same survey pass as the MBES and SSS surveying.

Required elements

The MAG survey must include:

- Total Magnetic Intensity (TMI) at measurement altitude
- Transversal gradient at measurement altitude
- Calibrated, continuous magnetometer position and altitude.

Required Specification

A transverse gradiometer will be deployed, comprising two (2) magnetometers mounted in a single frame.

The magnetometer survey line spacing should be equal to or smaller than the line spacing for the SSS and SBP survey, with minimal track offset from these sensors, to enable comparison of datasets.

Nominal altitude (h) of Magnetometer from seabed: 4 m ≥ h

Magnetometer sensitivity: 0.01 nT/√Hz or better

Magnetometer sample rate: 10 Hz or greater

The magnetometer would preferably not be towed piggyback from the Side Scan Sonar. The preference of the CLIENT would be deployment of the Side-Sscan Sonar from a separate tow point, using a separate tow cable.

Guidance

The magnetometer should be deployed at sufficient distance from the survey vessel to minimize potential magnetic interference from the vessel. This distance is normally expected to be at least three times the length of the vessel. Where the magnetometer is towed close to other equipment such as a Side-Scan Sonar towfish, a tow distance sufficient to prevent interference from the towfish and other instruments should be ensured. The mounting of any position-tracking equipment ((USBL) on magnetometer tow cables must also be such that interference is minimized. Deck cabling should be arranged to minimize noise.

The magnetometer should be towed as close to seabed as practicable during surveying to optimise sensitivity to small deviations in the Earth's magnetic fields such as those produced by thin submarine communications cables. CLIENT requires a target altitude of no greater than 4 m above seabed. Exceptions will be allowed in areas where the presence of bedforms may create risk of damage to the equipment, in which case the increased tow height should be approved by the CLIENT or offshore CLIENT REPRESENTATIVE. In all cases it is recommended that the distance between the magnetometer sensor and the seabed should not exceed 7 m.

Data Processing

During processing, the CONTRACTOR is to edit the data to remove obvious noise spikes and to de-trend the raw data to extract residual magnetic anomalies. The de-trending and reduction to residual magnetic anomaly procedures must be described in detail in the Final Interpretation Report. Positioning using USBL systems is expected.

Magnetic signal with large scale spatial coherency may be indicative of geology, and CLIENT may request processing to recover such data in addition to the target picking data.

Residual (peak-to-peak) magnetic anomaly data must not be interpolated between adjacent lines and residual magnetic anomaly data must under no circumstances be gridded. Should it be required to plot the residual magnetometer data in plan-view in addition to plotting of the Contacts, ribbon plots should be used. Any spline filters applied must be agreed and shown to the onboard CLIENT REPRESENTATIVE.

Interpretation

Magnetometry Contact picking must be carried out based on magnetic residual profile data. Ribbon plots are to be used for co-location of contacts with SSS and MBES Contacts. A target confidence will be attributed to each selected target based on the following key:

- 1 – Single detection on one line with one sensor
- 2 – Detected on multiple lines at least twice using one sensor
- 3 – Detected on multiple lines using at least two sensors
- 4 – All of the above plus historical data records

Magnetometry Contacts must be identified and listed separately in a spreadsheet, along with a description of the anomaly type (positive/negative monopole, dipole). The recommended picking threshold is a peak-to-trough amplitude of ≥5 nT. A higher threshold may be appropriate if noise levels are high, subject to approval by the CLIENT.

Contacts must be classified *at minimum* into the following categories, with the appropriate SSDMv2 classification:

- Wreck-associated, correlated to local wreck registers, if available, and associated bathymetry/SSS Contacts;
- Debris-associated, correlated to associated bathymetry/SSS Contacts;
- Possible pipeline (with appropriate ID to indicate where multiple Contacts are thought to be associated with the same pipeline);
- Possible cable (with appropriate ID to indicate where multiple Contacts are thought to be associated with the same cable);
- Possible UXO (pUXO);
- Undesignated non-UXO (nUXO).

Checks must be carried out on the magnetometry data to identify those magnetometry contacts that are probably related to wrecks that are visible in the SSS/MBES data, and to identify additionally any magnetometry Contacts that may be indicative of buried wrecks (or potentially UXO). If possible UXO Contacts are identified, these must be indicated in the Contact table.

Deliverables

The following deliverables and their metadata are required at minimum:

Table 6: Magnetometry deliverables

Magnetometry deliverables						
Item ID	**Measurement**	**Module R = Raw P = Processing I = Interpretation**	**Description**	**Resolution**	**Format**	**Load into GIS-database**
d1	**MAG**	**R**	Raw magnetometry	n/a	Ascii +prj	N
d2		**P**	Cleaned de-spiked TVG & MAG data after application of positioning QC and (USBL derived) layback correction	n/a	Ascii+prj	N
d3			MAG tracks (navigation) data including altitude, Survey line ID included as attribute [lin] per sensor	n/a	.gdb	Y
d4			MAG tracks (navigation) data, fix point included as attribute [pnt] per sensor	n/a	.gdb	Y
d5			Processed residual signal	0.5 m	Encoded geotiff	Y
d6			Analytical signal	0.5m	Encoded geotiff	Y
d7			Cleaned de-spiked total magnetic field (nT)	0.5m	Encoded geotiff	
d8			Processed gradiometer data	0.5m	Encoded geotiff	Y
d9			Flying height grid	1.0 m	Encoded geotiff	Y
d10			Signal to noise ratio grid	1. 0 m	Encoded geotiff	Y
d11			Residual mag anomaly ribbon plot	1.0 m	Geotiff	Y
d12		**I**	MAG anomaly list	n/a	.xlsx	N
d13			MAG anomaly list [ptn]	n/a	.gdb	Y

Notes on magnetometry deliverables

Raw:

- Raw magnetometry is required as native sensor format, Ascii and .prj files per sensor

Processed:

- Cleaned, de-spiked gradiometer data as text (x,y,z) files per line/file, after application of positioning QC and layback including:
    - File name
    - Date of acquisition
    - Time (UTC) of acquisition
    - Line name
    - Easting gradient
    - Northing gradient
    - Easting MAG 1
    - Northing MAG 1
    - Easting MAG 2
    - Northing MAG 2
    - Raw magnetic response (nT) of MAG 1
    - Signal strength of MAG 1
    - Despiked total magnetic field (nT)of MAG 1
    - Despiked residual magnetic signal (nT) per sensor of MAG 1
    - Tow fish depth MAG 1 (m)
    - Flying height of MAG 1 (m)
    - Raw magnetic response (nT) of MAG 2
    - Signal strength of MAG 2
    - Despiked total magnetic field (nT)of MAG 2
    - Despiked residual magnetic signal (nT) per sensor of MAG 2
    - Despiked analytical signal (nT/m)
    - Tow fish depth MAG 2 (m)
    - Flying height of MAG 2 (m)
    - Derived gradient (nT/m)
- Magnetometer trackplot and altitude (fix point and line);
- Cleaned, de-spiked residual grid as encoded geotiff per line, including layback, detrended to residual anomaly.
- Cleaned, de-spiked total field as encoded geotiff per line
- Gradiometer grid as encoded geotiff per line
- Flying height as encoded geotiff per line
- Signal quality as encoded geotiff per line

Interpreted:

- The Magnetometry data series should have a Contact table and associated point, line, and polygon spatial data files with columns for:
    - unique ID;
    - Survey line number
    - Contact classification (wreck, boulder, debris, cable, pUXO, nUXO *etc.*);
    - X co-ordinate – northing and latitude (centre);
    - Y co-ordinate – easting and longitude (centre);
    - Altitude above seabed (m)
    - Depth below surface (m)
    - brief description;
    - where relevant, associated wreck number or cable/pipeline ID;
    - approximate total peak-to-trough magnitude (nT);
    - approximate gradient peak-to-trough magnitude (nT/m)
    - approximate in-line anomaly width;
    - anomaly shape, *e.g.* negative monopole, positive monopole, or dipole

- Confidence level
- and columns as appropriate to relate the Unique Contact ID where multiple sensors have detected the same feature.

- All raster deliverables for single-variable data should be supplied as single-band files with encoded cell values (e.g. elevation, intensity).

2.3.9 *Sub Bottom Profiling Survey*

The objective of the Sub Bottom Profiling (SBP) Surveys is to contribute to the Preliminary and later the Integrated Ground Model including:

- identification and mapping of static (and potentially mobile) bedforms, including the thickness of the sediments;
- identification and mapping of potential hazards or influences on the development of offshore wind farm infrastructure at the site *e.g.* faults, seabed or buried channels, shallow gas, peat, *etc.*;
- identification and mapping of significant stratigraphic and lithological horizons that characterise the site, the key geological units defined by the Geological Desk Study and any other relevant literature or data;
- identification and mapping of subsurface structures that may represent changes in material properties relevant to the design, emplacement and operation of Offshore Wind Farm infrastructure.

The SBP survey is required for sufficiently detailed imaging of the Quaternary formations. The primary purpose of the SBP survey is to provide information about the top 10 m as this depth range is important for cable design and installation.

Required elements

- Single-channel, shallow penetration seismic surveying with a parametric Sub-Bottom Profiler system (SBP). Sound Exposure Level single strike (SELss) specifications are required in the tender to support CLIENT's application for an environmental exemption (underwater noise).

Required Specification

Data acquisition should be designed to optimise vertical and horizontal resolution (defined here as ¼ dominant wavelength), the signal-to-noise ratio and the recovery of coherent signal throughout the depth range of interest.

Near surface resolution within 5 m of seabed (SBP):	Trace spacing <1 m
	Vertical resolution: 0.2 m
	Target penetration: ≥10 m

Positioning of all components of the instrumentation is to be accurately monitored.

All systems generating acoustic signal must conform to the sound pressure specifications described in the environmental permit. Acoustic deterrent systems and procedures are to be implemented and shall be described in the project documentation.

Guidance

A line-plan must be submitted with the CONTRACTOR's proposal as a properly referenced shapefile with description of line spacings and bearings of the primary and secondary line directions.

Vessel(s) or other platforms selected for data acquisition must be established as *low noise* relative to the SBP acquisition proposed, with particular reference to the source power and spectral characteristics in the context of the sea-bed conditions of the IA. Demonstration via representative data should be provided.

SBP must be hull- or pole-mounted and provide effective heave and attitude compensation. An appropriate tidal correction should be applied to the SBP data. A parametric system is to be used for the works.

Any required data processing and QA schemes must be described and demonstrated to be established in production work.

Data Processing

SBP data require data processing to be applied to optimise quality and resolution. Data processing will be monitored for quality, and CLIENT may require opportunity to inspect data, provide input and request modification at any point prior to delivery. Full reporting is required.

The data are to be located using accurate source and receiver positions.

Full navigation editing must be carried out to ensure that erroneous, zero and duplicate co-ordinates have been removed and new values interpolated. Trace numbering (trace, bytes 1-4) must be sequential in increments of 1, with no duplicates. Navigation data must be included in SEG-Y trace header bytes 73-80 and 81-88 for pre-stack shot and receiver locations, and 181-188 for stacked data.

SBP trace headers should conform to SEG Y Rev1 (2002)[9] in structure and should contain the appropriate information, including survey metadata in the text header.

Time correction for the source and receiver elevation to a single datum is required such that the SBP data have their seabed signal aligned in the Seismic Interpretation System project. Non-dipping seabed reflections should tie to ≤0.1 ms. Datum corrections should be written to the pre-stack header but *not* applied to the data.

Some, or all operations of the final, production processing sequence for SBP data may be applied onboard/while surveying or ashore/after surveying (the preferred option). In either case the details of all processing undertaken must be explained and discussed in the Final Interpretation Report. At minimum, the processing operations must be described and parameter tests presented.

Interpretation

The SBP data are to be interpreted using a Seismic Interpretation System package at least capable of picking interfaces in the time and depth domain, and rationalising these picks between the data elements and at line intersections to ensure consistency. The SBP interpretation is to be provided in the project in both the time and the depth domain, converted using a preliminary velocity field to be defined during the project and approved by CLIENT. Software used to be agreed at TKOM (e.g. IHS Kingdom, or a comparable system, after consultation with and approval from the CLIENT)

The interpretation must include consistency/line-tie checks within the SBP dataset within the Seismic Interpretation System project, and these checks must be described in the Final Interpretation Report.

Formation boundaries as required must be gridded and contoured. A single grid should be provided for each interface. The gridding methods and parameters used to generate interface grids from the original horizon files must be described in full. A quantitative discussion of the elevation uncertainty of all delivered interfaces must be included in the Final Interpretation Report.

[9] May be downloaded from http://www.seg.org/resources/publications/misc/technical-standards.

Interpreted horizons & features (e.g. seismic units ID'ed, channel features, geohazards, faults; indications of peat layers, gravel/till layers, interbedding laminae, etc) including the resultant gridded surfaces (depth and thickness) and maps of occurrence are expected.

Geohazard interpretations (e.g. peat, channels, till/ gravel) may be gridded or presented as horizon plots depending on their extent and continuity. The spatial extent of interfaces and geohazards is to be mapped in between the individual profiles and delivered within both the Seismic Interpretation System project and GIS deliverables as polygons.

It is required that seabed, base Holocene and any other further horizons detected are to be interpreted. The CONTRACTOR has access to the Geological Desktop Study and is expected to have estimated the number of horizons and features which can be expected as an experienced survey CONTRACTOR.

If a significant portion of the subsurface is characterised by intense faulting, the characterisation of the faulting pattern (aggregated fault-throw and fault density) can replace the picking of each individual fault.

Sub-Bottom Profiler deliverables

The following deliverables and their metadata are required at minimum:

Table 7: Sub-Bottom Profiler deliverables

Sub-Bottom Profiler deliverables						
Item ID	**Measurement**	**Module R = Raw P = Processing I = Interpretation**	**Description**	**Resolution**	**Format**	**Load into GIS-database**
f1	**SBP**	**R**	Raw data SBP with navigation applied. Heaven information to be provided separately and not applied to the raw data.	n/a	SEG-Y	N
f2		**P**	SBP tracks (navigation) data, Survey line ID as attribute [lin]	n/a	.gdb	Y
f3			SBP tracks (navigation) data, fix point included as attribute [ptn]	n/a	.gdb	Y
f4			Processed SBP data with navigation and heaven correction applied in depth and time domain, ALAT,MSL, and ms.	n/a	SEG-Y	N
f5			SBP navigation	n/a	ascii	N
f6			Horizon interpretation for all tracks: xyz file per horizon (in depth and time domain) ALAT and MSL as well as depth below seabed.	For all horizons identified within the top 10 m and 0.1-0.2m vertical resolution	Ascii (XYZ & XYT)	N

f7			Gridded elevation surface, horizon, or interface (in depth and time domain), ALAT, and MSL as well as depth below seabed.	Grid resolution 5 x 5m	ASCII (XYZ & XYT) & prj	N
f8			Gridded elevation surface, horizon, or interface (in depth and time domain), ALAT and MSL as well as depth below seabed	Grid resolution 5 x 5m	Encoded geotiff	Y
f9			Ispoach gridded surfaces	For all horizons identified within the top 10 m with a thickness over 0.5 m. Grid resolution 5 x 5m	Encoded geotiff & ASCII	Y
f10			Horizon files for each interpreted stratigraphic or other horizon or interface (in time and depth domain). ALAT and MSL as well as depth below seabed.	n/a	Ascii + prj (XYZ & XYT)	N
f11			SBP Target list	n/a	ASCII & GDB & .shp	Y
f12			Lateral plotted features as polygon	n/a	.gdb & .shp	Y
f13		**I**	Seismic Interpretation System project incorporating SBP data, horizon picks, grids, and other information used in interpretation (in the time and depth domain) ALAT, MSL		.tks/ or equivalent	N
f14			Elevation Contours for all gridded surfaces, reduced to ALAT and MSL datums [line]	Every 1m	.shp, .gdb	Y
f15			Elevation Contours for all gridded surfaces, below seabed [line] (ms)	Every 0,66 mS	.shp, .gdb	Y
f16			Depth below seabed contours	Every 1m	.shp, .gdb	y
f17			Extent polygons for sub-seabed geology [polygon]	n/a	.shp, .gdb	Y
f18			Sub-bottom Contacts that present a geohazard [point]	n/a	.shp .gdb	Y

f19			Sub-bottom Contacts that present a geohazard	n/a	.xlsx	N
f20			Laterally extensive geohazard (such as shallow gas or peat) [line, polygon]	n/a	.shp .gdb	Y
f21			Faults [line]	n/a	.shp .gdb	Y
f22			Area of faulting [polygon]	n/a	.shp .gdb	Y
f23			Preliminary zonation	n/a	.shp, .gdb	Y

Notes on Sub-Bottom Profiler deliverables:

Raw:

- Raw SBP data with correct navigation applied in SEG-Y format (if applicable, heave information shall be provided separately and not applied to the raw data).

Processed:

- Trackplots for the SBP survey.
- Processed SBP data where post-processing is required to deliver interpretable data at the resolution specified: interference is to be attenuated, and processes to achieve a compact wavelet with minimal ringing are to be applied.
- SBP targets will be delivered in both an ASCII format and .gdb including:
    - Contact ID
    - Easting, Northing, latitude, longitude
    - Burial depth (m)
    - Description
    - Seismic unit
    - Detection frequency
    - Correlation with MAG/ SSS/ MBES targets

Interpretation:

- All raster deliverables for single-variable data should be supplied as encoded single-band files with actual cell values (e.g. elevation, intensity), not as multi-band RGB images
- SBP Contact picking must be carried out based on the SBP processed profiles.
- Text (or csv) horizon files for each interpreted geological surface (including seabed and interfaces/features that were of too small extent or too sparse to be gridded) to be provided in an exchangeable format with at minimum fields for XY coordinates, survey line name, shot point/trace number, two-way time, and elevation relative to ALAT and MSL.
- Elevation surfaces for all interpreted horizons at an appropriate resolution (~0.25-1 x line spacing, to be agreed with CLIENT), reduced to datum, and produced by gridding the horizon

data to a regular grid, as an xyz text file (*.xyz/*.pts) ***and*** an encoded raster/grid. Products to be delivered relative to both ALAT and MSL datums.
- Elevation contours relative to ALAT and MSL for all interpreted horizons at an appropriate depth.
- Depth below seabed information for all interpreted horizons at the same resolution as the elevation grids, as an xyz text file (*.xyz/*.pts) ***and*** an encoded raster/grid.
- Depth below seabed contours at an appropriate interval.
- Sub-surface point geohazard (such as diffraction apices that may indicate the presence of boulders) table(s) and associated point spatial data with columns for X and Y co-ordinates (easting/ northing and latitude/longitude) at minimum and depth where appropriate.
- Formation/formation member/unit and laterally extensive geohazard (such as shallow gas or peat) extents as polygons in GIS format. Extent polygons should:
    - include and clearly indicate areas where the unit/feature is thought to be present, but the base/top cannot be interpreted; and
    - exclude areas where the unit/feature is absent.
- Faulting as linear features (individual faults) and/or polygons (areas of faulting).

Charting:
- Geological vertical cross-sections identifying all significant features and horizons (superimposed on the processed seismic data) for a representative subset of lines from each dataset (at least 50 are expected, 25 x inline, 25 x crossline) on one or more A0 charts at an appropriate scale.
- Gridded elevation surface and contours (isolines) for each interface showing depth to top of formation/formation member/unit below datum (ALAT & MSL), provided electronically as ascii data and GDB elements.
- Gridded depth below seabed and depth below seabed contours of each formation/formation member/unit provided electronically as ascii data and GDB elements.
- Gridded thickness maps for identified formation/formation member/unit, provided electronically as ascii data and GDB elements.
- Mapped extents for each formation/formation member/unit and laterally extensive geohazard (*e.g*. shallow gas, peat, buried channel or boulder-field), electronically as ascii data and GDB elements and as one or more A0 charts at an appropriate scale.
- Preliminary zonation of the site into zones of common geological sequence as ESRI shapefile, for input to geotechnical campaign planning.

2.4 Data Integration

2.4.1 *Preliminary Ground Model data integration*

Data acquired during the geophysical campaign are to be interpreted for the input to a coherent Preliminary Ground Model (PGM), to be performed by the Lot 2 contractor. The purpose of this PGM is to deliver the aggregation of the data associated with the seabed itself (MBES, SSS, MAG; this SoW and Sow Annex [5]-Section IV Lot2 3D UHRS) and to inform the design of the anticipated Geotechnical Investigation.

The integration operations required of the PGM are principally the aggregation of the seabed data (MBES, SSS, MAG) to deliver a set of interpreted datasets, the aggregation of the sub-seabed data (UHRS, SBP) to deliver a sub-seabed workstation project, the integration of all suitable data elements into a GIS project, and the Final Interpretation Report.

The integration will be performed by the Lot 2 CONTRACTOR**. The Lot 1 CONTRACTOR is expected to reasonably assist the Lot 2 CONTRACTOR** by providing information on the datasets, the processing steps taken, and the conclusions drawn within one week (5 working days) of the Lot 2 contractor request.

CLIENT expects to be actively involved with work during the interpretation of individual survey elements and the integration stage. **A workshop to finalize the interpretation shall be held**

prior to the assembly of the draft reporting at latest two (2) weeks before 1st revision Draft of the Interpretation Report.

2.4.2 *Seabed data integrated interpretation*

Overview

Contact picking must be carried out on SBP, SSS, magnetometry and MBES datasets. Targets should be reported as points, polygons, and polylines. Linear Contacts of lengths on the order of the line-spacing or greater must be provided as polylines, not points.

Contacts shall be assigned a unique number and a table relating this to the identifiers of events on the individual sensor datasets is required. A target confidence will be attributed to each selected target based on the following key:

- 1 – Single detection on one line with one sensor
- 2 – Detected on multiple lines at least twice using one sensor
- 3 – Detected on multiple lines using at least two sensors
- 4 – All of the above plus historical data records

Correlation between targets will be based on a CONTRACTOR proposed correlation radius.

Target Database

The contractor will compile and deliver a contact database, representing all individual anomalies identified during the fieldwork based on the sidescan sonar, multibeam, magnetometer, and sub-bottom profiler data. The target database will represent a unique ID for each surveyed anomaly. The anomalies will be correlated to each other where possible.

Where a linear Contact is identified based on several point Contacts from one or more of the MBES, SSS and magnetometry data, both the point and linear Contacts must be retained in the deliverables. Linear Contacts that are associated with known cables/pipelines must be mapped and included in the deliverables. The CONTRACTOR shall investigate before commencement of the survey if further in-service and out-of-service cables and pipelines can be found in the area, based on their own information and on the Geological Desk Study and associated GIS archive.

CONTRACTOR shall investigate before commencement of the survey if further in-service and out-of-service cables and pipelines can be found in the area. An information request from Rijkswaterstaat is required.

Seabed material classification

Seabed classification shall be carried out based primarily on MBES backscatter/snippets and SSS data. A single seabed material/reflectivity map shall be produced. Grab samples shall be used to inform the seabed classification.

Bedform classification

Bedform zonation, carried out according to a recognised, documented classification scheme, is required. It is suggested that nomenclature follows that used in the morphodynamical studies of other WFZ data packages of the Ten noorden van de Waddeneilanden series. The quantitative basis for the classification scheme selected must be described in the report and a table of parameters (bedform length, width, height, and shape) for each selected class must be provided. The following features and/or indication of features shall be mapped (if present):

- Bedforms
- Boulders
- Potential Megaripples/Sand Waves/Sand Ridges
- Anthropogenic features (*e.g.* dredging areas, trawl marks, jack-up traces, gravel dumps).

Where bedforms of different classes are co-located, this shall be indicated using separate, overlapping class polygons (*i.e.* in an area where small dunes are superimposed on large dunes, the polygons for these two classes shall overlap).

The seabed slope (degrees) shall be calculated on levelled DTM, classified, and mapped.

2.4.3 *Seabed – Integrated chart deliverables*

The result of the MBES, MAG, SSS and SBP survey shall be:

- One or more (NU) A0 charts at an appropriate scale showing both SSS, Magnetic Contacts, SBP, and MBES Contacts superimposed on the SSS mosaic. All pipelines/cables, both previously known and unknown, must be mapped both as linear and associated point Contacts.
- One or more (Aligned) A0 charts at an appropriate scale showing both SSS, Magnetic Contacts, and MBES Contacts, and SBP contacts superimposed on a ribbon plot of the processed magnetometer data. All pipelines/cables, both previously known and unknown, must be mapped both as linear and associated point Contacts.

2.4.4 *Seabed data - Integrated Interpretive deliverables*

The following interpretative deliverables and their metadata are required at minimum:

Table 8: Seabed (MBES, SSS, MAG, SBP) Integrated Interpretative deliverables

Seabed (MBES, SSS, MAG) Integrated Interpretative deliverables						
Item ID	**Measurement**	**Module I = Interpretation**	**Description**	**Resolution**	**Format**	**Load into GIS-database**
h1	**Integrated MBES SSS MAG**	**I**	Correlated Contact list for all sensors	n/a	.xlsx	N
h2			Correlated Contact file for all sensors [pnt]	n/a	.gdb .shp	Y
h3			Isolated boulder table containing co-ordinates and size measurements	n/a	.xlsx	N
h4			Isolated boulder file containing co-ordinates and size measurements	n/a	.gdb .shp	Y
h5			Bedform classification (polygon)	n/a	.gdb .shp	Y
h6			Linear features (scars, sand wave crests, cables, pipelines, etc) [lin]	n/a	.gdb .shp	Y
h7			Area features (trawl scars, debris fields, boulder fields	n/a	.gdb	Y

Seabed (MBES, SSS, MAG) Integrated Interpretative deliverables						
Item ID	**Measurement**	**Module I = Interpretation**	**Description**	**Resolution**	**Format**	**Load into GIS-database**
			etc) [pgn]		.shp	
h8			Sediment classification raster	50 x 50 m	Geotiff	Y
h9			Sediment classification [pgn]	50 x 50 m	.gdb .shp	Y
h10			Sediment classification	50 x 50 m	CAD [dxf]	N
h11			Cable/pipeline table containing vertex co-ordinates	n/a	.xlsx	N
h12			Cable/pipeline table containing vertex co-ordinates [lin]	n/a	.gdb .shp	Y

Notes on integrated interpretative deliverables:

- Boulder fields should describe the extent of the feature and be classified with a suitable array of boulder frequency values.
- Sediment distribution/seabed classification, depending on the classification method used to be provided as: either a single or tiled set of xyz text files (*.xyz/*.pts) without overlaps and a single or tiled raster/grid without overlaps; ***or*** a digital vector file/drawing (GIS)
- Separate table containing all vertex co-ordinates for each identified cable/pipeline, indexed by cable/pipeline ID.
- The .gdb is expected to follow the latest version of the IAOP's Seabed Survey Data Model (SSDMv2).

2.4.5 *Geographic Information Systems*

A project Geographic Information System (GIS) archive is to be delivered in a single GIS deliverables folder with metadata in accordance with requirements as specified in Appendix A (GIS Metadata Requirements). Accompanying map document(s) (*.mxd), containing data as specified throughout this Scope of Work should be provided.

Data should ideally be provided in a geodatabase file and exported as a Map Package, but shapefile data would be acceptable with appropriate handling of 'null' values.

The GIS data must be consistent with all other data deliverables (*e.g.* Contact feature classes in the GIS archive must contain the same attribute columns and values as in the Excel/text file Contact tables and report appendices, elevation grids from Seismic Interpretation System and GIS elevation rasters should match, *etc.*).

The GIS data archive must include *at minimum*:

Table 9: GIS deliverables

GIS deliverables						
Item ID	**Measurement**	**Module M = Map D = Database Meta = Metadata**	**Description**	**Resolution**	**Format**	**Load into GIS-database**
k1	**all**	**M**	Master Map document	n/a	.mxd	Y
k2	**all**	**D**	ArcGIS geodatabase	n/a	.gdb	Y
k3	**Survey**	**D**	Project area, wind farm and survey boundaries (polygons).	n/a	.gdb/ .shp: polygon	Y
k4	**Tracks**	**D**	Vessel trackplot(s) and fix points.	n/a	.gdb/ .shp: line, point	Y
k5	**Tracks**	**D**	Sensor trackplots and fix points	n/a	.gdb/ .shp: line, point	Y
k6	**Seabed**	**D**	Bathymetry grid and contours.	Full	.gdb/ Geotiff: raster, line	Y
k7	**Seabed**	**D**	TVU and TVH uncertainty grids.	Full	.gdb/ Geotiff: raster	Y
k8	**Seabed**	**D**	MBES backscatter grids.	Full	.gdb/ Geotiff: raster	Y
k9	**Seabed**	**D**	SSS mosaic	Full	.gdb/ Geotiff: raster	Y
k10	**Seabed**	**D**	Grab sample Station log	n/a	.gdb/ .shp point	Y
k11	**Contacts**	**D**	MBES, SSS and MAG Contacts	n/a	.gdb/ .shp: point, line, polygon	Y

k12	**Contacts**	**D**	Boulders and Boulder fields	n/a	.gdb/ .shp: point, polygon	
k13	**Geology**	**D**	Elevation grids and contours for all interpreted interfaces	Full	.gdb/. Geotiff: raster	Y
k14	**Geology**	**D**	depth below seabed grids and contours for all interpreted interfaces	Full	.gdb/ Geotiff: raster	Y
k15	**Geology**	**D**	Polygon extents for each identified geological unit, Formation, and feature	n/a	.gdb/ .shp: polygon	Y
k16	**Geo-hazards**	**D**	Point and polyline geohazards	n/a	.gdb/ .shp: point, line	Y
k17	**Geology**	**D**	Seabed sediment classification.	n/a	.gdb/ .shp: polygon	Y
k18	**Seabed**	**D**	Bedform classification.	n/a	.gdb/ .shp: polygon	Y
k19	**Seabed**	**D**	Geotiffs of waterfall images for all reported side scan sonar contacts.	n/a	.gdb/ Geotiff: raster	Y
k20	**all**	**Meta**	Metadata to specification provided in Appendix A	n/a	.gdb	Y

Notes on GIS deliverables:

- Sensor trackplots and fix points (transmitter/receiver midpoint where transmitter and receiver are not co-located).
- MBES, SSS, SBP and magnetometer Contacts (point, linear and polygon Contacts to be symbolised appropriately as per SSDMv2 guidelines; *e.g.* significant linear Contacts should be recorded as line features and not points), including as-found cables, pipelines, wrecks *etc.*
- MBES and SSS Contacts may be combined into a single Feature Class/shape-file but magnetometer & SBP Contacts must be kept separate.
- Elevation and depth below seabed grids and contours for all interpreted interfaces (including gridded geohazards, *e.g.* top shallow gas). Grid and contour coverage must be consistent with the associated extent polygons.
- Polygon extents for each identified geological unit and Formation and all spatially extensive geohazards (gas, channels, areas of faulting *etc.*). Areas where an interface or geohazard is thought to be present but is not interpretable must be differentiated from areas where it is thought to be absent.
- Point and polyline geohazards (suspected boulders, isolated expected peat occurrences of too small an extent to be gridded, *etc.*).
- The master map (*.mxd document) should include a layout containing at minimum a map window (with appropriate graticule), scale bar and legend. All data should be symbolised using similar schemes as per the report charts for ease of cross-referencing.

- Layers should be grouped into meaningful categories (background mapping, geohazards, seabed features, *etc.*) and layer and group names should be used that can be easily cross-referenced to the report text and charts (rather than simply using the feature class/grid names.
- All raster deliverables for single-variable data should be supplied as single-band files with encoded cell values (e.g. elevation, intensity).

2.5 Quality Assurance and Quality Control

Annex [5] - section VI Quality Requirements and Administrative Instructions contain a brief description of the operational quality management requirements to be implemented during the survey work. A Quality Management Plan (QMP) is required, this section describes specific operational QA requirements in support of those described in Annex [5] - section VI.

During data acquisition, MBES, SSS, MAG and SBP datasets shall be monitored continuously to ensure both coverage and quality (including signal stability and resolution) are maintained. The survey *speed over ground* shall be no more than 4.5 knots, vessel speed will be subject to weather and current conditions encountered and may impact on data quality, so shall be monitored, and reported.

Throughout the offshore survey activity, data quality checks shall be carried out onboard/while surveying by a qualified geophysicist including comparison of data collected on adjacent and perpendicular survey lines to ensure continuity. Any omissions, inconsistencies or other issues that may impair the quality, quantity or interpretation of the final data shall be immediately discussed with the offshore CLIENT REPRESENTATIVE and suitable actions agreed to rectify any dataset deficiencies. Upon demand by the CLIENT, a Data Quality Report (DQR) of the requested data will be delivered for review within 24 hours after the request.

As a minimum, the following datasets will be delivered to the CLIENT REPRESENTATIVE (and client where mentioned) for QC during the data acquisition:

Frequency	Data	Description	File Type	Shared with
Every 24h	MBES	Hit count per m² and Standard Deviation per m²	Encoded Geotiff	From contractor RepCo to CR
	MAG	Trackplots including flying height, towing depth, magnetic flux per magnetometer and data quality indicator	.shp	From contractor RepCo to CR
	SSS	Speed and slant range corrected mosaic per line	Geotiff	From contractor RepCo to CR
	SBP	Trackplots	.shp	From contractor RepCo to CR
2 weeks after completion of each block at each crew change of approximately 4 weeks	MBES	Hit count per m2 after processing, standard deviation per m2, average depth relative to ALAT and MSL per m2	Encoded geotiff	From contractor RepCo to Client

	MAG	Tracklines including Cleaned de-spiked TVG & MAG data after application of positioning QC and (USBL derived) layback correction	.shp	From contractor RepCo to Client
	SSS	Processed and corrected mosaic of the completed block	Geotiff	From contractor RepCo to Client
	SBP	Tracklines including depth of the seabed reflector in ALAT and MSL. Selected screenshots of the processed SBP data within the completed block	.shp & ppt	From contractor RepCo to Client
	Backscatter	Backscatter intensity	Encoded geotiff	From contractor RepCo to Client

Note that the client maintains the right to request additional QC datasets in the DQR's on top of the above-mentioned deliverables.

CONTRACTOR shall have the necessary hard drives available on board for the exchange of required data sets for QC at each crew change.

During data acquisition, specialised industry standard survey/navigation software (online and offline) will be used which:

- Is capable of the full range of standard survey operations, geodetics, offsets, and survey sensor interface (data acquisition, computation, calibration, display and logging of data);
- Allows to perform basic QC (including observation of data coverage in near real time);
- Allows for data management;
- Allows for an aid for navigation for the skipper by way of a helmsman display, live positioning of the vessel, and display of the planned survey lines and positions.
- The CONTRACTOR will include its planned survey system setup in its proposal, indicating:
- All survey systems which will be installed onboard;
- How the communication and interfacing between each system will be performed;
- And how all systems will be powered.

A print-out of the final on-board survey system database will be delivered in the contractor's project documentation. The system consists of all necessary IT software, hardware, and associated interface cabling and equipment. All recorded data shall be backed-up at least once a day. A suitable back-up system will be provided by the CONTRACTOR and presented in the CONTRACTOR's proposal. Suitable field data processing shall be undertaken onboard/while surveying by suitably qualified and experienced geophysicist to identify any anomalous or specific field data of interest, so that further investigation can be made while the offshore work is ongoing as appropriate. Any specific data processing operations required as a result of the data acquisition configuration shall be associated

with a QA operation onboard/while surveying to assure that collected data are acceptable. The CONTRACTOR shall implement and perform suitable quality control procedures to ensure that data of appropriate quality are being collected. The CONTRACTOR shall ensure that the offshore CLIENT REPRESENTATIVE is sufficiently aware of any obligatory data processing operations that the offshore CLIENT REPRESENTATIVE can effectively perform QA role.

All offshore data processing is to be considered preliminary and subject to rework should it be found deficient. The onboard/while surveying QA activities are specifically defined to assure that data acquired are fit-for-purpose. Any attempt at on-board *final* processing is to be secondary to the task of quality management of the acquired data.

Navigational accuracy, tidal height accuracy, frequency and method of navigation checks and positioning specifications shall be stated. Navigation and datum checks shall be completed prior to leaving harbour. The procedures to be followed in event of navigational non-compliance shall be logged and the offshore CLIENT REPRESENTATIVE advised at the Worksite.

Accurate positioning is essential, and in the discussion of interpreted Contact locations, interface depths *etc*. in reports and other documentation the chain of positioning errors (Contact to instrument package to vessel to GPS network) must be considered in order to provide quantified uncertainty values. The derivation of these uncertainty values must be explicitly described.

End-of-line quality assessment shall comprise of an end-of-line report summarising such pertinent QA monitors for all datasets being acquired. The content of the EOL QA shall be suggested within the CONTRACTOR's proposal and finalised before production data acquisition begins. The proposal will contain all software packages & procedures for on-board processing, QC, & QA.

2.5.1 *Offshore Representation*

Up to two (2) offshore CLIENT REPRESENTATIVES (CR) may be deployed offshore on each manned vessel or, in case of the use of Unmanned Survey Vessels, get viewer access the Online Survey System, during testing to facilitate optimisation and approval – suitable accommodation and messing shall be provided. If, in case of an offshore CLIENT REPRESENTATIVE, a port call is required to allow disembarkation of the CR, this shall be arranged to coincide with a planned port call at no charge, or a rate for a port call with no other purpose for CONTRACTOR shall be specified in the proposal. The CLIENT REPRESENTATIVE will be provided free-of-charge with:

- Any PPE required to function on the vessel;
- Safety induction;
- Private cabin including office space with power supply;
- Access to communication systems;
- Access to messing facilities;
- Victuals;
- And an uninterrupted internet connection with a minimum speed of 512 kbit/sec upload/ download.

The CLIENT REPRESENTATIVE shall be allowed full access across the vessel as reasonably required to assess the qualitative execution of the service. CONTRACTOR will communicate the planned pick-up date at least 72 hours prior at a port agreed upon prior to the start of the works. The CONTRACTOR makes available to the CLIENT REPRESENTATIVES capacity on the CONTRACTOR scheduled trips for its own personnel from land towards their survey or accompanying vessels.

In case of the use of manned vessels:

- The CONTRACTOR is to be responsible for providing safety induction training for the offshore CLIENT REPRESENTATIVE who are to work on or visit any vessel in connection with the execution of the work;
- The CONTRACTOR shall provide adequate facilities for the offshore CLIENT REPRESENTATIVE on any vessels to include board and lodgings, including but not limited to: a private cabin, office space, PC of sufficient power and with applications loaded suitable for QA operations, communication systems including satellite phone and appropriate internet connection and

messing facilities. The CLIENT REPRESENTATIVE cabin needs to have an internet connection with a minimum speed of 512 kbits/sec upload / download;
- The CONTRACTOR shall provide Personal Protective Equipment (PPE), life jackets and any special offshore PPE for the offshore CLIENT REPRESENTATIVE for the duration of the project;
- In case of the use of a remote operating centre:
- The CONTRACTOR shall provide the CLIENT REPRESENTATIVE access to the remote operating centre;
- The CONTRACTOR shall provide adequate facilities for the offshore CLIENT REPRESENTATIVE including board and lodging, an office space, a PC of sufficient power and with applications loaded suitable for QA operations, communications system and an appropriate internet connection with a minimum speed of 512 kbits/sec upload/ download.

2.5.2 *QAQC by CLIENT*

After demobilisation, CLIENT expects to be kept up to date of the processing and interpretation of the data at a regular basis. A workshop (online or live) shall be organised by the CONTRACTOR to explain and discuss how the data will be processed and interpreted. Examples of processed lines and interpretation shall be presented.

Follow up meetings shall be organised until the final processing methodology and interpretation is agreed. The frequency is to be agreed between CONTRACTOR and CLIENT.

As mentioned in 2.4.1, CLIENT expects to be actively involved with work during the interpretation of individual survey elements and the integration stage. A workshop to finalize the interpretation shall be held prior to the assembly of the draft reporting at latest two (2) weeks before 1st revision Draft of the Interpretation Report.

2.6 Reporting

The reporting requirements for the geophysical survey work are as follows:

2.6.1 *Daily & Weekly reporting*

Besides the reports to be delivered as result of the surveys as specified in this Scope of Work, CONTRACTOR shall issue daily, and weekly project progress reports as detailed below.

The purpose of this reporting is to inform CLIENT on all aspects of CONTRACTOR's performance over the period of reporting and to give an up-to-date and clear picture of the project progress such that CLIENT can directly establish whether the project is on schedule and within budget.

At the start of the project CLIENT and CONTRACTOR shall agree on the content and frequency of the reporting. CONTRACTOR shall provide accurate reports of the progress of the project and shall highlight all trends that have impact on the execution of the WORK.

2.6.1.1 Daily Progress Reporting

Throughout the period of the fieldwork the CONTRACTOR shall issue to CLIENT Daily Progress Reports (DPR) to be submitted before 09:00 CET each day , providing full details of previous 24 hours' work and results.

The format and content of the daily report shall be submitted to the CLIENT for approval prior to implementation, but shall include as a minimum:

- Activities executed in the past 24 hours and cumulative to date described in all phases.
- Activities planned for the upcoming 24 hours.
- Any occurrence causing delay to the project with consistent abbreviations/codes, including but not limited to:
    - equipment downtime.
    - scheduled maintenance.
    - instrument calibrations.

    - WAITING ON WEATHER.
    - Weather standby below WORKABLE WEATHER LIMITS.
    - other standby.
- Daily observation and registration of weather and sea state.
- HSE occurrences such as incidents, accidents, near misses, safety meetings, safety stand downs, number of HSE observations, together with measures taken and status
- Non-conformance reporting
- Any special features observed and notified (e.g. wreck) to the relevant authorities

The DPRs will be provided in a consistent PDF format and will preferably not be scanned. DPRs are to be signed by the offshore CLIENT REPRESENTATIVE before issuing to CLIENT, unless the content is subject of dispute.

In addition, the CONTRACTOR may be requested by the CLIENT to provide Data Quality Reports ("DQR") when appropriate (see 2.5). The DQR will not have to be provided on a daily basis, but the CONTRACTOR must be prepared to compile and provide these reports under the supervision of the offshore CLIENT REPRESENTATIVE. Content of standardised elements of DQRs is to be established at the TKOM.

2.6.1.2 Weekly Progress Reporting

CONTRACTOR shall issue to CLIENT weekly progress reports. These weekly progress reports shall provide progress data on the progress achieved during the reporting period of critical phases.

The weekly progress report of CONTRACTOR shall include - but not be limited to - the following subjects:

- Work in progress;
- Health Safety & Environment;
- Safety Statistics;
- Status summary work schedule, including weekly planning update.
- Forward looking information for the next two reporting periods.
- In case of deviations from the program: proposals for remedial action together with any revised plans and projections needed to substantiate or explain proposals.
- Any special features observed and notified (e.g. wreck) to the relevant authorities
- Status of queries / concession requests.
- Risk Log including areas of concern and actions taken to address them.
- Change control, including list of issued and Potential Variation Orders and their status.
- Updated document register.
- Photographs of relevant achievements.
- Areas of concern.
- Overview of the total time spent Waiting on Weather.

The Weekly Progress Report shall be based on a week cut-off date being each Sunday at 24:00h. CONTRACTOR shall issue the reports before Tuesday 12:00h (midday), following the cut-off date, and at least 4 hours before the start of the weekly progress meeting.

The CONTRACTOR will arrange a weekly progress meeting with the CLIENT and QES of a minimum duration of 1 hour, including all key personnel (for meetings in referred to [Annex 5_Section VI]). During the meeting when the geophysical survey is ongoing, the Weekly Progress Report and progress of the work will be discussed as well as any technical or HSE issues which might have arisen.

After demobilisation, progress meetings shall continue, at a frequency agreed between CONTRACTOR and CLIENT, to discuss processing and intermediate interpretation results (see 2.5.2).

2.6.2 *Mobilisation and testing report*

Within one (1) week after completion of the on- and offshore calibrations, verifications, and tests, the contractor will supply a mobilisation and testing report which contains at least the following structure:

- Introduction
  - Short description of the project
  - Executive summary including the end results and conclusions
- Project details
  - Dates, Times, and locations of the calibrations, verifications, and tests;
  - Project geodetic parameters;
- Methodology
  - The calibrations, verifications and tests performed (methods)
  - Final technical description and method statements of positioning systems, stating navigational accuracy, tidal height accuracy, frequency and method of navigation checks and positioning specifications
- Results
  - Results of all calibrations, verifications and tests performed, including but not limited to a statistical analysis of all results, calculates C-O's and offsets, as well as standard deviations
- All instrument performance checks and test
  - Details on the equipment involved
  - Equipment used and the serial numbers;
- Details on the personnel involved
- A daily log detailing the sequence of events
- Appendices
  - The dimensional control report of the vessel;
  - A schematic overview of the survey setup;
  - Include the technical data sheet of all equipment mobilised;
  - The factory calibration certificates of all equipment mobilised;
  - The raw data;
  - A copy of the survey database (PDF and digital).

One report is expected per deployed vessel.

2.6.3 *Field (Operations) report - Geophysics*

The CONTRACTOR shall provide a Draft Field (Operations) Report within three (3) weeks after vessel demobilisation. For all revisions a document version with track changes on and a final version are expected to be provided for ease of reviewing changes.

All revisions shall be distributed through ftp site or other electronic means, which shall be made final after processing of comments and approval by the CLIENT. The Field (Operations) Report shall contain daily logs and summaries of the work completed, together with any preliminary results that can be provided.

The Field (Operations) Report should include as a minimum:

- Introduction
  - A statement of the purpose of the investigation and Scope of work
  - Executive summary including the end results and conclusions
- Project Details
  - Dates, Times, and locations of the survey;
  - Project geodetic parameters;
- Methodology:
  - Exact positions of all survey data and details of survey positioning control (positioning calibrations, geodetic data, *etc.*), with accompanying calibration records; field procedures, including methodology,
  - Acquisition methodology for each dataset.
  - Quality Control procedures and reference to specifications and standards adopted and any deviations from them for each survey type;
- Field operations:

    - End-of-line reports.
    - Health & Safety records, Incident reports and safety meeting minutes as well as mitigative measures taken;
    - Any technical and qualitative incidents occurred, and the mitigative measures taken;
    - If instrument configurations were changed in the field, each instrument configuration;
    - Environmental observations;
- Equipment used
    - Equipment list including their serial numbers
    - If instrument configurations were changed in the field, each instrument configuration
- An overview of all vessels involved in the operations
- Personnel involved
    - An overview of all personnel which was involved on the project (name, vessel deployed on, function, and date present (GDPR compliant)
- A daily log summarizing the sequence of events
- Appendices
    - Copies of the daily reports
    - Copies of the weekly reports
    - Copies of the incident reports
    - Survey logs
    - Calibration and testing report
    - Signed calibration, validation, and test result sheets
    - Any other relevant survey documentation
    - A copy of the final survey database (PDF and digital)

For publication on the RVO website offshorewind.rvo.nl, CONTRACTOR may provide a Final Field (Operations) Report in which personal information from personnel and details on the incidents are redacted.

2.6.4 *Final Interpretation Report - Geophysics*

A first version of the Final Interpretation Report shall be made available, incorporating interpretational reporting within 8-16 weeks following demobilisation. This Final Interpretation Report shall include:

- Introduction
    - A statement of the purpose of the investigation and Scope of work
- Executive summary including the end results and conclusions. The executive summary should be extensive and will be used as input into the project site description report (PSD produced by RVO)
- Project Details
    - Dates, Times, and locations of the survey;
    - Project geodetic parameters;
- Methodology:
    - Methodology used for processing each dataset and the positioning data,
    - Quality control procedures applied during the processing, with reference to the specifications and standards adopted, and any deviations from them
- Results
    - A discussion on the results obtained by each individual sensor
    - A discussion integrating all results and their geophysical and geological interpretation (including the results deliverables specified in section 2.3, 2.4, and 2.5)
    - A discuss of all anthropogenic hazards and geohazard identified which can influence the planned development works (e.g. cables, pipelines, wrecks, gas pockets, faults, peat, fluid emissions, mass wasting, boulders, debris, UXO, etc.)
    - A hazard registry
    - In addition to a full Contact list (within the report or as an appendix), the report must contain a summary table indicating the number of magnetometry Contacts of each classification.
    - In addition to a full Contact list (within the report or as an appendix), the report must contain a summary table indicating the number of SSS Contacts of each classification.
    - The report must contain a table of the wrecks identified through all methods. If any known wreck is not identified, then the possible reasons for this must be discussed.

    - If an object is located offset from the location recorded in the relevant database, both the recorded and as-found locations and dimensions must be indicated on charts and Contact tables.
    - The report must contain a table of cables and pipelines identified through all methods. The report must contain an evaluation comparing the expected and actual location for cables and pipelines in the IA. The evaluation should include a map and a discussion in the text. If identity/location of (part of) cables and pipelines cannot be confirmed the reason for this shall be clearly specified.
- A comprehensive conclusion outlining the findings of the survey
- Appendices
    - Electronic copies of all processed survey data
    - Charts at an appropriate scale on A0 of all outputs defined by the CLIENT. Including but not limited to:
        - Grab sample locations
        - Bathymetry
        - Backscatter
        - Side-scan sonar mosaic of the HF and LF including interpreted contacts
        - Magnetic grids and interpreted magnetic contacts
        - Seabed interpretation map with the interpreted contacts
        - Traffic light map of the interpretation uncertainty
    - The GIS and processing databases required by the CLIENT
    - The digital deliverables required by the CLIENT
    - The exact locations of all survey lines sailed
    - The laboratory analysis report of the obtained grab samples

All reports and data deliverables shall be accompanied by metadata that are compliant with RVO's metadata requirements specified.

The CONTRACTOR shall provide a Draft version of the Final Interpretation Report, which shall be made final after processing of comments and approval by the CLIENT.

For all revisions a document version with track changes on, a document review form (DRF) and a final version are expected to be provided for ease of reviewing changes.

It is anticipated that a physical meeting should be arranged after delivery of draft report and data, to facilitate the review and implementation of any corrections and changes required.

Deliverables

A complete data archive, as defined in the preceding sections, must be provided with each and all draft version of the Final Interpretation Report.

The following reporting and charting deliverables are required at minimum:

Table 10: Reporting and chart deliverables

Reporting and Chart Deliverables						
Item ID	**Measurement**	**Module R = Reports C = Charts**	**Description**	**Resolution**	**Format**	**Load into GIS-database**
m1	**Report and Charts**	**R**	Mobilisation and Testing Report	n/a	.pdf	N
m2			Field (Operations) Report	n/a	.pdf	N
m3			SBP Processing Report	n/a	.pdf	N
m4			Final Interpretation Report including laboratory analysis (grab samples)	n/a	.pdf	N
m5		**C**	Bathymetry overview chart	n/a	.pdf	N
m6			Backscatter overview chart	n/a	.pdf	N
m7			HF sidescan sonar overview chart, including selected targets	n/a	.pdf	N
m8			LF sidescan sonar overview chart, including selected targets	n/a	.pdf	N
m9			Magnetic ribbon overview chart, including interpreted anomalies	n/a	.pdf	N
m10			Seabed features overview chart	n/a	.pdf	N
m11			Seabed sediment classification chart	n/a	.pdf	N
m12			Seabed contacts overview chart	n/a	.pdf	N
m13			Geohazards overview chart	n/a	.pdf	N
m14			Geological Cross Sections	n/a	.pdf	N
m15			Geological unit elevations, extents and thickness	n/a	.pdf	N
m16			Preliminary Zonation chart	n/a	.pdf	N

Notes on reporting and charting:

A table of file names against line names for all MBES, SSS, MAG, and SBP data files as plain text file or spreadsheet is required. For lines associated with multiple line-part data files, each data file should have its own entry in the index table. The table should also contain the following information against each line name entry:

- Acquisition vessel;
- Acquisition date;
- Source type and ID;
- Receiver type and ID;
- Start and End fix points;
- Name of the relevant Vessel Offset Diagram;
- Indication of whether the file is a production file or has not been processed;

All raster deliverables for single-variable data should be supplied as single-band files with encoded cell values (e.g. elevation, intensity), not as multi-band RGB images, with the exception of the SSS mosaic.

2.6.5 *Delivery*

Draft and Final deliveries should contain all reports, data, and charts. All Deliverables are subject to rigorous QC by the CONTACTOR to ensure completeness and correctness of all components.

CONTRACTOR to propose in their Quality Management Plan how best to manage the large volume of data to be delivered., i.e. provide an estimation of volume of data (in TBs) to be expected and how best to deliver it per data bloc, which data transfer technique, and over what frequency throughout the operations and delivery phases. Individual file sizes should not exceed 150 GB. The proposal shall include a robust method of data handling and coordination of the data between all teams offshore and onshore and data/document sharing with CLIENT.

The Draft (1st and 2nd version) and Final reports must each be accompanied by a complete set of data deliverables as defined in section 2.6, including the project GIS archive.

Draft versions of reports shall be provided via online transfer systems. The draft data package will be provided to the CLIENT by means of two identical hard drives. The same hard drives can be exchanged between CONTRACTOR and CLIENT until final version is accepted.
Final versions shall be provided via multiple portable hard drives (7) for all data. Electronic delivery may be accepted with prior agreement of CLIENT, though agreement to delivery in this way is not guaranteed.

Additional to the delivery of the final data on HDD, the final data shall be uploaded to the RVO data portal with the use of a by RVO provided upload tool. Contractor shall install an uploading program (provided by RVO) and use the provided program to upload the data.

2.6.6 *Webinar and Project Site Description*

The CONTRACTOR is expected to prepare and host a webinar for potential developers which will outline the work performed and the main results of the study. The webinar should be at least 1 hour and no more than 1.5 hour, with 30 minutes considered for questions. The webinar is to be recorded, and the recordings shared with the CLIENT.

CONTRACTOR shall provide a short description for the CLIENT's PSD wind farm site. In general this will be a summary of the works performed and site specific findings. Examples can be found on offshorewind.rvo.nl.