Date 9th October 2019

Status Final

Soil Investigations Wind Farm Zones

Annex 6 - Section V

Scope of Work Geotechnical Survey and Ground Model

Ten Noorden van de Waddeneilanden Wind Farm Zone

Colophon

Project name	Geotechnical Survey and Ground Model Ten Noorden van de Waddeneilanden
Project number	Contract: WOZ2190179 (Lot 1), WOZ2190180 (Lot 2)
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Approved	R. de Bruijne

Contents

References

ASTM D 6528-17	Standard Test Method for Consolidated Undrained Direct Simple Shear Testing of Fine Grain Soils, ASTM International, 2017
ASTM D 5311-13	Standard Test Method for Load Controlled Cyclic Triaxial Strength of Soil, ASTM International, 2013
ASTM D7400-08	Standard Test Methods for Downhole Seismic Testing, ASTM International, 2008
BS 1377	Soils for civil engineering purposes Part 1 to 9. British Standard, 1990 to 2018 depending on the section (latest version of each part to be considered).
BS 5930	Code of practice for ground investigation, British Standard, 2015
EN ISO 9001:2015	Quality management systems — Requirements. International Organization for Standardization (ISO), 2015.
EN ISO 14688-1:2017	Geotechnical investigation and testing — Identification and classification of soil — Part 1: Identification and description. International Organization for Standardization (ISO), 2017.
EN ISO 14688-2:2017	Geotechnical investigation and testing — Identification and classification of soil — Part 2: Principles for a classification. International Organization for Standardization (ISO), 2017.
EN ISO 19901-8:2014	Petroleum and natural gas industries — Specific requirements for offshore structures — Part 8: Marine soil investigations. International Organization for Standardization (ISO), 2014.
EN ISO 19901-2:2017	Petroleum and natural gas industries: specific requirements for offshore structures – Part 2: Seismic design procedures and criteria. International Organization for Standardization (ISO), 2017.
EN ISO 22476-1:2012	Geotechnical investigation and testing — Field testing — Part 1: Electrical cone and piezocone penetration test. International Organization for Standardization (ISO), 2012.
Eurocode EN 1997-2:2007	Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing. European Committee for Standardisation (CEN), 2007.
Eurocode EN 1998-&:2004	Eurocode 8: Design of structures for earthquake resistance – Part 1: General rules, Seismic actions and rules for buildings. European Committee for Standardisation (CEN), 2004.
ISO/IEC80000	Quantities and Units – Part 1: General. Organization for Standardization (ISO), 2009.

ISSMGE International Reference Test Procedure for the Cone Penetration Test (CPT) and the Cone Penetration Test with pore pressure (CPTU). International Society of Soil Mechanics and Geotechnical Engineering, 2001.

1 Introduction & Background (Lot 1 and Lot 2)

1.1 Scope document

This document details the scope of the WORK as part of the SPECIFIC AGREEMENT that CLIENT has awarded to CONTRACTOR for carrying out geotechnical investigations at Ten Noorden van de Waddeneilanden (TNW) Wind Farm Zone (WFZ).

1.2 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 subsidy for construction and operation of (a) wind farm(s) will be organized under the Offshore Wind Energy Act. 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.

1.3 Objective of geotechnical survey and Ground Model

The tender is divided into two lots

Lot 1 contains the site investigation phase, i.e. offshore site investigation comprising:

- A seabed campaign (Phase I): CPTs, (i.e.: PCPTs/SCPTs/TCPTs), Vibrocores, laboratory testing and reporting.
- A downhole campaign (Phase II): borehole sampling, downhole in-situ testing, laboratory testing and reporting.

Lot 2 contains the development of a Geological Ground Model and an Integrated Ground Model.

The overall objective of the geotechnical soil investigation and the ground models is to improve the geological and geotechnical understanding of Ten Noorden van de Waddeneilanden Wind Farm Zone and to obtain geotechnical information on this location, which is suitable to progress the design and installation requirements for offshore wind farms, including, but not limited to foundations and cables.

1.3.1 Objective of geotechnical survey (Lot 1)

The geotechnical soil investigation must provide relevant information about the soil to a depth below which the possible existence of weak formations will not influence the safety or performance of the wind turbines and their support structure. In addition, the geotechnical soil investigation must provide high resolution information regarding the shallower soils as input for cable burial and morphodynamic assessments.

The geotechnical investigation of Ten Noorden van de Waddeneilanden Wind Farm Zone consisting of a combination of sampling with subsequent laboratory testing and in situ testing, should include, but not be limited to, the following assessments for all important layers:

- Description and index classification
- Strength parameters
- Deformation properties
- Permeability
- In-situ stress conditions

The laboratory test programme for determination of soil strength and deformation properties shall cover a set of different types of tests and a number of tests of each type, which will permit preliminary foundation design to be performed and to give basic details for the detailed foundation design.

1.3.2 Objective of Ground Model (Lot 2)

The objective of the Geological and Integrated Ground Model is to:

- Further develop the geological / geophysical model for the Ten Noorden van de Waddeneilanden Wind Farm Zone;
- Determine the vertical and lateral variation in seabed conditions;
- Update the findings of the geological desk study and provide a detailed Geological and Integrated Ground Model of the site.
- Provide relevant geotechnical data for the design of the Ten Noorden van de Waddeneilanden offshore wind farm, including, but not limited to foundations and cables.

1.4 Site description

The location of Ten Noorden van de Waddeneilanden WFZ and the other Wind Farm Zones are shown in Figure 1. After the Borssele WFZ, Hollandse Kust (zuid, noord and west) WFZs, this is the fifth WFZ for which site investigations shall be executed within the Offshore Wind Energy Roadmap 2030.

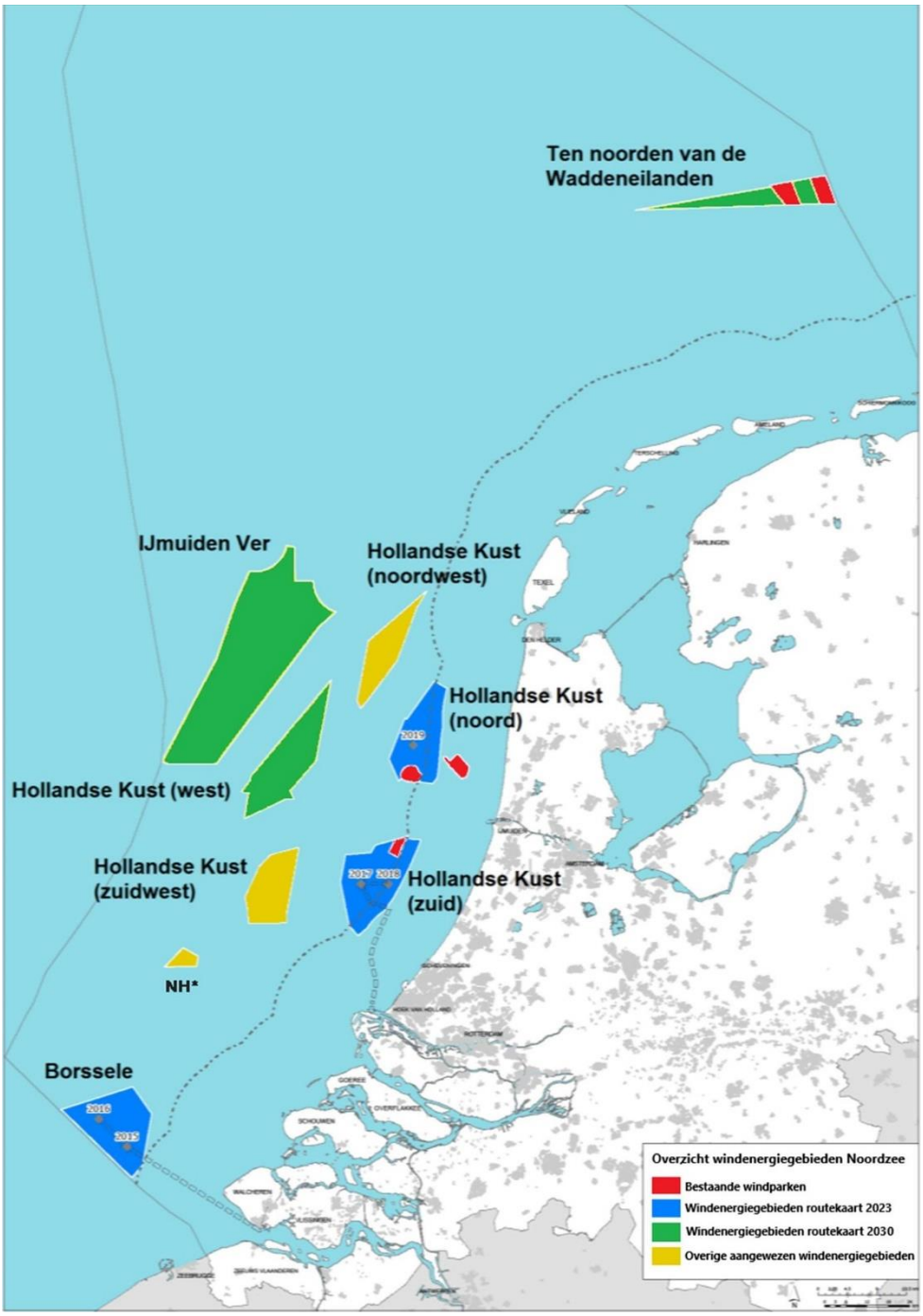

Figure 1 Designated Wind Farm Zones in the Netherlands.

1.5 Investigation areas (IA)

It is the intention to obtain a single set of data, reports and drawings for the TNW WFZ. The Investigation Areas are defined as the following for Lot 1 (Geotechnical Survey) and Lot 2 (Ground Model):

- The geotechnical investigation area contains the designated wind farm zone, EXCLUDING an additional buffer zone (0.5 km) around the wind farm zone (see Figure 2);
- the Ground Model Investigation area contains the designated wind farm zone, INCLUDING an additional buffer zone (0.5 km) around the wind farm zone. This area has also been investigated during the geophysical investigation (see Figure 3).

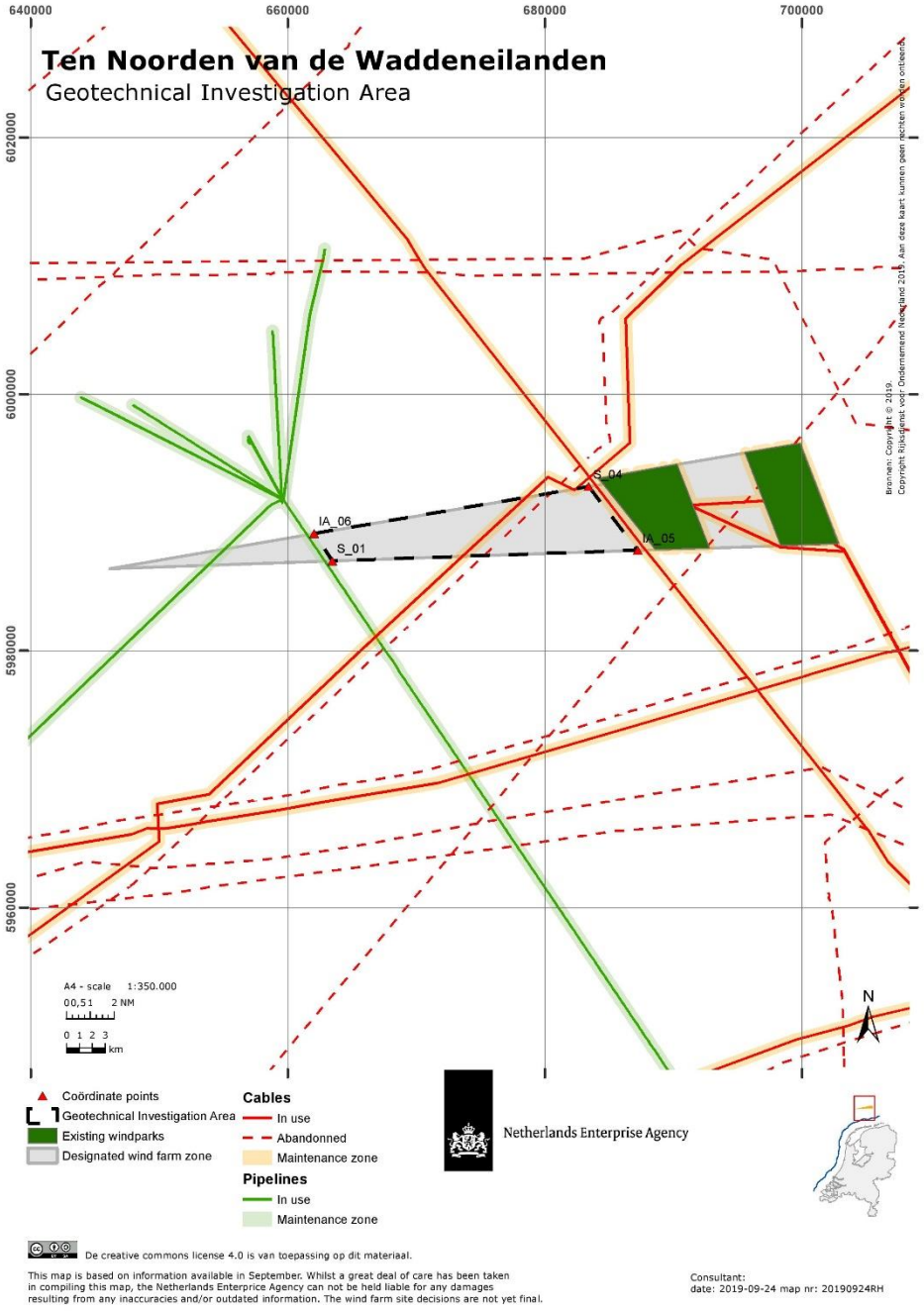

Figure 2: Investigation Area (IA) Geotechnical Survey (Lot 1) Ten Noorden van de Waddeneilanden

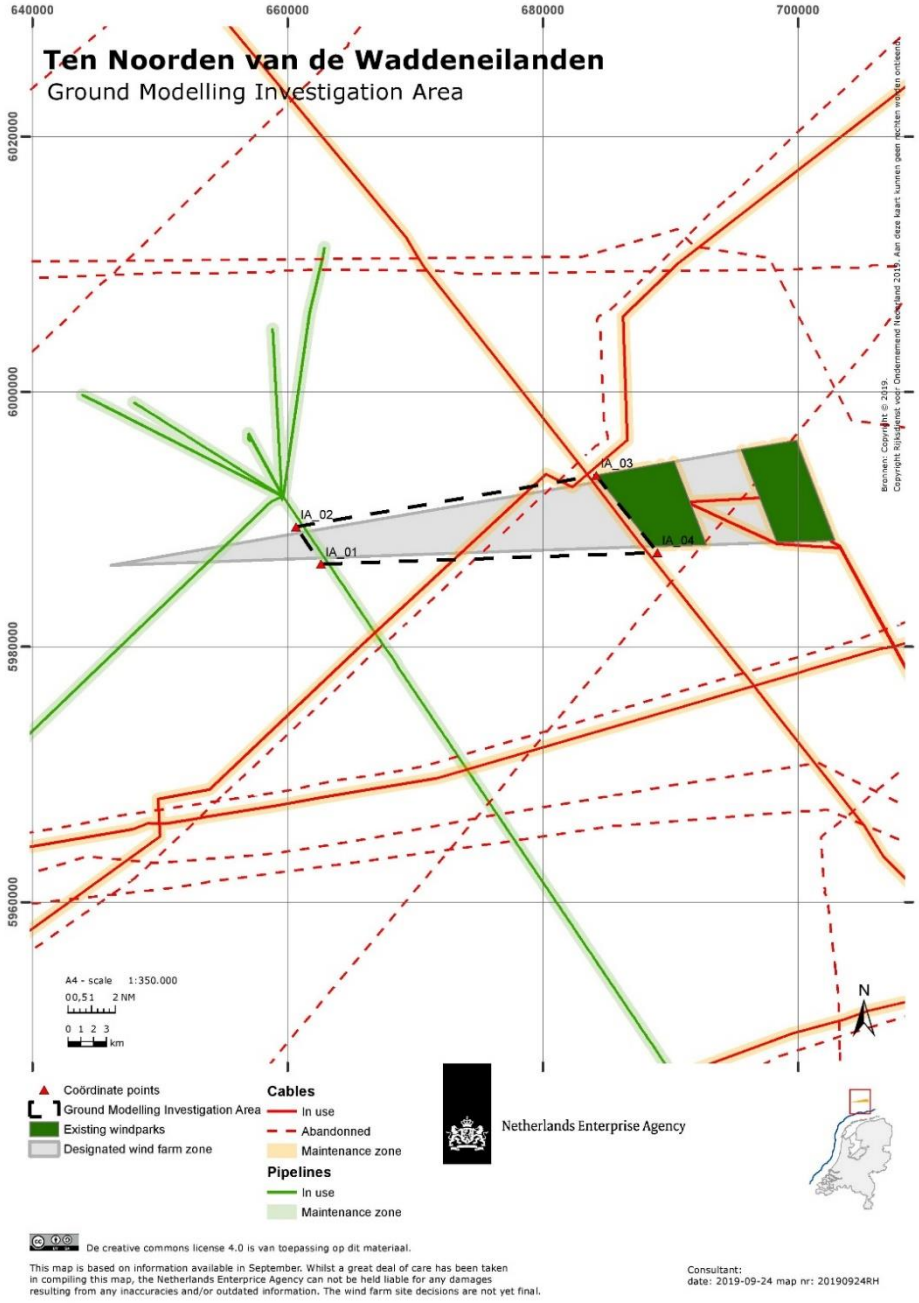

Figure 3: Investigation Area (IA) Ground Model (Lot 2) Ten Noorden van de Waddeneilanden

Table 1: Investigation Area (IA) for Geotechnical Survey (Lot 1) and Ground Model (Lot 2)

IA Coordinates Geotechnical Survey				IA Coordinates Ground Model		
NR	ETRS_X	ETRS_Y		NR	ETRS_X	ETRS_Y
S_01	663458,0	5987029,0		IA_01	662609,9	5986499,5
IA_05	687217,8	5987845,7		IA_02	660637,1	5989424,6
S_04	683402,7	5992812,4		IA_03	684166,9	5993451,0
IA_06	662029,4	5989155,6		IA_04	688960,9	5987405,4

1.6 Execution of the investigation

CONTRACTOR shall take into account that alignment on the survey plans (timing and location at the site where the survey is carried out) shall be performed with other contractors working at the site if required.

1.7 Planning of the works

The offshore soil investigation campaign is foreseen to be carried out latest Q2 2020 (Phase I Seabed campaign) and Q3 2020 (Phase II Downhole campaign). The integrated ground model is to be delivered Q2 2021 latest.

1.8 Available information

The following studies will be provided by CLIENT separately to the CONTRACTOR before start of the works[1]:

- Geological desk study, via https://offshorewind.rvo.nl/TNW_Soil;
- UXO desk study, via https://offshorewind.rvo.nl/TNW_Obstruction;
- Persistence tables for TNWWFZ;
- Base map (MPK) containing information on location;
- Geophysical survey reports (2D and 3D survey executed by MMT Sweden AB in 2019)

Further, for information only, the results of the geophysical and geotechnical surveys carried out for Borssele as well as HKZ and HKN WFZ are available at http://offshorewind.rvo.nl/. It should be noted that the scope of work for the previous surveys carried out by the CLIENT may deviate from the current scope of work.

1.9 Webinar

It is anticipated that the end results will be disclosed through several webinars. See examples at http://offshorewind.rvo.nl/presentationshk. Both Contractors are requested to include in their offer following activities:

- Prepare presentations, including illustrations
- Attend the webinars at a location in Amsterdam with at least two experts
    - One expert (each lot) to present the presentation

[1] All studies, excluding the Geophysical Survey Reports, are available within this Tender package

    - One expert (each lot) to participate in the expert panel to support in the answering of questions of the webinar participants during the presentation
- Support in the answering of questions after the webinars.

The date of the webinar will be determined in cooperation with end users of the study. The following assumptions serve as a guideline for the planning of the webinar:

- The complete set of certified end products has been published at offshorewind.rvo.nl
- End users are in a phase when they are potentially using the end product for the preparation for the upcoming permit tender.
- End users should have sufficient time for a detailed reading between disclosure of certified end product and webinar.

The webinar for the present Scope of Work is anticipated to be held for both contractors in Q3 2021. It is preferred that the webinar of both contracts will be held on the same day. Facility of webinars will be at cost of Contracting Authority.

1.10 Interfaces Lot 1 and Lot 2 Contractor and Certification

Lot 1 and Lot 2 CONTRACTOR shall fully cooperate with certification body contracted by CLIENT. The aim of contracted certification body is to issue for each report to be delivered a Certification Report that the report has been derived by best practice, according to applicable norms and industry standards (e.g. DNV GL-SE-0190:2015-12 or equal or better).

Lot 1 and Lot 2 CONTRACTOR are requested to cooperate in the process towards this Certification Report. The scope should include time to adjust the results on review rounds of CLIENT and certification body. The cooperation and adjustment works shall be done by senior personnel of CONTRACTOR. The work can and will only be accepted once the Certification Report is received.

Lot 1 and Lot 2 CONTRACTOR shall fully cooperate with other actors involved in the Ten Noorden van de Waddeneilanden works of the CLIENT. The main interfaces for Lot 1 CONTRACTOR are described in chapter 2.2. The main interfaces for Lot 2 CONTRACTOR are described in chapter 3.2. The scope should include time for all cooperation works. The cooperation works shall be done by senior personnel of CONTRACTOR.

1.11 Co-creation

The CLIENT wants to explore the concept of co-creation in the project. This means that new working forms between contractors of Lot 1 and Lot 2 and client will be explored. In this context, the following co-creation opportunities are foreseen:

- Definition of the BH / CPT plan following the geophysical campaign;
- Development of the Integrated Ground Model;
- Dissemination activities such as webinar and answering questions from the market.

2 Scope of Work (Lot 1)

2.1 Activities

The activities that need to be carried out to obtain the information detailed in section 1.3.1 are the following for Lot 1:

Preparation

- All preparatory works required for the geotechnical survey, including preparation of all plans that need to be provided (and approved) before the works can start.

Geotechnical in situ measurements in the wind farm zone

- Seabed cone penetration tests (CPT) using either standard piezocones (PCPT) or seismic cones (SCPT)
- Dissipation tests during seabed PCPT
- In situ thermal conductivity testing using either a temperature cone penetrometer (TCPT) or an in situ thermal probe (depending on soil conditions)
- Vibrocore sampling
- Boreholes with a combination of downhole sampling, downhole PCPT and downhole SCPT
- Borehole geophysical logging (BGL) including P-S logging, density logging and spectral gamma ray logging tests in completed sampling/PCPT boreholes

Laboratory testing

- Standard laboratory tests (including static strength tests)
- Advanced laboratory test program (including dynamic & cyclic strength tests)

Data processing and Interpretation

- Process the data obtained through the geotechnical survey
- Produce derived products including interpretation

Reporting

- Create final data package with QA and metadata elements
- Present the results in clear reports and drawings

Delivery

- Products of the survey are to be delivered as a coherent and integrated data package with clear documentation.

This scope of work is designed to provide a minimum specification. The description of the survey targets should inform the contractors for preparing their proposal which should clearly describe their suggested specification suitable for achieving the survey objectives. Proposals of higher specification than the minimum may receive net higher scores if this is justified against a relevant performance improvement (i.e. a better chance of achieving the survey objectives to an appropriate quality level). A specification deemed to be of lower quality than the minimum will receive lower scores.

It should be recognised that the results of the survey are to be integrated with other products and made available to multiple parties as part of the information package associated with the tender process described in section 1.2. 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, positioning information, reporting and metadata are important elements of the deliverable package including a clear description of the data provision chain.

As part of the tender submission CONTRACTOR shall be required to clarify the limitations of performing each test type (seismic cone, P-S logging, dissipation testing, thermal conductivity testing) in the respective modes (downhole, seabed) and detail any perceived advantages in changing the anticipated deployment method.

2.2 Interfaces

CONTRACTOR shall fully cooperate with other actors involved in the Ten Noorden van de Waddeneilanden works of the CLIENT. The main interfaces are described below:

- The Lot 1 CONTRACTOR and Lot 2 CONTRACTOR will in cooperation with the CLIENT experts develop a CPT and borehole plan, which is subject to approval by the CLIENT. A meeting shall be included in the Scope of Work of the CONTRACTOR.
- Particle Size Distributions of the vibrocores and boreholes are used as input for the morphodynamic study for TNW. Therefore, these results shall be delivered as a separate memo as soon as possible but not later than six (6) weeks after the Offshore Completion Date incl. WAITING ON WEATHER.
- Selected CPTs and boreholes are performed for the substations of TenneT. These results need to be included in the overall downhole campaign report and provided as a separate report.
- An archaeological assessment will be made of the geotechnical results. This is anticipated to take 2 meetings for alignment. These meetings shall be included in the Scope of Work of the CONTRACTOR.
- Lot 1 and Lot 2 CONTRACTOR will fully cooperate with the certification body in the process which aims towards a Certification Report for all report deliverables.

2.3 General requirements of survey works

2.3.1 General requirements for offshore geotechnical site investigation

- Obtaining all necessary permissions and / or notifications;
- Making oneself acquaint with the local conditions before the start of the work;
- Carrying out an independent UXO risk assessment for the proposed borehole and seabed CPT locations by using the data from the geophysical campaign (e.g. magnetometer data) and undertake any required additional measures in order to reduce the risk to as low as reasonably practical (ALARP);
- Preparation of the geotechnical survey and plans that need to be provided (and approved) before the works can start;

- Preparing the necessary laboratory testing specifications and schedules for CLIENT approval and performing laboratory testing on obtained soil samples;
- The currently anticipated quantities of investigations and tests are specified in Annex 4a. These quantities should be considered indicative. The CLIENT will adjust these in accordance with the provisions in the Contract, once the geophysical data becomes available;
- Lot 1 CONTRACTOR shall advise on the target coordinates of boreholes, seabed CPT and vibrocores, following the borehole and CPT memo from the geophysical campaign. Lot 1 and Lot 2 CONTRACTOR will jointly discuss this with the CLIENT. The CLIENT will give final approval on the final target coordinates of boreholes, seabed CPT and vibrocores;
- Inform the CLIENT on the progress of the works;
- Process the data obtained through the geotechnical survey, provide provisional raw data of results (for QC and definition of subsequent tests) and present all results in clear reports and drawings.

2.3.2 General scope survey works for Phase I (seabed campaign)

The activities that need to be carried out to obtain the information detailed in section 1.3 are the following for Phase I:

- Carry out deep seabed CPT with a target depth of 60 m, using either a standard piezocone penetrometer (PCPT) or a seismic cone (SCPT), for foundation design purposes. It should be noted that the CONTRACTOR has been incentivised to reach target depth using the best available system by the bonus payment structure shown in Annex 4a. The CPT rate per m will be double for a depth larger than 50 m;
- Although the seabed CPTs using the SCPT shall be carried out to a target depth of 60 m in order to obtain standard cone data at least, the seismic tests may be stopped after the depth at which the seismic signal is no longer strong enough for providing reliable shear wave velocity data. This decision will be made by the CLIENT OFFSHORE REPRESENTATIVE after consulting the CONTRACTOR. The seismic cone should include dual geophones (set approx. 0,5 m - 1 m apart) to enable an accurate measurement of the shear wave velocity over the associated soil interval. The seismic tests should be performed at depth intervals of approximately 1-2 m, as directed by the CLIENT OFFSHORE REPRESENTATIVE;
- Perform *in situ* thermal conductivity tests using a temperature cone or thermal probe, as appropriate depending on soil conditions (or similar equipment approved by CLIENT) at selected locations across the site, for the purpose of subsea electrical cable design. At each location tests should be carried out at approx. 1 m intervals to a target depth based on the expected burial depth at each location (to be advised in advance by CLIENT OFFSHORE REPRESENTATIVE). N.B. The CONTRACTOR should have both a temperature cone and thermal probe available onboard vessel (or similar equipment approved by CLIENT);
- Perform dissipation tests during seabed PCPT tests at locations and depths to be agreed with CLIENT OFFSHORE REPRESENTATIVE;
- Perform vibrocores at selected locations to a depth at least 3 m below the base of the mobile seabed (using 6 m core barrel), for the main purpose of seabed morphodynamic assessment. These vibrocores will be located in groups of 5 along transects perpendicular to selected sand waves, at separation intervals of approx. 75 m. The locations will be proposed by the CONTRACTOR and confirmed by the CLIENT.

Please note that for the purpose of tendering all quantities for the above items are presented in Annex 4a of the Invitation to Tender.

2.3.3 General scope survey works for Phase II (downhole campaign)

The activities that need to be carried out to obtain the information detailed in section 1.3 are the following for Phase II:

- Drilling boreholes with a combination of sampling, downhole piezocone penetration tests (PCPT) and downhole seismic cone tests (SCPT) to a target depth ranging between 60 m and 100 m. These boreholes can be sub-divided into four types, as follows:
    - Type 1 - where the sampling/testing regime consists of quasi-continuous sampling from seabed to a predetermined depth following by a combination of sampling and PCPT to a target depth of 60-80 m. This may include oversampling of a PCPT stroke in order to verify material type, as directed by the CLIENT OFFSHORE REPRESENTATIVE. The main purpose of the Type 1 borehole is to obtain general soil data for developing geological and engineering soil models. Type 1 boreholes will be located adjacent to one of the deep seabed CPTs;
    - Type 2 – where the sampling/testing regime consists of quasi-continuous SCPTs carried out to a target depth of 60 m or the depth at which the seismic signal is no longer strong enough for providing reliable results. The main purpose of the Type 2 borehole is to obtain *in situ* shear wave velocity measurements for deriving small-strain shear modulus. The SCPT system shall include dual geophones (set approx. 1 m apart) to enable an accurate measurement of the shear wave velocity over the associated soil interval. The seismic tests shall be performed at depth intervals of approximately 1-2 m, as directed by the CLIENT OFFSHORE REPRESENTATIVE. Oversampling of selected SCPT strokes may be required, as directed by the CLIENT OFFSHORE REPRESENTATIVE. A Type 2 borehole will be located adjacent to a selected Type 1 borehole for correlation with the relevant laboratory test results;
    - Type 3 – combined downhole sampling/PCPT boreholes at selected locations with a target depth of at least 80 m (optional up to 100 m) for the purpose of the TenneT platform foundation design. The detailed sampling/testing regime will be specified by TenneT.
    - Type 4 – these boreholes will be drilled purely for the purpose of extending a seabed CPT to a depth of 60 m because of the shallow refusal depth of the seabed CPT. Between seabed and a fixed distance (approx. 2 m) above the seabed CPT termination depth, occasional samples will be required in units of engineering significance. Below this depth, quasi-continuous downhole PCPT shall commence with occasional sampling/oversampling as directed by the CLIENT OFFSHORE REPRESENTATIVE. A Type 4 borehole will be located adjacent to a selected seabed CPT;
- P-S logging is to be performed in selected Type 1 boreholes for cross-correlation/verification with either adjacent seabed SCPT or adjacent downhole SCPT results. This should involve drilling-out the Type 1 borehole to a sufficient depth beyond 60 m so that the first P-S logging test can be performed at 60 m below seabed. P-S logging tests should be undertaken at depth intervals of approximately 1 m, or as directed by the CLIENT OFFSHORE REPRESENTATIVE;

- Density logging and spectral gamma ray logging is to be performed in selected Type 1 boreholes;
- In some of the Type 1, Type 3 or Type 4 boreholes, selected downhole PCPTs may be replaced with downhole SCPTs. Any such replacements will be notified by the CLIENT OFFSHORE REPRESENTATIVE in advance of moving to the relevant borehole location;
- For any of the borehole types, oversampling of a PCPT or SCPT stroke may be requested by the CLIENT OFFSHORE REPRESENTATIVE in order to verify the soil material type being tested.

For the purpose of tendering, estimated quantities of the different borehole types and the associated samples/tests are presented in Annex 4a.

2.4 Preparation of geotechnical site investigations

2.4.1 Scrutinise available information

CONTRACTOR shall scrutinise the information that has been made available by CLIENT. Information that is relevant for carrying out the WORK shall be taken into account while preparing the WORK.

2.4.2 Preparations

Permits

Obtaining and arranging all necessary permissions and/or notifications to perform the survey (including all permissions and fees necessary for access and safety arrangements to harbours and offshore positions).

Project Plans

CONTRACTOR shall prepare all project plans as required by the CONTRACT. These documents shall include, but are not limited to:

- Project Execution Plan (including applicable Method Statements and Risk Assessments);
- Project HSE Plan, including Emergency Response plan;
- Project Quality Plan/Quality Manual.

Risks will be discussed with CONTRACTOR on a weekly basis during the progress meetings. CONTRACTOR shall only commence the WORK when all project plans have been reviewed by CLIENT and CLIENT has confirmed to have no further comments. All project plans shall be approved as final at least three days prior the Start of Mobilisation, as defined in Schedule of Key Dates (chapter 3).

2.4.3 UXO risk assessment and measures

The general risk regarding the presence of UXO (unexploded ordnance) has been assessed and reported by REASeuro. Their report is to be found here: https://offshorewind.rvo.nl/TNW_Obstruction.

CONTRACTOR shall carry out an independent UXO risk assessment for the proposed borehole, seabed PCPT and vibrocore locations (that will be located on the magnetometer lines or crosslines) and undertake any required additional measures in order to reduce the risk to as low as reasonably practical (ALARP). The approach shall be described in the Project Execution Plan.

2.5 Offshore Representation

The CLIENT may require up to three (3) CLIENT OFFSHORE REPRESENTATIVES per vessel to witness the offshore phase of the surveys works in addition to any other CLIENT representatives required under the contract.

The CONTRACTOR is responsible for providing safety induction training for the CLIENT OFFSHORE REPRESENTATIVES 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 CLIENT OFFSHORE REPRESENTATIVES on any vessel to include a private cabin, office space including colour printer, communication systems and messing facilities. The CLIENT cabin shall have an uninterrupted internet connection with a minimum speed of 512 kbits/sec upload / download. This internet connection shall be used solely for the CLIENT OFFSHORE REPRESENTATIVES.

CONTRACTOR shall provide Personal Protective Equipment (PPE), life jackets and any special offshore PPE for the CLIENT OFFSHORE REPRESENTATIVES for the duration of the project.

CONTRACTOR shall make a port call at least every four weeks to allow rotations of CLIENT OFFSHORE REPRESENTATIVES.

2.6 Mobilisation

2.6.1 Mobilisation

Mobilisation of the vessel(s) to the site, complete with all necessary geotechnical equipment and personnel. CONTRACTOR shall indicate the proposed port of mobilisation/demobilisation as well as the number of port calls foreseen during the survey.

The CLIENT requires a port call every four weeks (as a minimum) for CLIENT OFFSHORE REPRESENTATIVE crew changes (applies to both phases).

The CLIENT requires a biweekly transport of soil samples to laboratory (as a minimum).

The harbour to be used for mobilisation of survey vessel(s), equipment and personnel shall be approved by the CLIENT.

Mobilisation commences with the installation of equipment, continues through the performance of harbour and offshore trials (e.g. positioning/navigational equipment), and finishes with the completion of equipment calibrations, transit to the site and positioning on the first location. A detailed mobilisation checklist shall be presented in the Project Execution Plan.

Mobilisation is deemed complete:

- After all trials and calibrations have been completed to the approval of the CLIENT OFFSHORE REPRESENTATIVE and the CONTRACTOR REPRESENTATIVE. Notice of approval shall be in writing and shall be incorporated in the Mobilisation Report.
- When the vessel(s) is (are) at the first investigation location, ready to deploy the sea bed frame/rig to perform the WORKS

For the avoidance of doubt, WAITING ON WEATHER will only apply when the mobilisation is deemed complete as described above.

The CONTRACTOR must provide a Mobilisation Report within two (2) days of the CLIENT's acceptance of mobilisation, which must document but is not limited to the following:

- Equipment mobilised on board and any deviation from the CONTRACTOR procedures;
- Equipment trials and calibrations;
- Equipment calibration certificates;
- Vessel Safety Audit not older than 6 months before Start of Mobilisation;
- POB list;
- Any non-critical defects.

2.6.2 Positioning

The location of survey vessel(s) (at least DP2) and testing devices shall be determined using at least two independent Differential GPS (DGPS) systems.

GPS system accuracy shall be:

- 10 cm accuracy in x & y direction
- 20 cm accuracy in z direction

Independence between DGPS systems implies that both segments are at least two independent systems. RVO has a preference for tertiary and quaternary systems for added positioning redundancy. The secondary system shall be available both as a backup for the primary system and for online quality assurance. Additional systems shall be used as independent checks on the primary systems.

The independent secondary system (i.e. independent in all respects except satellites) must be operated in parallel with the primary system, so as to provide full real time redundancy. A continuous comparison between the position solutions derived from the primary and secondary systems must be made throughout the survey. Any differences of more than 1 metre between the primary and the secondary system must be investigated; survey operations must be suspended until the source of discrepancy is found and solved.

The elevation of the CPT / drilling equipment (with reference to the seabed level) shall be accurately measured during the execution of the WORKS. Any settlement of the equipment is to be recorded and reported to the CLIENT OFFSHORE REPRESENTATIVE. CONTRACTOR shall provide detailed methodologies on how the settlement of the seabed frame into the seabed shall be measured along with measurement of frame inclination. At least two independent methods should be applied on site by CONTRACTOR in order that cross-comparison can be made. For the Phase II (downhole campaign), the drill string or the casing (if any) can be used to control the elevation of the deck or reference datum for sampling. The elevation of strata changes within boreholes is established relative to seabed and to the specified reference level.

The CONTRACTOR shall set up the required equipment (e.g. echosounder) to check the water depth. Water depth data both measured and reduced to the specified datum shall be made available to the CLIENT OFFSHORE REPRESENTATIVE and shall be included on the measured and interpreted logs.

Accuracy of water depth measurement: 10 cm.

For each location, a CTD probe profile or equivalent CLIENT approved methods is established to determine at least the water depth and the water temperature at seafloor.

The exact position of the measurements must be recorded with an acoustic tracking system such as a USBL, giving the position of the equipment underwater relative to the vessel surface position.

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 GPS time base.

USBL system accuracy: 0.5 % of Slant Range

The CONTRACTOR must calibrate 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.

All measurements should be positioned within a 5 m radius of the target coordinates. If re-positioning is required, the seabed frame should be positioned as close to the target coordinates as possible. If an obstruction is encountered on the seabed or the seabed level exceeds 5-10 degrees (depending on availability of a levelling system), the seabed CPT shall be re-positioned to avoid the obstruction or excess slope whilst keeping the CPT location as close to the target co-ordinates as possible.

Repositioning is to be confirmed and approved by the CLIENT OFFSHORE REPRESENTATIVE.

2.6.3 Coordinate reference system and datum

Units of measurements:

SI units (ISO/IEC80000) are applicable for any activities carried out at the Wind Farm Zone. 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).

The vertical datum for the survey is Lowest Astronomical Tide (LAT)

The methodology and height reduction model used to reduce the data to LAT shall be described in the CONTRACTOR's Project Execution Plan and Final report. The reduction method used should be well-established and proven, *e.g*. BLAST method.

2.6.4 Sea Bed Frames for Seabed CPT and Boreholes

Although there are sand waves in the area, it is normally possible to avoid the more onerous seabed gradients by micrositing the seabed CPTs or boreholes. However, the CLIENT prefers the CONTRACTOR to provide a system that allows for some adjustment in the level of the seabed frame in order to increase flexibility. It is noted that skirts could be helpful in this respect. CONTRACTOR is requested to propose practical methods to attain a level sea bed frame for vertical alignment of the cone rods or drill-string, including for drill-string re-entry purposes. CLIENT will prefer practical and proven methods of attaining a level and stable re-entry platform. CONTRACTOR shall provide detailed methodologies on how the tilt and settlement of the seabed frame into the seabed shall be measured in case of scour during CPT/drilling operations, along with measurement of frame inclination.

2.7 Execution of Seabed CPT and Vibrocores (Phase I)

2.7.1 Executing seabed CPTs

The seabed CPT system shall include a minimum 20 tonne thrust reaction and at least a cone tip capacity of 100 kN or 150 kN, depending on the cone tip area (see below).

CONTRACTOR should have both 36 mm and 44 mm rods, and a friction reducer available in order to increase the chances of achieving a greater test depth. CONTRACTOR is permitted to use rods of other configurations with written CLIENT approval but should describe in the offer how and whether they can reach the target depth and why the method is deemed by the CONTRACTOR to be suitable. References, data sheets and other supporting documentation including examples of previous results shall be included to justify deviation from convention.

The tests shall be carried out in full accordance with ISSMGE Reference Test Procedures, EN ISO 22476-1:2012, and Eurocode EN 1997-2:2007. In particular, the cone penetration rate shall be between 15 mm/s and 25 mm/s with a target of 20 mm/s, except if a deviation from this range is accepted by the CLIENT in advance for some specific cases.

At start of the individual PCPT, the tip and friction sleeve readings shall be zeroed and the pore pressure reading checked to confirm compliance with the water depth. Calibration of PCPT should not be older than 3 months before Start of Mobilisation. CONTRACTOR shall provide the calibration certificates for CLIENT review and approval before Start of Mobilisation.

The seabed elevation at the test location shall be registered by pressure transducers mounted on the seabed frame and corrected for specific gravity of the water column at the location. Comparative rod length measurements versus depths registered as pressure shall be performed at all locations. Water depths shall be reduced to LAT.

The specifications of the seabed CPT equipment shall include:

- A minimum thrust capacity of 200 kN (20 tonnes);
- Cones with projected areas of 10 cm^2 and 15 cm^2;
- A target penetration depth of 60 m;
- Cone tip capacity of 100 kN (10 tons for a 10 cm^2 cone) (or 150 kN / 15 tons if using 15 cm^2 cone).

The typical parameters that define refusal of the seabed CPT are as follows:

1. Total thrust equals nominal reaction provided;
2. Cone tip load is 100 % of the cone tip capacity;
3. Sleeve friction is more than 15 % of the cone tip capacity or 1.5 MPa;
4. Rod deviation from vertical is greater than fifteen (15) degrees between the tip and the top of the hole;
5. Cone deviation increases by more than three (3) degrees over a penetration length of one metre or less;
6. The CONTRACTOR operator judges that further penetration would damage the equipment, in which case an explanation shall be provided within 24 hours.

The PCPT accuracy class should be a minimum of class 2 or preferably class 1 as detailed in Table 2 below.

Table 2: Allowable CPT accuracy Class (ISO 22476-1:2012)I

Application class	Test type	Measured parameter	Allowable minimum accuracy[a]	Maximum length between measurements	Use	
					Soil[b]	Interpretation / evaluation[c]
1	TE2	Cone resistance	35 kPa or 5 %	20 mm	A	G, H
		Sleeve friction	5 kPa or 10 %			
		Pore pressure	10 kPa or 2 %			
		Inclination	2°			
		Penetration length	0,1 m or 1%			
2	TE1 TE2	Cone resistance	100 kPa or 5 %	20 mm	A	G, H*
		Sleeve friction	15 kPa or 15 %		B	G, H
		Pore pressure[d]	25 kPa or 3 %		C	G, H
		Inclination	2°		D	G, H
		Penetration length	0,1 m or 1 %			
3	TE1 TE2	Cone resistance	200 kPa or 5 %	50 mm	A	G
		Sleeve friction	25 kPa or 15 %		B	G, H*
		Pore pressure[d]	50 kPa or 5 %		C	G, H
		Inclination	5°		D	G, H
		Penetration length	0,2 m or 2 %			
4	TE1	Cone resistance	500 kPa or 5 %	50 mm	A	G*
		Sleeve friction	50 kPa or 20 %		B	G*
		Penetration length	0,2 m or 2 %		C	G*
					D	G*

NOTE For extremely soft soils, even higher demands on the accuracy can be needed.

[a] The allowable minimum accuracy of the measured parameter is the larger value of the two quoted. The relative accuracy applies to the measured value and not the measuring range.

[b] According to ISO 14688-2 [1]:
- A homogeneously bedded soils with very soft to stiff clays and silts (typically q_c < 3 MPa)
- B mixed bedded soils with soft to stiff clays (typically $q_c \leq$ 3 MPa) and medium dense sands (typically 5 MPa $\leq q_c <$ 10 MPa)
- C mixed bedded soils with stiff clays (typically 1,5 MPa $\leq q_c <$ 3 MPa) and very dense sands (typically $q_c >$ 20 MPa)
- D very stiff to hard clays (typically $q_c \geq$ 3 MPa) and very dense coarse soils ($q_c \geq$ 20 MPa)

[c]
- G profiling and material identification with low associated uncertainty level
- G* indicative profiling and material identification with high associated uncertainty level
- H interpretation in terms of design with low associated uncertainty level
- H* indicative interpretation in terms of design with high associated uncertainty level

[d] Pore pressure can only be measured if TE2 is used.

The additional detailed refusal criteria of 1.5 MPa on the sleeve friction is set in order to maximise the performance of the cone and achieve maximum data where cone tip resistance is not in accordance with the default requirement. This shall apply to both seabed and downhole tests.

As part of CONTRACTOR tender submission, evidence shall be provided to demonstrate performance of proposed equipment in similar ground conditions, including the physical ability to reach a target depth of 60m below seabed. Limitations of the equipment are to be stated clearly by the CONTRACTOR within the proposal. Reports summarising ground conditions in the general area of investigation is available at http://offshorewind.rvo.nl/ for Borssele, HKZ and HKN WFZ. It should be noted that the soil conditions may differ from the previous wind farm zone investigations, e.g. higher cone resistances in TNW WFZ.

2.7.2 Seismic cone penetration tests (SCPT)

Although the seabed CPTs using seismic cone shall be carried out to a target depth of 60 m in order to obtain at least the standard cone data, the seismic tests may be stopped at the depth at which the seismic signal is no longer strong enough for providing reliable shear wave velocity data.

CONTRACTOR shall perform seismic cone tests in seabed CPT mode to the refusal depth or the depth at which the seismic signal is no longer strong enough for providing reliable shear wave velocity data or to refusal, as directed by the CLIENT OFFSHORE REPRESENTATIVE. The seismic cone shall be deployed in seabed CPT mode using dual array x, y, z receivers mounted behind a conventional 10 cm^2 or 15 cm^2 cone.

Further specifications are given in section 2.7.1.

Lot 1 and Lot 2 CONTRACTOR will advise on the preferred locations based on the results of the geophysical survey and the initial results of phase I if available. Final locations after approval of CLIENT. The seismic source shall be mounted on a seabed frame. Acquisition, and processing methods and procedures shall be in accordance with ISO 19901-8:2014, ASTM D7400-08 or equivalent CLIENT approved methods. Full details of the proposed methodology, processing and data presentation shall be presented as part of the CONTRACTOR tender submission.

Seismic tests shall be performed at intervals of 1-2 m, as directed by the onboard CLIENT OFFSHORE REPRESENTATIVE. Signals shall be stacked in order to achieve an acceptable signal to noise ratio to be agreed with the CLIENT OFFSHORE REPRESENTATIVE. CLIENT OFFSHORE REPRESENTATIVE has the right to reject any or all of the stacked signals or components thereof.

Plots shall include CLIENT approved measured and cone resistance based shear wave velocity for presentation as part of the final report.

Plots shall include s-wave velocities (and, where available, p-wave) for presentation as part of the final report. CONTRACTOR shall allow for provision of raw and processed digital SCPT data as a deliverable to CLIENT within the proposal.

2.7.3 Dissipation Testing

CONTRACTOR will be required to perform dissipation tests in specific layers at certain locations across each of the site. These tests shall be performed with the PCPT in seabed mode normally. Testing and reporting shall be in accordance with CLIENT approved standards and procedures. CONTRACTOR shall allow for dissipations of 90 percent in granular soils and either 50 percent or 90 percent in cohesive soils. Testing shall be in accordance with ISO 19901-8:2014, ISSMFE Reference Test Procedures or CLIENT approved equivalent. Full details of the proposed methodology shall be presented as part of the CONTRACTOR submission. Testing shall also be focussed on the near sea bed section to allow for cable route heat dissipation to be assessed.

2.7.4 Thermal Conductivity

For the purposes of cable burial CONTRACTOR shall propose a method to measure the *in situ* thermal conductivity and heat capacity of the shallow soils using a temperature cone and a thermal probe or similar method approved by CLIENT. CONTRACTOR should assume testing at metre intervals to a maximum of 6 m below sea bed. Depending on the actual soil conditions a temperature cone (ideal for dense sands or stiff clays where frictional heat is easily generated during penetration) or a

thermal probe cone (uses electrically generated heat) shall be used and shall be available on the vessel(s). The results are to be used to inform the design basis for inter array cable installation and shall be used in conjunction with onshore laboratory tests.

CONTRACTOR shall provide full details of the proposed method including deployment and recovery of the proposed unit, methods of calculation of thermal conductivity and specific heat capacity of the soil, and presentation of the results.

2.7.5 Vibrocoring

In situ sampling

To enable a detailed assessment of sand wave characteristics, vibrocores shall be taken. Per selected sand wave, a group of 5 measurements will be performed (one on the crest, one on the through and three on the side slopes). These 5 measurements will be aligned perpendicular to the sand wave crest and be performed with a spacing of about 75 m. The vibrocores shall extend to a depth at least three metres below the base of the sand waves. The vibrocorer must therefore be able to achieve a maximum penetration depth of 6 m. The inner diameter of the liner should be 100 mm however smaller diameters (e.g. 86 mm) are permitted if the CONTRACTOR ensures an equivalent quality of the recovered material when compared to the 100 mm system. A minimum of three (3) m recovery is required per location and if requested by CLIENT REPRESENTATIVE, CONTRACTOR shall undertake a maximum of one (1) re-test per location at no cost to CLIENT. Once recovered, the filled core liner is to be cut into one metre long segments, described and tested at top/bottom, capped, sealed, labelled, preserved and stored for onshore testing.

Field test at the core liner bottom shall contain the following:

- Natural water (moisture) content
- Bulk density
- Index strength tests in cohesive soils (torvane and pocket penetrometer)

CLIENT does not allow to use an extra vessel to perform vibrocoring during seabed campaign solely. CONTRACTOR shall carry out the vibrocores using the same vessel performing the seabed CPT.

Vibrocores can also be carried out during the downhole campaign using the same vessel performing the boreholes after approval of the CLIENT.

Laboratory Testing

All onshore laboratory testing on vibrocores shall be carried out at an approved geotechnical laboratory. Any subcontracted testing shall require the approval of CLIENT. All core logging and soil testing shall be carried out, where applicable, respectively to Eurocode EN 1997-2:2007, ISO 19901-8:2014, BS 5930, and BS 1377 or CLIENT approved equivalent. The CONTRACTOR ensures that the laboratories, also subcontracted laboratories, are accredited for the newest issues of standards. If the CONTRACTOR deviates from the latest standards a detailed statement is expected from the CONTRACTOR. The borehole logs shall be compiled under the terms of EN ISO 14688-1 and EN ISO 14688-2. All test data shall be presented in ASCII format for easy manipulation, data transfer, and integration.

CONTRACTOR shall be required to demonstrate a system to prove that every sample is photographed during analysis onshore to a standard to be accepted by CLIENT and recorded on to hard storage media. Examples shall be provided to nominated CLIENT expert CLIENT for approval prior to photography commencing.

As a general guideline, the following types of tests will normally be required for the different material types expected. The testing programme shall be proposed by CONTRACTOR and approved by CLIENT.

Granular Soil

- Natural water (moisture) content
- Bulk density
- Particle density
- Particle size analysis (sieve)
- Particle size analysis (using sieve and pipette method for fines fraction)
- Carbonate tests
- Organic and total carbon content (elementary analysis)
- Organic content (loss on ignition)
- Determination of thermal conductivity and specific heat capacity (needle probes)
- Electrical resistivity
- Pore water salinity

Cohesive Soil

- Natural water (moisture) content
- Bulk density
- Particle density
- Particle size analysis (using pipette method for fines and if applicable sieve)
- Atterberg limits (plastic and liquid limits, fall cone test)
- Organic and total carbon content (elementary analysis)
- Organic content (loss on ignition)
- Unconsolidated undrained (UU) triaxial compression tests on undisturbed samples
- Determination of permeability and porosity
- Determination of thermal conductivity and specific heat capacity (needle probes) (on undisturbed and remoulded samples)
- Electrical resistivity
- Pore water salinity

2.7.6 Demobilisation

Upon completion of the survey, all CONTRACTORS personnel shall be demobilised from the vessel(s) in accordance with the CONTRACT. CONTRACTOR is responsible for the removal of all equipment, instrumentation and materials from the project area following CLIENT approval of survey completion.

Demobilisation is deemed to commence when all survey operations have been completed, after approval by means of a sign-off by the CLIENT OFFSHORE REPRESENTATIVE.

2.8 Data processing and reporting for seabed CPT and vibrocores (Phase I)

After carrying out the seabed CPT and vibrocore investigation of Phase I, CONTRACTOR shall process the data that is gathered during the field work and prepare a detailed report covering the total scope of work.

The reporting requirements for the seabed CPT and vibrocore work are detailed below. Quality requirements are described in Annex 6 – Section VII - Quality Requirements & Administrative Instructions.

All reports will be written in English and include both an English and Dutch management summary.

Reports and deliverables will be delivered by contractors in pdf and original, regular, formats (docx; xlsx; ppt; etc).

2.8.1 Daily & Weekly reporting

The CONTRACTOR is to submit daily reports throughout the period of the fieldwork for each vessel, providing full details of previous 24 hours' work and results and projected locations for the forthcoming 24-hour period. Further, CONTRACTOR shall issue a weekly report providing insight in the progress of the WORK on a weekly basis. The formatting of the daily and weekly report is specified in Section VII of this Contract.

2.8.2 Preliminary CPT results and vibrocore logs

The CONTRACTOR is to provide preliminary (field) results (PCPT plots, SCPT plots, dissipation test plots, thermal conductivity test plots, vibrocore logs including ASCII data from CPT, dissipation tests and thermal conductivity tests) within 24 hours of completion of each test/vibrocore.

2.8.3 Field reports Phase I (seabed campaign)

The CONTRACTOR shall be required to submit a reporting template for the seabed campaign, Phase I, Field Reports within one week after the Start of the offshore works. Two field reports shall be made available within one week of the completion of the fieldwork for each vessel:

- a public field report for the developers/designers;
- a "not-to-be-published" Operations field report for the CLIENT.

The public field report shall include, but is not limited to:

- A statement of the purpose of the investigation;
- A description of the Work carried out, including reference to specification and standards adopted and any deviations from them;
- Exact locations of all tests/vibrocores (coordinates shall be with respect to ETRS89 datum, given in degrees and decimal minutes format as well as in eastings and northings using ETRS89 UTM Zone 31N projection). The coordinates shall also be provided in electronic format (xlsx);
- Water depth at each location, reduced to LAT;
- Drawings (GIS format or similar as well as PDF) showing the locations of all tests/vibrocores undertaken;
- Any and all calibration certificates;
- Plots of the following CPT results:
    - Measured cone resistance
    - Measured sleeve friction
    - Measured pore water pressure
    - Friction Ratio
    - Net cone resistance
    - Pore pressure ratio
    - Dissipation test plots of cone resistance and pore pressure versus time
    - Interpreted relative density (granular materials), inclusive a description of the type of correlation used for the interpretation

    - Interpreted undrained shear strength (cohesive materials), inclusive a description of the type of correlation used for the interpretation
    - Seismic test results including interpreted small-strain shear modulus versus depth inclusive of a description of the calculation method used
- Plots of thermal conductivity test results i.e. temperature versus time;
- Preliminary (field) vibrocore logs;
- Obstruction list (lost equipment on seabed and within the soil) incl. coordinates and depth;
- ASCII data of CPT tests inclusive of dissipation and thermal conductivity and specific heat capacity test results;
- ASCII data of SCPT tests.

The "not-to-be-published" field report shall contain:

- Daily logs (DPRs)
- CPT and vibrocore operator's log
- Incident reports
- Full details of all lost and damaged equipment;

The CONTRACTOR shall provide two (2) electronic copies of the field report.

2.8.4 Report Phase I

The CONTRACTOR shall submit a reporting template for the Report Seabed PCPT campaign within two (2) weeks after Start of the offshore works. CONTRACTOR shall submit a Draft Report Seabed CPT and Vibrocores no later than six (6) weeks following the completion of fieldwork. This report shall summarize the results gathered by all vessels used during seabed campaign. This report should include:

- A statement of the purpose of the investigation;
- A description of the work carried out, including reference to specification and standards adopted and any deviations from them;
- Exact locations of all tests/vibrocores, co-ordinates, water depth (LAT) shall be as defined in Section 2.8.3. The coordinates shall also be provided in electronic format (xlsx);
- Drawings (GIS or similar as well as PDF) showing the locations of the tests/vibrocores undertaken;
- Plots of the following final (quality assured) CPT results:
    - Measured cone resistance
    - Measured sleeve friction
    - Measured pore water pressure
    - Friction Ratio
    - Net cone resistance
    - Pore pressure ratio
    - Dissipation plots of cone resistance and pore pressure versus time inclusive permeability of the soil and definition of used method
    - Interpreted relative density (granular materials), inclusive a description of the type of correlation used for the interpretation
    - Interpreted undrained shear strength (cohesive materials), inclusive a description of the methods of correlation used for the interpretation and any assumptions made during the interpretation
    - Seismic test results including interpreted small-strain shear modulus versus depth inclusive of a description of the calculation method used

- Plots of final (quality assured) thermal conductivity test results i.e. temperature versus time and specific heat capacity results;
- Final (approved) vibrocore logs;
- Final (approved) detailed laboratory test results;
- Summary of Laboratory Test Results;
- Colour photographs of samples/cores;
- ASCII data of CPT tests inclusive of dissipation and thermal conductivity test and specific heat capacity results;
- Lab test data in AGS and ASCII format.

All maps (in GIS and PDF) will not show the specific Wind Farm Site. The maps will only show the outer boundary of the Wind Farm Zone and the Geotechnical Investigation Area.

The CONTRACTOR shall provide a digital draft report, which shall be made final after processing of comments and approval by the CLIENT. The draft report shall contain all information is to be included into allow a comprehensive review to be performed by CLIENT.

CONTRACTOR shall provide four (4) HDD electronic copies of the FINAL REPORT and data.

2.9 Execution of Boreholes (Phase II)

2.9.1 Executing boreholes

The boring log, a detailed description of the soil types, and the *in situ* geotechnical properties determined for the boreholes shall be documented to characterise the strata. These shall be performed in accordance with Eurocode EN 1997-2:2007 and ISO 19901-8:2014. The borehole logs shall be compiled under the terms of EN ISO 14688-1 and EN ISO 14688-2.

The general requirements for the boreholes are as follows:

1. When the vessel(s) is (are) on station, the position of the vessel(s) and the water depth shall be logged prior to commencing any investigation work at each of the locations. Water depths shall be reduced to LAT.
2. The target depths for the boreholes will generally be somewhere between 60 m and 80 m, depending on the depths of the geological formations of interest at a particular location and the interpreted subseabed structure. The CLIENT OFFSHORE REPRESENTATIVE may request the depth of boring/testing to be terminated prematurely or extended beyond the target depth to a maximum depth of 80 m, should it be determined by the CLIENT REPRESENTATIVE that this is appropriate.
3. For the TenneT platform locations the target depths for the boreholes will generally be somewhere between 80 m and 100 m, depending on the depths of the geological formations of interest at a particular location and the interpreted subseabed structure. The CLIENT OFFSHORE REPRESENTATIVE may request the depth of boring/testing to be terminated prematurely or extended beyond the target depth to a maximum depth of 100 m, should it be determined by the CLIENT REPRESENTATIVE that this is appropriate.

The boreholes shall be progressed by a drilling and sampling technique approved by the CLIENT. It is the CLIENT preferred method to use standard straight flush API drilling and associated sampling and testing methods however CLIENT is open to suggestions of equivalent approved and verified methods. The drilling and sampling

technique used must be fit for sampling with a minimum of disturbance. The drilling and sampling equipment and procedures are to be designed on the aim of obtaining a high sample quality class (according to Eurocode EN 1997-2:2007 and ISO 19901-8:2014) and good core recovery. For cohesive soil samples, quality class 1 or 2 are mandatory. For non-cohesive soil samples, a minimum of quality class 3 or 4 are required.

The sampling and PCPT requirements will depend on the material type encountered. The following regimes should be applied, unless otherwise agreed by the CLIENT OFFSHORE REPRESENTATIVE on site.

Between the seabed and the final depth of the seabed CPT at that particular location, quasi-continuous sampling should be undertaken at a nominal interval of 1.0 m. The spacing between consecutive samples shall not exceed 0.5 m. The appropriate type of sampling tool to use will depend on the soil type. In stiff cohesive soils, push sampling shall be used. In granular materials, push sampling shall be used if possible, unless sample recovery is poor, in which case a push sampler with a core catcher or a hammer sampler shall be used instead. Blow counts measured during hammer sampling shall be recorded and presented on the Borehole Logs.

Below the final depth of the deep seabed CPT at that particular location, the following appropriate regime should begin immediately upon encountering a new layer: within granular deposits, the boreholes are to be advanced by alternating PCPT (up to 3 m stroke) and 1 m sampling (4 m cycle). CLIENT OFFSHORE REPRESENTATIVE has the right to change the alternating PCPT/sampling cycle in response to the encountered soil layer without extra charges. Furthermore, CONTRACTOR shall oversample a PCPT stroke where requested in order to provide enough sample material for the subsequent laboratory programme and to verify soil types where uncertainty regarding material exists or refinement is required on interpretation of soil types.

Within the cohesive deposits, boreholes are to be advanced by PCPT followed by two samples (5 m repeat cycle). CLIENT OFFSHORE REPRESENTATIVE has the right to change this regime in response to the encountered soil layer without extra charges

Use of sampling tubes with external diameters other than 76 mm shall only be used after consultation with, and the express permission of the CLIENT OFFSHORE REPRESENTATIVE.

The spacing between the end of samples/PCPT and/or start of samples/PCPT shall not exceed 0.5 m. A minimum sample recovery of 80% is mandatory for cohesive soil layers and loose to medium dense non-cohesive soil layers. For dense or very dense non-cohesive soil layers, a minimum sample recovery of 50% is acceptable. If the sample recovery is less than 50% in non-cohesive layers or less than 80% in cohesive soil layers, CONTRACTOR shall be required to perform at no cost to CLIENT an additional push sampling stroke to recover the missing soil samples.

The net weight of the seabed frame shall be reduced to a minimum for the first push to avoid shear failure or other disturbance of the uppermost sediments. The penetration of the seabed frame is to be monitored and recorded as stated previously. The first sample shall be taken at seabed level and be representative of at least the top 0.2 m of the seabed.

CLIENT has the right to reject the sampling sequence particularly in the upper section of continuous sampling where quality and/or sample spacing and gaps

compromise the aforementioned objectives. CONTRACTOR is to state in their proposal what remedial action they propose in this event at no cost to CLIENT.

2.9.2 Executing downhole wireline piezocone penetration tests (PCPT)

The down-hole wireline PCPT system shall include a minimum 10 tonne thrust reaction and at least a cone tip capacity of 100 kN or 50 kN, depending on the cone tip area. The equipment shall be capable of recording tip resistance values of up to 100 MPa.

In soils with a normal range in cone tip resistance, 10 cm² piezocones shall be used. In very dense granular soils where the cone tip resistance is very high, 5 cm² cones with or without a piezometer may be used instead with CLIENT OFFSHORE REPRESENTATIVE approval.

The tests shall be carried out in full accordance with ISSMFE Reference Test Procedures, EN ISO 22476-1, and Eurocode EN 1997-2:2007.

The CONTRACTOR shall provide the calibration certificates for verification before Start of Mobilisation. Calibration dates of all PCPT cones shall not be older than 3 months before Start of Mobilization. Contractor shall ensure adequate equipment redundancy and spares for all components, approval of which shall be upon inspection by CLIENT REPRESENTATIVE prior to Start of the Offshore Works.

2.9.3 Seismic cone penetration tests (SCPT)

CONTRACTOR shall perform selected seismic cone tests to a depth of up to 60 m below sea bed with the vessel(s) in borehole mode. The seismic cone shall be deployed in downhole mode using dual array x, y, z receivers mounted behind a conventional 10 cm^2 cone.

CLIENT shall select the preferred locations based on the results of the geophysical survey and results of Phase I, seabed survey, if available. The seismic source shall be mounted on a seabed frame. Acquisition, and processing methods and procedures shall be in accordance with ISO 19901-8:2014, ASTM D7400-08 or equivalent CLIENT approved methods. Full details of the proposed methodology, processing and data presentation shall be presented as part of the CONTRACTOR tender submission.

Seismic tests shall be performed at least at the end of each CPT stroke-, as directed by the onboard CLIENT OFFSHORE REPRESENTATIVE. The CLIENT OFFSHORE REPRESENTATIVE may request on seismic test, e.g. if major changes in stratigraphy occur. Signals shall be stacked in order to achieve an acceptable signal to noise ratio to be agreed with the CLIENT OFFSHORE REPRESENTATIVE. CLIENT OFFSHORE REPRESENTATIVE has the right to reject any or all of the stacked signals or components thereof. Drill outs between CPT strokes and hence data gaps shall **not** exceed 0.5 m without the express approval of the CLIENT OFFSHORE REPRESENTATIVE.

Plots shall include CLIENT approved measured and cone resistance based shear wave velocity for presentation as part of the final report.

CONTRACTOR shall allow oversampling in order to verify soil types where uncertainty regarding material exists or refinement is required on interpretation of soil types.

Plots shall include s-wave velocities (and, where available, p-wave) for presentation as part of the final report. CONTRACTOR shall allow for provision of raw and processed digital SCPT data as a deliverable to CLIENT within the proposal.

2.9.4 P-S Logging

CONTRACTOR shall perform P-S logging following the completion of selected boreholes.

CLIENT shall select the preferred locations based on the results of the geophysical survey and results of the Phase I, seabed survey if available.

Full details of the proposed equipment (including full technical specifications), methodology, processing and data presentation shall be presented as part of the CONTRACTOR tender submission

The P-S logging equipment consists of a P-S logger recorder, a winch and a digital P-S suspended log probe (diameter and length are the region of up to 5.4 cm and 8.3 m respectively). The down-hole tool comprises a directional seismic source and a pair of three directional, (x-y-z) seismo-acoustic detectors. For the purpose of data logging, the suspended probe is lowered into the borehole to the depth required, and the seismic source is fired. The seismic source generates 'local pressure sound waves' into the fluid between the suspended probe and the borehole wall. The movement of these propagated local pressure sound waves along the borehole axis and circumferential wall, is recorded (by means of two built-in three directional seismic detectors in the suspended probe), as sound wave velocities i.e. compression (p-wave) and shear (s-wave).

After completion of the borehole to the required depth, the borehole is to be deepened by drilling an approximately 6 m additional socket (depending on the dimensions of the P-S logging tool) to allow the first test to be carried out at 60 m depth.

Depending on the encountered soil conditions and the requirements of the CONTRACTOR engineer and the CLIENT OFFSHORE REPRESENTATIVE, the drill pipes are to be pulled to a sufficient distance above the P-S logging tool to avoid a collapse of the borehole, to expose the borehole walls and to enable accurate measurement of the seismic velocities within an open and fluid-filled borehole without any interference from the drill string.

Logging with the P-S tool shall start shortly after removal of the wireline tool and pulling of the drill string, beginning from the bottom of the hole and continuing upwards, in order to prevent a collapse of the borehole.

The intervals between individual measurements shall be approximately 1-2 m, as directed by the CLIENT OFFSHORE REPRESENTATIVE.

Plots shall include p-wave and s-wave velocities for presentation as part of the final report.

2.9.5 Density Logging

CONTRACTOR shall perform density downhole logging following the completion of P-S Logging within the same boreholes. The objective is to gather a continuous data set of porosity and bulk density of the soils.

CLIENT shall select the preferred locations based on the results of the geophysical survey and results of the seabed survey if available.

Full details of the proposed equipment (including full technical specifications), methodology, processing and data presentation shall be presented as part of the CONTRACTOR tender submission.

For density logging e.g. a gamma-gamma-probe is to be used. The main components of a Gamma-Gamma-probe are:

- Gamma source (e.g. Cs – 137)
- One or two (compensated log, preferred) detectors detecting the backscattered radiation
- A shield between source and detectors to protect direct radiation

Gamma-Gamma, Spectral Gamma tests (Natural Gamma Radiation) and Caliper are preferred to run as combination (one tool). Spectral Gamma tests and Caliper are to be used for correction of the density of cohesive soils predominantly.

A Spectral Gamma test device is to be taken onboard in case of extra natural gamma measurements are needed, directed by the CLIENT OFFSHORE REPRESENTATIVE.

Density downhole logging shall start shortly after removal of the P-S Logging tool beginning from the bottom of the hole and continuing upwards.

2.9.6 Recovery of Samples and Laboratory Testing

General

The following tasks shall be carried out offshore on the vessel(s):

- Sample logging immediately after a sample has been retrieved by a qualified CONTRACTOR's (engineering) geologist, and photography;
- Moisture content and unit weight measurements;
- Pocket penetrometer tests-, torvanes and lab vane test if appropriate on cohesive soil samples;
- Thermal conductivity measurement on undisturbed core samples including heat capacity measurement of the soil using thermal needle probe procedure according to ASTM D5334-14. These tests only need to be undertaken on the upper 2 m to 5 m of a borehole;
- Unconsolidated Undrained Triaxial Compression Tests (UU tests);
- Selection and proper preservation of suitable of "undisturbed" cohesive samples to avoid a change of the soil properties (e.g. waxing of and preservation in cardboard tubes or preservation of whole cores) including labelling of core sub-samples for onshore testing;
- Selection and proper preservation of suitable samples retained in the Shelby tubes without extrusion (to minimise handling and contamination) for onshore MIC testing.

As part of the sub-sampling process CLIENT shall instruct CONTRACTOR to remove appropriate sub-samples from nominated boreholes for dating analysis. A full list of the required boreholes, samples and depths shall be provided by CLIENT upon completion of Phase I.

All onshore laboratory testing shall be carried out at an approved geotechnical laboratory. Any subcontracted testing shall require the approval of CLIENT. CONTRACTOR shall submit a list of subcontracted laboratory tests to RVO experts in advance for internal use only. All core logging and soil testing shall be carried out, where applicable, respectively to Eurocode EN 1997-2:2007, ISO 19901-8:2014, BS 5930, and BS 1377 or CLIENT approved equivalent. Cyclic soil testing, if any, shall be carried out in accordance with the relevant ASTM standard (e.g. ASTM D 5311-13 & ASTM D 6528-17), where applicable. The CONTRACTOR ensures that the laboratories, also subcontracted laboratories, are accredited for the newest issues of

standards. If the CONTRACTOR deviates from the latest standards a detailed statement is expected from the CONTRACTOR. The borehole logs shall be compiled under the terms of EN ISO 14688-1 and EN ISO 14688-2. All test data shall be presented in ASCII format for easy manipulation, data transfer, and integration.

The CLIENT requires a biweekly transport of soil samples to laboratory (as a minimum).

Sample Photography

Each recovered sample shall be cleaned of drilling fluid, photographed intact, and after removal of a thin veneer of sample to expose any stratigraphy, surface structure or change in properties shall be photographed again. After subsampling to preserve undisturbed material and testing the remaining core shall be split and photographed again to record the internal structure so that all details are clearly recognisable in accordance with a CLIENT approved standard. As a minimum 12MPX resolution is required in order that quality, focus, colour and resolution shall be adequate to resolve millimetre scale features.

The borehole identification, date of sampling, depth data and top/bottom identification must be legible along with the project identification, borehole number, sample identification, sample depth, a graphic length scale and a standard of tints.

CONTRACTOR shall be required to demonstrate a system to prove that every sample is photographed to a standard to be accepted by CLIENT and recorded on to hard storage media. Examples shall be provided to CLIENT OFFSHORE REPRESENTATIVE for approval prior to photography commencing.

Laboratory Testing

Onshore Laboratory testing shall be performed on the preserved samples at an approved laboratory selected by the CONTRACTOR. Any subcontracted testing shall require the approval of CLIENT.

As a general guideline, the following types of tests will normally be required for the different material types expected. The actual testing programme shall be proposed by the CONTRACTOR and approved by the CLIENT.

Granular Soil

- Natural water (moisture) content
- Bulk density
- Particle density
- Particle size analysis (sieve)
- Particle size analysis (using sieve and pipette method for fines fraction)
- Maximum and minimum density
- Carbonate tests
- Organic and total carbon content (elementary analysis)
- Organic content (loss on ignition)
- Isotropically consolidated drained (CID) compression triaxial tests (on undisturbed samples if possible)
- Shear box tests
- Direct simple shear (DSS) tests
- Ring shear tests (soil/soil)
- Ring shear tests (soil/steel)
- Bender element tests (as part of selected CID or DSS tests)
- Permeability testing with permeameter
- Permeability testing in triaxial cell

- Binocular microscopy tests inclusive microscopic photography (where batching of samples is considered)
- Microbially Influenced Corrosion (MIC) tests
- Thermal Conductivity and heat capacity
- Electrical resistivity
- Pore water salinity
- Age dating

Cohesive Soil

- Natural water (moisture) content
- Bulk density
- Particle density
- Particle size analysis (using pipette method for fines and if applicable sieve)
- Atterberg limits (plastic and liquid limits, fall cone test)
- Organic and total carbon content (elementary analysis)
- Organic content (loss on ignition)
- Unconsolidated undrained (UU) triaxial compression tests on undisturbed samples
- Unconsolidated undrained (UU) triaxial compression tests on remoulded samples
- Direct simple shear (DSS) tests
- Isotropically consolidated undrained triaxial compression test (CIU)
- Incremental Loading (IL) oedometer compressibility tests
- Constant Rate of Strain (CRS) compressibility tests
- Permeability testing with permeameter
- Permeability testing in triaxial cell
- Anisotropically consolidated undrained triaxial compression test (CAU_c)
- Anisotropically consolidated undrained triaxial extension test (CAU_e)
- Ring shear tests (soil/soil)
- Ring shear tests (soil/steel)
- Bender element tests (as part of selected CIU, CAU or DSS tests)
- Thermal Conductivity and heat capacity (on undisturbed and remoulded samples)
- Electrical resistivity
- Pore water salinity
- Microbially Influenced Corrosion (MIC) tests
- Age dating

Sample preparation (e.g. moist-tamped, vibrated, pluviated specimens in sands) is to be stated clearly by the CONTRACTOR within the proposal. Controlled sample preparations, e.g. for ring shear test in non-cohesive soils, which most closely replicates the in-situ soil densities and conditions are preferred.

Any results from the above standard laboratory test programme that are required for specifying the advanced (cyclic/dynamic) shall be issued to the CLIENT as soon as they become available, in advance of the draft Geotechnical Borehole Report.

Cyclic/Dynamic Tests

In addition to the static laboratory testing program, a dynamic/cyclic testing program will be required in order to determine the behavior of the soils at small strains and under cyclic loading. The following tests are to be considered as comprising the cyclic/dynamic component.

- Cyclic direct simple shear tests (CSS) *with* pre-shearing (done on limited cohesionless soil samples) using undrained conditions – Stage 1: 400 two-way load cycles of at relatively low stress ratios (pre-shearing); Stage 2: 1500 two-way cycles at slightly higher cyclic stress ratios; Stage 3: Post-cyclic static testing to failure if cyclic failure does not occur in Stage 2.
- Cyclic direct simple shear tests (CSS) *without* pre-shearing (done on both cohesive and cohesionless soil samples) for complement exemplarily the CSS with preshearing– Stage 1: 1500 two-way cycles at slightly higher cyclic stress ratios; Stage 2: Post-cyclic static testing to failure if cyclic failure does not occur in Stage 1
- Cyclic triaxial compression tests (CTX) (done on both cohesive and cohesionless soil samples) – Stage 1: 1500 one-way load cycles at relatively low stress ratios; Stage 2: 400 one-way cycles at slightly higher cyclic stress ratios; Stage 3: Post-cyclic static testing to failure if cyclic failure does not occur in Stage 2.
- Resonant column tests (RC) (done on both cohesive and cohesionless soil samples) using undrained conditions– To include the following stages: saturation, consolidation, initial loading, repeat loading.

The various loading stages of the CSS and CTX tests will be undertaken in either "drained" or "undrained" conditions, as proposed by CONTRACTOR and approved by CLIENT. The CONTRACTOR should adjust the magnitude and rate of the loading to avoid excess pore water pressure build up during the testing.

The RC samples are to be consolidated under either isotropic or anisotropic conditions, as proposed by CONTRACTOR and approved by CLIENT. The shearing stages will be carried out under either drained or undrained conditions, also as specified by the CLIENT.

A set of cyclic tests will be undertaken on each soil unit or sub-unit of engineering significance across the WFZ.

2.9.7 Thermal Conductivity Testing

CLIENT wishes to undertake testing on selected samples to determine the thermal conductivity/resistivity and specific heat capacity properties of the near surface granular and cohesive soils in undisturbed and disturbed state for the purpose of cable design and installation. CONTRACTOR is to detail methods of obtaining, storing and testing undisturbed samples of appropriate size bearing in mind the sampling method available and reconstituting for remoulded tests.

Tests shall be carried out using the (dual) needle probe method in accordance with ASTM D5334-14.

Tests should be undertaken on fully saturated samples. Two separate specimens should be tested from each sample in order to duplicate the results. For cohesionless soil specimens, tests should be undertaken at five (5) different densities e.g. starting from the loosest state and using a vibration table to progressively increase the specimen density.

2.9.8 Microbially Influenced Corrosion (MIC)

CLIENT wishes to perform chemical and microbiological laboratory tests testing on selected samples to determine microbial influenced corrosion. The soil samples have to be analysed to determine chemico-physical parameters and also microorganism groups. These are:

- Nitrate-reducing microorganisms
- Nitrogen compounds oxidizing bacteria (nitrification)
- Neutrophilic ferrous ion oxidizing bacteria,
- Manganous ion oxidizing bacteria,
- Ferric ion-reducing bacteria,
- Manganese IV ion-reducing bacteria,
- Moderately acidophilic and neutrophilic sulfur compounds oxidizing bacteria,
- (Thio-) Sulfate-reducing bacteria.

Regarding the bacteria, the laboratory test should show in particular the metabolic activity of the microorganisms. The microbiological risk potential should be derived from the laboratory results as well as the assessment of a biologically influenced mass loss rate of the steel-based material.

The cell counts of living bacteria shall be determined by the Most-Probable-Number-technique via dilution series using standardized, selective ocean water media (see ASTM D1141). The microbial activity shall be detected by measuring the heat output of sediment samples by microcalorimetry.

In addition, the TOC shall be determined for each MIC sample. The contractors shall also include the method they plan to use for the assessment (e.g. publication, external experts, own experiences). Furthermore, some geotechnical index tests as water content (WC), unit weight (UW), pocket penetrometer test (PP) and torvane tests (TV) shall be carried out 2x in every soil type within the liner sample on cohesive soils of MIC liner samples. The processing of MIC liner samples includes the shipment to laboratory if needed, splitting of liners, sample photograph, sample description and classification, index test as described above, disturbed (double bags) and undisturbed (wax) sub-sampling for further laboratory testing and integration of results in the various report. The processing of MIC samples shall be included in MIC pricing

CONTRACTOR is to detail methods of designated testing, correlation of risk potential due to metabolic activity of microorganism as well as derivation of a mass loss rate of steel-based material per year for CLIENT’s approval. Upon approval CONTRACTOR shall be required to perform said tasks in accordance with CONTRACT.

Sub-samples are to be taken with sterile sampling tools and are to be stored in sterile containers/bags. A storage in sample (“Shelby”) tubes is preferred to avoid any contamination from tools or lab personnel during sub-sampling. CONTRACTOR shall detail in their proposal how the material is to be subsampled and what precautions are to be taken to avoid contamination at all stages of the test.

As part of the reporting process CONTRACTOR shall produce an interpretative report which shall include a risk assessment of the results detailing the level of activity of each of the groups analysed and the resultant interpreted risk potential to emplaced infrastructure. The risk assessment should also indicate which of the groups or individual compounds analysed are likely to constitute the most aggressive in the sampled environment with respect to the prospective material types to be used in offshore wind foundation construction. This analysis should be summarised, tabulated and presented in an ascending scalar form.

2.9.9 Dating Analysis

CONTRACTOR shall undertake a programme of soil dating (micropalaeontological) analysis on selected samples recovered from selected sample boreholes. The analysis shall include but not be limited to the following depending on the interpreted palaeo-environment:

- Palynological analysis, (pollen)
- Algae
- Fungi
- Spores
- Dinoflagellate Cysts
- Foraminifera
- Carbon (C14) Dating

The report shall detail:

- Individual analytical techniques
- Chronostratigraphic succession
- Biostratigraphic Events
- Interpreted stratigraphy
- Interpreted stratigraphic stage
- Extinction markers
- Any issue potentially affecting the stratigraphic interpretation and succession for the area

The results of these tests shall be interpreted and integrated into the geological ground model report. Given that, the age dating test results shall be delivered by CONTRACTOR in a separate Age Dating Report as annex to Phase II Final Report.

2.9.10 Storage of Samples

On board the vessel(s), samples shall be stored in a temperature stable environment (5-10°C) with no exposure to direct sunlight and in compliance with the standards as specified above. In the onshore laboratory, samples shall be stored in a temperature (5-10°C) and humidity controlled enclosure and in compliance with the standards as specified. CLIENT shall approve proposed methods and conditions of storage.

The MIC samples shall be stored in a temperature of 5-8°C preferred in sample ("Shelby") tubes to avoid any contamination during sub-sampling. The samples should not be stored for more than two weeks prior to testing.

The soil samples shall be stored onshore by the CONTRACTOR for a period of thirty-six (36) months following the soil samples receipt at the onshore laboratory during which time the CLIENT shall be granted free access to the same. The CONTRACTOR shall store the cores in containers so that they can be retrieved easily. Storage shall be in a temperature and humidity controlled environment to ensure the samples do not dry out or suffer any other damage and in compliance with the standards as specified. CONTRACTOR shall confirm and detail the precise method of long-term storage and temperature control for CLIENT approval.

Following the minimum thirty-six (36) months storage period the CLIENT shall instruct the CONTRACTOR of one of the following:

i) a further period of storage,
ii) safe and legal disposal of all samples or
iii) CLIENT collection of said samples.

Option i) shall be at cost to the CLIENT by way of a VARIATION ORDER where such additional cost is incurred. For the avoidance of doubt the CONTRACT PRICE shall include for the safe and legal disposal of all samples of storage.

A number of undisturbed samples will be reserved for further advanced testing including cyclic testing. Samples shall be stored at the CONTRACTORS nominated

laboratory unless otherwise instructed in writing by CLIENT. Full rights of ownership and access to the samples shall remain with CLIENT for the full storage duration (minimum 36 months).

2.9.11 Demobilisation

Upon completion of the survey, all CONTRACTORS personnel shall be demobilised from the vessel(s) in accordance with the CONTRACT.

CONTRACTOR is responsible for the removal of all equipment, instrumentation and materials from the project areas following survey completion. Any and all lost equipment whether above, on or below seabed shall be recorded along with co-ordinates. Lost equipment shall be detailed in the Field Report.

Demobilisation is deemed to commence when all survey operations have been completed, the sea bed frame has been recovered, and after approval of the CLIENT.

2.10 Data processing and reporting for boreholes (Phase II)

After carrying out the borehole investigation, CONTRACTOR shall process the data that is gathered during the field work, carry out the laboratory tests according to the programme that is agreed with CLIENT and prepare a detailed report covering the total scope of work.

The reporting requirements for the geotechnical borehole work are detailed below. Quality requirements are described in Annex 6 – Section VII - Quality Requirements & Administrative Instructions.

All reports will be written in English and include both an English and Dutch management summary.

Reports and deliverables will be delivered by contractors in pdf and original, regular, formats (docx; xlsx; ppt; etc).

2.10.1 Daily & Weekly reporting

The CONTRACTOR is to submit daily reports throughout the period of the fieldwork for each vessel, providing full details of previous 24 hours' work and results and a projection of the work to be completed over the next 48 hours. Further, CONTRACTOR shall issue a weekly report providing insight in the progress of the WORK on a weekly basis. The minimum content of the daily and weekly report is specified in Section VII of this CONTRACT.

2.10.2 Preliminary Field Borehole Logs and PCPT results

The CONTRACTOR is to provide preliminary PCPT results within 24 hours of completion of the borehole. The CONTRACTOR is to provide the preliminary (field) borehole logs containing the offshore laboratory test results within 48 hours of completion of the borehole. Prior to submitting the borehole logs and PCPT results, CONTRACTORS lead engineer shall review and approve the data for release to the CLIENT. The combined results will be used to complete the onshore laboratory test schedule.

2.10.3 Field reports Phase II (downhole campaign)

Two field reports shall be made available within one week of the completion of the fieldwork for each vessel:

- a public field report for the developers/designers.
- a full "not-to-be-published" field report for the CLIENT;

The CONTRACTOR shall be required to submit a reporting template for the downhole campaign, Phase II, Field Report within one (1) week after the Start of the offshore works. Two (2) field reports shall be made available within one (1) week of the completion of the fieldwork:

The public field report shall include but is not limited to:

- A statement of the purpose of the investigation;
- A description of the work carried out, including reference to specification and standards adopted and any deviations from them;
- Exact locations of all boreholes, co-ordinates shall be with respect to ETRS89 datum, given in degree sand decimal-minutes format as well as in metres using an ETRS89 UTM Zone 31N projection. The coordinates shall also be provided in electronic format (xlsx);
- Water depth at each downhole location, reduced to LAT (quality assured)
- Drawings (GIS format or similar as well as PDF) showing the locations of the boreholes undertaken;
- Preliminary (field) borehole logs (including offshore laboratory tests results);
- Plots of the following final (quality assured) PCPT results:
    - Measured cone resistance
    - Measured sleeve friction
    - Measured pore water pressure
    - Friction Ratio
    - Net cone resistance
    - Pore pressure ratio
    - Interpreted relative density (granular materials), inclusive of a description of the type of correlation used for the interpretation
    - Interpreted undrained shear strength (cohesive materials), inclusive of a description of the type of correlation used for the interpretation
    - Seismic Cone (SCPT) test results including interpreted small-strain shear modulus versus depth inclusive of a description of the calculation method used
    - Results of thermal conductivity and specific heat capacity testing
- P-S logging results including interpreted small-strain shear modulus versus depth and a summary of the calculation methods used;
- Calibration report including all on board calibration sheets and calibration certificates of CPT cones used;
- Mobilisation report;
- Positioning data;
- Obstruction list (lost equipment on seabed and within the soil) incl. coordinates and depth.

The "not-to-be-published" field report for the CLIENT shall contain:

- Daily logs (DPRs)
- Driller's and CPT operator's log and recorded drilling parameters (i.e. torque, mud pressure, bit weight)
- Incident reports
- Full details of all lost and damaged equipment

2.10.4 Report Phase II (Downhole campaign)

The CONTRACTOR shall submit a reporting template for the reports within two (2) weeks after Start of the offshore works.

The reporting for Phase II is comprising:

- A Final Report for the Phase II (excluding the cyclic and dynamic test results)
- An advanced laboratory test report including the results of the most advanced test i.e. the cyclic and dynamics test results as well as the other results associated with test tests.

Final Report – Phase II

CONTRACTOR shall also submit an Interim Geotechnical Downhole Campaign Report containing all available standard laboratory test results four (4) weeks following the completion of fieldwork. CONTRACTOR shall submit a Draft Geotechnical Downhole Campaign Report containing all standard laboratory test results no later than seven (7) weeks following the completion of fieldwork. The Draft Geotechnical Downhole Campaign Report should include:

- A statement of the purpose of the investigation;
- A description of the work carried out, including reference to specification and standards adopted and any deviations from them;
- Exact locations of all boreholes, coordinates shall be with respect to ETRS89 datum, given in degrees and decimal minutes format as well as in metres using an ETRS89 UTM Zone 31N projection. The coordinates shall also be provided in electronic format (xlsx);
- Water depth at each downhole location, reduced to LAT. If water depths (LAT) at same locations differ from each other during the seabed and downhole campaign the CONTRACTOR shall provide an explanation;
- Drawings (GIS or similar as well as PDF) showing the locations of the boreholes undertaken;
- Plots of the following final (quality assured) CPT results:
    - Measured cone resistance
    - Measured sleeve friction
    - Measured pore water pressure
    - Friction Ratio
    - Net cone resistance
    - Pore pressure ratio
    - Seismic Cone (SCPT) test results including interpreted small-strain shear modulus versus depth, inclusive a description of the used calculation
    - Interpreted relative density (granular materials), inclusive of a description of the type of correlation used for the interpretation
    - Interpreted undrained shear strength (cohesive materials), inclusive of a description of the type of correlation used for the interpretation
- Parameter plots, including plots for each borehole are to include the following measured data:
    - Measured Water Content and Atterberg Limits versus depth;
    - Measured Wet and Dry Unit Weight and Submerged Unit Weight versus depth;
    - Particle size by mass percentage less than 2, 60 & 2000 µm versus depth;
    - Measured Undrained Shear Strength versus depth;
    - Thermal conductivity/resistivity and heat capacity versus depth;
    - Summary of dissipation test results for the tested units
- P-S logging results including interpreted small-strain shear modulus versus depth inclusive of a description of the calculation method used;

- Results of thermal conductivity and specific heat capacity testing Final offshore and onshore and laboratory test results and summaries shall be reported in accordance with the requirements set out in Annex 4a;
- Final borehole logs including the measurement while drilling results;
- Summary of Laboratory Test Results by type of tests; For each laboratory test it shall be specified in which laboratory the test was performed;
- Colour photographs of samples and cores;
- ASCII data of CPTs and P-S logging (incl. all raw data);
- ASCII data of SCPT tests;
- ASCII data of density log, gamma ray, caliper (incl. raw data)
- Laboratory test data in PDF, AGS and ASCII/Excel format;
- An overview of the remaining samples that will be stored.

The CONTRACTOR shall provide a digital draft report, which shall be made final after processing of comments and approval by the CLIENT. The draft report shall contain all the information which is to be included in the final report. Both draft and final field report shall consist of two (2) electronic copies to be provided digitally (HDD). CONTRACTOR shall provide four (4) electronic copies of the final geotechnical report and data. Digital data shall be provided for both draft and final reports.

All maps (in GIS and PDF) will only show the outer boundary of the Wind Farm Zone and the Geotechnical Investigation Area.

Advanced Laboratory Tests Report

The CONTRACTOR shall submit a Draft Advanced Laboratory Tests Report containing all available cyclic/dynamic laboratory test results not later than twenty-eight (28) weeks following the completion of fieldwork. The Draft Advanced Laboratory Tests Report should include:

- A statement of the purpose of the advanced laboratory tests;
- A description of the advanced laboratory tests carried out, including reference to specification and standards adopted and any deviations from them;
- Results of all advanced laboratory tests results documented in single protocol for each test;
- Summary of advanced laboratory test results by type of tests; for each advanced laboratory test it shall be specified in which laboratory the test was performed;
- Laboratory test data in PDF, AGS and/or ASCII/Excel format;
- Digital data (ASCII) of cyclic tests, all cycles;
- An overview of the remaining samples that will be stored.

The CONTRACTOR shall provide a digital Draft Advanced Laboratory Tests Report, which shall be made final after processing of comments and approval by the CLIENT. The draft report shall contain all the information which is to be included in the final report. Both Draft and Final Advanced Laboratory Tests Report shall consist of two (2) electronic copies to be provided digitally (HDD). CONTRACTOR shall provide four (4) electronic copies of the Final Advanced Laboratory Tests Report and data. Digital data shall be provided for both draft and final reports.

2.10.5 TenneT report

The results of the seabed PCPTs and boreholes performed for TenneT shall be included both within the Phase II Report of TNW (as an appendix) and as a separate (standalone) report to be issued to TenneT.

2.10.6 Project and Site Description

The Contractor shall provide a 2-5 page summary including the aims, objectives and approach and the main results to be published in the Project and Site Description (PSD). (Example https://offshorewind.rvo.nl/generalnh) The summary for the PSD shall be provided as Word file.

2.10.7 Answering additional questions

It is anticipated that additional questions (from market or within RVO.nl) regarding this geotechnical survey will be received after delivery of the study results. The Contractor is requested to support the Contracting Authority in answering these questions.

By means of a Variation Order time and financial consequences will be arranged.

3 Scope of Work (Lot 2)

3.1 Activities

The activities that need to be carried out to obtain the information detailed in section 1.3.2 are the following for Lot 2:

Geological Ground Model:

- Re-interpretation of all geophysical data (2D and 3D)
- Verification and update geophysical study by results from geotechnical site investigation and laboratory tests and identification of the geological units
- Present the results in clear reports and drawings
- Create final data package with QA and metadata elements

Integrated Ground Model (IGM):

- Identification and definition of geotechnical units
- Characterization of each unit by geotechnical parameters and characteristic values of geotechnical parameters within an interpretative report using results of the geotechnical site investigation inclusive laboratory test results
- Create a detailed 3D integrated ground model (IGM) of the TNW WFZ
- Present the results in clear reports and drawings
- Create final data package with QA and metadata elements

Both, the Geological Ground Model and the Integrated Ground Model, shall consider the Ground Model Investigation Area.

3.2 Preparations

Project Plans

CONTRACTOR shall prepare all project plans as required by the CONTRACT. These documents shall include, but are not limited to:

- Project Execution Plan (including applicable Method Statements and Risk Assessments);
- Project Quality Plan/Quality Manual.

Risks will be discussed with CONTRACTOR on a weekly basis during the progress meetings. The Project Quality Plan shall be issued according to EN ISO 9001:2015.

CONTRACTOR shall only commence the WORK when all project plans have been reviewed by CLIENT and CLIENT has confirmed to have no further comments

3.3 Interfaces

CONTRACTOR shall fully cooperate with associated contractors involved in the site investigations of the CLIENT. The main interface is described below:

- The geophysical contractor, Lot 1 CONTRACTOR and Lot 2 CONTRACTOR will provide independent proposals of the geotechnical site investigation locations (CPT and borehole plan), which shall be reviewed by Client. Then, a meeting will be organized with CLIENT experts and both CONTRACTORS (lot 1 and lot 2) to discuss and determine the final target locations. The Lot

2 CONTRACTOR will have the lead defining the final target locations. This meeting shall be included in the Scope of Work of the CONTRACTOR.
- Lot 1 CONTRACTOR will provide a Report Seabed PCPT campaign and a Report Downhole Campaign as basis geotechnical information for developing ground models. This is anticipated to take 2 meetings for alignment. These meetings shall be included in the Scope of Work of the Lot 2 CONTRACTOR.

3.4 Geological model of the Wind Farm Zone

Based upon the information that is gathered through the geotechnical soil investigation and the geophysical survey, including results provided by the CLIENT and through interpretation of all other relevant data available (provided by the CLIENT and in the public domain). It should be noted that the geophysical data set contain additional processed but not fully interpreted 3D Ultra High Resolution Seismic (3D-UHRS) of a subset of the area (3,75 E/W by 1,5 km (N/S). CLIENT will provide a report including the assessment geological hazards and interpretability of 3D geological data from the geophysical campaign. CONTRACTOR shall integrate all data sets and create a geological subsoil model (report including drawings) of the site. The CONTRACTOR shall be required to submit a reporting template for the Geological Model Report in their proposal.

As part of the integration and modelling process, should difficulties be experienced in integration due to either the geophysical or soils data, CONTRACTOR shall discuss with CLIENT and agree what processes are required to enhance the integration process. This may involve but not be limited to reinterpretation of the geophysical data set. CONTRACTOR is encouraged to discuss any issues that may arise and to seek advice and guidance where required. CONTRACTOR is encouraged to engage with CLIENT early in the ground model phase and to encourage discussion on the progression of the works and any perceived issues.

CONTRACTOR must ensure that the terminology used in the geophysical report is transferred without alteration into the final report and model, including that of geological formation naming. In case of changing the terminology at least an explanation / transferring table should be shown in the reports.

The objective of this geological model is to:

- Develop an insight into the overall stratification and soil conditions over the Wind Farm Zone and to identify possible constraints for the design and installation of offshore wind turbines and cables in the Ten Noorden van de Waddeneilanden Wind Farm Zone as a result of the as-found soil conditions.

The geological model shall integrate and refine data from the following sources:

- The seismo-acoustic model developed during the geophysical survey, including re-assessment and refining of the seismic interpretation by CONTRACTOR using the geotechnical data and age dating analysis.
- Identification of the geological unit and extent thereof that can be found over the Wind Farm Zone.
- The following charts / cross-sections are to be reported and are considered to be a minimum:
    - Long line sections through BH and CPT tests, (superimposed) and fully annotated.

    - Cross line sections through BH and CPT tests, (superimposed) and fully annotated.
    - Charts comprising the mapped top of each major geological soil unit surface identified and one mapping each of the major geological soil unit thicknesses.
    - Charts are to be provided in PDF and in an approved GIS compatible format.
- CONTRACTOR shall provide the digital data files of the geological model (Kingdom 2017 format is preferred).
- CONTRACTOR to provide GIS data and model in accordance with requirements in Section VII – Quality Requirements & Administrative Instructions for:
    - Depth to Top of Geological Soil Unit maps, and contours for all units;
    - Thickness of Soil Unit maps, and contours for all units;
    - Geohazards;
    - Location of all 12 grab samples (geophysical campaign), boreholes, seabed CPTs and vibrocores.

Note that the minimum, maximum and mean values of geotechnical parameters shall be mathematically calculated from a data set for a particular test type and per individual geological soil unit.

It is important that the geophysical and geotechnical data are interpreted sufficiently comprehensively and accurately to allow the specification and definition of all "geotechnically significant" subsurface units within the following creation of the integrated ground model.

CONTRACTOR shall provide four (4) electronic copies of the GIS model and data on flash drive, HDD drive or CLIENT approved equivalent.

3.5 Integrated Ground Model

CLIENT aims to reduce the design time and risks for tenderers when preparing their bids for the Ten Noorden van de Waddeneilanden wind farm zone (TNWWFZ) permit. To facilitate this goal, CONTRACTOR shall prepare an 3D Integrated Ground Model and Interpretative Report containing characteristic values of geotechnical parameters for tendering and preliminary pile foundation design (focusing on a monopile foundation design.

The CONTRACTOR shall be required to submit a reporting template for the Interpretative Report. The templates shall be provided by the Contractor after award of Contract. These templated give insight to the Client on working methods and applicable reasoning.

The scope of work should include the following basic tasks:

- Integrated Ground Model:
    - Development of an Integrated Ground Model including lateral (plan-view) spatial zonation and the sub-division of the soil profile into soil units with similar composition and geotechnical properties (e.g. soil type with at least primary fraction, cohesionless or cohesive, relative density, plasticity, etc.). These "engineering soil units" may differ from the "geological soil units" included in the Geological Ground Model;
    - The Integrated Ground Model shall show interpolated soil profiles (soil type with at least primary fraction, density, consistency) or cross sections for arbitrary coordinates within the wind farm zone; the ground model shall **not** serve for the derivation of location-specific design profiles

- Interpretative Report:
  - Provision of Laboratory Test Results Overview (LTRO) tables, with the following summarised for each engineering soil unit:
    - total quantity of sample material recovered;
    - total quantity of test results undertaken per test type;
    - minimum, maximum and mean values of selected laboratory tests results
  - Provision of general ranges (including low, best and high estimates, where appropriate) of the geotechnical parameters for each engineering soil unit, as derived from laboratory and in situ tests using appropriate statistical analyses. The derived geotechnical parameters should include, but not be limited to, the parameters listed in Table 3 below. Any inconsistencies in the derived parameters, particularly between different test types, should be highlighted and discussed, so that the reader fully understands why some data sets may be weighted higher than others, for example.
  - Determination of characteristic values of geotechnical parameters for each engineering soil unit (soil type with at least primary fraction, density, consistency) as appropriate for a preliminary design of offshore pile foundations (monopiles) under static loading conditions;
  - Commentary on the methodology for selecting characteristic values of geotechnical parameters from the general ranges in derived geotechnical parameters.
  - Identification of areas within the Ten Noorden van de Waddeneilanden Wind Farm Zone that can be qualified in terms of suitability and quantified in terms of reduced or elevated development and installation costs inclusive explanation of appropriate measure for mitigation.
  - Identify the suitability of or possible constraints across the Ten Noorden van de Waddeneilanden Wind Farm Zone regarding:
    - Transfer of forces from wind turbine & substation foundation to seabed;
    - Microbially Induced Corrosion;
    - Piling of foundations e.g. presence of boulders or rocks;
    - The use of jack-ups;
    - The use of gravity base foundations;
    - The use of foundations based on suction piles or suction buckets;
    - The use of novel or composite foundations;
    - The installation of cables.
  - A seismic hazard assessment:
    - Probabilistic and determinist assessment of the seismic hazard.
    - Assessment of the design parameters as per ISO 19901-2:2017 and EN 1998-1:2004 Eurocode 8
    - Seismic zone classification according to ISO 19901-2:2017

The ranges in characteristic values of geotechnical parameters shall take into account the spatial soil variability and the general requirements of the various design approaches and methods currently being used in the offshore wind energy industry for piled foundations. A statistical evaluation of the derived geotechnical parameters shall be undertaken and engineering judgement shall be applied. Any possible differences between the derived parameters obtained from *in situ* field tests and laboratory tests shall be considered, understood and taken into account.

In addition, the selection of characteristic values of geotechnical parameters shall be based on EN 1997-1 guidance, which includes taking into account the following:

- Geological and other background information, such as data form previous or neighbouring projects;
- The variability of the measured properties and other relevant information e.g. from existing knowledge;
- the extent of the field and laboratory investigation;
- the type and number of samples;
- the extent of the zone of ground governing the behaviour of the geotechnical structure at the limit state being considered;
- the ability of the geotechnical structure to transfer loads from weak to strong zones in the ground.

The characteristic values of geotechnical parameters shall be selected as cautious estimate of the value affecting the occurrence of the limit state, as defined in EN 1997-1.

The characteristic values of geotechnical parameters shall be defined by considering all requirements and references specified in chapter 2.4.5.2 of EN 1997-1.

The following table gives an overview of which characteristic values of geotechnical parameters should be considered, as a minimum. All soils (cohesive and non-cohesive) are to be considered.

Table 3: Characteristic Values of Geotechnical Parameters - all soils (cohesive and non-cohesive) are to be considered

Characteristic values of geotechnical parameters	
Parameter	**Symbol**
Undrained shear strength	s_u
Relative Density	D_r
Unit weight	γ
Submerged unit weight	γ'
Constrained modulus	M
Angle of internal friction	φ'
Cohesion	c'
Interface friction angle (steel-soil and soil-soil)	δ'
Strain (at one-half the maximum stress on undrained triaxial test)	ε_{50}
Small strain shear modulus	G_{max}
Coefficient of water permeability	k

CONTRACTOR shall provide five (5) electronic copies of digital data of the Integrated Ground Model and appropriate Interpretative Report on flash drive, HDD drive or CLIENT approved equivalent. CONTRACTOR shall provide information how to implement the Ground Model (e.g. stand-alone). CONTRACTOR shall present the full Integrated Ground Model in a freeware version. CONTRACTOR shall provide a user manual which explain clearly, how to use the presented freeware version of full Integrated Ground Model.

3.6 Answering additional questions

It is anticipated that additional questions (from market or within RVO.nl) regarding this geotechnical survey will be received after delivery of the study results. The Contractor is requested to support the Contracting Authority in answering these questions.

By means of a Variation Order time and financial consequences will be arranged.

4 SCHEDULE OF KEY DATES

The SCHEDULE OF KEY DATES are presented in Annex 4a (Lot 1) and Annex 4b (Lot 2)