RWE

Awel y Môr Offshore Wind Farm

Geotech survey method statement & supporting information

Date: December 2021

Revision: 1

Fferm Wynt Alltraeth
AWEL Y MÔR

REVISION	DATE	STATUS/ REASON FOR	AUTHOR:	CHECKED BY:	APPROVED BY:
0	16/11/2021	For review	AH	MO	AB
1	26/11/2021	For issue	AH	MO	AB

Contents

Figures

Tables

1 Geotechnical survey

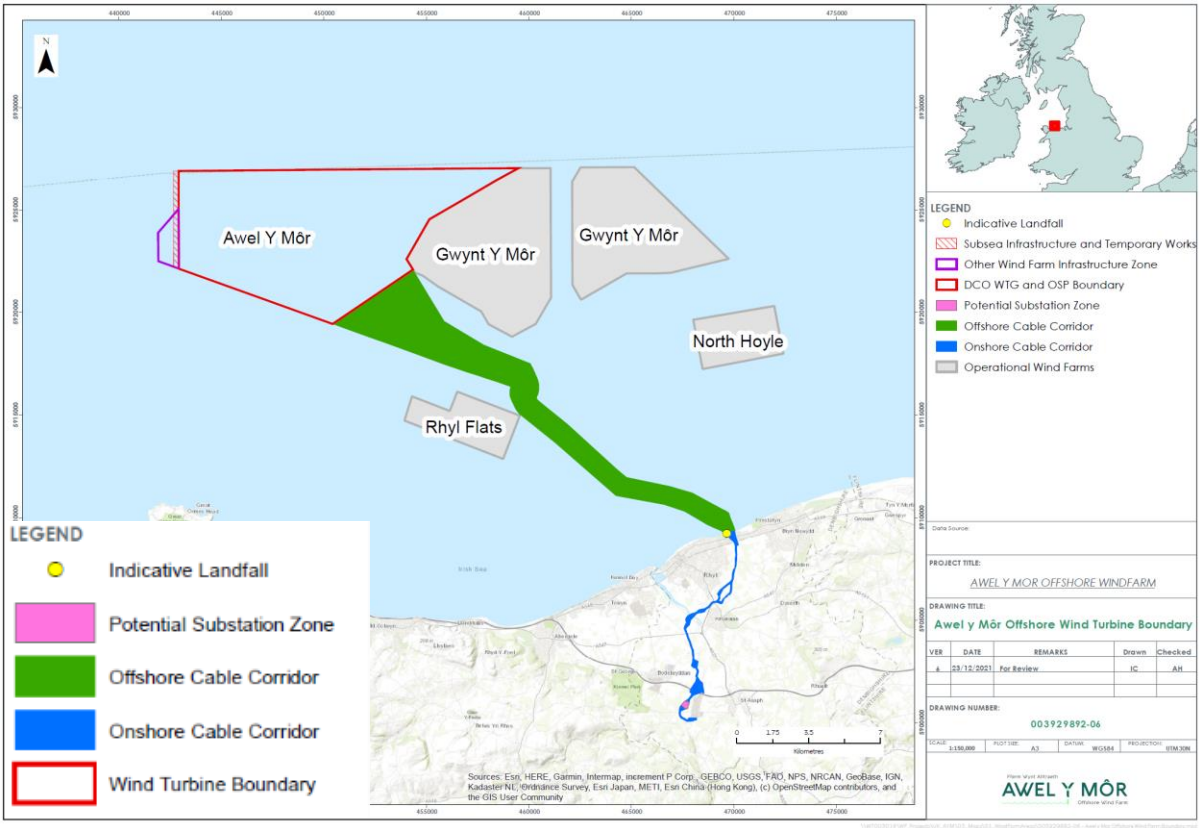
1.1 Purpose of study

1 Awel y Môr Offshore Wind Farm (AyM) is an extension of the Gwynt y Môr Offshore Wind Farm originally developed by RWE in the Irish Sea. The development will include wind turbine generators and offshore transmission assets, with the export cable route planned to reach landfall on the North Wales coast to allow a grid connection at Bodelwyddan in Denbighshire.

2 AyM will undertake an offshore geotechnical site investigation to characterise the site area, expected to take place during Q3 of 2022.

3 AyM expects to complete the project to a high level of accuracy and with no safety or environmental incidents.

Figure 1: Awel y Môr geotechnical survey, site context.



1.2 Scope of work

4 The project will be split into four work elements: preparation and project management; geotechnical fieldwork (array boreholes); laboratory testing; and reporting. Of these, only the geotechnical fieldwork (array boreholes) is described in this document.

5 The contractor will perform an offshore geotechnical survey within the WTG Array area to include all reporting and laboratory testing. The fieldwork element will comprise five boreholes to 55m below seafloor (incl. MWD data) to include:

- CPT push (3m length or refusal)
- Thin-walled push sample (1.0m)
- Wireline P-S at 1m interval
- Natural gamma and caliper
- Rotary coning where bed rock encountered.

1.3 Location of boreholes

6 The boreholes will be located as shown in the figure and table below, and in the embedded shapefile provided here:

004013045-02 - AYM_Borehole_shapefiles.zip

7 The proposed borehole locations are not located within any designated conservation areas and are not predicted to have any significant impacts on these areas.

8 The locations have been chosen to avoid archaeological features. Borehole option 7 (see Table 1) is 99.69 metres from an Archaeological Exclusion Zone (AEZ) which is considered a safe distance should the option be taken. The RCAHMW has no objections.

Figure 2: Awel y Môr geotechnical survey, borehole locations and bathymetry

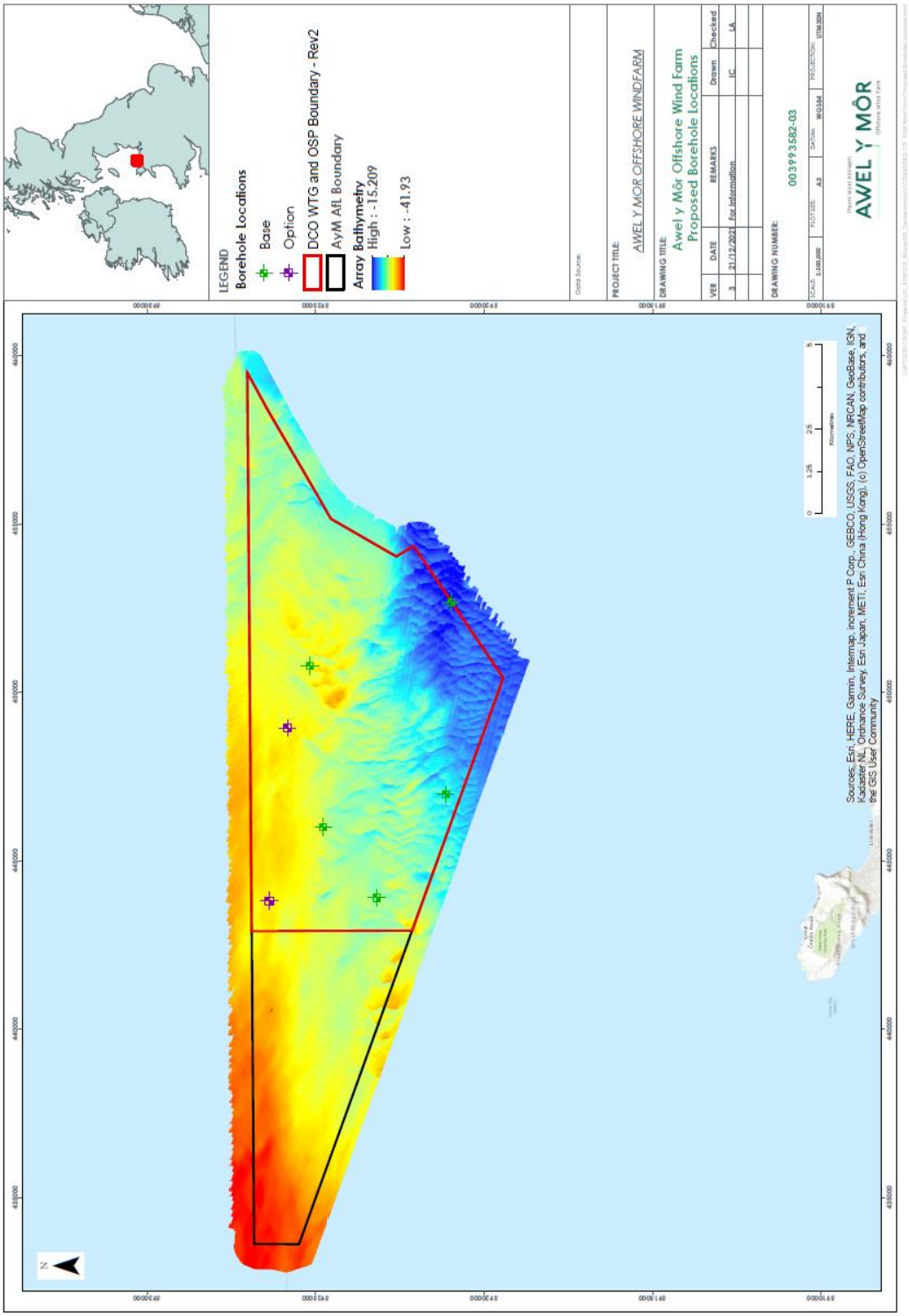


Table 1: Borehole and options coordinates

Object ID	Scope	BH priority	Features T	Latitude (DD) - WGS84 Zone 30	Longitude (DD) - WGS84 Zone 30	Easting (m) - WGS84 Zone 30	Northing (m) - WGS84 Zone 30
1	Base	1	SSG / MMG interface, characterisation of bedrock, Unit 2, 3 and 4 characterisation	53.469163	-3.8133325	446011	5924771
2	Base	2	Sand wave characterisation, Edge of buried channels,Close to MMG / SSG boundary	53.436743	-3.7981715	446977	5921153
3	Base	3	SSG / MMG interface, Fault characterisation, Shallow bedrock	53.473254	-3.7413327	450795	5925174
4	Base	4	SSG characterisation, Unit 1, 2 and 4 characterisation	53.435821	-3.7121552	452690	5920990
5	Option	6	MMG characterisation, Unit 2, 3 and 4 characterisation	53.479064	-3.7692504	448949	5925840
6	Base	5	SSG characterisation, Unit 2, 3 and 4 characterisation	53.454743	-3.8446829	443911	5923191
7	Option	7	SSG characterisation, Unit 4 characterisation	53.483458	-3.8465794	443823	5926387

Figure 3: Awel y Môr geotechnical survey, constraints map – larger image included as separate PDF.

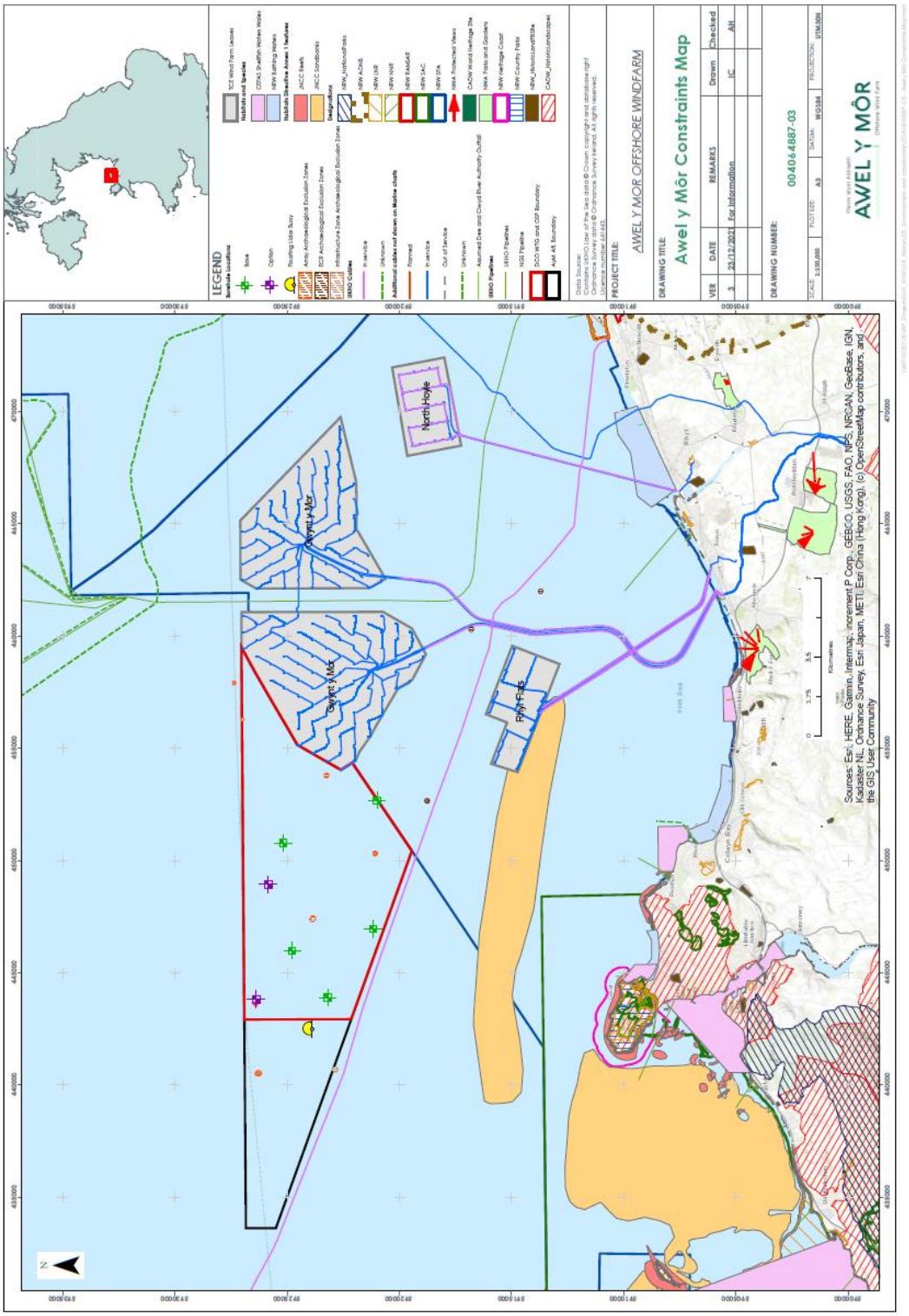
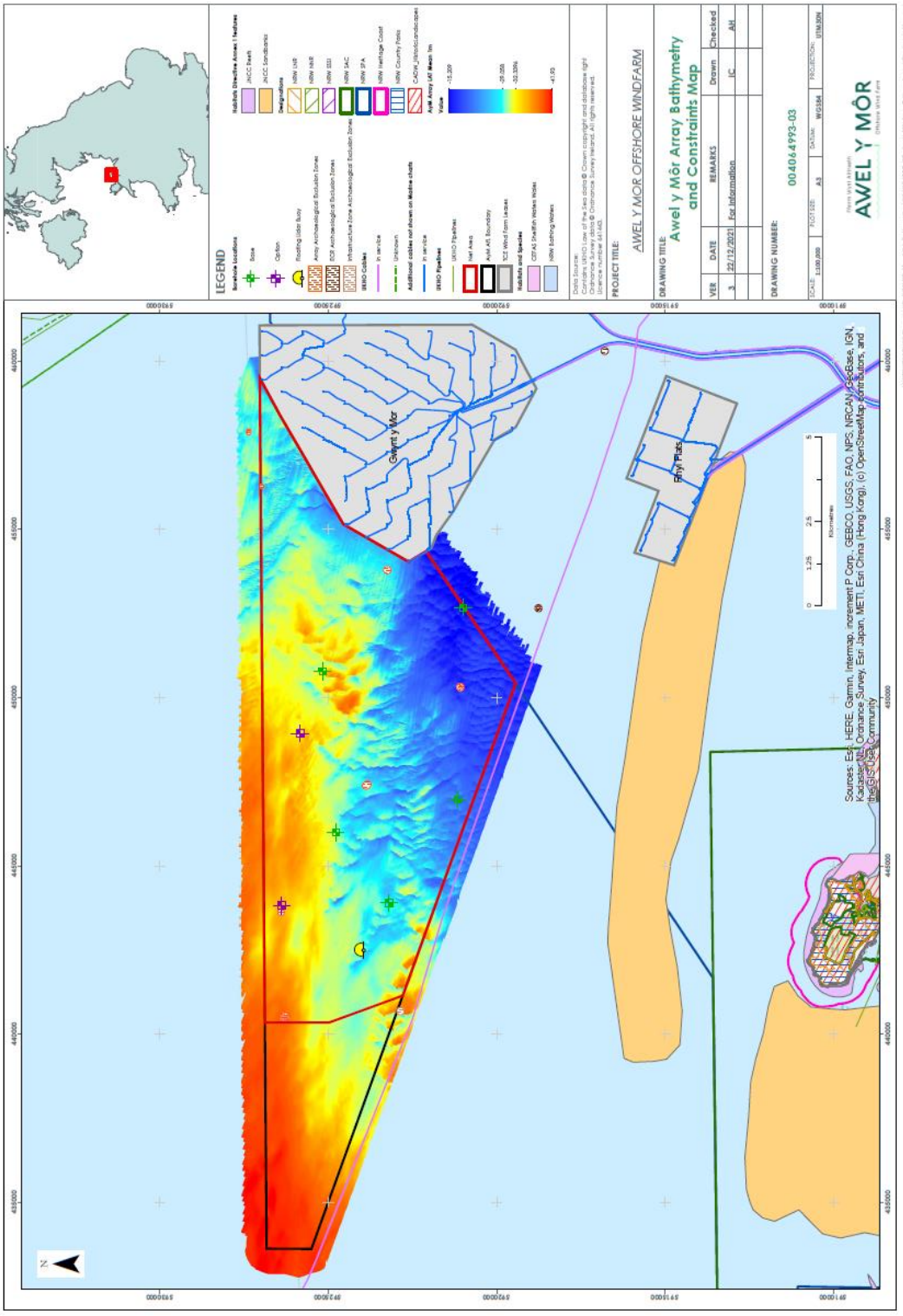


Figure 4: Awel y Môr geotechnical survey, bathymetry and constraints map – larger image included as separate PDF.



1.4 Vessels

9 Only one vessel is required for the five boreholes but the final vessel has not yet been selected. Candidate vessels are:

Table 2: Vessel options

Vessel Name	Year Built	Dimension (m) (L x W x Draft)	Details
Fugro Synergy 	2009	103 x 20 x 6.3	Equipped with Fugro's R190 heave compensated marine drill and a WISON cone penetrometer testing and sampling system and geotechnical laboratory
Fugro Scout 	2015	83 x 20 x 5.6	Equipped with Fugro's R100 heave compensated marine drill and a WISON cone penetrometer testing and sampling system and geotechnical laboratory

1.5 Methodology

10 **Reporting:** During fieldwork, the project manager will manage, monitor and/or report the following activities:

- Offshore daily reporting submitted and agreed with the client or client representative;
- Periodic progress reporting (frequency, format and content as agreed);
- Registers (quality, health, safety, security and environment (QHSSE), risk);
- Key decision points/gateways;
- Preparation of field reports;

- Any changes to project scope.

11 **Drilling operations:** Drilling will be performed using soil boring equipment through a central moon pool using a topdrive power swivel. The equipment includes a fixed derrick rig, mud mixing and pumping unit, and other tools and accessories required to carry out the survey. A heave motion compensator is fitted to the power swivel to ensure the drill bit maintains a uniform pressure on the base of the borehole during drilling operations. An ample supply of drilling mud is provided; a spare string of drill pipe, sufficient spare parts and other supplies required to avoid delays are available.

12 Operations will be conducted on a continuous basis, 24 hours a day, seven days a week.

13 The most effective drilling solution in these ground conditions is for the downhole CPT locations to be undertaken in American Petroleum Institute (API) mode. The contractor proposes undertaking the CPT borehole first then reviewing the data and deciding whether API or piggyback mode would be more appropriate for the ground conditions, based on the sample borehole.

14 Note that if API is selected but the borehole progress and sample quality reduce before the required depth, then the borehole will be terminated early. In which case the sampling will be converted to piggyback coring and destructively drill to the previously achieved depth, before continuing to 60 m with Geobor-S coring. The Geobor-S piggyback coring system is compatible with the proposed downhole CPT equipment.

15 **Downhole sampling:** The most appropriate sampler for the *in situ* soil characteristics will be chosen. Sampling is performed using either a thin-walled wireline push sampler with or without a stationary piston (WIP or piston sampler), or a thick-walled wireline push sampler (also WIP sampler). Sampling and testing are performed from the bottom of a vertically stabilised drill string. This provides optimum protection against buckling of tools and drill string. It also makes it possible to accurately control and monitor the penetration of the sampling tube or sensor into the soil below the bottom of the borehole. Most of the equipment utilises a hydraulic jacking system that is operated downhole via an electrohydraulic umbilical cable, which allows the measured data to be displayed at the surface as the test proceeds. Downhole instrumentation is available to check tool position, proper latch-in, total applied thrust and penetration of sensor or sampling tube into the soil. Digital data transmission is used with this equipment.

16 A range of thin-walled and thick-walled Shelby tubes is provided. These are used without core catchers for cohesive sediments and with a range of core catchers for non-cohesive soils. For very dense granular soils, thin-walled push sample tubes are supplied with catchers to improve recovery. Push sample tubes are 63 mm to 76 mm outside diameter (OD). Tubes of 50 mm OD are also provided for use in very dense granular soils where 63 mm to 76 mm OD tubes are unable to achieve the necessary recovery. Hammer sampling may be performed, as a last option, where push sampling fails to recover an acceptable sample.

17 **Geobor-S piggyback coring:** Where the borehole is expected to contain mainly over-consolidated soils and rock, the best sampling technique is piggyback coring.

18 The use of a dedicated Geobor-S coring string working through a riser in a 'piggyback' formation offers many advantages over conventional wireline drilling/coring when sampling in rock. This is achieved by installing a land coring rig into the heave-compensated platform of the main drill system, from which dedicated coring strings can be deployed. The main advantages of this system are:

- Much higher RPM can be achieved using a land coring rig;

- Use of a dedicated coring string reduces the area drilled compared with conventional API drilling, increasing penetration while capturing a higher amount of core;

- Working from the heave-compensated platform increases control and accuracy of depth and weight on bit (WOB) over the drilling operation, resulting in higher core quality and recovery as the coring rig is stationary with respect to the seabed.

19 **Downhole Piezocone Penetration Testing:** *In situ* piezocone CPTs (PCPTs) are performed using a system consisting of a wireline downhole jacking unit with a 3 m stroke and a thrust capacity of 90 kN.

20 After the borehole has been advanced to the required test level, it is cleaned by mud flushing and if there is a centre insert plug in the drill bit it is retrieved. The system is lowered by its electrohydraulic umbilical to the bottom of the drill pipe, where it sits just behind the drill bit and latches under its own weight. The test sequence is then activated from a surface control cabin and the cone penetrometer is hydraulically pushed into the soil at a constant rate of 2 cm/s. Throughout the test, the measurements of cone resistance, sleeve friction and pore pressure, if measured, are displayed graphically in the control cabin. These data are simultaneously recorded by computer. This facilitates detailed data processing, interpretation and presentation both offshore and onshore. Upon reaching the maximum achievable stroke of either 1.5 or 3 m (depending on which cones are used), or the limiting thrust capacity of 90 kN, the test is terminated and the system depressurised. The drill string is lifted to extract the cone and test rod out of the ground and the unit is retrieved; the complete operation takes 10 to 15 minutes.

21 Depending on soil conditions, either a 10 cm^2 or 5 cm^2 cone is utilised with a 3 m or 1.5 m stroke respectively.

22 Borehole Geophysical Logging (BGL): BGL is a data acquisition method for continuous and discontinuous measurements of physical properties of soil and rock (i.e. formation). This is achieved by operating borehole geophysical tools in open hole borehole. Results typically consist of borehole geophysical logs versus depth. The following tools will be run:

- Natural gamma radiation tool (GR): measures gamma radiation naturally emitted by the formation, providing inferred information on soil and rock type. GR can be used for correlating data over several runs and between closely spaced boreholes. Open hole logging only;
- Caliper tool (CAL): measures borehole diameter using a mechanical caliper providing information on borehole geometry, rugosity and general condition (e.g. borehole stability, swelling, caving). The number of independent or pairs of caliper arms may vary between tool types, allowing for measurements along one or multiple axes. Open hole logging only;
- P and S suspension logger (PSSL): measures acoustic waveforms for deriving discontinuous (requiring a static position of the tool) primary (P-) wave and shear (S-) wave interval velocities in the formation. The PSSL utilises a built-in acoustic dipole source. The PSSL is used for open hole logging only.

23 **Offshore Laboratory Testing:** The majority of testing will occur in laboratories onshore. However, the contractor will provide one dedicated offshore modular laboratory container, equipped with all the required laboratory testing equipment, work units, sink, water supply, lighting and electrical supply. The tests will be conducted in real time as samples are obtained. Offshore laboratory equipment and testing includes:

- Extruder;
- Visual description soil colour chart and sand charts;
- Moisture content;

- Bulk density;
- Pocket penetrometer;
- Torvane;
- Carbonate content estimation using dilute hydrochloric acid (HCl);
- Laboratory miniature vane;
- Unconsolidated undrained (UU) triaxial test machine;
- Point load strength tests on selected samples of rock;
- Photography of samples.

24 **Demobilisation:** Once RWE/AyM accepts that all fieldwork is complete, the vessel(s) proceed to port to demobilise personnel and equipment. Samples and data are dispatched to a laboratory and office for further laboratory testing, and factual and interpretative reporting.

25 **Noise & noise mitigation:** The noise generated will be limited to that of the vessel propulsion systems and the dynamic position system to hold the vessel stationary. The noise created by the drilling shall be less than that produced by the vessel itself. Work is expected to be completed in Q3 2022.

2 Safety

2.1 Health & safety

26 Before mobilisation, the contractor will produce a full quality, health, safety, security and environment (QHSSE) plan for AyM's approval.

27 The project kick-off meeting will be held onboard the vessel prior to departure and will be attended by everyone involved in the fieldwork, including RWE's representative and the vessel manager. Its purpose is to brief all parties on the scope of work, data requirements, and, importantly, safety aspects and procedures. The project manager will record the discussion and update the PEP accordingly, before circulating it to all involved.

2.2 Weather

28 The contractor's meteorologists and oceanographers will work closely with the survey teams. To allow for safe and efficient programming of works, they will issue the following to all offshore and nearshore geophysical and geotechnical vessels:

- Twice daily weather forecasts with a 5-day weather outlook period;
- Weather windows forecast;
- Supply of weather imagery.

29 The forecasts will comprise:

- Meteorological situation;
- 24-hour warning section;
- Tabular forecast at 3-hourly intervals 120 hours ahead for wind, waves and current data;

- Built-in operational limit exceedance based on vessel limits;
- Advanced forecast models available to our forecasting team, including Fugro's own inhouse high-resolution metocean numerical models;
- Graphic wave and surface wind presentation.

2.3 UXO

30 The contractor will take all risk of UXO and ensure that the areas are reduced to ALARP before any intrusive activities commence.

2.4 Navigation

31 The vessel will be undertaking the geotechnical works while on dynamic positioning (DP). The vessel is a DP2 vessel. While on station with restricted navigation, the vessel shall display the appropriate lighting and navigational warnings to other vessels (as prescribed in the International Rules for the Prevention of Collisions at Sea (COLREGS) Rule 27, to indicate that the survey vessel is restricted in its ability to manoeuvre). A Notice to Mariners shall be issued ahead of the work, detailing the locations of the work. While on location, suitably trained DP operators shall be on the bridge at all times. A listening watch on Channel 16 will be maintained. A proper and effective lookout by sight and sound appropriate to the prevailing circumstances will also be undertaken.

Fferm Wynt Alltraeth
AWEL Y MÔR
Offshore Wind Farm

RWE Renewables UK Limited

Windmill Hill Business Park
Whitehill Way
Swindon
Wiltshire SN5 6PB
T +44 (0)8456 720 090
www.rwe.com

Registered office:
RWE Renewables UK Limited
Windmill Hill Business Park
Whitehill Way
Swindon