2022

Valentia Island Energy Ltd

VI Energy

METHODS STATEMENT AND PROGRAMME OF WORKS

AQUALICENSE

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1. INTRODUCTION

1.1. RATIONALE

Aqualicense has been commissioned by Valentia Island Energy Ltd. ("the Applicant") to prepare this Report in support of a Foreshore Licence Application to the Marine Planning and Foreshore Section of the Department of Housing, Local Government and Heritage. This licence, if granted, will allow Valentia Island Energy Ltd to carry out necessary site investigation surveys which will enable the project to confirm the most suitable site and design for offshore wind energy production off the coast of Valentia Island in county Kerry. In advance of these surveys, Valentia Island Energy Ltd has identified indicative potential development areas which are visualised in *Figure 1*. These potential development areas are subject to change based on survey results, stakeholder engagement, technology design and other reports. This document should be read in conjunction with the Other Marine Users document, the Schedule of Works document, the Appropriate Assessment Reports (SISAA/NIS/Article 12) and Foreshore Investigatory Licence Application Form.

The sections that follow provide details regarding the various planned surveys to be undertaken within the investigation area should the investigatory licence be granted. These surveys are set out under the following headings:

- Geophysical Surveys
- Geotechnical Surveys and Sediment Sampling
- Metocean Surveys
- Environmental Surveys

The Methods Statement and Programme of Works document outlines the extent of the proposed surveys, giving a description and quantity of each. These surveys are predominantly required to confirm the optimum site location, to inform the detailed environmental impact assessments, and to determine to a fuller extent the structural design and layout of the proposed development. Should the licencing authority grant the Foreshore Investigatory Licence requested, this will allow Valentia Island Energy Ltd to:

- Obtain a comprehensive understanding of the nature and characteristics of the seabed
- Determine the water depths relative to sea level across the investigation area to inform structural and design selection
- Identify the location and characteristics of significant seabed obstructions and hazards to inform structural locations
- Obtain and characterise geological information applicable to rock and sediment layers beneath the sea floor to inform structural and design requirements
- Obtain critical site-specific metocean data to determine the optimum location and layout for the Project and the wind resource potential of the Project
- Obtain benthic and soil samples to enable the environmental and ecological characterisation of the area

- Obtain video/photographic imagery to further inform environmental and other assessments and to ground truth the findings from desktop studies and other investigations conducted in respect of the investigation area
- Enable appropriate structural design and location selections, as well as system designs, to be adopted at the earliest possible stage in order to avoid, reduce and mitigate any risks identified.

2. THE PROJECT

2.1. VALENTIA ISLAND ENERGY LTD

The overall project is for an offshore windfarm project off the southwest coast of Ireland, more specifically Valentia Island in county Kerry. This offshore renewable energy site will take a phased approach to development which includes the use of floating turbine technology. The overall project will consist of c. 154 turbine, with c. 92 of these located within the 12 nm boundary. The remaining c. 62 turbines will be located outside this 12 nm limit, and subject to an application separate from this. The combined total output for the complete project is predicted to be c. 1.5GW. The nearshore arrays occupy an area of c. 234 km ^{2} or 23,447 ha. The Overall Project is visualised below in *Figure 1*.

This project is currently in the planning stages and is, therefore, subject to change. The application for a Foreshore Investigatory Licence is not an application for development. If granted, this licence will allow the project team to further refine the site choice and to carry out surveys considered necessary to accurately assess the viability of the project across a spectrum of technical, environmental, social and economic factors.

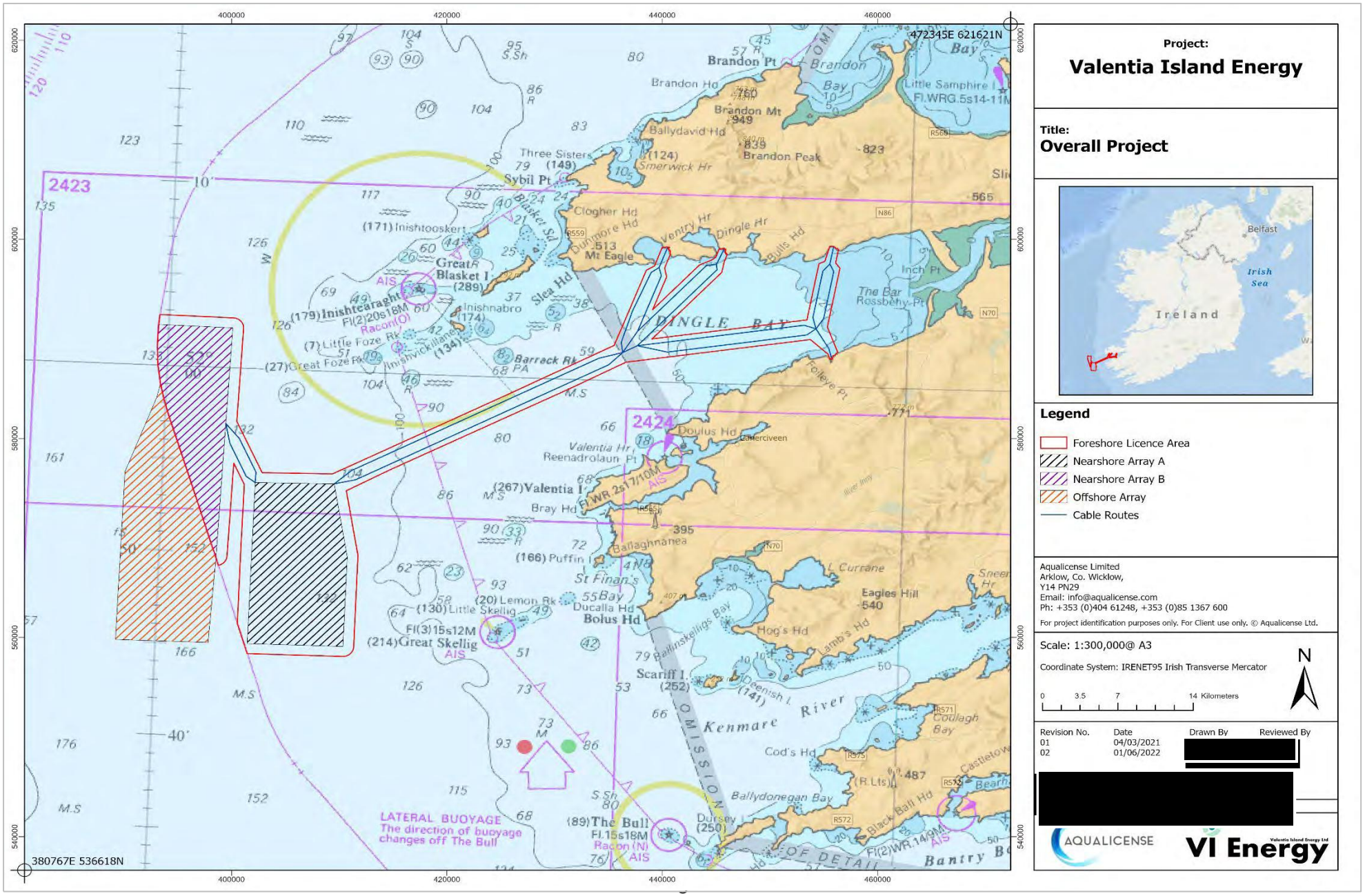

Figure 1: Overall Project

3. Foreshore Licence Area

The Foreshore Licence Area, outlined in Red, reflects the area being applied for under the Foreshore Licence Application. The area measures c. 474 km², or 47,407.80 ha, and is the area within which all surveys will be conducted, *Figure 2*. The coordinates of the boundaries of the Foreshore Licence Area are provide in *Table 2* of *Section 10*. The area is described as the Foreshore Licence Area, and it is the area within which the Applicant seeks to conduct investigations appropriate to developing a wind farm project. The Foreshore Licence Area is larger than the proposed development area as it incorporates both potential development sites as well as potential cable route options and it must be understood that no structural development of any nature will take place at this stage of the Project.

The Foreshore Licence Area was identified following a sequence of assessments and consultations that included, but are not limited to, the following:

1. The team's consultation with offshore wind energy production experts,

2. An independent assessment of a number of potential areas for ORE development off the Irish coast, and

3. Constraint mapping and site selection assessment focused on the marine space proximate to the coastline,

4. Detailed consideration of survey requirements.

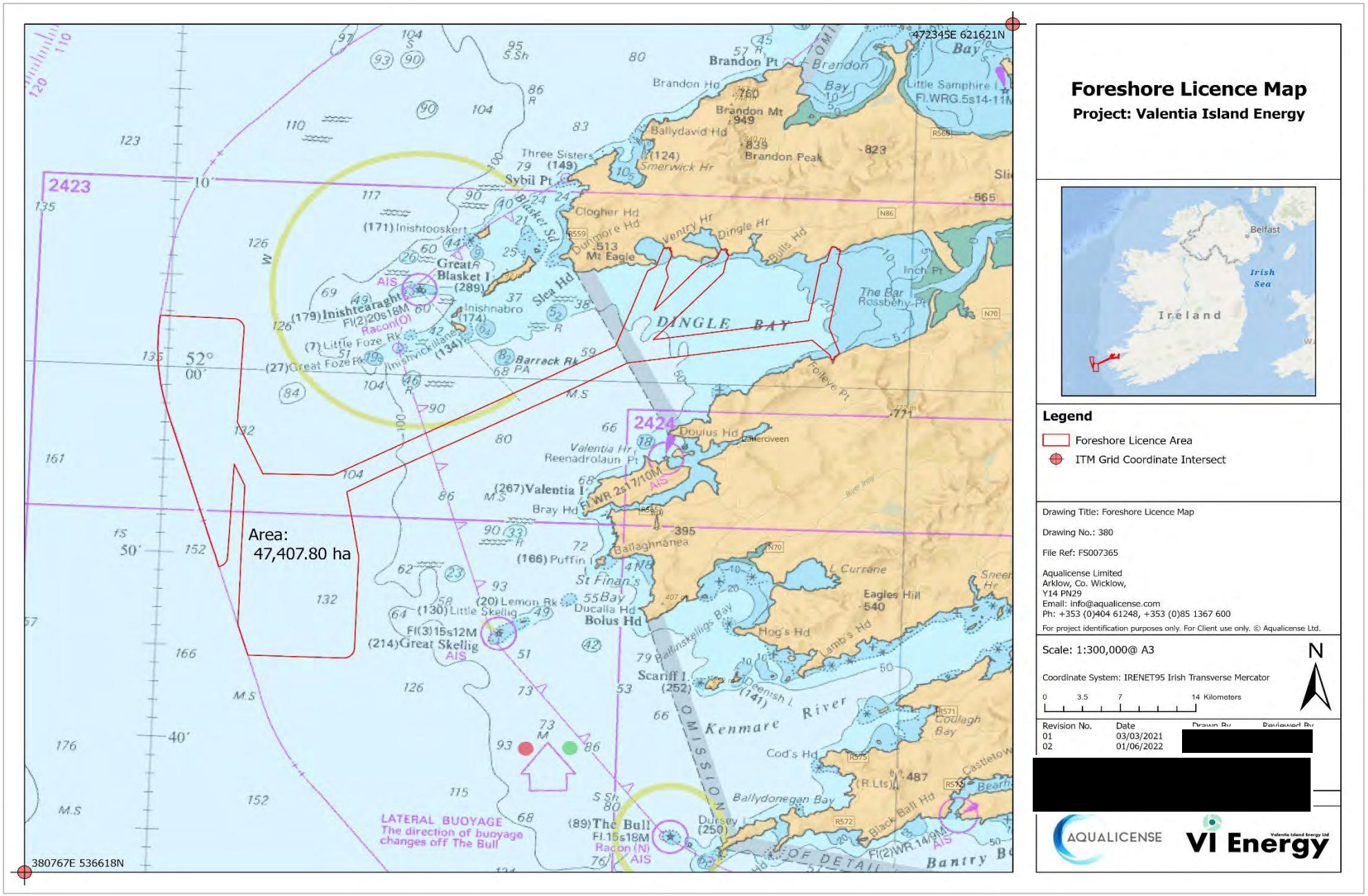

Figure 2: Foreshore Licence Area

4. GEOPHYSICAL SURVEYS

The main purpose of the geophysical surveys is to assess the seabed features and subsurface character of the seabed sediment and bedrock within the site area. This survey requires 100% coverage of the proposed development area to produce a digital terrain model with 0.25m spatial resolution along with comprehensive maps of the surface geology, surface morphology and manmade or naturally occurring hazards. Typically, the geophysical investigations precede any geotechnical investigations, and the results of the geophysical investigation are then used to inform more appropriately the selection of geotechnical investigation locations.

Acquisition of geophysical data primarily utilises a suite of acoustic-based instruments but also incorporates magnetic, electrical, and optical based systems where appropriate to characterise the seabed, shallow soils, and geology. Geophysical surveys comprise the following elements:

- Multibeam Echosounders (MBES)
- Side Scan Sonar (SSS)
- Sub-bottom Profiling (SBP)/Ultra-High resolution seismic (UHRS)
- Marine Magnetometry/Gradiometer

The following sets out the methodology and equipment detail for each survey type. All equipment will be calibrated and tested to ensure it is ready to deploy using the correct settings for the survey site. This survey campaign is not intrusive on the seabed and will aim for 100% coverage of the proposed Development Area, Cable routes and appropriate areas within the total Investigation area (***Error! Reference source not found.***). The survey duration and timeframes are indicated in *Section 9.*

4.1. MULTIBEAM ECHOSOUNDER (MBES)

4.1.1. PURPOSE

Multibeam echo sounders map the seafloor by producing a fan of narrow acoustic beams, thus providing 100% coverage of the bottom. The resulting seabed maps are more detailed than those obtained using single-beam mapping. Most modern shallow to mid water systems satisfy the International Hydrographic Organisation's (IHO) IHO-S44 and LINZ standards. MBES can also produce backscatter data similar to Side Scan Sonar data. This data can be used for benthic habitat mapping. MBES data can act as a check to the positioning and accuracy of Side Scan Sonar and Magnetometer data. An example of this equipment is the SeaBat 7160 by Teledyne Marine which has a nominal operating frequency of 44kHz with a range resolution of 12cm. The likely equipment to be used for this survey will be the R2Sonic R2024 and the Kongsberg Maritime EM 2040. These have operating frequencies of 170 - 450kHz (optional 700kHz) and 200 to 400 kHz in steps of 10 kHz, respectively with depth ranges of 400 and 520 metres. Both systems surpass the IHO S44 and Linz accuracy and resolution criteria.

4.1.2. METHODOLOGY

The selected MBES will likely be mounted on a hydrodynamic pod, deployed via a moonpool on the survey vessels. It will operate in conjunction with an Inertial Navigation System (INS) and a Motion Reference Unit (MRU). The vessel passes over the tract of seabed under survey and emits a fan of acoustic waves which are reflected off the seabed and back to the receiver. Several hundred data

points per second are recorded simultaneously across the survey swath and the depth and topography of the seafloor are captured from the varying transit times of the signals. Recorded travel times for the beams that are reflected off the seabed are converted to water depth and distance. MBES systems use beamforming to correct directional differences in the returning acoustic waves. The resolution of the data largely depends on the number of beams used, beam separation angle, frequency of acoustic energy, and update rates.

Vessel To Be Used

To be confirmed once the survey contractor is appointed. It's possible that two vessels will be used, one offshore in water depths greater than 50m and a second inshore vessel operating from a water depth of 50 metres to as close to the shore as possible. The offshore vessel will have a length of approximately 75 metres and the inshore vessel circa 22 metres. Significantly the draft of the inshore vessel will be 1.5 metres or less.

Swath Width

MBES swath widths can be approximately 10 times the water depth depending on the product selected. For the EM 2040 the manufacturers claim a swath width of 10 times the water depth at the 300 kHz frequency. The R2Sonic produces a swath angle of 120-130deg under normal use.

Location

To provide 100% coverage of the array areas of the Foreshore Licence Area as shown in *Figure 2*.

4.1.3. Examples of Equipment

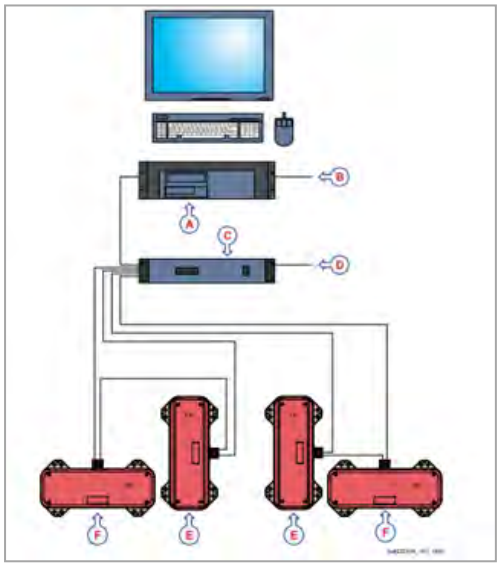

Figure 4: Kongsberg Maritime EM2040 System Diagram (Kongsberg, 2021) (KM Shallow Survey 2020)

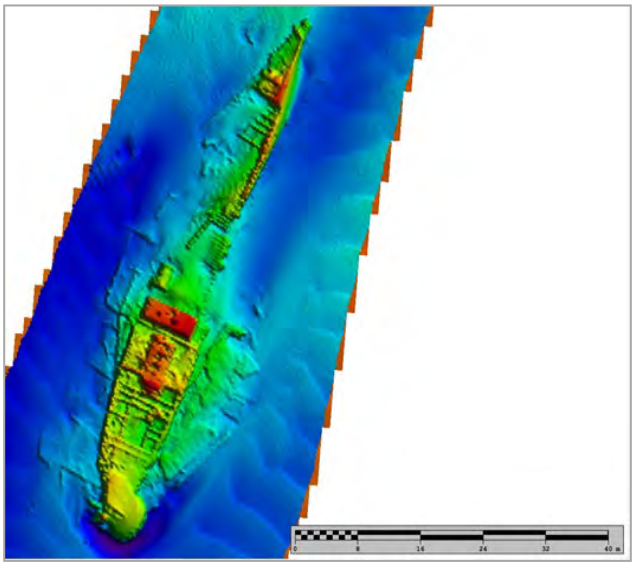

Figure 3: EM 2040 Image of a wreck near the Saltees Courtesy of GSI

4.2. Side Scan Sonar (SSS)

4.2.1. Purpose

The Side Scan Sonar (SSS) builds up an acoustic picture of the seabed akin to aerial photography on land. SSS is used to identify and map seabed features. It also allows for manmade artefacts or natural obstructions to be accurately located and measured including accurate definition of height off the seabed. For this survey work a tri frequency SSS will be used. The preferred SSS equipment for these surveys is the Edge Tech 4205 system. This is becoming industry standard for the water depths involved. It is a tri frequency system and has a multipulse/motion tolerant high-definition mode. In this mode you have a choice of the following, 120/410 kHz, 230/540 kHz, 540/850 kHz or 230/850kHz.

4.2.2. Methodology

The device is generally towed behind the vessel on a fish. An SSS works by emitting fan-shaped acoustic pulses to the seafloor and then recording the intensity of the reflections. It is important that the nadir area immediately under the fish is isonified by the adjacent survey line. This means that over most of the area surveyed there will be at least 200% coverage. The position of the fish is tracked using the USBL system (Sonardyne Mini Ranger 2 USBL System). The SSS will be operated at the same time as the MBES and SBP.

Vessel To Be Used

To be confirmed once the survey contractor is appointed. It's possible that two vessels will be used, one offshore in water depths greater than 50m and a second inshore vessel operating from a water depth of 50 metres to as close to the shore as possible. The offshore vessel will have a length of approximately 75 metres and the inshore vessel circa 22 metres. Significantly the draft of the inshore vessel will be 1.5 metres or less.

Swath Width

Operating ranges are as follows 120 kHz: 600m, 230 kHz: 350m, 410 kHz: 200m, 540 kHz: 150m, 850 kHz: 90m.

Location

To provide 100% coverage of the array area of the Foreshore Licence Area as shown in *Figure 2*.

4.2.3. Examples of Equipment

Figure 6: Edge-Tech 4205 SSS Fish. (Edge Tech, 2020)

Figure 5: EdgeTech 4205 Side Scan Sonar MT example. (Edge Tech, 2020)

4.3. Sub Bottom Profiling (SBP)

4.3.1. Purpose

Various SBP equipment types will be required to survey the proposed development sites and cable routes. The SBP transducers will be deployed on a pole over the side or through a small moonpool. SBP types to be used will include Parametric SBP inshore and standard SBP offshore. These profilers produce a high resolution 2D image of the subsea bed geology using reflection seismology.

4.3.2. Methodology

It is expected that the inshore vessel will have a Parametric SBP most likely an INNOMAR SES–2000 medium –100 system. This will be pole mounted over the side or through a small moonpool. It can operate in water depths from 2 – 2000 metres. It has a penetration of up to 70 metres below seabed and uses primary frequencies between 85-115kHz with secondary low frequencies between 2-22kHz. The offshore vessel will be fitted with a hull mounted or moonpool deployed SBP probably an EdgeTech 3400 OTS Low Frequency system. It has a maximum penetration of 20-200 metres depending on sediment type. The SBP will be run at the same time as the Side Scan Sonar and Multibeam. Line spacing will be dictated by the Side Scan Sonar coverage requirements. Cross lines may be necessary to further define sub seabed layers. It is expected that software such as SonarWiz will be used to process and analyse the standard SBP data. The INNOMAR system comes with its own processing and analysis package.

Vessel To Be Used

To be confirmed once the survey contractor is appointed. It's possible that two vessels will be used, one offshore in water depths greater than 50m and a second inshore vessel operating from a water depth of 50 metres to as close to the shore as possible. The offshore vessel will have a length of approximately 75 metres and the inshore vessel circa 22 metres. Significantly the draft of the inshore vessel will be 1.5 metres or less.

Depth of Penetration

Penetration with the Parametric SBP will be to a maximum of 70 m and with the standard LF SBP array to a maximum of 200m. Both limits are dependent on the sediment type encountered. The standard LF SBP has a vertical resolution of 10 - 30 cm and the INNOMAR Parametric system has a vertical resolution of up to 5cm.

Location

To provide 100% coverage of the array area of the Foreshore Licence Area as shown in *Figure 2*.

4.3.3. Examples of Equipment

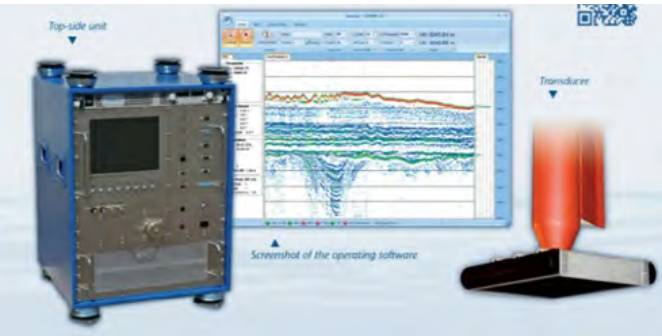

Figure 8: INNOMAR SES-2000 Medium-100 Parametric Sub-Bottom Profiler (Innomar, 2021)

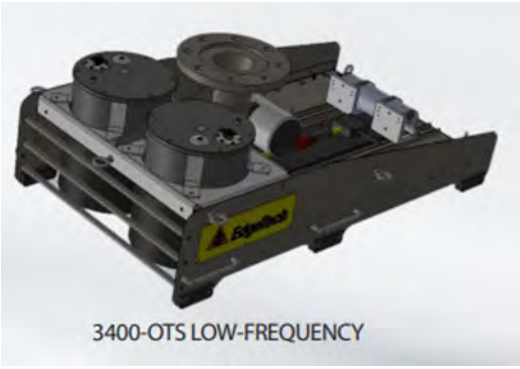

Figure 7: EdgeTech 3400-OTS LF SBP (Edge Tech, 2020)

4.4. Ultra-High Resolution Seismic (UHRS) Surveys

4.4.1. Purpose

When there are glacial deposits expected in an area being surveyed a UHRS system will be necessary to achieve penetration through these deposits and establish rock head beneath.

4.4.2. Methodology

Following a preliminary interpretation of SBP data a decision will be made as to where in the survey area it is necessary to carry out a UHRS survey. This will be a stand-alone operation. In general, the line spacing need not be as tight as for the SBP survey. However, particular attention might be paid to actual installation and structure locations. Software such as the Kingdom Suite will be used to process and interpret the data. It is anticipated that Geo-Spark 100 J LW PPS source with a 400 multi tip sparker and UHR 24 channel Geo-Sense streamer will be used. This system can be deployed from an Inshore or offshore vessel.

Vessel To Be Used

To be confirmed once the survey contractor is appointed. It's possible that two vessels will be used, one offshore in water depths greater than 50m and a second inshore vessel operating from a water depth of 50 metres to as close to the shore as possible. The offshore vessel will have a length of approximately 75 metres and the inshore vessel circa 22 metres. Significantly the draft of the inshore vessel will be 1.5 metres or less.

Location

To provide 100% coverage of the array area of the Foreshore Licence Area as shown in *Figure 2*.

4.4.3. EQUIPMENT EXAMPLES

Figure 10: 1 KJ Portable Spread 0-750 Meters. Geo Marine Survey Systems – Geo-Spark 1000 system. (Geomarine Survey Systems, 2021)

Figure 9: Multi-Trace 24-28 Channels. Geo Marine Survey Systems – Multi Trace Acquisition System. (Geomarine Survey Systems, 2021)

4.5. MAGNETOMETER

4.5.1. PURPOSE

Magnetometer surveys are employed to identify magnetic anomalies, typically associated with human activities. They can detect obstacles or hazards that need to be avoided or removed prior to construction or can be culturally significant archaeological artifacts that need to be documented, researched, and avoided or possibly excavated during offshore wind energy development. These include Munitions of Explosive Concern (MEC), also known as Unexploded Ordnance (UXO), active or abandoned submarine cables/pipelines, abandoned debris from marine vessels, anchors and shipwrecks.

4.5.2. METHODOLOGY

Magnetometers measure total magnetic field therefore can only detect items that have an associated ferrous metal casing or magnetic signature. The magnetometer is required to be towed close to the seabed. A general magnetometer survey will be carried out at the same time as the MBES, SSS and SBP surveys, with the same line spacing.

Following a UXO risk assessment, if necessary, a potential UXO (pUXO) survey will also be carried out. This will involve towing a gradiometer array behind the vessels. Typically, these arrays are composed

of 4 - 5 sets of two vertical pairs (Gradiometers) of magnetometers on an ROTV frame. It is likely that this equipment and operators would be hired in especially for UXO surveys.

Vessel To Be Used

To be confirmed once survey contractor appointed. Typically, a survey vessel in this water depth would be around 20-60m long.

Survey Spacing

For the general survey with a single magnetometer the line spacing will depend on the spacing required to achieve full Side Scan Sonar coverage

Location

To provide 100% coverage (with above survey spacing) of the array area of the Foreshore Licence Area as shown in *Figure 2*.

4.5.3. Example of Equipment

Figure 12: Geometrics –G882 Magnetometer. (Geometrics, 2021)

Figure 11: ROTV with four sets of Gradiometers Array. (Deep BV 2021)

5. Geotechnical Surveys and Sediment Sampling

Geotechnical survey campaigns are required so that the project can evaluate the viability of the proposed sites. This survey will include Cone Penetration Testing (CPT) and Vibrocore and Borehole drilling and sampling. These surveys provide detailed sample analysis to derive data on the geotechnical properties of the seabed. Data from the previously obtained geophysical survey campaign will be relied upon to fully review and refine the optimum location of geotechnical samples. However, indicative survey locations have been selected to ensure that a generalised ground profile can be provided across the licence area. These locations were chosen through the best use of existing data and based on the expected characteristics of the seabed. Separately, the locations were chosen to ensure a full range of seabed lithologies and formations are sampled, and any environmental constraints considered.

The final outputs from collection of the geotechnical data will include a refined ground model which integrates the geotechnical and geophysical data. This ground model will clearly outline the lateral and vertical variability in the ground conditions of the seabed. The quantity of samples, duration and timeframe required is indicated in *Section 9* while the sample locations are indicated in *Figure 20.* These sample locations in the array site are at individual turbine locations, while along the proposed cable routes, each sample is spaced 1 km apart up to the Mean High-Water mark.

The following describes the survey methodologies and equipment detail for each survey type. All equipment will be calibrated and tested to ensure it is ready to deploy using the correct settings for the survey site.

5.1. Cone Penetrometer Tests (CPTs)

5.1.1. Purpose

CPT is an in-situ test used to identify the soil type. A CPT is pushed into the ground and a measure is made of the resistance of ground to steady and continuous penetration of the cone. The resistance is recorded using sensors in the tip of the cone as well as sensors in the friction sleeve recording sleeve friction, pore water pressure and penetration inclination. These measurements permit interpretation of ground conditions, including soil profiling, classification, and geo stratigraphy.

5.1.2. Methodology

CTP tests measure four different parameters, the cone resistance (qc), the sleeve friction (fs) pore pressure (u2) and inclination. Information from the borehole test data is utilised as an input for calculations of effective vertical stress used to calculate net cone resistance. The cone can be pushed directly into the seabed or from the base of pre-drilled boreholes. Data is recorded in real-time and transferred back to the operator. To obtain pore pressure dissipation tests (PPDT) a piezo-cone penetrometer will be utilised during the CTP testing.

Vessel To Be Used

500mm^2, 1,000 mm^2 or 1,500 mm^2 plus other sizes as determined required by CPT operator.

Depth of Penetration

Up to 50m depth below seabed or to refusal, unless the maximum thrust capacity of the equipment is reached or other operational occurrence.

Location

Points as shown in *Figure 20.*

5.1.3. Examples of Equipment

Figure 13: GeoQuip Seabed CPT GMC200 Cone Penetration Test System

5.2. Boreholes

5.2.1. Purpose

A borehole is a narrow hole drilled into the seabed. Its purpose is to establish the nature of the subsurface through in situ testing or to collect samples for geotechnical laboratory analysis and testing and to inform the foundation designers of the regional ground model. Boreholes have the benefit of being able to penetrate deep into the subsurface as required for foundation designs. The number of boreholes and their exact location will be reviewed once the geophysical survey results are determined.

5.2.2. METHODOLOGY

Boreholes are drilled from a jack-up platform / rig or a drillship depending on the water depth in the area of investigation. Boreholes are drilled using a casing or drilling mud depending on the character of the hole. For rock sampling, coring can be initiated once competent rock is encountered. Sampling of soils can be alternated with downhole CPTs to obtain samples for laboratory tests and CPT soundings at the same borehole location.

Diameter

Will be determined by drilling company – typically 150mm (6inch) or 200mm (8inch) diameter casing are utilised.

Depth of Penetration

Dependent on downhole surveys to be obtained and the results of the geophysical survey. It is expected that borehole depths will vary across all sample locations. Generally, the borehole depth should be half to one pile diameter below the planned pile tips for a static installation.

Location

Points as shown in *Figure 20.*

5.2.3. Examples of Equipment

Figure 14: Example Geotechnical Borehole rig (Geoquip Marine, 2020)

Figure 15: Example Geotechnical Ship, Fugro Synergy (Geoquip Marine, 2020)

5.3. Vibrocore / Gravity Sampler

5.3.1. Purpose

Shorter than a borehole, vibrocores and gravity cores can be used to collect samples down to around 8 to 12m (depending on soil conditions). Where seabed soils are soft, gravity cores are often more suitable than vibrocoring. These cores are more suited to areas where concerns are based around the shallower substrate, for example cable routes rather than deep foundations.

5.3.2. Methodology

A vibrocore comprises a simple steel tube with an inner plastic liner which, once in place on the seabed, is vibrated into the seabed by the action of two counter rotating eccentric weights driven by high power vibrator motors. The tube is recovered from the seabed by the same A-frame or crane used for deployment and the 96mm diameter sample is retained by a core catcher. Once recovered to deck, the plastic liner is removed, and the sample described is stored for detailed description and laboratory testing onshore. The vibrocore offers seabed samples of 3m to 12m in depth.

Where the vibrocore cannot be utilised, a gravity corer or piston corer will be used. To collect a sample, a tube is lowered into the seabed on a single steel cable, with weights rather than vibration causing penetration. Seabed penetration is achieved by allowing the unit to free fall the last 5 - 10 metres. For a piston corer, a messenger operated release mechanism triggers the final free fall penetration to obtain a core sample. The mechanical trigger enables the free fall distance to be adjusted via the length of cable from clamp to counterweight.

Diameter

Typically, a 3- or 4-inch diameter aluminium core barrel.

Depth of Penetration

The length of the recovered cores typically ranges from 1.5 to 9.0 meters. depending on soil type.

Location

Points as shown in *Figure 20.*

5.3.3. Examples of Equipment

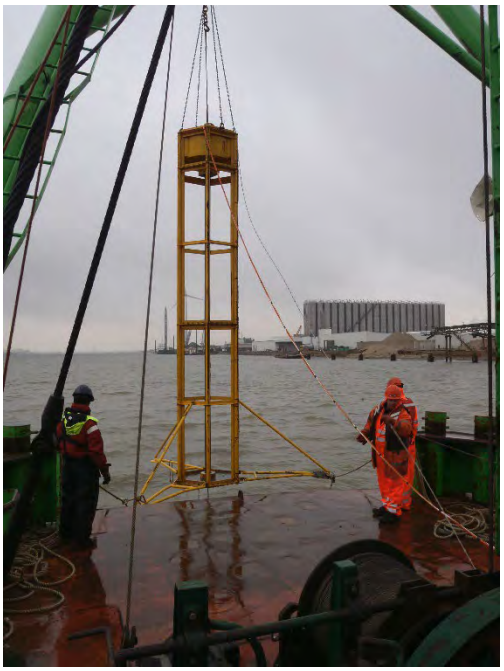

Figure 16:Vibrocore Deployment (OSIL, 2020)

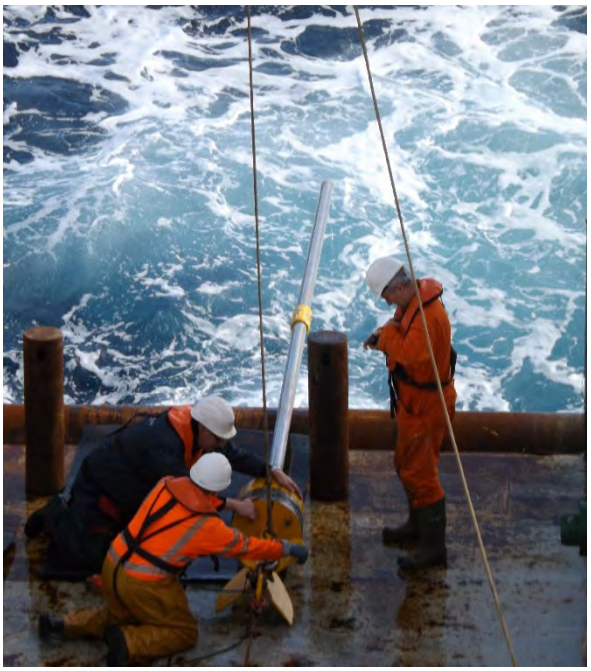

Figure 17: Gravity Core deployment from RV Celtic Explorer (OSIL, 2020)

5.4. Grab Samples

5.4.1. Purpose

Grab samples provide a description of the uppermost seabed and ground truthing of geophysical interpretation.

5.4.2. Methodology

A grab sample is simple device, which operates like an articulated bucket. When it comes into contact with the seabed, the bucket closes, collecting a sample of the surface deposits. Grab samples can be used on a hard seabed where gravity cores may not recover any material or become damaged. The grab samples are split in number between benthic survey samples and geotechnical samples.

Diameter/Size of Sample

A range of sizes are available, the size selected will be capable of recovering a representative volume of soil. Small 'Shipek' grabs are suitable in muds and sands, while a large grab is required for gravel. Examples of the grab equipment are shown in Figures

Depth of Penetration

Negligible as only collects from upper most surface of the seabed.

Location

Points as shown in *Figure 26.*

5.4.3. Examples of Equipment

Figure 18: Shipek Grab examples.
(Marine Geophysics Department,NIOF, 2020)

Figure 19. Seatools Excavator Grab being recovered.

6. Environmental Surveys

Environmental surveys required for the proposed foreshore licence area, include surveys of fisheries, benthic organisms, birdlife, and marine mammals. These surveys enable the collection of data to inform the Environmental Impact Assessment (EIAR). This collection of surveys is used to describe the environmental condition of the area and provide a baseline level in terms of living organisms. This permits mitigation measures to be put in place for any potential environmental impacts and comparisons to be made during the construction and operation of the windfarm to measure any effects on the environment.

The quantity of samples, duration and timeframe required is indicated in *Section 9* while indicative locations are show in *Figure 26.*

6.1. Fisheries Survey

6.1.1. Purpose

A fisheries survey is carried out to determine fish species and their distribution within the receiving environment.

6.1.2. Methodology

An initial desk study utilising all available literature will be carried out to determine the presence, distribution, and seasonality of fish within the area. For areas where there is insufficient data, specific site surveys assessing fish resources will need to be undertaken. The full scope and methodology concerning these baseline pre- and post-construction surveys will be finalised following consultation with the Sea Fisheries Protection Authority (SFPA) prior to their commencement.

This survey will use local commercial fishers and their existing equipment for collecting data on adult fish and shellfish so that local commercial fishing knowledge can be utilised where possible. Equipment will be selected based on the desk study and stakeholder engagement once the main species of fish have been identified.

6.1.3. Examples of Equipment

As an example, otter trawls are recommended for groundfish and pelagic fish, while a large beam trawl (4m+) is more suitable for sampling flatfish.

Figure 19: Example of a beam trawl being deployed over the side of a Survey Vessel. (Wageningen University & Research, 2020)

6.2. Benthic Survey

6.2.1. Purpose

Benthic surveys provide details on the distribution and extent of marine benthic communities and habitats located within the proposed application area. Repeated surveys pre-construction and post-construction will be carried out if it is deemed necessary.

6.2.2. Methodology

Sampling locations, for both grab samples and video / photography, are spread over the wind farm site and along cable routes. Exact sampling locations will be selected following interpretation of the geophysical data and after the final design of the farm structures. The sampling will ensure that the full range of habitats and biological communities that are expected in the survey area are included.

A set of reference samples are taken from outside of the farm sites, selected to have comparative environmental variables (e.g., sediment type, water depth, topographical features, faunal structure). This will allow for comparison of the sites within the farm to those outside to examine changes in benthic communities.

Grab samples, as discussed in *Section 5.4,* are used to retrieve a sediment sample from the seabed. Grab samples can be split between the geotechnical and benthic analysis to maximise the data.

For areas that are difficult to sample, or present data of special interest, Drop Down Video (DDV) may be used for more information. DDV can also be utilised in areas where geophysical data is not available

as a precursor to physical sampling and prior to each grab sample to determine the presence or absence of sensitive or unsuitable habitats.

6.2.3. Examples of Equipment

Figure 20: Towed and drop down SeaSpy system comprising SeaSpectrumHD camera offering high quality 1080P video feed via HD-SDI over dedicated high speed fibre optic link video and a high quality 18 mega pixel digital SLR Camera. (Subsea Technology & Rentals Ltd, 2021)

Figure 21: 2m scientific beam trawl utilised for epibenthic faunal sampling (Eggleton, et al., 2017, p. 122)

6.3. Bird Survey

6.3.1. Purpose

Given the proposed development site locations having proximity Special Protection Areas (SPA) designated under the EC Birds Directive (Directive 2009/147 EC) a full bird survey is required.

6.3.2. Methodology

A desk study will be carried out initially to gather all available information on the bird populations along the coastal area and out to sea. All ornithology work will be carried out by suitably qualified persons at appropriate times of the year, depending on the species being surveyed. This survey will be designed by the successful tenderer and may include monthly vantage Point Surveys, boat-based seabird surveys and or aerial surveys and breeding bird surveys. The quantity of samples, duration and timeframe required is indicated in *Section 9.*

Figure 22: Example aerial imagery - Gannet Population on Bass Rock (firth of forth) at c.2cm resolution (APEM)

6.4. Marine Mammal Survey

6.4.1. Purpose

Marine mammal surveys are carried out to assess the trends and distributions of marine mammals within and surrounding the proposed wind farm area. In addition to understanding the distribution of marine mammals, it is also important to track the levels of underwater noise within the area.

In water, sound waves propagate rapidly (typically 1500 m/s) and can travel over very large distances (few kilometres to hundreds of kilometres). How the noise behaves in the water column depends on the acoustic sources present, i.e., natural, anthropogenic or of animal origin, and is affected by the bathymetric conditions, temperature and salinity, the nature of the seabed and the state of the sea. Underwater noise expected from these investigations has been considered separately in the Appropriate Assessment and Natura Impact Statement which supports the Foreshore Licence Application.

6.4.2. Methodology

Acoustic pressure (noise) in the water column is measured using a pressure-sensitive device such as a hydrophone (an underwater microphone). It is proposed that the marine mammal survey will utilise a set of Continuous Porpoise Detectors (C-PODs) which will be installed for the purpose of passive acoustic monitoring (PAM) of marine mammal activity and for the recording of general noise within the water column. This will measure dolphin/porpoise echolocation click occurrence and collect data on background noise levels and other vocalisations made by cetaceans. The placement and distances

between the deployed devices will be selected following underwater noise modelling. Data from the CPODs will be supplemented by vessel-based sighting surveys. These survey methods are both non-invasive. The on-board Marine Mammal Observer (MMO) study can be carried out concurrently with the bird survey.

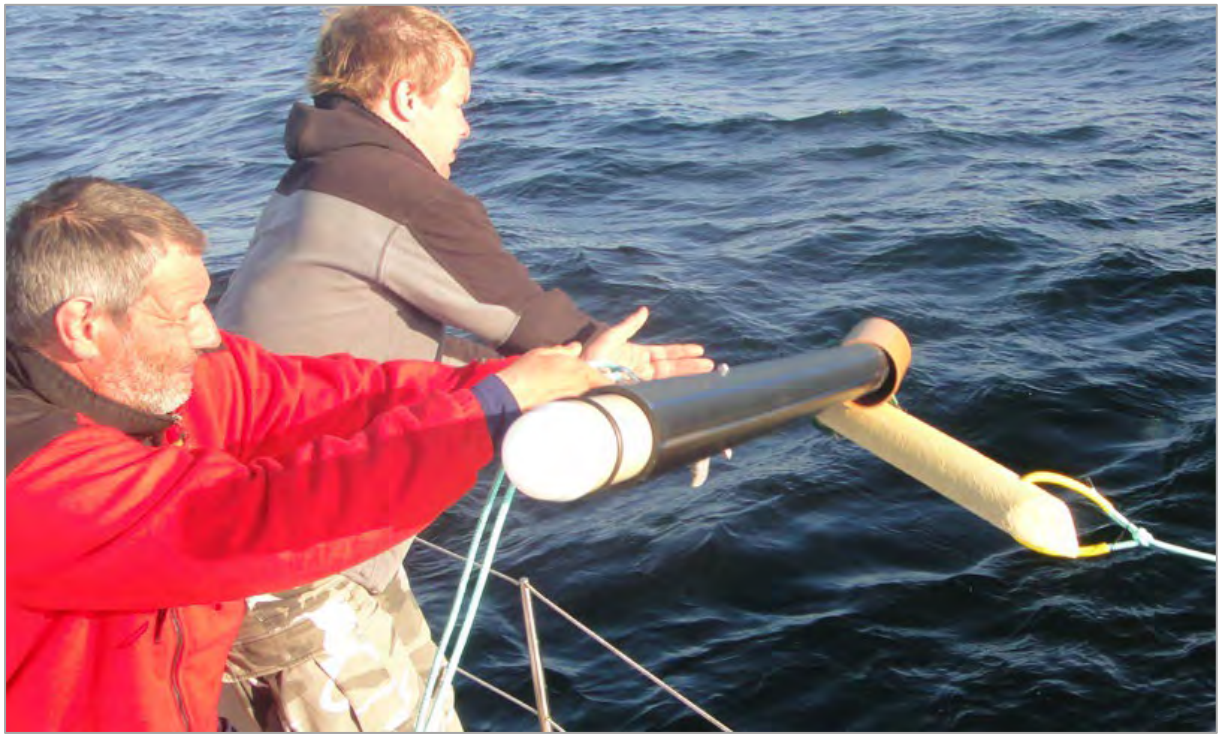

Figure 24: Deployment of a C-POD from a vessel (Chelonia Limited, 2021)

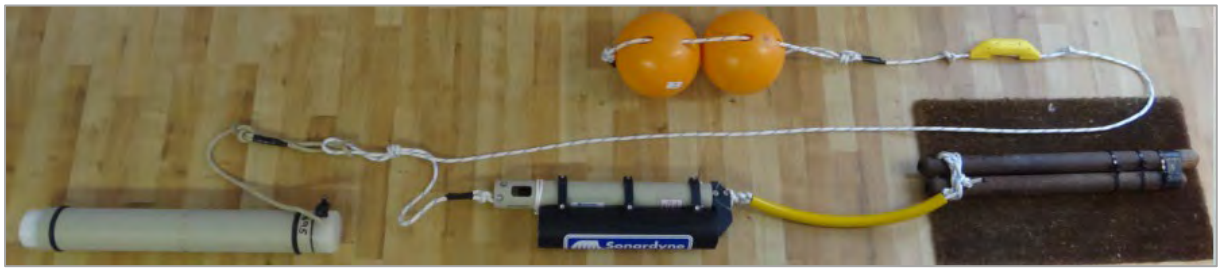

Figure 23: C-POD setup (Chelonia Limited, 2021)

6.5. Archaeological Survey

6.5.1. Purpose

An archaeological survey provides mapping of any metallic (or other solid) items on or below the seabed within the license area. This is critical when planning the location of structures and the accompanying foundations, moorings, anchoring.

The archaeology surveys will be run concurrently with the geophysical surveys, with a large amount of overlap in the techniques and equipment utilised. Within the intertidal areas, for example where

the cables are planned to come ashore, walkover surveys and metal detection surveys will be undertaken to identify areas for avoidance or additional mitigation.

6.5.2. METHODOLOGY

A suitably qualified and experienced archaeologist will be required to assess the area prior to any intrusive geotechnical and environmental surveys are conducted.

7. MET OCEAN SURVEYS

Metocean surveys are focused on understanding the average and extreme conditions faced within the proposed license area from wind, wave, tidal and current forces, plus the characteristics of the seawater in terms of temperature and salinity. This data is utilised in the selection of the most appropriate structures, mooring lines, anchoring, foundations, and other design specifications.

To fulfil these surveys, buoys carrying specialist recording equipment, and seabed fixed profilers will be utilised to capture the required information.

The quantity of samples, duration and timeframe required is indicated in *Section 9* while indicative locations are shown in *Figure 32.*

7.1. FLOATING LIDAR

7.1.1. PURPOSE

Floating lidars take offshore wind measurements from a vertical profiling lidar, integrated onto a standalone floating structure, such as a buoy. The lidar buoy will be deployed to understand wind resource and the data will be incorporated into various reports e.g., hydrodynamic and wind resource. The device can be equipped with one or two profiling LiDARs as well as a full suite of metocean monitoring equipment including wave dynamics, environmental and biological sensors.

7.1.2. METHODOLOGY

A floating LiDAR emits 5 or 6 laser beams to form a cone around 100 metres high with a spread of approximately 30° to measure wind vectors (speed and direction) at multiple altitudes. Measurements are taken at 1 hertz frequency, and the data gathered is transmitted at set intervals to the recording station. Example shown in *Figure 27.*

Challenges exist in accounting for the movement of the sea imparting motion on the LiDAR, and the subsequent impact on maintaining wind speed and direction accuracy. As with all offshore monitoring systems, the deployed system has a requirement to be robust, autonomous, and reliable.

Deployment and Mooring

The devices are deployed and recovered from an installation vessel with a crane and winch capacity. The final product selected will likely utilise a simple mooring system e.g., chain anchor and clump weight. The floating lidar system be fitted with a geo-location device and a position warning system to ensure it can be tracked and any issues with positioning be identified. An example of this equipment is the EOLOS FLS 200 (*see Figure 28*) which is specifically designed for offshore data recovery.

7.1.3. Examples of Equipment

Figure 25: AXYS-FliDAR Platform. (AXYS Technologies, 2020)

Figure 26: EOLOS FLS200, purposely designed exclusively for the needs of the offshore Wind Industry. (Eolos, 2020)

7.2. Acoustic Doppler Current Profiler (ADCP)

7.2.1. Purpose

ADCP is the most widely use instrument to measure ocean currents. This sonar-based tool provides a single device that can deliver a wide scope of water measurements; currents, waves, water level.

7.2.2. Methodology

An ADCP anchored to the seafloor measures current speed at equal intervals all the way up to the surface. A sound burst is emitted by the ADCP, *Figure 30 left*, along beams angled downward. The echoes are returned due to scattering off particles carried by the water currents. Analysis of these echoes enables the ADCP to make four different measurements at once; a current profile of speed and direction of water currents at many levels through the water column, the spatial distribution of sediments or plankton carried by the water, the speed-over-ground and path of travel of the ADCP over the seabed, and the distance to a boundary i.e., water depth. An example of the outputs from this data is shown in *Figure 30 right* and *Figure 31.*

Deployment and Mooring

ADCP units are deployed from a suitable vessel using a deck crane or winch. To permit recovery, an additional clump weight and buoy with an acoustic seabed release are also deployed to the seabed. When recovery is required, the acoustic release is triggered causing the buoy to return to the surface allowing the frame and ADCP to be recovered to the vessel. No surface markers are expected to be required as no part of the frame or mooring will be on or near the sea surface.

7.2.3. Examples of Equipment

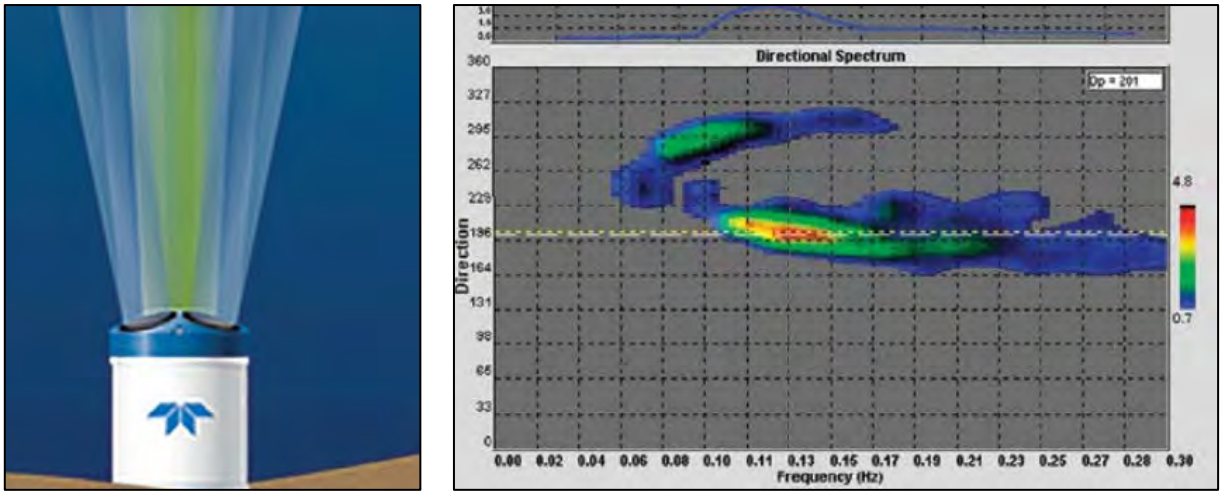

Figure 28: left - Teledyne Workhorse Waves Array, Right - Example Output. (Teledyne Marine, 2021)

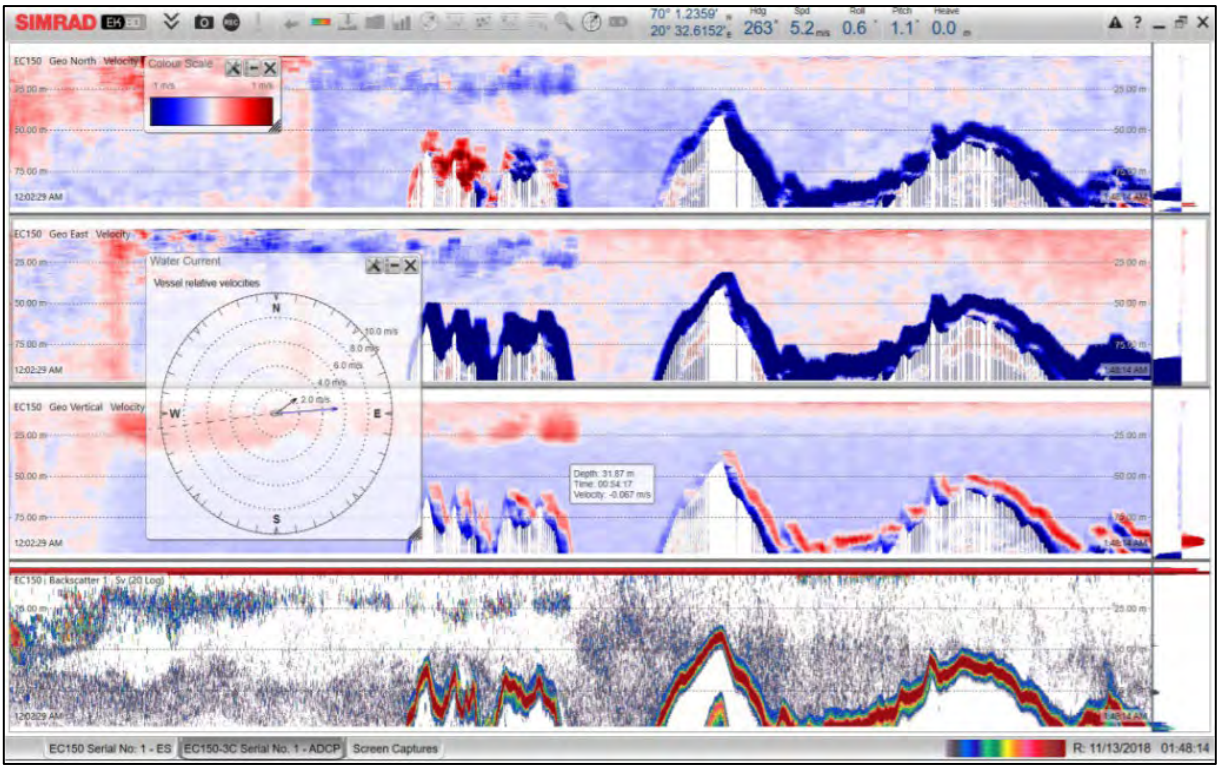

Figure 27: Example data capture from the Simrad EK80 using the EC150-3C transducer and ADCP functionality. (Kongsberg Martime, Simrad, 2020, p. 3)

7.3. Wave Buoy

7.3.1. Purpose

Wave Buoys are floating structures capable of recording wave, currents, water, and meteorological parameters.

7.3.2. METHODOLOGY

Wave Buoys record atmospheric, surface and shallow water parameters; wave frequency, wave height, wave period, wave direction, current speed, current direction, water temperature. Buoys can also be equipped with an ADCP. Wave buoys utilise real-time communications to recover data using web, satellite, UHF/VHF communication systems.

Deployment and Mooring

The Wave Buoy will be deployed from a suitable vessel and moored to the seabed. Maximum wave condition measured depends on the product and can range from 10 to 30m. The weight of the mooring system is dependent on the depth of deployment. The buoy will use Global Navigation Satellite Systems (GNSS) to warn if the buoy goes outside of their specified zone of operation.

An example of this equipment is 'Mona' from Flydog Solutions LLC as pictured in *Figure 31*.

7.3.3. EXAMPLE OF EQUIPMENT

Figure 29: Flydog Solutions LLC Profiler data buoy '<u>Mona</u>'. (Fly Dog Marine, 2020)

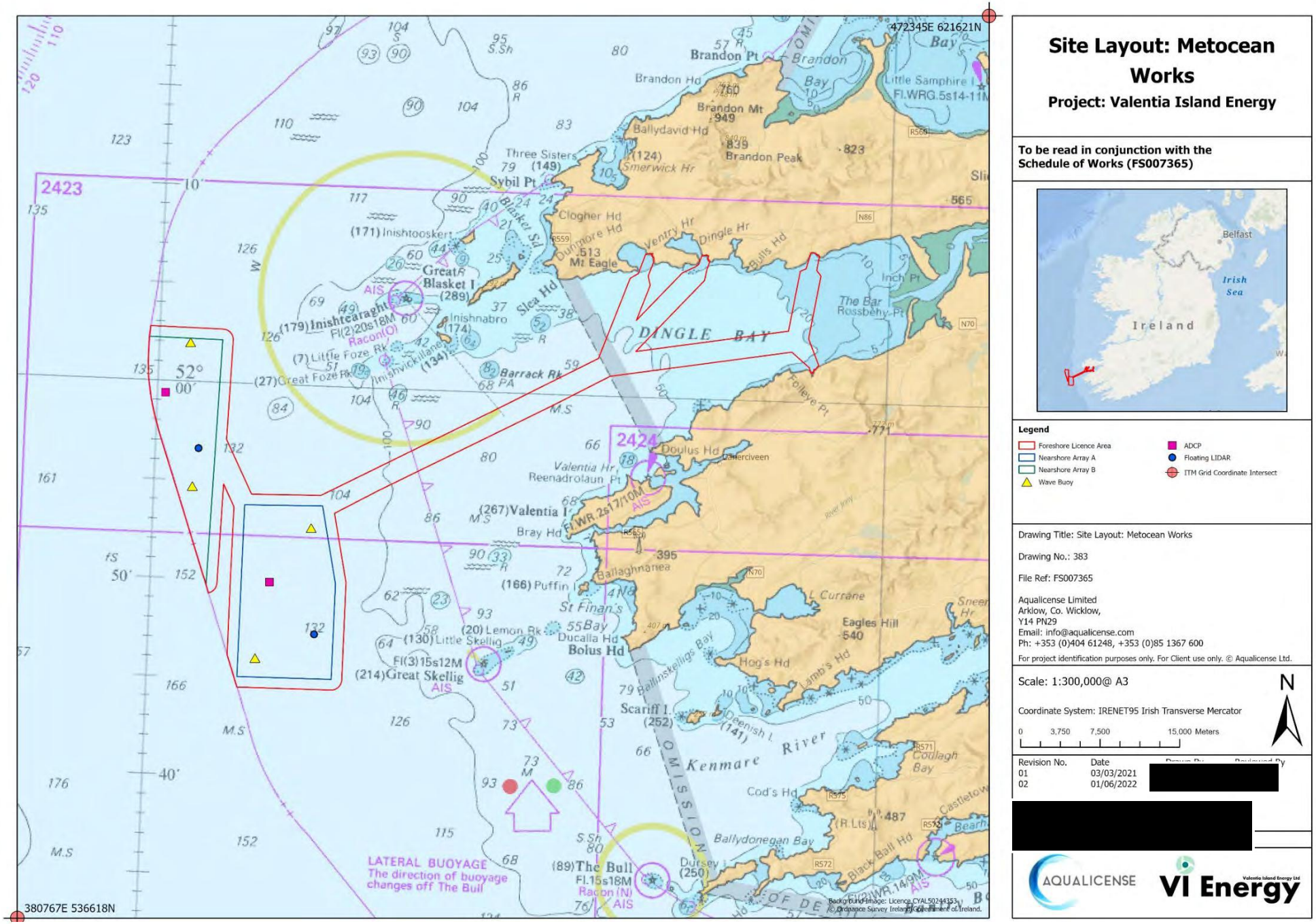

Figure 30: Metocean Works

8. VESSELS

At several points throughout this Programme of Works and as appropriate, the length of vessel required has been highlighted. In all cases a suitable vessel for the survey undertaken will be utilised. This vessel will carry the appropriate licence, certifications, and capacity to undertake the survey however, this work will be subject to a competitive tender process and full vessel specifications will be provided as soon as possible thereafter. Mobilisation will depend upon the successful survey contractor and the location of the vessel prior to undertaking the relevant survey. Dingle fishing port is within the vicinity of the Foreshore Licence Area e.g., Geophysical, Environmental & Metocean Surveys.

9. Timeframe and Locations

Table 1: Timeframe and Locations

	Survey	Purpose	Samples / area	Timing
Geophysical	**Multibeam Echosounder (MBES)**	Water depth and seabed topography.	**Array sites** Over entirety of array area within 12 nautical mile limit. **Cable routes** Along each route with a 500m track size.	4-6 months per survey with additional time for interpretation and analysis. Note: many survey types can be run concurrently.
	Side Scan Sonar (SSS)	Map seabed features and / or obstructions.		
	Magnetometer	Map any metallic obstacles or hazards, including UXO.		
	Sub-Bottom Profiling (SBP)	Identify character of the shallow geology.		
Geotechnical	**Boreholes**	Deep subsurface sampling – required at the centre of each floating mooring system.	**Array sites** 1 borehole (or CPT) per turbine (at centre of mooring arrangement) = 92 samples **Cable routes** None Indicative locations are Displayed in *Map 3*	4-6 months per campaign, with additional time for lab analysis.
	Cone Penetrometer Tests (CPTs)	Strength profiles of seabed substrate.	**Array sites** 1 borehole (or CPT) per turbine (at centre of mooring arrangement) = 92 samples **Cable routes** Every 1km along route up to MHWS Indicative locations are Displayed in *Map 3*	
	Vibrocore / Gravity Sampler	Subsurface sampling typically to 6 - 12m depth.	**Array sites** None **Cable routes** Every 1km along route up to MHWS Indicative locations are Displayed in *Map 3*	

	GRAB SAMPLES	Description of uppermost seabed, ground truthing of geophysical interpretation.	To be determined following geophysical surveys and dependent on the quality of the shallow substrate sample collection from other survey types. Indicative locations are Displayed in *Map 4*	1 month additional to overall schedule if grab samples are required.
ENVIRONMENTAL	**BENTHIC SURVEY – GRAB SAMPLES, POSSIBLE VIDEO DEPLOYMENT**	Habitat characterisation.	**Array sites** 39 samples **Cable routes** Approx. 1 every 2 km along each cable route. Indicative locations are Displayed in *Map 4*	2 -3 weeks depending on site layout / cable length.
	ECHOLOCATION CLICK DETECTORS (POD's)	Marine mammal acoustic monitoring.	**Array sites** 4 PODs An additional 4 PODs are located outside of the array site Indicative locations are Displayed in *Map 4*	Up to 12 months pre-construction and/or baseline
METOCEAN	**FLOATING LIDAR**	Wind speed characteristics (plus range of metocean measurements).	**Array site** 2 floating Lidars Indicative locations are displayed in *Map 5*	12 – 36 months total deployment.
	WAVE BUOYS	Wave height and spread.	**Array site** 4 wave buoys Indicative locations are displayed in *Map 5*	
	ACOUSTIC DOPPLER CURRENT PROFILERS (ADCP's)	Subsurface wave and current measurements.	**Array site** 2 ADCPs Indicative locations are displayed in *Map 5*	

10. Full Coordinates List

Table 2:Foreshore licence Area Coordinates

Object ID	ITM X	ITM Y	WGS84 X	WGS84 Y
1	402845.6205	576559.9826	-10.86552571	51.90625133
2	402830.2094	576560.2668	-10.86574956	51.90624843
3	402845.6233	576559.9765	-10.86552567	51.90625128
4	402845.6205	576559.9826	-10.86552571	51.90625133
5	409378.2036	576439.4958	-10.77063371	51.90744173
6	409386.4489	576439.3465	-10.77051393	51.90744321
7	435536.7139	589346.9793	-10.39699446	52.03169921
8	438521.7335	596895.3811	-10.35709744	52.10037018
9	439292.2426	597340.4329	-10.34607039	52.10459155
10	439983.678	599167.32	-10.33684384	52.12119976
11	440736.386	598424.106	-10.3255137	52.11474191
12	440221.084	597113.0821	-10.33241644	52.10281856
13	440409.0998	596228.7207	-10.3292603	52.09493
14	439104.9004	592930.2685	-10.34672319	52.06492812
15	443446.7206	597411.1691	-10.28550722	52.10641765
16	444679.0106	597972.7737	-10.26778846	52.11180908
17	445287.924	599053.286	-10.25939627	52.12168463
18	446022.417	598453.825	-10.24840772	52.1165053
19	445524.3873	596680.9844	-10.2548702	52.10044308
20	439048.9737	589997.904	-10.34615759	52.03857528
21	453434.2556	591907.7616	-10.13744987	52.05971819
22	454551.096	597551.5458	-10.12358048	52.11070866
23	455097.0617	597788.6096	-10.11571602	52.11298137
24	455539.962	599217.293	-10.10986015	52.12593062
25	456367.0254	598974.9051	-10.09768727	52.12396874
26	456096.7808	597634.9481	-10.10106495	52.11186199
27	456500.813	597100.7777	-10.09494515	52.10716858
28	455332.0781	591195.0274	-10.10949158	52.05381439
29	456294.8958	588656.0008	-10.09439555	52.03125696
30	455654.187	587964.3181	-10.10343496	52.02487736
31	455644.999	588045.287	-10.10360289	52.0256023
32	455638.121	587961.159	-10.10366757	52.0248448
33	455523.1041	587994.3028	-10.10535638	52.0251126
34	455428.617	588352.412	-10.1068835	52.02830484
35	455428.746	588406.613	-10.10690451	52.02879175
36	455389.884	588475.296	-10.10749946	52.0293986
37	453756.8265	589932.9049	-10.13190436	52.0420639
38	436631.005	587660.314	-10.38025577	52.01687422
39	410646.2605	574746.2638	-10.75129635	51.89267081
40	411741.6645	568239.4921	-10.7318559	51.83461766
41	411340.8915	559034.6582	-10.73266086	51.75183188
42	410311.0466	558101.5189	-10.74705071	51.74310563
43	401420.8557	558388.2643	-10.87578993	51.74260216
44	400454.0182	559427.4676	-10.89036823	51.75158882
45	400454.1636	559430.9952	-10.89036815	51.75162054
46	401185.9089	575378.0702	-10.88893442	51.89505103
47	400209.2472	577518.2433	-10.90434643	51.91391557
48	400093.3434	575798.6644	-10.90503204	51.89843638
49	399579.5525	568175.9324	-10.90806815	51.82981824
50	398497.8255	567246.3725	-10.92320116	51.82108419

OBJECT ID	ITM X	ITM Y	WGS84 X	WGS84 Y
51	398494.2848	567246.7086	-10.92325265	51.82108593
52	398581.5003	568243.1849	-10.92256855	51.83006327
53	398453.126	568422.013	-10.92453271	51.83162243
54	393404.1128	585513.182	-11.00792951	51.98320262
55	393221.2261	592457.7306	-11.01477902	52.04547252
56	400162.9928	592110.9634	-10.91351131	52.04490389
57	401119.7625	591027.764	-10.89895184	52.03552343
58	400492.2541	581717.0044	-10.90267126	51.95171153
59	402845.6205	576559.9826	-10.86552571	51.90625133

Table 3: Array A Coordinates

OBJECT ID	ITM X	ITM Y	WGS84 X	WGS84 Y
1	401453.547	559388.034	-10.87588754	51.75158971
2	402197.078	575571.7141	-10.87437233	51.8971491
3	409536.805	575436.1956	-10.76777728	51.89848768
4	410754.8443	568076.0883	-10.74606884	51.83281719
5	410342.8531	559101.2747	-10.74713554	51.75209323

Table 4: Array B Coordinates

OBJECT ID	ITM X	ITM Y	WGS84 X	WGS84 Y
1	400122.8843	591111.4368	-10.91351131	52.0359164
2	398581.5003	568243.1849	-10.92256855	51.83006327
3	398453.126	568422.013	-10.92453271	51.83162243
4	393143.2256	587559.0866	-11.01295572	52.00147079
5	393170.6874	591458.6631	-11.01491077	52.03648559

Table 5: Future Array Coordinates

OBJECT ID	ITM X	ITM Y	WGS84 X	WGS84 Y
1	389218.4919	559808.4289	-11.0531	51.75089667
2	390103.561	576655.9633	-11.05050775	51.9024613
3	393039.1814	584083.8148	-11.01237335	51.97023605
4	393404.1128	585513.182	-11.00792951	51.98320262
5	398453.126	568422.013	-10.92453271	51.83162243
6	398581.5003	568243.1849	-10.92256855	51.83006327
7	397817.1265	559509.8708	-10.92855731	51.75138373

11. MAPPING

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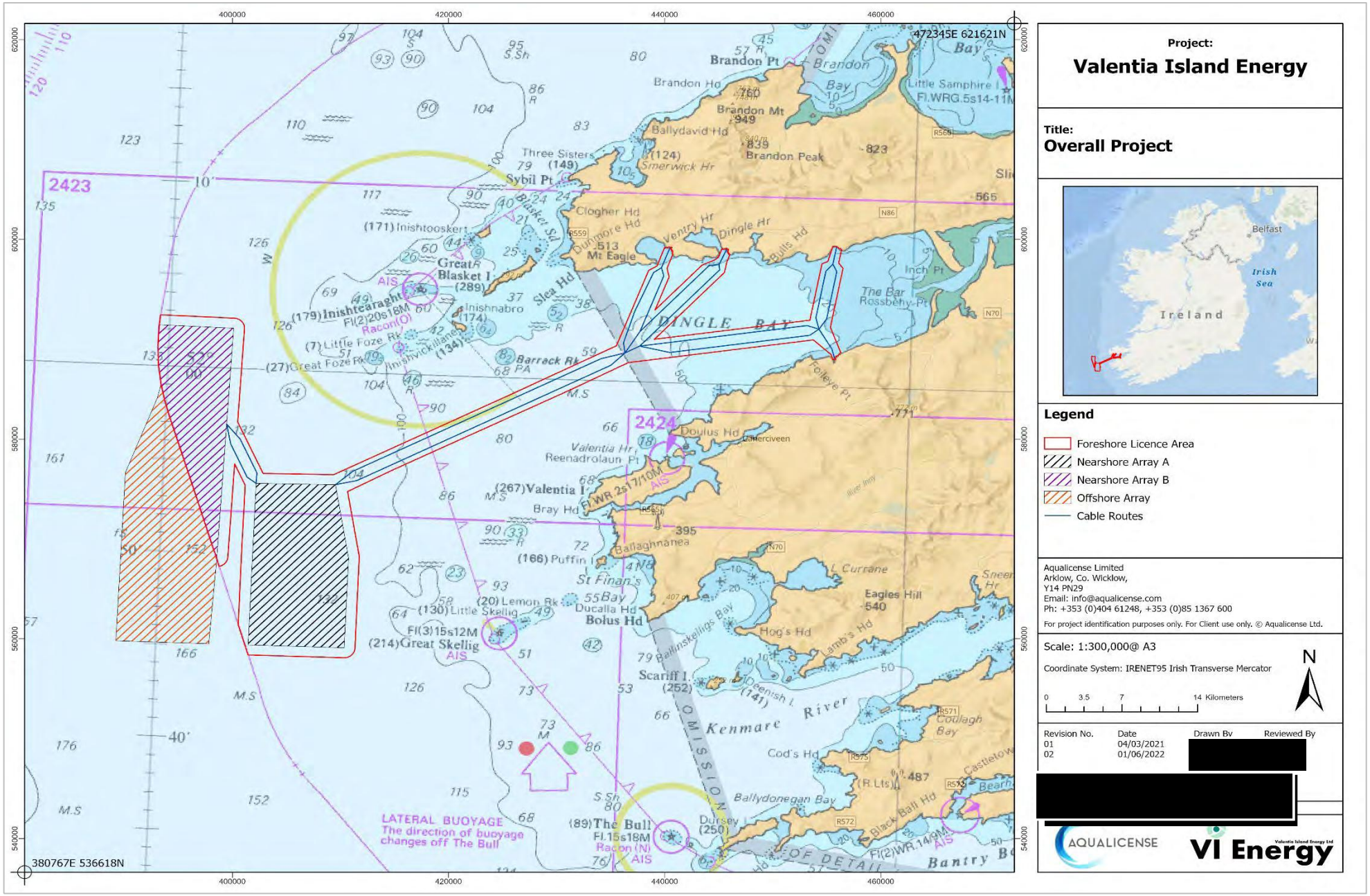
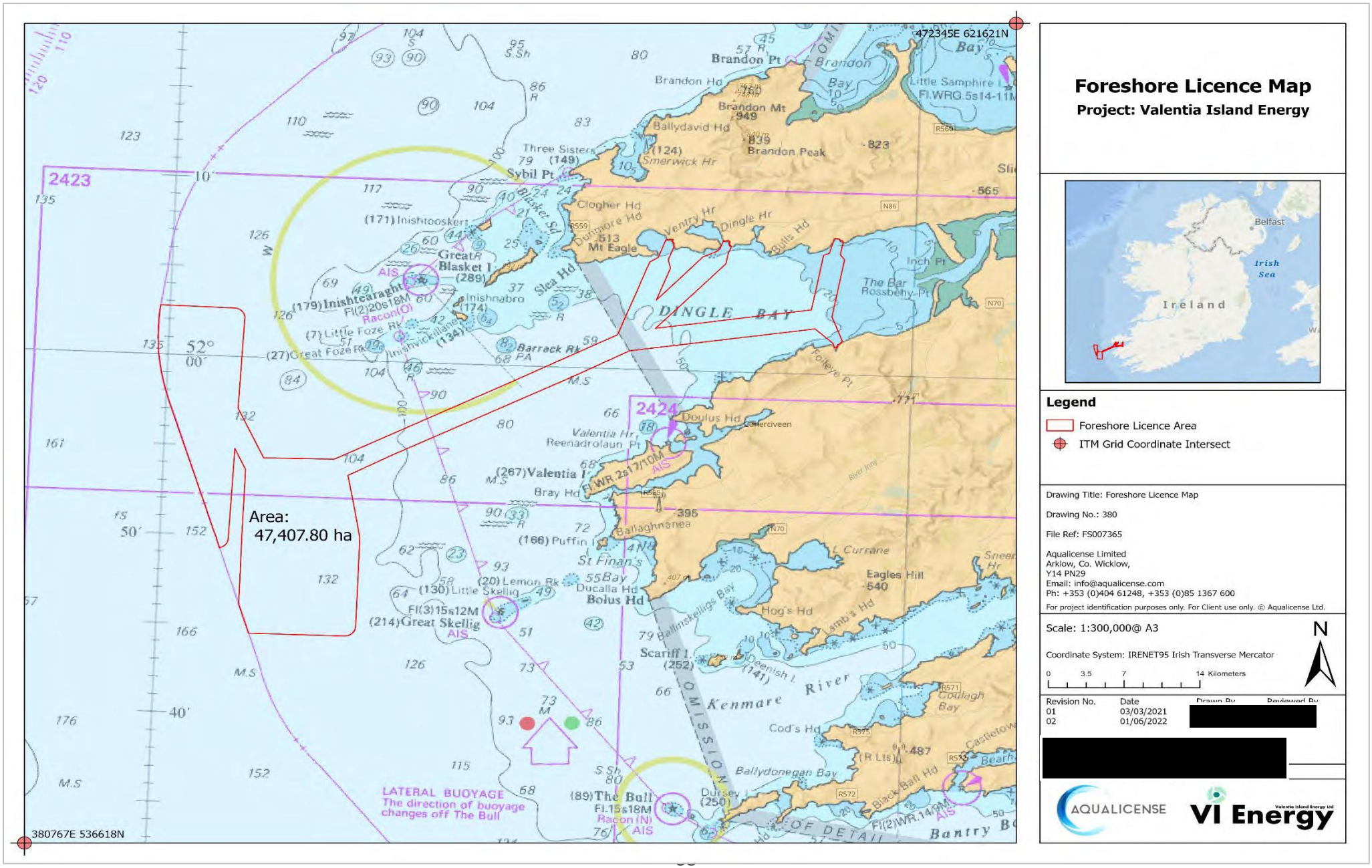
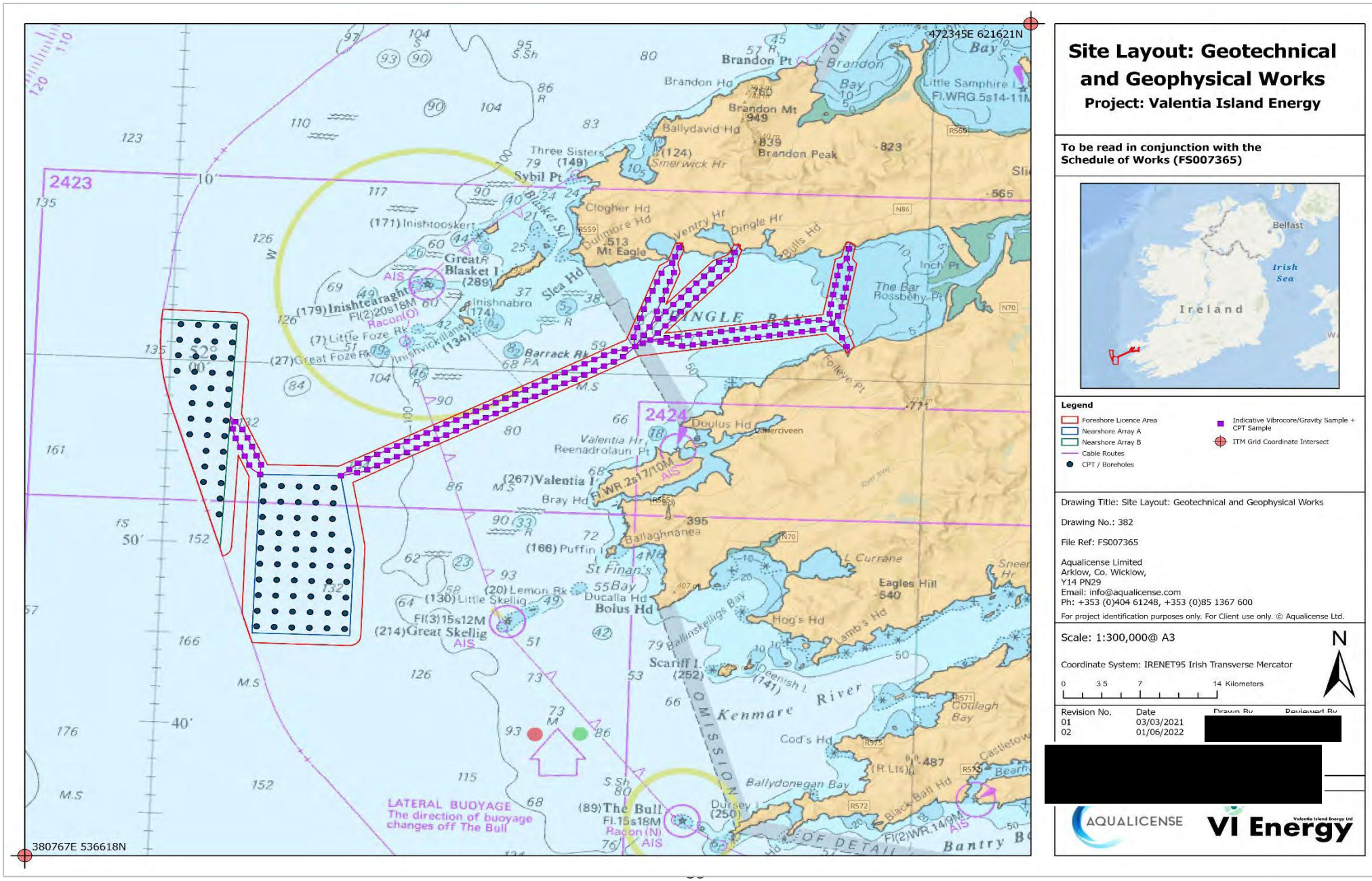
Map 4: Environmental Works 40
Map 5: Metocean Works 41



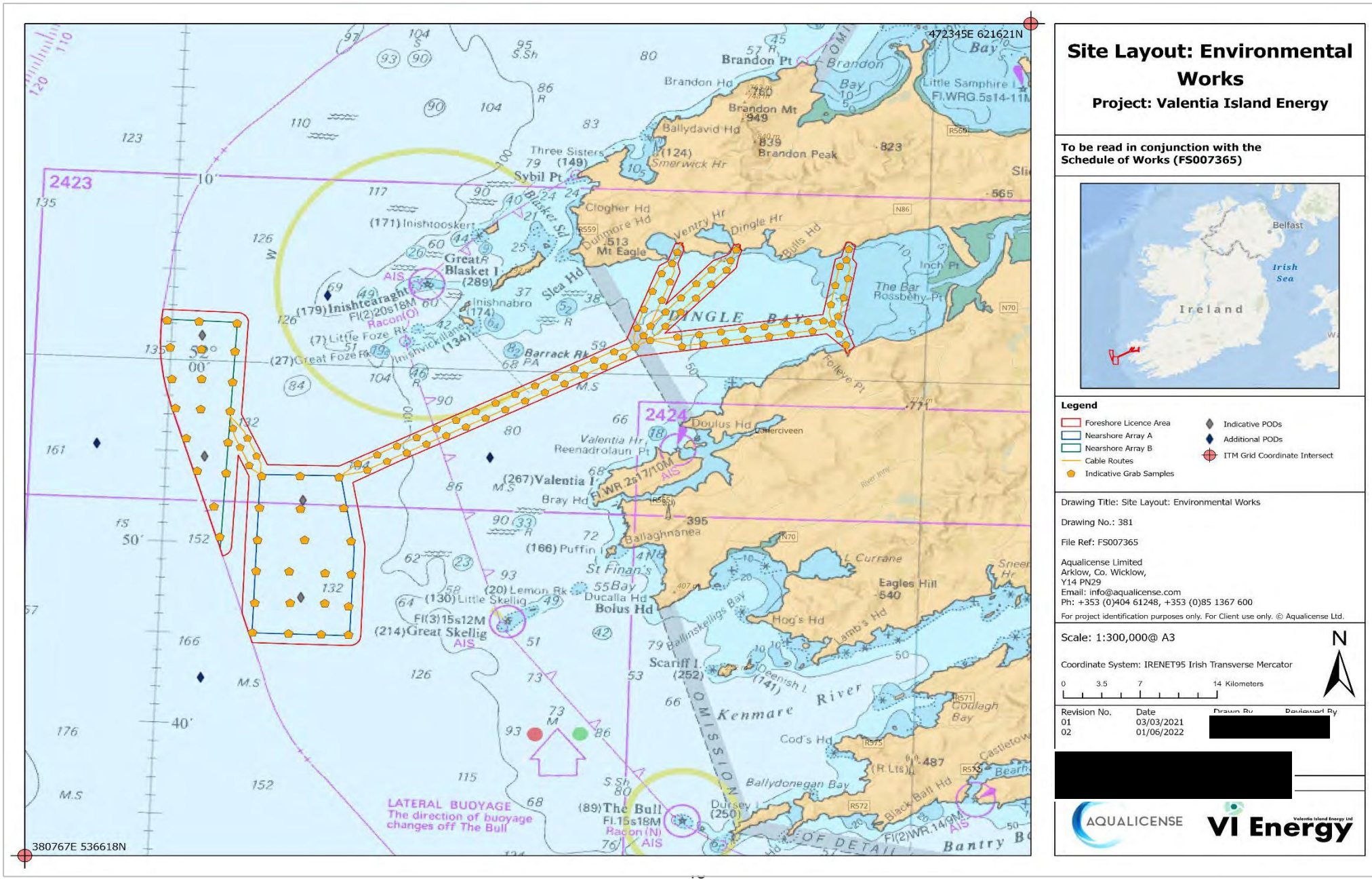
Map 1: Overall Project



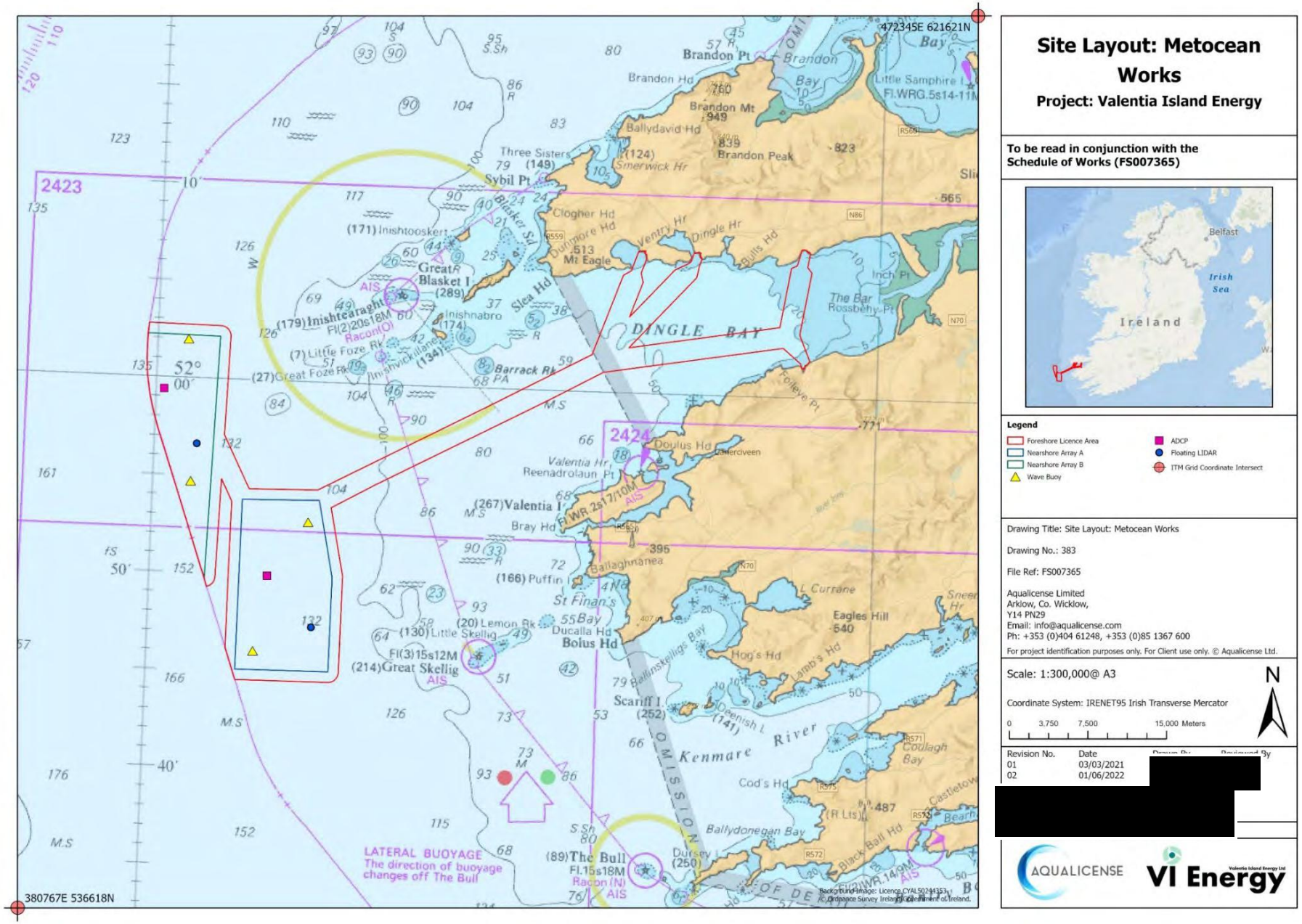
Map 2: Foreshore Licence Area



Map 3: Geotechnical and Geophysical Work



Map 4: Environmental Works



Map 5: Metocean Works

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Appendix 1. EQUIPMENT SPECIFICATIONS

1. R2SONIC MULTIBEAM ECHOSOUNDER
2. 3400-OTS SUB – BOTTOM PROFILER
3. ES-2000 MEDIUM – 100 PARAMETRIC SUB-BOTTOM PROFILER
4. TRI-FREQUENCY/MOTION SIDE SCAN SYSTEM
5. ECHOTRAC E20
6. EM 2040C MULTIBEAM ECHO SOUNDER
7. GEO-SENSE LIGHT-WEIGHT UHRS
8. G EO SPARK 1000 – 1500 – 2000
9. G--882 MARINE MAGNETOMETER
10. S ONARDYNE MINI-RANGER 2 USBL
11. GEOQUIP MARINE IS DRG 03 SEABED CPT GMC200
12. AXYS FLIDAR PLATFORMS
13. TELEDYNE WAVE ARRAY
14. SIMRAD EK80
15. FLYDOG SOLUTIONS PROFILER DATA BUOY
16. OSIL-GRAVITY-CORER
17. OSIL-VIBROCORERS

1. R2SONIC MULTIBEAM ECHOSOUNDER

Multibeam Echosounder Specifications

OUR VISION IS SOUND™

We apply our technical expertise and experience as surveyors to serve you: Our portfolio is elegantly simple while technologically advanced and user-friendly. **Beamwidth** and **depth range** are the 2 main characteristics that differentiate each of those MultiBeam EchoSounders (MBES). All options can be implemented on all products, except for the option to operate at 90kHz/100kHz that is exclusive to the Sonic 2026 (at the expense of the UHR option). This provides **high flexibility** to end-users to upgrade their equipment **remotely**. These options go beyond just opting for a longer cable; they all bring extra capabilities and functionalities, allowing even the entry level sonar to benefit from advanced operating modes. **Additionally, the firmware of all 4 MBES can be upgraded remotely.**

Standard Features for all R2Sonic MBES

SONIC 2020

Extra Light & Compact!

- Power supplied to sonar head
- Synchronization of multiple heads

User-friendly, simple and easy to learn controller interface

Clean and small data files which require minimum data processing time

- Ultra High Density (UHD): 1024 soundings per ping
- Selectable operating frequencies 'on-the-fly' in steps of 1Hz
- Ability to rotate the swath sector 'on-the-fly'
- Free firmware updates can be done remotely by end users
- Low power consumption for the performance delivered
- Light & compact
- Training delivered by experts
- Options upgradable remotely
- Embedded processor / controller in the sonar head that enables fast and powerful computation at low power (no separate topside processor)
- 3-year warranty
- All R2Sonic MBES exceed IHO-S44 Special Order, when installed following the instructions from the Manual and used with the I2NS and the Sound Velocity Sensor offered by R2Sonic

Only R2Sonic does it...

- Multispectral mode: survey with up to 5 frequencies in 1 pass and with 1 MBES. **Saves Time & Money!**
- Increased true sounding density with UHD → **It Provides Accurate and Truthful Resolution***
- **Smallest Beamwidth Available!** Down to **0.3° x 0.6°**
- Clean and small data files which reduces processing time and **Saves Time & Money!**
- Ability to upgrade options remotely
- Free firmware updates
- Optional 6-year warranty, which **minimizes risk** on investment
- 24/7 technical support via email and phone wherever you are in the world
- Express and high quality repairs, performed by the team that engineered the systems

Options

- Ultra High Resolution (UHR): beamwidth down to 0.3° x 0.6°
- Multimode
  - Pipeline mode: 2 frequencies, requiring UHR (700kHz)
  - Multispectral mode: ability to survey with up to 5 different frequencies in one pass and with one system
- TruePix™: provides highly compact water column imagery and backscatter
- Raw water column data output
- Robo: automated operation
- On-site training (theory class & hands-on demo)
- 6-year warranty
- 4000m and 6000m immersion depth rating
- Mounting hardware & assemblies, including Dual Head for Sonic 2020
- Antifouling coating protection
- Switchable Forward Looking Sonar Imagery
- I2NS™ (Integrated Inertial Navigation System): 3 types available that provide different accuracy for roll / pitch and heading
  Please consult specification sheet for more information on the I2NS™
- Software available: HYPACK®, QINSy™, SonarWiz 7, Fledermaus GeoCoder
- Sound Velocity Sensors available

Quick Mobilization

Easy to Pack

Easy to Maneuver

Easy to Check-In

Sonic Series store easily in Peli™ Case, for increased mobility

US Patent 10,132,924

*Please consult the "Making Concepts Simple" booklet for clarification on technical terms / concepts.

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MADE IN USA

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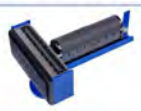
Technical Specifications

Multibeam Echosounders



	Sonic 2020	Sonic 2022	Sonic 2024	Sonic 2026
Applications	Entry level hydrography Very small vessels Small ASV and AUV	Construction Dredging Autonomous Surface Vehicle (ASV) Offshore O&G (pipeline)	Autonomous Surface Vehicle (ASV) Construction Dredging Offshore O&G (pipeline) Offshore WindFarm (cable, towers)	Advanced hydrography Research Seafloor characterization Autonomous Underwater Vehicle (AUV) Remote Operated underwater Vehicle (ROV)
Selectable Frequencies	200kHz - 450kHz. Optional 700kHz	170 - 450kHz. Optional 700kHz		170 - 450kHz. Optional 90kHz and 100kHz
Minimum frequency increase	1Hz			
Beamwidth, across track and along track	1° x 1° at 700kHz (optional) 2° x 2° at 450kHz 4° x 4° at 200kHz	0.6° x 0.6° at 700kHz (optional) 0.9° x 0.9° at 450kHz 2° x 2° at 200kHz	0.3° x 0.6° at 700kHz (optional) 0.45° x 0.9° at 450kHz 1° x 2° at 200kHz	0.45° x 0.45° at 450kHz 1° x 1° at 200kHz 2° x 2° at 90kHz & 100kHz (optional)
Number of soundings	Up to 1024 soundings per ping			
Max speed (vessel)	11.1 knots for full coverage (*)			
Near-field focusing*	Yes			
Roll stabilized beams	Yes			
Pitch stabilized beams	Yes	No		Yes
ROBO™ Automated Operation	Yes Auto Power, pulse width, rangeTrac™, GateTrac™, SlopeTrac™			
Saturation monitor	Yes			
Selectable Swath Sector *(also referred as Max Coverage)*	10° to 130° User selectable in real-time	10° to 160° User selectable in real-time		
Sounding Patterns	Equiangular Equidistant single / double / quad modes Ultra High Density (UHD)			
Sounding Depth	up to 200m+	up to 400m+		up to 800m+
Pulse Length	15µs - 1ms			15µs - 2ms
Pulse Type	Shaped CW			
Ping rate	up to 60Hz			
Bandwidth	up to 60kHz			
Immersion Depth	100m Optional 4000m		100m Optional 4000m & 6000m	100m Optional 4000m
	FLS projectors are rated 4000m	FLS projectors are rated 3000m		FLS projectors are rated 4000m
Bottom Detect Resolution	3mm			
Operating Temperature	-10°C to 40°C	-10°C to 50°C		
Storage Temperature	-30°C to 55°C			
Electrical Interface				
Mains	90-260VAC, 45-65Hz			
Power consumption	20W avg	35W avg	50W avg	100W avg
Uplink/downlink	10/100/1000Base-T Ethernet			
Sync in, Sync out	TTL			
Deck cable length	15m, optional 25m and 50m			
Mechanical				
Sonar Dimension (Sonic 2020)	140 x 161 x 133.5 mm			
Sonar Mass (Sonic 2020)	4.4kg			
Receiver Dim (LWD)		276 x 109 x 190 mm	480 x 109 x 190 mm	
Receiver Mass		7.7kg	12.9kg	
Projector Dim (LWD)		273 x 108 x 86 mm		480 x 109 x 196 mm
Projector Mass		3.3kg		13.4kg
Sonar Interface Module Dim (LWH)	280 x 170 x 60 mm			
Sonar Interface Module Mass	2.4kg			

(*) The speed of the survey is primarily limited by the installation of the MBES.

Specification Sheet 2020 version 1.4 subject to change without notice

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2. 3400-OTS Sub – Bottom Profiler

3400-OTS

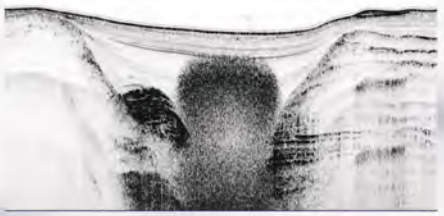
POLE-MOUNT SUB-BOTTOM PROFILER

FEATURES

- Three over-the-side mount configurations:
  - Ultra-Lightweight Shallow Water
  - Lightweight Shallow Water
  - Low Frequency Deep Water
- Pipeline survey mode
- Digital receiver with ethernet telemetry and power
- Real-time pitch, roll, heave and depth sensors
- Surface echo attenuation
- Pulse library tailored for different survey applications
- Dual frequency transmission

APPLICATIONS

- Geological surveys
- Environmental site investigations
- Sediment classification
- Buried pipeline & cable surveys
- Archeological surveys
- Mining/dredging surveys
- Map, measure & classify sediment layers within the sea floor



Building on the long running success of the EdgeTech sub-bottom profiler product line, the new over-the-side pole mount 3400-OTS provides users many unique enhancements to current sub-bottom profiler systems. The 3400-OTS transmits wide band Frequency Modulated (FM) pulses utilizing EdgeTech's proprietary Full Spectrum CHIRP technology. The system uses flat multi-channel hydrophone array to generate high resolution images of the sub-bottom stratigraphy in oceans, lakes, and rivers and provides excellent penetration in various bottom types. The 3400-OTS receiver array is segmented for standard sub-bottom profiling operations or "pipeline" mode for optimal location and imaging of buried pipelines or cables. The system offers real-time reflection coefficient measurements. This unique ability of the EdgeTech sub-bottom profiler system allows users the ability to collect complex 'analytic' data using linear system architecture to measure sediment reflection and analyze sediment type determination. Additionally, the system has discrete transmit and receive channels allowing for continuous data collection resulting in a high ping rate particularly important for construction and pipeline surveys.

The lightweight 3400-OTS is ideal for shallow water surveys using small boats of opportunity. While the low frequency model with dual transmitters and large receive array is ideal for deep water and windfarm applications.

The EdgeTech 3400-OTS sub-bottom profiling system comes as a complete package including EdgeTech's DISCOVER sub-bottom acquisition & processing software. The 3400-OTS can also be interfaced to 3rd party software.

For more information please visit EdgeTech.com

info@EdgeTech.com | USA 1.508.291.0057

3. SES-2000 Medium – 100 Parametric Sub-Bottom Profiler

SES-2000 medium-100

Parametric Sub-bottom Profiler

▶ Performance
- water depth range: 2 – 2,000 m
- penetration: up to 70 m, depending on sediments
- layer resolution: up to 5 cm
- motion compensation: heave, roll
- beam width @ 3 dB: ±1 ° / footprint < 3.5 % of water depth for all frequencies

▶ Transmitter
- primary frequencies: approx. 100 kHz (band 85 – 115 kHz)
- secondary low frequencies: 4, 5, 6, 8, 10, 12, 15 kHz (band 2 – 22 kHz)
- primary source level: > 247 dB//µPa re 1 m
- pulse width: 0.07 – 2 ms
- pulse rate: up to 40/s
- multi-ping mode
- pulse type: CW, Ricker, LFM (chirp)

▶ Acquisition
- primary frequency (echo sounder, bottom track)
- secondary low frequency (sub-bottom data, multi-frequency mode)
- sample rate 96 kHz @ 24 bit

▶ System Components
- transceiver unit 19 inch / 14 U (WHD: 0.52 m x 0.65 m x 0.50 m; 80 kg)
- transducer incl. 30 m cable (WHD: 0.50 m x 0.12 m x 0.50 m; 60 kg)
- system control: internal PC
- KVM remote control

▶ Software
- SESWIN data acquisition software
- SES Convert SEG-Y/XTF data export
- SES NetView remote display
- ISE post-processing software

▶ Power Supply Requirements
- 100 – 240 V AC / 50 – 60 Hz
- power consumption: < 700 W

Innomar

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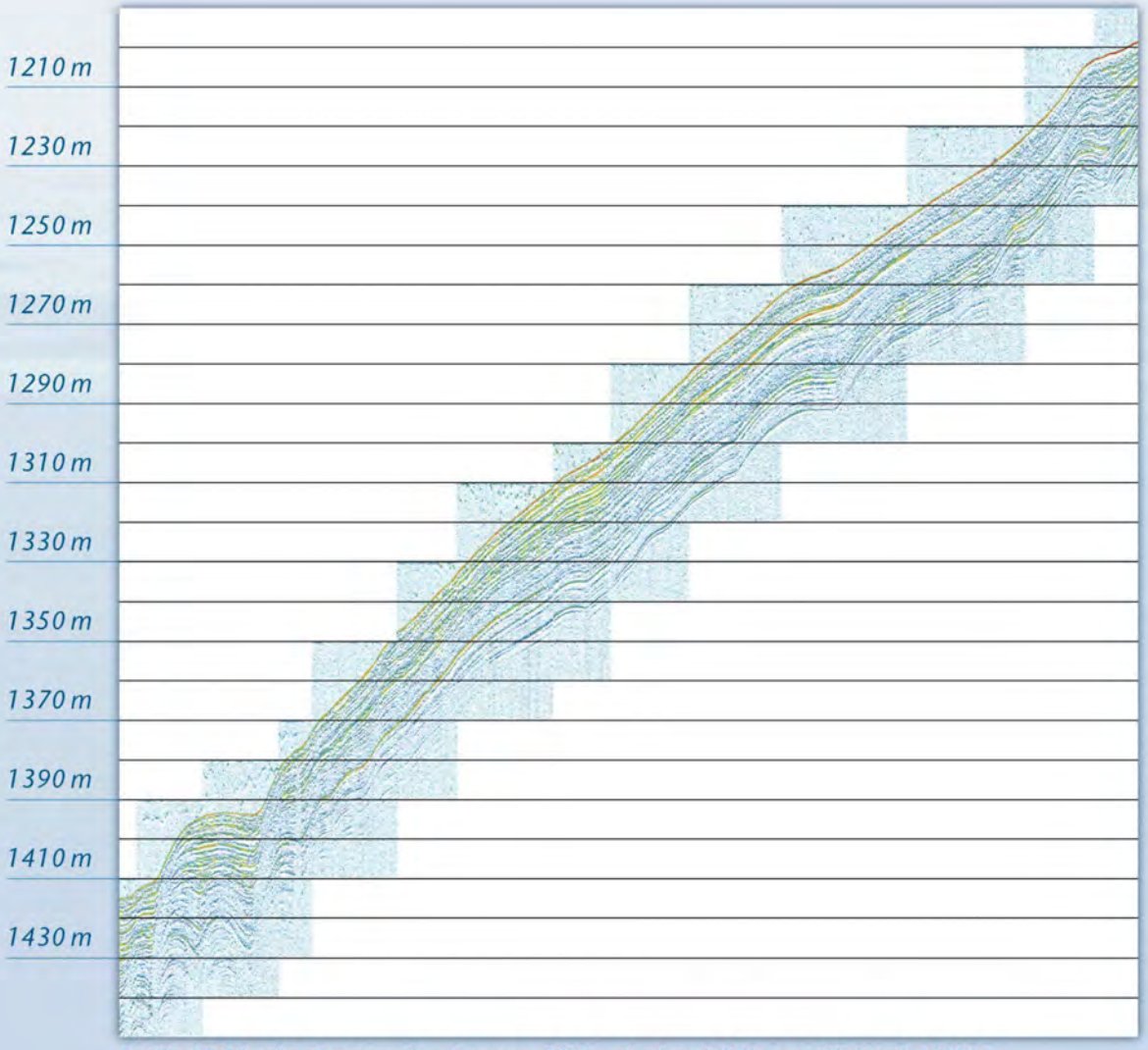
Survey example of SES-2000 medium-100



Pacific (Chile) echo plot example *– Frequency 8 kHz, pulse length 800 µs, profile length 10800 m*

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Innomar

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EdgeTech

4205

TRI-FREQUENCY / MOTION TOLERANT SIDE SCAN SONAR SYSTEM

FEATURES

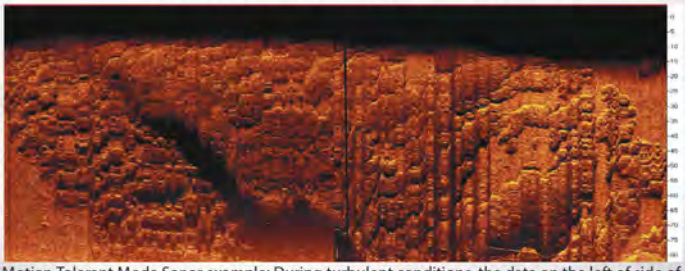
- Tri frequency side scan sonar
- Motion tolerant mode
- Improved target positioning
- Crisp, high resolution CHIRP imagery
- Increased towfish power to support wider range of 3rd party sensors
- Single pulse high resolution mode

APPLICATIONS

- Cable & pipeline surveys
- Geological/geophysical surveys
- Mine countermeasures (MCM)
- Geohazard surveys
- Channel clearance
- Search and recovery
- Archeological surveys

The next generation 4205 is a versatile side scan sonar system that can be configured for almost any survey application from shallow to deep water operations. The 4205 utilizes EdgeTech's Full Spectrum® CHIRP technology to provide crisp, high resolution imagery at ranges up to 50% greater than non-CHIRP systems; thus allowing customers to cover larger areas and save money spent on costly surveys. In addition to the high-resolution imagery that EdgeTech is known for, the 4205 comes with a number of new features which makes the system even more flexible and powerful in offshore operations. The 4205 is available in either a tri-frequency side scan sonar configuration or motion tolerant and multi-pulse configuration. The tri-frequency version allows surveyors the option to operate any two frequencies simultaneously from the tri-frequency system. Long range operations for example can be achieved with a selection of 230/540 kHz combination. Then, on-demand the system can be changed to a 540/850kHz system for an even higher resolution survey. The 4205 motion tolerant configuration with multi-pulse provides surveyors the ability to operate either at faster survey speeds or in more adverse weather conditions while still obtaining high quality underwater imagery. Additionally, this configuration can be operated in a single pulse high-resolution mode for those operations that require an even more finite view of the seafloor.

In both the tri-frequency and motion tolerant/ multi-pulse configurations, towfish and target positioning has been improved with the integration of a more accurate heading sensor that can be coupled with an optional USBL beacon. Additionally, all systems now come with increased towfish power to support a wider range of additional 3rd party sensors. All EdgeTech 4205 systems are comprised of a topside system and a reliable stainless steel towfish. Topside processors are rack mountable and come with easy-to-use GUI software that can be installed on the optional industrial workstation, laptop or customer provided PC.



Motion Tolerant Mode Sonar example: During turbulent conditions, the data on the left of side of this image was recorded using the EdgeTech 4205 Motion Tolerant mode. The right side of the image, depicting motion induced striping was captured without the Motion Tolerant mode for comparison.

For more information please visit EdgeTech.com

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4205

TRI-FREQUENCY / MOTION TOLERANT SIDE SCAN SONAR SYSTEM

KEY SPECIFICATIONS

SONAR SPECIFICATIONS	4205 TRI-FREQUENCY	4205 MULTI-PULSE/MOTION TOLERANT (MP/MT) AND HIGH DEFINITION MODE	
Frequency	Choice of either 120/410/850 kHz or 230/540/850 kHz	Choice of either 120/410 kHz, 230/540 kHz, 540/850 kHz or 230/850 kHz	
Operating Range (meters/side)	120 kHz: 600m, 230 kHz: 350m, 410 kHz: 200m, 540 kHz: 150m, 850 kHz: 90m		
		MP/MT	HDM
Horizontal Beam Width	120 kHz: 0.70° 230 kHz: 0.44° 410 kHz: 0.28° 540 kHz: 0.26° 850 kHz: 0.23°	120 kHz: 0.95° 230 kHz: 0.62° 410 kHz: 0.40° 540 kHz: 0.36° 850 kHz: 0.33°	0.70° 0.44° 0.28° 0.26° 0.23°
		MP/MT	HDM
Resolution Along Track	120 kHz: 2.4m @ 200m 230 kHz: 1.2m @ 150m 410 kHz: 0.5m @ 100m 540 kHz: 0.45m @ 100m 850 kHz: 0.20m @ 50m	120 kHz: 3.3m @ 200m 230 kHz: 1.7m @ 150m 410 kHz: 0.7m @ 100m 540 kHz: 0.6m @ 100m 850 kHz: 0.26m @ 50m	2.4m @ 200m 1.2m @ 150m 0.5m @ 100m 0.45m @ 100m 0.20m @ 50m
Resolution Across Track	120 kHz: 8cm; 230 kHz: 3cm; 410 kHz: 2 cm; 540 kHz: 1.5cm; 850 kHz: 1cm		
Vertical Beam Width	50°		
Depression Angle	Tilted down 25°		
TOWFISH	**STAINLESS STEEL**		
Diameter	12cm (4.75 inches)		
Length	140cm (55 inches)		
Weight in Air	52 kg (115 pounds)		
Depth Rating (Max)	2,000m		
Standard Sensors	Heading, pitch & roll		
Optional Sensor Port	(1) Serial – RS 232C, Bi-directional & 28 VDC +/- 4%		
Options	Pressure Sensor, Magnetometer, Integrated USBL Acoustic Tracking System, Built-in Responder Nose, Depressor, Power Loss Pinger and Custom Sensors		
TOPSIDE PROCESSOR	**4205 INTERFACE**		
Hardware	19" rack mount interface (150 watt or 400 watt)		
Display & Interface	Optional industrial workstation, laptop or customer provided PC		
Power Input	115/230 VAC		
File Format	Native JSF or XTF		
Sensor Interfaces	Ethernet, RS 232		
TOW CABLE			
	Coaxial Kevlar or double-armored up to 6,000m, winches available		

For more information please visit EdgeTech.com

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TELEDYNE MARINE

PRODUCT DATASHEET

ECHOTRAC E20

Hydrographic Echosounder for demanding 24/7 use

The new ECHOTRAC E20 is the result of more than 40 years of experience in precise echosounding and market leading sonar technology.

A portable, compact and robust echosounder designed for survey in all environments allowing you to maximize your utilization of the equipment and reducing your costs by having one unit for all applications.

Easy to use and fast to mobilize, the E20 allows you to begin your survey rapidly, delivering accurate results first time, every time. The E20 saves time and enables you to get results faster.

The ECHOTRAC E20 completes our portfolio of sonar solutions introducing yet another groundbreaking innovation into the day-to-day work life of our customers.

E20 product features

- 1 or 2 frequency agile channels from 10 to 250kHz
- 0.5 to 6,000m depth range
- Ruggedized and shock-proof, water resistant IP67

The new SBES UI operator software is being used to operate the ECHOTRAC E20 in shallow water at 200kHz

PRODUCT FEATURES

- Precise and reliable survey data for shorter data processing time, enabling you to complete your project faster.
- Dual channel survey echosounder from very shallow to deep sea, from 10 kHz to 250 kHz – giving you the flexibility for all your survey projects, maximizing utilization of your investment.
- The compact system with minimal interfacing effort, allows for fast mobilization, and extremely low space to go anywhere, enabling you to start work immediately.
- Intuitive user interface, easy to use, so you can focus on the job at hand.
- The ECHOTRAC E20 is compatible with a broad range of transducers with straightforward transducer interfacing.

TELEDYNE MARINE
ODOM HYDROGRAPHIC
Everywhereyoulook™

ECHOTRAC E20

TECHNICAL SPECIFICATIONS

	Single channel	Dual channel	Dual channel Extended Range
Operating frequency	HF channel 10 to 250Khz, optimized for 50-250kHz		
	LF channel 10 to 250khz, optimized for 10-50kHz		
Channels	Single[1]	Dual	Dual
Accuracy and Resolution			
200kHz	1cm resolution and 2cm +/- 0.1% of depth accuracy		
33kHz	5cm resolution and 10cm +/- 0.1% of depth accuracy		
12kHz	15cm resolution and 15cm +/- 0.1% of depth accuracy		
Depth Range[2]			
200kHz	0.5 to 250m		0.5 to 400m
33kHz	1.0 to 1,000m		1.0 to 3,000m
12kHz	3.0 to 1,000m		3.0 to 6,000m
Max ping rate	50Hz		
Pulse type	CW	CW	CW and FM (chirp)
Output power	Typically max output power varies between 1 and 3kW, depending on transducer		
Input power	10-30VDC, 100-230VAC[3] , max 50W		
Data output	Via LAN interface: For each channel the measured depth and full amplitude-time echogram, passed through auxiliary sensor data, s7k data protocol. Via serial port: For each channel the measured depth		
Transducer interfaces	Impedance: minimum 50 Ohm, Max power: 15W per channel RMS		
	• Single-connector TX1 for dual transducer		
	• Two separate connectors TX1 and TX2 for separate transducer cables		
Interfaces	3 serial connectors (RS-232):		
	• Input: GPS position and time, heave, motion, heading		
	• Output: depth		
	1 Ethernet LAN connector		
	1 sync connector		
Dimensions H x W x D	83.0mm x 300.0mm x 221.0mm		
Weight	5.7kg (excl. external cables and transducers)		
Environmental conditions and ingress protection	Temperature Operation (Storage): -20°C to +55°C (-30°C to +70°C)		
	IP67, Vibration, Drop: Complies with standard EN 60945 §8.7 and §8.6		

[1]The E20 SC single channel can utilize both channels, but not at the same time.
[2]The depth values are based on the performance of TC2122 for 200 and 33kHz, and HM210/12-8/20 for 12kHz. Stated depth ranges may be impacted by environmental conditions, vessel installation, and motion
[3]External AC power supply is included and intended for dry installation (not IP67 compliant).

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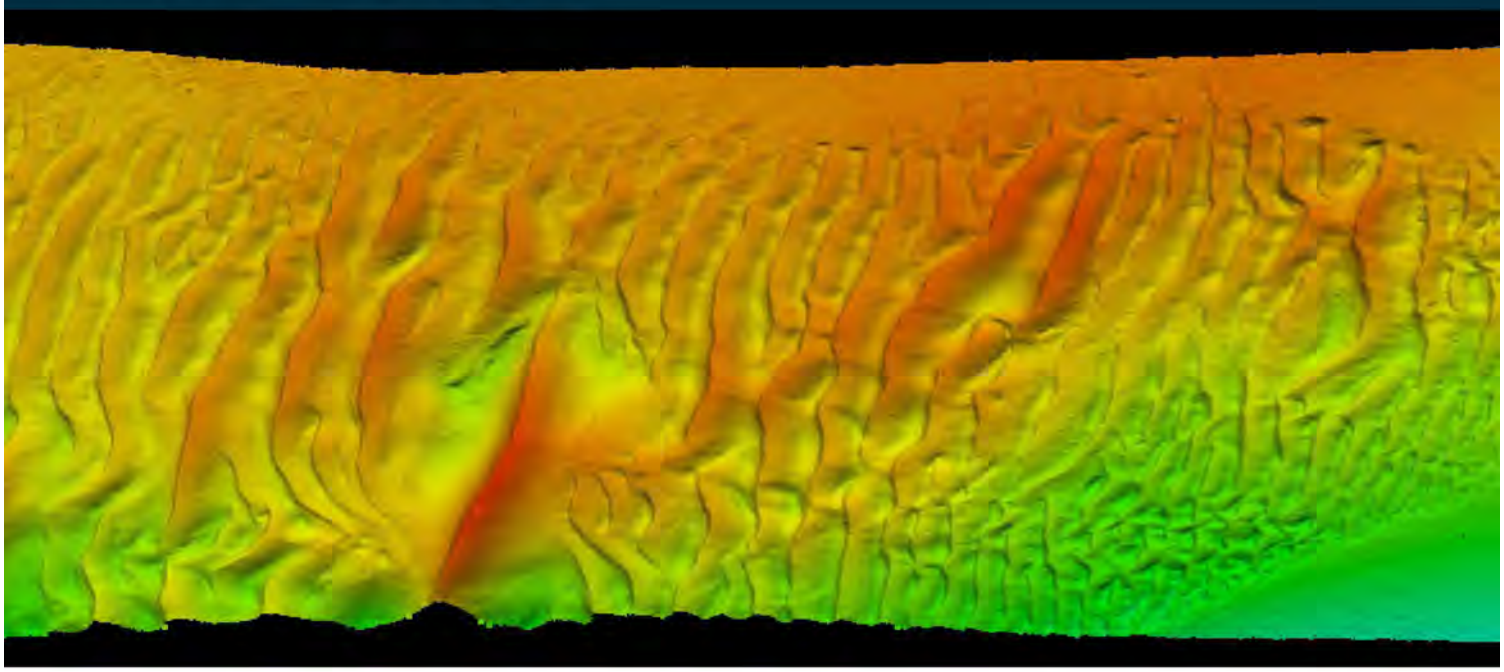
EM® 2040C

KONGSBERG



MULTIBEAM ECHO SOUNDER

The EM 2040C (C for Compact) is a shallow water multibeam echo sounder based on the EM 2040 technology, an ideal tool for any high resolution mapping and inspection application. The receiver and transmitter are integrated in a common sonar head, with the same dimensions as its predecessor EM 3002. The system fulfils and even surpasses the IHO-S44 special order and the more stringent LINZ specification.

Key facts

The operating frequency range is from 200 to 400 kHz with frequency selection in steps of 10 kHz, enabling the user to choose on the fly the best operating frequency for the application. Due to the very large operating bandwidth available, the system will have an output sample rate up to 60 kHz. The system can effectively operate with very short pulse lengths. The shortest pulse is 14 microseconds, which gives a raw range resolution (cτ/2) of 10.5 mm.

By utilizing both CW and FM chirp pulses, the system can achieve a much longer range capability with a high resolution. The maximum depth range for a dual head system in cold ocean water is 520 m at 200 kHz with a swath with up to 700 m.

The angular coverage for 200 to 320 kHz is 130 degrees with one sonar head, allowing coverage of 4.3 times water depth. With two sonar heads tilted 35-40 degrees to each side, 200 degrees can be covered. This allows surveying to the water surface or up to 10 times water depth on flat bottoms. For frequencies above 320 kHz the angular coverage per head is gradually decreasing to 70 degrees at 400 kHz.

As an option, the EM 2040C can be delivered with the dual swath capability, allowing a sufficient sounding density along track at a high vessel speed.

Components

The basic EM 2040C has three units: a sonar head, a processing unit and a hydrographic workstation. For completeness, data input from a motion sensor and a positioning system is required, as is the sound speed profile of the water column between the transducers and the bottom. Sound speed at the transducer depth is an optional input and is highly recommended, especially for a dual head system.

Optionally, the sonar head(s) may be delivered mounted on a frame together with the motion sensor and a sound speed sensor, factory aligned for ease of mounting.

All electronics are contained in the sonar head(s) which is interfaced to the processing unit via GBit Ethernet. The processing unit also supplies 48 VDC power via the same cable. Operator control, data quality inspection and data storage is handled by the hydrographic workstation running SIS software or by 3rd party software.

The EM 2040C is available in an EM 2040CX version where the subsea part has a depth rating of 1500 m for operation on ROV or AUV.

FEATURES

- High resolution
- Wide frequency range
- FM chirp
- Roll and pitch stabilisation
- Yaw stabilisation - for dual head
- Nearfield focusing both on transmit and receive
- Short pulse lengths, large band-width
- Water column display
- Seabed image
- Depth rated to 50 m
- Easy to install

Options:
- Water column logging
- Extra detections
- Dual swath
- Depth rated to 1500 m (EM 2040CX)
- Dual Head (EM 2040CD)

TECHNICAL SPECIFICATIONS

Frequency range:	200 to 400 kHz in steps of 10 kHz
Beam width:	1 * 1 degree at 400 kHz
Max ping rate:	50 Hz
Swath coverage sector:	Up to 130 degrees (single head) / 200 degrees (dual head)
Sounding patterns:	Equiangular, equidistant and high density
No. of soundings per ping:	400 (single head, single swath) 800 (single head, dual swath) 1600 (dual head, dual swath)
Roll stabilised beams:	+/-15 degrees
Pitch stabilised beams:	+/-10 degrees
Yaw stabilised beams:	+/-10 degrees (Dual head)

Coverage example for EM 2040C in cold ocean water with bottom type rock (BS = - 10 dB), NL = 45 dB, FM mode			
Operating frequency	**Max depth**	**Max coverage across**	
		Single head	**Dual head**
200 kHz	520 m	580 m	700 m
300 kHz	450 m	580 m	670 m
350 kHz	400 m	510 m	600 m
400 kHz	350 m	375 m	530 m

	200 - 400 kHz in 10 kHz step	**200 - 400 kHz in 10 kHz step**
	CW	**FM**
Pulse lengths	14, 27, 54, 135, 324 and 918 µs	3 and 12 ms

Physical dimensions (excluding connectors and mounting arrangements)			
Sonar head EM 2040C	332 x 119 (diameter x height)	18.8 kg (8.4 kg in water)	Depth rating 50 m
Sonar head EM 2040CX	332 x 122 (diameter x height)	26.1 kg (17 kg in water)	Depth rating 1500 m
Processing Unit (2U 19" rack)	482.5 x 424 x 88.6 mm (WxDxH)	10.5 kg	NA

Laptop, HWS and monitor can be delivered on request.

369468 / G August 2017

Specifications subject to change without any further notice.
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KONGSBERG

Geo-Sense Light-weight UHRS

Technical Specifications 24 - 48 channel model

STREAMER GEOMETRY (standard for 24 channels)

Group Length,	50 cm
Group Spacing:	3.125 m spacing between the groups *Note customized spacing available upon request*
Deck Lead:	25 m armoured LAN
Tow lead:	75.0 m
Front-Stretch:	12.5 m
Total Active Length:	75 m
Tail-Stretch:	12.5 m
Total length streamer c/w tow lead	75 tow lead + 12.5 + 75 + 12.5 = 175 m

STREAMER STRUCTURE

Jacket size ID & OD:	35 mm & 41,3 mm
Jacket material:	Unreinforced polyurethane, wall thickness 3.14 mm
Connectors	none, all in one length
Spacing of spacers	24 cm
Stress members	2 x 5 mm Kevlar rope, breaking strength >3000 kg
Ballast fluid:	Shell Sol T (standard)
Buoyancy:	Slightly positive, must be zero balanced using lead
Wiring:	32 twisted pair, super flexible, conductor diam 0,38mm
Shielding	100 % ground shielding all along

HYDROPHONE

type;	AQ 2000 or Sensor
No of hydrophones per group:	3 (three)
Frequency response:	1 Hz to 10,000 Hz ± 3.0 dB
Sensitivity:	201 dBV re 1 uPa @ 20 C
Sensitivity Change vs. Frequency:	±0.25 dB from 1 Hz to 1 kHz
Sensitivity Change vs. Frequency:	±2.00 dB 1 kHz to 10 kHz
Sensitivity Change vs. Temperature:	< 0.03 dB per 1° C change
Capacitance hydrophone:	4.5 nF @ 20° C

PRE-AMP

Type	GEO, High imp, low noise, differential pre-amplifier
Gain:	26 dB
Size:	60 x 16 mm
Gain:	26 dB
Ground reference:	Single-ended
Power :	9 -12 V DC (polarity protected)
High-pass:	-3 dB : 3 Hz
Low-pass:	-3 dB :13 kHz
ESD handling	conform IEC 61000-4 norm

TOW -CABLE

Length:	Standard 75 m
Diameter:	18 mm
Type:	31 or 62 screened twisted pair extra flex 26 AWG
Insulation:	Polyurethane
Strain member:	Double reverse spiral Kevlar, 25 kg breaking strength
Termination	62 pin ITT D connector compatible with Multi-Trace 24

MANUAL CABLE REEL for 24 channel	Manual SS Cable reel with integrated Multi-Trace foot print 120 x 70 cm, height 120 cm, weight 280 kg LAN deck lead to acquisition PC
ELECTRIC WINCH for 48 channel	foot print 160 x 170 cm, height 180 cm, weight 480 kg LAN deck lead to acquisition PC
Depth Control	Lead-in depth controller, AIS-GPS option

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Website: www.geo-spark.com

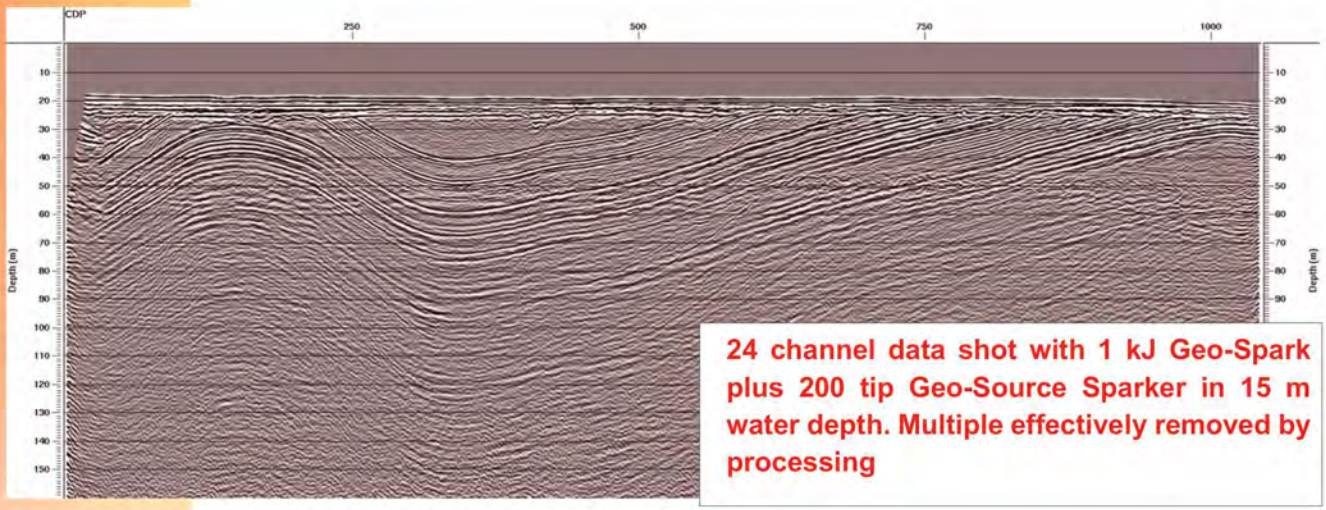
Geo-Sense Light-weight UHRS 24 - 48 Channel Streamers

Main Characteristics

- Small diameter skin (41 mm), small bending radius, < 40 cm
- Very rugged harness made of Delrin spacers plus two 5 mm Kevlar ropes with > 3000 kg breaking strength
- Compact, stainless steel cable reel for easy and safe deployment
- Multi-Trace 24 A-D module integrated in cable reel, minimizing E-noise
- No connectors, all in one section
- Specially designed to capture the HF spectrum from the Geo-Source Sparkers
- Short 3-element active section of 50 cm minimizes spacial filtering
- Small group interval of 3,125 m allows detailed velocity analysis
- Classic analogue design, repairable in any cable shop

Streamer Outrigger

Too many times streamer perfomance is compromised by a bad towing configuration. The use of a 6-8 m outrigger is imperative to keep the streamer out of the prop wash



24 channel data shot with 1 kJ Geo-Spark plus 200 tip Geo-Source Sparker in 15 m water depth. Multiple effectively removed by processing

Geo-Spark 1000 - 1500 - 2000

Solid State Pulsed Power Supplies

Applications

- **Very high resolution seismic acquisition e.g. site & route surveys**

  Is typically combined with:
- **Geo-Source 200-400-tip sparkers (marine and fresh water)**
- **Geo-Boomer 300-500 Joules**
- **Borehole Sparkers**
- **Pulsed power projects & research**

100 % Safety Features

All possible features have been integrated into the systems to safeguard against potential human error.

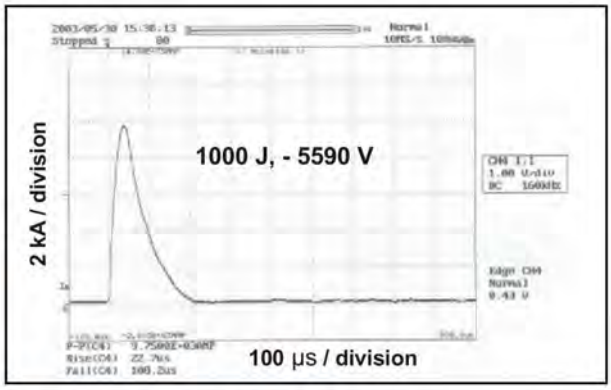
- To open and gain access to the high voltage (HV) connection box, the 230 V mains CE-form connector must first be physically removed.
- High voltage can only be activated when the HV connection box is completely closed.
- If the HV connection box is opened, even partially, during operation, the HV will automatically switch off and the unit will generate a final trigger to discharge the capacitors.
- Similarly, when the HV is switched off normally by pushing the red stop button, an automatic final trigger will discharge the capacitors.
- When the HV connection box has been opened completely, both poles (zero and negative) will automatically be shorted.
- The systems contain internal bleed-off resistors to eliminate any possibility of unwanted charging effects.
- A power lock limits the output to Geo-Boomer to 300 J.

Operational Features

- **100 to 1000-1500-2000 J real power**
- **No electrical oscillations**
- **User-friendly & 100 % safe**
- **Modular internal design**

Cutting-Edge Pulsed Power Technology

The Geo-Spark 1000 -1500 - 2000 are revolutionary high voltage (HV) power supplies based on cutting-edge 'pulsed power' technology. The systems use an extremely reliable, state-of-the-art thyristor switch that can generate very short (60 - 200 µs) high voltage pulses of up to 10 kA at -5.6 kV.



Preserving Electrode Mode

These pulsed power supplies are fundamentally different from any other HV power supplies. They have been designed specifically to power the Geo-Source range of multi-tip sparkers in our patented 'Preserving Electrode Mode'. In this mode the electrodes have a negative potential with respect to the source frame (= ground), thereby reducing electrode wear to almost zero.

Negative Electric Discharge Pulse

There is no other unit commercially available that allows you to generate a negative high voltage pulse with such a high dI/dt ratio.

No Electrical Oscillations

The pulse output has NO electrical oscillations, which affect the acoustic signature. The integrated capacitor bank consists of two (1000 PPS), three (1500) or four (2000 PPS) indestructible 32 µF capacitors rated for more than 200 million (= 2 x 10^8) discharges. For example, a ¼ second discharge rate would give continuous work for 1½

Low Power Consumption

The Geo-Spark 1000 -1500 - 2000 PPS can be operated from an ordinary 230 V/16 A mains socket or from a portable 230 V/3.5 kVA generator.
The systems do not draw excessive peak currents.

Geo-Spark 1000 - 1500 - 2000

Solid State Pulsed Power Supplies

Safe and Intuitive Operation

All connections, command buttons, switches and status LEDs are front-mounted to ensure direct safe access and intuitive operation.

Flexible Energy Output

The systems feature a very flexible energy output, ranging from 100 to 2000 J (in steps of 100 J), that can be modified while online.

This is achieved by:

- varying the operating voltage (selectable from -2000 V to -5600 V);
- varying the capacitance (selectable from 32 µF to 64 or 128 µF).

Microprocessor Control

All internal initialising and safety procedures are microprocessor-controlled and the current system status can be monitored via a comprehensive series of LEDs. This provides an easy and straightforward system operation that is basically limited to the following actions:

- switching on/off the control unit (230 V/50-60 Hz single phase);
- selecting the capacitance and voltage;
- activating/deactivating the HV generation.

Triggering

Remote triggering of the unit is implemented by a TTL pulse, which is internally converted into a fibre-optic signal to the thyristor trigger device. There is no need for any external opto-isolator on the trigger line. During standby between survey lines, the unit will NOT trip - it will slowly bleed off but will remain ready for the next line.

USB connection on front

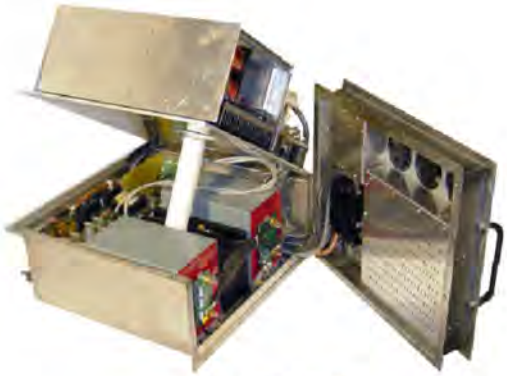
This new feature allows to connect a PC and provides direct access to the control software. You can check the usage data and the system functionality. It also allows customise the control software and internal configuration.

Modular Internal Architecture

The pictures below give an idea of the advanced modular architecture that allows the opening and inspection of the systems without disconnecting any units.

The internal construction comprises three main individual compartments:

- upper compartment with pulsed HV module, thyristor stack and relay/opto-control PCB;
- lower compartment with the pulse capacitors, capacitor switch, etc.
- front compartment with line filter, mains breaker, HV connection box, main control PCB and cooling fans.



Quality Built to Last

These pulsed power supplies are built to last, electronically and mechanically. Ten rubber shock absorbers in a sturdy, high quality polyester flight case support the compact inner housing that contains the actual unit.

Additionally, rubber shock absorbers support each vibration-sensitive component inside the inner housing.

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G-882
Cesium Marine Magnetometer

GEOMETRICS
Innovation • Experience • Results

Geometrics' G-882 Marine Magnetometer is the leading marine system in the industry with over 1,000 systems sold! The G-882 is the only system that meets the standards for UXO clearance in the North Sea.

This very high-resolution Cesium vapor marine magnetometer is low in cost, small in size, and offers flexibility for professional surveys in shallow or deep water. Use your personal computer with our MagLog™ software to log, display and print GPS position and magnetic field data.

The system directly interfaces to all major side-scan manufacturers for tandem tow configurations. Being small and lightweight, it is easily deployed and operated by one person. But add several streamlined weight collars and the system can quickly weigh more than 100 lbs for deep-tow applications.

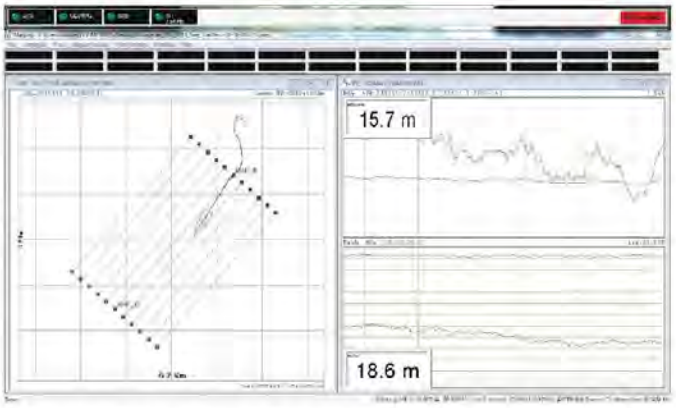
This marine magnetometer system is particularly well-suited for the detection and mapping of all sizes of ferrous objects. This includes anchors, chains, cables, pipelines, ballast stones and other scattered shipwreck debris, munitions of all sizes (UXO), aircraft, engines and any other object with a magnetic expression. The G-882 is also perfect for geological studies. Its high sensitivity and high sample rates are maintained for all applications.

Objects as small as a 5-inch screwdriver are readily detected provided that the sensor is close to the seafloor and within practical detection range (refer to table on back).

FEATURES & BENEFITS

- **Cesium Vapor High Performance** – Highest detection range and high probability of detecting all sized ferrous targets.
- **Streamlined Design for Tow Safety** – Low probability of fouling in fishing lines or rocks. Rugged fiber-wound fiberglass housing.
- **Sample at up to 20Hz** – Unparalleled data density while also covering larger areas per day.
- **Sensor can be Rotated for Optimal Signal** – Can be used worldwide.
- **Easy Portability and Handling** – No winch required. Built-in easy-carry handle. Operable by a single man; only 44 lb with 200 ft cable.
- **Combine Multiple Systems for Increased Coverage** – Internal CM-221 Mini-counter provides multi-sensor sync and data concatenation, allowing side-by-side coverage which maximizes detection of small targets and reduces noise.
- **Export Version Available** – Use anywhere in the world without need for an export license (except embargoed countries). See specifications.

SPECIFICATIONS | G-882 Cesium Marine Magnetometer



MagLogLite™ Data Logging software is included with each magnetometer and allows recording and display of data and position with automatic anomaly detection. Additional software options include: MagLog Pro™, advanced logging software; MagMap™, a plotting and contouring package; and MagPick™ post-acquisition processing software.

MAGNETOMETER / ELECTRONICS

Operating Principle: Self-oscillating split-beam Cesium vapor (non-radioactive).

Operating Range: 20,000 to 100,000 nT.

Operating Zones: The earth's field vector should be at an angle greater than 10° from the sensor's equator and greater than 6° away from the sensor's long axis. Automatic hemisphere switching.

Noise: <0.004 nT/$\sqrt{Hz}_{rms}$; (SX (export) version: <0.02 nT/$\sqrt{Hz}_{rms}$).

Max Sample Rate: 20 Hz.

Heading Error: < 1 nT (over entire 360° spin).

Output: RS-232 at 1,200 to 19,200 Baud.

Power: 24 to 32 VDC, 0.75 A at power-on and 0.5 A thereafter.

MECHANICAL

Sensor Fish

DIA: 7 cm; L: 137 cm (2.75x54 in) (with fin assembly).
Weight: 18 kg (40 lb).
Includes sensor and electronics and 1 main weight. Additional collar weights are 6.4 kg (14 lb) each; total of 5 capable.

Tow Cable

DIA: 12 mm; L: 800 m (0.47 in x 2,625 ft).
Weight: 7.7 kg (17 lb) with terminations.
Break strength: 1,630 kg (3,600 lb)
Bend diameter: 30 cm (12 in).

Typical Detection Range for Common Objects

1.	Ship: 1000 tons	0.5 to 1 nT at 800 ft (244 m)
2.	Anchor: 20 tons	0.8 to 1.25 nT at 400 ft (120 m)
3.	Automobile	1 to 2 nT at 100 ft (30 m)
4.	Light Aircraft	0.5 to 2 nT at 40 ft (12 m)
5.	Pipeline (12 inch)	1 to 2 nT at 200 ft (60 m)
6.	Pipeline (6 inch)	1 to 2 nT at 100 ft (30 m)
7.	Iron: 100 kg	1 to 2 nT at 50 ft (15 m)
8.	Iron: 100 lb	0.5 to 1 nT at 30 ft (9 m)
9.	Iron: 10 lb	0.5 to 1 nT at 20 ft (6 m)
10.	Iron: 1 lb	0.5 to 1 nT at 10 ft (3 m)
11.	Screwdriver: 5-inch	0.5 to 2 nT at 12 ft (4 m)
12.	Bomb: 1000 lb	1 to 5 nT at 100 ft (30 m)
13.	Bomb: 500 lb	0.5 to 5 nT at 50 ft (16 m)
14.	Grenade	0.5 to 2 nT at 10 ft (3 m)
15.	Shell: 20 mm	0.5 to 2 nT at 5 ft (1.8 m)

ENVIRONMENTAL

Operating Temperature: -35°C to –50°C (-30°F to –122°F).

Storage Temperature: -45°C to +70°C (-48°F to +158°F).

Altitude: 9,000 m (30,000 ft).

Depth: 4,000 psi (2,730 m; 8956 ft).

Water Tight: O-Ring sealed for up to 4,000 psi depth operation.

ACCESSORIES

Standard: Operation manual, shipping/storage container, ship kit with tools and hardware, power supply, MagLogLite™, MagMap™ and MagPick™ processing software, depth transducer, altimeter.

Optional: Steel tow cable to 6,000 m (19,600 ft) with telemetry, longitudinal or transverse gradiometer, plastic Pelican® case, MagLogPro™, collar weights.

Specifications subject to change without notice. G-882_v1 (0110)

GEOMETRICS
Innovation • Experience • Results

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10. SONARDYNE MINI-RANGER 2 USBL

Mini-Ranger 2 is a sixth-generation (6G) Ultra-Short BaseLine (USBL) underwater target tracking system. It offers a standard operating range of 995 metres (extendable up to 4,000 metres) and the ability to simultaneously track up to 10 subsea targets (e.g. divers, ROVs and structures) at very fast update rates. These features mean that Mini-Ranger 2 is ideal for nearshore operations on small, quiet vessels, vessels of opportunity, pipelay and construction barges that need survey grade positioning performance without the cost and complexity of a deep water USBL solution.

SONARDYNE MINI-RANGER 2 USBL UNDERWATER TARGET TRACKING SYSTEM

SYSTEM OVERVIEW

Mini-Ranger 2 calculates the position of an underwater target by measuring the range (distance) and bearing (heading) from a vessel-mounted transceiver to an acoustic transponder fitted to the target; a technique known as Ultra-Short BaseLine (USBL) positioning. One of the main advantages of the USBL technique is that no other in-water acoustic equipment has to be deployed before underwater operations can commence. Only the targets being tracked need to be equipped with a transponder.

The Sonardyne 6G and Wideband 2 digital signal technology inside Mini-Ranger 2 USBL offers precise acoustic ranging and hardware that is easier to set up and operate, even in the most challenging subsea operating environments. These features improve the efficiency of subsea survey operations, reduce vessel delays and generate cost savings for owners.

Mini-Ranger 2 is compact and highly portable, comprising the 1U-high (desk or rack-mounted) Ethernet Serial Hub (ESH), HPT 3000 acoustic transceiver and software which is installed on the user's own PC or ruggedised laptop. A wide range of Sonardyne 6G mini transponders can be used with Mini-Ranger 2 allowing the user to select the most appropriate beacon for the task in hand. These include; Wideband Sub-Mini 6+ (WSM 6+), Wideband Release Transponder 6 (WRT 6), Wideband Mini Transponder 6 (WMT 6) and the ultra-small Nano.

WHAT YOU NEED TO KNOW

- Portable and quick to install on all types of vessel
- 0.2% system accuracy when optimised
- 995 metres standard tracking range; exempt from export control for fast, uncomplicated international shipping
- Tracking range extendable up to 4,000 metres depending on operating set up
- Fast target position updates; up to 3 per second
- Automatic discovery and tracking of Sonardyne 6G transponders
- Audio Codec for live listening and recording acoustics
- Audio and visual diagnostic tools enable optimised performance
- Importable DXF chart backdrops

HPT 3000

At the heart of Mini-Ranger 2 is the HPT (High Performance Transceiver) 3000 transceiver Small and lightweight, HPT 3000 is perfect for installation on very small boats using temporary, over-the-side deployment arrangements.

The transceiver features a unique design of receiver array and transmitter which are optimised to provide excellent performance in shallow water, at high elevations, as well as in deeper water. USBL precision is dependent on the baseline between the receiver elements and signal to noise. This is where the HPT 3000 excels in that the larger diameter array provides excellent precision and noise rejection, dramatically better than USBL systems on the market with much smaller diameter arrays.

A key feature of the HPT 3000 is that communications are all Ethernet based. This means connection to the topside computer (via the Ethernet Serial Hub) is simple and user friendly as it can be connected through a ship's network via a single network socket – eliminating challenging USB to serial drivers and their associated compatibility problems. Ethernet based communications also enable improved in-water diagnostics, allowing the operator to both listen to, and visualise, signals and noise in the water. The HPT 3000 is available in durable Aluminium Bronze or lightweight Aluminium Alloy.

SOFTWARE

Mini-Ranger 2 uses the same modern and intuitive software as Sonardyne's deep water USBL system, Ranger 2, thereby ensuring users quickly become confident in its use
An extensive set of tools are included to allow the user to optimise the system performance, including real-time audio and visual signal and noise analysis displays. Sonardyne's CASIUS calibration tool is also included to correctly calibrate gyro and VRU offsets, and so improve positioning accuracy. There is a built-in calibration routine of the internal magnetic sensor to minimise the time between installation and tracking.

ETHERNET SERIAL HUB

With Mini-Ranger 2, the Ethernet Serial Hub provides a simple, but all-encompassing, robust interface between peripheral sensors, acoustic instruments, mains power and the software running on the PC. Communications are all Ethernet based, allowing connection through a ship's network and eliminating the requirement for all equipment to be co-located on the bridge. The Ethernet Serial Hub also supports responder trigger and 1PPS synchronisation across systems.

Software Mini-Ranger 2 shares the same modern and intuitive interface as Sonardyne's established Ranger 2 USBL system ensuring users quickly become confident in its use.

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Ethernet Serial Hub and HPT 3000
The Ethernet Serial Hub (ESH) is a 1U-high (desk or rack-mounted) unit for interfacing the HPT 3000 transceiver, GPS and user's PC running the Mini-Ranger 2 software. The HPT 3000 is designed for portable installation on very small boats. It offers excellent performance in shallow water, at high elevations, as well as in deeper water.

Transponder options
Mini-Ranger 2 is compatible with Sonardyne's mini transponders including; WSM 6+ (below left top),Nano (below left bottom), WRT 6 (below right), WMT 6, as well as aircraft pinger locators.

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GEOQUIPMARINE

SAFELY DELIVERING RELIABLE DATA.

Seabed CPT GMC200

Introduction

Geoquip Marine have developed a 200kN cone penetration testing system (GMC200) capable of operating in water depths up to 2,000m providing a push capacity of 200kN (20t), enabling the recovery of *in situ* soil data to a depth of 40m or more below the seabed depending on soil conditions.
The unit has a subsea HPU which is mounted on the subsea frame and provides power to the chain drive system to push/pull the CPT string and clamping force onto the CPT string by means of hydraulic cylinders.

Mobilisation

The system is designed to enable the unit to be mobilised onto a vessel of opportunity or onto an existing Geoquip Marine vessel. This versatility enables the system to be deployed quickly and efficiently to the port of mobilisation.

Operations

Once on location the CPT unit is lowered to the seabed and the test is commenced with the rod penetrating the soil at a rate of 2cm/s. Data is relayed to the operator on board in real time where it is then processed.

Data Acquisition

The 200kN system provides a continuous profile of tip resistance, sleeve friction and pore water pressure, which can be used for the derivation of shear strength in cohesive soils and the relative density of non-cohesive soils. The system has the ability to operate a range of cone sizes and optionally seismic CPT cones, T-bar and ball PCPT equipment.

GMC200	
Type	200kN seabed PCPT
Operating conditions	20 – 2,000m water depth
Available measurements	Tip resistance, sleeve friction, pore water pressure, cone inclination, rig inclination, altitude and total thrust
Cones	10cm² or 15cm²
Specifications	Penetration adjustable to soil conditions, tip resistance up to 200kN
Applications	Determination of engineering parameters including *in situ* relative density and shear strength for use in engineering analysis

12. AXYS FLiDAR Platforms

AXYS OCEAN Renewables

UNDERSTAND YOUR WHOLE ENVIRONMENT

COMPLETE DATA SETS
PROVEN TECHNOLOGY
FULL SERVICE
PROJECT LIFE CYCLE MANAGEMENT

AXYS can assist in every part of the offshore wind production life cycle

Project Maturity

- Offshore wind resource assessment
- Wind farm design & contract management data
- Site character weather data

- Real-time met ocean data during construction of the offshore wind farm

- Real-time met ocean data after construction of the offshore wind farm aids with routine service maintenance

- Wind assessment data to analyse turbine performance and/or adding new turbines

Time

ASSESSMENT | MANUFACTURING | PRODUCTION | UPGRADE

Project Life Cycle Management

AXYS Technologies has over 40 years of experience in the development, deployment and maintenance of offshore systems that accurately record and transmit ocean data in near real time, equipping offshore energy developers with the information that they need in order to make sound financial decisions.

ISO 9001 SYSTEM CERTIFICATION SGS

www.axystechnologies.com | 1.250.655.5850 | info@axys.com

AXYS TECHNOLOGIES INC.

FLiDAR Platforms

Highly accurate offshore wind resource assessment

AXYS TECHNOLOGIES INC.

Floating LiDAR | FLiDAR

The AXYS FLiDARs were developed to meet the offshore wind industry's need for accurate, reliable wind resource assessment data offshore, which is used to:

- Evaluate & assess the energy yield of the wind farm for financing purposes
- Support structural design activities for the wind farm
- Support construction and installation, as well as operations & maintenance planning

PROVEN TECHNOLOGY

AXYS FLiDARs are world leaders in the provision of bankable wind resource assessment data used to secure financing of offshore wind farms. They have been used in over 85% of the world's floating LiDAR deployments and have supplied data longer and more consistently than any other system.

FLIDAR DESIGN

FLiDAR systems are designed with:

- Marine buoy-adapted LiDARs specifically built for long-term offshore deployment
- Single or dual-LiDAR configuration option
- Industry standard hull designs with a long history of successful deployments in harsh environments
- Multiple redundant power supply systems, ensuring long-term operation in the event of failure of one system
- Fail-over telemetry systems ensuring consistent access to the buoy systems and data

COMPREHENSIVE SITE DATA

AXYS FLiDARs were designed to support the long term, consistent operation of LiDARs offshore while also integrating a wide range of sensors to provide comprehensive environmental information at the site. Sensor suites commonly used include:

- wind speed, direction & gust
- significant and max wave height
- atmospheric pressure
- air temperature
- water temperature
- current speed & direction
- relative humidity
- dissolved oxygen
- conductivity
- wave period and direction
- position (GPS)

DATA AS A SERVICE

AXYS FLiDARs are available for purchase or on a Data as a Service (DaaS) basis. Both options provide clients with accurate data delivered securely through the AXYS-APS platform, a robust and secure web-based portal for controlling a network of systems and sensors, as well as collecting, managing, analyzing, visualizing and disseminating environmental and oceanographic data from AXYS sensor platforms and a variety of other sources.

FLiDAR WindSentinel

FLiDAR 4-Metre

PRODUCT DATASHEET

TELEDYNE MARINE

Workhorse Waves Array

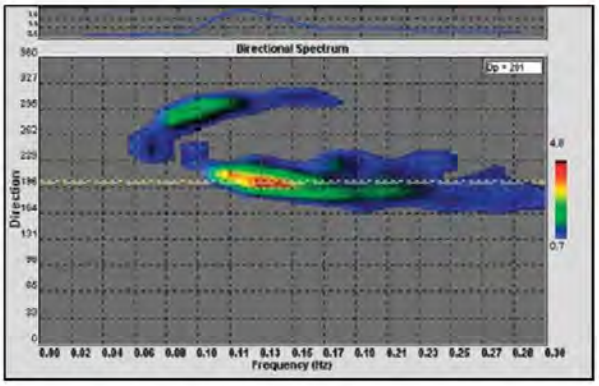
Directional Wave Measurement ADCP Option

Teledyne RDI's **Workhorse Waves Array** is an innovative, cost-effective upgrade that allows you to take your Teledyne RDI ADCP to the next level. Via a simple upgrade, you can capture not only the industry's most field-proven and dependable Broadband current profiling data, but highly accurate multi-directional wave measurements as well.

Teledyne RDI's Workhorse ADCP has long been viewed as the industry's most versatile ADCP. With a single instrument you can collect precision ADCP data from the seafloor, the surface, or even a moving vessel. And now, for the fraction of the cost of a stand-alone waves measurement tool, you can add highly robust multi-directional waves measurement capability to your instrument's repertoire.

Why limit yourself to a single measurement, or settle for inferior measurements, when Teledyne RDI's Waves Array allows you to have it all—at a price that meets your budget.

Frequency/Direction spectrum. The ADCP is showing multiple waves at similar frequencies that arrive from different directions.



PRODUCT FEATURES

- **More than a basic wave gauge.** Waves Array not only measures the complete frequency/direction wave spectrum, it provides you with the most reliable and field proven ADCP data available.
- **Better than a directional buoy.** This ADCP distinguishes waves from multiple directions with high resolution. Ocean floor deployment reduces the risk of loss or damage.
- **More powerful than a single-purpose instrument.** Waves Array allows your existing ADCP to measure multi-directional wave spectra, current velocity profiles, and water level—all at the same time.
- **Waves data when and where you need it.** Store your data in our stand-alone configuration, or use a cabled system to transmit the data to surface or shore for processing.
- **Available as an option to your new ADCP, or as an upgrade to your existing Workhorse or Horizontal ADCP.**

TELEDYNE MARINE
RD INSTRUMENTS
Everywhereyoulook™

Workhorse Waves Array

Directional Wave Measurement ADCP Option

TECHNICAL SPECIFICATIONS

Measurement Technique	Derivation of directional distribution	Array processing			
	Location of sensors	Remotely measured near surface			
	Number of independent sensors	12			
	Array aperture	~0.7 x depth			
	Acoustic sensor signal processing	Broadband			
	Simultaneous sampling of wave burst + standard current profile	Yes			
Calculated Wave Parameters	Primary data source	Near-surface velocity sensors			
	Redundant data sources	Pressure sensor and "surface track" derived parameters for data QA			
	Height	H_s $H_{1/10}$ H_{mean}			
	Period	T_p T_{mean}			
	Direction	D_p			
	Custom	H_{sea} H_{swell} T_{sea} T_{swell} D_{sea} D_{swell}			
Minimum Wave Period Measured	Deployment Depth	Surface Track High-Frequency Cutoff[1]	Non-Directional High-Frequency Cutoff	Directional High-Frequency Cutoff	
	5 m	1.0 s	1.7 s	1.8 s	
	20 m	1.0 s	2.2 s	3.5 s	
	80 m	1.0 s	4.4 s	7.0 s	
Recommended Deployment Depths	ADCP Frequency	Depth[2]			
	1200 kHz	2.5–14 m			
	600 kHz	5–45 m			
	300 kHz	10–80 m			
Raw Sensor Data *All sensors are sampled at a 2 Hz rate default. Sample rates of up to 4 Hz are possible with a specialized setup with a 1200 kHz.*	Velocity	1200 kHz accuracy	±0.3% ±0.3 cm/s		
		600 kHz accuracy	±0.3% ±0.3 cm/s		
		300 kHz accuracy	±0.5% ±0.5 cm/s		
	Precision	See Workhorse ADCP brochure			
	Surface track range	Accuracy	1.0% of full scale		
		Resolution	ADCP bin size/3.5		
	Pressure	Accuracy	0.25% of full scale		
		Resolution	1/40,000 of full scale		
	Compass	Accuracy	±2°[3]		
		Precision	±0.5°		
Installation	Cable Power/Communications	Provides unlimited duration for real-time data.			
	Battery Power	For remote locations, power for 90 days or more available. Optional external pack available.			
Software	Planning software	Self-contained or real-time deployment set up with waves, current profiles, or both.			
	Monitoring software	Data acquisition and processing.			
	Viewing Software	Zoom, animate, average. Export to bmp, png, or text files.			
Available Options	New ADCPs can be ordered with the Waves Array option, or you can upgrade your existing ADCP to include this capability.				

1 Acoustic surface track is only reliable in non "whitecapping" conditions.
2 Assumes bottom-mounted ADCP, near-surface deployment on top of a current meter mooring is possible.
3 ±1.0° is commonly achieved after field calibration.

TELEDYNE MARINE
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Simrad EK80

Combining a scientific echo sounder with ADCP

www.simrad.com SIMRAD

TECHNOLOGY FOR SUSTAINABLE FISHERIES

The Simrad EK80 once again confirms its position as the leading scientific instrument for measurements of aquatic ecosystems. With the EC150-3C transducer, the EK80 repeats its performance as an innovative acoustic system. It combines the absolute backscatter measurements from the split-beam echo sounder with physical oceanographic measurements from the acoustic doppler current profiler (ADCP) beams. And it all happens in one single instrument.

The common phrase "two-in-one" can easily describe the new functionality available for the EK80.

With the EC150-3C transducer the EK80 offers a dedicated calibrated wideband split-beam echo sounder with a 3 degrees beam opening angle. The narrow beam effectively increases the ability to resolve single targets within the beam. The system characterizes and quantifies objects in the water column and bottom backscatter using wideband and split-beam algorithms. The absolute backscatter measurements are used as foundations for science and resource management. The echo sounder transducer is calibrated with a sphere using the built-in EK80 functionality.

In addition to the backscatter measurements, the EK80 offers accurate current velocity measurements. The speed and direction of the currents throughout the water column are measured, and presented as a function of the depth. This offers a valuable tool for understanding how organisms, nutrients and other biological and chemical constituents are transported through the ocean. The information can also help understand how climate changes have an effect on how the warm water is transported through the oceans. Physical current measurements can also improve models for how the sea currents behave. This improves various forms of ocean and meteorological forecasts.

The acoustic doppler current profiler (ADCP) and narrow split-beam functionality offered by the Simrad EK80 is based on the EC150-3C transducer. The EC150-3C is a phased array transducer with the advanced transceiver circuitry inside. The common EK80 user interface is used for operational control.

You can use the EK80 and the EC150-3C transducer as a "stand-alone" system. You can also add the EC150-3C to an existing EK80 system by simply connecting the additional units to your Ethernet switch.

To use the EC150-3C you need EK80 software version 1.13.0 or later.

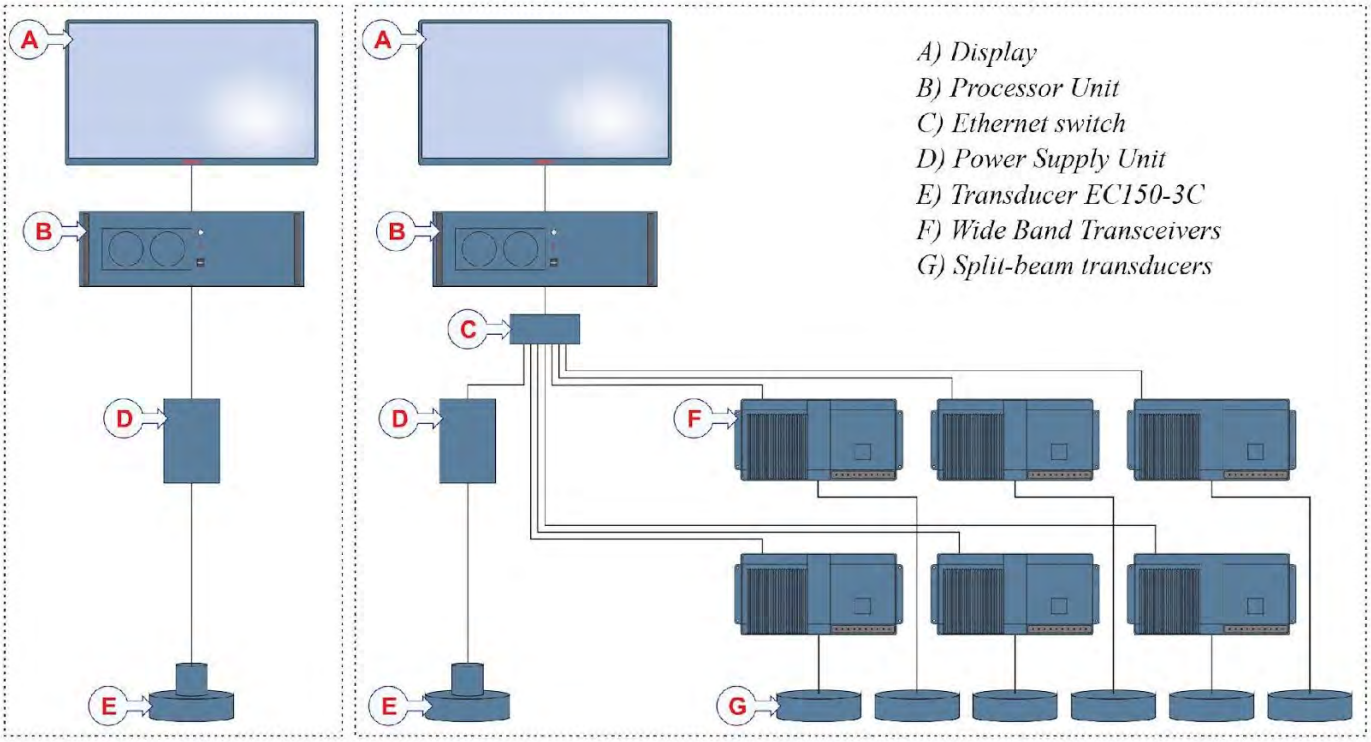
The EC150-3C is provided with a dedicated power supply to feed the built-in electronic circuitry. The transducer is easily installed using mounting- and clamping rings. The open-ended cable between the transducer and the power supply is provided with the delivery.

Key functionality

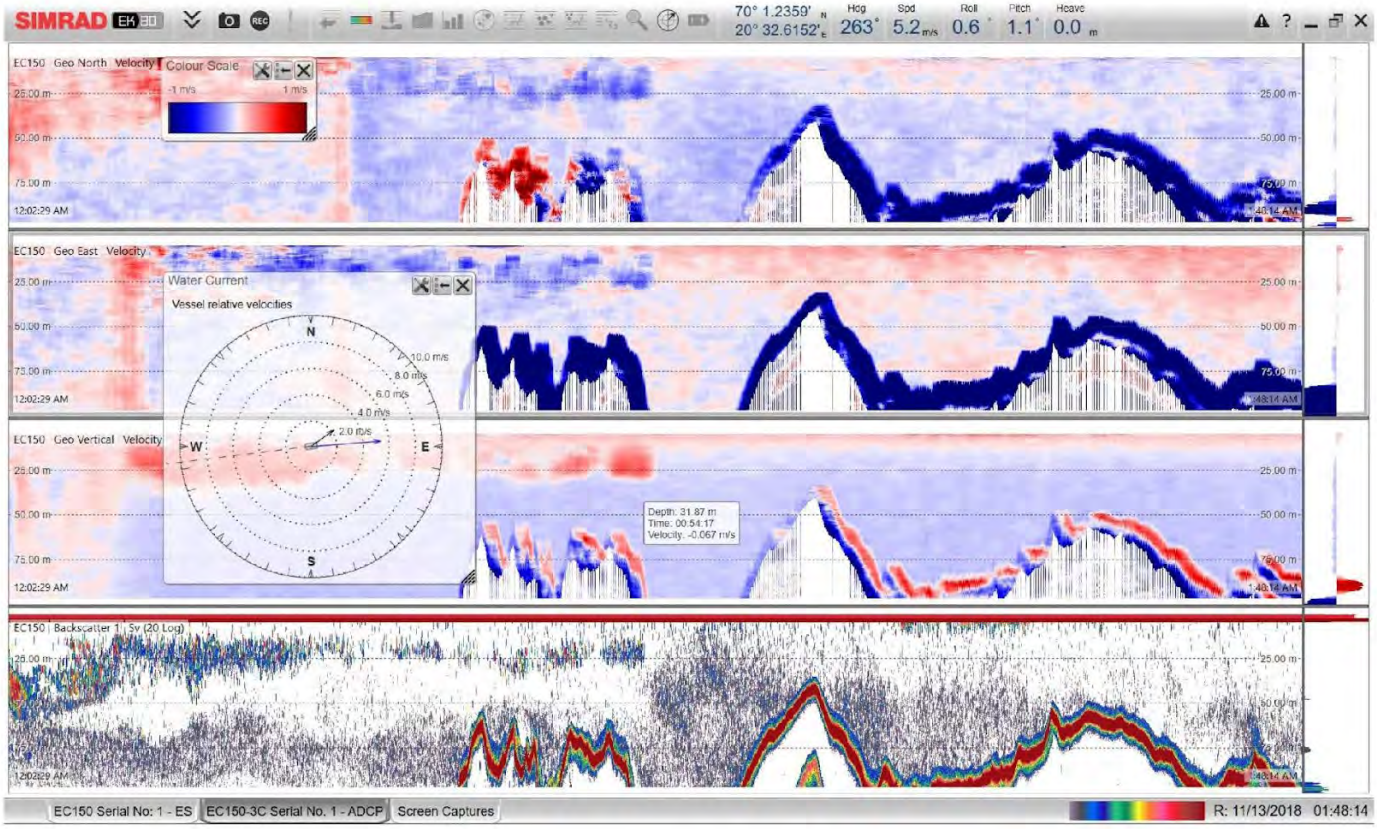
- State of the art current velocity and backscatter measurements
- Easy synchronization of ADCP and scientific echo sounder
- Wideband capability
- Built-in sphere calibration of echo sounder
- Auxiliary sensor data are integrated in the data files, such as heave, pitch, roll, GPS information, sound speed and temperature
- User friendly and flexible user interface
- Low installation costs by reducing the system complexity

System diagrams

Basic system *Complete EK80 scientific system with ADCP functionality*



This screen capture presents four typical views from a Simrad EK80 using the EC150-3C transducer and ADCP functionality. The top three views present the current water velocity in the north/south, east/west and vertical (down/up) directions. The colours indicate the water speed as specified by the colour scale. The bottom view contains the traditional echogram provided by one of the four ADCP beams. In this view the colours indicate the backscatter intensity..



Technical specifications

We are continuously working to improve the quality and performance of our products. Technical specifications may therefore be changed without prior notice.

Overall performance

- Nominal frequency: 150 kHz
- Frequency range: 130 to 170 kHz
- Dynamic range: 135 dB

ADCP performance

- Number of beams: 4
- Beam vertical tilt: 30 degrees
- Beam width: 3 degrees @ 150 kHz
- Pulse type: CW or FM
- Cell size: 2 to 16 m
- Max output sample interval: 40 µs
- Max number of depth cells: Unlimited
- Max range: > 400 m @ CW, 8 m cell size
  Maximum range depends on the acoustic scattering conditions.

Echo sounder performance

- Number of beams: 1 split beam
- Beam width: 2.5 deg @ 150 kHz
- Pulse type: CW or FM
- Calibration functionality: Included

Output specifications

- Ethernet: ZeroMQ
- File: NetCDF

Processor Unit

- Computer: EK80 Processor Unit
- Operating system: Windows® 10
- Software: EK80

Interfaces

- Internal sensor: Temperature
- External sensors: Position, Attitude and Heading

EC150-3C connections

- A dedicated 40 m open ended cable is provided with the transducer.

EC150-3C power requirements

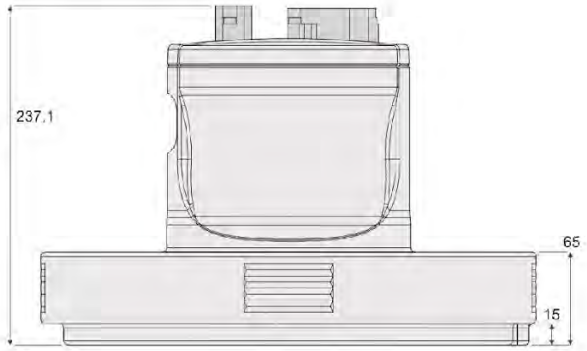
- Voltage requirement: 115 to 230 VAC, 50-60 Hz (nominal)
- Power consumption: 70 W
- Inrush current: 30 A with cold start @ 230VAC/25°C
- Input current: <0.65 A@230 VAC

EC150-3C environmental requirements

- Operational temperature: -5 to +50°C
- Storage temperature: -20 to +60 °C

Weight and outline dimensions

All measurements are in mm. The drawings are not to scale.



Transducer
Largest diameter is 346 mm
Weight in air: 12 kg

Power Supply Unit
Depth is 171 mm
Weight: 5 kg

449326 / Rev.A / April 2019

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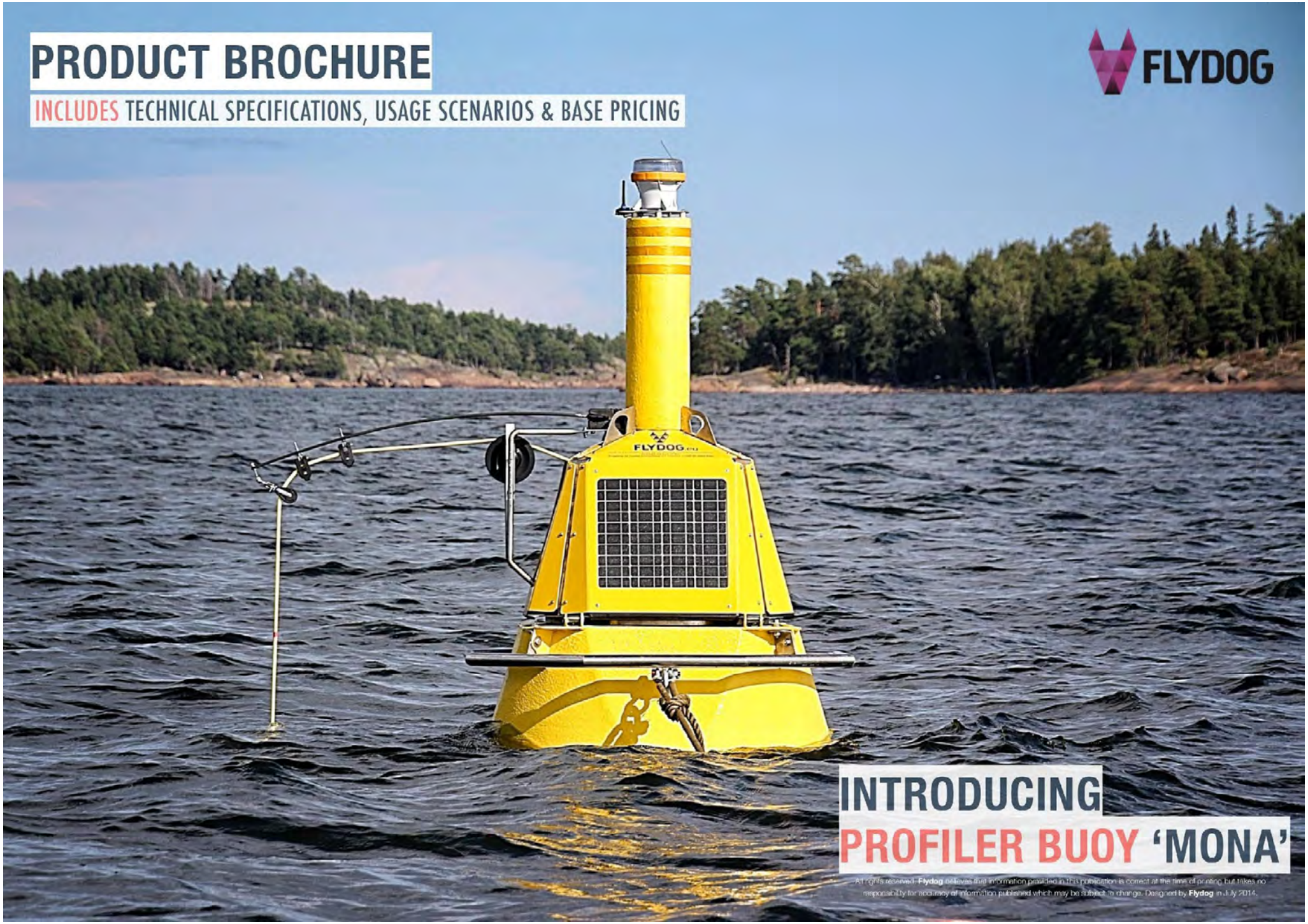
SIMRAD

15. FLYDOG SOLUTIONS LLC PROFILER DATA BUOY



INTRODUCING PROFILER BUOY 'MONA'

A SEA MONITORING SYSTEM CONSISTING OF AN AUTONOMOUS PROFILER BUOY, DATA-LOGGER AND SOFTWARE BASED DATA MANAGEMENT SYSTEM. THIS SYSTEM PROVIDES A COMPREHENSIVE PRODUCT THAT IS BOTH COST-EFFECTIVE AND TIME-EFFICIENT.

To provide a tool for commercial and research purposes to record on-going changes in the marine environment, **Profiler Buoy 'Mona'** is designed to be an end to end solution. Flydog's profiler buoy is equipped with sensors to measure parameters specified by the customer (temperature, salinity, microbiology, etc.). The sensors are lowered to the bottom of the sea from an on-board winch making measurements on the way.

> *Current methods for collecting data from marine environment are expensive. The cost for merely running a ship to carry out a study in one location makes up 80% of the overall monitoring budget. The platform may be anchored in one location for long periods of time – this eliminates the need for constant vessel traffic, thus reducing the costs significantly.*

The collected data is sent to the server for further processing. Multiple data transfer protocols are supported (GPRS, UMTS, Iridium). The waterproof cargo bay can carry different measuring, surveillance and data equipment.

Mona has two-ways communication making it controllable in real time. It is possible to change the profiling depths and times over the whenever needed. It also possible to make manual profiles allowing quick reacting times. It is straightforward to set up alerts to different parameters. For example, when the GPS position changes, then the system sends out SMS's and e-mail alerts.

The profiler buoy is equipped with marine grade solar panels. It has built-in solar panel charger makes it possible to add solar panels to the system and have it working off the grid. This allows it to operate the buoy autonomously during the whole season with having to go to the sea to replace the batteries.

Flydog's controllers works with any sensor using serial interface. It is possible to add a web-cam and weather-station. With built-in GPS makes sure that the location of the devices is always known and tracked.

AT FLYDOG, OUR BUOYS CAN BE CUSTOMIZED IN SHAPE, DESIGN, SIZE, FUNCTIONALITY AND WEIGHT REQUIREMENTS. E.G. IN AUTUMN 2014, FLYDOG WILL DELIVER AND DEPLOY A BOTTOM ANCHORED MONITORING SYSTEM IN ESTONIA.

Our hardware is powered by intelligent software developed in house by us. The data delivery is powered by **SensorNest**. It enables the buoys to be controlled and managed with the app or web-based interface over the internet which eliminates the need for a dedicate computer or installation. It also allows backups of your critical data and can acts as delivery agent for your data if needed.

Starting at only €74,995 including hardware controller & data-logger.

The sensory equipment is not included in the price, which can be ordered via Flydog. We will ensure full sensor compatibility with our data logger which has been engineered to work with multi vendor sensors and telemetry. We also provide installation facilities for sensors.

TECHNICAL SPECIFICATIONS

- **Profiling Depth:** *200 m*
- **Profile Speed:** *0.05-0.2 cm/s*
- **Length:** *4 m* **Height Above Water:** *2 m*
- **Diameter:** *1,2 m* **Weight:** *450 kg*
- **Batteries:** *LIFePO4 cells (12 V, 20 Ah) charged by 3x24W marine grade solar panels.*
- **Spare Batteries:** *Non-rechargeable alkaline battery packs (12 V, 2x500 Ah)*
- **Comms:** *GPRS, UTMS, Iridium* **GPS:** *Yes*
- **Construction:** *Float from polyurethane foam covered with hard polyurethane coating, with autonomous lantern and passive radar reflector.*
- **Hardware Controller & Data-Logger:** *Integrated*
- **Software:** *Web-based user interface for controlling the buoy in real-time, no software installation needed.*
- **Integration:** *It can be equipped with various multi-parameter CTD's. (YSI, Sea-Bird, Idronaut, etc.)*
- **Customization:** *Can be altered for specific needs.*
- **Cost:** *Starting at* ***€74,995****. Available for sale.*

FLYDOG HARDWARE FAMILY
DESIGNED TO PERFORM, BUILT TO LAST
AVAILABLE NOW.

01. DAMPER ROD

The waves make the buoy rock up and down causing constant stress on the cable. The damper takes the stress off the cable.

03. CABLE GUIDE

Guides the cable on the drum during winding resulting in an even layup and no tangling.

05. BUOY DRUM

It can hold up to 200 meters of cable while keeping it completely tangle-free. We can use different cable types depending upon the customer requirements for the project.

07. STAINLESS STEEL BUMPER

Protects the buoy from getting hit by the ship during deployments. It is comfortable to stand on it when needed to service the buoy.

09. CARGO BAY & STEEL FRAME

The custom designed frame of the buoy makes the system rigid and long lasting. The design allows room for the buoy to have a waterproof compartment to add any additional equipment.

13. COUNTERWEIGHTS

It can be added and taken off depending of the weight of the instrumentation to fine tune the buoyancy of the buoy.

02. LANTREN

Making the buoy visible at night from two nautical miles. It has built-in solar panels making it a standalone unit.

04. PASSIVE RADAR REFLECTOR

Integrated to the top part of the buoy. Making the buoy visible from 2 nautical miles.

06. SOLAR PANELS

3x24W marine grade solar panels are responsible for making the buoy autonomous during the whole season with having to go to the sea to replace the batteries.

08. CONTROLLER & DATA-LOGGER

The brains of the buoy. Taking care of the winching, logging readings and sending them to the cloud using sophisticated software programmed in house by us.

10. POLYURETHANE FLOAT

Polyurethane foam is sprayed on the steel frame making the float rugged and monolithic. The foam is covered with polyurethane plastic making it extremely durable and resistant to mechanical impacts.

12. ALKALINE BATTERIES 2 X 500 AH

During intensive profiling or days with low sunlight the system switches from the rechargeable batteries to the spare batteries.

PROFILER BUOY 'MONA'

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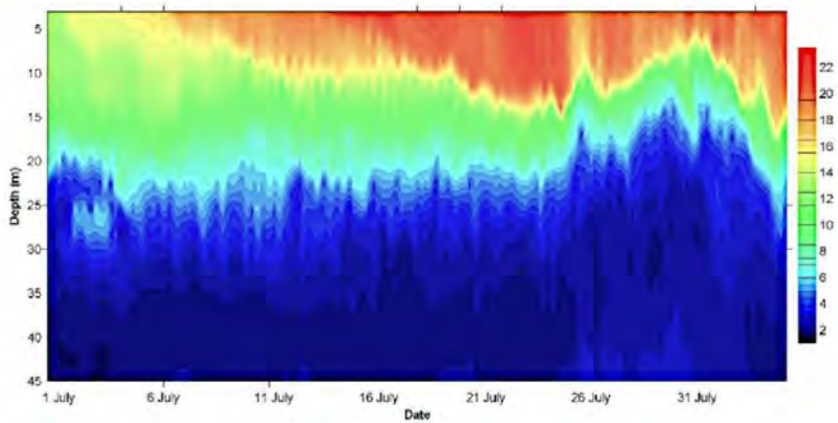
With an integrated profiler module and probe, as our autonomous in-situ sea monitoring system profiler buoy Mona, transmits real-time data of the sea profile. The plot below highlights the consistent and continuous monitoring at different depths can present extremely useful knowledge. With the choice of sensors available to measure the parameters required by the customer (temperature, salinity, microbiology, etc.), our hardware allows customers to focus on the actual goal of their projects without having to worry about technicalities, installation or servicing matters.

The unprecedented level of real-time data monitoring enabled by our products, have allowed our customers to be more critical, thorough and have access to consistently reliable source of information at their finger tips.

VERTICAL DISTRIBUTION OF TEMPERATURE IN THE GULF OF FINLAND (BALTIC SEA)



GEO: 59°41.05 N, 24°37.45 E | DEPTH RANGE: 3M – 45M | DATE: JUN 30 – AUG 4

SensorNest is our intelligent data processing, analysis system and cloud service. It acts as a reliable backbone to the infrastructure of data delivery and communications, being the central dashboard to access devices from any computer or mobile device. At Flydog, with *servicing options* in place for our customers, we are always available for when needed ensuring that their investments will be safe for years to come.

Flydog embodies a team of professionals in engineering, industrial design and manufacturing. Overall, the uniqueness in our innovation lies in vertical integration of our hardware, software, services and processes to keep tight control of our curated and efficient solutions.

We always appreciate all forms of feedback to continue to serve our customers the best way possible. We look forward to hearing from you. Thank you for taking time to learn about **Flydog's Profiler Buoy 'Mona'**.

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16. OSIL GRAVITY CORER

OSIL
Environmental Instruments and Systems

GRAVITY CORER

COST-EFFECTIVE AND ROBUST SEDIMENT SAMPLER

OSIL's Gravity Corer is a simple and reliable instrument for collecting sediment cores from coastal and deepwater sites for sample analysis. The corer uses the pull of gravity to penetrate the seabed with it's carbon steel core barrel, which can collect samples of up to six metres in length.

OSIL's Gravity Corer is easy to use and very cost-effective. The entire corer is made from carbon steel and is fitted with stabilising fins to ensure that the corer penetrates the seabed in a straight line. The standard lead weights supplied with the corer comprise of four layers, each weighing 62 kg. Each layer comes in two segments and the total added weight is 248 kg.

A replaceable core liner is housed within the carbon steel barrel to ensure that it is simple to remove the collected sample. The barrel is fitted with a sharpened replaceable carbon steel core cutter to ensure minimal disturbance. Sample loss on retrieval is minimised by a core catcher fitted inside the end of the barrel.

The robust design of OSIL's Gravity Corer's can be easily customised for a wide variety of application's. The Gravity Corer's simplistic design means it calls for little maintenance and can be galvanised or painted to the customers requirements.

Features:

- Collects core samples of up to six meters in length
- Totally customisable design including weights and core length
- Easily replaceable carbon steel core catcher and core cutter
- Easy to use and reliable

FOR FURTHER INFORMATION PLEASE CONTACT:

OSIL, Culkin House, C7/8 Endeavour Business Park, Penner Road, Havant, Hampshire PO9 1QN

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OSIL

Environmental Instruments and Systems

GRAVITY CORER

Gravity Corer Specifications

- Weight:
  400kg (3m), 450kg (6m) - 248 kg adjustable
- Core Length:
  3m or 6m
- Core Diameter:
  66.5mm
- Lower & Recovery Rate:
  Winch speed
- Max. Operating Depth:
  Full Ocean (6000m)
- Total Wire Load:
  560kg (3m), 630kg (6m)
- Material:
  Carbon Steel (other options available)

APPLICATIONS

- Deep sea sediments
- Biological studies
- Geochemical analysis
- Environmental monitoring
- Interstitial waters
- Environmental Impact Assessment

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17. OSIL VIBROCORERS

OSIL
Environmental Instruments and Systems

High Power Vibrocorer

AN EASY TO TRANSPORT, EASY TO USE CORING SYSTEM

OSIL's vibrocorers have been designed as easy to use, easy to transport modular systems capable of collecting up to 12m cores in 600m water depth (max).

- For use in dense/compact sediments in up to 600m water depth.
- Easy to assemble modular system offering cores of 3m, 6m, 9m or 12m system.
- Assemble dockside or on vessel, over stern deployment.
- High power vibrator motors engaged once unit is on the sea floor to drive the core barrel into the bed.
- Cutting shoe and core catcher specifically designed to minimise sample disturbance.
- Unit designed for easy horizontal recovery to the vessel, and easy recovery of the core on deck.
- System can be can be quickly and easily deployed, delivering a well defined core.
- Epoxy coated steel construction.
- PVC Core barrel liner.
- 96mm diameter sample.

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OSIL
Environmental Instruments and Systems

High Power Vibrocorer

AN EASY TO TRANSPORT, EASY TO USE CORING SYSTEM

Operational Dimensions:

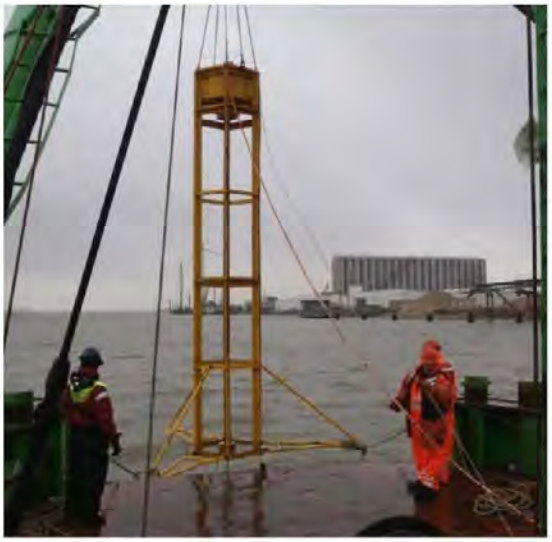
Height	3m unit	3.75m
	6m unit	6.75m
	9m unit	9.75m
	12m unit	12.75m
Width Tower	***Standard Vibrocorer*** 1.2m	
	Lightweight Vibrocorer 1.0m	
Width Base Supports		5.0m
Weight	***Standard Vibrocorer***	
	3m	1450kg
	6m	1800kg
	9m	2150kg
	12m	2500kg
	Lightweight Vibrocorer	
	3m	900kg
	6m	1250kg
	9m	1600kg
	12m	1950kg

Power Supply:
415V 3 phase supply, 2.7kW motors, 43A Start up current, 8A Operational current.
or
380V, 3 phase supply, 1.8kW motors, 28A Start up current, 4A Operational current

Vibration Force:

Standard Vibrocorer	44kN
Lightweight Vibrocorer	30kN

Optional Sensors:
Inclinometer
Penetration Rate
Penetration Distance
Additional sensors available on request



Features:

Frame
- Base Plate
- Support Legs
- Vibrocorer Frame (3m sections)
- Vibrocorer Head fitted with high power vibrator motors

Coring
- Corer Barrel 114mm OD
- Core Cutter
- Core Catcher
- Liner

Surface
- Armoured Deck supply cable (415V)
- Direct On Line Starter Box
- Armoured High Power Vibrocorer cable (non load bearing)

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