GREEN VOLT

Technical Appendix 7.1

Export Cable Route EIA Data Acquisition Survey Report

Offshore EIA Report: Volume 2

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GREEN VOLT EXPORT ROUTE
EIA DATA ACQUISITION SURVEY REPORT

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April 2022

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Services Warranty

Hydrofix Limited ("Hydrofix") have prepared this report with all reasonable skill and care, as would be expected of an experienced reputable company, within the terms and conditions of the contract between Hydrofix and the Client. The findings of this report are based on the interpretation of data which is a matter of opinion and upon which professionals may differ. Any reliance upon the Report is subject to the Contract terms and conditions.

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1 INTRODUCTION

This report presents an overview of the mobilisation, operation and results of the hydrographic survey equipment installed on the survey vessel Green Quest.

In March 2022, Hydrofix Limited (Hydrofix) were commissioned by Green Marine to complete a Multi-Beam Echo Sounding (MBES) survey and sediment grab positioning over the proposed export cable route for the Green Volt floating offshore windfarm project. Hydrofix were contracted to supply a surveyor and equipment to complete the MBES survey and vessel positioning for the grab samples / drop camera survey onboard the survey vessel Green Marine.

The survey was completed across two cable corridor routes situated close to Peterhead, extending from the 5m contour out to the 12nm limit. The inshore limit was subsequently updated to be 1° 40' E following agreement with the local fisheries. The vessel was mobilised on the 30th March and MBES data was collected on 31st March. The vessel waited on weather on 1st April before grab samples and drop camera operations were conducted on 2nd April. The vessel demobilised on 3rd April.

2 VESSEL

Hydrofix mobilised a MCA category 2 coded workboat for this campaign. "MV Green Quest" operated from Peterhead Harbour, is a 18m CTV, with a 60mile operating limit. Selected and chartered by Green Marine, the vessel offers a fast transit speed, of over 22 knots, and the shallow draft provided an ideal platform for survey at this site. The vessel operated on a nominal 12-hour quayside to quayside working basis from her home port. As well as hydrographic surveys the Green Quest also conducted the sediment grabs.

Vessel Particulars	
Name	Green Quest
Length	18m
Beam	6.4m
Draft	1.5m
Propulsion	Twin 1300kw Caterpillar diesel with fixed pitch propellers
MCA Category	II (60 miles from safe haven)

Table 1 – Vessel particulars

Figure 1 – Green Quest

A vessel specification is provided in Appendix A.

3 SURVEY EQUIPMENT

3.1 Equipment List

The following equipment was mobilised aboard the Green Quest:

- Hydrofix NaviSTAK compact modular survey system comprising:
- Positioning – "Applanix" WaveMaster GPS with real-time SBAS corrections and PPK post processing;
- Positioning – Trimble SPS855 RTK GNSS with real-time SBAS corrections;
- Multibeam Echo Sounder – "Norbit" 0.9°x0.9° @ 400kHz (0.5°x0.5° @ 700kHz), 512 beam system, with integrated INS and sound velocity correction;
- SVS – AML Mini SVS;
- Inertial Navigation System (INS) (Motion Reference) – "Applanix" WaveMaster INS;
- Navigational Software – QPS Qinsy;
- Sound Velocity – Valeport Swift SVP.

Technical specifications for the key equipment are presented in Appendix A

3.2 Equipment Locations

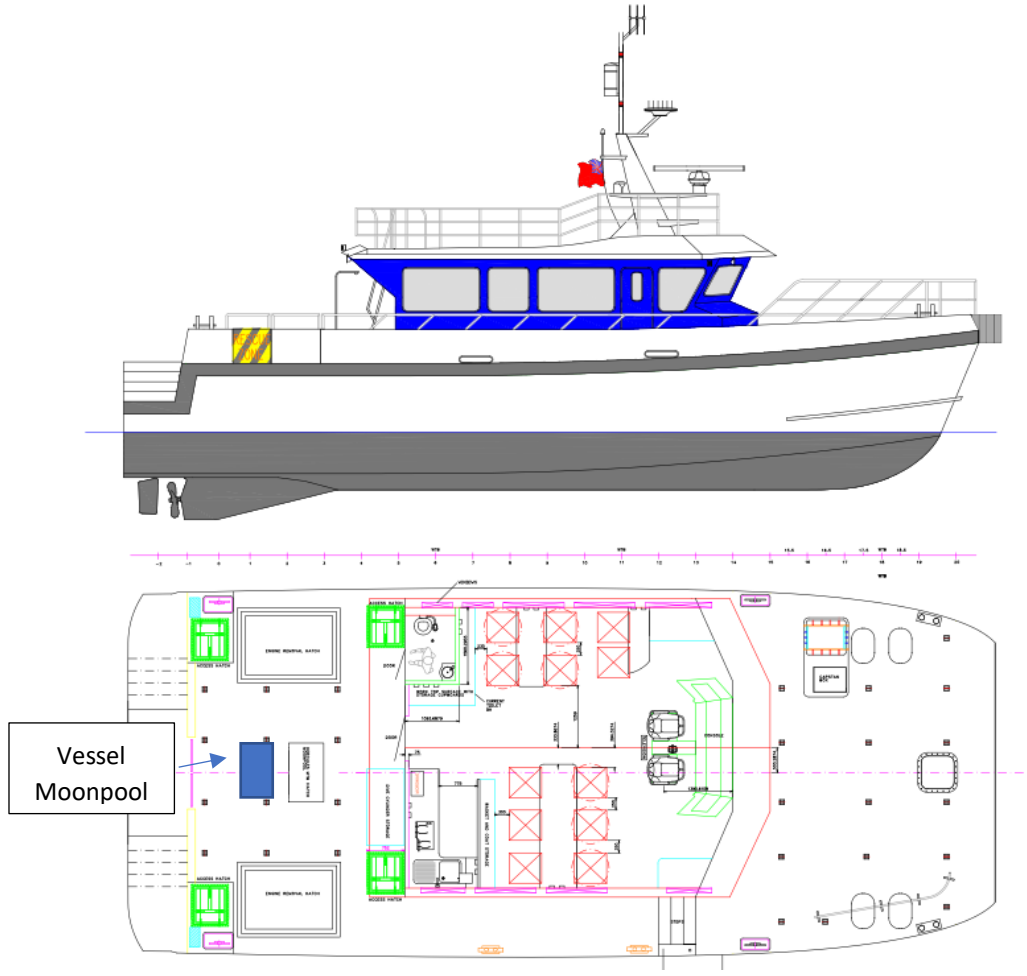


Figure 2 – Position of equipment on Survey Vessel

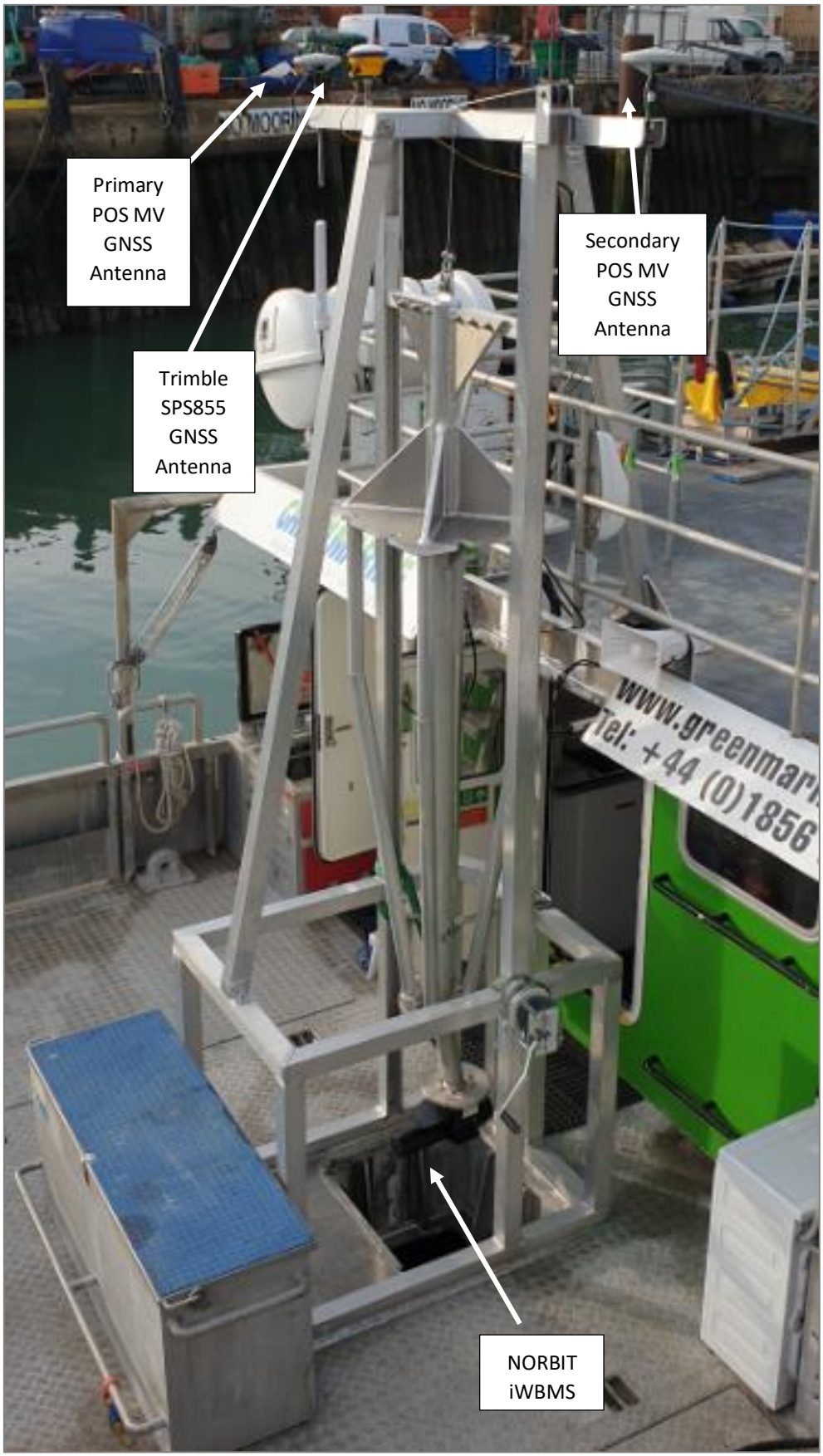


Figure 3 - Position of GNSS antennas and iWBMS

4 MOBILISATION

4.1 OFFSETS

4.1.1 Qinsy

NavAQ	X (Starboard)	Y (Forward)	Z (Up)
POS MV	0.000	0.000	0.000
Norbit iWBMS	0.000	0.000	0.000
Trimble SPS855 (Position Check)	-0.600	0.122	7.289

Table 2 – Qinsy offsets

4.1.2 Norbit iWBMS

iWBMS (POS MV)	+Fwd	+Stbd	+Down
WBMS Ref. Point to IMU Ref. Point	0.248	0.000	0.079
Measure Point to Antenna Bottom	-0.100	-0.990	-7.080
Primary to Secondary Antenna Baseline Vector	-0.058	1.955	-0.069
IMU Mounting Angles	90.00°	0.00°	-90.00°

Table 3 – iWBMS POS MV offsets

4.2 SURVEY CONTROL

4.2.1 Project Geodesy

The following geodetic projection parameters were used:

Geodetic Datum Parameters	
Geodetic Datum	WGS84
Spheroid	GRS 1980
Semi-Major Axis (m)	6378137.000
Semi-Minor Axis (m)	6356752.314
Inv. Flattening	1/298.25722210103
Eccentricity^2	0.0066943800229
Projection Parameters	
Projection Name	Universal Transverse Mercator Zone 30 North
Units	Metres
Longitude of Central Meridian	003° 00.0000’ W
Latitude of Origin	000° 00.0000’ N
False Easting	500,000.00
False Northing	0.00

Scale Factor at Central Meridian	0.99960
Vertical Datum	
Vertical Reference	Vertical Reference
Units	Metres

Table 4 – Geodetic reference system

4.2.2 UKHO VORF

For this project, the UKHO Vertical Offshore Reference Frame (VORF) model was used both online in the acquisition software and in the processing software, to apply a Datum separation to the accurate heights from the GNSS and reduce levels to Lowest Astronomical tide (LAT). The separation between the Ellipsoidal height and LAT at Western end of the data collected is 46.79 metres and on the Eastern end of the collected data is 46.59 metres.

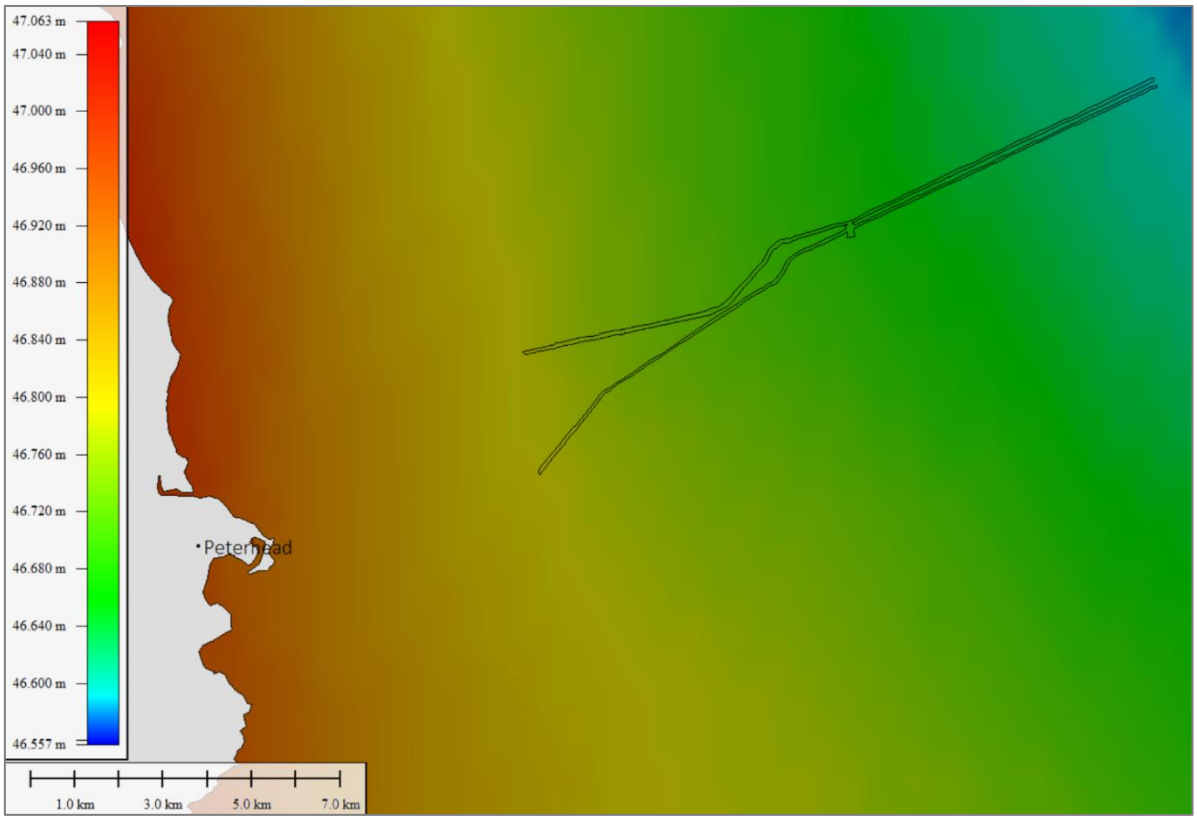


Figure 4 – UKHO VORF model for survey site (Black line represents collected data extents)

4.2.3 Time Reference

All data received by the Qinsy software is be referenced to Coordinated Universal Time (UTC+0). A timing pulse and ZDA message from the primary GNSS is used to synchronise all sensors to a common time signal.

4.2.4 Sign Convention

The convention for vessel reference frame follows the standard form as described in Table 5

Convention	Direction
Vessel Heading	From Vessel Forward: Positive Clockwise
Pitch	Bow UP = Positive
Roll	Port UP = Positive

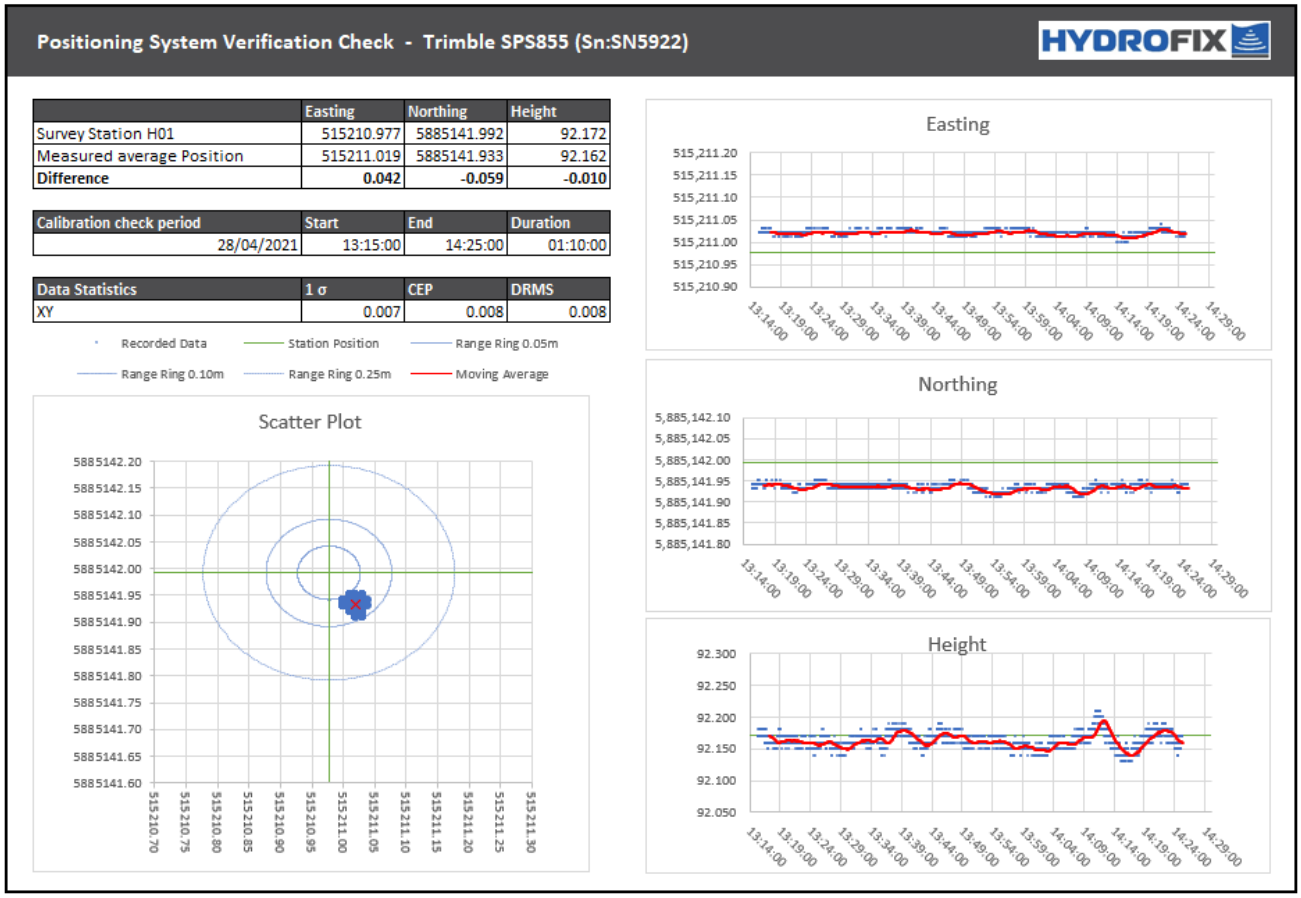
Table 5 – Sign Convent

4.3 ALONGSIDE VERIFICATIONS AND CALIBRATIONS

4.3.1 GNSS Verifications

Introduction

Primary GNSS system for verifications was the Trimble SPS855, which was verified against a known benchmark. This system was then used to verify the POS MV GNSS installed aboard the vessel.



	Easting	Northing	Height
Survey Station H01	515210.977	5885141.992	92.172
Measured average Position	515211.019	5885141.933	92.162
Difference	0.042	-0.059	-0.010

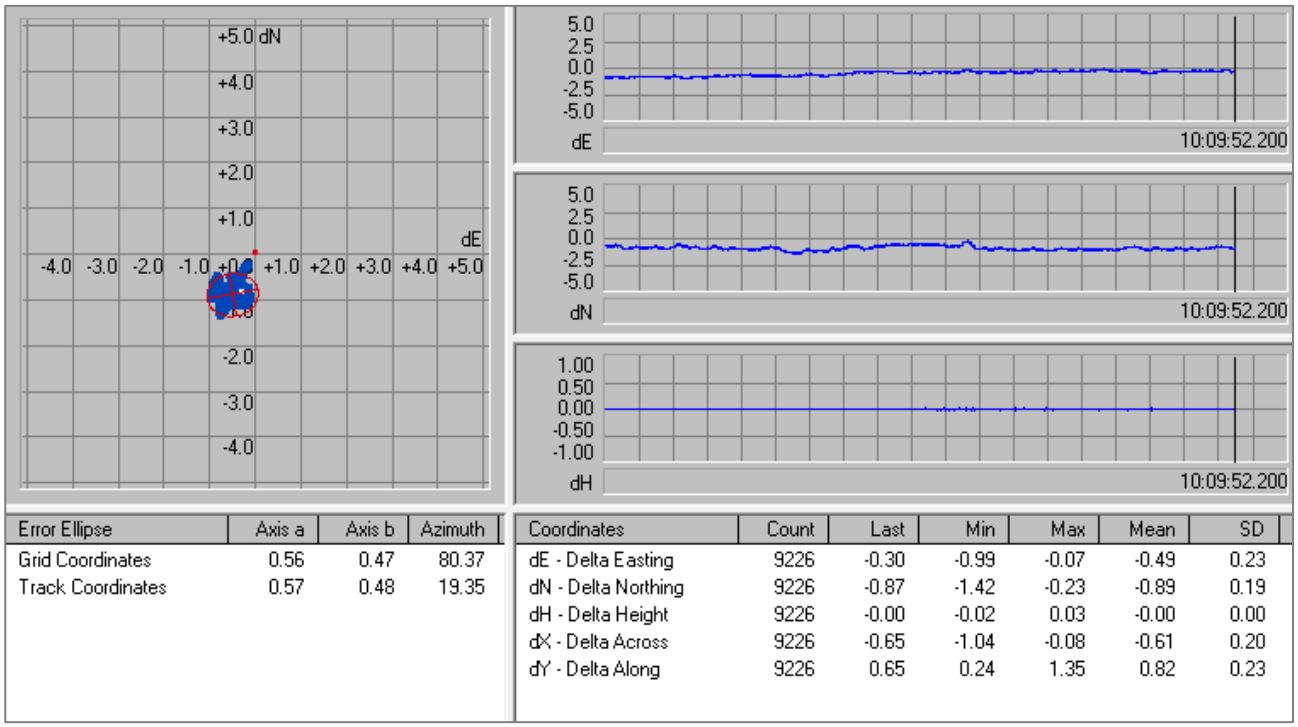
Calibration check period	Start	End	Duration
28/04/2021	13:15:00	14:25:00	01:10:00

Data Statistics	1 σ	CEP	DRMS
XY	0.007	0.008	0.008

Figure 5 – Trimble G855 GNSS verification Scatterplot

POS MV

With both systems utilising SBAS corrections, a dynamic verification was carried out between the two GNSS systems and the results was within anticipated limits.



Error Ellipse	Axis a	Axis b	Azimuth
Grid Coordinates	0.56	0.47	80.37
Track Coordinates	0.57	0.48	19.35

Coordinates	Count	Last	Min	Max	Mean	SD
dE - Delta Easting	9226	-0.30	-0.99	-0.07	-0.49	0.23
dN - Delta Northing	9226	-0.87	-1.42	-0.23	-0.89	0.19
dH - Delta Height	9226	-0.00	-0.02	0.03	-0.00	0.00
dX - Delta Across	9226	-0.65	-1.04	-0.08	-0.61	0.20
dY - Delta Along	9226	0.65	0.24	1.35	0.82	0.23

Figure 6 – Dynamic positional verification - POS MV vs Trimble SPS855 at CoG (Utilising SBAS)

4.4 Dynamic Verifications and Calibrations

4.4.1 GNSS Azimuth Measurement Subsystem (GAMS) Calibration

To confirm the measured baseline between the Applanix POS MV WaveMaster IMU and GNSS antennae, a GNSS Azimuth Measurement Subsystem (GAMS) calibration was completed in accordance with the manufacturer's procedure.

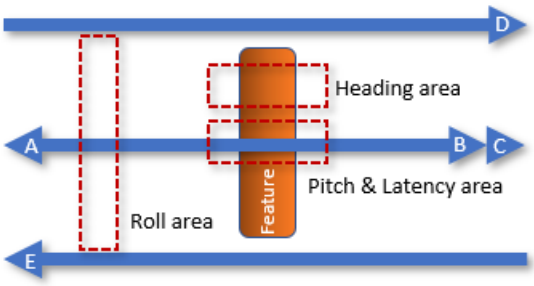
The GAMS calibration was carried out on the 30/03/2022 outside Peterhead harbour, and the results were:

Measurement	Value
X (Fore/Aft)	-0.058
Y (Port/Stb)	1.955
Z (Vertical)	-0.069

Table 6 – GAMS calibration results

4.4.2 Multibeam Echo Sounder Calibration

During the mobilisation, the echo sounder underwent an industry standard Patch over a seabed feature on the southern route on the 02/04/2022. This involved running the following set of lines over an object with a distinct relief:



Roll	A & B run in opposite direction with lines centred on multibeam
Pitch	A & B run in opposite direction with lines centred on multibeam
Heading	A & D (B & E = Backup) run in opposite direction with overlap centred on object
Latency	B & C with Cat double vessel speed

Figure 7 – Multibeam calibration line set

The multibeam echo sounder was mounted in a moonpool in the centre of the vessel behind the wheelhouse. The iWBMS has an integrated Applanix POS MV WaveMaster within the transducer head, which gives it robust repeatability and data quality due to tight coupling with motion sensor and RTK GPS. The calibration results are presented in the table below.

Angle	Value
Roll	-0.03
Pitch	-0.053
Heading	0.674

Table 7 – Multibeam calibration results

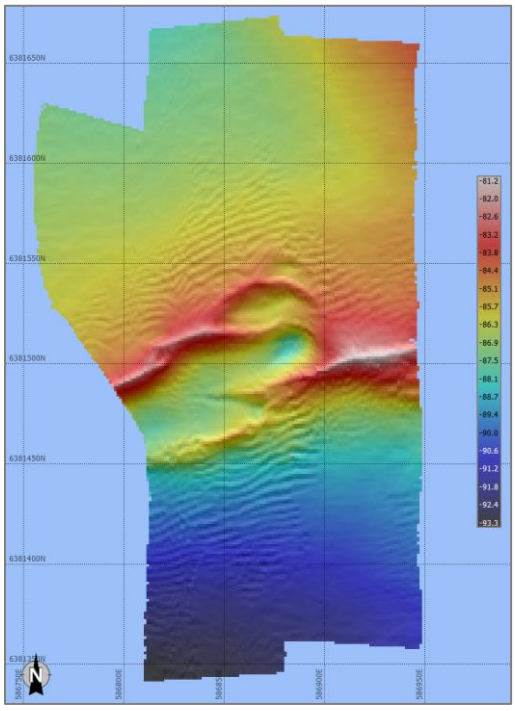


Figure 8 – Multibeam calibration data with results applied

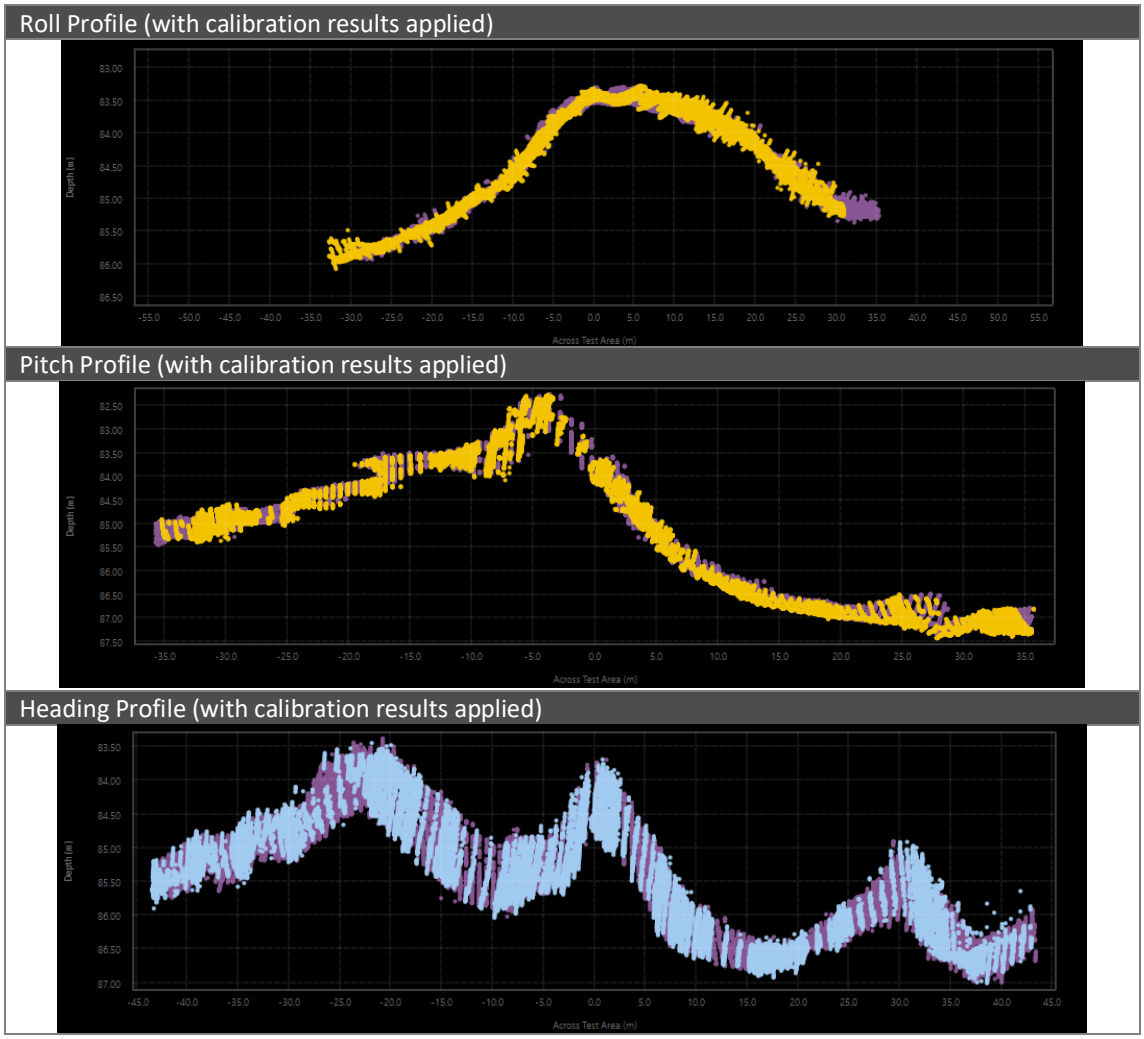


Figure 9 – Post MBES calibration profiles

5 OPERATIONAL SUMMARY

5.1 Summary of Events

Date	Activity
29 March 2022	Project preparation and travel to site
30 March 2022	Travel to site & vessel mobilisation
31 March 2022	MBES survey operations
1 April 2022	Standby on Weather
2 April 2022	Grab sampling / camera drop operations
3 April 2022	Vessel demobilisation & travel to office

Table 8 – Summary of Operations

5.2 Operational Limit

No MBES data acquisition was conducted West of latitude 1.40 ^{0} W due to fishing activity at the clients request. This also reduced the number of sediment grabs conducted in the area. Five camera drops were conducted over the site before the light failed preventing further camera drops.

The location of the two routes is shown in the Figure 10 and coverage in Figure 11.

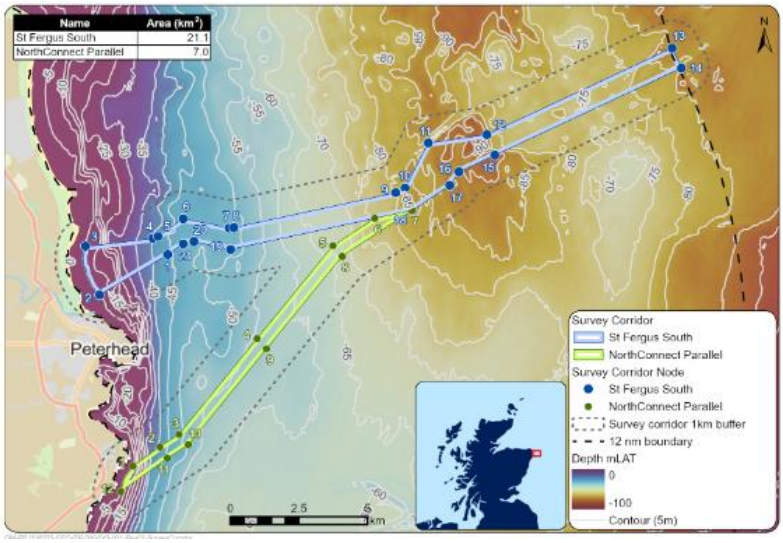


Figure 10 – Northern and Southern routes

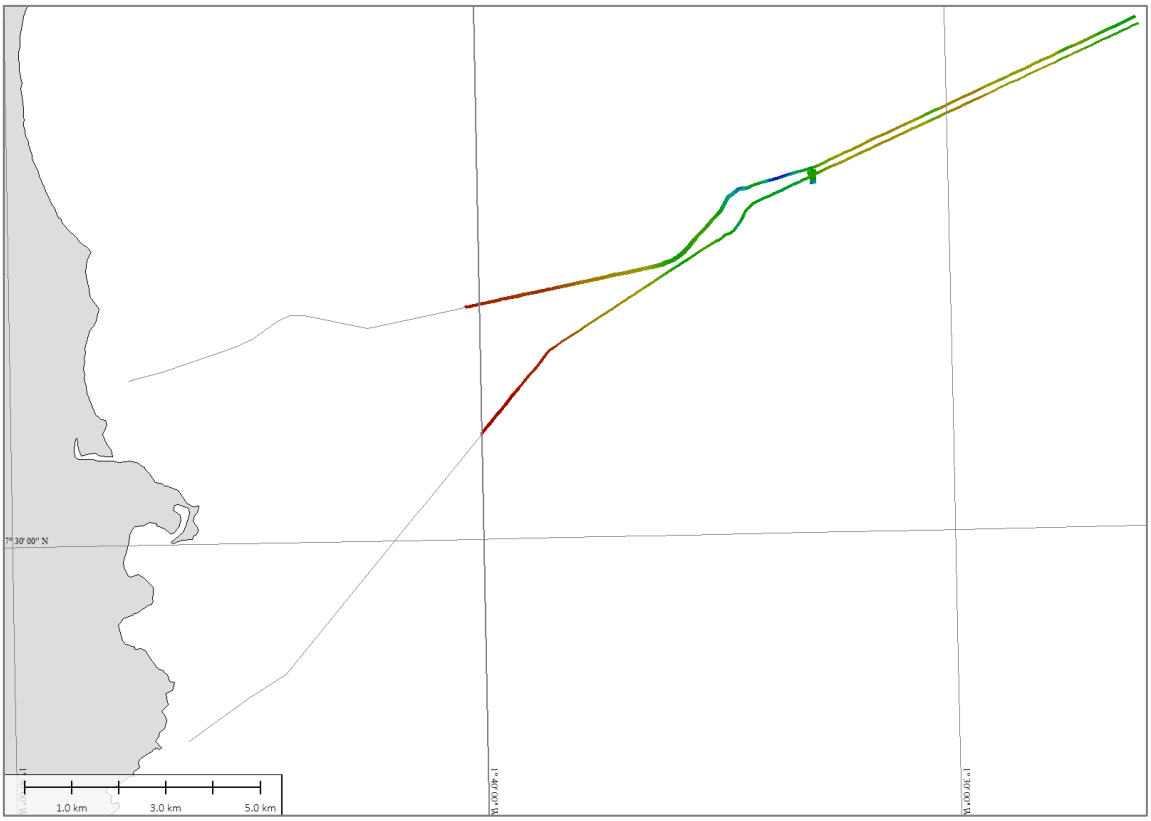


Figure 11 – MBES coverage vs survey route (Grey line)

6 DATA PROCESSING

The POS MV data was recorded during the survey and post processed with POSPac, to provide centimetric positional accuracy, far exceeding expected specifications of the survey.

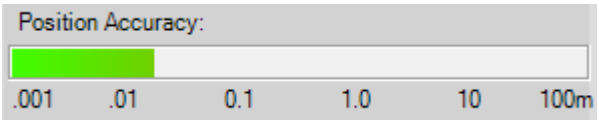


Figure 12 - Processed positional accuracy (m)

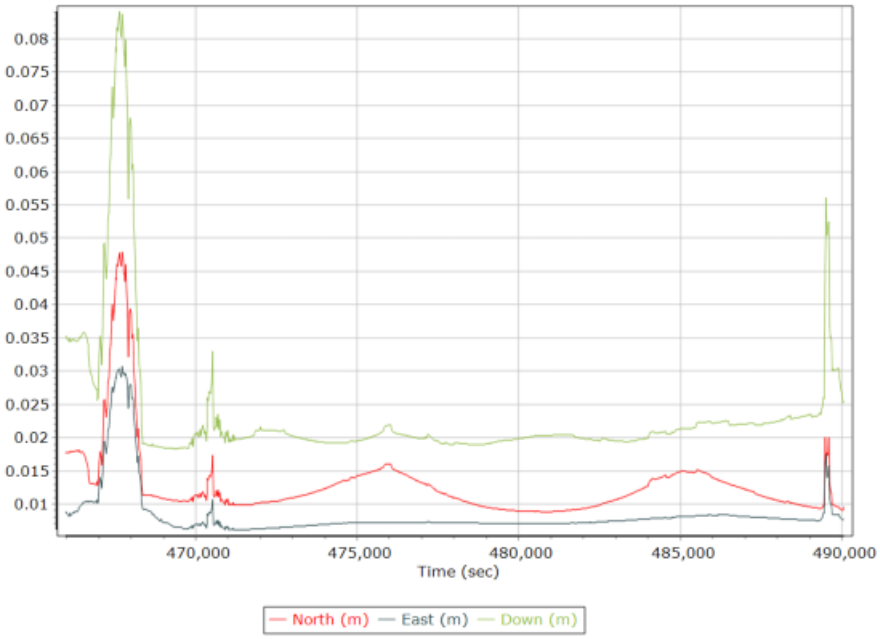


Figure 13 – PPK North, East & Down position error RMS (m)

The PPK position data were applied to the bathymetric data in order to provide centimetric positional accuracy. Reduction of the seabed soundings to Lowest Astronomical Tides (LAT) was completed using the UK Hydrographic Office (UKHO) VORF model to adjust from ellipsoidal height to LAT.

A final multibeam bathymetry dataset was produced using the following workflow:

- Apply calibration and SBET to Qinsy databases and export FAU files;
- Create a new processing project in BeamworX AutoClean software and import the FAU files which contain all multibeam and peripheral data including disabled online soundings;
- Inspect and edit motion data, heading, latency and sound velocity;
- Inspect data visually and apply a spline filter (medium strength) to remove large data spikes;
- Check remaining data visually for horizontal and vertical positioning quality, ensuring there is good correlation between features on overlapping lines of data;
- Clean the remaining data for water column noise and depth spikes manually;
- Export data to a gridded format, with data points binned at 1.5m & 2.0m intervals and generate final deliverables.

The choice of 2.0m and 1.5m grid outputs were selected to provide a dataset with minimal data gaps caused by sea conditions and the aim of achieving sensible coverage (2.0m grid) and an improved definition dataset (1.5m grid) although the latter experience some data gaps and artefacts of the sea conditions. No interpolation has been applied to the datasets.

The statistics of the 1.5m grid dataset are provided in Figure 14 and Figure 15

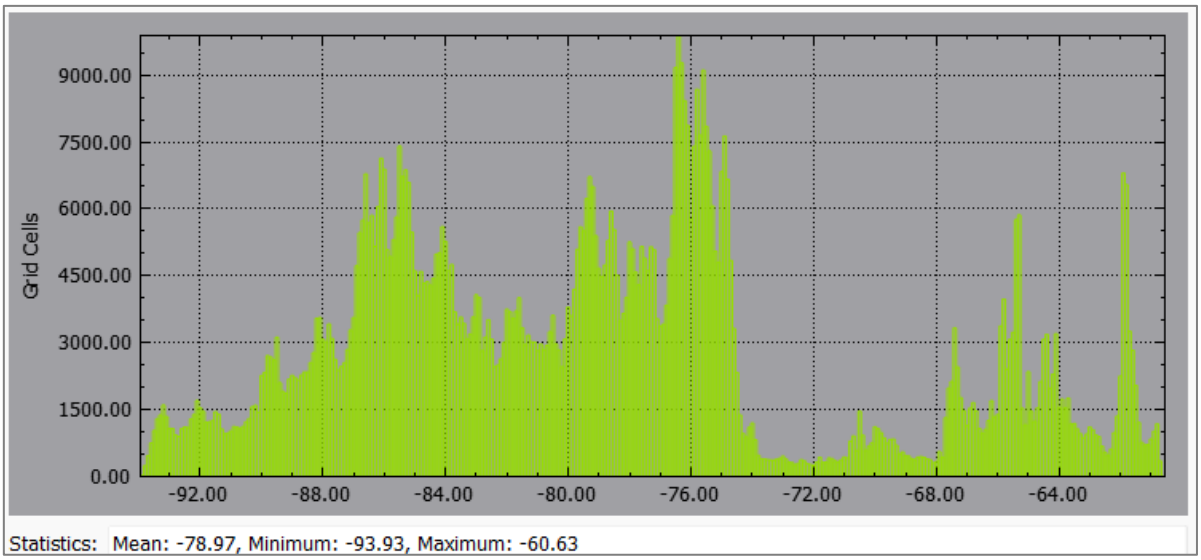


Figure 14 – Depth distribution (1.5m Grid cells)

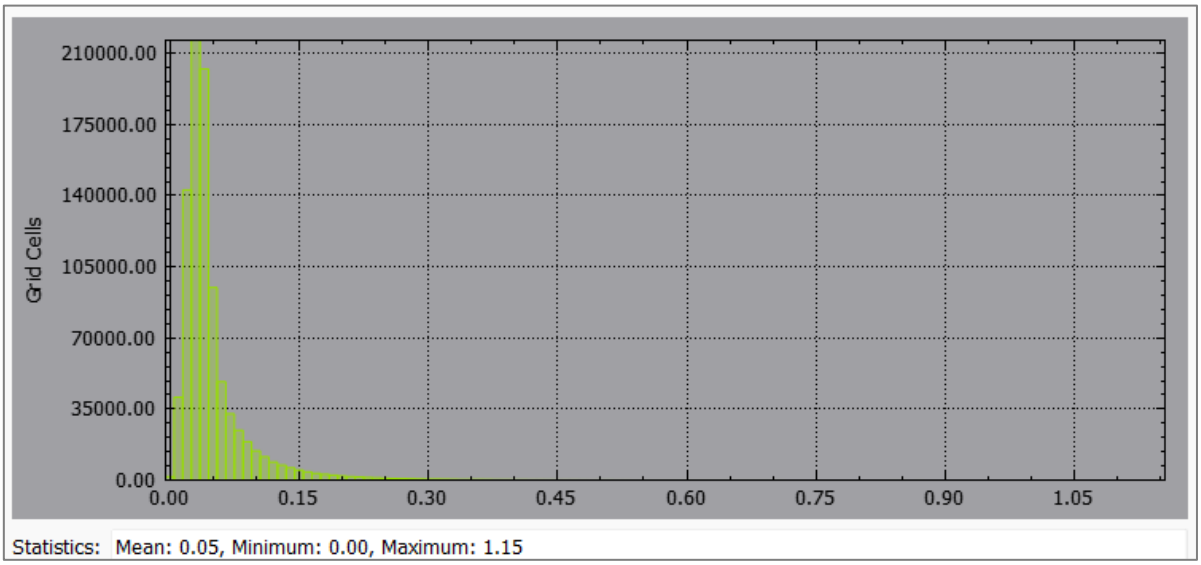


Figure 15 – 95% confidence distribution (1.5m Grid cells)

7 RESULTS

7.1 MBES

7.1.1 Northern route

Water depths range from 62.6m to 93.6m LAT.

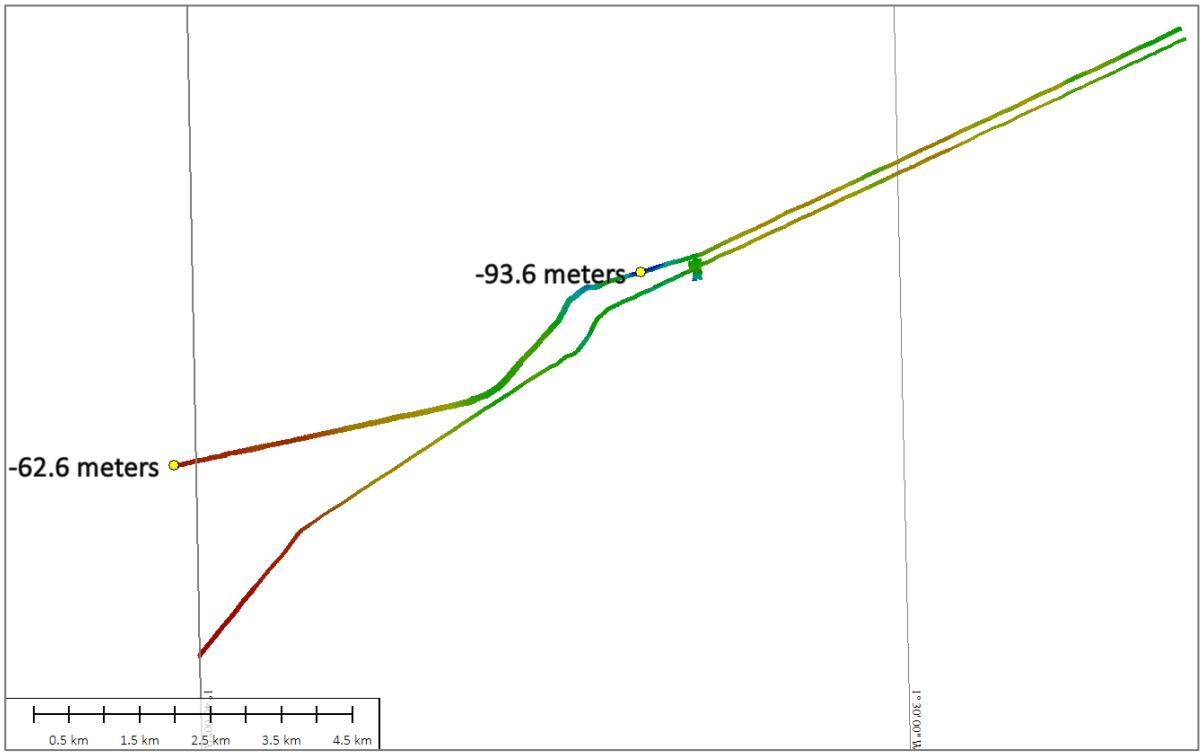


Figure 16 – Deepest and shallowest locations on the northern route (Collected data)

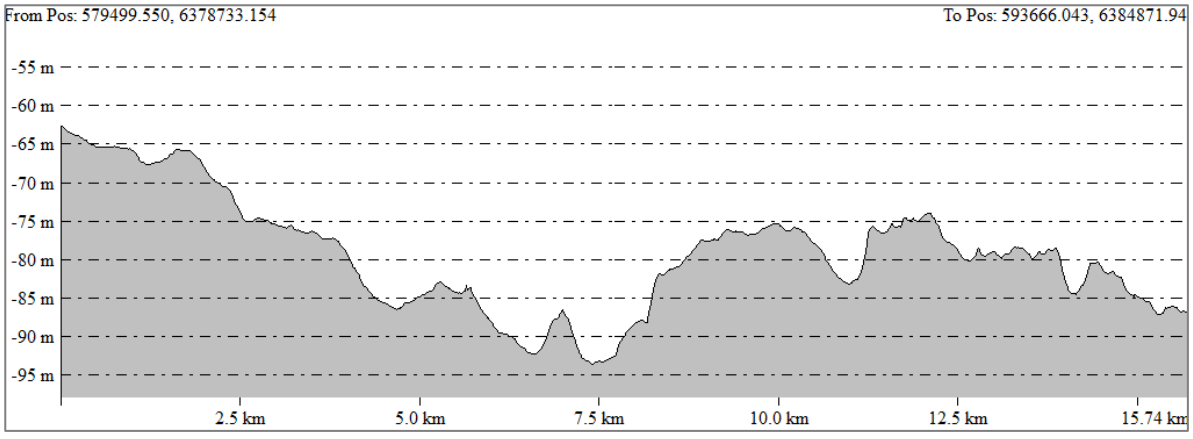


Figure 17 – Profile along northern route centre line

7.1.2 Southern route

Water depths range from 60.7m to 90.2m LAT.

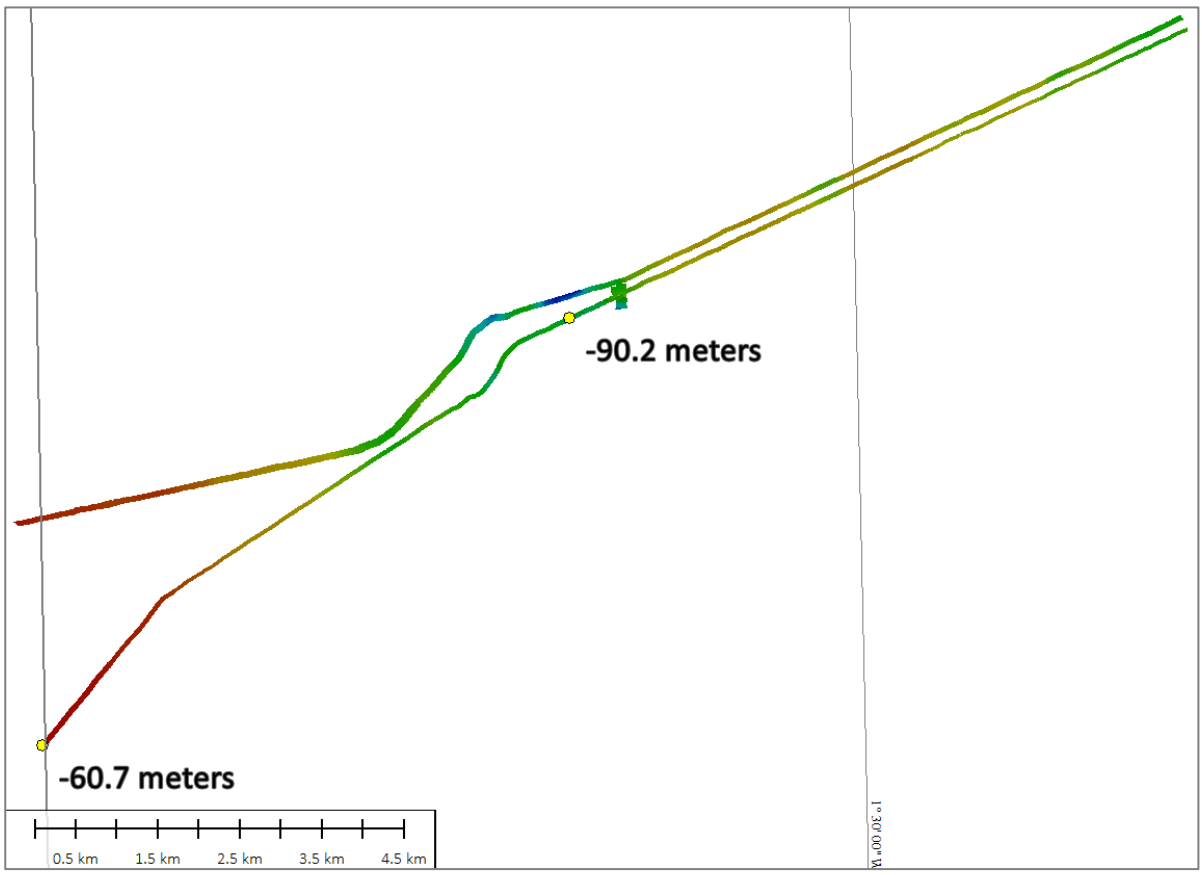


Figure 18 – Deepest and shallowest locations on the southern route (Collected data)

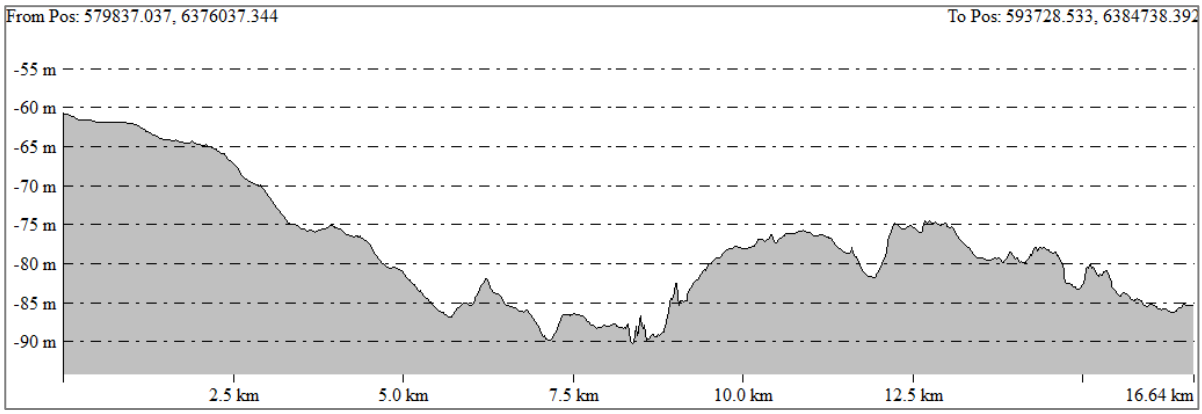


Figure 19 – Profile along Southern route centre line

7.2 Data Deliverables

Multibeam datasets produced:

- 1.5mBin XYZ
- 2.0mBin XYZ (Primary dataset)

- 1.5mBin GeoTiff
- 2.0mBin GeoTiff (Primary dataset)
- 1.5mBin GeoTiff PDF Document
- 2.0mBin GeoTiff PDF Document (Primary dataset)

7.3 Sediment Grabs and Camera

The sediment grab samples and camera locations are summarised in the table below, out of the 18 proposed grab locations 12 were conducted. Hydrofix was provided the positioning of the grabs but were not involved in the sample collection and analysis.

Date	Sample ID	Grab	Camera	Provided Sample Coordinates		Sample Collection Coordinates		Sample Collection Coordinates WGS84		Difference	
				Easting	Northing	Easting	Northing	Latitude (N)	Longitude (W)	Δ Easting	Δ Northing
N/A	St Fergus South 1			572186.77	6376994.63					**N/A**	**N/A**
N/A	St Fergus South 2			574614.99	6377890.34					**N/A**	**N/A**
N/A	St Fergus South 3			577018.64	6378385.61					**N/A**	**N/A**
02/04/2022	St Fergus South 4	✓		579585.07	6378752.27	579599.1	6378777.3	57 35.6689242	01 40.2089574	14.03	25.03
02/04/2022	St Fergus South 5	✓		582149.46	6379305.62	582155.9	6379296.5	57 32.9212538	01 37.6362982	6.44	-9.12
02/04/2022	St Fergus South 6	✓		584509.03	6380248.02	584519.3	6380212.7	57 33.3887800	01 35.2486242	10.27	-35.32
02/04/2022	St Fergus South 7	✓	✓	586529.40	6381561.34	586519.2	6381541.4	57 34.0819808	01 33.2155714	-10.20	-19.94
02/04/2022	St Fergus South 8	✓	✓	588911.77	6382652.46	588918.3	6382640.3	57 34.6461150	01 30.7858884	6.53	-12.16
02/04/2022	St Fergus South 9A	✓		591287.92	6383764.30	591283.3	6383770.2	57035.2265786	01 28.3884717	-4.62	5.90
02/04/2022	St Fergus South 9B	✓	✓	591287.92	6383764.30	591282.5	6383747.2	57035.2141966	01 28.3897935	-5.42	-17.10
02/04/2022	St Fergus South 10A	✓	✓	593664.08	6384876.14	593660.1	6384886.4	57 35.7987487	01 25.9782699	-3.98	10.26
02/04/2022	St Fergus South 10B	✓		593664.08	6384876.14	593691.2	6384889.2	57 35.7998702	01 25.9469983	27.12	13.06
02/04/2022	St Fergus South 10C	✓		593664.08	6384876.14	593671.2	6384859.2	57 35.7839564	01 25.9677623	7.12	-16.94
N/A	North Connect Parallel 1			573504.90	6369368.35					**N/A**	**N/A**
N/A	North Connect Parallel 2			576202.39	6371577.08					**N/A**	**N/A**
N/A	North Connect Parallel 3			578417.47	6374295.27					**N/A**	**N/A**
02/04/2022	North Connect Parallel 4	✓		580632.55	6377013.47	580639.1	6377015.5	57 31.7085932	01 39.2017933	6.55	2.04
02/04/2022	North Connect Parallel 5	✓		583345.40	6379179.67	583341.1	6379170.8	57.32.8405200	01 36.4510822	-4.30	-8.87

Table 9 – Grab sample and camera locations log

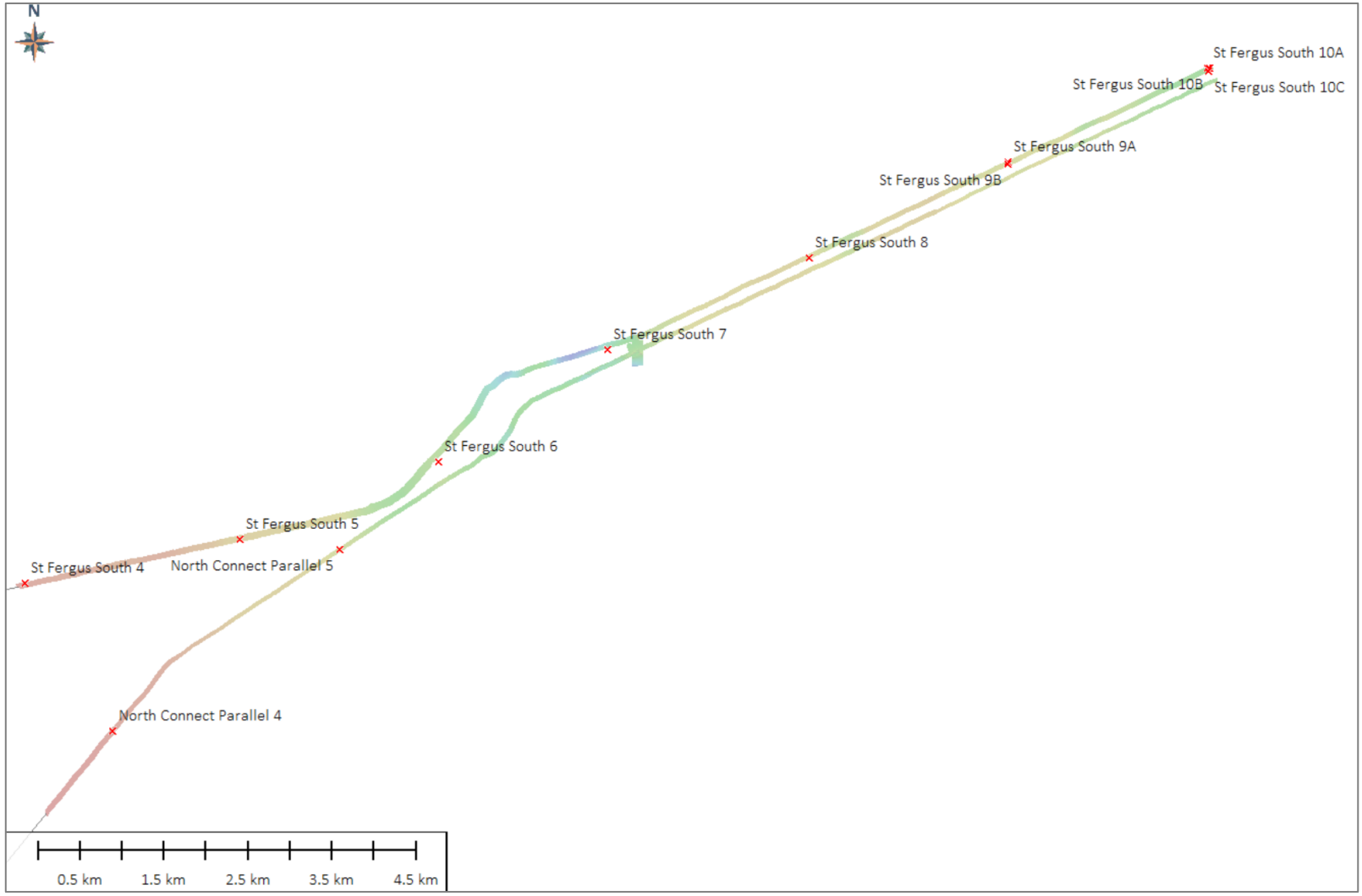


Figure 20 – Collected grab sample locations

APPENDIX A

Vessel & Equipment Specifications

GREEN QUEST

The Green Quest is an 18m survey and crew transfer vessel equipped to carry out nearshore operations.

The Green Quest has carried a number of seabed bathymetric surveys using it's onboard deployment frame and side mounted survey pole. This can be completed using MultiBeam EchoSounder technology or Side Scan Sonar equipment.

In addition to surveys the vessel has can also be hired to carry out offshore personnel and light cargo transfers. The Green Quest has operated on a number of offshore wind farms in this capacity. The vessel has also completed operations acting as a guard vessel on cable operations and an ROV deployment vessel to be conducted. For more information on this hardware and Green Marine's capabilities please see "Services"

Specifications Summary

FLAG	UK Flag
"MCA Coding"	Category 2 Waters
Length O.A	17.21m
Beam O.A	6.45m
Draught (98%)	1.5m
Gross Tonnage	37.22 GT
Speed (max)	27kn
Deck Area	24m^2 forward
Deck Capacity	1.5te / m^2
Person's Onboard	15 Persons (subject to area of operation)

NORBIT
- explore more -

DATASHEET - PS-120006-16

NORBIT - iWBMS TURNKEY MULTIBEAM SONAR SYSTEM

For High Resolution Bathymetry

Introducing the all-new, compact and high-resolution curved array bathymetric mapping system by NORBIT.

This all-in-one tightly integrated broadband multibeam turnkey solution offers high resolution bathymetry over a wide swath. The high-end sonar with globally leading GNSS/Inertial Navigation System (Applanix WaveMaster II) embedded into the unit ensures fast and reliable mobilization and highest quality sounding for installations in all conditions.

The WBMS-series are based on a flexible sonar platform that utilizes the latest in analog and digital signal processing. With broad R&D expertise NORBIT has developed, from the ground-up, exciting new technology that allows existing and new applications to benefit from the advantages offered by a compact wideband curved-array multibeam sonar.

Features

- ✓ State-Of-The-Art Curved Array Multibeam Sonar Tightly Integrated with High-end GNSS-aided Inertial Navigation System (Applanix WaveMaster II)
- ✓ 80kHz Bandwidth
- ✓ Roll-stabilisation, Side-scan, Water Column, Backscatter, Snippets
- ✓ Simple Ethernet Interface
- ✓ Integrated Sound Velocity Probe
- ✓ Hydrodynamic Fairing
- ✓ Mounting Bracket Included
- ✓ FM & CW Processing
- ✓ Flexible Power
- ✓ Exceeds IHO *Special Order*, CHS *Exclusive Order* & USACE *New Work*

Applications

- ✓ Shallow Water Bathymetry
- ✓ Pipeline Surveys
- ✓ Pond, River and Estuary Surveys
- ✓ Harbor and Lake Surveys
- ✓ USV & UUV
- ✓ MCM & Littoral Combat Zone Surveys
- ✓ Open Ocean Coastal Surveys

Options

- ✓ Senior Hydrographer For Support and Training
- ✓ Sound Velocity Profiler
- ✓ Laptop
- ✓ Turnkey Survey Solutions
- ✓ Permanent Hull Mount Option
- ✓ Pole Mount and Travel Option
- ✓ 200kHz Version
- ✓ Narrow Beam Option
- ✓ Top-end INS (Roll, Pitch & Heading 0.01degree)
- ✓ Entry level INS
- ✓ Acquisition, Navigation and Post Processing Software
- ✓ Can be Delivered with all Major Software Packages e.g. HYPACK, QINSy, EIVA, CARIS and Others

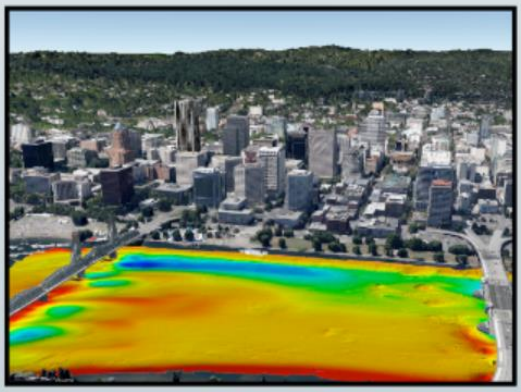
EXPERTS in sensor equipment providing telemetry and communication solutions for harsh environments.
NORBIT develops and delivers innovative products - allowing you to explore more.

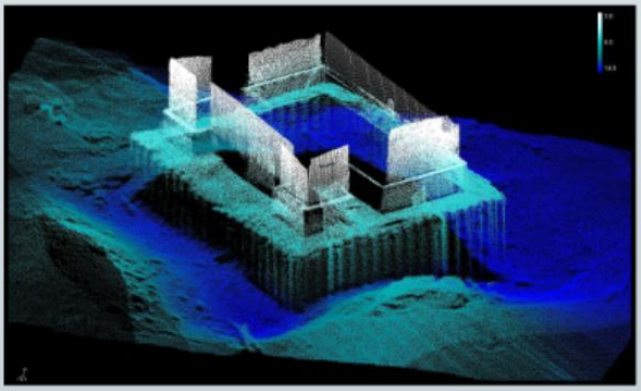
www.norbit.com

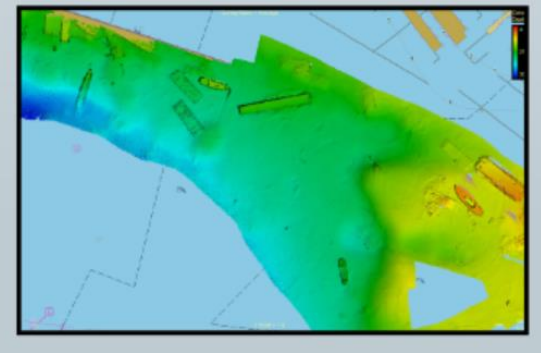
DATASHEET - PS-120006-16

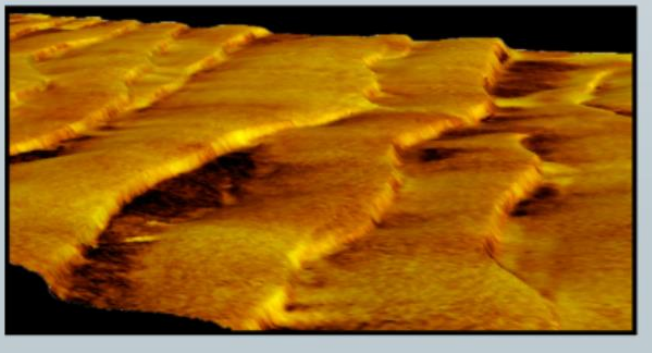
NORBIT iWBMS Wideband Multibeam Sonar

For High Resolution Bathymetry



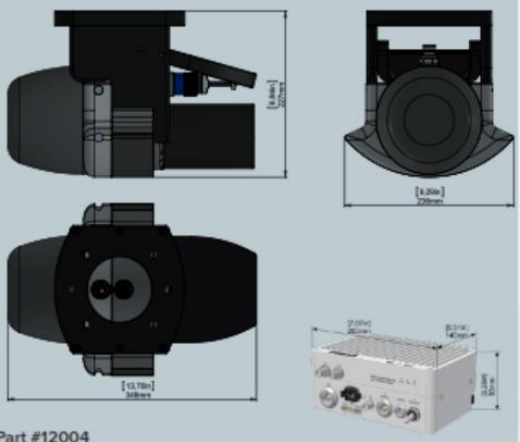






TECHNICAL SPECIFICATION

SWATH COVERAGE	7-210° FLEXIBLE SECTOR (SHALLOW WATER IHO SPECIAL ORDER >155°)
RANGE RESOLUTION	<10mm ACOUSTIC w. 80kHz BANDWIDTH
NUMBER OF BEAMS	256-512 EA & ED
OPERATING FREQUENCY	NOMINAL FREQUENCY 400kHz (FREQUENCY AGILITY 200-700kHz)
DEPTH RANGE	0.2-275m (>300m WITH 0.9° X 0.9° OPTION)
PING RATE	UP TO 60Hz, ADAPTIVE
RESOLUTION (ACROSS X ALONG)	STANDARD: 0.9° X 1.9° @400kHz AND 0.5° X 1.0° @700kHz. NARROW OPTION: 0.9° X 0.9° @400kHz AND 0.5° X 0.5° @700kHz
POSITION	HOR: ±(8mm +1ppm X DISTANCE FROM RTK STATION) VER: ±(15mm +1ppm X DISTANCE FROM RTK STATION) (ASSUMES 1m GNSS SEPARATION)
HEADING ACCURACY	0.03° (RTK) WITH 2m ANTENNA SEPARATION
PITCH/ROLL ACCURACY	0.02° INDEPENDENT OF ANTENNA SEPARATION
HEAVE ACCURACY	5cm or 5% (2cm RTK)
WEIGHT	APPROX. 9.5kg (AIR) LESS THAN 6kg (WATER)
INTERFACE	ETHERNET
CABLE LENGTH	STD 8m, OPTIONS: 25m, PIGTAIL, CUSTOM UP TO 50m
POWER CONSUMPTION	60W (75W MAX) (10-28VDC, 110-240VAC)
OPERATING TEMP.	-4°C to +40°C (TOPSIDE -20°C to +55°C)
STORGAGE TEMP.	-20°C to +60°C
ENVIRONMENTAL	TOPSIDE: IP67: DUST TIGHT, PROTECTED AGAINST THE EFFECT OF IMMERSION UP TO 1m/WET-END: 100m



Part #12004

NORBIT SUBSEA | STIKLESTADVEIEN 1 | N-7041 TRONDHEIM | NORWAY | PHONE +47 73 98 25 50 | subsea@norbit.com

DATASHEET

TRIMBLE SPS855 GNSS MODULAR RECEIVER

FLEXIBLE RECEIVER FOR JOBSITE MEASUREMENT

Whether you need a reliable GNSS base station or a rugged rover, the Trimble® SPS855 GNSS Modular Receiver gives you the flexibility to perform all of your construction site measurements. As a permanent or semi-permanent base station, it provides GNSS corrections for site measurements and machine control. As a rover, it can move easily from a site supervisor truck to a pole mount for grade checking, site measurement and stakeout.

The versatile SPS855 receiver is available in a range of options to suit your jobsite or marine construction performance requirements. Simply purchase the receiver that you need today, and upgrade as your needs change.

Secure and Easy to Use

The Trimble SPS855 is comprised of an integrated GNSS receiver and radio plus a choice of external antenna. The receiver can be placed in a secure environment such as the job trailer or boat cabin where it is protected from theft and weather. The less expensive antenna can be placed in a location with clear visibility to the sky and maximum radio coverage.

You don't have to be a GNSS expert to use the SPS855. Integrated 450 or 900 MHz license-free radio and interface with Trimble SCS900 Site Controller Software make the SPS855 easy to use, fast to setup and more productive on the job. Trimble Autobase™ technology means anyone on the jobsite can perform daily base station set up with one button push.

For more advanced troubleshooting, the receiver's web interface allows your GNSS manager to remotely monitor base station performance, availability, and configuration. No need for time-consuming and costly visits to the base station to set up each day or diagnose issues that may arise.

The fully upgradable SPS855 GNSS Modular Receiver can be configured in a variety of ways. For example:

- As a base station only
- As a rover only with SBAS, Location, or Precision Real-Time Kinematic (RTK) accuracy
- As a flexible base or rover with Precision RTK accuracy

The SPS855 can be combined with the Trimble SPS555H Heading Add-on Receiver, for applications on cranes, construction vessels, and dredges where real-time position and orientation are important.

Trimble
The Construction Technology Standard
www.trimble.com

TRIMBLE SPS855 GNSS MODULAR RECEIVER

GENERAL

Keyboard and display ...... Vacuum fluorescent display 16 characters by 2 rows
Dimmable. On/Off key for one-button startup
Dimensions (L × W × D) .... 24 cm × 12 cm × 5 cm (9.4 in x 4.7 in x 1.9 in)
Weight .... 1.65 kg (3.64 lb) receiver with internal battery and radio
1.55 kg (3.42 lb) receiver with internal battery and no radio

ANTENNA OPTIONS

GA530 .... L1/L2/L2C GPS, SBAS, and OmniSTAR
GA810 .... GPS, Glonass, OmniSTAR, SBAS, Galileo (optimized for OmniSTAR)
Zephyr™ 2 Models .... L1/L2/L2C/L5 GPS, Glonass, OmniSTAR, SBAS, Galileo, BeiDou

ENVIRONMENTAL

Operating[1] .... -40 °C to +65 °C (-40 °F to +149 °F)
Storage .... -40 °C to +80 °C (-40 °F to +176 °F)
Humidity .... MIL-STD 810F, Method 507.4
Waterproof .... IP67 for submersion to depth of 1 m (3.3 ft), dustproof
Pole drop ..... Designed to survive a 1 m (3.3 ft) pole drop onto a hard surface

MEASUREMENTS[2]

- 440-channel L1C/A, L1/L2/L2C GPS and QZSS. Upgradable to L5 and GLONASS L1/L2C/A, L1/L2P Full Cycle Carrier
- Galileo
- BeiDou
- OmniSTAR
- Trimble EVEREST™ multipath signal rejection
- 4-channel SBAS (WAAS/EGNOS/MSAS/QZSS)

CODE DIFFERENTIAL GPS POSITIONING[3]

Horizontal accuracy .... 0.25 m + 1 ppm RMS (0.8 ft + 1 ppm RMS)
Vertical accuracy .... 0.50 m + 1 ppm RMS (1.6 ft + 1 ppm RMS)

REAL-TIME KINEMATIC (RTK UP TO 30 KM) POSITIONING[3]

Horizontal accuracy .... 8 mm + 1 ppm RMS (0.026 ft + 1 ppm RMS)
Vertical accuracy .... 15 mm + 1 ppm RMS (0.05 ft +1 ppm RMS)

TRIMBLE XFILL

Horizontal accuracy .... RTK[4] + 10mm/minute RMS
Vertical accuracy .... RTK + 20mm/minute RMS

INITIALIZATION TIME

Initialization reliability[5] .... >99.9%

POWER

Internal .... Integrated internal battery 7.2 V, 7800 mA-hr, Lithium-ion
External .... Power input on 7-pin 0-shell Lemo connector is optimized for lead acid batteries with a cut-off threshold of 11.5 V
Power input on the 26-pin D-sub connector is optimized for Trimble Lithium-ion battery input with a cut-off threshold of 10.5 V
Power consumption .... 6.0 W in rover mode with internal receive radio
8.0 W in base mode with internal transmit radio

OPERATION TIME ON INTERNAL BATTERY

Rover .... 13 hours; varies with temperature
Base station
450 MHz systems .... Approximately 11 hours; varies with temperature[6]
900 MHz systems .... Approximately 9 hours; varies with temperature

REGULATORY APPROVALS

- FCC: Part 15 Subpart B (Class B Device) and Subpart C, Part 90
- Canadian ICES-003. Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.
- Canadian RSS-310, RSS-210, and RSS-119.
- Cet appareil est conforme à la norme CNR-310, CNR-210, et CNR-119 du Canada.
- ACMA: AS/NZS 4295 approval
- CE mark compliance
- C-tick mark compliance
- UN ST/SG/AC.10.11/Rev. 3, Amend. 1 (Lithium-ion Battery)
- UN ST/SG/AC. 10/27/Add. 2 (Lithium-ion Battery)
- RoHS compliant
- WEEE compliant

COMMUNICATIONS

Lemo (Serial) .... 7-pin 0S Lemo, Serial 1, 3-wire RS-232
Modem 1 (Serial) .. 26-pin D-sub, Serial 2, Full 9-wire RS232, using adaptor cable
Modem 2 (Serial) ..... 26-pin D-sub, Serial 3, 3 wire RS-232, using adaptor cable
1PPS (1 Pulse-per-second) .... Available on Marine versions
Ethernet .... Through a multi-port adaptor
Bluetooth wireless technology .... Fully-integrated, fully-sealed 2.4 GHz Bluetooth module[7]
Integrated radios (optional) .... Fully-integrated, fully-sealed internal 450 MHz (UHF) Tx/Rx; Internal 900 MHz Tx/Rx
External GSM/GPRS, cell phone support .... For Internet-based correction streams
Receiver position update rate .... 1 Hz, 2 Hz, 5 Hz, 10 Hz, and 20 Hz positioning
Correction data input/output .... CMR™, CMR+™, CMRx™, RTCM v 2.x & 3.x
Data outputs .... NMEA, GSOF, 1PPS Time Tags (Marine version)

1 Receiver will operate normally to –40 °C. Internal batteries are rated to –20 °C.
2 The Trimble SPS855 GNSS Modular Receiver is capable of supporting existing and planned GNSS satellite signals, including GPS, GLONASS, Galileo, Quasi Zenith Satellite System and BeiDou, and existing and planned augmentations to these GNSS systems. Support for the Galileo system is developed under a license of the European Union and the European Space Agency.
3 Accuracy and reliability may be subject to anomalies such as multipath, obstructions, satellite geometry, and atmospheric conditions. Always follow recommended practices.
4 RTK refers to the last reported precision before the correction source was lost and xFill started.
5 May be affected by atmospheric conditions, signal multipath, and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.
6 For receivers with the 2.0W upgrade, reduced battery performance should be expected compared to the 0.5W solution.
7 Bluetooth type approvals are country specific. For more information, contact your local Trimble office or representative.

Specifications subject to change without notice.

YOUR SITECH HEAVY CIVIL CONSTRUCTION TECHNOLOGY PROVIDER

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www.trimble.com

SWiFT SVP

Sound Velocity /Temperature/ Pressure Salinity /Conductivity / Density

Designed from the outset with the intention of a seamless workflow, the SWiFT profiler provides survey-grade sensor technology coupled with the convenience of Bluetooth connectivity and rechargeable batteries. An integral GPS module, to geo-locate each profile, completes the package. Data can be easily and quickly downloaded and reviewed wirelessly, via Bluetooth, using the SWiFT App on iOS devices and instantly shared, in industry standard SVP formats through email and cloud services. Using the provided USB adapter or cable, Valeport's DataLog x2 software package provides further tools.

In addition to the directly measured sound speed, temperature and pressure observations, Conductivity, Salinity and Density are calculated using Valeport's proprietary algorithm developed from extensive laboratory and field work.

With an operational battery life of up to 5 days and the convenience of charging via USB, SWiFT is intended for coastal, harbour and inland hydrographic survey use and offers the highest quality sound velocity profiles in a compact, robust and portable package.

Optionally, the supplied deployment weight is available to bolt onto the sensor protection cage to help get the SWiFT to depth in fast flowing currents.

Sensor Specifications

The SWiFT SVP is fitted with Valeport's digital time of flight sound velocity sensor, temperature compensated piezo-resistive pressure transducer and a PRT temperature sensor

Sound Velocity	
Range:	1375 – 1900 m/s
Resolution:	0.001 m/s
Accuracy:	±0.02 m/s
Pressure	
Range:	10 Bar or 20Bar
Resolution:	0.001% FS
Accuracy:	±0.05% FS
Temperature	
Range:	-5°C to +35°C
Resolution:	0.001°C
Accuracy:	±0.01°C

Calculated Accuracies

Conductivity:	±0.05 mS/cm
Salinity:	±0.05 PSU
Density:	±0.05 kg/m³

Physical

Materials:	Titanium Stainless Steel deployment weight
Depth Rating:	200m
Dimensions:	Ø78mm x Length 277mm 321mm with deployment weight
Weight:	2.0kg (in air) / 0.9kg (in water) 3.0kg (in air) /1.8kg (in water) with deployment weight

Communications (set up and data offload)

USB Serial
Bluetooth v4 - low energy

Memory

2 GB Internal Flash Card Storage

Electrical

Battery:	Internal Rechargeable Battery Pack
Battery Life:	Up to 5 days of operations
Charging:	USB typically, 1 hour fast charging will give 12 hours operation

Software

iOS App for Bluetooth 4 compatible iPad and iPhone – instrument set up, data offload, display and translation to common SVP formats, Android to follow.
DataLog x2 Windows based PC software, with both USB cable and Bluetooth 4 connectivity, for instrument setup, data extraction, display and translation to common SVP formats.

Ordering

0660047 **XX**	SWIFT SVP Profiler - Titanium housing rated to 200m
Note:	**XX** pressure transducer range - select from 10 or 20 Bar
	Supplied with: • Deployment weight • 20m deployment line • PC Bluetooth adapter • USB interface and charging cable • 1.5 A charger • DataLog x2 software, operating manual • System transit case

Data Sheet Reference: SWiFT SVP - May 2016

Valeport Limited, St. Peter's Quay Totnes, Devon, TQ9 5EW UK
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NAViSTAK

HYDROFIX

Designed by Hydrofix, NAViSTAK is a compact modular survey system, that offers reliability, redundancy, performance, flexibility, and quick mobilisations. The size and weight is a crucial factor with transportation and installation on vessels of all sizes.

The core module is a self-contained system that can be expanded internally or with further modules that can be stacked and locked together (No need for a vessel with their own server cabinet). Further modules can contain for example geophysical equipment, further UPS's and larger MBES systems. The compact core module contains everything needed for a typical hydrographic survey (Positioning, multibeam surveys etc.)

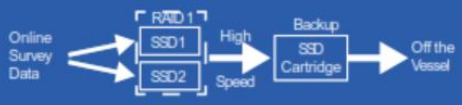
- Compact
- Stackable
- Multiple Redundancies
- Versatile
- Expandable
- High Performance
- Data Safety
- Time and Cost Savings

Workstation

The workstations are compact, but at the same time remaining versatile and powerful. They are powered by a Intel i7 processor with 16GB of RAM and contain a wide range of inputs and outputs:

4 x gigabit network ports
4 x flexible display outputs (VGA, DVI, HDMI, mDP & DP)
3-4 x true serial ports (Motherboard - RS232 & RS422)
6 x USB 3.0 ports (2 USB 2.0)

The workstations are equipped exclusively with solid state drives and importantly the data SSD's are raided for redundancy. Backup is carried out by using drive cartridges, available with both standard 2.5" HDD or 2.5" SSDs. They connect straight to SATA6 which enables the fastest regular backups during the day or end of day backups (Over 500MB/s transfer with SSD cartridges).



Core Module - Standard Equipment

2 identical survey workstations (1 for redundancy)
Trimble GNSS and heading
UPS
Serial server (RS232 & RS422)
USB to 8 Port RS232 (Backup)
QPS PPS TTL Adapter
4G Modem (Inc. serial input)
Gigabit switch
Network attached storage

Case

Compact
Shock protection
Waterproof
Stackable and lockable

Length:	58cm
Length inc lids:	78.5cm
Width:	55.5cm
Height:	46cm

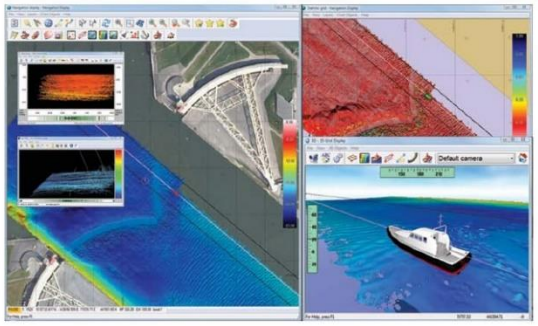
www.hydrofix.co.uk

In a world where everything seems to get faster and bigger, software needs to be even better. The ideal software package needs to be as flexible as the people who use it, and most importantly it must be easy to operate. QINSy provides a total hydrographic solution to serve the small as a well as the large survey companies.
Its modular design and inherent flexibility makes QINSy perfect for a wide variety of applications.

- Inland Surveys
- Hydrographic & Oceanographic Surveys
- Laser Scanning for Land & Maritime applications
- Complete offshore construction and survey applications
- Barge, Tug and Fleet Management
- Dredging Monitoring & Navigation
- Electronic Navigation Chart production

Since its launch in 1996, QINSy has become the standard in marine surveying, bathymetric chart and ENC production.

For this purpose QINSy makes use of a "project template" database which contains all survey configuration parameters relevant to the project. QINSy supports most of the world's datums and projections, multiple units and geoidal models used world-wide. The project template also contains vessel shapes, administrative information, as well as vessel offsets and I/O parameters.
Using real-time depth measurements, sound velocity profiles, tide levels, RTK heights etc. QINSy calculates the final foot print positions on-the-fly and visualizes these on various displays.



Typical QINSy displays

Real-time DTM production is the dream of every surveyor. In QINSy all computations are performed in 3D. Together with accurate RTK heights or real-time tide gauges, all depth observations are immediately available in absolute survey coordinates. This unique technique is called 'on-the-fly DTM production'.

Accurate timing is imperative in the survey industry. QINSy uses a sophisticated timing routine based on the PPS option from the GNSS receiver. All incoming and outgoing data is accurately stamped with a UTC time label. Internally QINSy uses 'observation ring buffers' so that data values can be 'placed' for the exact moment of an event or ping. This combination gives QINSy a proven accuracy of 1 msec.

QPS

www.qps.nl
www.qps-us.com

Total Hydrographic Solution

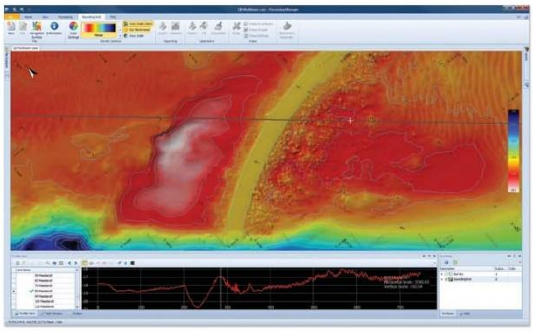
Online Data Acquisition

- Real-time calculation of footprint positions and on-the-fly DTM production.
- Accurate Timing: Combination of ring buffers and PPS gives QINSy a proven accuracy of 1 msec.
- Storage of Raw sensor data enables total replay of performed survey in the office with different settings.
- Total Propagated Uncertainty (error budget) calculation in real-time which can be used for on-line data clipping.
- Multi-layer sounding grid used for on-line visualization of on the fly DTM, SSS draping, layer differences etc.
- Support for Anchor handling & Tug management.
- Advanced Dredging functionality.
- Multiple ROV positioning & monitoring.
- Side Scan Sonar support for targeting and mosaicking.
- Great flexibility in sensor support which ensures interfacing of almost all sensors.
- Survey planning tool enables you to prepare your project in the office.
- Visualization of project using powerful 2D and 3D visualization techniques together with flexible user defined information displays.
- Ocean Bottom Cable & 2D seismic support.

3D View

Post Processing

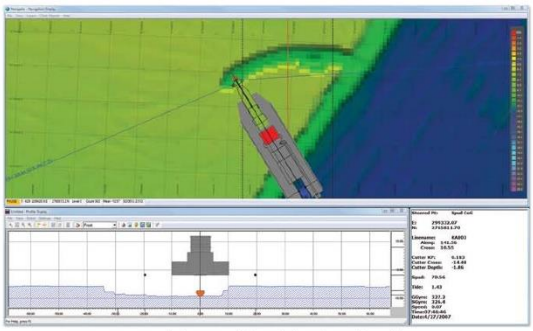
- Powerful Data Processing & Validation techniques
- Export to all popular formats and more.
- Sound velocity manager which enables time & spatial processing of SVP casts.
- Plotting of engineering charts with bathymetric data, cross and long profiles.
- Different volume calculation methods.
- S-57 ENC production, both file based and spatial database solutions, incl. notice to mariners, updates.
- S-57 ENC distribution.



Processing Manager

Qloud

- Fast area based data cleaning tool.
- Ideal for processing of large multibeam data sets.
- Reliable automatic cleaning methods.
- Manual data clipping.
- Easy to search for problems in the bathymetric data using statistical information.
- Combination of sounding grid and DTM points.
- CUBE support.
- 3D spot sounding generation.
- TIN reduction.



Advanced Dredging functionality

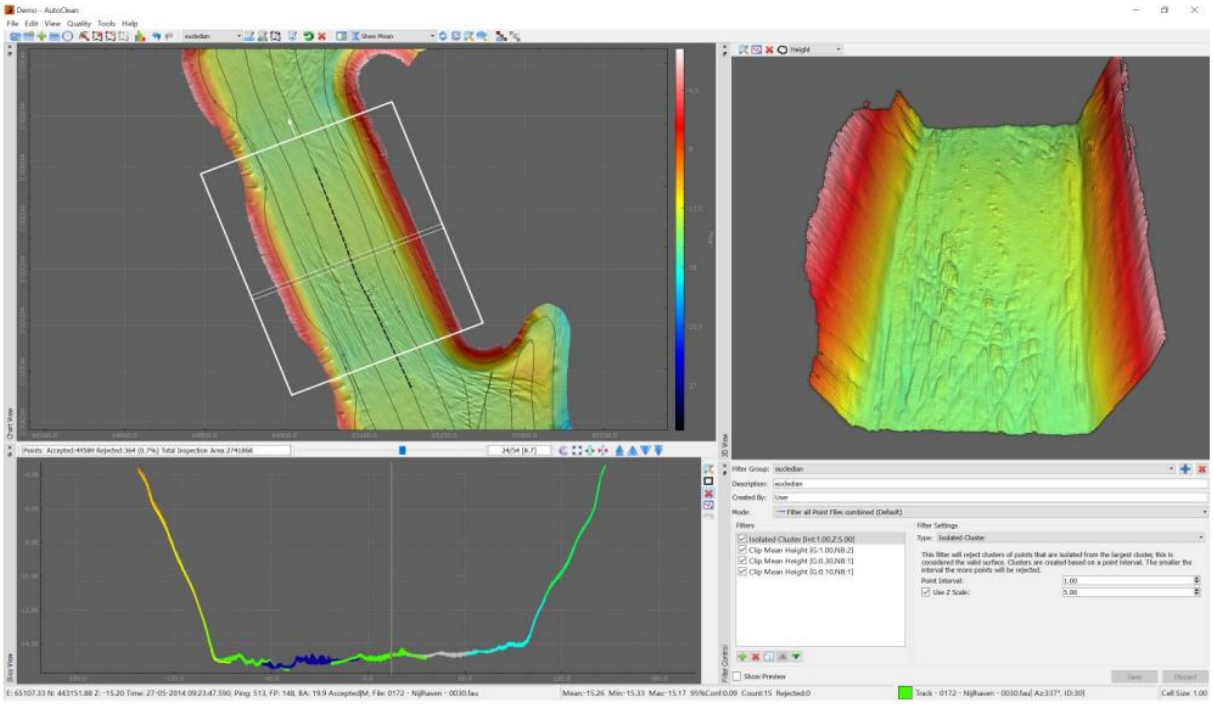
www.qps.nl
www.qps-us.com

AutoClean

Cleaning tool for bathymetric and Lidar point data

Cleaning program for Bathymetric and Lidar point data. Focused on day to day cleaning on board of survey vessels or near site.

- Automatic cleaning and validation for bathymetric and Lidar point clouds
- Manual flagging of points in 2D Slice and 3D View
- Stand-alone application, easy to learn and use
- Optimum use of modern computer hardware(multi-core, 64-bit, GB's mem)
- Supports many cleaning algorithms: statistical, spline filter, spatial
- Full undo on all modification actions
- Import/export to various file formats, e.g. FAU/GSF/ALL/LAS/LAZ/Hypack HS2(X)/ASCII/Grids/PDS
- Respects the point status as flagged by the acquisition software
- Optionally exports only the changes back to the original source files
- Automatic Least Square Adjustment Height Fitting for Tide errors
- Reference layer for design or previous survey
- Multiple rejection flags and classification
- Automatic import of files through folder monitoring during the survey
- Corrected 95% confidence grid attribute



For inquiries:

sales@beamworx.com

Emmalaan 4 Utrecht, The Netherlands

BeamworX
Hydrographic Software & Consultancy

APPENDIX A

Hydrofix positional check station “H01”

HYDROFIX

CASTATION DESCRIPTION

Station ID – H01

STATION CO-ORDINATES

WGS84		ETRS89	
Latitude	53° 06′ 55.77797″ N	Latitude	53° 6' 55.76078" N
Longitude	02° 46′ 21.82513″ W	Longitude	2° 46' 21.85255" W
Height	92.174	Height	92.172
UTM30N (WGS84)		UTM30N (ETRS89)	
Easting	515211.485	Easting	515210.977
Northing	5885142.526	Northing	5885141.992
Height	92.174	Height	92.172
OSGB36 (OSTN15)			
Easting	348376.076		
Northing	357867.224		
Height	40.223 [ODN]		

TRANSFORMATION PARAMETERS

1.1 WGS84 to ETRS89

	From	To (Epoch 2020)	To (Epoch 2021)
	WGS84 (ITRF08), t_o = 2000	ETRS89 (ETRF2000)	
Spheroid	WGS 1984	GRS 1980	
Semi major	6378137	6378137	
Flattening	298.2572236	298.2572221	
Parameters			
Shift X (m)		0.0541	0.0542
Shift Y (m)		0.0513	0.0514
Shift Z (m)		-0.0945	-0.0963
Rotation X (arcSec)		0.002511	0.002592
Rotation Y (arcSec)		0.01519	0.01568
Rotation Z (arcSec)		-0.024552	-0.025344
Scale (ppm)		0.00294	0.00302

HYDROFIX

1.2 WGS84 / ETRS89 to UTM30 North

UTM zone	30 North
Datum	WGS84
Prime Meridian	0
Projection	Transverse Mercator
Latitude of Origin	0
Central Meridian	-3
Scale Factor	0.9996
False Easting	500000
False Northing	0

1.3 ETRS89 Cartesian to OSGB36

OSTN15 shifts from ETRS cartesian co-ordinates to OSGB.

Δ Easting	0.000
Δ Northing	0.000
Δ Height	0.000

Refer to ETRS89 to OSGB36(OSTN15) converter to obtain correct shift values

HYDROFIX

STATION LOCATION PLAN

General Plan

Detail Plan

HYDROFIX

PHOTOGRAPHS

General Area

HYDROFIX

Station

GREEN VOLT

Flotation Energy Ltd | 12 Alva Street | Edinburgh EH2 4QG | Scotland
Tel: [redacted] | enquiries@flotationenergy.com | www.flotationenergy.com