SHORELINE SURVEYS LIMITED

HYDROGRAPHIC – GEOPHYSICAL – TOPOGRAPHIC

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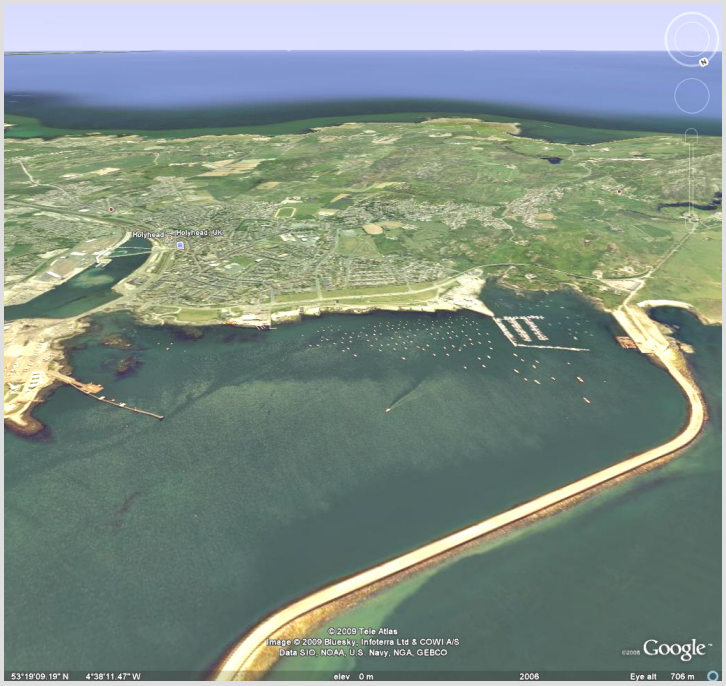
SURVEY REPORT

HOLYHEAD HARBOUR INVESTIGATIONS

BATHYMETRIC & GEOPHYSICAL SURVEYS



PREPARED FOR:

AXIS

JANUARY 2010

Reference: J500_REPORT

Compiled by: E M J Foote BSc
Version 1.0

INDEX

LIST OF SHEETS

J500_01 - (1:1500): Bathymetric Survey: Seabed Levels Relative To Chart Datum

J500_02 - (1:1500): Geophysical Survey: Bedrock Levels Relative To Seabed

J500_03 - (1:1500): Geophysical Survey: Bedrock Levels Relative To Chart Datum

1. INTRODUCTION

Axis (in conjunction with Black & Veatch Limited acting as consultants for the survey) contracted Shoreline Surveys Limited to execute bathymetric and sub-bottom profiling surveys within Holyhead Harbour, Anglesey.

The surveys took place on Wednesday 13th and Thursday 14th January 2010. Sea conditions were ideal for the survey.

This report describes the survey methods employed and presents the results obtained.

2. SCOPE OF WORK

2. 1. General

Black & Veatch Ltd defined the survey area in which the following surveys were executed:

- Bathymetric survey
- Geophysical survey (using Pinger system)

2. 2. Navigation System

- Minimum absolute horizontal accuracy of hydrographic positioning equipment: +/-0.5 metre.
- Minimum relative horizontal accuracy of hydrographic positioning equipment: +/- 0.05 metre.

2. 3. Bathymetric Survey

- Survey lines were ran at 20 metre intervals with several cross lines also ran.
- High frequency soundings were collected (210 kHz).
- Results have been presented relative to Chart Datum and contoured at 1.0 metre intervals.

2. 4. Sub-Bottom Profiler – Pinger Survey

- An over-the-side pinger system was used for the sub-bottom profiling investigations.
- The purpose of the sub-bottom profiling survey was to locate the depth of bedrock and map any detected sub-bottom layers.
- Survey lines were ran at 20 metre intervals with several cross lines also ran.
- Survey vessel speed was approximately 1.5 metres per second.
- Sub-bottom levels were determined from acoustic reflectivity.
- No ground truthing, bore holes or other physical investigations took place by Shoreline Survey Limited. No such existing data was provided.
- Interpretation was made from the digital records.

2. 5. Deliverables

- This survey report.
- Three paper copies of three survey drawings (as per list of sheets (above)).
- Digital copies of three AutoCad drawings (as per list of sheets (above)).
- Digital copies of above AutoCad drawings in PDF format.
- Sounding XYZ (ASCII text format, labelled J500_XYZ).
- All digital data has been emailed to the client.

3. METHOD

3. 1. Positioning

A Trimble RTK Global Positioning System (RTK DGPS) enabling sub-decimetre accuracy in the horizontal and vertical planes was used for positioning all surveys. Differential corrections were received via the Leica SmartNet real-time RTK service.

Positional data was collected at five time per second. Positional data was electronically interfaced (RS232 via serial connections) into all other survey systems ensuring the achievement of an identical time base.

3. 2. Soundings

Depth measurements were made to within 100 mm resolution with a Reson 215 echo sounder (210 kHz).

Soundings were recorded within the onboard navigation computer at a rate of 10 times per second (approximately) within Hypack Software. The navigation computer was linked to the echo sounder through an RS232 serial lead.

Further details of equipment specifications are given in Section 4.

3. 3. Sub-Bottom Profiler – Pinger System

The pinger system was an over-the-side mounted system. The GPS antenna was placed directly over the pinger transceiver, obviating the requirement for a gyro or offset calculations.

A continuous record of sub-seabed reflectivity was recorded on a digital trace. Interpretation of the slab levels was made via a CODA system. Interpreted levels were exported into Hypack.

3. 4. Tidal data

Tidal data was obtained via RTK DGPS. Tidal levels were verified regularly throughout the survey with port control on VHF channel 14. Observed levels matched those supplied by port control to within the expected tolerance (5cm).

A value of -3.05 metres was used to offset Chart Datum from Ordnance Datum Newlyn (source Admiralty Tide Tables Volume 1, Table 3).

4. EQUIPMENT SPECIFICATIONS

4. 1. Navigation System

Manufacturer:	Trimble
Product name:	SPS751 MAX (base and rover)
Differential corrections:	Leica SmartNet
Absolute horizontal accuracy:	+/- 0.05 metre
Relative horizontal accuracy:	+/- 0.05 metres
Relative vertical accuracy:	+/- 0.05 metres
Channels:	12

4. 2. Echo Sounder: Reson 215

Manufacturer:	Reson
Product name:	Reson 215
Frequency:	210 kHz
Record type:	Thermal chart of digital output
Relative accuracy:	+/- 0.01 metres

4. 3. Sub-Bottom Profiler – Pinger System

Manufacturer:	Sonar Equipment Services
Data presentation/ processor:	CODA DA2000 system
System consists of:	Processor
	Transceiver

4. 4. Survey Vessel *Shoreline*

Survey vessel *Shoreline* is towed to and launched from location

The survey was executed onboard survey vessel *Shoreline, a* 6.5m purpose built stable, manoeuvrable and shallow draft survey vessel, ideal for all coastal and harbour operations.

Make:		Leeward 18
Size:		6.5m x 2.2m
Draft:		30cm
Speed:		30 knots
Engines	Main:	100 HP Mariner outboard
	Auxiliary:	5 HP Mariner outboard

Class 3 MECAL certified (20 miles day and night)
Fully insured as survey vessel with full crew and third party cover

4. 5. Tidal Levels

Tidal levels were recorded using RTK DPGS

Sample period:	5 Hz
Absolute accuracy:	+/- 0.05 metres

5. GEODESY

5. 1. Datum Parameters

Projection:	Transverse Mercator, OSTN02
Central Meridian (W) (Lng):	2º
Grid Origin: (N) (Lat):	49º
False Northing:	-100000.000 m
False Easting:	400000.000 m
Scale Factor:	0.999601272

5. 2. Projection Parameters (OSTN02)

Raw data was collected in WGS 84 (no projection) and converted to OSTN02 within the navigation software using point to point modelling parameters.

6. EQUIPMENT PERFORMANCE

6. 1. Navigation System

The system performed without fault. A position check proved that the system was providing positional accuracy within the specified tolerance.

6. 2. Echo Sounder

The sounder performed without fault.

The mean velocity of sound was determined at the beginning and end of the survey by means of a bar-check. A round metal plate was lowered beneath the transducer to known depths. The correlation between this and the echo sounder reading was checked. If there was a discrepancy, the apparent speed of sound setting was changed appropriately and noted both in the surveyor's log and on the echo sounder trace.

6. 3. Sub-Bottom Profiler

The pinger system performed without fault. Within post processing one CODA file was not useable due to a corrupted format. This missing line is not deemed to have a detrimental effect on the survey results.

6. 4. Tide Gauge

The RTK tidal levels presented a tide curve which matched that of the predicted curve for the day. Checks against the harbour gauge matched within the expected tolerance (5cm).

7. PROCESSING & PRESENTATION

Industry standard DXF and ASCII text data formats have been used to present and archive the survey results. Data was processed and presented in house.

7. 1. Navigation

All survey data was processed off-line. No smoothing algorithm was applied. Positional data was recorded and post processed using Hypack Software.

7. 2. Bathymetry

All survey data was processed off-line. No smoothing algorithm was applied. Sounding data was recorded and post processed using Hypack Software. Depths are presented on sheet J500_01.

All survey data was processed off-line using Hypack Software. Interpretation was made from the digital records. Further details can be found within Section 8 (Side Scan Sonar Survey). Results are presented on sheet J456_02.

7. 3. Sub-Bottom Profiler

Sub-bottom profiler data was interpreted using the collected digital records via CODA. Timing of key features on the pinger trace were noted and correlated to the navigation records. Results are presented on sheets J500_02 & J500_03.

8. SUB-BOTTOM PROFILER SURVEY

8. 1. General

The purpose of the survey was to identify the depth of bedrock and determined the thickness of the overlaying sediments between the bedrock and seabed. A pinger geophysical system was used to achieve this.

Pinger Survey

Data collection for the pinger system was at 20 metres intervals with several cross lines ran also. Results are presented on sheets J500_02 & J500_03. Sheet 02 presents the interpreted bedrock level relative to seabed and sheet 03 presents the interpreted bedrock level relative to Chart Datum.

Pinger interpretation was made from the digital CODA records. A sub-bottom sediment sound velocity of 1650m/s was used for interpretation. The pinger system was deemed to have a vertical resolution of approximately 0.6 metres.

The data was generally of very good quality. However, despite the survey being conducted at high water shallow multiples were present in certain locations which partially masked the sub-bottom data hindering precise interpretation.

Cross lines interpreted data matched the normal lines within the expected tolerance in most cases. In some locations the difference was greater but this is thought to be due to the nature of acoustics and not due to errors in the system.

8. 2. Geology

The thickness of the interpreted unit layer (Isopach) above the interpreted bedrock varied between zero and 3.5 metres. Only one horizon was observed within the data and it is this horizon that has been presented. It has been interpreted that this isopach comprises of a mix of broken rock, shale, sand and clay. It is thought that clay forms a greater component within this isopach further offshore, especially where the isopach is towards its thickest.

8. 3. Comment

Data quality was good and sea conditions ideal. However, the exact location of the bedrock and extent of any overlaying sediments can only be conclusively determined via physical examination of the site conditions.

It is our recommendation that a physical sampling program take place before any further financial commitment is given to exploring the possibility of any development within the survey area.

9. QUALITY CONTROL

Shoreline Surveys Limited strives to collect as good quality data as possible. The performance characteristics and operating constraints of the equipment are fully understood and on that basis survey work is undertaken only when the conditions permit. It is our objective to become fully accredited with the ISO 9002 Quality Standard and the groundwork for such accreditation has been implemented from the onset of our operations.

10. DATA ACCURACY

Although the survey data is of good quality the only way by which seabed/ sub-seabed type/ levels can be accurately identified is through the implementation of an extensive sampling/ boring program. All seabed/ sub-seabed interpretation is based on acoustic reflectivity and should be treated accordingly.

Although extreme care has been taken during the planning, acquisition, processing and charting of the project, it is important to recognise the limitations of data acquisition with a single beam echo sounder and the employed geophysical survey instruments. Unless extremely tight line spacing is adopted, it is possible that the location and extents of troughs or peaks within the survey area could remain undetected. Shoreline Surveys Limited cannot be held responsible for any loss, consequential or otherwise, as a result of the use of this data.

This project has been undertaken on the understanding that the client accepts the above.

11. SUMMARY OF SURVEYOR'S/ GEOPHYSICIST'S LOG

15th December 2009 Pinger system arrive at office. Check contents and function. OK.

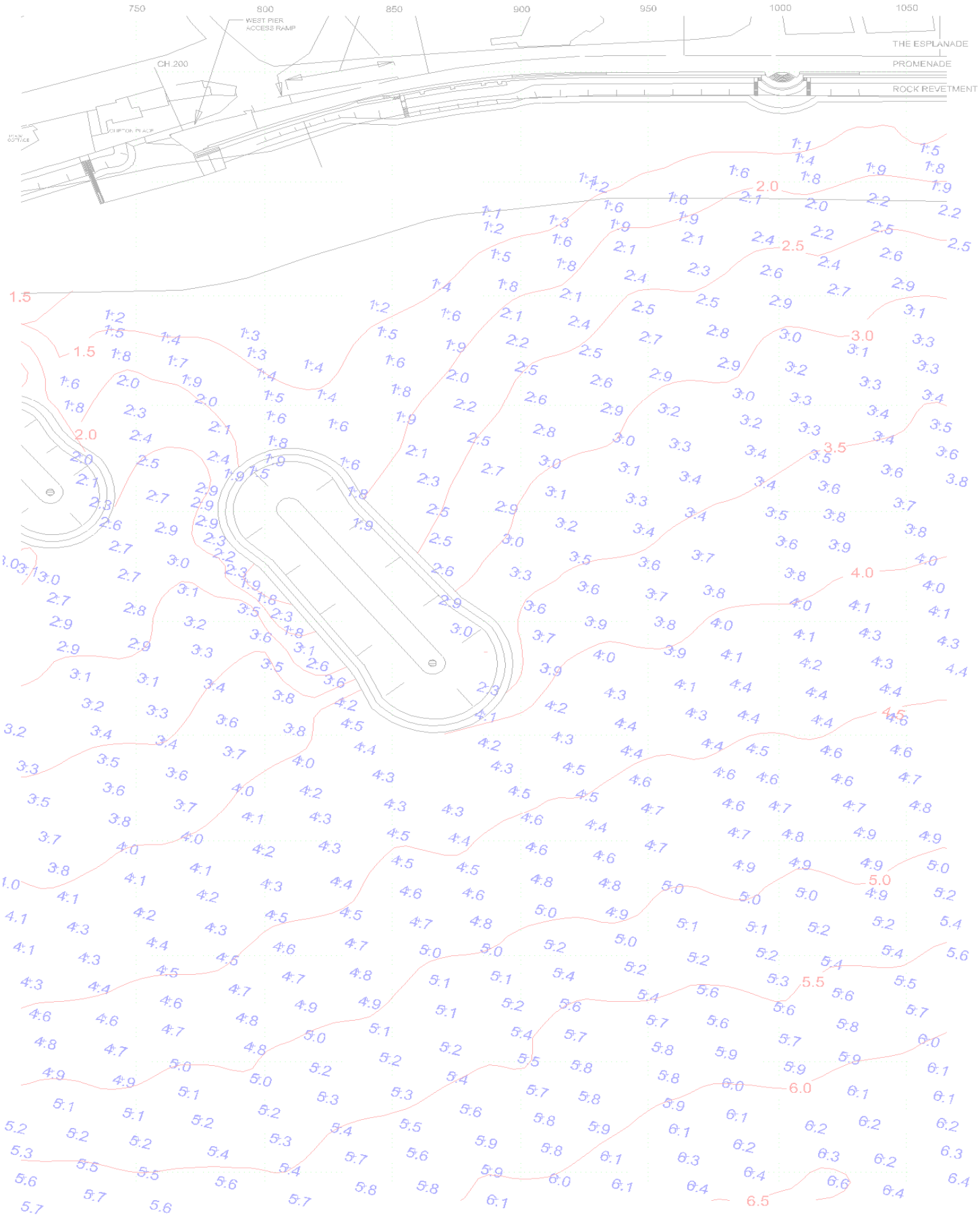
11th January 2010 Mobilise to Holyhead.

12th January 2010

08:00	Start of day, on-site, install survey equipment
12:00	Run test line, bar check, position check
12:30	Review and check test line
14:00	Commence survey, outer area
17:05	Complete survey for the day
18:00	End of day

13th January 2010

08:00	Start of day, on site
08:10	Run test line, bar check, position check
08:20	Review and check test line
08:30	Commence survey, inshore over high water
11:25	Complete survey
12:00	Review and check data
13:00	Demobilise
1630	End of survey



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