Appendix 10D

Geophysical Survey

Works Order Number GE/2010/02.7

Agreement No. CE 38/2008 (HY)

Kai Tak Development – Trunk Road T2 and Infrastructure at South Apron –

Investigation, Design and Construction

Archaeological Geophysical Survey

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1 INTRODUCTION

1.1 Instructions and Objectives

METHOD	OBJECTIVE
Echo sounding and swath survey	To measure sea bed levels in detail and for archaeological analysis
Marine seismic profiling survey	To identify the geological succession over the survey area
Marine side scan sonar survey	To find objects on or above the seabed, such as rock outcrops, dumped materials and other artefacts and objects for the archaeological assessment

The survey was carried out under the Works Order No. GE/2010/02.7 dated 21st June 2010 issued by Civil Engineering and Development Department.

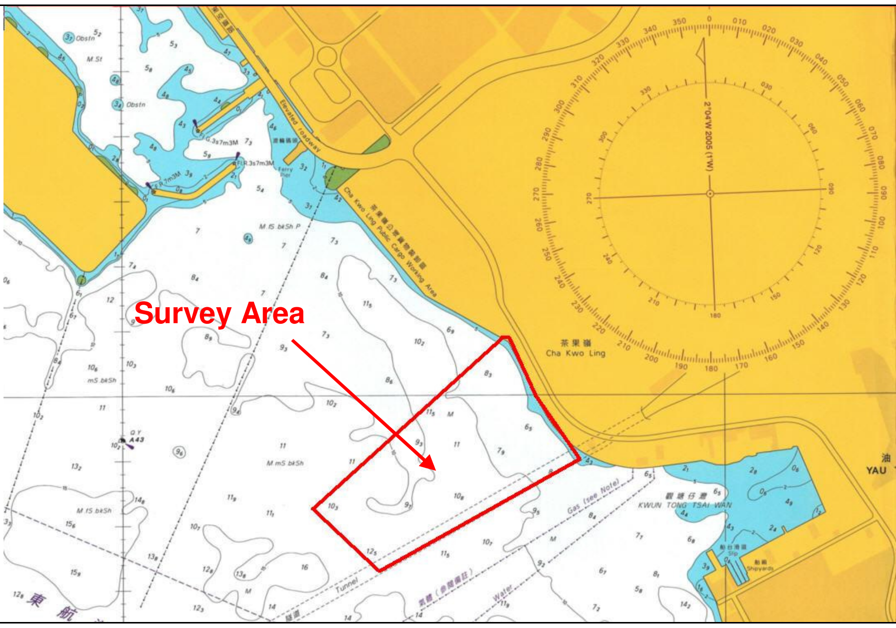
1.2 Survey Period

The survey was carried out on 24th June 2010. Details are listed below:

DATE	SURVEY TYPE	SURVEY VESSEL
24th June 2010	Swath, Seismic and SSS	WH2

1.3 Site Description

The survey area lies along the southwestern coast of Cha Kwo Lin to the southeast of South Apron of old Kai Tak Airport. The Eastern Harbour Tunnel is located at the southern survey boundary. The Figure below shows the location of the survey area described.



Extract from HK Chart – HK0801 (for illustration only; not to scale)

The survey area was located adjacent to the Cha Kwo Ling Public Cargo Working Area and many loading activities were observed during the survey period. Several drainage channels were found along the seawall. Pictures illustrating the coastal environment are shown below.

	
Containers in the cargo working area	Drainage outfall along the seawall of cargo working area
	
Stacking of metallic garbage for recycling use	Stacking of construction steel bars

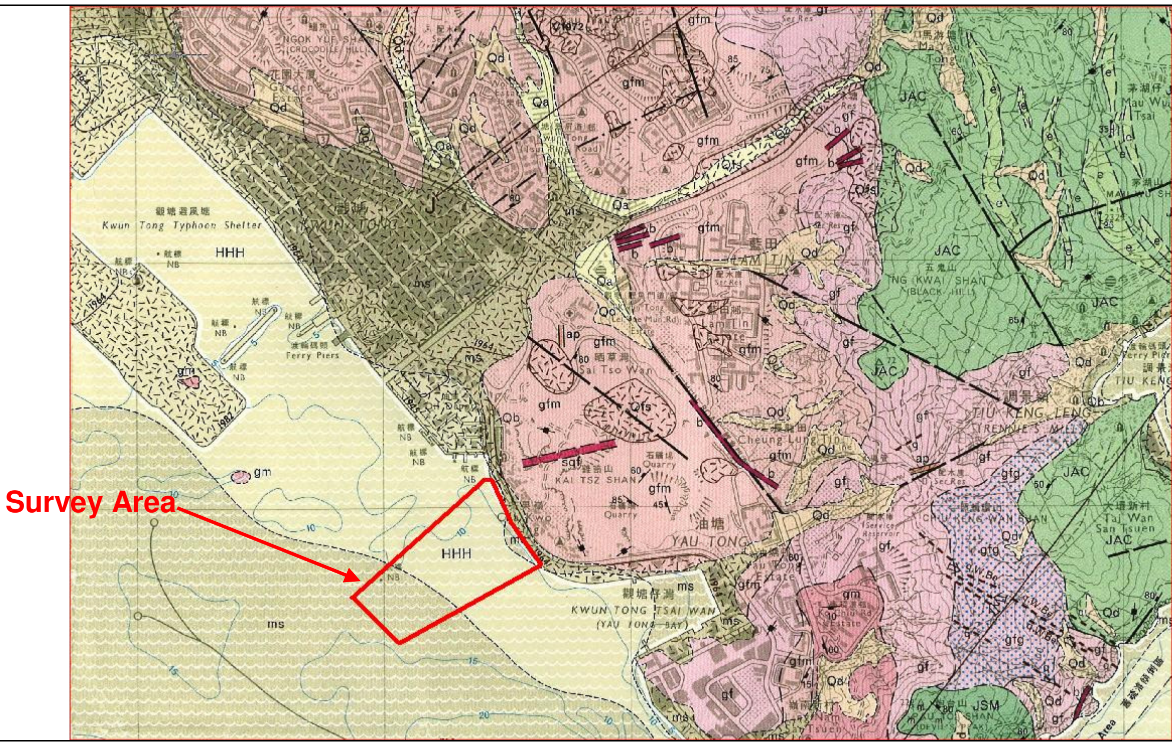
Although there were vessels passing by, the marine traffic around the survey area was not very busy during the survey period. Some of these marine activities are illustrated in the pictures below.

	
Passenger carrying boat passed the survey area	Passenger carrying boat travelled between Sai Wan Ho and Yau Tong

	
Tug boat around the survey area	Flat barge carrying construction materials

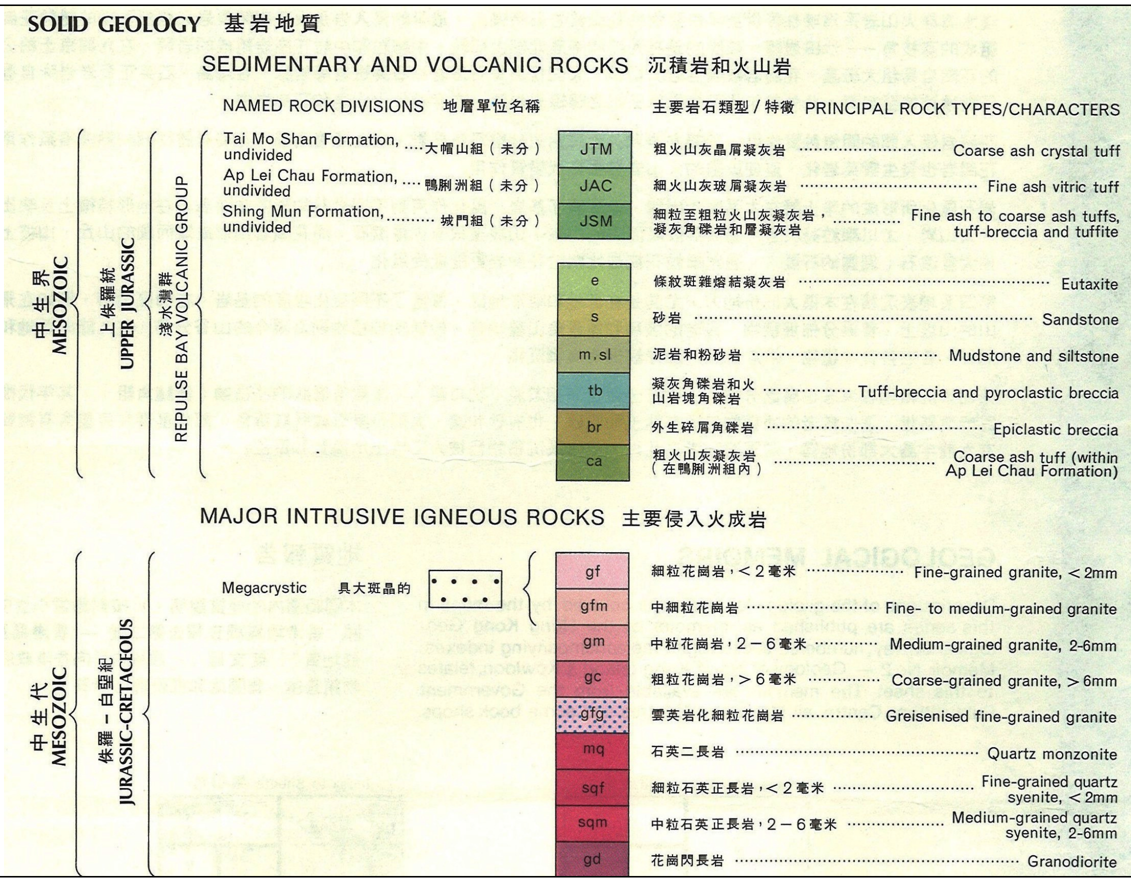
2 GEOLOGICAL BACKGROUND OF THE AREA

According to sheet 11 of the 1:20000 solid and superficial geological map of Hong Kong (Edition 1, GEO, 1986), granitic rock of Jurassic to Cretaceous age with some granitic and basaltic dyke intrusions is expected to be the country rock over the survey area. In addition, there is a NW-SE trending fault passing through the survey area as shown in the geological map of Hong Kong (Edition 1, GEO, 2000).



Geological map of the survey area, extracted from the Solid and Superficial Geological Map of Hong Kong - Sheet 11, Year 1986 Edition 1 (for illustration only; not to scale)

Geological map of the survey area, extracted from the Geological Map of Hong Kong, Year 2000 Edition 1 (for illustration only; not to scale)



Legend of the geological map

3 EQUIPMENT LIST

In this survey, the following equipment was mobilised onboard WH2, a Class IV commercially licensed vessel.

Equipment	Qty	EGS Serial No.
C-Nav GcGPS	1	GPS73
The EGS computerised navigation package v1.23r1 and PC	1	D525
Knudsen 320M single beam echo sounder	1	ESD19
Reson multibeam echo sounder	1	SWA06
Swath PC	1	D595
Boomer	1	LVB007
Hydrophone	1	HYD16
EGS TVG console	1	TVG11
Waverley recorder	1	GPR12
EdgeTech 272 side scan sonar system with digital tow fish	1	SSS39A
Side scan transceiver	1	SSS38
TSS Gyro compass	1	HMC34
TSS 320B heave motion compensator (for SBES)	1	HMC21
TSS DMS 3-05 motion sensor (for MBES)	1	HMC34
Valeport velocity profiler	1	SVP12
Generators, spares	Various	n/a

4 LOCATION CONTROL

4.1 Horizontal

4.1.1 Basic Method

The survey vessel was located with a Globally Corrected Global Positioning System (GcGPS) unit called C-Nav, for which no shore based differential correction transmitter is required. The system provides corrected positions to an accuracy of +/- 0.3m without the need for a shore-based transmitting system.

4.1.2 Computerised Navigation

The EGS computerized navigation system was added to the positioning system to control the steering of the boat along the traverses specified, and to log all horizontal and vertical control data.

This system provides the user with a dynamic analogue and digital screen display on which the following are continuously updated:

- Skewed grid set parallel to the desired line direction;
- Boat position;
- Water depth;

- Date and Time; and
- GcGPS diagnostics enabling quality control.

Other information displayed for the assistance of the hydrographic surveyor includes, course, speed, fixing status, and coordinates on the National Grid (in this case, the Hong Kong Metric Grid), as well as a number of other user-defined options for marine surveying.

4.1.3 Calibration, Accuracy and Quality Assurance

The positioning system was calibrated by checking the co-ordinates displayed by the navigation system at the previously co-ordinated point located at Yau Ma Tei.

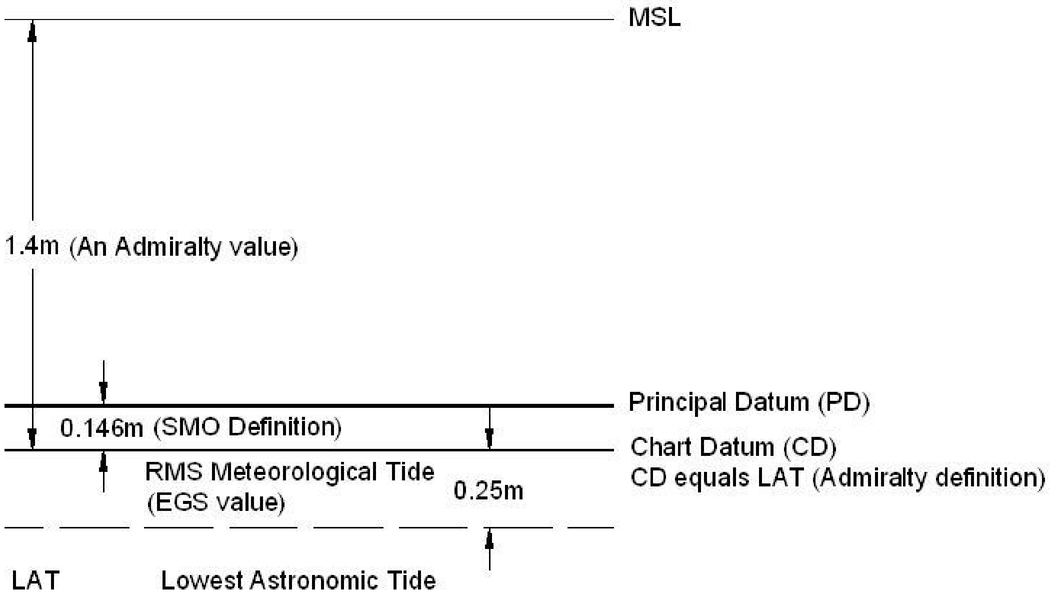
Carrying out the above quality assurance checking procedure ensured an accuracy of +/-1m or better.

4.2 Vertical

Tidal measurements were recorded at Quarry Bay and tidal data collected were used to reduce all echo sounding data to Principal Datum, Hong Kong (PD). Also routine bar checks were conducted during the survey period.

4.2.1 Datums

The datums in use or implied in Hong Kong are as follows:



LAT	Lowest Astronomic Tide
MSL	Mean Sea Level
RMS	Root Mean Square
SMO	Survey and Mapping Office, Lands Department

4.2.2 Utilization of Tidal Measurements

Based on the relationship between datums mentioned in Section 4.2.1, above, tide data collected at Quarry Bay was used by interpolation to reduce all observations to Hong Kong Principal Datum (PD).

4.3 Operating System on Board the Survey Vessels and in the Office

EGS has developed the C-View operating and interpretation software package. This system was installed on survey vessels and in the office, to carry out the following functions:

1. OPERATIONS DURING SURVEYING
   - The system provided screen displays on up to two monitors for seismic profiling and side scan systems;
   - Full operating systems coverage was provided, to enable the best survey records to be obtained; and
   - All raw data was logged digitally.

2. SUB-BOTTOM AND SIDE SCAN SONAR INTERPRETATION
   - While interpretation of SSS data was conducted with c-view software, and interpretation files were uploaded to AutoCAD without the need for further re-digitizing, seismic data interpretation was carried out on paper rolls.

5 FIELD PROCEDURES

5.1 Survey Vessels

The multibeam echo sounding, seismic reflection and side scan sonar surveys were carried out from a Class IV survey vessel, MV Wing Hung 2.

Wing Hung 2, Class IV commercially licensed survey vessel

5.2 Coverage

The survey boundary and survey traverse intervals were proposed and agreed with the client before the start of the survey:

Survey Type	Survey Spacing (m)
Swath, Seismic and Side Scan Sonar	20 x 50

5.3 Swath (Multibeam) Bathymetry

5.3.1 Arrangement of Swath Equipment on Board

Seabed level observations were made with a multibeam echo sounder system with the transducers mounted over the starboard side of the survey vessel. The GcGPS antenna was mounted directly above the transducers and as such the swath transducer acted as the datum for the survey vessel.

5.3.2 Principle

The swath system is a multibeam echo sounder. Instead of transmitting a single vertical pulse, which provides a record of water column thickness beneath the vessel track, the swath measures the same type of data over a 'fan' on both sides of the vessel.

5.3.3 Calibration

For errors to be avoided, the MBES system requires careful calibrations. A potential source of error relates to the speed of sound in water; the MBES system requires the speed of sound be measured through the water column, and for these data to be entered into a file which is accessed by the MBES acquisition and processing software. In addition, due to the fact that the speed of sound can vary significantly near the sea surface, a speed velocity probe is installed at MBES transducer so that measurements are recorded at all times during the survey and the corresponding corrections can be made within the MBES system in real-time

In addition, a patch test is required to calibrate system components, as follows:

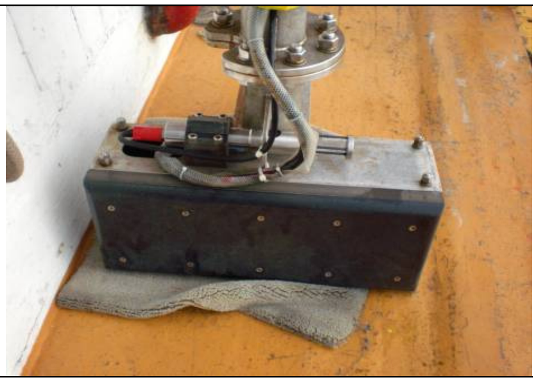
1. Navigation Delay
   A survey line is set exactly over a well-defined feature, such as a rock outcrop, a significant slope or a man-made structure. The line is run twice in the same direction, once at the slowest possible speed and once at the highest speed.

2. Pitch Offset
   A survey line is set exactly over a well-defined feature. The line is run in opposite directions at the same speed.

3. Roll Offset
   A survey line is set over an area with a flat and featureless seabed. The line is run in opposite direction at the same speed.

4. Yaw (Heading) Offset
   Two parallel lines are set to either side of a well-defined feature with the feature positioned in the middle of the two lines. The off-track distance between the feature and the lines are selected according to water depth and the fan width of the MBES system, so that the feature will be detected at the outer part of sounding "fan". The lines are run in the same direction at the same speed; once passing the feature to Port and once to Starboard.

By applying appropriate algorithms to match the apparent differences in the positions of the selected feature and the seabed topography measured in the individual calibration line, these calibration factors can be determined and are entered into the acquisition system to correct the seabed level measurements in real-time.

	
Illustrations of swath bathymetry systems	The transducer of the swath system

5.4 Side Scan Sonar Survey

Prior to the commencement of survey, the side scan sonar system was wet tested to ensure the system working properly.

The side scan sonar tow fish was towed behind the vessel at a depth of about 4-10m beneath the sea surface to ensure sufficient data coverage.

The recording parameters for the side scan survey were as follows:

- Vessel speed: 1.5 – 2.0 m/sec
- Fix interval: 10 seconds
- Source frequency: 500 kHz
- Pulse length: 25 *us*
- Gain setting: Manually controlled
- Slant range: 50m

All data was logged to the C-View SDMP where one channel (500kHz port and starboard) was simultaneously recorded with navigation, fix, vessel heading, cable out angle and length, fish heading, water depth.

Detailed log sheets were recorded with unique survey line number, start fix and end fix of each survey line, survey time, SSS range, frequency and cable out value and angle. The corresponding C-View data file name was also recorded in these log sheets.

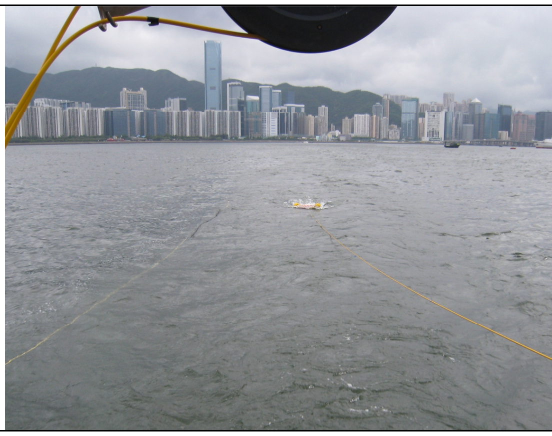
EdgeTech 272 was used in the side scan sonar survey

5.5 Seismic Reflection Survey

Prior to the commencement of survey the EGS LVB boomer was wet tested to ensure the working status of the system. The EGS boomer was towed from the stern of the survey vessel, at a distance of 23m behind such that noise induced by the survey vessel was kept to minimum.

The recording parameters for the seismic reflection survey were as follows:

- Vessel Speed: 1.5 – 2.0m/sec
- Fix Interval: 10 seconds
- Sweep: 80ms (paper)
- Delay: 0ms
- Gain setting: manually controlled

	
Seismic acquisition and printing system	The EGS boomer and hydrophone were towed astern of the vessel for sub-bottom seismic profiling

5.6 Site Safety

Onboard safety measures were generally in accordance with the 'Marine Geophysical Operations Safety Manual' (International Association of Geophysical Contractors, Ninth Edition, 2004).

In particular, site safety was assured by adopting the following measures:

- All high voltage electrical devices were installed in steel containment boxes, and operated well away from other site personnel.

- A first aid box was carried at all times.

- Only Class IV commercially licensed vessels which fitted with all prescribed safety equipment were used.

- A mother boat was standby close to the survey area to ensure a safe and secure condition during speedboat survey.

- The survey vessel was in contact with Port Control through the marine radio.

5.7 Quality Assurance

Quality was assured by adopting the measures set out in the EGS ISO9001 Quality Handbook.

6 REDUCTION OF OBSERVATIONS AND INTERPRETATION

6.1 Sounding and Swath (Multibeam) Data

For sounding readings, the influence of wave action was corrected in real time by the TSS heave motion compensator. The smoothed sounding data was then reduced to levels below Principal Datum (PD) using the measured tide levels.

Tidal correction and filters were applied before the swath data sets were edited manually. Judgement was required at this stage, to identify small features which were real reflections from low-level noise; for guidance, two or more mutually consistent soundings which were higher or lower than the general sea bed level were accepted, especially if the same anomalous soundings were present on separate survey traverses.

Gridded sounding selection was used for engineering purposes. The selection procedures for this project were as follows:

1. The processed data were gridded to 1m spacing dataset. The 1m gridded dataset has been presented here as En, Nn, Zn, in ASCII format on disc. During the gridding process, median sounding values were used;

2. These gridded data were then plotted at a spacing of 6mm at the charting scale, to provide a sounding plan for the whole area surveyed; and

3. This gridded plot was contoured using the 1m spacing dataset and coloured using 'C-View Bathy' processing and charting software, to provide the sounding plans.

6.2 Side Scan Sonar Data

Processing and interpretation of side scan sonar data was carried out using the C-View interpretation software. All features were individually marked or grouped into regions using on-screen digitising. All offsets and laybacks were applied to the C-View system. The subsequently generated interpretation files were then imported to the Auto CAD environment on a line by line basis where the interpretation and a detailed check was performed.

The interpretation of the side scan sonar records in this area had sought to quantify the following elements and features on the seabed:

- Unidentified Objects;
- Seafloor with fine sediments;
- Area badly polluted with debris and objects;
- Disturbed seafloor with dumped materials and debris; and
- Disturbed seafloor with trawl marks and anchor marks.

6.3 Seismic Data

6.3.1 General

The quality of the seismic records was good and acceptable. However, large part of the survey area was affected by organic masking, which is described in section 6.3.3 below.

6.3.2 Interpretation of the Geological Succession

The interpretation of the seismic records has sought to quantify the following four elements of the offshore geological succession:

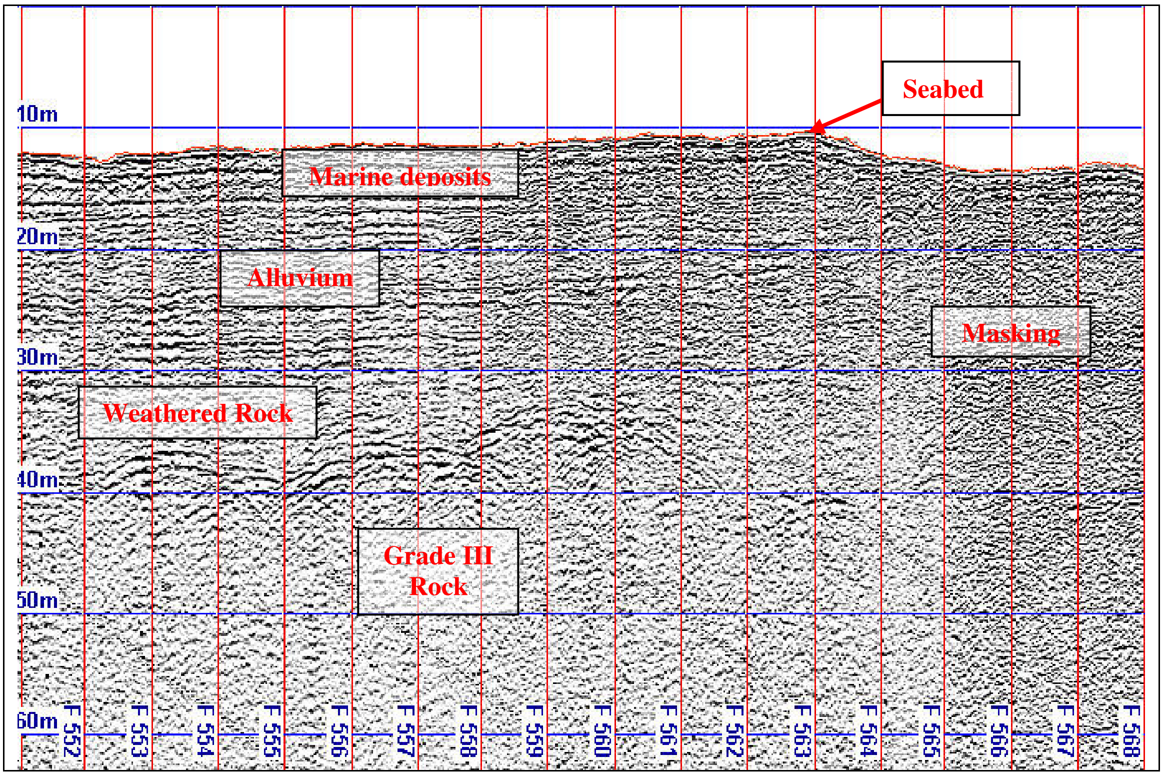
Geological Unit	Event
Sea bed	N/A
Marine Deposits of Holocene age (Hang Hau Formation)	The base of these deposits occurred during the last ice age
Alluvium (Chek Lap Kok Formation; mainly coarse sediments with gravels)	Up to four ice ages occurred during the Pleistocene

Marine Deposits are generally soft or very soft clays or silts, and as such are readily identifiable on seismic records as a clear conformable horizon sometimes with an unconformity represented by a desiccated layer or by local re-working of deposits by the water currents regime.

Interpretation was carried out as follows:

- The seismic horizons were selected for interpretation in accordance with the list above, and drawn on copies of the seismic records during preliminary interpretation.
- All traverse crossing points were then calculated, and marked on the seismic records.
- The records were then physically correlated at all of these points.
- Finally, the correlated horizons were digitized, plotted and contoured.

An example of the seismic data from the survey.



6.3.4 ORGANIC MASKING

The quality of seismic data was adversely affected by masking. Half of the survey area, especially the coastal area, was covered by masking. The masked zones are outlined in relevant Chart Figures 5-10 presented in Annex 10.D.1. Very little useable seismic data could be obtained over these masked zones.

Masking is caused by the presence of organic materials and gas bubbles in the water column and in the sediments which absorb the seismic energy and thereby preventing reflections from deeper horizons. In this case, it is believed that discharged water plays an important role in creating the masking on seismic data.

7 RESULTS

7.1 Presentation

The results have been presented as follows:

DRAWINGS

Chart Figure 1	Swath Bathymetry Track Plot
Chart Figure 2	Seismic and Side Scan Sonar Track Plot
Chart Figure 3	Colour Contoured Swath Bathymetry Plan
Chart Figure 4	Seabed Features
Chart Figure 5	Contoured Levels at the Base of Marine Deposits
Chart Figure 6	Contoured Levels on Top of Rock in Any State of Decomposition
Chart Figure 7	Contoured Levels on Top of Presumed Moderately Decomposed Rock
Chart Figure 8	Contoured Isopachs of Marine Deposits
Chart Figure 9	Contoured Isopachs of Alluvium
Chart Figure 10	Contoured Isopachs of Rock in Any State of Decomposition

The drawings are presented in Annex D.1

7.2 Data Coverage — CHART FIGURES 1 AND 2

Tracks are defined as follows:

POSITION/TRACK TYPE	DEFINITION
Swath bathymetry track	This is the track of swath system used to define seabed levels
Seismic and side scan sonar track	Seismic and side scan sonar surveys have been conducted simultaneously

7.3 Contoured Sounding Plan — CHART FIGURE 3

The seabed is generally flat with depths vary from -5.0mPD (close to the coast) to -14.6mPD.

The most obvious feature on the sounding plan is the channel running across the centre part of the survey area. Its depths vary between -11.6mPD to -14.6mPD and was formed by dredging in the past.

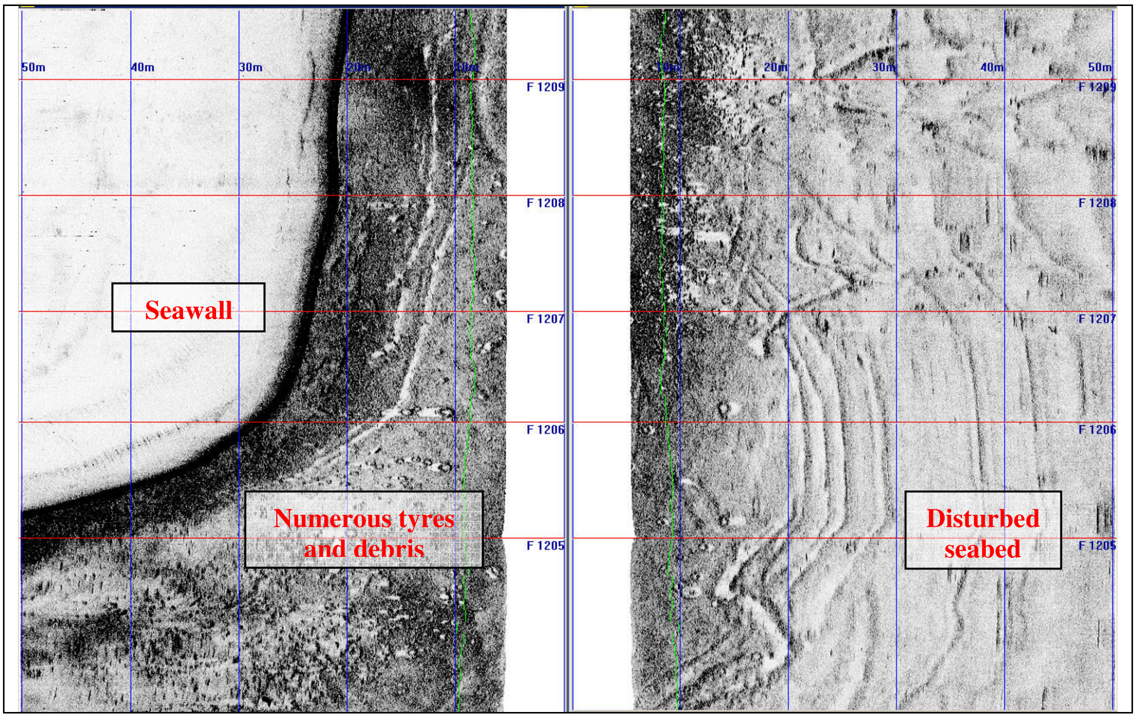
7.4 Seabed Features

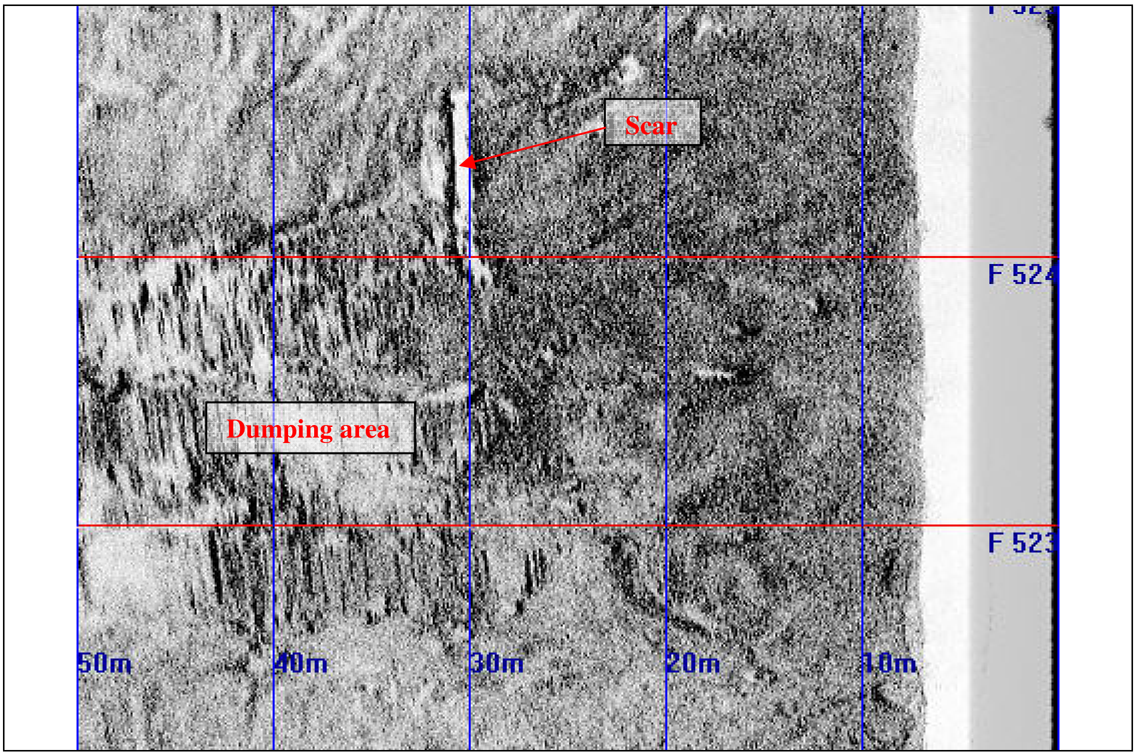
CHART FIGURE 4

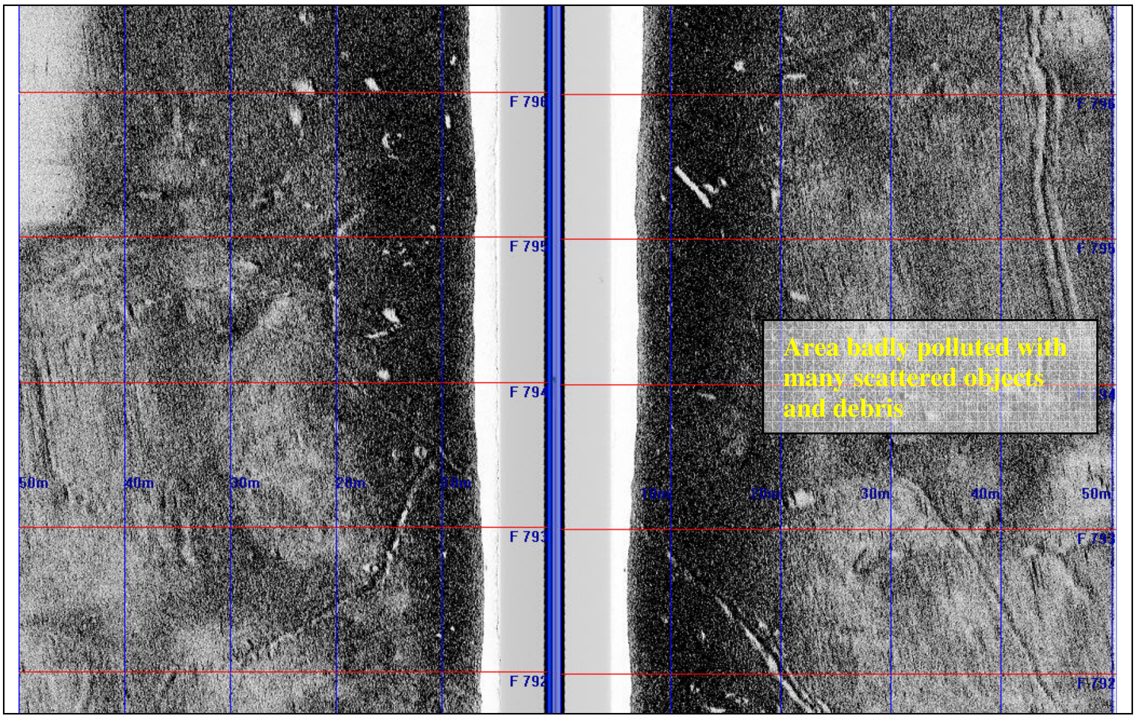
As shown on the drawing, the survey area was covered with soft and fine sediments with numerous scars and debris. Dumping areas were scattered over the entire survey area and there was a dredged channel across the centre part of the survey area, which was in good agreement with the bathymetric data.

Thirty sonar contacts, WH2-SC001 to WH2-SC030 were identified from the survey. Details of the contacts including position, dimension and description are presented in Annex 10.D.2 of this report. Images of the sonar contact from both side scan sonar data and bathymetric data are also captured and presents as Annex 10.D.3 of the report.

Examples of side scan images are shown below for reference.




Scar
F 524
Dumping area
F 523
50m
40m
30m
20m
10m


F 796
F 795
F 794
F 793
F 792
Area badly polluted with many scattered objects and debris

7.5 Marine Deposits — CHART FIGURES 5 AND 8

Figure 5 illustrates the general regime of the base of the marine deposits. It varies from -15.5mPD to -18.4mPD in general.

Isopachs of marine deposits are presented on Chart Figure 8. The layer of marine deposit is quite uniform with thickness generally around 4m to 6m. In area adjacent to the masking zone near the southern survey boundary, the layer is thinner with thickness around 2.5m to 3.5m.

No seismic contact was identified from the seismic records.

7.6 Alluvium — CHART FIGURES 6 AND 9

Figure 6 shows the level on the top of rock in any state of decomposition, equivalent to the base of Alluvium where present. Isopachs of Alluvium is presented on Figure 9.

The surface of base of Alluvium varies from -31.1mPD at the north near the masking zone and gradually getting deeper to maximum around -39.6mPD near the southern survey boundary.

Thickness of the layer of Alluvium varies from 14.6m to 23.0m. It is thinner at the north near the masking zone and gradually getting thicker to the south.

7.7 Rock in Any State of Decomposition — CHART FIGURES 7 AND 10

The topographic variation of the base of rock in any state of decomposition corresponds to the top of moderately decomposed rock. This horizon is presented in Figure 7.

The rock head level varies from -29.4mPD at the north near the masking zone and gradually drop down to maximum -58.4mPD near the south western survey boundary.

Isopachs of Rock in any state of decomposition are presented in Figure 10.

Rock in any state of decomposition is missing in area at the northern survey boundary. The maximum thickness of rock in any state of decomposition is about 19.4m near the centre part of the interpreted survey area.

8 ACCURACY

8.1 Accuracy of Sea bed Levels

In theory, at least the following factors can affect the overall accuracy of an echo sounding survey:

- Incorrect bench mark level*
- Settlement of bench mark between successive surveys*
- Error in setting up the tide gauge*
- Reading off errors of the tide gauge data

- Surveyor bias in sea bed interpretation
- Incorrect removal of the effects of waves
- The (inevitable) assumption that there is no water surface gradient between the tide gauge and the survey boat from time to time
- Variations in the salinity of the sea water across the survey period which in turn affect the speed of sound in water
- Minor errors in the bar checks*
- Error in horizontal control*
- Beam width of the transducer
- Variations in boat 'balance'
- Manufacturer's stated echo sounder accuracy*

The Quality Assurance procedure seeks to eliminate many of the above factors (marked *)

However, some errors perforce remain such that even under ideal sea state conditions, the minimum error will be +/- 0.15m.

8.2 Accuracy of Sub-sea bed Horizons

The two states of decomposition that can be interpreted are the top of the solid geology of whatever Grade, and Grade III (moderately) decomposed rock.

It should be noted that it is particularly difficult to determine the state of decomposition of the solid geology from seismic evidence alone. However, no drillhole record is available for correlation within or in the vicinity of the survey area.

8.3 Presentation of Data in Contoured Form

Presentation of data in contoured form implies knowledge of the level of each horizon between survey lines. The extent to which such interpolation is justified depends on the traverse separation, and on the topographic relief of the horizon in question.

Where traverses are closely spaced and for smooth horizons, the interpolation error will be small, but for surfaces the level of which fluctuates rapidly, errors between survey lines could greatly exceed the estimates given below.

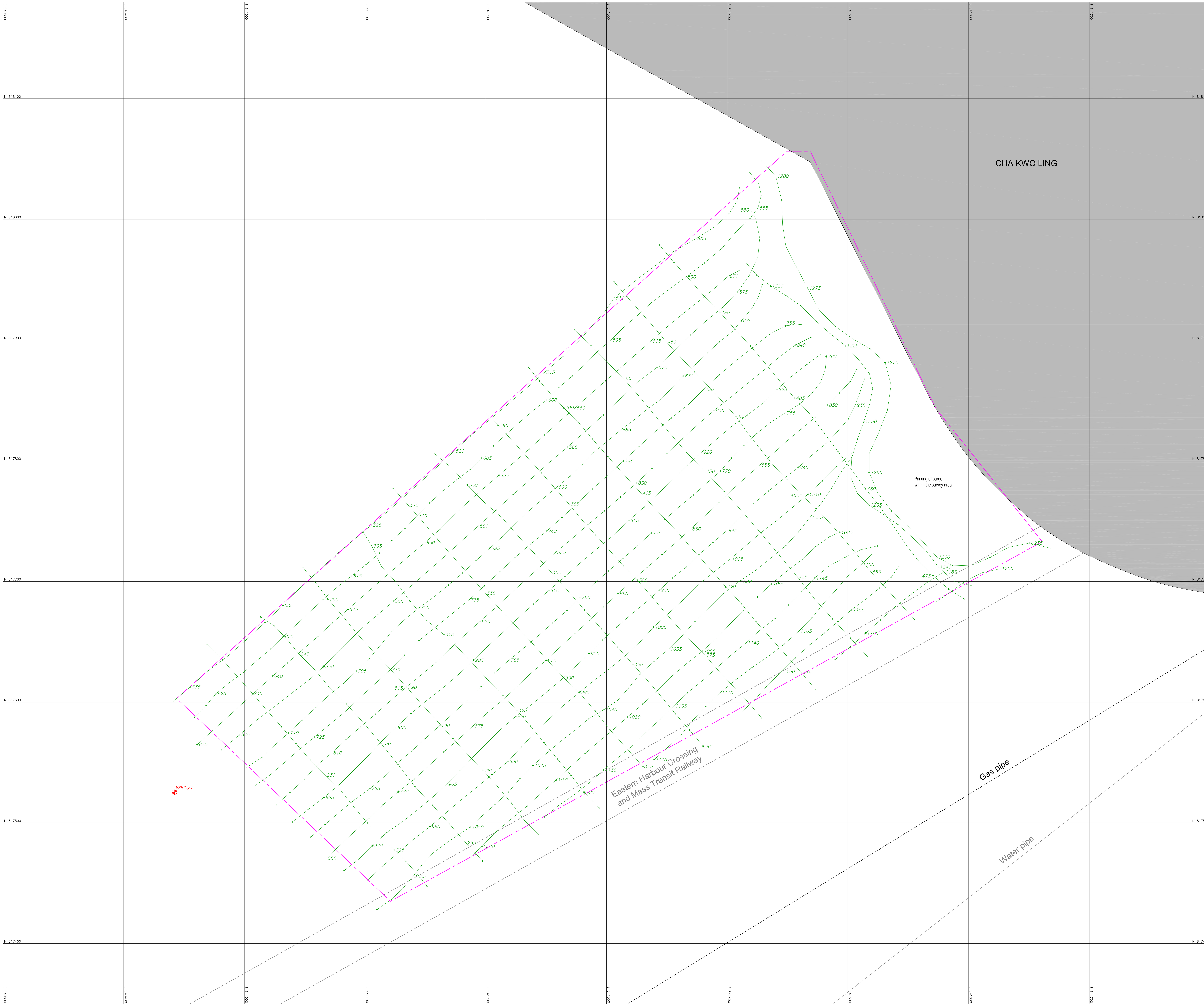
8.4 Estimates of Accuracy, All Horizons

The following estimates of accuracy would seem to be appropriate in this case:

Sounding	+/- 0.15m
Seabed features	+/- 3 m
Base of Marine Deposits	+/- 1 m
Top of Rock in Any State of Decomposition	+/- 2 m
Top of Grade III, II Rock	+/- 5 m

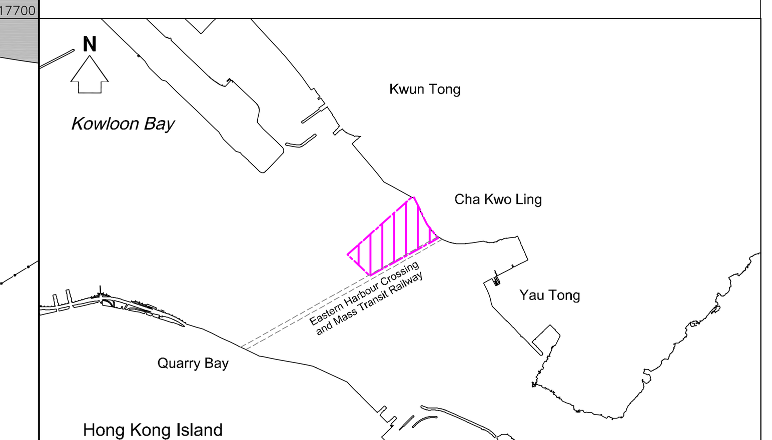
ANNEX D.1

CHART FIGURES



Legend :

- 760 — Swath bathymetry track with fix positions
- Survey boundary
- Gas pipe
- Water pipe
- MBH71/1 — Drillhole position



Location Plan

Project :

WORKS ORDER NUMBER GE/2010/02.7
AGREEMENT NO. CE 38/2008 (HY)
KAI TAK DEVELOPMENT - TRUNK ROAD T2 AND INFRASTRUCTURE AT SOUTH APRON - INVESTIGATION, DESIGN AND CONSTRUCTION

FIGURE NUMBER : 1

Drawing Title :

SWATH BATHYMETRY TRACK PLOT

Notes :

1. Survey Date : 24/06/2010
2. Survey Grid : HK1980 Grid System
3. Survey Datum : Hong Kong Principal Datum
4. Positioning : C–Nav GcGPS (Globally corrected GPS)
5. Equipment : Knudsen 320M Echo Sounder
   Reson Multibeam Echo Sounder
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
0	08/07/2010	Chester Quek	Margie Chen	R. E. Hale	Preliminary
1	05/08/2010	Chester Quek	Margie Chen	R. E. Hale	Final

METRIC SCALE 1:1,000

50 40 30 20 10 0 50 100

Client : Civil Engineering and Development Department

Surveyor : EGS (ASIA) LIMITED
9/F SOUTH, SOMERSET HOUSE, TAIKOO PLACE, 979 KING'S ROAD, QUARRY BAY, HONG KONG
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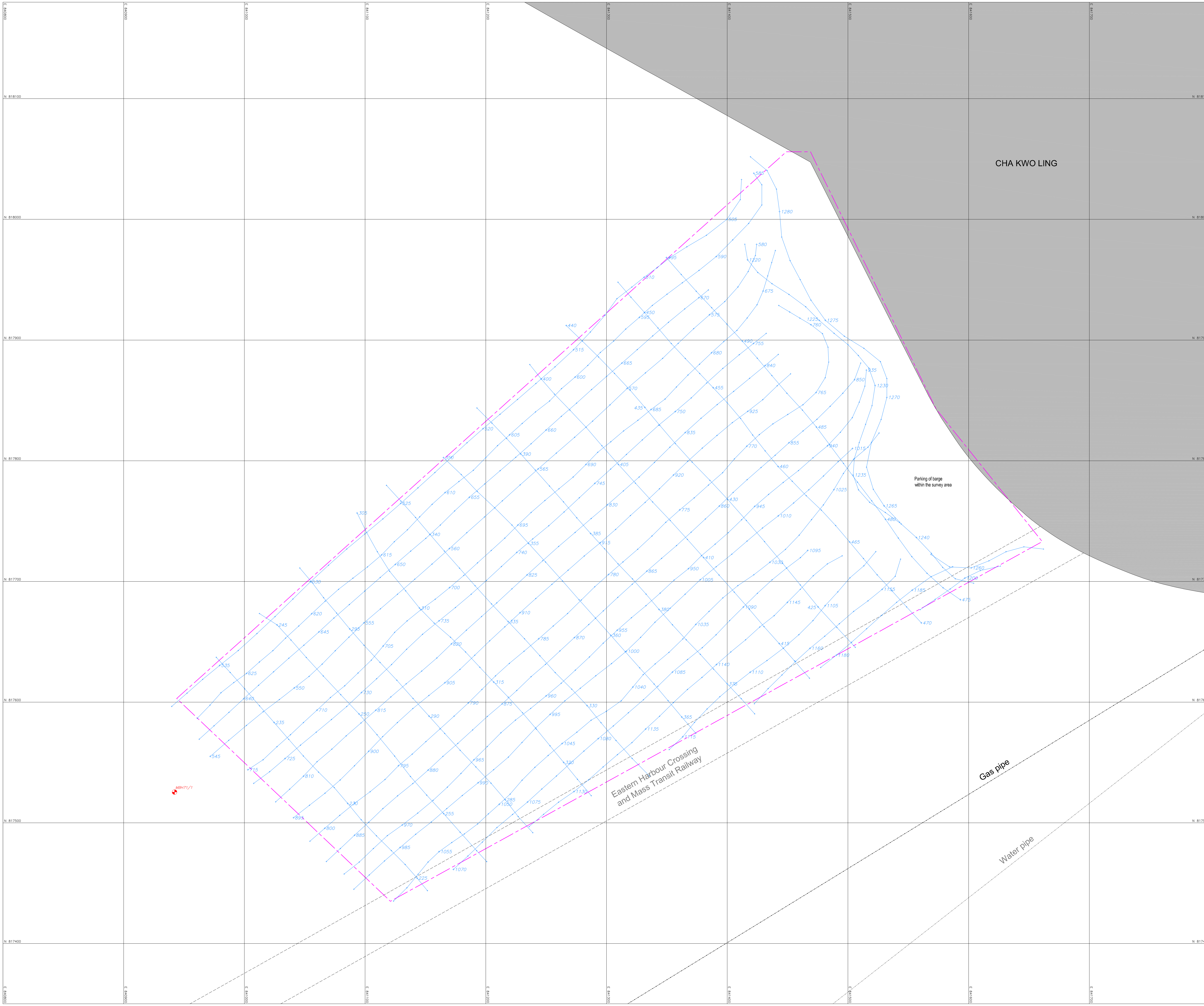
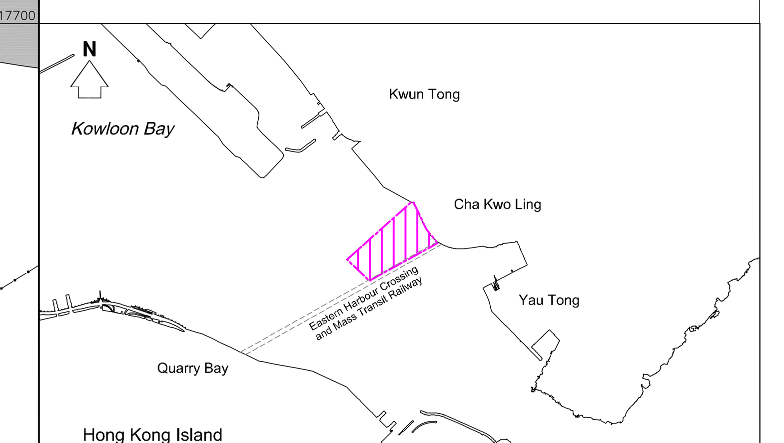
Fax: (852) 25763590
Web: www.egssurvey.com
EARTH SCIENCES & SURVEYING

JOB NO. : HK220410





Location Plan

Project :

WORKS ORDER NUMBER GE/2010/02.7
AGREEMENT NO. CE 38/2008 (HY)
KAI TAK DEVELOPMENT - TRUNK ROAD T2 AND INFRASTRUCTURE AT SOUTH APRON - INVESTIGATION, DESIGN AND CONSTRUCTION

FIGURE NUMBER : 2

Drawing Title :

SEISMIC AND SIDE SCAN SONAR TRACK PLOT

Notes :
1. Survey Date : 24/06/2010
2. Survey Grid : HK1980 Grid System
3. Survey Datum : Hong Kong Principal Datum
4. Positioning : C-Nav GcGPS (Globally corrected GPS)
5. Equipment : EGS Boomer System
   Knudsen 320M Echo Sounder
   EdgeTech 272 Side Scan Sonar System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
0	08/07/2010	Chester Quek	Margie Chen	R. E. Hale	Preliminary
1	05/08/2010	Chester Quek	Margie Chen	R. E. Hale	Final

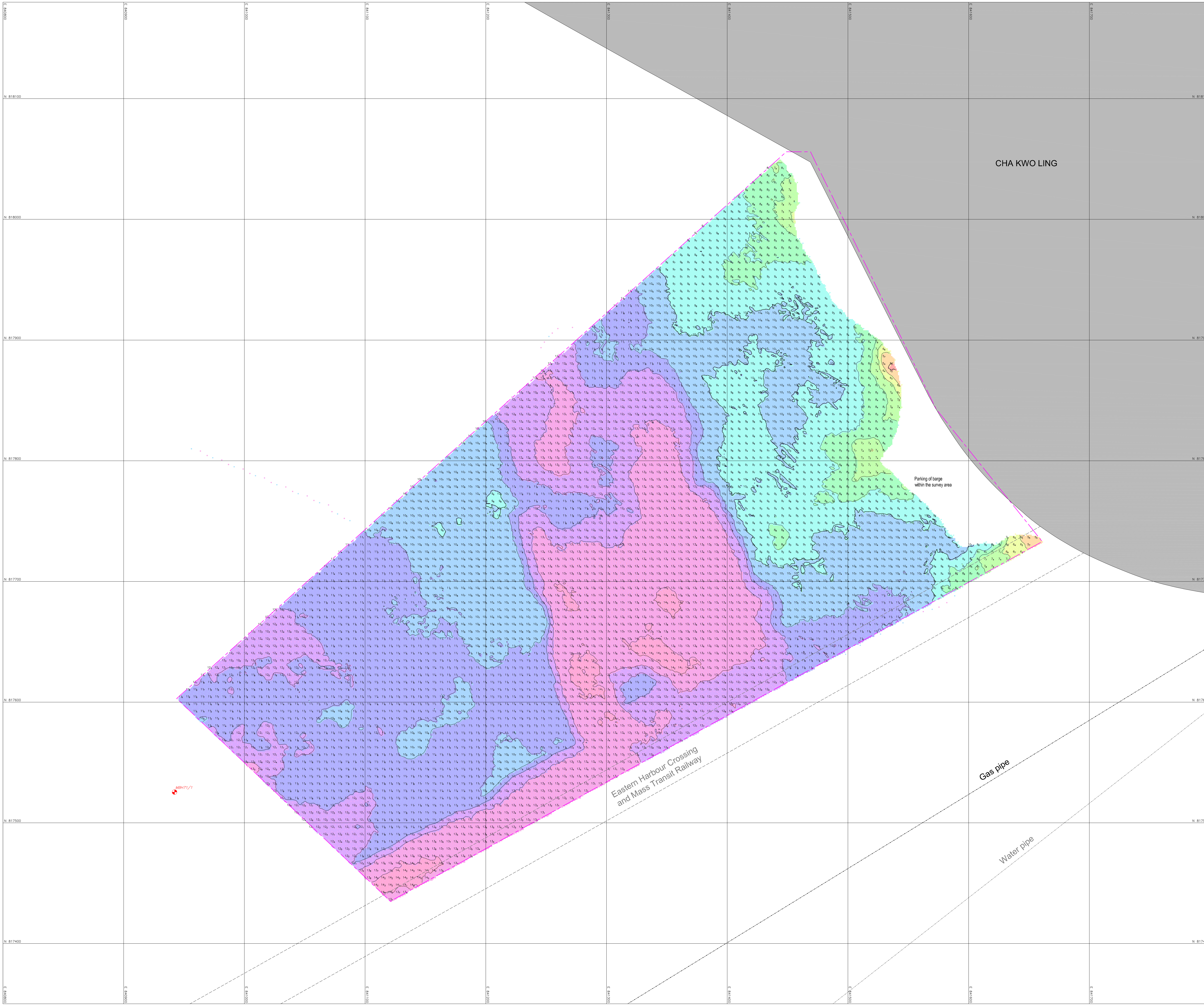
METRIC SCALE 1:1,000

50 40 30 20 10 0 50 100

Client : Civil Engineering and Development Department

Surveyor : EGS (ASIA) LIMITED
9/F SOUTH, SOMERSET HOUSE, TAIKOO PLACE, 979 KING'S ROAD, QUARRY BAY, HONG KONG
Tel: (852) 28948622
Fax: (852) 25763590
Web: www.egssurvey.com
EARTH SCIENCES & SURVEYING

JOB NO. : HK220410

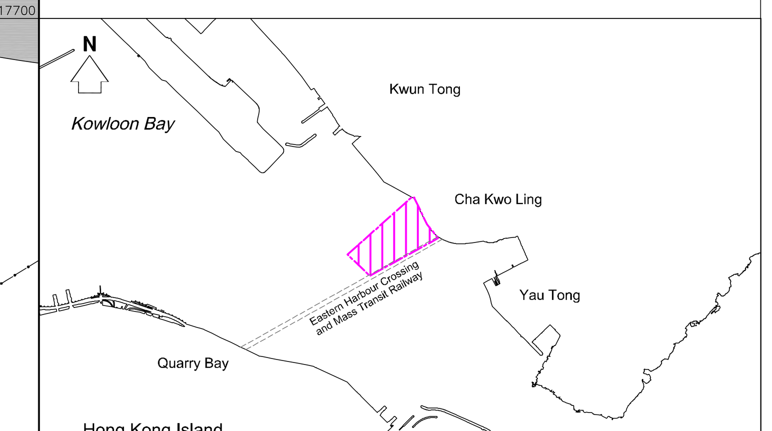


Legend :

- Gridded sounding data in metres below HKPD
- Contour at 1m interval
- Survey boundary
- Gas pipe
- Water pipe
- MBH71/1 Drillhole position

Metres below HKPD

4 5 6 7 8 9 10 11 12 13 14 15



Location Plan

Project :

WORKS ORDER NUMBER GE/2010/02.7
AGREEMENT NO. CE 38/2008 (HY)
KAI TAK DEVELOPMENT - TRUNK ROAD T2 AND INFRASTRUCTURE AT SOUTH APRON - INVESTIGATION, DESIGN AND CONSTRUCTION

FIGURE NUMBER : 3

Drawing Title :

COLOUR CONTOURED SWATH BATHYMETRY PLAN

Notes :

1. Survey Date : 24/06/2010
2. Survey Grid : HK1980 Grid System
3. Survey Datum : Hong Kong Principal Datum
4. Positioning : C–Nav GcGPS (Globally corrected GPS)
5. Equipment : Knudsen 320M Echo Sounder
   Reson Multibeam Echo Sounder
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
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1	05/08/2010	Chester Quek	Margie Chen	R. E. Hale	Final

METRIC SCALE 1:1,000

50 40 30 20 10 0 50 100

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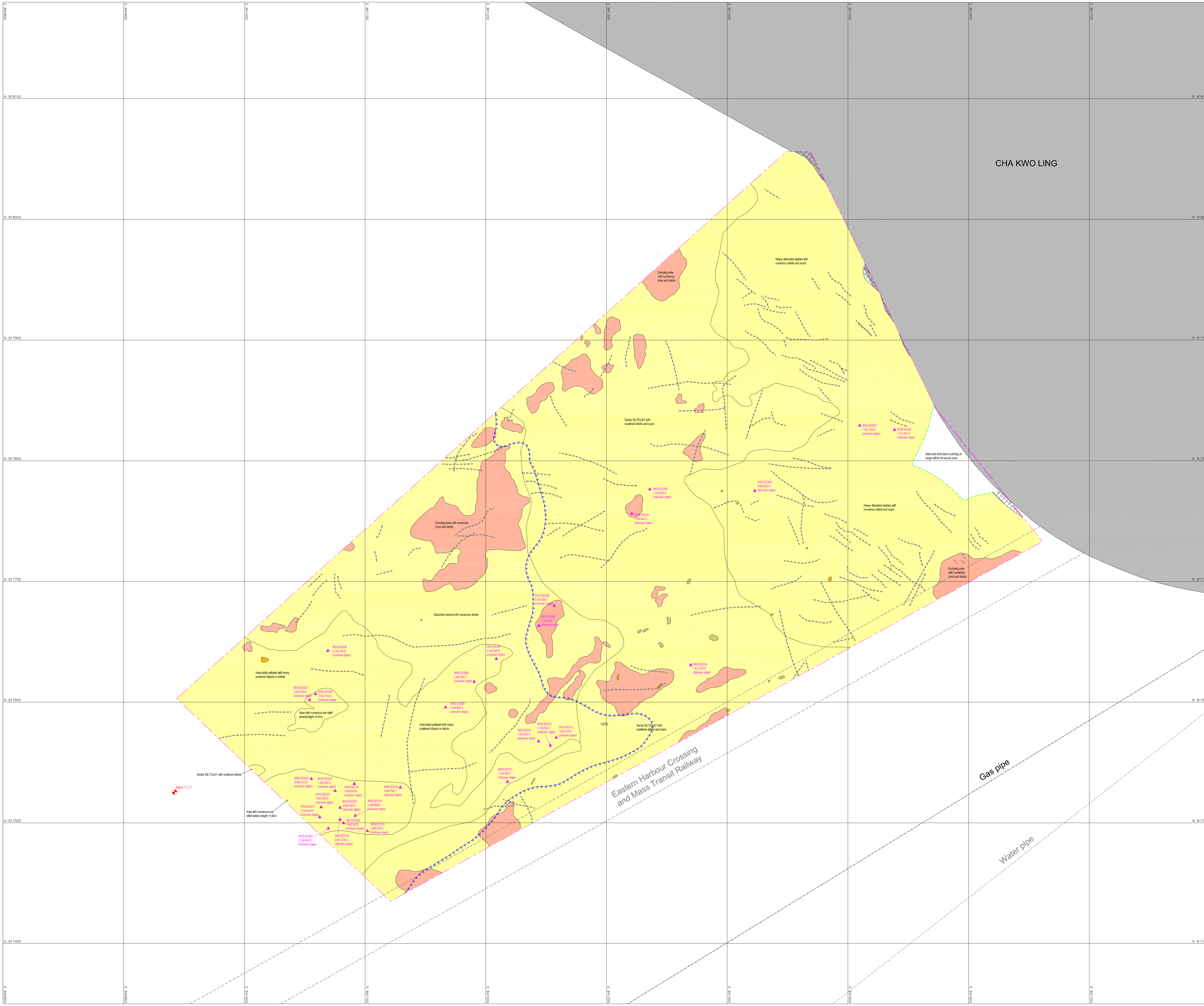
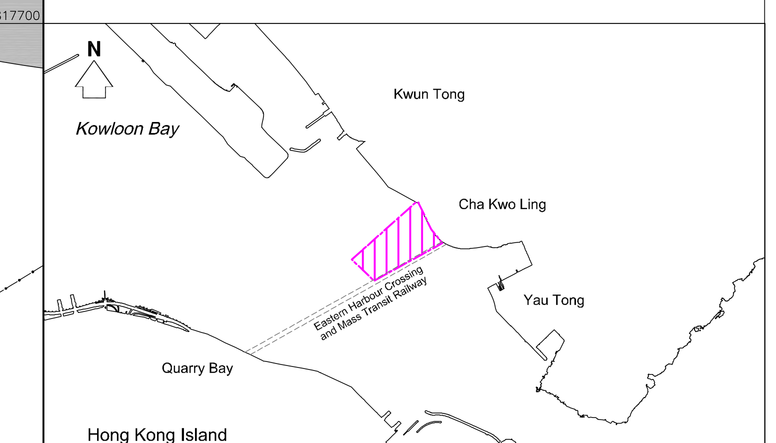


Legend :

	Survey boundary	WH2-SC001 2.7x1.4x0.4 Unknown object	Isolated sonar contact with reference number (length x width x height in metres where measurable; nmh = no measurable height)
	Sediment or feature boundary		
	Seabed scar (trawl or anchor)		
	Gas pipe		Side scan limit due to parking of barge within the survey area
	Water pipe		
MBH71/1	Drillhole position		Masking area
	SILT / CLAY		Dumping area
	Seawall		Depression area
			Debris



Location Plan

Project :

WORKS ORDER NUMBER GE/2010/02.7
AGREEMENT NO. CE 38/2008 (HY)
KAI TAK DEVELOPMENT - TRUNK ROAD T2 AND INFRASTRUCTURE AT SOUTH APRON - INVESTIGATION, DESIGN AND CONSTRUCTION

FIGURE NUMBER : 4

Drawing Title :

SEABED FEATURES

Notes :
1. Survey Date : 24/06/2010
2. Survey Grid : HK1980 Grid System
3. Survey Datum : Hong Kong Principal Datum
4. Positioning : C-Nav GcGPS (Globally corrected GPS)
5. Equipment : EdgeTech 272 Side Scan Sonar System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
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1	05/08/2010	Chester Quek	Margie Chen	R. E. Hale	Final

METRIC SCALE 1:1,000
50 40 30 20 10 0 50 100

Client : Civil Engineering and Development Department

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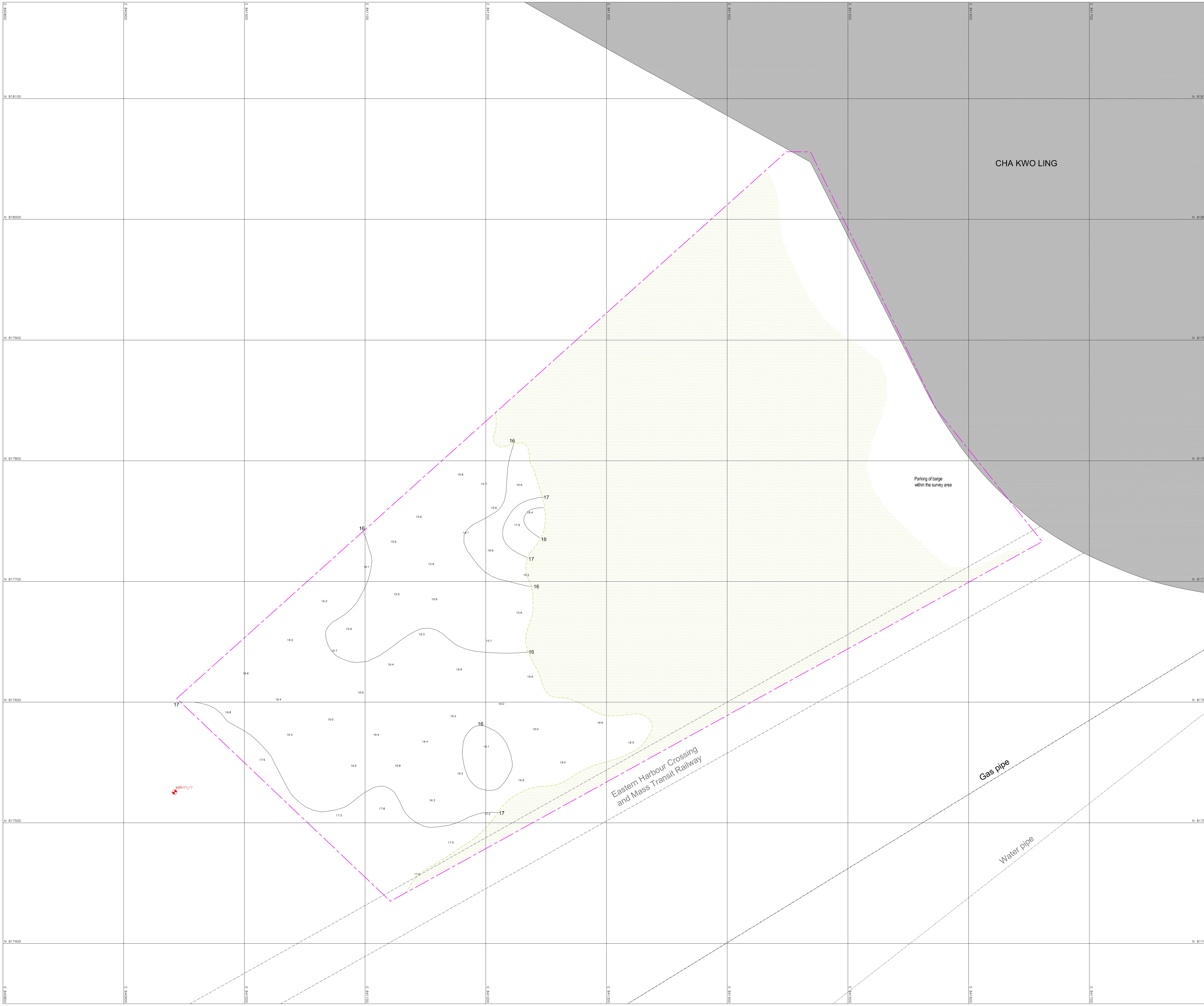
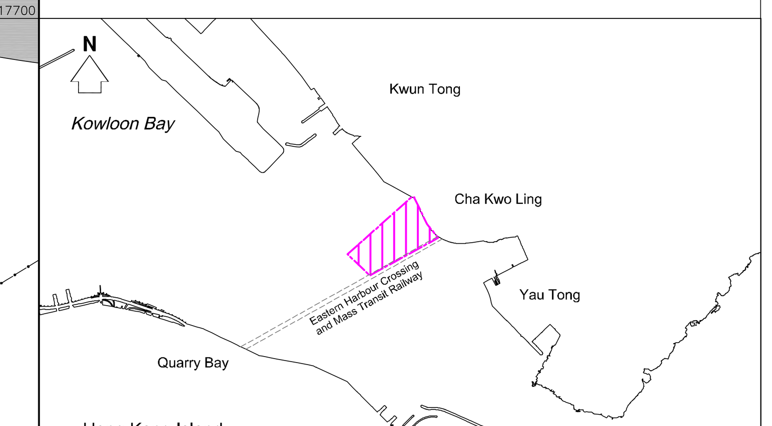


Legend :

16·9	Spot value in metres below HKPD
	Contour at 1m interval
	Survey boundary
	Gas pipe
	Water pipe
	Masking Area
MBH71/1	Drillhole position



Location Plan

Project :

WORKS ORDER NUMBER GE/2010/02.7
AGREEMENT NO. CE 38/2008 (HY)
KAI TAK DEVELOPMENT - TRUNK ROAD T2 AND INFRASTRUCTURE AT SOUTH APRON - INVESTIGATION, DESIGN AND CONSTRUCTION

FIGURE NUMBER : 5

Drawing Title :

CONTOURED LEVELS AT THE BASE OF MARINE DEPOSITS

Notes :
1. Survey Date : 24/06/2010
2. Survey Grid : HK1980 Grid System
3. Survey Datum : Hong Kong Principal Datum
4. Positioning : C-Nav GcGPS (Globally corrected GPS)
5. Equipment : EGS Boomer System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
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1	05/08/2010	Chester Quek	Margie Chen	R. E. Hale	Final

METRIC SCALE 1:1,000
50 40 30 20 10 0 50 100

Client :
Civil Engineering and Development Department

Surveyor :
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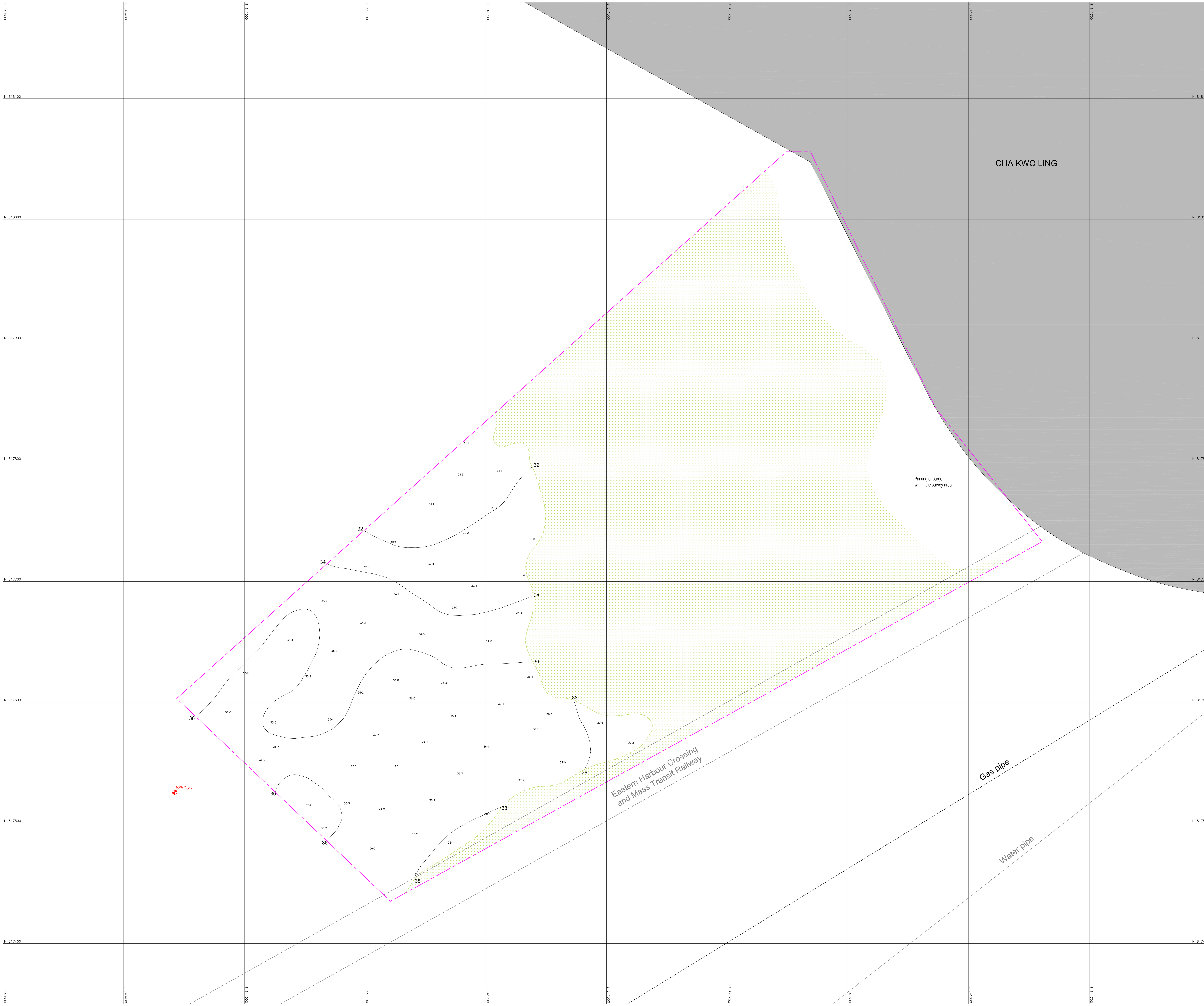

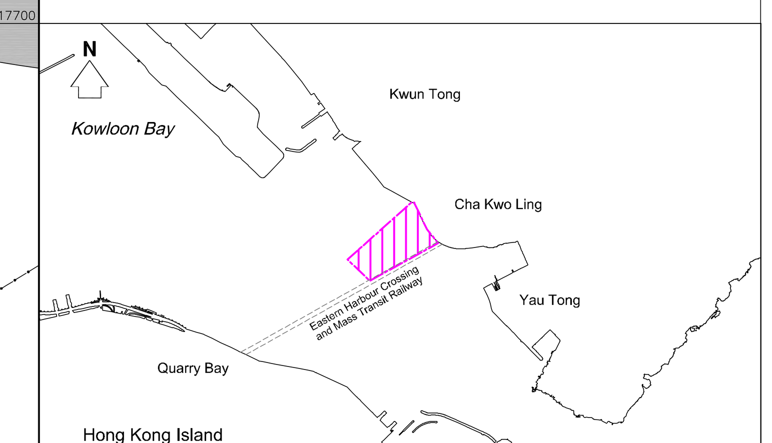

Location Plan

Project :

WORKS ORDER NUMBER GE/2010/02.7
AGREEMENT NO. CE 38/2008 (HY)
KAI TAK DEVELOPMENT - TRUNK ROAD T2 AND INFRASTRUCTURE AT SOUTH APRON - INVESTIGATION, DESIGN AND CONSTRUCTION

FIGURE NUMBER : 6

Drawing Title :

CONTOURED LEVELS ON TOP OF ROCK IN ANY STATE OF DECOMPOSITION

Notes :
1. Survey Date : 24/06/2010
2. Survey Grid : HK1980 Grid System
3. Survey Datum : Hong Kong Principal Datum
4. Positioning : C-Nav GcGPS (Globally corrected GPS)
5. Equipment : EGS Boomer System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
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1	05/08/2010	Chester Quek	Margie Chen	R. E. Hale	Final

METRIC SCALE 1:1,000

Client : Civil Engineering and Development Department

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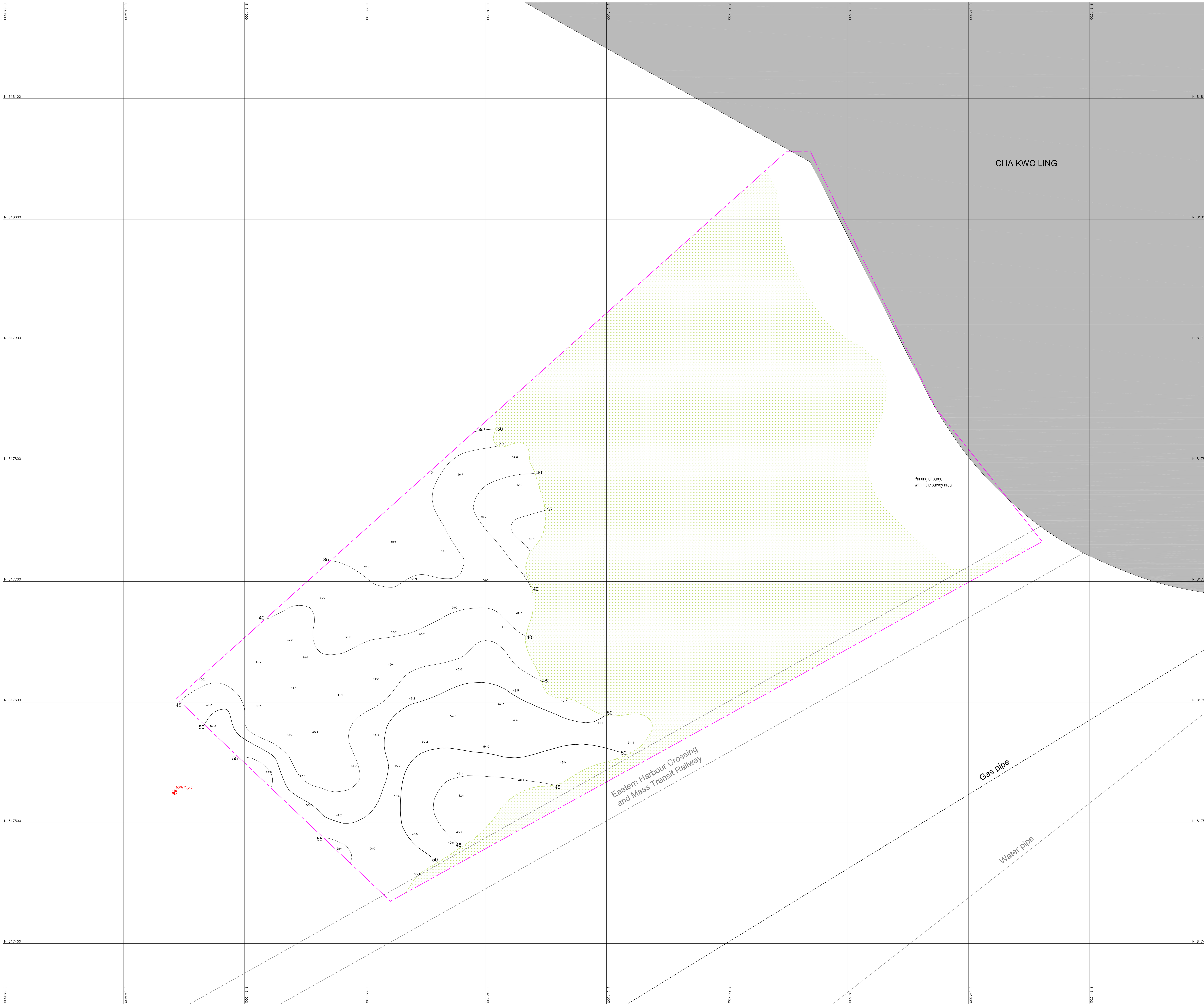
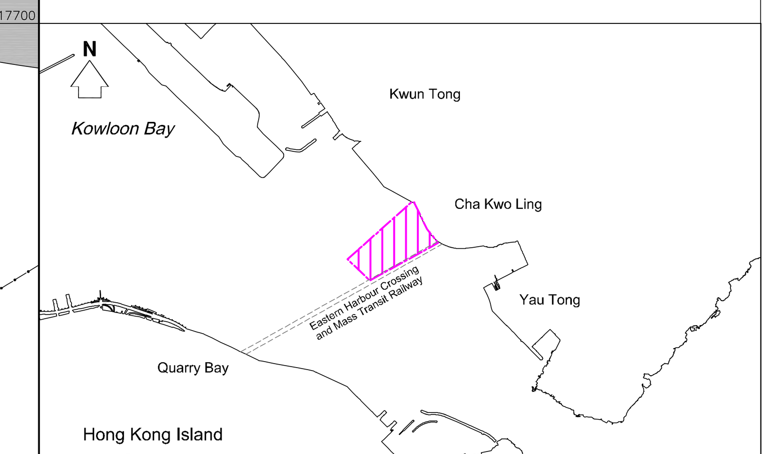


Legend :

48.2	Spot value in metres below HKPD
	Contour at 5m interval
	Survey boundary
	Gas pipe
	Water pipe
	Masking Area
MBH71/1	Drillhole position



Location Plan

Project :

WORKS ORDER NUMBER GE/2010/02.7
AGREEMENT NO. CE 38/2008 (HY)
KAI TAK DEVELOPMENT - TRUNK ROAD T2 AND INFRASTRUCTURE AT SOUTH APRON - INVESTIGATION, DESIGN AND CONSTRUCTION

FIGURE NUMBER : 7

Drawing Title :

CONTOURED LEVELS ON TOP OF PRESUMED MODERATELY DECOMPOSED ROCK

Notes :
1. Survey Date : 24/06/2010
2. Survey Grid : HK1980 Grid System
3. Survey Datum : Hong Kong Principal Datum
4. Positioning : C-Nav GcGPS (Globally corrected GPS)
5. Equipment : EGS Boomer System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
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1	05/08/2010	Chester Quek	Margie Chen	R. E. Hale	Final

METRIC SCALE 1:1,000

50 40 30 20 10 0 50 100

Client :

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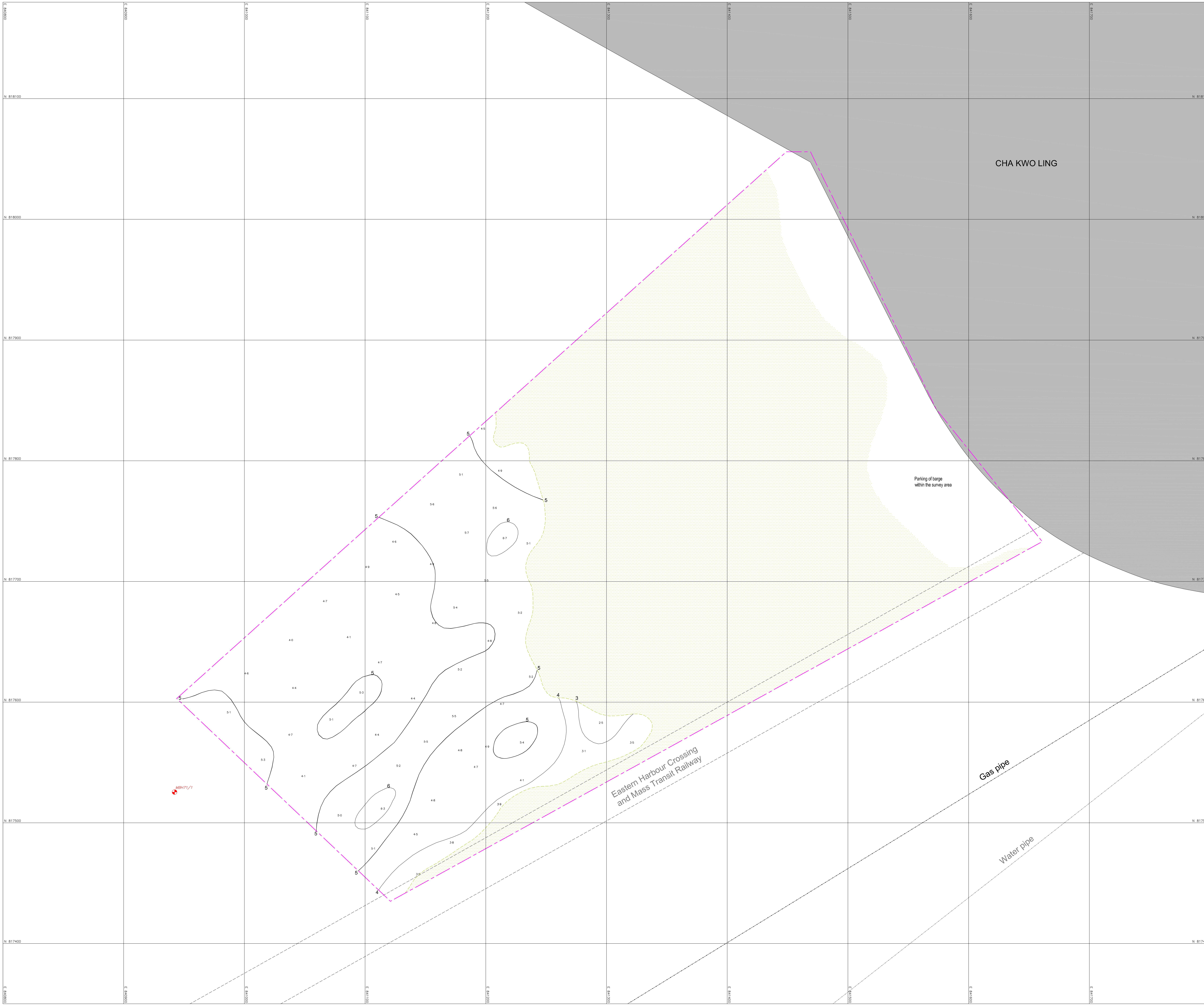
Surveyor :

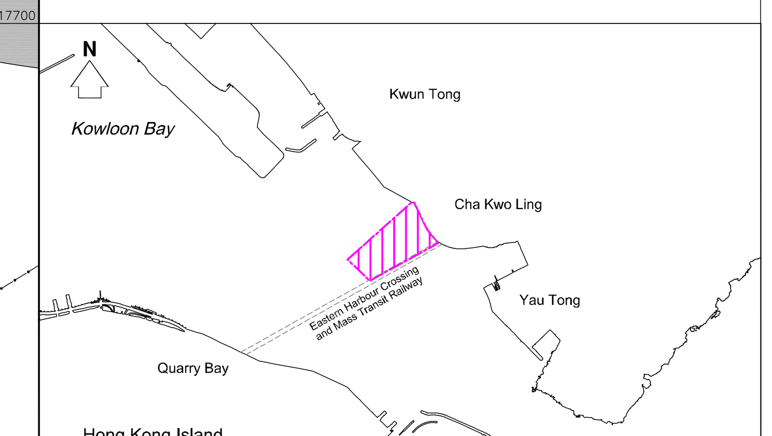
EGS (ASIA) LIMITED

JOB NO. : HK220410



Legend :

4·8	Isopachs value in metres (thickness of the layer)
	Contour at 1m interval
	Survey boundary
	Gas pipe
	Water pipe
	Masking Area
MBH71/1	Drillhole position



Location Plan

Project :

WORKS ORDER NUMBER GE/2010/02.7
AGREEMENT NO. CE 38/2008 (HY)
KAI TAK DEVELOPMENT - TRUNK ROAD T2 AND INFRASTRUCTURE AT SOUTH APRON - INVESTIGATION, DESIGN AND CONSTRUCTION

FIGURE NUMBER : 8

Drawing Title :

CONTOURED ISOPACHS OF MARINE DEPOSITS

Notes :
1. Survey Date : 24/06/2010
2. Survey Grid : HK1980 Grid System
3. Survey Datum : Hong Kong Principal Datum
4. Positioning : C-Nav GcGPS (Globally corrected GPS)
5. Equipment : EGS Boomer System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
0	08/07/2010	Chester Quek	Margie Chen	R. E. Hale	Preliminary
1	05/08/2010	Chester Quek	Margie Chen	R. E. Hale	Final

METRIC SCALE 1:1,000

50 40 30 20 10 0 50 100

Client : Civil Engineering and Development Department

Surveyor : EGS (ASIA) LIMITED
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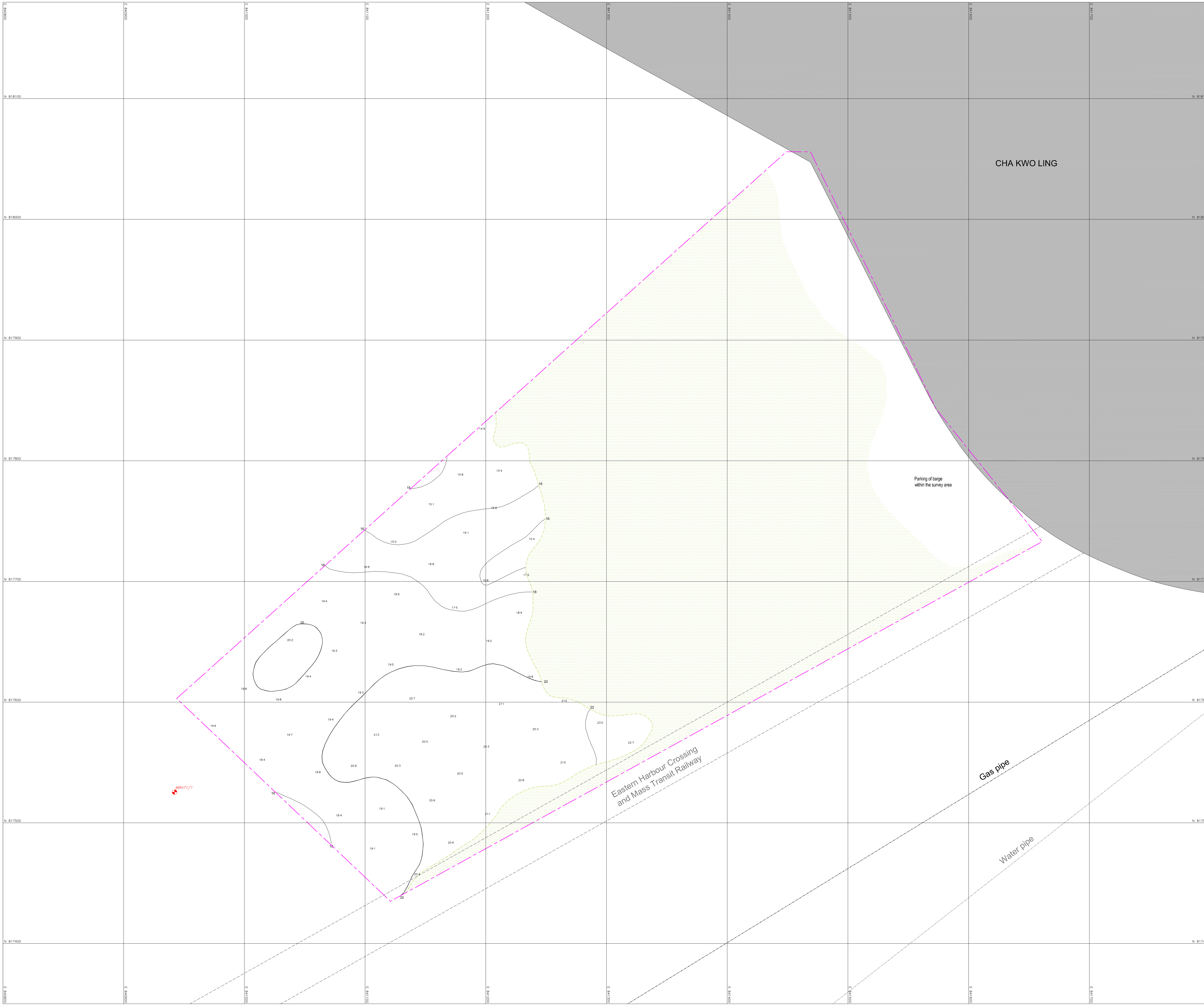
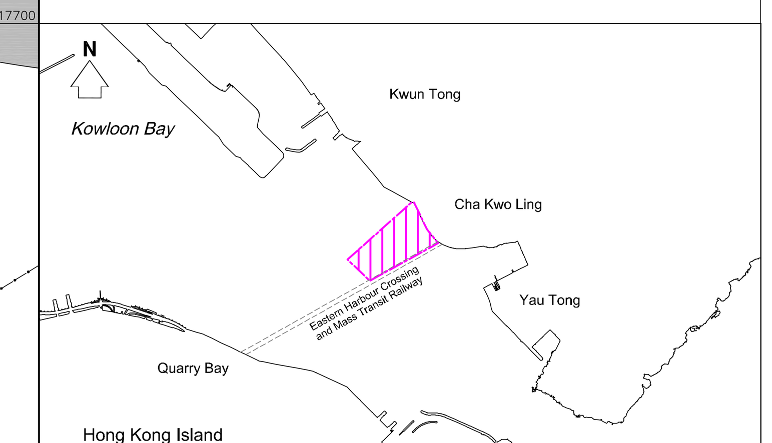


Legend :

19·5	Isopachs value in metres (thickness of the layer)
	Contour at 2m interval
	Survey boundary
	Gas pipe
	Water pipe
	Masking Area
MBH71/1	Drillhole position



Location Plan

Project :

WORKS ORDER NUMBER GE/2010/02.7
AGREEMENT NO. CE 38/2008 (HY)
KAI TAK DEVELOPMENT - TRUNK ROAD T2 AND INFRASTRUCTURE AT SOUTH APRON - INVESTIGATION, DESIGN AND CONSTRUCTION

FIGURE NUMBER : 9

Drawing Title :

CONTOURED ISOPACHS OF ALLUVIUM

Notes :
1. Survey Date : 24/06/2010
2. Survey Grid : HK1980 Grid System
3. Survey Datum : Hong Kong Principal Datum
4. Positioning : C—Nav GcGPS (Globally corrected GPS)
5. Equipment : EGS Boomer System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
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1	05/08/2010	Chester Quek	Margie Chen	R. E. Hale	Final

METRIC SCALE 1:1,000

50 40 30 20 10 0 50 100

Client : Civil Engineering and Development Department

Surveyor :

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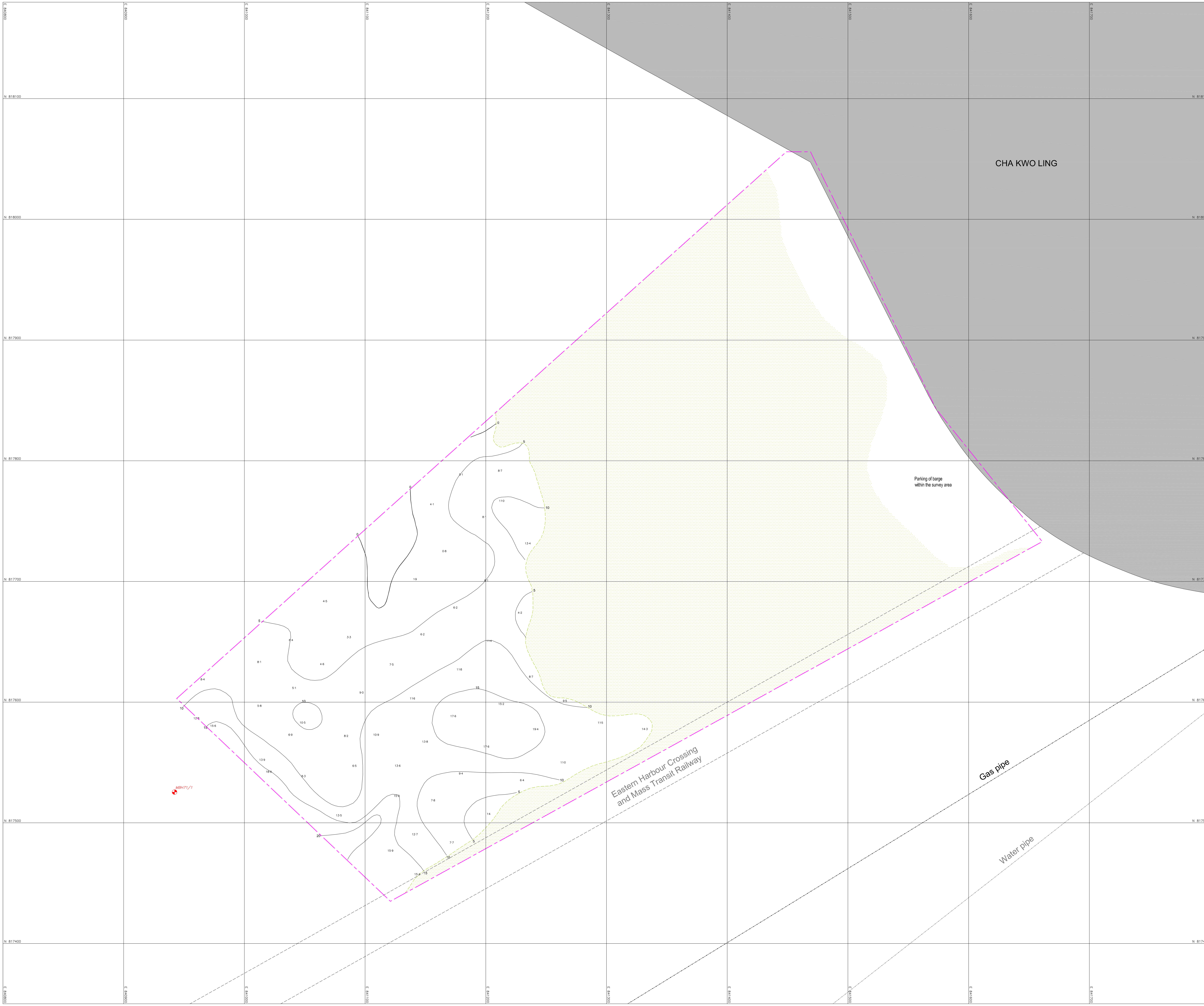
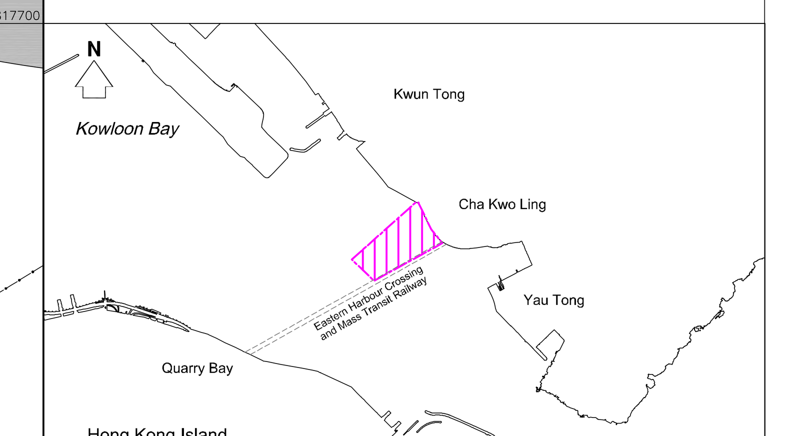


Legend :

11·6	Isopachs value in metres (thickness of the layer)
	Contour at 5m interval
	Survey boundary
	Gas pipe
	Water pipe
	Masking Area
MBH71/1	Drillhole position



Location Plan

Project :

WORKS ORDER NUMBER GE/2010/02.7
AGREEMENT NO. CE 38/2008 (HY)
KAI TAK DEVELOPMENT - TRUNK ROAD T2 AND
INFRASTRUCTURE AT SOUTH APRON -
INVESTIGATION, DESIGN AND CONSTRUCTION

FIGURE NUMBER : 10

Drawing Title :

CONTOURED ISOPACHS OF ROCK IN ANY STATE OF DECOMPOSITION

Notes :
1. Survey Date : 24/06/2010
2. Survey Grid : HK1980 Grid System
3. Survey Datum : Hong Kong Principal Datum
4. Positioning : C–Nav GcGPS (Globally corrected GPS)
5. Equipment : EGS Boomer System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
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1	05/08/2010	Chester Quek	Margie Chen	R. E. Hale	Final

METRIC SCALE 1:1,000

50 40 30 20 10 0 50 100

Client : Civil Engineering and Development Department

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JOB NO. : HK220410

ANNEX D.2

LIST OF SONAR CONTACTS

Annex D.2 Sonar Contact List

Contact number	Latitude Longitude	Easting Northing	Water depth (m)	Dimensions (m)	Description
WH2-SC001	22° 17.963' N 114° 13.665' E	841509.9E 817829.2N	8.7	1.4x1.1x0.8	Unknown object
WH2-SC002	22° 17.962' N 114° 13.682' E	841538.6E 817825.7N	8.7	1.7x1.4x1.4	Unknown object
WH2-SC003	22° 17.934' N 114° 13.614' E	841422.9E 817775.1N	10.0	0.8x0.6x0.5	Unknown object
WH2-SC004	22° 17.856' N 114° 13.583' E	841369.9E 817630.8N	14.0	1.8x1.2x0.5	Unknown object
WH2-SC005	22° 17.883' N 114° 13.517' E	841256.7E 817679.9N	13.8	2.6x1.8x0.7	Unknown object
WH2-SC006	22° 17.874' N 114° 13.510' E	841244.0E 817663.3N	10.3	1.3x0.5x0.7	Unknown object
WH2-SC007	22° 17.859' N 114° 13.489' E	841208.8E 817635.9N	11.0	1.3x0.9x0.6	Unknown object
WH2-SC008	22° 17.849' N 114° 13.479' E	841190.3E 817617.0N	11.2	1.4x0.9x0.7	Unknown object
WH2-SC009	22° 17.837' N 114° 13.465' E	841166.7E 817595.8N	10.8	1.3x0.6x0.5	Unknown object
WH2-SC010	22° 17.823' N 114° 13.518' E	841258.4E 817570.7N	11.0	1.6x0.7x0.5	Unknown object
WH2-SC011	22° 17.822' N 114° 13.510' E	841243.8E 817567.6N	11.2	1.0x0.9x0.5	Unknown object
WH2-SC012	22° 17.820' N 114° 13.516' E	841253.5E 817564.1N	11.0	1.7x0.5x0.5	Unknown object
WH2-SC013	22° 17.804' N 114° 13.495' E	841218.0E 817534.1N	12.3	1.2x0.5x0.5	Unknown object
WH2-SC014	22° 17.801' N 114° 13.443' E	841129.3E 817529.4N	11.3	1.6x0.7x0.7	Unknown object
WH2-SC015	22° 17.803' N 114° 13.421' E	841091.1E 817532.4N	11.6	1.6x0.6x0.5	Unknown object
WH2-SC016	22° 17.782' N 114° 13.427' E	841102.0E 817493.4N	12.1	1.8x0.7x0.5	Unknown object
WH2-SC017	22° 17.788' N 114° 13.404' E	841062.5E 817504.7N	12.1	1.7x0.6x0.6	Unknown object
WH2-SC018	22° 17.788' N 114° 13.421' E	841091.8E 817505.9N	12.2	1.2x0.8x0.8	Unknown object
WH2-SC019	22° 17.787' N 114° 13.414' E	841079.4E 817502.9N	12.1	0.8x1.2x0.5	Unknown object
WH2-SC020	22° 17.785' N 114° 13.416' E	841082.1E 817499.8N	12.1	1.8x0.5x0.6	Unknown object
WH2-SC021	22° 17.792' N 114° 13.414' E	841079.3E 817512.6N	12.1	0.9x0.9x0.5	Unknown object
WH2-SC022	22° 17.783' N 114° 13.408' E	841069.6E 817495.4N	12.2	2.7x0.6x0.5	Unknown object
WH2-SC023	22° 17.792' N 114° 13.405' E	841063.6E 817513.0N	11.9	1.8x0.9x0.6	Unknown object
WH2-SC024	22° 17.800' N 114° 13.412' E	841075.3E 817526.6N	11.5	1.3x0.5x0.5	Unknown object
WH2-SC025	22° 17.805' N 114° 13.400' E	841055.6E 817536.5N	11.2	0.9x0.3x0.5	Unknown object
WH2-SC026	22° 17.843' N 114° 13.402' E	841059.0E 817606.9N	11.3	2.0x0.7x0.6	Unknown object
WH2-SC027	22° 17.840' N 114° 13.399' E	841054.1E 817601.9N	11.2	1.5x0.7x0.8	Unknown object
WH2-SC028	22° 17.862' N 114° 13.408' E	841069.2E 817642.7N	11.9	2.3x0.7x0.6	Unknown object

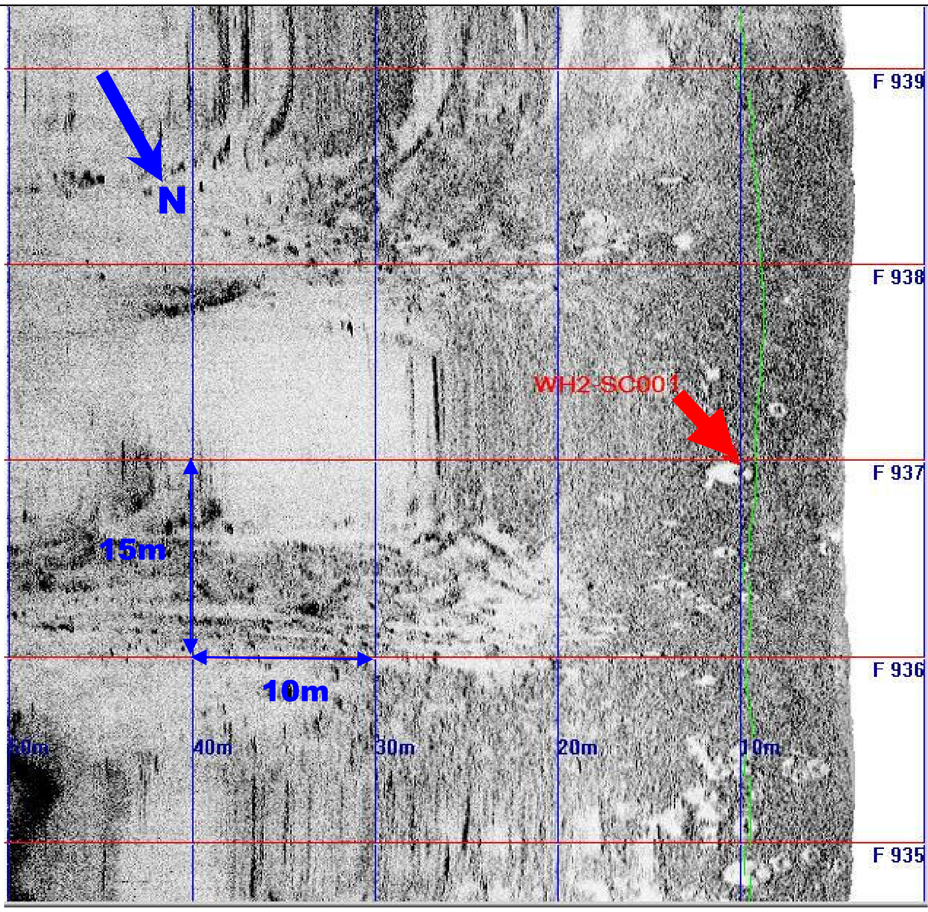
Annex D.2 Sonar Contact List

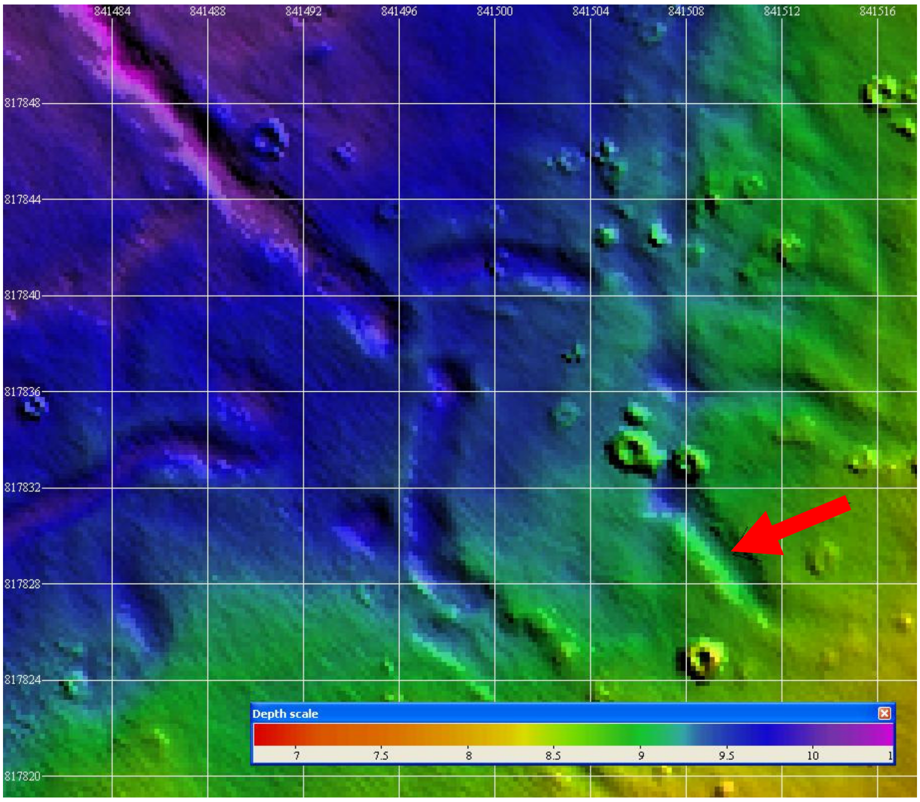
Contact number	Latitude Longitude	Easting Northing	Water depth (m)	Dimensions (m)	Description
WH2-SC029	22° 17.924' N 114° 13.555' E	841321.0E 817756.2N	12.3	1.8x0.8x0.5	Unknown object
WH2-SC030	22° 17.935' N 114° 13.564' E	841336.0E 817776.4N	13.6	1.2x0.6x0.5	Unknown object

ANNEX D.3

SONAR IMPAGE OF EACH CONTACT

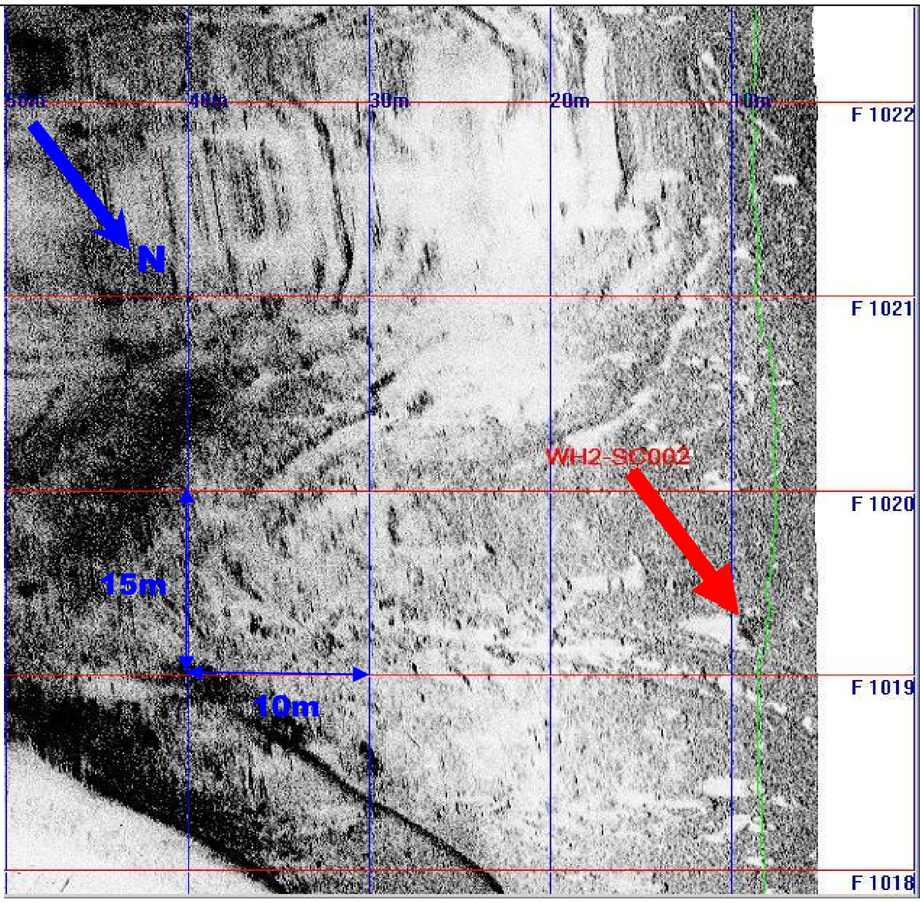
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

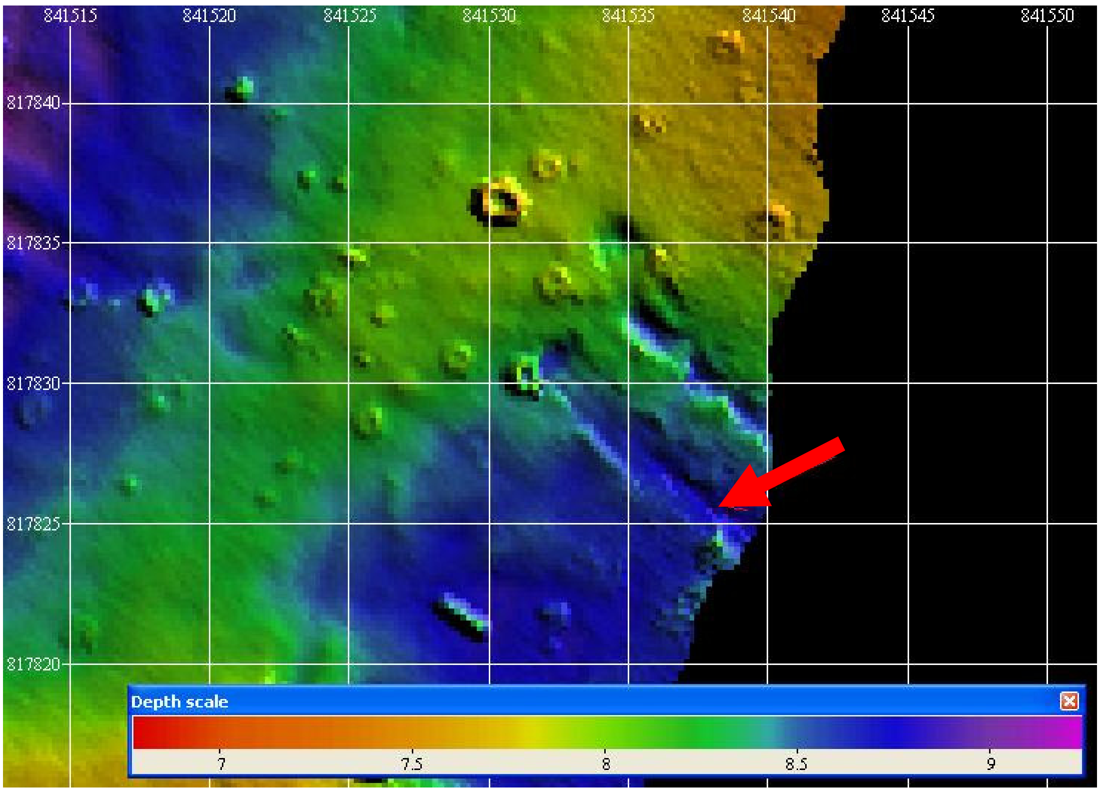




WH2-SC001 – 1.4m x 1.1m x 0.8m Unknown object

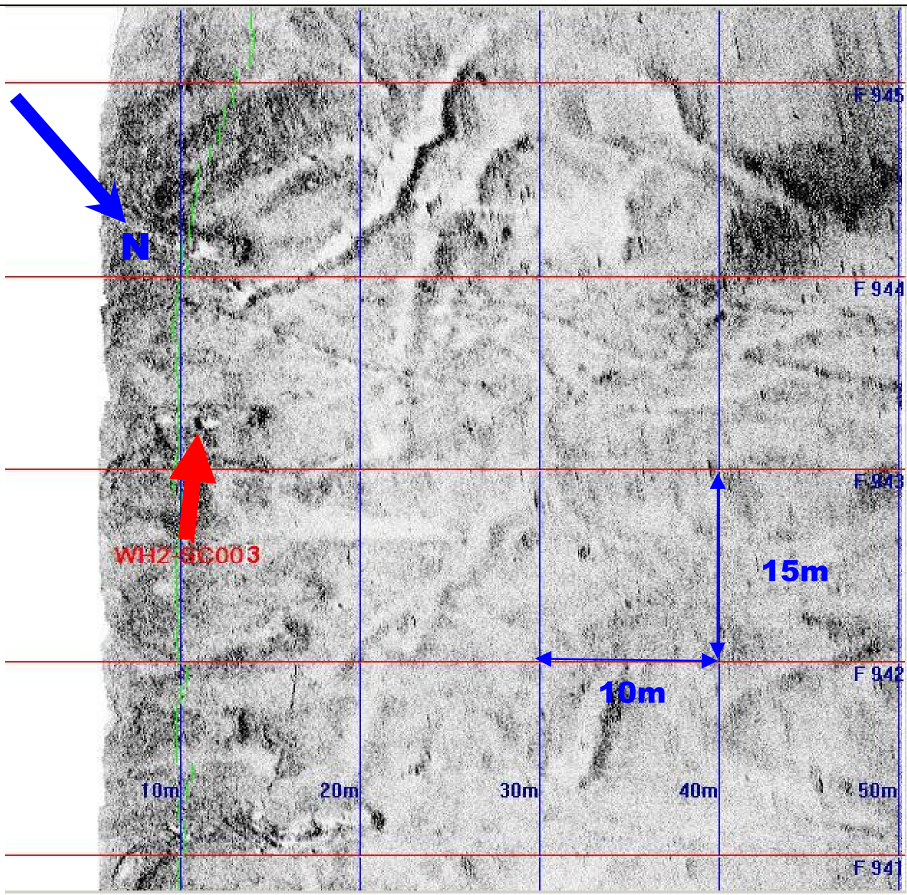
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

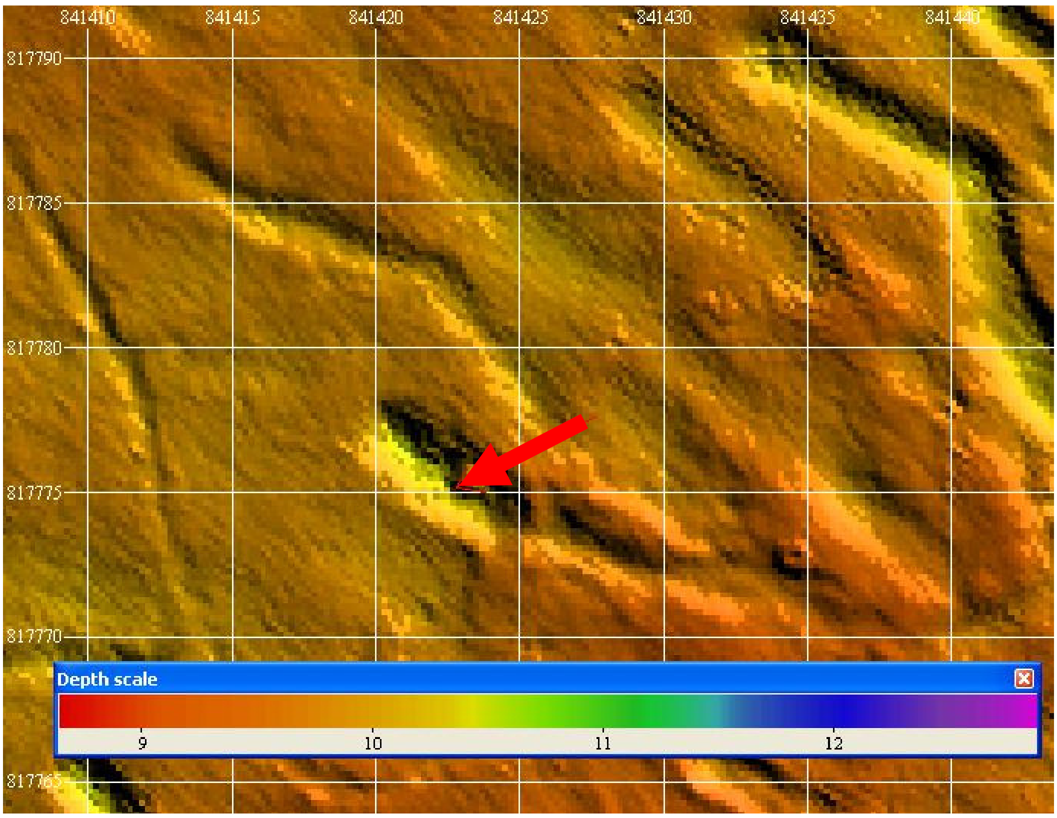




WH2-SC002 – 1.7m x 1.4m x 1.4m Unknown object

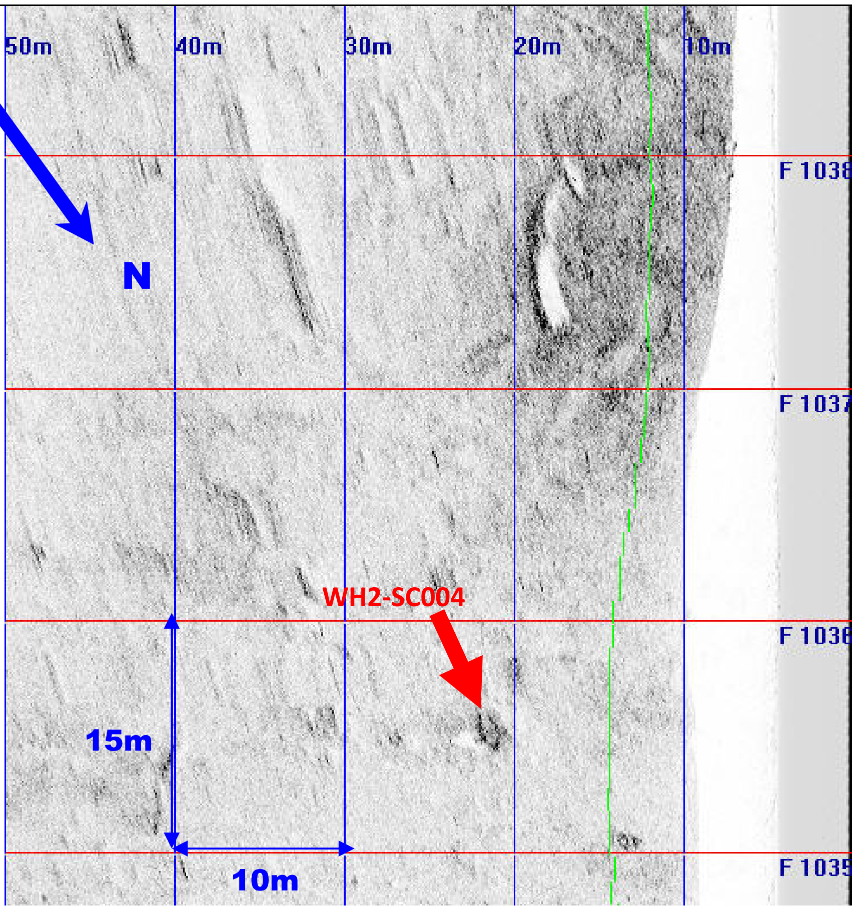
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

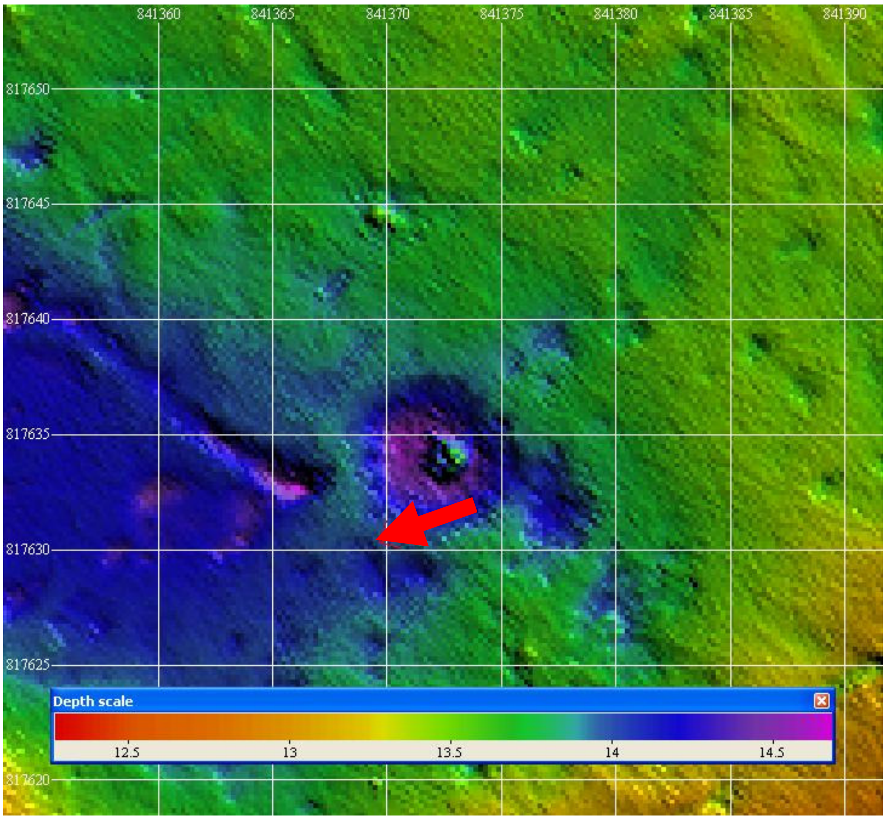




WH2-SC003 – 0.8x0.6x0.5 Unknown object

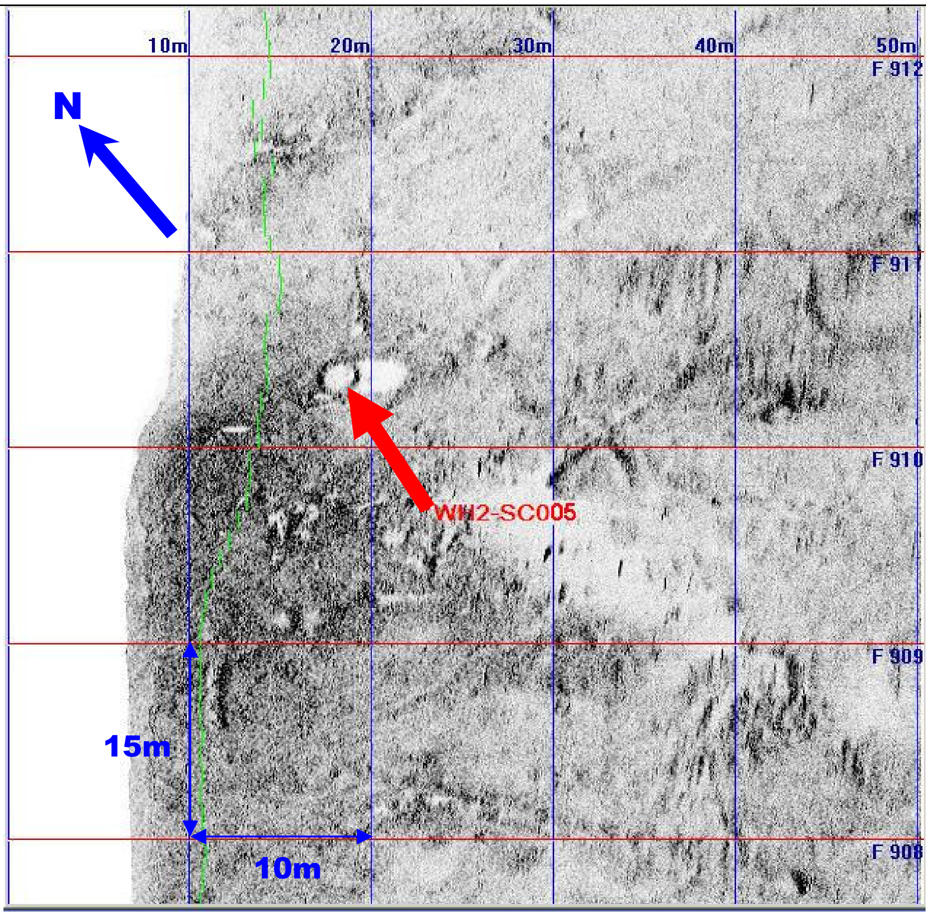
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

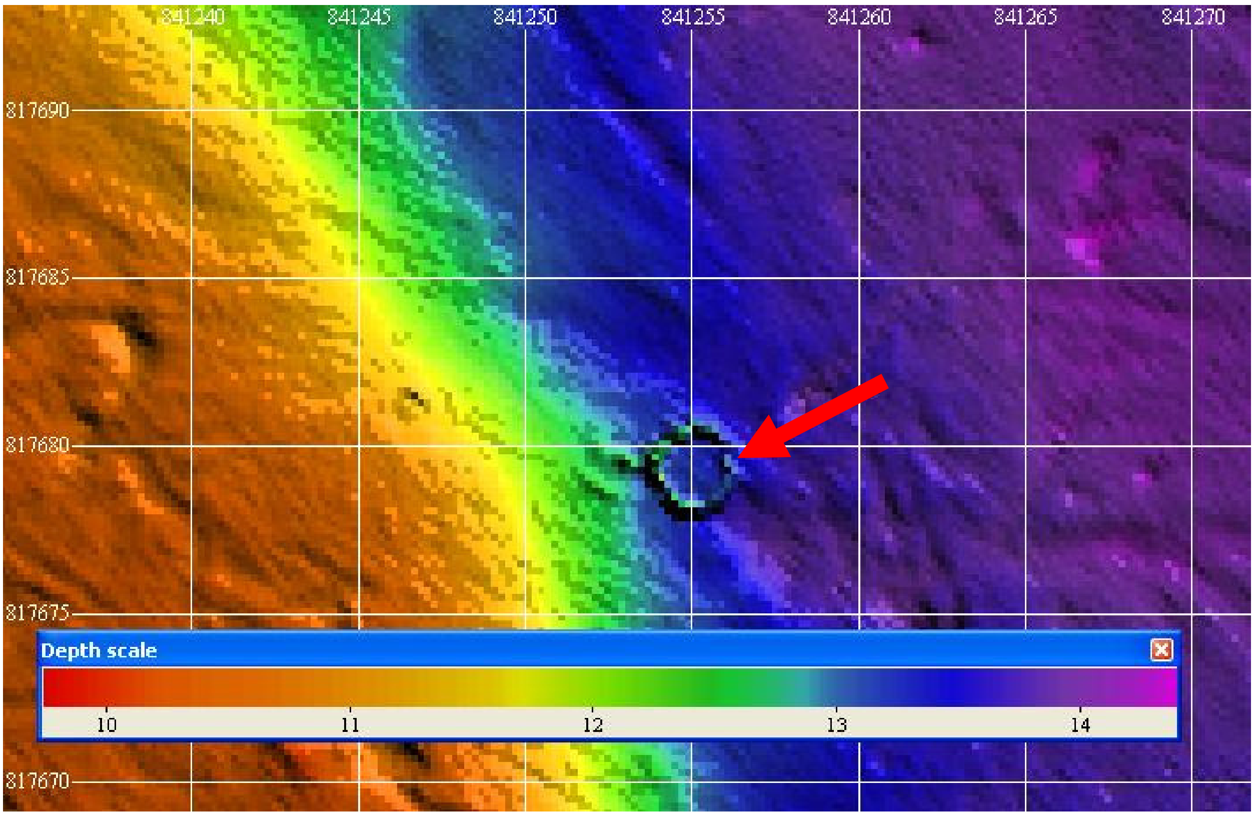




WH2-SC004 – 1.8m x 1.2m x 0.5m Unknown object

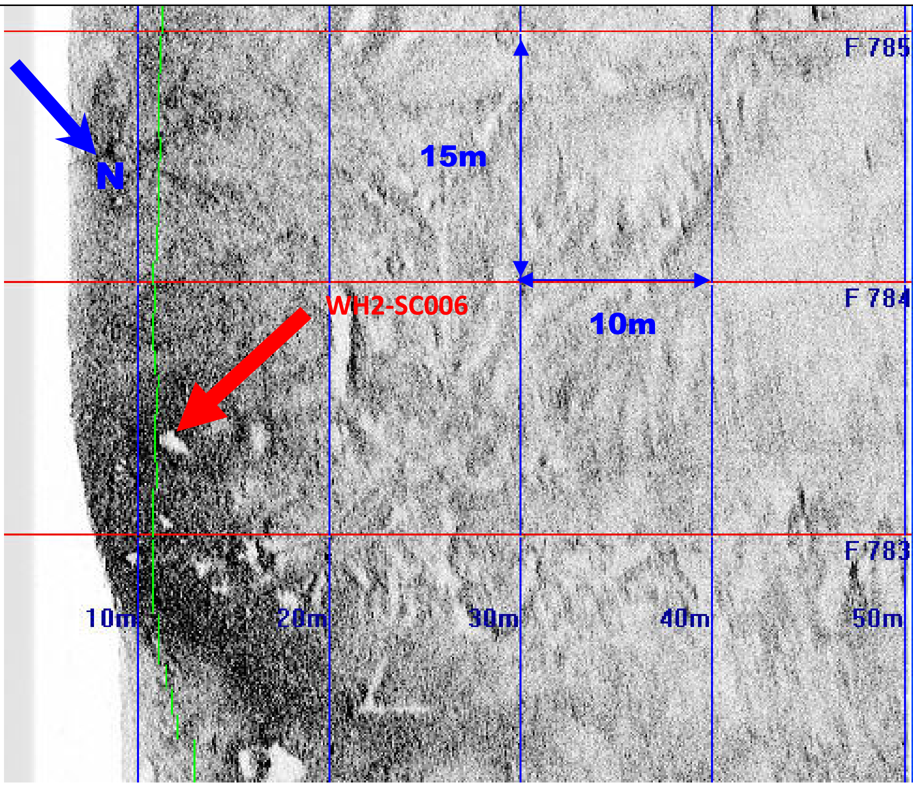
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

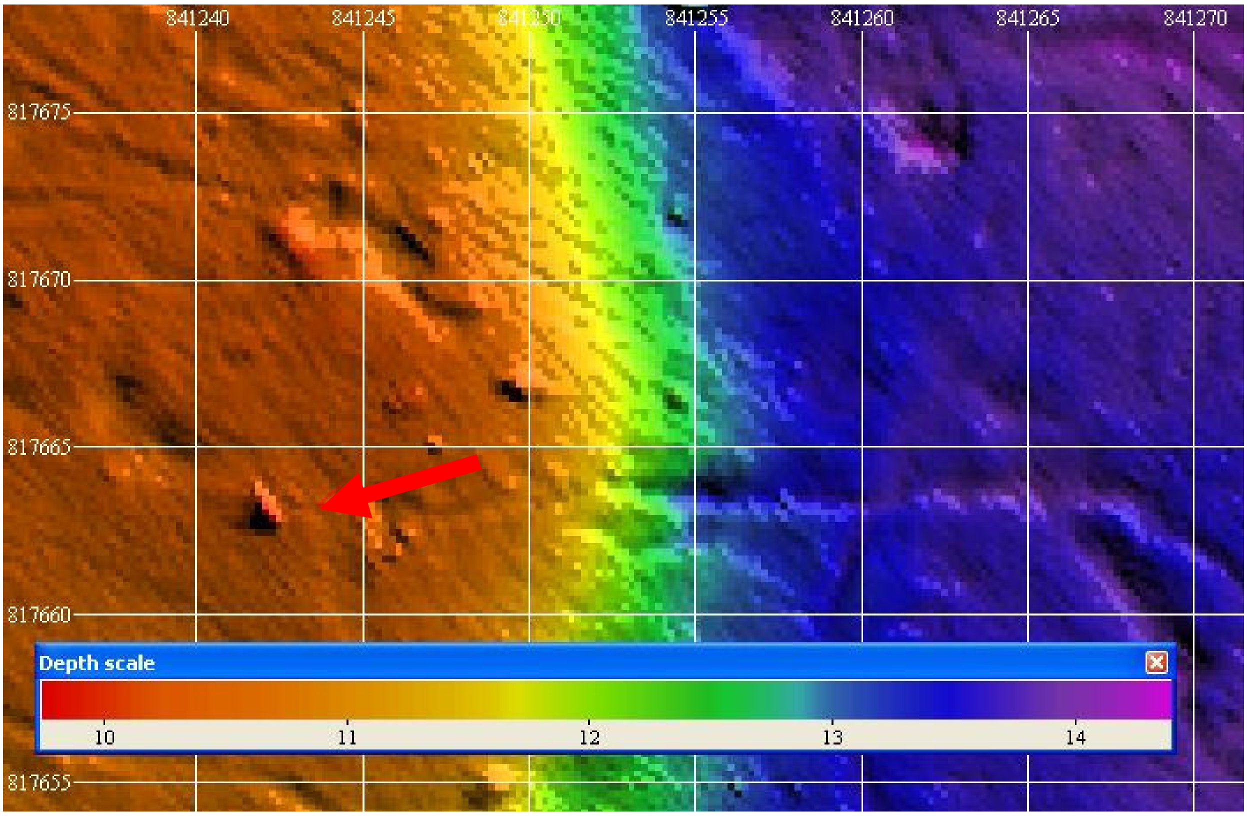




WH2-SC005 – 2.6m x 1.8m x 0.7m Unknown object

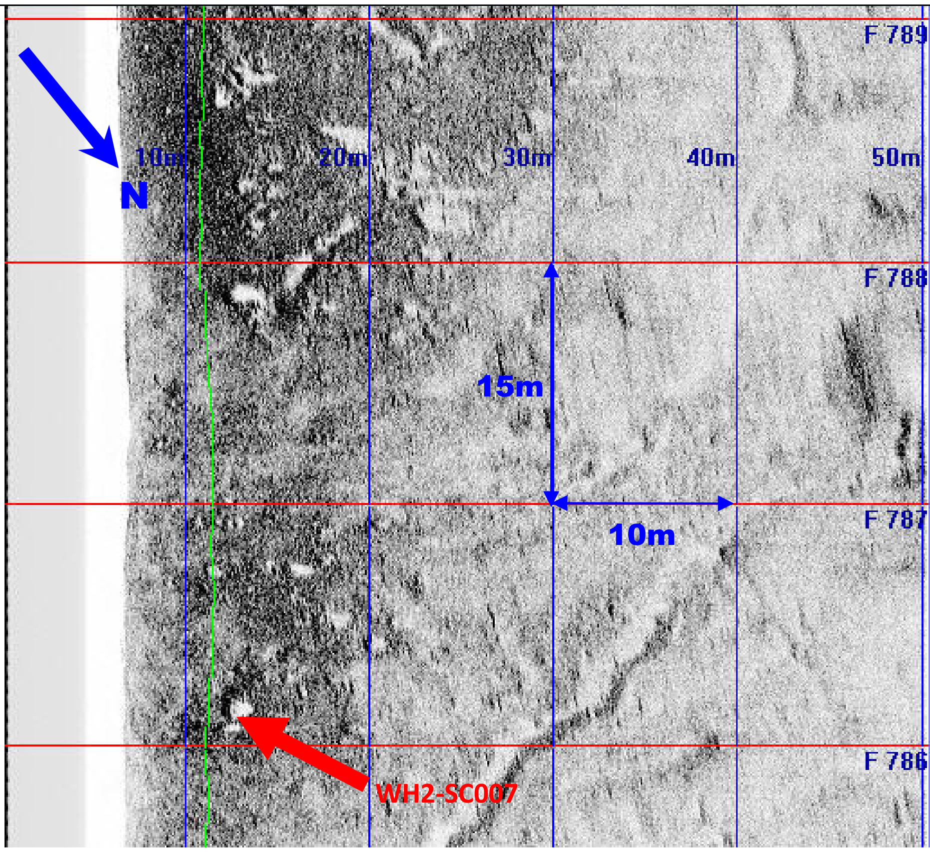
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

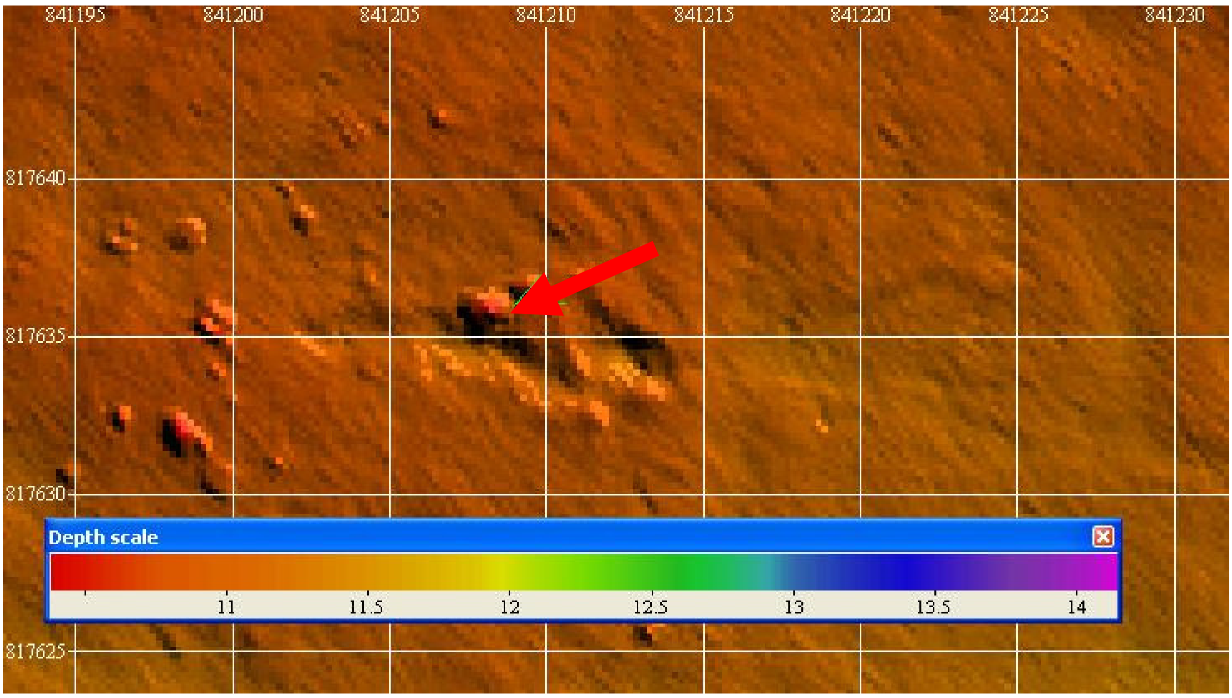




WH2-SC006 – 1.3m x 0.5m x 0.7m Unknown object

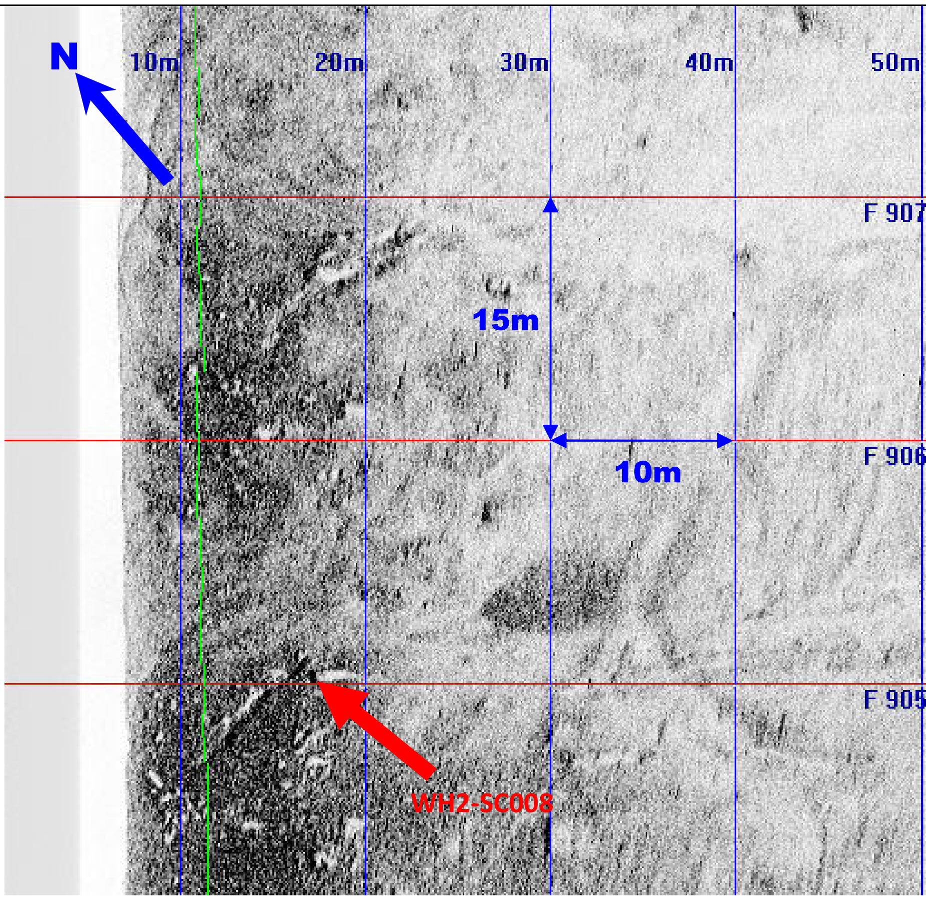
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

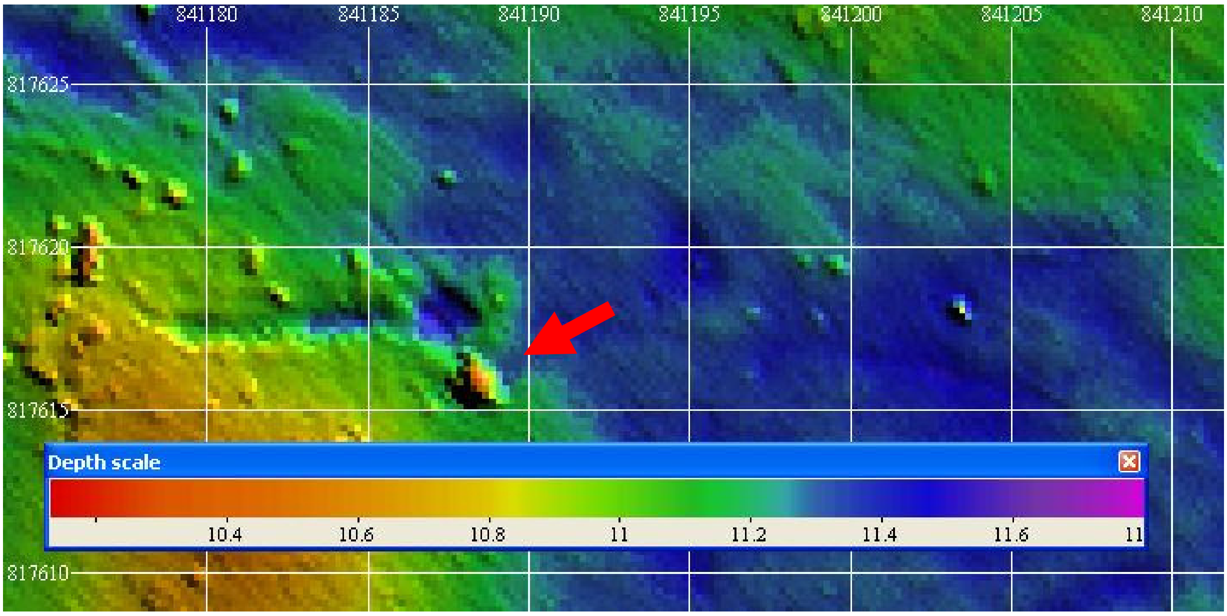




WH2-SC007 – 1.3m x 0.9m x 0.6m Unknown object

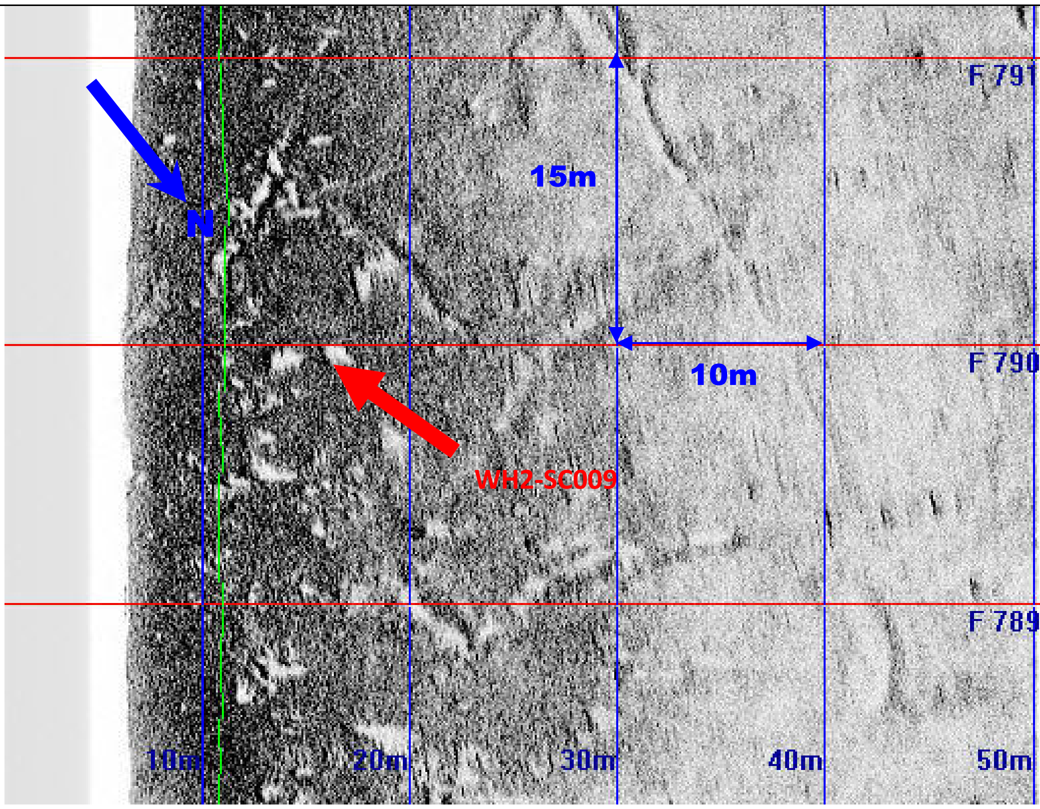
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

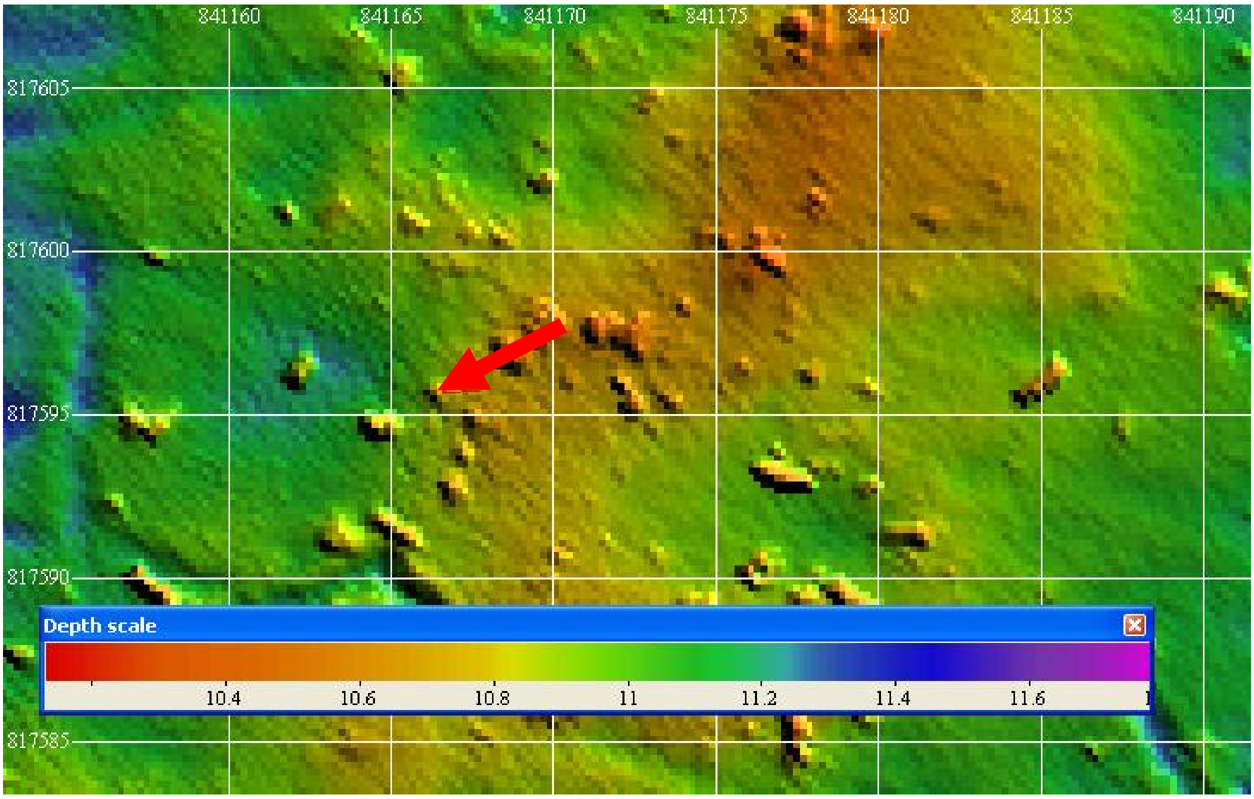




WH2-SC008 – 1.4m x 0.9m x 0.7m Unknown object

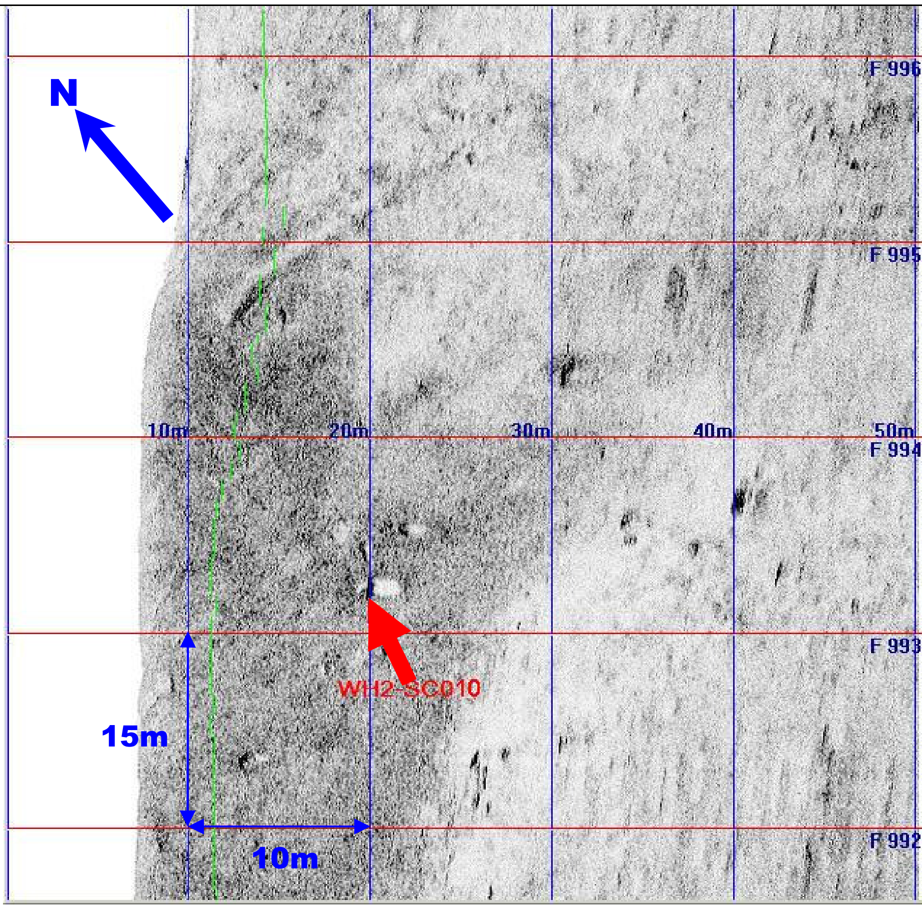
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

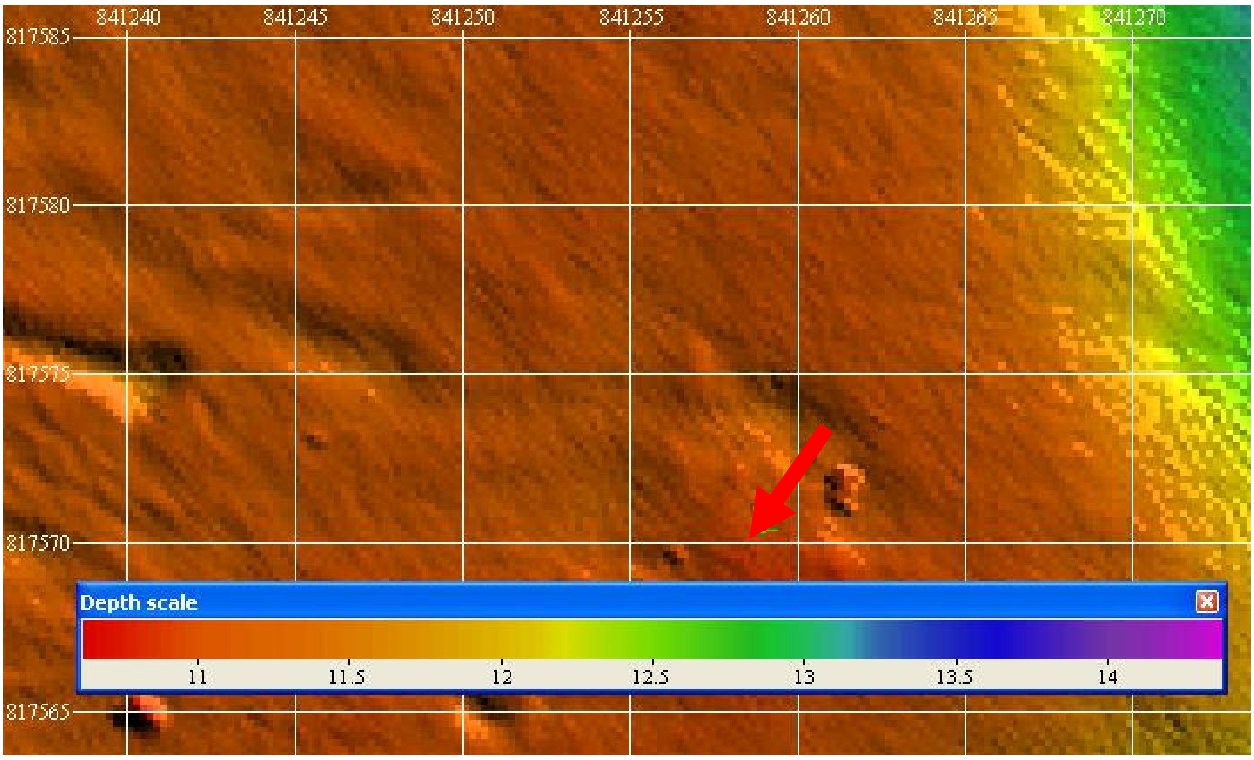




WH2-SC009 – 1.3m x 0.6m x 0.5m Unknown object

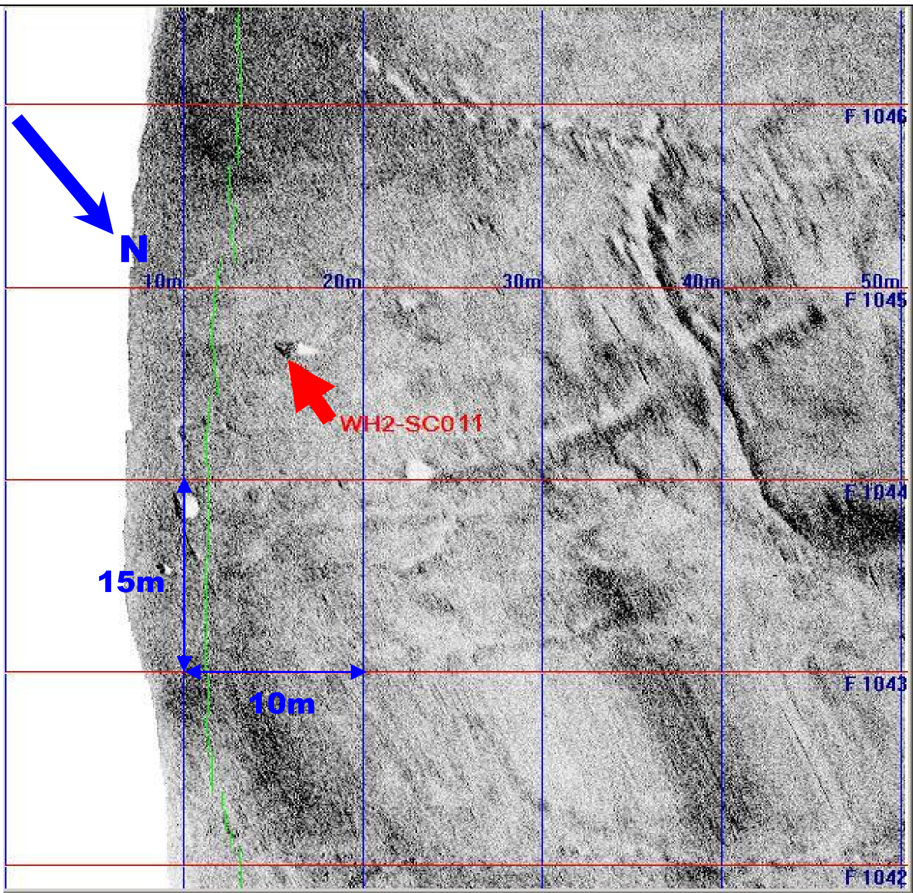
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

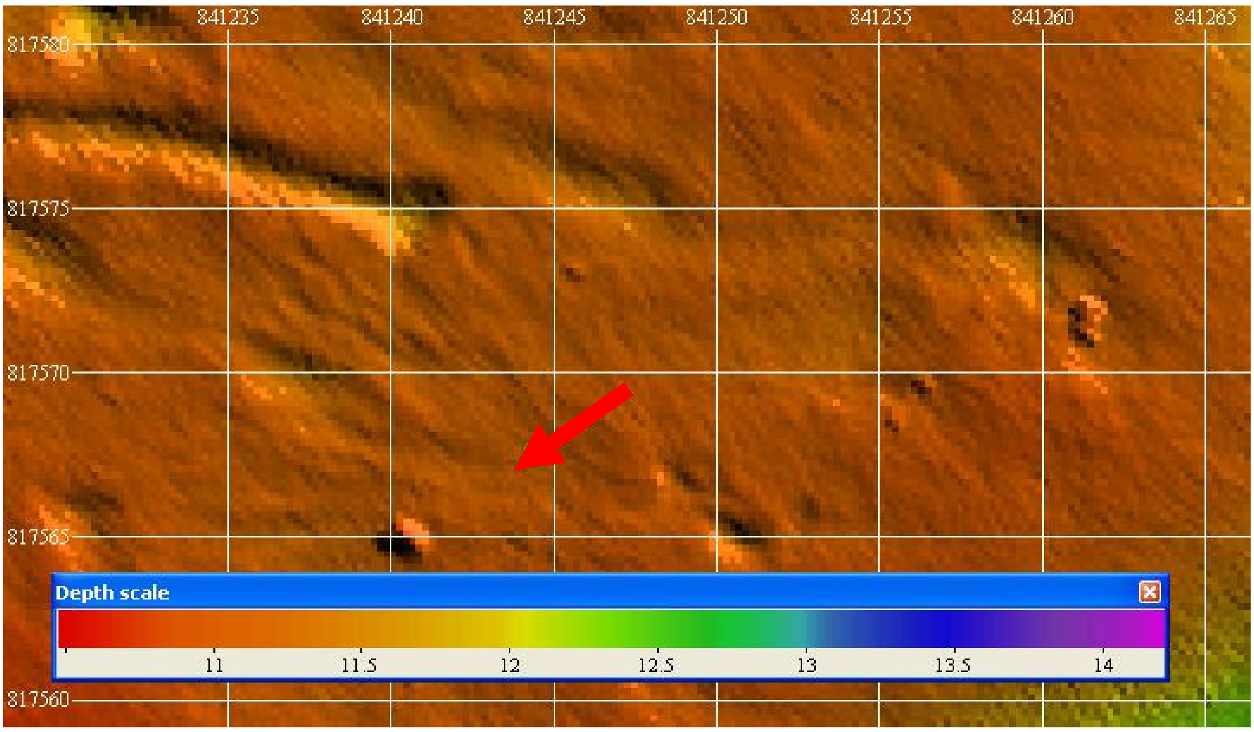




WH2-SC010 – 1.6m x 0.7m x 0.5m Unknown object

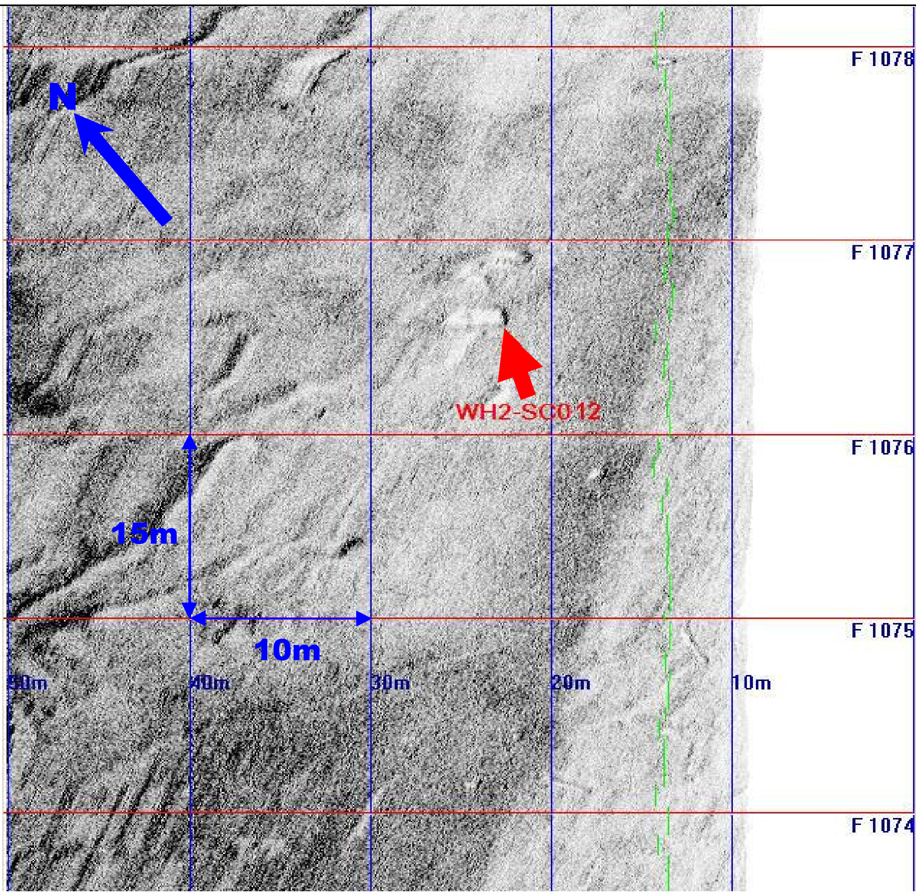
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

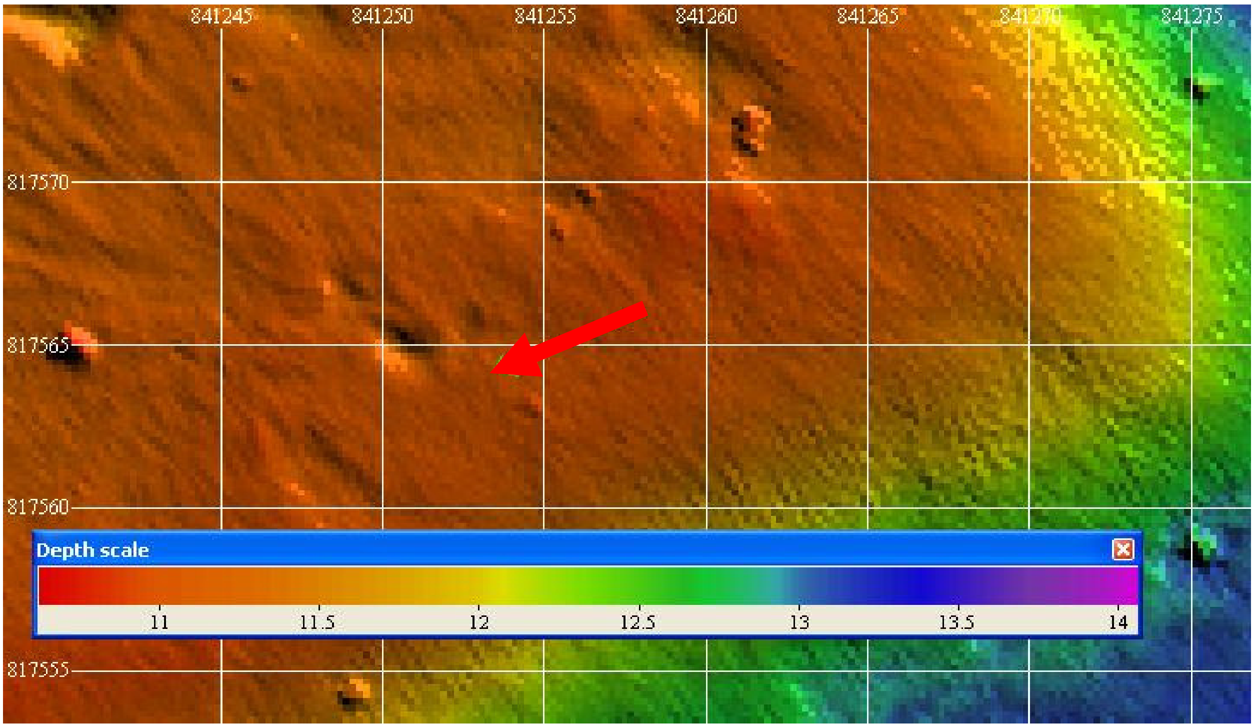




WH2-SC011 – 1.0m x 0.9m x 0.5m Unknown object

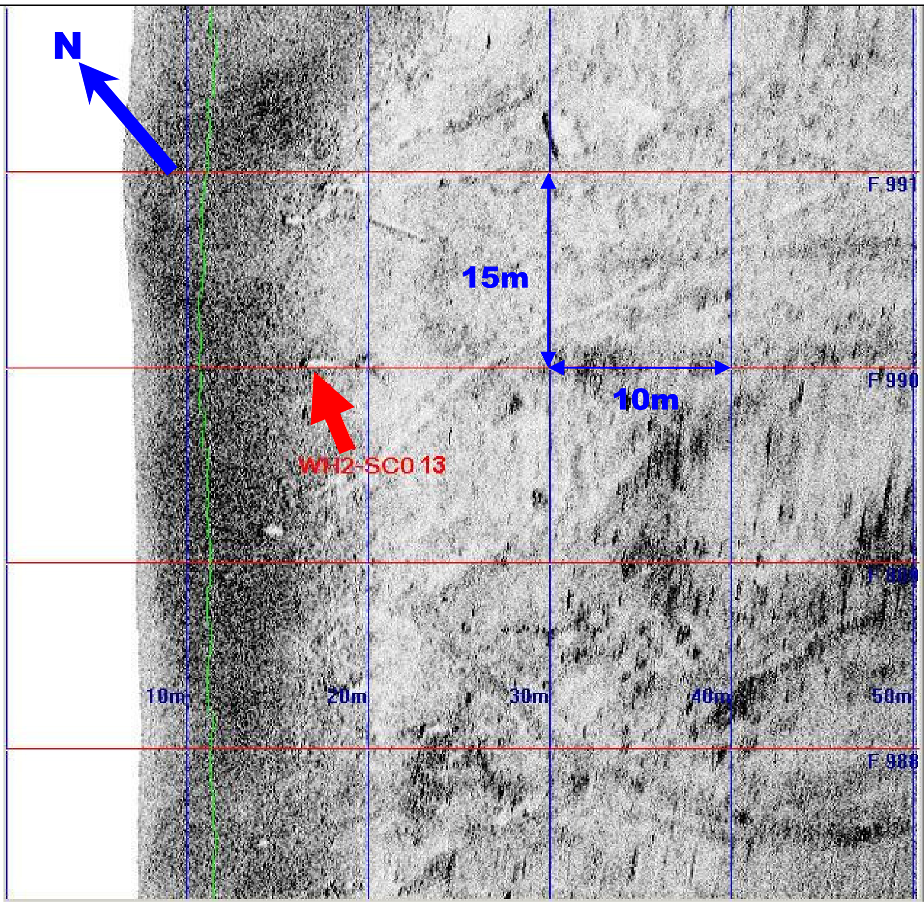
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

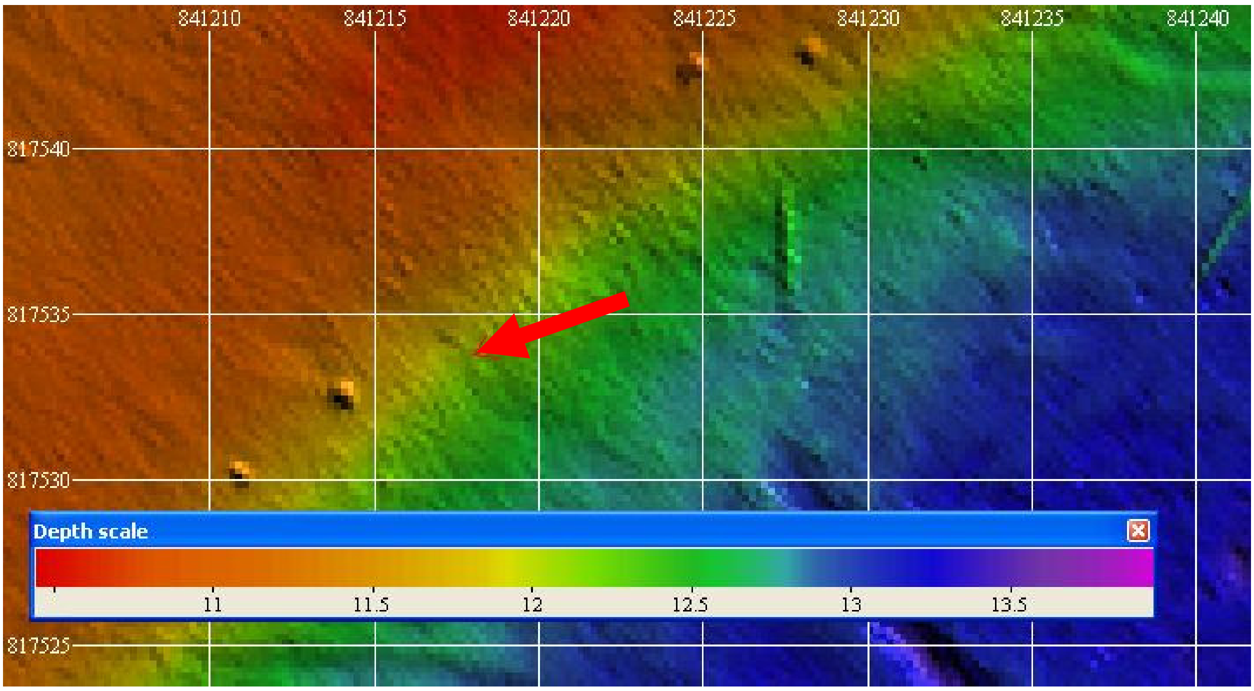




WH2-SC012 – 1.7m x 0.5m x 0.5m Unknown object

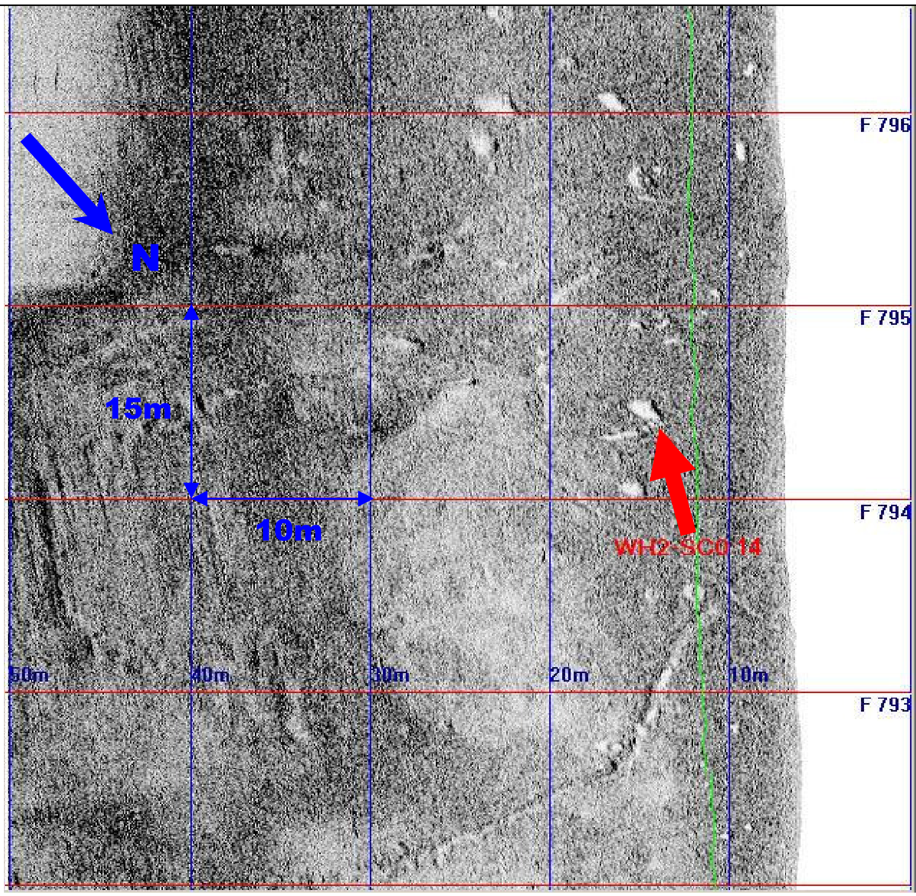
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

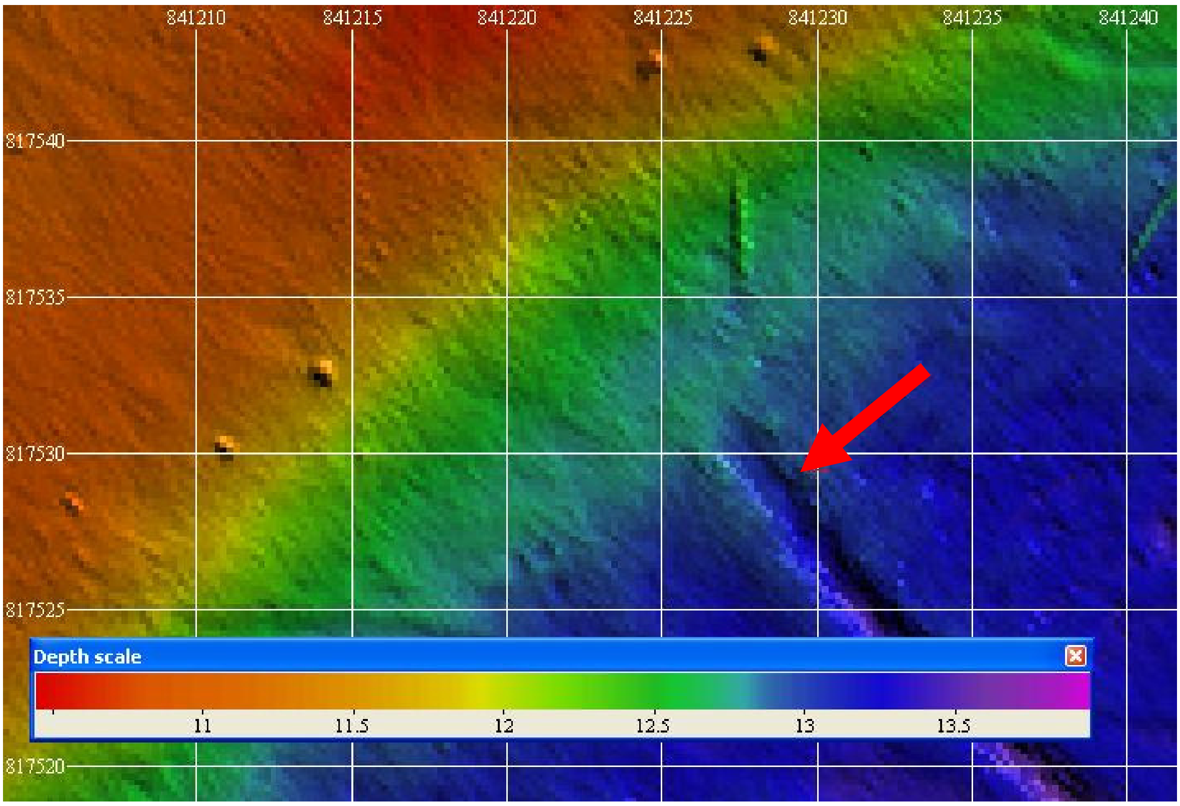




WH2-SC013 – 1.2m x 0.5m x 0.5m Unknown object

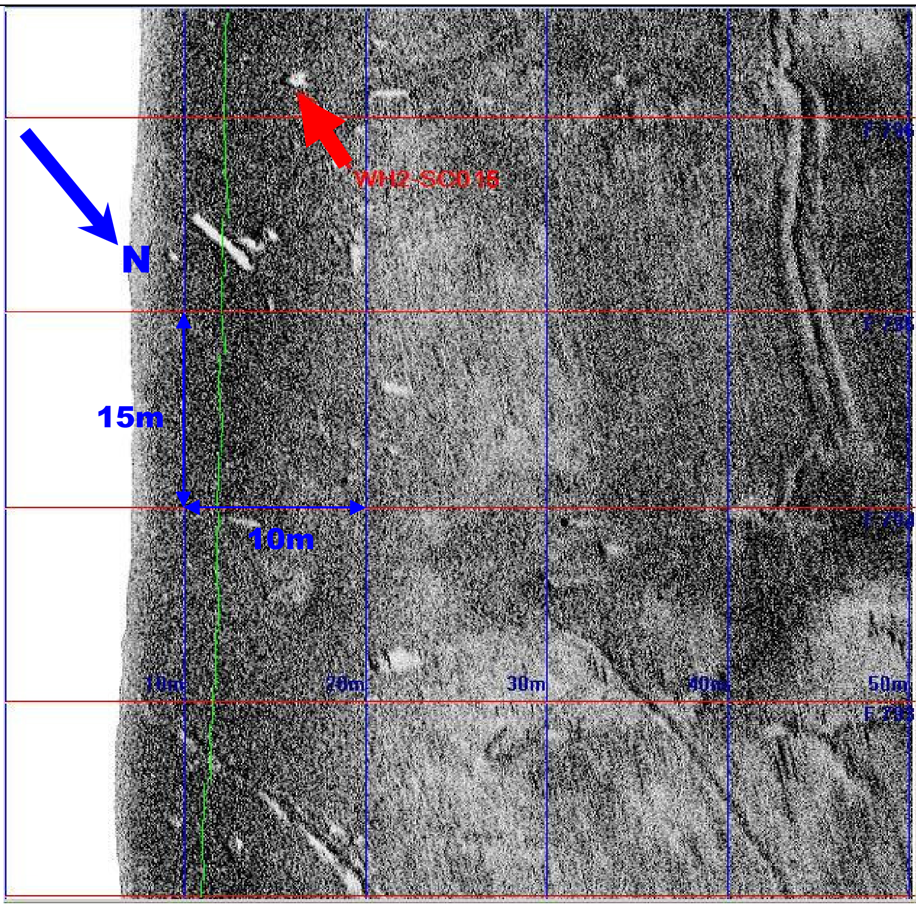
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

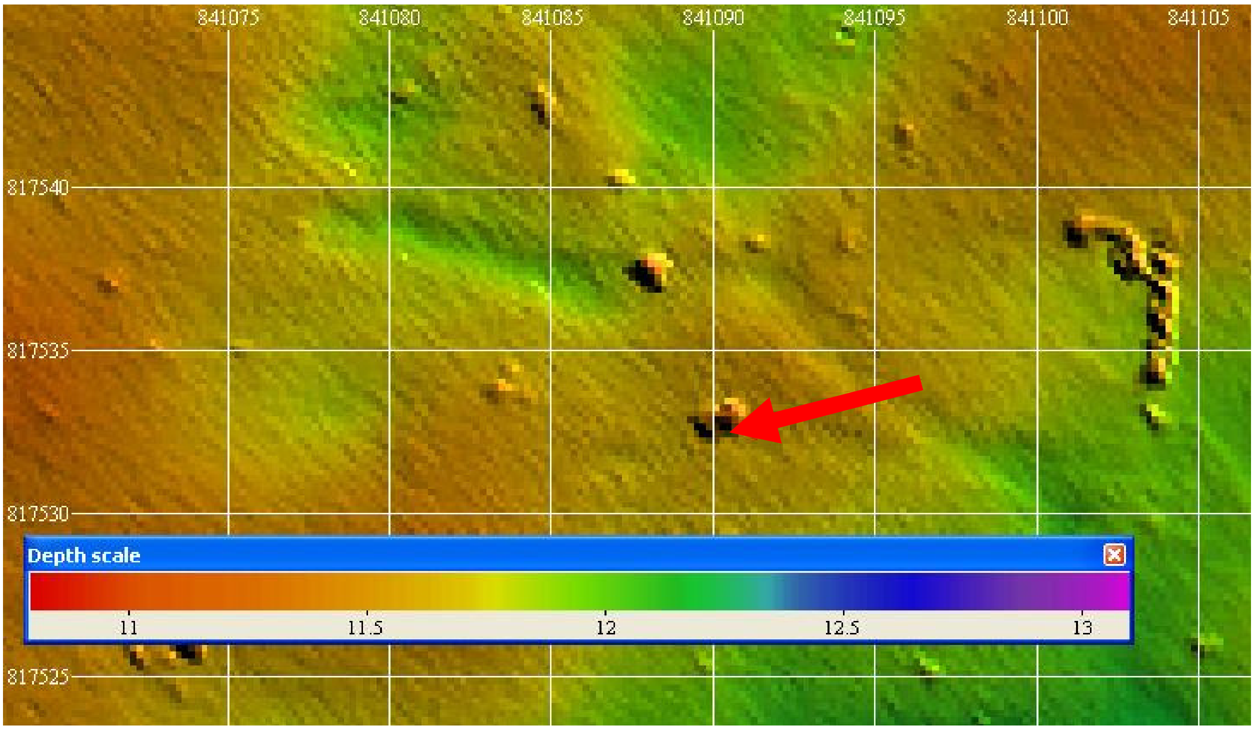




WH2-SC014 – 1.6m x 0.7m x 0.7m Unknown object

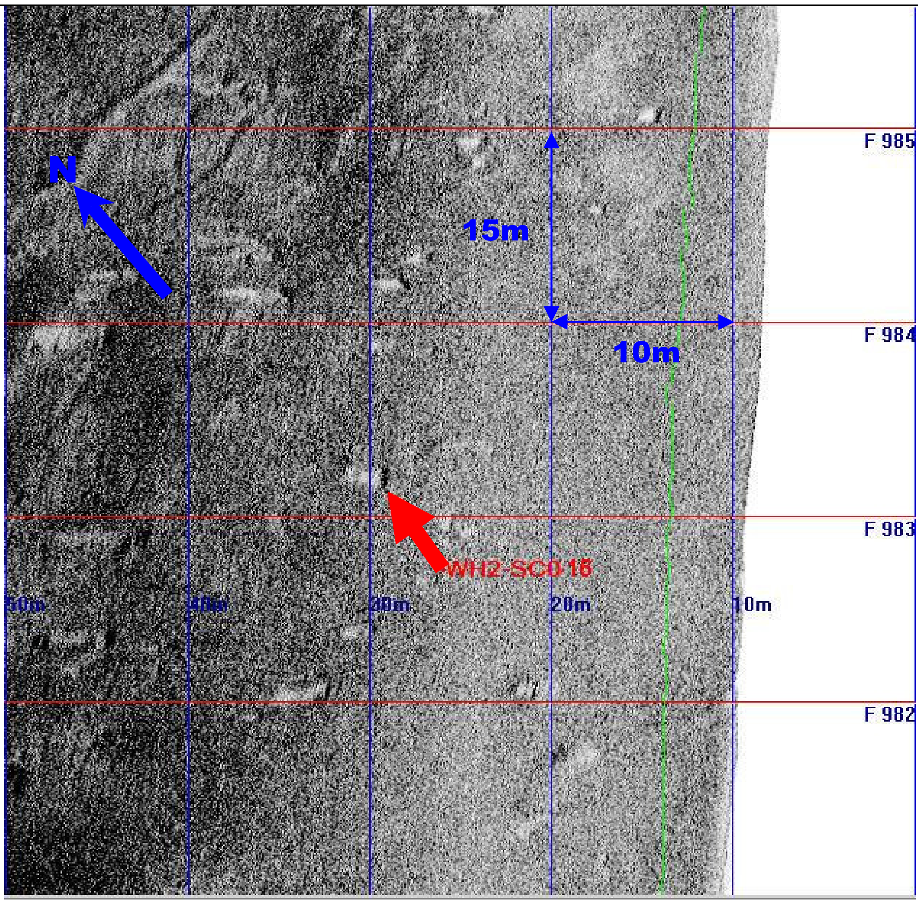
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

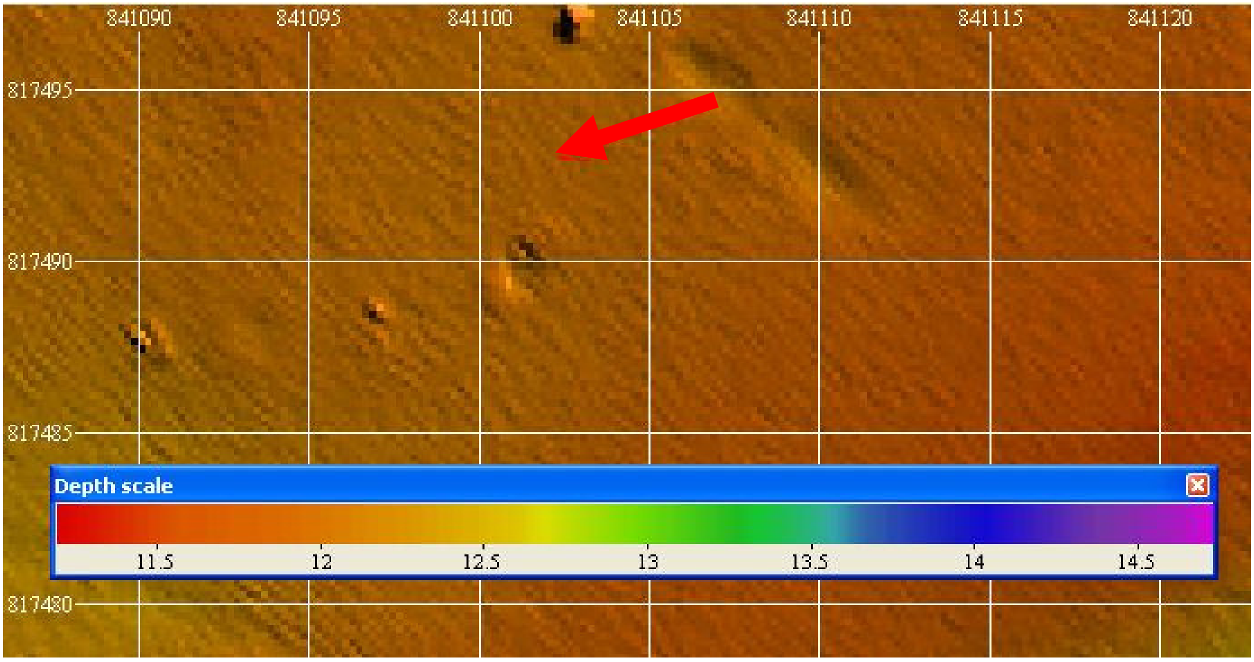




WH2-SC015 – 1.6m x 0.6m x 0.5m Unknown object

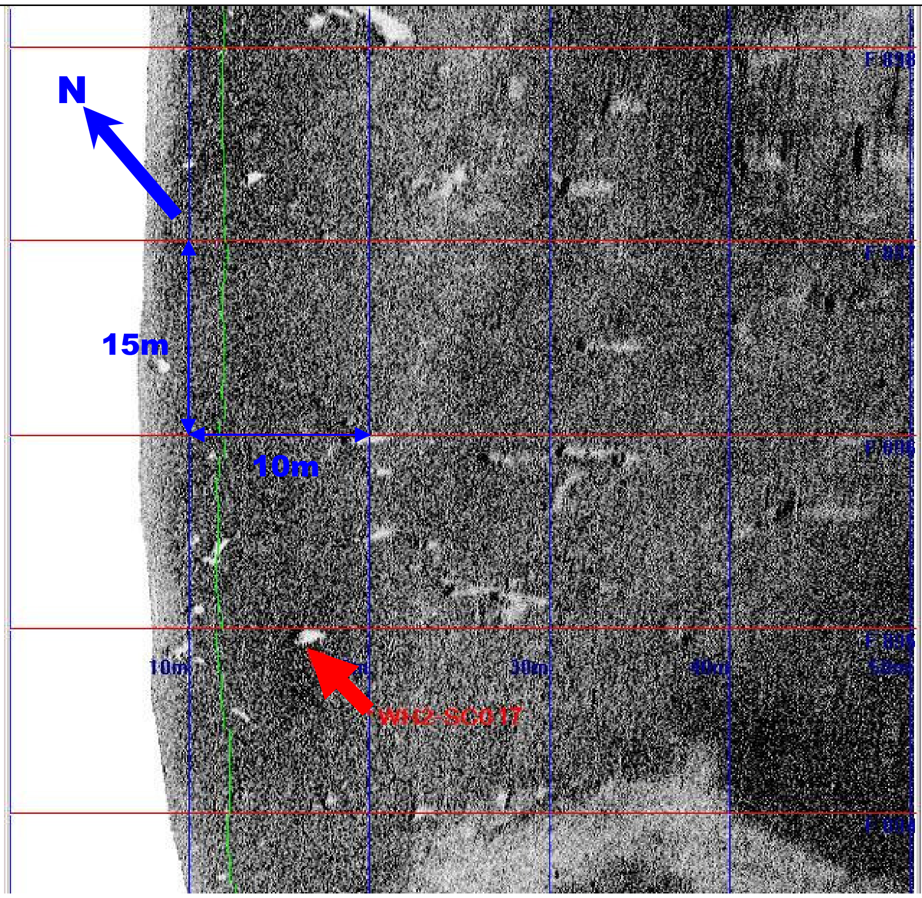
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

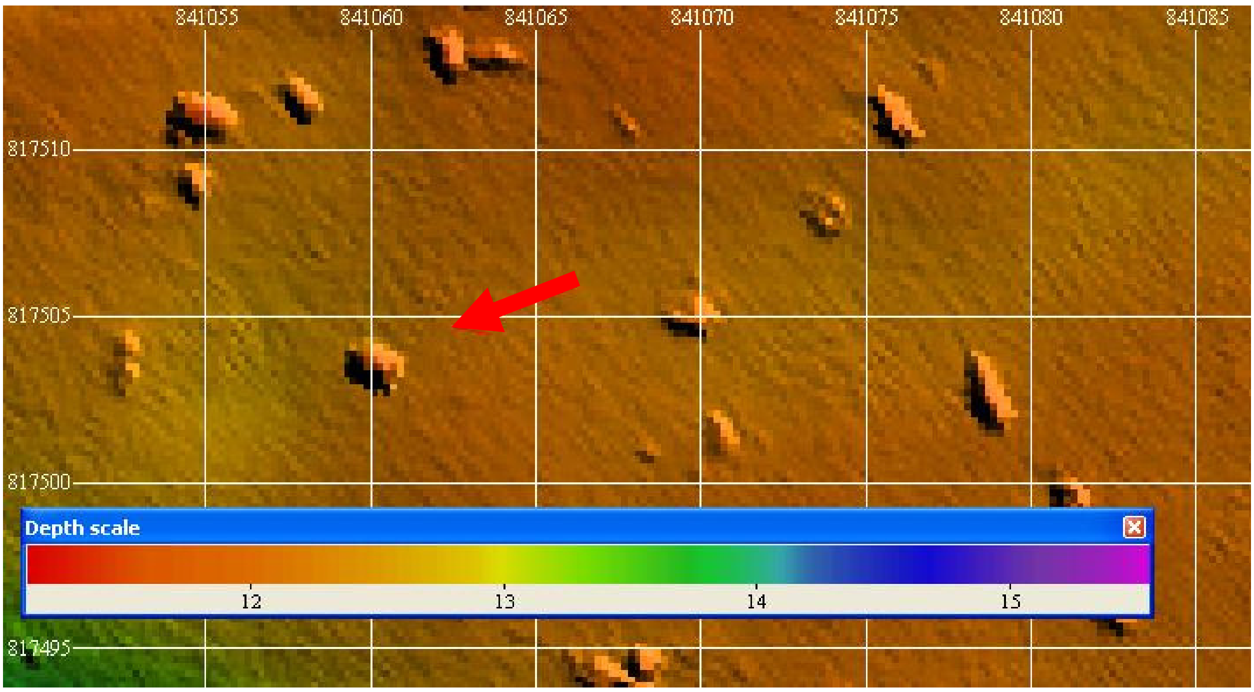




WH2-SC016 – 1.8m x 0.7m x 0.5m Unknown object

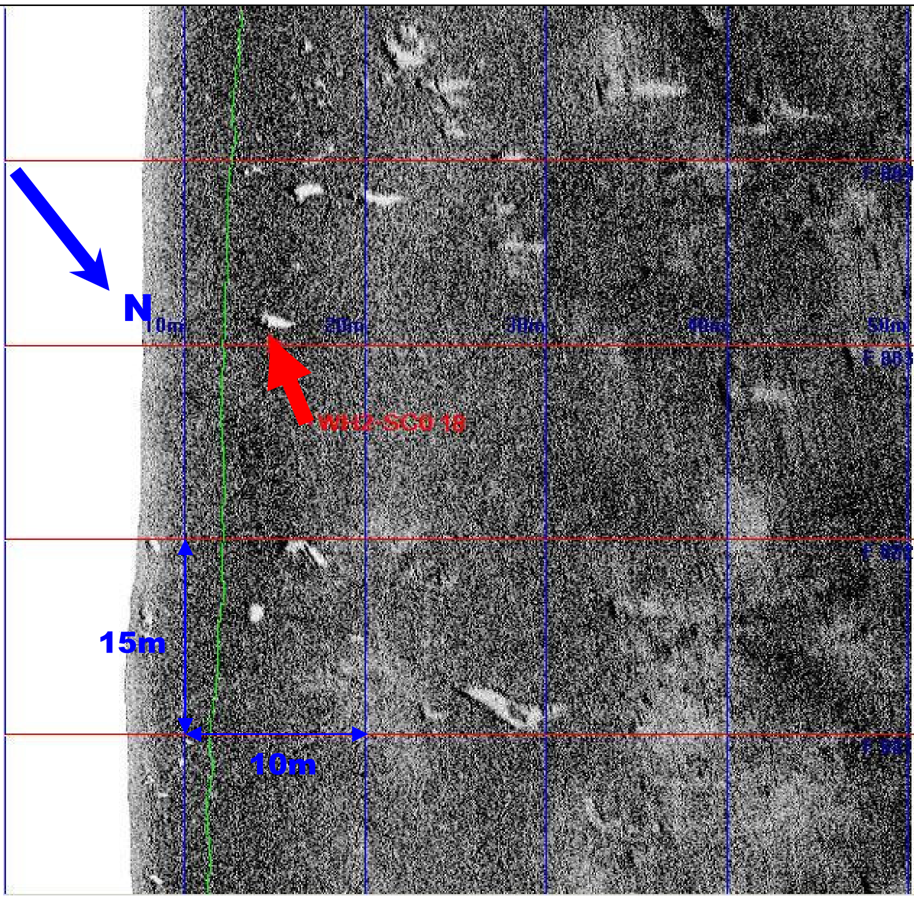
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

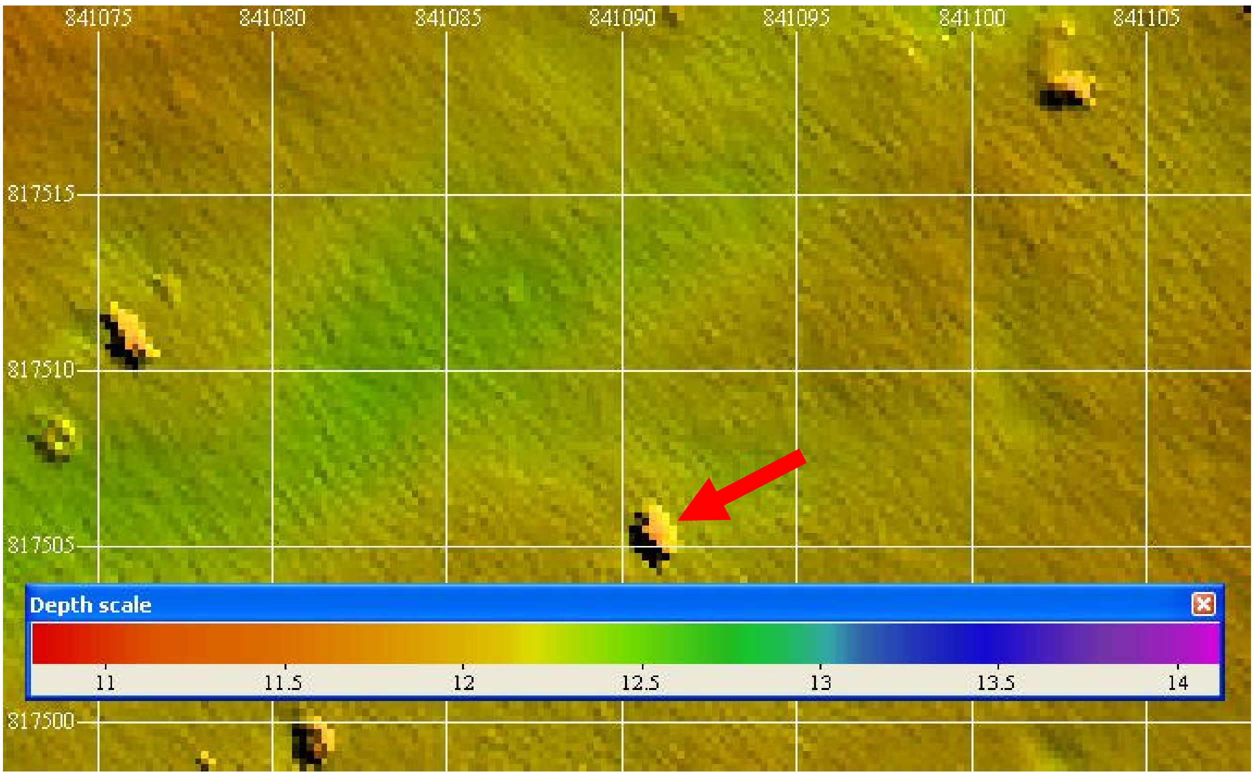




WH2-SC017 – 1.7m x 0.6m x 0.6m Unknown object

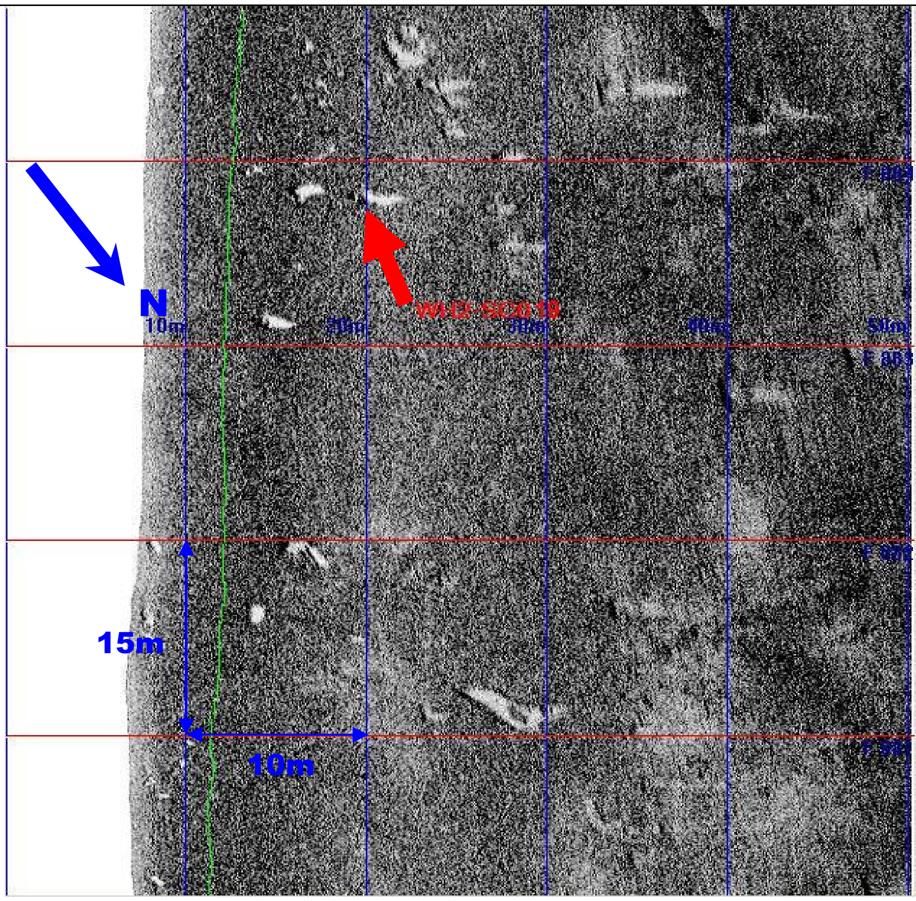
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

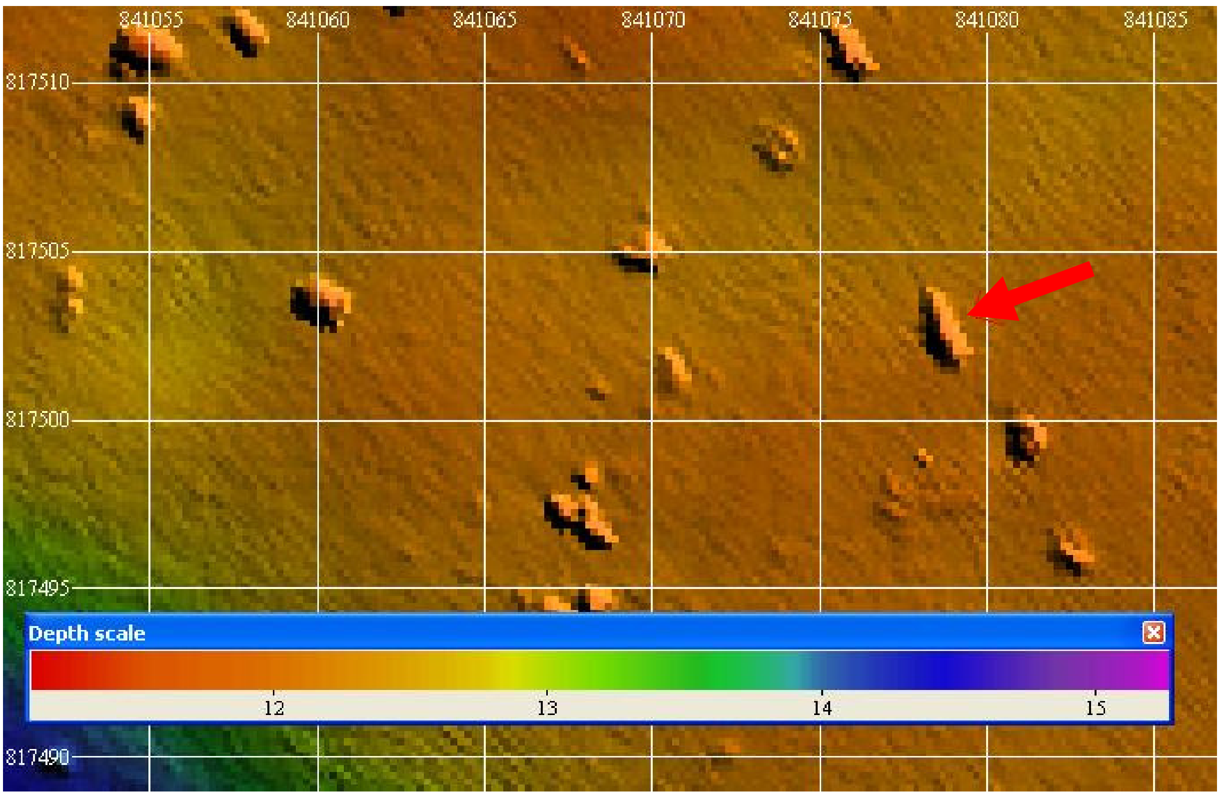




WH2-SC018 – 1.2m x 0.8m x 0.8m Unknown object

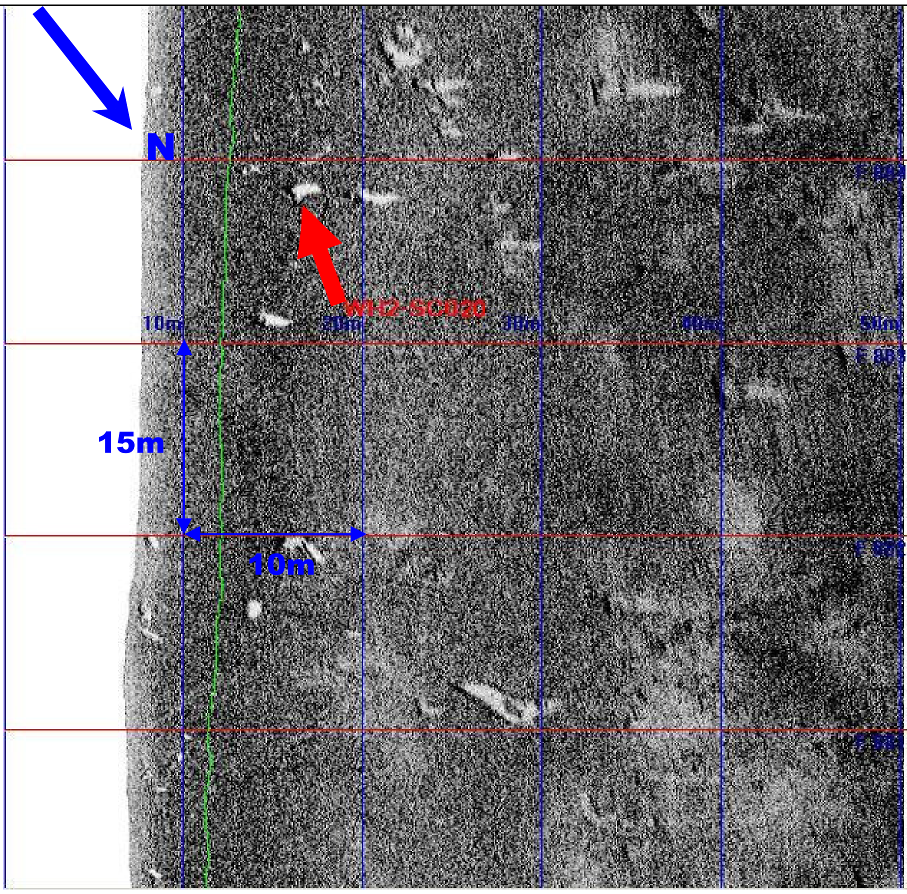
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

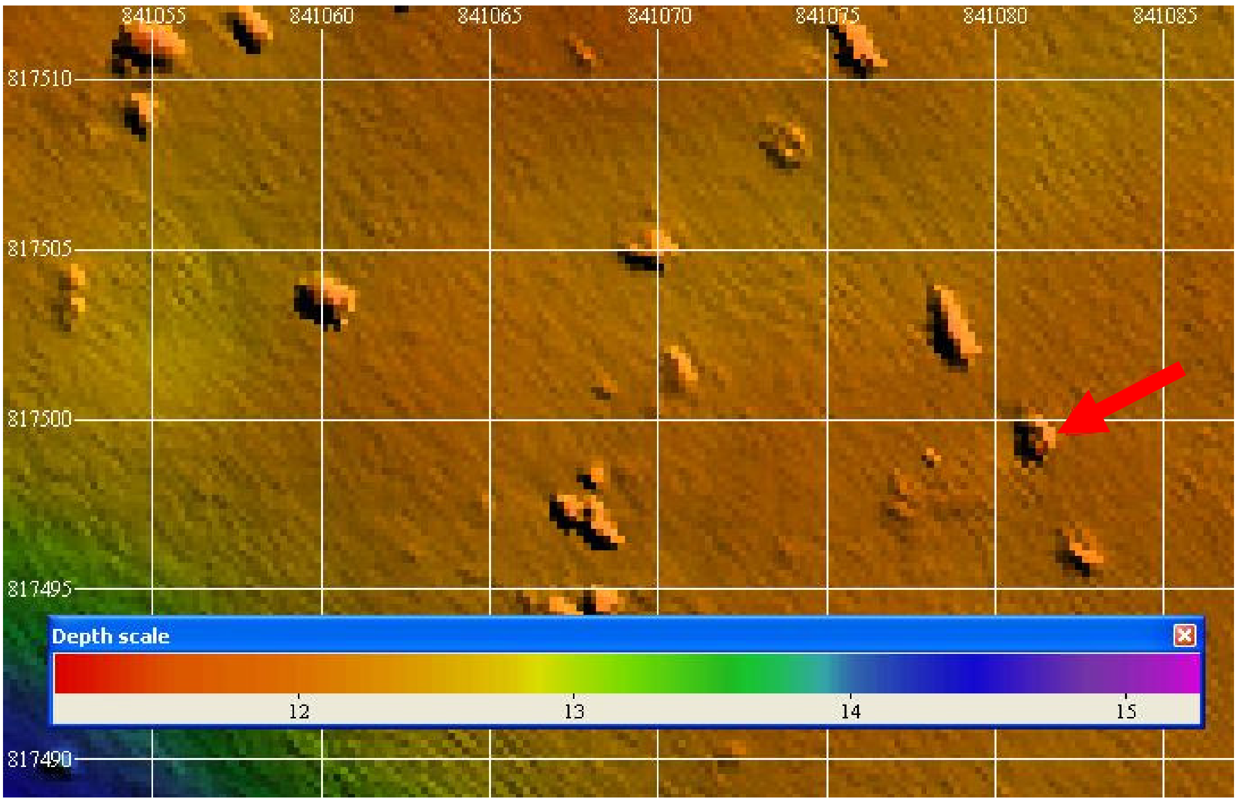




WH2-SC019 – 0.8m x 1.2m x 0.5m Unknown object

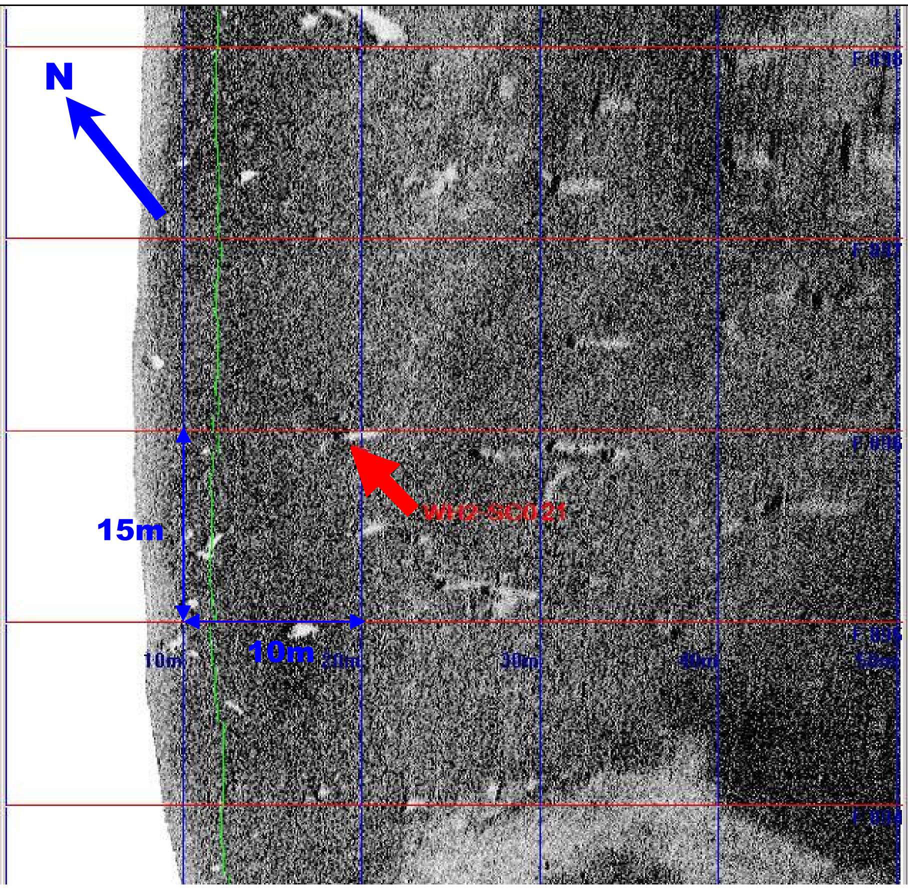
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

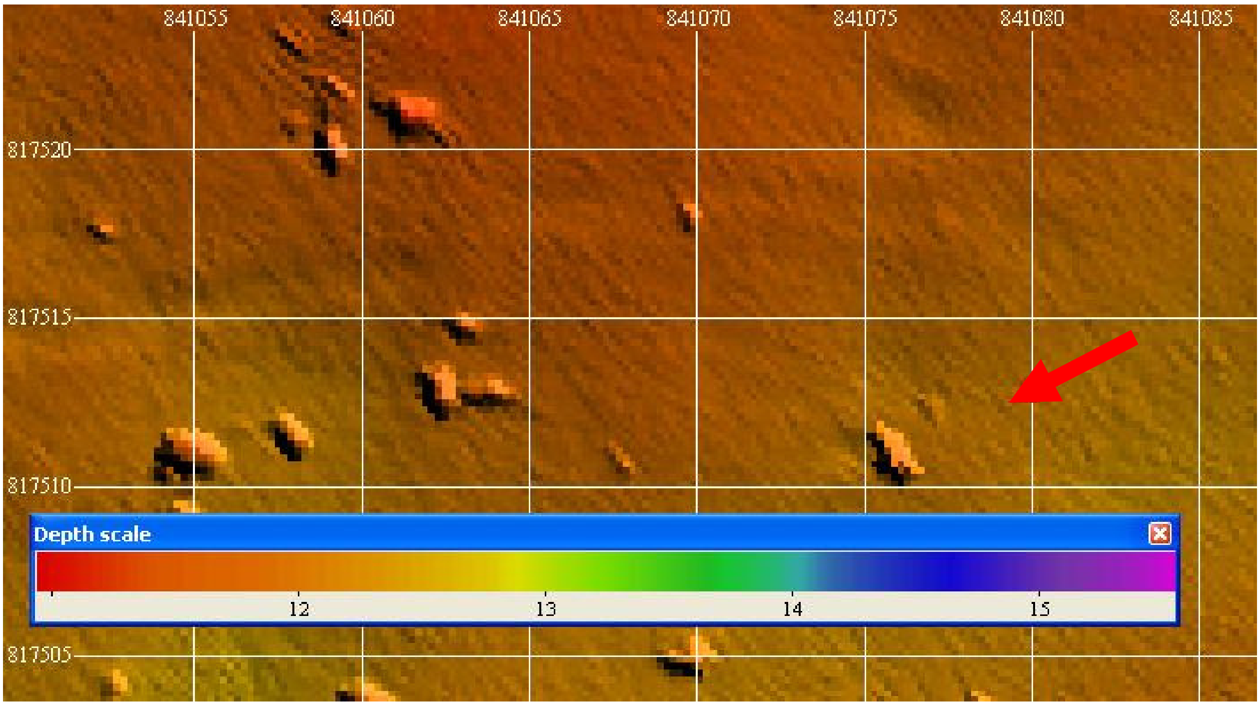




WH2-SC020 – 1.8m x 0.5m x 0.6m Unknown object

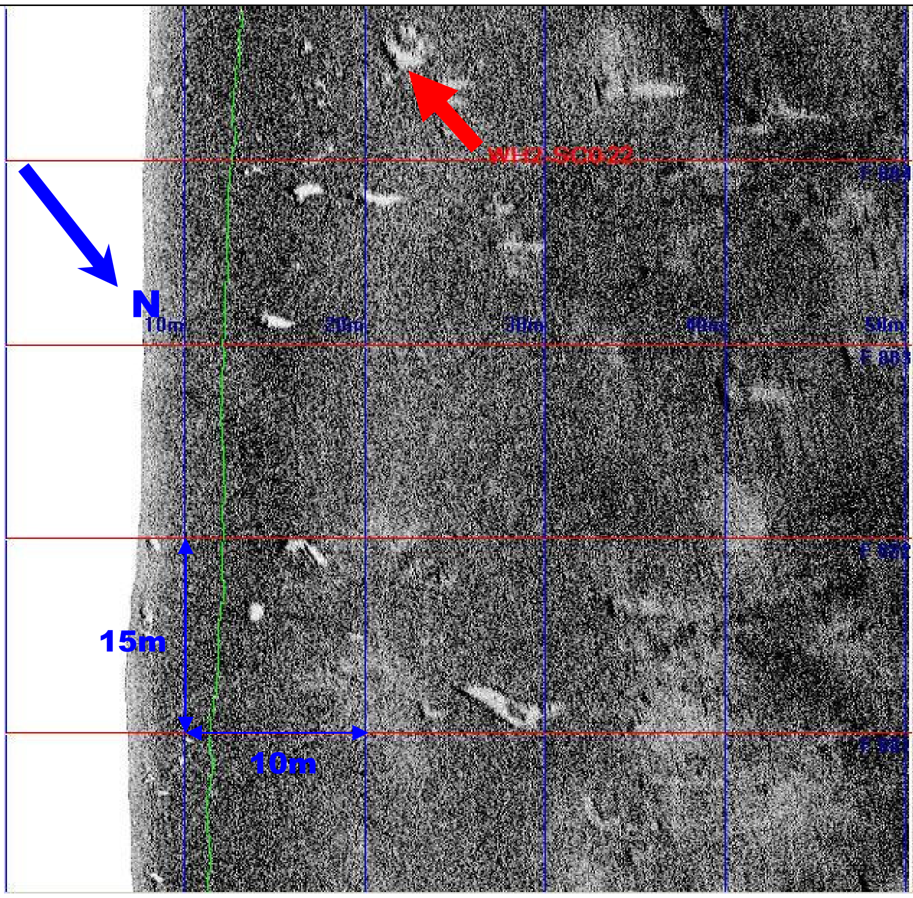
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

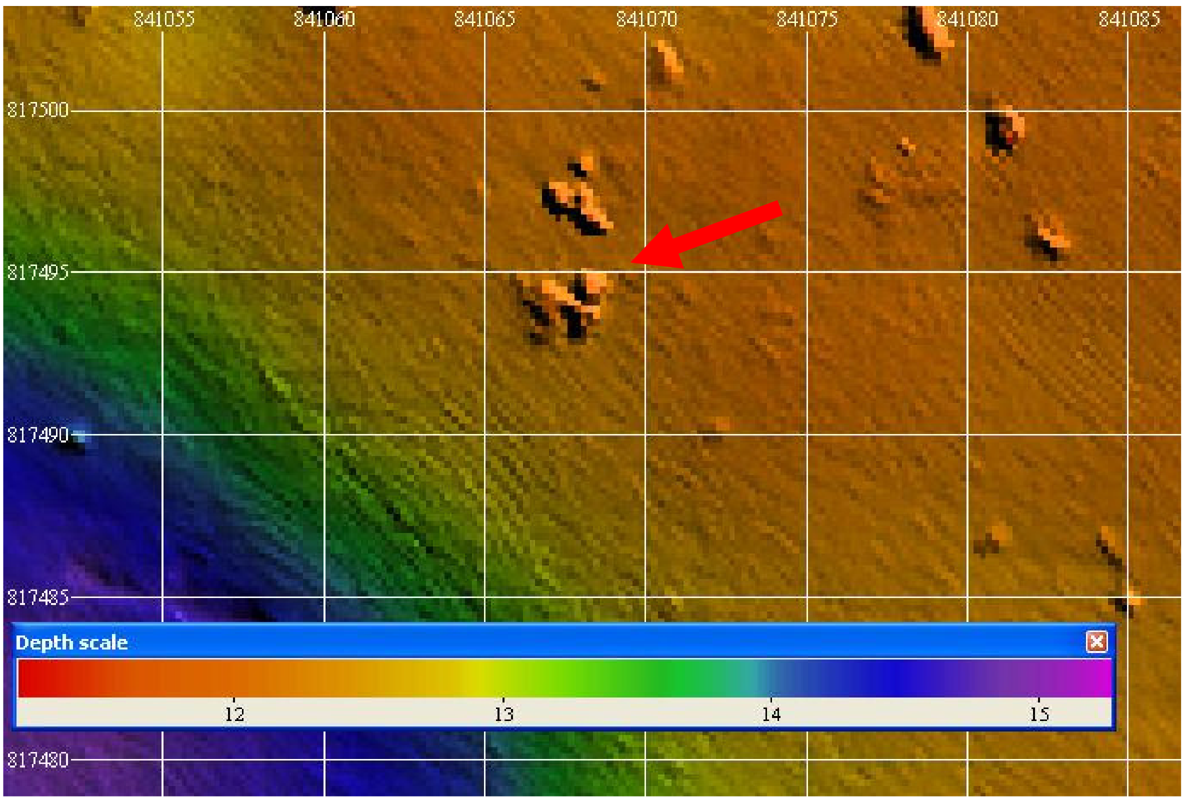




WH2-SC021 – 0.9m x 0.9m x 0.5m Unknown object

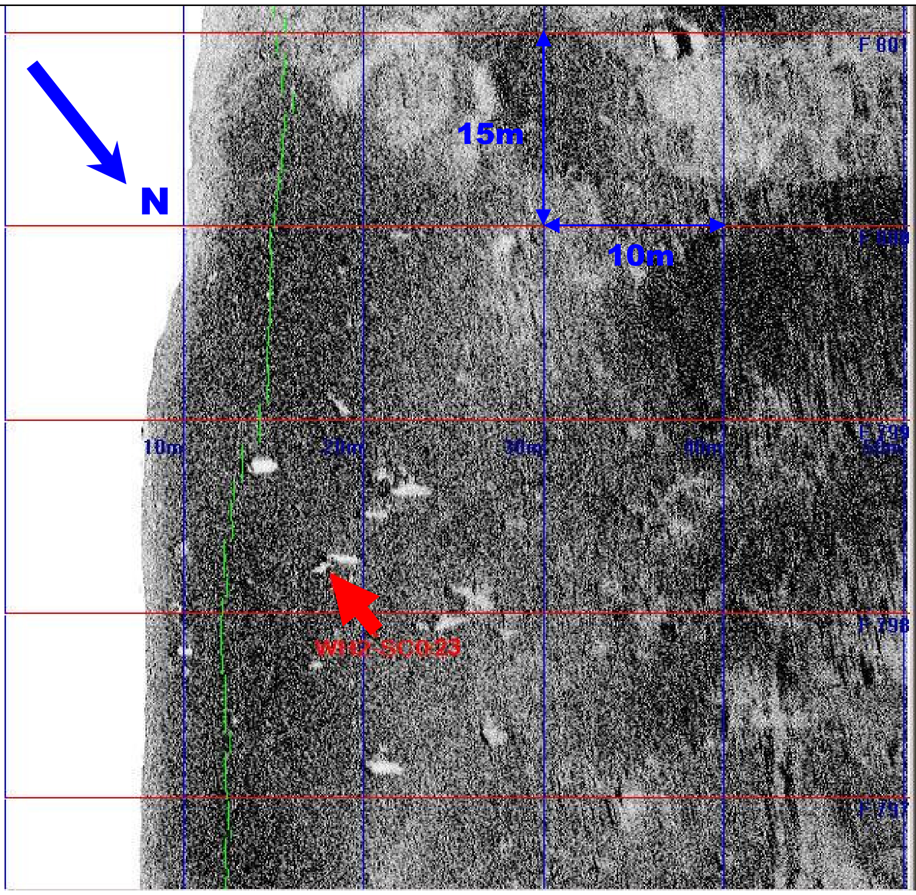
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

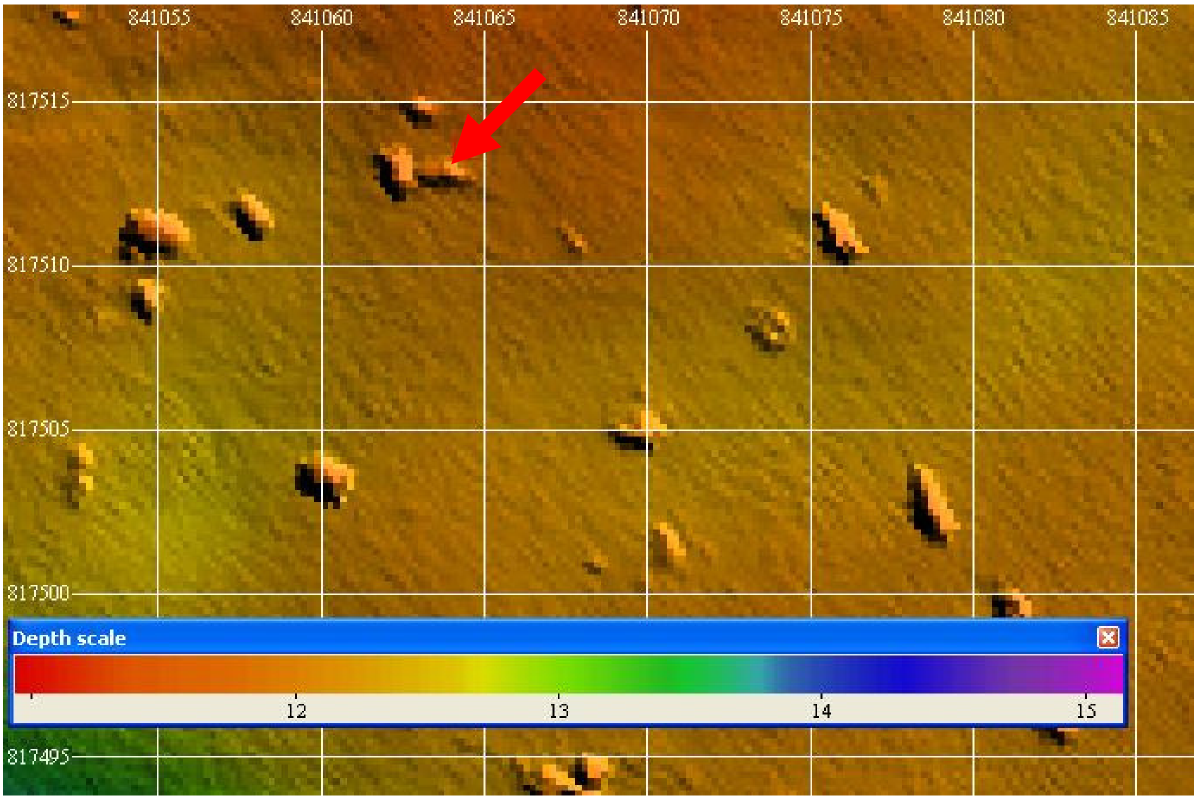




WH2-SC022 – 2.7m x 0.6m x 0.5m Unknown object

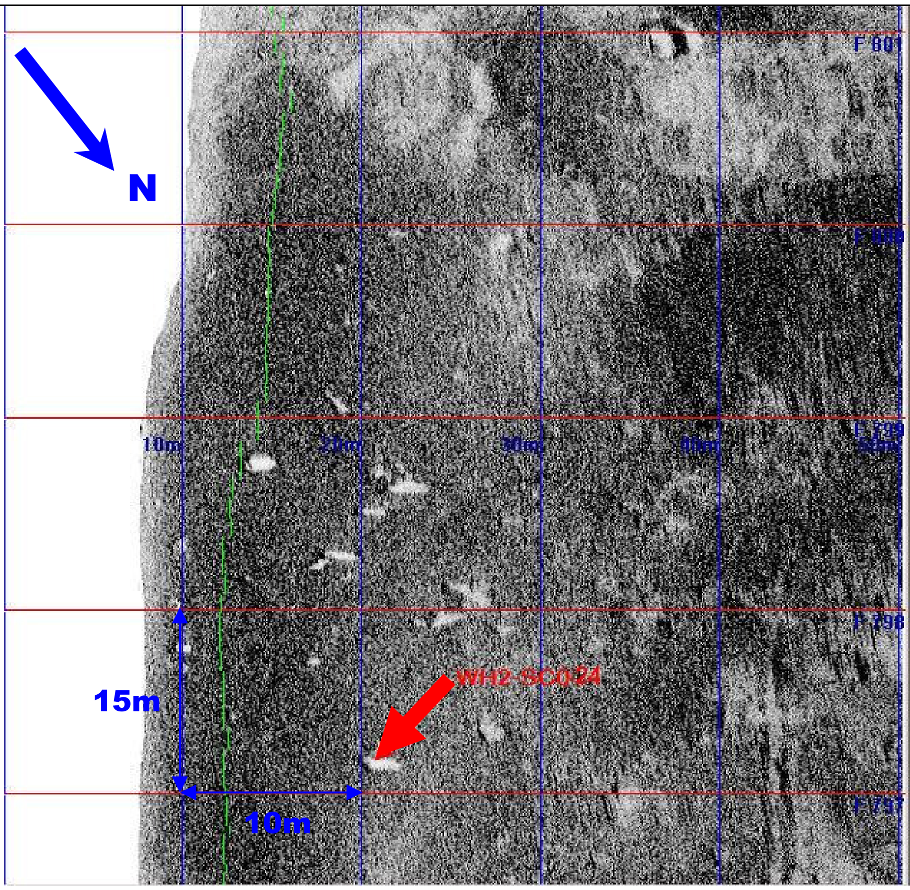
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

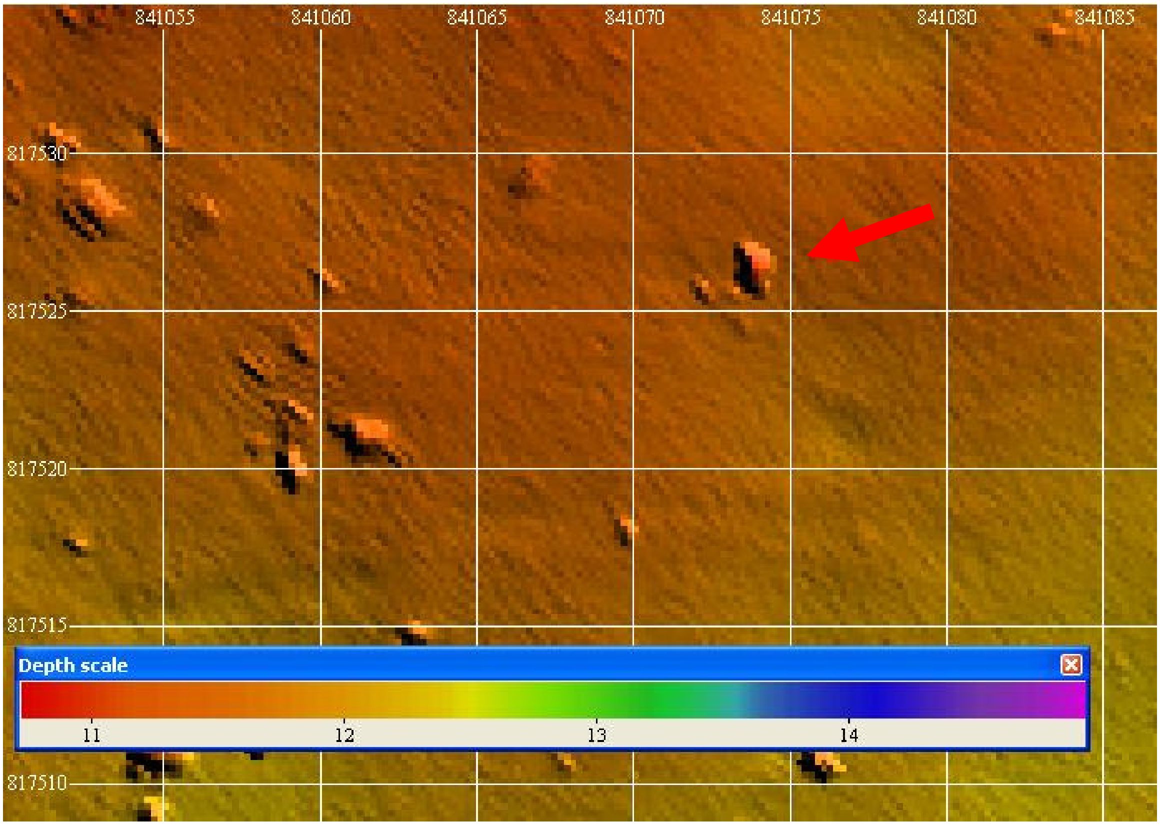




WH2-SC023 – 1.8m x 0.9m x 0.6m Unknown object

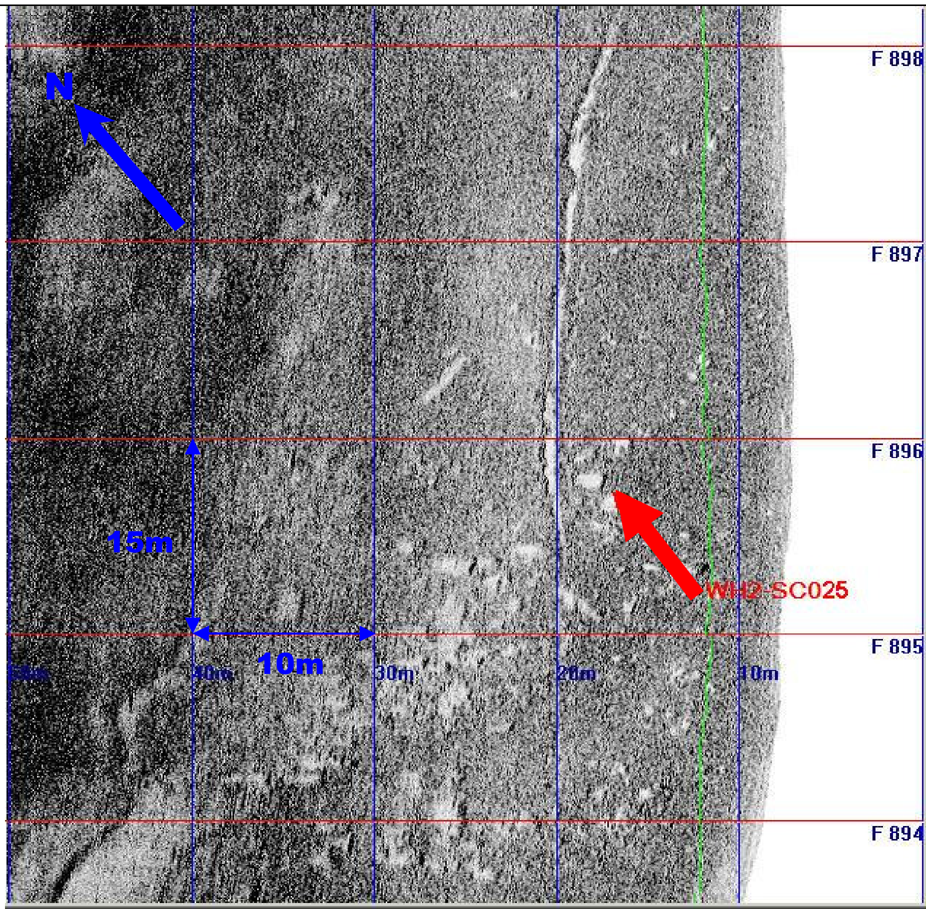
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

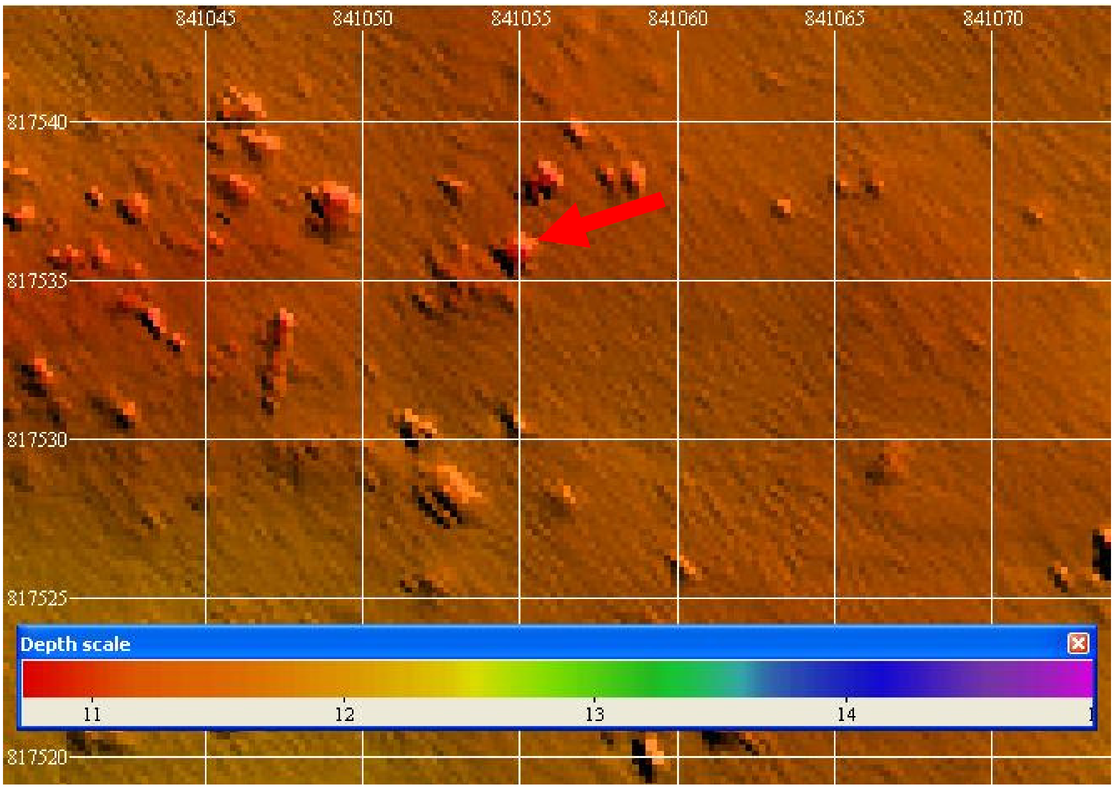




WH2-SC024 – 1.3m x 0.5m x 0.5m Unknown object

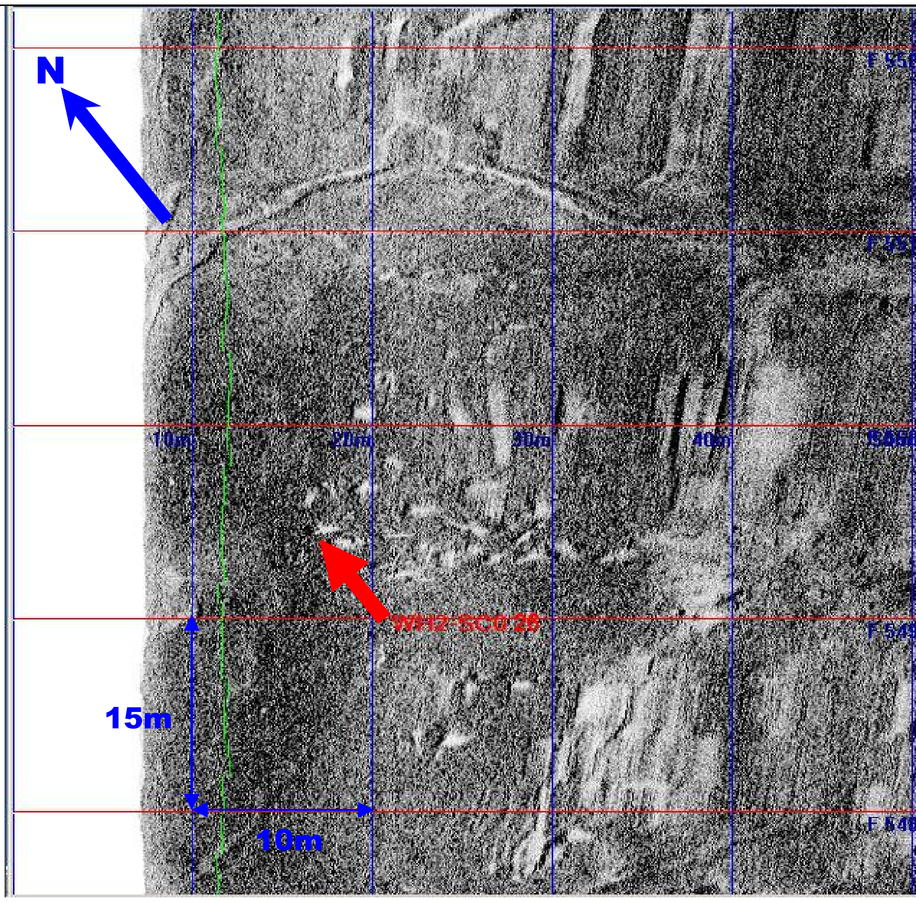
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

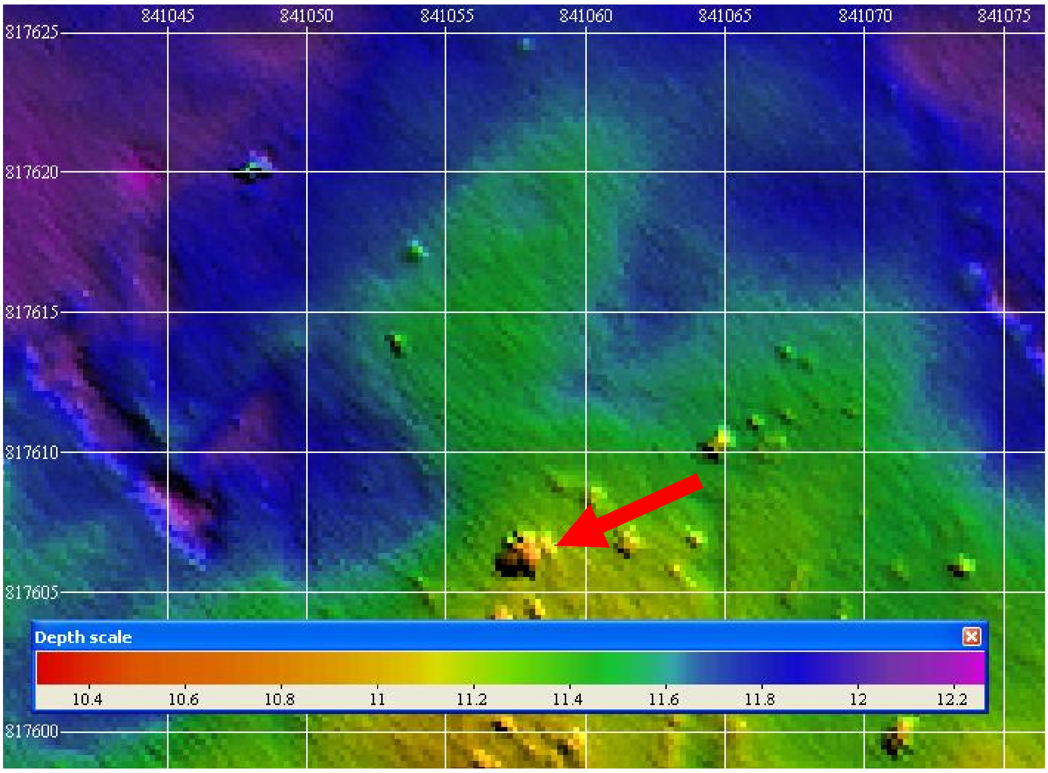




WH2-SC025 – 0.9m x 0.3m x 0.5m Unknown object

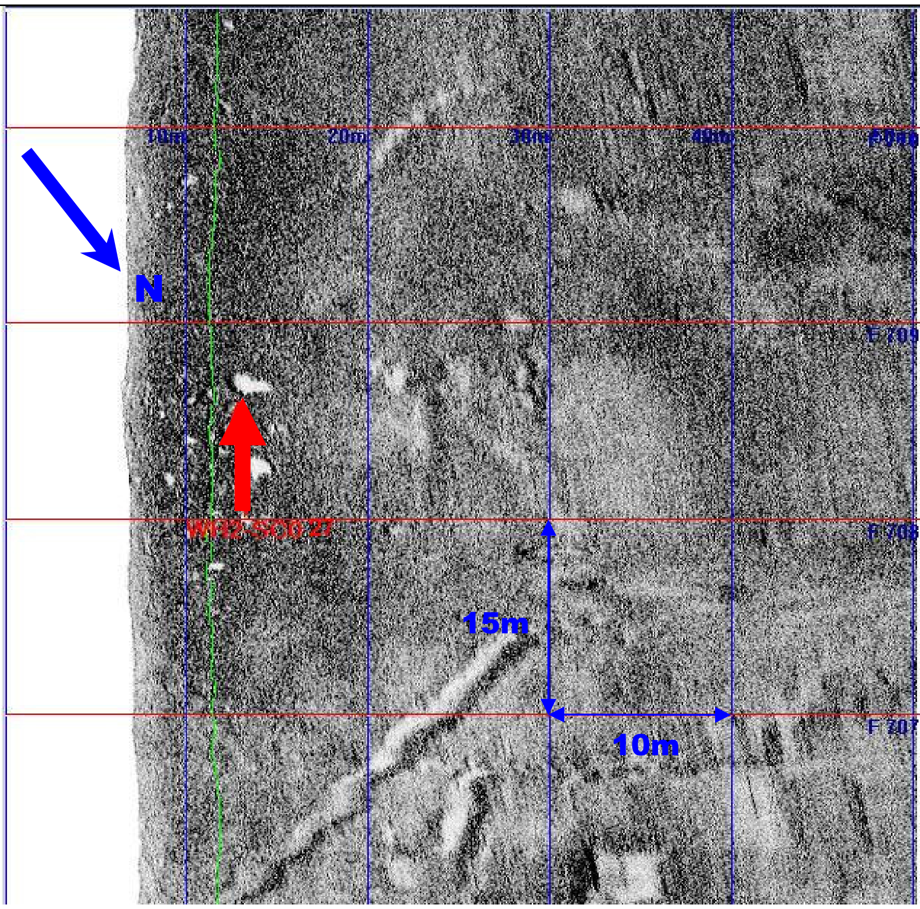
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

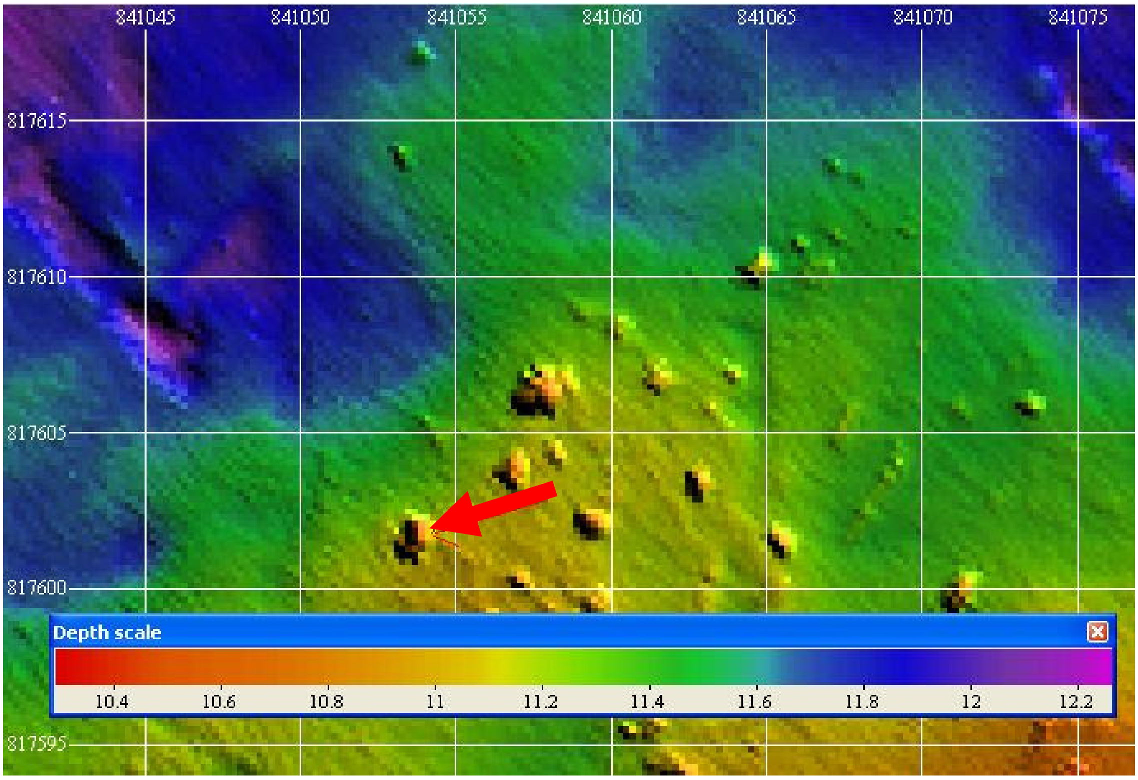




WH2-SC026 – 2.0m x 0.7m x 0.6m Unknown object

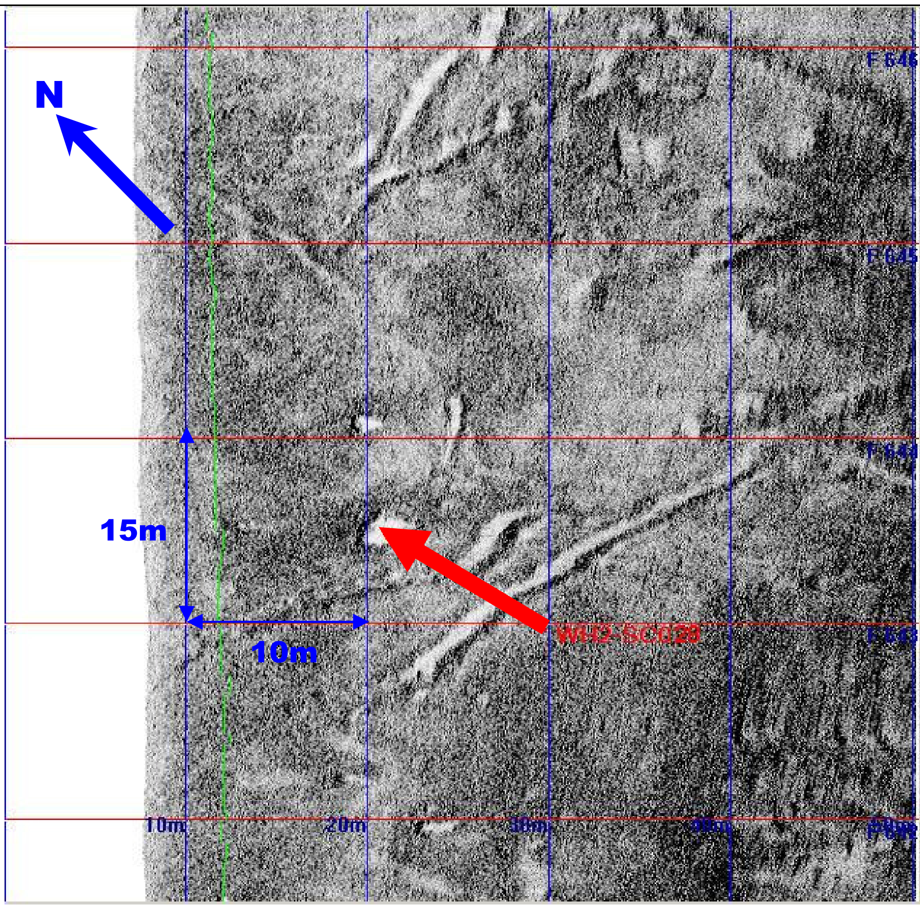
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

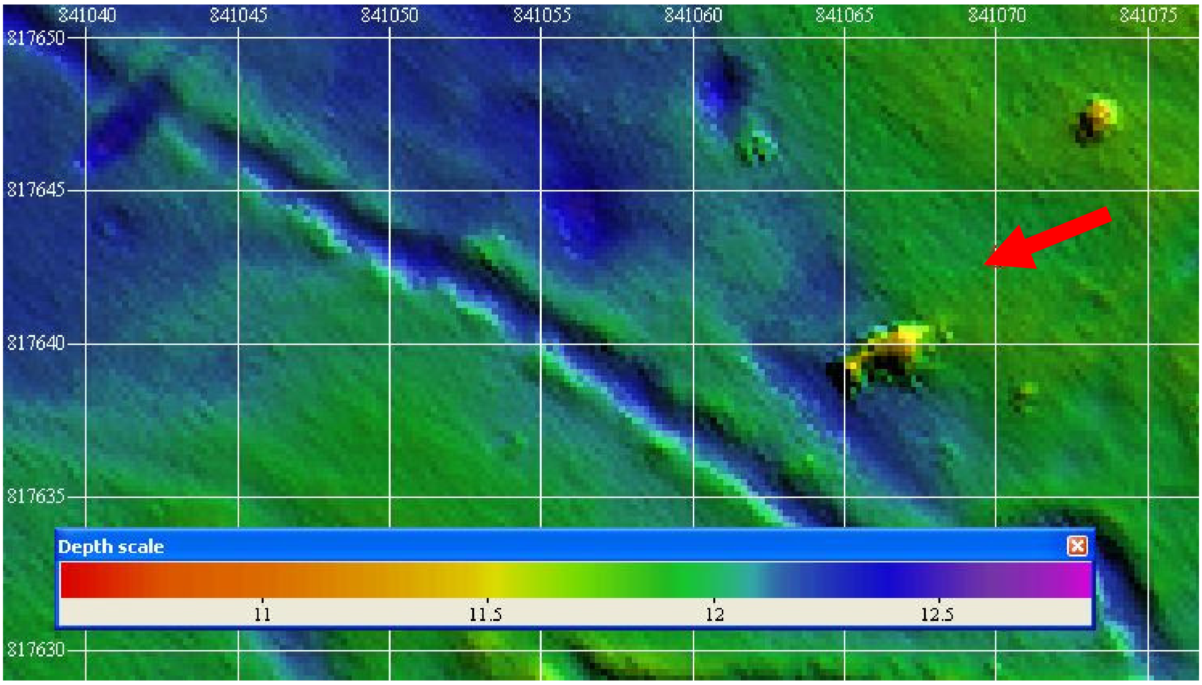




WH2-SC027 – 1.5m x 0.7m x 0.8m Unknown object

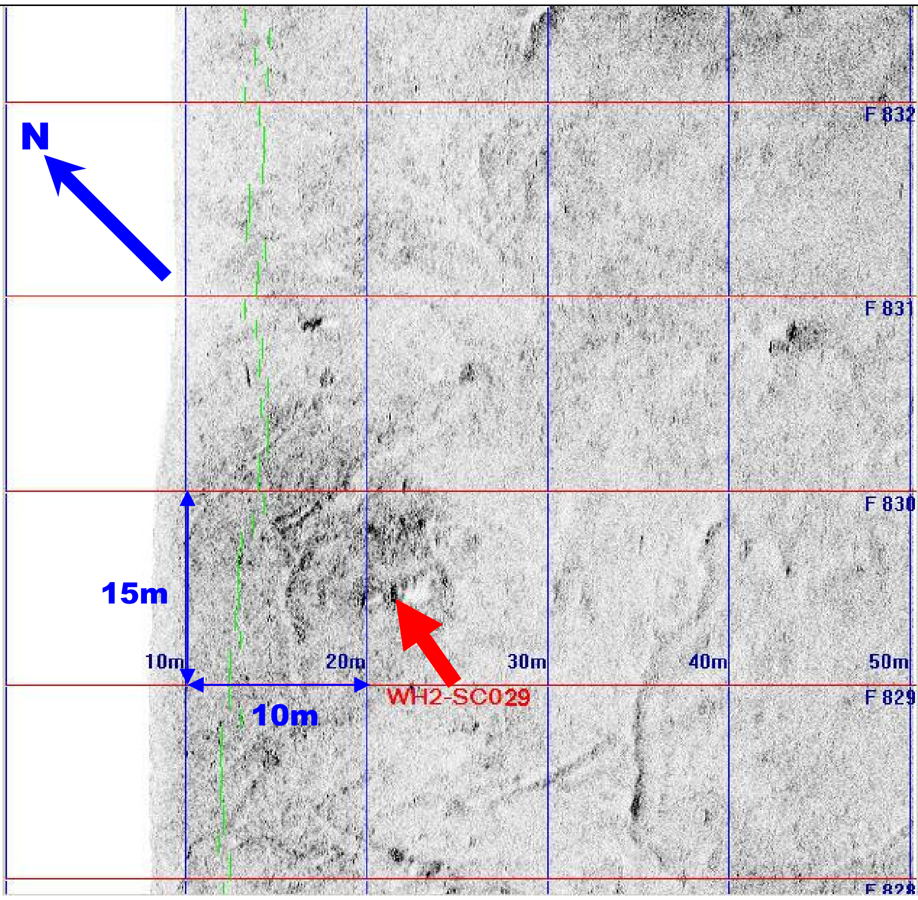
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

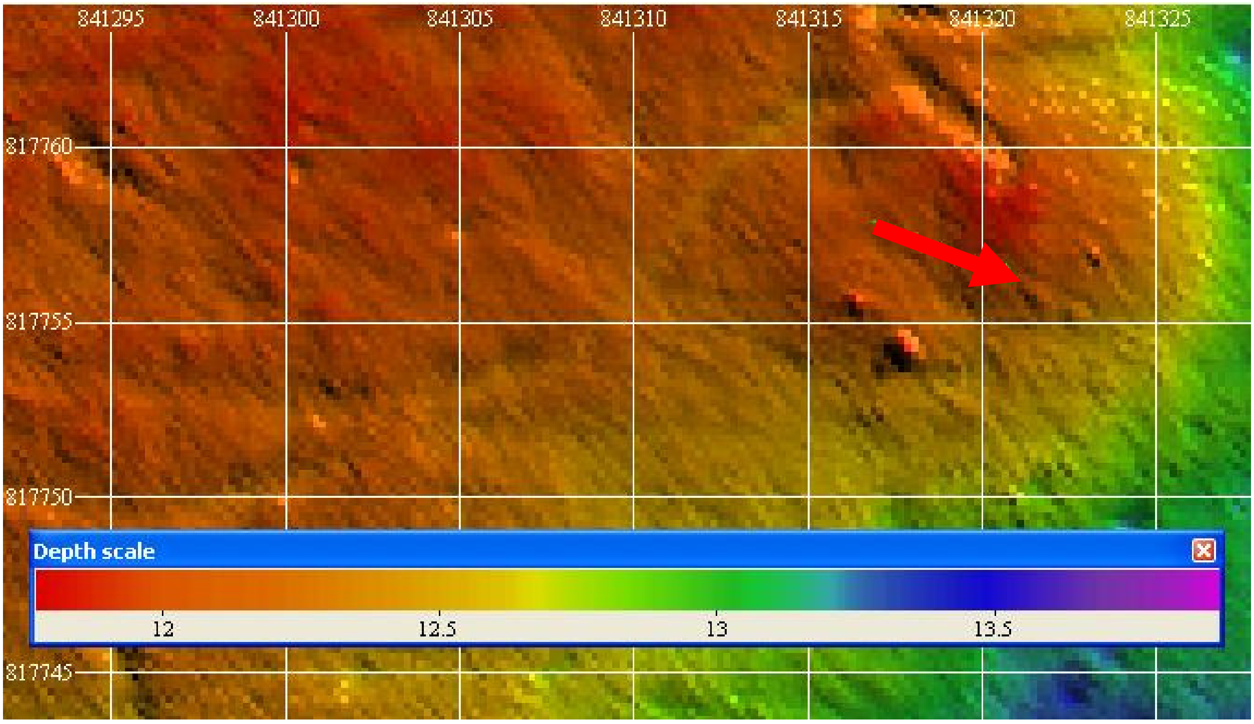




WH2-SC028 – 2.3m x 0.7m x 0.6m Unknown object

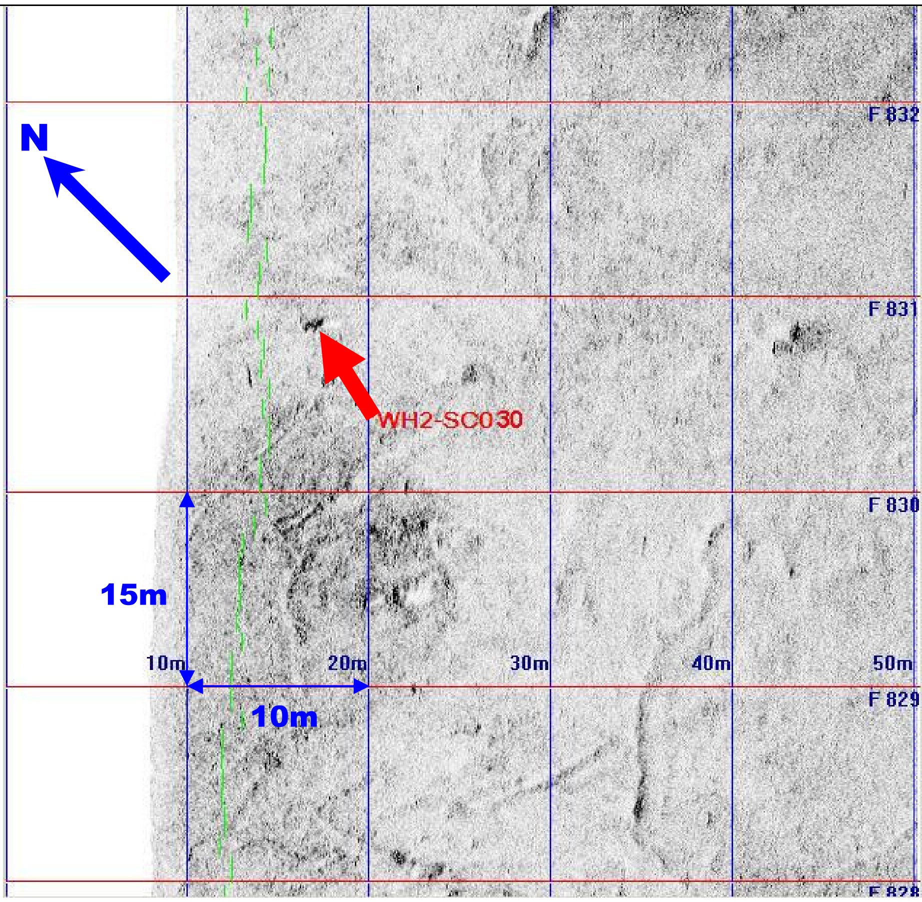
Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts

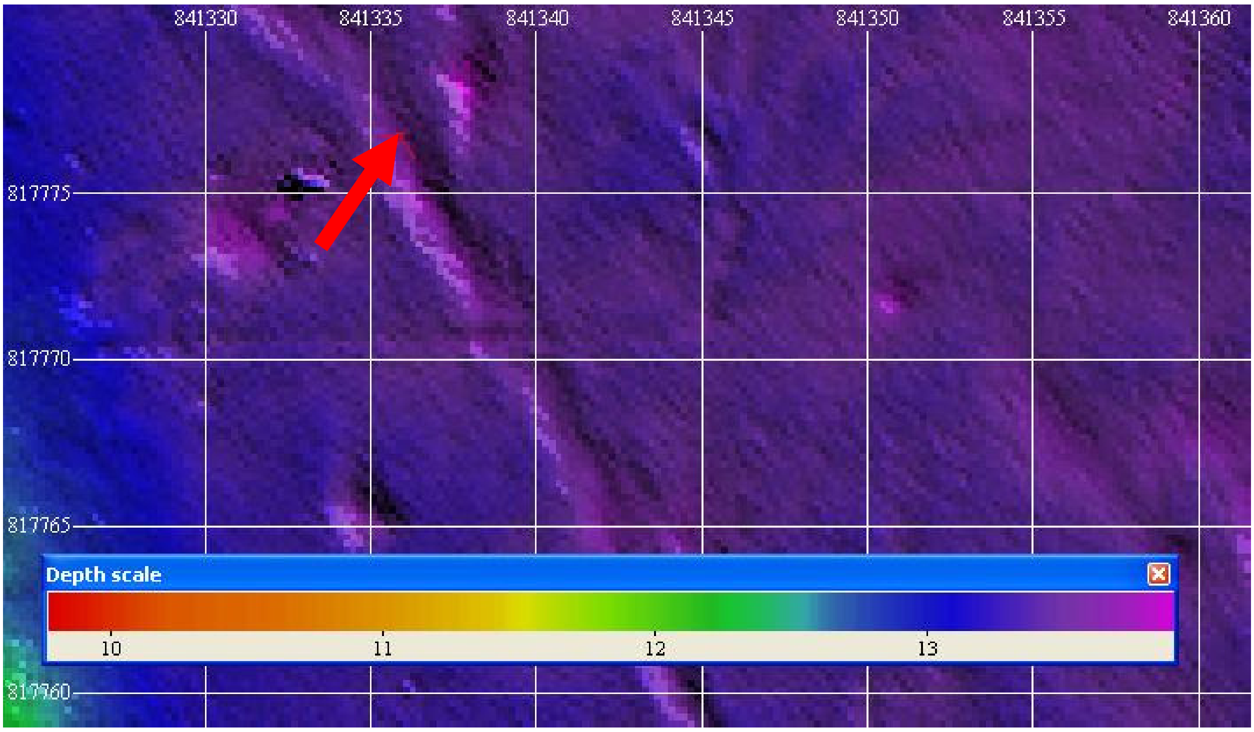




WH2-SC029 – 1.8m x 0.8m x 0.5m Unknown object

Annex D.3
Side scan sonar and mulit beam swath images for sonar contacts





WH2-SC030 – 1.2m x 0.6m x 0.5m Unknown object