

## **Appendix 11.4**

### **Marine Geophysical Survey**

## **Appendix 11.4 - MARINE GEOPHYSICAL SURVEY**

### **1 INTRODUCTION**

Additional marine geophysical survey was required to ensure 100% coverage of the study area when combined with the results of the 2008 data. The survey was designed to meet the requirements of the SI and MAI. The survey was carried out by EGS Asia and the data were made available for the archaeological assessment.

The following techniques were deployed:

<b>METHOD</b>	<b>OBJECTIVE</b>
Marine seismic profiling survey	To identify the geological succession at and beneath the link corridor.
Marine side scan sonar survey	To locate objects at or above the sea bed, such as shipwrecks, isolated artefacts, seabed disturbance and dumped materials.
Marine magnetic survey	To detect the existing pipelines, to record the presence of ferrous metal objects at or close to the sea bed such as cannons.

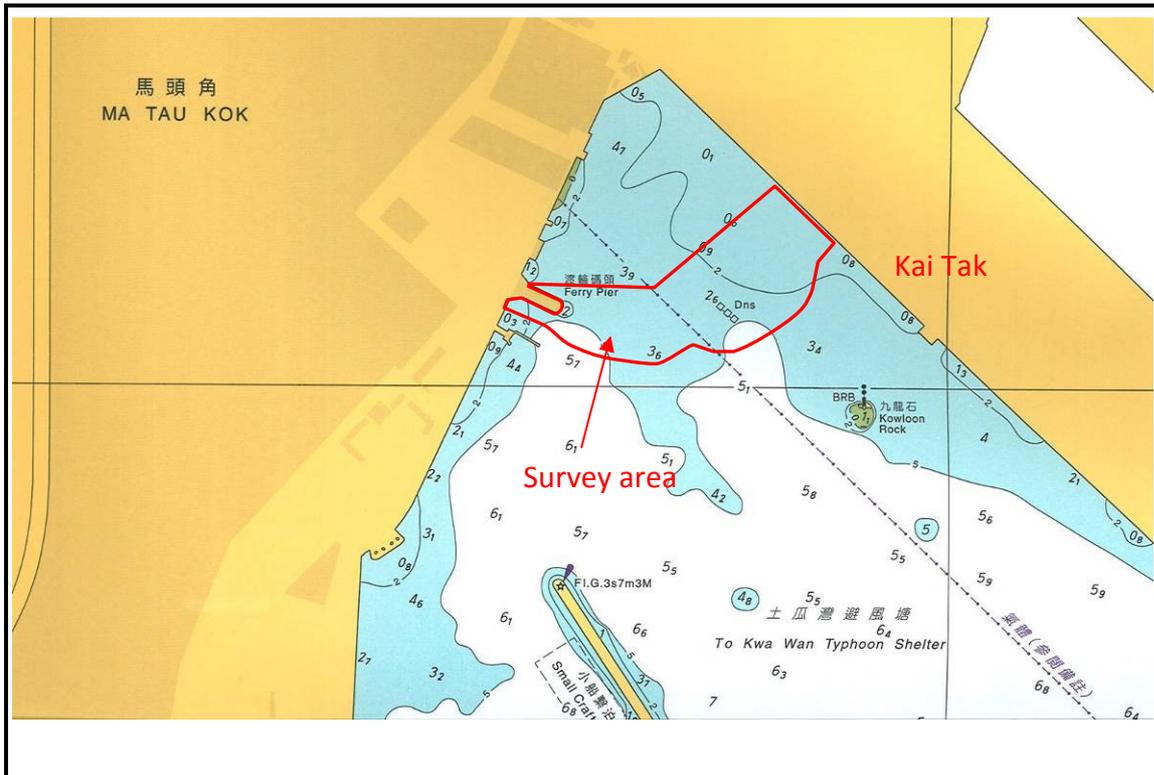
The survey was carried out under the Geophysical Survey Term Contract Works Order No. GE/2010/02.50 dated 12<sup>th</sup> January 2012 issued by Civil Engineering and Development Department.

#### **1.1 Survey Period**

The survey was carried out on 30<sup>th</sup> January 2012.

### **2 SITE DESCRIPTION**

The survey area lies inside To Kwa Wan Typhoon shelter between To Kwa Wan ferry pier and the Ex-Hong Kong International Airport (Kai Tak). An extraction from the Hong Kong Chart No. HK0802 is provided below,



Extract from HK Chart – HK0802. For illustration only. Not to scale

There is a drilling platform working for the same project in the vicinity of the survey area and a disused fuel dolphin connecting to the former airport runway within the survey area.

As a ferry pier, a public pier and a vehicular ferry pier are located to the west of the survey area, the survey area was quite busy during the survey period. The site condition and some of the marine activities are illustrated in pictures below.

<p>A drilling platform and sampan working for the same job near the survey area</p>	<p>A disused fuel dolphin within the survey area</p>



The disused fuel dolphin is enclosed by its safety protection



A barge remained stationary to the north of the survey area during the survey period



Boulders near seawall of Kai Tak



Two ferries were berthed at the ferry pier during survey period



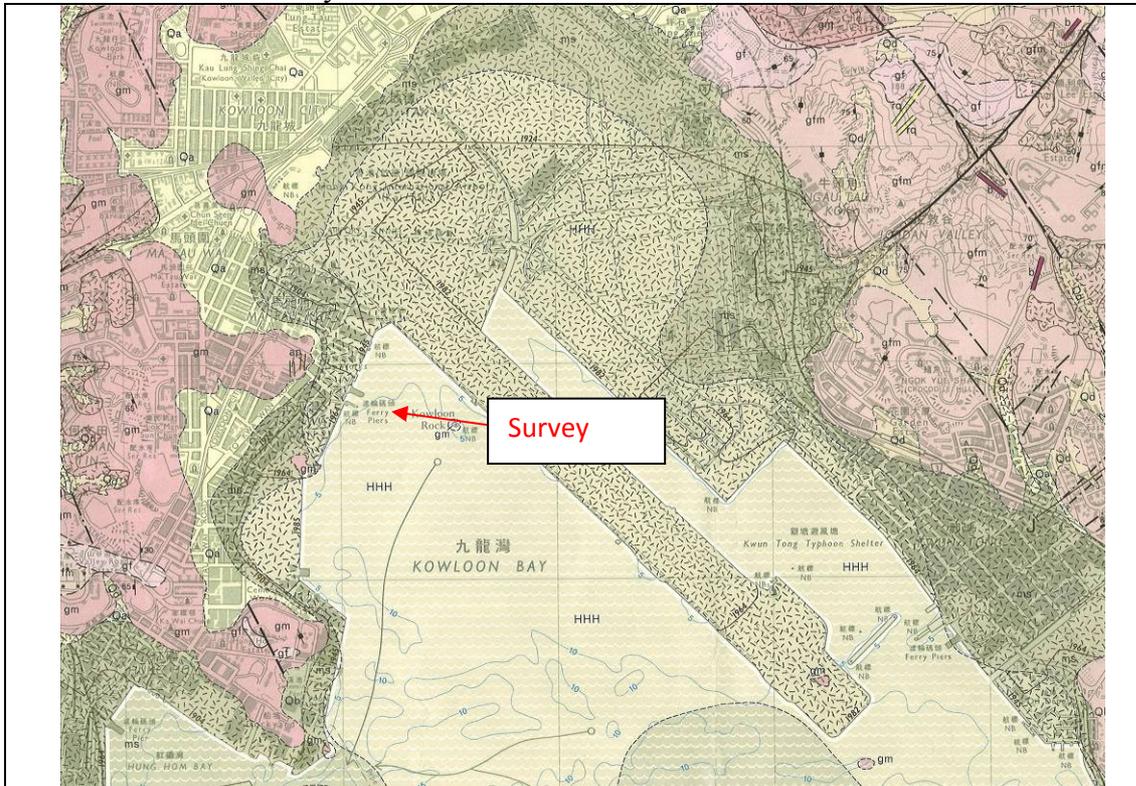
First Ferry operates daily service between North Point and Kowloon City



A sampan was berthed at the marker buoy within survey area

### 3 GEOLOGICAL BACKGROUND OF THE AREA

As shown on the geological map below, the survey area is dominated by superficial deposits that are of Holocene, Quaternary period. The sediments are undivided and mainly dark grey marine mud. The survey area is surrounded by reclaimed land to the NE and NW, while to the south is Kowloon Bay.



Geological map of the survey area

SUPERFICIAL DEPOSITS (OFFSHORE) 地表沉積 (離岸地區)		NAMED DIVISIONS	地層名稱	主要物質成份	PRINCIPAL MATERIALS	
第四系 QUATERNARY	全新統 HOLOCENE	坑口組 HANG HAI FORMATION	East Lamma Channel Member	東博寮海峽段	Hhh	未分、主要深灰色海相泥 ..... Undivided, mainly dark grey marine mud
			Telegraph Bay Member	鋼線灣段	elm	海相泥 ..... Marine mud
	更新統 PLEISTOCENE	赤鱗角組 CHEK LAP KOK FORMATION			tbn	海相泥 ..... Marine mud
					ms	海相砂，部份粉砂質 ..... Marine sand, part silty
				PCK	未分；紅色、黃色和灰色的粘土、粉砂、砂和礫石 ..... Undivided; red, yellow and grey clay, silt, sand and gravel	

Legend of the geological map

## 4 EQUIPMENT LIST

The following equipment was mobilised on a speedboat while the mother boat Wing Hung 2, a Class I commercially licensed vessel was secure nearby.

Type	Equipment
Horizontal positioning	C-Nav Globally Corrected GPS (GcGPS) system
Single beam echo sounding	ODOM Echotrac DF3200 MKIII
Side scan sonar	Edgetech 272TD side scan sonar system with digital tow fish
Seismic sub-bottom profile	C-Boom low voltage boomer system
	C-Phone hydrophone system
Magnetometer	SeaSPY Overhauser Marine Magnetometer
Software	C-View Nav computerized navigation suite
	C-View digital recording and processing system
Others	A/C generators, computers and bar check equipment

## 5 LOCATION CONTROL

### 5.1 Horizontal

#### 5.1.1 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.

#### 5.1.2 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

GcGPS diagnostics enabling quality control

The 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.

### 5.1.3 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 the Yau Ma Tei typhoon shelter.

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

## 6 FIELD PROCEDURE

### 6.1 Survey Vessels

Due to the shallow water in the survey area, seismic reflection and side scan sonar survey, and magnetic survey were conducted using a small speedboat. A mother boat, MV Wing Hung 2, was standby close to the survey area to ensure a safe and secure conduction of the survey.



Wing Hung 2, Class I commercially licensed survey vessel



Speedboat for survey

### 6.2 Coverage

Main traverses for the seismic, side scan sonar, and magnetic surveys were set at 20m intervals with cross lines at 60m intervals.

### 6.3 Side Scan Sonar Survey

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

The side scan sonar tow fish was towed from the bow of the sampan, at a depth of about 1m beneath the sea surface.

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

- Vessel speed: 1.1 – 1.3 m/sec
- Fix interval: 10 seconds
- Source frequency: 500 kHz
- Pulse length: 10  $\mu$ s
- Gain setting: Manually controlled
- Slant range: 50m

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

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



272TD was used in the side scan sonar survey

### 6.4 Seismic Reflection Survey

Prior to the commencement of survey the EGS C-Boom (low voltage) boomer was wet tested to ensure the system was working properly. The EGS boomer was towed from the stern of the survey vessel, at a distance such that noise from the survey vessel was kept to a minimum.

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

- Vessel Speed: 1.1 – 1.3 m/sec
- Fix Interval: 10 seconds
- Out put power: +/- 500 volts

- Sweep: 250ms
- Delay: 0ms
- Gain setting: Manually controlled



The computer with C-NAV package for navigation



The EGS boomer (left) and hydrophone (right) were towed astern of the vessel for sub-bottom seismic profiling

### 6.5 The Magnetic Survey

A magnetic survey was conducted to locate any metal objects above or buried within the seabed sediments. During the survey, the magnetometer transducer was towed astern of the survey vessel. A depth sensor was attached to the magnetometer sensor and used to maintain a sensor height above the seabed in the range 2m to 5m. In this case, the magnetometer towfish was deployed at a distance of 20m at the stern of the survey vessel.

EGS has written software for the display of marine magnetic data in profile form on the PC screen; there are two displays:

A large display within the range 100 to 500 nT

A smaller display to a scale of 10 times the above large display

It is necessary to monitor both displays as the data is collected, to be able to see the effects of both large (regional) and small (local) anomalies.



The marine magnetometer sensor

## 6.6 Site Safety

Safety was 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.

Only Class I commercially licenced vessels were used, fitted with all prescribed safety equipment.

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

## 7 REDUCTION OF OBSERVATIONS AND INTERPRETATION

### 7.1 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 was reconciled and a detailed check was performed.

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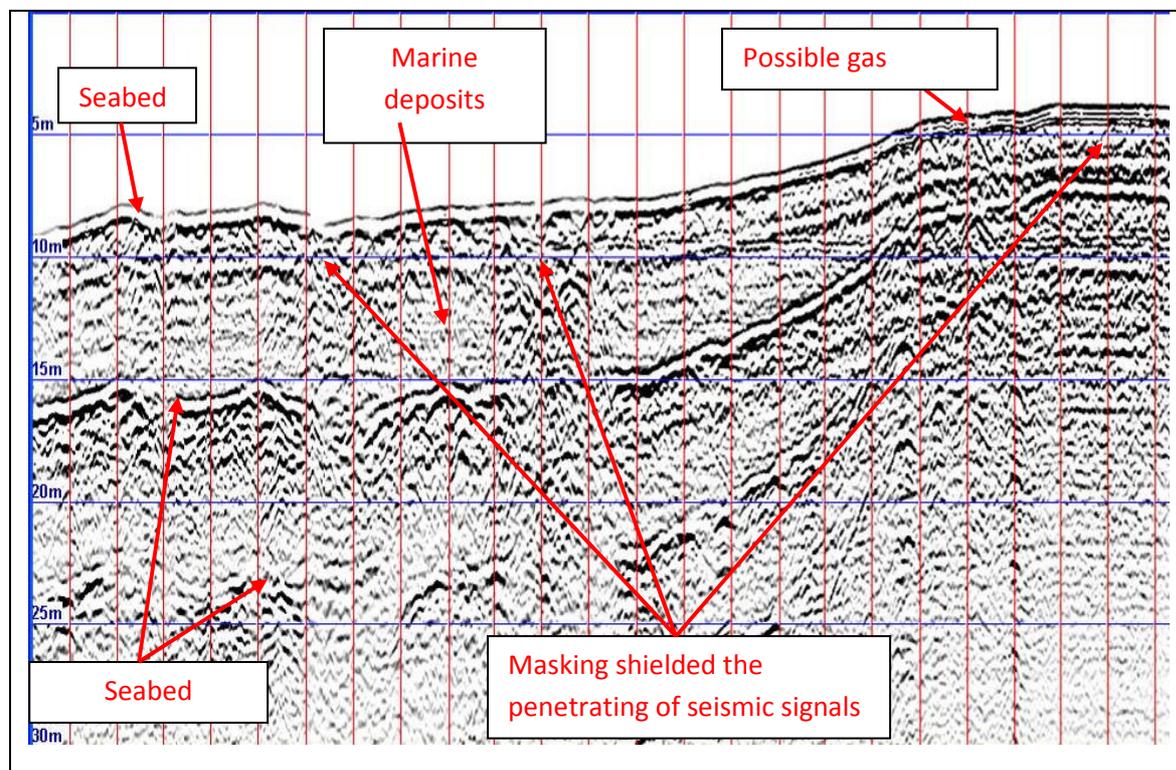
- Indicators for the presence of intact or broken up shipwrecks
- Isolated objects which could have archaeological potential

- Areas of disturbed seabed attributed to anchored vessels
- Large area of debris or dumped materials
- Seafloor with pipeline/cable related scars

## 7.2 Seismic Data

Seismic data showed that the survey area was covered by marine deposits which was identifiable on seismic records as a clear conformable horizon. However, the area was heavily masked as expected which blocked the interpretation work for sub bottom geology. Masking is probably caused by the presence of organic materials on the seabed (e.g. discharge from the water outfall) and the gas bubbles so generated absorb the seismic energy, thereby preventing reflections from deeper horizons.

In addition, the very shallow water in the survey area produced multiples that could not be removed by the processing. Consequently, interpretation of seismic profiles below the first seabed multiple was severely reduced.

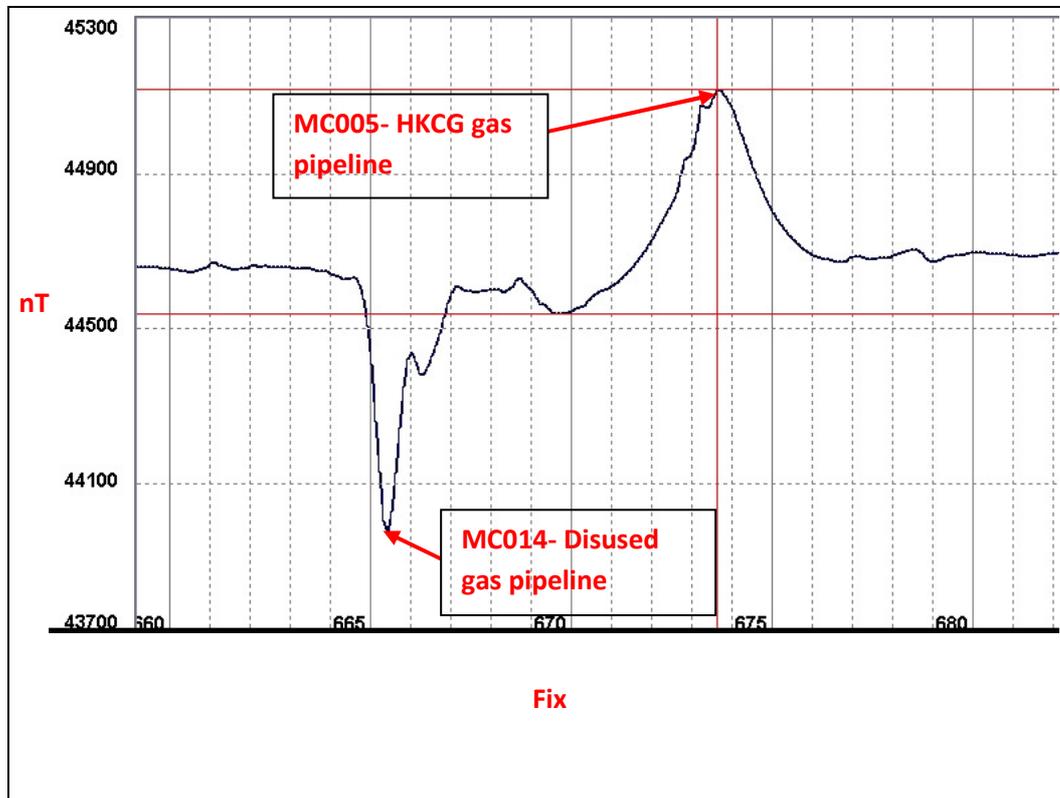


## 7.3 Magnetic Data

The earth's magnetic field is locally distorted by:

- Changes in the magnetic susceptibility of sediments and the solid geology
- Magnetic anomalies caused by made-made ferrous metal objects

Magnetic data are plotted in the form of profiles; these are inspected by an experienced geophysicist for anomalies likely to have been caused by the pipelines and other ferrous objects. Following is an example from this survey.



The alignment of the existing pipelines was successfully detected by the magnetometer except the area close to the disused fuel dolphin. The disused fuel dolphin generates strong magnetic anomalies which confused the anomalies from the pipeline.

## 8 RESULTS

A summary drawing showing the distribution of the Seabed Features is presented in Appendix 11.3.

### 8.1 Seabed Features

A total of 39 sonar contacts were located. Eight of these were identified as tyres and one as a marker buoy sinker. The remaining 30 need diver inspection to assess their archaeological value.

A total of 18 magnetic contacts were recorded. Of these, 12 are connected to disused gas pipelines and 6 are unknown. The other six will require diver inspection to assess their archaeological value.

The quality of the seismic data was adversely affected by the presence of organic materials on the seabed such as discharge from the water outfall. Only 1 seismic contact was recorded which was associated with the disused gas pipeline.

Anchor scars were observed on soft seabed sediments as barges, ferries and other commercial boats anchor there.

