本署檔號
OUR REF: (26) in EP2/H17/C/05 Pt.2
來函檔號
YOUR REF:
電　話
TEL. NO.: 2835 1155
圖文傳真
FAX NO.: 2591 0558
電子郵件
E-MAIL:
網　址
HOMEPAGE: http://www.epd.gov.hk

Environmental Protection Department
Branch Office
28th Floor, Southorn Centre,
130 Hennessy Road,
Wan Chai, Hong Kong.

環境保護署分處
香港灣仔
軒尼詩道
一百三十號
修頓中心廿八樓

3 March 2009

By Registered Post & Fax (2723 5660)
Environmental Resources Management
21/F, Lincoln House,
979 King's Road,
Taikoo Place, Island East, Hong Kong
(Attn.: Dr. Robin Kennish)

Dear Dr. Kennish,

Environmental Impact Assessment (EIA) Ordinance, Cap.499,
VSNL Intra Asia Submarine Cable System – Deep Water Bay
(Environmental Permit No. EP-294/2007 & FEP-01/294/2007)

Change in Cable Alignment details under Condition 2.1

We refer to your letter ref: 0067564_Letter_EPD_20090211.doc dated 11.2.09 enclosing a 'Supplementary Assessment Report (SAR)' requesting our approval for changes in the cable alignment details, and your letter ref: 0067564_Letter_EPD_20090219.doc dated 19.2.09 enclosing an amended page 43 for the SAR.

For ease of reference, the concerned Environmental Permit Condition is reproduced below:

"2.1 The submarine cable shall be laid along the alignment as delineated in Figure 1 attached to this Permit. The Permit Holder shall obtain prior approval from the Director of any changes in the Project details, including cable alignment, burial depth, trench width and installation methods as shown in Figure 1 attached to this Permit and as described in the Project Profile (Register No.: PP-324/2007)."

Please be advised that we hereby approve the proposed specific changes in cable alignment, burial depth, trench width and installation methods as submitted by ERM on behalf of the EP holder, Tata Communications Ltd., through the two letters referred above. Figures 1 to 4 of ERM's submissions showing locations of the proposed alignment shift and the cable installation details at the gas pipeline crossing, where the burial depth, trench width and installation methods are proposed to be changed, are reproduced and attached to this letter for ease of reference.

The approval is given based on ERM's letter of 11 Feb 09 and its associated SAR as amended by ERM's letter dated 19 Feb 09, in accordance with Condition 2.1 of EP-294/2007 and FEP-01/294/2007, as we are satisfied with ERM's analysis that the proposed changes is compliant with the impact predictions presented in the Project Profile PP-324/2007 for the Project.

The above approval is granted solely based on the environmental perspective as examined under the EIAO (Cap. 499) and does not absolve the proponent from any approvals or obligations under other laws in force in Hong Kong, nor the proponent's liability due to any conflicts that proposed changes may cause with third parties, including the Hongkong Electric Co., Ltd. as the owner of the submarine gas pipeline that the concerned cable will cross.

Please note that ERM's letter of 11.2.09, the SAR as amended by ERM's letter of 19.2.09 and this letter will be placed in the EIA Ordinance Register Office for public information.

Yours sincerely,

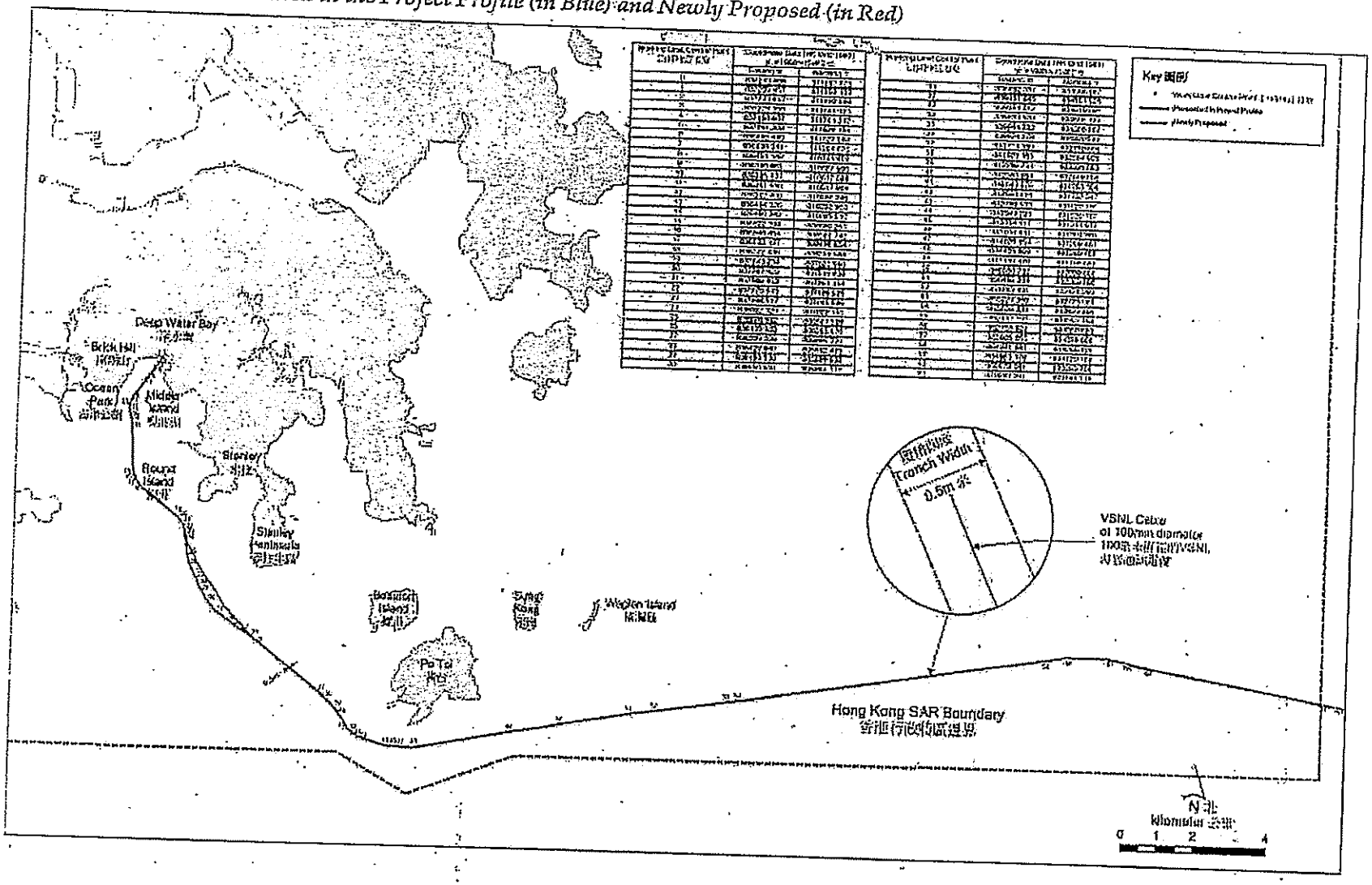
(Victor W.T. Yeung)
Senior Environmental Protection Officer
for Director of Environmental Protection

c.c.

AFCD	(Attn: Mr. Cary Ho)	2377 4427
AMO, LCSD	(Attn: Ms. Doris Chan)	2721 6216
DLO/HKW&S	(Attn: Mr. Michael Wong)	2833 1945
Hongkong Electric Co.	(Attn: Mr. C.W. Tso)	2810 0506
S(MA)5		

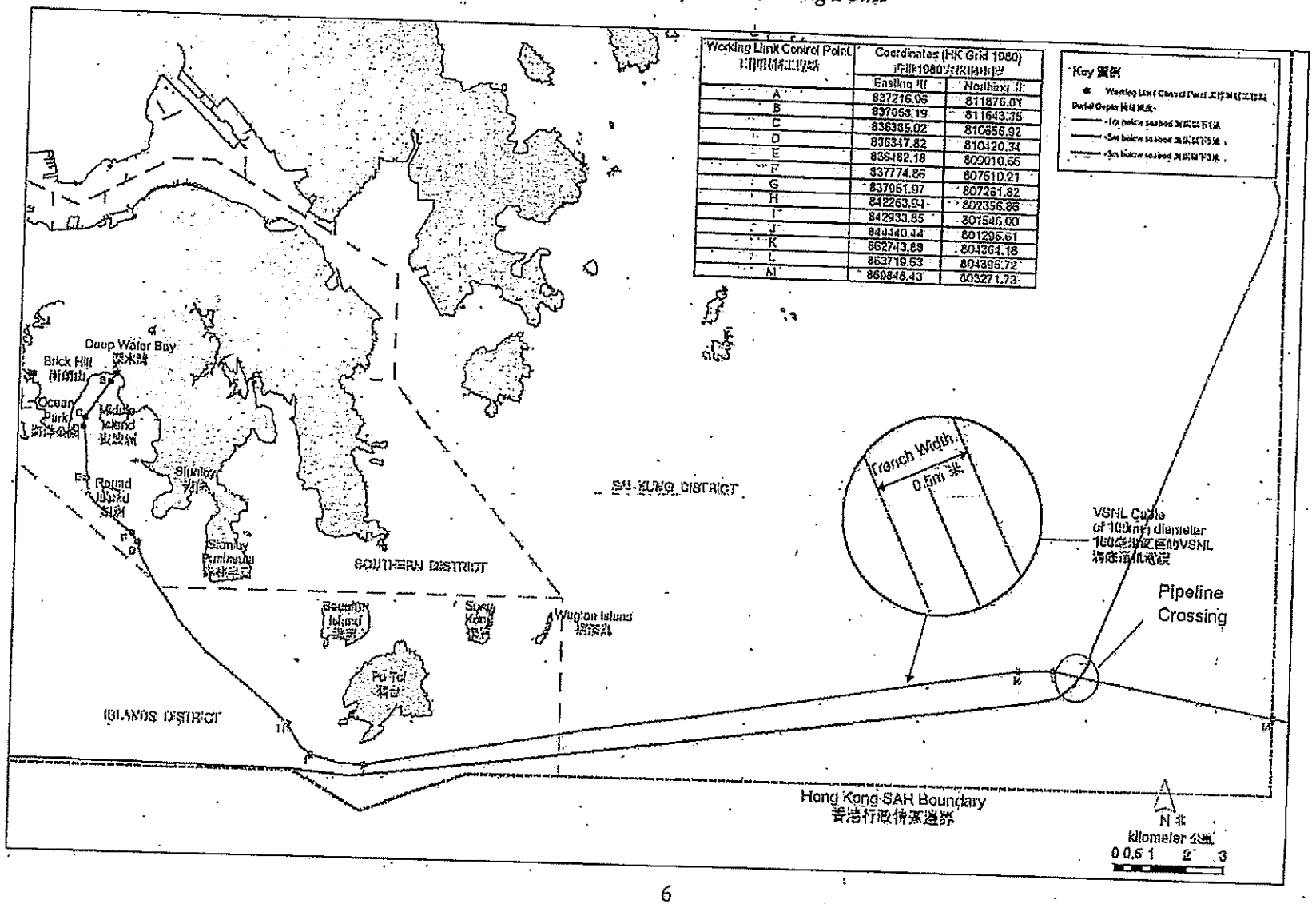
Internal w/ERM's submissions.
EO(EA) – Please place ERM's submissions and this letter in the EIAO register office
S(RS)5
S(RA)2

Figure 1 *Tata Cable Route Presented in the Project Profile (in Blue) and Newly Proposed (in Red)*



(Extracted from ERM's letter ref: 0067564_Letter_EPD_20090211.doc dated 11.2.09)

Figure 2 *Proposed Tata Cable Route with Burial Depth and the HKE Gas Pipeline Crossing Point*



(Extracted from ERM's letter ref: 0067564_Letter_EPD_20090211.doc dated 11.2.09)

Figure 3 *Proposed Design for Cable Protection at the Gas Pipeline Crossing*

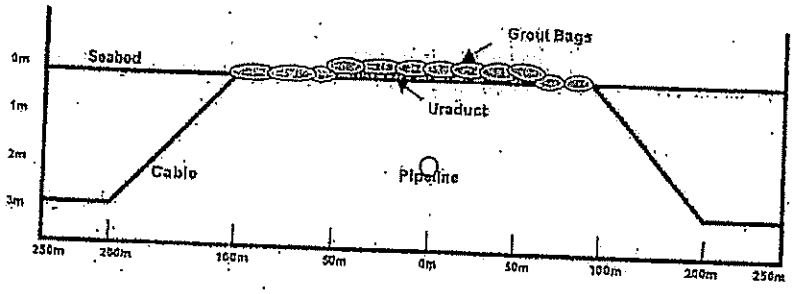
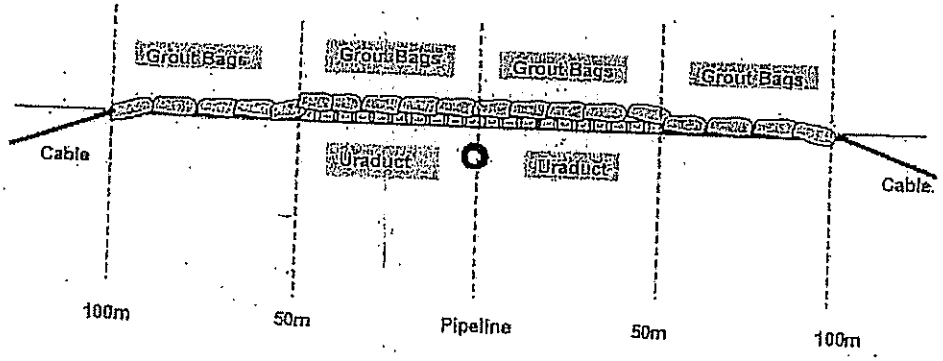


Figure 4 *Proposed Design for Cable Protection at the Gas Pipeline Crossing (Close-up)*



(Extracted from ERM's letter ref: 0067564_Letter_EPD_20090211.doc dated 11.2.09)

Environmental
Resources
Management

21/F Lincoln House
979 King's Road
Taikoo Place
Island East
Hong Kong
Telephone: (852) 2271 3000
Facsimile: (852) 2723 5660
E-mail: post.hk@erm.com
http://www.erm.com

19 February 2009

The EIA Ordinance Register Office
27th floor, Southorn Centre
130 Hennessy Road
Wan Chai
Hong Kong

BY Hand

Attn: Ms Mable Chan (Env Protection Offr(Metro Assessment)33)

Our ref: 0067564_Letter_EPD_20090219.doc

Dear Ms Chan,

Environmental Impact Assessment (EIA) Ordinance, Cap 499
Project title: VSNL Intra Asia Submarine Cable System – Deep Water Bay
(Environmental Permit No. EP-294/2007 & FEP-01/294/2007)
Amended page 43

Further to AFCD's comment dated 19 February 2009 (through email), we are pleased to provide the amended page for your replacement.

Should you any further queries, please do not hesitate to contact the undersigned.

Yours faithfully
For ERM-Hong Kong, Ltd

Terence Fong
Principal Consultant
Tel: 2271 3156
E-mail: terence.fong@erm.com

Encls

cc Mr CM So (Agriculture, Fisheries and Conservation Department, 100A Shek Pai Wan Road, Aberdeen, Hong Kong), by hand

5.1 ENVIRONMENTAL PROTECTION

In order to minimise risks to the operation and to the environment, full procedures and mitigation measures will be adopted and followed, as summarised below:-

Work responsibilities:

- All responsibilities will be clearly defined, starting with the definition of the responsibilities of The Offshore Superintendent, who is responsible to the Project Manager for the planning and execution of all the work offshore in a safe and environmentally friendly manner;
- Deployment of the mattresses
- Filling the grout bags
- Hand jetting
- Inspecting and documenting the work
- Reporting as required to all third parties
- Ensuring that the work is carried out in a safe and environmentally responsible manner in compliance with all permit conditions
- Liaising with the Environmental Auditor & Inspectors

5.2 ENVIRONMENTAL MONITORING AND AUDIT (EM&A)

The key EM&A works will include:

- Conduct a pilot study to monitor the water quality performance of the grout mattress installation works;
- Conduct *ad hoc* water monitoring in the event that any accidental minor or major release of grout material occurs during grout mattress installation works;
- Conduct geophysical survey to obtain the bathymetric data to identify any debris or other physical changes to the surface of the seabed due to the burial); and,
- Conduct video inspection within which the mattress protection is to be installed to demonstrate the conditions of the local environment prior to and after the installation of the mattress protection.

The above EM&A works will form part of the requirement of the EM&A Manual, under the requirement of Condition 3 of the Environmental Permits (EP-294/2007 and FEP-01/294/2007).

E(MA)33

H17/C/05

(18)

Environmental Resources Management

21/F Lincoln House
979 King' s Road
Taikoo Place
Island East
Hong Kong
Telephone: (852) 2271 300
Facsimile: (852) 2723 566(
E-mail: post.hk@erm.com
http://www.erm.com

11 February 2009

The EIA Ordinance Register Office
27th floor, Southorn Centre
130 Hennessy Road
Wan Chai
Hong Kong

BY POST AND E-MAIL

Attn: Ms Mable Chan (Env Protection Offr(Metro Assessment)33)

Our ref: 0067564_Letter_EPD_20090211.doc

Dear Ms Chan,

Environmental Impact Assessment (EIA) Ordinance, Cap 499
Project title: VSNL Intra Asia Submarine Cable System – Deep Water Bay
(Environmental Permit No. EP-294/2007 & FEP-01/294/2007)

Further to your letter dated 5 February 2009 (your ref: EP2/H17/C/05 Pt.2), we are writing on behalf of our Client, Tata Communications Limited, to provide further clarification concerning a change to their captioned project. *Condition 2.1* of the current *Environmental Permits* (EP-294/2007 and FEP-01/294/2007) stated that: "*The submarine cable shall be laid along the alignment as delineated in Figure 1 attached to this Permit. The Permit Holder shall obtain prior approval from the Director of any changes in the Project details, including cable alignment, burial depth, trench width and installation methods as shown in Figure 1 attached to this Permit and as described in the Project Profile (Register No.: PP-324/2007)*".

Under *Condition 2.1* of the current *Environmental Permits*, we are required to seek the approval from the Director of Environmental Protection regarding the minor changes in the design which refer to (1) cable alignment, and (2) cable burial depth along a 200m cable section with additional cable protection (grout mattress) at the crossing of the Hongkong Electric Co., Ltd (HKE)' s gas pipeline. It should be noted that the trench width and installation methods has no change. The design changes are summarised in the following table:

Issue	Original Design	New Design
Cable Alignment	Approximately 40km (*Figure 1*).	Approximately 40km, cable alignment between the south of Round Island and the west of Beaufort Island was altered due to the engineering concern (refer to *Figure 1*).
Burial Depth	Broad areas of -1m, -3m and -5m burial below seabed are shown in *Figure 2*.	Almost the same, except the pipeline crossing point location at 22° 10.6007' N, 114° 26.9619' E (*Figure 2*) with approximately 200m cable section will be laid on the surface of the seabed (with additional protection measures (Uraduct and grout mattress on top of the cable).
Trench Width	Approximately 0.5m.	No change, but the 200m section at the crossing point with no trench.
Installation Method	Mainly jet ploughing technique.	No change.

(1) Cable Alignment

An indicative cable alignment was presented in the *Project Profile* (Register No.: PP-324/2007). During the detailed design stage carried out recently, the cable alignment between the south of Round Island and the west of Beaufort Island was altered due to the engineering concern. Both the indicative and revised cable alignments are shown in *Figure 1*. Based on the results of the marine archaeological investigation conducted in late November 2007, there were no anomalies in the vicinity of the revised section. There will be no change of cable installation method for the revised cable alignment, and the marine environment is also very similar between the indicative and revised cable alignments. As such, the minor revision of the cable alignment is not expected to pose any impacts on the water quality, marine archaeological, marine ecological and fisheries resources.

(2) Cable Burial Depth and Additional Cable Protection due to Pipeline Crossing

Recent communication between Tata and HKE has raised an issue associated with the crossing of Tata' s proposed cable system and HKE' s gas pipeline in south east Hong Kong waters. HKE have requested that Tata' s cable be laid above the gas pipeline but not by burial. HKE have stipulated that trenching works should not occur for 100m either side of the gas pipeline (a total length of 200m). This is based on concerns over the stability of the seabed around the pipeline during trenching operations and the potential for physical disturbance/damage. The crossing point location is 22° 10.6007′ N, 114° 26.9619′ E (see *Figure 2*).

As stated above, cable burial therefore will not be undertaken 100 metres before the gas pipeline crossing point, and will resume 100 metres after the pipeline crossing point. Within this "200m zone" the cable will be laid on the surface of the seabed. In order to protect the cable, additional measures (Uraduct and grout mattress (bag)) will be required.

The Uraduct will be applied to the cable for a distance of 50 metres either side of the crossing point. This application will be undertaken onboard the cable installation vessel prior to the cable passing over the stern. The Uraduct is composed of half shells which are held together by titanium strapping.

Mattress protection will be laid over the Cable and the Uraduct for a distance of 100 metres either side of the pipeline crossing (with 4 m wide). This combination will have the added benefit of disturbing the seabed in a minimal way and will ensure that a smooth, low profile is presented on the seabed (See *Figures 3 & 4*).

Figure 3 Proposed Design for Cable Protection at the Gas Pipeline Crossing

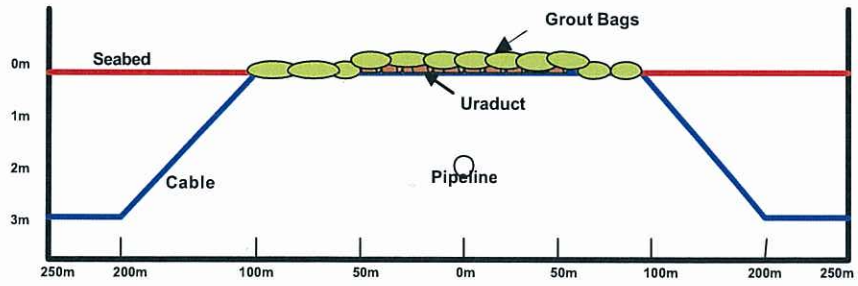
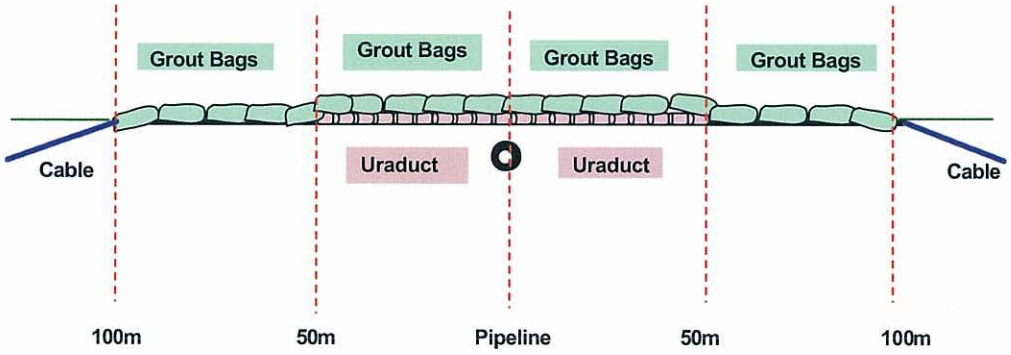


Figure 4 Proposed Design for Cable Protection at the Gas Pipeline Crossing (Close-up)



The detailed pipeline cable crossing mattress installation method, operational management and measure of pollution prevention and control, as well as the grout mattress (bag) and grout pumping system specification, are presented in the attached *Supplementary Assessment Report (Annex 2)*. Pilot test and environmental monitoring for the grout mattress installation works are also presented in the document. It should also be noted that the Hong Kong and China Gas Company Limited conducted an EIA Study in 2003 for *The Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong* (hereinafter referred to as the Towngas Project). The Towngas Project (under Environmental Permit No. FEP-01B/167/2003/D), which involved similar technique of grout mattress installation work, was completed in 2006.

Supplementary assessment on the potential impact on fisheries resources resulting from the crossing is also attached for your reference. The findings of the supplementary assessments concluded that the proposed design should lead

to negligible and short term impacts on fisheries, marine ecology and water quality.

It is considered that the change in the project is compliant with the impact predictions presented in the Project Profile and we look forward to receiving EPD's approval of this change urgently as the construction works expected to be commenced in March 2009.

Should you any further queries, please do not hesitate to contact the undersigned or our Terence Fong of ERM-Hong Kong, Ltd.

Yours faithfully
For ERM-Hong Kong, Ltd

Dr Robin Kennish
Director
Tel: 2271 3120
E-mail: robin.kennish@erm.com

Encls

cc Mr CM So (AFCD), by e-mail
Ms Doris Chan (AMO, LCSD), by e-mail
Mr Michael Wong (DLO/HKW&S), by e-mail
Mr Claes Segelberg (Tata Communications), by e-mail

Figure 1 ***Tata Cable Route Presented in the Project Profile (in Blue) and Newly Proposed (in Red)***

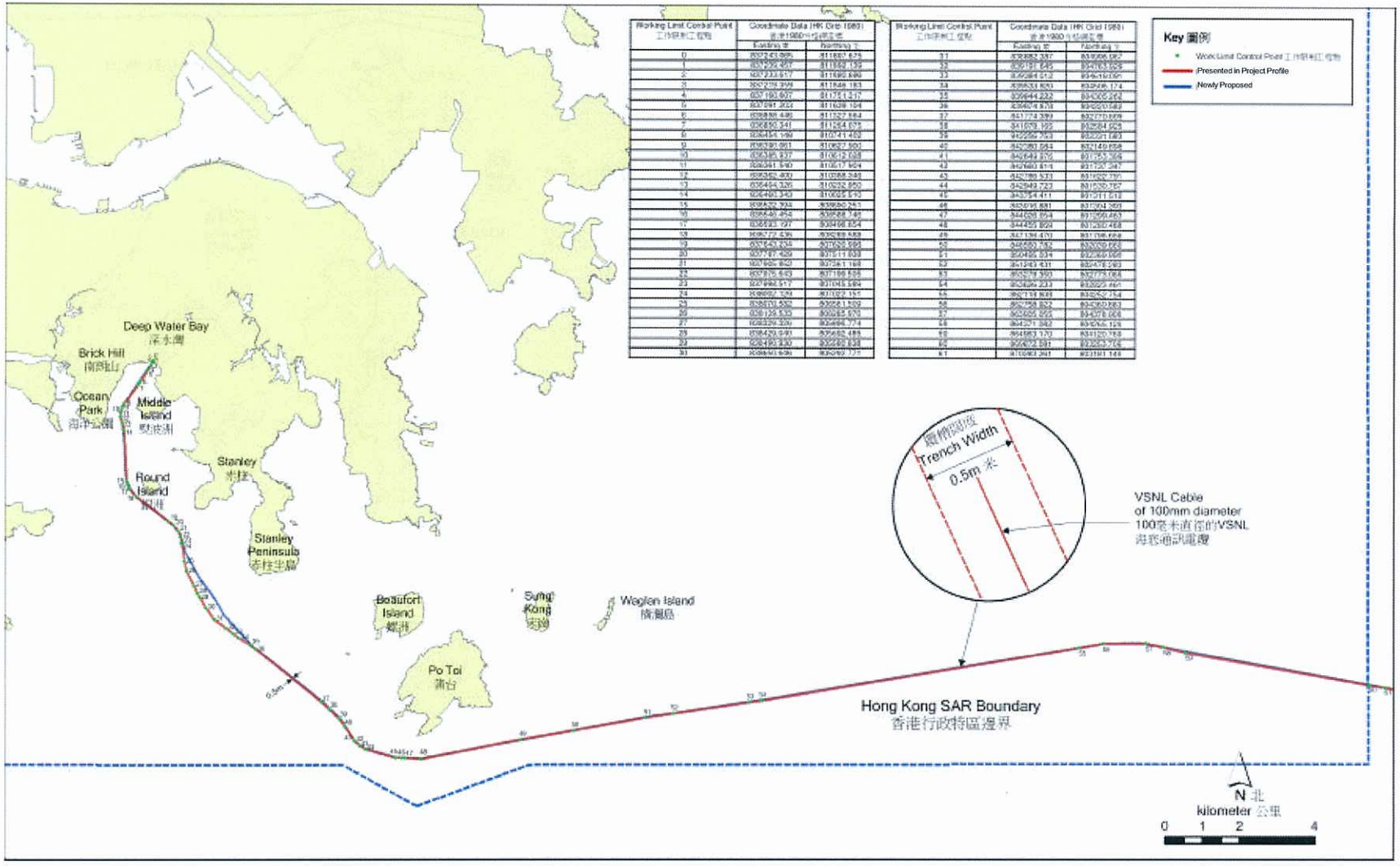
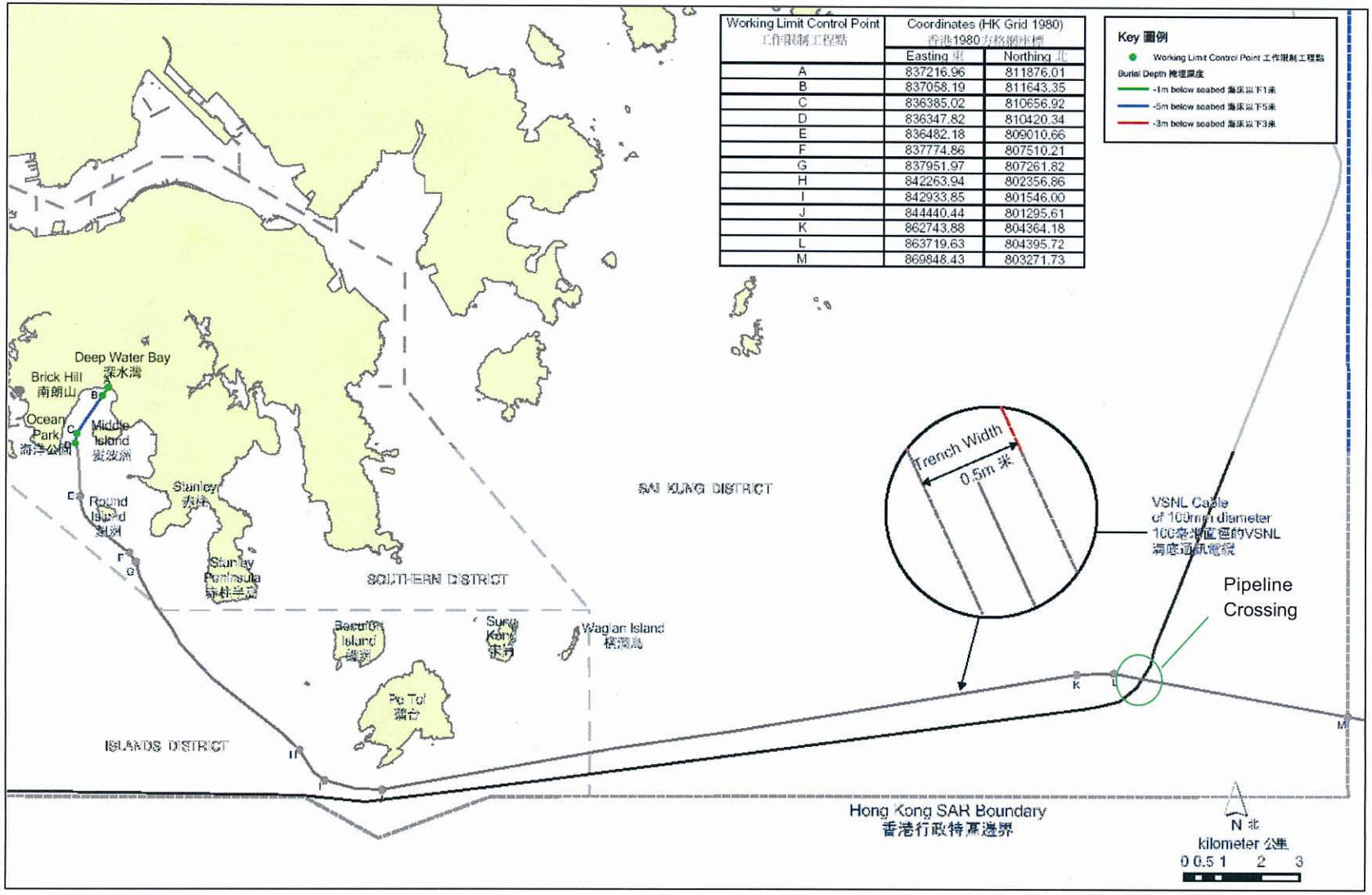


Figure 2 ***Proposed Tata Cable Route with Burial Depth and the HKE Gas Pipeline Crossing Point***



Supplementary Assessment Report

1 INTRODUCTION

1.1 BACKGROUND

Tata Communications (Bermuda) Ltd (hereinafter referred to as Tata, formerly known as VNSL) propose to install a cable of approximately 6,480 km, which consists of six segments connecting Singapore to the existing TGN Pacific Submarine Cable in the Pacific Ocean and; which in turn connects to Toyohashi in Japan. There are three branching units which will connect to Vung Tau in Vietnam, Deep Water Bay in the Hong Kong SAR (HKSAR) and Ballesteros in the Philippines (*Figure 1.1*).

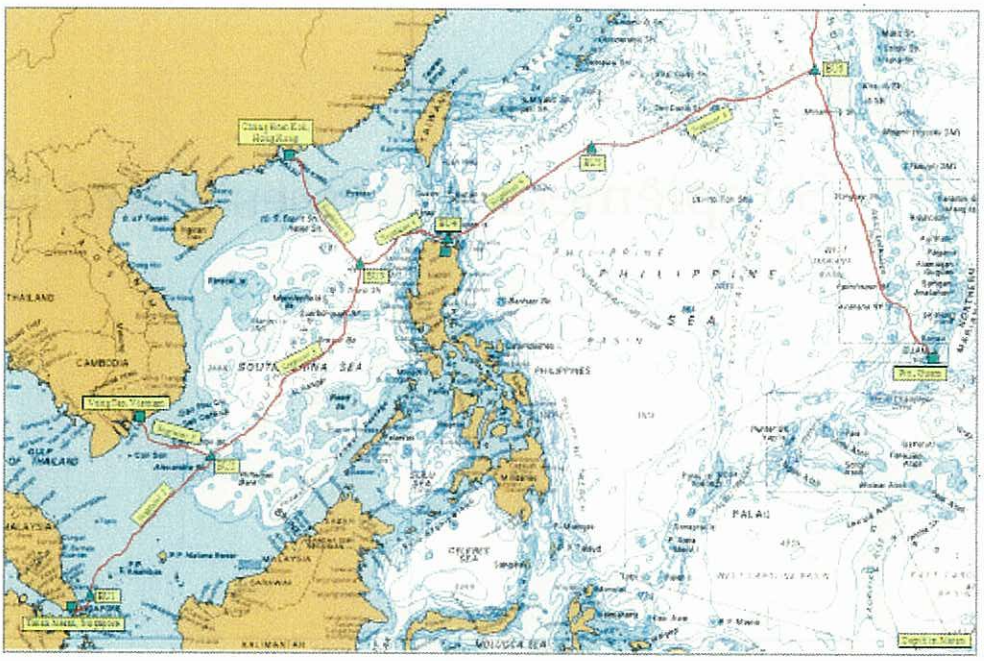


Figure 1.1

An application for permission to apply directly for environmental permit was submitted to the Director of Environmental Protection under section *5.(1)(b) and 5.(11) of the Environmental Impact Assessment (EIA) Ordinance* in August 2007. This application was supported by the submission of a Project Profile, which included an assessment of the potential environmental impacts associated with the installation of the submarine telecommunications cable system. The Environmental Protection Department (EPD) subsequently issued an Environmental Permit (EP-294/2007).

At this time, it was proposed that the cable would be buried by means of water jetting techniques. These techniques would allow burial of the cable into the seabed at a depth of over 2 metres.

However, communication between Tata and Hongkong Electric Co., Ltd (HKE) has raised an issue associated with the crossing of Tata' s proposed cable system and HKEs gas pipeline in south east Hong Kong waters; in that

HKE have requested that Tata' s cable is afforded physical protection by means of additional material and not by burial, this was described by HKE as ' No Dredging'. The crossing point location is 22° 10.6007' N, 114° 26.9619' E (see *Figure 1.2*).

HKE have stipulated that dredging (trenching) works should not occur for 100m either side of the gas pipeline (a total length of 200m). This is based on concerns over the stability of the seabed around the pipeline during trenching operations and the potential for physical disturbance/damage.

Additional discussions on permitting requirements associated with the revised cable laying methodology at the gas pipeline crossing with the Agriculture, Fisheries and Conservation Department (AFCD) and EPD has determined that additional information is required with respect to design, emplacement methodology and potential impacts.

1.2 *CHANGE OF CABLE ALIGNMENT*

An indicative cable alignment was presented in the *Project Profile* (Register No.: PP-324/2007). During the detailed design stage carried out recently, the cable alignment between the south of Round Island and the west of Beaufort Island was altered due to the engineering concern. Both the indicative and revised cable alignments are shown in *Figure 1.3*. Based on the results of the marine archaeological investigation conducted in late November 2007, there were no anomalies in the vicinity of the revised section.

The subtidal habitats along the revised cable alignment are expected to consist of fine muddy sediments and similar to benthic assemblages in majority of other subtidal habitats in Hong Kong No rare or important benthic species are expected to occur in this area [1][2]. Although the Indo-Pacific Hump-backed Dolphin (*Sousa chinensis*) and the Finless Porpoise (*Neophocaena phocaenoides*) are regularly sighted in Hong Kong waters, the southern waters where the revised cable alignment located is not considered to represent one of the more important habitats for these marine mammals. The closest Fish Culture Zones (FCZ) and water intakes to the revised cable alignment are over 5 km away from the cable corridor at the closest point. The findings of 2001 – 2002 Port Survey [3] show that all the fish fry production (>0 to 50 tails per hectare), fisheries production (50 – 100 kg per hectare) and the number of fishing vessels (50 – 100 per hectare) from the grids traversed by the revised cable corridor are low.

There will be no change of cable installation method for the revised cable alignment, and the marine environment is also found to be very similar

(1) CityU Professional Services Limited (2002). Consultancy Study on Marine Benthic Communities in Hong Kong (Agreement No. CE 69/2000). Final Report submitted to AFCD.

(2) Agriculture, Fisheries and Conservation Department website: http://www.afcd.gov.hk

(3) Agriculture, Fisheries and Conservation Department (2002) Op cit.

between the indicative and revised cable alignments. As such, the minor revision of the cable alignment is not expected to pose any impacts on the water quality, marine archaeological, marine ecological and fisheries resources, and therefore they will not be discussed further.

1.3 PURPOSE OF THIS REPORT

As discussed in *Section 1.1*, further information is required for permitting of the proposed Tata submarine cable with respect to the revised design for crossing of the HKE gas pipeline, particularly associated with impacts on fisheries and marine ecology.

In light of this situation, this report has been compiled to provide supplementary assessment to address issues raised for fisheries and marine ecology.

It is not considered necessary to repeat assessments contained within the *Project Profile* for the cable burial methodology elsewhere along the cable route given that no significant impacts were identified. The focus of this report, is therefore, related to the gas pipeline crossing point only.

1.4 STRUCTURE OF THE REPORT

The remainder of this report is structured as follows:

- *Section 2* – Provides engineering design details on the cable crossing;
- *Section 3* – Provides an update of the baseline conditions, particularly related to updated fisheries information;
- *Section 4* - Provides a supplementary assessment of fisheries and marine ecological impacts associated with the cable crossings; and,
- *Section 5* – Provides conclusions on the potential impacts of the proposed design for the pipeline crossing.

Figure 1.2 Proposed Tata Cable Route and the HKE Gas Pipeline Crossing Point

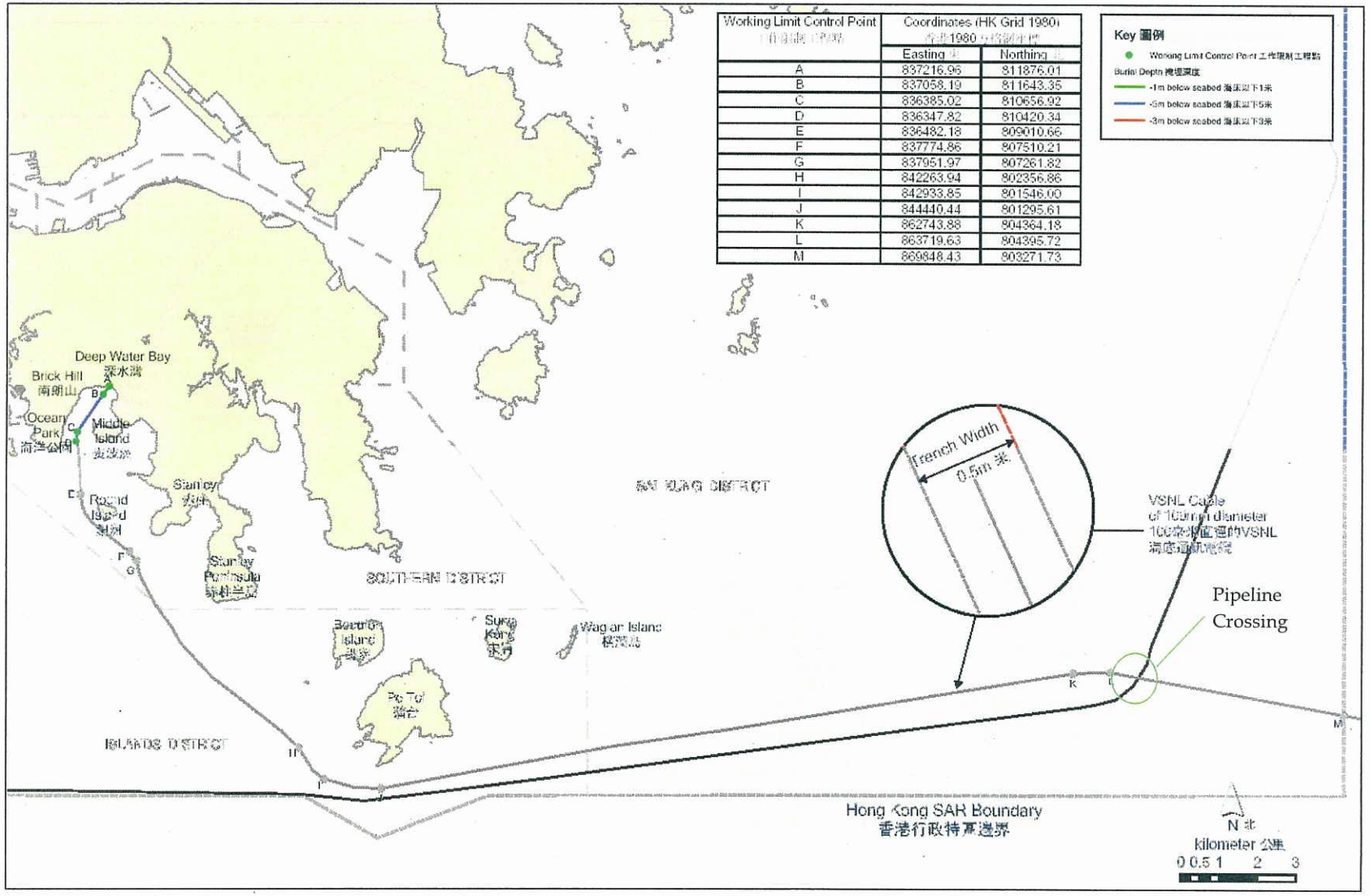
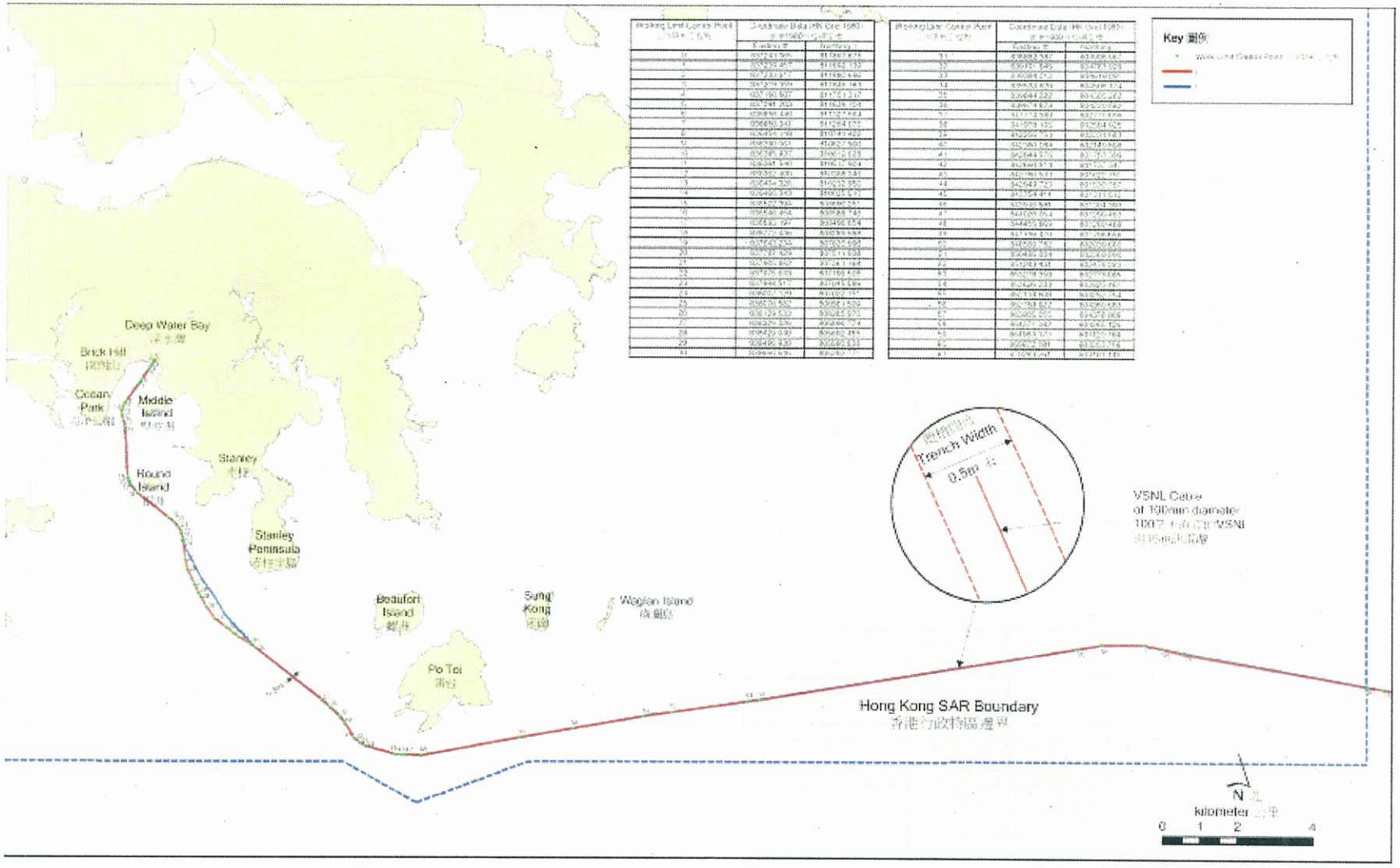


Figure 1.3 Tata Cable Route Presented in the Project Profile (in Blue) and Newly Proposed (in Red)



2.1 ALTERNATIVES

A number of alternatives have been considered to provide protection to the above-bed (surface laid) cable at the pipeline crossing point, including the use of rock armour, pre-cast concrete mattresses or grout filled bags known as ' fill in situ' mattresses. Following a review of these techniques and consideration given to minimising potential impacts, the design preferred by Tata is the use of a combination of pre-cast and Grout Bag ' fill in situ' technology in conjunction with Polyurethane protective shells (Uraduct). The selected protection method is simply described as mattressing in the remainder of this document other than where the design and physical attributes are being described.

2.2 OVERVIEW OF THE PREFERRED APPROACH

As stated in *Section 1.1*, cable burial will not be undertaken 100 metres before the gas pipeline crossing point, and will resume 100 metres after the pipeline crossing point. Within this 200m zone the cable will be laid on the surface of the seabed. The following describes the measures proposed to protect the cable in this area.

The Uraduct will be applied to the cable for a distance of 50 metres either side of the crossing point. This application will be undertaken onboard the cable installation vessel prior to the cable passing over the stern. The Uraduct is composed of half shells which are held together by titanium strapping.

Mattress protection will be laid over the Cable and the Uraduct for a distance of 100 metres either side of the pipeline crossing. This combination will have the added benefit of disturbing the seabed in a minimal way and will ensure that a smooth, low profile is presented on the seabed (See *Figure 2.1a & b*).

Figure 2.1a ***Proposed Design for Cable Protection at the Gas Pipeline Crossing***

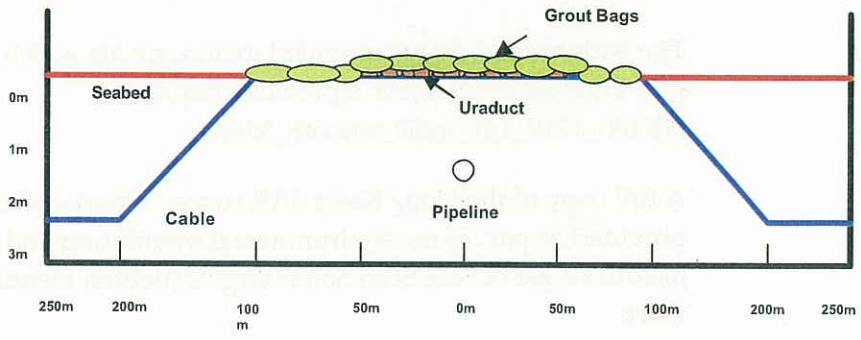
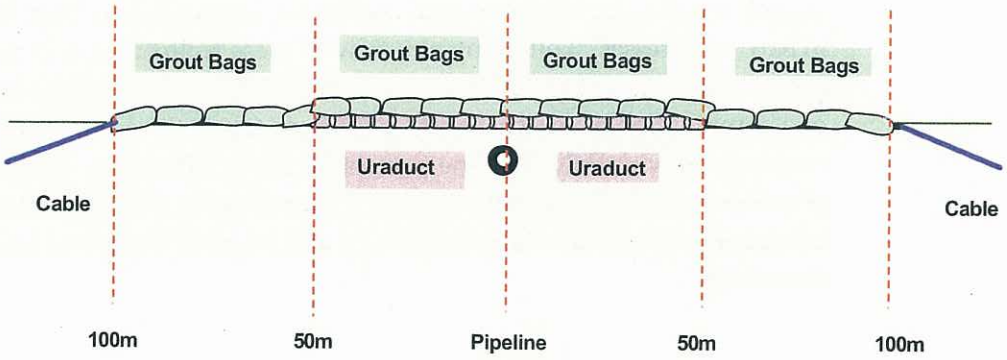


Figure 2.1b Proposed Design for Cable Protection at the Gas Pipeline Crossing (Close-up)



2.3 GEOPHYSICAL SURVEY

The cable route was surveyed in August 2007 by EGS survey Hong Kong, sub-contracting to Fugro Survey Pte. Limited during which all existing pipelines and cables were identified using side-scan sonar, sub bottom profiler, magnetometer and/or multi beam bathymetry. The proposed crossing positions were subsequently charted and recorded. The survey was conducted using precise DGPS positioning to a reported accuracy of +/- 2m.

The survey methodology used to obtain the bathymetric data, which has an absolute bathymetric accuracy in the order of 0.15m, with the ability to detect the pipeline position (shallow depression above the pipeline due to the burial) provided through the use of a digital terrain model which is described in the document:

HONG KONG ELECTRIC_Bathymetric processing

The bathymetric data is provided in an x,y,z file which has soundings at 1m grid intervals as per HKE' s previous request:
HK180_1219_1x1_int50_smooth_Mean

A full copy of the Hong Kong SAR survey report and charts will also be provided as part of the environmental monitoring and audit works, this includes a list of Side Scan Sonar targets (debris) identified during the survey work.

The survey methodologies and pre-works survey reports will be submitted to the EPD and AFCD for review and the works will not commence until the approval of these submissions is confirmed.

The same digital terrain modelling is proposed for the post installation survey, along with side scan sonar to demonstrate that there is no debris remaining after the work is completed. To gauge the impact of the mattressing on other seabed users, it is not the absolute depth over the highest point of the mattress that needs to be measured, but the relative height of the mattress over that of the surrounding seabed.

The quality of the data from a Multi Beam Echo Sounder is a complicated function of its components. However, the digital terrain model, with the effects of the various factors influencing the measured depth mitigated through accurate positioning, timing, the use of motion and sound velocity compensation does provide a method where by we can clearly visualise the texture, structure and seabed type and accurately identify objects such as pipelines, rock berms, trenches and in our case, the mattressing on the seabed at the pipeline crossing. This, when sun illuminated, as per the pipeline in the pre-survey data set provided, will allow us to easily view the finished installation relative to the surrounding seabed.

2.4 *PRE, DURING AND POST SEABED SURVEYS*

It is a requirement that the general area, within which the mattress protection is to be installed, be surveyed and videoed to demonstrate:

- The condition of the local environment prior to the installation of the mattress protection; and
- The condition of the local environment after the installation of the mattress protection.

During/after the installation of the mattresses protection, an inspection shall be made & video recorded that demonstrates that the following requirements have been met:

- The tapered edges of the mattresses form a smooth transition with the seabed;
- The tapered edges are below the level of the adjacent sea bed where burial of the edge of the mattress has been feasible; and
- The top of the mattress is not higher than 350mm above the existing seabed level (This requirement shall be demonstrated by a post installation bathymetric survey and the creation of a new digital terrain model).

These requirements will be followed by adopting the procedures outlined below.

2.4.1 *Pre Operation Seabed Video Survey*

The grout bag installation work will be undertaken by an ROV; the ROV will also undertake the Pre Operations Seabed Video Survey. The ROV will be equipped with a number of selectable lights and cameras providing the most appropriate platform from which to obtain high quality video images for all surveys.

Prior to starting the installation the ROV will make an inspection run commencing 50m prior to the Uraduct start point, along the cable, the 100m of Uraduct clad cable and a further 50m of cable. The ROV will then complete inspection runs between start and end points offset to either side and parallel at 5m, 10m & 15m intervals. The ROV will run the offset lines and follow track as planned and displayed on the ROV Operator's navigation screen. The spacing of the offset lines will be adjusted based on visibility to ensure good coverage of the seabed is obtained.

The purpose of the inspection runs shall be obtain the best possible video images of the seabed and any benthic flora/fauna that may exist. The line plan for the survey is provided below in Figure 2.2:-

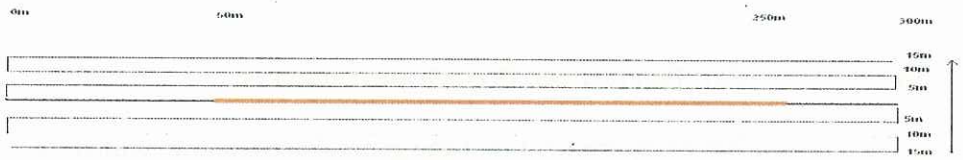


Figure 2.2

The pre operation survey will:-

- note and survey any significant scars on the seafloor within the area covered by the line plan;
- collect video imagery of seafloor features, (drag scars, mounding, or depressions);
- take footage of any industry-related items in the immediate vicinity (e.g., lost anchors, discarded pipe, debris etc); and
- provide a benchmark for the existing benthic flora and fauna against which impact of the installation and installation work may be gauged.

2.4.2 *During Operation Seabed Video Survey*

To ensure the best possible chance of having visibility, the inspection aspect of the work will not be left till the end of the mattressing operation (to be completed as a single operation).

Should the opportunity present itself, after one third of the mattresses have been installed, during a period of good visibility, a post installation survey shall be undertaken of the completed mattresses installed up to that point in time. This shall be repeated after approximately two thirds of the mattresses have been installed. This approach is based on the expectation that visibility may be poor.

2.4.3 *Post Operation Seabed Survey*

On completion of the mattressing work, the ROV shall again make the parallel inspection runs at 5m, 10m & 15m intervals with the centre run being over the middle of the bag/mattress installation. The purpose of the inspection runs shall be to again obtain the best possible video images of the seabed.

A plot shall be produced for each of the above video inspections & labeled with any pertinent information from the inspection. Continuous video shall be recorded during the inspections of the surrounding seabed. The line plan for the post operation survey is illustrated below in Figure 2.3:-

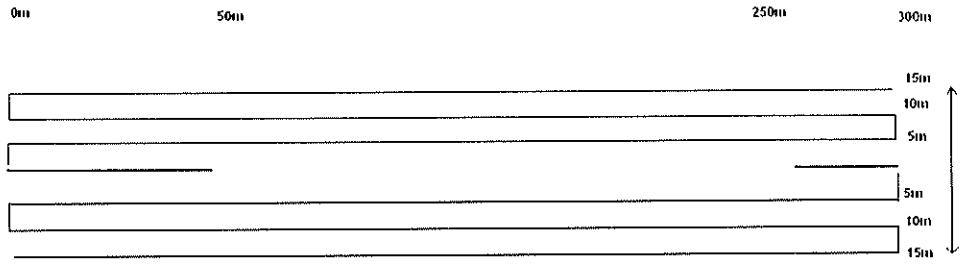


Figure 2.3

The ROV shall video the perimeter of the installed mattress protection after the filling operations have been completed (the short edge at each end of the installed protection and both long edges shall be videoed).

The height of the ROV and camera above the edge of the mattress shall be adjusted along with the lighting and any zoom facility on the camera, to provide an image that provides as true a picture as possible of the installation.

All video inspection work shall include a voice over commentary.

The video footage shall be identified clearly and collated such that they create a presentation that is easy to follow with the position of the mattress being viewed clearly identifiable (the 200m of mattressing will be installed as a number of discreet lengths, the exact number has yet to be decided but in the order of perhaps 20 x 10m long mattresses).

2.4.4 *Post Installation Geophysical Survey*

After the mattress installation work is complete, a survey will be carried out to the same standard as that described in the documents at Section 2.3. The new digital terrain model may be compared with the data gathered during the original survey and the height above the surrounding seabed level derived. The survey will include a side scan sonar survey so that any debris or other physical changes to the surface of the seabed may be identified.

2.5 WATER COLUMN ENVIRONMENTAL SURVEY

To ensure that the grout mattress works installation works will not cause any significant impacts to water quality and marine ecological systems, a pilot study will be conducted to confirm the environmental performance of the grouting operations. Given that the nature of the current proposed grout mattress installation works are very similar to those applied for the Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong (approved EIA project, FEP-01B/167/2003/D), the previous approved pilot test on grouting performance (Appendix C of FEP-01B/167/2003/D) is considered to be relevant and applicable for this study.

The following Section provides details of the pilot study water quality monitoring during the installation of the grout mattress.

2.5.1 *Sampling Methodology*

Parameters Measured

The parameters to be measured in situ are:

- turbidity (NTU)
- pH

The only parameter to be measured in the laboratory is:

- suspended solids (SS) (mgL^{-1})

In addition to the water quality parameters, other relevant data shall also be measured and recorded in field logs, including the location of the sampling stations and cable burial machine at the time of sampling, water depth, time, weather conditions, sea conditions, tidal state, current direction and speed, special phenomena and work activities undertaken around the monitoring and works area that may influence the monitoring results.

Equipment

For water quality monitoring, the following equipment shall be supplied and used by the environmental contractor.

- *Turbidity Measurement Equipment* - Turbidity should be measured from a split water sample from the SS sample. A suitable turbidity test kit should be used to measure the turbidity level.

- *pH Measurement Equipment* - A portable pH meter capable of measuring pH in the range of 2-12 units with an accuracy of ±0.2 units. The cable shall be not be less than 35 m in length. Sufficient stocks of spare electrodes and cable shall be available for replacement where necessary.

- *Water Depth Gauge* - No specific equipment is recommended for measuring the water depth. However, water depth gauge affixed to bottom of the water quality monitoring vessel is preferred. The environmental contractor shall seek approval of their proposed equipment with the client prior to deployment.

- *Current Velocity and Direction* – No specific equipment is recommended for measuring the current velocity and direction. However, the environmental contractor shall seek approval of their proposed equipment with the client prior to deployment.

- *Positioning Device* - A Global Positioning System (GPS) shall be used during monitoring to ensure the accurate recording of the position of the monitoring vessel before taking measurements. The use of DGPS is preferred for positioning device, which should be well calibrated at appropriate checkpoint (e.g. Quarry Bay Survey Nail).

- *Water Sampling Equipment* - A water sampler, consisting of a transparent PVC or glass cylinder of not less than two litres, which can be effectively sealed with cups at both ends, shall be used (Kahlsico Water Sampler 13SWB203 or an approved similar instrument). The water sampler shall have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is at the selected water depth.

Sampling / Testing Protocols

All *in situ* monitoring instruments shall be checked, calibrated and certified by a laboratory accredited under HOKLAS or any other international accreditation scheme before use, and subsequently re-calibrated at-monthly intervals throughout all stages of the water quality monitoring. Responses of sensors and electrodes shall be checked with certified standard solutions before each use.

For the on-site calibration of field equipment, the BS 1427: 1993, Guide to Field and On-Site Test Methods for the Analysis of Waters shall be observed. Sufficient stocks of spare parts shall be maintained for replacements when necessary. Backup monitoring equipment shall also be made available so that monitoring can proceed uninterrupted even when equipment is under maintenance, calibration etc.

Water samples for SS measurements shall be collected in high density polythene bottles, packed in ice (cooled to 4° C without being frozen), and delivered to a HOKLAS laboratory as soon as possible after collection.

At least 2 replicate samples should be collected from each of the monitoring events for *in situ* measurement and lab analysis.

Laboratory Analysis

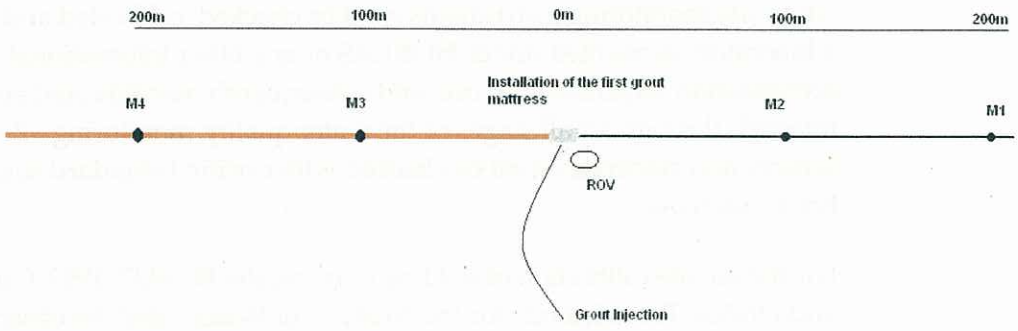
All laboratory work shall be carried out in a HOKLAS accredited laboratory. Water samples of about 1,000 mL shall be collected at the monitoring and control stations for carrying out the laboratory determinations. The determination work shall start within the next working day after collection of the water samples. The SS laboratory measurements shall be provided to the client within 2 days of the sampling event (48 hours). The analyses shall follow the standard methods as described in APHA Standard Methods for the Examination of Water and Wastewater, 19th Edition, unless otherwise specified (APHA 2540D for SS).

The submitted information should include pre-treatment procedures, instrument use, Quality Assurance/Quality Control (QA/QC) details (such as blank, spike recovery, number of duplicate samples per-batch etc), detection limits and accuracy. The QA/QC details shall be in accordance with requirements of HOKLAS or another internationally accredited scheme.

2.5.2 *Monitoring Locations*

The monitoring locations have been identified to check the water quality performance of the grout mattress installation. It should be noted there are no water quality/ecological sensitive receivers in the vicinity of the grouting location.

During the grout mattress installation works, water quality sampling will be undertaken at 4 fixed monitoring stations (M1, M2, M3 and M4) located on both sides of the barge (shown below).



- Stations M1 and M4 are located 200 m from the barge.
- Stations M2 and M3 are located 100 m from the barge.

2.5.3 *Sampling Procedures*

Monitoring Frequency

To monitor the water quality performance of grouting, monitoring will commence when grouting works on the barge begin. The pilot test monitoring will be only be conducted during the construction phase for 3 days. Baseline and post project monitoring is not required.

Timing

Water samples will be taken at each sampling station every 3 hours continuously for a period of 72 hours.

Depths

Each station will be sampled and measurements will be taken at three depths, 1 m below the sea surface, mid-depth and 1 m above the seabed.

2.5.4 *Compliance /Event Action Plan*

Water quality monitoring results will be evaluated against Exceedence Criteria shown in *Table 2.1*.

Table 2.1 ***Pilot Study Exceedence Criteria***

Parameter	Station	Depth	Exceedence Criteria	Other Conditions
SS	M1 or M4	Bed Layer	13 mg/L	For any parameter, if lower level is measured at M2 and M3, the exceedence will not be considered to be caused by the works and it will not be recorded as an exceedence event.
Turbidity	M1 or M4	Bed Layer	13 NTU	
pH	M1 or M4	Bed layer	8.5	

The following actions shall be taken according to the monitoring results of the pilot test.

- If there is no record of three consecutive exceedence events for any specific parameter during the pilot test, no further water quality monitoring is required except that *ad hoc* water quality impact will be triggered by accidental incidents (see *Section 4*).
- If three consecutive exceedence events for any specific parameter are recorded, the construction method and activities as well as the relevant water quality monitoring results shall be reviewed immediately by the Contractor in conjunction with the Monitoring Team to determine whether the exceedences are due to the works. If it is determined that the exceedences are due to the works, the grouting operation shall be suspended immediately. Remedial action shall be taken before continuing the remaining grout mattress installation works. The remedial

action shall be certified by the Monitoring Team Leader and approved by EPD and AFCD.

2.5.5 *Reporting*

Schedule for the monitoring should be submitted to EPD at least 2 weeks before commencement of the pilot study for agreement.

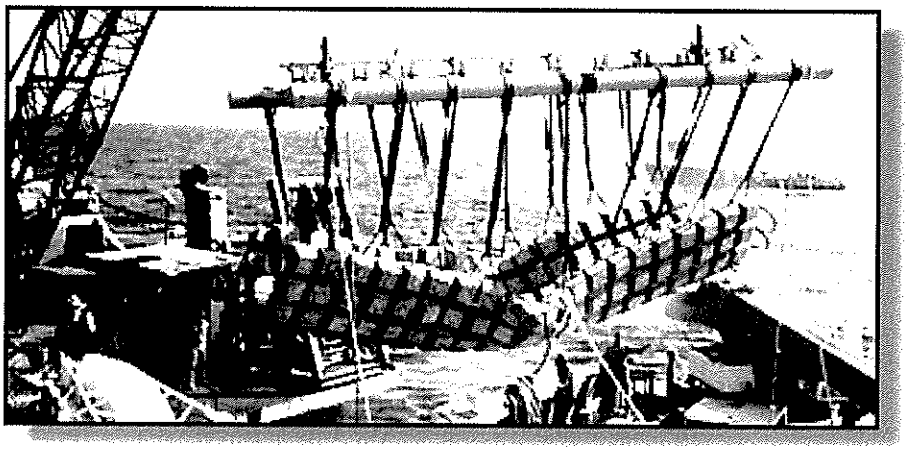
Turbidity and pH data shall be submitted to EPD and AFCD by email within 24 hours after the measurements are taken in the field. SS data shall be reported to EPD and AFCD within 48 hours, if possible, after the water samples are received by the testing laboratory.

A letter report which includes the monitoring results in addition to grouting operation practices during sampling (including: position) and an interpretation of monitoring results will be submitted to EPD and AFCD. The monitoring data should be provided graphically to show compliance or non-compliance with respect to the Exceedence Levels.

The Pilot Study Monitoring Report will be provided within one week of completing all the pilot study monitoring surveys.

2.6 *SPECIFICATION OF THE MATTRESS*

The design of the mattress has been reviewed in order to address the specific conditions existing at the telecommunications cable at pipeline crossing. The solution adopted is a combination of a pre-cast mattress base with a grout filled ' fill in situ' cover or bag. The type of pre-cast mattress base is shown below in Figure 2.5. In this case, the mattress is being lifted in a frame ready for deployment.



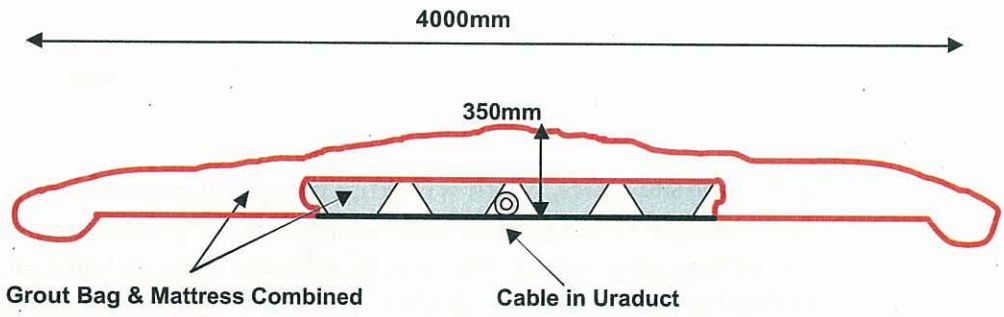
A concrete mattress used for cable protection.

Figure 2.4

The ' fill in situ' bag that is to be filled with grout, is made-to-measure, of a double-layer polyester fabric. The fabric is cut and sewn together with internal gusseting as required to a defined pattern to create the cross sectional shape as shown in *Figure 2.5*.

A fill-in-situ grout bag will be securely fixed on top of each pre-cast concrete mattress. The combined grout bag and mattress will be deployed by a specially designed deployment frame and the grout bag will be filled on site and will cover the entire pre-cast mattress overhanging by 1m on each side.

Figure 2.5 ***Grout Bag/Mattress Bed Profile***

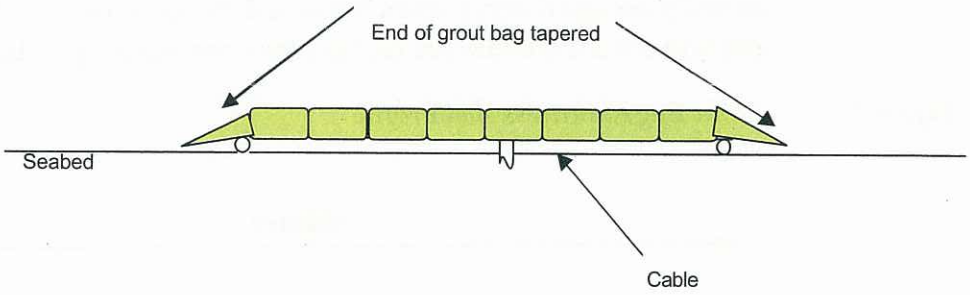


The design has the following advantages:-

- The fill-in-situ grout bag on top of the pre-cast concrete mattress presents a smooth top profile that does not hamper fishing gear;
- The pre-cast mattress on the bottom is flexible enough to follow the seabed profile;
- The pre-cast mattress on the bottom will straddle the cable and will not sit on top of the cable. This results in a smoother top profile;
- The use of a pre-cast concrete mattress reduces the amount of grout to be used for the 'fill-in-situ' bagand thereby reduces the risk of environmental contamination;
- During deployment, the use of the combined ' fill in situ' grout bag/pre-cast concrete mattress makes deployment quicker and more accurate as the greater stability of the structure is easier to control and position exactly where required; and
- Should any problems be encountered with a particular assembly, it can be recovered to the surface, which is not the case with a partially filled mattress which is entirely of the "Fill in situ" type

The ' fill in situ' grout bags forming the ends of the mattress protection will also be tapered so that a smooth profile is obtained at all points of the protection and so that there is a smooth path from the seabed over the grout bags from all angles of approach. This is illustrated in *Figure 2.6*.

Figure 2.6 ***Grout Bag Tapered Edge Design***



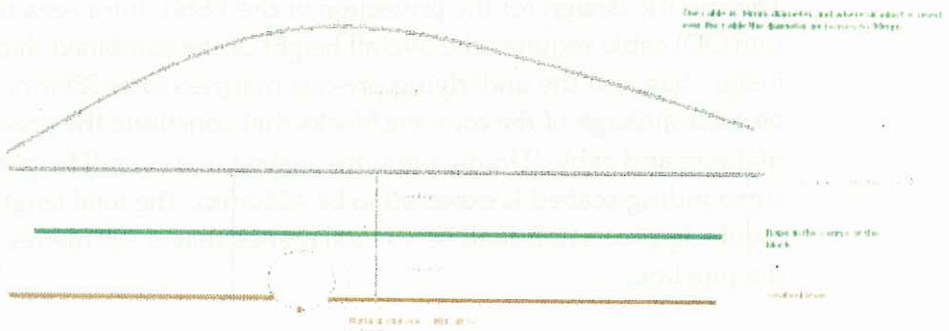
The ' fill in situ' bags, which will lie on top of and extend beyond the pre-cast mattress, will be designed to ensure that all the edges are beneath the level of the surrounding seabed. This will be achieved through hand jetting carried out by the ROV, creating a shallow trench in which the tubular edge section of the ' fill in situ' bag will lie. This is to ensure that the bags do not pose any obstacle to the trawl gear used in the area. Along each long edge of a mattress (and either end of the 200m long row of mattresses) there is a large diameter (circa 600mm) tube section, the mid point of which is to lie beneath the surrounding seabed level. The tube sections will be filled in the same manner as the main central chamber.

' Fill in situ' grout bag technology has been used widely for numerous projects worldwide to provide pipeline / cable support, protection and stability (cross-over / spanning). A ' fill in situ' grout bag is a large fabric assembly where cement grout (cement and water typically) will be injected. The raw materials (pre-cast mattresses with the fabric bag attached and grout) will be transported offshore and lowered into position using a crane with an ROV used to guide the mattress (pre-cast mattress with attached fabric bag) to the designated position and cement based grout will be pumped into the ' fill in situ' bag via a hose. Various ' fill in situ' grout bag varieties have been made available in the market to cater for different scenarios /situations and project requirements. The ' fill in situ' grout bag for this application is a special design to achieve the desired outcomes.

The objective of the mattress is to protect the cable from external damage while also offering a minimal change in the seabed profile. For a mattress 4 metres wide and 350 mm high, the slope will be 10° which will not present any obstruction to fishing gear. The mattresses are designed with tapered sides and all edges will lie below the level of the surrounding seabed, a shallow trench having been created by a ROV using a water jetting tool, prior to the

tubular section being filled. With this design, where a trawl board or otter board comes into contact with the bag, it will run over the bag, rather than hook into or foul it.

The mattress is able to deflect trawl board' s due to the angle of impact, this will also be the case for small dragging anchors. In the event of a trawl-board dropping onto the mattress, the weight of the trawl-board for these local fishing vessels should be absorbed by the mattress and no damage will be suffered by the cable. The grout in the ' fill in situ' bag will be 200 mm in height over the 38mm cable, with the cable lying between the blocks of the pre-cast base mattress. These blocks are 150mm high; therefore a minimum of 275 mm of mattress will be above the cable providing protection from any impact. (Based on the cable, or the cable encased in Uraduct, lying underneath the rope that runs between the blocks in the pre-cast mattress that forms the base of the overall mattress protection as illustrated below in Figure 2.7) In addition, the cable is a robust, double armoured cable design.



The stability of the mattress has been studied and it is shown that the finished assembly is stable both under installation and operational conditions.

The benefits of using the type of mattress protection proposed in this situation is that there is minimal physical disruption to the existing seabed profile and minimal environmental issues, as natural backfilling action will take place around the edge of the mattress.

The ' fill in situ' grout bag over the pre-cast base mattress at each end of the 200m length of installed mattresses will have a similar sloping profile and will deflect trawl gear and other dragged items in the same manner should they approach the mattresses longitudinally.

2.7 SPECIFICATION OF THE MATTRESS FOR THE LAMMA GAS PIPELINE CROSSING

The mattress will be a design combining both an underlying pre-cast mattress, with a 'fill in situ' grout bag (the manufacturer is "Sea Struct") overlying it to provide the shape required. Job reference of the proposed grout bag is provided in *Annex 1*. The pre-cast mattress is manufactured on shore with the grout bag being attached as a separate operation The mattress assemblies, pre cast base with ' fill in situ' grout bag attached & folded in, are installed and then filled on location/the seabed with grout (salt water and cement mix) using a grout pumping system located on a surface vessel. The grout is delivered via a hose.

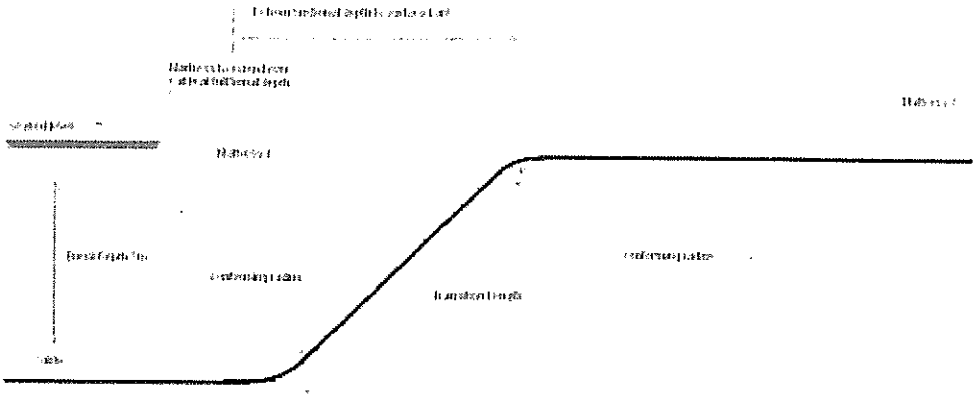
The ' fill in situ' grout bag comprises a purpose designed sewn polyester fabric bag which when inflated with grout will form the required shape and pre-determined thickness. All seams are double sewn to ensure maximum strength. The fabrics used are proprietary brand, heavy duty industrial products which are suitable for rough seabed conditions and have been used in numerous, similar situations. They are a proven and tested product shown to be stable both under installation and operational conditions.

The specific design for the protection of the VSNL Intra Asia fibre optic (38 mm OD) cable requires the overall height of the combined thickness of the ' fill in situ' bag and the underlying pre-cast mattress to be 350mm. As there will be some sinkage of the concrete blocks that constitute the pre-cast base mattress and cable/Uraduct into the seabed, the overall height above the surrounding seabed is expected to be <350mm. The total length of the cable requiring protection shall be +/- 200 metres that is 100 metres either sides of the pipeline.

Each ' fill in situ' bag will be supplied with multiple injection points that shall be set at distances to suit the injection volume required. The width of the bag should be as small as possible without loss of profile ensuring a robust, heavy mattress is produced that cannot be dislodged from the cable, this requirement has driven the 4m width.

The total area of the mattressing and therefore the maximum area where the protection may be above the level of the surrounding seabed is 210m x 4m = 840 square meters. The increase in the overall area over which mattressing is to be installed is as a result of the detailed design work now being carried out and the desire to ensure that the length of cable in the 'transition zone', which is not buried to 5m or greater, is fully protected by the mattressing. As HK Electric will not allow the burial tool to be used within 100m of the pipeline, the cable will need to be on the surface for fully 200m and with the mattress protection over this length at 4m wide, this would be a total of 800 square meters. However as it is not possible to have a step change in the burial depth, from 5m to surface laid, there will therefore be a short length of cable beyond the end of the 200m long mattressed area over which we would prefer to install an additional mattress leading to an increased area of 40 square

meters - the sketch below illustrates what we would like to achieve at each end of the mattress installation.



The duration of the works at the pipeline crossing with the above proposed method will be approximately 14 working days.

2.8 *MATTRESS INSTALLATION*

2.8.1 *Overview*

The VSNL-IA cable will be installed by a specially mobilised cable laying barge, after the cable installation operation is complete, a mattress installation barge will be mobilised with a crane and the grouting spread (this may be the same barge, cable lay spread de-mobilised and mattress installation & dive spread mobilised). The mattress installation barge will set up in a pre designated and agreed anchor pattern that is clear of the pipeline and other cables. No anchor will be deployed within 200m of the HKE gas pipeline.

The seabed will be surveyed by the ROV prior to start of operations to determine the condition of the seabed and the status of the cable on the seabed.

The combined mattress assembly will be deployed using a crane and positioned over the cable by commands from the ROV operator. The grout bag will be filled from the surface, with the ROV in position and the operator continually monitoring the operation. Water monitoring will be undertaken during the operations, and ROV surveys will be undertaken during the ' fill in situ' grout bag inflation and hand jetting at the edge of the mattress.

The seabed and mattress protection will also be surveyed by the ROV after the installation. A geophysical survey for bathymetric depth (terrain model) and a side scan sonar survey will be carried out after the installation is completed.

2.8.2 *Installation of the Grout Bag/ Mattress*

The pre-cast base concrete mattress is fabricated on shore; it is made up of concrete blocks cast on a web of ropes to form a flexible mattress. Each pre-

cast mattress section is currently planned to be 10 metres long by 2 metres wide by 0.15 metre high.

The (empty) fabric form for the ' fill in situ' grout bag is fabricated onshore to the specified design. The ' fill in situ' bag, will be attached to the top of the base pre-cast mattress prior to deployment, either onshore, or on the barge and the overhang will be folded back on top of the pre-cast mattress.

The grout bag will be 2 metres wider than the base pre-cast mattress described above and will be positioned on the top of the base pre-cast mattress so that a 1 metre overhang exists on either side of the mattress. This overhang includes the 600mm diameter tubular section.

The mattress assembly will be deployed using a lifting frame and carefully positioned over the cable using the ROV. The design of the underlying or base pre-cast mattress will be such that the blocks that form the mattress will straddle the cable and Uraduct and will sit on the seabed and not on top of the cable or Uraduct.

When is position, the lifting frame will be released by the ROV. In this position the mattress is 10 metre long by 2 metres wide. The ROV will be used to measure and excavate a trench on either side of the mattress into which the grout bag bulbous/ tubular edge will be placed. Excavation will be by hand jetting, where water is delivered to the seabed via a hose from a ' trash pump' on the barge. The excavation will need to create a trench some 600mm wide and 600mm deep running the full length of the mattress to ensure that the requirement for the edge of the mattress to be below the level of the surrounding sea bed, is met.

ROV jetting is widely used for minor excavation works and will ensure that only sufficient material is moved or liquefied to allow the edge of the mattress to lie below seabed level. Water quality monitoring will be carried out during any such operations and though solids may be suspended this will be localised and short term in duration. As such only minimal disturbance to water quality are expected to result which will not significantly effect the marine environment.

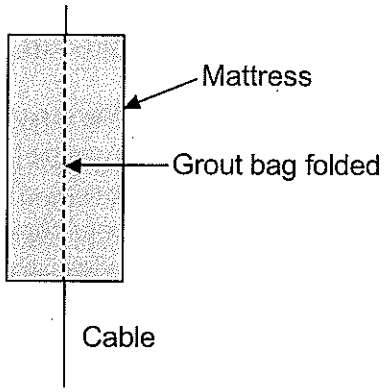
The ' fill in situ' grout bag will then be unfolded from the top of the pre-cast mattress and will be placed on the seabed with the tubular edge placed into the trench.

The ROV will then attach the grout hose, that has been lowered from the barge, to the ' fill in situ' grout bag, the ROV Operator will instruct the pump on the barge be operated and will monitor the filling process. The grout will be mixed on the barge, pumped down the hose and the ' fill in situ' grout bag will be filled.

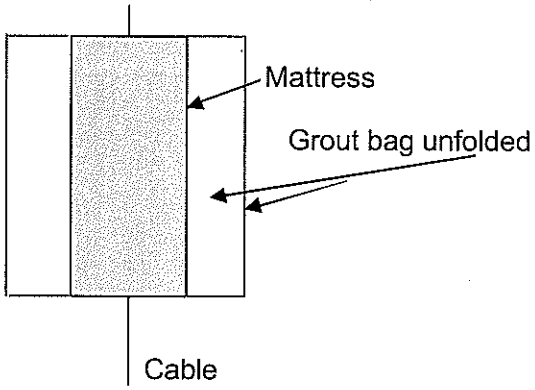
The ' fill in situ' grout bag, once filled, will be surveyed by the ROV and any remedial work will be undertaken before installing the next bag. The edges will be inspected to ensure that a smooth edge and profile has been obtained.

The next mattress assembly will then be deployed as described above and illustrated below:-

Grout bag and mattress deployed from deployment frame



Grout bag unfolded from mattress



The detailed mattress installation procedures are presented in *Annex 2.*

2.8.3 *Grout Mixing and Pumping System*

The offshore installation of the grouting materials will be completed using select grouting equipment consisting of the grout mixing and pumping system, which is designed for use with silos and a bulk cement system, along with all installation hardware.

Bulk Cement Silos

The grout bag is filled with cement grout offshore. This is by use of ISO standard 20 ft cement silos.

Offshore Grout Testing Laboratory Equipment

To ensure that the quality of the grout / cement is maintained the product is tested and checked. This can be done offshore as well as onshore. It is feasible to supply an offshore lab spread comprised of a compression tester, 100 mm cube moulds, micrometers and scales suitable for determination of grout compressive strength testing. Alternatively a more efficient method of ensuring grout quality is to agree grout testing procedure whereby grout cubes shall be made prior to departure of the vessel using the cement supplied to the project, which shall be mixed and witnessed to ensure that the correct strength and density grout product is produced and delivered.

The use of a suitable Anti-Washout Admixture, added to the grout mix can minimise the effect of the grouting process on the immediate seafloor environment during the addition of the grout to the pre-placed bags. ' Fill in situ' grout bags have been used for many years in continental USA to minimise scour effects of bridges and on pipelines. The US Corp of Engineers has investigated the impact on the environment of the grout used to fill the grout bags. Their conclusions are that there is a very short term effect lasting a few hours where the grout locally affects the ph of the water immediately surrounding the grout bags, thereafter there the environmental impact is not discernable on a local scale.

3.1 FISHERIES BASELINE CONDITIONS

The baseline conditions originally described in Annex C (Fisheries Assessment) of the Project Profile were based on data presented in the Agriculture and Fisheries Conservation Department (AFCD) 2001-2002 Port Survey. In the intervening years, AFCD have released an updated dataset on fisheries resources and operations in the 2006 Port Survey for use in fisheries assessments.

In the following sections, this information is used to provide an updated description of fisheries baseline conditions. Since the scope of this report is confined to assessment of the gas pipeline crossing, the Study Area under review is limited to the vicinity of the pipeline crossing location. Also, because the key issues surrounding the cable crossings are related to demersal (bottom) trawling activities, this updated baseline is only focused on this type of activity; namely shrimp trawlers (also known as beam trawlers), stern trawlers (also known as otter trawlers) and pair trawlers. Comparison is, however, provide with fisheries data for all types of activity to provide a context for the pipeline crossing area.

3.1.1 *Capture Fisheries in the Vicinity of Cable Crossings*

Using the most up-to-date information, the level of fishing operations and production are discussed below.

Fishing Operations

The level of fishing operation in terms of the estimated number of vessels in the vicinity of the gas pipeline crossing is considered to be very low. A summary of the level of key fishing operations is presented in *Table 3.1 and Figures 3.1 to 3.4*.

Table 3.1 ***Fishing Operations at the Pipeline Crossing Point by Vessel Type***

Overall Number of Vessels (1)	Shrimp Trawlers (2)	Stern Trawler (2)	Pair Trawlers (2)
10-50	>0 and =10	>0 and =10	0

Note: (1) All fishing vessel types – Shrimp trawlers, stern trawlers, pair trawlers, hang trawlers, gill-netters, long-liners, hand liner, purse seiners, sampans and miscellaneous craft.

(2) Vessel type which uses demersal (bottom) trawl gear.

Figure 3.1 ***Distribution of Fishing Operations (All Vessels) in Hong Kong Waters as recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006***

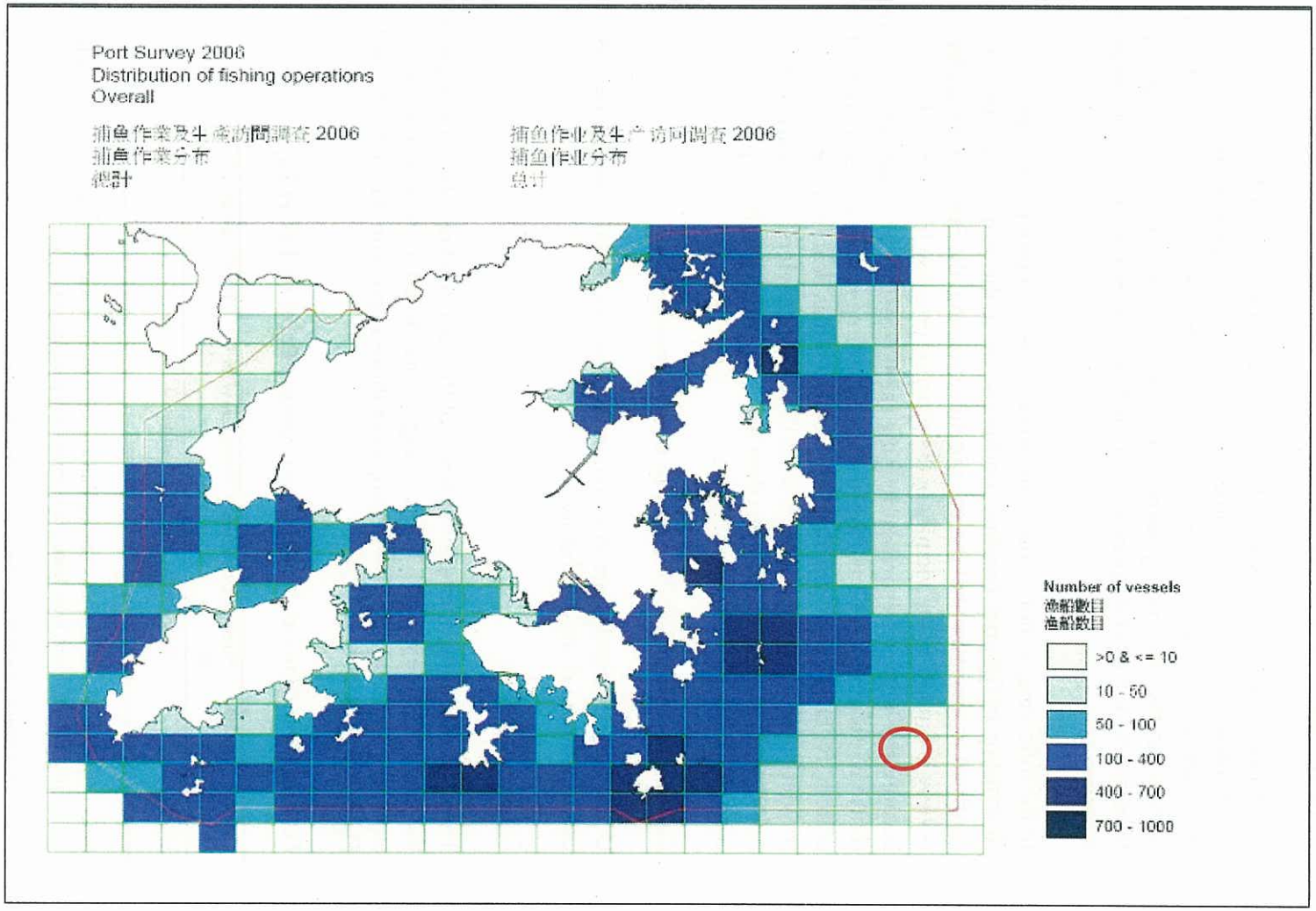


Figure 3.2 ***Distribution of Fishing Operations (Shrimp Trawler) in Hong Kong Waters as recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006***

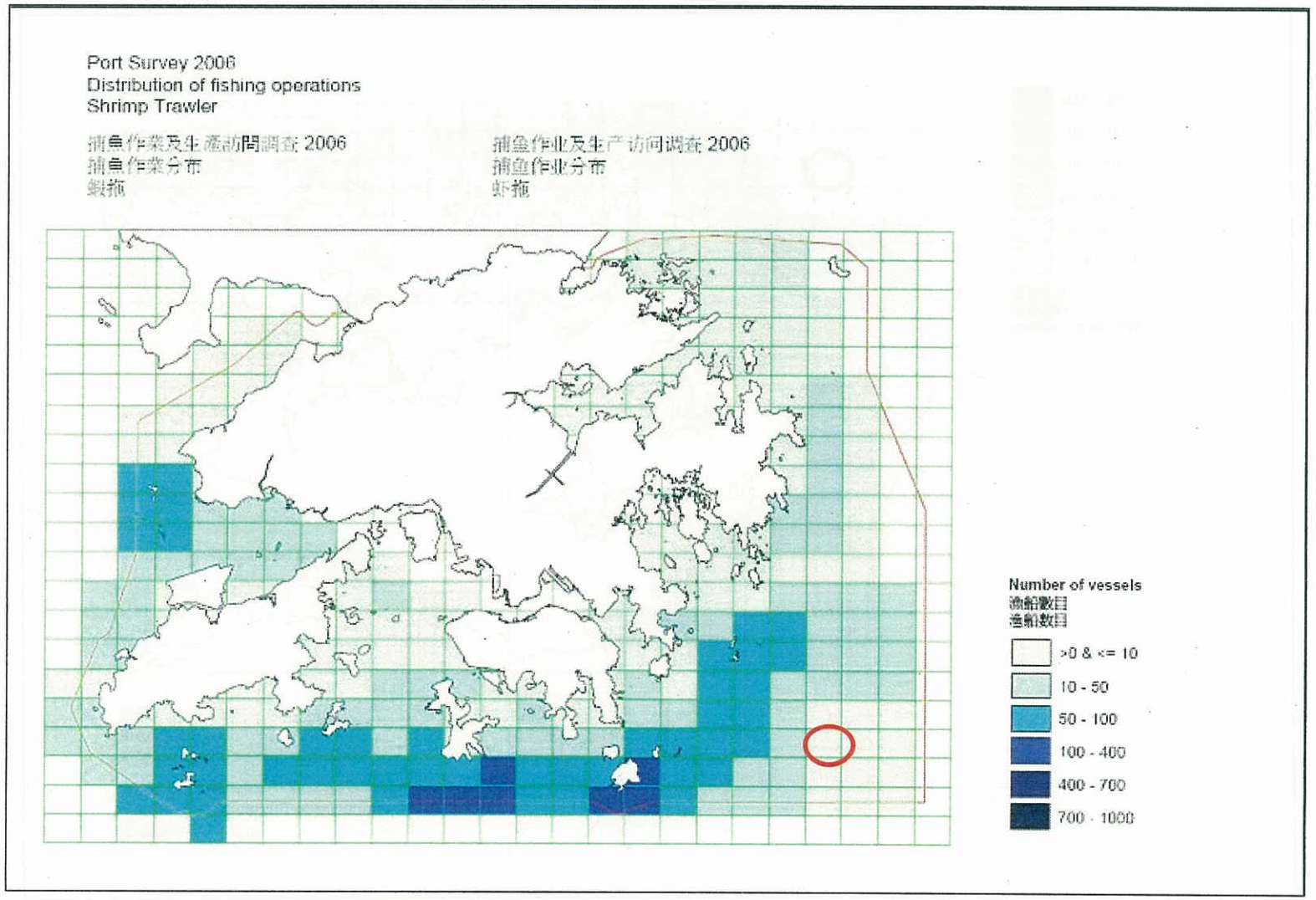


Figure 3.3 ***Distribution of Fishing Operations (Stern Trawler) in Hong Kong Waters as recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006***

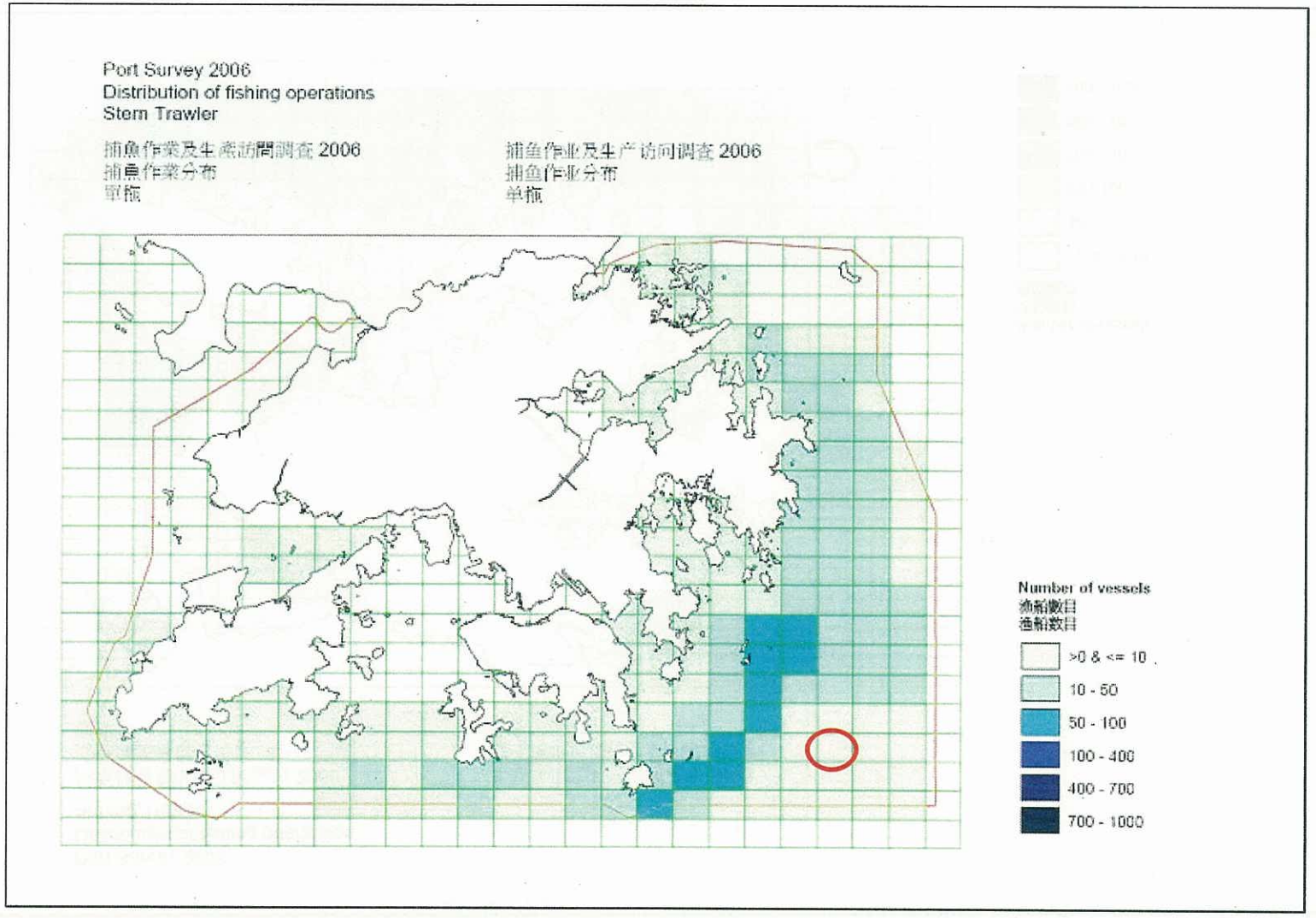
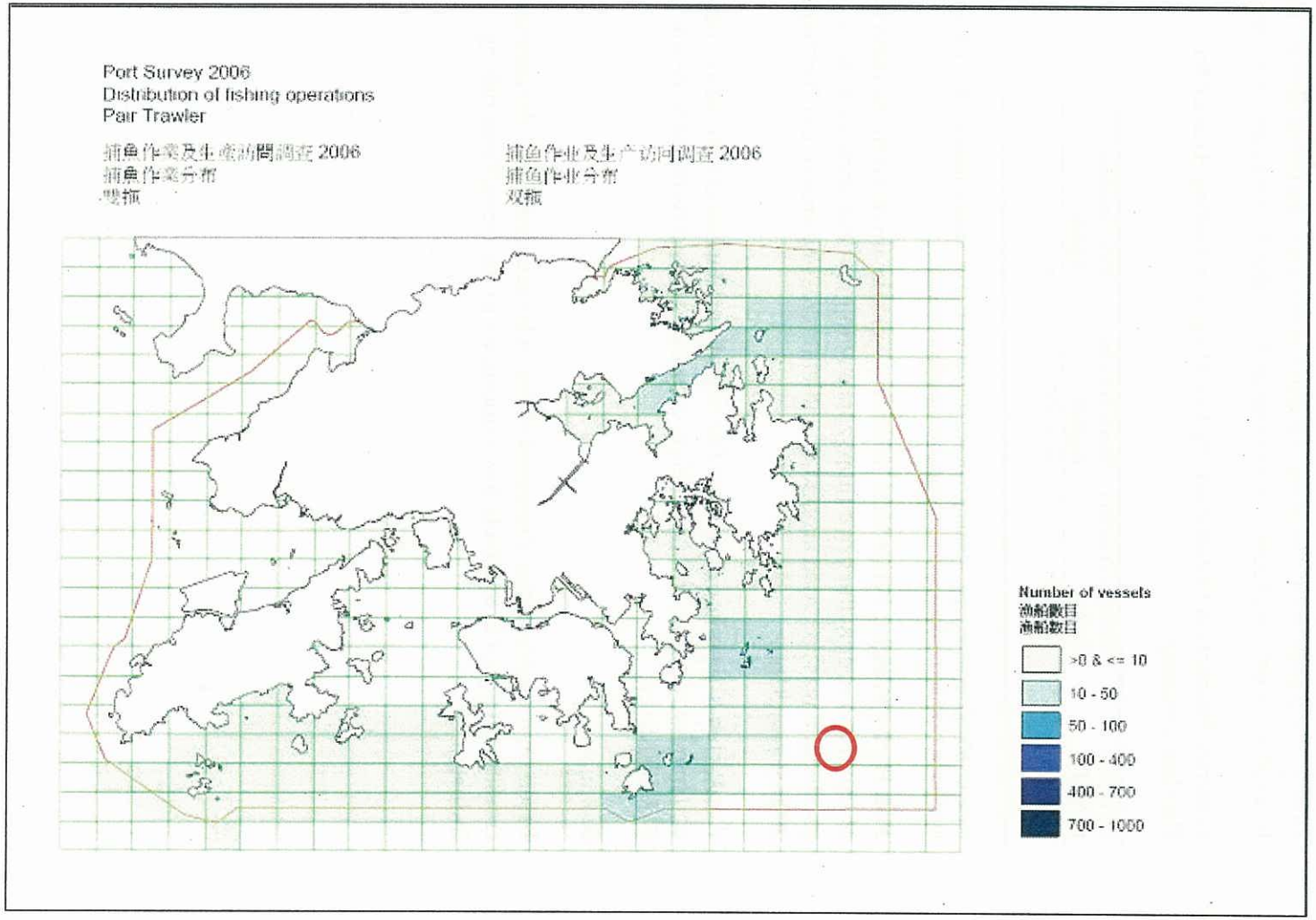


Figure 3.4 ***Distribution of Fishing Operations (Pair Trawler) in Hong Kong Waters as recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006***



Fisheries Production

Adult Fish by Weight: Overall fish production levels at the pipeline crossing closely correspond with the level of fishing operations discussed above. The level of adult fish production is summarised in *Table 3.2* and *Figures 3.5 to 3.8*.

Table 3.2 ***Fisheries Production (Adult Fish) by Vessel Type in Fishing Area at the Pipeline Crossing***

Overall [1] (kg/ha)	Shrimp Trawlers (kg/ha)	Stern Trawler (kg/ha)	Pair Trawlers (kg/ha)
>0 & <50	>0 & <50	>0 & <50	0

Note: (1) All fishing vessel types – Shrimp trawlers, stern trawlers, pair trawlers, hang trawlers, gill-netters, long-liners, hand liner, purse seiners, sampans and miscellaneous craft.

Fish Fry by Weight: While local fishers may also be involved in the collection of fish fry to supply the fish culture zones with grow out stock; no fish fry production was recorded around the pipeline crossing area in the Port Survey 2006 (*Figure 3.9*).

Adult Fish & Fish Fry by Value: The overall catch value of both adult fish and fish fry recorded for the pipeline crossings are is considered to be low at 0-500 HK$/ha.

3.1.2 *Summary*

Based on the information presented above, it is considered that the pipeline crossing area is of is relatively low importance to the Hong Kong fishing industry.

Figure 3.5 *Distribution of Fisheries Production (Adult Fish) in terms of Weight (kg ha^{-1}) in Hong Kong Waters as Recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006*

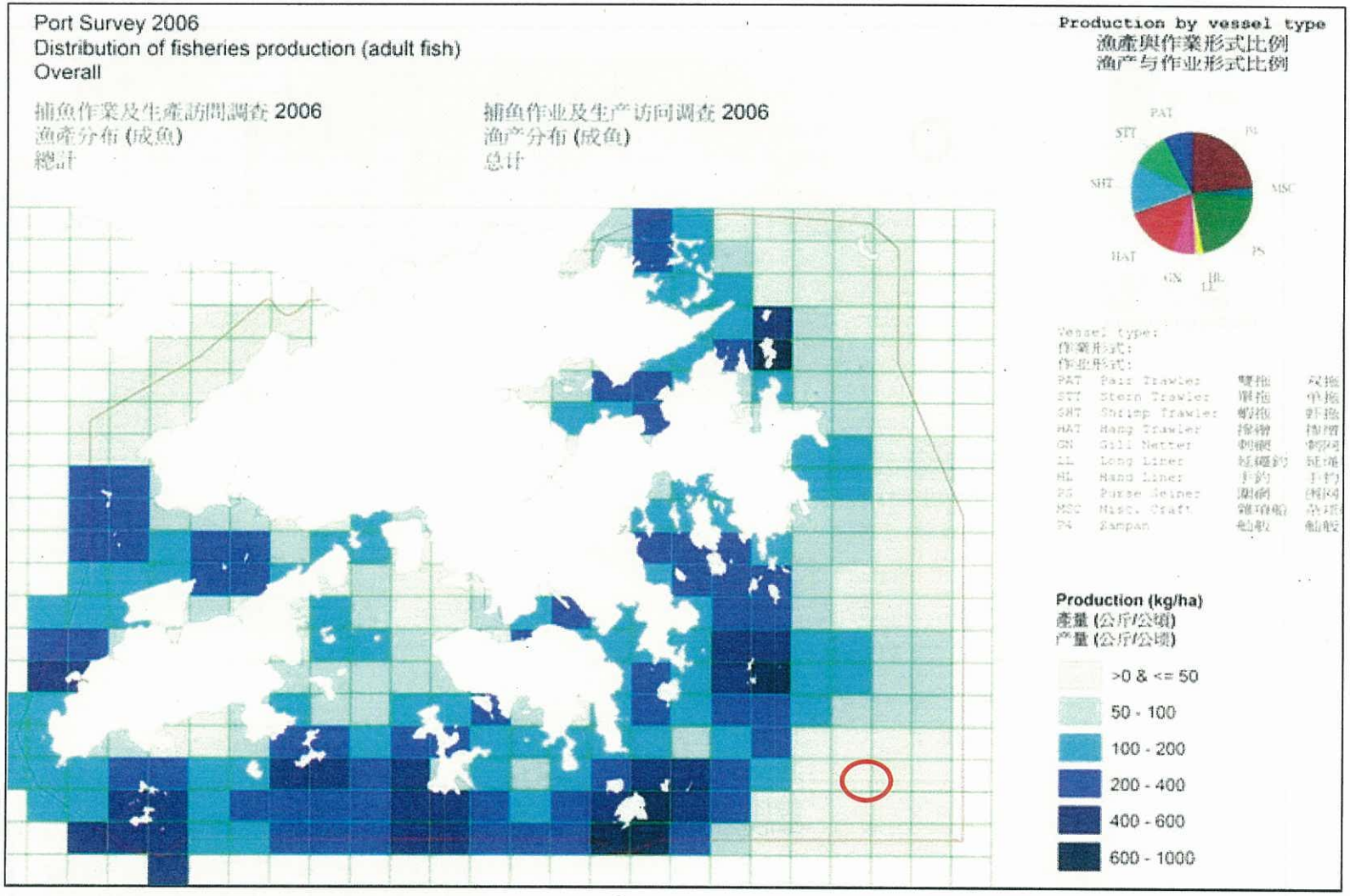


Figure 3.6 *Distribution of Fisheries Production (Adult Fish) by Shrimp Trawlers in terms of Weight (kg ha-1) in Hong Kong Waters as Recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006*

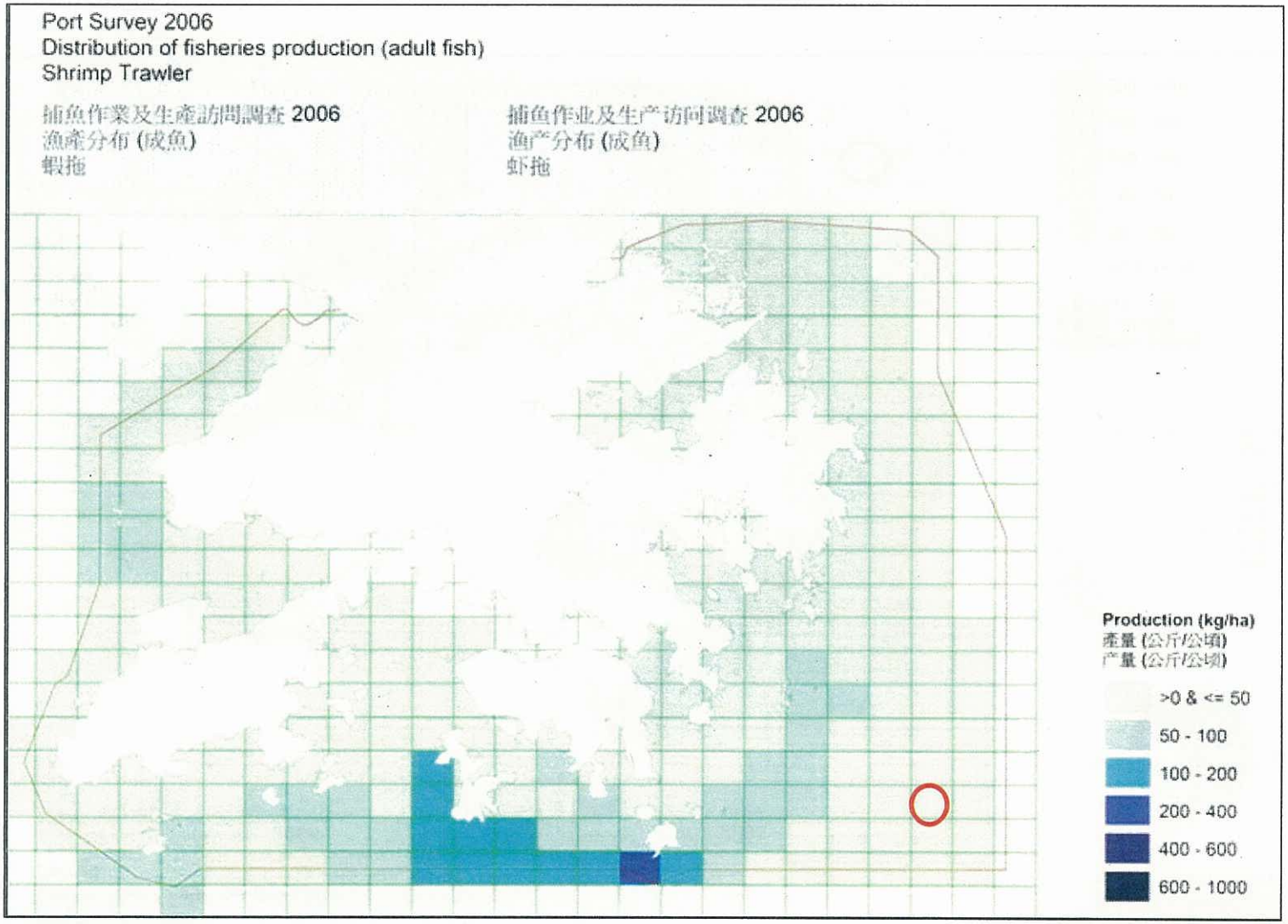


Figure 3.7 *Distribution of Fisheries Production (Adult Fish) by Stern Trawlers in terms of Weight (kg ha^{-1}) in Hong Kong Waters as Recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006*

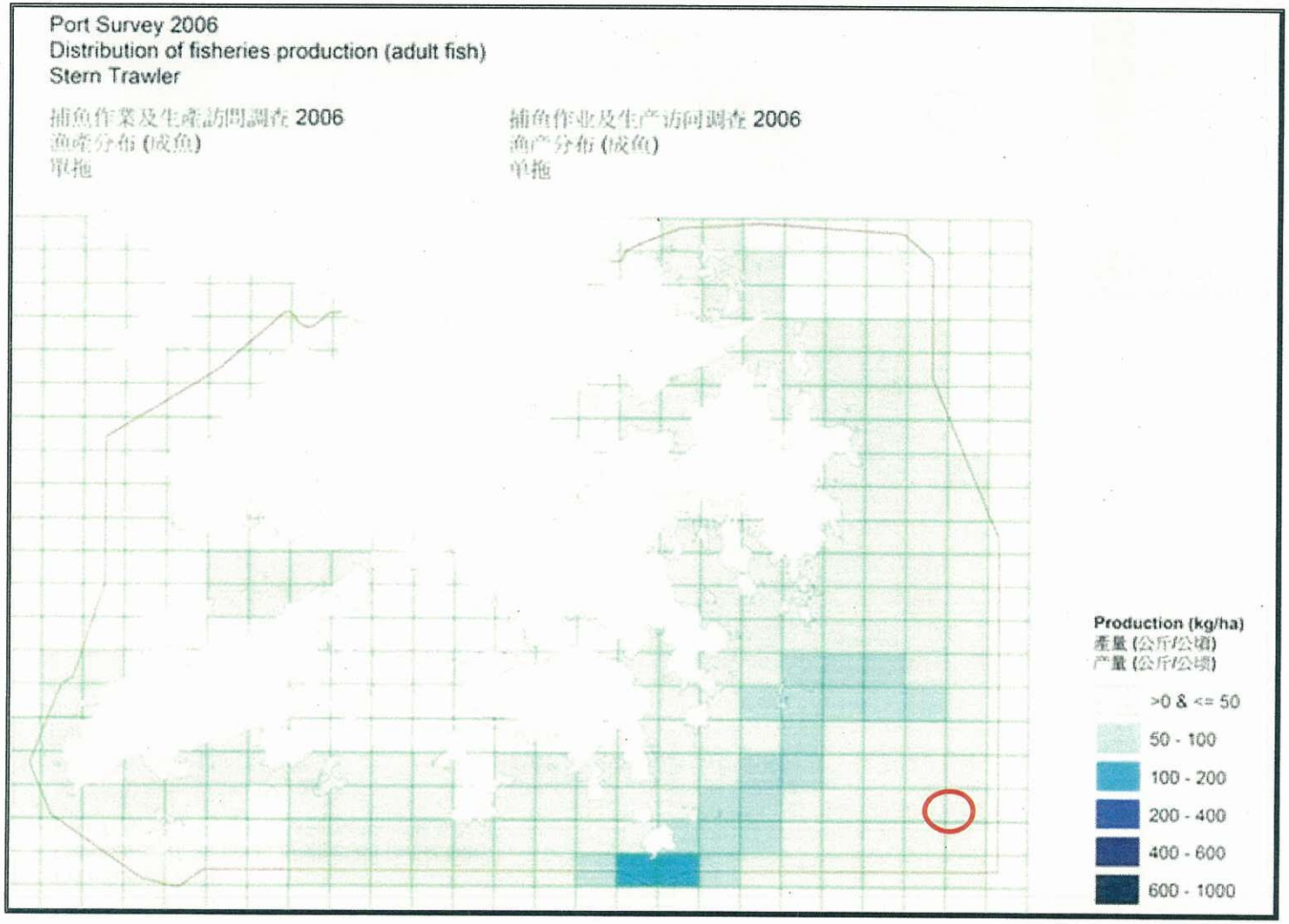


Figure 3.8 *Distribution of Fisheries Production (Adult Fish) by Pair Trawlers in terms of Weight (kg ha^{-1}) in Hong Kong Waters as Recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006*

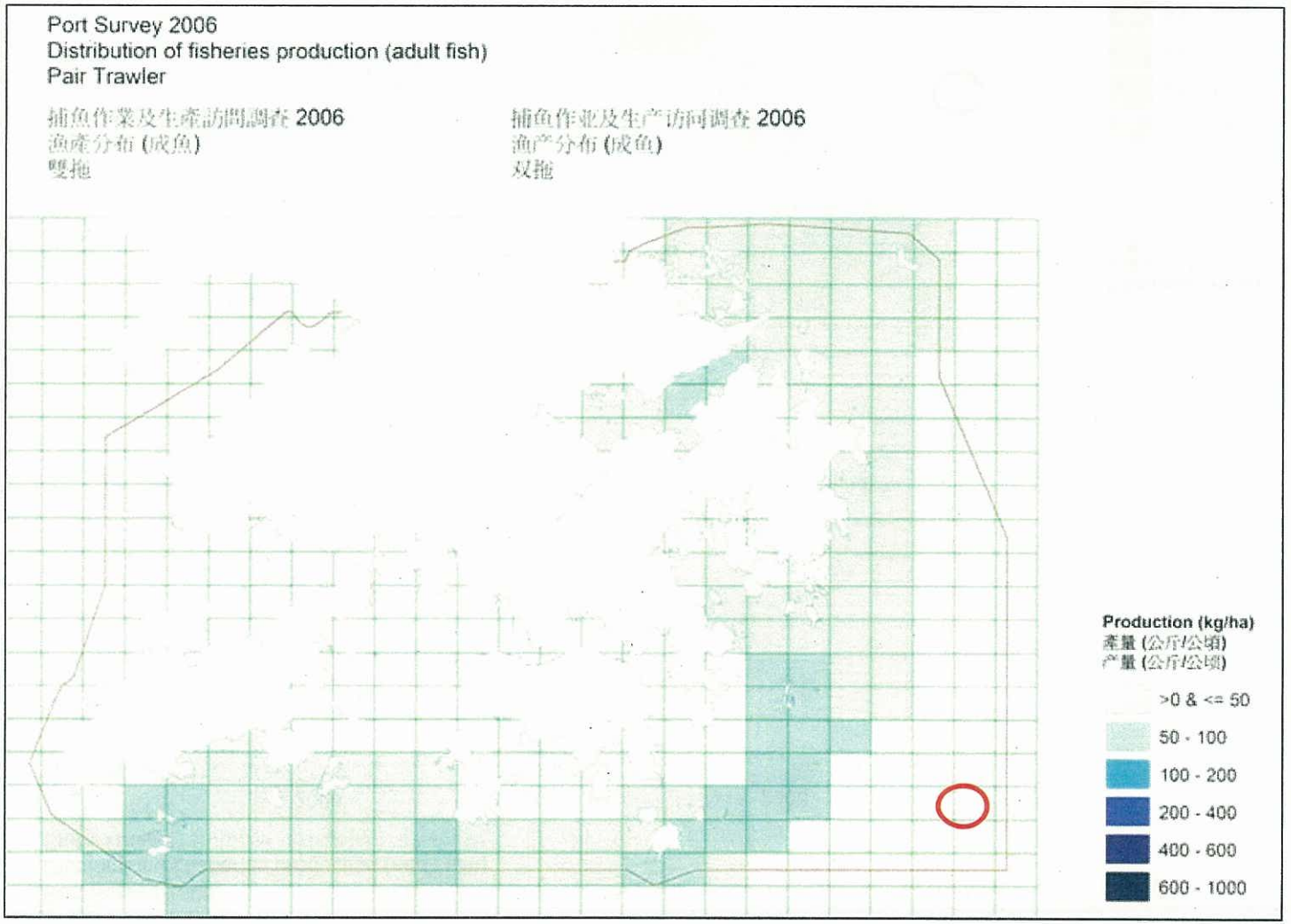


Figure 3.9 *Distribution of Fisheries Production (Fish Fry) in terms of Density (Tails ha^{-1}) in Hong Kong Waters as Recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006*

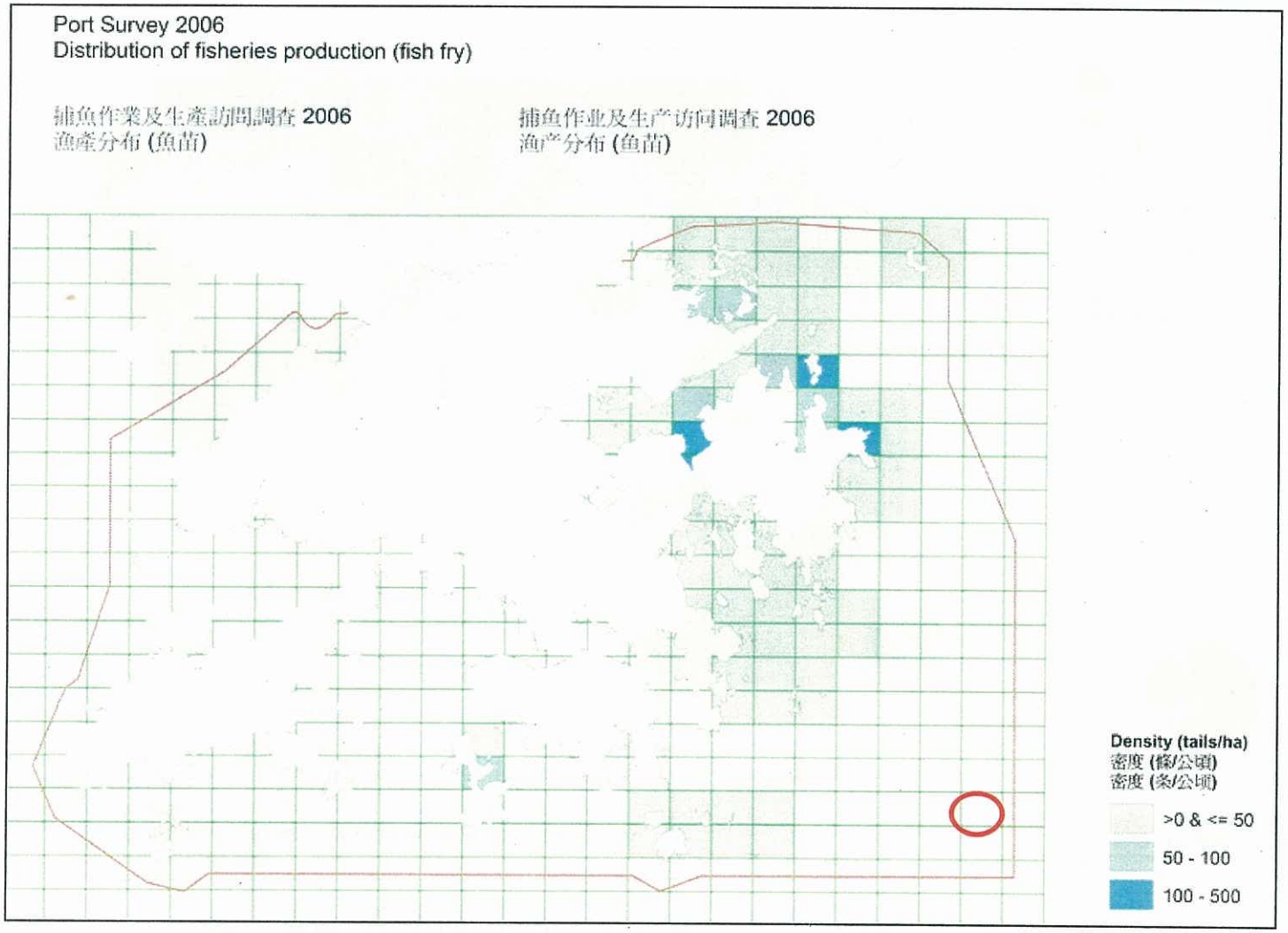
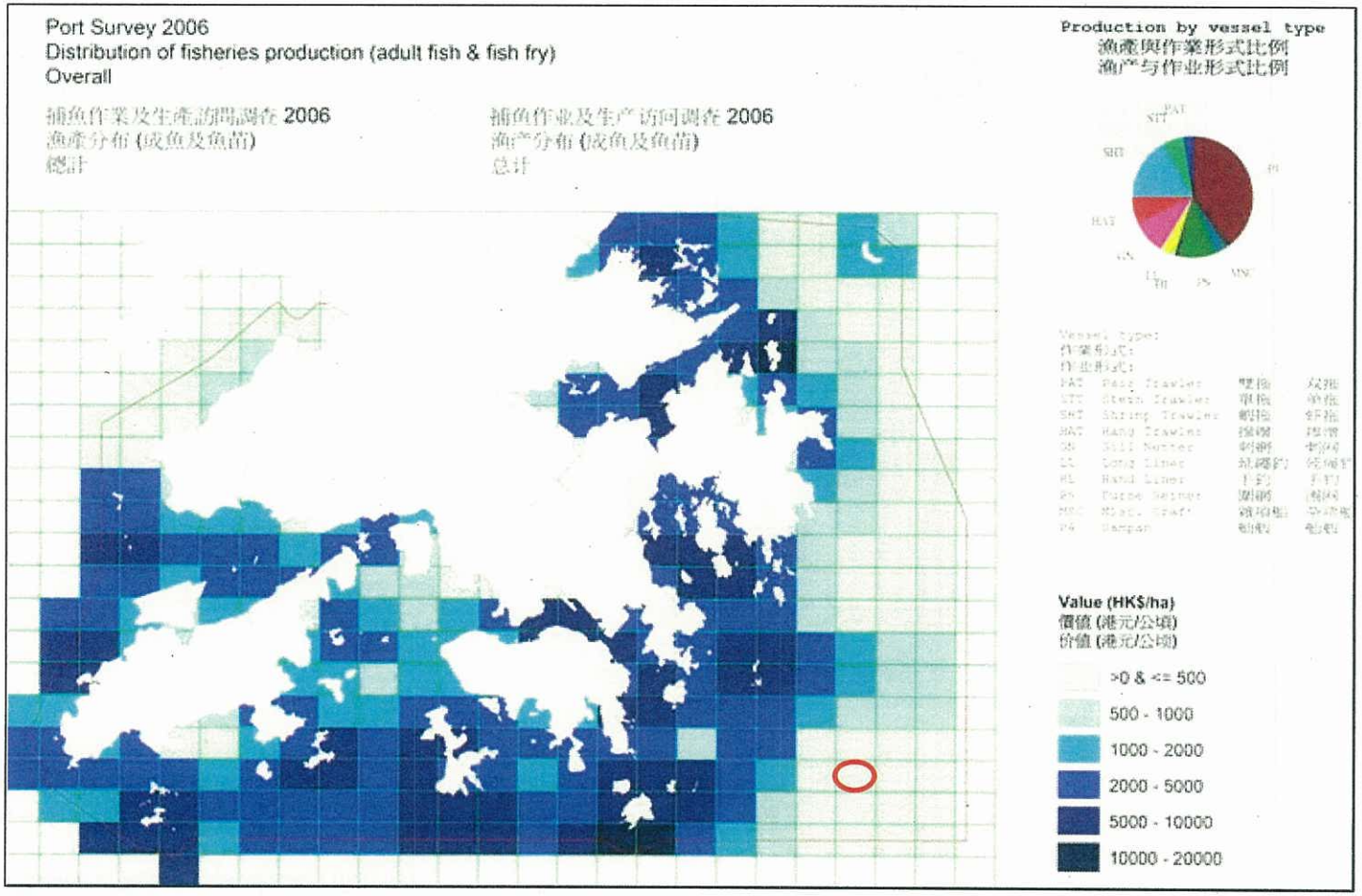


Figure 3.10 *Distribution of Fisheries Production (Adult & Fish Fry) in terms of Value (HK$ ha^{-1}) in Hong Kong Waters as Recorded by Agriculture, Fisheries and Conservation Department in Port Survey 2006*



3.2 BASELINE MARINE ECOLOGICAL RESOURCES

The ecological assessment presented in the Project Profile is still relevant to this assessment. The following provides a summary of key features at the pipeline crossing point.

3.2.1 *Subtidal Habitats*

The subtidal habitats at the pipeline crossing point are expected to consist of fine muddy sediments and similar to benthic assemblages in majority of other subtidal habitats in Hong Kong. No rare or important benthic species are expected to occur in this area [1] [2].

3.2.2 *Marine Mammals*

Although the Indo-Pacific Hump-backed Dolphin (*Sousa chinensis*) and the Finless Porpoise (*Neophocaena phocaenoides*) are regularly sighted in Hong Kong waters, the south eastern waters where the pipeline crossing area is located is not considered to represent one of the more important habitats for these marine mammals.

(1) CityU Professional Services Limited (2002). Consultancy Study on Marine Benthic Communities in Hong Kong (Agreement No. CE 69/2000). Final Report submitted to AFCD.

(2) Agriculture, Fisheries and Conservation Department website: http://www.afcd.gov.hk

4 SUPPLEMENTARY ASSESSMENT OF FISHERIES AND MARINE ECOLOGICAL IMPACTS

4.1 INTRODUCTION

This section presents the findings of the assessment of the impact of the gas pipeline crossings design on marine ecological resources and existing fishing resources and operations. The assessment is based on the Gas Pipeline Cable Crossing Design (*Section 2*) and updated baseline conditions of the fisheries resources and operations in areas where the cable crossings are located (*Section 3*). The findings of this supplementary assessment are compared to those presented in the Project Profile to evaluate whether or not the impact predictions held within remain valid.

4.2 IMPACT ON FISHING OPERATIONS

4.2.1 *Background*

This section addresses the issues raised with regard to the loss of fishing grounds and changes in fishing patterns resulting from the proposed design for the pipeline crossing.

The fisheries baseline information presented in *Section 3* has suggested that the area is of relatively low importance for fisheries. However, given that activities occur in the area then it is considered that the potential for impacts should be reviewed.

As the design comprises a graded slopes with minor elevation above the seabed level in waters >30m deep, any effects are limited to demersal (bottom) trawler vessels. Indeed, only shrimp and stern trawling activities (primarily shrimp) are thought to occur in the area. Other fishing vessel types (hang trawlers, long-liners, gill-netters, purse seiners, sampans and miscellaneous craft) are not affected and are not discussed further because their gear is not deployed close to the seabed.

Shrimp trawlers tow up to ten small beam trawl nets from each of the two outriggers on either side of the boat (20 nets in total). Each beam trawl comprises a 2.5m galvanised iron pipe with a 25kg to 38kg cement sinker at each end, behind which trails a small shrimp net (1).

The majority of stern trawlers operate by towing an otter trawl, with a pair of otter boards (measuring 1 x 2 m) and weighing 180kg each, which hold open a

(1) Selby I & Evans NC (1996) Origins of mud clasts and suspensions on the sea bed in Hong Kong. *Continental Shelf Research* 17:57-78.

net with a foot rope 50m in length weighted down by up to 100 sinkers, each weighing 1 kg [1].

Trawling is generally limited to areas with soft sediment. Rocky seabed and areas with large scattered boulders are typically avoided. During trawling, the gear digs into the seabed. The extent to which trawling gear digs into the seabed depends on the sediment type, with deeper penetration occurring on muddy grounds compared to sandy grounds. Penetration depths of 10-60 mm for shrimp trawling gear have been reported in the literature [2] [3]. Otter boards which are dragged upright along the bottom have deeper penetration, leaving characteristic "tramlines" on the seabed and may penetrate to about 0.5m.

4.2.2 *Impact Assessment*

Potential for Damage to Fishing Gear

Nature of Impact: The placement of structures on the seabed could present opportunity for damage to demersal fishing gear. However, the proposed cable protection Grout Bag mattress structure is designed to minimise the potential for this.

The structure will result in a minimal change in seabed profile. The proposed design would provide a slope of 10^0 over a length of 4m giving a total height of 35cm, which would unlikely present any obstruction to fishing gear. The mattress is also designed with tapered sides, which will be buried below the seabed through the ROV being used to creating a shallow trench in which the tubular edge of the mattress will lie. With this design, where a trawler board or otter board comes into contact with the outer edge of the structure they will run over the bag. The bag is also able to deflect trawler board' s impact and small dragging anchors. In the event of a trawl-board dropping onto the grout bag, the weight of the trawl-board used for local fishing vessels should be absorbed by the grout bag and no damage will be suffered by the cable.

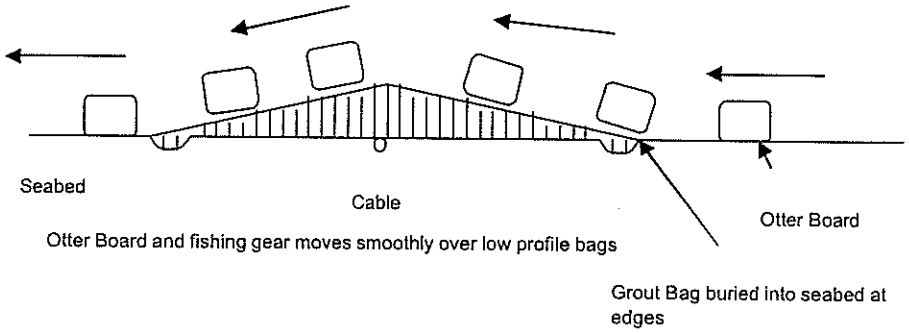
The path of a trawl door / otter board over the grout bag is illustrated in *Figure 4.1*.

(1) Selby I and Evans NC (1996) *ibid*

(2) Groot, S.J. de. (1995) On the penetration of the beam trawl into the sea bed. ICES C.M. 1995/B 36

(3) Gubbay S & Knapman PA (1999) A Review of the Effects of Fishing within UK European Sites. English Nature (UK Marine SACs Project). 134 pages.

Figure 4.1 *Illustration of Trawl Otter Board moving over Grout Bag*



In addition, typical trawling gear used in Hong Kong includes features to avoid snagging. For instance, the sweep rope, which forms the leading edge of the net as it drags across the bottom is beaded with weights shaped as small rollers. In addition, shrimp nets are equipped with a layer of netting (made from hemp) which is intended to protect the main net. Nevertheless, the features of the gear intended to protect it from snagging are not as well-developed as in other countries.

It should also be borne in mind that nets by necessity are robust, and it is not uncommon for rocks and boulders as well as man-made items and solid debris to be brought up in nets. It is also noted that the loss of or damage to nets is an everyday issue for trawling operations and so spares and repair equipment are kept on board. A single damaged shrimp trawl net can be changed in minutes. Similarly, bent iron pipes can be repaired on board the vessel.

The pipeline and cable route will be clearly marked on the relevant charts (eg the nautical charts published by the Hydrographic Office, Marine Department) and on this basis and therefore avoidance of the specific areas is achievable in the same manner as other seabed features with a perceived risk to gear can be avoided. However, as stated above, it is not expected that fishermen would need to avoid the area as impacts on fishing gear should not occur.

Likely Significance: Impacts are considered to be of negligible significance.

Potential for Injury to Fishers

Nature of Impact: Potential risk of injury to fishermen is associated with gear becoming stuck on underwater obstructions. However, as stated above, the proposed design should avoid this situation.

The risk is also generally low as fishers are cognisant of the risk and would generally position themselves in safer locations on deck during trawling and because the demersal trawling vessel operate at low speed. Furthermore, experienced fishers have procedures for dealing with instances of trawl gear being caught on the bottom.

Likely Significance: The risk of injury is considered to be negligible.

Potential for Loss of Fishing Ground and Change in Pattern of Fishing Operations

Nature of Impact: The placement of a new hard structure on the seabed could potentially lead to an alteration in the local fishing resource which could lead to an adverse impact on fishing operations.

The proposed structure would lead to a maximum loss of 0.08ha of existing soft sediment seabed habitat, which represents a very minor loss of fishing grounds for demersal trawlers. In addition, due to the low height of the grout bags above seabed, it is likely that the structure would be partially covered by soft sediments and fishing resource in these areas should remain unaffected. Given that there is no reason for trawlers to avoid the area to safeguard gear or to minimise risk to fishermen, it is expected that there should not be a significant change to fishing activity in the area.

In addition, the pipeline crossing area being of relatively low importance for fisheries and given the availability for higher valued areas elsewhere in Hong Kong, impacts are likely to be low.

As noted, the pipeline crossing area does not constitute a loss of fishing grounds for other kinds of vessels which operate with different fishing gear (i.e. non demersal trawl vessels).

Likely Significance: Impacts are expected to be of negligible significance.

Impact on Fishing Vessel Traffic during the Construction Period

Nature of Impact: The construction works could provide an obstacle to marine traffic movement. However, the working area is expected to be very small and the completed over a very short period of time (approximately 14 working days). In addition, fishing operations are relatively low here in comparison to other areas in Hong Kong waters.

Likely Significance: Given the small area and short timeframe of works, it is not expected that fishing traffic would be significantly affected.

Obstruction of Migration or Passage of Sea Life and Disruption of Food Web

Nature of Impact: The placement of a new structure on the seabed provides potential for obstruction to the flow of food and nutrients and migration of bottom dwelling marine organisms.

The proposed Grout Bag mattress would only be 350 mm high with a very gradual 10^0 slope. This would not have any barrier effect on the movement of marine organisms. Self-evidently, movements of free-swimming and mobile organisms including commercially important species such as certain crustaceans and finfish living on the bottom would not be deterred or hampered by the structure. These and other sedentary organisms generally rely on planktonic dispersion of larvae which drift in the water column. Minor and localised modifications resulting from construction of the mattress bed would not impede the flow of currents and the plankton they contain. The design on the cable crossing would also exert no influence on the movement of larvae.

Likely Significance: Given the small size of the structure it is not expected that the pipeline crossing would significantly affect local communities, which would lead to minimal knock-on effects on the fisheries resources of the area.

4.3 IMPACT ON MARINE ECOLOGY

Loss of Subtidal Habitat

Nature of Impact: The proposed design would lead to a maximum loss of 0.08ha of soft subtidal habitat. As stated above it is possible that the structure could be smothered with mud sediments very soon after being constructed, which would reduce the magnitude of loss in the short term. The maximum loss of habitat, however, represents a very minor loss of similar available habitat in the local area and Hong Kong waters. In addition, no protected or rare infauna or epifaunal species are expected to be located in this area, with communities being very common to Hong Kong waters.

Likely Significance: Impacts are expected to be of negligible significance. Nevertheless, pre-works and post-works surveys for seabed profile and condition will be conducted to confirm that the status of subtidal habitat at the crossing point is comparable to that predicted in this impact assessment using the method as stated in Sections 2.3 & 2.4

4.4 IMPACT ON WATER QUALITY

Nature of Impact: The Grout Bags would be filled with cement grout offshore via a hose. This potentially could lead to impact on water quality if leakage occurs. However, the use of a suitable Anti-Washout Admixture, added to the grout mix can minimise the effect of the grouting process on the immediate seafloor environment during the addition of the grout to the pre-placed bags.

In addition, the adoption of appropriate operational management by the contractor should lead to low potential for leakage during the pumping phase. Grout bags have been used for many years in continental USA to minimise scour effects of bridges and on pipelines. The Department of Transportation, Virginia in the US, has investigated the impact on the environment of grout bags (1) which has been a key concern of the some of these agencies, namely the Virginia Department of Environmental Quality and the U.S. Army Corps of Engineers (USACE). Their conclusions are that there is a very short term effect lasting a few hours where the grout locally affects the pH of the water immediately surrounding the grout bags, thereafter there the environmental impact is not discernable on a local scale. It is important to note that seawater will act as a buffer to the minor pH change.

Likely Significance: Impacts are expected to be of negligible significance.

(1) G. Michael Fitch (2003). Minimizing the Impact on Water Quality of Placing Grout Underwater to Repair Bridge Scour Damage. Virginia Transportation Research Council in cooperation with Federal Highway Administration, the US Department of Transportation, Charlottesville, Virginia. Final Report.

5 ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENT

5.1 ENVIRONMENTAL PROTECTION

In order to minimise risks to the operation and to the environment, full procedures and mitigation measures will be adopted and followed, as summarised below:-

Work responsibilities:

- All responsibilities will be clearly defined, starting with the definition of the responsibilities of The Offshore Superintendent, who is responsible to the Project Manager for the planning and execution of all the work offshore in a safe and environmentally friendly manner;
- Deployment of the mattresses
- Filling the grout bags
- Hand jetting
- Inspecting and documenting the work
- Reporting as required to all third parties
- Ensuring that the work is carried out in a safe and environmentally responsible manner in compliance with all permit conditions
- Liaising with the Environmental Auditor & Inspectors

5.2 ENVIRONMENTAL MONITORING AND AUDIT (EM&A)

The key EM&A works will include:

- Conduct a pilot study to monitor the water quality performance of the grout mattress installation works;
- Conduct *ad hoc* water monitoring in the event that any accidental minor or major release of grout material occurs during grout mattress installation works;
- Conduct geophysical survey to obtain the bathymetric data to detect the pipeline position (shallow depression above the pipeline due to the burial); and,
- Conduct video inspection within which the mattress protection is to be installed to demonstrate the conditions of the local environment prior to and after the installation of the mattress protection.

The above EM&A works will form part of the requirement of the EM&A Manual, under the requirement of Condition 3 of the Environmental Permits (EP-294/2007 and FEP-01/294/2007).

6 SUMMARY AND CONCLUSIONS

This report provides a supplementary fisheries and marine ecology assessment of cable crossings based on detailed information available on the as-built design and updated baseline conditions.

The findings of these supplementary assessments are that the proposed design should lead to negligible impacts on fisheries and, at worst, minor impacts on marine ecology. Notwithstanding, Tata will ensure that the proposed cable laying and protection method at the pipeline crossing, if approved, is fully implemented and performs as designed such that any resulting fisheries and marine ecology impact will be negligible as predicted in the impact assessment. Tata are also aware that fishermen adversely affected by the works may claim for compensation from the Proponent for damages.

In addition, pre-works surveys and post-works surveys for the seabed profile and conditions (by sounding) will be conducted to confirm that the status of subtidal habitats at the crossing point is comparable to that predicted in the impact assessment report (details refer to *Section* 2.3). Tata will also confirm through the post-works surveys that the proposed cable laying and protection method has been implemented as designed and will unlikely cause any significant fisheries and marine ecology impact.

ANNEX 1

JOB REFERENCE OF THE PROPOSED GROUT BAG

SEA-STRUCT Group

Incorporated in Australia during 1993, SEA-STRUCT Pty Ltd has expanded to become a recognized service provider to the Oil and Gas Industry. With offices in Western Australia, Singapore, Indonesia and represented in the UAE and South Korea. SEA-STRUCT is a leader in the engineering design, manufacture, supply and installation of pipeline stabilization and protection systems.

In 1998 SEA-STRUCT expanded the core business and pioneered the ROV installation of pipeline supports thereby pushing the boundaries in both depth and efficiency of this method of professionally rectifying freespan problems on deep water submarine pipelines and cables.

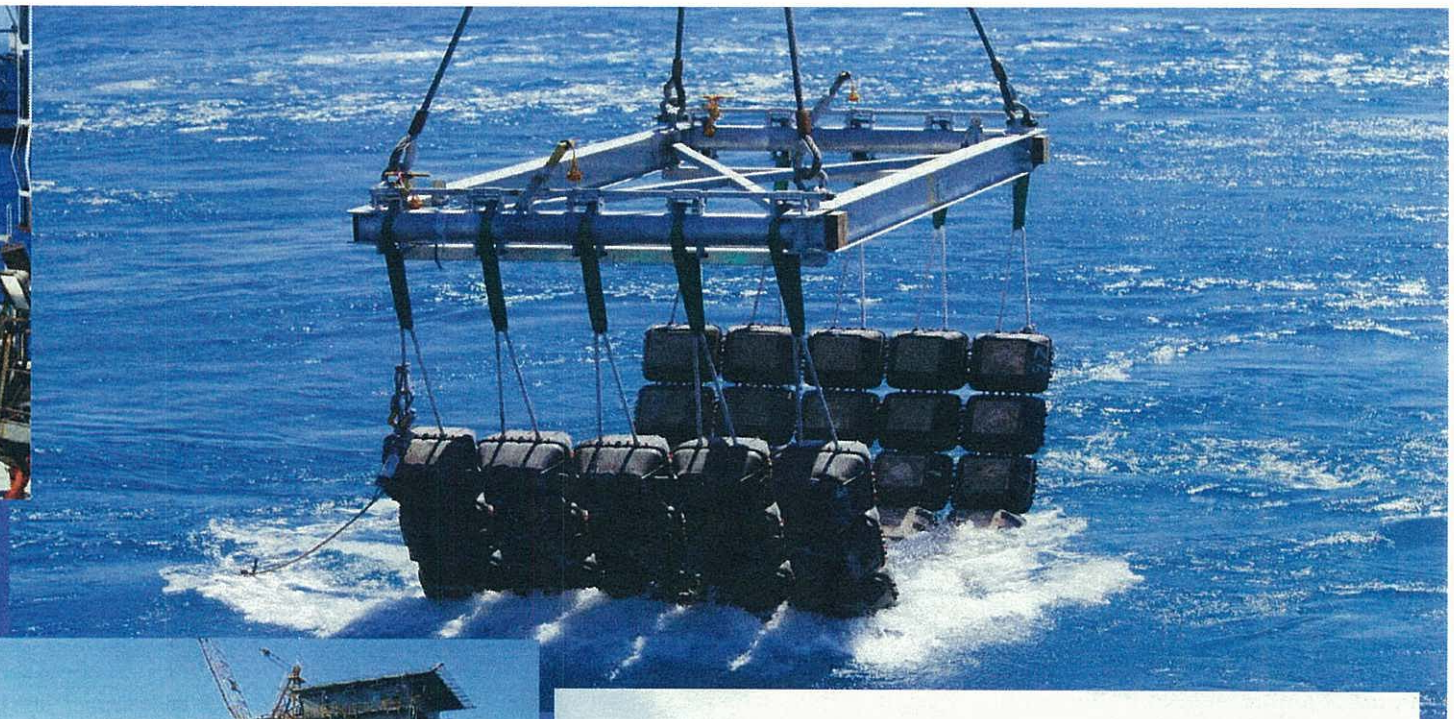
In 2002 SEA-STRUCT was awarded a prestigious WAISS award by the West Australian Govt. for innovative design with the development to a commercial level of SEAMAT. SEAMAT is an entirely new concept of concrete mattress manufacture that has enabled SEA-STRUCT to supply quality products at affordable prices to remote offshore locations.

With the expansion of the SEA-STRUCT Engineering team and the development of software such as MATSTAB for the assessment of mattress stability, SEA-STRUCT pipeline stability solutions have gained International verification from parties such as DNV and Bureau Veritas.

The client base of Oil Companies that have used SEA-STRUCT products and services include many majors such as Shell, Esso, BP, Chevron, Conoco, ADNOC, Petronas, Woodside, Origin, Santos – to name but a few. The contractors read like a who's who of the industry - with Hyundai, Global, Mermaid Marine, Technip, Saipem, McDermott, NPCC, Covus, Clough and many others Worldwide.

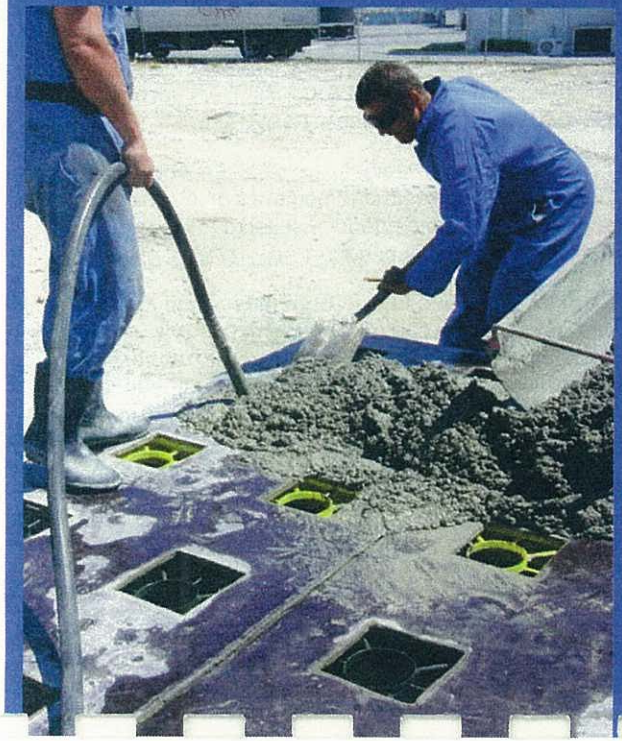
SEA-STRUCT has grown to be a respected provider of fully engineered solutions for stabilization and protection of submarine installations.

For further Information please email: sales@sea-struct.com



PIPELINE PROTECTION & STABILISATION:

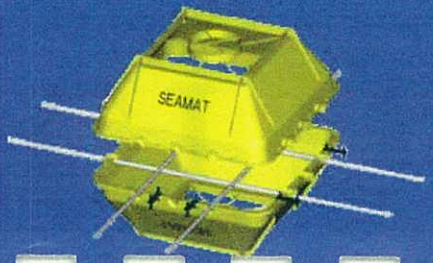
Submarine protection and stabilisation of pipelines and cables is available using one of the following SEA-STRUCT products. SEAMAT, ANCHORMAT, BITUMAT and GROUTMAT can be combined with in house engineering and procedures to provide a turn key solution.

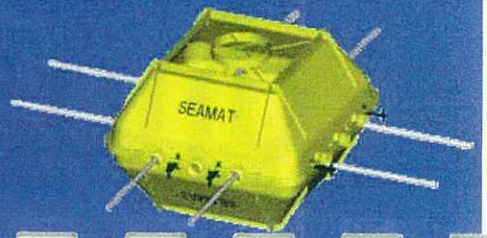


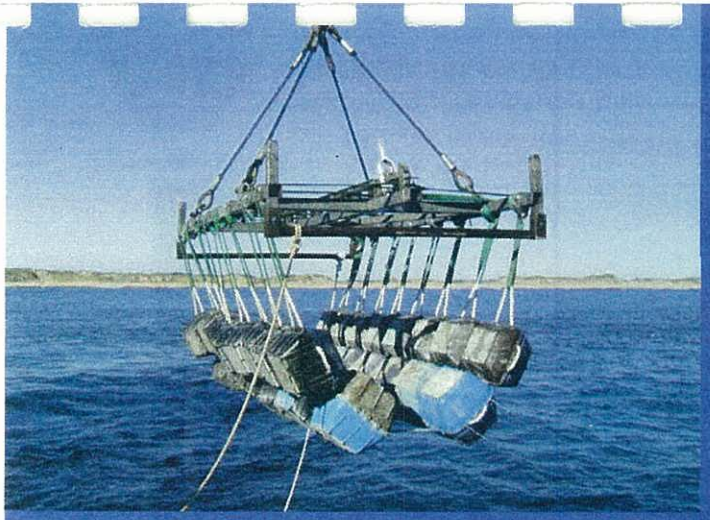
SEAMAT has been developed to provide the Oil & Gas Industry with a fully articulating concrete mattress system for pipeline and cable stabilisation or protection. The mattress may articulate and flex in all directions thereby adapting to the contour of the seabed.

The unique quality of SEAMAT® is the portable moulding system which allows large numbers of mattresses to be manufactured quickly and efficiently at the proposed project load out location.

The concrete density used to fill the SEAMAT moulds can be altered so as to adjust mattress weight. Individual block weights within a single mattress can be increased in size and weight with ease. The use of extreme heavy aggregates can be achieved without any loss in manufacturing time.

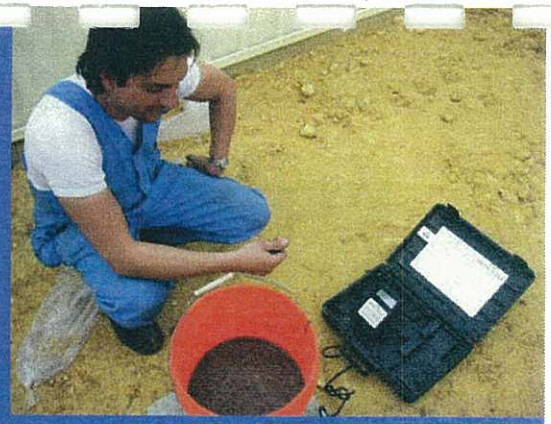


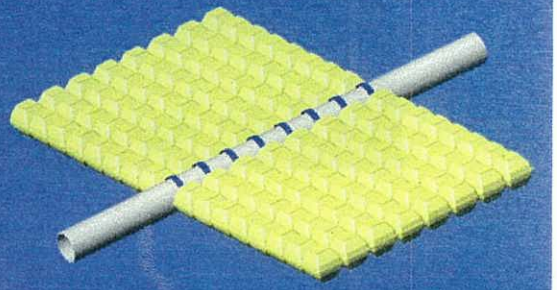




ANCHORMAT is a natural progression from the SEAMAT concept. Using the SEAMAT casting system the mattress is constructed in two parts which are then connected together using certified polyester webbing slings.

The webbing slings are cast into the concrete during manufacture and once the mattress is installed onto the pipeline shall transfer the load from the mattress onto the line without any increase in the pipeline profile.





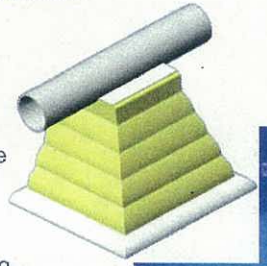
GROUTMAT is a custom manufactured mattress injected with grout to provide stabilisation and dropped object protection. They are available in any size or shape to suit the project requirements.

BITUMAT contain bitumen -bound materials allowing the mattress to mould themselves around a pipe or cable and provide a high level of protection against impact damage. The bitumen rich mix prevents chemical breakdown or corrosion enabling the integrity of the mattress whilst the pipe or cable is protected and stabilized. Mattresses are manufactured with internal reinforcement and certified lifting points. BITUMAT mattresses are custom designed, can be virtually any size required and can be constructed with differing densities of mixes.

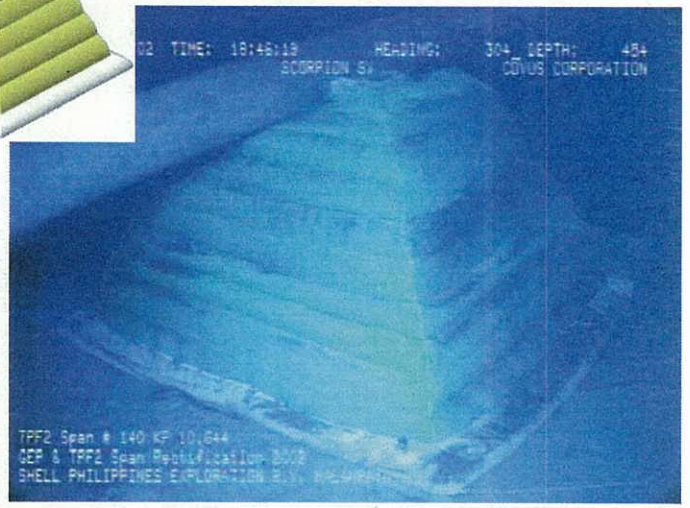
FREESPAN RECTIFICATION:

The rectification of pipeline freespans using fabric formwork to manufacture pipeline supports has been the core business of SEA-STRUCT since 1993. The vast amount of experience developed by the company has culminated in the extremely efficient methods now developed. All Support Forms can be installed with divers or with ROV using SEA-STRUCT specialized ROV installation equipment.

Stabilized Base Pyramids (SBP series Groutbags) provide an enlarged base, high payload stable support for pipeline freespan correction. The standard design of the SBP formwork allows for savings in placement time filling and cement requirement.



The SBP forms are of multiple compartment construction with internal structural partitioning and base height limiting straps to provide form shape during inflation.



GM Groutbags (below) provide an economical means to pipeline support and are used for small spans. GM forms can also be used in conjunction with SBP forms for pipeline crossovers.

Custom Manufacture – The custom design and manufacture of our products is a specialised service available from SEA-STRUCT. The combination of in house engineering and design with extensive offshore installation enables SEA-STRUCT to provide this highly regarded personnel service to our clients.

AUSTRALIA - SEA-STRUCT Pty Ltd, 10 Sultan Way (PO Box 67), North Fremantle 6159, Western Australia, Tel: +61-8-9430-4753 Fax: +61-8-9430-6343
SINGAPORE - SEA-STRUCT International Pte Ltd, Unit 1 Block 323 (Box 5197), Loyang Offshore Supply Base, Singapore 508988, Tel: +65-6543-4058 Fax: +65-6543-4059
INDONESIA - PT SEA-STRUCT Jl. RE. Martadinata, Sekupang-Batam 322034, Tel: +62-788-322-655 Fax: +62-778-321-766

SEA-STRUCT PTY LTD

Major Projects Completed to 2003

Client	*Location*	*Product*
WAPET	NW Australia	Subsea Pipeline Supports
Hadson Energy	NW Australia	Subsea Pipeline Supports for Grouted Anchors
Contract Diving Services	NW Australia	Subsea Pipeline Supports
Hadson Energy	NW Australia	Subsea Pipeline Supports
Oceaneering / WAPET	NW Australia	Pipeline Bundle and Crossover Supports
WAPET	NW Australia	Crossover Supports
Divcon	Indonesia	Custom Formwork
TOTAL	Indonesia	Custom Formwork
Subsea International	NW Australia	Subsea Pipeline Supports for Grouted Anchors
Stena Offshore / PTT	Thailand	Subsea Pipeline Supports
P.T. Petrosea	Indonesia	Subsea Pipeline Supports
Divcon / PTT	Thailand	Subsea Pipeline Supports + Grout Pumping
AMPOLEX	NW Australia	Custom Formwork + Engineering
Subsea International / WAPET	NW Australia	Subsea Pipeline Supports
Transfield	NW Australia	Custom Formwork
Clough Engineering	Perth Australia	Subsea Pipeline Supports for Grouted Anchors
Offshore Pipelines Inc / Shell	Shell Sarawak - Malaysia	Subsea Pipeline Supports
BHP Petroleum	Griffin Field	Subsea Pipeline Supports
WAPET	Saladin Field	Bundle / Pipeline Crossover Supports
Shell Sarawak	East Malaysia	Subsea Pipeline Supports
Leighton Construction	Hong Kong	Pipeline Mattresses, & Grout Pumping
Henry Walker Contracting	Argyle Diamond Mine	Erosion Control Mattresses and Grout Pumping
WA Water Authority	Mundaring Weir WA	Project Management & Subsea Pipeline Supports
AWP Contracting	Muja Power Station	Erosion Control Mattresses and Grout Pumping
WA Waterski Park	Baldivis WA	Erosion Control Mattresses and Grout Pumping
MacMahon Construction	Ludlow Deviation WA	Erosion Control Mattresses and Grout Pumping
Bayside Civil Engineering	Busselton WA	Erosion Control Mattresses and Grout Pumping

SEA-STRUCT PTY LTD

Major Projects Completed to 2003

Client	*Location*	*Product*
Shapadu Rockwater / Shell	East Malaysia	Subsea Pipeline Supports
WA Water Authority	Bold Park Weir WA	Project Management, Diving, Pumping & Subsea Pipeline Supports
Tamboritha Consultants	NW Australia	Scour Protection and Subsea Pipeline Supports
Apache Energy	NW Australia	Subsea Pipeline Supports
Brunei Shell Petroleum	Borneo	Subsea Pipeline Supports
Ideal Contractors	Bunbury WA	Scour Control Mattresses and Grout Pumping
Subsea International / WAPET	North West Shelf	Subsea Pipeline Supports
Dawson Rockwater / ESSO	Bass Strait	Pipeline Scour Protection Mattresses
Underground Services	Dandalup Dam	Project Management, Diving, Supports, Pumping
Thiess Contractors	BHP Pt Hedland	Erosion Control Mattresses and Grout Pumping
BHP Petroleum	Griffin Field	Grout Pumping and ROV installed Supports
Contract Diving Services	East Spar Field	Grouting Services for Pipeline Anchors
BHP Petroleum	Griffin Field	Custom Formwork – ROV Installed Ballast Bags
Subsea International	Stag Field	Scour Control Mattresses for PLEM
Brunei Shell Petroleum	Borneo	Stabilization Subsea Pipeline Supports
Boral Contracting	Collie WA	Erosion Control Mattresses
Oceantech	Fremantle South Mole	Grout Pumping and Mattresses for HDPE Pipe
Subsea / Global	Stag Field	Grout Pumping and ROV installed Subsea Pipeline Supports
Oceantech	RPYC	Grout Pumping and Pile Jacket Formwork
Hyundai Offshore	China	CB Mattresses and Grout Pumping
Boral Contracting	Collie Power Station	Erosion Control Mattresses and Grout Pumping
Esperance Port Authority	Esperance Port	Erosion Control Mattresses and Grout Pumping
Global Industries / Petrovietnam	Vietnam	Grout Pumping and ROV installed Subsea Pipeline Supports
Sual Construction / So. Energy	Philippines	Erosion Control Mattresses and Grout Pumping
Coflexip Stena / BHP	Timor Sea	Grout Pumping and Diver installed Subsea Pipeline Supports
NPCC	Abu Dhabi	CB Mattresses and Grout Pumping
Allied Marine (Kuala Lumpur)	Thailand	Grout Pumping and ROV installed Subsea Pipeline Supports
P.T. Calmarine	Indonesia	CB Mattresses and Grout Pumping

SEA-STRUCT PTY LTD

Major Projects Completed to 2003

Breswater Marine Contractors	China	CB Mattresses and Grout Pumping
CONHWA	China	CB Mattresses and Grout Pumping
Leighton Lama	Malaysia	Diver installed Subsea Pipeline Supports
Coflexip Stena / BHPP	Timor Sea ZOCA	Grout Pumping and Diver installed Subsea Pipeline Supports
Global Brunei / Brunei Shell	Brunei	Diver installed Subsea Pipeline Supports
Clough Offshore	NW Australia	Crossover Mattresses
NPCC / QGPC	Abu Dhabi	Custom Formwork and Mattresses
ADNOC	Abu Dhabi	Pipeline Protection Mattresses and Grout Pumping
Brunei Shell Petroleum	Brunei	Load Spreading Mattresses
McDermott Industries	Indonesia	Grout Pumping and ROV installed Supports
Robe River Associates	NW Australia	Scour Control Mattresses and Grout Pumping
Clough Sandwell	NW Australia	Scour Control Mattresses and Grout Pumping
Global Industries / PTT	Thailand	Crossover Formwork and Mattresses
Fraser Diving / Nippon Steel	Thailand	Grout Pumping and Diver installed Subsea Pipeline Supports
McDermott / Premier	Burma	Grout Pumping and Diver installed Subsea Pipeline Supports
Esperance Port Authority	Esperance Port	200 Filter Point Mattresses and Grout Pumping
Thiess / Fluor Daniel	Worsley Reservoir	Grout Pumping and Diver installed Subsea Pipeline Supports
Esso Australia	Bass Strait	ROV installed Ballast Forms in 420 msw
Coflexip Stena / Esso	Bass Strait	Grout Pumping and Diver installed Mattresses
Underwater Centre	Australia	Grout Pumping and Diver installed Mattresses
Brown + Root	Brunei	Grout Pumping and Diver installed Subsea Pipeline Supports
Brunei Shell Petroleum	Brunei	Load Spreading Mattresses
Brown + Root / Sarawak Shell	Malaysia	Diver installed Subsea Pipeline Supports
McDermott / Aramco	Dubai / Saudi Arabia	Subsea Pipeline Supports
Sarku / SSB	Malaysia	Grout Pumping and Diver installed Subsea Pipeline Supports
McDermott / ONGC	India	Subsea Pipeline Supports for crossovers (including a 8.5 m tall support)
Oceaneering / ONGC	India	Grout Pumping and Diver installed Subsea Pipeline Supports
NPCC / QGPC	Abu Dhabi	Diver installed Grout in Situ Mattresses
Covus Corp / Apache	NW Australia	Grout Pumping and Diver installed Subsea Pipeline Supports
Barclay Mowlem	Darwin NT	Custom Grout in Situ Diver Formwork

SEA-STRUCT PTY LTD

Major Projects Completed to 2003

Brown + Root / CACT	China	Grout Pumping and Diver installed Subsea Pipeline Supports
Apache Energy	NW Australia	Grout Pumping and Diver installed Subsea Pipeline Supports
McDermott / Mobil	Indonesia	Grout Pumping and ROV installed Supports
McDermott / ONGC	India	Grout Pumping and Diver installed Subsea Pipeline Supports
Saipem / Total	Indonesia	Custom Grout in Situ Diver Formwork and Grout Pumping
Pacific Marine Group / Chevron	Papua New Guinea	Grout Pumping and Diver installed Subsea Pipeline Supports
Clough / Brunei Shell	Brunei	CB Mattresses and Grout Pumping
NPCC	Qatar	Diver installed Grout in Situ Mattresses and Supports
CSOAP / BHP	Timor Sea	Custom Pre-Filled Sand / Cement Bags
Woodside Energy	NW Australia	ROV Installed Supports and Grout Pumping Services
Fulton Hogan	Australia	Erosion Control Mattresses and Grout Pumping
Esperance Port Authority	Esperance Port	Erosion Control Mattresses and Grout Pumping
Clough / Chevron	Australia	CB Mattresses and Grout Pumping
Halliburton / Shell Philippines	Philippines	Grout Pumping and ROV installed Supports
Apache Energy	Australia	Diver installed Subsea Pipeline Supports
PTTEP / Stolt Offshore	Thailand	ROV Installed Supports and Grout Pumping Services
CUEL / UNOCAL	Thailand	SEAMAT® Mattresses
Shell / Global	Malaysia	Grout Pumping and Diver installed Subsea Pipeline Supports
TOTALELFFINA/ Komaritim	Indonesia	SEAMAT® Mattresses
TL Geohydrographics	Japan	Grout Pumping and ROV installed Cable Stablilization forms
Chevron	Australia	SEAMAT® Mattresses and Lifting Frames
NPCC / ADMA OPCO	United Arab Emirates	SEAMAT® Mattresses and Grout in Situ Cable Stabilization forms
Chevron / Global	Thailand	ROV Installed Supports and Grout Pumping Services
Coflexip / Woodside	Australia	SEAMAT® Mattresses
Apache / Mermaid	Australia	SEAMAT® Mattresses and Lifting Frames
Conoco / PT Komaritim	Indonesia	Grout Pumping and ROV installed Supports
Ertech	Australia	Erosion Control Mattresses and Grout Pumping
Apache Energy	Australia	Custom Diver Installed Grout Plugs
Fulton Hogan / MRD	Australia	Erosion Control Mattresses and Grout Pumping
Esso / Allseas	Australia	SEAMAT® Mattresses
Saipem	Indonesia	ROV installed Grout Bags ADGF Project

SEA-STRUCT PTY LTD

Major Projects Completed to 2003

Global Industries	Malaysia	Freespan Supports – Sarawak Shell
Duke Energy / Allseas	Australia	ROV Installation of Freespan Supports
ESSO / Halliburton	Australia	SEAMAT® Mattresses and lifting frames
Hallin Marine	Malaysia	ROV Installed Grout Bags ADGF Project 2
OMV	Australia	SEAMAT® Cable Protection Mats
Barclay Mowlem	Australia	SEAMAT® Pipeline Stabilisation Mats
Hyundai HI	Brunei	BRUNEI SHELL - SEAMAT® Crossover Mats
Hallin Marine	Brunei	ROV Installation of Freespan Supports
Hyundai HI	Indonesia	SEAMAT® Mattresses
NPCC / ADMA OPCO	United Arab Emirates	SEAMAT® Mattresses and Lifting Frames
Global Industries	Bangladesh	SEAMAT® Mattresses and Lifting Frames
Technip Coflexip	Indonesia	Diver Installation of Freespan Supports and Grout pumping
PT Komaritim	Indonesia	Pagerungan - ROV Installation of Freespan Supports
Covus / Shell	Philippines	ROV Installed Grout Bags – Malampaya Project
Technip Coflexip	ZOCA Timor Sea	SEAMAT® Mats, Grout in situ Mats, Grout pumping
Ocean Technix	Australia	SEAMAT® Cable Stabilization Mats

10 Sultan Way, PO Box 67
North Fremantle, 6159
Western Australia,
Ph: +61-8-9430-4753
Fax: +61-8-9430-6343

SEA-STRUCT Pty Ltd
PROJECT HISTORY 2004 - 2008

Project Number	Project Name	Client	Location	Product
1025	NPCC 028-2002848MJ Dropped Impact Mats	UPC/ADMA OPCO	Abu Dhabi	Seamat
1067	Port Kembla Wave Energy Project	Energetech	Australia	Grouting
2009	MUT Project	Hyundai Heavy Industries Korea	China	Grouting
2016A	Otway Development Project	Technip Oceania	Portland	Grouting
2016B	Otway Development Project	Allseas	Portland	Grouting/Seamat
2016C	Otway Development Project	Subsea7 Australia	Portland	Seamat
2016X	Otway Development Project	Technip Oceania	Portland	Groutbags
2024	Casino Project	Stolt Offshore	Portland	Seamat
2026	ROC Oil	ROC Oil	Dongara	Seamat
2050	HAZIRA Gulf	Clough	India	Seamat
2057	SEAPOWER Wave Generator	Seapower Pacific	North Fremantle	Seamat
2077	Powells Creek	Agility Management	Australia	Grouting
2078	Cossack Wanea 2	Technip	Dampier	Seamat
2101	NSW Cable	Norddeutsche Seekabelwerke	Malaysia	Seamat
2110	Sarku Mats Labuan	Sarku Engineering	Labuan	Seamat
2112	TLO Champion West Phase 3	TL Offhsore	Brunei	Seamat
2116	SubTec Mats	GIL Mauritius Holdings	India	Seamat
2126	Perseus on Goodwyn - Seamat	Technip Oceania	Dampier	Seamat
2134	HHI Thailand Freespan	Fugro Survey	Thailand	Grouting
2135	Kerisi Project Petrosea Clough	PT Petrosea	Indonesia	Grouting
2138	PM3 Ca Mau GP Vietnam	McDermott	Vietnam	Grouting
2140	PTT Project	Mermaid Offhsore	Thailand	Grouting
2145	Panyu China	Global Industries	China	Seamat/Grouting
2147	McDermott Yard Grouting	PT McDermott	Indonesia	Grouting
2148	ExxonMobile Bass Strait Settlement	Kellogg Brown & Root	Bass Strait	Grouting
2151	Stawell Gold Mines	Leviathan Resources	Australia	Groutbags
2157	Casino Grouting Work	Technip Oceania	Portland	Grouting
2160	Star Energy Mat	PT Atamora Tehnik Makur	Indonesia	Seamat
2161	Star Energy Grouting	Fraser Diving	Indonesia	Grouting
2162	Fuelquip Australia	Fuelquip	Australia	Seamat
2163	Angel Project	McDermott Hydro Marine	North West Shelf	Grouting
2164	CTOC Project	Offshore Subsea Works	Malaysia	Grouting
2169	CUEL Thailand Seamat	CUEL Limited	Thailand	Seamat
2171	West Java Gas- Project LM-CO Pipeline	Fugro Survey	South Sumatra	Grouting
2174	PT Newmont	Pt Newmont	Indonesia	Seamat
2175	Laminaria IMR Phase 4	Subsea7 Australia	Dampier	Bulkbags
2177	ONGC Mats Global	Global Industries	Batam	Seamat
2178	Clough Panna Project	Clough Projects Int'l	Singapore	Seamat
2188	Woodside Mortar Mix Bags	Woodside Energy	Dampier	Mortar Mix
2194	Covus GP Cement Bag	Covus Corporation	Perth	Mortar Mix
2195	McDermott EPMI P-L Replacement	McDermott	KSB	Grouting
2197	Apache Stag Water Injection	Covus	Dampier	Seamat
2200	WNTS Conoco Phillips	PT Patra Dinamika	Indonesia	Grouting
2206	Panyu 2	Global Industries	Shenzhen China	Seamat
2211	Woodside Silo Rental	Woodside	Australia	Rental
2215	Saudi Aramco Tokyo	Saudi Aramnco	Australia	Seamat
2217	Origin Yolla Freespan Rectification	Fugro	Geelong	Grouting
2219	Pohokura Grouting	Technip	New Plymouth	Groutbags
2220	Pacific Marine PNG	Pacific Marine	PNG	Grouting
2226	BSP Champion East	Joffren Omar	Brunei	Grouting/Seamat
2228	Clough Basker Manta	Clough	Bass Strait	Seamat/Sandbags
2229	Dai Hung Vietnam Acergy	Acergy	Veitnam	Seamat
2232	Perseus on Goodwin Grouting	Allseas	Dampier	Grouting
2233	Sarku- Tripatra Consortium Jakarta	Sakru (Conoco Phillips)	Jakarta	Seamat
2236	Apache Simpson Alpha Mats	Allied Diving Services	Dampier	Groutbags
2241	Melut Basin Oil Development Sudan	Leighton	Sudan	Groutbags
2242	Canyon Offshore Thialand	Canyon	Thailand	Grouting
2250	Apache John Brookes Grouting	Allied Diving	Dampier	Groutbags
2256	TSPL Lambert Hermes Mats	Technip	Dampier	Seamat
2262	ULO 5 oceans mats	ULO- 5 Oceans	UAE	Seamat

10 Sultan Way, PO Box 67
North Fremantle, 6159
Western Australia,
Ph: +61-8-9430-4753
Fax: +61-8-9430-6343

SEA-STRUCT Pty Ltd
PROJECT HISTORY 2004 - 2008

Project Number	Project Name	Client	Location	Product
2263	WEL 2TL	Subsea 7	Dampier	Grouting
2282	PLUTO	Technip Oceania Subsea7	Perth	Sand Bags
2284	Technip Mortar Mix Bags	Technip	Australia	Mortar Mix
2286	Mineral Sand Fillering Bags	Geo Subsea	Perth	Groutbags
2291	Upstream Petroleum - Puffin Project	AED Oil Limited	Singapore	Mortar Mix
2293	Geoseas Mortar-Mix Bags	GeoSubsea	Perth	Mortar Mix
2295	Otway WEL	Fugro Survey	Portland	Grouting
2300	Allied Mortar-Mix Bags	Allied Diving Services	Perth	Mortar Mix
2302	Santos Henry Vic P44	Santos	Portland	Seamat
2303	Venturer Sandbags	Technip Oceania Subsea7	Dampier	Sand Bags
2307	Allied Diving Mortar-Mix Bags	Allied Diving Services	Perth	Mortar Mix
2310	Roc Oil	Subsea Developments	Perth	Grouting
2311	Sand support bags (TS7)	Technip Oceania	Perth	Groutbags
2313	Apache Energy Anchormats	Subsea Developments	Dampier	Seamat
2314	Lady Christine AC01123P-0309	Subsea 7	Perth	Mortar Mix
2316	CTC ANGEL	CTC Marine Projects	Australia	Engineering
2317	WEL Sand Bags	Woodside Energy	Australia	Sand bags
2320	Technip x-over mats	Technip Oceania	Australia	Seamat
2321	Woodside Mortar Mix	Woodside	Darwin	Mortar Mix
2322	Technip Sandbags	Technip Oceania	Dampier	Sandbags
2325	TS7 Woollybutt 2008	Technip Subsea7	Dampier	Seamat
2326	Montara Field Grouting	Coogee Resources	Singapore	Grouting
2327	Brisbane River Canstruct	Canstruct	Brisbane	Seamat
2330	TS7 20T Mortar Mix	Technip Subsea7	Dampier	Mortar Mix
2331	Simpson Project Apache	Neptune Marine Services	Dampier	Lifting Frame
2333	ARK Construction Grout Tube	Ark Contruction	Cairns	Custom Groutbag
2336	Esso Remedial Works	Benthic Geotech	Bass Strait	Grouting
2340	WEL Lift Frame Hire	Woodside Energy	Dampier	Lifting Frame
2341	TS7 GP Cement Bags	Technip Subsea7	Dampier	GP Cement
2344	TOPL Sandbags May 08	Technip Oceania	Perth	Sandbags
2346	TS7 Venturer Mortar Mix	Technip Subsea7	Singapore	Mortar Mix
2349	WEL Mortar Mix KBSB	Woodside Energy	Dampier	Mortar Mix
2352	TS Marine Mortar Mix	TS Marine	Dampier	Mortar Mix

ANNEX 2

MATTRESS INSTALLATION PROCEDURE

1 PURPOSE

This procedure describes how the Contractor will install the mattress protection over the H.K. Electric Gas Pipeline.

It has been developed to ensure the safety of the personnel, the environment, the pipeline and the product.

2 SCOPE

A series of mattresses, with a pre-cast base combined with a "fill in situ" grout bag cover, (See Appendix A for drawings) will be installed to provide continuous protection over the Intra – Asia submarine cable for a distance of 200m. The 200m of mattresses will be centred on the crossing of the H.K. Electric Gas Pipeline in 31m of water at:

N22 10.6007	E114 26.9619

The gas pipeline has been buried to a depth of approximately 3.0m in the vicinity of the crossing.

The cable will be pre-installed from a cable-installation barge and surface laid for a distance of 100m either side of the pipeline crossing. Uraduct polyurethane sleeve will be applied over the 200m of cable where the mattressing is to occur.

This procedure applies to the offshore personnel involved in the installation work; the contractor' s personnel on the vessel/barge, the ROV team and the Seastruct' personnel.

3 REFERENCE

'Installation Vessel Name' Safety Management System & Procedures Manual
Seastruct Documentation & safety procedures/data sheets
Dive operations manual and project specific instructions
ROV operations manual and project specific instructions
Environmental Permits & monitoring requirements.

4 DEFINITIONS

Nil

5 Mattress Design

The purpose of the mattresses is to provide physical protection for the submarine cable from fishing gear & small vessel anchors in the vicinity of the gas pipeline, where H.K. Electric will not permit cable burial. The

mattress solution has been adopted and a specific mattress shape developed, to minimize the impact of the cable protection on bottom fishing activities. The completed mattress installation will be 4m wide, 200m long with a maximum design height of 350mm. This will provide a low profile ramp with a shallow angle, in the order of 10° over which an otter board or similar such fishing device, will pass over smoothly. The edge of the mattress is designed to sit below the level of the surrounding seabed such that an otter board does not easily foul on it; should an otter board or small anchor bepulled under the edge of the mattress, the large diameter ' tubular' section is designed to provide the best possible chance of the otter board or anchor pivoting free.

The mattress is designed to have a maximum height of approximately 350mm in the centre, a compromise between the protection of the cable and maintaining a low profile to minimize the effect on bottom fishing.

The mattress is composed of a pre-cast base mattress with a "fill in situ" grout bag cover; the combination of the two types of mattress provides a number of benefits:

- The fill-in-situ grout bag on top of the pre-cast concrete mattress presents a smooth top profile that does not hamper fishing gear
- The pre-cast mattress on the bottom is flexible enough to follow the seabed profile
- The pre-cast mattress on the bottom will straddle the cable and will not sit on top of the cable. This results in a smoother top profile
- The use of a pre-cast concrete mattress reduces the amount of "fill-in-situ" grout to be used and thereby reduces the risk of environmental contamination
- During deployment, the use of the combined grout bag/concrete mattress makes deployment quicker and more accurate as the greater stability of the mattress assembly is easier to control and position exactly where required
- Should any problems be encountered with a particular assembly, it can be recovered to the surface, which is not the case with a partially filled mattress which is entirely "Fill in situ"

The base concrete mattress is prefabricated and made up into sections ashore. The base mattress is currently planned to be 10 metres long by 2 metres wide by 0.15 metre high. The base is comprised of concrete blocks cast on a matrix of rope, rather like a heavy duty net, one block cast on each point at which the ropes cross.

The (empty) top cover, comprising the "fill in situ" grout bag is fabricated onshore and will be attached to the top of the base mattress. The "fill in situ" grout bag is currently planned to be 10 metres long by 4 metres wide by 0.2 metre high. The "fill in situ" grout bag will be 2 metres wider than the base mattress and will be positioned on the top of the base mattress so that a 1 metre overhang exists on either side of the base mattress. The overhang at each side will include the 600mm diameter 'tube section' that is to be jetted below seabed level and ensure that otter boards and the like do not easily foul the overall mattress assembly.

6 RESPONSIBILITIES

The Installation Superintendent is responsible to the Project Manager for the planning and execution of the Mattress installation and filling, including:

- The mobilization and testing of the necessary equipment
- Loading of the pre-cast mattresses with the ' fill in situ' grout bags attached.
- Deployment and positioning of the pre-cast mattresses with the "fill in Situ" grout bag forms folded into the centre.
- Instructing and coordination with the Dive Supervisor for the
    i. All ROV survey work _(Pre, During and Post installation surveys.)
    ii. Lowering and positioning of the mattresses
    iii. The jetting work prior to injecting grout into the "fill in situ" grout bags,
    iv. The control & monitoring of the filling of the grout bags.
- Instructing and coordinating with the Seastruct Grout Technicians
- Ensuring the Inspection and documenting of the work
- Ensuring that the work is carried out in a safe and environmentally responsible manner in compliance with all permit conditions.
- Liaising with the Environmental Auditor & Inspectors
- Reporting to the Project Manager.

During the mobilization, testing and installation phases, the SeaStruct personnel on each watch shall be responsible for the safe operation of the grouting equipment, assisted by the Contractor' s ' Deck Team.

The Contractor' s Deck Team Leader on each watch is responsible for the safe and efficient operation of the Deck Team.

ROV Pilot/Supervisor

The ROV team shall be under direct control of the Installation Superintendent. They provide support to:

- ROV Survey: - Pre-installation surveys, surveys during and post installation work
- ROV Location of existing sub sea infrastructure / excavation of existing cables and seabed material where required.
- ROV Positioning of the mattresses over the cable and grout injection into the "fill in situ" grout bags.

7 PROCEDURE

7.1 General

The operation will include the following phases:

- Mobilisation of the vessel with the Grout Spread, ROV Spread, crane if necessary and loading of the necessary pre-cast base mattresses complete with the fabric form/"fill in situ" grout bags, grout etc.
- Pre-Mattress installation video inspection of the installation site according to the agreed procedures.
- The trial phase (Pilot Test) where a mattress is filled with grout according to this procedure while the water quality is being monitored according to the permit requirements.
- Modifications to the procedures should they be required after the results of the trial phase (Pilot Test) have been analysed.
- Mattress installation (With monitoring by the Tyco's Environmental Representative on board the vessel.)
- Post mattress installation video inspection of the installation site and perimeter of the mattresses according to the agreed procedure. (Note that if visibility is generally poor then after 1/3rd & 2/3rd of the mattresses have been installed, the opportunity to obtain video footage should be taken as it arises.)

The methodology for the installation of the mattresses is based on the use of an ROV to position the mattress on the seabed and then control the injection of the grout into the "fill in situ" grout bag The "fill in situ" grout bag will be securely attached to the underlying pre-cast base mattress and will therefore be held in position during the filling operations despite current and tidal movements. The form of the bag is pre-calculated at the design stage such that the filled bag will meet all the requirements previously outlined. (Shape, separation between cable and pipeline and minimal impact on other seabed activities such as fishing.) The "fill in situ" bag comes ready for installation complete with all the necessary,

injection points, flaps and fittings required to fill the bag; these are fitted before the mattress is deployed over the side of the installation vessel

7.2 Environmental Monitoring

The work carried out from the vessel may be monitored for environmental impact in accordance with Appendix C of this document. As the installation is to be carried out by an ROV, it will be possible to obtain video images at all stages of the work, provided the visibility on the seabed permits.

Where an incident or non compliance with the requirements of the Environmental Permit occurs, remedial action and monitoring in line with Appendix D shall be undertaken immediately.

7.3 Grout Supply

The vessel will be fitted with 20ft container based tank(s) for storage of grout. (Tank numbers dependant on the available deck space.)

Connected to the tank on deck, will be the mixing skid and pump skid. A 38mm grout hose is deployed to the seabed from the grout pump via the Form Turntable. The grouting system will be bunded to ensure that any failure, including a catastrophic failure is fully contained on deck.

Details of typical container based tanks, a mixing skid and pump are included at Appendix B.

7.4 Grout Specification

The Grout Specification for the installation is: Portland Cement mixed with seawater.

The grout mix shall have an anti-washout additive included at 0.5% this will help ensure visibility is maintained and that the minimum amount of grout is washed out of the "fill in situ" grout bag and into the environment.

7.5 Installation Method

The barge will set-up in a four point mooring, with the anchors deployed more than 200m either side of the pipeline & outside the "No Anchor" zone. This will allow the barge to be moved up and down the cable line over the 200m (100m either side of the crossing point) where the mattressing is to be installed, by picking up and paying out anchor wire from the winches. Pre installation ROV surveys will then be completed, if this work has not already been completed from another vessel.

7.5.1 Mattress – Preparation for Deployment

A mattress will be prepared and checked on the deck of the barge. The check of the mattress will include:

- Pre-cast base mattress general inspection.
- "Fill in situ" grout bag securely attached to the pre-cast base mattress.

- Material or fabrication defects that may cause a failure of the "fill in situ" grout bag, or grout to leak.
- All hardware attached to the "fill in situ" grout bag for filling
- The "fill in situ" grout bag has been folded in over the base mattress in the defined manner for ease of positioning and subsequent un-folding by the ROV.

7.5.2 Grout Hose Preparation for Deployment:

The grout hose will be coiled down on the Turntable in such a way that it can be easily removed by the ROV.

Prior to coiling down and securing:

- The grout hose and couplings will be carefully inspected prior to being deployed; only hose & couplings in good condition shall be used for transporting the grout mix.
- The 10m (approximately) of free grout hose, which is pulled along behind the form will be strengthened and stiffened to protect it while being dragged along the seabed and to reduce twisting and kinking. This may be by the application of protective banding or split hose over the grout hose. Similarly, any hose that may be subject to abrasion will be protected.

The Turntable is then ready to be deployed.

The Turntable will be prepared and launched from a position on the vessel, selected such that it is conveniently positioned to allow the crane to easily plumb over it and, after lifting the Turntable, lower it to the seabed in a convenient position for the subsequent ROV operations. Ideally, just forward of the ROV launch & recovery system

7.5.3 ROV Deployment

The ROV will descend to the installation site from the launch point on the side of the barge.

The ROV will be positioned on the seabed in a pre-determined spot such that the mattress is not swung over, nor suspended over the ROV at any point during the deployment

7.5.4 Mattress Installation

On the deck of the barge, under the control of the Installation Superintendent or his nominated deputy, the mattress deployment frame will be hung from the crane; the deployment frame will be plumbed over the first mattress to be deployed and securely attached to the mattress deployment ropes. The mattress will be swung outboard in the pre-determined arc (to ensure ROV & personnel safety) then lowered to approximately 2m from the seabed. (The

crane rope will be marked such that this is easily achievable.) After the load is stationary, the ROV will then approach the mattress and the ROV operator, via the voice communications link, direct the Installation Superintendent (or his nominated deputy) as to the crane movements required to place the mattress in the desired position. The mattress will be lowered under the direction of the ROV operator and any fine adjustments made as required, till the mattress is in the correct position and alignment, where it will be lowered to the seabed. The base mattress need not but hard up against the adjacent mattress as there is a 200mm allowance in the overall design through an overlap in the "fill in situ" grout bags. The mattress will then be released, eithr by the ROV or from a remote release on the surface.

This operation will be repeated after the mattress deployment frame has been recovered to the surface. After the mattresses have been installed within the safe working arc of the crane, the "fill in situ" grout bags will be filled.

7.5.5 Mattress Completion (Jetting & Grout Injection)

The ROV will be equipped with a small jetting system, which will be used along each side of the base pre-cast mattress to create a trench approximately 600mm deep and 600mm wide. The trench centre to be approximately 0.7m from the edge of the pre-cast base mattress; i.e. There should be 400mm of seabed between the edge of the base mattress and the start of the trench.

After the trench is created, the "fill in situ" grout bag will be unfolded from on top of the pre-cast mattress by the ROV.

The ROV will then collect the grout hose from the turntable and insert the nozzle into the first chamber of the "fill in situ" grout bag that is to be filled.

When the "fill in situ" grout bag is in the correct position, the ROV operator will then give the OK for the grout pumping to commence.

The grout mixing plant and bulk system will be energized and a bowl of grout mixed. The pump should be started and the injection into the formwork commenced.

The flow of grout shall be controlled by the ROV Operator giving instructions over the communications link to the operator at the grout mixing system.

Speed of injection shall be dependent upon grout bag height but should not exceed 4m3 per hour.

When the grout bag is almost full, the ROV will carry out an inspection of the form.

The ROV operator will know the grout bag is full when small grout returns are seen from the vents.

At this point, grout pumping is halted. Once the grout bag is filled, the pump should be stopped and the grout allowed a settling period of approximately 15 minutes.

After this settling period the grout bag will be topped up with grout. Failure to top up, will result in unsatisfactory results. Once inflation is satisfactory, the ROV will take up position beside the release mechanism and the grout hose will be disconnected, taking care to ensure that the absolute minimum quantity of grout is lost.

The ROV will then be used to insert the nozzle into the next changer to be filled.

This procedure will continue till all the chambers in each mattress that has been deployed have been filled.

As the ' tubular' sections down each side of the "fill in situ" mattress are filled with grout, the ROV operator will ensure that the fabric form takes up the desired shape. I.E. Does not fold over, or under or become twisted, intervening as required to carry out corrective action.

7.5.6 Equipment Recovery

The grout hose and turntable will then be recovered to deck ready for the barge to be moved and the following mattresses to be deployed.

7.5.7 Mattress Completion

The mattress will be considered complete when the 200m of Uraduct sheathed cable have been covered with mattresses, positioned such that:

- They sit closely to one another such that there are no gaps in the cover provided by the completed "fill in situ" grout bags
- The grout bags have been properly filled and attained the desired profile.
- The the edges of the grout bags are beneath the level of the surrounding seabed.

7.6 Safety Considerations

In addition to the Vessel Safety Management Systems & Procedures the following additional Safety Considerations should be made during this operation.

7.6.1 Grout Spread

Care should be taken to minimise trip hazards due to air and grout hoses. Every endeavour must be made to minimise cement spillage, all work should take place within a bunded area. When dry cement powder is present, eye protection and dust masks should be worn.

7.6.2 Work Deck

All cement spillages should be cleaned up, as this can be a trip hazard to personnel working on the deck in the vicinity of the Form Table Platform

7.6.3 Deployment Operations

All personnel involved in deploying mattresses, hoses or over the side operations should be equipped with working life vests and, when necessary, a safety harness to prevent a man overboard situation occurring.

8 RECORDS

All Mattress Installation records are to be held by the Installation Superintendent on the vessel until the work is complete.

Records are then to be transferred to the Contractor's Project Office for retention by the Contractor for 5 years.

9 ATTACHMENTS & APPENDICES

Appendix A: Grout Bag Specification (Plan & Elevation drawings for 2 form types)

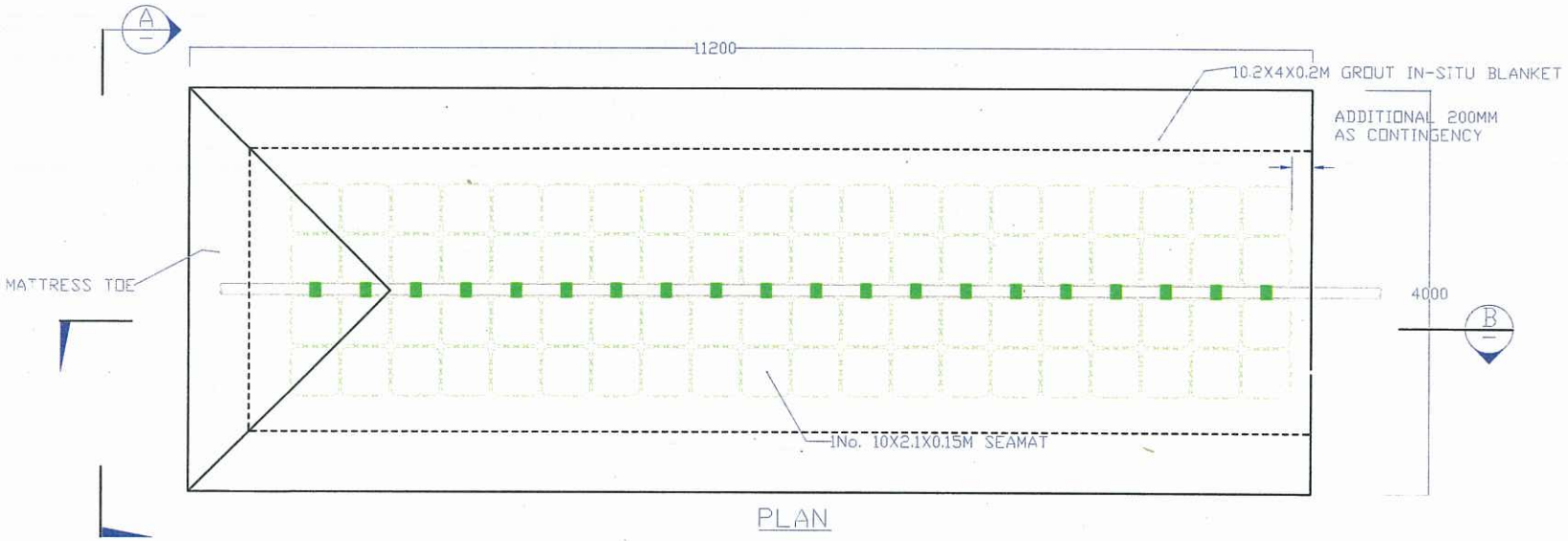
Appendix B: Grout Pumping System Specification &Bulk Silo

Appendix C: Pilot Test On Grouting Performance

Appendix D: Environmental Monitoring

Appendix E: Measure for Pollution Prevention and Control for Grout Mattress Installation Works

APPENDIX A



PLAN

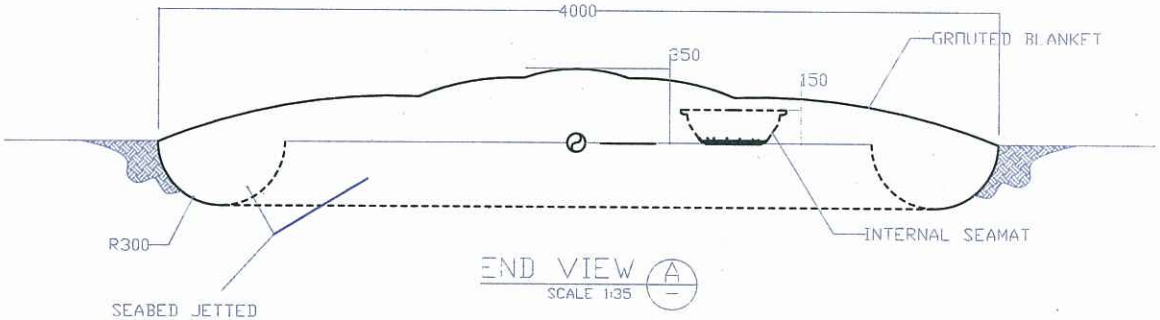
SECTION VIEW B

NOTES:
1. GROUTED BLANKET IS ATTACHED TO 1NO. 10X2X0.15M SEAMAT
2. SEAMAT IS INSTALLED WITH TYPICAL LIFTING DEVICE
3. ONCE THE SEAMAT IS IN POSITION GROUTING MAY COMMENCE
4. WHEN FILLED THE GROUT BLANKET CREATES A SMOOTH CONTOUR OVER THE CABLE/SEAMAT.

SEAMAT - 10X2X0.15M
5. WT IN AIR - 4.3TE
6. SUBMERGED WT - 2.45TE
7. CONCRETE DENSITY - 2400KG/M3
8. ALL LAT/LONG ROPES - 16MM PP (MBL>3.5TE)

GROUT BLANKET - 10.5X4X0.2M
9. TOTAL VOLUME - 8.5M3
10. GROUT S.G - 1.87

11. ALL DIMENSIONS IN 'MM'



END VIEW A
SCALE 1:35

RE-ISSUED FOR CLIENT REVIEW	14/10/08	B	YS
ISSUED FOR CLIENT REVIEW	09/10/08	A	JH
DESCRIPTION	DATE	ISSUE	DRAWN

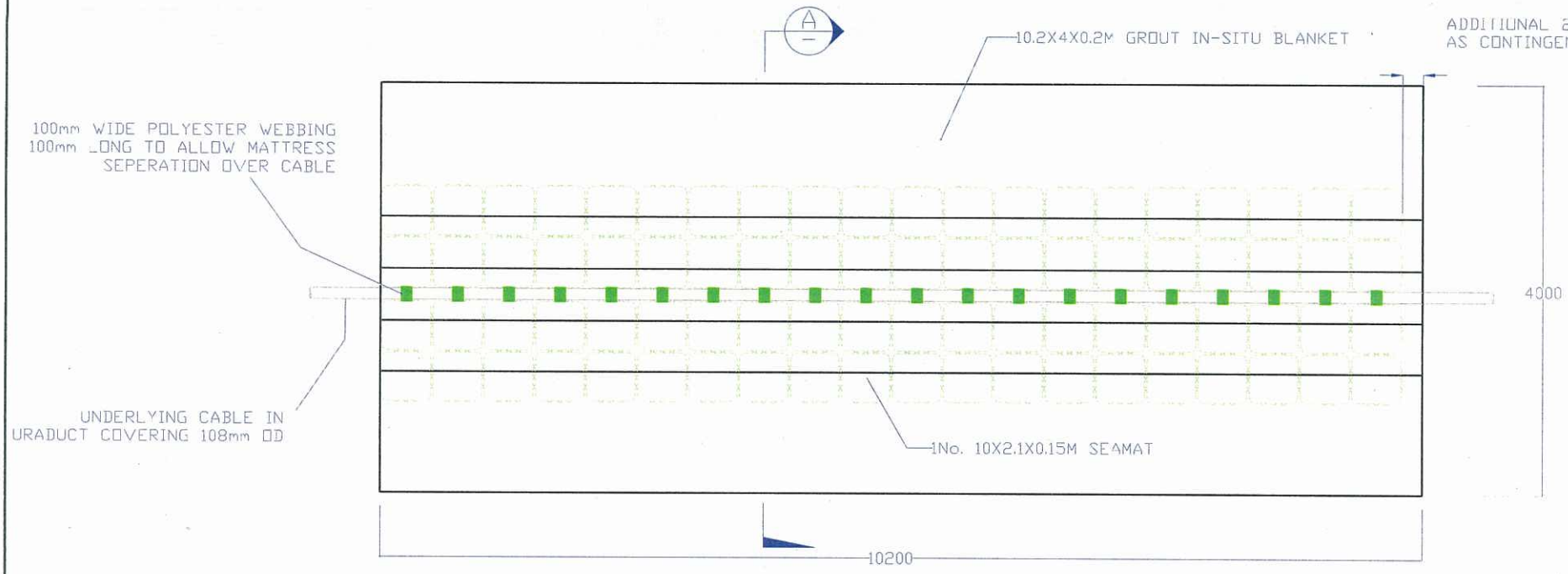
sea-struct

CLIENT - TYCO
PROJECT- HONG KONG - CABLE PROTECTION MATTRESS
PO NUMBER- TBA

DRAWING TITLE:
CABLE PROTECTION MATTRESS END UNITS GENERAL ARRANGEMENT

DRAWING NO 5113-DWG-141008-02
REV B

DRAWN BY Y. Saunier
DATE 14th Oct 2008
CHECKED BY D.MACLEAN
APPROVED
SCALE 1:70



PLAN

NOTES:

1. GROUTED BLANKET IS ATTACHED TO 1NO. 10X2X0.15M SEAMAT
2. SEAMAT IS INSTALLED WITH TYPICAL LIFTING DEVICE
3. ONCE THE SEAMAT IS IN POSITION GROUTING MAY COMMENCE
4. WHEN FILLED THE GROUT BLANKET CREATES A SMOOTH CONTOUR OVER THE CABLE/SEAMAT.

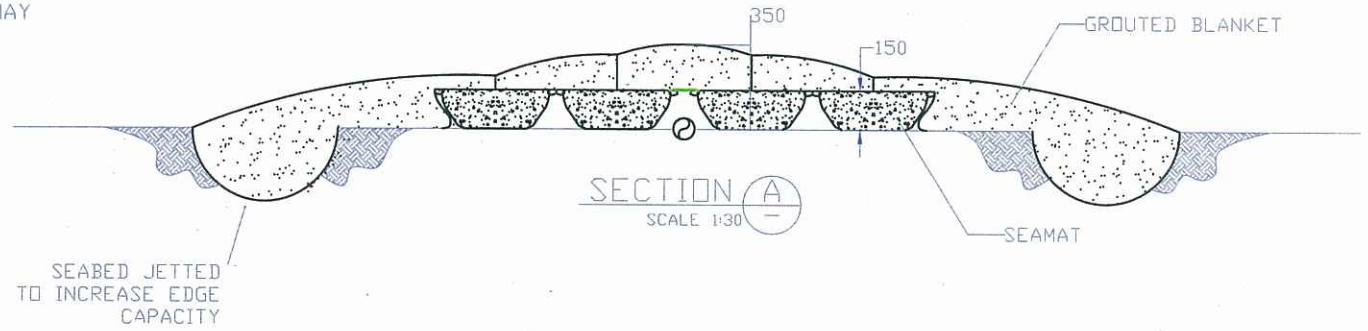
SEAMAT - 10X2.1X0.15M

5. WT IN AIR - 4.3TE
6. SUBMERGED WT 2.45TE
7. CONCRETE DENSITY - 2400KG/M3
8. ALL LAT/LONG ROPES - 16MM PP (MBL>3.5TE)

GROUT BLANKET - 10.2X4X0.2M

9. TOTAL VOLUME - 8.25M3
10. GROUT S.G - 1.87

11. ALL DIMENSIONS IN 'MM'



ISSUED FOR CLIENT REVIEW	09/10/08	B	JH
DESCRIPTION	DATE	ISSUE	DRAWN

CLIENT - TYCO
PROJECT- HONG KONG - CABLE PROTECTION MATTRESS
PO NUMBER- TBA

DRAWING TITLE:
CABLE PROTECTION MATTRESS GENERAL ARRANGEMENT- INTERMEDIATE UNITS

DRAWING NO 5113-DWG-091008-01 REV B

DRAWN BY J.HOMES
DATE 9th Oct 2008
CHECKED BY D.MACLEAN
APPROVED
SCALE 1:60

APPENDIX B

SEA-STRUCT

SEA-STRUCT PTY LTD

10 Sultan Way, (Postal Address PO Box 67), North Fremantle 6159, Western Australia
Website - www.sea-struct.com.au Email – tgillingham@sea-struct.com.au
Tel: +61-8-9430-4753 Fax: +61-8-9430-6343

ISO Bulk Cement Silo

Sea-Struct's ISO Bulk Cement Silos are pressurized silo for transport and storage of cement. As the silos are in guage 20 ft standard ISO configuration it is easily transported by conventional shipping container lines.

The Silo Specifications are as follows:

Length	-	20 Ft
Width	-	8 ft
Height	-	8 ft
MGW	-	24,000 kg
Tare	-	3,500 kg
Net	-	20,500 kg (bulk cement)
Vol	-	17.5m3
Air supply	-	700 CFM (20 m3/MIN) @ 30 PSI (200 kPa)

System certification includes Lloyds certification. Some tanks also include in date MPI and Load Tests along with certified slings. Further information can be obtained from Sea-Struct Pty Ltd.

SEA-STRUCT PTY LTD

10 Sultan Way, (Postal Address PO Box 67), North Fremantle 6159, Western Australia
Website - www.sea-struct.com.au Email – tgillingham@sea-struct.com.au
Tel: +61-8-9430-4753 Fax: +61-8-9430-6343

SS-RCM Grout Pumping System

The SS-RCM Grout Pumping System is comprised of two major components, the power pack / pump skid and the mixing bowl skid.

The power pack / pump skid contains a Perkins 4.41 (60.5 kW) diesel engine coupled to a Halco Supreme 2500 4" x 3" centrifugal pump. The Perkins engine additionally drives a Vickers Hydraulic pump which is used for supply power to the agitator paddles.

The grout mixing bowl skid is comprised of cement and water jet mixing head, inlet and outlet piping along with recirculation and overboard pumping valves. The mixing bowl capacity is 1.6 m3.

The SS-RCM 04 Grout Pumping System is normally used with bulk cement supply from vessel P tanks or silos but can be used with bagged cement if required.

The SS-RCM 04 Grout Pumping System dimensions are as follows:

Power/Pump Skid	-	2.5 m L x 1.4 m W x 1.4 m H x 1.4 tonne
Mixing Bowl Skid	-	1.5 m L x 1.5 m W x 1.75 m H x 700 kg

Mixing and pumping capacity exceeds 4 m3 / hour.

System certification includes in date MPI and Load Tests along with certified slings. Further information can be obtained from Sea-Struct Pty Ltd.

Appendix C

Pilot Test on Grouting Performance

To ensure that the grout mattress installation works will not cause any significant impacts to water quality and marine ecological system, a pilot test shall be conducted to confirm the environmental performance of the grouting operations. Given that the nature of the current proposed grout mattress installation works are very similar to those applied for the Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong (approved EIA project, FEP-01B/167/2003/D), the previous approved pilot test on grouting performance (Appendix C of FEP-01B/167/2003/D) is considered to be relevant and applicable for this study. It should be noted that there is no water quality/ ecological sensitive receivers identified in the vicinity of the grouting location, which locate near the southeast of HKSAR boundary.

Water Quality Monitoring

1. Parameters: suspended solids, turbidity and pH. In addition to the water quality parameters, other relevant data shall also be measured and recorded in field logs, including the location of the sampling stations and barge at the time of sampling, water depth, time, weather conditions, sea conditions, tidal state, current direction and speed, special phenomena and work activities undertaken around the monitoring and works area that may influence the monitoring results.

2. Monitoring locations: 4 fixed monitoring stations, namely M1, M2, M3 and M4, located on both sides of the grouting barge as shown in Figure 1. Stations M1 and M4 are 200 m from the barge while M2 and M3 are 100 m away.

3. Duration: 3 Days

4. Frequency: Every 3 hours for 72 hours continuously.

5. Monitoring method:

(a) Three depths: 1 m below surface, mid-depth and 1 m above seabed;
(b) Number of replicates at each depth: 2
(c) .Equipment - For water quality monitoring, the following equipment shall be supplied and used by the environmental contractor:
   - Turbidity Measurement Equipment - Turbidity should be measured from a split water sample from the SS sample. A suitable turbidity test kit should be used to measure the turbidity level.
   - Water Depth Gauge - No specific equipment is recommended for measuring the water depth. However, water depth gauge affixed to bottom of the water quality monitoring vessel is preferred. The environmental contractor shall seek approval of their proposed equipment with the client prior to deployment.
   - Current Velocity and Direction – No specific equipment is recommended for measuring the current velocity and direction. However, the environmental contractor shall seek approval of their proposed equipment with the client prior to deployment.
   - Positioning Device - A Global Positioning System (GPS) shall be used during monitoring to ensure the accurate recording of the position of the monitoring vessel before taking measurements. The use of DGPS is preferred for positioning device,

which should be well calibrated at appropriate checkpoint (e.g. Quarry Bay Survey Nail).

- Water Sampling Equipment - A water sampler, consisting of a transparent PVC or glass cylinder of not less than two litres, which can be effectively sealed with cups at both ends, shall be used (Kahlsico Water Sampler 13SWB203 or an approved similar instrument). The water sampler shall have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is at the selected water depth.

(d) .Sampling / Testing Protocols

- All in situ monitoring instruments shall be checked, calibrated and certified by a laboratory accredited under Hong Kong Laboratory Accreditation Scheme (HOKLAS) or any other international accreditation scheme before use, and subsequently re-calibrated at-monthly intervals throughout all stages of the water quality monitoring. Responses of sensors and electrodes shall be checked with certified standard solutions before each use.
- For the on-site calibration of field equipment, the BS 1427: 1993, Guide to Field and On-Site Test Methods for the Analysis of Waters shall be observed. Sufficient stocks of spare parts shall be maintained for replacements when necessary. Backup monitoring equipment shall also be made available so that monitoring can proceed uninterrupted even when equipment is under maintenance, calibration etc.
- Water samples for SS measurements shall be collected in high density polythene bottles, packed in ice (cooled to 4 aC without being frozen), and delivered to a HOKLAS laboratory as soon as possible after collection.
- At least 2 replicate samples should be collected from each of the monitoring events for in situ measurement and lab analysis.

(e) .Laboratory Analysis

- All laboratory work shall be carried out in a HOKLAS accredited laboratory. Water samples of about 1,000 mL shall be collected at the monitoring and control stations for carrying out the laboratory determinations. The determination work shall start within the next working day after collection of the water samples. The SS laboratory measurements shall be provided to the client within 2 days of the sampling event (48 hours). The analyses shall follow the standard methods as described in APHA Standard Methods for the Examination of Water and Wastewater, 19th Edition, unless otherwise specified (APHA 2540D for SS).
- The submitted information should include pre-treatment procedures, instrument use, Quality Assurance/Quality Control (QA/QC) details (such as blank, spike recovery, number of duplicate samples per-batch etc), detection limits and accuracy. The QA/QC details shall be in accordance with requirements of HOKLAS or another internationally accredited scheme.

6. Reporting:

The monitoring results shall be submitted to EPD and AFCD in the following schedule:

(a) Turbidity and pH data - within 24 hours after the monitoring results are recorded in the field.

(b) SS data - within 48 hours after the water samples are received by the testing laboratory.

(c) Video footage taken by Remote Operated Vehicle (ROV) for the underwater grouting operation: 24 hours after video recording.

7. Exceedance Criteria:

Parameter	Station	Depth	Exceedance Criteria	Other Conditions
SS	M1 or M4	Bed Layer	13 mg/L	For any parameter, if lower level is measured at M2 or M3, the exceedance will not be considered to be caused by the works and it will not be recorded as an exceedance event.
Turbidity	M1 or M4	Bed Layer	13 NTU	
pH	M1 or M4	Bed Layer	8.5	

8. Actions

The results of the pilot test will indicate how the grout mattress installation works is performing in comparison with previous similar works (Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong, for details refer to Environmental Permit No. FEP-01B/167/2003/D). It should be noted that that the previous similar works referred to did not cause any significant impact on water quality and marine ecological system. In this connection, the following actions shall be taken according to the monitoring results of the pilot test:

(a) If there are no record of three consecutive exceedance events for any specific parameter during the pilot test, no further water quality monitoring is required except that ad hoc water quality impact monitoring will be triggered by accidental incidents.

(b) If three consecutive exceedance events for any specific parameter are recorded, the construction method and activities as well as the relevant water quality monitoring results shall be reviewed immediately by the Contractor in conjunction with the ET to determine if the exceedances are due to the works. If it is determined that the exceedances are due to the works, the grouting operation shall be suspended immediately. Remedial action shall be taken before continuing the remaining grout mattress installation works. The remedial action shall be certified by the ET Leader and approved by EPD and AFCD.

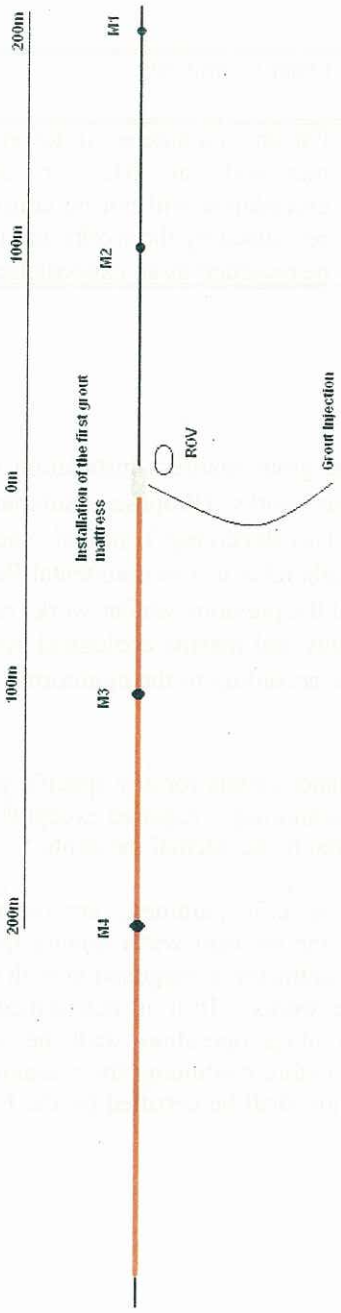

200m
100m
0m
100m
200m
M1
M2
M3
M4
Installation of the first grout mattress
ROV
Grout Injection

Figure 1

APPENDIX D

Environmental Monitoring and Audit (EM&A) for Grout Mattress Installation Works

Ad Hoc Impact Monitoring Triggered by An Accidental incident

Water Quality Monitoring

Ad hoc water quality impact monitoring shall be triggered when an accidental incident which may cause pollution to the marine environment occurs during the grout mattress installation works. Different levels of monitoring will be conducted depending on whether it is a "Major" or "Minor" accidental incident as detailed in Appendix E. Details of the ad hoc impact monitoring are as follows:

1. Parameters: suspended solids, turbidity and pH

2. Monitoring locations: 4 monitoring locations as described in Appendix C

3. Duration:

   (a) 1 day for a minor accidental incident (monitoring to be completed within 24 hours on notification of the accidental incident)

   (b) 3 days for a major accidental incident (first day of monitoring to be completed within 24 hours on notification of the accidental incident)

4. Frequency: During mid-flood and mid-ebb in each monitoring day

5. Other monitoring requirements: same as Section 5 (c), (d) & (e) of Appendix C.

6. Reporting:

   The monitoring results shall be submitted to EPD and AFCD in the following schedule:

(a) Turbidity and pH data - within 24 hours after the monitoring results are recorded in the field.

(b) SS data - within 48 hours after the water samples are received by the testing laboratory.

7. Exceedance Levels:

Parameter	Station	Depth	Exceedance Criteria	Other Conditions
SS	M1 or M4	Bed Layer	13 mg/L	For any parameter, if lower level is measured at M2 or M3, the exceedance will not be considered to be caused by the works and it will not be recorded as an exceedance event.
Turbidity	M1 or M4	Bed Layer	13 NTU	
pH	M1 or M4	Bed Layer	8.5	

8. Event-Action Plan - If the Action or Limit Levels are exceeded, the Event-Action Plan as presented below, shall be followed.

Event	**Contractor**
Action Level Exceedance	**Step 1** - repeat sampling event. **Step 2** – identify source(s) of impact and confirm whether exceedance was due to the construction works; **Step 3** – inform EPD and AFCD and confirm notification of the non-compliance in writing; **Step 4** - discuss with cable installation contractor the most appropriate method of reducing suspended solids during cable installation (e.g. reduce cable laying speed/volume of water used during installation). **Step 5** - repeat measurements after implementation of mitigation for confirmation of compliance. **Step 6** - if non compliance continues - increase measures in Step 4 and repeat measurements in Step 5. If non compliance occurs a third time, suspend cable laying operations.
Limit Level Exceedance	Undertake **Steps 1-5** immediately, if further non compliance continues at the Limit Level, suspend cable laying operations until an effective solution is identified.

Appendix E

Measure for Pollution Prevention and Control for Grout Mattress Installation Works

Release of grout materials to the marine environment is the major concern for the grout mattress installation works. Measures and actions to prevent and minimise the potential pollution impacts are set out in the table below where:

(a) Preventive Measures shall be fully and properly implemented; and

(b) when an accidental incident occurs, Remedial Action/Mitigation Measures shall be taken/implemented.

It should be noted that neither the accidental incidents nor the actions/measures listed in the table are exhaustive. Additional actions/measures, as agreed by the Director, may be taken/implemented where appropriate.

Accidental incident	**Preventive Measure**	**Remedial Action/Mitigation Measure**	**Responsible Party**
A. General			
Normal operations	Implement appropriate measures of pollution prevention and control		
Occurrence of any major or minor accidental incidents		1. Notify EPD and the ET within 3 hours after the accidental incident occurs. 2. Take remedial actions and/or implement mitigation measures. 3. Conduct ad hoc impact monitoring for water quality (see Appendix D for details). 4. If any Action or Limit Level exceedance is recorded, the Event-Action Plans for water quality Monitoring in the EM&A Manual should be followed (see Appendix D).	Contractor Contractor ET Contractor and ET
B. Dry Grout Transportation			
1. Spillage of dry grout into the	1. The grout will be loaded onto the vessel	1. Likelihood of dry grout spillage into the sea on	Contractor

Accidental incident	Preventive Measure	Remedial Action/Mitigation Measure	Responsible Party
sea.	in bulk while alongside a wharf.	site or in transit to site is negligible and specific mitigation measure is not considered necessary. 2. If the dry grout is spilled into the sea, a. Ad hoc impact monitoring should be conducted. b. If any Action or Limit Level exceedance is recorded, the Event-Action Plan in the EM&A Manual will be followed.	ET Contractor and ET
C. Loading and Mixing			
1. While being moved by compressed air from tank to tank, or from tank to mixing bowl, there may be a dry spill.	1. Ensure all hoses and couplings are in good condition. 2. Ensure the hoses are properly fastened to the couplings. 3. Ensure male/female couplings are fully engaged and locked prior to pressurizing the system.	1. If any disconnection occurs: a. Stop the transfer immediately. b. Store spilt materials in waste container. c. Remove spilt materials for land disposal or recycling. 2. If dry grout is spilled into the sea, a. Ad hoc impact monitoring should be conducted. b. If any Action or Limit Level exceedance is recorded, the Event-Action Plan in the EM&A Manual will be followed.	Contractor ET Contractor and ET
2. The grout is mixed in purpose built	1. All grout mixing equipment will be set up within a bunded	1. If leakage/spillage occurs: a. Stop mixing and	Contractor

Accidental incident	Preventive Measure	Remedial Action/Mitigation Measure	Responsible Party
grout mixers (propriety equipment). There may be spillage into the sea during the mixing operation due to mechanical failure, improper maintenance and operational error. (Minor event)	area of a suitable capacity (approximately 7.2m^3) to contain the contents of the mixer. 2. The equipment will be operated and frequently checked by experienced operators. 3. Ensure proper maintenance of equipment.	check for cause. b. Deposit spilt material into waste storage tank. c. Remove for land disposal or recycling. 2. If the mixed grout is spilled into the sea: a. Ad hoc impact monitoring should be conducted. b. If any Action or Limit Level exceedance is recorded, the Event-Action Plan in the EM&A Manual will be followed.	ET Contractor and ET
D. Grout Injection – Delivery Hose			
Once mixed the wet grout is pumped by hydraulic pumps from a holding tank through a one-piece hose to the grout mattress. Poten tial sources of leakage are: 1. Leakage from pumping equipment (Minor event)	1. All grout pumping equipment will be set up within a bunded area of a suitable capacity (approximatel y 7.2m^3) to contain the contents of the mixer. 2. Pumping equipment will be operated by experienced operator. 3. Pump operation and the grout flow rate will be monitored for any indications of abnormalities. 4. Ensure proper maintenance of equipment.	1. If the pump operation and flow rate indicate any abnormalities such as the amount of grout pumped per mattress exceeds the specified volume, then the pumping operation should stop immediately for leak checks and repair. 2. If leakage/spillage occurs, all grouting operations should stop and any leaks in the equipment should be repaired before grouting starts again. 3. If any grout is spilled into the sea: a. Ad hoc impact monitoring should be	Contractor Contractor ET

Accidental incident	Preventive Measure	Remedial Action/Mitigation Measure	Responsible Party
		conducted. b. If any Action or Limit Level exceedance is recorded, the Event-Action Plan in the EM&A Manual will be followed.	Contractor and ET
2. Leakage from delivery hose due to ruptured hose or loose connections (Minor event)	1. The delivery hose will be a single continuous hose to minimize connections. 2. The delivery hose and all connections will be inspected for wear and tear prior to pumping commencing. 3. Protective device will be installed to prevent charged hose from chafing. 4. Pump operation and the grout flow rate will be monitored for any indications of abnormalities. 5. A Remote Operated Vehicle (ROV) will be on station to observe the underwater pumping operation at all times for any indications of abnormalities. The ROV operator will have radio contact with the Deck. Note: The use of the ROV will allow constant monitoring of all operations in progress using the same video	1. If the pump operation and flow rate indicate any abnormalities such as the amount of grout pumped per mattress exceeds the specified volume, then the pumping operation should stop immediately for leak checks and repair. 2. If the ROV operator observes any abnormalities such as leaks from the delivery hose or the mattress not being filled properly, the pumping operation should be stopped for checks and repairs. 3. If the delivery hose is ruptured, it should be immediately retrieved and replaced by an intact one. 4. If leakage occurs underwater: a. Ad hoc impact monitoring should be conducted. b. If any Action or Limit Level exceedance is recorded, the Event-	Contractor Contractor Contractor ET Contractor and ET

Accidental incident	Preventive Measure	Remedial Action/Mitigation Measure	Responsible Party
	images as the ROV operator. No De-compression diver bottom time in 31m water depth being only 25 minutes.	Action Plan in the EM&A Manual will be followed.	
3. Leakage from delivery valve (connected by the ROV) due to valve malfunction or when connecting and disconnecting the hose with the mattress. (Minor event)	1. The delivery valve at the bottom of the hose will only be opened after it is securely fixed inside the pre-installed grout mattress sleeve. 2. The pumping will stop immediately when there appears to be a loss of grout at the bleed valve. 3. The hose will only be disconnected and removed once the surface and delivery valve has been shut The hose will then be immediately removed from the mattress and the mattress sleeve sealed and securely tied. 4. Pump operation and the grout flow rate will be monitored for any indications of abnormalities. 5. ROV operator (with CCTV and radio) will be on station to observe the underwater pumping operation at all times for any indications of abnormalities.	1. If the ROV Operator observes any abnormalities such as leaks from the delivery valve or that the mattress not being filled properly, the pumping operation should be stopped for checks and repairs. 2. If the pump operation and flow rate indicate any abnormalities such as the amount of grout pumped per mattress exceeds the specified volume, then the pumping operation should stop immediately for leak checks and repair. 3. If leakage from the valve occurs: a. Ad hoc impact monitoring should be conducted. b. If any Action or Limit Level exceedance is recorded, the Event-Action Plan in the EM&A Manual will be followed.	Contractor Contractor ET Contractor and ET

Accidental incident	Preventive Measure	Remedial Action/Mitigation Measure	Responsible Party
E. Grout Injection - Mattress			
1. During grouting there may be minor leakage from the mattress due to manufacturing defects, damage from handling or overfilling. (Minor event)	1. All mattresses are in palletized and containerized storage to prevent damage before use. 2. Every mattress will be checked for damage prior to placing it on the seabed. 3. Only trained and experienced operators will be allowed to handle the mattress. 4. The mattress will be frequently inspected while being filled underwater. 5. The grouting operation will stop immediately when there appears to be a loss of grout at the bleed valve. 6. ROV operator (with CCTV and radio) will be on station to observe the underwater pumping operation at all times for any indications of abnormalities.	1. If leakage from the mattress occurs (except normal bleeding) grouting operation should be stopped. 2. Seal leak using Hessian sacking and/or tie wraps. 3. If leakage from the mattress occurs: a. Ad hoc impact monitoring should be conducted. b. If any Action or Limit Level exceedance is recorded, the Event-Action Plan in the EM&A Manual will be followed.	Contractor Contractor ET Contractor and ET
2. During grouting the mattress may rupture due to manufacturing defect or damage from handling.	1. All mattresses are in palletized and containerized storage to prevent damage before use. 2. Every mattress will be checked for damage prior to installation.	1. If the mattress ruptures and the grout released, stop grouting operation until grout material has cured sufficiently to allow close examination. 2. The mattress may be	Contractor Contractor

Accidental incident	Preventive Measure	Remedial Action/Mitigation Measure	Responsible Party
(Major event)	3. Only trained and experienced operators will be allowed to handle the mattress. 4. ROV operator (with CCTV and radio) will be on station to observe the underwater pumping operation at all times for any indications of abnormalities.	removed if necessary and the grouting process repeated with a new mattress. 3. If a grout filled mattress ruptures underwater: a. Ad hoc impact monitoring should be conducted. b. If any Action or Limit Level exceedance is recorded, the Event-Action Plan in the EM&A Manual will be followed.	ET Contractor and ET
F. Cleaning			
1. Once the grouting operation is complete the equipment (mixer and pump) must be cleaned. There is a potential for spillage of the washing from the cleaning. (Minor event)	1. All surplus grout will be cleaned out and stored prior to disposal on shore. 2. All grouting equipment (including hoses) will be cleaned within the bunded area. All cleaning water will be collected and pumped to storage tanks for later disposal onshore.	1. If spillage occurs: a. Clean up spillage b. Repair any leaks of the bund. 2. If the washing is spilled into the sea: a. Ad hoc impact monitoring should be conducted. b. If any Action or Limit Level exceedance is recorded, the Event-Action Plan in the EM&A Manual will be followed.	Contractor ET Contractor and ET