FORM 5

Application No. :
Reference No. :
(For official use)

FORM 5
ENVIRONMENTAL IMPACT ASSESSMENT ORDINANCE
(CHAPTER 499)
SECTION 13(1)

Application for Variation of an Environmental Permit

PART A PREVIOUS APPLICATIONS

☐ No previous application for variation of an environmental permit.

☑ The environmental permit was previously amended.

Application No. : FEP-193/2019

PART B DETAILS OF APPLICANT

B1. Name : (person or company)

CLP Power Hong Kong Limited

[Note : In accordance with section 13(1) of the Ordinance, the person holding an environmental permit or a person who assumes responsibility for the designated project may apply for variation of the environmental permit.]

B2. Business Registration No. : (if applicable) [redacted]

B3. Correspondence Address :

[redacted]

B4. Name of Contact Person : [redacted]

B5. Position of Contact Person : [redacted]

B6. Telephone No. : [redacted]

B7. Fax No. : [redacted]

B8. E-mail Address : (if any) [redacted]

PART C DETAILS OF CURRENT ENVIRONMENTAL PERMIT

C1. Name of the Current Environmental Permit Holder :

CLP Power Hong Kong Limited

C2. Application No. of the Current Environmental Permit : FEP-193/2019

C3. The Current Environmental Permit was Issued in : month / year

01 2020

Important Notes : Please submit the application together with

(a) 3 copies of this completed form; and

(b) appropriate fee as stipulated in the Environmental Impact Assessment (Fees) Regulation

to the Environmental Protection Department at the following address :

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

RECEIVED 29 APR 2020 EIAO Register Office, E.P.D.

☐ Tick (✓) the appropriate box

EPD185

PART D PROPOSED VARIATIONS TO THE CONDITIONS IN CURRENT ENVIRONMENTAL PERMIT

D1. Condition(s) in the Current Environmental Permit :	D2. Proposed Variation(s) :	D3. Reason for Variation(s) :	D4. Describe the environmental changes arising from the proposed variation(s) :	D5. Describe how the environment and the community might be affected by the proposed variation(s) :	D6. Describe how and to what extent the environmental performance requirements set out in the EIA report previously approved or project profile previously submitted for this project may be affected :	D7. Describe any additional measures proposed to eliminate, reduce or control any adverse environmental impact arising from the proposed variation(s) and to meet the requirements in the Technical Memorandum on Environmental Impact Assessment Process :
• Landing portals and submarine cable alignment as shown in Figure 1; and • Condition 2.5(i) about acoustic disturbance to marine mammals.	• Revised Figure 1 showing updated landing portals and submarine cable routing; and • Proposed to waive Condition 2.5(i).	Details are given in Section 2.3 of the supporting document for this VEP application.	Details are given in Section 3 of the supporting document for this VEP application.	Details are given in Section 3 of the supporting document for this VEP application.	An Environmental Review has been carried out to assess the potential environmental impacts associated with the proposed changes. The assessment indicates that no adverse environmental impacts are anticipated from the proposed changes. Details are given in Section 3 of the supporting document for this VEP application.	No additional mitigation measures are considered necessary for the proposed changes.

PART E DECLARATION BY APPLICANT

E1. I hereby certify that the particulars given above are correct and true to the best of my knowledge and belief. I understand the environmental permit may be suspended, varied or cancelled if any information given above is false, misleading, wrong or incomplete.

[redacted]	[redacted]	[redacted]
Signature of Applicant	Full Name in Block Letters	Position

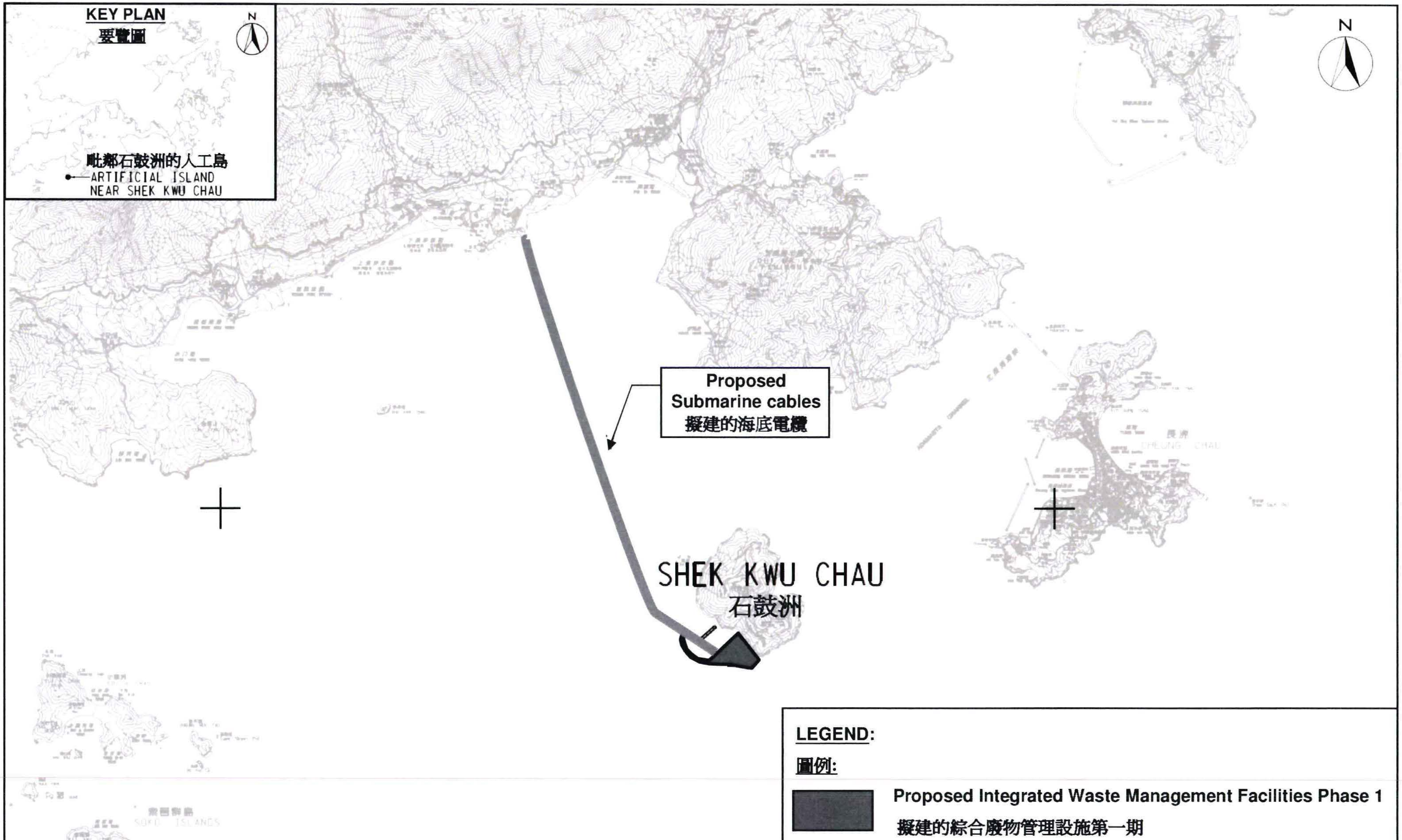
on behalf of CLP Power Hong Kong Limited — 29 April 2020

Company Name and Chop (as appropriate) — Date

NOTES :

1. A person who constructs or operates a designated project in Part I of Schedule 2 of the Ordinance or decommissions a designated project listed in Part II of Schedule 2 of the Ordinance without an environmental permit or contrary to the permit conditions commits an offence under the Ordinance and is liable to a maximum fine of $5,000,000 and to a maximum imprisonment for 2 years.

2. A person for whom a designated project is constructed, operated or decommissioned and who permits the carrying out of the designated project in contravention of the Ordinance commits an offence and is liable to a maximum fine of $5,000,000 and to a maximum imprisonment for 2 years.



Development of the Integrated Waste Management Facilities Phase 1
發展綜合廢物管理設施第一期
- Location Plan
- 位置圖

Environmental Permit No.:
環境許可證編號： EP-429/2012

Figure 1 圖 1

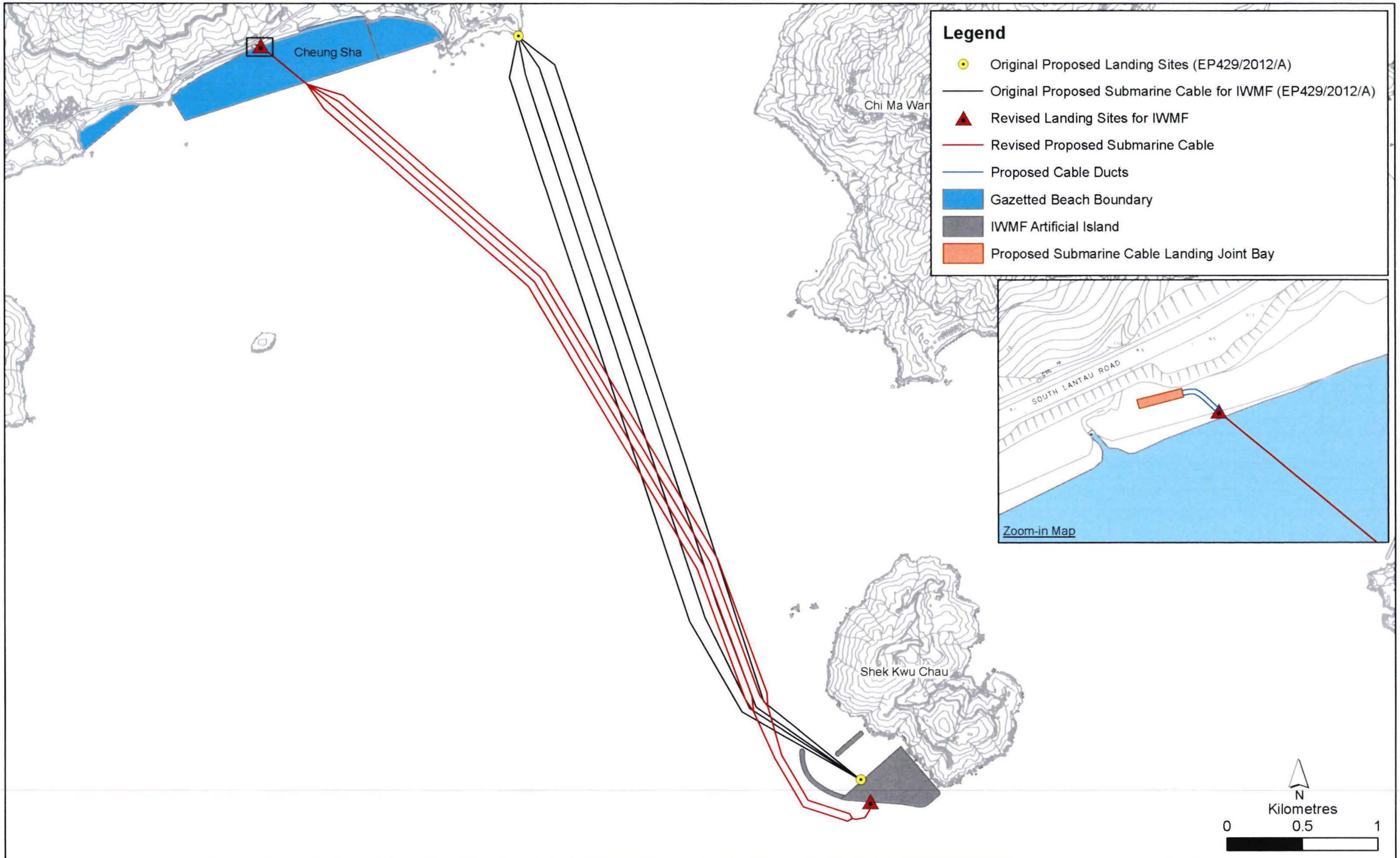


Figure 2

Revised Submarine Cable Circuits and Landing Sites for IWMF

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Date: 6/5/2019

Environmental Resources Management

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CLP Power

132kV Submarine Cable Circuits connecting Cheung Sha and Shek Kwu Chau Artificial Island

Environmental Review Report

20 April 2020

Project No.: 0500403

The business of sustainability

ERM

Document details	The details entered below are automatically shown on the cover and the main page footer. PLEASE NOTE: This table must NOT be removed from this document.
Document title	132kV Submarine Cable Circuits connecting Cheung Sha and Shek Kwu Chau Artificial Island
Document subtitle	Environmental Review Report
Project No.	0500403
Date	20 April 2020
Version	10.0
Author	Pako Yu
Client Name	CLP Power

Document history

				ERM approval to issue		
Version	Revision	Author	Reviewed by	Name	Date	Comments
Draft	1.0	Pako Yu	Mandy To	Terence Fong	12/3/2019	N/A
Revised	2.0	Pako Yu	Mandy To	Terence Fong	12/4/2019	N/A
Revised	3.0	Pako Yu	Mandy To	Terence Fong	25/7/2019	N/A
Revised	4.0	Pako Yu	Mandy To	Terence Fong	12/9/2019	N/A
Revised	5.0	Pako Yu	Mandy To	Terence Fong	27/12/2019	N/A
Revised	6.0	Mark Cheng	Mandy To	Terence Fong	22/01/2020	N/A
Revised	7.0	Mandy To	Mandy To	Terence Fong	19/02/2020	N/A
Revised	8.0	Mandy To	Mandy To	Terence Fong	26/03/2020	N/A
Revised	9.0	Mandy To	Mandy To	Terence Fong	9/4/2020	N/A
Revised	10.0	Mandy To	Mandy To	Terence Fong	20/4/2020	N/A

Signature Page

20 April 2020

132kV Submarine Cable Circuits connecting Cheung Sha and Shek Kwu Chau Artificial Island

Environmental Review Report

Terence Fong
Partner

ERM-Hong Kong, Ltd
2507, 25/F One Harbourfront
18 Tak Fung Street,
Hunghom,
Kowloon
Hong Kong

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Acronyms and Abbreviations

Name	Description
The Project	132kV Submarine Cable Circuits connecting Cheung Sha and Shek Kwu Chau Artificial Island
EP	Environmental Permit
PP	Project Profile
PME	Powered Mechanical Equipment
ASR	Air Sensitive Receiver
NSR	Noise Sensitive Receiver
C&D Materials	Construction and Demolition materials

1. INTRODUCTION

1.1 Background

The Environmental Protection Department (EPD) of the Government of the Hong Kong Special Administrative Region (the Government) proposed to construct the Integrated Waste Management Facilities (IWMF) Phase 1 on an artificial island near Shek Kwu Chau (SKC), south of Lantau Island for the purpose of treating municipal solid waste and generating electricity from the waste treatment process for its own use and export surplus electricity, if any, to the power grid.

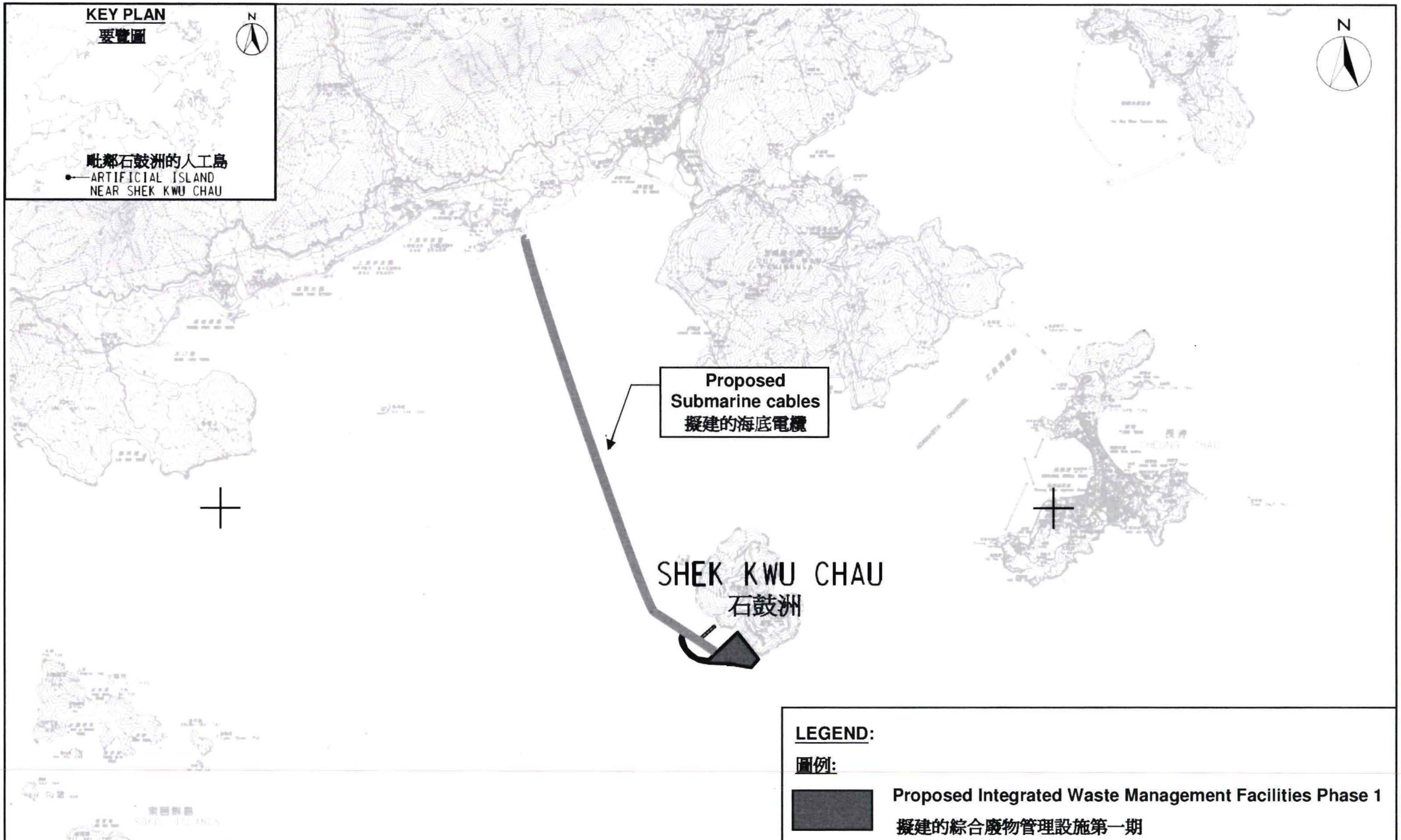
The Project is a Designated Project (DP) under Schedule 2 of the Environmental Impact Assessment (EIA) Ordinance (Cap. 499). The EIA Report (EIA-201/2011) was approved on 17 January 2012, and the Environmental Permit (EP) of the Project was issued on 19 January 2012 (EP-429/2012) and a variation of the EP on 14 October 2016 (EP-429/2012/A). A Further EP (FEP-01/429/2012/A) was granted to Keppel Seghers-Zhen Hua Joint Venture on 27 December 2017.

Further to the agreement with EPD, CLP Power Hong Kong Limited (CLP) will be responsible for the installation of the 132kV submarine cable circuits connecting the Cheung Sha, South Lantau and Shek Kwu Chau Artificial Island (the Project). EPD and Keppel Seghers-Zhen Hua Joint Venture (the current EP-429/2012/A and FEP-01/429/2012/A permit holders) surrendered part of the EP and FEP after ceasing to be responsible for the 132kV submarine cable circuits, to CLP on 17 January 2020. Upon CLP's review of the Further Environmental Permit (FEP-02/429/2012/A) and project details regarding the 4 proposed submarine cables assumed in the approved EIA Report, it is considered that an alternative landing portal at Cheung Sha beach should be adopted as it has been used as landing area for international submarine cables for many years and could reduce the corresponding works volume on land. And therefore revised design and construction methodology to take forward the alternative landing portals and cable routes (as presented in *Figure 1* of the current FEP) were proposed. *Figure 1* of this document shows the IWMF location plan including the proposed submarine cables for exporting surplus electricity to the power grid presented in the current EP and the proposed changes in the cable landing portals and submarine cable routing are indicated in *Figure* 2.

The proposed revised submarine cable routing and landing portal and construction methodology are outlined in *Section 2*.

1.2 Purpose of this Report

This *Report* provides information to describe the potential impacts on the environment due to the proposed variations and provides an evaluation of the potential impacts. The information presented herein will form part of the submission to the EPD for an Application for Variation of an Environmental Permit (VEP). The purpose of this *Report* is to demonstrate that no unacceptable impacts will arise from the proposed variations.



Development of the Integrated Waste Management Facilities Phase 1
發展綜合廢物管理設施第一期
- Location Plan
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Environmental Permit No.: 環境許可證編號： EP-429/2012

Figure 1 圖 1

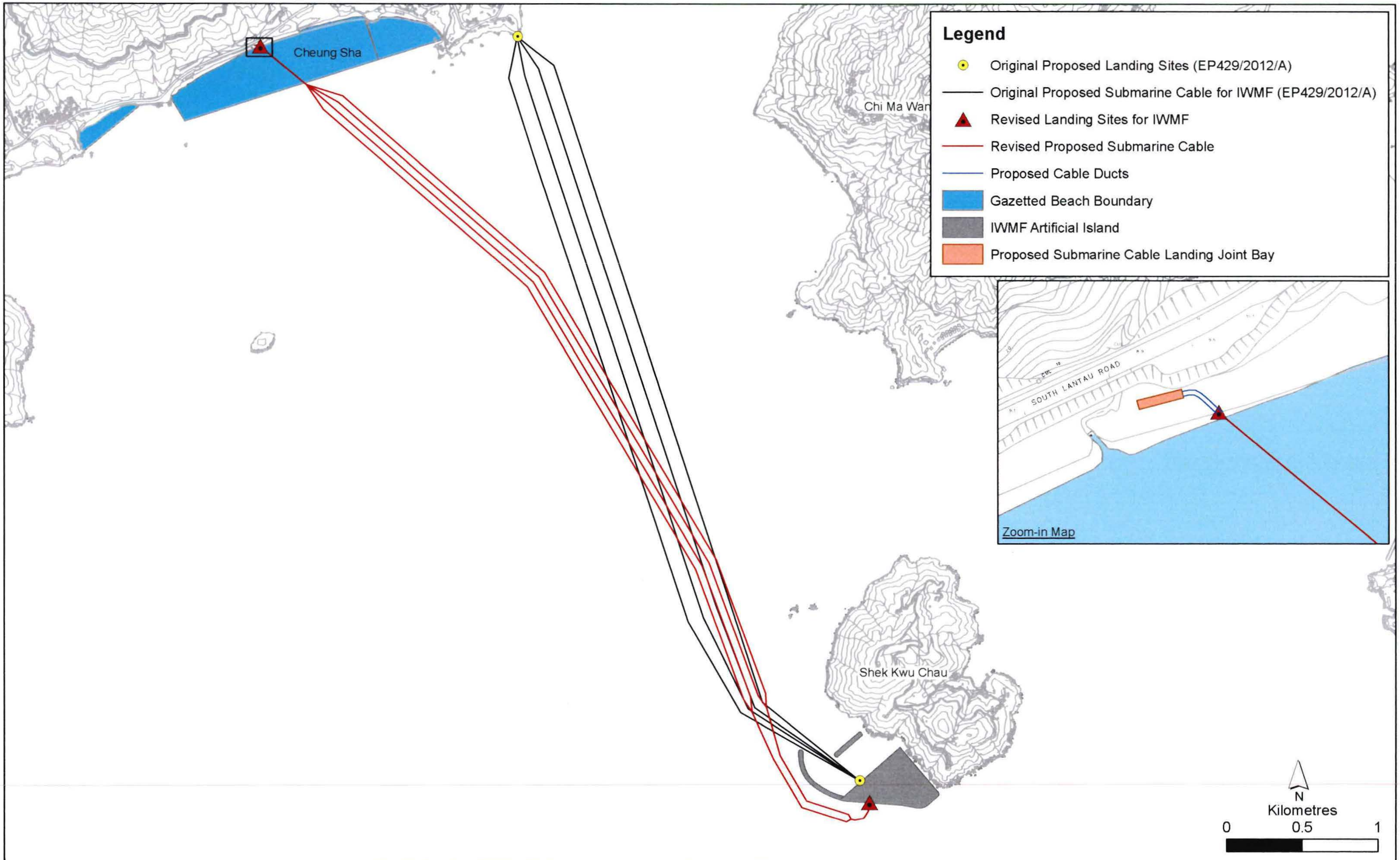

Figure 2

Revised Submarine Cable Circuits and Landing Sites for IWMF

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Date: 6/5/2019

Environmental Resources Management

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2. PROPOSED VARIATIONS AND ASSOCIATED ENVIRONMENTAL ISSUES

2.1 Changes to the Project and Comparison with the EIA Report

Further to the alternative landing portals and cable alignment described in *Section 1.1*, a high-level comparison of the assumptions in the EIA Report and the latest design is provided in *Table 2.1*.

Table 2.1: Comparison of the Assumptions in the EIA Report and the Latest Design

	Assumptions in the EIA Report	The Latest Design
Submarine cable alignment	■ 5.8km long from Cheung Sha to Shek Kwu Chau Artificial Island (see *Figure 1*)	■ Approximately 7 km from the alternative landing portal at Cheung Sha Beach to Shek Kwu Chau Artificial Island with the landing site shifted to the south of the SKC Artificial Island (see *Figure 2*).
Works method	■ Off-shore: A cable burying machine including an injector will be lowered to the seabed. The injector fluidizes a trench using high pressure water jets and a cable is immediately laid within the trench. The sides of the trench slip around the cable, burying it and leaving a small depression in the seabed. The trench dimensions will be about 5 m depth x 3 m width.	■ Off-shore: same water jetting technique with expected maximum trench width of the seabed fluidized by the injector reduced to 0.5 m for each cable.
	■ Near-shore: by open cut method using dredger for closing sections near shore ends.	■ Near-shore (within gazetted beach boundary): by divers using hand held water jet, same methodology/ technology as presented in the approved IWMF EIA Report but with smaller scale.
Affected area	■ Cheung Sha landing portal: - 20 m^2 of intertidal and subtidal habitat - 750 m^2 of backshore vegetated area	■ Cheung Sha landing portal: - Precasted Cable Joint Bay (20m (L) x 4m (W) x 1m (H)) - Precasted cable trough (1m (W) x 0.75m (H)) between the Cable Joint Bay on land and Low Water Mark (LWM)
	■ Submarine cable trench: 17,400 m^2 (5.8 km x 3 m)	■ Submarine cable trench: 14,000 m^2 (7 km x 4 cables x 0.5 m)
Key sensitive receivers at the landing site at Lantau	■ Landed at natural rocky shore which is zoned as "Residential (C)" in the Outline Zoning Plan. However, it is surrounded by areas mostly zoned as "Coastal Protection Area" along the coastline.	■ Gazetted beach

Details of Variation(s)

The proposed submarine cable circuits will remain in generally the same corridor, but their landing sites will be adjusted slightly, as indicated by comparing *Figure 1* (current cable landings and routing defined in EP) and *Figure 2* (proposed new cable landings and routing). The major changes in the

revised submarine cable route are the extension of the original route to connect the new landing sites at Cheung Sha and IWMF proposed reclaimed land (the total length will be approximately 7km).

In the approved EIA Report, the key project and methodology details for the works associated with the submarine cables were described in various sections of the EIA Report and extracted as follows:

2.4.3.12 The submarine cables would be installed by burying method using water jets. A cable burying machine would include an injector lowered to the seabed. The injector fluidizes a trench using high pressure water jets and a cable is immediately laid within the trench. The sides of the trench slip around the cable, burying it and leaving a small depression in the seabed.

5b.6.1.11 Whereas the installation of submarine cables will employ subsea burying machine to form narrow cable trench at sea bed up to 5 meter deep by water jetting and lay the submarine cable spontaneously. The trench will be backfilled at the same time with the sediments settling to the trench. The trench dimensions will be about 5 m depth x 3 m width. A short length of cable trench will be formed by open cut method using dredger for closing sections near shore ends. The whole submarine cable laying process would take about 20 working days to complete.

Table 7b.43 Area of Habitat to be Directly Affected under the Project

Cheung Sha	
Landing portal	*20 m^2*
Along submarine cable alignment	
Submarine cable trench	*5.8 km long, 17,400 m^2*

7b.6.2.22 The proposed landing portal at Cheung Sha would permanently occupy a small area of intertidal and subtidal habitat (total = 20 m^2). Slight encroachment into the backshore vegetated area of 750 m^2 may also be resulted during construction for siting of construction plants.

The submarine cables installation technique will be the same as those discussed in relevant sections of the approved EIA Report (EIA-201/2011), ie by burying method using water jets as described in *Sections 2.4.3.12* and *5b.6.1.11*. However, similar to other recent approved submarine cable projects using the water jetting technique (1) (2) (3) (4) (5) (6) (7) (8) (9) (10), the expected maximum trench width of the seabed fluidized by the injector is 0.5 m and the cable is immediately laid within the trench. It should be noted that the seabed can be expected to naturally reinstate to before-work level and condition shortly after completion of the works. And therefore the directly affected area along the submarine cable circuits is expected to be around 14,000 m^2 (= 7 km x 4 cables x 0.5 m).

The proposed revised methodology and construction schedule associated with submarine cable circuits particularly the landing portal at Upper Cheung Sha Beach (the methodology should have no

(1) South East Asia - Japan 2 Cable System - Hong Kong Segment (SJC2-HK) - Chung Hom Kok (AEP-572/2020). Environmental Permit was granted on Granted on 4 Mar 2020 (EP-572/2020).

(2) HKA Submarine Cable - Chung Hom Kok (AEP-567/2019). Environmental Permit was granted on 20 Feb 2019 (EP-567/2019).

(3) Ultra Express Link (AEP-543/2017). Environmental Permit was granted on 14 Sep 2017 (EP-543/2017).

(4) Pacific Light Cable Network (PLCN) – Deep Water Bay (AEP-539/2017). Environmental Permit was granted on 10 July 2017 (EP-539/2017).

(5) Asia-Africa-Europe-1 (AAE-1) Cable System (AEP-508/2016). Environmental Permit was granted on 20 Apr 2016 (EP-508/2016).

(6) Tseung Kwan O Express – Cable System (AEP-243/2015). Environmental Permit was granted on 20 May 2016 (EP-509/2016).

(7) Asia Pacific Gateway (APG) - Tseung Kwan O (AEP-485/2014). Environmental Permit was granted on 18 Feb 2014 (EP-485/2014).

(8) Replacement of the Existing 11KV Submarine Cable Circuit Connecting Liu Ko Ngam and Pak Sha Tau Tsui at Kat O (AEP-461/2013). Environmental Permit was granted on 27 August 2013 (EP-461/2013).

(9) Asia Submarine-cable Express (ASE) - Tseung Kwan O (AEP-433/2011). Environmental Permit was granted on 20 December 2011 (EP-433/2011).

(10) Proposed 132kV Submarine Cable Route for Airport "A" to Castle Peak Power Station Cable Circuit (AEP 267/2007). Environmental Permit was granted on 29 March 2007 (EP-267/2007).

change in the landing portal at IWMF proposed reclaimed land even the landing site shifted to the south of the artificial island) up to High Water Mark (HWM) is detailed as:

Stage 1 – Works within the Gazetted Beach during Non-bathing Season (Approx. 2 months)

- Precasted Cable Joint Bay and Cable Trough Installation at Upper Cheung Sha Beach New Landing Portal – Excavation with small excavator and hand tools will be carried out for installation of precasted Cable Joint Bay and Cable Trough. Precasted Cable Joint Bay (20m (L) x 4m (W) x 1m (H)) will be installed in the excavated trench of approximately 2-3 m below the soil. The 132kV cable segment between the Cable Joint Bay on land and Low Water Mark (LWM) will be buried to a precasted cable trough (1m (W) x 0.75m (H)) target of approximately -2 to -3 m below the soil level/ seabed at the LWM. Excavation works between High Water Mark (HWM) and LWM will only be carried out during low tide. The cable trough will be protected by metal plates and cable tiles. The depth of the trench to be excavated for the cable trough installation will be approximately 3 m. The Cable Joint Bay and Cable Trough will be backfilled to original level after the installation. Concrete and/or metal plate cover would be provided on top of the submarine cable duct bank/ trough between Cable Joint Bay & LWM. A silt curtain will be set up at the water line surrounding the works area on the beach to provide protection to surrounding water from sediment during the works between Cable Joint Bay and LWM.
- Cable installation for the in-shore segments from the LWM to the gazetted beach boundary (with target burial depth of approximately -2 m below the seabed) will be undertaken by divers using hand held water jet, same methodology/ technology as presented in the approved IWMF EIA Report but with smaller scale. The proposed revised methodology does not require open cut method using dredger for cable segments near shore ends as stated in the approved EIA Report (EIA-201/2011).
- Articulated Pipes installation/protection for the shore-end sections of the cable circuits (from LWM to ~80m outside the gazetted beach boundary of Upper Cheung Sha Beach) by divers. Such activities will be carried out almost concurrently with hand jetting by divers.

Stage 2 – Submarine Cable Installation/ Works outside the Gazetted Beach (Approx. 4 months including contingency such as bad weather, faulty vessel etc which require works to be intermittent)

- Same as the methodology presented in the approved IWMF EIA Report, but cable installation for the 80m segment just outside the gazetted beach boundary (with target burial depth of approximately -2 m below the seabed) will be undertaken by divers using hand held water jet.
- The actual cable installation using cable burying machine (not including the preparation and diver works or post-lay works or any weather downtime) is expected to be around 30 working days.
- As part of the cable installation, it is expected that the Route Clearance Operation (RC) and Pre-lay Grapnel Run (PLGR) over the proposed cable route (outside gazetted beach boundary) will be conducted. It is the common practice for all submarine cable installation works. The RC and PLGR operations are scheduled to take place before actual cable installation operation. The aim of RC and PLGR is to remove any debris or obstacles, which may pose a threat to the cable or the burial machine, deposited in the cable corridor. The penetration of grapnel fluke will not be more than 0.8 m. All debris recovered from seabed will be disposed to the approved dumping ground. Since the RC and PLGR operation will only be carried out by mechanical towing in a short period of time and restricted to limited areas, no adverse impacts to the marine environment is anticipated.

Stage 3 – Cable Operation (after installation, if required in the future), including Maintenance and Repair

It is considered unlikely that the submarine cable will require maintenance during operation, however should an occasion of cable fault arise that necessitates this, repair operation will be required.

Methods used for cable maintenance and repair at any location along the submarine cable route are anticipated to be as per those used for cable installation during construction, with the potential to use smaller equipment such as Remotely Operated Vehicles (ROVs) equipped with injector tool. Details are given below:

- During operation there may be a potential requirement for maintenance work to be carried out (i.e. cable repair at particular fault location due to unexpected damage). These works will be similar in nature to cable installation works described in Stages 1 and 2. Should repair operation be required, mitigation measures proposed for the construction phase will be implemented as outlined further in this ERR.
- For repairing works within the beach, the equipment and methods will be the same as for cable installation works, as outlined in Stage 1.
- For submarine cable repairs, equipment and methods would be similar to those outlined in Stage 2 but not along the full alignment, i.e. of smaller scale, with the potential to use smaller equipment such as Remotely Operated Vehicles (ROVs) equipped with injector tool and divers with hand held tools.

2.2 Proposed Variations to the Conditions of the Current FEP

In view of the proposed changes to the Project, a number of condition(s) in the current Further Environmental Permit (FEP-02/429/2012/A) shall be varied; these conditions, the proposed variations and the reason for variation are summarised in *Table 2.2*.

Table 2.2: Proposed Variations to the Conditions of FEP No. FEP-02/429/2012/A

Condition	Current EP	Proposed Variation	Reason for Variation
Figure 1	Submarine cable alignment as shown in Figure 1 of the current FEP	The changes in the cable landing sites and submarine cable alignment are indicated in Figure 2	▪ Reduce works volume on land, ie significant shorter length of land cable connecting to the existing substation; ▪ Technical challenge to form a landing portal at natural rocky shore; ▪ Minimise vegetation clearance; ▪ Match the latest civil design and cable landing arrangement at the artificial island. (Details are given in *Section 2.3.1*)
Condition 2.5 (i)	To minimize the acoustic disturbance to marine mammals: (i) construction works that may produce underwater acoustic disturbance shall be restricted within June to November to avoid peak season of Finless Porpoise occurrence	Proposed to waive the Condition 2.5 (i) on acoustic disturbance to marine mammals	Given the minimal acoustic disturbance, small scale and minor works of this Project, scheduling the submarine cable installation works of this project to avoid peak season of Finless Porpoise occurrence is considered not necessary. (Details are given in *Section 2.3.2*)
New Condition	n/a	Proposed new condition under Measures to Mitigate Water Quality Impacts during Construction of the Project: Section of cable from low water mark to 80 m outside of the gazetted boundary	With the implementation of the hand-held water jet, less disturbance to the seabed and less resulted sediment loss to the water column is expected.

Condition	Current EP	Proposed Variation	Reason for Variation
		would be installed by diver using hand held water jet.	

2.3 Reasons for Variations

2.3.1 Changes in the Cable Landing Sites and Submarine Cable Alignment

Upon CLP's review of the landing portals and methodology assumed in the approved EIA Report, it considered that an alternative landing portal at Cheung Sha beach has been recommended as it has been used as landing area for international submarine cables for many years and could reduce the corresponding works volume on land, ie with significant shorter length of land cable connecting to the existing substation. While the original proposed landing site at Cheung Sha is considered of technical challenging which requires to form a landing portal at natural rocky shore which will permanently disturb intertidal and subtidal habitats and backshore vegetated areas, and therefore a revised landing site located at Upper Cheung Sha Beach, a sandy beach with very gentle slope and without vegetation clearance which is considered as a preferred cable landing location and the time required for the cable installation works will be shorter. Given the revised landing site is a sandy and boulder shore which is generally considered as a preferred cable landing location, there are sufficient open areas for siting of construction plants, and therefore permanent loss of intertidal and subtidal habitats not anticipated and encroachment into the backshore vegetated area will not be required for the installation of the submarine cable circuits.

As a result, the revised locations and methodology outlined above has been proposed. Shifting the cable landing site at Shek Kwu Chau artificial island to the south of the new reclaimed land can match the latest civil design and cable landing arrangement at the artificial island, and reduce the possibility of cable damage due to maintenance dredging as well as dropping anchors within the sheltered area enclosed by the breakwater. The revised methodology will allow safer working conditions than the previous works areas allowed.

As mentioned in *Section 2.2*, the proposed submarine cable circuits will remain in generally the same corridor, but their landing sites will be adjusted slightly, as indicated by comparing *Figure 1* (current cable landings and routing defined in EP) and *Figure 2* (proposed new cable landings and routing). The major changes in the revised submarine cable route are the extension of the original route to connect the new landing sites at Cheung Sha and IWMF proposed reclaimed land (the total length will be approximately 7km).

2.3.2 Waiving of Restriction of Cable Installation during Peak Season of Finless Porpoise

With reference to the latest approved EIA Report in South Lantau (ie Hong Kong Offshore LNG Terminal EIA-256/2018), construction works including dredging and backfilling activities as well as jetting for the submarine gas pipeline installation can result in a minor and short term increase in underwater sound which may potentially affect Finless Porpoise (FP). Submarine pipeline construction works are not required to avoid the peak season of Finless Porpoise in the Hong Kong

Offshore LNG Terminal (EIA-256/2018) as well as other approved submarine cable projects that adopted the same water jetting technique and the cable alignment traversed FP habitats (1) (2) (3) (4) (5).

Dredging, jetting and large vessel traffic generally results in low frequency noise, typically in the range of 0.02 to 1 kHz (6), which is below the peak range of 142 kHz reported for porpoises. A study was conducted to investigate the underwater sound levels produced during the installation of submarine cable in southeastern waters of Hong Kong. The results indicated that the cable installation barge and the support vessels (with total up to 4 nos. vessels) generated sound with frequency between 40 Hz and 25 kHz, which were lower than the sound used for foraging and communication for FPs (7). For this reason, underwater noise generated by jetting and pipe laying and cable laying operations is not expected to acoustically interfere significantly with porpoises. Cable installation works are therefore not considered causing significant acoustic disturbance to marine mammals particularly FPs.

Given the minimal acoustic disturbance, small scale and minor works of this project compare with the Hong Kong Offshore LNG Terminal, and similar in nature to other recently approved submarine cable projects, scheduling the submarine cable installation works of this project to avoid peak season of Finless Porpoise occurrence is considered not necessary.

(1) HKA Submarine Cable - Chung Hom Kok (AEP-567/2019). Environmental Permit was granted on 20 Feb 2019 (EP-567/2019).

(2) Pacific Light Cable Network (PLCN) – Deep Water Bay (AEP-539/2017). Environmental Permit was granted on 10 July 2017 (EP-539/2017).

(3) Asia-Africa-Europe-1 (AAE-1) Cable System (AEP-508/2016). Environmental Permit was granted on 20 Apr 2016 (EP-508/2016).

(4) Asia Pacific Gateway (APG) - Tseung Kwan O (AEP-485/2014). Environmental Permit was granted on 18 Feb 2014 (EP-485/2014).

(5) Asia Submarine-cable Express (ASE) - Tseung Kwan O (AEP-433/2011). Environmental Permit was granted on 20 December 2011 (EP-433/2011).

(6) Richardson et al. 1995. Marine Mammals and Noise. Academic Press.

(7) See Annex A1 Report on Measurement of Underwater Sound Levels Around Submarine Cable Installation Barge under Appendix A of this ERR

3. POSSIBLE IMPACTS ON THE ENVIRONMENT

The installation process of Project will only require minor works within the marine environment and only small scale construction works are required at the cable landing site to enable the cable to enter the Cable Joint Bay and connect to the conduit underneath the seawall of Shek Kwu Chau Artificial Island. Further details are described in in the following sections. No environmental impacts are expected to occur during the normal operation of the 132kV submarine cable circuits as there is no changes to the Project. There is a potential requirement for maintenance work (i.e. cable repair at particular fault location due to unexpected damage) to be carried out during operation. *Table 3.1* identifies the potential environmental impacts associated with the proposed changes.

Table 3.3: Potential Environmental Issues

Potential Impact	Construction	Potential Repair during Operation
Air Quality (b)	-	-
Noise (b)	-	-
Water Quality	✓	✓
Waste Management Implications (b)	-	-
Terrestrial Ecology (c)	-	-
Marine Ecology	✓	✓
Fisheries	✓	✓
Health Impact (b)	-	-
Landscape and Visual (b)	-	-
Cultural and Heritage (b)	-	-
Landfill Gas Assessment (b)	-	-

Notes:
(a) '✓'=Possible, '-' = Not Expected
(b) Listed as impacts not being expected due to the submarine cable in the approved EIA Report.
(c) Land-based work activities will be restricted on the bathing beach, without impacts on terrestrial ecology (ie no disturbance to vegetation).

A description and evaluation, where appropriate, of these potential impacts associated with the submarine cables (including water quality, marine ecology, fisheries and culture heritage) are provided in the following sections during construction and maintenance and repair during operational phase.

3.1 Construction Phase

3.1.1 Water Quality

3.1.1.1 Works within the Gazetted Boundary of Upper Cheung Sha Beach

The following mitigation measures will be undertaken for the works within the gazetted boundary of Upper Cheung Sha Beach:

- No construction work would be conducted in the bathing season of April to October.
- Section of cable from low water mark to 80 m outside of the gazetted boundary would be installed by diver using hand held water jet.

All works within the gazetted boundary of the bathing beach would be conducted in non-bathing season and thus would has lower impact on the associated beneficial use of the Upper Cheung Sha Beach. The land-based works that will be carried out within the gazetted boundary of Upper Cheung Sha Beach are primarily related to surface water run-off and will remain the same as presented in the approved EIA Report (EIA-201/2011). Site runoff, sewage from workforce, as well as construction wastewater, if uncontrolled, can enter the receiving water and results in adverse change in water quality. Site preparation works for the submarine cable installation include cable laying and opening of the Cable Joint Bay and the seaward end of the cable trough which is not expected to generate surface water run-off. With the following measures incorporated into the works within the beach, no unacceptable adverse impacts to water quality from these activities are expected.

- The machinery employed will be inspected prior to work commencing on the beach then at least daily thereafter to ensure the waters and beach will not be polluted with oil/ grease/ fuel. No machinery maintenance will be carried out onsite. Oil absorbent materials will be readily placed on site and will be applied immediately should any oil leakage incidents occur, to ensure the swimming zone would not be affected; and
- All construction waste and drainage will be handled and disposed of in accordance with the Waste Disposal Ordinance and Practice Note for Professional Persons, Construction Site Drainage (ProPECC PN1/94) and in particular the following measures will be adhered to:
  - Stockpiles of materials will be covered with tarpaulin or similar fabric to minimise runoff during the rainy season;
  - Care will be taken during the cable landing and construction to avoid any spillage of materials to the adjacent marine waters and to ensure that spoil materials are not discharged into adjacent waters. A water line silt curtain will also be installed for mitigating the potential water quality impact due to surface runoff from the works on the beach (see *Figures 3.2 & 3.3*). Silt curtain has been used extensively in marine construction works projects in Hong Kong and has demonstrated its ability to confine sediment dispersion effectively [(1)]. For small scale marine works with limited and localized sediment disturbance under this Project, a floating or frame type silt curtain would be appropriate and sufficient for the control of the potential sediment dispersion [(2)]; and
  - Best Management Practices (BMPs) will be applied to avoid and minimise contaminated runoff from work sites, marine plants and vessels, including wastewater being properly treated and discharged to storm drain.

The nearest works boundary will be located at least 700 m away from the lower watercourse of the Ecological Important Streams. Site runoff would not be expected but a silt curtain will be set up at the water line for the works within the beach to provide additional protection to surrounding water from sediment dispersion. Therefore, no unacceptable adverse impact during the construction and operational phases is anticipated to the Ecologically Important Streams.

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(1) The sediment reduction rate by silt curtain systems may vary:

e.g. sediment reduction rate of 75% achieved using single-layered curtain (EIA for SCL Hung Hom to Admiralty section).

e.g. sediment reduction rates between 61% to 87% achieved using two-layered silt curtain, according to EIA for Hong Kong - Zhuhai - Macao Bridge Hong Kong Boundary Crossing Facilities.

(2) EM&A for other similar projects have indicated that deterioration of water quality from burying works by divers (with frame-type/screen silt curtain) are negligible such as:

- Pacific Light Cable Network (PLCN) – Deep Water Bay (AEP-539/2017).
- VSNL Intra Asia Submarine Cable System – Deep Water Bay (EP-294/2007)
- Replacement of the Existing 11KV Submarine Cable Circuit Connecting Liu Ko Ngam and Pak Sha Tau Tsui at Kat O (EP-461/2013)

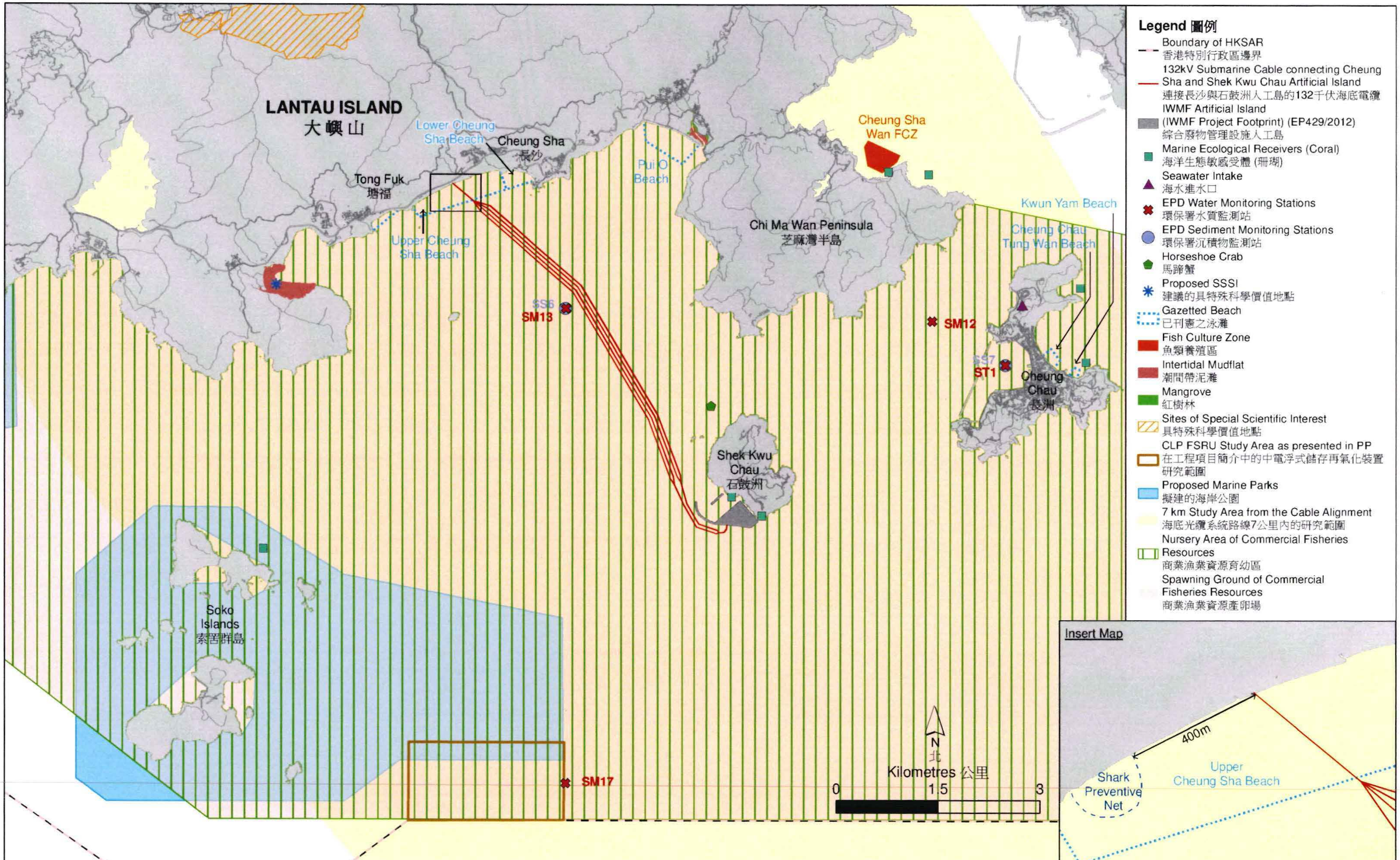

Figure 3.1
圖 3.1

Representative Marine Water Sensitive Receivers in the surrounding of the 132kV Submarine Cable connecting Cheung Sha and Shek Kwu Chau Artificial Island
在連接長沙及石鼓洲人工島132千伏海底電纜附近具代表性的海洋水質敏感受體

File: T:\GIS\CONTRACT\0500403\mxd\0500403_WSR_v2.mxd
Date: 10/7/2019

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Potential Impact on Dissolved Oxygen and E.coli

Key potential source of impact on dissolved oxygen (DO) and *E.coli* would be the discharge of sewage from workforce. It should be noted that public toilet is available in Upper Cheung Sha Beach. Therefore discharge of sewage from construction workforce is not expected. Chemical toilet(s) would be provided outside the gazetted beach area if necessary. Therefore, no increase in *E.coli* or depletion of DO would be anticipated from sewage generated by workforce.

With the implementation of above control measures, no unacceptable water quality impact associated with land-based construction site runoff and discharge of sewage/ wastewater, and the associated elevation in *E.coli* or DO depletion, would be expected.

Potential Impact on Suspended Solids from Cable Installation by Diver with Hand Jetting Tool

It is anticipated that the burying by divers will not cause significant water quality impacts as only a small area will be disturbed; the length is short (less than 500 m) and the burial depth is shallow (approximately 2 m). The potential level and extend of sediment impact from cable installation by diver with hand jetting tool is expected to be less significant than that of by jetting machine, which is expected to only result in elevation of suspended solids within 80 m from the work front. In addition, the following mitigation measures should be undertaken for the diver jetting works within the gazetted beach boundary (ie diver jetting and post-lay protection):

- Water quality monitoring will be carried out to verify that the Project works will not result in any impacts to water quality, and consequently to marine ecology and fisheries. In case of any Limit Level exceedances, repeat sampling event to confirm findings and implement the most appropriate method of reducing suspended solids (SS) during cable installation.
- Diver will work within a silt curtain enclosed area, to control fine dispersion, if any, to mitigate the potential water quality impact (see *Figures 3.2 & 3.3*).

Figure 3.3: Example of silt curtains for burial works at water line and shore-end diver working area

The use of silt curtain and jetting by diver have been adopted in a number of recently approved Direct to Permit applications of similar cable laying projects, including DIR-254/2017 Pacific Light Cable Network (PLCN) – Deep Water Bay where cable alignment also encroach into the gazetted boundary of the Deep Water Bay Beach. Results of water quality monitoring under statutory EM&A (1) (2) for PLCN showed there was no exceedance that was attributed to the project construction works during period of cable installation by diver with hand jetting tools, indicating minimal water quality impact from such method. With the adoption of jetting by diver within silt curtain enclosed area, potential water quality impact associated with the cable installation within the gazetted boundary of Upper Cheung Sha Beach is expected to be minimized. As no works will be carried out within the Upper Cheung Sha Beach during bathing season, no unacceptable water quality impact would be expected during the bathing season. Consequently, no unacceptable impact on the beneficial use of gazetted beach of Upper Cheung Sha is expected in both bathing and non-bathing seasons.

3.1.1.2 Works outside the Gazetted Boundary of Upper Cheung Sha Beach

Water Sensitive Receivers (WSRs) identified at or in the vicinity of the artificial island near Shek Kwu Chau and the submarine cable alignment include:

- Horseshoe Crab;
- Gazetted Beaches;
- Spawning and Nursery Grounds of Commercial Fisheries Resources;

(1) EP-539/2017 - 1st Weekly WQ Impact Monitoring Report
https://www.epd.gov.hk/eia/register/english/permit/ep5392017/documents/1stwimmr/pdf/1stwimmr.pdf

(2) EP-539/2017 – 2nd Weekly WQ Impact Monitoring Report
https://www.epd.gov.hk/eia/register/english/permit/ep5392017/documents/2stwimmr/pdf/2stwimmr.pdf

- Fish Culture Zones; and
- Coral Communities.

Locations of the WSRs are presented in *Figure 3.1*. Indicative burial depths of the submarine cable alignment are presented in *Figure 3.2*.

The construction activities that will be carried out outside the gazetted beach boundary include the submarine cable installation/ repair operation and associated preparation works (such as RC and PLGR operations) and involve burying the cables below the existing seabed which are generally the same as the assumption from the approved EIA Report (EIA-201/2011).

Based on the findings of the approved EIA Report, it is predicted sediment plume from the cable installation by jetting, and to a lesser degree some RC/ PLGR operation(s), would be settled within 80 m from the cable alignment. In view of the proximity, the premise for such prediction is considered hold true for the updated cable alignment as well. Based on the findings on review of marine ecological resources as well as survey under this Study (refer to *Section 3.1.2*), there is no major marine ecological resources, including coral and horseshoe crab, within 80 m from the cable alignment. The nearest fish culture zone of Cheung Sha Wan is over 4 km away from the cable alignment. On the other hand, the original and updated cable alignments are both within the Spawning and Nursery Grounds of Commercial Fisheries Resources south of Lantau Island, therefore elevation of SS is expected to reach this fisheries resource. Yet in any occasion the area with elevated level of suspended solids would be confined within 80 m from the cable alignment, thus would not be materially different from that of the original cable alignment assessed in the approved EIA.

To ensure sediment plume from jetting machine will not encroach into the gazetted boundary of the Upper Cheung Sha Beach, jetting machine will only be used for installation at cable alignment at least 80 m away from the gazetted boundary of the Upper Cheung Sha Beach. For installation of cable section within 80 m from the gazetted boundary of the Upper Cheung Sha Beach, cable installation would be conducted by diver with handheld jetting tool, which has less disturbance to bottom sediment and lower water quality impact overall. Assessment for each types of WSRs are summarized in *Table 3.4* below.

Table 3.4: Summary of Assessment on Each Type of WSRs

Type of WSRs	Shortest Geodesic Distance	Assessment Findings
Horseshoe Crab	> 600 m from the horseshoe crab habitat northwest of Shek Kwu Chau	Sediment plume will not encroach into sensitive receiver. No adverse water quality impact expected.
Gazetted Beaches	Immediate proximity of gazetted bathing beach of Upper Cheung Sha	No work would be conducted in the bathing season from April to October. Furthermore, cable laying with jetting machine will be avoided for cable section 80 m away from the gazetted boundary of Upper Cheung Sha to minimize SS impact on the gazetted beach of Upper Cheung Sha.
Spawning and Nursery Grounds of Commercial Fisheries Resources	Immediate proximity	Sediment plume will affect area within 80 m from the jetting operation in any occasion, which is the same as that in the approved EIA. Level of change in water quality is expected to be remain similar.

Type of WSRs	Shortest Geodesic Distance	Assessment Findings
Fish Culture Zones	>4000 m from the Cheung Sha Wan Fish Culture Zone	Sediment plume will not encroach into sensitive receiver. No adverse water quality impact expected.
Coral Communities.	> 350 m from coral habitat at the southwestern coast of Shek Kwu Chau	Sediment plume will not encroach into sensitive receiver. No adverse water quality impact expected.

The following mitigation measures should be undertaken for submarine cable works outside of the gazetted boundary of the Cheung Sha bathing beach:

- 80m cable segment outside the gazetted beach should be installed by divers using hand jet;
- The forward speed of the cable installation barge will be limited to a maximum of 1 km hr^{-1}; and
- Water quality monitoring will be carried out to verify that the Project works will not result in any impacts to water quality, and consequently to marine ecology and fisheries. In case of any Limit Level exceedances, repeat sampling event to confirm findings and implement the most appropriate method of reducing suspended solids during cable installation.

With the implementation of the above mentioned mitigation measures, no long term disruption of bottom sediment will occur and no disruption to water movement will result from the proposed changes. Once the cable is installed/ repaired, the bottom sediment will naturally resettle. No unacceptable adverse impacts to water quality will occur during or after the marine works.

3.1.2 Marine Ecology

There is no existing marine Site of Special Scientific Interest (SSSI) within the vicinity of the cable corridor and the landing site. A proposed Shui Hau Wan SSSI is located at ~2.5 km away from the Project and hence is not expected to be affected by the cable installation/ repair operation works (see *Figure 3.1*).

3.1.3 Marine Mammals

3.1.3.1 Underwater Sounds

It was found that Finless Porpoise (FP) rarely occurred in the inshore portion of South Lantau waters. And there is no clear temporal trend observed for the FP in the vicinity of the Project area over the years, the recent data suggested that the IWMF reclamation site and surrounding offshore waters (waters within ~1.2 km from the shoreline) remain as important FP habitats with high FP densities recorded. It is expected that the cable installation works will last for a short duration (approximately 30 working days for the actual cable installation using cable burying machine, excluded shore-end section) and will involve one main cable installation barge and limited number of supporting vessels (total up to 4 nos. vessels). Cable installation using injector burial tools are not expected to cause unacceptable elevations in underwater sounds to marine mammals as the water jets will be located within marine sediments which will dampen down sounds generated during the works. The cable installation works may still result in a minor and short-term increase in underwater sound.

With reference to the latest approved EIA Report in South Lantau (ie Hong Kong Offshore LNG Terminal EIA-256/2018), construction works including dredging and backfilling activities as well as jetting for the submarine gas pipeline installation can result in a minor and short term increase in underwater sound which may potentially affect FP. Small cetaceans are acoustically sensitive at certain frequencies, and

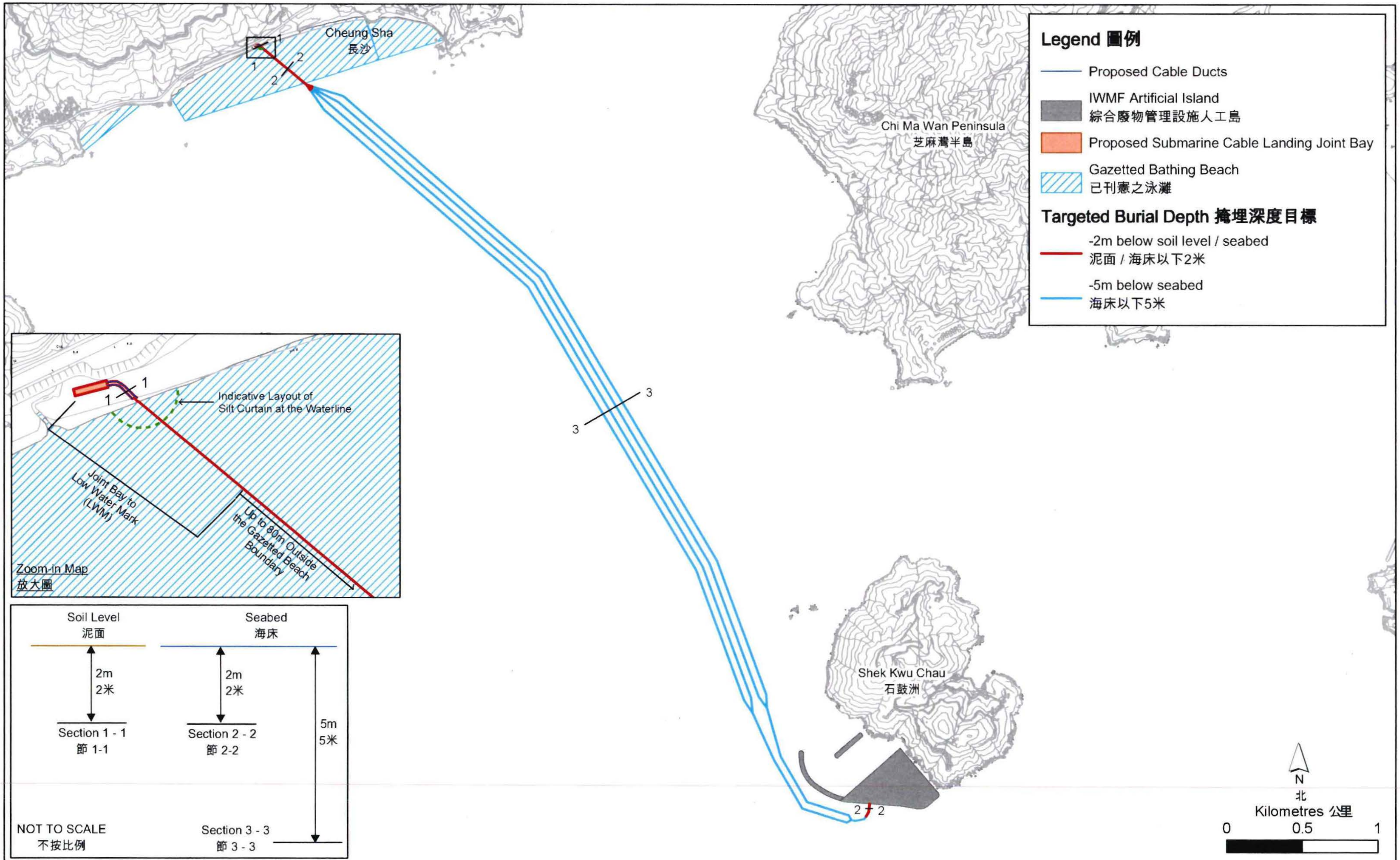

Figure 3.2
圖 3.2

Indicative Burial Depths of the 132kV Submarine Cable connecting Cheung Sha and Shek Kwu Chau Artificial Island
在連接長沙及石鼓洲人工島132千伏海底電纜的掩埋深度示意圖

File: T:\GIS\CONTRACT\0500403\mxd\0500403_Indicative_Burial_Depth_Silt_Curtain.mxd
Date: 20/3/2020

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sound is important to their behavioural activities. Most cetaceans can hear within the range of 1 to 150 kHz [(1)]. FPs vocalise at much higher frequencies and produce high frequency ultrasonic narrowband clicks at a peak frequency of 142 kHz, which are inaudible to the human ear [(2)].

Dredging, jetting and large vessel traffic generally results in low frequency noise, typically in the range of 0.02 to 1 kHz [(3)], which is below the peak range of 142 kHz reported for porpoises. A study was conducted to investigate the underwater sound levels produced during the installation of submarine cable in southeastern waters of Hong Kong. The results indicated that the cable installation barge and the support vessels (with total up to 4 nos. vessels) generated sound with frequency between 40 Hz and 25 kHz, which were lower than the sound used for foraging and communication for FPs [(4)]. Cable installation works are therefore not considered causing significant acoustic disturbance to marine mammals. Marine mammals may have short-term avoidance of the immediate works areas of sound generating activities, but are expected to return when the disturbance ceases. Unacceptable adverse impacts of increased underwater sound level on marine mammals are not anticipated.

Given the small scale and nature of this project compare with the Hong Kong Offshore LNG Terminal, the low frequency underwater sound associated with vessels, injection jetting and cable installation for the project would thus not be expected to interfere significantly with FPs which could occur in the South Lantau waters. The cable installation works of this project will be short-term and temporary and be carried out by one slow moving cable installation barge. Barge operation for cable installation works will take a total of approximately 30 working days (submarine cable section using cable burying machine, excluded shore-end section) and this short timeframe is not expected to interfere significantly with this cetacean species either. Significant disturbance to the FP, in terms of underwater noise, marine traffic and reduction of food source, is therefore not expected. Based on this, and the predicted localised and very short term impacts to water quality, no unacceptable adverse impacts are predicted to occur to marine mammals.

3.1.3.2 Temporary Disturbance

The submarine cable installation will involve jetting and is scheduled to last for 3 months, including contingency. With a short works programme involving day time work only, it is expected that marine mammals that have avoided the vicinity of the works areas can return to the area sooner. Considering the temporary nature of the disturbance, impacts on marine mammals are expected to be of minor significance. Upon cessation of the disturbance, no significant long-term change in marine mammal distribution, abundance and usage pattern in the wider Hong Kong waters is expected.

3.1.3.3 Increased Marine Traffic

The submarine cable installation for a submarine circuit will be conducted by one cable laying barge and total up to 4 vessels. There are two main ways that the increased vessel movements due to construction activities has the potential to impact marine mammals. Firstly, vessel movements may potentially increase risks of physical injuries to marine mammals. In Hong Kong, there have been

(1) Richardson et al. 1995. Marine Mammals and Noise. Academic Press.

(2) Goold JC & Jefferson TA (2002) Acoustic signals from free-ranging finless porpoises (*Neophocaena phocaenoides*) in waters around Hong Kong. The Raffles Bulletin of Zoology Supplement 10:131-139.

(3) Richardson et al. 1995. Marine Mammals and Noise. Academic Press.

(4) See Annex A1 Report on Measurement of Underwater Sound Levels Around Submarine Cable Installation Barge under Appendix A of this ERR

instances when small marine mammals have been killed or injured by vessel collisions [(1)] [(2)], and it is thought that this risk is mainly associated with high-speed vessels. Given the total up to 4 marine vessels to be used within a short works programme (ie 3 months) for cable installation works are slow moving, the risk of vessel collision with marine mammals is considered to be very small. As such, impacts to marine mammals due to vessel collision are not anticipated to be significant. Secondly, the physical presence of works vessels may cause short-term avoidance of the area where works vessels are operating, and this has been discussed above in terms of temporary disturbance.

Therefore overall no unacceptable adverse impacts to FP from the proposed changes of Project are expected to occur.

3.1.4 Other Marine Ecological Resources

A review of the existing information on the marine ecological resources surrounding the submarine cable route has identified the area as supporting benthic fauna which can be considered as typical for Hong Kong waters and thus of low ecological value (see *Appendix A*). Although these soft bottom assemblages will be disturbed during the submarine cable installation/ repair operation, the area of disturbance is small and rapid reinstatement of the seabed will result in the area being available for prompt recolonization. Hence, no permanent impacts are likely to occur.

No coral communities of high ecological importance have been identified within the cable corridor and the landing site (see *Appendix A* and *Figure A1*). The nearest coral communities were recorded at the southwestern coast of Shek Kwu Chau, which is located more than 350 m from the cable corridor. As the dispersion of the sediment plume is predicted to be no more than 80 m from the cable injector, the coral communities are not expected to be affected by the Project (see *Appendix A*).

Adverse impacts to marine ecological resources have largely been avoided during submarine cable installation/ repair operation, as well as RC/ PLGR operation, through the selection of a landing site and cable corridor that reduce impacts to marine ecological resources such as coral communities and through the employment of cable installation techniques that result in little disruption to the marine environment. It should be noted that the direct impacts on the marine ecological resources, especially intertidal and subtidal habitats, is further reduced compared to the impact assessment in the approved EIA Report (EIA-201/2011) through the selection of the alternative cable landing site (*Appendix A*).

3.1.5 Proposed Mitigation Measures

Mitigation measures that have been recommended to reduce impacts to water quality are also expected to control impacts to marine ecological resources, particularly for coral communities in the vicinity of the cable alignment. These mitigation measures include limiting the maximum speed of the cable installation machine (not exceed 1 km hr^{-1}) and implementing good house-keeping practices for the works within the beach. A marine mammal exclusion zone (within a radius of 250 m from the cable installation/ repair vessel) during submarine cable installation/ repair operation works along the whole cable route is recommended to be implemented as a precautionary measure to reduce disturbance to marine mammals, especially the FPs. In addition, jetting works will be limited to day time only and all marine vessels within the works areas shall not travel at a speed higher than 10 knots (ie 18.5 km hr^{-1}) to minimize vessel collision to the marine mammals. All these measures will ensure that no unacceptable adverse impacts to the marine mammals will be resulted from cable installation works. And therefore the Condition 2.5 (i) "*To minimize the acoustic disturbance to marine mammals:*

(1) Parsons ECM, Jefferson TA (2000) Post-mortem investigations on stranded dolphins and porpoises from Hong Kong waters. Journal of Wildlife Diseases 36: 342-356.

(2) Jefferson TA, Curry BE, Kinoshita R (2002) Mortality and morbidity of Hong Kong finless porpoises, with special emphasis on the role of environmental contaminants. Raffles Bulletin of Zoology (Supplement) 10: 161- 171.

construction works that may produce underwater acoustic disturbance shall be restricted within June to November to avoid peak season of Finless Porpoise occurrence." is deemed unnecessary.

3.1.6 Fisheries

A review of existing information on the fisheries resources and fishing operations in the vicinity of the proposed changes has identified the majority of the area is supporting a fishery of low to medium ranking in terms of fisheries production. In addition, the increase in suspended solids (SS) concentrations will be localised, occurring within 80 m of the cable alignment according to the calculation of the disturbed sediment due to the cable installation as presented in the approved EIA Report, and the marine works will last for a short period of time (ie about 30 working days for cable installation for submarine cable section using cable burying machine, excluded shore-end section). It is expected that the sediments lost in suspension are likely to remain in the lower part of the water column and settle back onto the seabed within a short period of time and fishing vessels could continue to operate in nearby waters during the construction the Project. Therefore, no long-term direct impacts to fisheries resources or fishing operations are expected to occur aside from minor short-term disturbances to the seabed and fishing ground/nursery area/ spawning ground of commercial fisheries resources in the immediate vicinity of cable installation/ repair operation activities, and short-term displacement of fishing activities from the works area. The seabed will be reinstated to before-work level and condition very shortly. Hence the works are not expected to result in any unacceptable adverse impacts to water quality and consequently fisheries resources or fishing operations from proposed changes.

There are no gazetted Fish Culture Zones within 500 m of the proposed cable route. The Cheung Sha Wan Fish Culture Zone is located about 4.5km away from the cable route. Mitigation measures that have been recommended to reduce impacts to water quality, including limiting the maximum speed of the cable installation machine (not exceed 1 km hr^{-1}) and implementing good house-keeping practices are also expected to control impacts to fisheries resources. No other specific mitigation measures have been recommended as no adverse impacts to fisheries resources have been identified (see *Appendix B*).

3.2 Maintenance and Repair during Operational Phase

It is considered unlikely that the submarine cable will require maintenance during operation, however should an occasion of cable fault arise that necessitates this, repair operation will be required. Methods used for cable maintenance and repair at any location along the submarine cable route are anticipated to be as per those used for cable installation during construction, with the potential to use smaller equipment such as Remotely Operated Vehicles (ROVs) equipped with injector tool. More details are provided in Stage 4 under *Section 2.2*.

Repair works will be conducted along the same proposed alignment as installed cable but duration of any cable repair work is anticipated to be of shorter duration than cable installation during construction, since repair work will generally be conducted at point fault location(s) rather than along the whole cable alignment. ROVs generally have reduced jetting power compared to installation injector tools (typical injector tools jet around eight times (x8) more litres of water per minute than typical ROVs) and diver hand jetting is even less powerful (ROVs jet around four times (x4) more litres of water per minute than typical diver jetting). Grapnels on the other hand do not use jetting but simply penetrate the sea bed and are therefore not expected to cause significant sediment plumes. The recovery of any faulty cable using diver, ROV or grapnels is expected to cause sediment plume that would be no greater than sediment plume generated during installation, i.e. the maximum distance of transport for the suspended sediments would not be more than 80 m.

Therefore overall, potential impacts are anticipated to be less during cable maintenance and repair works than those for cable installation during construction. Since cable installation during

construction is not considered to cause significant adverse environmental impacts, therefore no unacceptable adverse environmental impacts are considered likely should maintenance and repair be required.

4. REVIEW OF ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENTS

As no works will be carried out within the Upper Cheung Sha Beach during the bathing season, the review of the potential environmental impacts associated with the changes indicated that no unacceptable environmental impacts would be anticipated. However, monitoring for water quality should be carried out to ensure no water quality impact to nearby WSRs from the Project in accordance with the Environmental Monitoring and Audit (EM&A) requirements from the approved EIA Report for the IWMF and the newly proposed beach water quality monitoring in this VEP. This EM&A will be a separate EM&A programme to be undertaken by CLP for this VEP, and will be submitted in accordance with FEP Condition 3.1.

5. CONCLUSION

An Environmental Review has been carried out to assess the potential environmental impacts associated with the proposed changes. The assessment indicates that no unacceptable environmental impacts are anticipated from the proposed changes. No additional mitigation measures are considered necessary for the proposed changes.

APPENDIX A ASSESSMENT OF POTENTIAL IMPACTS TO MARINE ECOLOGY RESOURCES

1. INTRODUCTION

This *Appendix* presents the baseline conditions of marine ecological resources in the vicinity of the proposed changes of the Project and evaluates the potential for direct and indirect impacts to them during construction and operation of the Project. Baseline conditions are evaluated based on information from the literature and recent field verification conducted for the purposes of this assessment. Measures required to mitigate identified impacts are recommended, where appropriate.

2. RELEVANT LEGISLATION AND ASSESSMENT CRITERIA

The criteria for evaluating marine ecological impact are laid out in the *EIAO-TM*. *Annex 16* of the *EIAO-TM* describes the general approach and methodology for assessment of impacts to marine ecological resources arising from a project or proposal to allow a complete and objective identification, prediction and evaluation. *Annex 8* of the *EIAO-TM* sets out the criteria for evaluating such potential ecological impacts.

3. EXISTING MARINE ECOLOGICAL RESOURCES

3.1 Site of Special Scientific Interest

There is no existing marine Site of Special Scientific Interest (SSSI) within and in the vicinity of the proposed cable corridor and the landing site. However, it is noticed that Shui Hau Wan, located at ~2.5 km away from the Project, is a proposed SSSI. Shui Hau Wan is a large natural sand/ mudflat (> 10 ha) in Hong Kong, and is identified as an Extremely Important soft shore habitat for conservation and education purposes in Hong Kong [(1)]. It is also one of the confirmed nursery sites for horseshoe crabs in recent years [(2)] [(3)], and based on the abundance of juveniles, Shui Hau Wan is identified as the key nursery ground for *Tachypleus tridentatus* [(4)] [(5)] (*Figure A1*).

3.2 Marine Parks

Two marine parks are proposed to be designated in southern waters, including Southwest Lantau Marine Park and South Lantau Marine Park as shown in *Figure A1*. These proposed marine parks are important habitats for Chinese White Dolphins (CWDs) and Finless Porpoises (FPs).

3.3 Coastal Protection Areas

A long strip of land (approximately 162 ha) along the South Lantau Coast is zoned as "Coastal Protection Area" (CPA) which covers backshore coastal habitats and the sandy shore of the gazetted bathing beaches at Pui O, Cheung Sha and Tong Fuk (*Figure A1*). This zoning of CPA is intended to conserve, protect and retain the natural coastlines and the sensitive coastal natural environment, including attractive geological features, physical landform or area of high landscape, scenic or ecological value, with a minimum of built development.

Both Proposed Landing Site and part of the Proposed Land Cable Route fall within the CPA zone (*Figure A1*).

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(1) Shin PKS, Cheung SG (2005) A Study of Soft Shore Habitats in Hong Kong for Conservation and Education Purposes. Environment and Conservation Fund (ECF) Project 23/99. Final Report, 56 pp.

(2) Chiu HMC, Morton B (1999) The Biology, Distribution and Status of Horseshoe Crabs, *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda* (Arthropoda: Chelicerata) in Hong Kong: Recommendations for Conservation and Management. Final Report. The Swire Institute of Marine Science, The University of Hong Kong

(3) Li HY (2008) The Conservation of Horseshoe Crabs in Hong Kong. MPhil Thesis. The City University of Hong Kong

(4) Li HY (2008) *Op cit.*

(5) *Carcinoscorpius rotundicauda* has not been recorded in Shui Hau Wan (Li 2008)

3.4 Marine Mammals

A total of 18 (and possibly up to 20) species of marine mammals (mostly cetaceans) have been recorded in Hong Kong waters (including one humpback whale sighted in 2009, one stranding record of Omura's whale in 2014 and one short-fin pilot whale sighted in 2015), two of which are considered residents: the Indo-Pacific humpback dolphin (*Sousa chinensis*, locally called CWDs) and the FPs (*Neophocaena phocaenoides*) [(1)]. Studies on the distribution, abundance, habitat use and life history of CWDs and FPs within Hong Kong have been undertaken since 1995 [(2)]. The results of these ongoing studies indicated that an estimated number of over 2,500 CWDs are utilising waters of the Pearl River Estuary [(3)]. In the AFCD survey of 2016-2017, 150 CWD individuals have been seen within Hong Kong waters while 150 groups of 403 FPs were sighted during vessel and helicopter surveys [(4)]. The majority of FPs was sighted between Shek Kwu Chau and the Soko Islands, which is consistent with the findings in the past several years [(5)].

3.4.1 Summary of IWMF EIA Data

Line-transect surveys were conducted from December 2008 to May 2009 in the Southeast Lantau area as part of the IWMF EIA Study [(6)]. A total of 29 groups of 49 FP individuals were sighted and the majority of sightings was observed at the southwest of Shek Kwu Chau, and the offshore waters at the southwest portion of the survey area (*Figure A2).* CWD was not sighted in the Southeast Lantau waters during the survey period from December 2008 to May 2009.

Summary of AFCD Marine Mammal Monitoring Data Most CWD sightings were made in West Lantau and Southwest Lantau areas, while sightings of CWDs were rare in Southeast Lantau around the Project area, with five sightings recorded during April 2016 to March 2017 [(7)]. CWDs were rarely recorded around the Project area over the past few years, with only 1-2 sightings recorded each year [(8)(9)(10)(11)(12)(13)(14)]. As such, it is considered that the Project area is not a major habitat for CWD.

In 2016-2017, the majority of FP sightings were recorded between the Soko Islands and Shek Kwu Chau as well as to the south of Cheung Chau especially during the dry season (December to May) as shown in *Figure A3*. Some sightings were made to the south of Soko Islands, between Lamma Island and Cheung Chau, around and to the east of Po Toi Islands, and in the offshore waters to the east of Sai Kung Peninsula. It was found that FPs rarely occurred in the inshore portion of South Lantau waters, except a few sightings within Pui O Wan. When comparing with 2013-2016 data on FP distribution pattern, it was found that FP occurrence was less frequent in inshore portion of South

(1) Jefferson TA, Hung SK (2007) An updated, annotated checklist of the marine mammals of Hong Kong. Mammalia 2007: 105–114

(2) Hung, S.K.Y. (2017) Monitoring of Marine Mammals in Hong Kong Waters (2016-17). Final Report.

(3) Chen, T., Hung, S.K., Qiu, Y., Jia, X. and Jefferson, T.A. (2010) Distribution, abundance, and individual movements of Indo-Pacific Humpback Dolphins (*Sousa chinensis*) in the Pearl River Estuary, China. Mammailia 74: 117-125.

(4) Hung, S.K.Y. (2017) *Op. cit.*

(5) Hung, S.K.Y. (2017) *Op. cit.*

(6) AECOM (2011) Agreement No. CE29/2008 (EP) Engineering Investigation and Environmental Studies for Integrated Waste Management Facilities Phase 1 – Feasibility Study. EIA Report.

(7) Hung, S.K.Y. (2017) *Op. cit.*

(8) Hung, S.K.Y. (2016) Monitoring of Marine Mammals in Hong Kong Waters (2015-16). Final Report.

(9) Hung, S.K.Y. (2015) Monitoring of Marine Mammals in Hong Kong Waters (2014-15). Final Report.

(10) Hung, S.K.Y. (2014) Monitoring of Marine Mammals in Hong Kong Waters (2013-14). Final Report.

(11) Hung, S.K.Y. (2013) Monitoring of Marine Mammals in Hong Kong Waters (2012-13). Final Report.

(12) Hung, S.K.Y. (2012) Monitoring of Marine Mammals in Hong Kong Waters (2011-12). Final Report.

(13) Hung, S.K.Y. (2011) Monitoring of Marine Mammals in Hong Kong Waters (2010-11). Final Report.

(14) Hung, S.K.Y. (2010) Monitoring of Marine Mammals in Hong Kong Waters (2009-10). Final Report.

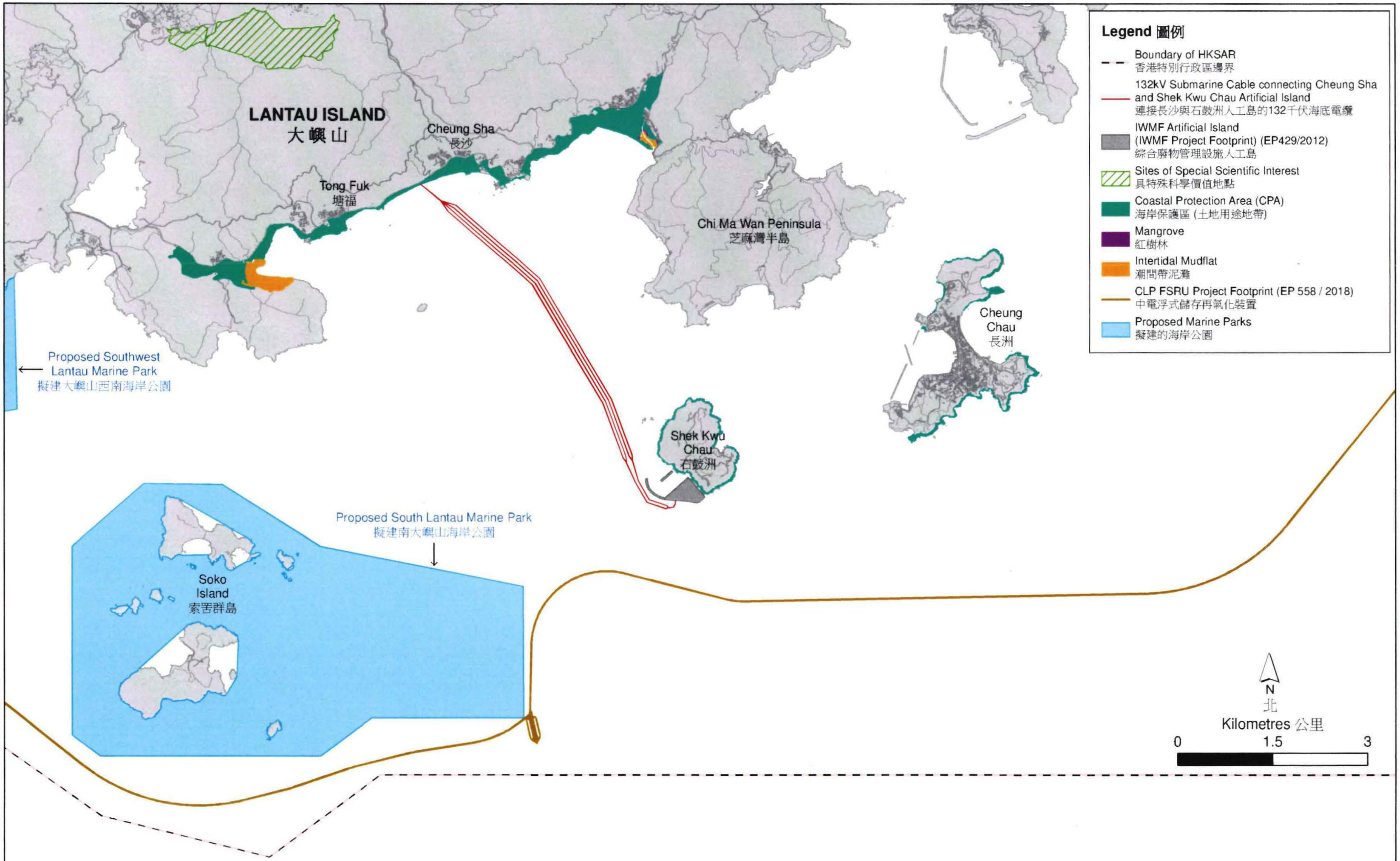

Figure A1
圖 A1

Major Marine Ecological Elements in the Surroundings of the 132kV Submarine Cable connecting Cheung Sha and Shek Kwu Chau Artificial Island
鄰近連接長沙及石鼓洲人工島132千伏海底電纜的主要海洋生態要素

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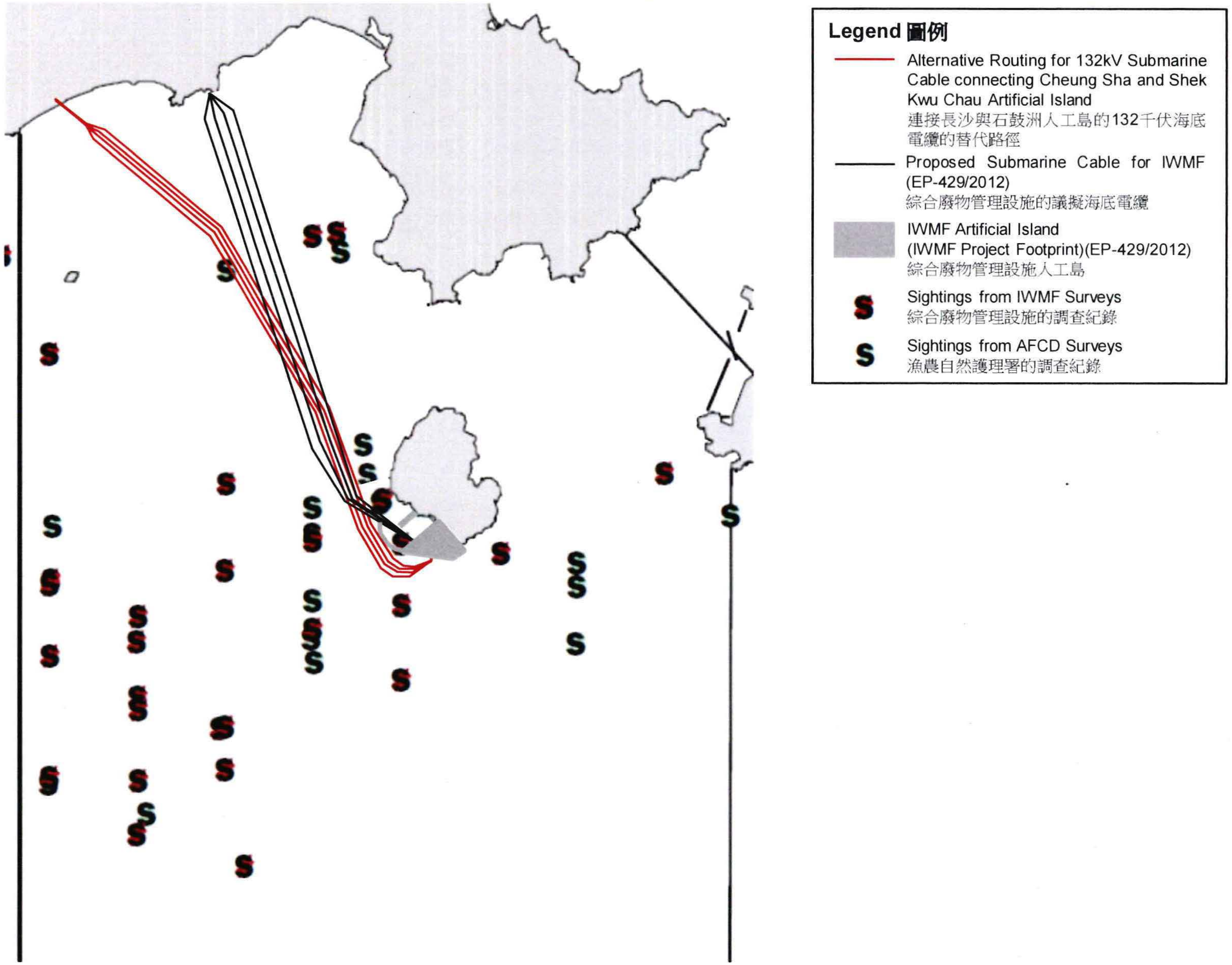

Figure A2
圖 A2

Distribution of Finless Porpoise Sighting in Southeast Lantau between December 2008 and May 2009
於2008年12月至2009年5月期間大嶼山東南面水域的江豚紀錄分佈
Source: IWMF EIA Report (EIA-201/2011)
來源：發展綜合廢物管理設施第一期環境影響評估報告（EIA-201/2011）

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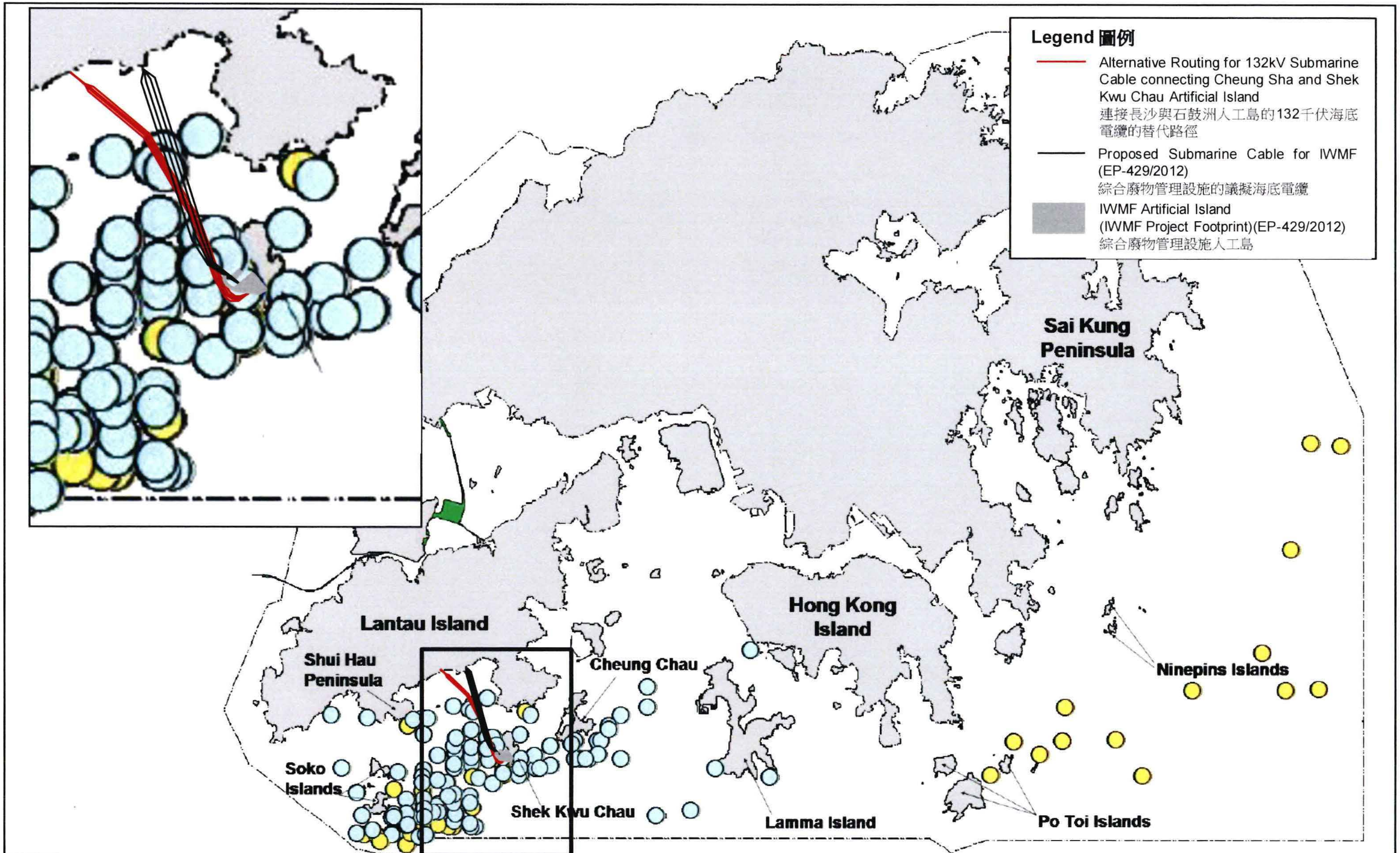

Figure A3
圖 A3

Distribution of Finless Porpoise Sightings between April 2016 and March 2017
於2016年4月至2017年3月期間的江豚紀錄分佈
Source: AFCD Marine Mammal Surveys 2016-17
來源：漁護署監察香港水域的海洋哺乳類動物(2016-17)
Yellow dots: sightings made during summer/autumn months (i.e. June to November)
黃點：於夏／秋季的紀錄（即六月至十一月）

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Lantau waters in 2013 and 2015 than in 2014 and 2016 (*Figure A4*). The FP encounter rate fluctuated over the years from 2002 – 2016 in Southeast Lantau and no clear temporal trend was observed (*Figure A5*).

The number of on-effort sightings per 100 units of survey effort (SPSE) and the number of dolphins per 100 units of survey effort (DPSE) values were calculated to obtain the habitat use patterns of FPs for the entire year of 2016 as well as the 10-year data from 2007 - 2016. It was found that the FP utilised more in the waters to the south of Cheung Chau, near Shek Kwu Chau and around the Soko Islands in 2016 (*Figure A6*). When using 2007-2016 data, it was found that important FP habitats were located to the south of Tai A Chau, west and southwest of Shek Kwu Chau, south of Cheung Chau and the waters between Shek Kwu Chau and the Soko Islands during dry season (*Figure A7*) while important FP habitats were also located at Po Toi and Ninepins during wet season (*Figure A8*).

3.4.2 Overall Summary

While there is no clear temporal trend observed for the FP in the vicinity of the Project area over the years, the recent data suggested that the IWMF reclamation site and surrounding offshore waters remain as important FP habitats with high FP densities recorded, which are similar to the findings in the IWMF EIA Study.

3.5 Intertidal Soft Bottom Assemblages

An individual of *Tachypleus tridentatus* was recorded at the northwestern waters offshore from Shek Kwu Chau, which was located more than 700 m away from the Project [(1)]. Nursery ground for juvenile horseshoe crabs was not identified at the coasts of Shek Kwu Chau and in the vicinity of the proposed cable corridor at Upper Cheung Sha [(2)]. The nearest nursery ground for horseshoe crabs is located at Shui Hau Wan in South Lantau, which is located over 2.5 km away from the Project footprint. Shui Hau Wan was identified as the key nursery ground for the horseshoe crab species *Tachypleus tridentatus* [(3)].

An updated intertidal survey was conducted in March 2017 to characterize the existing ecological conditions of the intertidal assemblages in the vicinity of the proposed cable corridor at the coastal areas of Upper Cheung Sha. The intertidal surveys consisted of quantitative transect surveys and qualitative walk-through surveys at the accessible shorelines in the vicinity of the proposed cable corridor.

For quantitative transect survey, survey locations were identified along the shoreline as shown in *Figure A9*. At each survey location, one 100 m horizontal (belt) transects were surveyed at each of the three shore heights: 2 m, 1.5 m and 1 m above Chart Datum. These transects were located to cover the intertidal sandy shores within 500 m of the proposed landing site at Upper Cheung Sha. On each transect, five quadrats (50 cm x 50 cm) were placed randomly in each transect to assess the abundance and distribution of flora and fauna. All organisms found in each quadrat were identified and recorded to species level so that density per quadrat could be determined. Sessile animals such as barnacles and oysters in each quadrat were not counted but estimated as percentage cover on the rock surface. All species of algae (encrusting, foliose and filamentous) were also identified and recorded by estimating the percentage cover on the rock surface. All organisms were identified to the lowest possible taxonomic level (at least Genus level). Species encountered outside the quadrat but in the vicinity of survey transect were also recorded. For qualitative walk-through surveys, the same

(1) Chiu HMC, Morton B (1999) The biology, distribution and status of horseshoe crabs, *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda* (Arthropoda: Chelicerata) in Hong Kong: Recommendations for conservation and management. Final Report. The Swire Institute of Marine Science, The University of Hong Kong

(2) AECOM (2011) *Op cit.*

(3) Li HY (2008) *Op cit.*

accessible shorelines were surveyed, and organisms encountered were recorded and their relative abundance noted.

A total of 22 intertidal fauna, 3 algae and 1 cyanobacteria species were recorded during intertidal surveys in the surveyed area, from both qualitative walk-through surveys and quantitative transect surveys. The majority of the intertidal fauna recorded was bivalves (*Caecella* sp., *Ruditapes* sp., *Tapes* sp.) in the sandy shore while gastropods, limpets and bivalves were also recorded on the boulders of the sandy shores. A list of organisms encountered during the qualitative walk-through surveys and transect surveys is provided in *Table 1.*

These species are all common and widespread species on intertidal shores of Hong Kong. Quantitative transect surveys were conducted and the mean density of intertidal species recorded at the three transect are presented in *Table 2.* In general, benthos were only present in middle and lower intertidal shores at locations T1, T2 and T3 and dominated by *Caecella* sp..

Overall, results of the intertidal survey showed that all species were common and widespread, and no species of conservation importance were recorded.

Table 1: Full List of Intertidal Species Recorded during the Intertidal Surveys

Class	Species	Type	T1	T2	T3
Gastropoda	*Peasiella* sp.	Periwinkle	Y	Y	
	Echinolittorina radiata	Periwinkle	Y	Y	
	Littoraria articulata	Periwinkle	Y	Y	
	Nipponacmea concinna	Limpet	Y		
	Cellana toreuma	Limpet	Y	Y	
	Patelloida saccharina	Limpet	Y	Y	
	Patelloida pygmaea	Limpet	Y	Y	
	Siphonaria laciniosa	False Limpet	Y	Y	
	Reishia clavigera	Whelk	Y	Y	
Polyplacophora	*Liolophura japonica*	Chiton	Y		
Bivalvia	*Perna viridis*	Bivalve	Y	Y	
	Saccostrea cucullata	Bivalve	Y	Y	
	Caecella sp.	Bivalve	Y	Y	Y
	Ruditapes sp.	Bivalve	Y		Y
	Tapes sp.	Bivalve	Y	Y	
Maxillopoda	*Capitulum mitella*	Barnacle	Y		
	Tetraclita japonica	Barnacle	Y	Y	
	Chthamalus malayensis	Barnacle	Y		
	Balanus amphitrite	Barnacle	Y		
	Copepoda	Copepod	Y		
Sipunculidea	*Siphonosoma* sp.	Sipunculid Worm	Y	Y	Y
Anthozoa	*Spheractis cheungae*	Anemone	Y		
Chlorophyceae	*Pseudulvella applanata*	Algae	Y		
Ulvophyceae	*Enteromorpha* sp.	Algae	Y		
	Ulva sp.	Algae	Y	Y	
Cyanophyceae	*Chroococcus* sp.	Cyanobacteria	Y	Y	

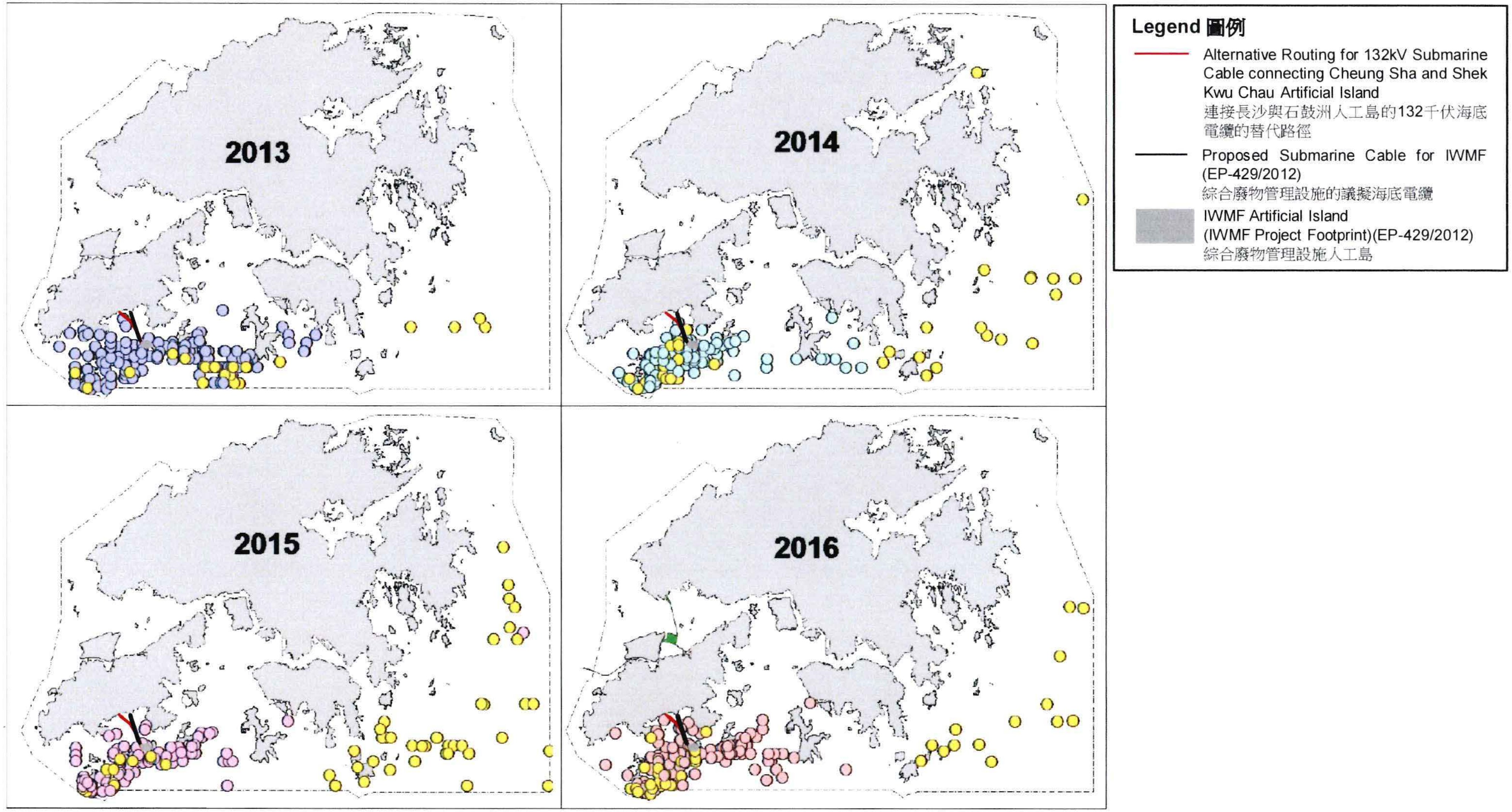

Figure A4
圖 A4

Annual Finless Porpoise Distribution Patterns between 2013 and 2016
2013至2016年度江豚分佈模式
Source: AFCD Marine Mammal Surveys 2016-17
來源：漁護署監察香港水域的海洋哺乳類動物(2016-17)
Yellow dots: sightings made during summer/autumn months (i.e. June to November)
黃點：於夏／秋季的紀錄（即六月至十一月）

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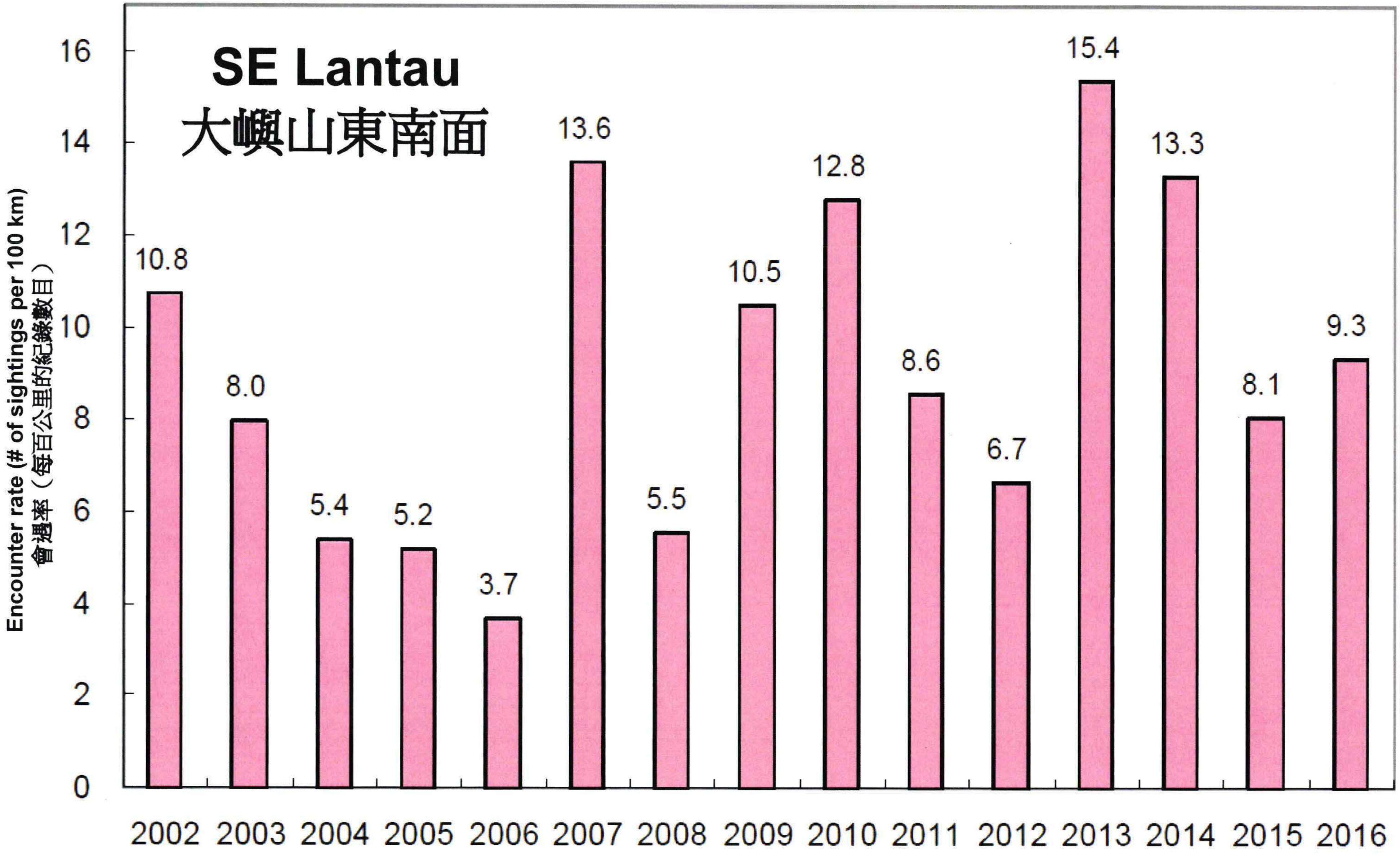

Figure A5
圖 A5

Temporal Trends in Encounter Rates of Finless Porpoise in Southeast Lantau between 2002 and 2016
2002至2016年度大嶼山東南面水域江豚會遇率的時間趨勢
Source: AFCD Marine Mammal Surveys 2016-17
來源：漁護署監察香港水域的海洋哺乳類動物(2016-17)

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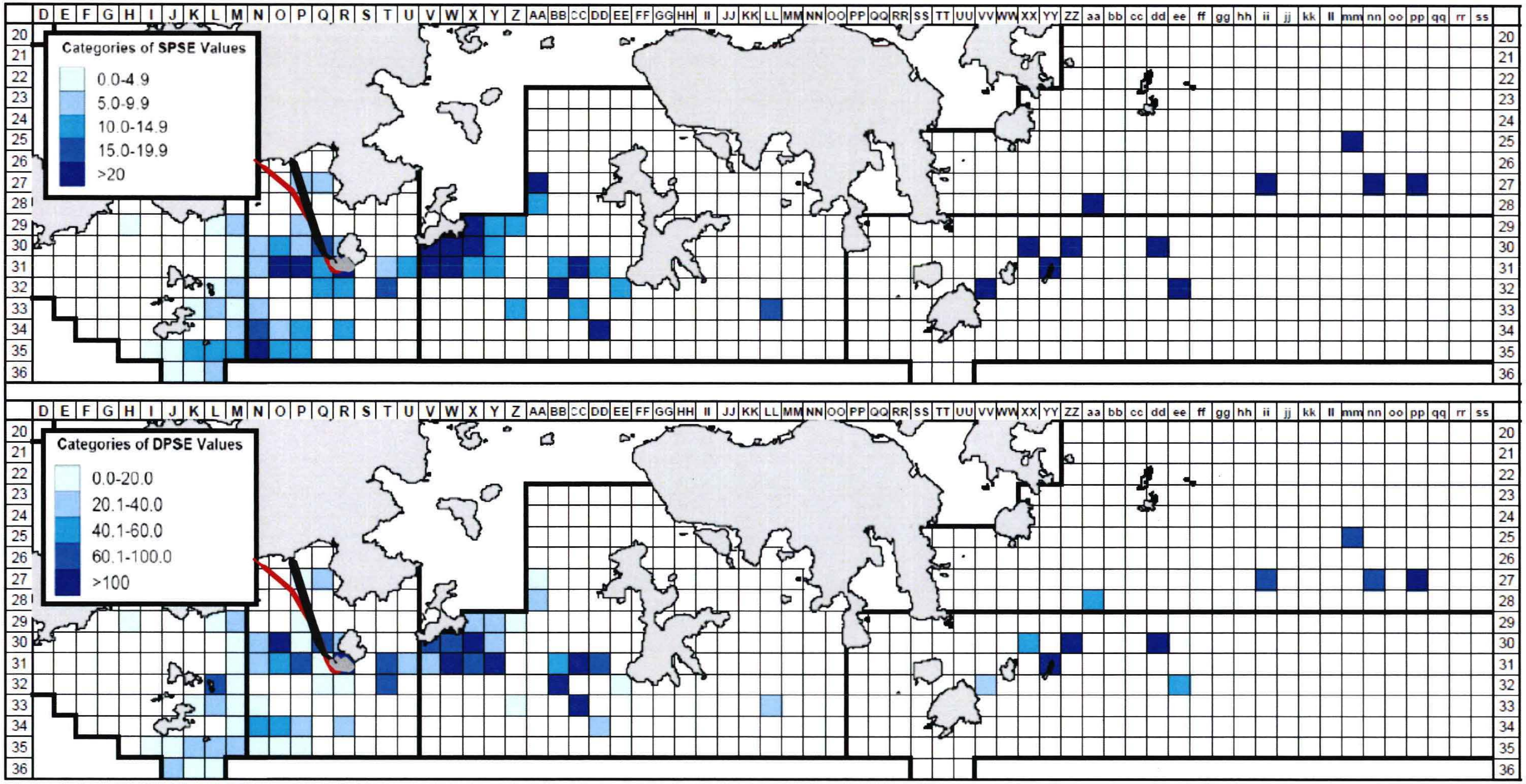

(Top) Sighting density of Finless Porpoises with corrected survey effort per km² in southern waters of Hong Kong (number within grids represent "SPSE" – no. of on-effort porpoise sightings per 100 units of survey effort)
(頂) 香港南面水域江豚紀錄密度（每百調查努力的有效江豚紀錄）

(Bottom) Density of Finless Porpoises with corrected survey effort per km² in southern waters of Hong Kong (number within grids represent "DPSE" – no. of porpoises per 100 units of survey effort)
(底) 香港南面水域江豚密度（每百調查努力的有效江豚數目）

Figure A6
圖 A6

SPSE and DPSE of Finless Porpoises in southern waters of Hong Kong in 2016
2016年度香港南面水域的江豚紀錄密度及江豚密度
Source: AFCD Marine Mammal Surveys 2016-17
來源：漁護署監察香港水域的海洋哺乳類動物(2016-17)

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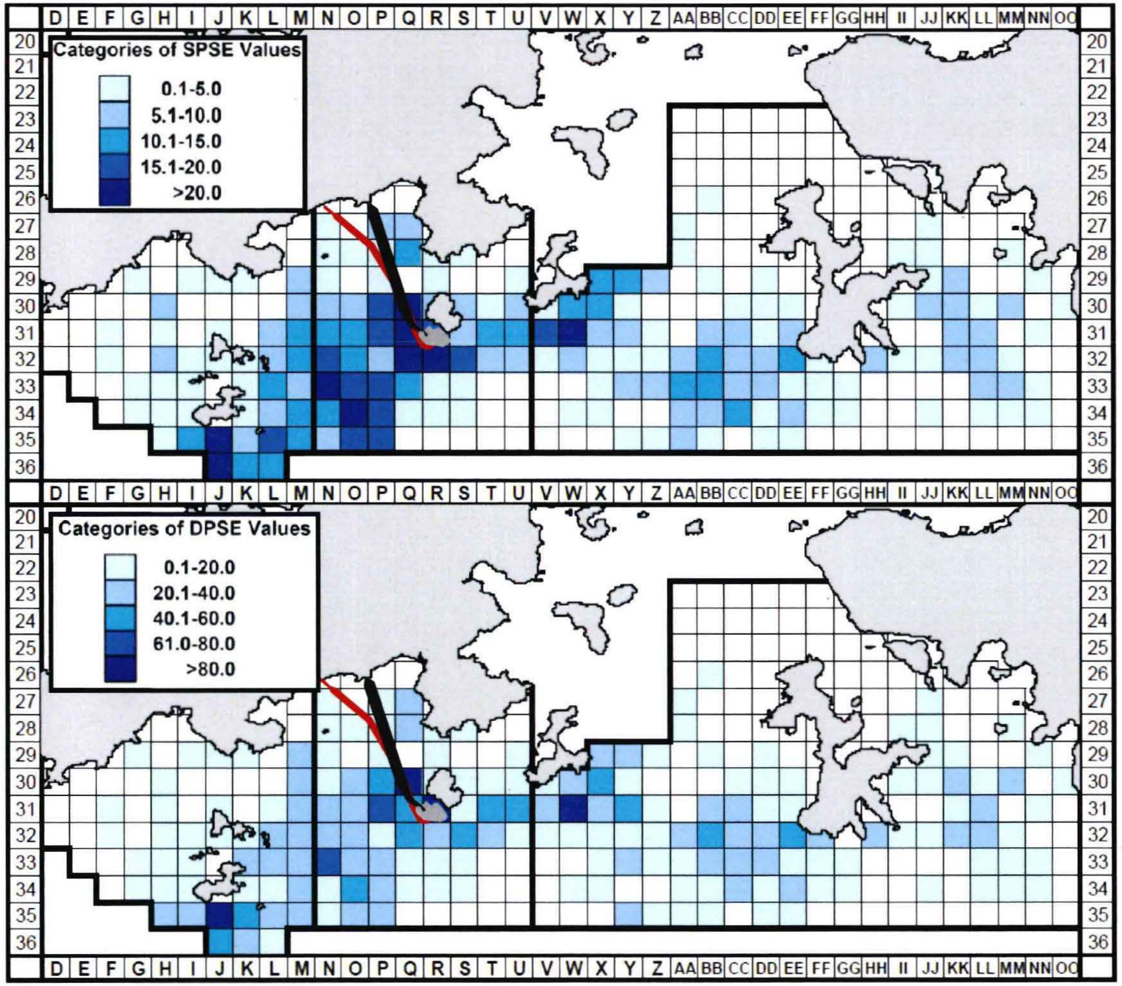

(Top) (頂) Sighting density of Finless Porpoises with corrected survey effort per km^2 in southern waters of Hong Kong (number within grids represent "SPSE" – no. of on-effort porpoise sightings per 100 units of survey effort)
香港南面水域江豚紀錄密度（每百調查努力的有效江豚紀錄）

(Bottom) (底) Density of Finless Porpoises with corrected survey effort per km^2 in southern waters of Hong Kong (number within grids represent "DPSE" – no. of porpoises per 100 units of survey effort)
香港南面水域江豚密度（每百調查努力的有效江豚數目）

Figure A7
圖 A7

SPSE and DPSE of Finless Porpoises in southern waters of Hong Kong during dry season (December to May) between 2007-2016
2007至2016年度旱季（十二月至五月）期間香港南面水域的江豚紀錄密度及江豚密度
Source: AFCD Marine Mammal Surveys 2016-17
來源：漁護署監察香港水域的海洋哺乳類動物(2016-17)

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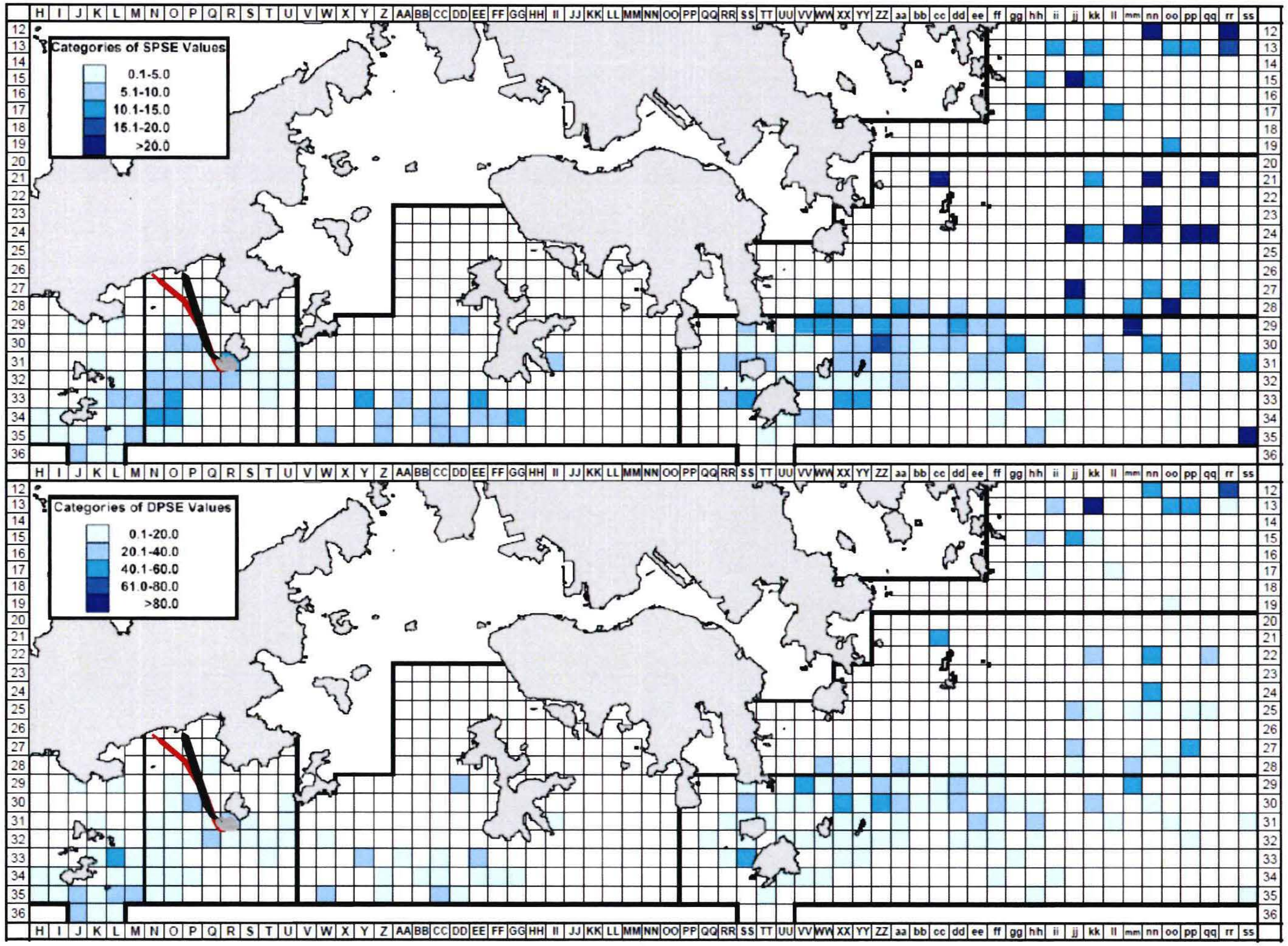

(Top)
(頂)

Sighting density of Finless Porpoises with corrected survey effort per km² in southern waters of Hong Kong (number within grids represent "SPSE" – no. of on-effort porpoise sightings per 100 units of survey effort)
香港南面水域江豚紀錄密度（每百調查努力的有效江豚紀錄）

(Bottom)
(底)

Density of Finless Porpoises with corrected survey effort per km² in southern waters of Hong Kong (number within grids represent "DPSE" – no. of porpoises per 100 units of survey effort)
香港南面水域江豚密度（每百調查努力的有效江豚數目）

Figure A8
圖 A8

SPSE and DPSE of Finless Porpoises in southern waters of Hong Kong during wet season (June to November) between 2007-2016
2007至2016年度雨季（六月至十一月）期間香港南面水域的江豚紀錄密度及江豚密度
Source: AFCD Marine Mammal Surveys 2016-17
來源：漁護署監察香港水域的海洋哺乳類動物(2016-17)

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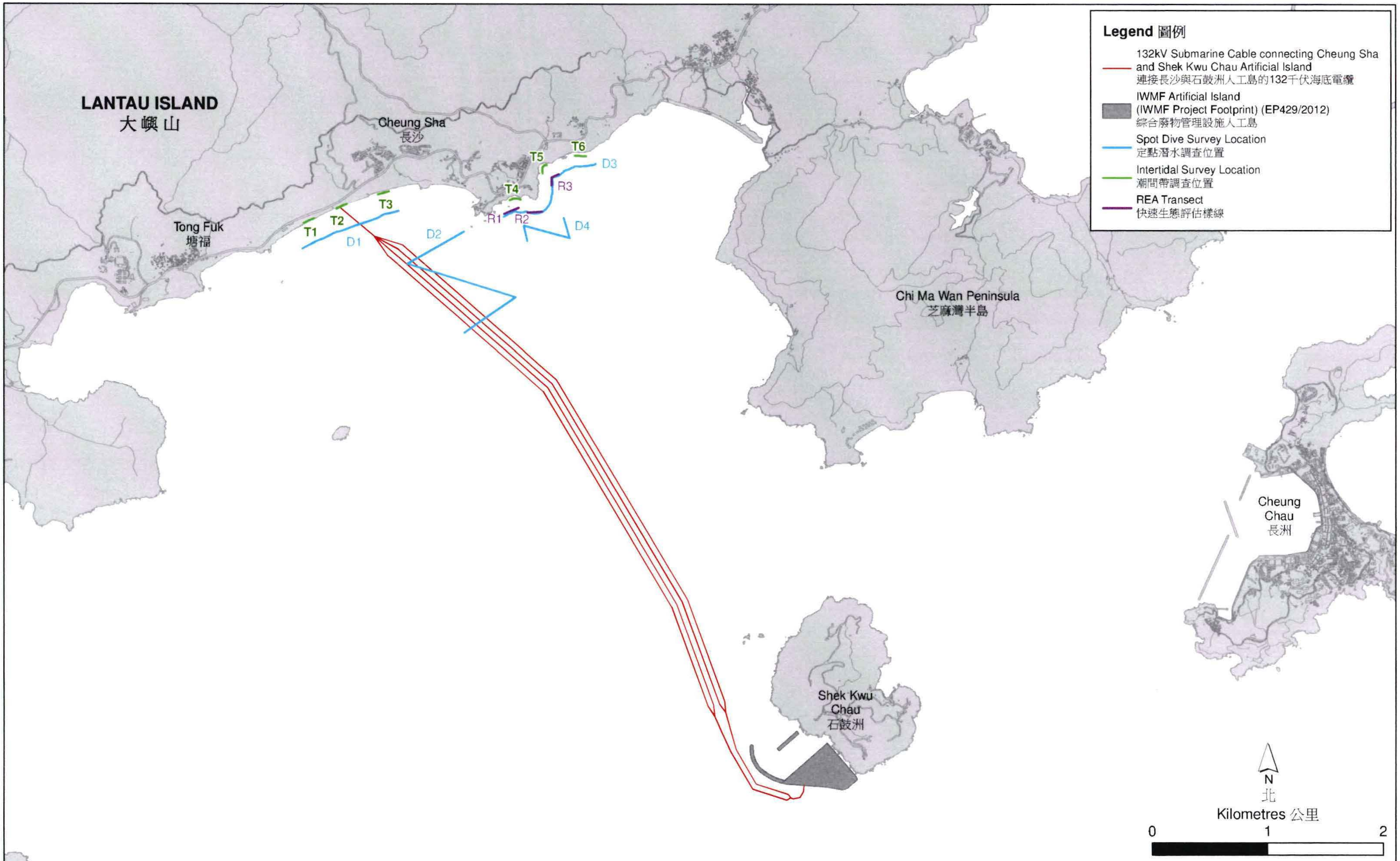

Figure A9
圖 A9

Locations of Intertidal and Subtidal Dive Surveys
潮間帶及潮下帶潛水調查位置

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Table 2: Average Density (abundance/ m^2) of Intertidal Fauna and Mean Coverage (% m^{-2}) of Sessile Fauna Recorded within and in the vicinity of the Project Area (L: low shore, M: mid shore & H: High shore)

Class	Species	Type	T1-L	T1-M	T1-H	T2-L	T2-M	T2-H	T3-L	T3-M	T3-H
Sipunculidea	*Siphonosoma* sp.	Sipunculid Worm	0.2	0.8	0	0.2	0	0	0.2	0	0
Bivalvia	*Caecella* sp.	Bivalve	2.2	1.2	0	1.8	10.8	0	0.4	1.2	0
	Ruditapes sp.	Bivalve	0	0.4	0	0	0	0	0.2	0.4	0
	Tapes sp.	Bivalve	0.8	0	0	0.4	1	0	0	0	0
Maxillopoda	Copepoda	Copepod	0	0	0	0	0	0	0.2	0	0

3.6 Intertidal Hard Bottom Assembladges

Information on the intertidal rocky shore assemblages in the vicinity of the proposed cable landing site is summarized from the IWMF EIA Study (1). A total of 34 and 53 floral and faunal species at rocky shore habitat of Shek Kwu Chau and Cheung Sha, respectively, were recorded during the walk-through and transect surveys(2). The survey locations for the IWMF EIA are shown in *Figure A9*. *Tetraclita squamosa* and *Saccostrea cucullata* were the dominant species at lower tidal level and *Echinolittorina radiata* and *Echinolittorina trochoides* were dominant at higher tidal level in Shek Kwu Chau; whilst *Echinolittorina radiata*, *Reishia luteostoma*, *Patelloida saccharina* and *Saccostrea cucullata* were the dominant species recorded during the surveys in Cheung Sha. No species of conservation importance was recorded. All of these species are common and typical fauna of this type of habitat. No recorded species was considered to be of conservation importance.

An updated survey was conducted in February 2017 at Cheung Sha to characterize the existing ecological conditions of the intertidal hard bottom assemblages in the vicinity of the original proposed cable corridor at the coastal areas of Upper Cheung Sha. The intertidal surveys consisted of quantitative transect surveys and qualitative walk-through surveys as described in *Section B3.5* at the accessible shorelines shown in *Figure A9*.

A total of 22 intertidal fauna, 8 algae and 1 cyanobacteria species were recorded during intertidal surveys at Cheung Sha, from both walk through surveys and transect surveys. The majority of the intertidal fauna recorded were gastropods. No infauna species was found in the sand at T5 (boulder shore) during the transect survey. A list of organisms encountered during the qualitative walk-through surveys and transect surveys is provided *Table 3*. These species are all common and widespread species on intertidal shores of Hong Kong.

Quantitative transect surveys were also conducted and the mean density of intertidal species recorded at the three transect are presented in *Table 4*. In general, there were more benthos present in middle and lower intertidal shores at locations T4, T5 and T6. Overall, results from IWMF EIA intertidal hard bottom surveys and the updated surveys have shown that the intertidal rocky shores at Shek Kwu Chau and Cheung Sha supported generally low abundances and densities of organisms, and therefore of low ecological value. It is also noted that no species of conservation importance were recorded.

(1) AECOM (2011) Op cit.

(2) AECOM (2011) Op cit.

Table 3: Full List of Intertidal Species Recorded during the Surveys

Class	Species	Type	T4	T5	T6
Gastropoda	*Echinolittorina radiata*	Periwinkle	Y	Y	Y
	Littoraria articulata	Periwinkle	-	-	Y
	Nipponacmea concinna	Limpet	Y	Y	Y
	Cellana toreuma	Limpet	Y	Y	Y
	Patelloida saccharina	Limpet	Y	-	Y
	Patelloida pygmaea	Limpet	Y	Y	
	Siphonaria laciniosa	False Limpet	-	Y	-
	Siphonaria japonica	False Limpet	Y	-	-
	Monodonta labio	Topshell	Y	Y	Y
	Planaxis sulcatus	Planaxid Snail	-	Y	-
	Nerita albicilla	Nerite	-	Y	-
	Thais clavigera	Whelk	Y	Y	-
Polyplacophora	*Acanthopleura japonica*	Chiton	Y	Y	Y
Bivalvia	*Isognomon isognomum*	Bivalve	-	-	Y
	Saccostrea cucullata	Bivalve	Y	Y	-
	Barbatia virescens	Bivalve	-	Y	-
Maxillopoda	*Capitulum mitella*	Barnacle	Y	Y	Y
	Tetraclita japonica	Barnacle	Y	Y	-
Anthozoa	*Haliplanella luciae*	Anemone	Y	Y	-
	Spheractis cheungae	Anemone	Y	-	-
Polychaeta	*Spirorbis spp.*	Tubeworm	Y	Y	-
Chlorophyceae	*Pseudulvella applanata*	Algae	Y	Y	Y
Florideophyceae	*Gelidium pusillum*	Algae	-	-	Y
	Hildenbrandia occidentalis	Algae	Y	Y	Y
	Hildenbrandia rubra	Algae	Y	Y	Y
Phaeophyceae	*Endarachne binghamiae*	Algae	-	Y	Y
	Hapalospongidion gelatinosum	Algae	-	Y	Y
	Hincksia mitchelliae	Algae	-	-	Y
Ulvophyceae	*Ulva spp.*	Algae	Y	Y	Y
Cyanophyceae	*Chroococcus* sp.	Cyanobacteria	Y	Y	Y
Malacostraca	*Hemigrapsus sanguineus*	Crab	Y	-	-
	Hermit Crab	Hermit Crab	-	Y	-

Table 4: Average Density (abundance/ m^2) of Intertidal Fauna and Mean Coverage (% m^{-2}) of Sessile Fauna and Flora Recorded within the Study Area (L: low shore, M: mid shore & H: High shore)

Class	Species	Type	T4-L	T4-M	T4-H	T5-L	T5-M	T5-H	T6-L	T6-M	T6-H
Gastropoda	*Echinolittorina radiata*	Periwinkle	0	0.8	43.2	1.6	12.8	12.8	0	0	9.6
	Littoraria articulata	Periwinkle	0	0	0	0	0	0	0	0	0.8
	Nipponacmea concinna	Limpet	8.8	3.2	0	1.6	0	0	0.8	2.4	0
	Cellana toreuma	Limpet	53.6	13.6	11.2	12.0	0	0	26.4	0	0
	Patelloida saccharina	Limpet	2.4	0	0	0	0	0	0.8	0	0
	Patelloida pygmaea	Limpet	0	0	0	0.8	0	0	0	0	0
	Siphonaria laciniosa	False Limpet	0	0	0	0	0	0	0	0	0
	Siphonaria japonica	False Limpet	1.6	1.6	0	0	0	0	0	0	0
	Monodonta labio	Topshell	11.2	8.8	14.4	0.8	8.0	8.0	15.0	6.4	0
	Planaxis sulcatus	Planaxid Snail	0	0	0	28.0	23.2	23.2	0	0	0
	Nerita albicilla	Nerite	0	0	0	0.8	0	0	0	0	0
	Thais clavigera	Whelk	0	0	0	3.2	0	0	0	0	0
Polyplacophora	*Acanthopleura japonica*	Chiton	1.6	1.6	0	0	0	0	0	0.8	0
Bivalvia	*Isognomon isognomum*	Bivalve	0%	0%	0%	0%	0%	0%	0%	0.2%	0%
	Saccostrea cucullata	Bivalve	0%	0%	0%	0.2%	0.2%	0.2%	0%	0%	0%
	Barbatia virescens	Bivalve	0%	0%	0%	2.2%	0.2%	0.2%	0%	0%	0%
Maxillopoda	*Capitulum mitella*	Barnacle	0.2%	1.2%	0.2%	0%	0%	0%	0.4%	0%	0%
	Tetraclita japonica	Barnacle	1.0%	0%	0%	0.2%	0%	0%	0%	0%	0%
Anthozoa	*Haliplanella luciae*	Anemone	0.2%	0.2%	0.2%	0%	0%	0%	0%	0%	0%
	Spheractis cheungae	Anemone	0%	0%	0%	0%	0%	0%	0%	0%	0%
Polychaeta	*Spirorbis spp.*	Tubeworm	0%	0.2%	0%	0%	0%	0%	0%	0%	0%
Chlorophyceae	*Pseudulvella applanata*	Algae	8.0%	3.2%	0%	2.0%	0%	0%	4.0%	0%	0%
Florideophyceae	*Gelidium pusillum*	Algae	0%	0%	0%	0%	0%	0%	1.0%	0%	0%
	Hildenbrandia occidentalis	Algae	25.0%	10%	0%	9.0%	0%	0%	23.0%	12.0%	0%

Class	Species	Type	T4-L	T4-M	T4-H	T5-L	T5-M	T5-H	T6-L	T6-M	T6-H
	Hildenbrandia rubra	Algae	0.2%	11.0%	7.0%	8.0%	5.0%	5.0%	5.0%	45.0%	4.0%
Phaeophyceae	*Endarachne binghamiae*	Algae	0%	0%	0%	0.2%	0%	0%	7.0%	0%	0%
	Hapalospongidion gelatinosum	Algae	0%	0%	0%	3.0%	0%	0%	0%	1.0%	0%
	Hincksia mitchelliae	Algae	0%	0%	0%	0%	0%	0%	3.0%	0.2%	0%
Ulvophyceae	*Ulva spp.*	Algae	0%	0.2%	0%	0%	0%	0%	0.4%	0%	0%
Cyanophyceae	*Chroococcus* sp.	Cyanobacteria	0%	0%	19.0%	0%	5.0%	5.0%	0%	0%	14.0%
Malacostraca	*Hemigrapsus sanguineus*	Crab	0	0	0	0	0	0	0	0	0
	Hermit Crab	Hermit Crab	0	0	0	4	0	0	0	0	0

3.7 Subtidal Soft Bottom Assemblages

Information on the subtidal soft bottom assemblages in the vicinity of the proposed cable corridor is available from the *Consultancy Study on Marine Benthic Communities in Hong Kong* [1]. Eight (8) sampling stations (Sampling Nos. 25-32) are in the vicinity of the proposed Project and data extracted from them can be considered to be representative of the assemblages within the corridor. According to the findings of the *Consultancy Study*, the substratum of the 8 sampling stations was covered by very fine sand and/or silt/clay. The benthic assemblages were typical of Hong Kong waters and generally dominated by small, short-lived polychaete and crustacean species which are common and widespread benthos of Hong Kong seabed. No species of conservation importance were found along the proposed cable corridor.

During the IWMF EIA Study [2], subtidal benthic grab surveys were conducted along the proposed submarine cable and the sampling locations are shown in *Figure A9*. A total of 42 polychaete species, 15 crustacean species, 12 mollusk species, 4 echinoderm species, 2 cnidarian species, 1 echiurans species, 1 sipunculan species were recorded during the surveys around Cheung Sha while a total of 60 polychaete species, 13 crustacean species, 8 mollusk species, 5 echinoderm species, 5 cnidarian species, 3 fish species, 2 echiurans species, 1 sipunculan species were recorded during the surveys around Shek Kwu Chau. Another recent EIA Study [3] recorded a total of 70 species of benthic organisms in four sampling stations located between Cheung Sha and Pui O (see *Figure A9*). No species of conservation importance was recorded during these surveys.

Based on the previous survey data, benthos assemblages within and in the vicinity of the Project area are generally considered to be of low to moderate ecological value, dependent on species diversity and rarity [4]. Small and short-lived polychaete and crustacean species which are common and widespread benthos of Hong Kong seabed are the dominant benthic species within the Project area. Species of conservation importance, ie *Amphioxus* species, have not been recorded in this part of Lantau.

3.8 Subtidal Hard Bottom Assemblages

Based on literature review from the IWMF EIA Study [5], it was identified that the natural coastline of Cheung Sha was mainly composed of natural bedrocks, big boulders and muddy/sandy substrates. Hard corals and octocorals were not recorded during the spot check dive surveys at the locations shown in *Figure A9*. The natural coastline of Shek Kwu Chau was mainly composed of natural bedrocks and big boulders near the coast, and muddy substrate towards to sea. A total of 15 coral species (8 hard coral species and 7 octocoral species) with less than 1% cover were recorded during the surveys. Another coral survey conducted for the South Lantau Sewerage EIA Study [6] recorded one hard coral species *Oulastrea crispata* with 1-5% coverage. *Oulastrea crispata* is a common species found throughout Hong Kong waters including the more turbid and harsh western waters [7].

Updated subtidal dive surveys were carried out in March 2017 to characterise the existing ecological conditions of the seabed in the vicinity of the proposed original IWMF cable landing site and the current proposed cable landing site at Upper Cheung Sha (*Figure A9*). Spot dive reconnaissance check surveys were conducted along the proposed submarine cable routes connecting to the

(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) AECOM (2011) Op cit.

(3) B&V/ERM (2016) Op cit.

(4) AECOM (2011) *Op. cit.*

(5) AECOM (2011) *Op. cit.*

(6) B&V/ERM (2016) Outlying Islands Sewerage Stage 2 – South Lantau Sewerage Works. EIA Report.

(7) AFCD (2005) Field Guide to Hard Corals of Hong Kong.

proposed landing sites at Upper Cheung Sha Beach (ie D1 – D2) and rocky shore of Cheung Sha (ie D3 – D4) , which consists of near-shore and offshore areas. The weather was mainly fine and the sea was calm during the surveys. The underwater visibility ranged between 0.3 m and 1 m. Along each transect the general substrata and biological conditions were recorded and presented in *Table 5.*

Table 5: Description of the Seabed Recorded along Each Area during the Qualitative Surveys (Spot Dive Reconnaissance Check Surveys)

Area	Depth	Description
D1 (Beach/ Near-shore)	-2 to -5 mCD	The area mainly comprised of silt and sand at depth of -2 to -5 mCD. A few individuals of sea anemone and bivalve *Ruditapes* sp. were found on the soft substrata. Hard corals or species with conservation importance were not recorded during the survey at near-shore area.
D2 (Beach/ Off-shore)	-6 to -9 mCD	The seabed was mainly comprised of silt in this area. Only one sea pen colony *Pteroeides* sp. was identified. Hard corals or species with conservation importance were not observed during the survey at off-shore area.
D3 (Rocky shore/ Near-shore)	-2 to -5 mCD	The sites mainly comprised silt and boulder at depth of -2 to -4 mCD and silt at depth of -5 mCD. Isolated small colonies of hard coral species, such as *Oulastrea crispate, Turbinaria peltata* and *Pseudosiderastrea tayami* and octocoral *Paraplexaura* sp., *Dichotella* sp. *Echinomuricea* sp. and *Guaiagorgia* sp.were recorded on the hard substrata. Other fouling organism, including sponges, bryozoans, coralline algae and sea anemone were found on the boulders.
D4 (Rocky shore/ Off-shore)	-5 to -6 mCD	The seabed was mainly composed of silt in this area. No corals or species with conservation importance were observed along the offshore areas of the proposed seabed survey corridor.

Overall, results of the updated dive surveys showed that hard corals and octocorals were only recorded at near-shore hard substrata of Cheung Sha (ie D3) during the survey within the Project area.

Semi-quantitative Rapid Ecological Assessment (REA) Survey

REA surveys were performed at location D3 where corals were recorded as presented in *Figure A9.* The seabed composition and coral species recorded from the REA transect (ie R1 – R3) are presented in *Tables 6* and *7*. Qualitative description of the seabed composition was provided in *Table 5* above. Hard coral and octocoral communities with small to medium size (<30 cm) were scattered and occurred in low abundance. A total of three (3) hard coral species and four (4) octocoral species were recorded and the percentage covers at each transect were estimated to be less than 5% for both hard coral and octocoral. The majority of the coral species was observed at Transects R1 and R2 and only hard coral species *Oulastrea crispata* and *Pseudosiderastrea tayami* were observed in Transect R3. Most hard coral and octocoral species recorded were common in the northeastern and eastern waters in Hong Kong, except *Pseudosiderastrea tayami,* which was only recorded in southern waters [(1)].

The coral communities at the shallow region of hard substratum of Cheung Sha were of relatively low coral cover (estimated mean of <5 %) and relatively low coral species richness with a total of three (3) hard coral species and four (4) octocoral species (*Tables 6* and *7*).

(1) AFCD (2005) *Op cit.*

Table 6: Tier I Results - Seabed Attributes along the Semi-Quantitative Survey Transects R1-R3

	Transect		
	R1	R2	R3
Transect depth (mCD)	-2 to -5	-2 to -5	-2 to -4
Substratum attributes			
Bedrock	0	0	0
Continuous pavement	0	0	0
Large boulder (>50cm)	4	5	4
Small boulder (<50cm)	3	3	4
Rock (<26cm)	2	2	2
Rubble	0	0	0
Sand	0	0	0
Mud/Silt	4	4	3
Other	0	0	0
Ecological attributes			
Hard coral	1	1	1
Octocoral (Soft corals and gorgonians)	1	1	0
Dead Coral	0	0	0
Other Benthos (sponges, zoanthids, ascidians and bryozoans)	1	1	1
Macroalgae	1	1	1

Notes:

(1) 0 = 0%, 1 = <5%, 2= 6 -10%, 3 = 11 – 30%, 4 = 31- 50%, 5 = 51 – 75%, 6 = 76 – 100%

Table 7: Tier I Results - Seabed Attributes along the Semi-Quantitative Survey Transects R1-R3

	Transect		
	R1	R2	R3
Hard Coral Species			
Oulastrea crispata	2	2	2
Pseudosiderastrea tayami	3	3	2
Turbinaria peltata	0	1	0
Octocoral			
Dichotella sp.	0	1	0
Echinomuricea sp.	0	1	0
Guaiagorgia sp.	0	1	0
Paraplexaura sp.	2	2	0

Notes:

(2) 0=absent, 1=rare, 2=uncommon, 3=common, 4=abundant, 5=dominant

(3) The ranks shown in the Table above indicate the relative abundance of each coral in relation to other corals in the community. In other words, these broad categories rank taxa in terms of relative abundance of individuals, rather than the contribution to benthic cover along each transect. The ranks are subjective assessments of abundance, rather than quantitative counts of each taxon. For instance, if a coral is ranked as 'common', it means it was more frequent than other coral species along the transect. It should be borne in mind that coral cover along all of the transects where corals occurred was very low (<5% cover).

4. IMPACT ASSESSMENT

4.1 Impact on Sites of Special Scientific Interest (SSSIs)

There is no existing marine Site of Special Scientific Interest (SSSI) within and in the vicinity of the proposed cable corridor and the landing site. The proposed Shui Hau Wan SSSI is located at ~2.5 km away from the Project. Since the maximum distance of transport of suspended sediments generated by the construction of the Project would be approximately 80 m as presented in the para 5b.7.4.5 of the approved EIA Report (EIA-201/2011) and the mentioned marine proposed SSSIs in the vicinity are ~2.5 km away from the closest cable segment, no direct or indirect impacts are anticipated.

4.2 Direct Impacts During Construction

An updated intertidal and subtidal survey showed that a relatively high abundance and diversity of intertidal fauna and present of low coverage of hard corals and octocorals in the vicinity of the hard substrate of the original cable landing portal compared to the soft shore of the proposed submarine cable landing site at Upper Cheung Sha Beach. Although IWMF EIA Study concluded that the overall impact to rocky shore and subtidal hard and soft bottom habitat is low for the original cable landing portal (1), direct impacts to the marine subtidal and intertidal habitat will be further reduced during the construction works through the selection of the current submarine cable landing site at Upper Cheung Sha Beach.

Marine Mammals: No direct loss of marine mammal habitats and the seabed can be expected to naturally reinstate to before-work level and condition shortly after completion of the cable installation/ repair works. As a result, direct impacts to marine mammals are not anticipated.

Intertidal Habitats: The sandy shore along the shoreline of Upper Cheung Sha will be temporarily affected, however, given the construction activities on the beach up to beach manhole (BMH) would be completed within a month, direct impacts to intertidal assemblages are not anticipated to be significant. A conduit underneath the seawall (~2 m below seabed) will be constructed during the formation of Shek Kwu Chau Artificial Island. No direct impacts are therefore expected as a result of the shore-end construction activities at Shek Kwu Chau Artificial Island.

Subtidal Soft Bottom Habitats: Short-term direct impacts will occur to soft bottom benthic assemblages present along the cable trench. It is, however, expected that once the cable installation/ repair operations are completed, the soft bottom habitats will be recolonised by benthic fauna which are expected to be similar to the assemblages presented before construction activities commenced. As a result, direct impacts to soft bottom benthic assemblages are not anticipated to be significant.

Subtidal Hard Bottom Habitats: Since no coral communities were recorded within the footprint of the Project, there will be no direct impact to the coral communities in the vicinity of the proposed cable alignment at near-shore and off-shore areas.

4.3 Indirect Impacts during Construction Phase

4.3.1 Short-term Changes in Water Quality

The injection jetting cable installation process, will result in the formation of suspended sediment around the Injector Burial Tool, which can be expected to remain very close to the seabed and would thus settle rapidly. An analysis of the potential transport of fine sediments suspended into the water column during the cable installation process has been conducted as presented in the approved EIA

(1) AECOM (2011) *Op. cit.*

Report (EIA-201/2011) and has determined that the maximum distance of transport for suspended sediments would be 80 m from the cable burial machine.

Based on the above, indirect impacts may occur through seabed disturbance, resulting in elevation of suspended solids (SS) in the water column. Such increase above background suspended solid levels may potentially cause impacts to filter feeders. As the cable installation works will be of a short duration, the increase is not predicted to be high except for in the immediate vicinity of the cable burial machine and are expected to settle rapidly back onto the seabed. As such, these impacts will be small scale and of a localised nature. Moreover, the nearest marine ecological sensitive receivers are located more than 350 m away from the cable route, which are not expected to be adversely affected by the elevation of suspended solids and settlement of sediment due to the works. Potential disturbance to corals are expected to be limited and transient given the short-term nature of the cable installation works which will only last for a total of 3 months (including contingency such as bad weather, faulty vessel etc which require works to be intermittent) for the whole alignment between Low Water Mark of Upper Cheung Sha to the conduit underneath the seawall of Shek Kwu Chau Artificial Island (including shore-end and submarine cable installation). Horseshoe crabs are particularly adapted to environment with high ambient SS level as a result of sand- or mud-burrowing behaviours and therefore not sensitive to SS. Marine mammals are highly mobile and are able to swim into open waters to avoid short term and localized seabed disturbance. In addition, they are air breathing and hence SS in the water column have no effect on their respiratory surfaces. Therefore, no unacceptable adverse impacts to marine ecological resources are predicted to occur.

4.3.2 Underwater Sounds

Cable installation works may result in a minor and short-term increase in underwater. With reference to the latest approved EIA Report in South Lantau (ie EIA-256/2018), construction works including dredging and backfilling activities as well as jetting for the submarine gas pipeline installation can result in a minor and short term increase in underwater sound which may potentially affect Indo-Pacific Humpback Dolphin/ Chinese White Dolphin (CWD) and Finless Porpoise (FP). Small cetaceans are acoustically sensitive at certain frequencies, and sound is important to their behavioural activities. Most small cetaceans can hear within the range of 1 to 150 kHz, though the peak for a variety of species is between 8 and 90 kHz and 142 kHz reported for dolphins and porpoises respectively [(1)].

Indo-Pacific Humpback dolphins have been reported to use five categories of vocalisation associated with different activities [(2)]. These animals use high frequency broad-band clicks in the range of 8 kHz to > 22 kHz during foraging. During both foraging and socialising, burst pulse sounds of barks and quacks in the frequency range of 0.6 kHz to >22 kHz are used. Low frequency narrow band grunt vocalisations in the range of 0.5 kHz to 2.6 kHz are also used during socialising activity. Dolphins also have whistle vocalisations in a wide frequency from 0.9 kHz to 22 kHz. CWD are acoustically sensitive at a peak range of 8 - 90 kHz, and sound produced during percussive piling would be audible and may overlap and mask frequencies including those used for socializing and foraging, resulting in behavioural responses including avoidance. Considering that CWD are rarely sighted near the works area and therefore the potentially affected waters do not constitute important habitat for these animals, potential disturbance impacts are not anticipated.

(1) Richardson et al. 1995. Marine Mammals and Noise. Academic Press.

(2) Van Parijs SM & Corkeron PJ (2001) Vocalizations and behaviour of Pacific Humpback Dolphins Sousa chinensis. Ethology 107: 701-716.

Finless porpoises, which are the more abundant marine mammal species in this area, vocalise at much higher frequencies than humpback dolphins. Finless porpoises produce high frequency ultrasonic narrowband clicks at a peak frequency of 142 kHz, which are inaudible to the human ear [(1)].

Dredging, jetting and large vessel traffic generally results in low frequency noise, typically in the range of 0.02 to 1 kHz [(2)], which is below the peak range of 8 - 90 kHz and 142 kHz reported for dolphins and porpoises respectively. A study was conducted to investigate the underwater sound levels produced during the installation of submarine cable in southeastern waters of Hong Kong. The results indicated that the cable installation barge and the support vessels (with total up to 4 nos. vessels) generated sound with frequency between 40 Hz and 25 kHz, which were lower than the sound used for foraging and communication for FPs (see *Annex A1* for details). For this reason, noise generated by dredging, jetting and pipe laying and cable laying operations is not expected to acoustically interfere significantly with dolphins or porpoises. Marine mammals may have short-term avoidance of the immediate works areas of sound generating activities, but are expected to return when the disturbance ceases. Unacceptable adverse impacts of increased underwater sound level on marine mammals are not anticipated.

As such, the low frequency underwater sound associated with vessels, injection jetting and cable installation/ repair operation of this project would thus not be expected to interfere significantly with FPs. Similarly, although some vessel sounds may be within the audible range of CWD, this is generally for high speed vessels [(3)]. The cable installation/ repair operation works will be short-term and temporary and be carried out by one slow moving cable installation barge. Barge operation for cable installation works will take a total of approximately 30 working days (submarine cable section using cable burying machine, excluded shore-end section), and repair operation will be even less compare installation, and over this short timeframe is not expected to interfere significantly with this cetacean species either.

4.3.3 Temporary Disturbance

For marine construction activities, it is important to reduce the number and size of works areas and total duration of marine works to limit potential short-term behavioural disturbance and/ or displacement of marine mammals.

The cable installation will involve jetting and is scheduled to take place within 3 months including contingency. With a short works programme enabled by working limited to day time only, it is expected that marine mammals that have avoided the vicinity of the works areas can return to the area sooner. Considering the temporary nature of the disturbance, impacts on marine mammals are expected to be of minor significance. Upon cessation of the disturbance, no significant long-term change in marine mammal distribution, abundance and usage pattern in the wider Hong Kong waters is expected.

Marine mammal exclusion zone monitoring has been demonstrated to be effective in reducing disturbance to marine mammals and has been adopted in marine construction activities in Hong Kong. It is considered that the implementation of marine mammal exclusion zone monitoring will be effective in further reducing the disturbance of marine mammals during construction works at both daytime and night-time. Marine mammal exclusion zone monitoring has been adopted in marine

(1) Goold JC & Jefferson TA (2002) Acoustic signals from free-ranging finless porpoises (*Neophocaena phocaenoides*) in waters around Hong Kong. The Raffles Bulletin of Zoology Supplement 10:131-139.

(2) Richardson et al. 1995. Marine Mammals and Noise. Academic Press.

(3) Sims P, Hung S, Würsig B. (2012) High-speed vessel noises in West Hong Kong Waters and Their Contributions Relative to Indo-Pacific Humpback Dolphins (*Sousa chinesnis*). Journal of Marine Biology. Vol. 2012, ID169103, 11pp

construction activities in Hong Kong during both daytime and night-time [1] [2] [3] [4]. Marine mammal exclusion zone monitoring has been demonstrated to be technically feasible, and also effective in reducing disturbance to marine mammals and there is no reported case of marine mammal injury/behavioural change due to marine construction works with the implementation of marine mammal exclusion zone monitoring.

4.3.4 Increased Marine Traffic

The cable installation for a submarine circuit will be conducted by one cable laying barge and total up to 4 vessels. There are two main ways that the increased vessel movements due to construction activities has the potential to impact marine mammals. Firstly, vessel movements may potentially increase physical risks to marine mammals. In Hong Kong, there have been instances when dolphins have been killed or injured by vessel collisions [5] [6], and it is thought that this risk is mainly associated with high-speed vessels such as ferries. Given the total up to 4 marine vessel to be used within a short works programme (ie 3 months) for cable installation works are slow moving, the risk of vessel collision with marine mammals is considered to be very small. As such, impacts to marine mammals due to vessel collision are not anticipated to be significant. Secondly, the physical presence of works vessels may cause short-term avoidance of the area where works vessels are operating, and this has been discussed above in terms of temporary disturbance.

Therefore overall no unacceptable adverse impacts to FP and CWD from the proposed changes of Project are expected to occur.

4.4 Operation Phase

During normal operation of the proposed cable system, impacts to marine ecological resources are not expected to occur. During operation however, there may be a potential requirement for maintenance work (i.e. cable repair at particular fault location due to unexpected damage) to be carried out. For repairs along the in-shore and remaining submarine cable alignment, equipment and methods would be similar in nature to that used during cable installation works, but not along the full alignment (i.e. of smaller scale), with the potential to use smaller equipment such as Remotely Operated Vehicles (ROVs) equipped with injector tool and divers with hand held tools. The repair works process for shore end and marine works is therefore expected to have similar or reduced impact as compared to construction phase.

5. IMPACT EVALUATION

An evaluation of the impact in accordance with the *EIAO-TM Annex 8 Table 1* is presented below.

(1) Arup (2009) EIA Report for the Hong Kong - Zhuhai - Macao Bridge Hong Kong Boundary Crossing Facilities (Register No.: AEIAR-145/2009)

(2) AECOM (2009) EIA Report for the Tuen Mun - Chek Lap Kok Link (Register No.: AEIAR-146/2009)

(3) AECOM (2012) EIA Report for the Tung Chung New Town Extension (Register No.: AEIAR-196/2016)

(4) Mott MacDonald (2014) EIA Report for the Expansion of Hong Kong International Airport into a Three-Runway System (Register No.: AEIAR-185/2014).

(5) Parsons ECM, Jefferson TA (2000) Post-mortem investigations on stranded dolphins and porpoises from Hong Kong waters. Journal of Wildlife Diseases 36: 342-356.

(6) Jefferson TA, Curry BE, Kinoshita R (2002) Mortality and morbidity of Hong Kong finless porpoises, with special emphasis on the role of environmental contaminants. Raffles Bulletin of Zoology (Supplement) 10: 161- 171.

- *Habitat Quality*: Short-term direct impacts are predicted to occur to subtidal soft bottom habitats along the cable trench. Short-term indirect impacts are predicted to occur to intertidal/ subtidal hard/ soft bottom habitats in the vicinity of the cable route such as Shui Hau Wan, northwestern coast of Shek Kwu Chau and coral communities at Shek Kwu Chau. The subtidal soft bottom habitats which may be directly affected are, however, considered to be of low ecological importance. Since the maximum distance of transport for suspended sediments would be 80 m from the cable burial machine and the short-term nature of the cable installation (3 months, including contingency, for the whole alignment between Low Water Mark of Upper Cheung Sha to the conduit underneath the seawall of Shek Kwu Chau Artificial Island)/ repair works, the potential indirect impacts on the intertidal/subtidal hard/soft bottom habitats are not expected to be significant.

- *Species*: No species that are considered of high ecological value are expected to be directly affected. FP occurs in southern waters with important habitats at the IWMF reclamation site and surrounding offshore waters (waters ~1.2 km from the Shek Kwu Chau shorelines). FPs are known to use high frequency ultrasonic clicks (over 100 kHz) for foraging and communication [(1)]. Given the short timeframe of the Project as well as the cable installation/ repair barge is slow-moving and emit low frequency underwater sound (40 Hz – 25 kHz), no unacceptable adverse impacts to FP from the Project are expected to occur. The coral communities at Shek Kwu Chau are located at ~350 m from the cable alignment and at least 270 m from the boundary of the dispersal range of suspended sediments generated from the injection jetting method, therefore no unacceptable adverse impacts to these coral communities are expected since the suspended sediment level in the water column is anticipated to be similar to the natural background level at the limit of the dispersal range and the potential impacts would be transient in nature.

- *Size*: The length of the submarine cable will be approximately 7 km. The cable will be buried using a cable burial machine and will fluidise approximately 0.5 m of the seabed in width along the alignment.

- *Duration*: The duration of the cable installation by jetting method between Low Water Mark of Upper Cheung Sha to the conduit underneath the seawall of Shek Kwu Chau Artificial Island will be for a total of approximately 3 months including contingency.

- *Reversibility*: Direct impacts to soft bottom marine community are expected to be short-term and re-colonisation of the sediments is expected to occur shortly. Indirect impact to hard bottom marine community is expected to be short-term and reversible.

- *Magnitude:* No unacceptable adverse impacts to ecologically important organisms or habitats are predicted to occur. The magnitude of impacts during the installation and operation (ie repair) of the cables is expected to be of low severity and is considered acceptable, given that the disturbances are of small scale, short-term and localised.

5.1 Mitigation Measures

In accordance with the guidelines in the *EIAO TM* on marine ecology impact assessment, the general policy for mitigating adverse impacts to marine ecological resources, in order of priority, are:

- **Avoidance:** Potential impacts should be avoided to the maximum extent practicable by adopting suitable alternatives.

- **Minimisation:** Unavoidable impacts should be minimised by taking appropriate and practicable measures such as constraints on intensity of works operations (e.g. dredging rates) or timing or works operations.

(1) Kamminga C, Cohen SA, Silber GK (1996). *Op cit.*

- **Compensation:** The loss of important species and habitats may be provided for elsewhere as compensation. Enhancement and other conversation measures should always be considered whenever possible.

Based on the above, mitigation measures are discussed below.

5.1.1 Overall Summary

Impacts to marine ecological resources have largely been avoided for the cable installation through the selection of a landing site and cable corridor that avoids adverse impacts to coral communities along the hard substratum of Cheung Sha and through the employment of cable installation techniques that result in little disruption to the marine environment. Due to the confined space along the proposed cable corridor, including due to existing cables and the Major Marine Vessel Fairway in South Lantau amongst other constraints, the proposed submarine cable routing has been carefully considered.

5.1.2 Minimisation of Impacts

Mitigation measures that have been recommended to reduce impacts to water quality are also expected to control impacts to marine ecological resources. In particular, for all marine works (both shore-end and submarine):

- A marine mammal exclusion zone (within a radius of 250 m from the cable installation operation vessel) during cable installation/ repair works along the whole cable route is recommended to be implemented as a precautionary measure to reduce disturbance to marine mammals, especially the FPs.

- The maximum speed of the cable installation/ repair will not exceed 1 km hr^{-1} so that the amount of seabed sediment disturbed and dispersed during the cable installation process can be kept to a minimum.

- All marine vessels within the works areas shall not travel at a speed higher than 10 knots (ie 18.5 km hr^{-1}) to minimize vessel collision to the marine mammals.

- Furthermore, with the implementation of good house-keeping practices, no unacceptable adverse impacts to either water quality or marine ecological resources are expected to occur from land based activities.

- Water quality monitoring will be carried out to verify that the Project works will not result in any unacceptable adverse impacts to water quality, and consequently to marine ecology and fisheries.

- Based on the above mitigation measures, no compensation will be required as no unacceptable adverse residual impacts to marine ecological resources are predicted to occur, however, precautionary measures for marine mammals (marine mammal exclusion zone, within a radius of 250 m from the cable installation operation vessel) will be implemented during the cable installation/ repair works.

These measures will ensure that no unacceptable adverse impacts to the corals and marine mammals will result from cable installation/ repair works.

6. SUMMARY AND CONCLUSIONS

The review of the existing information on the marine ecological resources in the vicinity of the proposed changes including cable landing point and the cable alignment have identified the area to be of generally low ecological value in terms of supporting marine fauna.

Although soft bottom assemblages will be disturbed during the cable installation/ repair works, the habitats will be reinstated by similar communities within a short time and thus no unacceptable adverse impacts are expect to be anticipated.

The southern waters of HKSAR are not considered to be frequently used habitat by the CWD. While there is no clear temporal trend observed for the FP within the Project area over the years, the recent data suggested that the IWMF reclamation site and surrounding offshore waters (~1.2 km from the shoreline of Sheck Kwu Chau) remain as important FP habitats with high FP densities recorded, which are similar to the findings in the IWMF EIA Study. It is expected that the submarine cable installation works will last for a short duration (approximately 30 working days in total for majority of the cable segments using cable burying machine). The cable installation for a submarine circuit will be conducted by one cable laying barge and total up to 4 vessels. Significant disturbance to the FP and CWD, in terms of underwater noise, marine traffic and reduction of food sources, is therefore not expected.

The rocky shores in the vicinity of the proposed cable landing site at Cheung Sha and Shek Kwu Chau support low abundance and diversity of intertidal organisms. All of these species are common and widespread on the similar shores in HKSAR and as such, are considered to be of low ecological value. Adverse impacts to these assemblages are, therefore, not expect to be anticipated.

A few hard coral species have been identified in the vicinity of the proposed cable landing site at Shek Kwu Chau but in low abundance and diversity. The coral communities along the shoreline of Shek Kwu Chau are within 350 m of the proposed cable alignment but at least 270 m from the boundary of the dispersal range of suspended sediments generated from the injection jetting method. Due to the small scale of the works, the short duration of impacts and the limited dispersion distance of sediment plume, any potential impacts are not considered to be significant or adverse.

Impacts to marine ecological resources have largely been avoided through the selection of a landing site and cable corridor that reduce impacts to coral communities and through the employment of techniques that result in little disruption to the marine environment.

Precautionary and mitigation measures that have been recommended to reduce impacts to water quality are also expected to control any impacts to marine ecological resources, particularly the coral communities in the vicinity of the cable alignment. These mitigation measures include limiting the maximum speed of the cable installation/ repair machine and implementing good house-keeping practices during land-based activities. Marine mammal exclusion zone will be implemented during cable works as the precautionary measures. All these measures will ensure that no unacceptable adverse impacts to the corals and marine mammals will result from cable installation/ repair works.

ANNEX A1 REPORT ON MEASUREMENT OF UNDERWATER SOUND LEVELS AROUND SUBMARINE CABLE INSTALLATION BARGE

MEASUREMENT OF UNDERWATER SOUND LEVELS AROUND SUBMARINE CABLE INSTALLATION BARGE

FINAL REPORT – Rev04

EGS CONTRACT NUMBER: HK246117

OCTOBER 2017

CLP Power Hong Kong Ltd.
6/F Shamshuipo Centre
215 Fuk Wa Street
Kowloon, Hong Kong

EGS (Asia) Limited
5th Floor, Zung Fu Industrial Building
1067 King's Road
Quarry Bay
Hong Kong

Tel. : +852 2894 8622
Fax : +852 2576 3590
http://www.egssurvey.com

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MEASUREMENT OF UNDERWATER SOUND LEVELS AROUND SUBMARINE CABLE INSTALLATION BARGE

FINAL REPORT – Rev04

EGS CONTRACT NUMBER: HK2461 17

October 2017
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1. INTRODUCTION

1.1 The Project

Submarine cables are buried under the seabed to protect them from external threats such as fishing and anchoring. In most of Hong Kong waters, a permit requirement for installation of a new cable is that it should be buried to a depth of 5 m below the seabed.

CLP Power Hong Kong Ltd. (CLP) installs submarine power cables to provide electricity to communities on outlying islands around Hong Kong. As part of its environmental compliance, concerning disturbance to the marine ecology during submarine cable installation, CLP required measurements of underwater sound around a dynamically-positioned cable installation barge.

This report documents the measurements of underwater sound levels and presents the results.

1.2 Commercial Instruction

The measurements were carried out in accordance with CLP's Purchase Order Number 4501093387 dated 3rd July 2017, under a variation to their Outline Agreement 4600006626.

1.3 Survey Period

The measurements of underwater sound levels around the installation barge were recorded on two days, 14th and 20th July 2017.

1.4 Sources of Underwater Sound

Ambient underwater sound sources consisted of the effects of wind and waves acting on the sea surface and sounds the passage of distant ships. Biological activity generates sounds, particularly the activity of snapping shrimp (genus *Alpheus* of the *Alpheidea* family).

The objective of this survey was to measure the additional underwater sound caused by the cable installation barge. The main sources of sound from the installation operation were:

- Sound from motors running on the installation barge, such as the main engines, generators, pumps, compressors and exhaust mufflers. Similar sounds from the barge's attendant tugs.
- The injector, deployed from the installation barge, pumps jets of water through nozzles into the seabed sediments. The jets briefly liquefy the sediments, allowing the cable to settle below the surrounding seabed. Cavitation vapour bubbles form around the jets. The bubbles oscillate vigourously as they gently rise to the sea surface, radiating

underwater sounds. Details of the power and pressure of the installation pumps, together with information about the size and distribution of the jet nozzles along the length of the injector, are to be provided in the next revision of this report.

2. UNDERWATER SOUND RECORDING SYSTEM

The main items of equipment used in this survey were:

- D-70 Hydrophone manufactured by Neptune Sonar Ltd, serial number 10433.
- EGS amplifier matched to the impedance of the hydrophone. The amplifier gain can be selected at x1 (0 dB) or x25 (28 dB).
- Computer with C-Products' "C-tacean" Recording System

Hydrophones and amplifiers are designed to have an approximately uniform response to a wide range of sound frequencies, but there are always minor non-linear effects that could lead to misleading results if not carefully compensated in the analysis. To allow this compensation to be carried out, the combined hydrophone/amplifier system was calibrated by the manufacturer, Neptune Sonar Ltd. The calibration was against U.K. national standards in accordance with the General Requirements for the Competence of Calibration and Testing Laboratories, ISO 17025:2000, through reference standards tested by the National Physical Laboratory (NPL), the UK's national standards laboratory. A copy of the calibration certificate is included in Appendix A.

Measurements of ambient underwater sound were recorded using the Class I registered vessel Wing Hung 3.

3. FIELD WORKS

3.1 LOCATION

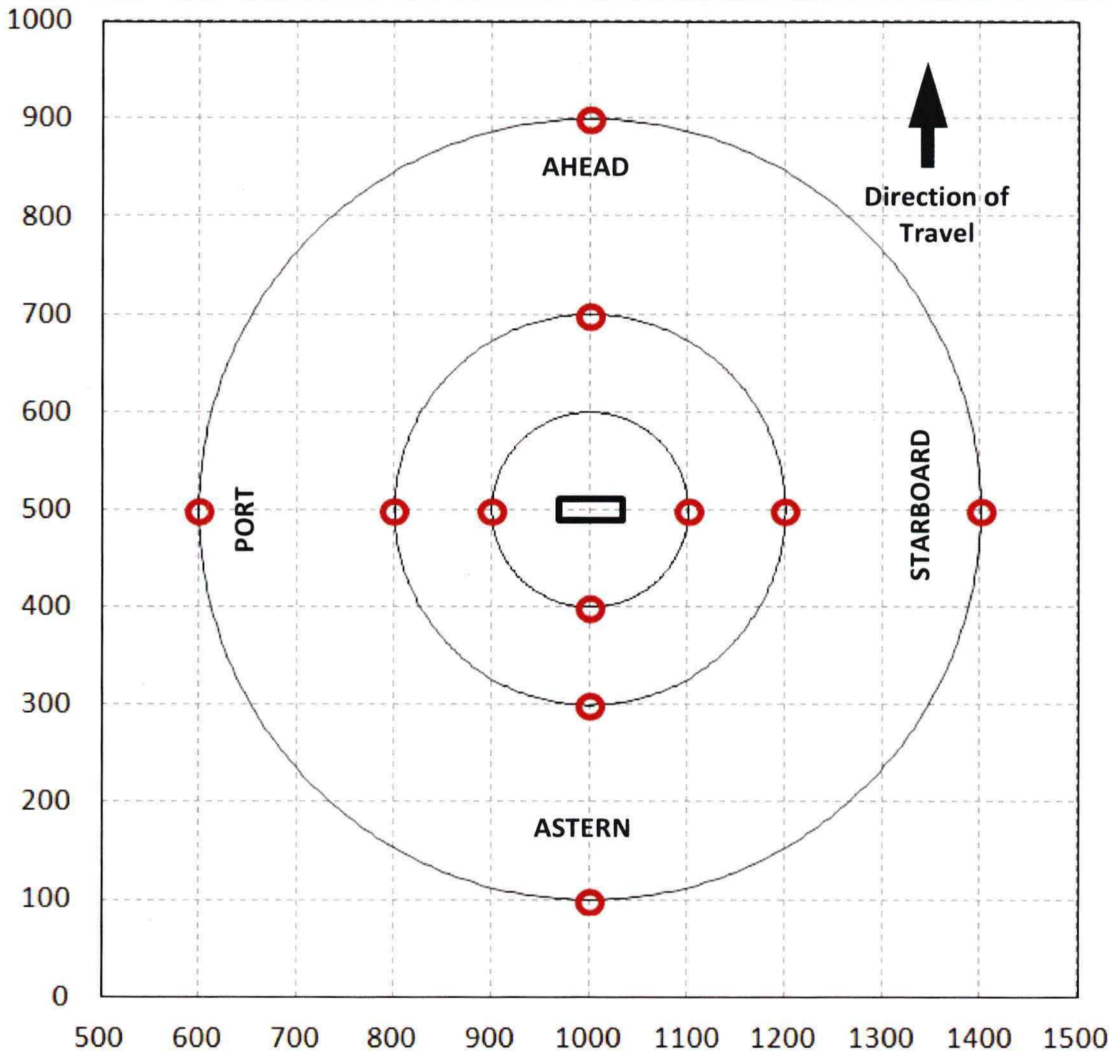
The cable was being installed in Hong Kong's eastern waters.

During transit and on arrival, routine daily checks were carried out to confirm all systems were operating correctly and to optimise the recording parameters.

3.2 PATTERN OF SURVEY MEASUREMENTS AROUND INSTALLATION BARGE

Measurements were taken in four directions relative to the cable laying barge: ahead, astern, to the port and to the starboard of the barge. Unlike most vessel movements, the barge travels broadside through the water, not lengthwise.

- An anchor was deployed ahead of the barge, used to haul the barge along the selected cable alignment. The anchor was laid ~1¼ km ahead of the barge, gradually reducing to ~¼ km as the barge was hauled in along the selected alignment. The anchor was then recovered and redeployed and the process iterated. Care was required to ensure that the hydrophone did not entangle the anchor line. Measurement positions: 200 m and 400 m ahead of the barge.
- The cable injector is deployed from the stern of the barge. To maintain adequate clearance from this sensitive part of the operation, measurement positions: 100 m, 200 m and 400 m astern of the barge.
- To the port and starboard of the barge, measurement positions: 100 m, 200 m and 400 m. Readings at 50 m were attempted, but the barge operators advised that this was too close for safety.



- Approximately to scale (m).
- Arrow shows direction of travel, pulled towards anchor laid ahead of barge.
- The barge is represented by the rectangle shown in the centre, 22 m x 65 m.
- The circles show distances of 100 m, 200 m and 400 m from the centre of the barge.
- The red points show the positions for measurement of underwater sound.

Figure 1: Schematic Diagram of Measurement Locations

3.3 Sources of Acoustic and Electrical Noise on the Survey Vessel

All sources of noise on the vessel were switched off for the duration of recording. In particular, the vessel's engine, pumps, generator and the echo sounder were all switched off. All survey systems were powered by batteries, to ensure silent operation.

For the delicate signals from the hydrophone, the hydrophone cable itself is a sensitive radio-frequency antenna. Any radio signals from the vessel would drive a voltage in the cable that would be recorded as electrical noise. For this reason, all mobile telephones were switched off for the duration of recordings.

3.4 MAIN RECORDING PARAMETERS

The main recording parameters are summarised in Table 1:

Recording Parameter	Parameter Value
Hydrophone depth	6 metres below the sea surface
Record length	60.5 seconds
Sampling rate	200,000 samples per second
Nyquist frequency	100 kHz
Amplifier gain	28 dB
Dynamic range	16 bits (±32,768 in integer steps)
Digitiser range	Selectable: ±1.0 V for most records. A few records at ±0.5 V and ±2.5 V were also recorded

Table 1: Recording parameters

The sampling interval was 200,000 samples per second. This gives a theoretical upper limit (Nyquist frequency) of 100 kHz for these measurements. In practice, the upper limit will be around 70 kHz, controlled by the hydrophone's resonant frequency.

3.5 RECORDING METHOD

During each day of recording, the survey vessel moved to each measurement position in turn. As the hydrophone was deployed at each position, all sources of sound on the survey vessel (the engine, pumps and echo sounder) were switched off. The vessel drifted silently as the underwater sound was recorded. On completion of each record, the hydrophone was recovered and the vessel moved to the next position to repeat the process.

After each record, the geoscientist on board checked the record to ensure that the measurements used much of the dynamic range without clipping. Examples of these on-site raster displays are shown in the following figures. In these diagrams, each row represents 1 second of the record. The record jumps to the next row and continues displaying, like a scanning TV raster display. 30 rows shown in the diagrams make up 30 seconds of the 60 second record. The same gain was applied in both of these examples.

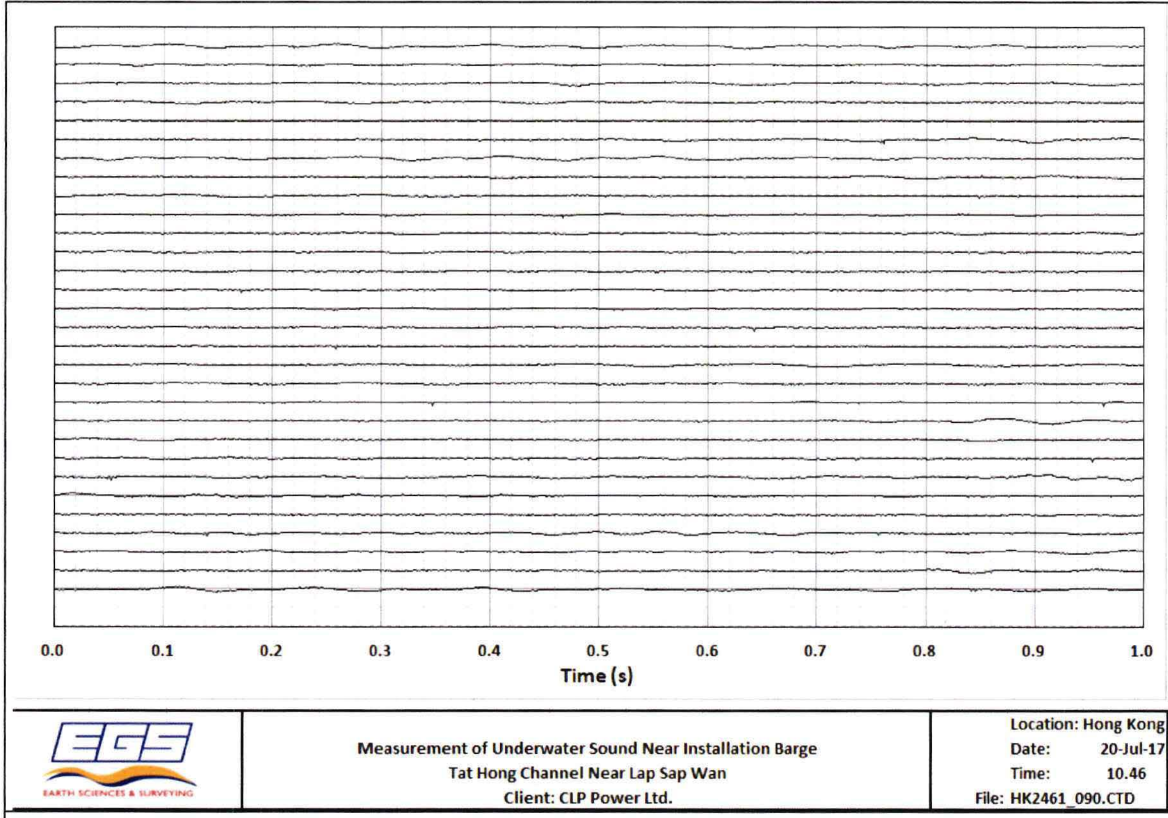


Figure 2: Example of Underwater Sound Variation 400 m from Barge: 10:46 20 July 2017.

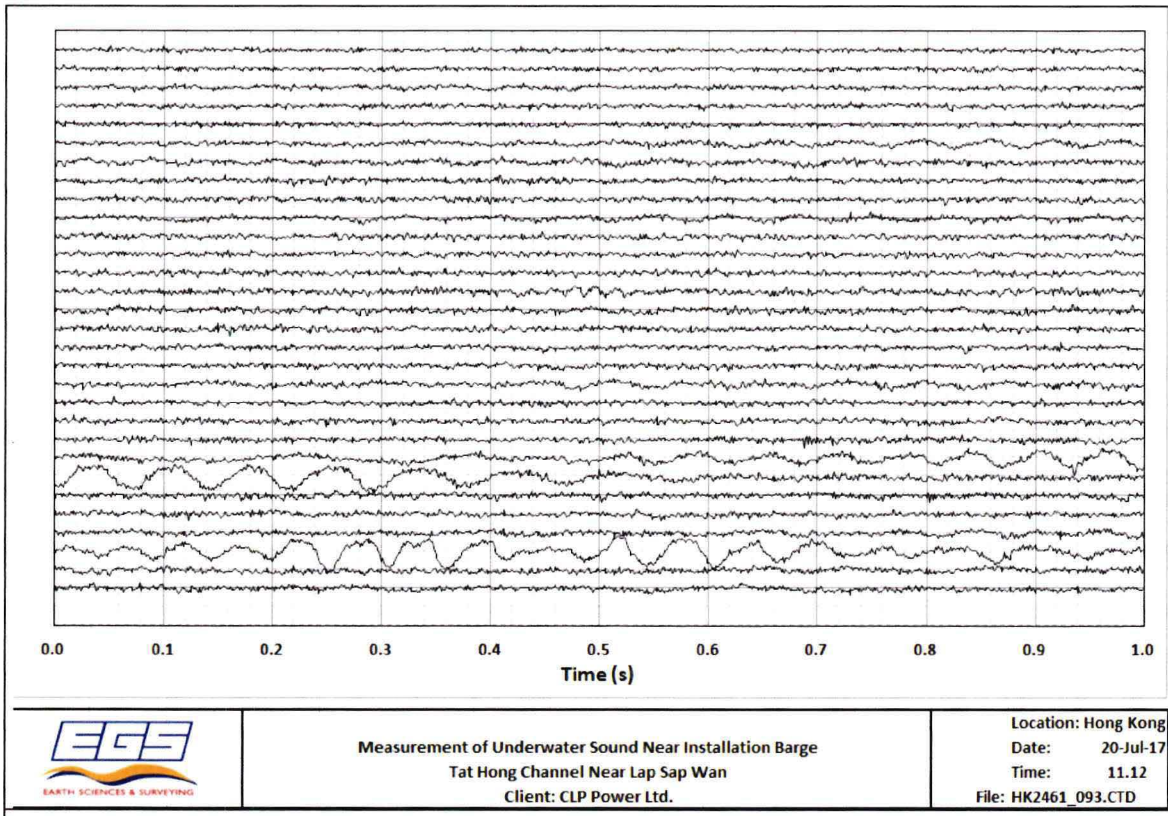


Figure 3: Example of Underwater Sound Variation 50 m from Barge: 11:12 20 July 2017.

3.6 Ancillary Measurements

At intervals through the day, measurements of ambient underwater sounds were recorded 1 km to 2 km away from the barge. While at these positions, vertical profiles of seawater temperature and salinity were recorded. Temperature and salinity are the controlling parameters for the speed of sound in seawater and for the natural frequency-dependent sound attenuation (in these shallow waters, variations due to increase in pressure with depth were not significant).

4. DATA PROCESSING

4.1 Summary

The processing was carried out in steps to remove the frequency-dependant effects of the matched amplifier and hydrophone; convert recorded voltages to pressures measured in the water and display the results in a form that can be used to assess ambient sound levels. The steps are described in turn below.

4.2 Amplitude Recovery

All records of underwater sound were passed through a first step to convert raw voltages recorded on the computer to received sound levels at the point of the hydrophone, as follows:

- The raw 16-bit integers (±32,768) were read from the field records into a computer as a time-series vector. The ±1.0 V dynamic range used to convert to voltage values.
- Any linear trend and d.c. bias was estimated by *l2*-norm regression and removed. Mathematically, this reduces Gibb's effect caused by finite record length.
- A Hanning taper of 500 ms length was applied to each end of the vector to ensure the continuity of the data and the first derivative at the start/end of record wrap-around. For practical purposes, this eliminates remaining Gibb's effect caused by finite record length.
- The time series vector was transformed to the frequency domain by a fast Fourier transform (FFT) algorithm, to give the frequency domain recorded voltages.
- The frequency dependant hydrophone/amplifier calibration (Appendix A) was used to convert frequency domain voltages to frequency domain pressure in microPascals (µPa).
- An inverse FFT was applied to give a time series of calibrated pressure amplitudes in the water at the position of the hydrophone.
- The time series pressure amplitudes in µPa were written to a storage file, with the Hanning taper in place.

4.3 Preparing Diagrams of Sound Pressure Density Spectrum Levels

The recordings were processed to produce sound pressure density spectrum levels using the following procedure:

- The time series pressure amplitudes in µPa were recovered from the storage file, with the Hanning taper in place.

- The complete time series was transformed to the frequency domain by FFT, to give the real and imaginary frequency domain amplitudes in μPa.
- The real and imaginary parts were squared and added together, discarding the phase information and leaving frequency domain magnitude^2 in μPa^2.
- A (minor) correction factor known as the "equivalent noise bandwidth" was applied to the magnitude^2 values, to compensate for the process gain of the 500 ms Hanning taper before the FFT.
- The amplitudes were normalised by the frequency domain sampling interval, 0.0333 Hz, to give sound pressure density spectrum in μPa^2/Hz.
- The sound pressure was integrated into ⅓-octave bands and printed as Sound Pressure Levels (dB re 1 μPa) in ⅓-Octave Bands, part of the statistical summaries in the next section.

5. RESULTS

5.1 Seawater Temperature and Salinity

3 vertical profiles of seawater temperature (degrees Celcius, °C) and salinity (practical salinity units, psu) were recorded on both 14th and 20th July 2017. The results are presented in Figure 4 and Figure 5.

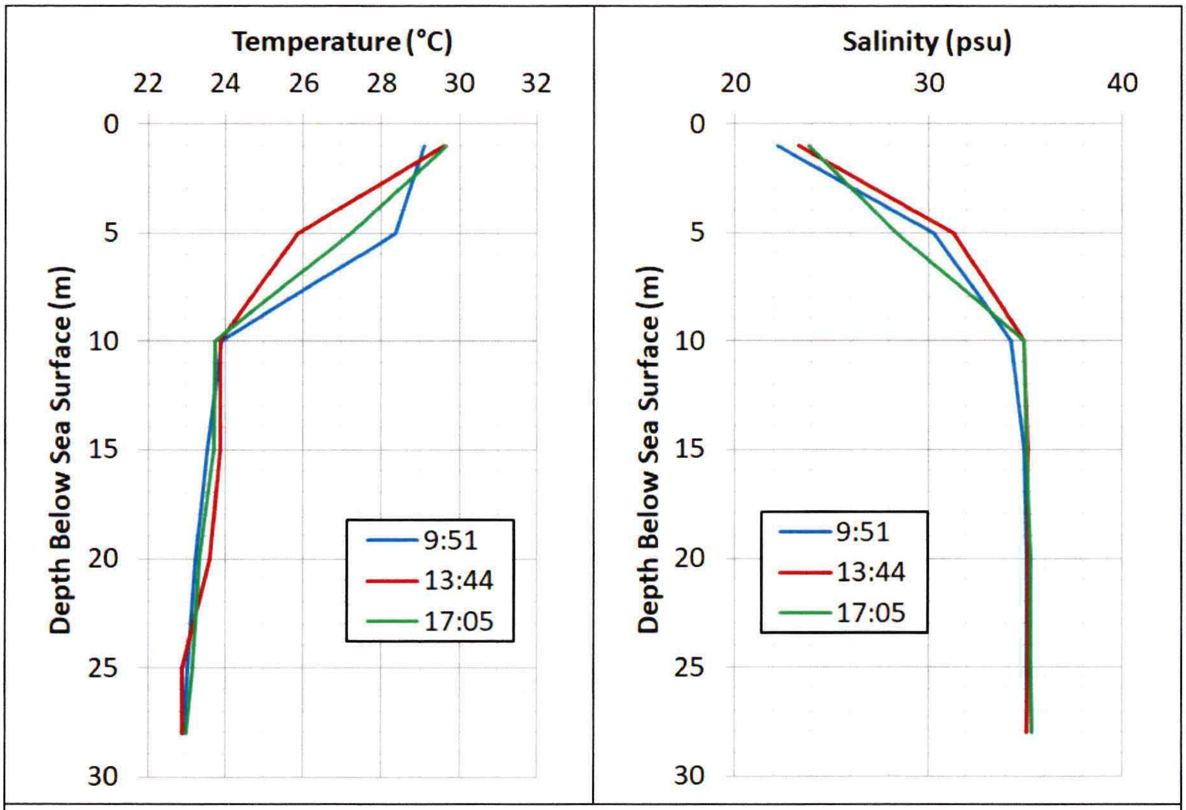


Figure 4: Vertical Profiles of Seawater Temperature and Salinity, 14 July 2017.

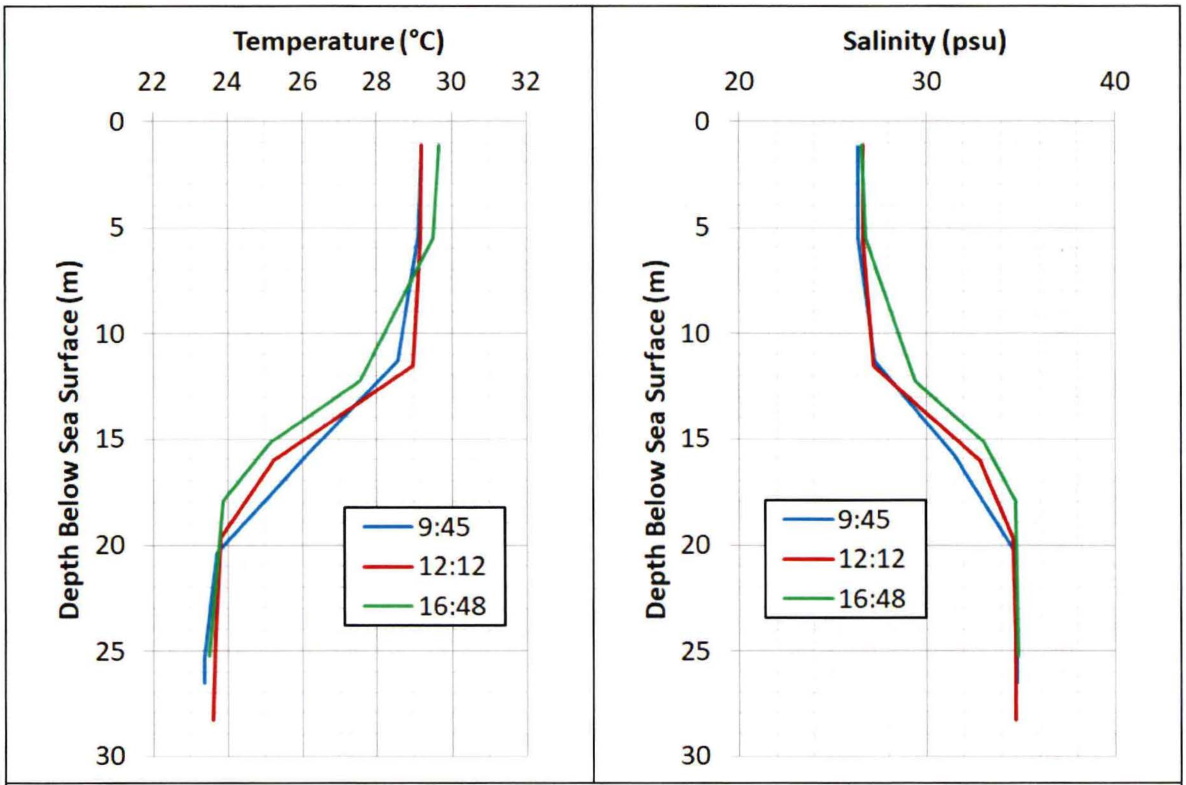


Figure 5: Vertical Profiles of Seawater Temperature and Salinity, 20 July 2017.

5.2 WEATHER CONDITIONS

The Hong Kong Observatory operates a weather station on Waglan Island, just south of the route of the submarine cable. Air temperature, humidity, wind speed and wind direction are shown below, copied from the Observatory's web site page for the Waglan Island weather station (http://www.hko.gov.hk).

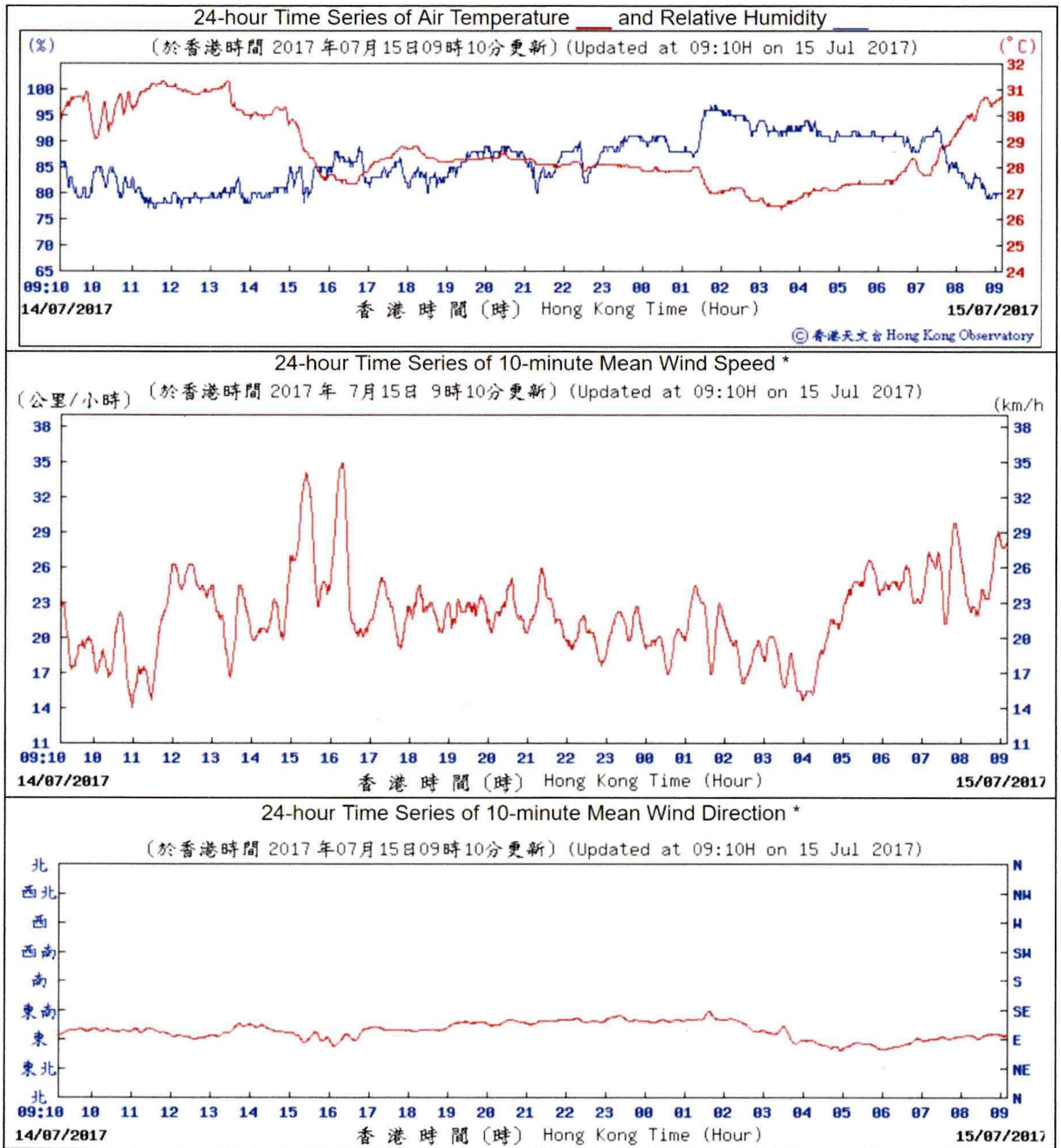


Figure 6: HK Observatory Weather Station, Waglan Island, 14 July 2017.

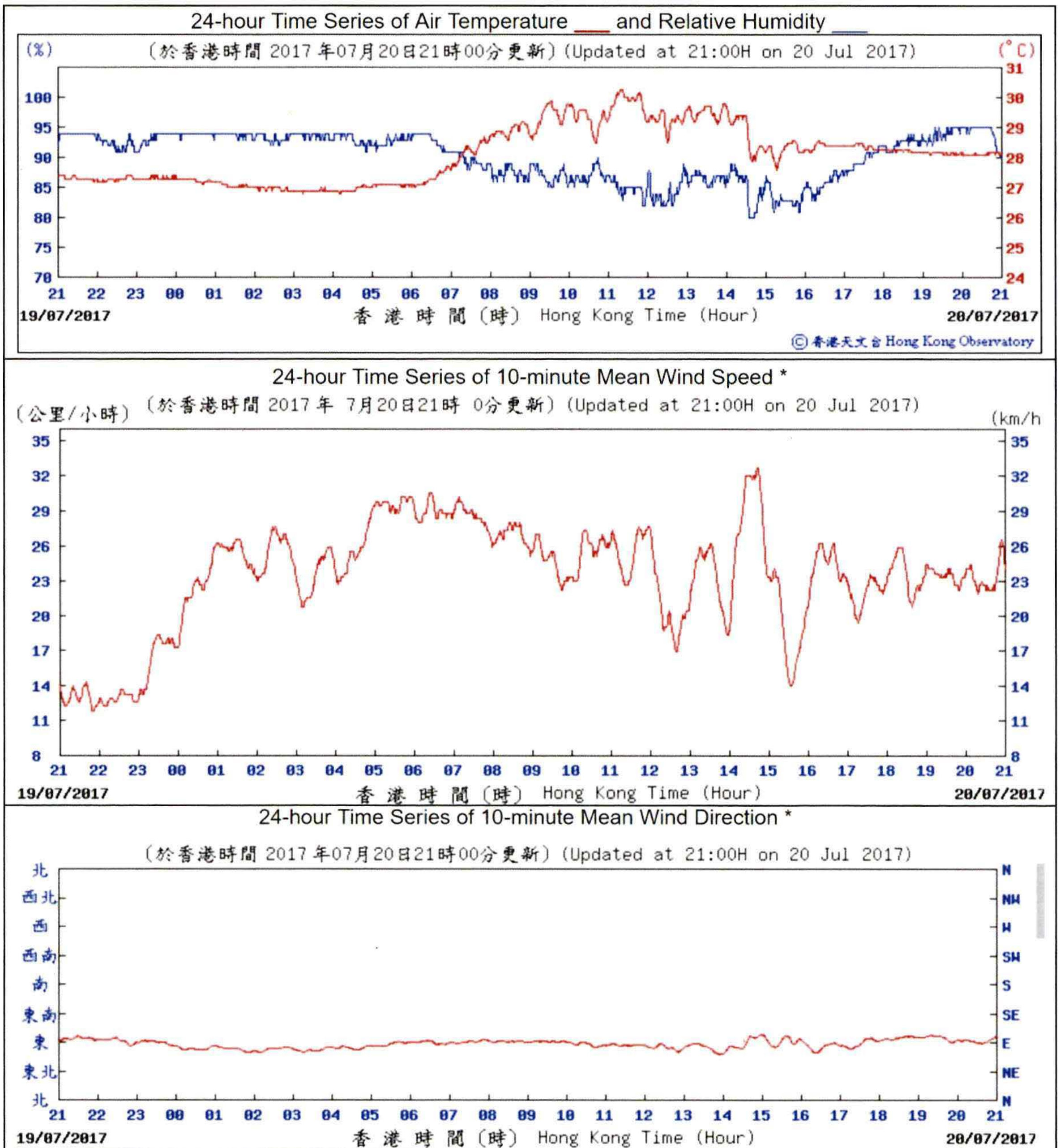


Figure 7: HK Observatory Weather Station, Waglan Island, 20 July 2017.

- Winds blew from the east and southeast on both days of recording.
- Winds were moderate breezes (Beaufort Scale 4, 20-28 km/hour) through most of the recording periods. There were some lulls to gentle breezes (Beaufort 3, 12-19 km/hour), and some periods gusting to fresh breezes (Beaufort 5, 29-38 km/hour).
- Most of the time, waves were ½ m to 1 m high with some gentle whitecaps. From 14:30-16:30 14th July and again around 14:30 20th July, wave heights increased to 1½ m under the influence of very heavy showers passing a few kilometres from the barge.

5.3 MEASUREMENTS OF UNDERWATER SOUND

Presentation of Results, Appendix B

84 underwater sound measurement data files were recorded on 14th and 20th July 2017. Details of the results have been presented in Appendix B.

- The same scale has been used on all time-series raster displays, 50 Pa between each raster centreline.
- Similarly, the same scale has been used for all frequency-domain displays of Received Sound Pressure Density Spectrum Levels (dB re 1 $\mu Pa^2/Hz$), integrated into ⅓-octave bands.

Summary of Measurements, Appendix C

Appendix C contains a summary of statistical parameters for each of the records:

- Record file number
- Date and time
- Coordinates of the barge and the recording boat, as easting and northing values on the Hong Kong Metric Grid (1980)
- The distance (m) of the recording boat from the installation barge.
- The bearing of the recording boat as seen from the installation barge (° clockwise from north).
- The level (dB re 1 µPa) of the most negative received sound pressure value.
- The level (dB re 1 µPa) of the most positive received sound pressure value.
- The level (dB re 1 µPa) of the root mean square (RMS) received sound pressure.
- Received Sound Pressure Density Spectrum Levels (dB re 1 $\mu Pa^2/Hz$), integrated into ⅓-octave bands. The centre of each ⅓-octave band increments by ⅓-octave, from 6.25 Hz to 81.275 kHz.

5.4 AMBIENT UNDERWATER SOUNDS

Assessment of ambient sound levels were complicated by variations in biological activity, particularly sounds attributed to intermittent activity of snapping shrimp (genus *Alpheus* of the *Alpheidea* family). For example, Figure 8 shows record numbers 147 and 148, recorded more than 2 km from the barge just 10 minutes apart.

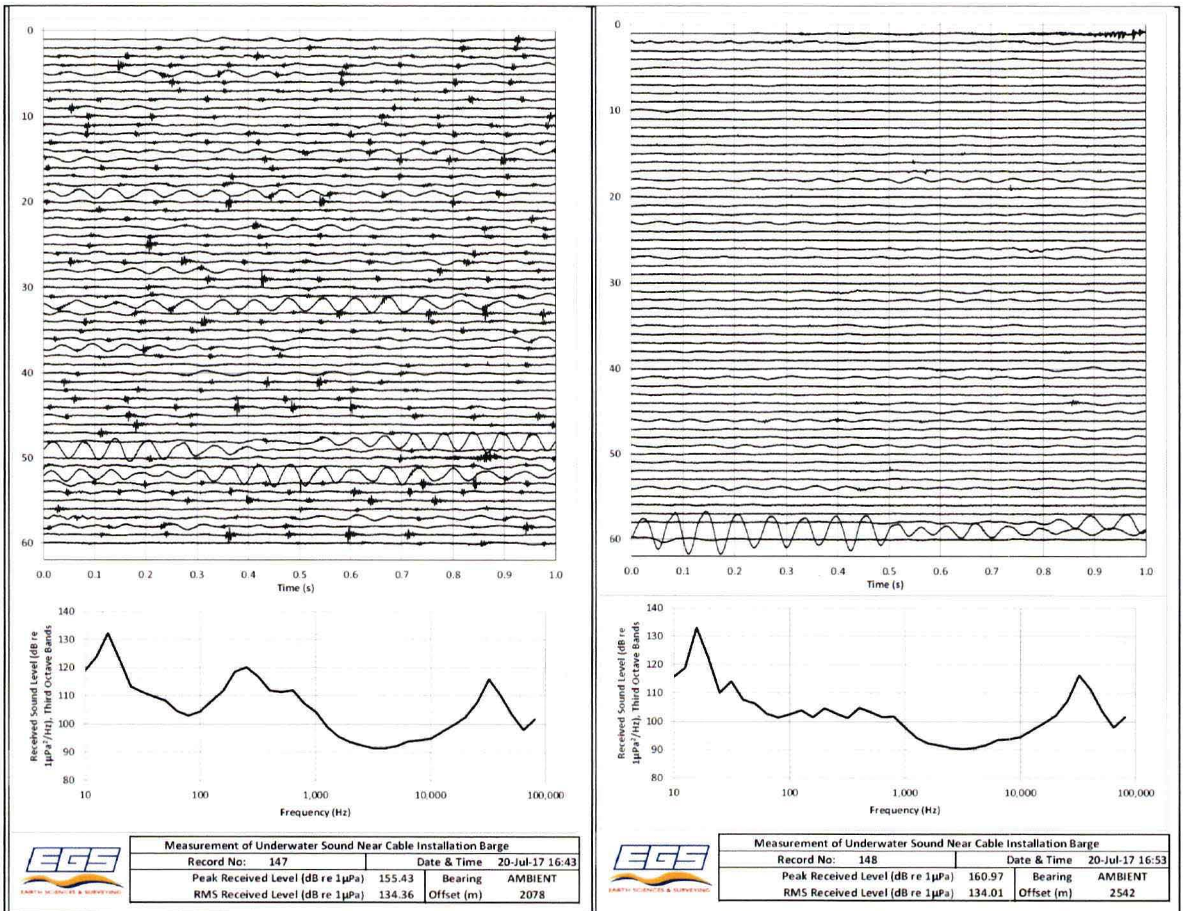


Figure 8: Ambient Sound Levels, 16:43 & 16:53 21 July 2017.

5.5 CHANGES IN ACTIVITIES ON THE INSTALLATION BARGE

Shortly before the survey vessel approached the installation barge on 14th July, the barge's injector was stopped for maintenance. For the rest of that day, the barge was stationary with generator and engines operating, but no pumps.

On the second day of recording, 20th July, the installation barge was burying the cable 5 m below the seabed at its normal rate progress, around ½ m/s. The injector pumps were operating as well as the generators and engines for winches and the dynamic positioning.

5.6 Variation in Received Sound Intensity with Distance from the Barge

The main feature that stands out from records around the barge is the great variability of sound levels. There was no overall decrease in received RMS sound intensity with distance from the barge. Nor was there a decrease in peak sound intensity. The following diagram shows the variation with distance of the level of the received minimum, maximum and RMS received sound pressure.

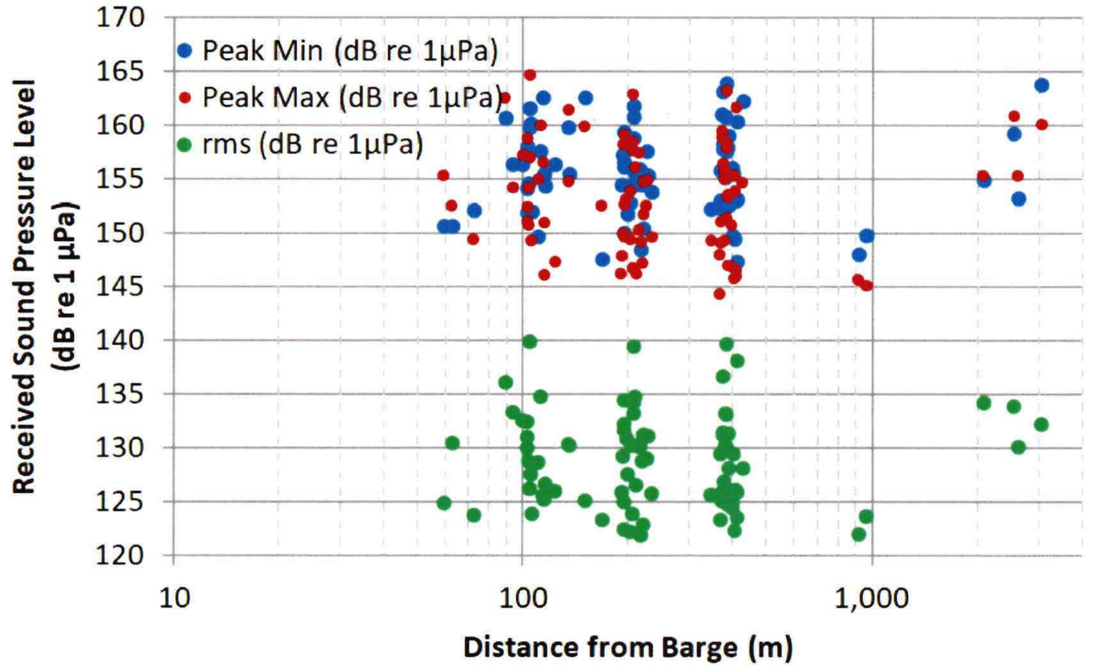


Figure 9: Variation of Received Sound Pressure Levels with Distance from Barge.

5.7 Directional Variation in Received Sound Intensity

Underwater sound was recorded ahead of the barge, behind the barge and to both port and starboard of the barge. The following diagram shows that there was no obvious directionality of sound from the barge.

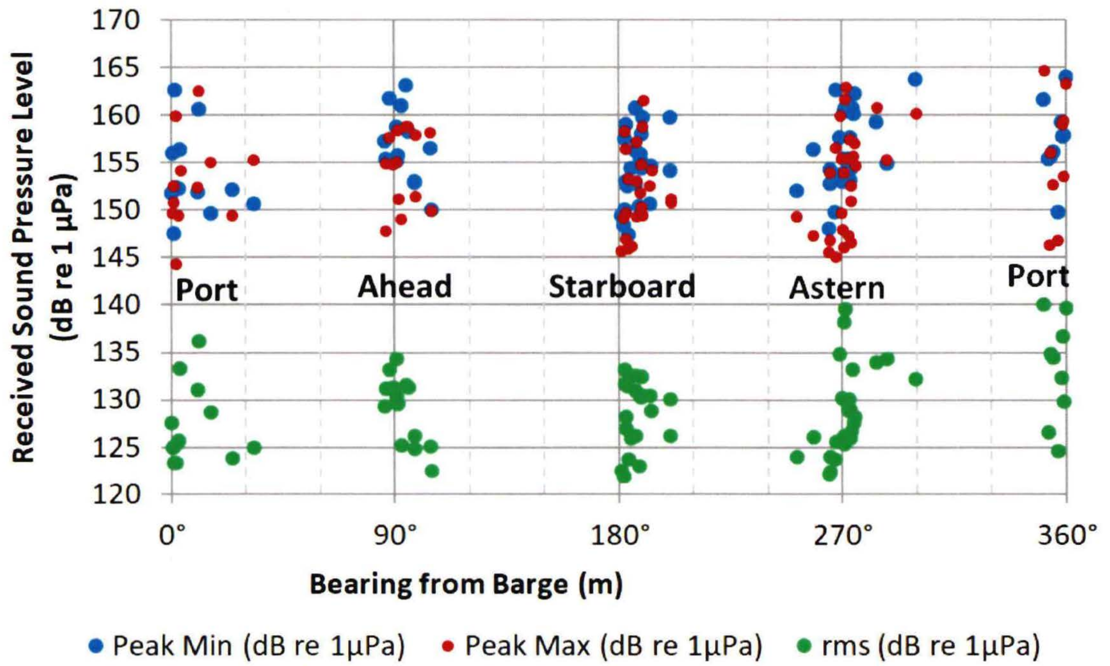


Figure 10: Variation of Received Sound Pressure Levels with Orientation from Barge.

5.8 STATISTICAL ANALYSIS OF MEASURED SOUND SPECTRA

The repeated measurements at fixed distances from the barge allow a statistical analysis of the distribution of measured values. Figure 11 shows the distribution of sound level spectra, integrated into one-third octave bands (dB re 1μPa). The upper panel shows the distribution of ambient sound spectra; the lower panel shows the distribution of spectra of measurements recorded at a distance of 100 m from the barge.

- The outer black dotted lines show the minimum and maximum ambient levels.
- The inner blue pecked line shows the 25% and 75% sound pressure levels. So 50% of all readings were between these blue lines.
- The central red line shows the median (50th percentile) sound levels.

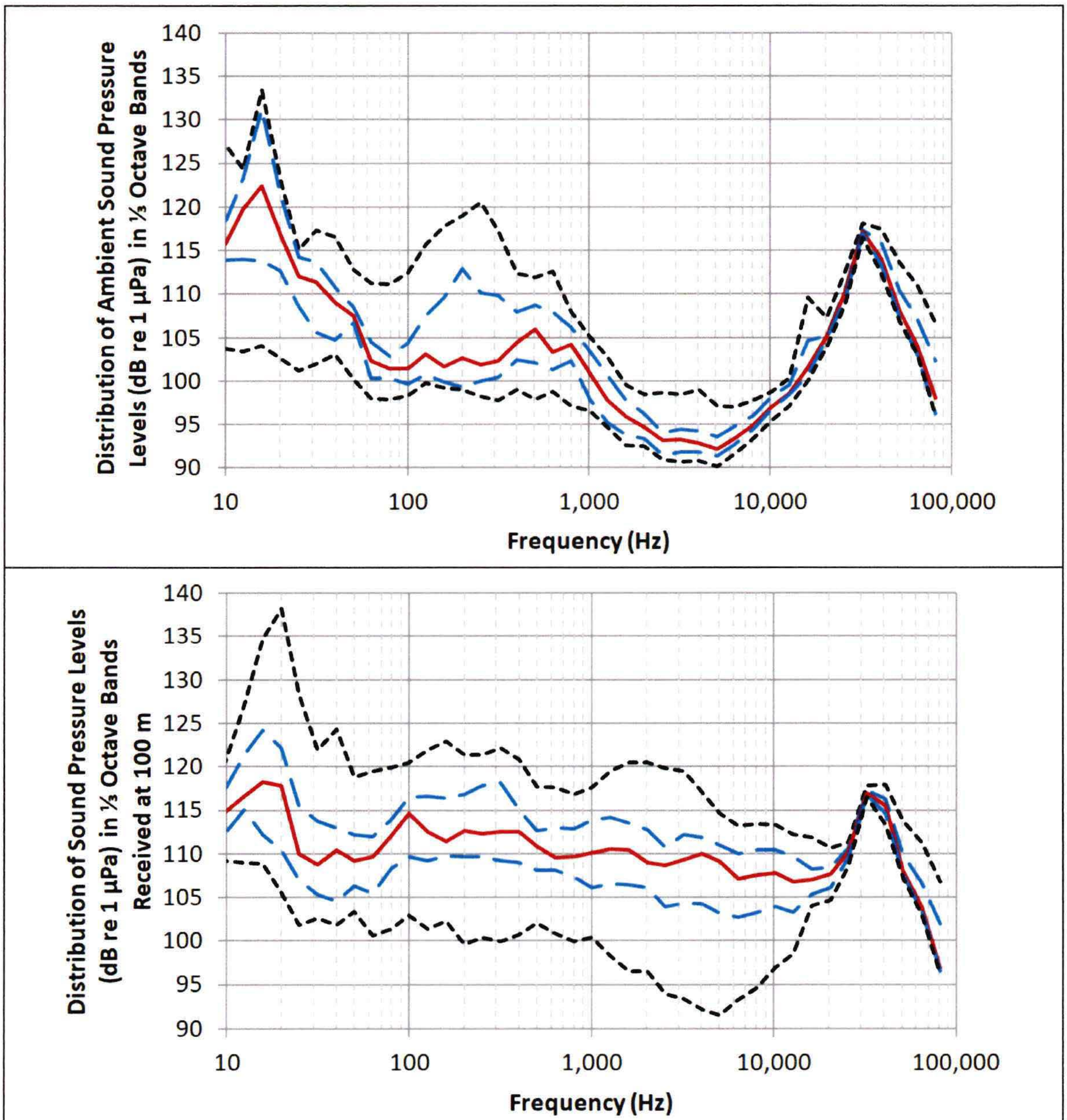


Figure 11: Statistical Distribution of Ambient Sound Pressure Levels.

The main points that emerge from this analysis are:

- The lowest frequency sounds, <25 Hz, are dominantly generated by wind and waves. There is considerable variability, but they are usually the most intense part of the spectrum with the highest sound pressure density levels. For this reason the low frequencies dominate the broadband measures of sound intensity such as peak sound levels and RMS sounds levels.

- At the lowest frequencies, <25 Hz, there was a very wide dynamic range of ambient sound levels, peaking at 29.3 dB at 16 Hz. The range of ambient sound levels declined irregularly to less than 10 dB at frequencies above 1 kHz.

- The dynamic range of measurements at 100 m from the barge was even more variable. The dynamic range was more than 10 dB from 10 Hz to 15 kHz, peaking at 32.7 dB at 20 Hz.

- It may seem obvious, but this clearly illustrates the point that the barge and its mechanical systems were optimised for installing a cable, not for providing a consistent detectable sound signal.

- There is considerable overlap between the distribution range of ambient sound pressure levels and sound levels at 100 m from the barge, Figure 12.

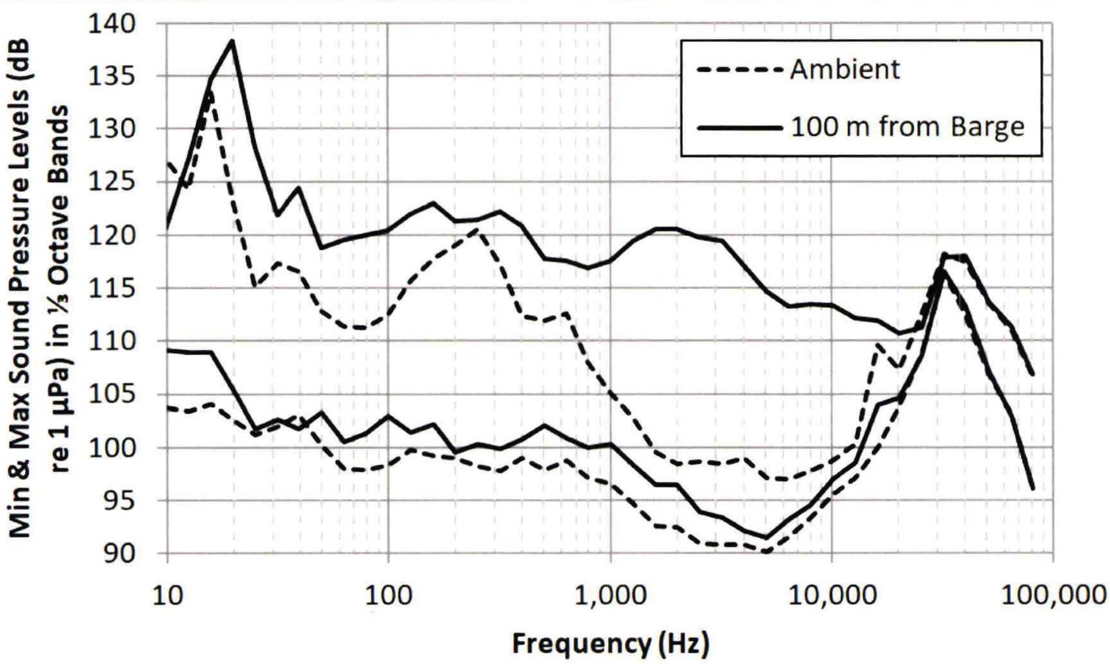


Figure 12: Comparison of Range of Ambient Sound Levels & Levels 100 m from Barge.

Using the power of statistical techniques, the central value of the distributions provides a more robust estimate of the underlying phenomenon than any measurement taken in isolation. The median was selected as the central value estimator:

- Medians are insensitive to wide variability that characterised both ambient conditions and installation barge sound sources.
- The median is independent of the difference in weighting that can be applied to measurements in the linear (pressure) and level (db, logarithm of pressure) domains.

5.9 Median Received Sound Pressure Level Spectra

Figure 13 shows the median received sound pressure levels integrated into ⅓-octave bands. The colours show the distance of the measurements away from the installation barge. A clearer picture now emerges.

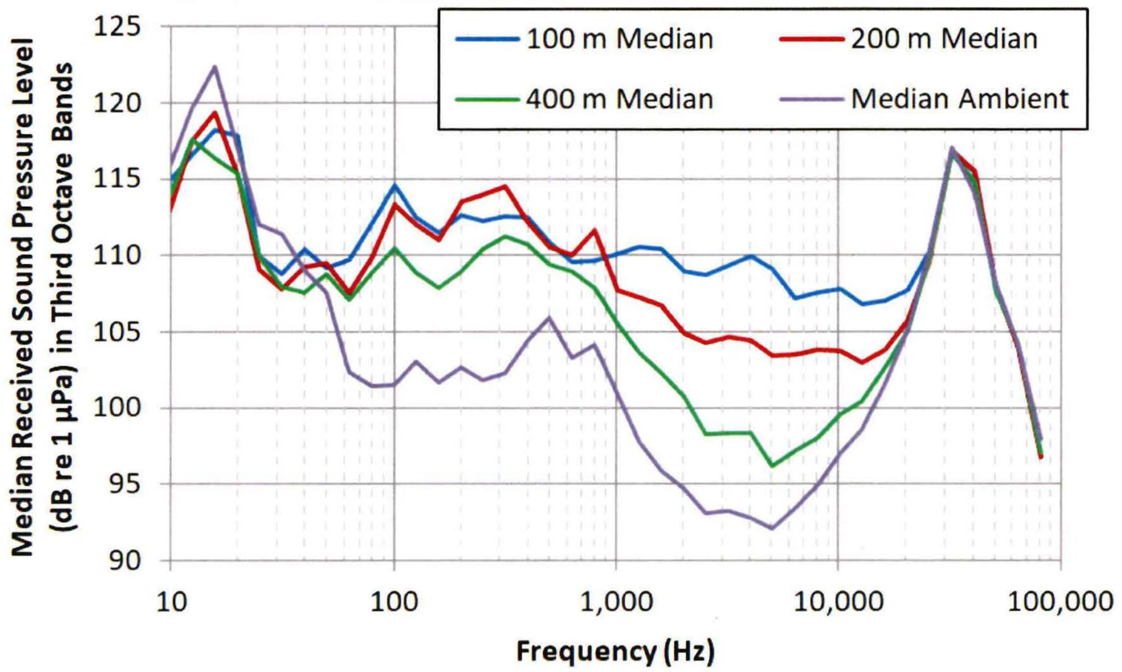


Figure 13: Median Received Sound Levels with Distance from Barge.

5.10 INCREASE IN MEDIAN RECEIVED SOUND PRESSURE LEVELS ABOVE AMBIENT

Simply subtracting median ambient levels from the received sound pressure level gives the increase in sound levels at 100 m, 200 m and 400 m from the installation barge, Figure 14.

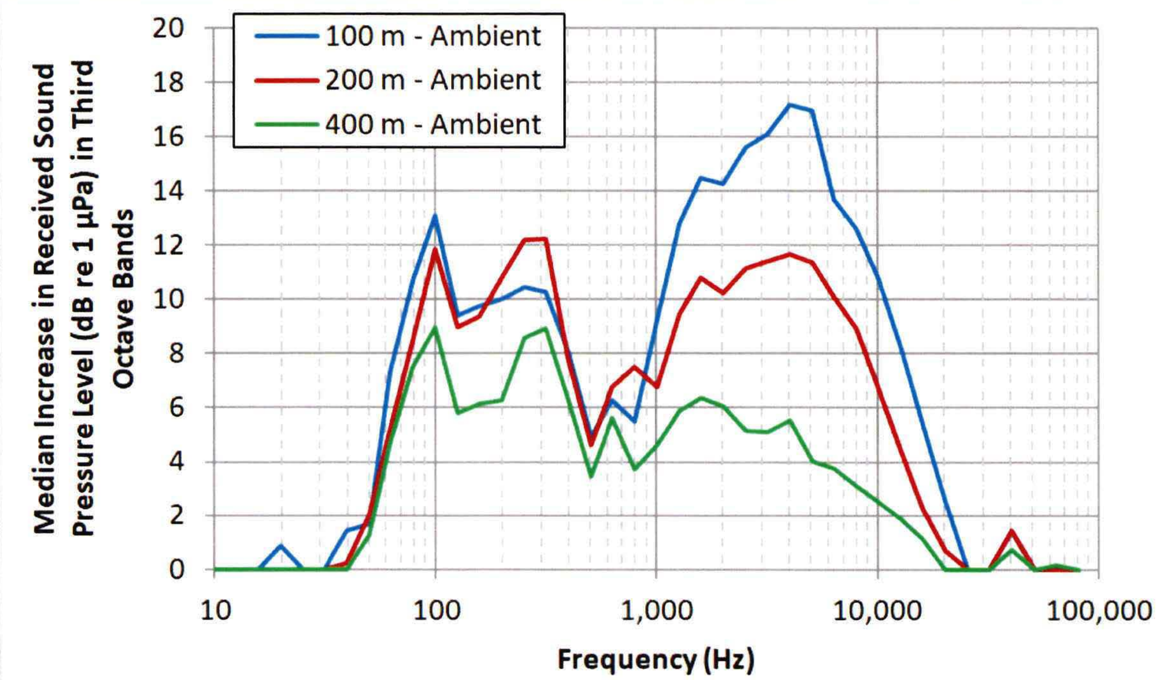


Figure 14: Median Increase in Received Sound Levels Above Ambient.

The main results from this analysis are:

- Fluctuations in sound levels at the lowest and highest frequencies sometimes made the ambient sound louder than the corresponding reading around the installation barge. Since it is physically unreasonable to suggest that the barge absorbed sounds, these values have simply been plotted as zero.
- There was no significant sound generated by the barge at frequencies below 40 Hz or above 25 kHz.
- There was a general increase in recorded levels of 8 to 13 dB re 1 µPa in the frequency range of 50 Hz to 400 Hz, declining to around 6 dB re 1 µPa from 500 to 900 Hz. This was attributed to sound from motors, such as the main engines, generators, pumps, compressors and exhaust mufflers. Note that during the measurements, three tugs were working closely around the installation barge, mostly within 200 m. Consistent with this distributed source of underwater sounds, there was little variation in sound levels within 200 m of the barge.
- Between 0.9 kHz and 15 kHz, recorded sound levels were more than 6 dB re 1 µPa above ambient. At a distance of 100 m from the barge, the increase peaked at 17 dB re 1 µPa above ambient at a frequency of 4 kHz. This has been attributed to cavitation vapour bubbles that formed around the installation jetting operation on the seabed (~30 m depth).

- The {minimum, mode, maximum} diameter of the cavitation bubbles at the seabed were {1 mm, 3 mm, 12 mm}. As the bubbles floated towards the sea surface, the bubble diameter decreased to {½ mm, 1½ mm, 6 mm}.

The size of the cavitation bubbles can be calculated from their frequency. Small bubbles oscillate at high frequencies, large bubbles oscillate at low frequencies. The bubble size also varies with depth below the sea surface (Leighton, T. G., 1994, Academic Press, "The Acoustic Bubble"). The following table lists the size of the bubble close to the seabed (30 m depth) and near the sea surface.

	Largest bubbles	Mid-sized bubbles	Smallest bubbles
Resonant Frequency	0.9 kHz	4 kHz	15 kHz
Bubble diameter, 30 m depth	12 mm	3 mm	1 mm
Bubble diameter, sea surface	6 mm	1½ mm	½ mm

The photograph below shows the calm area of the sea surface spread from vertically above the injector where these bubbles are released to the atmosphere.

Figure 15: Photograph of bubbles calming the sea surface directly above the injector.

6. CONCLUSIONS

From mobilisation to demobilisation, measurements of underwater sounds around a barge installing a submarine cable were conducted safely, with no HSE Incidents.

The main points that emerged from the analysis were:

- Broadband measures of sound intensity (peak and RMS values), integrating over the whole spectrum, did not show discernable variation with distance from the installation barge (Figure 9). This was attributed to sound energy concentrated in the lowest frequencies that are generated by wind and waves, independent of the presence of the barge.

- Similarly, broadband measures of sound intensity did not show discernable variation with bearing from the installation barge (Figure 10). Sounds generated by the barge were effectively omni-directional.

- There was considerable variability of sound intensity at all frequencies up to around 25 kHz. Figure 12 shows that ambient sound levels more than 1 km from the barge sometimes exceeded sound levels 100 m from the barge. Robust statistics based on median values (L1-norm central estimator) were required to extract meaningful results.

- The barge and the three attendant tugs generated sounds from motors, such as their main engines, generators, pumps, compressors and exhaust mufflers. They generated underwater sounds concentrated between frequencies of 50 Hz and 400 Hz. The three tugs were mostly within 200 m of the installation barge. Consistent with this distributed source of underwater sounds at these frequencies, there was little variation in sound levels within 200 m of the barge (Figure 14).

- The seabed was 30 m below the sea surface. The installation injector burying the cable beneath the seabed used high-pressure water jets to displace the seabed sediments. Cavitation vapour bubbles from the jets were 1 mm to 30 mm diameter. Oscillation of the bubbles as they floated up to the sea surface generated underwater sounds. Between 0.9 kHz and 15 kHz, recorded sound levels were more than 6 dB re 1 μPa above ambient (Figure 14). At a distance of 100 m from the barge, the increase peaked at 17 dB re 1 μPa above ambient at a frequency of 4 kHz.

Dr. Richard Hale
Director, EGS (Asia) Ltd
10th October 2017

APPENDIX B ASSESSMENT OF POTENTIAL IMPACTS OF FISHERIES

1. INTRODUCTION

This *Appendix* presents existing information on the fisheries resources and fishing operations within and adjacent to the proposed changes and evaluates the potential for direct and indirect impacts to them during construction and operation of the Project. The cable is unlikely to affect fishing activity during operation phase as it will be buried to a target depth of up to 5 m under the seabed for the majority of the cable corridor, and the seabed will be reinstated to the before-work level and condition very shortly. As a result, impacts to fisheries resources during the operation of the cable will not be discussed further.

2. RELEVANT LEGISLATION AND ASSESSMENT CRITERIA

The criteria for evaluating fisheries impacts are laid out in *Annex 17* of *Environmental Impact Assessment Ordinance (Cap. 499. S.16)* and the *Technical Memorandum on EIA Process (EIAO-TM)* and *Annex 9* of the *EIAO-TM* recommends some general criteria that can be used for evaluating fisheries impacts. Other legislation which applies to fisheries resources include: the *Fisheries Protection Ordinance (Cap 171)* 1987 which provides for the conservation of fish and other aquatic life and regulates fishing practices; and the *Marine Fish Culture Ordinance (Cap 353) 1983* which regulates and protects marine fish culture and other related activities.

3. DESCRIPTION OF THE ENVIRONMENT

In Hong Kong Special Administrative Region (HKSAR), the commercial marine fishing industry is divided into capture and culture fisheries. However, there are no gazetted Fish Culture Zones (FCZs) within 500 m of the proposed cable corridor. As such, culture fisheries are considered unlikely to be affected by the Project and they will thus only be discussed briefly. The following baseline information is focusing on capture fisheries and briefly describing the nearest culture fisheries. The baseline has been derived from the most up-to-date information on the HKSAR fishery [(1)]. Information from other relevant studies were also reviewed in order to determine if the waters of the proposed cable corridor are important spawning grounds or nursery areas for commercial fisheries [(2)]. Mariculture information was obtained from the AFCD Annual Reports [(3)].

3.1 Fisheries

3.1.1 Capture Fishing

The most updated Port Survey was carried out in 2016 - 2017 [(4)] in which grid analysis of fishing operations was performed, with each grid cover an area of 720 hectare. Generally moderate numbers of fishing vessels (100 - 400 vessels), except for two girds which had high number of fishing vessels (400- 800 vessels) operated in waters around Shek Kwu Chau (*Figure B1*). These vessels of no longer than 15 m in length (ie sampan) are the major type of fishing vessels along the cable route and are mostly sampans (*Figure B2*).

(1) Agriculture, Fisheries and Conservation Department (2018) Port Survey for year 2016 to 2017. Hong Kong SAR Government. <https://www.afcd.gov.hk/english/fisheries/fish_cap/fish_cap_latest/files/common/PS201617_ENG.pdf> accessed on 8 July 2019

(2) ERM - Hong Kong, Ltd (1998) Fisheries Resources and Operations in Hong Kong Water. Final Report for the Agriculture, Fisheries and Conservation Department. Hong Kong SAR Government.

(3) Agriculture, Fisheries and Conservation Department Annual Report 2015 -2016. Hong Kong SAR Government.

(4) Agriculture, Fisheries and Conservation Department (2018) *Op cit.*

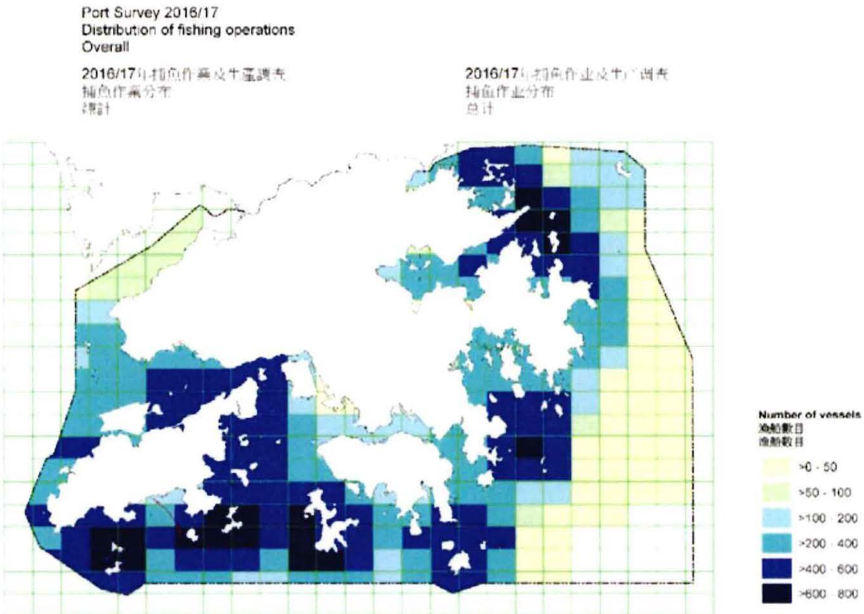


Figure B1: Distribution of Fishing Operations in HKSAR Waters and Locations of the Proposed Cable Corridor

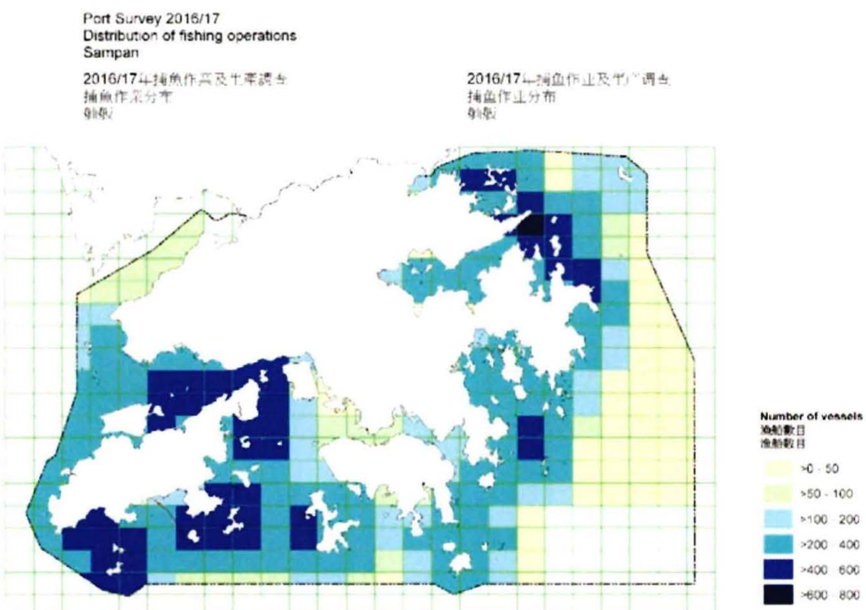


Figure B2: Distribution of Fishing Operations (vessel not exceeding 15 m in length) in HKSAR Waters

3.1.2 Capture Fisheries Resources

Fisheries production from the grids traversed by the cable corridor range from > 0 – 50 kg per hectare to 400 – 600 kg per hectare (*Figure B3*). High level of production value of adult fish (400 – 600kg per hectare) was recorded in waters around Shek Kwu Chau (*Figure B3*).

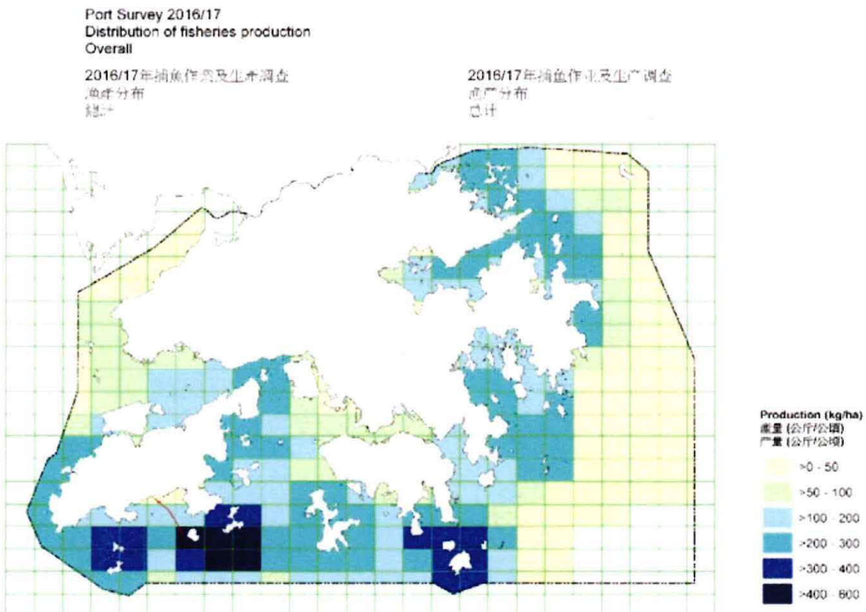


Figure B3: Distribution of Fisheries Production (Adult Fish) in HKSAR Waters and Location of the Proposed Cable Corridor

3.1.3 Culture Fisheries

There are no gazetted Fish Culture Zone (FCZ) within 500 m of the proposed cable corridor. The closest FCZ is the Cheung Sha Wan FCZ located just over 4.5 km away from the cable corridor at the closest point. According to the water quality impact assessment (see para 5b.7.4.5) in approved EIA Report (EIA-201/2011), the maximum travel distance of the sediment plume generated during cable installation is 80 m. As such, no impact is expected on the Cheung Sha Wan FCZ due to the cable installation/ operation (ie repair) works. As the Cheung Sha Wan FCZ will not be affected by the proposed Project due to their relative remoteness from the alignment, they will not be discussed further and water quality monitoring at Cheung Sha Wan FCZ for the Environmental Monitoring and Audit of the proposed Project is considered not necessary.

3.1.4 Spawning and Nursery Areas

The 1998 fisheries study [5] reported that the proposed cable corridor is located within spawning and nursery grounds of commercial fisheries resources. The Port Survey 2016 – 2017 records negligible fish fry collection within grids traversed by the proposed cable corridor [6].

(5) ERM - Hong Kong (1998) Fisheries Resources and Operations in Hong Kong Waters. *Op cit.*

(6) Agriculture, Fisheries and Conservation Department (2018) *Op cit.*

4. IMPACT ASSESSMENT

4.1 Direct Impacts

The proposed cables will be submerged through the injection jetting technique to a maximum depth of 5 m under the seabed. Through the employment of this burial technique, the seabed will be reinstated by resettlement of disturbed sediments and natural erosion from nearby seabed. Recolonisation of the sediments by benthic infauna is expected to occur, therefore providing food for bottom dwelling fisheries resources. In addition, minor interruptions to spawning and nursery grounds of commercial fisheries resources and fishing operations are expected to occur only during the cable installation of the proposed Project. These disruptions are, however, expected to be minimal as the duration of time required for cable installation/ repair works, will be short (ie approximately 30 working days for the actual submarine cable installation and duration of any cable repair work during operation is anticipated to be of shorter duration) in HKSAR waters. Moreover, the directly impacted area of spawning and nursery grounds of commercial fisheries resources is small when compared to the whole area of spawning and nursery grounds of commercial fisheries resources in south Lantau waters. Given the cable will be deployed using the injection jetting method, no unacceptable impact to fisheries resources or fishing operations is anticipated. Therefore, no long-term direct impacts to fisheries resources or fishing operations are expected to occur aside from minor short-term disturbances to the seabed in the immediate vicinity of cable installation activities and short-term displacement of fishing activities from the works area. These disturbances are not predicted to affect either fisheries resources or fishing operations in an unacceptable manner.

4.2 Indirect Impacts

Indirect impacts may occur through elevation in suspended solids (SS) resulting from the disturbance of the seabed through the burial of the cables and other marine work activities. However, the proposed injection jetting technique of burial will only lead to localized disturbance of seabed sediments, and expected to result in short-term SS elevations in the immediate vicinity (within 80 m from the cable alignment). Sediments that may be lost in suspension are likely to remain in the lower part of the water column and settle back onto the seabed within a short period of time (approximately 200 seconds). Cable installation and burial, as well as PLGR operation, and any repair work during operation, are thus not predicted to cause unacceptable impacts to water quality and consequently unacceptable impacts to fisheries will not occur.

5. FISHERIES IMPACT EVALUATION

An evaluation of the impact in accordance with the *EIAO-TM Annex 9* is presented as follows:

- *Nature of Impact*: The Project will involve the installation and operating of a submarine cable connecting Upper Cheung Sha Beach and Shek Kwu Chau Artificial Island. As a result of the small scale and relatively localized disturbances to the seabed, no unacceptable impacts to fisheries resources and subsequently fishing operations are predicted to occur during the cable installation process or during operation.

- *Size of Affected Area*: The total length of the cable is approximately 7 km. The cable will be deployed using the injection jetting method and will not affect fisheries resources or fishing operations. In addition, the maximum works area occupied by the cable installation barge during normal operation will be approximately 30 m either side along the cable route. In view of the small area occupied by the cable installation barge during construction (cable installation works (for both submarine cable and shore-end cable sections) will last for a total of approximately 3 months including contingency), potential impacts on vessel transit and fishing activities along the cable alignment are not expected.

- *Loss of Fisheries Resources/ Production*: Fisheries production of the affected areas ranges from > 0 – 50 kg per hectare to 400 – 600 kg per hectare, with the majority of them showing fisheries production between > 0 and 50 kg per hectare to 100 – 200 kg per hectare in terms of catch weight of adult fish. Fisheries production (in terms of weight of adult fish) in areas traversed by the cable corridor is generally low to moderate. Since the cable installation works will only last for approximately 3 months including contingency, and the disturbance on seabed is localized, and the seabed will be reinstated by resettlement of disturbed sediments and natural erosion, no unacceptable impact on the fisheries resources/ production is expected.

- *Destruction and Disturbance of Spawning and Nursery Grounds*: The proposed cable corridor passes through waters identified as spawning and nursery grounds of commercial fisheries resources, however, directly impacted area of spawning and nursery grounds of commercial fisheries resources is small when compared to the whole area of spawning and nursery grounds of commercial fisheries resources in south Lantau waters. In addition, the cable installation works are of relatively short duration in HKSAR (approximately 30 working days for the actual submarine cable installation) that no unacceptable water quality impact to nearby sensitive receivers with more than 80 m distance away from the cable installation work is expected. Given relatively small impacted area of nursery and spawning grounds were identified within the close vicinity (i.e. 80 m) of the proposed cable installation work and small size of the temporary affected areas, the construction and operation of the proposed submarine cables is not expected to result in unacceptable adverse impacts to nursery and spawning grounds in HKSAR waters.

- *Impact on Fishing Activity*: The proposed cable corridor passes through fisheries operation areas which mostly have moderate to high numbers of fishing vessels (100 – 800 vessels per hectare) and are mostly fished by vessels less than 15 m in length. The submarine cable installation works will restrict to a small area (ie subject to the location of the cable installation barge) at any one time and all works only last for approximately 3 months including contingency. In addition, the disturbance on seabed is localized and the seabed is expected to reinstate naturally to before-work level and condition very shortly. As such, impacts to fishing activities are not expected to occur. It should also be noted that the target burial depth of the cable after shore-end section is approximately 5 m below the seabed. Damages on the fishing gears/ tools by the cable are not expected.

Impact on Aquaculture Activity: Impacts to the closest Fish Culture Zone at Cheung Sha Wan, which is at least 4.5 km from the cable corridor at the closest point, are not predicted to occur.

5.1 Mitigation Measures

Mitigation measures that have been recommended to reduce impacts to water quality are also expected to control impacts to fisheries resources. In particular, for all marine works (both shore-end and submarine):

- The maximum speed of the cable installation will not exceed 1 km hr^{-1} so that the amount of seabed sediment disturbed and dispersed during the cable installation/ repair process can be kept to a minimum.

- Furthermore, with the implementation of good house-keeping practices, no unacceptable adverse impacts to either water quality or fisheries resources are expected to occur from land based activities.

- Water quality monitoring will be carried out to verify that the Project works will not result in any unacceptable adverse impacts to water quality, and consequently to marine ecology and fisheries (See *Annex A* for all marine ecology mitigation measures).

6. CONCLUSION

A review of existing information on the fisheries resources and fishing operations in the vicinity of the proposed cable corridor has identified the majority of the area is supporting a fishery of low to medium ranking in terms of fisheries production. Given the short duration of works and localized sediment plume (within 80 m from the cable alignment) arising from the cable installation/ repair works, no unacceptable impacts have been predicted to occur to fisheries resources or fishing operations as a result of the Project.

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ERM Hong Kong
2507, 25/F One Harbourfront
18 Tak Fung Street
Hunghom
Kowloon
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T: +852 2271 3000
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