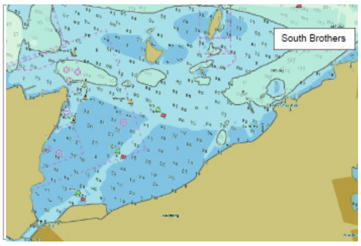
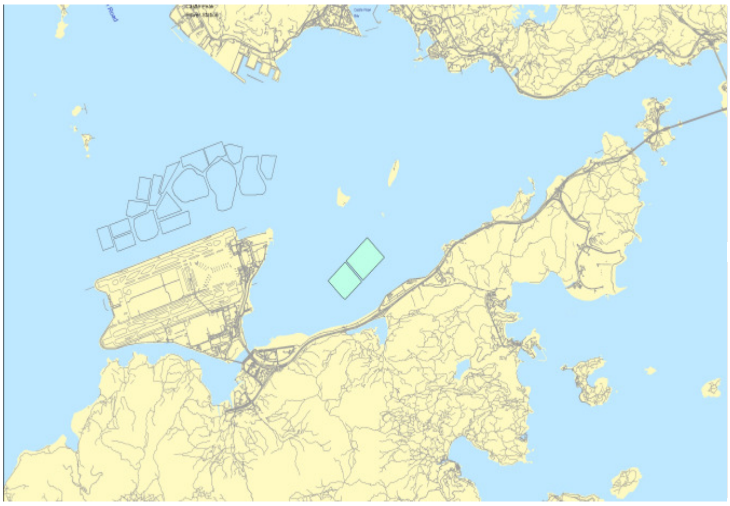
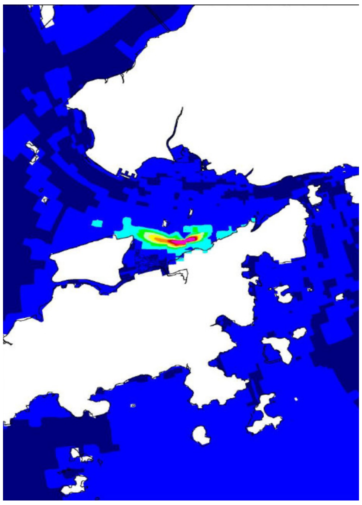
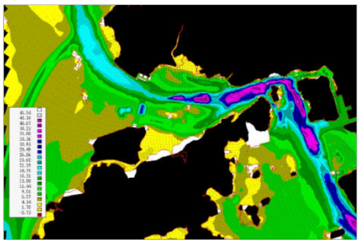




土木工程拓展署
CEDD Civil Engineering and Development Department

Agreement No. FM 2/2009 Contaminated Sediment Disposal Facility at South of Brothers

Environmental Impact Assessment (EIA) Review Report

Revised Final (Rev 5)

September 2010

Environmental Resources Management
21/F Lincoln House
Taikoo Place, 979 King's Road
Island East, Hong Kong
Telephone 2271 3000
Facsimile 2723 5660

www.erm.com

ERM

Delivering sustainable solutions in a more competitive world

土木工程拓展署
Civil Engineering and Development Department

ERM

Agreement No. FM 2/2009 Contaminated Sediment Disposal Facility at South of Brothers

Environmental Impact Assessment (EIA) Review Report

Revised Final (Rev 5)

Document Code: 0106271_EIA Review Report_v5.doc

Environmental Resources Management

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

Client:	Project No:
Civil Engineering and Development Department (CEDD)	0106271
Summary:	Date: September 2010
This document presents the EIA Review Report for the CEDD consultancy Contaminated Sediment Disposal Facility at South of Brothers (Agreement No. FM 2/2009).	Approved by: *Dr Robin Kennish* *Project Director*

5	EIA Review Report (Revised Final)	Var	CAR	RK	10/09/10
4	EIA Review Report (Final) – Addendum	Var	CAR	RK	27/07/10
3	EIA Review Report (Final)	Var	CAR	RK	01/06/10
2	EIA Review Report (Revised Draft)	Var	CAR	RK	25/02/10
1	EIA Review Report (Draft)	Var	CAR	RK	12/02/10
Revision	Description	By	Checked	Approved	Date

Distribution

☒ Government

☐ Public

☒ Confidential

OHSAS 18001:1999 Certificate No. OHS 515956

ISO 9001 : 2000 Certificate No. FS 32515

ISO 9001:2000 Certificate No. CC 479

CONTENTS

1 INTRODUCTION

1.1 BACKGROUND

Since early 1990s, contaminated sediment (1), or commonly termed as contaminated mud, arising from various construction works in Hong Kong has been disposed of at a series of seabed pits at East of Sha Chau (ESC). The current facility at ESC, namely the Contaminated Mud Pit (CMP) IV, was put into operation in 1998.

Since then, the HKSAR Government had commissioned a study entitled *Strategic Assessment and Site Selection Study for Contaminated Mud Disposal (Agreement No. CE 105/98)* to look for suitable strategies to sustain the contaminated sediment management issue in Hong Kong. The study findings were further reviewed and reassessed by the subsequent study entitled *Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/ East of Sha Chau Area (Agreement No. CE 12/2002(EP))*. Both the ESC and the South Brothers (SB) sites were concluded as the only available sites suitable for the provision of contaminated sediment disposal facility.

The environmental acceptability of the construction and operation of a contaminated sediment disposal facility at both the ESC and SB sites were confirmed by findings of the associated Environmental Impact Assessment (EIA) study completed under *Agreement No. CE 12/2002(EP)*. The Director of Environmental Protection (DEP) has approved the respective EIA report under the *Environmental Impact Assessment Ordinance (Cap. 499)* (*EIAO*) in September 2005 (*EIA Register No.: AEIAR-089/2005*). Whilst the SB site was identified as the viable site, due to the uncertainties in relation to concurrent projects at the North Lantau Coastline, it was remarked in the EIA report that the EIA of the SB facility shall be reviewed and assessed for its relevance prior to the construction works to be commenced on site to ensure that the information presented under *Agreement No. CE12/2002 (EP)* is not outdated.

In late 2008, it was reviewed that the existing and potential facilities at ESC would not be able to meet the disposal demand after 2012. As such, the HKSAR Government decided to pursue a new contained aquatic disposal (CAD) (2) facility at the recommended SB site in order for it to be able to accommodate arisings from 2012 onwards. The need to review the EIA findings for the SB site is thus imminent before the environmental

(1) According to the *Management Framework of Dredged/ Excavated Sediment of ETWB TC(W) No. 34/2002*, contaminated sediment in general shall mean those sediment requiring Type 2 – Confined Marine Disposal as determined according to this TC(W).

(2) CAD options may involve use of excavated borrow pits, or may involve purpose-built excavated pits. CAD sites are those which involve filling a seabed pit with contaminated mud and capping it with uncontaminated material such that the original seabed level is restored and the contaminated material is isolated from the surrounding marine environment.

acceptability of the SB site with respect to the latest development programme of various projects at its vicinity can be ascertained.

To this end, the Civil Engineering and Development Department (CEDD) has commissioned ERM-Hong Kong, Limited (ERM) to undertake this Study, namely *Contaminated Sediment Disposal Facility at South of Brothers (Agreement No. FM 2/2009)*, to provide a detailed review and update of the EIA findings for the SB site approved, in principle, under *Agreement No. CE 12/2002(EP)* and the EIAO.

1.2 *Scope & Objectives of this Study*

This Study will provide an update and verification of the relevance of the previous EIA findings, including those documented in the EIA report (1), for the SB facility to the satisfaction of DEP to facilitate the award of an Environmental Permit (EP) for the proposed facility.

The specific objectives of this Study are to:

- Conduct desktop investigations, inquiries, supplementary assessments and consultations to confirm that the previous EIA findings established as per the detailed requirements of the *EIA Study Brief (No. ESB-095/2001)* for the proposed SB facility are updated and verified with reference to the up-to-date information of other concurrent projects in the vicinity or any updated requirements/ guidelines; and

- Recommend with respect to the updated findings on the environmental viability of the proposed SB facility.

1.3 *Objectives of this EIA Review Report*

This *EIA Review Report* presents the outcomes of the update and verification of the approved EIA report (AEIAR-089/2005) for the proposed SB facility. The attributes of the approved EIA report which require updating and/ or verification, details of the updating and verifying requirements, and the appropriate methodologies for such update and verification, have been identified and presented in the *Initial Review Report* (2).

Specific objectives of this *EIA Review Report* include:

- Provide the updated details of the EIA for the SB site;

- Recommend, based on the review findings, the environmental acceptability of the proposed SB facility; and

(1) These findings are documented in the approved EIA report and the associated EM&A Manual on the EIAO Register at http://www.epd.gov.hk/eia/english/register/aeiara/all.html.

(2) ERM (2010) *Contaminated Sediment Disposal Facility at South of Brothers. Agreement No. FM 2/2009. Final Initial Review Report*. Prepared for Civil Engineering and Development Department.

- Recommend on the layout of the proposed SB facility and the associated mitigation measures to achieve optimal environmental performance of the proposed facility.

1.4 STRUCTURE OF THIS REPORT

Following this introduction section, the remainder of this *EIA Review Report* is arranged as follows:

Section 2	Reviews the statutory status, scope and current status of the approved EIA;
Section 3	Provides a description of the proposed SB facility. This section forms the basis of the EIA review presented in *Sections 4 – 10* below;
Section 4	Presents the details of a review of the water quality assessment of the approved EIA study;
Section 5	Presents the details of a review of the marine ecology assessment of the approved EIA study;
Section 6	Presents the details of a review of the fisheries assessment of the approved EIA study;
Section 7	Presents the details of a review of the hazard to health assessment of the approved EIA study;
Section 8	Presents the details of a review of the noise assessment of the approved EIA study;
Section 9	Presents the details of a review of the cultural heritage assessment of the approved EIA study;
Section 10	Presents the details of a review of the marine traffic impact assessment of the approved EIA study; and
Section 11	Presents a summary of the environmental outcomes of this EIA review;
Section 12	Introduces a summary of the environmental monitoring and audit (EM&A) measures for the SB facility; and
Section 13	Presents the conclusions of the EIA review.

2 APPROVED EIA STUDY OF THE SOUTH BROTHERS FACILITY

2.1 STATUTORY STATUS

For the EIA study of the proposed contaminated sediment disposal facility at South of Brothers, under *Agreement No. CE 12/2002(EP)*, an EIA report, together with an EM&A Manual and Executive Summary, were prepared in accordance with the *EIA Study Brief (No. ESB-095/2001)* and the *Technical Memorandum of the Environmental Impact Assessment Process (EIAO-TM)*. Such documentation was submitted to the DEP in March 2005. Following a period of public comment, the EIA report was subsequently approved by the DEP without conditions on 1st September 2005 and placed on the EIAO Register (No. AEIAR-089/2005).

Under the EIAO, prior to the construction of the SB facility, the Project Proponent, CEDD, is required to apply to the DEP for an Environmental Permit (EP). It is intended that CEDD will apply for an EP upon completion of this Study (FM 2/2009).

2.2 PURPOSE & OBJECTIVES OF THE EIA STUDY

The purpose of the approved EIA study was to provide information on the nature and extent of environmental impacts arising from the construction and operation of the SB facility as an intermediate facility and related activities that take place concurrently.

The objectives of the EIA study are specified in *Clause 2* of the *EIA Study Brief* and are presented in *Table 2.1*. To achieve the above objectives, specific tasks have been completed as per the requirements of the EIAO-TM and the respective findings have been presented in the approved EIA report.

Table 2.1 Objectives of the South Brothers Facility EIA Study (Clause 2 of EIA Study Brief No. ESB 095/2001)

EIA Objectives
(a) to describe the proposed facility (i.e. to construct and operate a contaminated mud disposal facility) and associated works together with the requirements for carrying out the proposed facility
(b) to identify and describe elements of the community and environment likely to be affected by the proposed facility, and/or likely to cause adverse impacts on the proposed facility, including natural and man-made environment and associated environmental constraints
(c) to identify and quantify emission sources and determine the significance of impacts on sensitive receivers and potential affected uses

EIA Objectives
(d) to identify and quantify impact to water quality and to propose measures to mitigate these impacts
(e) to identify and quantify impact to marine ecology and to propose measures to mitigate these impacts
(f) to identify any negative impacts on fisheries and to propose measures to mitigate the impacts
(g) to identify the human health risk and ecological risk associated with consumption of seafood from the proposed site of the facility
(h) to identify and quantify any potential impacts to Chinese White Dolphins and to propose measures to mitigate the impacts
(i) to identify any negative impacts on site of cultural heritage and to propose measures to mitigate these impacts
(j) to identify and quantify the potential long-term impact of seabed ecology and bioaccumulation of contaminants in biota of the subject site and to proposed measures to mitigate the impacts
(k) to identify any potential noise impacts to the sensitive receivers during construction and operation and to propose measures to mitigate these impacts
(l) to propose the provision of mitigation measures so as to minimize pollution, environmental disturbance and nuisance during construction and operation of the proposed facility
(m) to investigate the feasibility, effectiveness and implications of the proposed mitigation measures
(n) to identify, predict and evaluate the residual environmental impacts (i.e. after practicable avoidance or mitigation measures) and the cumulative effects expected to arise during the construction and operation of the proposed facility in relation to the sensitive receivers and potential affected uses
(o) to identify, assess and specify methods, measures and standards, to be included in the detailed design, construction and operation of the Proposed facility which are necessary to mitigate these environmental impacts and cumulative effects and reduce them to the acceptable levels
(p) to design and specify environmental monitoring and audit requirements to ensure the effective implementation of the recommended environmental protection and pollution control measures.

2.3 *SCOPE OF THE EIA STUDY*

As specified in *Clause 3.2.2* of the *EIA Study Brief*, the EIA Study has addressed the key environmental issues associated with the construction and operation of the Project. These issues, which are summarised in *Table 2.2*, were assessed in accordance with the detailed technical requirements set out in *Clause 3* of the *EIA Study Brief* and the relevant criteria and guidelines stipulated in the *EIAO-TM*.

Table 2.2 Key Environmental Issues Associated with the South Brothers Facility (Clause 3.2.2 of EIA Study Brief No. ESB 095/2001)

EIA Scope	Key Environmental Issues
Water Quality	• Water quality impact associated with dredging works and construction and operation of the disposal facilities; and • Cumulative water quality impact, including the discharges from the Siu Ho Wan Sewage Treatment Works outfall.
Marine Ecology	• Impact on marine ecology of the Sha Chau and Lung Kwu Chau Marine Park during construction and operation of disposal facilities; • Potential long term impact of seabed ecology and bio-accumulation of contaminants in biota of the subject site; and • Impact on the Chinese White Dolphins and artificial reef complexes during the construction and operation of the disposal facilities.
Fisheries	• Impact on capture fisheries during construction and operation stages of the disposal facilities.
Hazard to Health	• Human health risk and ecological risk associated with consumption of seafood from the project area.
Noise	• Potential impact to the noise sensitive receivers during project construction.
Cultural Heritage	• Potential impacts to site(s) of cultural heritage.

In addition to the above, a Marine Traffic Impact Assessment (MTIA) was conducted under *Agreement No. CE 12/2002(EP)* for the construction and operation of the proposed SB facility to identify if the risk associated with traffic activity falls within acceptable levels. The assessment is presented in *Annex F* of the approved EIA report.

2.4 *NEED FOR AN EIA REVIEW*

Whilst the approved EIA study confirmed that the SB facility would be an environmentally viable option, it was noted in the EIA report that (Part 4, Section 1-4):

> *"For options 2 and 3 (i.e. sequential use of the ESC and SB facilities) it is recommended that before construction and activation of the pits at the South Brothers, a review and update of the EIA should be conducted to assess the validity of the assumptions made in this EIA report."*

The present Study has assessed the validity of the assumptions of the EIA study. The need for an EIA review and update has arisen owing to three key reasons:

- Changes in original project programme;
- The latest development programme of concurrent projects in the vicinity of the SB facility; and
- Changes in pit layout.

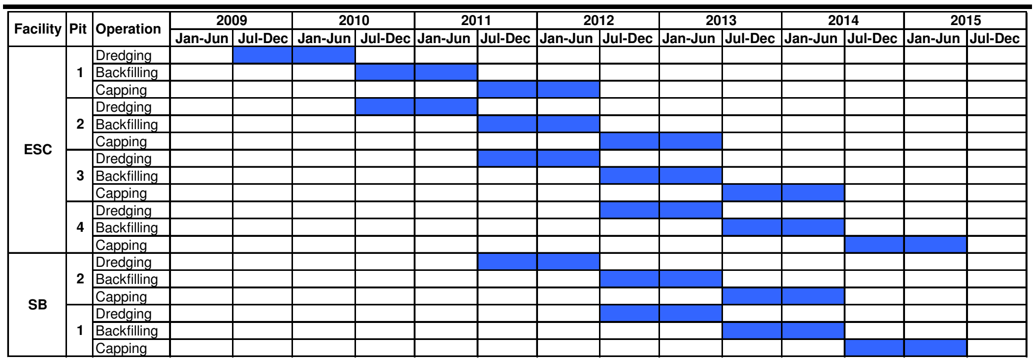
Each of these is described below.

2.4.1 *Project Programme*

Although various tentative programmes of works were developed in the EIA study, they were based on the construction of the SB facility in 2008, or in either 2011 or 2012 should the ESC facility be constructed and operated first. The latter also assumed that the ESC and SB facilities would only be operated sequentially hence allowing no concurrent backfilling operations in more than one pit at the same time.

The SB facility is expected to be constructed in mid 2011 (*Figure 2.1*; see *Section 3.6* for details). According to arisings estimates, concurrent backfilling of the ESC and SB facilities may be required to accommodate higher disposal capacity and to provide greater flexibility in the disposal of contaminated dredged material. The tentative programme of the ESB and SB facilities is presented in *Figure 2.1*. It should be noted that the timeline presents predicted timeframes for each works component.

Figure 2.1 ***Indicative Works Programme at the East Sha Chau & South Brothers Contaminated Sediment Disposal Facilities***



The above deviations from the tentative works programmes and works assumptions presented in the EIA study are likely to have an effect on the relevance of the previous EIA findings for the SB facility, in particular when evaluating potential cumulative impacts associated with other concurrent projects. These are discussed further in the following section.

2.4.2 *Concurrent Projects*

A requirement in the *EIA Study Brief* is to examine the cumulative effects of other projects concurrent with construction and operations at the SB facility (*Clauses 3.2.2* and *3.3.3* of the *EIA Study Brief*). During the EIA study in 2004-2005, a number of projects were identified as occurring potentially at the same time as the proposed facility (*Table 2.3*).

Table 2.3 ***Projects Concurrent with the Construction and Operation of the South Brothers Facility as Identified in the EIA Study (Agreement No. CE 12/2002(EP))***

Type of Project	Concurrent Project
Contaminated Sediment Disposal Facility	• Disposal at North Brothers • Dredging, Backfilling and Capping at East of Sha Chau (Pits IVc and V)
Reclamations along North Lantau Coastline	• Potential New Town Extension at Tung Chung East and Tung Chung West • Lantau Logistics Park • Potential Theme Park • Reclamations at Yam O
Fuel Storage & Transport	• Permanent Aviation Fuel Facility (PAFF)
Highway	• Tuen Mun to Chek Lap Kok link • North Lantau Highway Connection to the Hong Kong – Zhuhai – Macao Bridge
Sewage Discharges	• Siu Ho Wan Sewage Treatment Work (STW) • Pillar Point Sewage Treatment Work (STW)

The latest development programmes of some relevant infrastructure projects and other publicly available information suggest that some of the projects presented in *Table 2.3* may no longer be constructed or operated concurrently with the SB facility. A list of committed concurrent projects in the vicinity of the SB facility has been identified as part of this EIA review and is presented in *Table 2.4*.

Table 2.4 ***Projects Concurrent with the Construction and Operation of the South Brothers Facility as Identified in this EIA Review (Agreement No. FM 2/2009)***

Type of Project	Concurrent Project	Timeframe
Contaminated Sediment Disposal Facility	• Contaminated Mud Pits (CMPs) at ESC (Pits IVc and V)	• Backfilling of CMP IVc on-going and expected to be completed by end 2010. Capping operations to follow. • Dredging of first pit of CMP V commenced in mid 2009 and on-going. Dredging of other pits to follow. Backfilling of first pit expected in mid 2010.
Reclamations along North Lantau Coastline	• Lantau Logistics Park (LLP)	• Construction is scheduled to begin in second quarter of 2010 (1); however, it is understood that this project is currently not on such an advanced schedule and as such this is unlikely to occur. The reclamation works of the LLP are expected to commence in end 2015 the earliest.
Highway	• Tuen Mun – Chek Lap Kok Link (TMCLKL) and Tuen Mun Western Bypass	• Construction to start in late 2011, with a target opening date for the entire road link at the end of 2016. However, the part of the southern reclamation may be carried out in conjunction with the reclamation for HKBCF which will commence earlier and in 2010.
	• Hong Kong – Zhuhai – Macao Bridge (HZMB) Hong Kong Link Road (HKLR) (formerly known as North Lantau Highway Connection to the Hong Kong – Zhuhai – Macao Bridge)	• Construction to start in 2011, for completion in 2015, with a construction period of 4 years
	• HZMB Hong Kong Boundary Crossing Facilities (HKBCF)	• Construction to start in the 3rd quarter of 2010, for first phase completion by End 2015, and second (final) phase completion by End 2016.
Sewage Discharges	• Pillar Point Sewage Treatment Work (STW)	• Construction commenced in mid 2009 for completion in 2012
Container Terminal	• Kwai Tsing Container Terminals (KTCT) – Container Basin & Approach Channel Dredging	• Dredging to commence in 2010 for completion in 2013

(1) Lantau Development Task Force (2007) *Revised Concept Plan for Lantau*. Published in May 2007

The above concurrent projects may have a bearing on the environmental acceptability of the SB facility, and some of these projects, e.g. construction of the HZMB HKBCF and concurrent backfilling of the ESC CMP V pits, were not evaluated in the previous EIA study. The relevance of previous EIA findings should thus be reviewed taking into account these projects.

2.4.3 *Revised Pit Layout*

The present SB facility layout involves only two dredged pits instead of three pits as proposed in the EIA study (about 153 ha within Facility Boundary, *Figure 2.2*). This is due to planning constraints on the North Lantau coastline (1) and other physical constraints in the vicinity of the proposed facility, in particular the proposed reclamation of the Lantau Logistics Park (LLP) in Siu Ho Wan and the Sham Shui Kok Anchorage. The present works sequence for the two pits is also likely to be different from that considered in the approved EIA study.

Given that the pit layout and works programme have been revised, there is a need to revisit the previous EIA findings. Further minor changes may be required to the envelope enclosing the site of the pits, and indeed possibly to the number of pits within the envelope. However, any such changes would not be expected to materially affect the potential of the project to produce environmental impacts outside the works area. For the purposes of this *EIA Review Report* the tentative layout of two pits as shown in *Figure 2.2* is used and is considered representative of the degree and scale of the works.

2.5 RELEVANCE OF PREVIOUS EIA FINDINGS & ATTRIBUTES FOR EIA REVIEW

In light of the discussion in *Section 2.4*, it is considered necessary to review and assess the relevance of previous EIA findings for the SB facility prior to the commencement of construction works. Under each of the following scope of the EIA study, the attributes of the approved EIA study that require updating and/or verification, and the respective methodologies for update/ verification, have been determined as part of the *Initial Review Report*:

- Water Quality;
- Marine Ecology;
- Fisheries;
- Hazard to Health;
- Noise; and
- Cultural Heritage.

(1) Lantau Development Task Force (2007) *Op cit*

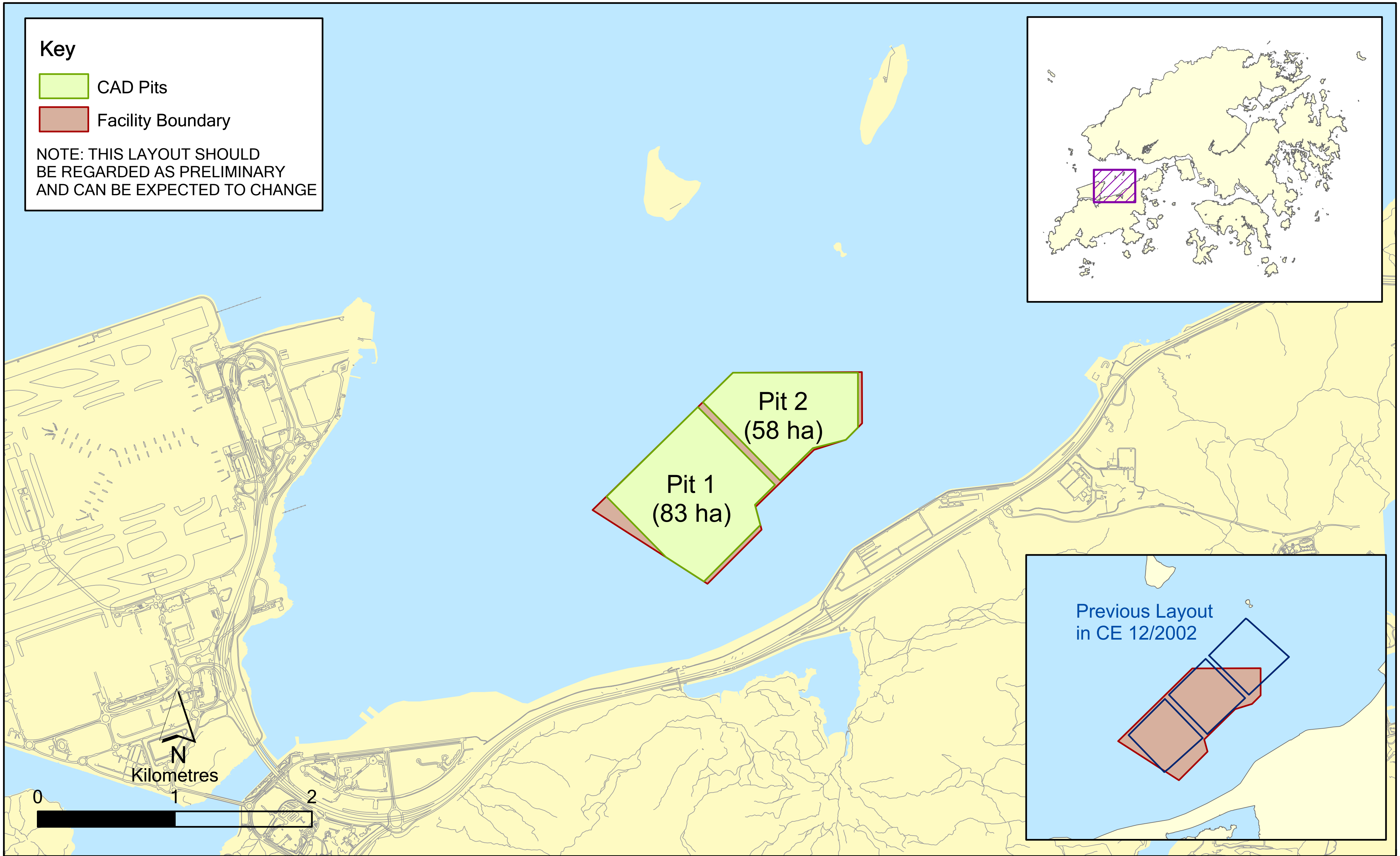


Figure 2.2

Tentative Layout of the Proposed Contaminated Sediment Disposal Facility at South of Brothers

File: E2 gazatte boundary\0106271_study area E2.mxd
Date: 31/05/2010

Environmental Resources Management

ERM

In addition, updating/ verification requirements for the MTIA conducted as part of *Agreement No. CE 12/2002(EP)* were also determined as part of the *Initial Review Report*.

Outcomes of the EIA update/ verification are presented in *Sections 4 – 10* of this Report. *Section 3* provides a description of the proposed SB facility which forms the basis of this EIA review.

3 PROJECT DESCRIPTION

3.1 THE PROJECT

The proposed CAD facility at the SB site is classified as a Designated Project by virtue of the following items of Item C (Reclamation, Hydraulic and Marine Facilities, Dredging and Dumping), Part I of Schedule 2 under EIAO:

- Item C.10 – A Marine Dumping Area; and
- Item C.12 – A dredging operation exceeding 500,000 m^3.

The Project involves the sequential dredging, disposal of contaminated mud into, and subsequent capping of the two dredged pits. The key components of the facility include the following:

- Dredging of two seabed pits *sequentially* within the proposed SB Facility Boundary;
- Backfilling each dredged pit *sequentially* with contaminated mud that has been classified as requiring Type 2 disposal in accordance with *ETWB TC(W) No. 34/2002*; and
- Capping each backfilled pit *sequentially* with uncontaminated mud and/or public fill effectively isolating the contaminated mud from the surrounding marine environment.

These components constitute the construction and operation phases of the SB CAD facility. They were the subject of the EIA study and this EIA Review.

3.2 PROJECT DESIGN

3.2.1 *Introduction*

The approved EIA study was based on a preliminary SB facility layout which involved the sequential construction and operation of a series of three dredged pits with a total capacity of about 8 Mm^3 (about 200 ha within the facility usable area). In view of the planning constraints on the North Lantau coastline and other physical constraints in the vicinity of the proposed SB facility, it is considered that the layout needs to be revised.

The following sections describe a layout and design for the proposed SB facility which is based on maximising disposal capacity, ensuring continuity in use of the site, and ensuring that potential impacts are environmentally acceptable and no greater than those associated with existing CMP operations. The information presented in this section is taken as the preliminary design and will be refined at the detailed engineering design stage.

3.2.2 *Current Pit Layout & Design*

The pit layout has been revised with consideration of the following key planning constraints:

- Proposed reclamation of the Lantau Logistics Park (LLP) in Siu Ho Wan and its possible extension;
- Sham Shui Kok Anchorage;
- Tung Chung Channel;
- Proposed Tuen Mun – Chek Lap Kok Link; and
- Proposed Brothers Island Marine Park.

The present proposed preliminary design has also been developed based on the following two key information sources:

- Results of geotechnical investigation (GI) surveys (1); and
- Results of sediment testing, i.e. chemical and biological screening tests (2) (3).

Results presented in these information sources suggest that across the Facility Boundary, pits can be formed by dredging to a depth of at least 9 m below seabed level (i.e. – 9 mPD) in order to maximise pit capacity.

The pit layout has been conservatively based on an assumed pit slope of 1:4 even though a steeper slope would increase the available storage capacity of the area and would improve the ratio between the disposal volume and the volume of the cap.

The overall design of the facility should maximise the disposal capacity of the area and minimise the volume of dredging required to form the pits. This will be achieved by optimising the dredged slopes, the shape of the pits and the spacing (i.e. earth bund) between the pits.

The current layout involves only two dredged pits, provisionally titled Pits 1 and 2, within the Facility Boundary. The area coverage of Pit 1 and Pit 2 are about 83 ha and 58 ha respectively, i.e. total area affected about 141 ha. With the current layout the SB facility is expected to have a total net capacity of no

(1) Fugro Geotechnical Services Limited (2009) Civil Engineering and Development Department. Geotechnical Engineering Office. *Contract No. GE/2008/03.15/* 5737CL- Dredging, Management and Capping of Sediment Disposal Facility at South of Brothers. Phase 1 Marine Ground Investigation. Final Factual Fieldwork Report.

(2) ALS Environmental (2009) Provision of Chemical and Biological Testing for Various Government Preojects *Service Order No. GP/CBT/2009/01.04.* 5737CL- Dredging, Management and Capping of Sediment Disposal Facility at South of Brothers. Laboratory Report – Chemical Testing (Final Report). Prepared for Civil Engineering and Development Department.

(3) ALS Environmental (2009) Provision of Chemical and Biological Testing for Various Government Preojects *Service Order No. GP/CBT/2009/01.04.* 5737CL- Dredging, Management and Capping of Sediment Disposal Facility at South of Brothers. Laboratory Report – Biological Testing (Final Report). Prepared for Civil Engineering and Development Department.

less than 5 Mm^3 and a maximum capacity of 8 Mm^3. The tentative layout of the proposed facility is shown in *Figure 3.1*.

Rationale for Current Pit Layout

It is understood that the approved EIA report recommended that "*Following the precautionary principle and due to the proximity of Tai Ho Bay and the uncertainties in the final plans for projects on the North Lantau coastline, operations at South Brothers Pit C should be avoided. It should be noted that Pit B at South Brothers will only be used if Pit A is proven to be environmentally acceptable through EM&A works*".

The current proposed pit layout, however, encroaches into the footprint of Pit C, which is close to Tai Ho Bay. This is due to the following reasons:

- Results of the GI works conducted in August 2009 show that the Pit A area is not suitable for use as a mud pit due to the presence of contaminated sediment within, hence it would not be cost effective to use this area.
- Other marine facilities in this area, including the Sham Shui Kok Anchorage and the proposed marine park at the Brothers, will constrain its use.
- Since it is considered not feasible to use the Pit A area, to offer sufficient capacity and cost effectiveness of the South Brothers Facility, the Pit C area needs to be used.

3.2.3 Backfill Levels

As with the design of the ESC facilities, a backfill level of 3 m below original seabed level has been employed in the design of this SB facility. This is considered to be appropriate since the proposed facility is located in shallow waters that experience low energy hydrodynamics (refer to *Section 1* of the previously approved *EIA and Final Site Selection Report* for SB). The relatively sheltered location would also protect contaminated sediment placed within the pits from storm or excessive wave action.

3.2.4 Cap Thickness

Upon completion of the backfilling operation in a pit, a 3 m capping layer of uncontaminated/ clean mud will be placed on top of the deposited contaminated sediment, by controlled bottom dumping from barges. The rationale for this cap design is to isolate the contaminated material, ensure such material is beyond the reach of bioturbation and to protect it against storm erosion. Additional clean mud may be added later, if required, to compensate for long-term consolidation of the contaminated sediment.

It is useful to note that the use of alternative capping material has been considered previously for its potential to increase marine biodiversity upon decommissioning of the facility. However it is the view of the AFCD and

Existing Facilities:	
E1	Urmston Road Navigation Channel
E2	Tung Chung Channel
E3	Effluent Outfall Off Pillar Point
E4	Effluent Outfall Off Siu Ho Wan
E5	Airport Approach Restricted Area (Area 4&6)
E6	Tune Mun Immigration Anchorage
E7	Sham Shui Kok Anchorages No.1 and No.2
E8	North Lantau Refuse Transfer Station at Sham Shui Kok
E9	Submarine Power Cable Off Sham Shui Kok
E10	Skypier
E11	Marine Cargo Terminal
E12	Tung Chung Ferry Pier
E13	Tung Chung Barging Point

Planned Developments:	
P1	Proposed Tuen Mun-Chek Lap Kok Link
P2	Proposed Hong Kong-Zhuhai-Macao Bridge Hong Kong Link Road
P3	Proposed Hong Kong-Zhuhai-Macao Bridge Hong Kong Boundary Crossing Facilities
P4	Future Tung Chung East and West Developments
P5	Proposed Lantau Logistics Park
P6	Possible Lantau Logistics Park Extension or Other Compatible Uses
P7	Contaminated Sediment Disposal Facility at South of Brothers
P8	Seawall Modification Works of Chlorine Transshipment Dock at Sham Shui Kok

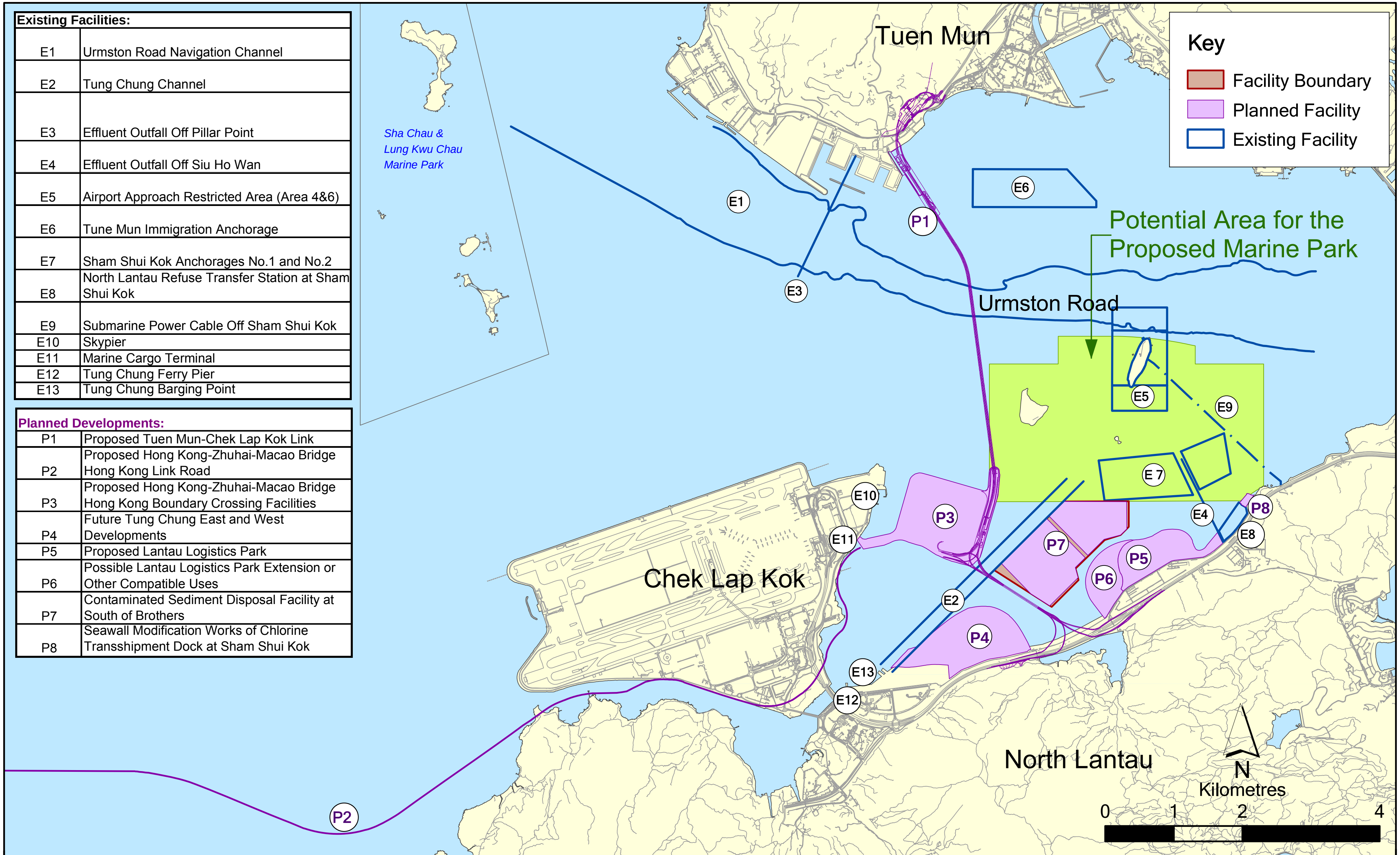


Figure 3.1

Proposed Contaminated Sediment Disposal Facility at South of Brothers and Other Planned/ Existing Projects

File: E2 gazatte boundary\0106271_ENC.mxd
Date: 01/06/2010

Environmental Resources Management

ERM

marine mammal experts that a soft substrate design (i.e. using clean mud/ sand) resembling the natural seabed environment in the vicinity is considered adequate and preferred.

The potential for damage and breaching of the cap due to anchorage has been considered, but the shallow water of the SB facility restricts the size of vessel which can anchor in the area which, in turn, restricts the size of anchor and the potential penetration depth (> 19 MT anchors for ships > about 10,000 dwt).

3.3 PROJECT CONSTRUCTION & OPERATION

3.3.1 Dredging

The two pits may be dredged to the base of the soft marine deposits but may be extended into the underlying alluvium if these materials are sufficiently soft to permit economic dredging operations.

Due mainly to constraints on access, the pits will likely be dredged using grab dredgers (water depth in the SB area constrains the use of trailing suction hopper dredgers [TSHD] (1)). In accordance with the approved EIA it has been assumed that dredging operations within the facility shall not exceed 100,000m^3 per week.

It is noted that in order to ensure continuity of disposal operations, it will be necessary to dredge the first pit in advance of the time when disposal operations are due to commence in the SB facility and to ensure that subsequent pits are dredged, in turn, before the preceding pit is completely filled with contaminated materials.

The dredged materials will be loaded into barges for onward transport to the disposal site. The disposal pits are to be dredged in sequence and in such a manner as to:

- Ensure continuity of disposal of contaminated sediments during the lifetime of the facility;
- Reduce environmental impacts on the surrounding areas; and
- Reduce the requirements for off-site disposal of the materials dredged to form the pits.

(1) The water depth within the South Brothers site is typically < 2 - 9 m and even a small trailer (which has a loaded draught of about 7m), would not be able to operate. Although access channels could be dredged to > 7 m depth, this would create unnecessary impacts to water quality and excessive generation of surplus mud. In addition, it would still be necessary for grab dredgers to first lower the seabed level by several metres in the area of the pits in order to permit continuation of dredging by trailers. Consequently, it is recommended that dredging at South Brothers focuses solely on grab dredging. It should be noted that almost all the purpose-dredged pits used to date were formed by grab dredging.

Minimisation of Off-Site Disposal of Dredged Materials

In order to minimise the need to dispose of dredged material off-site, as much as possible of the Category L material dredged to create the pits should be used for:

- The capping of ESC CMP V pits;
- Capping of Pit 2 of the SB facility, and
- Topping-up of other pits in the ESC Area where consolidation of placed materials may have resulted in seabed depressions.

Excess dredged material that cannot be used for the above purposes are to be disposed in areas allocated by the Marine Fill Committee.

3.3.2 *Backfilling*

The SB facility will be able to accept contaminated materials delivered either by hopper barges or by TSHDs (*Figure 3.2*). Barges and tugs will be able to enter the pits either directly, if their draft is small, or via short dredged channels leading from the maintained channel to Tung Chung. Barges will place the contaminated sediments in the pits by simple bottom discharge.

Figure 3.2 ***Trailing Suction Hopper Dredger (TSHD)***

Source: www.boskalis.com

1. Draghead 2. Suction tube 3. Hopper 4. Bottom doors 5. Jet nozzle

TSHDs are too large to enter the pits and will need to stand off in the deeper water to the north/ northeast of the area and pump the contaminated sediments to the pits using through a floating hose or a combination of floating hoses and a submerged pipeline. The hose will terminate with a down-pipe which will ensure that the contaminated sediment is released at a depth that is below the level of the seabed surrounding the pit.

It has been assumed that backfilling operations within the facility shall not exceed a disposal rate of 26,700 m^3 per day. This rate may be applied to both barges and TSHDs (*Box 1*).

Box 1 Management of Backfilling Operations

Management of Backfilling Operations at the SB Facility
The management system that is currently employed at East of Sha Chau should also be employed for the backfilling operations at the SB facility. The future operation of the mud dumping operations will be almost identical to current activity, in that a target barge will be stationed on site and a workboat escort incoming split-hopper barges, one at a time to the site. This operation ensures that marine activity at the site is controlled and not significant, however a suitable site for the temporary mooring of waiting barges, if any, will be required. Prior to the commencement of backfilling operations the Contractor should seek approval with CEDD by means of a Method Statement. No work should commence until written approval has been received. It is envisaged that due to the relatively weak currents in the area, in combination with the very shallow water, it will not be necessary to determine, based on real-time current measurements, the optimum disposal location for each barge. The facility management barge should be anchored adjacent to the disposal area. CEDD inspectors, as is the current practice, will check the documentation of incoming barges and register the disposal event. The pit will previously have been divided into a number of disposal 'target areas', each approximately 75 m in diameter. Disposal events will take place in the target areas in rotation so as to ensure an even backfill level. Periodic bathymetric surveys will be undertaken in order to check the backfill level. The frequency of surveying will be determined on the basis of the actual rates of backfill.

3.3.3 Capping

When a pit has been filled to capacity with contaminated sediments, a cap of uncontaminated sediments and/or natural uncontaminated soil is to be placed in order to isolate the contaminated sediment from the environment. The cap will be at least 3 m thick but should not result in the formation of areas where the seabed level is higher than the seabed that existed prior to the construction of the facility.

Construction of the cap is to commence as soon as practical after completion of backfilling with contaminated sediments. Where possible, the materials used for the cap are to be sourced from other disposal pits that are being dredged. It has been assumed that capping operations within the facility shall not exceed a disposal rate of 26,700m^3 per day.

Where possible, materials dredged to form the pits are to be used to cap pits of ESC CMP V and to top-up any depressions over other previously-capped pits in the area [1].

3.3.4 *Facility Decommissioning*

On completion of backfilling with contaminated sediments, and capping with uncontaminated sediments, it is likely that consolidation of the placed materials will continue for many years. The consolidation will eventually give rise to depressions on the seabed. The facility area should be periodically surveyed to monitor the extent and depth of the depressions, which should be backfilled using uncontaminated dredged materials (if available) of a type that are generally similar to the materials found on the surrounding seabed and/or natural uncontaminated soil.

3.4 *PROJECT PROGRAMME*

Preliminary works programme indicate that the SB facility will be put into service in phases in 2012. Once CEDD obtains the Environmental Permit (EP) for the construction and operation of this facility, the first pit is expected to be dredged in mid 2011 in order to be ready to receive contaminated mud in mid 2012. According to arisings estimates the second pit at the SB facility will be backfilled starting in mid 2013. It should be noted that should the rate at which contaminated mud arises change (either increasing or decreasing) then the second pit may be capped earlier or later than mid 2014.

The tentative construction programme is presented in *Figure 3.3*. It should be noted that the timeline presents predicted timeframes for each works component.

Figure 3.3 ***Indicative Works Programme at the South Brothers Facility (see Box 2)***

Pit	Operation	2011		2012		2013		2014		2015	
		Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec	Jan-Jun	Jul-Dec
2	Dredging		■	■							
	Backfilling				■	■					
	Capping						■	■			
1	Dredging				■	■					
	Backfilling						■	■			
	Capping								■	■	

(1) Water quality modelling results presented in the approved EIA report were based on the use of uncontaminated mud as capping material. This presents a worst-case scenario due to fines in uncontaminated mud being of a smaller size than those found in natural uncontaminated soil. Therefore, the use of natural uncontaminated soil for capping would be acceptable due to suspended sediment levels being lower than those modelled for. Additionally, it should be noted that this practice is taking place at present at the existing pits at East of Sha Chau and no adverse environmental impacts have been documented.

Box 2 *Minimisation of Environmental Impacts*

Minimisation of Environmental Impacts during Construction & Operation of the SB Facility
Environmental impacts arising from sediment release during dredging, backfilling and capping operations can be minimised by programming construction so that dredging and capping operations extend over the maximum length of time available, thus minimising the number of dredgers, and rate of dredging and capping, that are required. For example, if it is anticipated that a new pit will be required two years after commencement of backfilling operations in a pit, the dredging of the new pit should utilise as much of that time as is practical and economic so that the daily rate of dredging is minimised. Dredging production rates should be monitored so that, in the event that there is risk of a delay to completion of the new pit, additional plant can be mobilised at an early stage at the approval of EPD. This approach would reduce the risk that the dredging effort has to be suddenly greatly increased just before a pit is required for disposal operations.

3.5 CONCURRENT PROJECTS

Projects that have been identified as occurring potentially at the same time as the proposed SB facility are summarised in *Section 2.4.*2 and *Table 2.4*. The significance of these projects to the proposed SB facility is discussed in more detail in the remainder of this Report.

4 WATER QUALITY

4.1 INTRODUCTION

It has been identified and agreed in the *Initial Review Report* of this Study that the following attributes of the approved EIA report of the SB facility would be studied as part of this EIA review:

- Baseline water quality and sediment quality;
- Water Quality Sensitive Receivers to be re-examined; and
- Potential water quality impacts, specifically the cumulative impacts arising from other committed concurrent projects, to be re-assessed and validated.

The assessment of other concerns related to the SB facility have been addressed in the approved EIA report and based on initial review of these findings, no further updates were considered necessary.

As recommended in the *Initial Review Report*, the methodologies for the above update/ verification would be by a desktop review of publicly available up-to-date information, e.g. monitoring data and recently approved EIA reports. This Section presents the outcomes of the EIA update/ verification.

4.2 BASELINE CONDITIONS

4.2.1 Water Quality

Baseline water quality has been determined through a review of the following key data sources:

- HZMB HKBCF and HKLR, and TMCLKL EIA reports which have summarised the baseline water quality within the Study Area and identified the Water Quality Objectives (WQOs) to be used as part of the assessment; and
- CEDD routine water quality monitoring collected at and around CMP IVc between 2005 and 2009 as part of the EM&A programme conducted during that period (*Agreement No. CE 19/2004*).
- Locations of water quality data sources are present in *Figure 4.1*.

Recent EIA Investigations

Baseline water quality has been taken from the HZMB HKBCF, HZMB HKLR and TMCLKL EIA reports which was determined through a review of the EPD Routine Water Quality Data collected from monitoring stations in the

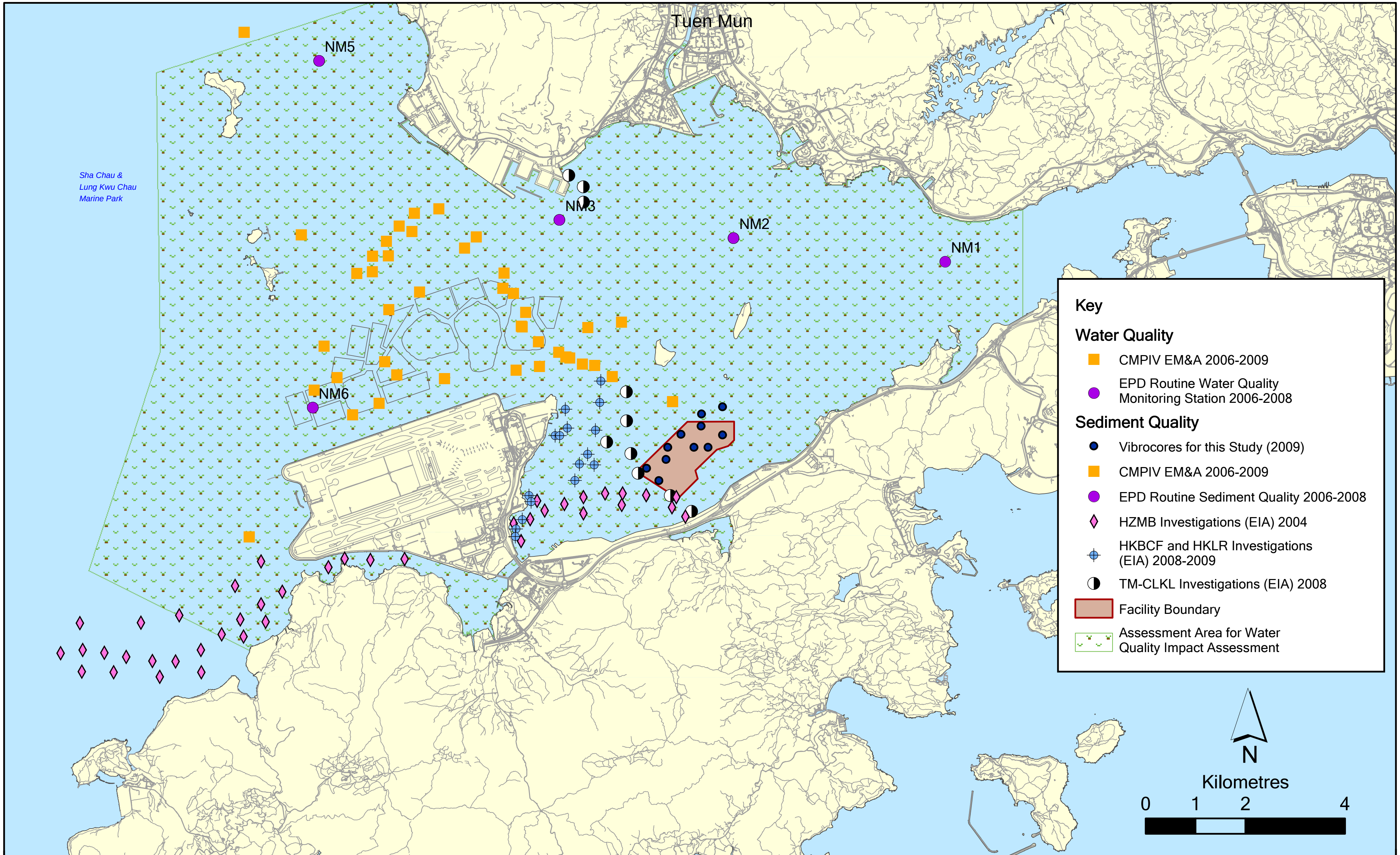


Figure 4.1

Water Quality and Sediment Data Sources

File: E2 gazatte boundary\0106271_WQ and sed Data source.mxd
Date: 31/05/2010

Environmental Resources Management

ERM

North Western Water Control Zone (WCZ)[1]. Five stations within the North Western WCZ are located within the Study Area for the water quality impact assessment in the approved EIA study (*Figure 4.1*). Water quality is monitored monthly at these stations. A summary of the baseline water quality data from the HZMB HKBCF, HZMB HKLR and TMCLKL EIA reports is given in *Table 4.1*.

(1) Environmental Protection Department (2009) Marine Water Quality in Hong Kong. Data available from http://www.epd.gov.hk/epd/

Table 4.1 ***Summary of EPD's Routine Water Quality data for North Western WCZ (NM1, NM2, NM3, NM5 and NM6) between 2006 and 2007***

Parameter	**Monitoring Station**									
	NM1		**NM2**		**NM3**		**NM5**		**NM6**	
	2006	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**
Temperature (°C)	23.7 (17.6 - 27.4)	23.0 (17.2 - 27.8)	23.8 (17.5 - 27.6)	23.4 (17.3 - 28.4)	23.7 (17.7 - 27.6)	23.2 (17.3 - 28.2)	24.0 (17.9 – 27.8)	23.4 (17.3 – 28.3)	24.0 (17.7 – 29.2)	23.8 (17.3 – 30.3)
Salinity (ppt)	29.6 (22.2 - 33.1)	30.9 (26.1 - 33.1)	28.6 (19.0 - 33.1)	29.5 (18.8 - 33.1)	29.4 (23.7 - 33.1)	30.1 (24.9 - 33.1)	27.2 (16.4 – 32.8)	28.6 (23.0 – 33.0)	26.0 (10.5 – 33.3)	27.5 (12.0 – 33.0)
DO (mg/L)	6.3 (4.4 - 8.0)	5.7 (3.5 - 9.2)	6.5 (4.9 - 8.4)	6.0 (3.3 - 9.7)	6.3 (4.4 - 8.3)	5.8 (3.2 - 9.6)	6.3 (4.3 – 8.2)	5.7 (3.0 – 9.3)	6.7 (4.8 – 8.7)	6.4 (3.2 – 10.0)
BOD_5 (mg/L)	0.6 (0.4 - 1.1)	1.0 (0.4 - 1.9)	0.6 (0.2 - 1.0)	1.0 (0.4 - 2.5)	0.7 (0.4 - 1.2)	1.1 (0.5 - 2.5)	0.7 (0.5 – 0.9)	1.1 (0.5 – 2.7)	0.7 (0.3 – 1.3)	1.1 (0.5 – 2.7)
SS (mg/L)	7.4 (2.5 - 17.4)	8.2 (2.3 - 14.7)	6.4 (2.9 - 21.3)	5.8 (1.8 - 9.3)	8.1 (3.0 - 14.0)	7.4 (3.9 - 11.7)	15.7 (3.8 – 53.8)	11.1 (4.3 – 18.7)	12.6 (4.1 – 35.9)	10.0 (3.5 – 27.7)
TIN (mg/L)	0.43 (0.17 - 0.75)	0.39 (0.09 – 0.70)	0.49 (0.18 – 0.85)	0.48 (0.09 – 1.05)	0.50 (0.22 – 0.80)	0.47 (0.13 – 0.87)	0.67 (0.29 – 1.07)	0.64 (0.22 – 1.06)	0.66 (0.09 – 1.40)	0.58 (0.12 – 1.40)
NH_3-N (mg/L)	0.005 (< 0.001 – 0.010)	0.005 (0.001 – 0.007)	0.005 (0.001 – 0.011)	0.006 (0.001 – 0.010)	0.005 (0.001 – 0.011)	0.006 (0.001 – 0.012)	0.008 (0.03 – 0.017)	0.008 (0.001 – 0.014)	0.006 (0.002 – 0.022)	0.006 (0.001 – 0.012)
Chl *a* (mg/L)	3.6 (0.8 – 19.2)	5.4 (0.7 – 17.7)	2.8 (0.8 – 10.6)	6 (0.7 – 20.7)	3.3 (1.0 – 7.7)	5.9 (1.0 – 22.0)	4.2 (1.3 – 17.4)	5.5 (1.3 – 23.0)	3.9 (1.1 – 12.0)	7.4 (1.2 – 26.3)
E. coli (cfu/100 mL)	1100 (340 – 2600)	670 (56 – 3100)	470 (280 – 1900)	360 (49 – 1900)	500 (140 – 2100)	430 (45 – 2400)	900 (220 – 2600)	1300 (160 – 3600)	64 (2 – 1900)	46 (2 – 2400)

Notes:

1. Data presented are depth averaged (except as specified) and are the annual arithmetic mean except for *E coli* (geometric mean)
2. Data in brackets indicate ranges
3. Underlined indicates occurrence of non-compliance with that parameter of WQO

CEDD Water Quality Monitoring – EM&A of CMP IVc

The CMP EM&A programme at ESC collects water quality data with the objective to identify whether there are differences between concentrations in water samples collected in areas of varying distances from the CMPs (*Figure 4.1*) (1). As such, water samples collected far field from the pits at the "Reference" stations can be considered to reflect ambient levels, which are summarised in *Table 4.2.* Between 2006 and 2009, concentrations of the majority of water quality parameters complied with relevant water quality standards. However, there were some exceedances for suspended solids (SS) and Total Inorganic Nitrogen at all monitoring stations. Significant spatio-temporal variations were observed in metal and inorganic contaminant concentrations during this monitoring programme, but clear, consistent patterns of spatial variation were not recorded. Some seasonal trends were evident for concentrations of Nickel, Zinc, Ammonical-Nitrogen, Total Inorganic Nitrogen and Nitrite/ Nitrate at all monitoring stations. This monitoring programme has concluded that there is no evidence to indicate disposal operations at CMP IV are adversely affecting marine waters in the vicinity of the pits or the ESC area as a whole.

Table 4.2 Water Quality Data Recorded between 2006 and 2009 at East of Sha Chau as part of the CMP IVc EM&A Programme

Parameter	DL	All Stations			Reference Station		
		Ave	Min	Max	Ave	Min	Max
Arsenic (µg/L)	2	1.3	1.0	2.7	1.3	1.0	2.5
Cadmium (µg/L)	0.2	0.1	0.1	0.4	0.1	0.1	0.1
Chromium (µg/L)	1	0.6	0.1	2.1	0.6	0.5	2.6
Copper (µg/L)	1	2.5	0.5	22.0	2.6	0.5	17.0
Lead (µg/L)	1	0.7	0.1	3.7	0.7	0.1	2.2
Mercury (µg/L)	0.1	0.0	0.1	0.1	0.0	0.1	0.1
Nickel (µg/L)	1	2.1	0.5	8.7	2.1	0.5	10.0
Silver (µg/L)	1	0.5	0.5	0.5	0.5	0.5	0.5
Zinc (µg/L)	4	5.7	2.0	24.0	5.2	2.0	21.0
NH_3-N (µg/L)	5	150.3	11.0	450.0	162.0	27.0	430.0
NO_x (µg/L)	10	515.7	49.0	6500.0	523.7	27.0	6900.0
TIN_4 (µg/L)	10	665.8	120.0	6650.0	686.0	55.0	7090.0
BOD_5 (mg/L)	0.5	0.8	0.3	4.5	0.8	0.3	7.3
TSS (mg/L)	2	16.6	3.6	77.2	16.7	2.5	50.0

4.2.2 *Sediment Quality*

Baseline sediment quality has been determined through a review of the following key data sources:

- EPD routine sediment quality monitoring data collected between 2006 and 2008;

(1) Agreement No. CE 19/2004 (EP) Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau (2005-2008) - Investigations. Civil Engineering and Development Department.

- CEDD sediment quality monitoring data collected around CMP IVc between 2006 and 2009 as part of the ongoing EM&A programme (*Agreement No. CE 19/2004*);

- Recent EIA studies for the HZMB HKBCF, HZMB HKLR and TMCLKL; and

- CEDD geotechnical investigation survey data: a series of chemical and biological screening tests (1) have been conducted on vibrocore sediment samples collected during the geotechnical investigation survey in 2009. This dataset provides additional site-specific sediment quality at the location of the proposed pits of the SB facility.

- Locations of marine sediment quality data sources are present in *Figure 4.1*.

EPD Routine Sediment Quality Monitoring

Baseline sediment quality has been determined through a review of the EPD Routine Sediment Quality Data collected from monitoring stations in the North Western Water Control Zone (WCZ) in 2006 and 2008 (2). Four stations within the North Western WCZ are located within the Study Area (*Figure 4.1*). However, NS2, NS3 and NS6 are considered to be most representative of baseline conditions due to the close proximity to the SB facility. Sediment quality is monitored every six months at these stations. A summary of the monitoring data is given in *Table 4.3*.

All sediment quality parameters, except arsenic, complied with both the *Lower Chemical Exceedance Level* (*LCEL*s) and *Upper Chemical Exceedance Level* (*UCEL*s) between 2006 and 2009. Arsenic concentrations in the region are likely to be high due to naturally high levels in the soil of some areas of the northern New Territories, which are transported to the area through river discharge and runoff (3).

(1) Test requirements as outlined in ETWB TC(W) No. 34/2002

(2) Environmental Protection Department (2009) Marine Sediment Quality in Hong Kong. Data available from http://www.epd.gov.hk/epd/

(3) EPD (2000). Marine Water Quality in Hong Kong. Environmental Protection Department.

Table 4.3 Summary of EPD's Routine Sediment Quality data for North Western WCZ (NS2, NS3, NS4 and NS6) between 2006 and 2008

Parameter	LCEL	UCEL	Monitoring Station			
			NS2	NS3	NS4	NS6
Arsenic (mg/kg dry wt)	12	42	8.3 (7.2 – 9.6)	10.9 (8.3 – 14.0)	9.5 (8.8 – 10.0)	8.8 (7.2 – 11.0)
Cadmium (mg/kg dry wt)	1.5	4	0.05 (< 0.1)	0.06 (< 0.1 – 0.1)	0.06 (< 0.1 – 0.1)	0.05 (< 0.1)
Chromium (mg/kg dry wt)	80	160	28.2 (24 – 31)	27.3 (20 – 36)	26.7 (22 – 34)	23.5 (18 – 27)
Copper (mg/kg dry wt)	65	110	32.2 (26 – 37)	23.3 (18 – 27)	23.8 (12 – 40)	14.8 (12 – 20)
Lead (mg/kg dry wt)	75	110	34.7 (31 – 40.0)	34.2 (27 – 43)	34.7 (32 – 38)	26.7 (20 – 33)
Mercury (mg/kg dry wt)	0.5	1	0.09 (0.08 – 0.10)	0.11 (0.06 – 0.16)	0.08 (0.06 – 0.10)	0.05 (< 0. 05 – 0.08)
Nickel (mg/kg dry wt)	40	40	18.3 (15 – 22)	17.7 (11 – 23)	16.8 (13 – 20)	16.5 (11 – 23)
Silver (mg/kg dry wt)	1	2	0.2 (0 – 1)	< 0 (< 0 – 0)	< 0 (< 0 – 0)	< 0 (< 0)
Zinc (mg/kg dry wt)	200	270	96.2 (88 – 110)	84.0 (62 – 96)	101.8 (93 – 110)	65.8 (47 – 81)
LMW PAH (µg/kg dry wt)	550	3160	9.2 (1 - 25)	9.2 (< 5 - < 50)	9.3 (2 - < 50)	8.8 (< 1 – 25)
HMW PAH (µg/kg dry wt)	1700	9600	7.0 (1 – 25)	5.9 (< 1 – 25)	5.9 (< 1 – 25)	4.0 (< 1 - 25)
Total PCBs (µg/kg dry wt)	23	180	18 (18)	18 (18)	18 (18)	18 (18)
Particle Size Fraction <63µm (%)	-	-	56.2 (35 – 63)	59.7 (34 – 87)	32.7 (14 – 61)	47.0 (31 – 62)
TKN (mg/kg dry wt)	-	-	338.3 (260 – 520)	288.3 (170 – 350)	253.3 (110 – 350)	233.3 (130 – 310)
NH_4-N (mg/kg dry wt)	-	-	4.27 (0.31 – 9.30)	5.15 (< 0.05 – 21.0)	12.03 (1.10 – 22.0)	2.38 (< 0.05 – 10.0)
Total Phosphorus (mg/kg dry wt)	-	-	193.3 (130 – 290)	178.3 (130 – 210)	157.8 (77 – 230)	130 (110 -160)

Note: The presented results are in average and range (min-max).

CEDD Sediment Quality Monitoring – EM&A of CMP IVc

The CMP EM&A programme at ESC collected sediment quality data with the objective to identify whether there were differences between concentrations in sediment samples collected in areas of varying distances for the CMPs (*Figure 4.1*) (1). As such, sediment samples collected far field from the pits can be considered to reflect ambient levels, which are summarised in *Table 4.4.* Sediments measured at all stations between 2006 and 2009 were mainly found to composed of silt and clay material (86%), and the majority of contaminant concentrations were recorded below levels of concern as defined by the *LCEL* at all monitoring stations. However, similar to the EPD monitoring programme, levels of arsenic exceeded the *LCEL* during the three years of monitoring at most stations, and further, levels of copper exceeded the *LCEL* at a station located mid-field to the pits during August and December 2006. However, both arsenic and copper remained below the *UCEL* throughout the monitoring period. Overall, these exceedances were isolated events and were considered as more likely to be caused by natural fluctuations in background levels. There were no overall trends of increasing contaminant concentrations with increasing proximity to the pit or over time, therefore, it was concluded that there is no evidence that disposal operations at CMP IVc are adversely affecting the level of contaminants in marine sediments in the vicinity of the pits or the ESC area.

Table 4.4 Sediment Quality Data Recorded between 2006 and 2009 at East of Sha Chau as part of the CMP EM&A Programme

Parameter	UCEL	LCEL	DL	All Stations			Far-Field Station		
				Ave	Min	Max	Ave	Min	Max
Arsenic (mg/kg)	12	42	0.5	13.0	8.4	22.0	14.3	11.0	18.0
Cadmium (mg/kg)	1.5	4	0.02	0.2	<0.02	0.7	0.2	0.1	0.3
Chromium (mg/kg)	80	160	0.05	34.0	18.0	58.0	35.3	28.0	43.0
Copper (mg/kg)	65	110	0.05	35.9	14.0	86.0	40.7	21.0	291.0
Lead (mg/kg)	75	110	0.05	42.4	26.0	70.0	44.4	36.0	56.0
Mercury (mg/kg)	0.5	1	0.05	0.1	<0.05	0.6	0.1	0.1	0.4
Nickel (mg/kg)	40	40	0.05	21.1	8.2	38.0	22.1	15.0	30.0
Silver (mg/kg)	1	2	0.05	0.3	<0.05	0.7	0.3	0.1	0.5
Zinc (mg/kg)	200	270	5	99.4	56.0	170.0	104.9	83.0	130.0
LMW PAH (μg/kg)	550	3160	55	<55	<55	<55	<55	<55	<55
HMW PAH (μg/kg)	1700	9600	170	<170	<170	<170	<170	<170	<170
Total PCB (μg/kg)	23	180	2	1.6	<2	46.0	<2	<2	<2
TBT (porewater) (μg/L)	-	-	15	<15	<15	<15	<15	<15	<15
TBT (sediment) (μg/kg)	-	-	8	14.0	<8	140.0	18.3	<8	62.0
Total DDT (μg/kg)	-	-	0.1	2.4	0.5	38.0	2.3	0.8	8.7
Total DDE (μg/kg)	-	-	0.1	0.8	<0.1	9.4	0.9	0.3	4.4

(1) Agreement No. CE 19/2004 (EP) Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau (2005-2008) - Investigations. Civil Engineering and Development Department

Parameter	UCEL	LCEL	DL	All Stations			Far-Field Station		
				Ave	Min	Max	Ave	Min	Max
TOC (mg/kg)	-	-	100	8190.0	4400.0	13000.0	8509.6	4500.0	12000.0

Recent EIA Investigations

Recent EIA studies for the HKBCF, HKLR and TMCLKL have also measured sediment quality from vibrocores in the Study Area. Locations of sediment samples collected are presented in *Figure 4.1*.

In 2004, investigations for the HKLR (1) found 47 % of samples (Category M) showed slight exceedance of arsenic concentrations for the LCEL and 3 % of samples (Category H) exceeded nickel concentrations for UCEL as well as chromium and zinc concentrations for LCEL . The Category M samples also went through biological screening, in which half of samples failed.

For the HKBCF and HKLR EIA investigations (2) done in 2008 and 2009, 90 samples exhibited compliance with the *LCEL*, but 27 samples showed exceedance of *LCEL*. All exceedances were a result of elevated arsenic concentrations, except for one sample which was a result of lead concentrations. Subsequent biological screening for sediment samples that exceeded the *LCEL* resulted in seven (26 %) samples not complying.

Further for the TMCLKL EIA (3) investigations done in 2008, 78 % of samples exhibited compliance with the *LCEL*, however 22 % of samples showed exceedance of *LCEL* (Category M and H). Exceedances in these samples were recorded for arsenic, lead and high molecular weight (HMW) polycyclic aromatic hydrocarbons (PAHs), however, all samples passed subsequent biological testing.

Elutriate and porewater testing during these EIA investigations found that concentrations of cadmium, mercury, silver, tributyltin (TBT), PAHs, polychlorinated biphenyl (PCBs) and pesticides were mostly below detection limits. Whereas, concentrations of copper, nickel, zinc, arsenic and nutrients (NH_4-N, NO_3-N, NO_2-N, TKN, PO_4-P and TP) were detected and showed variation among locations.

CEDD Ground Investigation Works 2009

In addition to the background data presented above, a ground investigation and marine sediment sampling survey was conducted and provides additional site-specific sediment quality at the location of the proposed pits of

(1) Ove Arup & Partners Hong Kong Ltd. (2009) Agreement No. CE26/2003 (HY) Hong Kong Section of Hong Kong – Zhuhai – Macao Bridgeand Connection with North Lantau Highway (now renamed as HZMB Hong Kong Link Road) – Investigation. EIA prepared for the Highways Department.

(2) Ove Arup & Partners Hong Kong Ltd. (2009) Agreement No. CE14/2008 (HY) Hong Kong – Zhuhai – Macao Bridge Hong Kong Boundary Crossing Facilities – Investigation. EIA prepared for the Highways Department.

(3) AECOM (2009) Agreement No. CE 52/2007 (HY) Tuen Mun – Chek Lap Kok Link – Investigation. EIA prepared for the Highways Department.

the SB facility (*Figure 4.1*) [1] [2] [3]. Although the primary objective of this survey was to investigate the thickness of marine deposit, sediment samples were also analysed to determine the potential for contamination. Ten of the twelve vibrocores had concentrations of arsenic above the *LCEL* (Category M), with one of these samples also exceeding the nickel *UCEL* criterion (Category H) at certain sediment depths. Subsequent testing of these sediments showed that some of these sediments also failed the biological screening, particularly for the surface sediment layer and sediments between 9 and 15 m deep.

4.3 *WATER QUALITY SENSITIVE RECEIVERS*

The water quality sensitive receivers (WSRs) that may be affected by changes in water quality during the construction or operation of the SB facility are presented on *Figure 4.2* and *Table 4.5*.

Table 4.5 Water Quality Sensitive Receivers of the South Brothers Facility

Sensitive Receiver	Name	Observation Point	Distance (m) to SB
Artificial Reefs	Artificial Reef at NE Airport	WSR 41	2516.3
	Artificial Reef at Sha Chau	WSR 42	9407.0
Beaches	Lung Kwu Sheung Tan (non-gazetted beach)	WSR 08	10821.4
	Butterfly Beach (gazetted beach)	WSR 12	6104.2
	Gazetted Beaches at Tuen Mun	WSR 15	6197.3
	Gazetted Beaches along Castle Peak Road	WSR 18	8146.3
	Gazetted Beaches at Ma Wan	WSR 19	9262.5
Ecological	Ta Pang Po (near Sunny Bay Mangrove) *	WSR 21	3058.7
	San Tau Beach SSSI	WSR 27	4347.2
	Tai Ho Wan Outlet (inner)	WSR 22a	770.3
	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	WSR 22b	997.1
	Tai Ho Wan Outlet (outside) /Near coral site*	WSR 22c	595.3
	Hau Hok Wan (Horseshoe Crab Habitat)	WSR 29	5658.9
	Sha Lo Wan (Horseshoe Crab Habitat)	WSR 30	6510.0
	Sham Wat Wan (Mangrove and Horseshoe crab Habitat)	WSR 31	8882.2
	Tai O (Mangrove Habitat)	WSR 32	12359.6
	Yi O (Mangrove and Horseshoe crab Habitat)	WSR 34	14231.1
	River Trade Terminal (near coral site)	WSR 47b	5611.8
	Sham Shui Kok (CWD habitat range)	WSR 45c	1419.1
	Tai Ma To (near coral / CWD habitat range)	WSR 46	1541.6
	River Trade Terminal	WSR 47a	5129.6
	Tai Mo To (Deep Channel / CWD habitat range)	WSR 49	543.1

(1) Fugro Geotechnical Services Limited (2009) Civil Engineering and Development Department. Geotechnical Engineering Office. *Contract No. GE/2008/03.15/* 5737CL- Dredging, Management and Capping of Sediment Disposal Facility at South of Brothers. Phase 1 Marine Ground Investigation. Final Factual Fieldwork Report.

(2) ALS Environmental (2009) Provision of Chemical and Biological Testing for Various Government Preojects *Service Order No. GP/CBT/2009/01.04.* 5737CL- Dredging, Management and Capping of Sediment Disposal Facility at South of Brothers. Laboratory Report – Biological Testing (Final Report). Prepared for Civil Engineering and Development Department.

(3) ALS Environmental (2009) Provision of Chemical and Biological Testing for Various Government Preojects *Service Order No. GP/CBT/2009/01.04.* 5737CL- Dredging, Management and Capping of Sediment Disposal Facility at South of Brothers. Laboratory Report – Chemical Testing (Final Report). Prepared for Civil Engineering and Development Department.

WSR	Name
WSR 08	Lung Kwu Sheung Tan (non-gazetted beach)
WSR 09a	Urmston Road (Main Channel)
WSR 10	Sha Chau and Lung Kwu Chau Marine Park
WSR 11	Castle Peak Power Station Cooling Water Intake
WSR 12	Butterfly Beach (gazetted beach)
WSR 13	WSD Seawater Intake at Tuen Mun
WSR 15	Gazetted Beaches at Tuen Mun
WSR 18	Gazetted Beaches along Castle Peak Road
WSR 19	Gazetted Beaches at Ma Wan
WSR 20	Ma Wan Fish Culture Zone
WSR 21	Ta Pang Po (near Sunny Bay Mangrove)
WSR 22a	Tai Ho Wan Outlet (inside)
WSR 22b	Tai Ho Wan Outlet (inner), Near Tai Ho Stream SSSI
WSR 22c	Tai Ho Wan Outlet (outside) / Near coral site
WSR 25	Airport Cooling Water Intake (NE)
WSR 27	San Tau Beach SSSI
WSR 28	Airport Channel / Airport Cooling Water Intake (S)
WSR 29	Hau Hok Wan (Horseshoe Crab Habitat)
WSR 30	Sha Lon Wan (Horseshoe crab Habitat)
WSR 31	Sham Wat Wan (Mangrove and Horseshoe crab Habitat)
WSR 32	Tai O (Mangrove Habitat)
WSR 34	Yi O (Mangrove and Horseshoe crab Habitat)
WSR 41	Artificial Reef at NE Airport
WSR 42	Artificial Reef at Sha Chau
WSR 45c	Sham Shui Kok (CWD habitat range)
WSR 46	Tai Ma To (near coral / CWD habitat range)
WSR 47a	River Trade Terminal
WSR 47b	River Trade Terminal (near coral site)
WSR 48	Airport Channel western end
WSR 49	Tai Mo To (Deep Channel / CWD habitat range)

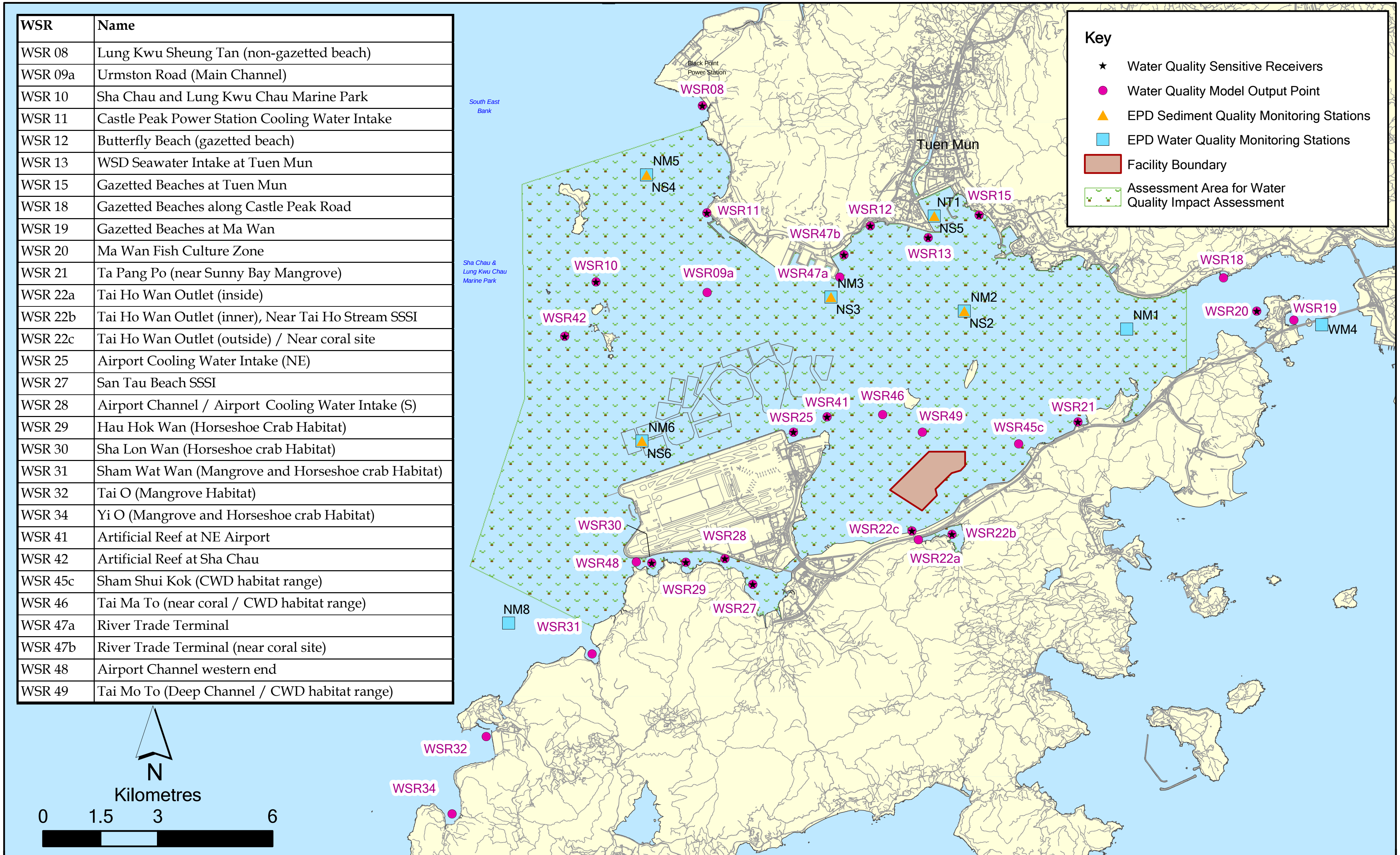


Figure 4.2

Location of Water Quality Model Output Points and Associated EPD Stations

File: E2 gazatte boundary\0106271_water quality model_E2.mxd
Date: 31/05/2010

Environmental Resources Management

ERM

Sensitive Receiver	Name	Observation Point	Distance (m) to SB
Fish Culture Zones	Ma Wan Fish Culture Zone	WSR 20	8470.1
Intakes	Castle Peak Power Station Cooling Water Intake	WSR 11	8527.0
	WSD Seawater Intake at Tuen Mun	WSR 13	5595.8
	Airport Cooling Water Intake (NE)	WSR 25	2936.2
	Airport Channel / Airport Cooling Water Intake	WSR 28	4669.7
Marine Park	Sha Chau and Lung Kwu Chau Marine Park	WSR 10	9412.1
Other Marine Facilities	Urmston Road (Main Channel)	WSR 09a	7031.0
	Airport Channel western end	WSR 48	6888.0

* Indicate new SRs from previously approved EIA

It is noted that the Yam O seagrass bed and the Area 38 Industries Intake that were identified in the previous approved SB EIA Report have been excluded from as WSRs as recent information from the HKBCF, HKLR and TMCLKL suggests that they are no longer valid.

The present proposed layout of the SB facility does not overlap with the proposed marine park at the Brothers. As a result potential interface issues between the SB facility and the proposed marine park are not anticipated. Recently available information suggests that the proposed marine park at the Brothers Islands is expected to be established in 2015/2016 when the construction of the HZMB HKBCF is completed. This implies that operation of the proposed SB facility and the proposed marine park are unlikely to coexist, hence the proposed marine park is not regarded as a new WSR to the SB facility.

4.4 *ASSESSMENT CRITERIA*

In order to keep Water Quality Objectives (WQOs) similar to those in the recently approved EIAs in the Study Area, WQOs are calculated from the EPD's Routine Monitoring Programmes in the same manner as done for the HKBCF, HKLR and TMCLKL EIAs. Details of the calculations used to obtain WQOs are presented below.

The WQO for SS is defined as not to raise the natural ambient level by 30%, nor cause the accumulation of SS which may adversely affect aquatic communities. Data in the North Western and Western Buffer WCZs from EPD's routine water quality monitoring programme from 1998 to 2007 at stations NM1, NM2, NM3, NM5, NM6, NM8 and WM4 (*Figure 4.2*) have been analysed in order to determine the ambient SS concentrations in the waters likely to be impacted by the SB facility. Since concentrations of SS are likely to be variable between season and depth, data near the surface, at mid-depth and near the seabed in both the wet (from mid-April until the end of September) and dry seasons are shown. The WQOs were calculated as 30 % of the 90th percentile value and are presented for each EPD water quality monitoring station in *Table 4.6*.

Each WSR was assigned the WQO of the closest EPD water quality monitoring station. In addition, water quality observation points that will be examined during water quality modelling were also assigned the WQO of the closest EPD water quality monitoring station (see *Figure 4.2* for locations). The WQOs of each WSR and observation point that will be assessed in the water quality modelling during the impact assessment (see *Section 4.5*) is shown in *Table 4.7.*

Table 4.6 ***Average, range, 90th percentile and Water Quality Objectives (WQOs) of SS at the EPD Routine Water Quality North Western and Western WCZ stations (NM1, NM2, NM3, NM5, NM6, NM8 and WM4). Data between 1998 and 2007 were analysed.***

Monitoring Station	**Value**	**Monitoring Station**							
		Surface		**Middle**		**Bottom**		**Depth-average**	
		Dry Season	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**	**Wet Season**
NM1	Average	7.3	5.4	9.8	6.5	13.4	12.3	10.2	7.9
	Range	(1 – 43)	(0.7 – 25)	(1.1 – 43)	(1.3 – 21)	(1.4 – 53)	(1.2 – 45)	(1.5 – 41)	(3.1 – 20.5)
	90th Percentile	14.6	8.1	17.6	11.2	34.0	21.0	20.4	12.4
	WQO (1)	*4.4*	*2.4*	*5.3*	*3.4*	*10.2*	*6.3*	*6.1*	*3.7*
NM2	Average	6.7	4.4	8.7	4.9	12.1	7.7	9.1	5.6
	Range	(1.1 – 21)	(1.2 – 9.7)	(1.6 – 28)	(1 – 14)	(2.2 – 47)	(1.7 – 32)	(1.7 – 30)	(2.4 – 17.3)
	90th Percentile	11.1	6.9	17.5	8.2	20.2	13.0	15.5	9.4
	WQO	*3.3*	*2.1*	*5.3*	*2.5*	*6.1*	*3.9*	*4.6*	*2.8*
NM3	Average	7.1	5.3	9.3	7.2	15.4	13.8	10.6	8.8
	Range	(1.6 – 16)	(1.2 – 15)	(1.2 – 21)	(1.4 – 20)	(2.3 – 71)	(2.1 – 46)	(1.9 – 32.3)	(2.7 – 23)
	90th Percentile	12.0	8.2	16.0	12.5	27.0	23.2	17.9	13.5
	WQO	*3.6*	*2.4*	*4.8*	*3.8*	*8.1*	*7.0*	*5.4*	*4.1*
NM5	Average	8.4	6.5	10.4	7.9	20.8	27.7	13.2	14
	Range	(1.6 – 19)	(1.2 – 17)	(1.6 – 29)	(2.3 – 44)	(2.3 – 81)	(3.2 – 210)	(7.2 – 37)	(3.3 – 86.9)
	90th Percentile	15.2	11.6	18.4	11.0	46.2	46.2	26.9	21.0
	WQO	*4.6*	*3.5*	*5.5*	*3.3*	*13.9*	*13.9*	*8.1*	*6.3*
NM6	Average	10.2	5.4	11.4	6.2	16.0	12.4	12.5	8.3
	Range	(2.9 – 32)	(0.9 – 12)	(2.1 – 40)	(1.8 -12)	(3.2 – 60)	(2.4 – 84)	(2.8 – 42.7)	(2.6 – 35.7)
	90th Percentile	21.0	8.4	22.8	9.6	31.0	23.6	25.8	13.0
	WQO	*6.3*	*2.5*	*6.8*	*2.9*	*9.3*	*7.1*	*7.8*	*3.9*
NM8	Average	11.6	5.9	14.7	8.8	21.9	16.5	16	10.3
	Range	(1.3 – 48)	(2.4 – 17)	(2.6 – 63)	(2.0 – 25)	(3.6 – 73)	(2.4 – 63)	(2.7 – 56.7)	(4.5 – 30.5)
	90th Percentile	21.5	10.2	28.0	18.1	43.2	28.8	30.6	18.8
	WQO	*6.5*	*3.1*	*8.4*	*5.4*	*13.0*	*8.6*	*9.2*	*5.7*
WM4	Average	6.9	3.9	11.1	6.2	14.8	12.7	10.9	7.6
	Range	(0.8 – 21)	(0.9 – 7.9)	(0.6 – 52)	(1.2 – 17)	(1.5 – 80)	(1.2 – 110)	(1.3 – 49)	(1.2 – 40)
	90th Percentile	13.0	5.7	20.0	9.5	30.0	20.0	20.2	11.3
	WQO	*3.9*	*1.7*	*6.0*	*2.8*	*9.0*	*6.0*	*6.1*	*3.4*

(1) The water quality objective was calculated as 30 % of the 90th percentile for each monitoring station.

Table 4.7 Water Quality Objectives for Suspended Solids for Water Quality Sensitive Receivers and Observations Points

Output Point	Name	EPD Station	Dry Season WQO/WQC				Wet Season WQO/WQC			
			Surface	**Middle**	**Bottom**	**Depth-ave**	**Surface**	**Middle**	**Bottom**	**Depth-ave**
WSR 08	Lung Kwu Sheung Tan (non-gazetted beach)	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 09a	Urmston Road (Main Channel)	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 10	Sha Chau and Lung Kwu Chau Marine Park	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 11	Castle Peak Power Station Cooling Water Intake (3)	-	764	764	764	764	764	764	764	764
WSR 12	Butterfly Beach (gazetted beach)	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 13	WSD Seawater Intake at Tuen Mun	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 15	Gazetted Beaches at Tuen Mun	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 18	Gazetted Beaches along Castle Peak Road	WM4	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 19	Gazetted Beaches at Ma Wan	WM4	3.9	6.0	9.0	6.1	1.7	2.8	6.0	3.4
WSR 20	Ma Wan Fish Culture Zone (4)	-	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 21	Ta Pang Po (near Sunny Bay Mangrove)	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22a	Tai Ho Wan Outlet (inside)	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22b	Tai Ho Wan Outlet (inner), Near Tai Ho Stream SSSI	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22c	Tai Ho Wan Outlet (outside) / Near coral site	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Airport Cooling Water Intake (NE)	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	San Tau Beach SSSI	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 28	Airport Channel / Airport Cooling Water Intake (S)	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 29	Hau Hok Wan (Horseshoe Crab Habitat)	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 30	Sha Lon Wan (Horseshoe crab Habitat)	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 31	Sham Wat Wan (Mangrove and Horseshoe crab Habitat)	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 32	Tai O (Mangrove Habitat)	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 34	Yi O (Mangrove and Horseshoe crab Habitat)	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Artificial Reef at NE Airport	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 42	Artificial Reef at Sha Chau	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 45c	Sham Shui Kok (CWD habitat range)	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	Tai Ma To (near coral / CWD habitat range)	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47a	River Trade Terminal	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Output Point	Name	EPD Station	Dry Season WQO/WQC				Wet Season WQO/WQC			
			Surface	Middle	Bottom	Depth-ave	Surface	Middle	Bottom	Depth-ave
WSR 47b	River Trade Terminal (near coral site)	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 48	Airport Channel western end	NM (5,6,8)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 49	Tai Mo To (Deep Channel / CWD habitat range)	NM (1,2,3)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Notes:

1. Based on outliers adjusted 90%ile and denotes an elevated in SS, not an absolute value.
2. "-" the criteria for construction plumes are not based on ambient level but on specific information as noted below.
3. There is a specific requirement for the Castle Peak Power Station intake and the SS should be maintained at below 764 mg/L (ERM, 2006)
4. Allowable increase based on general water quality protection guideline for FCZ (CityU, 2001) and long-term average of EPD monitoring results.

In addition to the WQOs described above, there are other criteria used for fish culture zone (FCZ), seawater pumping stations (intakes), coral habitats and for contaminant concentrations.

There is only one FCZ located within the northwestern waters of Hong Kong, which is at Ma Wan. This FCZ is actually outside of the water quality assessment area but is included for completeness. The only WQO that is specific to FCZs is for DO, which is set at **no less than 5 mg L^{-1}**. In addition to DO there is a general water quality protection guideline for SS, which has been proposed by Agriculture, Fisheries and Conservation Department (AFCD) (1). The guideline requires the maximum SS levels remain **below 50 mg L^{-1}**. This criterion has been adopted in previous approved EIA Reports (2) (3) (4). Thus, for the purposes of this assessment, both the AFCD criterion and the WQO are considered to be generally applicable.

There are several water intakes in the Study Area which are mainly for cooling purpose. The WQOs of Sea Water for Flushing Supply (at intake points) issued by the Water Supplies Department (WSD) are used as the criteria at intake points and are presented in *Table 4.8*. In addition, the Castle Peak Power Station intake for which there is a specific requirement that suspended sediment concentrations be maintained below a level of 150 mg L^{-1} within a 5 km radius of the intake.

Table 4.8 Water Quality Criteria for Seawater Intakes

Parameter	Concentration (mg/L)
Colour (HU)	< 20
Turbidity (NTU)	< 10
Odour Threshold No.	< 100
NH_4-N	< 1
SS	< 10
DO	> 2
BOD_5	< 10
Synthetic Detergents	< 5
E. coli per 100 ml	< 20,000

The deposition of suspended sediments may also adversely affect coral habitats within the Study Area. An impact criterion of 200 g m^{-2} day^{-1} has been used previous as an indicator level and will be used here to assess upper limit levels. Further, in order to conservatively assess the impacts to coral

(1) City University of Hong Kong (2001) Agreement No. CE 62/98, Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment, Final Report, for the Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government.

(2) ERM – Hong Kong, Ltd (2002) EIA for the Proposed Submarine Gas Pipeline from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plank, Hong Kong. Final EIA Report. For the Hong Kong and China Gas Co., Ltd.

(3) Maunsell (2001) EIA for Tai Po Sewage Treatment Works - Stage V. Final EIA Report. For Drainage Services Department, Hong Kong SAR Government.

(4) ERM - Hong Kong, Ltd (2007) Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities. For CAPCO. Final EIA Report. December 2006

habitats, any areas that are predicted to deposition rates of more than 100 g m^{-2} day^{-1} will be further investigated for sensitive species in the vicinity.

Contaminants within the sediments may be released into the water column during dredging and filling activities. Since there are no relevant standards for these contaminants in Hong Kong, criteria have been adopted from the European Union Environmental Quality Standards for arsenic, heavy metals (other than Silver), PCBs and PAHs and from the Criterion Maximum Concentration (CMC) of the US EPA Water Quality Criterion for silver and TBT. *Table 4.9* summaries these criteria.

Table 4.9 ***Water Quality Objectives for Contaminants in marine water***

Parameter	Maximum Concentration (μg/L)
Arsenic	25
Cadmium	2.5
Chromium	15
Copper	5
Lead	25
Mercury	0.3
Nickel	30
Silver	1.9
Zinc	40
PCBs	0.3
PAHs	0.2
TBT	0.01

4.5 REVIEW OF WATER QUALITY IMPACT ASSESSMENT – CUMULATIVE IMPACTS

The most significant amendment that requires a review from the previous water quality impacts are potential impacts that result from concurrent construction and operation of other projects in the Study Area. Whilst there are several external projects in the vicinity of the SB facility that are to be concurrently under construction and/or in operation, those which are considered to be key are the HKBCF, HKLR and TMCLKL projects, and as such, cumulative impacts with these projects need to be assessed.

The recently approved EIA reports for the HKBCF, HKLR and TM-CLKL [(1)(2)(3)] conducted an extensive water quality modelling assessment that examined key concurrent project impacts. Under this assessment, modelling scenarios examining potential sediment loss through construction activities and changes in hydrodynamics due to new coastline and facility development

(1) Ove Arup & Partners Hong Kong Ltd. (2009) Agreement No. CE26/2003 (HY) Hong Kong Section of Hong Kong – Zhuhai – Macao Bridgeand Connection with North Lantau Highway (now renamed as HZMB Hong Kong Link Road) – Investigation. EIA prepared for the Highways Department. Approval reference: AEIAR-144/2009.

(2) Ove Arup & Partners Hong Kong Ltd. (2009) Agreement No. CE14/2008 (HY) Hong Kong – Zhuhai – Macao Bridge Hong Kong Boundary Crossing Facilities – Investigation. EIA prepared for the Highways Department. Approval reference: AEIAR-145/2009.

(3) AECOM (2009) Agreement No. CE 52/2007 (HY) Tuen Mun – Chek Lap Kok Link – Investigation. EIA prepared for the Highways Department. Approval reference: AEIAR-146/2009.

have included the construction of the SB facility, as well as that of the CMP IV and V facilities at ESC.

Scenarios were run for 3 potential peak sediment loss times of the TM-CLKL, HKBCF and HKLR projects; February 2011, April 2012 and April 2013. Of these, a number of scenarios included dredging, backfilling and capping operations for CMP IV, V and the SB facility were included in the assessment. In addition, other facilities included in the modelling were as follows:

- Hong Kong Link Road (HKLR);
- Kwai Tsing Container Basin Dredging;
- Lantau Logistics Park (LLP);
- Tonggu Channel;
- Mainland section of the Hong Kong Zhuhai Macao Bridge (HZMB);
- Hong Kong Boundary Crossing Facility (HKBCF);
- Tuen Mun – Chek Lap Kok Link (TMCLKL); and
- Mud disposal at North Brothers.

This water quality impact assessment will use results from the TM-CLKL, HKBCF and HKLR EIA Reports to determine any potential impacts of concurrent projects in the vicinity of the SB facility. Readers are referred to the TM-CLKL, HKBCF and HKLR EIA reports to obtain full details of water quality modelling, including specific methodologies or detailed output (1) (2) (3).

2011 & 2012 Scenarios

Although acknowledged in the TM-CLKL, HKBCF and HKLR EIA reports that the SB facility would commence construction in 2011 as advised by the CEDD (*Table 5* of *Appendix 9D5*, HKBCF EIA), modelling scenarios only included a simulation where dredging activities for the SB facility begin in 2013. As such, the scenarios modelled in 2011 and 2012 did not include impacts associated with the SB facility.

Nevertheless, the worst case scenario modelled as part of the TM-CLKL, HKBCF and HKLR EIA reports was during February 2011 when the projects are predicted, based on preliminary works programmes, to produce sediment loads of approximately 4,500,000 kg/day. Since the SB facility is not planned to commence until June 2011, sediment loss from the SB facility will not be

(1) Tuen Mun – Chek Lap Kok Link http://www.epd.gov.hk/eia/register/report/eiareport/eia_1742009/index.html

(2) Hong Kong – Zhuhai – Macao Bridge Hong Kong Link Road http://www.epd.gov.hk/eia/register/report/eiareport/eia_1722009/Cover(all).html

(3) Hong Kong – Zhuhai – Macao Bridge Hong Kong Boundary Crossing Facilities http://www.epd.gov.hk/eia/register/report/eiareport/eia_1732009/Cover(all).htm

concurrent with this worst case scenario. Rather, construction of the SB facility will commence when sediment loads from the HKBCF, HKLR and TMCLKL projects will be reduced to approximately 3,000,000 kg/day, and thus the additional 241,920 kg/day from dredging operations at the SB facility will remain less than the sediment losses modelled during February 2011 for the HKBCF, HKLR and TMCLKL EIA. Likewise, operation of the SB facility will commence in mid-2012 when sediment loads from the HKBCF, HKLR and TMCLKL projects will be reduced to approximately 1,900,000 kg/day (in June 2010), and thus the additional 241,920 kg/day from dredging operations and 602,800 kg/day from backfilling operations at the SB facility will remain less than the sediment losses modelled during February 2011 for the HKBCF, HKLR and TMCLKL EIA. Key to this will be the proviso that the schedule of the SB facility does not overlap with the worst case construction period assumed in the TM-CLKL, HKBCF and HKLR EIA reports.

The results of the 2011 and 2012 water quality modelling mitigated (with silt curtains) and with concurrent projects scenarios from the HKBCF, HKLR and TMCLKL EIA Reports are presented in *Annex A*. The maximum elevation in SS for concurrent projects shows exceedances of at three WSRs (WSR21, WSR25 and WSR41) in 2011 and at two of these SRs (WSR25 and WSR41) in 2012. All other water quality parameters modelled comply with the relevant standards outlined in *Section 4.3* (see *Annex A* for results).

As such, based on the detailed modelling conducted as part of the HKBCF, HKLR and TMCLKL EIA it is clear that no unacceptable adverse impacts to water quality are predicted to occur during cumulative project operations between 2011 and 2012.

2013 Scenario

The current scenario for 2013 concurrent projects modelled in the TM-CLKL, HKBCF and HKLR EIA reports incorporates dredging activities at the SB facility. This water quality model incorporates potential changes to the tidal flows as a result of the proposed new coastline. This represents the most significant change in the coastline due to these concurrent projects, and therefore, determines any potential impacts of the cumulative works while taking into account the proposed reclaimed land scenarios. Results from the TM-CLKL, HKBCF and HKLR EIS water quality modelling for 2013, with concurrent projects is presented in *Annex A.*

It is noted, however, that during 2013 concurrent backfilling and dredging operations are likely to be occurring at the SB facility. If concurrent backfilling (from TSHD disposal) and dredging activities in Pits 1 and 2 occurs, the total sediment loss rate would increase, along with the contribution of the SB facility to the total sediments lost in the concurrent projects modelled in 2013. In order to account for the possible concurrent backfilling and dredging operations at the SB facility, the following updates have been made to the HKBCF, HKLR, and TMCLKL EIA 2013 modelling scenarios (mitigated with concurrent projects):

1. Calculate the Sediment Loss Rate (SLR) contribution (in %) from SB facility presented in the EIA;

2. Update SLR contribution (in %) based on new operational (ie include backfilling) contribution from SB facility;

3. Recalculate SS elevations and Sedimentation predictions from EIA based on new SLR contribution (in %);

4. Identify and highlight any new exceedences above WQO at Sensitive Receivers due to new SLR contribution.

Based on the above methodology the results have been found:

1. Water quality modelling of the HKBCF-HKLR-TMCLKL EIA indicates that in the 2013 mitigated with concurrent projects modelling scenario, construction (i.e. dredging) activities at the SB facility (Cumulative SLR of 483,840 kg/day from dredging Pit 1 and Pit 2 concurrently) contributed to approximately 6.5 % of the total SLR modelled (7,416,425 kg/day).

2. If concurrent backfilling and dredging activities in Pits 1 and 2 occur at the SB facility, rather than dredging activities alone, the Total SLR increases (7,777,305 kg/day) and the contribution from the SB facility would increase to approximately 10.9 % (844,720 kg/day).

3. Modelling output data from the HKBCF-HKLR-TMCLKL EIA 2013 modelling scenarios (mitigated with concurrent projects) have been recalculated using this inflation value. The scenario that has included mitigation is selected as this may represent the "worst-case", i.e. residual exceedances in WQO occur post-mitigation. These results are presented in *Tables 4.10* to *4.19*.

4. If the contribution from activities at the SB facility increases from 6.5 % to 10.9 %, there are **no new exceedances** of WQOs at Sensitive Receivers for all water quality parameters *Tables 4.10*, *4.12*, *4.14*, *4.16* and *4.18*.

5. If a more conservative inflation value is applied, i.e. the contribution from activities at the SB facility increases from 6.5 % to 20 %, the number of Sensitive Receivers at which exceedances of WQOs were predicted **remains the same** *Tables 4.11*, *4.13*, *4.15*, *4.17* and *4.19*.

Through updating the *EIAO-TM* approved modelling data potential impacts to water quality sensitive receivers through changes in the SB facility operations have been calculated. These results show that changes in operations at SB are predicted to cause no additional impacts at any SRs other than those that have been deemed to be acceptable under the *EIAO-TM* as part of the HKBCF-HKLR-TMCLKL EIAs. However, the model shows exceedances in levels of SS at three SR (WSR25, WSR41 and WSR47b). Additional silt curtain was proposed to be deployed under the HKBCF-

HKLR-TMCLKL EIA. All other water quality parameters modelled comply with the relevant standards outlined in *Section 4.3* (see *Annex A* for results).

For dissolved oxygen, heavy metals and nutrients levels, no exceedances of the relevant WQOs and assessment criteria were predicted (*Tables 4.12* to *4.19*), and hence unacceptable impacts are not anticipated.

Table 4.10 ***Predicted Maximum SS (mg/L) Elevations above ambient levels at Observation Points for the Scenario Year 2013 Mitigated with Concurrent Projects from the TMCLKL EIA - with South Brothers Sediment Loss Rate Contribution of 10.8%.***

			Dry season				Wet Season			
WSR	**SR**	**Name**	**S**	**M**	**B**	**DA**	**S**	**M**	**B**	**DA**
WSR08	Y	Lung Kwu Sheung Tan (non-gazetted beach)	0.210	1.992	3.040	1.782	0.000	0.419	1.048	0.524
WSR09a	N	Urmston Road (Main Channel)	9.330	12.999	16.144	10.483	0.524	5.346	12.475	5.556
WSR10	Y	Sha Chau and Lung Kwu Chau Marine Park	0.629	1.887	3.774	1.572	0.210	1.677	4.612	2.097
WSR11	Y	Castle Peak Power Station Cooling Water Intake	1.992	6.395	8.491	5.661	0.314	1.782	6.185	2.726
WSR12	Y	Butterfly Beach (gazetted beach)	0.210	0.629	0.629	0.419	0.314	0.943	1.153	0.734
WSR13	Y	WSD Seawater Intake at Tuen Mun	0.943	1.048	1.258	1.048	0.210	0.524	0.943	0.524
WSR15	Y	Gazetted Beached at Tuen Mun	0.105	0.210	0.314	0.210	0.000	0.105	0.105	0.000
WSR18	Y	Gazetted Beaches along Castle Peak Road	1.677	2.411	3.145	2.201	0.943	1.048	1.468	1.048
WSR19	Y	Gazetted beaches at Ma Wan	0.734	0.943	1.048	0.839	0.210	0.314	0.314	0.314
WSR20	Y	Ma Wan Fish Culture Zone	3.145	2.830	3.040	2.830	0.839	1.363	1.677	1.153
WSR21	Y	Ta Pang Po (near Sunny Bay Mangrove)	2.097	2.621	3.145	2.621	0.629	1.258	2.097	1.153
WSR22A	N	Tai Ho Wan Outlet (inside)	0.210	0.210	0.314	0.210	0.000	0.210	0.210	0.105
WSR22B	Y	Tai Ho Wan Outlet (outside)/ Near Tai Ho Stream SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR22C	Y	Tai Ho Wan Outlet (outside)/ near coral site	0.419	0.524	0.629	0.524	0.105	0.419	0.629	0.314
WSR25	Y	Airport Cooling Water Intake (NE)	5.346	6.709	7.652	6.080	1.992	5.975	4.298	3.669
WSR27	Y	San Tau Beach SSSI	0.000	0.105	0.105	0.105	0.000	0.000	0.000	0.000
WSR28	Y	Airport Channel/ Airport Cooling water Intake (S)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR29	Y	Hau Hok Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR30	Y	Sha Lo Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.105	0.000
WSR31	Y	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.105	0.105	0.000
WSR32	Y	Tai O (Mangrove Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.105	0.105
WSR34	Y	Yi O (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.105	0.105	0.105
WSR41	Y	Artificial Reef at NE airport	5.661	7.233	8.596	5.975	7.548	5.975	4.193	4.298
WSR42	Y	Artificial Reef at Sha Chau	1.258	1.363	1.468	1.363	0.314	0.314	0.734	0.314
WSR45C	N	Sham Shui Kok (CWD Habitat)	2.306	3.564	4.298	2.830	0.734	1.782	1.887	1.153
WSR46	N	Tai Mo To (near coral/ CWD habitat range)	2.097	3.145	3.774	2.411	1.572	1.992	2.830	1.363
WSR47A	N	River Trade Terminal	1.363	4.508	5.661	3.774	0.210	2.411	5.137	2.201
WSR47B	Y	River Trade Terminal (near coral site)	2.726	6.185	11.007	5.451	4.193	9.330	12.370	6.290
WSR48	N	Airport Channel western end	0.000	0.000	0.000	0.000	0.000	0.105	0.105	0.105
WSR49	N	Tai Mo To (Deep Channel/ CWD habitat range)	2.201	3.145	4.403	2.516	1.048	1.782	3.669	1.468

Grey shaded cells indicate values exceed the criteria defined in the HKBCF-HKLR-TMCLKL EIAs. Water Depths: S = Surface; M = Middle; and, B = Bottom

Table 4.11 Predicted Maximum SS (mg/L) Elevations above ambient levels at Observation Points for the Scenario Year 2013 Mitigated with Concurrent Projects from the TMCLKL EIA - with South Brothers Sediment Loss Rate Contribution of 20%

			Dry season				Wet Season			
WSR	**SR**	**Name**	**S**	**M**	**B**	**DA**	**S**	**M**	**B**	**DA**
WSR08	Y	Lung Kwu Sheung Tan (non-gazetted beach)	0.234	2.220	3.389	1.986	0.000	0.467	1.168	0.584
WSR09a	N	Urmston Road (Main Channel)	10.399	14.489	17.994	11.685	0.584	5.959	13.905	6.193
WSR10	Y	Sha Chau and Lung Kwu Chau Marine Park	0.701	2.103	4.206	1.753	0.234	1.870	5.141	2.337
WSR11	Y	Castle Peak Power Station Cooling Water Intake	2.220	7.128	9.464	6.310	0.351	1.986	6.894	3.038
WSR12	Y	Butterfly Beach (gazetted beach)	0.234	0.701	0.701	0.467	0.351	1.052	1.285	0.818
WSR13	Y	WSD Seawater Intake at Tuen Mun	1.052	1.168	1.402	1.168	0.234	0.584	1.052	0.584
WSR15	Y	Gazetted Beached at Tuen Mun	0.117	0.234	0.351	0.234	0.000	0.117	0.117	0.000
WSR18	Y	Gazetted Beaches along Castle Peak Road	1.870	2.687	3.505	2.454	1.052	1.168	1.636	1.168
WSR19	Y	Gazetted beaches at Ma Wan	0.818	1.052	1.168	0.935	0.234	0.351	0.351	0.351
WSR20	Y	Ma Wan Fish Culture Zone	3.505	3.155	3.389	3.155	0.935	1.519	1.870	1.285
WSR21	Y	Ta Pang Po (near Sunny Bay Mangrove)	2.337	2.921	3.505	2.921	0.701	1.402	2.337	1.285
WSR22A	N	Tai Ho Wan Outlet (inside)	0.234	0.234	0.351	0.234	0.000	0.234	0.234	0.117
WSR22B	Y	Tai Ho Wan Outlet (outside)/ Near Tai Ho Stream SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR22C	Y	Tai Ho Wan Outlet (outside)/ near coral site	0.467	0.584	0.701	0.584	0.117	0.467	0.701	0.351
WSR25	Y	Airport Cooling Water Intake (NE)	5.959	7.478	8.530	6.777	2.220	6.660	4.791	4.090
WSR27	Y	San Tau Beach SSSI	0.000	0.117	0.117	0.117	0.000	0.000	0.000	0.000
WSR28	Y	Airport Channel/ Airport Cooling water Intake (S)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR29	Y	Hau Hok Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR30	Y	Sha Lo Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.117	0.000
WSR31	Y	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.117	0.117	0.000
WSR32	Y	Tai O (Mangrove Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.117	0.117
WSR34	Y	Yi O (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.117	0.117	0.117
WSR41	Y	Artificial Reef at NE airport	6.310	8.062	9.581	6.660	8.413	6.660	4.674	4.791
WSR42	Y	Artificial Reef at Sha Chau	1.402	1.519	1.636	1.519	0.351	0.351	0.818	0.351
WSR45C	N	Sham Shui Kok (CWD Habitat)	2.571	3.973	4.791	3.155	0.818	1.986	2.103	1.285
WSR46	N	Tai Mo To (near coral/ CWD habitat range)	2.337	3.505	4.206	2.687	1.753	2.220	3.155	1.519
WSR47A	N	River Trade Terminal	1.519	5.024	6.310	4.206	0.234	2.687	5.725	2.454
WSR47B	Y	River Trade Terminal (near coral site)	3.038	6.894	12.269	6.076	4.674	10.399	13.788	7.011
WSR48	N	Airport Channel western end	0.000	0.000	0.000	0.000	0.000	0.117	0.117	0.117
WSR49	N	Tai Mo To (Deep Channel/ CWD habitat range)	2.454	3.505	4.907	2.804	1.168	1.986	4.090	1.636

Grey shaded cells indicate values exceed the criteria defined in the HKBCF-HKLR-TMCLKL EIAs. Water Depths: S = Surface; M = Middle; and, B = Bottom.

Table 4.12 Predicted Maximum Metal Elevations (µg/L) and Dissolved Oxygen (DO) depletion (mg/L) from ambient levels during the Dry Season at Observation Points for the Scenario Year 2013 Mitigated with Concurrent Projects from the TMCLKL EIA - with South Brothers Sediment Loss Rate Contribution of 10.8%

WSR	SR	Name	Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	DO
WSR08	Y	Lung Kwu Sheung Tan (non-gazetted beach)	0.010	0.283	0.199	0.000	0.073	0.199	0.000	0.482	0.073	0.000
WSR09a	N	Urmston Road (Main Channel)	0.042	1.677	1.153	0.010	0.419	1.153	0.021	2.830	0.440	0.210
WSR10	Y	Sha Chau and Lung Kwu Chau Marine Park	0.010	0.252	0.178	0.000	0.063	0.178	0.000	0.430	0.063	0.000
WSR11	Y	Castle Peak Power Station Cooling Water Intake	0.021	0.902	0.618	0.010	0.231	0.618	0.010	1.530	0.241	0.105
WSR12	Y	Butterfly Beach (gazetted beach)	0.000	0.063	0.042	0.000	0.021	0.042	0.000	0.115	0.021	0.000
WSR13	Y	WSD Seawater Intake at Tuen Mun	0.000	0.168	0.115	0.000	0.042	0.115	0.000	0.283	0.042	0.000
WSR15	Y	Gazetted Beached at Tuen Mun	0.000	0.031	0.021	0.000	0.010	0.021	0.000	0.052	0.010	0.000
WSR18	Y	Gazetted Beaches along Castle Peak Road	0.010	0.356	0.241	0.000	0.084	0.241	0.000	0.598	0.094	0.000
WSR19	Y	Gazetted beaches at Ma Wan	0.000	0.136	0.094	0.000	0.031	0.094	0.000	0.231	0.031	0.000
WSR20	Y	Ma Wan Fish Culture Zone	0.010	0.451	0.314	0.000	0.115	0.314	0.010	0.765	0.115	0.000
WSR21	Y	Ta Pang Po (near Sunny Bay Mangrove)	0.010	0.419	0.294	0.000	0.105	0.294	0.010	0.713	0.115	0.000
WSR22A	N	Tai Ho Wan Outlet (inside)	0.000	0.031	0.021	0.000	0.010	0.021	0.000	0.052	0.010	0.000
WSR22B	Y	Tai Ho Wan Outlet (outside)/ Near Tai Ho Stream SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR22C	Y	Tai Ho Wan Outlet (outside)/ near coral site	0.000	0.084	0.063	0.000	0.021	0.063	0.000	0.147	0.021	0.000
WSR25	Y	Airport Cooling Water Intake (NE)	0.021	0.975	0.671	0.010	0.241	0.671	0.010	1.646	0.252	0.105
WSR27	Y	San Tau Beach SSSI	0.000	0.021	0.010	0.000	0.000	0.010	0.000	0.031	0.000	0.000
WSR28	Y	Airport Channel/ Airport Cooling water Intake (S)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR29	Y	Hau Hok Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR30	Y	Sha Lo Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR31	Y	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR32	Y	Tai O (Mangrove Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR34	Y	Yi O (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR41	Y	Artificial Reef at NE airport	0.021	0.954	0.660	0.010	0.241	0.660	0.010	1.614	0.252	0.105
WSR42	Y	Artificial Reef at Sha Chau	0.010	0.220	0.147	0.000	0.052	0.147	0.000	0.367	0.052	0.000
WSR45C	N	Sham Shui Kok (CWD Habitat)	0.010	0.451	0.314	0.000	0.115	0.314	0.010	0.765	0.115	0.000
WSR46	N	Tai Mo To (near coral/ CWD habitat range)	0.010	0.388	0.262	0.000	0.094	0.262	0.000	0.650	0.105	0.000
WSR47A	N	River Trade Terminal	0.010	0.608	0.419	0.000	0.147	0.419	0.010	1.017	0.157	0.105
WSR47B	Y	River Trade Terminal (near coral site)	0.021	0.870	0.598	0.010	0.220	0.598	0.010	1.468	0.231	0.105
WSR48	N	Airport Channel western end	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR49	N	Tai Mo To (Deep Channel/ CWD habitat range)	0.010	0.398	0.273	0.000	0.105	0.273	0.000	0.681	0.105	0.000

No values exceed the criteria defined in the HKBCF-HKLR-TMCLKL EIA. Water Depths: S = Surface; M = Middle; and, B = Bottom.

Table 4.13 ***Predicted Maximum Metal Elevations (µg/L) and Dissolved Oxygen (DO) depletion (mg/L) from ambient levels during the Dry Season at Observation Points for the Scenario Year 2013 Mitigated with Concurrent Projects from the TMCLKL EIA - with South Brothers Sediment Loss Rate Contribution of 20%***

WSR	SR	Name	Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	DO
WSR08	Y	Lung Kwu Sheung Tan (non-gazetted beach)	0.012	0.315	0.222	0.000	0.082	0.222	0.000	0.537	0.082	0.000
WSR09a	N	Urmston Road (Main Channel)	0.047	1.870	1.285	0.012	0.467	1.285	0.023	3.155	0.491	0.234
WSR10	Y	Sha Chau and Lung Kwu Chau Marine Park	0.012	0.280	0.199	0.000	0.070	0.199	0.000	0.479	0.070	0.000
WSR11	Y	Castle Peak Power Station Cooling Water Intake	0.023	1.005	0.689	0.012	0.257	0.689	0.012	1.706	0.269	0.117
WSR12	Y	Butterfly Beach (gazetted beach)	0.000	0.070	0.047	0.000	0.023	0.047	0.000	0.129	0.023	0.000
WSR13	Y	WSD Seawater Intake at Tuen Mun	0.000	0.187	0.129	0.000	0.047	0.129	0.000	0.315	0.047	0.000
WSR15	Y	Gazetted Beached at Tuen Mun	0.000	0.035	0.023	0.000	0.012	0.023	0.000	0.058	0.012	0.000
WSR18	Y	Gazetted Beaches along Castle Peak Road	0.012	0.397	0.269	0.000	0.093	0.269	0.000	0.666	0.105	0.000
WSR19	Y	Gazetted beaches at Ma Wan	0.000	0.152	0.105	0.000	0.035	0.105	0.000	0.257	0.035	0.000
WSR20	Y	Ma Wan Fish Culture Zone	0.012	0.502	0.351	0.000	0.129	0.351	0.012	0.853	0.129	0.000
WSR21	Y	Ta Pang Po (near Sunny Bay Mangrove)	0.012	0.467	0.327	0.000	0.117	0.327	0.012	0.795	0.129	0.000
WSR22A	N	Tai Ho Wan Outlet (inside)	0.000	0.035	0.023	0.000	0.012	0.023	0.000	0.058	0.012	0.000
WSR22B	Y	Tai Ho Wan Outlet (outside)/ Near Tai Ho Stream SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR22C	Y	Tai Ho Wan Outlet (outside)/ near coral site	0.000	0.093	0.070	0.000	0.023	0.070	0.000	0.164	0.023	0.000
WSR25	Y	Airport Cooling Water Intake (NE)	0.023	1.087	0.748	0.012	0.269	0.748	0.012	1.834	0.280	0.117
WSR27	Y	San Tau Beach SSSI	0.000	0.023	0.012	0.000	0.000	0.012	0.000	0.035	0.000	0.000
WSR28	Y	Airport Channel/ Airport Cooling water Intake (S)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR29	Y	Hau Hok Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR30	Y	Sha Lo Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR31	Y	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR32	Y	Tai O (Mangrove Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR34	Y	Yi O (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR41	Y	Artificial Reef at NE airport	0.023	1.063	0.736	0.012	0.269	0.736	0.012	1.799	0.280	0.117
WSR42	Y	Artificial Reef at Sha Chau	0.012	0.245	0.164	0.000	0.058	0.164	0.000	0.409	0.058	0.000
WSR45C	N	Sham Shui Kok (CWD Habitat)	0.012	0.502	0.351	0.000	0.129	0.351	0.012	0.853	0.129	0.000
WSR46	N	Tai Mo To (near coral/ CWD habitat range)	0.012	0.432	0.292	0.000	0.105	0.292	0.000	0.724	0.117	0.000
WSR47A	N	River Trade Terminal	0.012	0.678	0.467	0.000	0.164	0.467	0.012	1.133	0.175	0.117
WSR47B	Y	River Trade Terminal (near coral site)	0.023	0.970	0.666	0.012	0.245	0.666	0.012	1.636	0.257	0.117
WSR48	N	Airport Channel western end	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR49	N	Tai Mo To (Deep Channel/ CWD habitat range)	0.012	0.444	0.304	0.000	0.117	0.304	0.000	0.759	0.117	0.000

No values exceed the criteria defined in the HKBCF-HKLR-TMCLKL EIA. Water Depths: S = Surface; M = Middle; and, B = Bottom.

Table 4.14 ***Predicted Maximum Metal Elevations (µg/L) and Dissolved Oxygen (DO) depletion (mg/L) from ambient levels during the Wet Season at Observation Points for the Scenario Year 2013 Mitigated with Concurrent Projects from the TMCLKL EIA - with South Brothers Sediment Loss Rate Contribution of 10.8%***

WSR	SR	Name	Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	DO
WSR08	Y	Lung Kwu Sheung Tan (non-gazetted beach)	0.000	0.084	0.063	0.000	0.021	0.063	0.000	0.147	0.021	0.000
WSR09a	N	Urmston Road (Main Channel)	0.021	0.891	0.608	0.010	0.220	0.608	0.010	1.499	0.231	0.105
WSR10	Y	Sha Chau and Lung Kwu Chau Marine Park	0.010	0.335	0.231	0.000	0.084	0.231	0.000	0.566	0.084	0.000
WSR11	Y	Castle Peak Power Station Cooling Water Intake	0.010	0.440	0.304	0.000	0.105	0.304	0.010	0.734	0.115	0.000
WSR12	Y	Butterfly Beach (gazetted beach)	0.000	0.115	0.084	0.000	0.031	0.084	0.000	0.199	0.031	0.000
WSR13	Y	WSD Seawater Intake at Tuen Mun	0.000	0.084	0.063	0.000	0.021	0.063	0.000	0.147	0.021	0.000
WSR15	Y	Gazetted Beached at Tuen Mun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR18	Y	Gazetted Beaches along Castle Peak Road	0.000	0.168	0.115	0.000	0.042	0.115	0.000	0.283	0.042	0.000
WSR19	Y	Gazetted beaches at Ma Wan	0.000	0.052	0.031	0.000	0.010	0.031	0.000	0.084	0.010	0.000
WSR20	Y	Ma Wan Fish Culture Zone	0.000	0.189	0.126	0.000	0.042	0.126	0.000	0.314	0.052	0.000
WSR21	Y	Ta Pang Po (near Sunny Bay Mangrove)	0.000	0.189	0.126	0.000	0.042	0.126	0.000	0.314	0.052	0.000
WSR22A	N	Tai Ho Wan Outlet (inside)	0.000	0.021	0.010	0.000	0.000	0.010	0.000	0.031	0.000	0.000
WSR22B	Y	Tai Ho Wan Outlet (outside)/ Near Tai Ho Stream SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR22C	Y	Tai Ho Wan Outlet (outside)/ near coral site	0.000	0.052	0.031	0.000	0.010	0.031	0.000	0.084	0.010	0.105
WSR25	Y	Airport Cooling Water Intake (NE)	0.010	0.587	0.409	0.000	0.147	0.409	0.010	0.996	0.157	0.000
WSR27	Y	San Tau Beach SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR28	Y	Airport Channel/ Airport Cooling water Intake (S)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR29	Y	Hau Hok Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR30	Y	Sha Lo Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR31	Y	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR32	Y	Tai O (Mangrove Habitat)	0.000	0.021	0.010	0.000	0.000	0.010	0.000	0.031	0.000	0.000
WSR34	Y	Yi O (Mangrove and Horseshoe Crab Habitat)	0.000	0.021	0.010	0.000	0.000	0.010	0.000	0.031	0.000	0.000
WSR41	Y	Artificial Reef at NE airport	0.021	0.692	0.472	0.000	0.168	0.472	0.010	1.164	0.178	0.105
WSR42	Y	Artificial Reef at Sha Chau	0.000	0.052	0.031	0.000	0.010	0.031	0.000	0.084	0.010	0.000
WSR45C	N	Sham Shui Kok (CWD Habitat)	0.000	0.189	0.126	0.000	0.042	0.126	0.000	0.314	0.052	0.000
WSR46	N	Tai Mo To (near coral/ CWD habitat range)	0.010	0.220	0.147	0.000	0.052	0.147	0.000	0.367	0.052	0.000
WSR47A	N	River Trade Terminal	0.010	0.356	0.241	0.000	0.084	0.241	0.000	0.598	0.094	0.000
WSR47B	Y	River Trade Terminal (near coral site)	0.021	1.006	0.692	0.010	0.252	0.692	0.010	1.698	0.262	0.105
WSR48	N	Airport Channel western end	0.000	0.021	0.010	0.000	0.000	0.010	0.000	0.031	0.000	0.000
WSR49	N	Tai Mo To (Deep Channel/ CWD habitat range)	0.010	0.231	0.157	0.000	0.063	0.157	0.000	0.398	0.063	0.000

No values exceed the criteria defined in the HKBCF-HKLR-TMCLKL EIA. Water Depths: S = Surface; M = Middle; and, B = Bottom.

Table 4.15 ***Predicted Maximum Metal Elevations (μg/L) and Dissolved Oxygen (DO) depletion (mg/L) from ambient levels during the Wet Season at Observation Points for the Scenario Year 2013 Mitigated with Concurrent Projects from the TMCLKL EIA - with South Brothers Sediment Loss Rate Contribution of 20%***

WSR	SR	Name	Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	DO
WSR08	Y	Lung Kwu Sheung Tan (non-gazetted beach)	0.000	0.093	0.070	0.000	0.023	0.070	0.000	0.164	0.023	0.000
WSR09a	N	Urmston Road (Main Channel)	0.023	0.993	0.678	0.012	0.245	0.678	0.012	1.671	0.257	0.117
WSR10	Y	Sha Chau and Lung Kwu Chau Marine Park	0.012	0.374	0.257	0.000	0.093	0.257	0.000	0.631	0.093	0.000
WSR11	Y	Castle Peak Power Station Cooling Water Intake	0.012	0.491	0.339	0.000	0.117	0.339	0.012	0.818	0.129	0.000
WSR12	Y	Butterfly Beach (gazetted beach)	0.000	0.129	0.093	0.000	0.035	0.093	0.000	0.222	0.035	0.000
WSR13	Y	WSD Seawater Intake at Tuen Mun	0.000	0.093	0.070	0.000	0.023	0.070	0.000	0.164	0.023	0.000
WSR15	Y	Gazetted Beached at Tuen Mun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR18	Y	Gazetted Beaches along Castle Peak Road	0.000	0.187	0.129	0.000	0.047	0.129	0.000	0.315	0.047	0.000
WSR19	Y	Gazetted beaches at Ma Wan	0.000	0.058	0.035	0.000	0.012	0.035	0.000	0.093	0.012	0.000
WSR20	Y	Ma Wan Fish Culture Zone	0.000	0.210	0.140	0.000	0.047	0.140	0.000	0.351	0.058	0.000
WSR21	Y	Ta Pang Po (near Sunny Bay Mangrove)	0.000	0.210	0.140	0.000	0.047	0.140	0.000	0.351	0.058	0.000
WSR22A	N	Tai Ho Wan Outlet (inside)	0.000	0.023	0.012	0.000	0.000	0.012	0.000	0.035	0.000	0.000
WSR22B	Y	Tai Ho Wan Outlet (outside)/ Near Tai Ho Stream SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR22C	Y	Tai Ho Wan Outlet (outside)/ near coral site	0.000	0.058	0.035	0.000	0.012	0.035	0.000	0.093	0.012	0.117
WSR25	Y	Airport Cooling Water Intake (NE)	0.012	0.654	0.456	0.000	0.164	0.456	0.012	1.110	0.175	0.000
WSR27	Y	San Tau Beach SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR28	Y	Airport Channel/ Airport Cooling water Intake (S)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR29	Y	Hau Hok Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR30	Y	Sha Lo Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR31	Y	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WSR32	Y	Tai O (Mangrove Habitat)	0.000	0.023	0.012	0.000	0.000	0.012	0.000	0.035	0.000	0.000
WSR34	Y	Yi O (Mangrove and Horseshoe Crab Habitat)	0.000	0.023	0.012	0.000	0.000	0.012	0.000	0.035	0.000	0.000
WSR41	Y	Artificial Reef at NE airport	0.023	0.771	0.526	0.000	0.187	0.526	0.012	1.297	0.199	0.117
WSR42	Y	Artificial Reef at Sha Chau	0.000	0.058	0.035	0.000	0.012	0.035	0.000	0.093	0.012	0.000
WSR45C	N	Sham Shui Kok (CWD Habitat)	0.000	0.210	0.140	0.000	0.047	0.140	0.000	0.351	0.058	0.000
WSR46	N	Tai Mo To (near coral/ CWD habitat range)	0.012	0.245	0.164	0.000	0.058	0.164	0.000	0.409	0.058	0.000
WSR47A	N	River Trade Terminal	0.012	0.397	0.269	0.000	0.093	0.269	0.000	0.666	0.105	0.000
WSR47B	Y	River Trade Terminal (near coral site)	0.023	1.122	0.771	0.012	0.280	0.771	0.012	1.893	0.292	0.117
WSR48	N	Airport Channel western end	0.000	0.023	0.012	0.000	0.000	0.012	0.000	0.035	0.000	0.000
WSR49	N	Tai Mo To (Deep Channel/ CWD habitat range)	0.012	0.257	0.175	0.000	0.070	0.175	0.000	0.444	0.070	0.000

No values exceed the criteria defined in the HKBCF-HKLR-TMCLKL EIA. Water Depths: S = Surface; M = Middle; and, B = Bottom.

Table 4.16 Predicted Maximum Nutrient (mg/L) Elevations above ambient levels and Predicted Maximum Daily Sedimentation Rate (g/m²) during the Wet Season at Observation Points for the Scenario Year 2013 Mitigated with Concurrent Projects from the TMCLKL EIA - with South Brothers Sediment Loss Rate Contribution of 10.8%

WSR	SR	Name	TKN	NH4	NH3	NO3	NO2	TIN	TP	Sed
WSR08	Y	Lung Kwu Sheung Tan (non-gazetted beach)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.72
WSR09a	N	Urmston Road (Main Channel)	0.010	0.000	0.000	0.000	0.000	0.010	0.010	143.20
WSR10	Y	Sha Chau and Lung Kwu Chau Marine Park	0.000	0.000	0.000	0.000	0.000	0.000	0.000	22.22
WSR11	Y	Castle Peak Power Station Cooling Water Intake	0.000	0.000	0.000	0.000	0.000	0.000	0.000	84.91
WSR12	Y	Butterfly Beach (gazetted beach)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.48
WSR13	Y	WSD Seawater Intake at Tuen Mun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	11.32
WSR15	Y	Gazetted Beached at Tuen Mun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.05
WSR18	Y	Gazetted Beaches along Castle Peak Road	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.29
WSR19	Y	Gazetted beaches at Ma Wan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.51
WSR20	Y	Ma Wan Fish Culture Zone	0.000	0.000	0.000	0.000	0.000	0.000	0.000	15.30
WSR21	Y	Ta Pang Po (near Sunny Bay Mangrove)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	24.74
WSR22A	N	Tai Ho Wan Outlet (inside)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.31
WSR22B	Y	Tai Ho Wan Outlet (outside)/ Near Tai Ho Stream SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR22C	Y	Tai Ho Wan Outlet (outside)/ near coral site	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6.71
WSR25	Y	Airport Cooling Water Intake (NE)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	64.15
WSR27	Y	San Tau Beach SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.21
WSR28	Y	Airport Channel/ Airport Cooling water Intake (S)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR29	Y	Hau Hok Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.10
WSR30	Y	Sha Lo Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.52
WSR31	Y	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.15
WSR32	Y	Tai O (Mangrove Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.26
WSR34	Y	Yi O (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.36
WSR41	Y	Artificial Reef at NE airport	0.000	0.000	0.000	0.000	0.000	0.000	0.000	38.05
WSR42	Y	Artificial Reef at Sha Chau	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.56
WSR45C	N	Sham Shui Kok (CWD Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	23.17
WSR46	N	Tai Mo To (near coral/ CWD habitat range)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25.05
WSR47A	N	River Trade Terminal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	73.48
WSR47B	Y	River Trade Terminal (near coral site)	0.010	0.000	0.000	0.000	0.000	0.010	0.000	154.62
WSR48	N	Airport Channel western end	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.94
WSR49	N	Tai Mo To (Deep Channel/ CWD habitat range)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	41.09

No values exceed the criteria defined in the HKBCF-HKLR-TMCLKL EIA. Water Depths: S = Surface; M = Middle; and, B = Bottom.

Table 4.17 Predicted Maximum Nutrient (mg/L) Elevations above ambient levels and Predicted Maximum Daily Sedimentation Rate (g/m²) during the Wet Season at Observation Points for the Scenario Year 2013 Mitigated with Concurrent Projects from the TMCLKL EIA - with South Brothers Sediment Loss Rate Contribution of 20%

WSR	SR	Name	TKN	NH4	NH3	NO3	NO2	TIN	TP	Sed
WSR08	Y	Lung Kwu Sheung Tan (non-gazetted beach)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.26
WSR09a	N	Urmston Road (Main Channel)	0.012	0.000	0.000	0.000	0.000	0.012	0.012	159.61
WSR10	Y	Sha Chau and Lung Kwu Chau Marine Park	0.000	0.000	0.000	0.000	0.000	0.000	0.000	24.77
WSR11	Y	Castle Peak Power Station Cooling Water Intake	0.000	0.000	0.000	0.000	0.000	0.000	0.000	94.64
WSR12	Y	Butterfly Beach (gazetted beach)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	11.68
WSR13	Y	WSD Seawater Intake at Tuen Mun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.62
WSR15	Y	Gazetted Beached at Tuen Mun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.17
WSR18	Y	Gazetted Beaches along Castle Peak Road	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.01
WSR19	Y	Gazetted beaches at Ma Wan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.02
WSR20	Y	Ma Wan Fish Culture Zone	0.000	0.000	0.000	0.000	0.000	0.000	0.000	17.06
WSR21	Y	Ta Pang Po (near Sunny Bay Mangrove)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	27.58
WSR22A	N	Tai Ho Wan Outlet (inside)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.57
WSR22B	Y	Tai Ho Wan Outlet (outside)/ Near Tai Ho Stream SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR22C	Y	Tai Ho Wan Outlet (outside)/ near coral site	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7.48
WSR25	Y	Airport Cooling Water Intake (NE)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	71.51
WSR27	Y	San Tau Beach SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.23
WSR28	Y	Airport Channel/ Airport Cooling water Intake (S)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR29	Y	Hau Hok Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.12
WSR30	Y	Sha Lo Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.58
WSR31	Y	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.29
WSR32	Y	Tai O (Mangrove Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.40
WSR34	Y	Yi O (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.52
WSR41	Y	Artificial Reef at NE airport	0.000	0.000	0.000	0.000	0.000	0.000	0.000	42.41
WSR42	Y	Artificial Reef at Sha Chau	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.97
WSR45C	N	Sham Shui Kok (CWD Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25.82
WSR46	N	Tai Mo To (near coral/ CWD habitat range)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	27.93
WSR47A	N	River Trade Terminal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	81.91
WSR47B	Y	River Trade Terminal (near coral site)	0.012	0.000	0.000	0.000	0.000	0.012	0.000	172.35
WSR48	N	Airport Channel western end	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.05
WSR49	N	Tai Mo To (Deep Channel/ CWD habitat range)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	45.80

No values exceed the criteria defined in the HKBCF-HKLR-TMCLKL EIA. Water Depths: S = Surface; M = Middle; and, B = Bottom.

Table 4.18 ***Predicted Maximum Nutrient (mg/L) Elevations above ambient levels and Predicted Daily Sedimentation Rate (g/m²) during the Dry Season at Observation Points for the Scenario Year 2013 Mitigated with Concurrent Projects from the TMCLKL EIA - with South Brothers Sediment Loss Rate Contribution of 10.8%***

WSR	SR	Name	TKN	NH4	NH3	NO3	NO2	TIN	TP	Sed
WSR08	Y	Lung Kwu Sheung Tan (non-gazetted beach)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	33.96
WSR09a	N	Urmston Road (Main Channel)	0.010	0.000	0.000	0.000	0.000	0.010	0.010	125.69
WSR10	Y	Sha Chau and Lung Kwu Chau Marine Park	0.000	0.000	0.000	0.000	0.000	0.000	0.000	34.17
WSR11	Y	Castle Peak Power Station Cooling Water Intake	0.010	0.000	0.000	0.000	0.000	0.010	0.000	128.73
WSR12	Y	Butterfly Beach (gazetted beach)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	11.64
WSR13	Y	WSD Seawater Intake at Tuen Mun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	20.76
WSR15	Y	Gazetted Beached at Tuen Mun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.88
WSR18	Y	Gazetted Beaches along Castle Peak Road	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.59
WSR19	Y	Gazetted beaches at Ma Wan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	11.01
WSR20	Y	Ma Wan Fish Culture Zone	0.000	0.000	0.000	0.000	0.000	0.000	0.000	26.73
WSR21	Y	Ta Pang Po (near Sunny Bay Mangrove)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	44.66
WSR22A	N	Tai Ho Wan Outlet (inside)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.20
WSR22B	Y	Tai Ho Wan Outlet (outside)/ Near Tai Ho Stream SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR22C	Y	Tai Ho Wan Outlet (outside)/ near coral site	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.14
WSR25	Y	Airport Cooling Water Intake (NE)	0.010	0.000	0.000	0.000	0.000	0.010	0.000	99.48
WSR27	Y	San Tau Beach SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.52
WSR28	Y	Airport Channel/ Airport Cooling water Intake (S)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR29	Y	Hau Hok Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR30	Y	Sha Lo Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR31	Y	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.42
WSR32	Y	Tai O (Mangrove Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.10
WSR34	Y	Yi O (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.10
WSR41	Y	Artificial Reef at NE airport	0.010	0.000	0.000	0.000	0.000	0.010	0.000	42.77
WSR42	Y	Artificial Reef at Sha Chau	0.000	0.000	0.000	0.000	0.000	0.000	0.000	8.91
WSR45C	N	Sham Shui Kok (CWD Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	47.91
WSR46	N	Tai Mo To (near coral/ CWD habitat range)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25.05
WSR47A	N	River Trade Terminal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	103.36
WSR47B	Y	River Trade Terminal (near coral site)	0.010	0.000	0.000	0.000	0.000	0.010	0.000	108.50
WSR48	N	Airport Channel western end	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.21
WSR49	N	Tai Mo To (Deep Channel/ CWD habitat range)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	32.71

No values exceed the criteria defined in the HKBCF-HKLR-TMCLKL EIA. Water Depths: S = Surface; M = Middle; and, B = Bottom.

Table 4.19 ***Predicted Maximum Nutrient (mg/L) Elevations above ambient levels and Predicted Daily Sedimentation Rate (g/m²) during the Dry Season at Observation Points for the Scenario Year 2013 Mitigated with Concurrent Projects from the TMCLKL EIA - with South Brothers Sediment Loss Rate Contribution of 20%***

WSR	SR	Name	TKN	NH4	NH3	NO3	NO2	TIN	TP	Sed
WSR08	Y	Lung Kwu Sheung Tan (non-gazetted beach)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	37.86
WSR09a	N	Urmston Road (Main Channel)	0.012	0.000	0.000	0.000	0.000	0.012	0.012	140.10
WSR10	Y	Sha Chau and Lung Kwu Chau Marine Park	0.000	0.000	0.000	0.000	0.000	0.000	0.000	38.09
WSR11	Y	Castle Peak Power Station Cooling Water Intake	0.012	0.000	0.000	0.000	0.000	0.012	0.000	143.49
WSR12	Y	Butterfly Beach (gazetted beach)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.97
WSR13	Y	WSD Seawater Intake at Tuen Mun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	23.14
WSR15	Y	Gazetted Beached at Tuen Mun	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.32
WSR18	Y	Gazetted Beaches along Castle Peak Road	0.000	0.000	0.000	0.000	0.000	0.000	0.000	11.80
WSR19	Y	Gazetted beaches at Ma Wan	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.27
WSR20	Y	Ma Wan Fish Culture Zone	0.000	0.000	0.000	0.000	0.000	0.000	0.000	29.80
WSR21	Y	Ta Pang Po (near Sunny Bay Mangrove)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	49.78
WSR22A	N	Tai Ho Wan Outlet (inside)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.45
WSR22B	Y	Tai Ho Wan Outlet (outside)/ Near Tai Ho Stream SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR22C	Y	Tai Ho Wan Outlet (outside)/ near coral site	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.73
WSR25	Y	Airport Cooling Water Intake (NE)	0.012	0.000	0.000	0.000	0.000	0.012	0.000	110.89
WSR27	Y	San Tau Beach SSSI	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.58
WSR28	Y	Airport Channel/ Airport Cooling water Intake (S)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR29	Y	Hau Hok Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR30	Y	Sha Lo Wan (Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00
WSR31	Y	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.47
WSR32	Y	Tai O (Mangrove Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.12
WSR34	Y	Yi O (Mangrove and Horseshoe Crab Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.12
WSR41	Y	Artificial Reef at NE airport	0.012	0.000	0.000	0.000	0.000	0.012	0.000	47.67
WSR42	Y	Artificial Reef at Sha Chau	0.000	0.000	0.000	0.000	0.000	0.000	0.000	9.93
WSR45C	N	Sham Shui Kok (CWD Habitat)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	53.40
WSR46	N	Tai Mo To (near coral/ CWD habitat range)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	27.93
WSR47A	N	River Trade Terminal	0.000	0.000	0.000	0.000	0.000	0.000	0.000	115.21
WSR47B	Y	River Trade Terminal (near coral site)	0.012	0.000	0.000	0.000	0.000	0.012	0.000	120.93
WSR48	N	Airport Channel western end	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.23
WSR49	N	Tai Mo To (Deep Channel/ CWD habitat range)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	36.46

No values exceed the criteria defined in the HKBCF-HKLR-TMCLKL EIA. Water Depths: S = Surface; M = Middle; and, B = Bottom

4.6 *MITIGATION MEASURES*

While no new exceedances are predicted at the SB facility, the HKBCF-HKLR-TMCLKL EIA reports showed exceedances of SS WQOs at Urmston Road (WSR09a), Ta Pang Po near Sunny Bay Mangrove (WSR21), the airport cooling water intake (WSR25), the Artificial Reefs (WSR41) and at the River Trade Terminal near coral habitat (WSR47b). Mitigation measures outlined in the HKBCF-HKLR-TMCLKL EIA reports have been suggested to minimise these impacts and are outlined below.

Urmston Road is a marine fairway and is not regarded as a water quality sensitive receiver. Therefore, there are unlikely to be any unacceptable impacts at this location.

Ta Pang Po, which is near Sunny Bay Mangrove (WSR21) shows a slight exceedance in surface levels of SS during the dry season in 2011 only. Contour plots of this exceedance suggest it is due to sediment plumes from the LLP. However, this is examining the LLP unmitigated, however in reality there is likely to be extensive mitigation measures in place to avoid cumulative impacts. Therefore, it is unlikely that this will occur.

Levels of SS at the cooling water intake at the airport (WSR25) are predicted to exceed the WQOs at all depths in the wet and dry seasons in 2011, at mid depth during the wet season in 2012 as well as at surface and mid depths during the dry season and mid depth during the wet season in 2013. The TM-CLKL, HKBCF and HKLR EIA reports have outlined the mitigation measures will be to install additional silt screen in the intakes, which can provide a further 60% reduction of the SS level resulting in SS levels meeting the desired WQO criteria.

For the Artificial Reef (WSR 41) elevated SS level and exceedance are also predicted at all depths during the wet and dry seasons in both 2011, 2012 (except at mid-depth during the dry season) and 2013 (except at mid-depth during the wet season) scenarios. This artificial reef has been deployed there for over eight years and is unlikely to withstand relocation or mechanical disturbance. The TM-CLKL, HKBCF and HKLR projects plan to mitigate this exceedance by deploying a replacement artificial reef as a compensation of the disturbance on by the HKBCF reclamation works. As such, exceedances recorded at this site are not considered unacceptable.

For the 2013 modelling scenario, exceedances are predicted at the River Trade Terminal (WSR47b) at all depths during the wet season and at mid and bottom depths during the dry season. However, this site is a SR due the nearby corals and the sedimentation rates are predicted to be much less than the 100 $g^{-1}m^{-2}$/day criteria. Therefore, there are unlikely to be any unacceptable impacts to these habitats.

Overall, the water quality modelling works have indicated that for both the dry and wet seasons, works can proceed at the recommended working rates without causing unacceptable impacts to water quality sensitive receivers. Changes to other water quality parameters have generally been demonstrated to be minor, compliant with applicable standards and, therefore, not of concern.

Unacceptable impacts to water quality sensitive receivers have largely been avoided through the adoption of the following measures:

- **Siting:** A number of siting options were studied and the preferred location avoids direct impacts to sensitive receivers (refer to the approved SB EIA).

- **Adoption of Acceptable Working Rates**: The modelling work has demonstrated that the selected working rates for the dredging and backfilling and capping of the SB facility will not cause unacceptable impacts to the receiving water quality. A summary of these rates are as follows:

    - Dredging operations within the SB facility will not exceed 100,000 m^3 $week^{-1}$.

    - Backfilling operations within the SB facility will not exceed a disposal rate of 26,700 m^3 day^{-1}.

    - Capping operations within the SB facility will not exceed a disposal rate of 26,700 m^3 day^{-1}.

Aside from the above, pro-active measures that have been instituted for the Project, the following operational constraints should also be applied.

1. Dredged marine mud shall be disposed of in a gazetted marine disposal area in accordance with the *Dumping at Sea Ordinance* (*DASO)* permit conditions.

The following good practice measures shall apply at all times:

1. All disposal vessels should be fitted with tight bottom seals in order to prevent leakage of material during transport.

2. All barges should be filled to a level, which ensures that material does not spill over during transport to the disposal site and that adequate freeboard is maintained to ensure that the decks are not washed by wave action.

3. After dredging, any excess materials should be cleaned from decks and exposed fittings before the vessel is moved from the dredging area.

4. The contractor(s) should ensure that the works cause no visible foam, oil, grease, litter or other objectionable matter to be present in the water within and adjacent to the dredging site.

5. If installed, degassing systems should be used to avoid irregular cavitation within the pump.

6. Monitoring and automation systems should be used to improve the crew's information regarding the various dredging parameters to improve dredging accuracy and efficiency.

7. Control and monitoring systems should be used to alert the crew to leaks or any other potential risks.

8. When the dredged material has been unloaded at the disposal areas, any material that has accumulated on the deck or other exposed parts of the vessel should be removed and placed in the hold or a hopper. Under no circumstances should decks be washed clean in a way that permits material to be released overboard.

9. All dredgers should maintain adequate clearance between vessels and the seabed at all states of the tide and reduce operations speed to ensure that excessive turbidity is not generated by turbulence from vessel movement or propeller wash.

Lastly, to verify the calculated prediction in this assessment taking into account latest programmes of construction and operation of the SB facility with the presence of other latest concurrent projects as well as coastline changes due to these projects, a remodelling exercise will be carried out.

4.7 RESIDUAL IMPACTS

No residual environmental impacts, in terms of exceedances of applicable standards (ie Water Quality Objectives and marine ecology and fisheries tolerance criterion), were predicted to occur as a result of the construction and operation of the SB facility, provided that the mitigation measures, described in *Section 4.6* are implemented. The mitigation measures are generally being implemented by the TM-CLKL, HKBCF and HKLR projects.

4.8 ENVIRONMENTAL MONITORING & AUDIT (EM&A)

The construction and operation of the proposed SB facility has been defined at rates that maintain environmental impacts to within acceptable levels. Actual impacts during the works will be monitored through a detailed Environmental Monitoring and Audit (EM&A) programme. Full details of the EM&A programme are presented in the approved EM&A Manual which has been based on the on-going and previous monitoring programmes conducted at the Contaminated Mud Disposal facility at East of Sha Chau.

This programme will provide management actions and supplemental mitigation measures to be employed should impacts arise, thereby ensuring the environmental acceptability of the SB facility.

4.9 *CONCLUSIONS*

This Section has described the impacts to water quality arising from the construction and operation of the SB facility, with particular focus on the impacts arising from the concurrent construction and operation of other projects in the Study Area. The purpose of the assessment was to update and evaluate the SB facility in terms of the acceptability of predicted impacts to water quality from dredging, backfilling and capping of the pits and also concurrent activities. The assessment of other concerns related to the SB facility have been addressed in the approved EIA report and based on an initial review of these findings, no further updates were considered necessary.

The previously approved EIA for SB demonstrated the loss of sediment to suspension during dredging, backfilling and capping operations from computer modelling. The assessment concluded that any sediment disturbed by the works would settle rapidly back onto the seabed and the suspended sediment elevations would be of short duration. This indicates that there would be little transport of suspended sediment away from the pits and that the sediment would not impact upon sensitive receivers. In general, the sediment plumes generated by the works remain in open waters.

The current assessment has used findings of the water quality modelling from the previously approved EIAs from the TM-CLKL, HKBCF and HKLR projects to show that, even with multiple concurrent projects and an alteration in coastline, there will still be no unacceptable exceedances of assessment criteria, given all proposed mitigation measures are applied.

No residual environmental impacts, in terms of exceedances of applicable criteria, were predicted to occur as a result of the dredging, backfilling and capping of the SB facility and with concurrent projects in the area, provided that the recommended mitigation measures are implemented.

5 MARINE ECOLOGY

5.1 INTRODUCTION

It has been identified and agreed in the *Initial Review Report* of this Study that the following attributes of the approved EIA report of the SB facility would be updated and/ or verified as part of this EIA review:

- Baseline marine ecological conditions and the ecological significance of organisms and habitats in the Study Area to be updated and re-assessed;
- Validate habitat maps and include colour photograph of each habitat type;
- Data and literature for the bioaccumulation assessment to be validated, including re-analysing data based on changes in the water quality if required; and,
- Sensitive Receivers and any potential marine ecological impacts to be re-examined based on changes in the design of the SB facility and the cumulative impacts arising from other committed concurrent projects concurrent projects in the area.

The assessment of other concerns related to the SB facility have been addressed in the approved EIA report and based on an initial review of these findings, no further updates were considered necessary

As recommended in the *Initial Review Report*, the methodologies for the above update/ verification would be by a desktop review of available up-to-date information. Further field surveys were not considered necessary. This Section presents the outcomes of the proposed update and/ or verification.

5.2 BASELINE CONDITIONS

The following habitats and/or organisms of ecological interest have been identified within the Study Area [1] (*Figure 4.1*):

- Subtidal hard bottom habitats;
- Subtidal soft bottom habitats;
- Intertidal hard bottom habitats;
- Intertidal soft bottom habitats, including:

(1) Study Area for the marine ecology assessment is the same as the assessment area for the water quality assessment (*Section 4*).

    - Mangroves;
    - Mudflats and Horseshoe Crab Habitats;
    - Seagrass beds;
- Marine Mammals;
- Sites of Special Scientific Interest (SSSI); and
- Sha Chau and Lung Kwu Chau Marine Park.

Existing conditions of each of the above has been evaluated based on available literature as well as detailed surveys that have been conducted and presented in public reports. Key data sources that have been used to determine baseline marine ecology in the Study Area includes:

- ESC CMP IV and V EM&A Programme Benthic Monitoring 2006-2009;
- Ecological Baseline Survey (EBS) undertaken for the Hong Kong – Zhuhai – Macao Bridge (HZMB) North Lantau Highway Connection, now renamed Hong Kong Link Road (HKLR) between September 2003 and May 2004;
- Ecological Verification Survey (EVS) undertaken for the HZMB HKLR between August 2008 and January 2009;
- Ecological surveys undertaken for the HZMB Hong Kong Boundary Crossing Facilities (HKBCF) between August and December 2008;
- Marine Supplementary Survey (MSS) undertaken for the HZMB HKLR between December 2008 and May 2009; and
- Ecological surveys undertaken for the Tuen Mun – Chek Lap Kok Link (TMCLKL) between July 2008 and April 2009; and,
- The Indo-Pacific Humpback Dolphin Monitoring Programme conducted by the AFCD.

The sampling locations for these key data sources are shown *Figures 5.1* to *5.5*. Based these data sources, baseline ecological information has been updated, and the ecological significance of organisms and habitats in the Study Area have subsequently been re-assessed in the following sections. Readers are referred to the above report, in particular the TM-CLKL, HKBCF and HKLR EIA reports (1)(2)(3) for specific details of these investigations, including methodologies and raw data output.

(1) Ove Arup & Partners Hong Kong Ltd. (2009) *Op Cit*.

(2) Ove Arup & Partners Hong Kong Ltd. (2009) *Op Cit*.

(3) AECOM (2009) *Op Cit*.

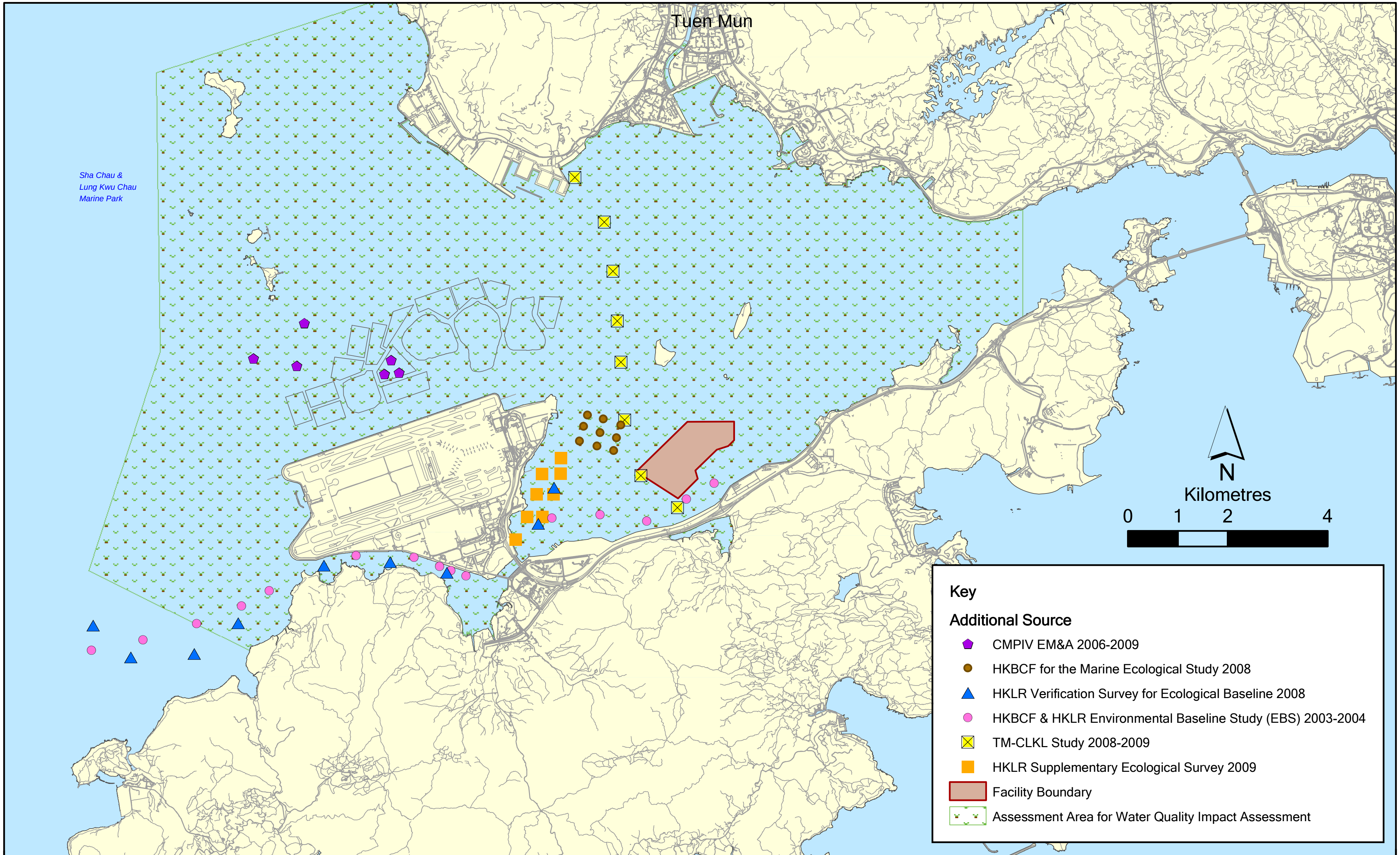


Figure 5.1

Benthic Data Sources

File: E2 gazatte boundary\0106271_benthic2.mxd
Date: 31/05/2010

Environmental Resources Management

ERM

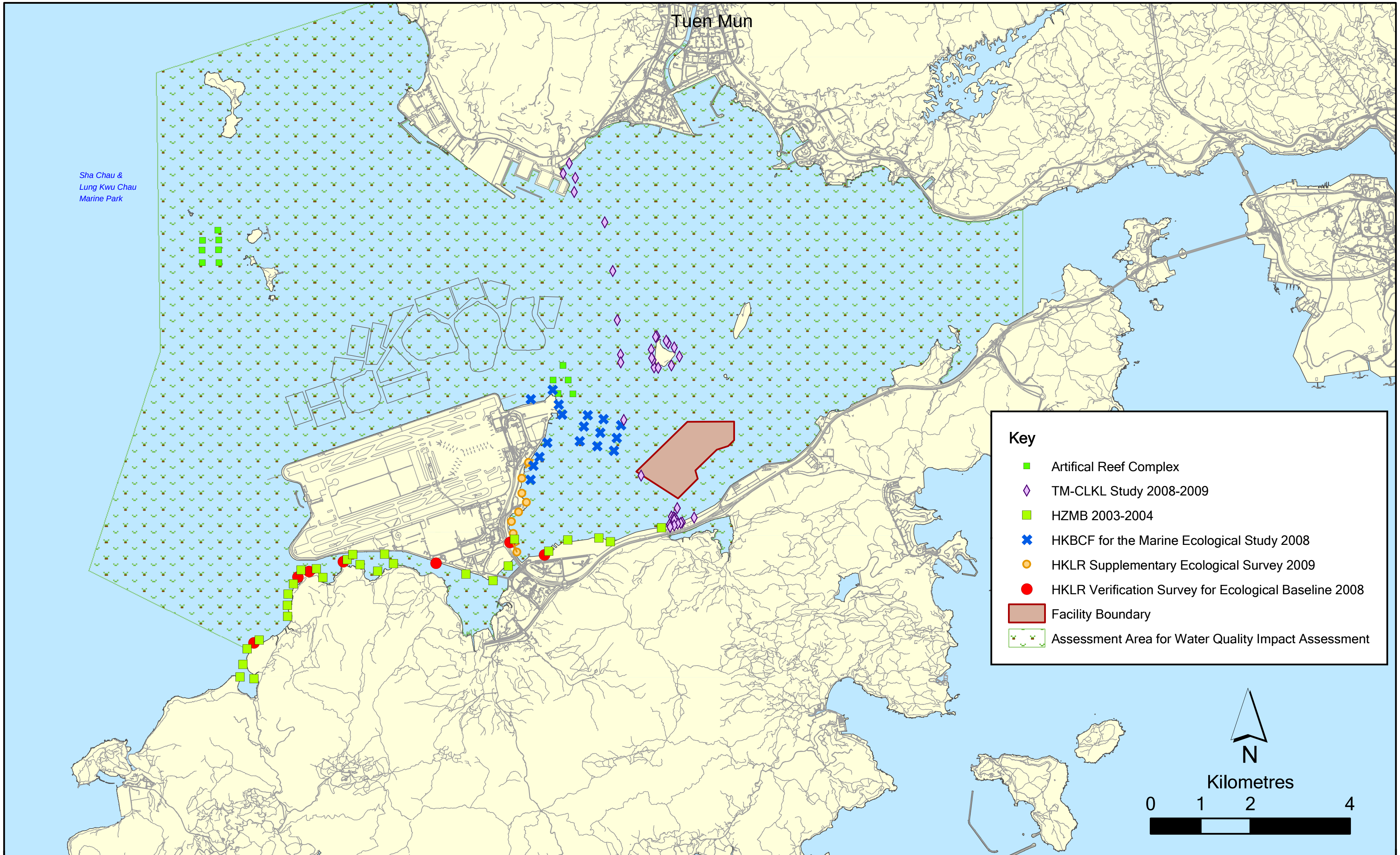


Figure 5.2

Coral Data Sources

File: E2 gazatte boundary\0106271_coral data source.mxd
Date: 31/05/2010

Environmental Resources Management

ERM

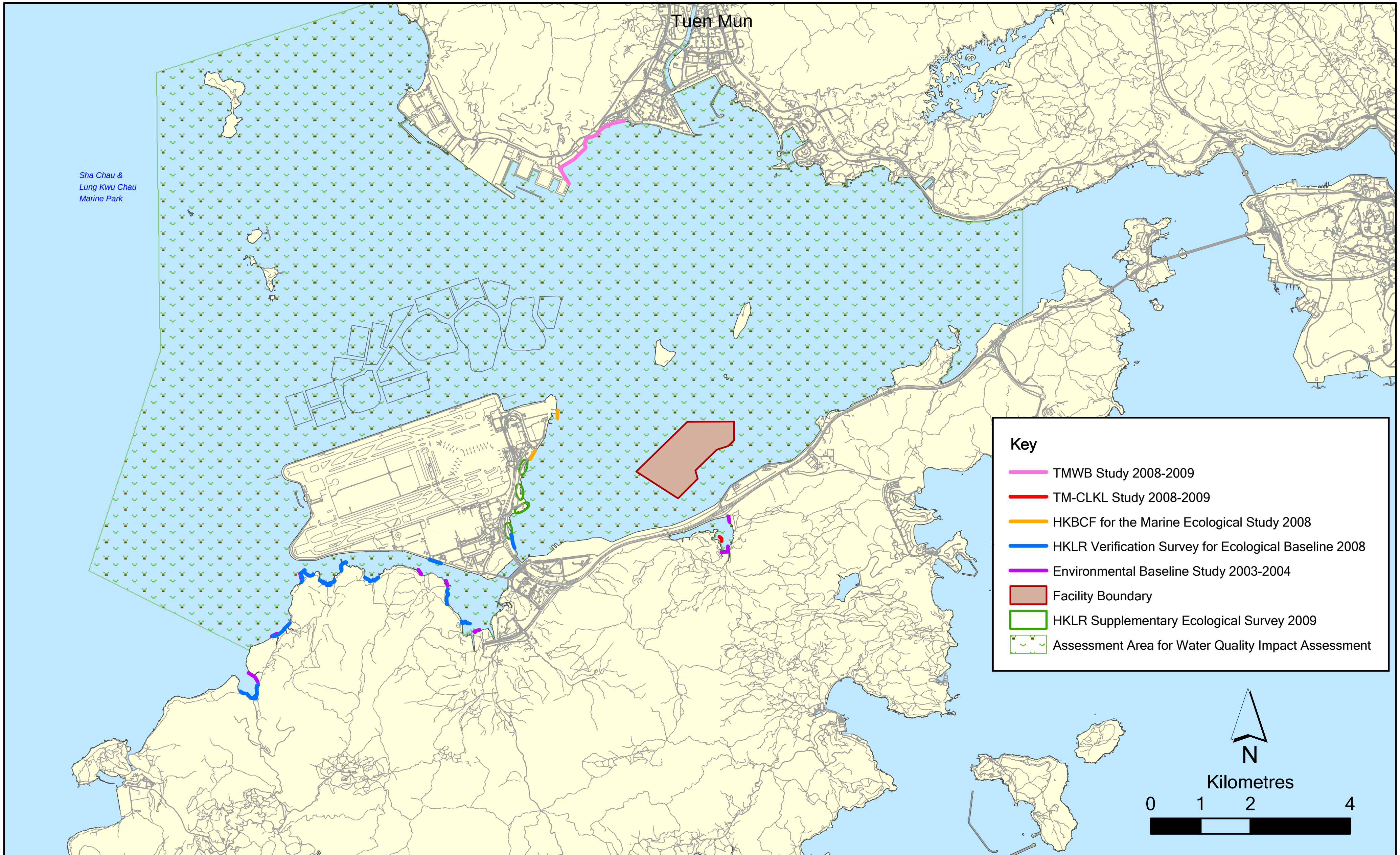


Figure 5.3

Intertidal Data Sources

File: E2 gazatte boundary\0106271_intertidal data source.mxd
Date: 31/05/2010

Environmental Resources Management

ERM

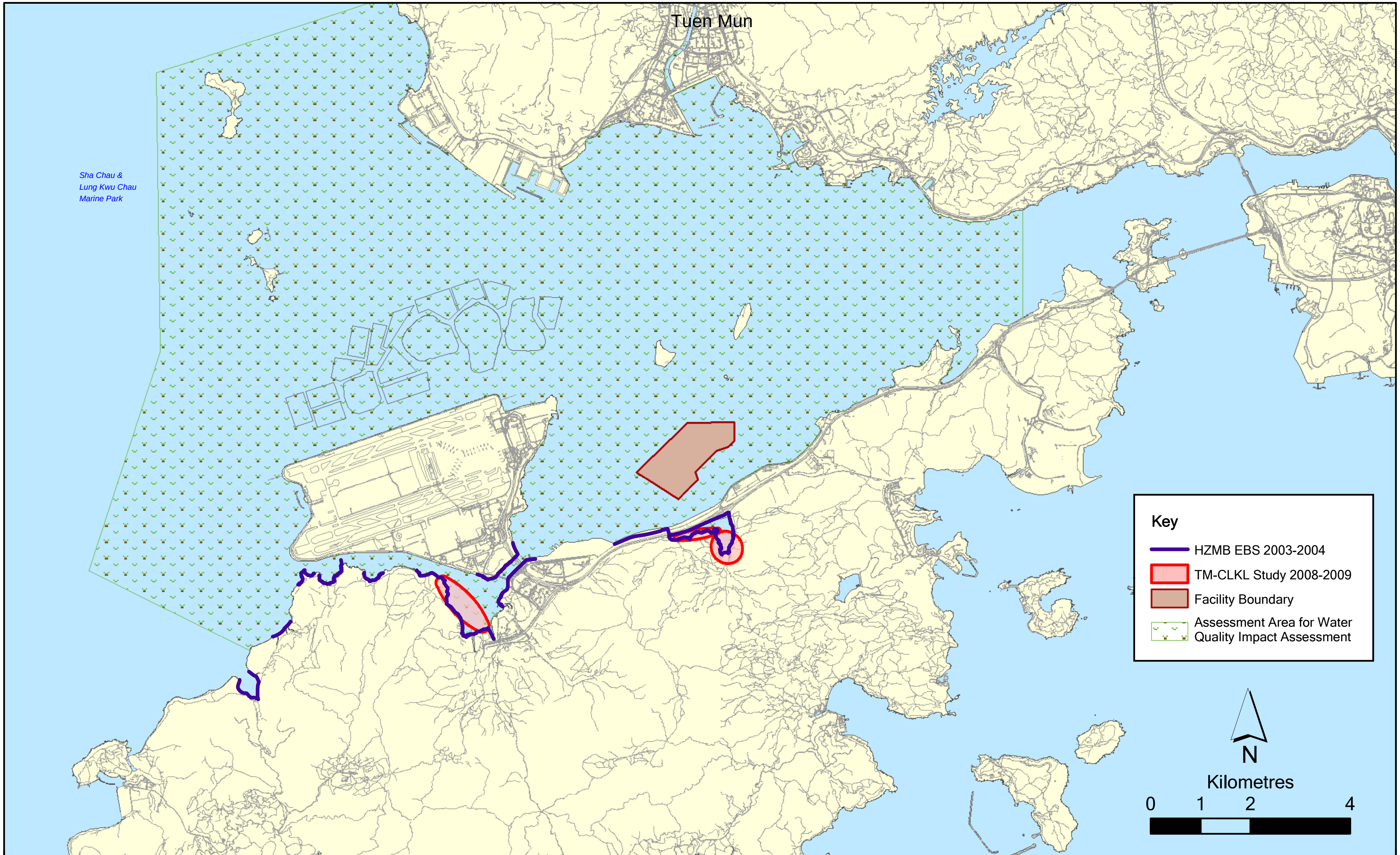


Figure 5.4

Seagrass, Mangroves and Mudflats Data Sources

File: E2 gazatte boundary\0106271_seagrass mangroves mudflats.mxd
Date: 31/05/2010

Environmental Resources Management

ERM

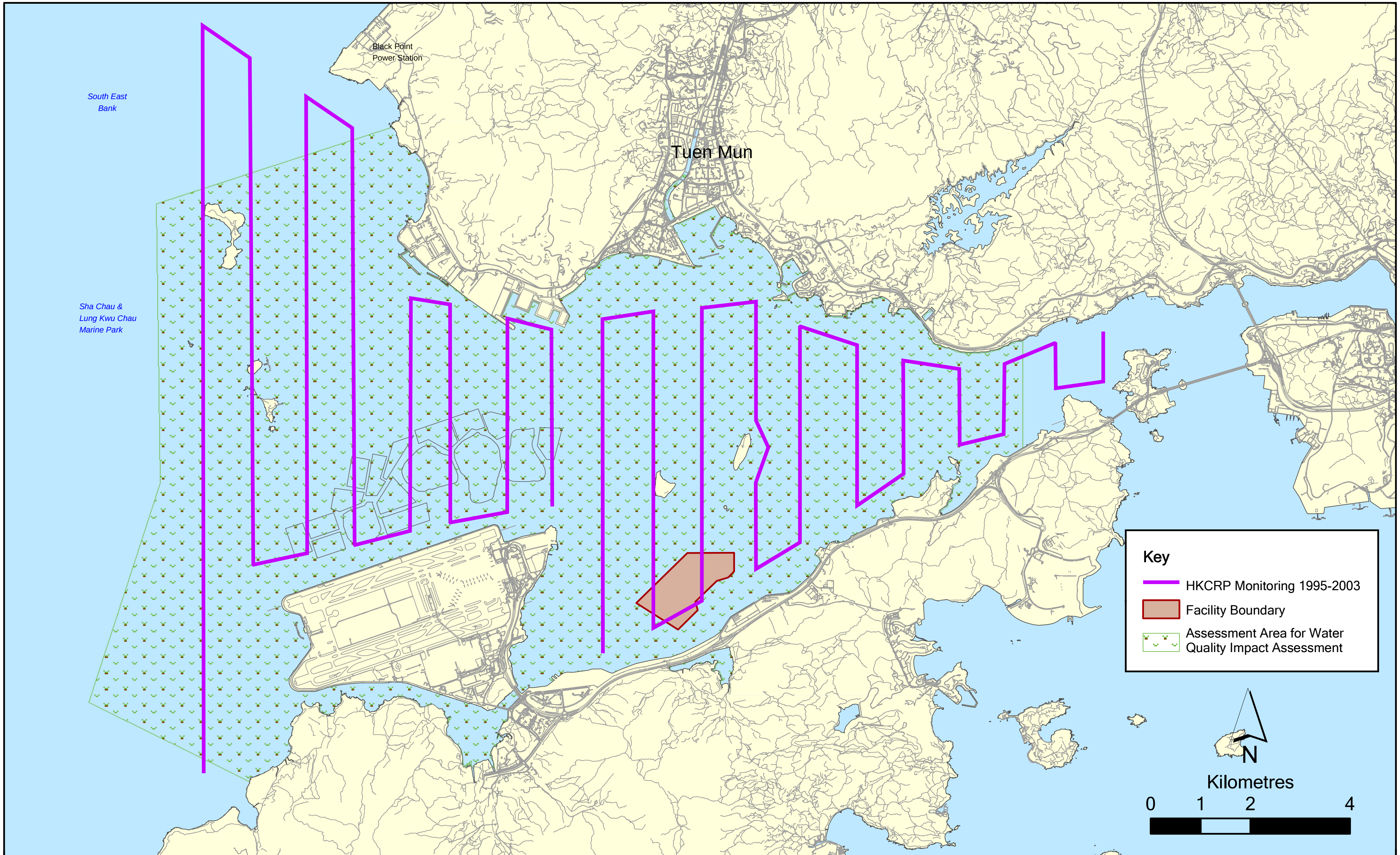


Figure 5.5

Marine Mammal Data Sources

File: E2 gazatte boundary\0106271_Mammal Data source.mxd
Date: 31/05/2010

Environmental
Resources
Management

ERM

5.2.1 *Subtidal Soft Bottom Habitats*

Soft sediments consisting of mud, clay and sand dominate the seabed of Hong Kong. These soft bottom habitats support both infauna and epibenthic faunal marine communities, which in turn play a vital role as a food source for the majority of Hong Kong's inshore fisheries resources. There have been a plethora of benthic surveys in the Study Area since the previously approved SB EIA. Locations of these surveys are presented in *Figure 5.1* and details are summaries below. Scouring marks on the seafloor (refer to *Section 9*) show that the Study Area, and therefore the benthic communities within this area, are subject to a high degree of disturbance from vessels and trawling activities.

CEDD Benthic Infaunal Monitoring – EM&A of CMP IVc

As part of the ongoing environmental monitoring conducted for the existing CMPs at ESC, long term data has been collected on benthic communities (1). This monitoring has been conducted since the 1996 with aim of examining recolonisation on the capped pits (2). As such, assemblages are compared in sediments from capped pits and in reference areas. Monitoring between 2006 and 2008 indicated that the macrobenthic assemblages were different at the capped pit CMP IIId compared to reference areas; however benthic recolonisation was occurring at the capped pits. It is expected that over a longer time period there would be only minor differences between capped pit and reference locations. Details on the macrobenthos infauna assemblages collected in August and December during 2006, 2007 and 2008 from capped pit CMP IIId and reference areas are shown in *Table 5.1*. Twelve species were considered dominant in terms of abundance within samples. Dominant species recorded between 2006 and 2008 were mainly polychaetes, bivalves and crustaceans.

Table 5.1 *Macrobenthic Infauna Assemblages at Capped-Pit and Reference Stations collected as part of the CMP EM&A programme between 2006 and 2008*

Index	Capped-Pit	Reference
Average No. of Genera	5.9	14.4
Average Genera Richness	2.0	3.7
Average Pielou's Evenness	0.9	0.9
Average Shannon Wiener Diversity	0.6	0.9
Average Number of Individuals	13.3	34.3
Average Biomass	2.5	2.3

(1) Agreement No. CE 19/2004 (EP) Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau (2005-2008) - Investigations. Civil Engineering and Development Department

(2) ERM (2008) Review of Past Monitoring results for Contaminated Mud Pits Agreement No. CE 19/2004 (EP) Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau (2005-2008) - Investigations. Report submitted to the Civil Engineering and Development Department

Recent EIA Investigations

Recent investigations of benthic assemblages between 2003 and 2009 have yielded similar results to the benthic monitoring results of the CMP EM&A programme (see *Figure 5.1* for sampling locations) (1)(2)(3). Overall, between 22 and 59 families were reported in the wet season surveys and 24 to 44 families were recorded in the dry season surveys. Up to 9 phyla were found, which included Annelida, Arthropoda, Branchiopoda, Chordata, Cnidaria, Echinodermata, Mollusca, Nemertea and Platyhelminthes. Polychaetes and annelids dominated all samples during all investigations and no species of high conservation significance were recorded.

Ecological Significance

Subtidal soft bottom habitats in the Study Area have been well described as being dominated by species that are typical throughout Hong Kong and of low conservation value. Further, monitoring post capping at previous CMPs has indicated that these communities recolonised the impacted area. Following the *EIAO-TM* criteria, the ecological importance of the infaunal and epifaunal assemblages both within, and in close proximity to the proposed SB facility is assessed to be of low ecological value (*Table 5.2*).

5.2.2 Subtidal Hard Bottom Habitats

The majority of the subtidal habitat within Hong Kong waters, including those within the Study Area consists of soft bottom habitat; however, there are some natural and artificial hard bottom habitats present. Of the marine organisms that inhabit this substratum, corals have a protected status, and thus are of conservation interest.

Over 80 species of coral occur in Hong Kong, with the highest diversities recorded in eastern waters. It appears that coral distribution in Hong Kong is primarily controlled by hydrodynamic conditions as Hong Kong's western waters are influenced by the Pearl River, which lowers salinities and generally records higher concentrations of suspended solids. As such, the western waters of Hong Kong have previously been identified as being relatively devoid of coral species (4) (5).

Recent coral surveys, including spot check dives and rapid ecological assessments, have been done on natural and artificial (eg. seawalls) hard bottom habitats within the Study Area as part of recently approved EIA investigations (*Figure 5.2*) (6)(7)(1). These studies have found corals in the Study

(1) Ove Arup & Partners Hong Kong Ltd. (2009) *Op Cit.*.

(2) Ove Arup & Partners Hong Kong Ltd. (2009) *Op Cit.*.

(3) AECOM (2009) *Op Cit.*

(4) Scott PJB (1984) The Corals of Hong Kong. Hong Kong University Press.

(5) Lun JCY (2003) Hong Kong. Reef Building Corals. Cosmos Books Limited.

(6) Ove Arup & Partners Hong Kong Ltd. (2009) *Op Cit.*

(7) Ove Arup & Partners Hong Kong Ltd. (2009) *Op Cit.*

Area, including the hard ahermatypic corals *Balanophyllia* spp. and *Paracyathus rotundatus* as well as the gorgonian *Echinomuricea* spp. and *Guaiagorgia* sp.. These coral colonies are generally small, have a limited density (< 5 % cover), low diversity and the majority of surveys have also noted partial mortality of colonies. Within the Study Area, corals mainly occur on the natural rocks of the Brothers Islands and on the artificial seawalls of the North Lantau Expressway and Hong Kong International Airport. In addition to corals, other more common organisms have also been recorded during these investigations included mussels, barnacles, sponges, oysters and coralline algae.

Two artificial reef (AR) sites are within the Study Area, one is located east of the Chek Lap Kok Airport within the Chek Lap Kok Marine Exclusion Zone (AR1) and the other is within the Sha Chau and Lung Kwu Chau Marine Park (AR2) (*Figure 5.2*). AR1 was deployed in May 2000 and has a footprint area of 1,200 m^2 and a space area of 3,600 m^2 (2). AR2 was deployed in March 2000 with a footprint and space area of 3,600 m^2 and 5,580 m^2, respectively (3). The deployed ARs provide hard surfaces for colonization of invertebrates, including corals, barnacles, bivalves, tube worms, sponges, bryozoans and squirts (tunicates). They also provide habitats for juveniles of many commercial fish, including bream and snapper. Both AR complexes are designed to enhance fisheries resources and promote feeding opportunities for the Indo-Pacific humpback dolphin.

Ecological Significance

Hard corals in the order Scleractinia, including *Balanophyllia* spp., are protected under *Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586)* and are considered to be a species of conservation interest. Corals in the Study Area are generally in low diversity compared to the eastern waters of Hong Kong and generally consist of small colonies in potentially poor health condition. Following the *EIAO-TM* criteria, the ecological importance of subtidal hard bottom habitats has been assessed in *Table 5.2.* Coral within the Study Area are considered to be of low to moderate significance. Areas where corals occur, such as the two ARs, along the coastline of Tai Mo To, outside the Tai Ho Wan Outlet and the River Trade Terminal are regarded as sensitive receivers for the SB facility.

5.2.3 *Intertidal Hard Bottom Habitats*

The majority of the coastal areas in the Study Area, particularly in vicinity of the proposed disposal facility at SB, have been reclaimed and replaced. Thus in general, artificial seawalls have replaced naturally occurring intertidal hard bottom habitats. The largest of these seawalls is at the Chek Lap Kok International Airport. Surveys have been conducted on the colonisation of organisms on artificial seawalls in Hong Kong and fouling organisms have

(1) AECOM (2009) *Op Cit.*

(2) AFCD (2003) http://www.artificial-reef.net/main2.htm#

been recorded as common on such artificial seawalls, wharf piles and other marine structures [1].

Recent surveys, done between 2003 and 2009, have been done on both natural and artificial hard bottom intertidal habitats within the Study Area (*Figure 5.3*). This has generally been done as a series of walk through surveys and/ or quantitative quadrats sampled on belt transects.

In 2004, between 24 and 30 common species were found on the natural rocky shores at San Shek Wan headland and Sha Lo Wan and 21 to 26 species were found on the artificial seawall of the airport [2]. The remaining natural shore on Airport Island was sampled in 2009, which found the area to be highly disturbed, with 26 taxa were recorded during the both dry and wet seasons [3]. Artificial walls southeast of Airport Island were also found to have low species richness, with a total of 19 taxa recorded and the northeast Airport Island seawalls have a low abundance and diversity of intertidal fauna. Surveys of various locations on the northern coastline of Lantau Island found a total of 21 common taxa [4]. In addition, the TMCLKL investigations found species diversity varied temporally, with 18 species recorded in the wet season, 45 species recorded in the dry season and 53 species recorded in the transitional months [5].

Common species recorded during all these investigations included acorn barnacle *Tetraclita squamosa*, rock oyster *Saccostrea cucullata*, false limpet *Siphonaria japonica*, limpets *Patelloida pygmaea* and *P. saccharina*, snail *Monodonta labio* and *Nerita yoldii*, Littorid snail *Echinolittorina radiata* and *Echinolittorina malaccana*, and crab *Gaetice depressus*.

(1) ERM-Hong Kong, Ltd (2000) Construction of an International Theme Park in Penny's Bay of North Lantau together with its Essential Associated Infrastructures – EIA Report. For the Civil Engineering Department, Hong Kong SAR Government.

(2) Mouchel Parkman Asia Ltd. (2004) Hong Kong-Zhuhai-Macao Bridge Hong Kong Section and North Lantau Highway Connection (now renamed as Hong Kong Link Road) – Hong Kong-Zhuhai-Macao Bridge Final 9 Months Ecological Baseline Survey Report. Report prepared for the Highways Department.

(3) Asia Ecological Consultants Ltd (2004) Hong Kong-Zhuhai-Macao Bridge Hong Kong Link Road – Verification Survey for Ecological Baseline. Report prepared for the Highways Department.

(4) Ecosystems Ltd (2009) Report for Ecological Survey Results. Agreement No. CE 14/2008 (CE) Hong Kong-Zhuhai-Macao Bridge, Hong Kong Boundary Crossing Facilities – Investigation. Report prepared for the Highways Department.

(5) AECOM (2009) *Op Cit.*.

Overall, all surveys have been consistent with the previously approved *EIA Report* for SB in that intertidal species recorded have low diversity and are common and characteristic of intertidal habitats throughout Hong Kong.

Ecological Significance

Following the *EIAO-TM* criteria, the ecological importance of intertidal hard bottom habitats within the Study Area for the proposed CMPs at SB and ESC has been assessed in *Table 5.2*. The intertidal hard habitats are considered to be of low ecological value.

Table 5.2 *Ecological Significance of Soft Subtidal Habitats, Hard Subtidal Habitats and Hard Intertidal Habitats within the Study Area for the proposed SB Facility*

EIAO-TM Criteria	Subtidal Soft Bottom	Subtidal Hard Bottom	Intertidal Hard Bottom Habitats
Naturalness	The assemblages are expected to be disturbed due to fishing operations and high marine traffic propeller wash within these waters	There is limited natural intertidal hard bottom habitat within the Study Area	There is limited natural intertidal hard bottom habitat within the Study Area
Size	Large. The seabed of the Study Area comprises mainly of this habitat.	The subtidal hard-substrates are relatively small and coral coverage very low (< 5%)	No intertidal hard bottom habitat will be permanently affected by the proposed works
Diversity	The assemblages are of low or similar diversity compared to other areas in Hong Kong	Low species diversity, only 3 coral species recorded, and mostly dominated by barnacles, mussels and rock oysters.	Due to the estuarine conditions, diverse assemblages are not expected to be present
Rarity	No organisms were found that are considered rare in Hong Kong	No rare (in Hong Kong) species, protected hard corals are present	No rare (in Hong Kong) species present
Re-creatability	The habitat can be expected to recreate naturally within a relatively short timeframe	Subtidal hard bottom habitats can be re-created and coral can colonise depending on conditions	Intertidal hard bottom habitats can be re-created
Fragmentation	Not fragmented. The surrounding environment contains many other areas of similar substrate	The subtidal hard bottom habitat within the Study Area is fragmented	The intertidal hard bottom habitat within the Study Area is fragmented
Ecological Linkage	Infauna are a food source for epibenthic fauna, which in turn are a food source for demersal fisheries	The subtidal hard bottom habitats within the Study Area have low ecological linkage with habitats of conservation interest	The intertidal hard bottom habitats within the Study Area have low ecological linkage with habitats of conservation interest
Potential Value	Unlikely that the site can develop conservation interest	Moderate, given corals are in the Study Area, however, the low diversity would suggest it is unlikely that these habitats will develop conservation interest	Unlikely that these habitats can develop conservation interest within the Study Area
Nursery Ground	None identified	None identified	None identified

EIAO-TM Criteria	Subtidal Soft Bottom	Subtidal Hard Bottom	Intertidal Hard Bottom Habitats
Age	The sediments in the habitat are constantly accreting and eroding and the fauna present there are typically short lived	Subtidal hard bottom habitats within the Study Area are not expected to be mature	Intertidal hard bottom habitats within the Study Area are not expected to be mature
Abundance	Abundance is generally low or similar in comparison to other areas in Hong Kong	Abundance of subtidal hard bottom associated species is low; with scattered colonies of Gorgonacea/ Scleractini on the hard substratum.	Abundance of intertidal hard bottom associated species is expected to be low
Summary	*The subtidal fauna assemblages within the proposed SB area are likely to be typical of common in Hong Kong with no rare species present.*	*Natural subtidal hard bottom habitat within the Study Area is limited. Artificial subtidal hard bottom habitats generally support small scattered colonies of Scleractini, which are of conservation interest.*	*Due to extensive development in the area, natural intertidal hard bottom habitats are limited. Artificial intertidal hard bottom habitats (generally support less abundance and diversity than natural substratum.*
Ecological Value	**Low**	**With corals: Low to Moderate (Coral habitats at Ta Pang Po, Tai Mo To, Ta Ho Wan and the River Trade Terminal)** **Without Corals: Low**	**Artificial Hard Shores = Low** **Natural Hard Shores = Low to Moderate**

5.2.4 *Intertidal Soft Bottom Habitats*

Intertidal habitats within the Study Area include the mangrove, mudflat and horseshoe crab habitat Tung Chung Bay, Tai Ho Bay and Yam O Bay as well as the seagrass habitat at San Tau, Tai Ho Bay and Yam O Bay. Recent data on these habitats have been collected by two investigations from the recently approved EIA reports (see *Figure 5.4* for sampling locations).

Mangroves

Mangroves provide food, shelter and breeding grounds for a range of organisms including various pelagic and coastal fisheries, and birds (1). Mangroves are considered to be an important habitat where an ecological assessment is necessary in *Note 2*, *Annex 16* of the *EIAO-TM*. Three main mangrove stands are present within the SB Study area, located at Tung Chung Bay, Tai Ho Bay and Yam O. The mangrove habitat at Tai Ho Bay is medium in size (~ 2.4 ha) and has less floristic diversity (12 species of mangrove and associated flora) (1) compared to that of nearby stands at Tung Chung Bay (~ 4.8 ha) and Yam O (~ 0.5 ha) (2).

The Tai Ho Bay habitat is dominated by the relatively common mangrove *Kandelia candel*. Six true mangrove species occur, including *Lumnitzera racemosa*, *Kandelia candel*, *Bruguiera gymnorrhiza, Avicennia marina, Aegiceras corniculatum* and *Acanthus ilicifolius*. *A. corniculatum* is the dominant species, with patches of *B. gymnorrhiza* interspersed. The "Many-petaled Mangrove" *B. gymnorrhiza* is considered to have a restricted distribution in Hong Kong (3). This true mangrove species has established a relatively large population in Tai Ho and is known to adjust to hardened and stiff mud.

Surveys done in Tai Ho Wan in 2003 and 2004 as part of the HKBCF EIA found a fairly high number of floral species in Tai Ho. This included six true mangrove species, *L. racemosa*, *K. candel*, *B. gymnorrhiza*, *A. marina*, *A. corniculatum* and *A. ilicifolius*. Additionally, a number of mangal associated flora were recorded, including *Limonium sinensis, Clerodendrum inerme* and *Acrostichum aureum*. Common species were also recorded, such as *Zoysia sinica*, *Suaeda maritima* and *Vitex rotundifolia*.

Surveys done in 2008 and 2009 also found a fairly high number of floral species in Tai Ho, despite the relatively small habitat size (4). A total of 17 plant species were recorded, including the four true species of mangroves, *K. candel*, *B. gymnorrhiza*, *A. corniculatum* and *A. ilicifolius*. Additionally, mangal associated flora was recorded, including *A. aureum* and *Thespesia populnea*.

(1) Tam NFY and Wong YS (1997) Ecological Study on Mangrove Stands in Hong Kong: Volume 1. University Press, Hong Kong.

(2) Shin, P. K.S, Li, H. and Cheung, S.G. (2009) *Op cit.*

(3) Xing, F., S. C. Ng and L. K. C. Chau. (2000). Gymnosperms and angiosperms of Hong Kong. Memoirs of the Hong Kong Natural History Society 23, 21-135.

(4) Mouchel Parkman Asia Ltd. (2004) *Op cit.*

Within Tung Chung Bay, there are two separate stands, namely Tung Chung Bay itself and San Tau Beach. On the basis of the presence of locally rare mangroves (and seagrass beds) at San Tau Beach, this area covering approximately 2.7 ha has been designated as a Site of Special Scientific Interest (SSSI; refer to *Section 5.2.6*). Due to the relatively large mangrove stand at this site (2.14 ha) and high floristic diversity (18 mangrove species and associated flora, this habitat ranked highly in comparison to other mangrove habitats in Hong Kong. Survey done at Tung Chung Bay and San Tau found locally rare species including *T. poplnea*, *Stenoloma*, *Ipomoea imperati* and *B. gymnorrhiza* (2).

Mangrove habitats at Yam O, in the northeast of the Study Area support two smalls stands (~ 0.5 ha) (1), one at the Luk Keng entrance and one at Yam O Tuk (inner Yam O Bay). Both were found to support moderate floristic diversity in comparison to other mangrove habitats in Hong Kong, particularly considering the small habitat size. However, both habitats appeared to be disturbed, possibly due to the log storage area works in close proximity to the site and the nearby Yam O reclamation works.

Ecological Significance

Mangroves are considered to be an important habitat where an ecological assessment is necessary in *Note 2*, *Annex 16* of the *EIAO-TM*. In addition, the "Many-petaled Mangrove" *Bruguiera gymnorrhiza* is considered to have a restricted distribution in Hong Kong (2). This true mangrove species has established in Tai Ho and Tung Chung Bay. Following the *EIAO-TM* criteria, the ecological importance of mangrove habitats has been assessed in *Table 5.3.*

Mudflats & Horseshoe Crab Habitats

Mudflats are classified as areas of fine-grained sediment (ie. silt or fines) which lie between the high and low tide marks which are not covered by seagrass, mangroves or typical wetland vegetation and are generally fed with freshwater streams. Generally considered to be habitats of ecological importance, mudflats provide key breeding grounds for a variety of species, and species present there act as food source for both fish and, resident and wintering birds. In Hong Kong, mudflats over 0.5 hectares are recognised as important habitats where an ecological assessment is necessary in *Note 2*, *Annex 16* of the *EIAO-TM*.

Mudflats occur throughout Hong Kong, with the largest present in the Deep Bay area. Within the Study Area for the SBs facility, Tung Chung Bay, Tai Ho Bay and Yam O have mudflat habitats present. Two species of horseshoe crabs (*Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*), which have been identified as a species of conservation concern in Hong Kong, can be

(1) ERM - Hong Kong, Ltd (2000) Northshore Lantau Development Feasibility Study. Environmental Impact Assessment. Final Report. For the Civil Engineering Department, Hong Kong SAR Government.

(2) Xing, F., S. C. Ng and L. K. C. Chau. (2000). Gymnosperms and angiosperms of Hong Kong. Memoirs of the Hong Kong Natural History Society 23, 21-135.

found at these mudflat habitats [1] [2]. Horseshoe crabs are listed on the *IUCN Red List* as Data Deficient due to the lack of existing knowledge to determine whether they are endangered. Horseshoe crabs are also on the *China Red Data Book*. However in Hong Kong, Horseshoe crabs are thought to be declining and under increasing pressure from habitat loss, pollution and over exploitation [3].

Tai Ho Wan is one of the confirmed nursery grounds for these two species [4]. A total of 49 individuals (adult and juvenile) horseshoe crabs were sighted between 1998 and 2004 surveys and an average of ten individuals have been found between 2000 and 2004 in AFCD field surveys. Investigations done in 2004 found 14 live and 3 molts of *C. rotundicauda* [5]. In addition, surveys done in 2004 and 2005 to examine the distribution of Horseshoe crabs in Hong Kong, found two *C. rotundicauda* in Tai Ho Wan [6] . However, it should be noted that survey done in 2008-2009 found no horseshoe crabs present on Tai Ho Wan [7]. This does not indicate that horseshoe crabs are no longer present in Tai Ho Wan because these species are often camouflaged and may require a larger survey effort than reported here. Therefore, it is conservatively assumed that the mudflat habitat at Tai Ho Bay has the potential to continue to support horseshoe crabs both as a nursery area and for adult populations.

Surveys have also identified *T. tridentatus* and *C. rotundicauda* at Tung Chung and Yam O. An average of 11 and nine individuals were found during AFCD surveys between 200 and 2004 at Tung Chung and Yam O, respectively. Further, in survey conducted in 2004 to 2005, one *C. rotundicauda* was found at both Tung Chung and Yam O, whereas five *T. tridentatus* were recorded at Tung Chung and one *T. tridentatus* was recorded at Yam O [1]. More recent survey in 2008 to 2009 also found two *C. rotundicauda* at Tung Chung Bay, and two *T. tridentatus* as well as three *C. rotundicauda* at San Tau [4].

<u>Ecological Significance</u>

In Hong Kong, mudflats over 0.5 hectares are recognised as important habitat where an ecological assessment is necessary (*Note 2*, *Annex 16* of the *EIAO-TM*). Following the *EIAO-TM* criteria, the ecological importance of mudflats and horseshoe crab habitats has been assessed in *Table 5.3.*

(1) The HZMB HKBCF EIA (Ove Arup 2009) described that '*T. tridentatus* and *C. rotundicauda* have been recorded at Tai Ho Wan, Tung Chung Wan, San Tau and Sha Lo Wan and Sham Wat (Huang 1997; Chiu and Morton 1999; Fong 1999; Mouchel 2000 2002c; Mott 2003)' and 'during the field surveys of the EBS, horseshoe crab juveniles were recorded in Tai Ho Wan and Pak Mong (fourteen live and three molts of *Carcinoscorpius rotundicauda*)'.

(2) Ove Arup & Partners Hong Kong Ltd. (2009) Agreement No. CE14/2008 (HY) Hong Kong – Zhuhai – Macao Bridge Hong Kong Boundary Crossing Facilities – Investigation. EIA prepared for the Highways Department. And references within

(3) Shin, P. K.S, Li, H. and Cheung, S.G. (2009) Horseshoe Crabs in Hong Kong: Current population status and human exploitation. Tanacredi, J.T, Bolton, M.L. and Smith, D.R. (Eds) , Biology and Conservation of Horseshoe Crabs pp 347-360.

(4) Fong TCW (1999) Tai Ho Wan: breeding and nursery ground of horseshoe crabs. Porcupine! 20:8

(5) Mouchel Parkman Asia Ltd. (2004) *Op Cit.*.

(6) Shin, P. K.S, Li, H. and Cheung, S.G. (2009) *Op Cit.*

(7) AECOM (2009) *Op cit.*.

Seagrass Beds

Seagrass beds occur in shallow, sheltered or subtidal areas and are recognised as areas of high biological productivity therefore identified as important habitat in *Note 2*, *Annex 16* of the *EIAO-TM*. They provide high value habitat as feeding and nursery ground for a range of marine species [(1)]. Within Hong Kong, seagrass beds have been recorded with a very low distribution, occupying less than 0.1% of the total land area. Nevertheless, within the Study Area, seagrass beds have been recorded at three sites, namely San Tau, Tai Ho Bay and Yam O Bay [(2)].

The seagrass beds (~ 500 m^2) at Tai Ho Bay are seasonal and consist solely of the species *Halophila beccarii*. Studies on this species appear to indicate that the habitat is an important feeding ground for juvenile horseshoe crabs [(3)]. Surveys done in 2003-2004 found more than 20 colonies of *H. beccarii* with approximate patch size of 30cm x 30cm were present in Tai Ho Wan[(4)]. Since, *H. beccarii* is locally restricted seagrass [(5)], the seagrass beds at Tai Ho Wan are of importance due to the presence of this species. However, it should be noted that surveys done in 2008 and 2009 found no seagrass present at Tai Ho Wan [(6)]. It should be noted that sparse populations of *H. beccarii* may be hard to find and seasonal and therefore may require a larger survey effort than reported here. Furthermore, if there has been partial mortality of this species at Tai Ho Wan, the area should be considered to be of high conservation importance due to the presence of seagrass seedbanks and habitat that seagrass may recolonise.

Yam O Bay and San Tau support seagrass beds of *Halophila ovalis*, with *Zostera japonica* also present at San Tau. Although the latter of these species has been recorded elsewhere in Hong Kong, San Tau represents this species only habitat, albeit of a relatively small size (15 m^2), on Lantau. Ecological surveys, done as part of the HKBCF EIA, confirmed the presence of both *Halophila ovata* and *Zostera japonica* in Tung Chung Bay. However, it should be noted that surveys done in 2008 and 2009 for the TMCLKL EIA found no seagrass present at Tai Ho Wan or San Tau.

Ecological Significance

(1) Lee SY (1997) Annual cycle of biomass of a threatened population of the intertidal seagrass *Zostera japonica*. Marine Biology 129: 183 - 193.

(2) Fong TCW (1998) Distribution of Hong Kong seagrasses. Porcupine! 18, December 1998.

(3) Fong TCW (1998) *ibid*.

(4) Mouchel Parkman Asia Ltd. (2004) *Op Cit.*.

(5) Shin, P. K.S, Li, H. and Cheung, S.G. (2009) *Op cit*.

(6) AECOM (2009) *Op cit*.

Seagrass beds occur in shallow, sheltered or subtidal areas and are recognised as areas of high biological productivity and are recognised as important habitat in *Note 2*, *Annex 16* of the *EIAO-TM*. Following the *EIAO-TM* criteria, the ecological importance of seagrass habitats has been assessed in *Table 5.3.*

Table 5.3 ***Ecological Significance of Intertidal Soft Habitats within the Study Area for the proposed CMPs at South Brothers***

EIAO-TM Criteria	Soft Bottom Habitats								
	Mangrove Habitat			Mudflat and Horseshoe Crab Habitat			Seagrass Habitat		
	Tung Chung Bay	Tai Ho Bay	Yam O Bay	Tung Chung Bay	Tai Ho Bay	Yam O Bay	San Tau	Tai Ho Bay	Yam O Bay
Naturalness	The habitat is natural, although affected by the Tung Chung Development	The habitat is natural	The habitat is natural, although affected by the Yam O reclamation	The mudflats are natural but under stress from nearby works and shellfish collection	The mudflats are natural	The mudflats are natural but under stress from nearby works	The seagrass beds are natural but under stress from nearby works and shellfish collection	The seagrass beds are natural	The seagrass beds are natural but under stress from nearby works
Size	The 2 stands are both large (2.7 and 2.14ha)	Mangrove stand is medium in size (1.9ha)	Mangrove stand is small ~0.5ha	Compared to other mudflats in Hong Kong the habitat is of medium size	Compared to other mudflats in Hong Kong the habitat is of medium size	Compared to other mudflats in Hong Kong the habitat is of small size	*Zostera japonica* bed is small (15m^2) but the *Halophila ovalis* bed is large (2ha)	Size of the seagrass bed is medium (500m^2)	Size of the seagrass bed is relatively large (~ 1 ha)
Diversity	Diversity is high compared to other mangroves in Hong Kong	Diversity is low compared to other mangroves in Hong Kong	Diversity is moderate in comparison to other sites in Hong Kong	Generally, species diversity on mudflats is high	Generally, species diversity on mudflats is high	Generally, species diversity on mudflats is high	Species diversity associated with seagrass beds is generally high	Species diversity associated with seagrass beds is generally high	Species diversity associated with seagrass beds is generally high
Rarity	One locally rare mangrove species has been recorded at San Tau Beach within Tung Chung Bay	Locally restricted species recorded	No rare mangrove species recorded	Two species of horseshoe crab have been identified as using these mudflats	Two species of horseshoe crab have been identified as using these mudflats	Two species of horseshoe crab have been identified as using these mudflats	Seagrass beds are relatively rare in Hong Kong.	Seagrass beds are relatively rare in Hong Kong.	Seagrass beds are relatively rare in Hong Kong.

EIAO-TM Criteria	Soft Bottom Habitats								
	Mangrove Habitat			Mudflat and Horseshoe Crab Habitat			Seagrass Habitat		
	Tung Chung Bay	Tai Ho Bay	Yam O Bay	Tung Chung Bay	Tai Ho Bay	Yam O Bay	San Tau	Tai Ho Bay	Yam O Bay
Re-creatability	Although re-creatable, the habitat may not return to it original status	Although re-creatable, the habitat may not return to it original status	Habitat is considered poor thus re-creatable	Although re-creatable, the habitat may not return to it original status	Although re-creatable, the habitat may not return to it original status	Although re-creatable, the habitat may not return to it original status	Seagrass beds have been found to be difficult to re-create in Hong Kong	Seagrass beds have been found to be difficult to re-create in Hong Kong	Seagrass beds have been found to be difficult to re-create in Hong Kong
Fragmentation	The mangrove stand at this site is not fragmented	The mangrove stand at this site is not fragmented	The mangroves at this site are fragmented	The mudflats at this site are relatively unfragmented	The mudflats at this site are relatively unfragmented	The mudflats at this site are relatively fragmented	The seagrass beds at this site are relatively unfragmented	The seagrass beds at this site are relatively unfragmented	The seagrass beds at this site are relatively unfragmented
Ecological Linkage	Site also includes mudflat, seagrass and horseshoe crab habitat	Site also includes mudflat, seagrass and horseshoe crab habitat	Site also includes mudflat and seagrass habitat	Site also contains mangroves and seagrass species	Site also contains mangroves and seagrass species	Site also contains mangroves and seagrass species	Site also contains mangroves and mudflat habitat	Site also contains mangroves and mudflat habitat	Site also contains mangroves and mudflat habitat
Potential Value	Mangroves provide high value habitat	Mangroves provide high value habitat	Mangroves provide high value habitat	The site is of conservation interest	The site is of conservation interest	The site is of limited conservation interest due to small size and potential impact of nearby works	The site is of conservation interest	The site is of conservation interest	The site is of conservation interest

EIAO-TM Criteria	Soft Bottom Habitats								
	Mangrove Habitat			Mudflat and Horseshoe Crab Habitat			Seagrass Habitat		
	Tung Chung Bay	**Tai Ho Bay**	**Yam O Bay**	**Tung Chung Bay**	**Tai Ho Bay**	**Yam O Bay**	**San Tau**	**Tai Ho Bay**	**Yam O Bay**
Nursery Ground	Mangroves act as a nursery ground for many species	Mangroves act as a nursery ground for many species	Mangroves act as a nursery ground for many species	Mudflats act as a nursery ground for numerous species. Also identified as nursery ground for two species of horseshoe crab	Mudflats act as a nursery ground for numerous species. Also identified as nursery ground for two species of horseshoe crab	Mudflats act as a nursery ground for numerous species. Also identified as nursery ground for two species of horseshoe crab	Seagrass beds act as a nursery ground for numerous species. Also identified as nursery ground for two species of horseshoe crab	Seagrass beds act as a nursery ground for numerous species. Also identified as nursery ground for two species of horseshoe crab	Seagrass beds act as a nursery ground for numerous species.
Age	Mangrove habitat are relatively slow growing	Mangrove habitat are relatively slow growing	Mangrove habitat are relatively slow growing	Mudflats constantly accreting and eroding and the fauna present there are typically short lived	Mudflats constantly accreting and eroding and the fauna present there are typically short lived	Mudflats constantly accreting and eroding and the fauna present there are typically short lived	The seagrass beds at this site are somewhat seasonal, therefore, relatively short-lived	The seagrass beds at this site are somewhat seasonal, therefore, relatively short-lived	The seagrass beds at this site are somewhat seasonal, therefore, relatively short-lived
Abundance	Abundance of mangroves is high in comparison to other sites in Hong Kong	Abundance is similar to other mangroves in Hong Kong	Abundance is low in comparison to other sites in Hong Kong	Mudflats generally support organisms in high abundances	Mudflats generally support organisms in high abundances	Mudflats generally support organisms in high abundances	Seagrass at this site is of relatively low abundance	Seagrass at this site is of medium abundance	Seagrass at this site is of medium abundance

EIAO-TM Criteria	Soft Bottom Habitats								
	Mangrove Habitat			Mudflat and Horseshoe Crab Habitat			Seagrass Habitat		
	Tung Chung Bay	**Tai Ho Bay**	**Yam O Bay**	**Tung Chung Bay**	**Tai Ho Bay**	**Yam O Bay**	**San Tau**	**Tai Ho Bay**	**Yam O Bay**
Summary	*The mangrove habitat has high species diversity and is large in comparison to other sites in Hong Kong. The site has associated mudflat and seagrass habitat and has been recorded as a nursery ground for horseshoe crabs in Hong Kong.*	*The mangrove habitat has medium species diversity in comparison to other sites in Hong Kong. The site has associated mudflat and seagrass habitat and has been recorded as a nursery ground for horseshoe crabs in Hong Kong.*	*The mangrove habitat is small in comparison to other sites in Hong Kong with moderate species diversity. The site has associated mudflat and seagrass habitat, however, is potentially under continued stress from nearby works.*	*The mudflats at Tung Chung Bay provide a nursery ground for horseshoe crabs in Hong Kong and have associated mangrove and seagrass habitat.*	*The mudflats at Tai Ho Bay provide a nursery ground for horseshoe crabs in Hong Kong and have associated mangrove and seagrass habitat.*	*The mudflats at Yam O Bay have associated mangrove and seagrass habitat, however, are under stress from nearby works*	*The seagrass beds at San Tau within Tung Chung Bay provide a nursery ground for horseshoe crabs and have associated mangrove and mudflat habitat. Although small in size, these seagrass beds are the only site on Lantau for Zostera japonica*	*The seagrass beds at Tai Ho Bay provide a nursery ground for horseshoe crabs in Hong Kong and have associated mangrove and mudflat habitat.*	*The seagrass beds at Yam O Bay have associated mangrove and mudflat habitat, however, are under stress from nearby works*
Ecological Value	**High**	**High**	**Moderate**	**Moderate**	**High**	**Low**	**High**	**High**	**Moderate**

5.2.5 *Marine Mammals*

An extensive review of available information on marine mammals in the Study Area has been done by Dr Samuel Hung, an expert in marine mammals of Hong Kong. *Figure 5.5* show the location of the dolphin monitoring transects in the Study Area and the results of the review of available information are presented in *Annex B* and summarised below.

A number of Indo-Pacific humpback dolphin, *Sousa chinensis*, sightings overlapped with the Study Area. More dolphin groups were sighted at the northeastern end near the Brothers Islands while much fewer were sighted at the southwestern end. Dolphins occurred at the site throughout most of the year, except during spring months (i.e. March through May). It appeared their peak occurrence at the site occurred during summer months (i.e. June through August). Most dolphin sightings that overlapped with the site were small (1-4 animals per group) and medium (5-9 animals per group) sized groups, and the larger (>10 animals) groups were mostly sighted adjacent to the site between the Brothers Islands. Only one of the 14 grids within the Study Area recorded moderately high densities. Overall, the DPSE values (number of dolphins from on-effort sightings per 100 units of survey effort) of unspotted calves (newborn calves up to six months old that have not been weaned) and unspotted juveniles (older calves up to 1-2 years old but still dependent on their mothers) per grid around Lantau Island was 0.2 ± 0.47 and 0.9 ± 1.84 respectively. The mean DPSE values of unspotted calves and unspotted juveniles among the grids that overlapped with and adjacent to the proposed CMP were 0.2 and 1.1 respectively. Therefore, the Study Area is not particularly important for mother-calf pairs, and the mean densities of calves were very similar to the overall means with most grids in the Study Area recording moderately low densities. The Study Area is an important area for socializing activities and for many resident dolphins, with the ranges of a large proportion of individuals overlapped with the Study Area, most of them being considered Hong Kong residents.

Following the *EIAO-TM* criteria, the ecological importance of the waters within the proposed CMPs at SB and ESC for marine mammals has been assessed in *Table 5.4.*

5.2.6 *Sites of Special Scientific Interest (SSSI)*

The sites of Special Scientific Interest have not changed since the previously approved *EIA and Site Selection* for SB. These include Tai Ho Stream and San Tau Beach (*Figure 5.6*). Refer to *Section 5.2.3* for recent data that has been collected from these sites. Another SSSI within the Study Area is the Lung Kwu Chau, Tree Island and Sha Chau SSSI which lies within the Sha Chau and Lung Kwu Chau Marine Park, which is discussed below. As with the previously approved EIA for SB, these SSSI are of high ecological value (*Table 5.4).*

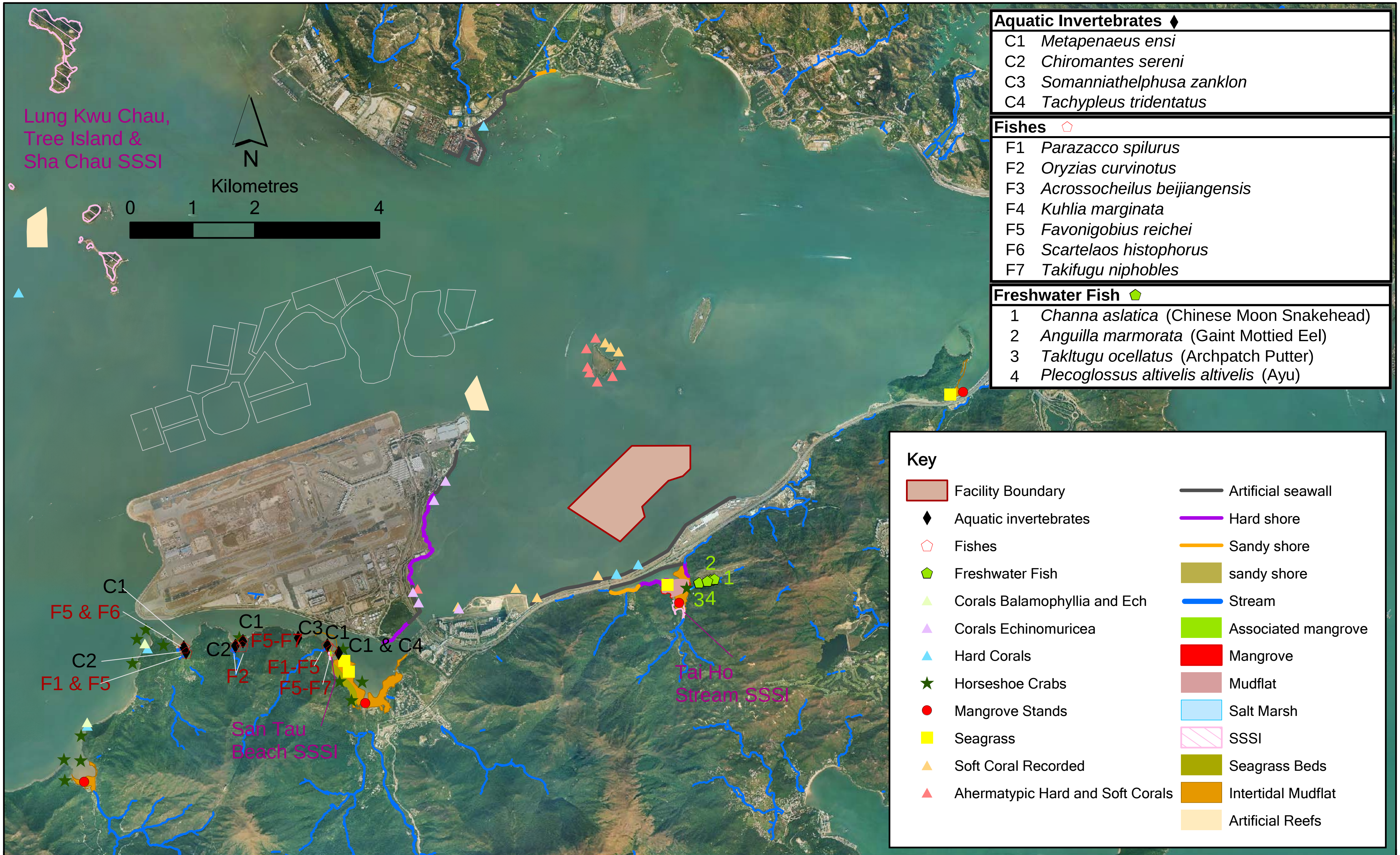


Figure 5.6

Marine Ecological Habitat Map of the Study Area

File: E2 gazatte boundary\0106271_habitat_zoom out.mxd
Date: 31/05/2010

Environmental Resources Management

ERM

Tai Ho Stream

With a total area of approximately 5 ha, Tai Ho Stream originates from Lin Fa Shan and flows to Tai Ho Wan. Tai Ho Stream was designated as a Site of Special Scientific Interest (SSSI) in 1999 due to the high diversity of freshwater fish species.

Aquatic stream surveys done at Tai Ho indicated that many of the streams have a seasonal water flow, with some streams completely drying up seasonally [(1)]. These streams are unlikely to support a high species diversity. However, stream surveys during 2008 and 2009 at the more permanent aquatic streams identified 22 taxa from Tai Ho and 15 taxa from Pak Mong [(2)]. These taxa were generally dominated by freshwater fish, with *Zacco platypus* being the most abundant species. All fish species recorded during the survey were common in Hong Kong. Tai Ho Stream also supports a high diversity of invertebrates, some of which are have a limited distribution or are endemic to Hong Kong [(3)].

Sampling of the freshwater and estuarine environments at Tai Ho has shown a high abundance of fish in the area. Between 1980 and 1991, 46 species of freshwater fish were recorded in Tai Ho stream, which represent the highest diversity of freshwater fish in all streams in Hong Kong [(4)]. The locally rare [(5)] and of immediate regional concern [(6)] salmonid Sweetfish, Ayu *Plecoglossus altivelis*, and of global concern [(7)] catadromous Giant Mottled eel, *Anguilla marmorata,* which are both in the *China Red Data Book* (as vulnerable and endangered, respectively), have both been recorded in Tai Ho Stream [(8)]. Further, surveys conducted in 2003 and 2004 also indicate high diversity. In addition to *A. marmorata* and *P. altivelis*, these surveys also recorded other species of conservation interest, including *Channa asiatica* (Chinese Moon Snakehead; uncommon [(9)] and of local concern [(10)]), *Takifugu ocellatus* (Archpatch Puffer, local rare [(11)]) and *Parazacco spilurus* (vulnerable in *China*

(1) Mouchel Parkman Asia Ltd. (2004) Hong Kong-Zhuhai-Macao Bridge Hong Kong Section and North Lantau Highway Connection (now renamed as Hong Kong Link Road) – Hong Kong-Zhuhai-Macao Bridge Final 9 Months Ecological Baseline Survey Report.

(2) AECOM (2009) Tuen Mun -Chek Lap Kok Link - Investigation. EIA Report. Chapter 8: Marine Ecology. Submitted to the Highways Department.

(3) Mouchel Parkman Asia Ltd. (2004) *ibid.*

(4) Chong, D. H. and Dudgeon, D. (1992). Hong Kong stream fishes: An annotated checklist with remarks on conservation status. Memoirs of the Hong Kong Natural History Society, 19, 79-112.

(5) AFCD Hong Kong Biodiversity Database: http://www.afcd.gov.hk/english/conservation/hkbiodiversity/database/

(6) Fellowes, J.R., Lau M.W-N., Dudgeon, D., Reels, G.T., Ades, G.W.J., Carey, G.J., Chan B.P-L., Kendrick, R.C., Lee K.S., Leven, M.R., Wilson, K.D.P., and Yu Y.T. (2002). Wild animals to watch: terrestrial and freshwater fauna of conservation concern in Hong Kong. Memoirs of the Hong Kong Natural History Society 25: 123-160

(7) AFCD Hong Kong Biodiversity Database. *Op cit.*

(8) Chong, D. H. and Dudgeon, D. (1992). *Op cit.*

(9) AFCD Hong Kong Biodiversity Database. *Op cit.*

(10) Fellowes *et al.* (2002). *Op cit.*

(11) Chong, D. H. and Dudgeon, D. (1992). *Op cit.*

Red Data Book) [1]. Many freshwater species, such as *P. altivelis*, also require a passage between freshwater and saltwater habitats in order to breed [2].

Recent surveys conducted between 2008 and 2009 examined freshwater and estuarine fish in Tai Ho Wan [3]. Fourteen fish species were recorded in the streams, including the Grey Mullet (*Mugil cephalus*), Bartail Flathead (*Platycephalus indicus*), Golden-lined Seabream (*Rhabdosargus sarba*), Common Mudskipper (*Periophthalmus modestus*), Bluespotted mudskipper (*Boleophthalmus pectinirostris*), Mottled spinefoot (*Siganus fuscescens*), *Halichoeres poecilopterus*, Spotted scat (*Scatophagus argus*), *Terapon theraps, Evynnis cardinalis*, *Acanthopagrus schlegeli,* Marbled rock fish (*Sebastiscus marmoratus*) and the Shortnose ponyfish (*Leiognathus brevirostris*). These surveys also found six common species of crustacean, including *Scylla paramamosain*, *Portunus pelagicus*, *Portunus trituberculatus*, *Charybdis* spp., *Metapenaeus affinis* and *Metapenaeus* spp.

5.2.7 *Sha Chau and Lung Kwu Chau Marine Park*

As with the previously approved *EIA Report* for SB, there is one designated Marine Park in the Study Area, namely the Sha Chau and Lung Kwu Chau Marine Park (*Table 5.4)*. The waters within the boundary of this Marine Park are considered of high ecological value.

(1) Mouchel Parkman Asia Ltd. (2004) *Op cit.*

(2) Chong, D. H. and Dudgeon, D. (1992). *Op cit.*

(3) AECOM (2009) *Op cit.*

Table 5.4 Ecological Significance of Marine Mammal Habitats, SSSIs and Marine Park within the Study Area for the proposed CMPs at South Brothers

EIAO-TM Criteria	Marine Mammal Habitats	SSSI			Sha Chau and Lung Kwu Chau Marine Park
		San Tau Beach SSSI	**Tai Ho Stream SSSI**	**Lung Kwu Chau, Tree Island & Sha Chau SSSI**	
Naturalness	n/a	The SSSI at San Tau is natural under stress from surrounding works	Natural	The SSSI is natural and within the Marine Park	The Marine Park is natural but under stress from surrounding works
Size	Moderate but no habitat will be lost through CMP works.	No habitat will be lost through CMP works. SSSI is 2.7ha	5 ha	No habitat will be lost through CMP works. The total land area of the SSSI is 78.7ha	No habitat will be lost through CMP works. The MP covers 1,200ha
Diversity	Only one species of marine mammal, *Sousa chinensis*, has been recorded within these waters	Species diversity within the SSSI is high	Very diverse, supports the highest diversity of freshwater fish in all streams in Hong Kong.	Species diversity within the SSSI would be expected to be relatively high	Species diversity within the Marine Park would be expected to be relatively high
Rarity	Marine mammals are relatively common in western Hong Waters	Two species of horseshoe crab have been identified as using these mudflats as well as two species of seagrass	Species of conservation interest have been identified in this stream.	The SSSI is utilised during the winter by cormorants *Phalacrocorax carbo*	The Marine Park is extensively utilised by *Sousa chinensis* and birds
Re-creatibility	n/a	The SSSI would be expected to be difficult to recreate within a short timeframe	Difficult to recreate	The SSSI would be expected to be difficult to recreate within a short timeframe	The Marine Park would be expected to be difficult to recreate within a short timeframe
Fragmentation	This habitat is unfragmented	The SSSI is relatively unfragmented	Relatively unfragmented, but some tributaries have reduced flow in the dry season	The SSSI is relatively unfragmented	The Marine Park is relatively unfragmented

EIAO-TM Criteria	Marine Mammal Habitats	SSSI			Sha Chau and Lung Kwu Chau Marine Park
		San Tau Beach SSSI	**Tai Ho Stream SSSI**	**Lung Kwu Chau, Tree Island & Sha Chau SSSI**	
Ecological Linkage	Areas of more frequent sightings are located to the west and northwest of the site	Site contains mangroves, mudflat habitat and seagrass species	Site is closely linked to mangrove, mudflat and seagrass patches	The SSSI consists of numerous varying substratum but is land based	The Marine Park consists of numerous varying substratum
Potential Value	Limited value due to relative small size in comparison to the more important marine mammal range areas to the west and northwest	The site is of conservation interest	High ecological value (SSSI)	The site is of conservation interest and is designated within a Marine Park	The Marine Park is of conservation interest
Nursery Ground	This area is not particularly important for mother-calf pairs	The SSSI acts as a nursery ground for numerous species, including horseshoe crabs	Spawning ground for locally rare fish.	The SSSI has been identified as night-time roosting site for cormorants	The Marine Park has been identified as acting as a nursery ground for *Sousa chinensis*
Age	n/a	Due to the nature of the habitat the substratum is accreting and eroding and the fauna present there are typically short lived	Unknown	Not applicable	Due to the estuarine conditions, the habitats within the Marine Park are not expected to be mature
Abundance	Abundance of marine mammals within these waters are low to moderate in comparison to other areas where marine mammals have been recorded in Hong Kong	The SSSI would be expected to support organisms in high abundances in comparison to other habitats	High abundance of freshwater fish.	There are thought to be around 400 cormorants that roost during the winter.	Due to it's protected status the Marine Park would be expected to support organisms in high abundances in comparison to other habitats

EIAO-TM Criteria	Marine Mammal Habitats	SSSI			Sha Chau and Lung Kwu Chau Marine Park
		San Tau Beach SSSI	**Tai Ho Stream SSSI**	**Lung Kwu Chau, Tree Island & Sha Chau SSSI**	
Summary	*The waters within the proposed CMP at South Brothers have low sightings of marine mammals recorded in comparison to other sites in Hong Kong*	*The SSSI provides a nursery ground for horseshoe crabs in Hong Kong and has associated mangroves, mudflat habitat and seagrass beds*	*Tai Ho Bay stream has a high abundance and diversity if freshwater fish and is closely linked to mangrove, seagrass and mudflat habitats. This site is a designated SSSI*	*The SSSI provides night roosting opportunities for a large population of wintering cormorants.*	*Due to its designation and the use of the waters by Sousa chinensis the Marine Park is of conservation importance*
Ecological Value	**SB Facility – Low to Moderate** **Study Area – Low to Moderate**	**High**	**High**	**High**	**High**

5.3 *MARINE ECOLOGICAL SENSITIVE RECEIVERS*

A marine ecological habitat map of the Study Area is presented in *Figure 5.6* some of marine species and habitats of ecological importance is presented in *Figures 5.7* and *5.8*. The ecological value of each of the marine organisms and habitats within the Study Area has been evaluated based on the criteria presented in the *EIA-TM.* The marine ecological sensitive receivers that may be affected during the construction or operation of the SB facility presented in *Figure 5.6* and in *Table 5.5*.

Table 5.5 Marine Ecological Sensitive Receivers of the proposed South Brothers Facility

Habitat/Organism	Ecological Value		Marine Sensitive Receiver
	South Brothers	Study Area	
Soft Bottom Habitats			
Subtidal Soft Bottom Habitats			
Infaunal	Low	n/a	✗
Epifaunal	Low	n/a	✗
Intertidal Soft Bottom Habitats			
Mangroves	n/a	Low to High	✗[1]
Mudflats	n/a	Low to High	✗[1,2]
Seagrass	n/a	High	✗[1]
Hard Bottom Habitats			
Subtidal Hard Bottom Habitats	n/a	Low to Moderate	✗[3]
Intertidal Hard Bottom Habitats	n/a	Low to Moderate	✗
Marine Mammal Habitats	Low to Moderate	Low to Moderate	✓
Sites of Special Scientific Interest (SSSI)	n/a	High	✓
Marine Parks	n/a	High	✓

Notes:

1. High ecological habitat considered a marine sensitive receiver under the San Tau Beach SSSI.
2. Due to its high ecological value Tai Ho Bay has been regarded as a marine sensitive receiver under SSSI.
3. Coral habitat at Ta Pang Po, Ta Ho Wan and the River Trade Terminal have high ecological value

It is noted that the Yam O seagrass bed and the Area 38 Industries Intake that were identified in the previous approved SB EIA Report have been excluded from as WSRs as recent information from the HKBCF, HKLR and TMCLKL suggests that they are no longer valid.

The present proposed layout of the SB facility does not overlap with the proposed marine park at the Brothers. As a result potential interface issues between the SB facility and the proposed marine park are not anticipated. Recently available information suggests that the proposed marine park at the Brothers Islands is expected to be established in 2015/ 2016 when the construction of the HZMB HKBCF is completed. This implies that operation

A. Seagrass bed at San Tau

B. Mudflat and Mangrove at San Tau

C. Mangrove Stands at Tai Ho Bay

D. Seagrass bed at Tai Ho Bay

E. Horseshoe Crab in seagrass bed

D. *Bruguiera gymnorrhiza*

Figure 5.7 Species and Habitats of Ecological Importance within the Study Area

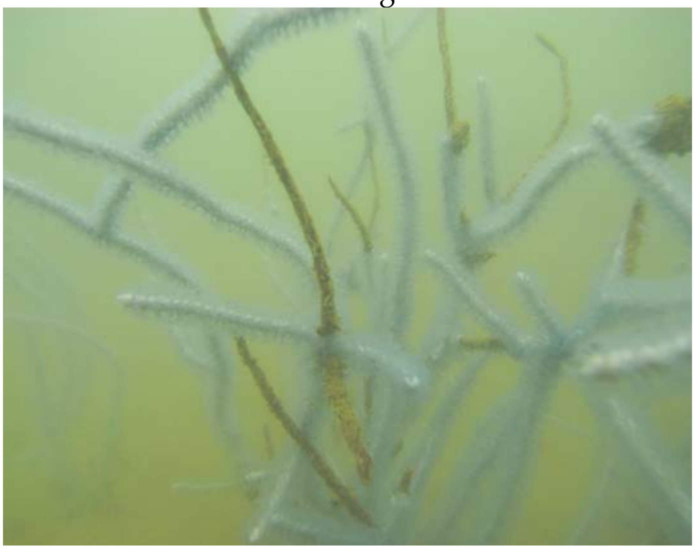
Environmental Resources Management

ERM

A. *Seagrass bed*

B. Mangrove stand

C. Coral



D. Coral

E. Chinese White Dolphin

Figure 5.8 Species and Habitats of Ecological Importance within the Study Area.

Environmental Resources Management

ERM

of the proposed SB facility and the proposed marine park are unlikely to coexist, hence the proposed marine park is not regarded as a new sensitive receiver to the SB facility.

5.4 *REVIEW OF MARINE ECOLOGY ASSESSMENT*

As identified in the *Initial Review Report*, impacts that require updating since the previously approved EIA for SB are those associated with water quality from the construction and operation of concurrent projects in the area (refer to *Section 4*). This includes impacts that results from changes in water quality parameters as well as uptake of contaminants through processes such as bioturbation and bioaccumulation. In addition, impacts associated with increases in noise and marine traffic will be assessed.

5.4.1 *Habitat Loss*

The construction of the SB facility will result in the temporary loss of approximately 141 ha of soft bottom seabed. This is about 23 ha less than the previous design which was approved as part of the approved *EIA Report*. Although this habitat will be temporarily removed filling and capping works associated with the SB facility will reinstate the seabed and hydrodynamic regime to their original condition. This will mitigate the adverse impacts of removal of the seabed. A review of long term monitoring of benthos in and around the capped pits at ESC has demonstrated that within a relatively short period of time, recolonisation of sediments by benthic assemblages occurs returning the site to a similar pre-dredged state (1) (2). These studies have shown that initially the capped backfilled area will be colonised by opportunists and during the early stages of recovery diversity is expected to be low. However, as more competitive species begin to colonise, the diversity of the community will increase until it returns to conditions to the pre-dredged habitat. This temporary loss of habitat is, therefore, not considered as unacceptable.

5.4.2 *Changes in Water Quality*

Modelling results of concurrent projects with the Study Area during construction and operation of the SB facility have been updated from the previous EIA report (refer to *Section 4*). As a result, there have been some changes in the predicted water quality of the Study Area. Since the concurrent projects modelled for 2011, 2012 and 2013 are predicted to be the worst-case scenarios, impacts of changes in water quality to marine ecology needs to be re-evaluated in relation to these scenarios. Increases in SS could potentially impact subtidal benthos, intertidal habitats (including SSSIs),

(1) ERM - Hong Kong, (2003) Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau (Agreement No. CE 12/2002 (EP)) - Environmental Monitoring Data Review. For the Civil Engineering Department, Hong Kong SAR Government.

(2) Qian PY, Qiu JW, Kennish R and Reid C (2003) Recolonization of benthic infauna subsequent to capping of contaminated dredged material in East Sha Chau, Hong Kong. Estuarine, Coastal and Shelf Science 56: 819-831.

corals and marine mammal (through a reduction in prey). Based upon the water quality modelling in *Section 4*, it was concluded that, assuming sufficient mitigation from concurrent projects are put in place as per the commitments in the approved EIA reports, there are not predicted to be any unacceptable effects on flows or water quality in the Study Area.

Suspended Solids

Subtidal Habitats: The subtidal soft benthos in and around the SB is considered to be of low ecological value (*Table 5.1*). However, these organisms will be susceptible to the effects of increased sediment. From the water quality models of impacts associated with concurrent projects presented in *Section* 4, SS levels and daily sedimentation rates within close proximity to the pit boundaries (< 1 km; WSR49, WSR22a) will be < 15 mg/L and < 50 g/m^2, respectively. These rates are lower that those predicted for CMP IV (20 mg/L and 1 kg m^{-2} day^{-1}, for SS concentrations and sedimentation rates, respectively).

A review of long term monitoring data has shown that disposal operations at CMP IV are considered to be environmentally acceptable, thus there does not appear to be evidence of adverse impacts of the aforementioned deposition rates to the subtidal soft benthos (1). Based on this, the currently predicted rates for concurrent operations of the SB facility and projects in the Study Area are also considered to be acceptable.

Corals may be particularly sensitive to increases in SS and sediment deposition. Habitats that are SRs due to the presence of corals include outside Tai Ho Wan outlet (WSR22c), Tai Mo To (WSR46) and River Trade Terminal (WSR47b). Corals have a tolerance threshold ranging between 100 g m^{-2} day^{-1} (2) and 200 g m^{-2} day^{-1} (3). Daily sedimentation rates at these coral SRs are predicted to remain < 100 g m^2, except at the River Trade Terminal where concentrations may reach 121 g m^2 for a short period of time. Sediment deposition is predicted to be below the coral threshold level of 200 g/m^2 per day at all coral sites. Further, hard corals in the area generally do not contain symbiotic photosynthetic zooxanthellae (ie. ahermatypic), and are therefore, more tolerant to changes in light conditions from increased suspended sediments.

Intertidal Habitats: Intertidal habitats identified within the Study Area of ecological value consist of soft bottom mangrove, mudflats, seagrass beds and

(1) ERM- Hong Kong, Ltd (2010) Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau (2005-2008). Draft Final Report. For the Civil Engineering and Development Department, Hong Kong SAR Government.

(2) ERM - Hong Kong, Ltd (2003) The Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong – Environmental Impact Assessment Study. For The Hong Kong and China Gas Company Limited. (EIA – 089/2003)

(3) Mouchel Asia Limited (2002) Environmental Assessment Study for Backfilling of Marine Borrow Pits at North of the Brothers (Agreement No GEO 01/2001) - Environmental Assessment Report. For the Civil Engineering Department, Hong Kong SAR Government.

horseshoe crab habitats. These habitats occur at Tai Ho Bay and Tung Chung. Sediment dispersion results predict that maximum depth averaged elevations in SS concentrations are expected to be < 1 mg/L at the mouth of Tai Ho Bay in both wet and dry seasons (WSR22a), which is complaint with the WQO. In addition, as current velocities at Tai Ho Bay are extremely low, it is expected that the SS entering the bay will settle out very quickly and not reach the sensitive receivers located further inside the bay. The maximum elevations in SS concentrations at the San Tau Beach SSSI (WSR27) and Ta Pang Po (WSR21) are also predicted to be < 5 mg L^{-1} in both seasons and, therefore, do not exceed the allowable increases. It is thus expected that unacceptable impacts to these intertidal habitats arising from elevated SS levels will not occur.

Marine Mammals: The Indo-Pacific Humpback Dolphin, *S. chinensis*, is thought to be an opportunistic feeder with the most important prey species being demersal fish (such as croakers, Sciaenidae) as well as several pelagic groups (Engraulids, Clupeids and Trichiurids). Information from the fisheries impact assessment (*Section 6*) indicates that indirect impacts are not predicted to adversely impact fisheries. The consequences of this are that impacts to marine mammals through loss of food supply (fisheries resources) are not predicted to occur as impacts to fisheries resources are regarded as of low severity and acceptable.

Sha Chau and Lung Kwu Chau Marine Park: The Sha Chau and Lung Kwu Chau Marine Park is located more than 7 km from the SB facility at its nearest point. The maximum SS concentrations at the Marine Park (WSR10) from the concurrent projects water quality scenarios predicted to be < 6 mg L^{-1} in both the dry and wet seasons, and thus, the WQOs are not exceeded.

In terms of deposition of sediments, the maximum daily deposition rate within the Marine Park (WSR10) is predicted to be < 50 g m^{-2}. Corals, which have been identified in the Marine Park, have been documented in previous studies in Hong Kong as having a tolerance threshold ranging between 100 g m^{-2} day^{-1} [(1)] and 200 g m^{-2} day^{-1} [(2)]. As these predicted deposition rates are well below these thresholds, any corals within the Marine Park are not expected to be impacted by the concurrent construction and operation of projects and the SB facility.

Dissolved Oxygen

Predictions from the 2011, 2012 and 2013 scenarios for concurrent projects impacts on shows only minor depletions in DO of the water (< 0.3 mg/L). Thus, all DO water quality objectives are predicted to be met under these scenarios. It is, thus, expected that unacceptable impacts to the marine ecological habitats and species present in the vicinity of the SB facility are not predicted to occur.

(1) ERM - Hong Kong, Ltd (2003) *Op Cit.*

(2) Mouchel Asia Limited (2002) *Op Cit.*

Nutrients

Modelling results have indicated that the levels of nutrients are not predicted to increase appreciably (< 0.03 mg/L elevation) from background conditions during the construction and operation of SB and concurrent projects in the area during 2011, 2012 and 2012. Algal blooms are not expected through works and unacceptable impacts to the marine ecological habitats and species present in the vicinity of the SB facility are not predicted to occur.

5.4.3 *Uptake of Contaminants*

Bioturbation

Bioturbational effects are an important consideration in assessing the ultimate effectiveness of any contaminated mud disposal pit because the thickness of the cap layer required to biologically isolate contaminated sediments is typically greater than that needed to physically isolate them.

The depth of reworking of sediments in Hong Kong, as evidenced from sediment profile images, is generally confined for the most part to the upper 10 cm of sediment and rarely exceeds 15 cm (1). However, based on an international and local literature review conducted as part of the Environmental Impact Assessment for CMP IV at East of Sha Chau, a 1 m cap was considered to be sufficiently thick to act as an effective barrier to macrofauna in the East of Sha Chau area (2). A highly conservative cap design would require placement of at least 3 m of uncontaminated material predicted that there would be no appreciable risk of cap penetration by bioturbating organisms.

As the present design of the South Brothers Facility proposes to employ a cap of 3 m of uncontaminated mud, cap penetration and the subsequent uptake of contaminated material by bioturbating organisms is not expected to occur.

Bioaccumulation

The concurrent operation of projects in the Study Area may increase the amount of contaminants released into the water column from the sediments. Subsequently, this may increase the risk contaminants enter the food chains and bioaccumulate. A comprehensive bioaccumulation assessment has been conducted and results of the assessment are presented in *Appendix A* of *Annex C* of this Report.

In addition, the potential for food chain bioaccumulation has also been examined through a hazard to health risk assessment (refer to *Section 7* for

(1) ERM - Hong Kong, Ltd (2001) Ecological Monitoring for Uncontaminated Mud Disposal (Agreement CE 37/99) - Sediment Profile Imagery (SPI) Surveys in the East Lamma Channel. For the Civil Engineering Department, Hong Kong SAR Government

(2) ERM - Hong Kong, Ltd (1997) Environmental Impact Assessment Study for Disposal of Contaminated Mud in the East of Sha Chau Marine Borrow Pits. Final Report. For the Civil Engineering Department, Hong Kong SAR Government

results). The marine mammal risk assessment examined the potential risks to the Indo-Pacific humpback dolphin population in the waters of Hong Kong, resulting from the consumption of prey items potentially bioaccumulating COCs at the proposed South Brothers facility. Two dietary scenarios of the dolphin were considered and the associated doses and hazard evaluated.

Results of the assessment indicated that, under the dietary scenarios evaluated, the risks of an adverse effect in Indo-Pacific humpback dolphins associated with the consumption of prey items collected at South Brothers is low and is significantly lower that those from the Background area. It is important to note that the consumption of prey from both the South Brothers and Background areas are not predicted to pose unacceptable risks and systematic toxicity to dolphins under both dietary scenarios.

Details of the assessment are presented in *Section 7.5*.

5.4.4 *Habitat Disturbance through Increased Traffic and Noise*

Disposal of contaminated mud could potentially result in an increase in marine traffic and underwater noise affecting *Sousa chinensis*.

In terms of the potential for noise impacts, small cetaceans are acoustically sensitive, and sound is extremely important to their survival, thus noise from construction activities are a potential concern. In addition, vessel passes during operations of the SB facility have the potential to cause behavioural disturbance or harassment. Most dolphins can hear within the range of 1 - 150 kHz though the peak for a variety of species is between 8 - 90 kHz (1). Dredging and large vessel traffic generally results in mostly low frequency noise typically in the range of 0.02 - 1 kHz (2) which are below the peak range of 8 - 90 kHz reported for dolphins.

Contaminated mud disposal facilities have been in operation in the ESC area for over ten years. Data available on the use of the waters does not appear to indicate that the operations of these facilities are resulting in behavioural changes. On this basis and the observations that dolphins do not frequent the waters of the SB facility, marine traffic associated with the SB activities are not expected to have an adverse impact on the species.

Multiple projects operating in the Study Area may increase the risk of collision with the dolphins with marine vessels, alter diving and surfacing behaviours and displace dolphins from preferred habitats. Fast moving vessels are more of a threat to dolphins therefore a speed limit of 10 knots has been recommended by the HKBCF and HKLR with the TM-CLKL EIAs in high density dolphin habitats within the works area. Given these mitigation measures are implemented for these projects, cumulative impacts associated

(1) Richardson et al (1995). *Op cit.*

(2) Richardson et al (1995). *Ibid.*

with vessel traffic and noise are considered to reduce cumulative impacts to acceptable levels.

5.5 ASSESSMENT OF MARINE ECOLOGICAL IMPACTS

The following section discusses and evaluates the impacts to marine ecological habitats as a result of the proposed SB Facility. From the information presented above, the marine ecological impact associated with the construction and operation has been evaluated in accordance with the *EIAO-TM (Annex 8, Table 1)* as follows:

- *Habitat Quality*: Direct impacts are predicted to occur only to the low ecological value benthic habitats identified within the proposed area for the SB Facility. The closest habitat of high ecological value is Tai Ho Bay, located approximately 1 km from the site and no unacceptable impacts have been predicted to occur.

- *Species:* Organisms of ecological interest reported from the literature include the Indo-Pacific Humpback Dolphin; however sightings within or in the vicinity of the SB Facility are not frequent. Mangroves, seagrasses, horseshoe crabs and corals also occur within the Study Area. Impacts are not predicted to occur to these habitats or species as water quality perturbations are predicted to be compliant with the WQOs.

- *Size:* The total size of the SB Facility is about 141 ha. The low ecological value benthic assemblages within the areas of the proposed CMPs will be temporarily lost during the operation of the facility but are expected to become re-established within a few years following capping (see *Reversibility*).

- *Duration:* Construction of the SB Facility is currently proposed to commence in 2011 and capping operations complete in 2015. However, it should be noted that this duration has been based on arising predictions, and as such, should arisings of contaminated material change a subsequent change in duration could be expected. It should also be noted that the water quality modelling has been based on a worst-case dredging/ disposal/capping rate, however, in practice operations may be expected to be significantly lower. Nevertheless, under this worst-case scenario increases in SS concentrations in the vicinity of sensitive receivers as a result of the construction and operation of the SB facility are within environmentally acceptable limits (as defined by the WQOs).

- *Reversibility:* Impacts to the benthic assemblages inhabiting the soft bottom habitats within the areas proposed for the SB Facility are expected to return to pre-dredging conditions within a relatively short timeframe once operations have ceased.

- *Magnitude:* No unacceptable impacts to the ecologically sensitive habitats have been predicted to occur.

5.6 *MITIGATION MEASURES*

In accordance with the guidelines in the *EIAO-TM* on marine ecology impact assessment, the general policy for mitigating 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 the intensity of works operations (eg dredging rates) or timing of works operations; and
- **Compensation:** The loss of important species and habitats may be provided for elsewhere as compensation. Enhancement and other conservation measures should always be considered whenever possible.

Impacts to marine ecological resources have largely been *avoided* during the construction and operation of the SB facility by the following measures:

- **Avoid Direct Impacts to Ecologically Sensitive Habitats:** The site for the SB facility has been selected based on a review of the environmental considerations of the area and the most environmentally preferable site within the Study Area to avoid direct impacts to ecologically sensitive habitats and species. Specifically, the area where dolphin sightings are less frequent or have not been recorded in comparison to other areas in the Study Area has been selected.
- **Avoid Indirect Impacts to Ecologically Sensitive Habitats:** The site for the SB facility has been selected so that it is located at a sufficient distance from ecological SRs so that dispersion of sediment from dredging, backfilling and capping operations does not affect the receivers at levels of concern (as defined by the WQO). By locating the SB facility in shallow area of relatively low hydrodynamic energy, thereby limiting the potential for material to be lost outside of the pit, the horizontal spread of suspended sediment is restricted to a confined area within close proximity to the pit boundary.

In addition, impacts to marine ecology have been *minimised* through the following measures:

- **Adoption of Existing Practices:** A review of all previous environmental monitoring results since the operation of the ESC Contaminated Mud Disposal facility has provided statistical analyses that mud disposal activities at the ESC area have remained within environmentally acceptable levels [1]. As dredging, backfilling and capping operations proposed for the SB facility have generally been designed to follow the current practices, no adverse unacceptable impacts are expected to occur.

- **CMP Design:** The SB CMPs have been designed as two separate pits which minimises exposure time of contaminated mud to the marine environment and consequently reduces the magnitude of potential impacts to ecological resources.

- **Adoption of Acceptable Working Rates:** The cumulative modelling work conducted under the HKBCF and HKLR with the TM-CLKL EIAs and updated within this *EIA Review Report* has demonstrated that the selected working rates for the dredging, backfilling and capping operations will not cause unacceptable impacts to the receiving water quality. Consequently, unacceptable indirect impacts to marine ecological resources have been avoided. Given mitigation measures outlined in the HKBCF and HKLR with the TM-CLKL EIAs are adopted, concurrent project impacts are also likely to be avoided.

The impact assessment presented above indicates that no unacceptable impacts to marine ecology are expected to occur. Although soft bottom habitat will be temporarily lost, it has been demonstrated through long term monitoring of previous and existing CMPs in the ESC area that marine organisms have recolonised capped SB facility following the completion of backfilling operations [2]. As such, it is anticipated that subtidal assemblages similar to those currently present will settle on and recolonise the capped SB facility returning it to pre-dredging conditions.

Impacts to marine ecological sensitive receivers during the operation of the SB facility are predicted to be within environmentally acceptable levels, as well as those in ecologically important areas. As such, no marine ecology specific mitigation measures are required during projects operation.

5.7 *RESIDUAL IMPACTS*

As outlined in the previously approved EIA for the SB facility, residual impacts occurring as a result of the construction and operation of the SB facility are the temporary loss of the low ecological value subtidal assemblages present within the pit boundaries. The residual impacts are considered to be acceptable as the habitats are of low ecological value and because infaunal organisms and epibenthic fauna are expected to recolonise the sediments. Such recolonisation of capped pits within the ESC area has previously been demonstrated to occur through long-term monitoring [3].

(1) ERM - Hong Kong, (2003) *Op cit.*

(2) Qian PY, Qiu JW, Kennish R and Reid C (2003) *Op cit.*

(3) Qian PY, Qiu JW, Kennish R and Reid C (2003) *Op cit.*

5.8 *ENVIRONMENTAL MONITORING & AUDIT (EM&A)*

The construction and operation of the proposed SB facility has been shown to proceed at rates that maintain environmental impacts to within acceptable levels. Actual impacts during the works will be monitored through a detailed Environmental Monitoring and Audit (EM&A) programme. Full details of the EM&A programme are presented in the approved EM&A Manual which has been based on the on-going and previous monitoring programmes conducted at the Contaminated Mud Disposal Facility at East of Sha Chau. This programme will provide management actions and supplemental mitigation measures to be employed should impacts arise, thereby ensuring the environmental acceptability of the SB facility.

5.9 *CONCLUSIONS*

This Section has described the impacts to marine ecology arising from the construction and operation of the SB facility, with particular focus on the impacts arising from the concurrent construction and operation of projects in the Study Area. The purpose of the assessment was to update and evaluate the SB facility in terms of the acceptability of predicted impacts to marine ecology SB and concurrent project activities.

Through the application of criteria utilised in previous EIAs in Hong Kong, impacts arising from the proposed dredging, backfilling and capping operations at the SB Facility in concurrent with other projects in the vicinity are predicted to be within acceptable levels (as defined by the WQOs) and are not expected to cause adverse impacts to marine sensitive receivers of high ecological value (habitats or species). The temporary loss of the subtidal habitats present within the pit boundaries are considered to be acceptable as the habitats are of low ecological value. Furthermore, recolonisation of the capped pits by infaunal organisms and epibenthic fauna is expected to occur following the completion of capping operations.

In addition, a review of all previous environmental monitoring results since the operation of the East of Sha Chau Contaminated Mud Disposal Facility has provided confirmation that mud disposal activities at the East of Sha Chau area consistently remain within environmentally acceptable levels. As all dredging, backfilling and capping operations proposed for the SB Facility have been designed to follow the current practice, no adverse unacceptable impacts are thus expected to occur.

The residual impacts occurring as a result of the construction and operation of the SB Facility are confined to the temporary loss of the low ecological value subtidal habitats present within the pit boundaries. The residual impacts are considered to be acceptable as the habitats are of low ecological value and because infaunal organisms and epibenthic fauna are expected to recolonise the sediments.

To protect against unacceptable impacts to marine ecological resources, an EM&A programme has been designed to specifically detect and mitigate any unacceptable impacts to marine ecological resources.

6 FISHERIES

6.1 INTRODUCTION

It has been identified and agreed in the *Initial Review Report* of this Study that the following attributes of the approved EIA report of the SB facility would be updated and/ or verified as part of this EIA review:

- Baseline fisheries conditions to be updated;
- Sensitive Receivers to be re-examined; and
- Potential fisheries impacts, specifically the cumulative impacts arising from other committed concurrent projects, to be re-assessed.

The assessment of other concerns related to the SB facility have been addressed in the approved EIA report and based on an initial review of these findings, no further updates were considered necessary.

As recommended in the *Initial Review Report*, the methodologies for the above update/ verification would be by a desktop review of available up-to-date information, e.g. AFCD reports. This section presents the outcomes of the proposed update/ verification.

6.2 BASELINE CONDITIONS

The following fisheries resources have been identified within the Study Area:

- Capture fisheries;
- Culture fisheries; and
- Artificial Reefs.

Existing conditions of each of the above fisheries resources based on available literature, mainly from the AFCD Port Survey 2006, AFCD Annual Reports and the ESC CMP EM&A programme, are presented in more detail in the following sections.

6.2.1 *Capture Fisheries*

The main fishing methods in Hong Kong are trawling, long-lining, hand-lining, gill-netting and purse-seining with the majority of the total catch obtained through trawling [1].

(1) Agriculture, Fisheries and Conservation Department 2010 www.afcd.gov.hk

In 2009, fisheries in Hong Kong waters were estimated to amount to 159,000 tonnes of fisheries produce and were valued at $2,000 million [(1)]. Further, the industry consists of approximately 3,700 fishing vessels and some 7,600 local fishermen working aboard and provides employment in ancillary sectors servicing the fishing industry, such as fish wholesale and retail marketing, fuel and fishing gear supply and ice manufacturing [(1)]. Similar estimates were made for 2006 to 2008 fisheries production. In 2008, fisheries in Hong Kong waters were estimated to amount to 158,000 tonnes and were valued at $1,780 million [(2)]. Further, the industry consists of approximately 3,800 fishing vessels and 7,900 fishermen [(1)]. In 2007, an estimated 4,000 fishing vessels and 8,500 fishermen operated in Hong Kong, producing 154,000 tonnes of fish products, of which about 41,000 tonnes were consumed in Hong Kong [(3)]. Whereas in 2006, an estimated 3,950 fishing vessels and 8,500 local fishermen were operating in Hong Kong, which produced an estimated 154,536 tonnes of fish products, of which about 46,206 tonnes were consumed in Hong Kong [(4)] .

The AFCD Port Survey for 2006, interviewed approximately 36% of the local fishing fleets from all homeports in Hong Kong and included 10 types of vessel. *Figures 6.1, 6.2* and *6.3* show the density maps for adult fish production, vessels and value, respectively. Based on the latest AFCD Port Survey data [(5)], the highest range of fisheries production in Hong Kong was recorded at Chek Chau, Ninepins and Po Toi Island, with a production of 600-1000 kg/ha class (*Figure 6.1*). For the Study Area, fisheries production varied widely from 0-50 in areas south of Chek Lap Kok Airport to 200-400 kg/ha for areas round the Brothers Islands (*Figure 6.1*). There was no fish fry production recorded in the Study Area. In the waters around the Brothers Island, 100-400 vessels per grid were in operation, whereas, 50-100 vessels per grid were operating in the water north of Lantau Island (*Figure 6.2*).

According to the AFCD Port Survey for 2006, the top ten adult fish families caught in Hong Kong waters were Carangidae (scad), Shrimp, Siganidae (rabbitfish), Squid, Sciaenidae (croaker) Crab, Mugilidae (mullet), Clupeidae (sardine), Sparidae (seabream) and Engraulidae (anchovy). Whereas, fish caught in the vicinity of the Brothers Islands comprised mostly of Carangidae, shrimp and Sciaenidae. The northern Lantau waters have been identified as important fisheries spawning grounds for high value commercial species, *including Leiognathus brevirostris* (ponyfish), *Lateolabrax japonicus* (sea bass/ perch) and *Clupanodon punctatus* (gizzard shad) [(6)]. The location of this spawning ground is presented in *Figure 6.4*.

(1) Agriculture, Fisheries and Conservation Department 2010 *Op cit.*

(2) Agriculture, Fisheries and Conservation Department 2010 *Op cit.*

(3) Agriculture, Fisheries and Conservation Department. Annual Report 2007-2008.

(4) Agriculture, Fisheries and Conservation Department. Annual Report 2006-2007.

(5) Agriculture, Fisheries and Conservation Department. Port Survey 2006.

(6) ERM - Hong Kong, Ltd (1998) Fisheries Resources and Fishing Operations in Hong Kong. Final Report. For the Agriculture, Fisheries and Conservation Department, Hong Kong SAR Government.

Port Survey 2006
Distribution of fisheries production (adult fish)
Overall

捕魚作業及生產訪問調查2006
漁產分布(成魚)
總計

捕 鱼 作 业 及 生 产 访 问 调 查 2006
渔 产 分 布 (成 鱼)
总 计

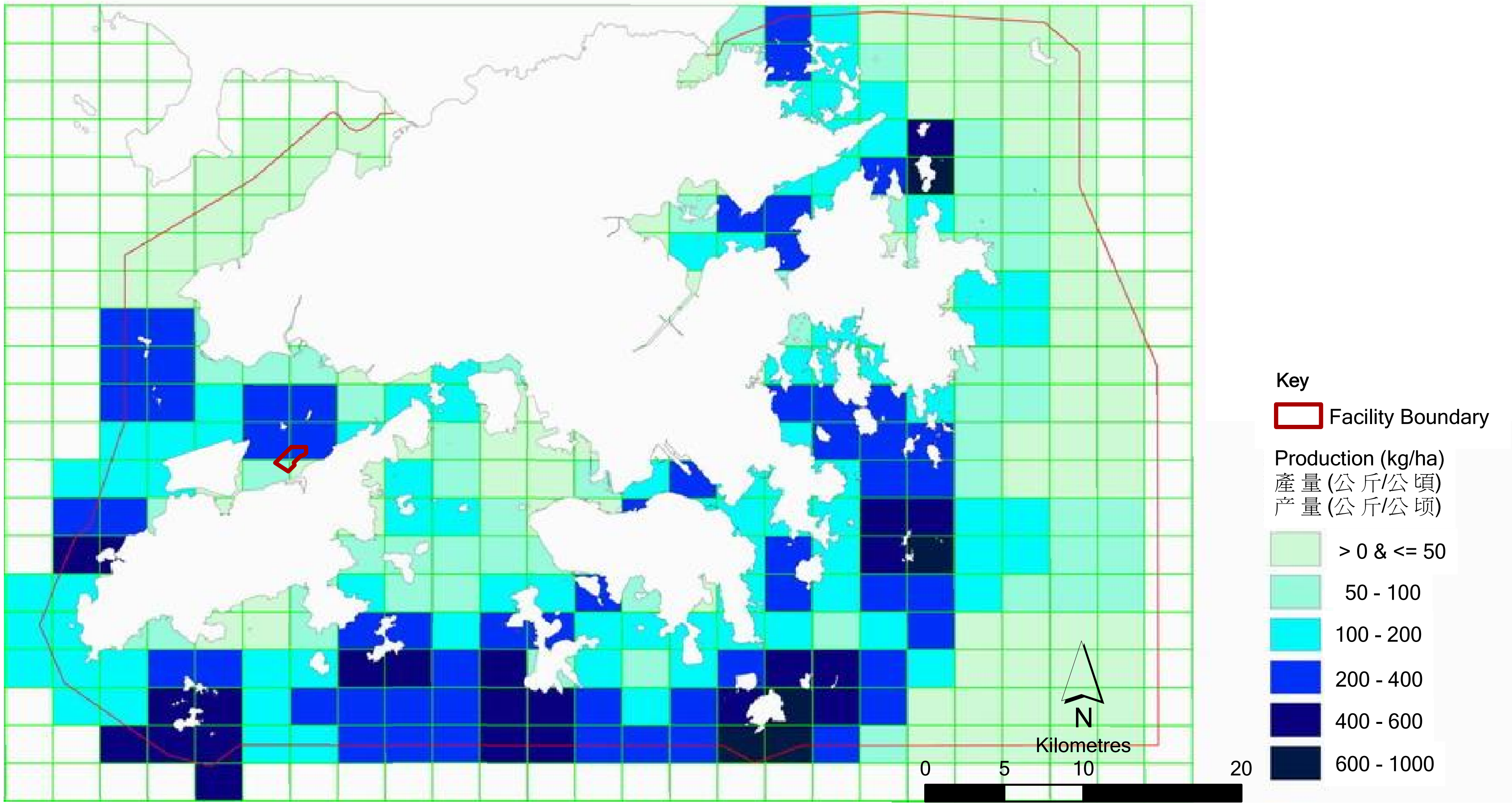


Figure 6.1

Adult Fisheries Production in Hong Kong from the AFCD Port Survey 2006

File: E2 gazatte boundary\0106271_production.mxd
Date: 31/05/2010

Environmental
Resources
Management

ERM

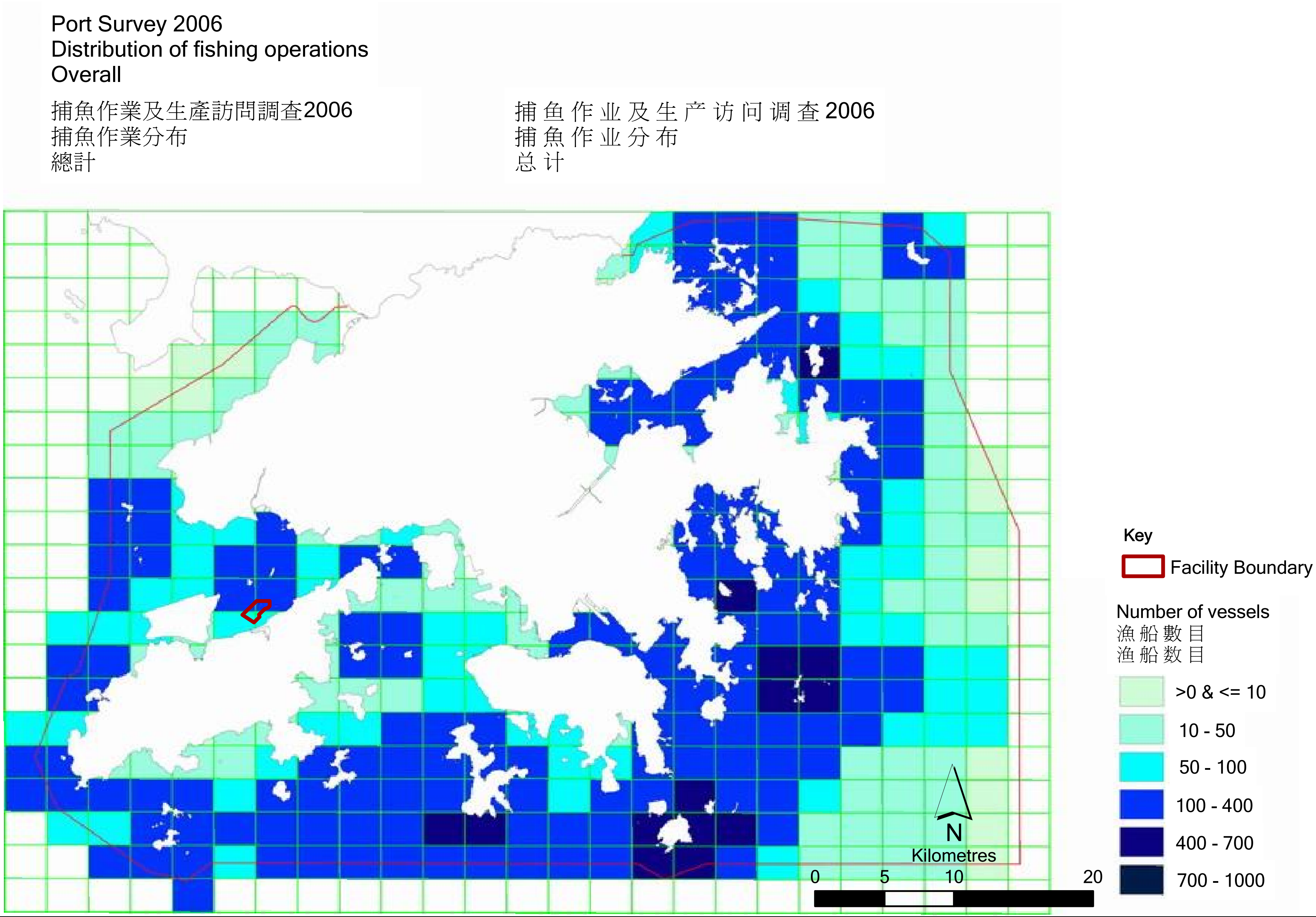


Figure 6.2

Fishing Vessel Distribution in Hong Kong from the AFCD Port Survey 2006

File: E2 gazatte boundary\0106271_vessels.mxd
Date: 31/05/2010

Environmental Resources Management

ERM

Port Survey 2006
Distribution of fisheries production (adult fish & fish fry)
Overall

捕魚作業及生產訪問調查2006
漁產分布(成魚及魚苗)
總計

捕 鱼 作 业 及 生 产 访 问 调 查 2006
渔 产 分 布 (成 鱼 及 鱼 苗)
总 计

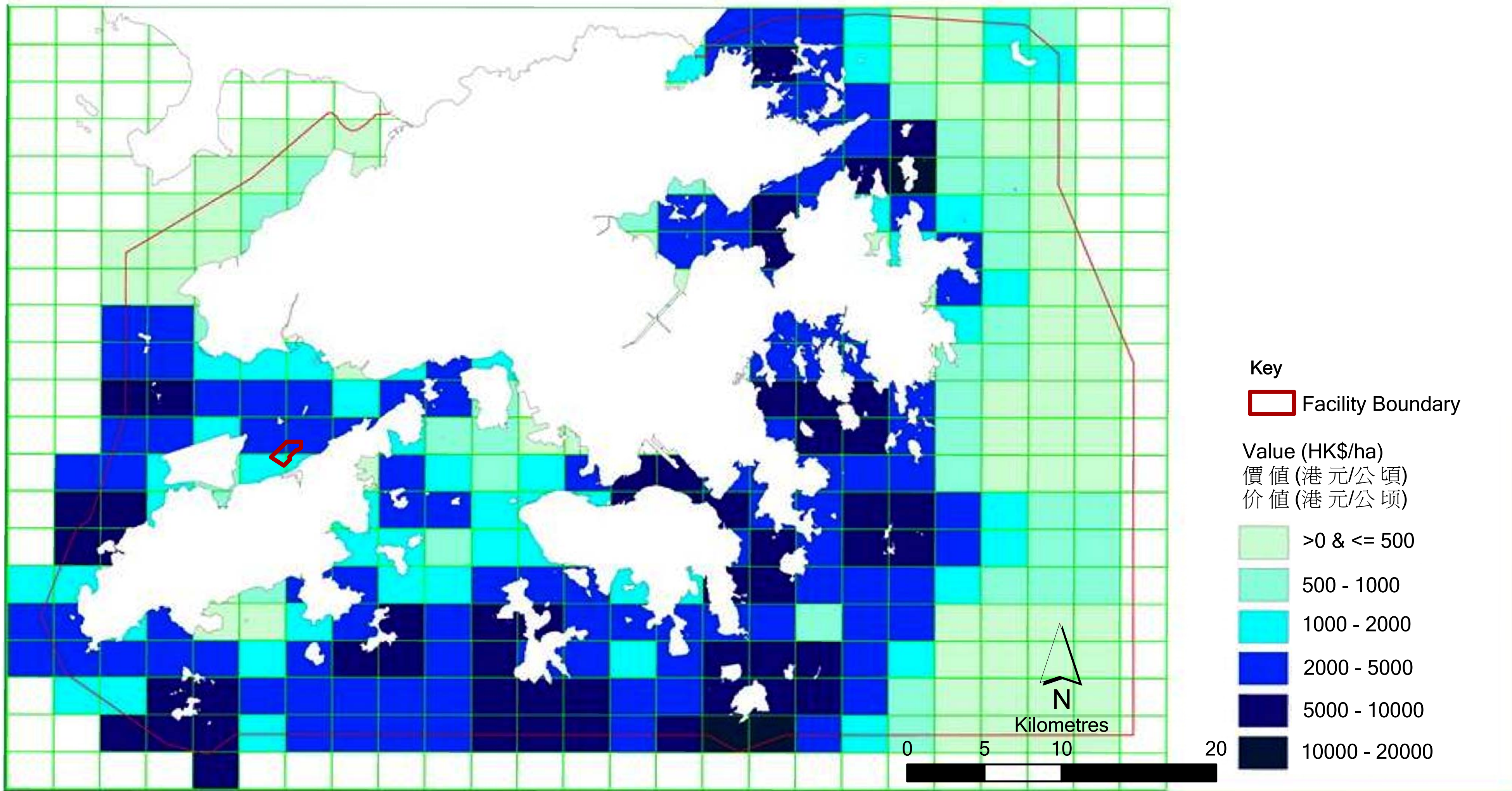


Figure 6.3

Value of Fisheries Production in Hong Kong from the AFCD Port Survey 2006

File: E2 gazatte boundary\0106271_fishing value.mxd
Date: 31/05/2010

Environmental
Resources
Management
ERM

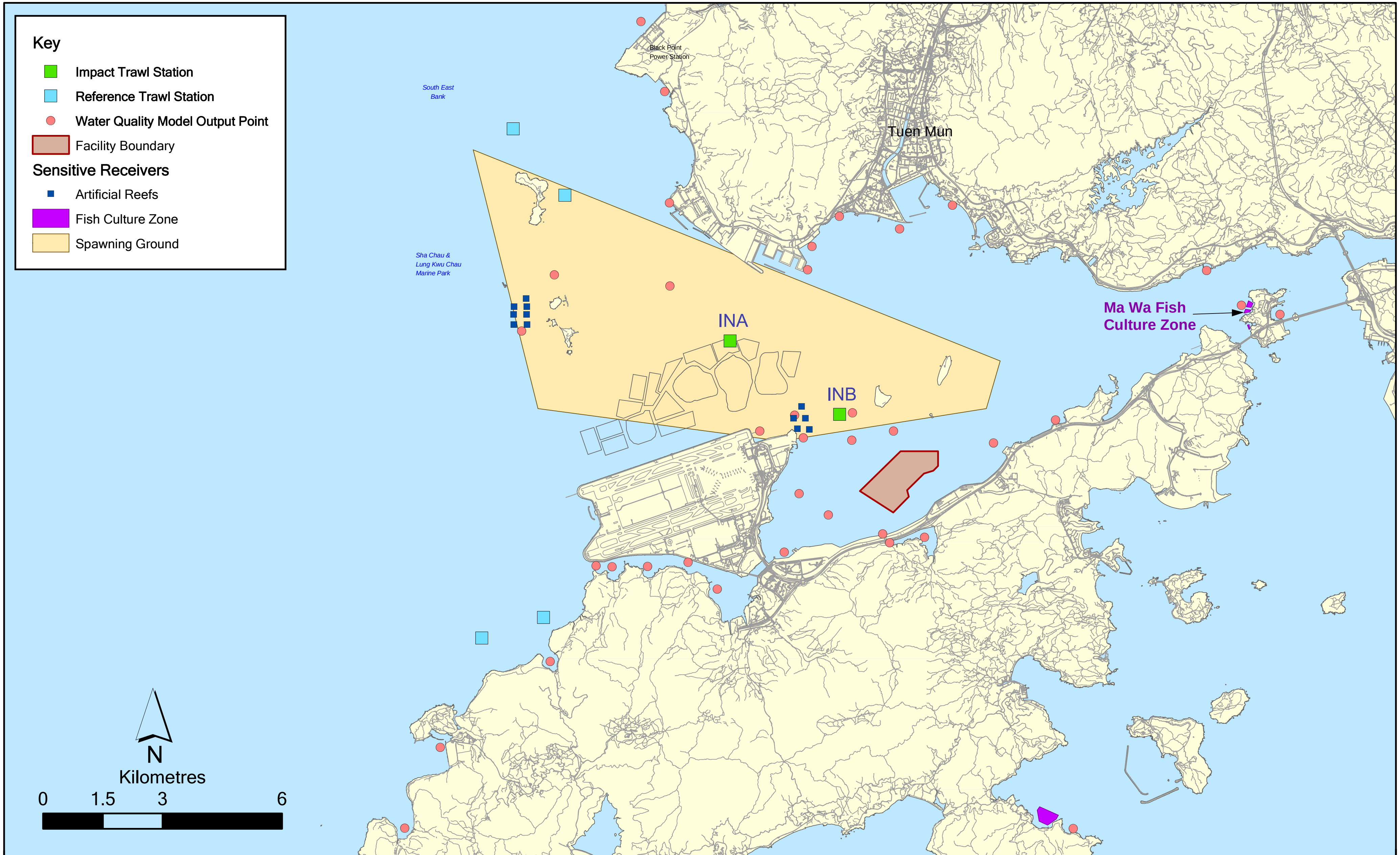


Figure 6.4

Fisheries Sensitive Receivers

File: E2 gazatte boundary\0106271_fisheries sensitive receivers.mxd
Date: 31/05/2010

Environmental Resources Management

ERM

The EM&A programme for CMPs at ESC quantitatively examined trawling catch within the Study Area. Between 2006 and 2009 samples were collected for analysis of fisheries resources abundance and composition in the wet (July and August) and dry seasons (January to March). Samples are collected for station located near the CMPs (impact) and are compared to nearby reference locations (*Figure 6.4*). Although station INB is impact station, this station is the closest to the proposed SB facility and therefore is considered to be most relevant to examine baseline conditions. The dominant species in the EM&A programme remained largely consistent through time, with the gastropod *Turritella terebra* being the dominant species for the majority of sampling events between 2006 and 2009.

6.2.2 *Culture Fisheries*

The closest AFCD designated Fish Culture Zone (FCZ) to the Study Area is located at Ma Wan, which is approximately 2.3 km from the eastern edge of the Study Area for water quality assessment (*Figure 6.4*). Information from AFCD shows the Ma Wan FCZ consists of 108 licensed floating rafts (1). The closest oyster production area is located in the Deep Bay mudflats between Tsim Bei Tsui and Ha Pak Nai, which is well beyond the area for this study and therefore, no oyster cultures will be assessed for potential impacts from the SB facility.

6.2.3 *Artificial Reefs*

As with the previously approved SB EIA, two artificial reef sites have been identified within the Study Area. One of them is located east of the Chek Lap Kok Airport within the Chek Lap Kok Marine Exclusion Zone (AR1) and the other is within the Sha Chau and Lung Kwu Chau Marine Park (*Figure 6.4*). The deployed artificial reefs provide hard surfaces for colonization of invertebrates, including barnacles, bivalves, tube worms, sponges, bryozoans and squirts (tunicates). They also provide habitats for juveniles of many commercial fish, including seabream and snapper. Both artificial reef complexes are designed to enhance fisheries resources and promote feeding opportunities for the Indo-Pacific Humpback Dolphin.

6.3 *FISHERIES SENSITIVE RECEIVERS*

The Study Area are characterised as mainly of low to moderate fisheries value, with the exception of The Brothers and Lung Kwu Sha Chau, which are of higher value. The catches from these zones were composed of juvenile mixed species, which are generally used as fish feed in mariculture.

The *EIAO TM* (*Annex 9*) states that spawning areas can be regarded as an important habitat type as they are critical to the regeneration and long term survival of many organisms and their populations. Consequently the

(1) As at May 2010, AFCD pers comm.

seasonal spawning ground in the northwestern waters can be considered as important to fisheries.

Based on the preceding review of the available information on the capture and culture fisheries of the waters of the Study Area and its immediate vicinity, the sensitive receivers which may be affected by the proposed works associated with the Project are identified as follows:

- Fish Culture Zone at Ma Wan (water quality output point WSR20);
- The seasonal spawning ground in Northwestern waters (the water quality output points within the seasonal spawning ground are WSR09a, WSR10, WSR25, WSr41 and WSR46) ; and,
- The two artificial reef complexes at the Airport and Marine Park (water quality output points WSR41 and WSR42).

No additional fisheries SRs have been identified since the previously approved EIA for SB. The locations of the fisheries sensitive receivers identified above are shown in *Figure 6.4*.

6.4 *REVIEW OF FISHERIES ASSESSMENT*

6.4.1 *Direct loss of habitat*

The construction of the SB facility will result in the direct short-term disturbance of approximately 141 ha of fishing ground, which is about 23 ha less than the previously approved design. No unacceptable impacts to the Hong Kong fishery as a result of operations at the SB facility are considered to occur, given the low to moderate importance of the area affected.

The seabed disturbance for concurrent projects in the vicinity of SB is shown in *Table 6.1*. A total of 1362 ha and 228 ha is expected to be temporally and permanently disturbed, respectively, through concurrent projects in the Northwest Lantau waters during the construction and operation of the SB facility. It should be noted that this estimate is conservative as it assumes that all projects are constructed and operated at the same time, rather than being staggered throughout lifetime of the SB pits. Nevertheless, compared to the available 165,000 ha for Hong Kong fishing waters, the loss is relatively small and is temporary. Further, that these temporary losses represent a short-term un-availability of fishing grounds to fishing operations rather than loss of fisheries resources as fishermen able to utilise other waters in Hong Kong. Little impact to fisheries from habitat loss is therefore predicted to be not significant.

It should be noted that once dredging, filling and capping works associated with the SB facility are completed, the seabed and hydrodynamic regime is expected to restore to original conditions. A review of long term monitoring in and around the existing capped pits at ESC has demonstrated that within a relatively short period of time, recolonisation of sediments occurs returning the site to a similar pre-dredged state [1] [2]. Initially capped pits will be colonised by infaunal opportunists and during the early stages of recovery and diversity is expected to be low. However, as more competitive species begin to colonise, the diversity of the infaunal, epifaunal benthic assemblages and demersal fisheries resources will increase until it returns to pre-dredged conditions.

Table 6.1 Seabed Loss (ha) from Projects Concurrent with and in the vicinity of the Construction and Operation of the South Brothers Facility (Between Mid-2011 and Mid-2015).

Type of Project	**Concurrent Project**	**Temporary Loss of Seabed**	**Permanent Loss of Seabed**
Contaminated Sediment Disposal Facility	• Capping at CMPIVc at ESC	101	-
	• Construction and operation of CMPV at ESC	106	-
Reclamations along North Lantau Coastline	• Lantau Logistics Park (LLP)	130	72
Highway	• TMCLKL and Tuen Mun Western Bypass	141	48
	• HZMB HKLR	243	30
	• HKBCF	226	138
Container Terminal	• KTCT – Container Basin & Approach Channel Dredging	415	-
Total		1,362	288

6.4.2 *Changes in Water Quality*

Modelling results of concurrent projects with the Study Area during construction and operation of the SB facility have been updated from the previous EIA report (refer to *Section 4*). As a result, there have been some changes in the predicted water quality of the Study Area. Since the concurrent projects modelled for 2011, 2012 and 2013 are predicted to be the worst-case scenarios, impacts of changes in water quality to fisheries need to be re-evaluated in relation to these scenarios. Increases in SS could potentially impact subtidal benthos, intertidal habitats (including SSSIs), corals and marine mammal (through a reduction in prey). Based upon the water quality modelling in *Section 4*, it was concluded that, assuming sufficient mitigation from concurrent projects are put in place, there are not

(1) ERM - Hong Kong, (2004) Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau (Agreement No. CE 12/2002 (EP)) - Environmental Monitoring Data Review. For the Civil Engineering Department, Hong Kong SAR Government.

(2) Qian PY, Qiu JW, Kennish R and Reid C (2003) Recolonization of benthic infauna subsequent to capping of contaminated dredged material in East Sha Chau, Hong Kong. Estuarine, Coastal and Shelf Science 56: 819-831.

predicted to be any unacceptable effects on flows or water quality in the Study Area.

Suspended Solids

Fluctuations in SS levels occur naturally in the marine environment, particularly within the influence zone of the Pearl River estuary, consequently fish have evolved behavioural adaptations to tolerate increased SS load (eg, clearing their gills by flushing water over them). However, where SS levels become excessive, fish may suffer from physical (eg. clogging of gills and feeding apparatus) and behavioural effects. Some fish will also be displaced from high SS areas as they tend to swim to clearer waters. Spawning grounds are additionally susceptible to effects on eggs and early stage life stages. The tolerance threshold of SS levels varies from species to species and at different stages of the life cycle. Although there is evidence that some local fish can tolerate SS levels as high as 5,000 mg/L, a conservative criterion of 50 mg/L for fishes has been proposed in recently approved EIA studies and will be used as the criterion here along with the WQO.

Ma Wan Fish Culture: Water quality modelling results presented in *Section 4* has shown that the maximum SS elevation at the FCZ (WSR20) as a result of backfilling operations is < 5 mg/L for all scenarios (2011, 2012 and 2013). These values do not exceed the criterion (50 mg/L) or the WQO. Impacts to the Ma Wan FCZ as a result of the backfilling works are thus unlikely to occur as the increases in SS are expected to be negligible.

Seasonal Spawning Ground: SS concentrations predicted to exceed the WQO are expected to stay within relatively close proximity to backfilling operations (*Section 4*). While there is a large spawning ground within the Study Area, the proposed SB Facility lies outside the area that is generally considered to be a seasonal spawning area for commercial fisheries resources (*Figure 6.4*). The spawning ground within the Study Area makes up the majority of central northwest Lantau waters, however impacts to these seasonal spawning grounds are expected to be low. In addition, no exceedance of the WQO for SS was predicted within the spawning ground area. All water quality modelling output points within the spawning ground (WSR 09a, 10, 25, 41 and 45) do not exceed 18 mg/L, which is below the tolerance criterion for fish (50 mg/L). It is also worth noting that SS levels on the surface layers, where most fish larvae, eggs and fry are likely to be found post-spawning, are much lower and do not exceed 11 mg/L.

Artificial Reefs: The predicted elevations of SS concentrations at the ARs (WSR41 and WSR42) as a result of the concurrent projects scenarios in 2011, 2012 and 2013 is predicted to be < 10 mg/L, which is well below the criterion of 50 mg/L for fish. As stated in *Section 4*, the water quality near the AR within the Sha Chau and Lung Kwu Chau Marine Park (WSR10) is predicted to comply with WQOs for all scenarios and will remain below 6 mg/L. In contrast, the AR near the Airport (WSR41) is predicted to exceed the WQOs in 2011, 2012 and 2013. This exceedance was also predicted for the HKBCF-

HKLR-TMCLKL EIA Reports and therefore appropriate mitigation measures outlined in these report have been suggested to minimise these impacts and are outlined below in *Section 6.5*.

Dissolved Oxygen

Depletions of DO as a result of backfilling activities have been predicted to be non-detectable and compliant with the relevant WQOs (*Section 4*). It is, thus, expected that unacceptable impacts to the fisheries resources in the vicinity of the SB facility will not occur.

Nutrients

Modelling results have indicated that the levels of nutrients are not predicted to increase appreciably from background conditions during the construction and operation operations. It is thus expected that unacceptable impacts to fisheries resources in the vicinity of the SB facility will not occur.

Contaminants

The potential for release of contaminants during disposal activities may result in an accumulation of contaminants in the tissue of fish and invertebrates resulting in sublethal effects which may affect behaviour, reproduction and increasing susceptibility to disease. In addition contaminants may cause increased mortality and sub lethal effects to, eggs, larvae and juvenile species, as these are particularly sensitive to elevated contaminant concentrations.

Contaminants that accumulate in commercially important fish species may ultimately impact human health. Investigation of these potential expected elevations in the body burden values of marine organisms has been determined through a bioaccumulation assessment in the previously approved SB EIA. Predictions from the water quality assessment (refer to *Section 4*) have indicated that the release of contaminants will cause only minor elevations in the immediate vicinity of the pits. Consequently, the bioaccumulation assessment has indicated that elevations in body burden levels are expected to be minimal. The implications of these elevations to the health of the Indo-Pacific Humpback Dolphin, *Sousa chinensis*, and human health through consumption of these organisms are discussed in *Section 7*.

In addition to the above, it is important to note that a review of long term biomonitoring data collected in the ESC area has indicated that current disposal operations are not resulting in an increase in contaminants in target species tissue levels [(1)]. As such, backfilling operations in the SB facility are also not expected to result in unacceptable impacts to fisheries resources with regard to contaminant loading.

(1) ERM - Hong Kong, (2010) Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau. Final Report. Submitted to the Civil Engineering Department, Hong Kong SAR Government.

6.4.3 *Vessel Traffic*

Fishing operations may be temporally disturbed by the increased marine traffic of working vessels for SB and for other concurrent project in the Study Area. Information from the Port Survey indicates that small vessels such as P4s mainly use the area. Given that these vessels are highly mobile it is not expected that the marine vessels will interfere with the fishing activities of the small vessel operators in this area. Given the low to moderate fisheries importance of the areas affected, any potential disturbances predicted from fishing vessels is predicted to be temporary and insignificant. No mitigation is thus required.

6.5 ASSESSMENT OF ENVIRONMENTAL IMPACTS

From the information presented above, the fisheries impact associated with the SB Facility is considered to be low. An evaluation of the impact in accordance with *Annex 9* of the *EIAO-TM* is presented below.

- *Nature of impact:* Low severity indirect impacts as a result of the dredging, backfilling and capping operations are predicted to occur in the vicinity of the pits as result of minor perturbations to water quality.
- *Size of affected area:* The construction of the SB Facility will result in the direct temporary loss of approximately 141 ha of fishing ground within northwestern Lantau waters, which is 23 ha less than the previously approved SB design. Upon completion of backfilling and capping the natural seabed will be restored and the fishing area reinstated.
- *Size of fisheries resources / production:* The construction of the SB facility will result in the direct short-term disturbance of approximately 141 ha of low to moderate importance fishing ground.
- *Destruction and disturbance of nursery and spawning grounds:* The central northwestern waters off Lantau have previously been identified as a seasonal spawning ground for commercially important species. The construction and operation of SB Facility is predicted to cause only minor disturbances to the spawning area as impacts to the surface layer, where most fish larvae, eggs and fry are likely to be found post-spawning, are minimal. Activities will be same as previous and ongoing CMP operations which have been shown to have no impacts to fisheries resources. Impacts can, therefore, be considered as of low likelihood and magnitude
- *Impact on fishing activity:* The SB Facility will be constructed and operated in area where previous and ongoing CMP operations have been undertaken for the last 15 years, as such, fishing vessel operators that frequent these waters are experienced with such operations. Furthermore, only 141 ha of fishing ground lies within will be temporally be lost as a result of the construction and operation of the SB Facility.

- *Impact on aquaculture activity:* Based on the WQOs and AFCD criteria, the Ma Wan FCZ is not predicted to be impacted by SS elevations, DO depletions or nutrient elevations as a result of the SB Facility.

6.6 *MITIGATION MEASURES*

In accordance with the guidelines in the *EIAO-TM* on fisheries impact assessment the general policy for mitigating impacts to fisheries, in order of priority, are avoidance, minimization and compensation.

Impacts to fisheries resources and fishing operations have largely been minimised during construction and operation of the SB facility through constraints on backfilling and dredging activities. These constraints were outlined in *Section 4.6* to control water quality impacts to within acceptable levels and are also expected to control impacts to fisheries resources. This includes the plan to replace the ARs near the Airport as a compensation of the disturbance by the HKBCF reclamation works (refer to *Section 4.6* for details. Hence, no fisheries-specific mitigation measures are required during construction and operation of the SB facility.

6.7 *RESIDUAL IMPACTS*

The only residual impact identified that may affect commercial fishing operations as a result of the construction and operation of the SB facility is the disturbance to fishing activities during the lifetime of the mud disposal facility. However, the severity of this residual impact is predicted to be no greater than during previous or ongoing mud disposal activities at ESC which has shown no adverse impacts to fisheries (1) and will be less than that outlined in the previously approved EIA for SB.

6.8 *ENVIRONMENTAL MONITORING & AUDIT (EM&A)*

The construction and operation of the proposed SB facility has been shown to proceed at rates that maintain environmental impacts to within acceptable levels. Actual impacts during the works will be monitored through a detailed Environmental Monitoring and Audit (EM&A) programme. Full details of the EM&A programme are presented in the EM&A Manual which has been based on the on-going and previous monitoring programmes conducted at the Contaminated Mud Disposal Facility at ESC. This programme will provide management actions and supplemental mitigation measures to be employed should impacts arise, thereby ensuring the environmental acceptability of the SB facility.

(1) ERM - Hong Kong (2004) *Op cit.*

6.9 CONCLUSIONS

Reviews of existing information on commercial fisheries resources and fishing operations located within the Study Area have been undertaken. Information from a study on fishing operations in Hong Kong and the AFCD Port Surveys indicate that fisheries production values in the vicinity of the SB facility vary but are low to moderate.

The construction of the SB facility will result in the direct short-term disturbance of approximately 141 ha of fishing ground. No unacceptable impacts to the Hong Kong fishery as a result of this short-term disturbance are expected to occur, given the low to moderate importance of the area affected. The construction and operation of the SB facility with concurrent projects in the vicinity may give rise to temporary fisheries impacts from disturbances to benthic habitats, changes in water quality and contaminant release. Disturbances to benthic habitats are predicted to be confined within the pit boundaries of the SB facility, and recolonisation of sediments is expected to occur following completion of works. As changes in water quality are minimal and transient, significant adverse impacts to fisheries resources are not predicted to arise. Assessment of contaminant release has indicated that the concentrations will be minimal and well within the relevant criteria.

While no special mitigation measures are required for fisheries resources, mitigation measures recommended to reduce impacts to water quality are also expected to mitigate any impacts to fisheries resources.

7 *HAZARD TO HEALTH*

7.1 *INTRODUCTION*

It has been identified in the *Initial Review Report* of this Study that the following attributes of the approved EIA report of the SB facility would be updated and/ or verified as part of this EIA review:

- Baseline literature and data to be updated; and
- Potential risks to humans and marine mammals associated with consuming seafood from the Project Area should be re-assessed, based on changes to the bioaccumulation assessment.

As recommended in the *Initial Review Report*, the methodologies for the above update/ verification would be by a desktop review of available up-to-date information, e.g. published literature and data presented in recently approved EIA reports. This Section presents the outcomes of the proposed update/ verification.

7.2 *UPDATE OF BIOACCUMULATION ASSESSMENT & BASELINE LITERATURE*

The bioaccumulation assessment presented in the previously approved EIA report for SB has been updated using recently available data from the environmental monitoring and audit programmes of the East of Sha Chau CMP IVc (*CE 19/2004*). A baseline literature and data review has also been undertaken as part of this update. Results of the bioaccumulation assessment are presented in *Appendix A* of *Annex C* of this Report.

7.3 *REVIEW OF HAZARD TO HEALTH ASSESSMENT*

The objective of the risk assessment is to determine whether disposal operations at SB are predicted to pose unacceptable risk to humans and dolphins. The assessment considers the effects of the consumption of seafood and marine prey species by humans and the Indo-Pacific humpback dolphin *Sousa chinensis* respectively. Predicted concentrations of contaminants of concern (COCs) from the bioaccumulation assessment (*Appendix A* of *Annex C*) are used as the basis for the analysis.

While concentrations of COCs from the bioaccumulation assessment have been updated as part of this EIA review, there are also new data on other input into the risk model, such as fisheries catch in the Study Area, seafood consumption rates of Hong Kong populations, and exposure duration of COCs.

Annex C describes the methodology used for this risk assessment. This methodology is the same as those used in the previously approved SB EIA and in the annual risk assessments undertaken as part of the environmental monitoring and audit programmes of the East of Sha Chau CMP IVc (*CE 19/2004*).

7.4 HUMAN HEALTH RISK ASSESSMENT

The intent of this evaluation is to determine the potential risks to various populations of Hong Kong, resulting from dredged material disposal at the proposed SB Contaminated Sediment Disposal Facility. The exposure pathway is assumed to be consumption of contaminated food by members of the various populations included in the assessment:

- Population 1 – **Hong Kong people** in general: this represented the average exposure to seafood from the Study Area by members of the Hong Kong population as a whole;
- Population 2 – **Hong Kong fishermen**: this population reflected the high end of risk and was considered to represent members of the Hong Kong fishing community; and
- Population 3 – **South Brothers fishermen**: this population represented the absolute highest risk of exposure to the seafood at South Brothers and was considered as representative of members of the fishing community that fish within the Study Area.

The methodology is designed to provide a conservative estimate of the risks to these populations. As discussed in *Annex C* the evaluation has been conducted in order to provide two estimates of risk:

- Carcinogenic risk to the three populations through the consumption of contaminated seafood. The contaminants assessed in this way are those where carcinogenic effects have been demonstrated and an oral Slope Factor (SF) is known. *Annex C* presents the list of known carcinogens along with their SFs and the relevant source data.
- An estimate of the hazard (i.e. non-carcinogenic risk) to each population through the consumption of contaminated seafood. The contaminants assessed in this way are those where hazardous effects have been demonstrated and a Reference Dose (RfD) is known. *Annex C* presents the list of known hazardous substances along with their RfDs and the relevant source data.

Several of the organic contaminants, including Low MW PAH and High MW PAH, were consistently recorded below the detection limits in marine biomonitoring programmes [1]. For this reason these two COCs were not included as part of this assessment. All of the inorganic contaminants listed in *ETWB TC(W) 34/2002* have been included in the assessment.

7.4.1 *Carcinogenic Risk Assessment*

Carcinogenic risk may be defined as the intake multiplied by the carcinogenic Slope Factor (SF). The resultant value reflects the additional lifetime carcinogenic risk from exposure to the particular COC. The intake is measured in terms of mg kg^{-1} (body weight) day^{-1} and has been calculated as described in *Annex C*.

The majority of the SF values for each of the COCs were taken from the US EPA's IRIS database [2], as discussed in *Annex C* of this report. As discussed in *Annex C*, the assessment of risk associated with the intake of carcinogens in the edible portion of seafood is calculated over the entire lifetime of the members of the population of concern.

Values for lifetime risk have been calculated for each COC and are summed to provide an estimate of the Total Lifetime Risk to which each of the populations of concern is exposed. The justification for use of an additive approach is presented in *Annex C*. Once the lifetime risk has been calculated the next step is to evaluate the magnitude of acceptability of the risk. At present the US EPA has defined acceptable lifetime risks for carcinogens as within the range of 10^{-4} to 10^{-6} for multiple contaminants and 10^{-4} for single contaminants. Higher risks have, however, been deemed acceptable if there were special extenuating circumstances [3].

The Hong Kong EPD has published in the *Technical Memorandum on the EIA Process* guidelines for acceptable levels of individual risk [4]. EPD states that the maximum level of off site individual risk should not exceed 1 in 100,000 per year ie 1×10^{-5} $year^{-1}$. Using the estimate for Life Expectancy (*Annex C*) of 70 years, the EPD criteria equates to an acceptable lifetime risk of 7×10^{-4} $year^{-1}$ which is commonly rounded to 1×10^{-3} $year^{-1}$. The criterion for risk due to an individual toxic contaminant is the equivalent of 1×10^{-4} $year^{-1}$. Whilst it is acknowledged that these guidelines are provided for the assessment of impact to air quality, it is considered appropriate to apply them to other environmental contamination issues.

(1) There is a lack of bioaccumulation and bioconcentration factors available in the literature for TBT and it is therefore not included in the Risk Assessment. This limitation does not limit the conservative nature of the assessment because background levels of TBT in sediment and dredged materials around the East of Sha Chau area are generally undetectable or very low. This statement is backed up by monitoring data collected at CMP IV since 1997 which has consistently recorded TBT in sediment and tissue samples below levels of concern.

(2) United States Environmental Protection Agency (US EPA) Integrated Risk Information System (IRIS) < http://www.epa.gov/ncea/iris/>

(3) LaGrega MD, Buckingham PL, Evans JC, ERM Group (1994) Hazardous Waste Management. McGraw-Hill Inc, 1146 pp

(4) Annex 4, Technical Memorandum, Environmental Impact Assessment Ordinance, Environmental Protection Department, HKSAR Government

Results

The lifetime risk values calculated from the predicted COC concentrations at the proposed SB facility are presented in *Table 7.1* for populations exposed for four years. Intakes and Carcinogenic Risks were only calculated for contaminants that had an oral Slope Factor (see *Table 1.3* of *Annex C*).

The lifetime risk of all COCs did not exceed the EPD single contaminant criterion for either the Background or SB values for all the populations. No exceedances in the total risk were also observed for any of the populations in either Background or SB values.

Table 7.1 Calculations of Carcinogenic Risk Levels (contaminant intake from seafood using mg kg^{-1} day^{-1} using Exposure Duration of 4 years)

COC	**Oral Slope Factor (mg kg^{-1} day^{-1})**	**Lifetime Risk**		
		HK People	**HK Fishermen**	**South Brothers Fishermen**
Background				
Arsenic	1.5	1.07×10^{-8}	3.19×10^{-7}	1.94×10^{-6}
Lead	0.0085	8.83×10^{-11}	2.71×10^{-9}	1.64×10^{-8}
PCBs	2.0	7.44×10^{-10}	2.30×10^{-8}	1.39×10^{-7}
Total Lifetime Risk		$\mathbf{1.15 \times 10^{-8}}$	$\mathbf{3.45 \times 10^{-7}}$	$\mathbf{2.09 \times 10^{-6}}$
South Brothers				
Arsenic	1.5	1.07×10^{-8}	3.20×10^{-7}	1.94×10^{-6}
Lead	0.0085	9.22×10^{-11}	2.82×10^{-9}	1.71×10^{-8}
PCBs	2.0	2.97×10^{-8}	8.93×10^{-7}	5.42×10^{-6}
Total Lifetime Risk		$\mathbf{4.05 \times 10^{-8}}$	$\mathbf{1.22 \times 10^{-6}}$	$\mathbf{7.38 \times 10^{-6}}$

7.4.2 *Hazard Assessment (Non-carcinogens)*

The measure used to establish the risk of toxic effects by non-carcinogenic substances is referred to as the **Hazard Quotient (HQ)**. The HQ is composed of two components:

- the daily intake of the particular COC from all dietary sources measured in terms of mg kg^{-1} (body weight) day^{-1} and used as the numerator; and
- the recommended Reference Dose (RfD) which is used as the denominator.

The RfD values for each of the COCs were taken from the US EPA's IRIS database (discussed in *Annex C*) of this report. The calculation of the HQ involves dividing the daily intake value (dose) by the RfD value (discussed in *Annex C*). According to the relevant guidelines [1] [2], HQs can be interpreted in a conservative risk assessment as follows:

(1) US EPA (1989) Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish. A Guidance Manual. EPA-503/8-89/002

(2) EVS (1996) Contaminated Mud Disposal at East Sha Chau: Comparative Integrated Risk Assessment. Prepared for the Hong Kong Civil Engineering Department

HQ < 1 the risk of an adverse effect occurring is low (as the intake of the COC is lower than the RfD);

HQ 1 to 10 there is some risk of an adverse effect occurring, however, typically within the bounds of uncertainty; and

HQ > 10 the risk of adverse effects on human health is moderate to high (depending on the HQ) as the intake of COCs is an order of magnitude, or more, higher than the RfD.

As can be seen from the above ranges, the greater the value of the HQ the greater the level of concern. However, it should be noted that the HQ does not define a linear dose-response relationship and therefore the numerical value should not be regarded as a direct estimate of risk (1). It is especially important to note that a Hazard Quotient exceeding 1 does not necessarily mean that adverse effects will occur. HQs are specific to each particular COC and do not provide an indication of the total hazard to the population of concern through intake of all the COCs in their diet. The approach used to address this, as discussed in *Annex C*, will be additive and consequently is considered a conservative method. The sum of all the HQs for each COC is referred to as the Hazard Index (HI). The HI is interpreted in the same way as described for HQs above.

Results

Once the RfD values and intake values were obtained for each COC, the HQs were calculated for all the three populations of concern in both SB and Background areas (South Brothers Fishermen, Hong Kong Fishermen and Hong Kong People) (*Table 7.2*). HQ values for all of the COCs in both Background and SB areas were less than one for all the three populations. The summation of the HQ values to produce the HI also indicates that for both areas the HI was less than one.

Table 7.2 ***Calculation of Hazard Quotients for Populations of Concern (contaminant intake from seafood using mg kg^{-1} day^{-1} using Exposure Duration of 4 years)***

COC	**Oral RfD (mg kg^{-1} day^{-1})**	**Hazard Quotient**		
		HK People	**HK Fishermen**	**South Brothers Fishermen**
Background				
Arsenic	0.0003	4.15×10^{-4}	1.24×10^{-2}	7.54×10^{-2}
Cadmium	0.001	3.21×10^{-5}	1.07×10^{-3}	6.50×10^{-3}
Chromium	0.003	1.93×10^{-5}	5.80×10^{-4}	3.52×10^{-3}
Copper	0.043	4.15×10^{-5}	1.44×10^{-3}	8.71×10^{-3}
Lead	0.00143	1.27×10^{-4}	3.90×10^{-3}	2.36×10^{-2}
Mercury	0.00022	4.11×10^{-4}	1.26×10^{-2}	7.62×10^{-2}
Nickel	0.02	1.14×10^{-5}	2.58×10^{-4}	1.57×10^{-3}

(1) US EPA (1989) Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish. A Guidance Manual. EPA-503/8-89/002

COC	Oral RfD (mg kg^{-1} day^{-1})	Hazard Quotient		
		HK People	HK Fishermen	South Brothers Fishermen
Silver	0.005	7.28 x 10^{-6}	2.32 x 10^{-4}	1.41 x 10^{-3}
Zinc	0.3	6.17 x 10^{-5}	1.92 x 10^{-3}	1.17 x 10^{-2}
	Hazard Index	**1.13 x 10^{-3}**	**3.44 x 10^{-2}**	**2.09 x 10^{-1}**
South Brothers				
Arsenic	0.0003	4.15 x 10^{-4}	1.24 x 10^{-2}	7.54 x 10^{-2}
Cadmium	0.001	1.07 x 10^{-4}	4.41 x 10^{-3}	2.68 x 10^{-2}
Chromium	0.003	2.80 x 10^{-5}	8.45 x 10^{-4}	5.12 x 10^{-3}
Copper	0.043	4.32 x 10^{-5}	1.49 x 10^{-3}	9.02 x 10^{-3}
Lead	0.00143	1.33 x 10^{-4}	4.07 x 10^{-3}	2.47 x 10^{-2}
Mercury	0.00022	5.41 x 10^{-4}	1.77 x 10^{-2}	1.07 x 10^{-1}
Nickel	0.02	1.17 x 10^{-5}	2.65 x 10^{-4}	1.61 x 10^{-3}
Silver	0.005	7.39 x 10^{-6}	2.35 x 10^{-4}	1.43 x 10^{-3}
Zinc	0.3	8.04 x 10^{-5}	2.75 x 10^{-3}	1.67 x 10^{-2}
	Hazard Index	**1.37 x 10^{-3}**	**4.41 x 10^{-2}**	**2.68 x 10^{-1}**

The exposure pathway examined in this risk assessment is focussed on exposure to COCs via ingestion of seafood from within a specific area only. It is acknowledged that other pathways, such as other seafood sources and foods other than seafood will also expose the study populations to the COCs and thereby could affect the HI value. Hence chemicals with a HQ (as well as the HI) of less than one do not necessarily imply that there is no risk.

Concerning the South Brothers fishermen subpopulation, the HI value for the South Brothers is 0.268 of which 28% is related to Arsenic and 40% due to Mercury. It is noted that exposure to Arsenic and Mercury from other pathways, such as via air (inhalation), water (drinking) and dermal contact are minor when compared to the diet and of the diet seafood contains the largest source of these COCs (1).

7.5 *MARINE MAMMAL RISK ASSESSMENT*

As previously discussed, the intent of this evaluation is to provide a determination of the potential risks to the Indo-Pacific humpback dolphin population in the waters of Hong Kong, resulting from dredged material disposal in the proposed South Brothers Facility. The exposure pathway has been assumed to be consumption of contaminated food by dolphins residing in potentially impacted areas near the mud pits, and in an area representative of background conditions.

It was assumed that dolphins may consume a variety of species. Therefore, the COC concentration in prey item is a function of the concentration of each contaminant in the various prey species as well as the fraction of the dolphin's

(1) FEHD (2002) Dietary Exposure to Heavy Metals of Secondary School Students. Food and Environmental hygiene Department, HKSARG.

diet comprised of the individual species. Two dietary scenarios were evaluated:

- Expected Diet (Exp): the diet consists of 50 % pelagic fish and 50 % predatory fish; and
- Average Diet (Ave): the diet consists of 20 % pelagic fish, 20 % predatory fish, 20 % predatory crab, 20 % predatory shrimp and 20 % molluscs.

This methodology is designed to provide a conservative estimate of the risks associated with potential dietary scenarios of the Indo-Pacific humpback dolphins.

As discussed in *Annex C*, estimates of risk were determined by dividing the estimated dose by the **Toxicity Reference Value (TRV)** to derive a **Hazard Quotient (HQ)**. *Annex C* presents the list of COCs along with their TRVs and the relevant source data. An HQ exceeding 1 indicates the potential for systemic toxicity to the exposed organism.

The HQ values calculated from the predicted COC concentrations at the proposed SB facility are presented in *Table 7.3*. HQ values for all of the COCs in both Background and SB areas were less than one for both dietary scenarios. The summation of the HQ values to produce the HI also indicates that for both areas and dietary scenarios the HI was less than one.

Table 7.3 Estimate of Risk to the Indo-Pacific Humpback Dolphin in South Brothers and Background area resulting from consumption of prey species (Contaminant intake from seafood using mg kg^{-1} day^{-1} using Exposure Duration of 4 years)

COC	TRV	Hazard Quotient	
		HQ_{exp}	**HQ_{ave}**
Background			
Arsenic	0.01	0.2401	0.3147
Cadmium	0.2	0.0025	0.0235
Chromium	570	0.0000	0.0000
Copper	3.17	0.0071	0.1649
Lead	1.67	0.0023	0.0093
Mercury	0.27	0.0071	0.0050
Nickel	8.34	0.0003	0.0462
Silver	0.04	0.0144	0.2530
Zinc	33.37	0.0112	0.0426
Total PCBs	0.04	0.0036	0.0023
	Hazard Index	**0.2886**	**0.8615**
South Brothers			
Arsenic	0.01	0.0600	0.0787
Cadmium	0.2	0.0006	0.0219
Chromium	570	0.0000	0.0000
Copper	3.17	0.0019	0.0413
Lead	1.67	0.0006	0.0024

COC	TRV	Hazard Quotient	
		HQ_{exp}	HQ_{ave}
Mercury	0.27	0.0020	0.0067
Nickel	8.34	0.0001	0.0116
Silver	0.04	0.0037	0.0654
Zinc	33.37	0.0028	0.0283
Total PCBs	0.04	0.0323	0.0192
	Hazard Index	**0.1040**	**0.2755**

7.6 *CONCLUSIONS*

7.6.1 *Human Health Risk Assessment*

The risk assessment work conducted for this Study has employed two approaches to predict the effects on human health of consuming seafood collected from the SB area. The first approach examined the risks associated with exposure to carcinogens and the second examined the hazards to human health associated with exposure to non-carcinogens. Three populations with differing potential to be exposed to seafood from the South Brothers area were examined, namely *Hong Kong People, Hong Kong Fishermen* and *South Brothers Fishermen*.

The carcinogenic risk assessment has indicated that lifetime risks associated with consumption of seafood were within the acceptability criteria for both the SB and the Background areas for all three populations.

Results of the hazard (ie non-carcinogenic) assessment indicated that the risk of an adverse effect occurring from consuming seafood collected at South Brothers is low and comparable with the Background area. It is important to note that the consumption of seafood from both the South Brothers and Background areas are not predicted to pose unacceptable public health risks to all three populations.

7.6.2 *Marine Mammal Risk Assessment*

The marine mammal risk assessment examined the potential risks to the Indo-Pacific humpback dolphin population in the waters of Hong Kong, resulting from the consumption of prey items potentially bioaccumulating COCs at the proposed South Brothers facility. Two dietary scenarios of the dolphin were considered and the associated doses and hazard evaluated.

Results of the assessment indicated that the risks of an adverse effect in Indo-Pacific humpback dolphins associated with the consumption of prey items collected at South Brothers is low and is significantly lower than those from the Background area. It is important to note that the consumption of prey from both the South Brothers and Background areas are not predicted to pose unacceptable risks and systematic toxicity to dolphins under both dietary scenarios.

8 NOISE

8.1 INTRODUCTION

It has been identified and agreed in the *Initial Review Report* of this Study that the following attributes of the approved EIA report of the SB facility would be updated and/ or verified as part of this EIA review:

- Sensitive Receivers to be re-examined; and
- Potential noise impacts, specifically the cumulative impacts arising from other committed concurrent projects, to be re-assessed.

The assessment of other concerns related to the SB facility have been addressed in the approved EIA report and based on an initial review of these findings, no further updates were considered necessary.

As recommended in the *Initial Review Report*, the methodologies for the above update/ verification would be by a desktop review of available up-to-date information, e.g. data presented in recently approved EIA reports. This Section presents the outcomes of the proposed update/ verification.

As indicated in *Section 2.4.2*, the Project may interact with the following concurrent projects:

- Contaminated Mud Pits (CMPs) at ESC (Pits IVc and V)
- Tuen Mun – Chek Lap Kok Link (TM-CLKL) and Tuen Mun Western Bypass
- Hong Kong – Zhuhai – Macao Bridge (HZMB) Hong Kong Link Road (HKLR) (formerly known as North Lantau Highway Connection to the Hong Kong – Zhuhai – Macao Bridge)
- HZMB Hong Kong Boundary Crossing Facilities (HKBCF)
- Pillar Point Sewage Treatment Work (STW)
- Kwai Tsing Container Terminals (KTCT) – Container Basin & Approach Channel Dredging

Among the above concurrent projects, CMPs at ESC, HZMB, western part of the HKLR, STW and KTCT are more than 5 km away from the SB facility, and HKI&I of CEDD has confirmed that the Lantau Logistic Park (LLP) are expected to commence in end 2015 the earliest which will not be constructed concurrently with the SB facility, therefore these projects are not included in the calculation of cumulative noise impacts.

Cumulative noise impacts were assessed for TM-CLKL, part of HKLR along east of the Hong Kong International Airport (HKIA) and HKBCF. The construction programme, plant inventory and the separation distances between the representative NSRs and the work sites for the above-mentioned concurrent projects are based on the information presented in the approved HKBCF and TM-CLKL EIAs *(Register Number: AEIAR-145/2009* and *AEIAR-146/2009*, respectively*)*.

8.2 REVIEW OF NOISE SENSITIVE RECEIVERS

The locations of the existing and planned Noise Sensitive Receivers (NSRs) identified in the approved EIA report, HKBCF and TM-CLKL EIAs are presented in *Figure 8.1*. Descriptions of the NSRs and the representative NSRs selected for assessment in this *EIA Review Report* are summarised in *Table 8.1*.

Table 8.1 Noise Sensitive Receivers

Ref. ID in Approved EIA	Representative NSR for this EIA Review Report	Description	Use
N1(1)	-(4)	Regal Airport Hotel	Hotel
N2(1)/126(2)	N2	Tung Chung Crescent III - Seaview Crescent	Residential
N3(1)/147(2)	N3	Caribbean Coast Phase 1 - Monterey Cove	Residential
N4(1)	N4	Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	Residential
N5(1)/149(2)	N5	Ho Yu Secondary School	School
N6(1)	N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	Residential
136(2)	N7	Coastal Skyline Phase 4 - Le Bleu Deux	Residential
NSR1(3)	N8	Pak Mong Village House	Residential

Notes:

(1) Relevant representative NSR identified in the approved EIA report *(Register No.: AEIAR-089/2005)*

(2) Relevant representative NSR identified in the approved HKBCF EIA *(Register No.: AEIAR-145/2009)*

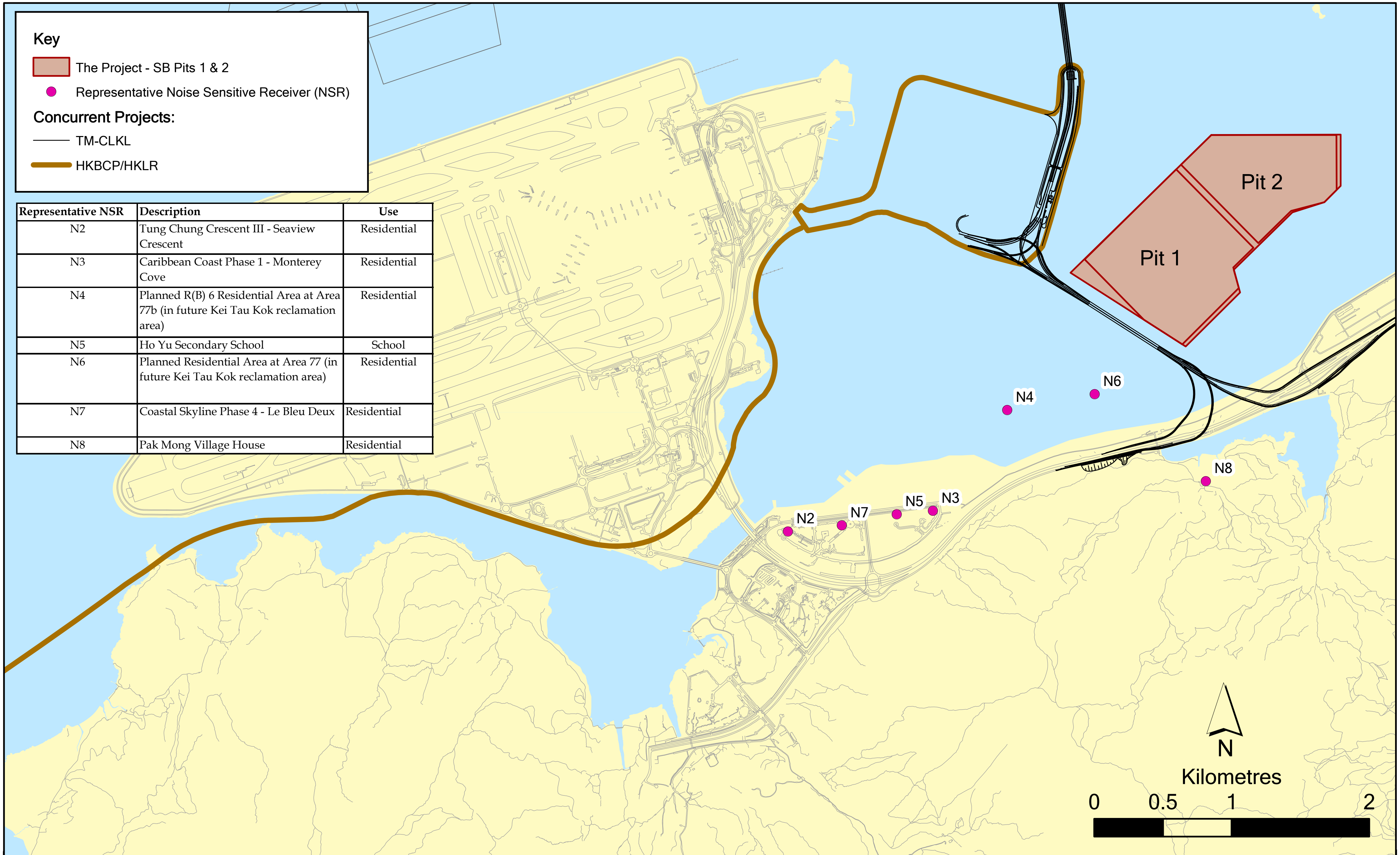
(3) Relevant representative NSR identified in the approved TM-CLKL EIA *(Register No.: AEIAR-146/2009)*

(4) Regal Airport Hotel is equipped with central air-conditioning system and does not rely on openable windows for ventilation. It is not considered as noise-sensitive, and therefore, not selected as a representative NSR for assessment in this *EIA Review Report*.

8.3 REVIEW OF NOISE ASSESSMENT – CUMULATIVE IMPACTS

8.3.1 *Methodology for the Noise Review*

The methodology of the noise assessment and the applicable noise criteria are the same as that used in the approved EIA report.



Representative NSR	Description	Use
N2	Tung Chung Crescent III - Seaview Crescent	Residential
N3	Caribbean Coast Phase 1 - Monterey Cove	Residential
N4	Planned R(B) 6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	Residential
N5	Ho Yu Secondary School	School
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	Residential
N7	Coastal Skyline Phase 4 - Le Bleu Deux	Residential
N8	Pak Mong Village House	Residential

Figure 8.1

Locations of Representative Noise Sensitive Receivers for the Project

File: 0106271_NSR_gazette boundary_2.mxd
Date: 28/05/2010

Environmental Resources Management

ERM

It has been assumed that 6 grab dredgers, 7 barges and 7 tug boats will be deployed on-site for dredging work, 2 barges and 2 tug boats for backfilling, and 2 barges and 2 tug boats for capping activity.

Noise assessments at the representative NSRs were updated based on the tentative works programme shown in *Figure 2.1*, Powered mechanical equipment (PME) list and corresponding Sound Power Level, distances attenuation, atmospheric absorption (1) and façade reflection. Since construction works during restricted hours may be required, the assessment results were compared against the *EIAO-TM* daytime (non-restricted hours) and the evening and night-time restricted hours criteria. As the construction programmes of HKBCF, HKLR and TM-CLKL indicate that no construction works will be carried out during restricted hours, cumulative noise impacts associated with these concurrent projects were assessed for daytime period only.

8.3.2 Results of the Noise Review

The predicted noise levels are summarised in *Tables 8.2* and *8.3* with detailed calculations presented in *Annex D*.

Table 8.2 Predicted Noise Levels during Daytime Period (Non-restricted Hours, Without Mitigation)

NSR	Description	Area Sensitivity Rating (1)	Noise Criteria, $L_{eq, 30 min}$ dB(A)	Predicted Noise Levels due to the Project, dB(A)	Cumulative Noise Levels, dB(A)
N2	Tung Chung Crescent III - Seaview Crescent	B	75	31 – 40	59 – 71
N3	Caribbean Coast Phase 1 - Monterey Cove	B	75	37 – 45	56 – 67
N4	Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	B	75	44 – 53	55 – 66
N5	Ho Yu Secondary School	B	70/65 (2)	35 – 44	54 – 66 (3)
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	B	75	48 – 59	59 – 69
N7	Coastal Skyline Phase 4 - Le Bleu Deux	B	75	33 – 42	57 – 69

(1) With reference to the 2005 approved EIA under the *Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/ East of Sha Chau Area (Agreement No. CE 12/2002(EP))* (*EIA Register No.: AEIAR-089/2005*), atmospheric absorption was included in calculation for works sites of the SB facility only

NSR	Description	Area Sensitivity Rating (1)	Noise Criteria, $L_{eq, 30 min}$ dB(A)	Predicted Noise Levels due to the Project, dB(A)	Cumulative Noise Levels, dB(A)
N8	Pak Mong Village House	A	75	45 – 54	58 – 74

Notes:

(1) Area Sensitive Rating is assumed in accordance with the GW-TM. Reference has also been made from the approved EIA report and approved HKBCF and TM-CLKL EIAs.

(2) Noise criteria during normal school days / examination period.

(3) The predicted cumulative noise level of 66dB(A) is expected from July 2010 to September 2010. This period shall be the summer holiday and normal school days. The predicted noise level would, therefore, comply with the noise criteria during normal school days and no exceedance of the noise criteria during examination period is anticipated.

Table 8.3 Predicted Noise Levels during Evening and Night-time Period (Restricted Hours, Without Mitigation)

NSR	Description	Area Sensitivity Rating (1)	Noise Criteria, $L_{eq, 5 min}$ dB(A) (2)	Predicted Noise Levels due to the Project, dB(A) (2)
N2	Tung Chung Crescent III - Seaview Crescent	B	65/50	31 – 40 /31 – 40
N3	Caribbean Coast Phase 1 - Monterey Cove	B	65/50	37 – 45 /37 – 45
N4	Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	B	65/50	44 – 53 /44 – **53** (3)
N5	Ho Yu Secondary School	B	-	35 – 44 /35 – 44
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	B	65/50	48 – 59 /48 – **59** (3)
N7	Coastal Skyline Phase 4 - Le Bleu Deux	B	65/50	33 – 42 /33 – 42
N8	Pak Mong Village House	A	60/45	45 – 54 /45 – **54** (3)

Notes:

(1) Area Sensitive Rating is assumed in accordance with the GW-TM. Reference has also been made from the approved EIA report and approved HKBCF and TM-CLKL EIAs.

(2) 65 / 50 indicates noise criteria for all days during the evening (1900-2300), and general holidays including Sunday during the day and evening (0700-2300) / all days during the night-time (2300-0700), respectively.

(3) The predicted noise level exceeded the noise criteria for all days during the night-time (2300-0700).

As indicated in *Tables 8.2* and *8.3*, the predicted noise levels, including cumulative noise levels, at the representative NSRs would comply with the daytime (ie non-restricted hours) and evening hours (ie restricted hours) noise criteria. No cumulative impact is anticipated due to construction of the identified concurrent projects.

Should works be required during the night-time period (ie. restricted hours) within Pit 1, an exceedance of the night-time criterion by 3 dB(A) at NSR N4, and an exceedance of the night-time criterion by 9 dB(A) at NSRs N6 and N8, have been predicted due to their close proximity to the facility. Therefore, mitigation measures will be required for night-time works within Pit 1.

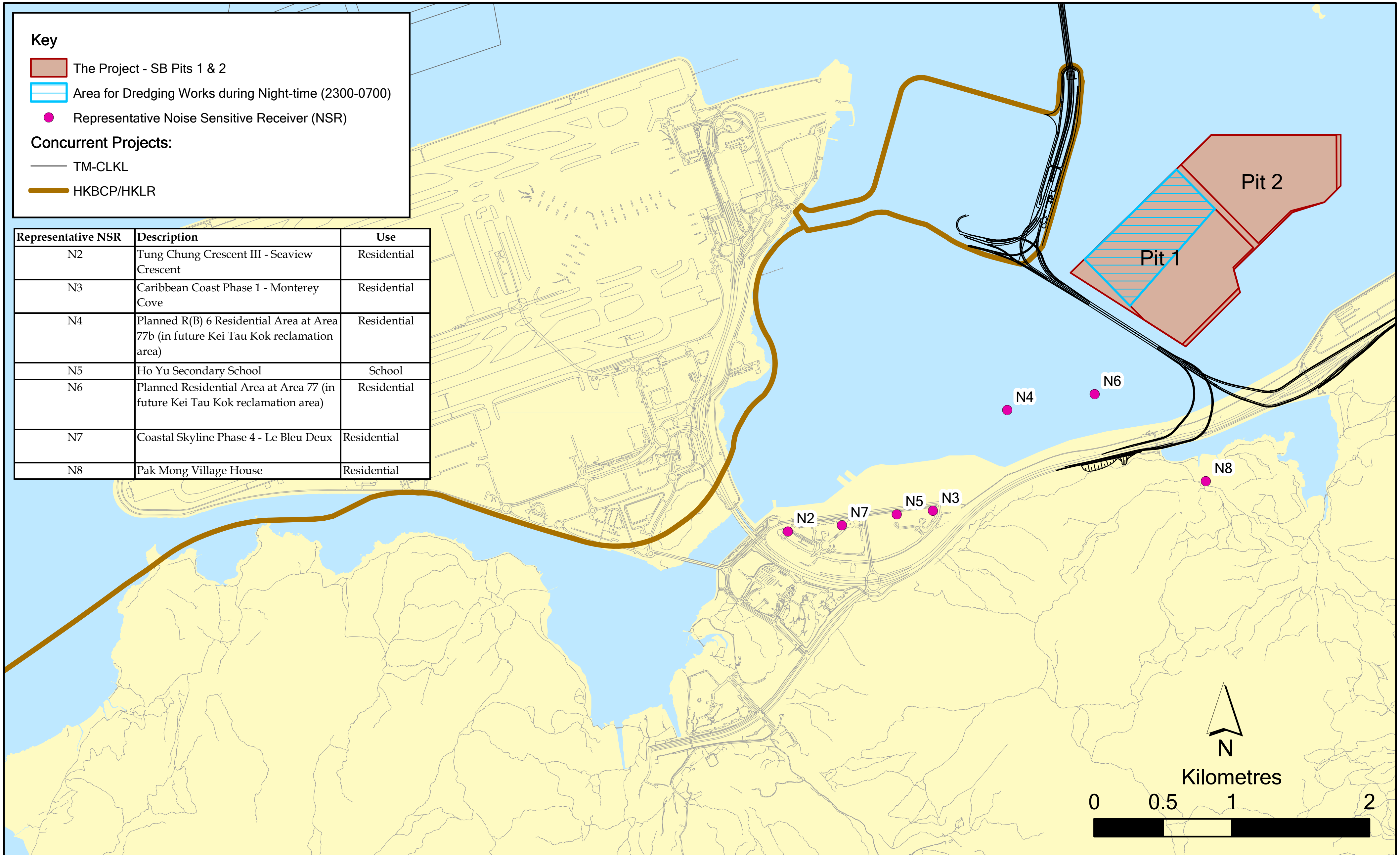
8.4 *MITIGATION MEASURES*

The above assessment indicates that no exceedance of the day and evening criteria is anticipated at the identified NSRs. However, exceedance of the night-time criterion has been predicted for NSRs N4, N6 and N8 during dredging activities at both Pits and backfilling activities at Pit 1.

It is proposed to mitigate the night-time scenario by reducing the number of PMEs. At Pit 1, the plants will be reduced to 2 nos. of dredgers and 3 nos. of barges and tug boats respectively for dredging activities, and 1 no. of barge and 1 no. of tug boat for backfilling activities. At Pit 2, the number of dredger, and, barges and tug boats for dredging activities will be reduced to 3 nos., 4 nos. and 4 nos. respectively. The night-time dredging area within Pit 1 is also recommended to be restricted to the north-west portion only (*Figure 8.2* refers) to provide sufficient separation distance between the works area and the NSRs. With implementation of the mitigation measures, the maximum night-time noise levels are predicted to be reduced to 49 dB(A), 55 dB(A) and 45 dB(A) at NSRs N4, N6 and N8 respectively. Compliance with the corresponding night-time criteria of 50 dB(A) and 45 dB(A) at NSRs N4 and N8 respectively is thus expected. Detailed calculations are presented in *Annex E*.

Compliance with the 50 dB(A) noise criteria at NSR N6, however, cannot be achieved for the mitigated scenario. It should be noted that N6 is a planned NSR and its development programme is yet to be confirmed. Whilst at present it is understood that the planned housing developments at NSR N6 are not on an advanced schedule and as such are unlikely to proceed in parallel with the South Brothers facility, should it be confirmed that these developments at NSR N6 are occupied prior to the dredging activities and backfilling activities at Pit 1 and Pit 2 respectively in July 2012 to June 2013, further mitigation measures will be recommended as part of the environmental monitoring and audit programme (1).

(1) The contractor will be required to further mitigate the night-time noise impact at NSR N6. For example, mitigation measures may include no dredging at Pit 1 during the restricted night-time period (2300-0700). Compliance with the corresponding night-time criteria of 50 dB(A) at NSR N6 will be expected.



Representative NSR	Description	Use
N2	Tung Chung Crescent III - Seaview Crescent	Residential
N3	Caribbean Coast Phase 1 - Monterey Cove	Residential
N4	Planned R(B) 6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	Residential
N5	Ho Yu Secondary School	School
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	Residential
N7	Coastal Skyline Phase 4 - Le Bleu Deux	Residential
N8	Pak Mong Village House	Residential

Figure 8.2

Area for Dredging Works at Pit 1 during Night-time (2300-0700)

File: 0106271_night time construction area.mxd
Date: 03/09/2010

Environmental Resources Management

ERM

Notwithstanding the compliance with mitigation measures, the Noise Control Authority will consider a well-justified Construction Noise Permit (CNP) application, for construction works within restricted hours as guided by the relevant TMs issued under the *NCO*. Nothing in this *EIA Review Report* shall bind the Noise Control Authority in making its decision.

8.5 *RESIDUAL IMPACTS*

No residual environmental impacts, in terms of exceedances of applicable noise criteria, were predicted to occur during the day and evening time. At night-time the noise exceedance for Pit 1 can be mitigated provided that the measure described in *Section 8.4* is implemented.

8.6 *ENVIRONMENTAL MONITORING & AUDIT (EM&A)*

Given the compliance with the noise criteria, noise monitoring is not required during the construction or operation of the SB facility.

8.7 *CONCLUSIONS*

Noise impact associated with the dredging, backfilling and capping works at the SB facility have been assessed. Potential cumulative impacts associated with the nearby concurrent projects, ie. TMCLKL, part of HKLR along east of the HKIA and HKBCF have also been examined.

The results indicated that daytime and evening works within the SB facility will comply with the noise criteria at all representative NSRs. As such the construction and operation of the facility can proceed with 6 grab dredgers and 7 barges and 7 tug boats for dredging work, 2 barges and 2 tug boats for backfilling, and 2 barges and 2 tug boats for capping activity during daytime and evening works. Cumulative impact due to construction of the identified concurrent projects is not anticipated.

However, exceedance of the night-time noise criteria has been predicted at NSRs N4, N6 and N8 during dredging works at both Pits and backfilling activities at Pit 1. It is thus recommended to reduce the number of PMEs for dredging at both Pits and backfilling at Pit 1 during night-time activities, and also to restrict the dredging works area during night-time activities at Pit 1. Should the planned housing developments at NSR N6 be occupied prior to dredging of Pit 1, further mitigation measures will be recommended. With implementation of the mitigation measures, the predicted night-time noise levels at all NSRs comply with the corresponding night-time criteria. No residual impact is anticipated.

With implementation of mitigation measures, no adverse noise impact is expected; noise monitoring is therefore not required during the construction or operational stage of the SB facility.

9 *CULTURAL HERITAGE*

9.1 *INTRODUCTION*

It has been identified and agreed in the *Initial Review Report* of this Study that the following attributes of the approved EIA report of the SB facility would be updated and/ or verified as part of this EIA review:

- Baseline conditions to be updated;
- Marine archaeological potential of the Study Area to be re-examined; and
- Potential cultural heritage impacts to be re-assessed.

As recommended in the *Initial Review Report*, the methodologies for the above update/ verification would be by a desktop review of available up-to-date information, e.g. data presented in recently approved EIA reports, together with a review of the findings from recent geophysical surveys undertaken by the CEDD. This Section presents the outcomes of the proposed update/ verification.

9.2 *BASELINE CONDITIONS*

In accordance with *Clause 3.3.9.2* of the *EIA Study Brief (ESB-095/2001)*, the Study Area for this MAI included the seabed that is expected to be affected by the Project, which is broadly defined as the area within 10 m of the pit boundary (*Figure 9.1*).

9.2.1 *Desktop Research & Review*

Geotechnical data

Generally, the submarine deposits in the Hong Kong region are subdivided into two formations, Chek Lap Kok Formations and the overlying Hang Hau Formations.

The Chek Lap Kok Formations, the lowest part of the Quaternary succession are considered to be Middle to Late Pleistocene in age and consists of colluvium, alluvium and lacustrine sediments (1). The marine sediments on top of this formation are sediments related to the Holocene period (from about 13,000 BP to the present day) and referred to as the Hang Hau Formations consisting of clayey silt sediments and some sand (mud, sandy mud).

(1) Fyfe, J.A., Shaw, R., Campbell, S.D.G., Lai, K.W. and Kirk, L.A., 2000, The Quaternary Geology of Hong Kong. Hong Kong Geological Survey, Geotechnical Engineering Office, Civil Engineering Department, The Government of Hong Kong, SAR.

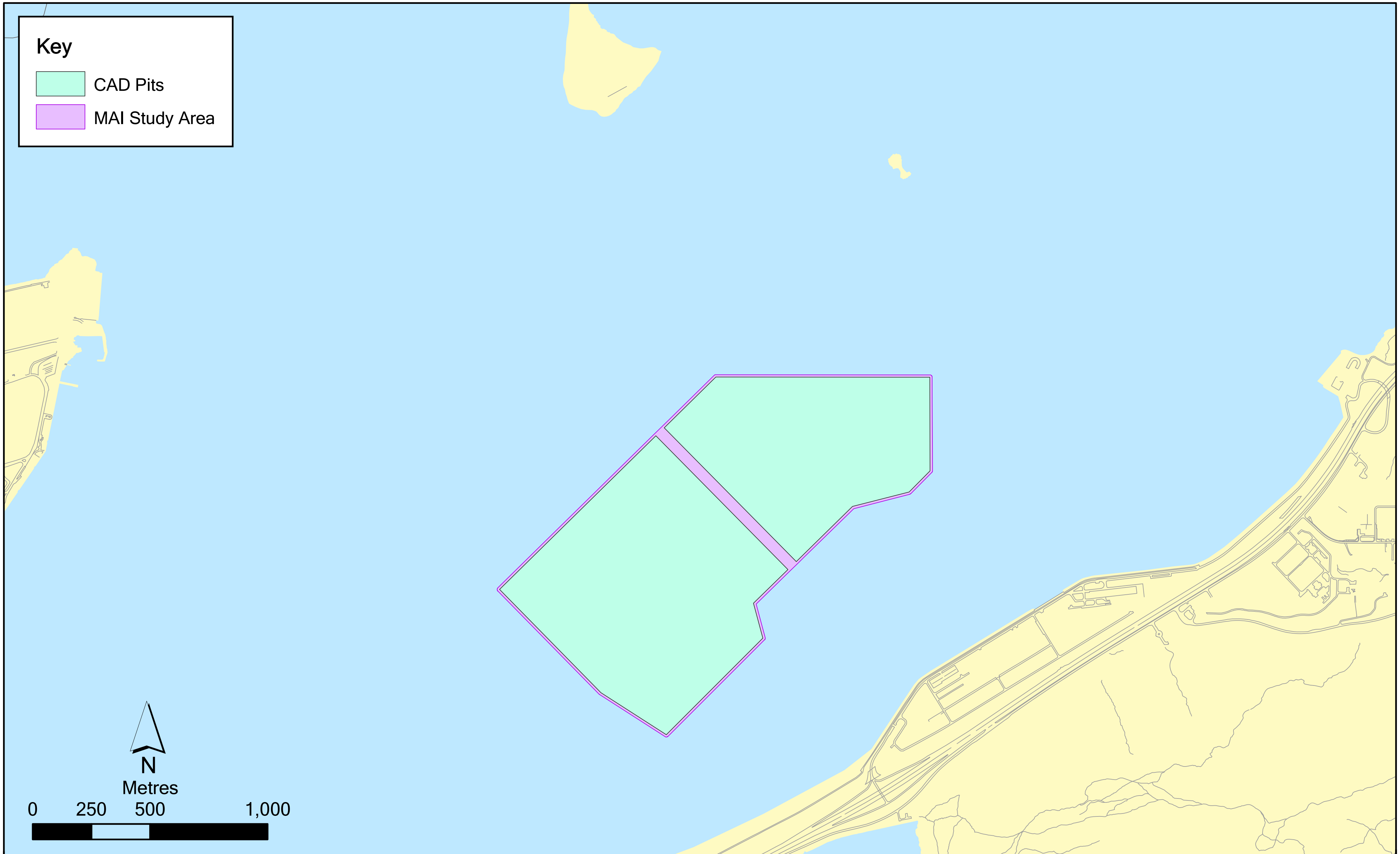


Figure 9.1

Study Area for Marine Archaeological Investigation

File: 0106271_MAI.mxd
Date: 27/05/2010

Environmental Resources Management

ERM

The Sham Wat Formation, found between Chek Lap Kok Formations and Hang Hau Formations is considered to be the Eemian deposit with uncertained age and consists of soft to firm silty clays with yellowish mottling. This formation is presently not widespread but only in subcrop beneath the Hang Hau Formation (1).

More modern sediments are related to the discharge from the Pearl River, (and which would have an effect on the project area, being located down stream from the mouth of the Pearl River) having a seasonal discharge of about 370,000 million cubic metres each year (2). They consist of sand, mud and some gravel.

Fyfe, et al. (2000) further explains the rate of sedimentation:

"In general, present day sedimentation rates in Hong Kong waters are low, though they were undoubtedly greater earlier in the Holocene when sea level was rising rapidly. … Without tidal flushing, the sediment entering Victoria Harbour from the Pearl River, sewage solids and losses from dredging and reclamation might be expected to raise the seabed level by 40mm per year. However, comparison of Hydrographic charts of Victoria Harbour from 1903 to 1980 revealed no conclusive evidence of net sedimentation, implying that the seabed is a state of dynamic equilibrium. Assuming that sedimentation in Hong Kong waters began about 8 000 years ago, deposition of the 10 to 20 m of marine mud must have occurred at an average sedimentation rate of between 1.25 and 2.5 mm per year. Available evidence indicates that the rate of Holocene sedimentation has not been steady. Radiocarbon dating suggests that the majority of sedimentation has taken place over the past 4 000 to 5 000 years."

During the late Pleistocene period (18,000 BP) sea levels began to rise until about 6,000 years BP and which is about the level of present day sea level. "The extent of the rise could be as great as perhaps 140 metres in parts" (3)..

The sediments of the Late Holocene period, considered to be relatively homogenous very soft to soft silty clay and with high moisture content, offers the greatest potential (as compared to the surface of the seabed which is often found to have been disturbed by fishing and other shipping related activities) to include well preserved remains associated with the occupation and use of the islands in Hong Kong waters. These remains could include shipwrecks.

The coverage of the Hang Hau Formation in the SB (SB) area varies from 17m to 25 m below sea level (PD) and there is a band of about 6 – 18 m of marine deposits. In this area the water depth varies from 7 m to 11 m below sea level (PD).

(1) Fyfe et al. 2000, *Op Cit.*

(2) Fyfe et al. 2000, *Ibid*

(3) Fyfe et al. 2000, *Ibid*

Review of Historical documents

Archaeological evidence indicates that seafarers have used the waters of Hong Kong for around 6,000 years [(1)].I It is reported that [(2)]:

"In the past decade, a great number of prehistoric sites have been discovered in the coastal sandbars which represent the opening up of the coastal and offshore island areas by the early settlers. Around six thousand years ago, the Neolithic folks had already settled in the coastal area of South China."

Coates [(3)] stated that *'Definite archaeological traces of this prehistoric activity have been found … on the beach at Shek Pik, on the south coast of Lantao [Lantau] Island. From these finds it is clear that about three thousand years ago the islands were used as a seasonal entrepôt for trade between the Yangtse mouth, the tribal states of what is to-day Kwangtung Province, and Indonesia.'* The islands at the mouth of the Pearl River were seen as more suitable for trade between the Cantonese merchants and those from other regions, and *'Temporary settlements were built near the beaches. Cooking utensils have been found from this period on Lamma and Lantao, but no trace of buildings.'*

Further information was found that states:

"Local history, still very far from being recorded fully, begins with the migration of Chinese into the area during the Sung dynasty (960-1279). … Lantao Island is the next of the group to appear in history. The last reigning Sung emperor, Ti-ping, made Kowloon his rallying point in the long Chinese retreat before the Mongol invasion. In 1279, not far from Tsuen Wan, his forces met the Mongols and were finally defeated. After the battle large numbers of the Court and nobility escaped across the comparatively narrow, sheltered stretch of water to Lantao. … Of those who fled to Lantao, there were those who settled and possibly intermarried with the inhabitants, traces of these cultured refugees are to be found at Tai O. … The Mongols did not enjoy for long their conquest of South China. The early part of the fourteenth century was a troubled time in the South, and from the Kowloon peninsula a number of families moved to safety in remoter spots. The families at present occupying villages in the Shek Pik area of Lantao moved there during the period of Mongol rule (1279-1368) (Braga 1957)."

Meacham (1994) [(4)] noted that *'The history of Chek Lap Kok [to the west of South Brothers] spans the entire period of human occupation in the Hong Kong area, from the earliest inhabitants of the painted pottery period around 4000 BC to the recent period.'* As part of the rescue archaeological project carried out on Chek Lap Kok before the construction of the international airport, archaeological work was carried out on several sites on Chek Lap Kok, including a 8th-10th century

(1) Bard, 1988, In Search of the past: A guide to Antiquities of Hong Kong

(2) Chau, Hing-wah, (ed) 1993, Collected essays on the culture of the Ancient Yue People in South China. Hong Kong Museum of History. Hong Kong.

(3) Braga, J. M., 1965, China Landfall 1513. Jorge Alvares Voyage to China. A complilation of some relevant material. Macao. Imprensa Nacional.

(4) Meacham, William, 1994, Archaeological Investigation on Chek Lap Kok. The Hong Kong Archaeological Society. Hong Hong.

site encompassing kilns and coins; burial sites of the Northern Sung period; a site containing pottery from the Middle and Late Neolithic period (4000-1500 BC); burial/ritual sites dated 3700-3400 BC; a number of Tang lime kilns (dated 750 and 1200 AD); and a site containing hard and soft geometric pattern pottery, axe moulds and cloth from the Bronze age. In 1993, part of a cannon was discovered during dredging of the seabed between Chek Lap Kok and Tung Chung (1). The discovery was then reported to the Provisional Airport Authority. Inscriptions found on the cannon revealed that it was manufacturing in 1808. This cannon is likely related to the fort at Tung Chung, reflecting the Chinese military presence in the area in the past.

Lantau Island, just to the south of the Study Areas, is the largest and most western of the islands in the Hong Kong group of islands and therefore provides shelter for the waters between it and Hong Kong Island. Being located at the outlet of the Pearl River '…*rightly called the artery of Southern China*' the area had '…*established contacts with the outer world by the Chin Dynasty…*' (2). An early maritime industry was the pearl fishing industry and '…*governmental control of this activity only began in the time of the Five Dynasties*…' (3). Lantau Island also became a prolific incense-producing district, although '…*nothing remains of it to recall the origin of the name Hong Kong (i.e. Fragrant Port)*" (4). The bay inside of Lantau Island attracted '…*trading vessels from Arabia, Persia, India, IndoChina, and the East Indies*…' (5), and local vessels involved in the fishing and salt making industries. Pirates were prolific in the area, as well as settling on Lantau Island, and forts and batteries were also built on the island to assist the Imperial Navy in controlling pirates.

It is only a few miles north of the project area, ie. Lin Tin (Neilingding) and Tuen Mun, that the Portuguese (the first European arrivals) established a presence there in 1513. The Portuguese explorer, Jorge Alvares was permitted to land on Lin Tin and for '…*about ten months he spent in the Canton River, at the anchorage of T'un Men…*' as this was '…*where all the foreign trade in south China was conducted…*' (6). '*Landward and closer to him, across the stretch of waters to the east, he could see towering Ching Shan (now known as 'Castle Peak') standing guard over the anchorage of T'un Men. A little to the north, the headland of Nan Shan reared its form protecting the naval station of Nan Tou, with the Imperial junks lying at anchor, under the guns of the fort on little Ta Shan Island; and a considerable movement of ships at the port of Nan Tou showed that it was an important town*' (7).

(1) Meacham, William, 1994, *Op. cit.*

(2) Lo, Hsiang-Lin, 1963, Hong Kong and its External Territories before 1842. Institute of Chinese Culture. Hong Kong.

(3) Lo, Hsiang-Lin, 1963, *ibid*

(4) Lo, Hsiang-Lin, 1963, *ibid*.

(5) Lo, Hsiang-Lin, 1963, *ibid*.

(6) Braga, 1965 *Op Cit.*

(7) Braga, 1965 *Op Cit.*

Further on this discovery of China by Europeans and containing an account of the significance of this area for trade in general can be found in a report by Tomé Pires, a Portuguese living in Malacca and which is '…*based possibly to some extent on information gathered by Jorge Alvares in China*' (1). '*Pires has a lot to say about the ports and the peoples who traded in China. He mentions that junks from Malacca anchor 'in the port of Tumon*.' Those from Siam anchor, he states "*in the port of Hucham. Our port of Tumon is three leagues nearer to China than the Siamese one. If our theory is correct that the island of Tumon is none other than Lin Tin Island, then it is likely that Hucham would be the port of Lantao Island*' (2). Cortesão (3) states, '*The city of Canton (Quamton) is where the whole kingdom of China unloads all its merchandise…*' and '*salt is a great merchandise among the Chinese. It is distributed from China to these regions; and it is dealt with by fifteen hundred junks which come to buy it, and it is loaded in China to go to other places*.'

Lo (1963) (4) further illustrates the importance of the area surrounding the Study Area:

"Though the trading contacts of T'un-mên with overseas countries can be traced back to quite ancient times—probably beginning in the Liu Sung period—it was during the T'ang Dynasty that trade greatly extended. … As traffic increased and more travellers passed through T'un-mên literary men began to learn of this place and its trading activities."

"The sovereign of Nan Han who seized power during the disintergration of the T'ang and established himself in southern China made it his policy to secure the support of outlaws, to extend his sway to the non-Chinese peoples, the Mans and the Tans (people who live on boats) and to derive the maximum profit from with foreign countries. Consequently special attention was paid to T'un-mên. When the Five Dynasties came to an end and the Sung emporers ascended the throne, governmental machinery in the T'un-mên area was elaborated. In addition to the royal garrison, an officer whose duty was to pursue and arrest bandits was installed. A system of administration for the land-locked waters and more remote seas was put into force at T'un-mên and two other posts (one at P'i-p'a Chou at the northern tip of Lantau Island, and one at Tan-kan Chou of Ju-chou). …during the Sung only three places on the coast round the outlet for Canton, namely T'un-mên, Kuan-fu Ch'ang and Ta-Yu Shan (Lantau) were guarded by imperial troops."

It is evident that the region between Lantau and Lintin and *T'un-mên*—the region that takes in the Study Area for the mud disposal was populated, and active in the movement of people and materials between various parts of China, and several other nations, over a period of at least 4000 years.

(1) Cortesão, A., 1994, The Suma Oriental of Tomé Pires and The Book of Francisco Rodrigues. London. Hakluyt Society.

(2) Cortesão, A., 1994, *Ibid.*

(3) Braga, 1965 *Op Cit.*

(4) Lo (1963). *Op Cit.*

Contemporary Description

A brief contemporary description of the area around Chek Lap Kok from 1978 states (1):

"Tung Chung Bay mostly dries at low water and you keep to the N of the Red and White buoy there at all times. There is a government pier at Ma Wan Chung and a pleasant walk will take you to the old Chinese sort, now a school, which still has cannon sticking through the walls. It is perhaps difficult to imagine that Tung Chung used to be the chief village of Lantao at which time no doubt its bay had more water than now. There is now a thriving village near the pier at Ma Wan Chung. Sampan ferries connect Ma Wan Chung to the nearby beaches of Chek Lap Kok. There is a beautiful beach in the bay SA of Red Pt [on Chek Lap Kok] with an unusual rock formation on its W side. There are small sandy bays on the NW shore of Chek Lap Kok; one has a concrete pier. Either side of Chu Lu Kok (Chek Lap Kok) makes a good anchorage, depending on the wind. The bottom is soft mud so it doesn't matter if, at low water, you touch."

"To the N of Lantao lie the Brothers, the Western of which has an abandoned graphite mine on its W side. ... The whole area to the North of Lantao is now occupied by shipping laid up as a result of the recession. … A mile S x E of Tung Ku lies the attractive Sha Chau, a series of rocky cones standing on the sandpits. There is a tiny Joss House on one islet and a good anchorage under the lee in 1.5 to 2 fathoms mud. The beaches are completely deserted."

United Kingdom and Hong Kong Hydrographic Office 'Wreck' Files & Other Charts

Shipwrecks are predominantly the primary archaeological site located underwater (Muckelroy, 1978). Since they are random and haphazard events it is difficult to predict their exact location as little written references survive or were ever made.

A review of a number of charts was carried out to ascertain if there were any other written records of shipwrecks in the Study Area.

Relevant British Admiralty Charts were reviewed and no records of wrecks were found on these charts.

The United Kingdom Hydrographic Office in Taunton and the Hong Kong Hydrographic Office in Hong Kong both maintain databases of known shipwrecks in the HKSAR. These databases were investigated and no sites on these databases were found to be located within the Study Area.

Other Marine Archaeological Investigations

Existing available information on relevant previous MAI works within and in the vicinity of the Study Area were reviewed. These MAI comprised geophysical surveys, using multi beam echo sounder, side scan sonar and sub-

(1) Hownam-Meek, R.S.S., (Ed.) 1978, Afloat in Hong Kong. T. Thomas Ltd. Hong Kong.

bottom boomer profiling, undertaken as part of the respective EIA studies. These MAIs and their key findings are presented below.

Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/ East of Sha Chau Area (Agreement No. CE 12/2002(EP))

As documented in the 2005 approved EIA Report of the proposed facility at SB (1), from the geophysical survey undertaken in July 2004, three sub-bottom anomalies (of an unknown nature and value) were found below the seabed that could prove to be material of archaeological potential (*Figure 9.2*). One of these anomalies is located within the present Study Area. Given the association of sub-bottom anomalies with surface dumped material, the absence of this anomaly in the recent survey supports the previous EIA conclusion that the likelihood of the South of Brothers area containing any well-preserved remains was considered minimal.

Tuen Mun - Chek Lap Kok Link

A geophysical survey was undertaken by the Highways Department in late 2008 as part of the EIA study for the *Tuen Mun – Chek Lap Kok Link* (2) and the survey area overlapped with that of CEDD's proposed facility at SB (*Figure 9.2*). No Sonar Contacts or sites of archaeological potential were identified in the surveyed area within the proposed facility at SB.

Desktop Review Findings

Although the baseline review of the literature found the Study Area had the potential to contain underwater cultural heritage sites, no sites of historical or archaeological significance were identified from the literature or the databases.

9.2.2 *Geophysical Surveys*

Introduction

Following a baseline review of available literature and databases, geophysical surveys were undertaken by CEDD's geophysical contractor EGS (Asia) Limited (EGS) within the Study Area in August and December 2009 as part of this Project. The survey was focused on the Study Area and extended beyond the proposed pit boundary to include a broader Survey Area (*Figure 9.3*).

The objective of the survey was to define the areas/ sites of greatest archaeological potential, assess the depth and nature of the seabed sediments and map any seabed and sub-bottom anomalies which may have

(1) ERM (2005) *Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area (Agreement No. CE 12/2002(EP)) - Environmental Impact Assessment (EIA) and Final Site Selection Report (Register No.: AEIAR-089/2005)*. Prepared for CEDD

(2) AECOM (2009) *Tuen Mun - Chek Lap Kok Link - Environmental Impact Assessment (EIA) Report (Register No.: AEIAR-146/2009)*. Prepared for Highways Department

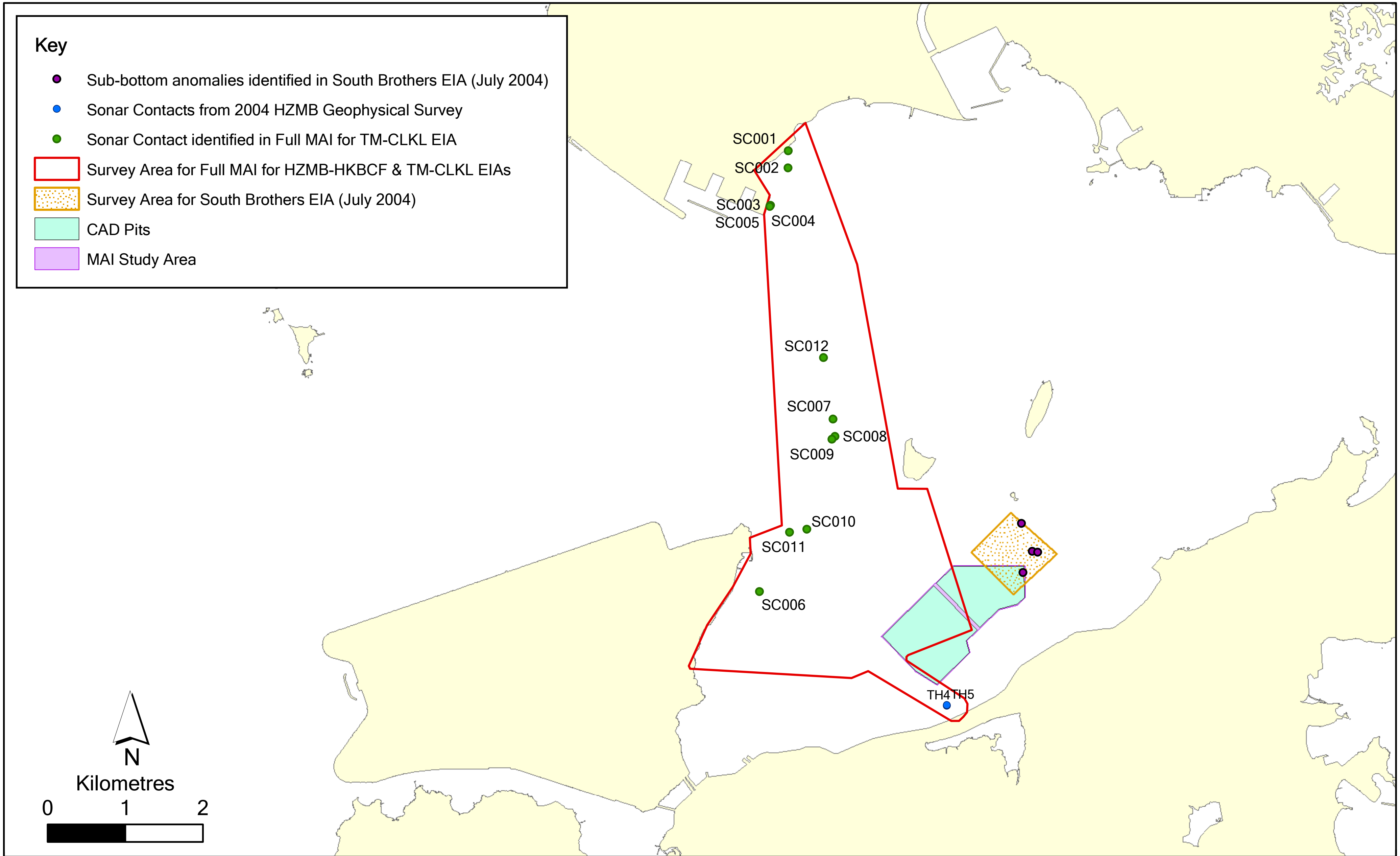


Figure 9.2

Relevant Previous Marine Archaeological Investigations near the Proposed Facility at South of Brothers

File: 0106271_survey area_.mxd
Date: 27/05/2010

Environmental Resources Management

ERM

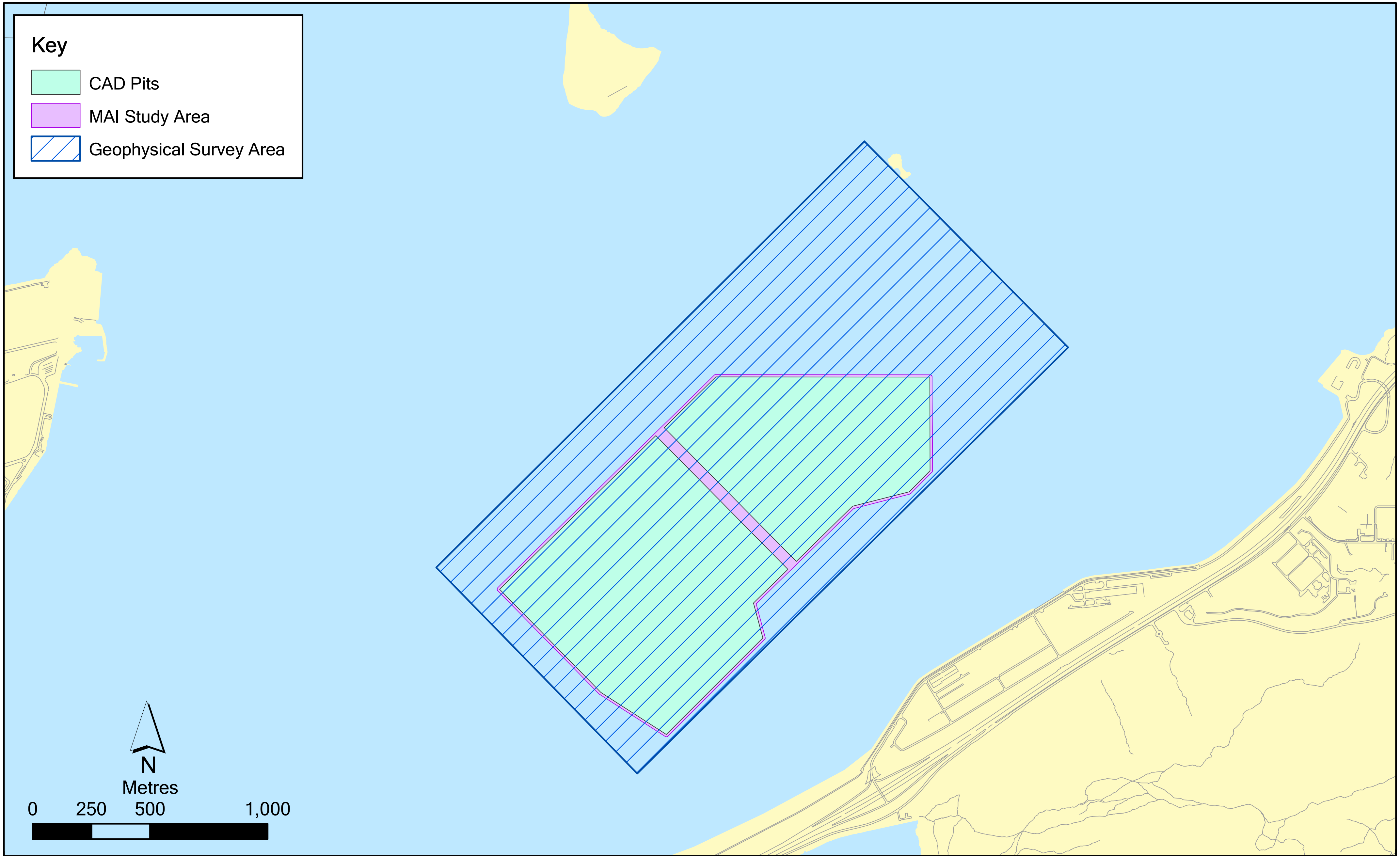


Figure 9.3

Geophysical Survey Area for Marine Archaeological Investigation

File: 0106271_MAI_geophysical study area.mxd
Date: 27/05/2010

Environmental Resources Management

ERM

archaeological material. The survey data obtained by EGS were reviewed and interpreted by a qualified marine archaeologist to identify features of possible archaeological potential. The detailed methodology and findings are described below.

Survey Methodology

EGS undertook a seismic boomer and a multi beam echo sounder survey of the Survey Area from 6 to 9 August 2009 (*Figure 9.4*). The main traverses carried out in a NE-SW orientation were 50 m apart and cross traverses of 200 m apart were also implemented. On 4 December 2009 and from 7-9 December 2009, EGS carried out a side scan sonar survey of the same area (*Figure 9.5*). The main traverses were 25 m apart running NE-SW and cross traverses 100 m apart were completed. These surveys allowed for a comprehensive coverage of the Study Area.

The vessel track plots of the surveys are presented in *Figures 9.4* and *9.5*. These surveys allowed for a comprehensive investigation of the seabed, and below the seabed.

Equipment Used

The following equipment was employed during the geophysical surveys:

- C-Nav GcGPS
- EGS Computerised navigation package v 1.2 and PC
- Klein 2000 dual channel side scan sonar
- Odom MK III echo sounder
- The Reson 8125 multibeam system
- Swath PC
- Seismic Profiler
- Hydrophone
- EGS TVG consule
- Waverley recorder
- TSS Gyro compass
- Valeport velocity profiler
- TSS DMS 3-05 heave motion compensator
- Generators, spares

Review of Geophysical Survey Results

The geophysical survey data obtained by EGS were processed by in house geophysicists and reviewed by a licensed marine archaeologist.

The side scan sonar survey was used to produce a seabed map which provided details on the nature of the seabed and how it has been impacted by anchoring, trawling and the dumping of materials (*Figure 9.6*). Within the Survey Area, the majority of the soft silt/ clay seabed has been greatly disturbed by anchoring and trawling (*Figures 9.7* and *9.8*).

Figure 9.7 Scarring of the Seabed from Fishing Trawlers Located within the Survey Area

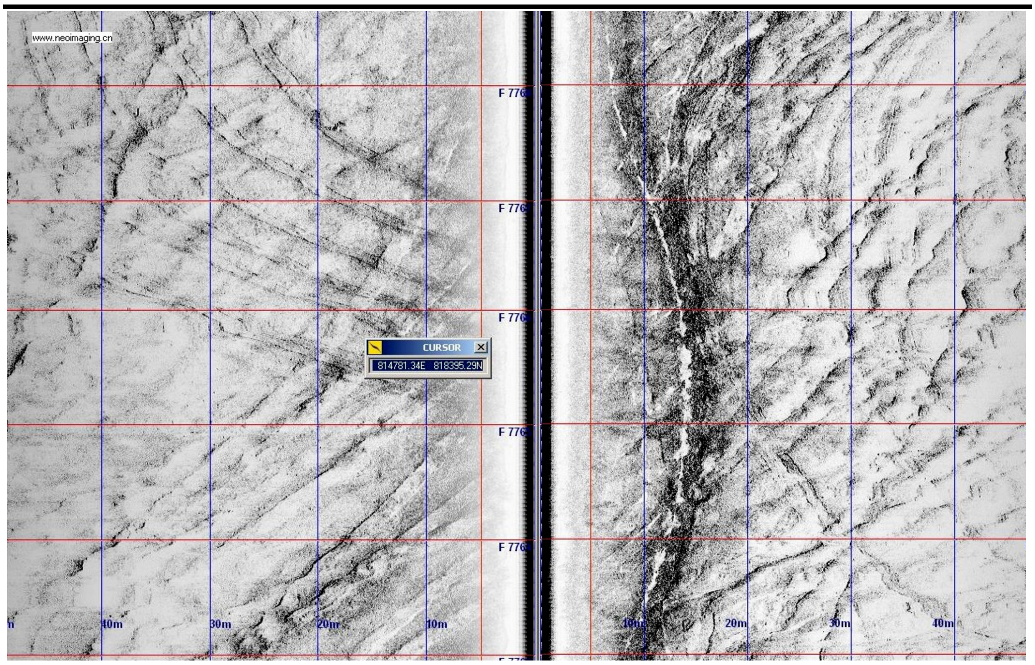
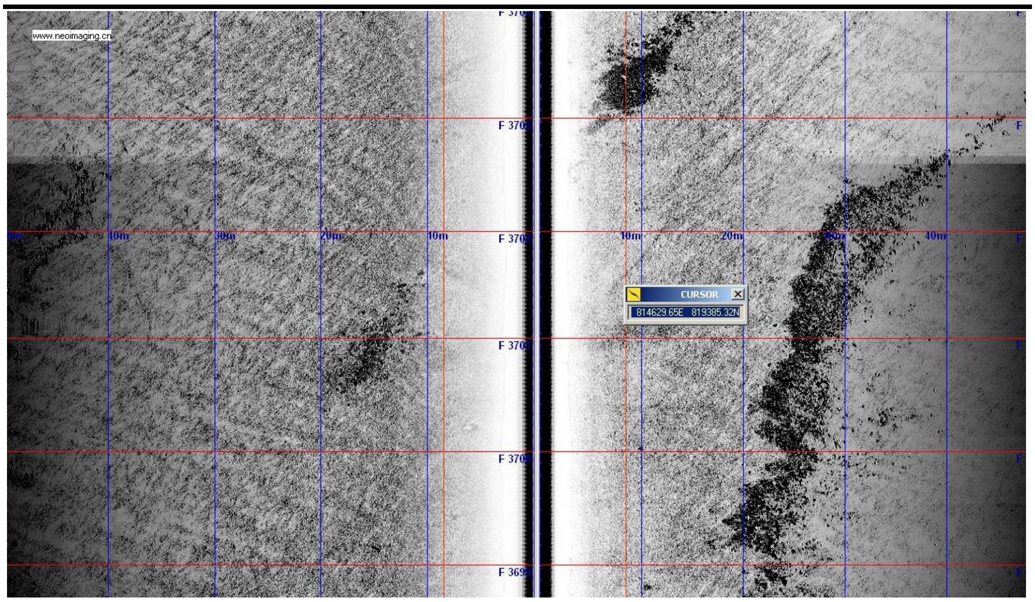
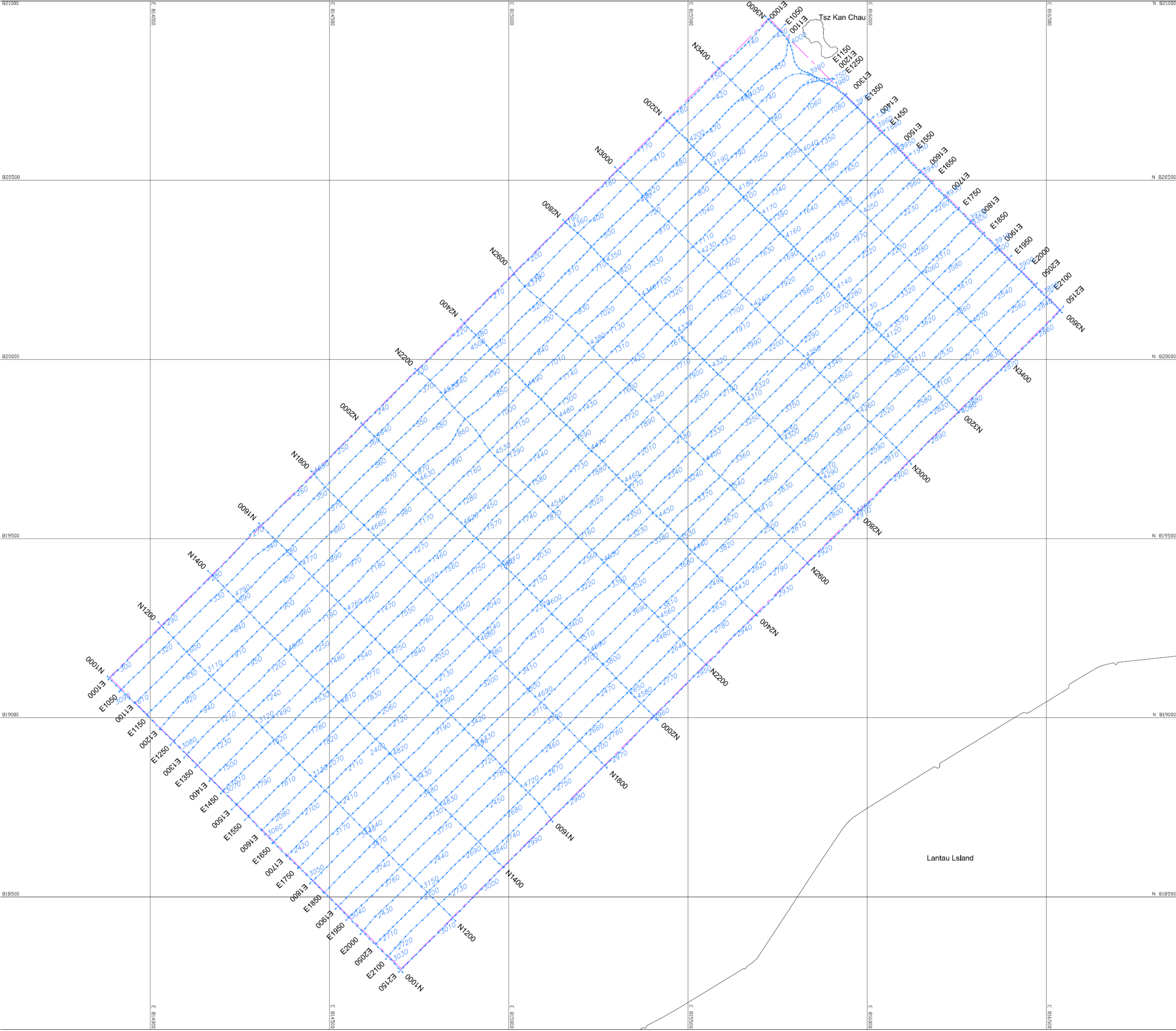


Figure 9.8 Dumped Materials Located within the Survey Area

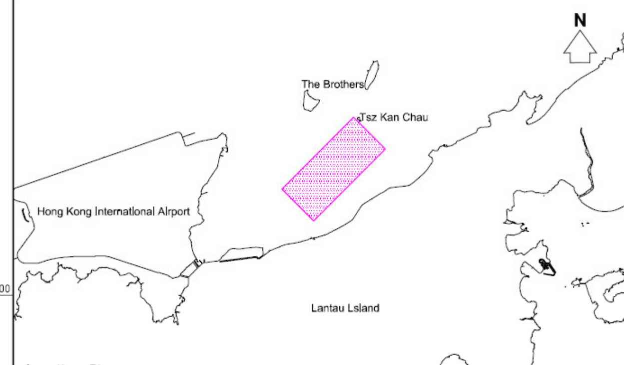




Legend :

225 E1000 Hydrophone track with fix positions and line number

Survey boundary



Location Plan

Project :

Contaminated Sediment Disposal Facility at South of Brothers

FIGURE NUMBER : 9.4

Drawing Title :

Survey Lines for Seismic Boomer and Multi Beam Echo Sounder Survey in August 2009

Notes :

1. Survey Date : 06-09/08/2009
2. Survey Grid : Hong Kong Metric Grid
3. Survey Datum : Hong Kong Principle Datum
4. Positioning : C-Nav GcGPS (Globally corrected GPS)
5. Equipment : EGS Boomer System
   Reson 8125 Multibeam Echo Sounder
   Odom Echo Sounder
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Offic
   Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
0	13/08/2009	Clarence Siu	Margie Chen	R. E. Hale	Preliminary
1	21/09/2009	Clarence Siu	Margie Chen	R. E. Hale	Final

METRIC SCALE 1:5,000

250 200 150 100 50 0 250 50

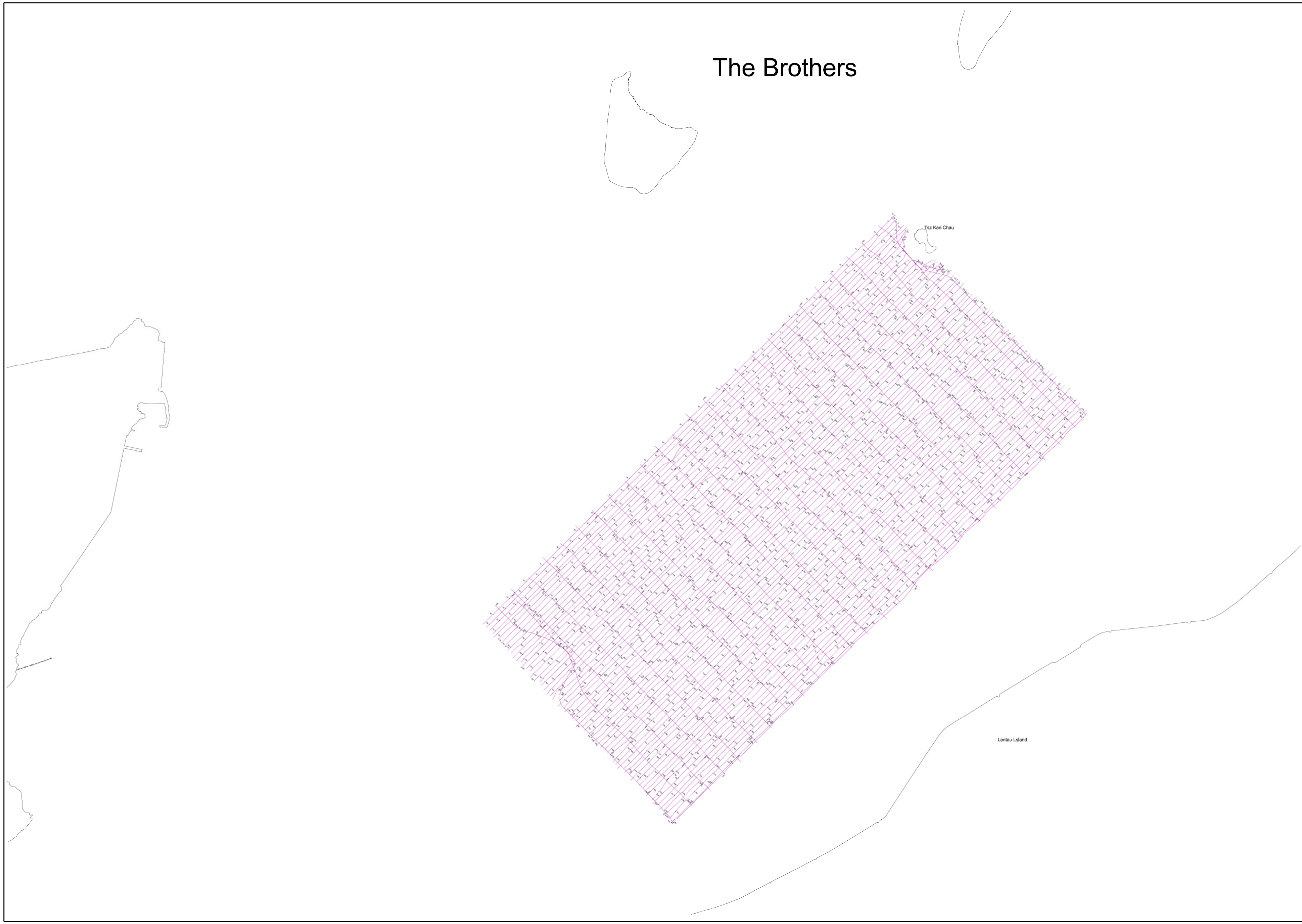
Client :

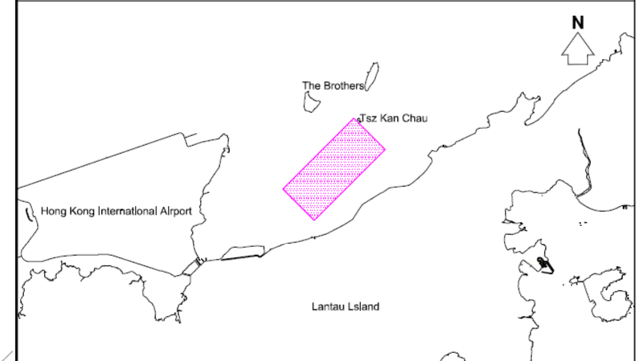
Civil Engineering and Development Department

Environmental Resources Management

ERM

JOB No.: FM 2/200





Location Plan

Project :

Contaminated Sediment Disposal Facility at South of Brothers

FIGURE NUMBER : 9.5

Drawing Title :

Survey Lines for Side Scan Sonar Survey in December 2009

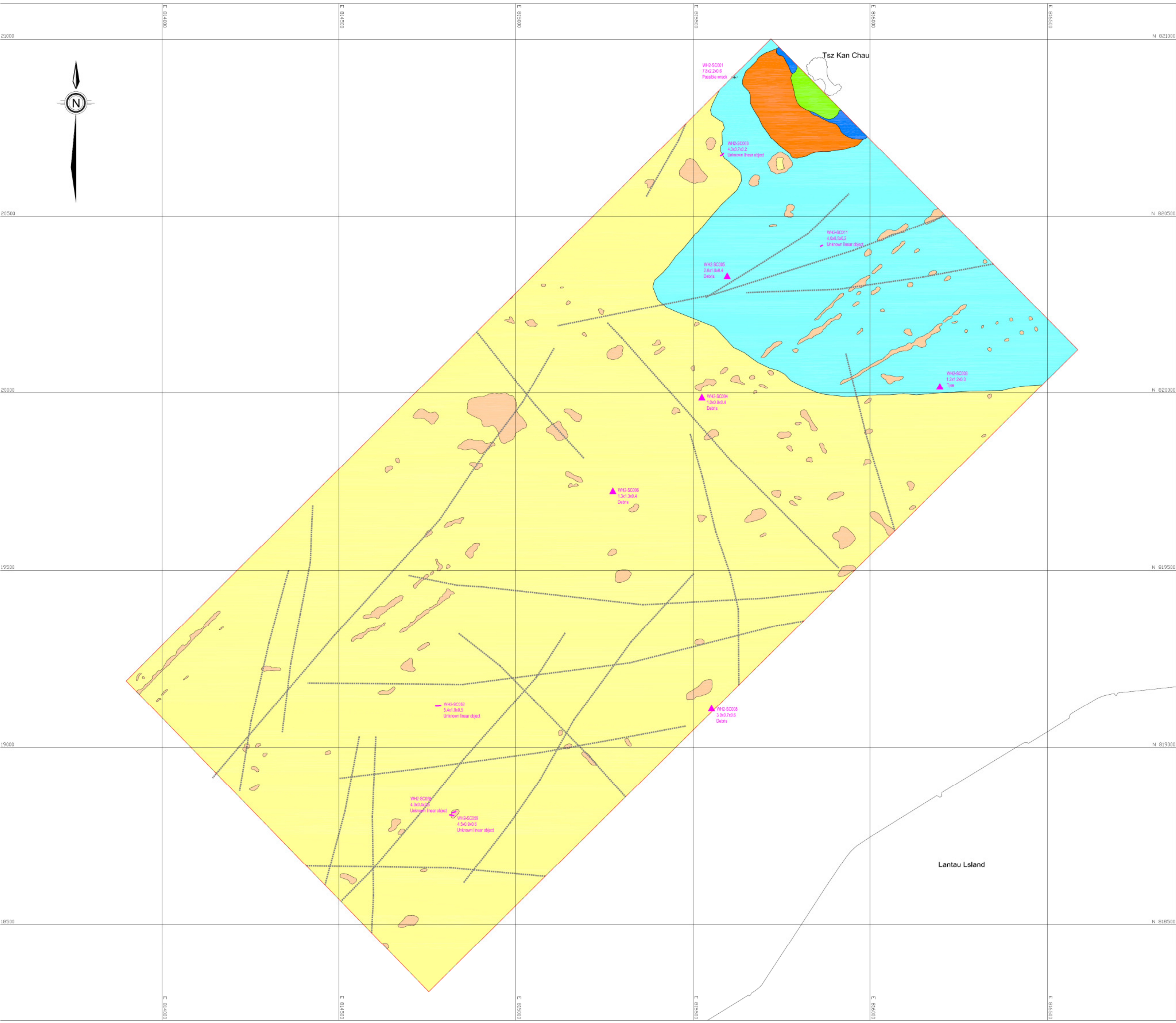
Client :

Civil Engineering and Development Department

Environmental Resources Management

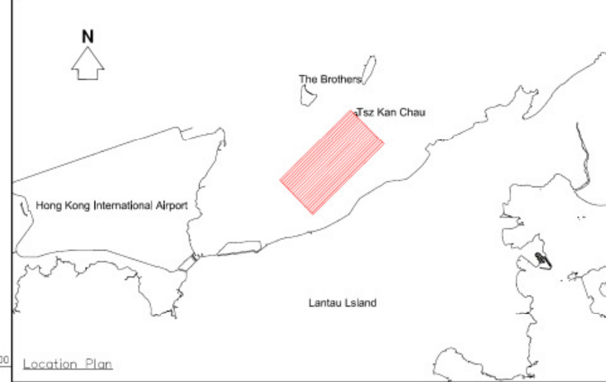
ERM

JOB No.: FM 2/2009



Legend :

- Relatively less disturbed seabed covered with soft SILT/CLAY with occasional trawl scars
- Disturbed seabed covered with soft SILT/CLAY with numerous trawl and anchor scars
- Veneer of soft SILT/CLAY over weathered ROCK/ROCK
- Soft SILT/CLAY with isolated small depressions (diameter < 1.5m, depth < 0.4m).
- Dumped material
- Low to medium relief ROCK outcrop
- Seabed scar (trawl or anchor)
- WH2-SC001 5x5x1 — Isolated sonar contact with reference number (length x width x height in metres where measurable; nmh = no measurable height)
- WH2-SC011 50x0.5x1 — Linear sonar contact with reference number (length x width x height in metres where measurable; nmh = no measurable height)
- Survey boundary



Location Plan

Project :

Contaminated Sediment Disposal Facility at South of Brothers

FIGURE NUMBER : 9.6

Drawing Title :

Seabed Features as Evaluated from December 2009 Side Scan Sonar Survey

Notes :

1. Survey Date : 4th and 7th–9th December, 2009
2. Survey Grid : Hong Kong Metric Grid
3. Survey Datum : Hong Kong Principle Datum
4. Positioning : C–Nav GcGPS (Globally corrected GPS)
5. Equipment : Klein 2000 Side Scan Sonar System
6. Coastline taken from 1:1,000 Survey Sheets, Survey and Mapping Office, Lands Department

Revision No.	Date	Drawn by	Checked by	Approved by	Remarks
0	24/12/2009	Clarence Siu	Margie Chen	R E Hale	Preliminar

METRIC SCALE 1:5,000

250 200 150 100 50 0 250

Client :

Civil Engineering and Development Department

Environmental Resources Management

ERM

Job No.: FM 2/20

In addition, the survey located 11 Sonar Contacts within the Survey Area, five of which were located within the Study Area (*Figure 9.6*). All Sonar Contacts identified from the side scan sonar survey were all reviewed and their interpretations were all supported by the geophysicists and the licensed marine archaeologist. The majority of them were identified as debris or linear objects (*Figures 9.9* and *9.10*), while one possible shipwreck were also located.

Figure 9.9 Two Linear Objects SC 058 and SC059

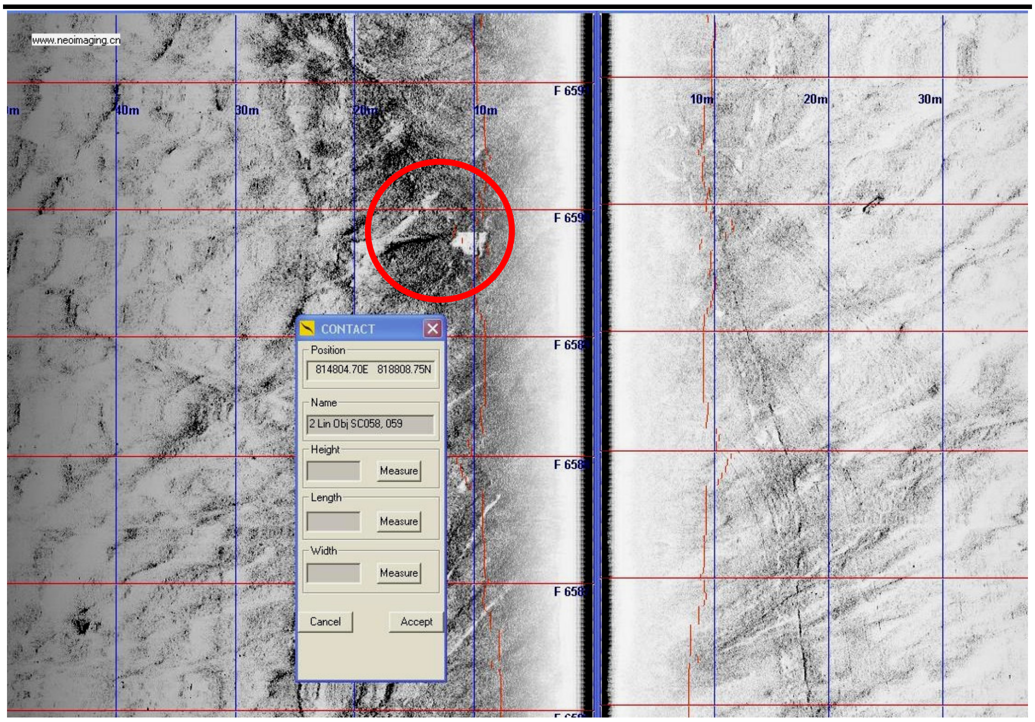
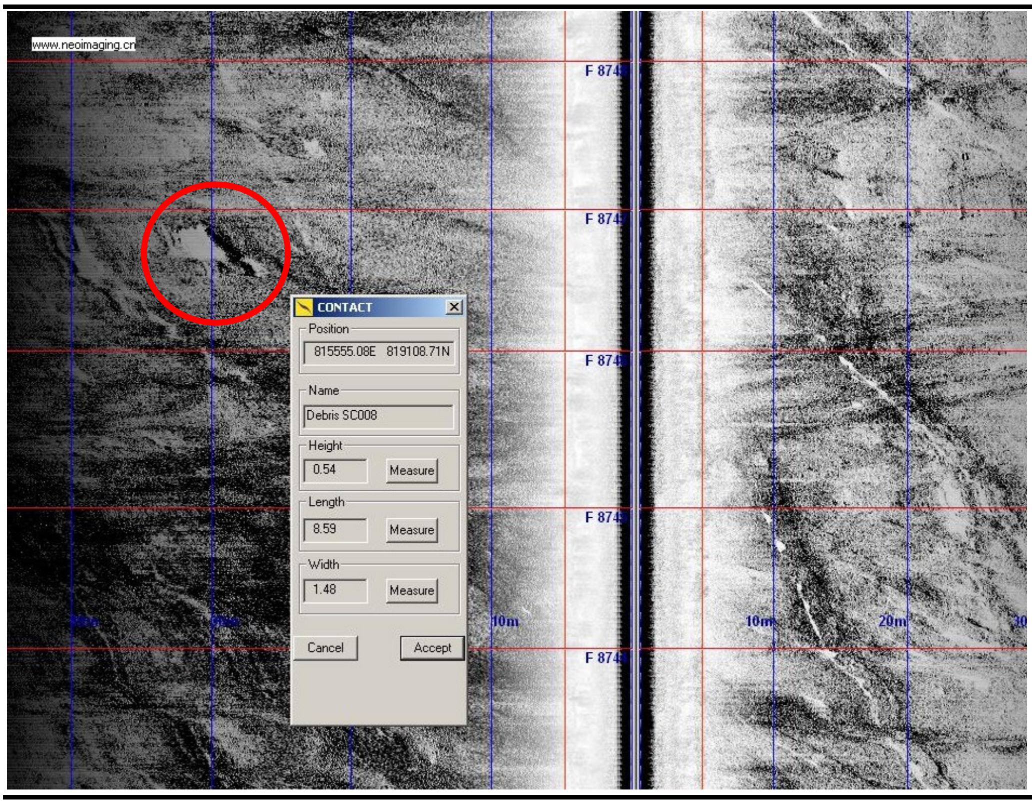
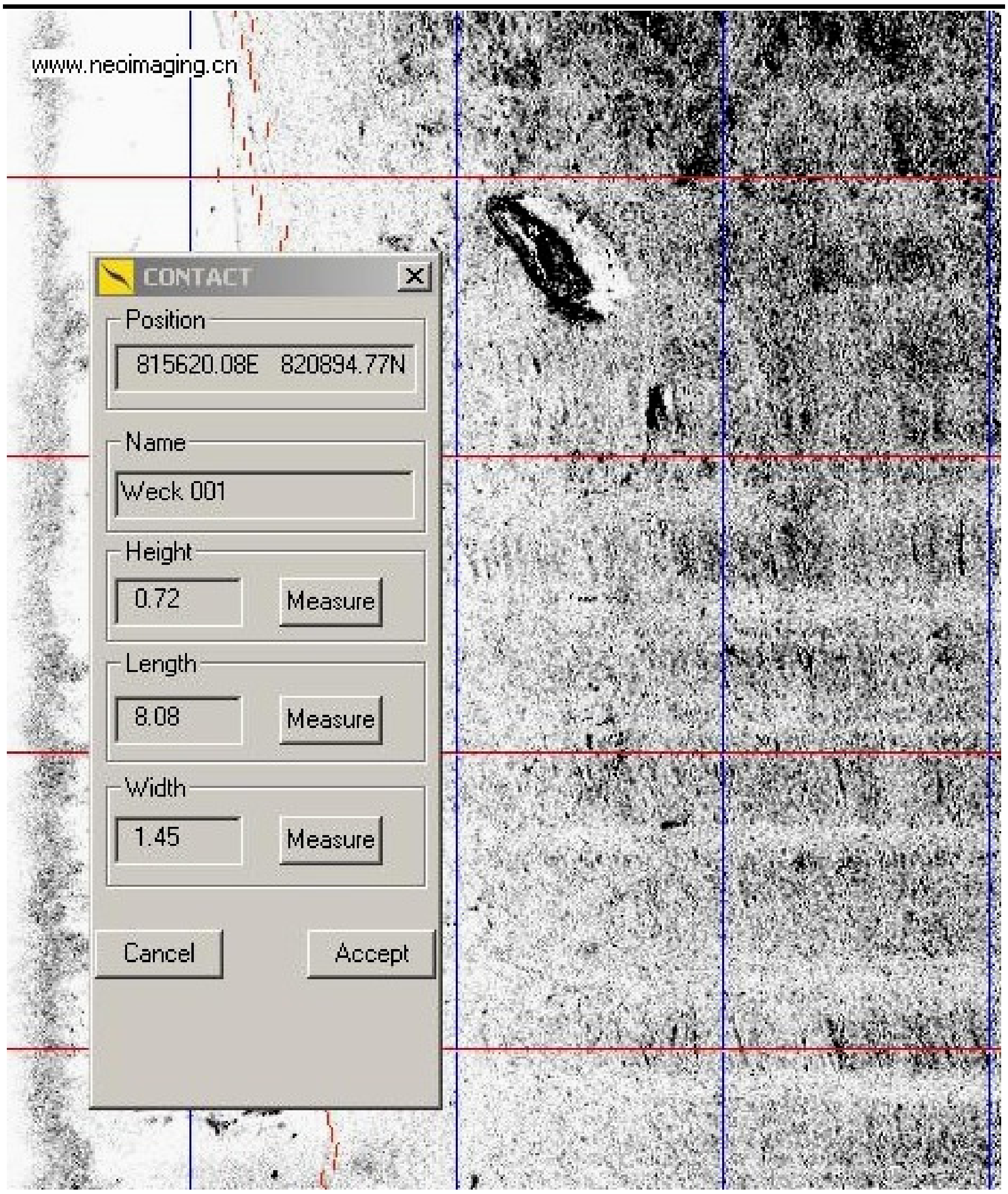


Figure 9.10 Sonar Contact 008 - Debris



The one shipwreck is a small vessel which looks to be in reasonable condition and is possibly a small, modern sampan (*Figure 9.11*). It is located on the north western edge of the boundary of the Survey Area which is well outside of the proposed pit boundary and Study Area (*Figure 9.6*).

Figure 9.11 *Sonar Contact 001 - a Wreck*



Overall, the Sonar Contacts identified within the Study Area of the proposed SB site are not considered to be material of an archaeological nature.

A review of the boomer data identified ten sub-bottom anomalies (*Figure 9.12*, see *Table 9.1*).

Table 9.1 ***Sub-bottom Anomalies Identified within the Survey Area***

Boomer Anomaly ID	Easting	Northing
1	816370 E	820310 N
2	816180 E	820500 N
3	815940 E	820600 N
4	815730 E	820670 N
5	815580 E	820810 N
6	815910 E	820280 N
7	815275 E	820500 N
8	815220 E	820445 N

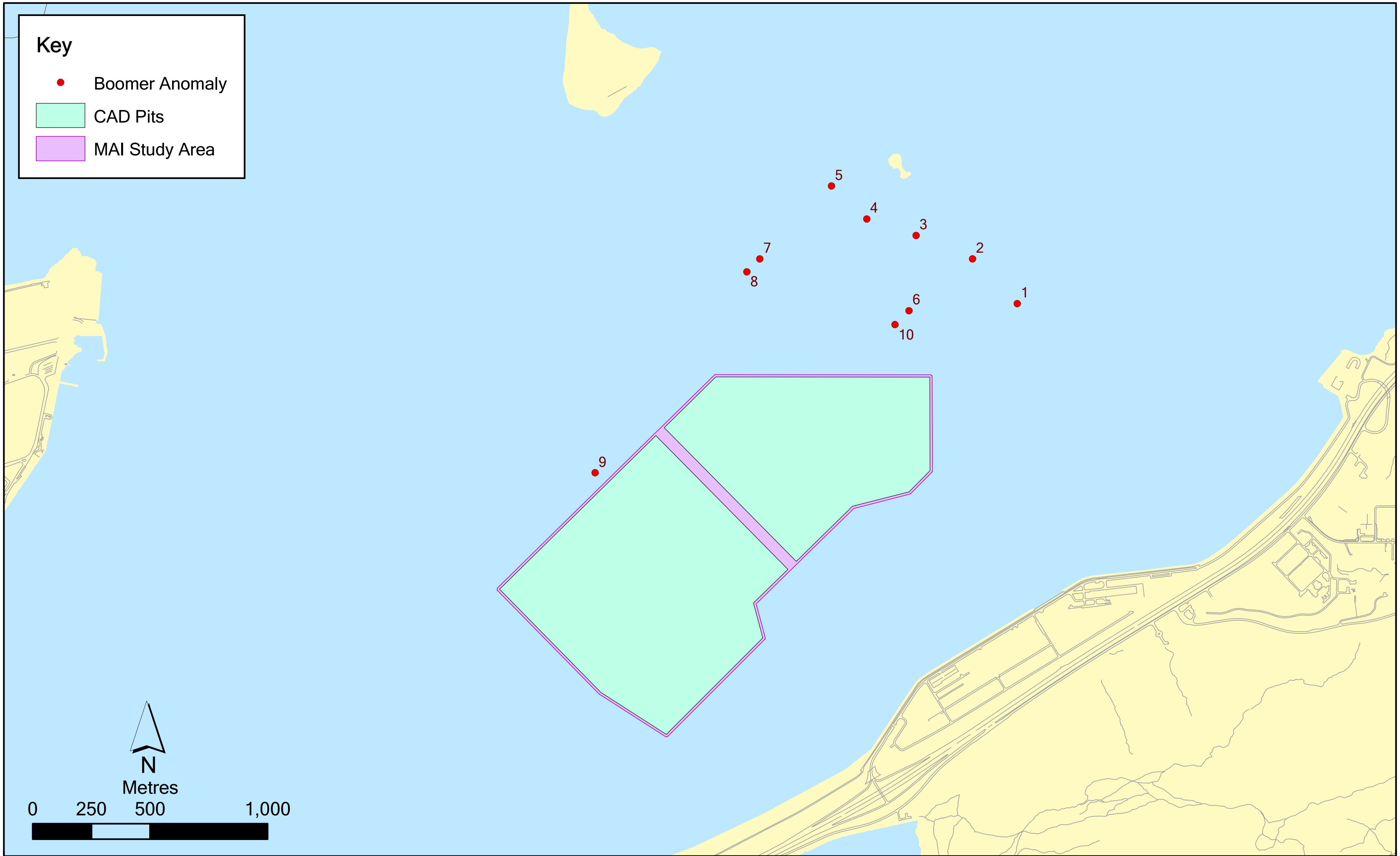


Figure 9.12

Boomer Anomalies Identified from the Geophysical Surveys

File: 0106271_boomer anomaly_v2.mxd
Date: 27/05/2010

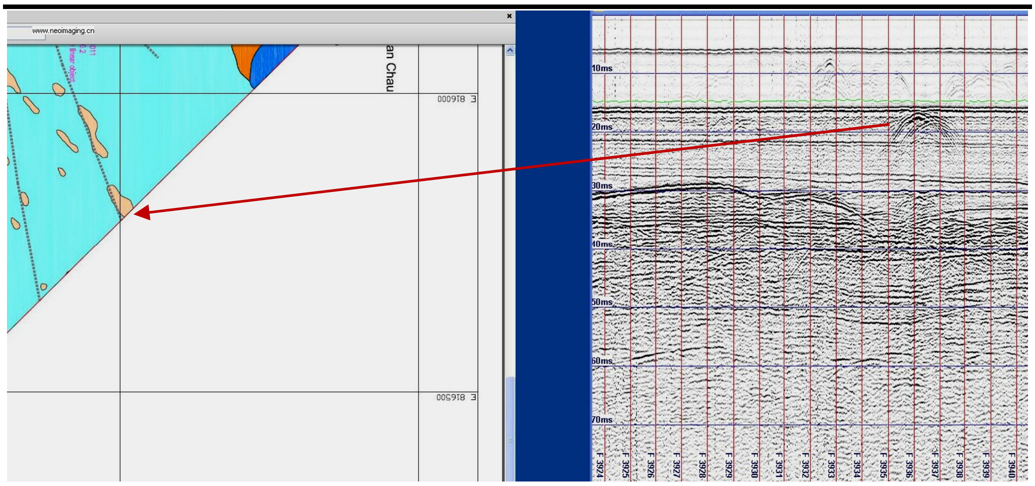
Environmental Resources Management

ERM

Boomer Anomaly ID	Easting	Northing
9	814575 E	819590 N
10	815850 E	820220 N

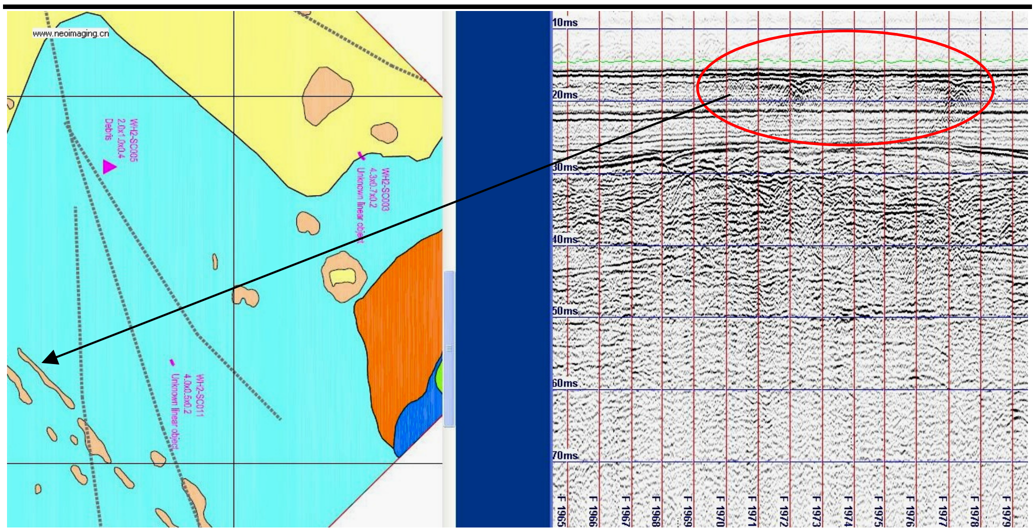
None of the sub-bottom anomalies identified are located within the Study Area. Boomer anomaly numbers 1, 2, 5, 7, 8 are located on the northern and western edges of the Survey Area. Boomer anomaly number 2 appears to be related to dumped materials in this locality (*Figure 9.13*).

Figure 9.13 Boomer Anomaly Number 2 and Dumped Materials on the Seabed



Also sub-bottom anomaly numbers 6 and 10 appear to be related to the dumped materials in this vicinity (*Figure 9.14*) as does sub-bottom anomaly number 4.

Figure 9.14 Boomer Anomaly Numbers 6 and 10 and Dumped Materials on the Seabed



Sub-bottom anomaly numbers 3 and 9 do not have any obvious connections with dumped materials but it could well be the case given the highly disturbed nature of the seabed.

Evaluation of Geophysical Surveys

A review of the data, maps and figures gathered during the geophysical surveys by the marine archaeologist verified the conclusions of the geophysicists that the seabed contained only natural or dumped materials. The Survey Area had been greatly impacted by anchoring, trawling and dredging and the likelihood of it containing any well-preserved remains is minimal.

Whilst no sub-bottom anomalies/ obstructions were encountered within the Study Area, five Sonar Contacts comprised of debris and linear objects were located within the Study Area. The geophysical surveys, therefore, did not locate any shipwrecks or other material of an archaeological nature, and no sites of potential archaeological potential/ values, e.g. possible wrecks or pre-1800 age shipwrecks, have been identified within the Study Area.

9.3 ESTABLISHMENT OF ARCHAEOLOGICAL POTENTIAL

The review of the historical documents and literature indicated that the region in the vicinity of SB was occupied and used by Chinese, then many other foreign traders for many years. The islands of the region contain archaeological evidence of occupation from about 4,000 years ago, including evidence of the use of the sea, and material from the seabed, during that time. The islands of this region became important trading centres for trading vessels from Arabia, Persia, India, IndoChina, the East Indies, and the Portuguese. They also became bases for the many Pirates, given the region's many maritime activities and therefore potential for plunder.

The literature review indicates that the area around SB could offer potential from an historical viewpoint for containing archaeological material, given its sheltered location and proximity to Lantau Island and Chek Lap Kok. The seabed in the region encompassing SB has potentially been affected by the deposition of sediments flowing down the Pearl River and it has also been greatly impacted by anchoring, trawling and dredging and the likelihood of the areas containing any well-preserved remains minimal.

Below the seabed and the Pearl River sediments, it is considered that the sediments of the Late Holocene period, the Hang Hau Formation, offers the greatest potential to include well preserved remains associated with the occupation and use of the islands. The SB area contains a layer of this formation of generally more than 10m in thickness. Fyfe et al. (2000) [(1)] states: '*… that the seabed is in a state of dynamic equilibrium. Available evidence indicates that the rate of Holocene sedimentation has not been steady. Radiocarbon dating suggests that the majority of sedimentation has taken place over the past 4 000 to 5 000 years.*'

(1) Fyfe et al (200) *Op Cit.*

The findings from the review of the databases and the literature failed to locate any evidence of archaeological or historical significant material. The geophysical surveys of the Survey Area located primarily debris, linear objects and dumped materials, and no sub-bottom anomalies/ obstructions were encountered within the Study Area. On the basis of the findings of the geophysical surveys, the Study Area is considered to be of little marine archaeological potential.

All sub-bottom anomalies identified during the geophysical surveys are outside of the Study Area. These anomalies are not considered to be of significant archaeological potential and given their distance from the proposed pits they are unlikely to be affected by this Project. Likewise, the small shipwreck, which due to its size and integrity is likely to be a small, modern sampan, located on the north western edge of the boundary of the Survey Area is well outside of the proposed pit boundary and is unlikely to be affected by this Project.

9.4 REVIEW OF MARINE ARCHAEOLOGICAL IMPACT ASSESSMENT

The proposed SB site is considered to be of little marine archaeological potential. As such, further marine archaeological investigation, i.e. magnetic survey, remote operated vehicle (ROV), visual diver survey or Watching Brief, is not considered necessary.

Since no sites of marine archaeological value are present within the Study Area, no impacts to marine archaeological resources are expected during the construction and operation of the proposed SB facility.

9.5 MITIGATION MEASURES

As no impacts to archaeological resources are expected, no mitigation measure is required.

9.6 RESIDUAL IMPACTS

As no impacts to archaeological resources are expected, no residual impacts are expected.

9.7 ENVIRONMENTAL MONITORING & AUDIT (EM&A)

No EM&A programme is required.

9.8 CONCLUSIONS

A literature review supplemented by geophysical surveys has concluded that no marine resources of archaeological potential have been identified within the proposed SB facility. The proposed Project is thus not expected to impose any archaeological impact and no mitigation measures are considered necessary. No cumulative impact or residual impact is expected.

10 MARINE TRAFFIC

10.1 INTRODUCTION

It has been identified and agreed in the *Initial Review Report* of this Study that the following attributes of the approved EIA report of the SB facility would be updated and/ or verified as part of this EIA review:

- Literature Review to be updated;
- Marine Traffic Impact Assessment to be re-examined; and
- Potential marine traffic impacts to be re-assessed.

The assessment of other concerns related to the SB facility have been addressed in the approved EIA report and based on an initial review of these findings, no further updates were considered necessary.

As recommended in the *Initial Review Report*, the methodologies for the above update/ verification would be by a desktop review of available up-to-date information. This Section presents the outcomes of the proposed update/ verification.

10.1.1 *Objectives of the Marine Traffic Impact Assessment*

The objective of the assignment is to review and update the marine traffic impact assessment conducted in the previous study taking into account traffic activity from adjacent developments and address the following tasks:

- To evaluate the existing and future planned marine traffic environment;
- To assess the impact on marine traffic arising from Project activity associated with the construction and operation of the proposed new South Brothers Facility;
- To ascertain the associated risk levels at the principal stages of the Project; and
- To, if necessary, recommend mitigation measures to reduce the risks to acceptable levels.

For the scope of the MTIA, the area of interest has covered the immediate vicinity of the proposed site and the adjoining fairways.

10.1.2 *Methodology*

The MTIA has been developed in accordance with the Formal Safety Assessment (FSA) methodology adopted by the International Maritime

Organisation (IMO) as a structured approach to the assessment of marine risks, and the effectiveness of control mechanisms. The FSA methodology may be summarised as follows:

- Identification of hazards (a list of all relevant accident scenarios with potential causes and outcomes);
- Assessment of risk (evaluation of risk factors);
- Risk Control Options (devising measures to reduce the identified risks);
- Cost Benefit Assessment (determining the cost effectiveness of each risk control option); and
- Recommendations for decision making (based on the hazards, their associated risks, the alternatives for risk control and their cost effectiveness).

10.2 MARINE HAZARD IDENTIFICATION

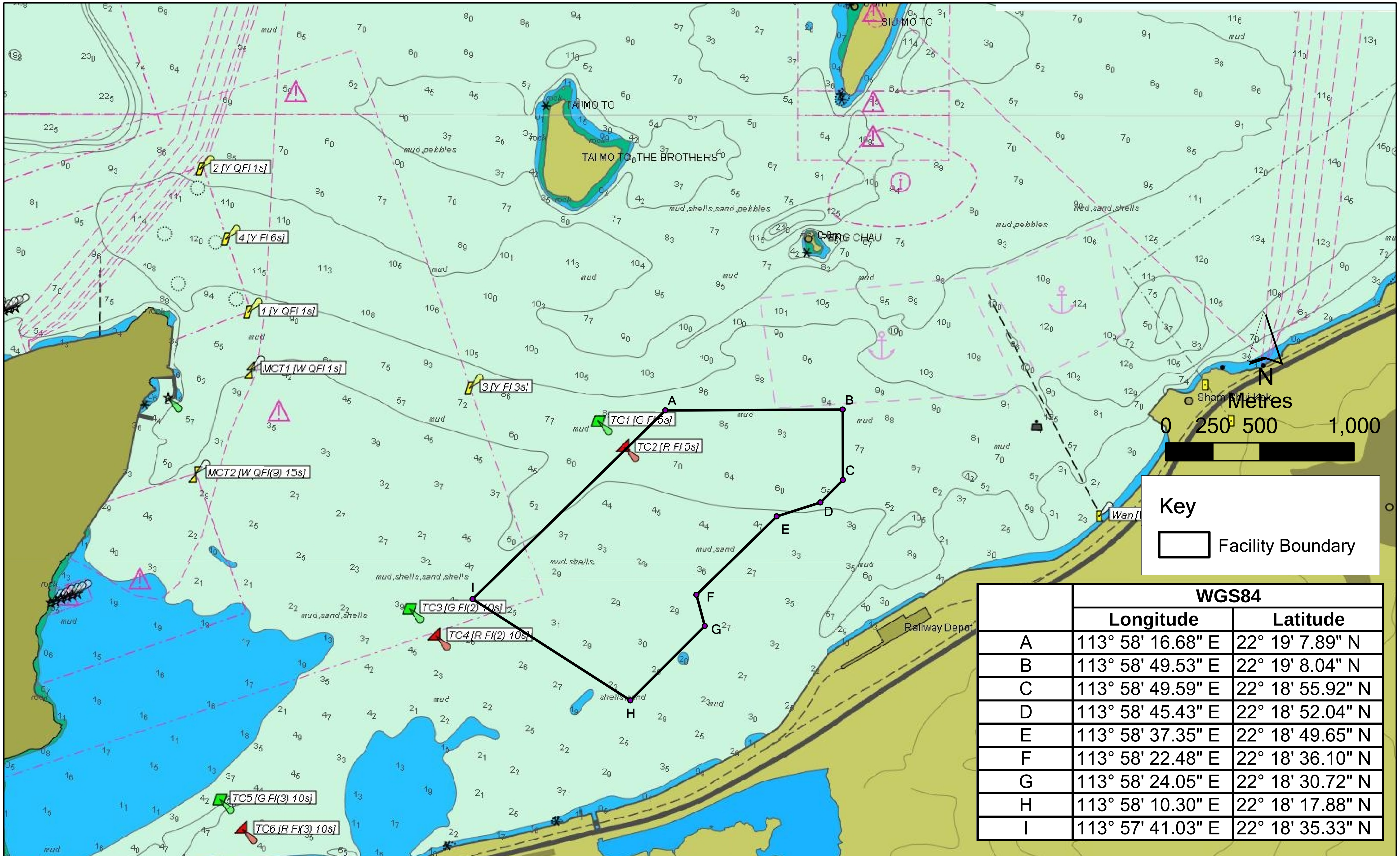
10.2.1 Background

This section reviews the Study Area's marine environment, comprising existing and anticipated marine facilities, a review of present and forecast marine traffic environment, and the Metocean (wind, wave and current) environment. Information on the potential hazards impacting operations at the site is also provided.

The location of the proposed SB facility with regard to other marine facilities is shown in *Figure 10.1*.

10.2.2 Existing Marine Facilities & Anticipated future developments

Figure 10.2 presents the Study Area adopted in this MTIA, and the locations of key local infrastructure adjacent to the SB facility Project area (Facility Boundary of Disposal Pit is marked with exact coordinates of each key boundary points).



	WGS84	
	Longitude	Latitude
A	113° 58' 16.68" E	22° 19' 7.89" N
B	113° 58' 49.53" E	22° 19' 8.04" N
C	113° 58' 49.59" E	22° 18' 55.92" N
D	113° 58' 45.43" E	22° 18' 52.04" N
E	113° 58' 37.35" E	22° 18' 49.65" N
F	113° 58' 22.48" E	22° 18' 36.10" N
G	113° 58' 24.05" E	22° 18' 30.72" N
H	113° 58' 10.30" E	22° 18' 17.88" N
I	113° 57' 41.03" E	22° 18' 35.33" N

Figure 10.1

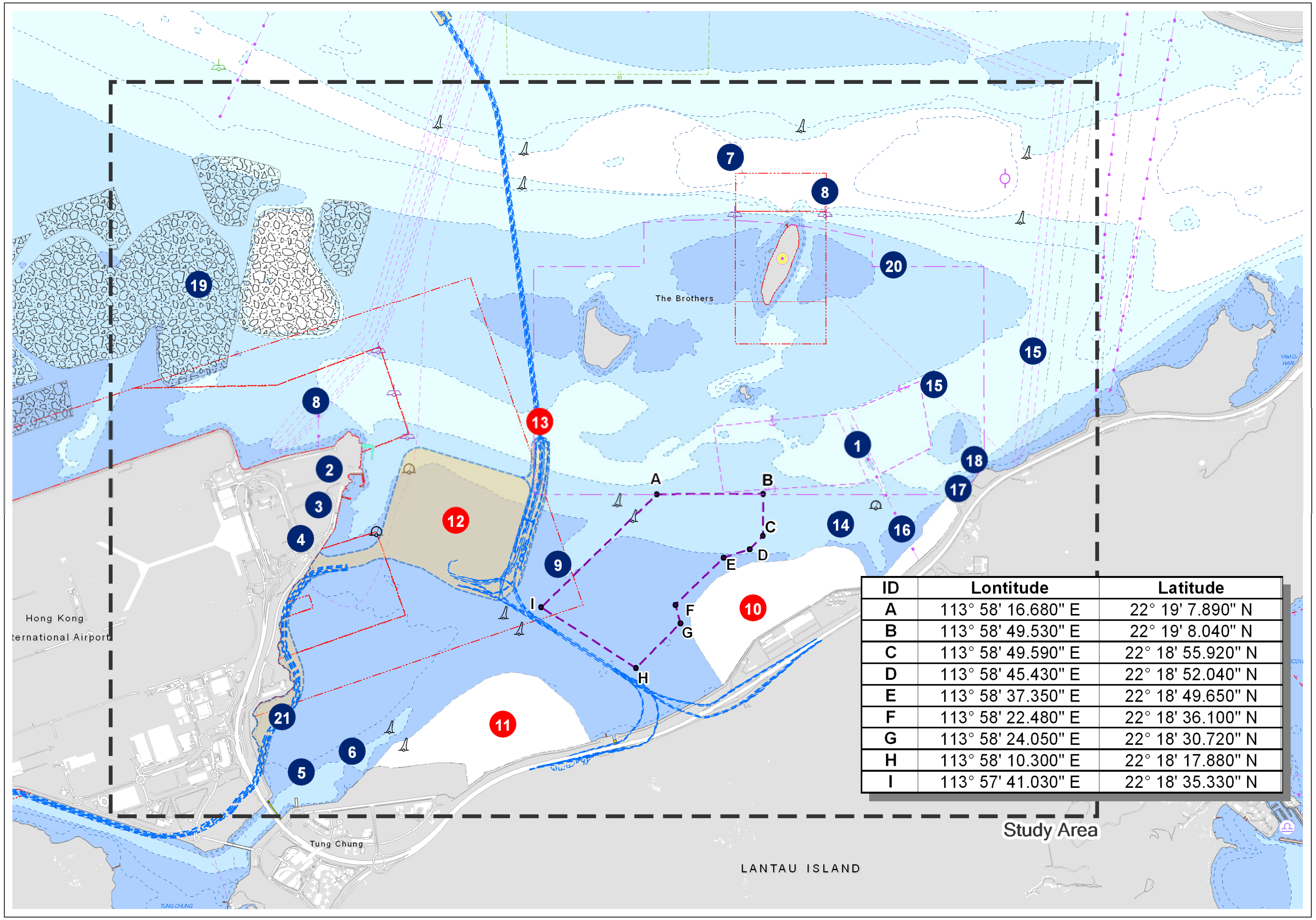
Tentative Layout of the Proposed Contaminated Sediment Disposal Facility at South of Brothers

File: 0106271_gazette boundary pt rev.mxd
Date: 04/05/2012

Environmental Resources Management

ERM

Figure 10.2 Existing and Anticipated Key Local Infrastructure within Study Area (see text below for description of Reference Numbers)



ID	Lontitude	Latitude
A	113° 58' 16.680" E	22° 19' 7.890" N
B	113° 58' 49.530" E	22° 19' 8.040" N
C	113° 58' 49.590" E	22° 18' 55.920" N
D	113° 58' 45.430" E	22° 18' 52.040" N
E	113° 58' 37.350" E	22° 18' 49.650" N
F	113° 58' 22.480" E	22° 18' 36.100" N
G	113° 58' 24.050" E	22° 18' 30.720" N
H	113° 58' 10.300" E	22° 18' 17.880" N
I	113° 57' 41.030" E	22° 18' 35.330" N

Key local marine facilities can be described as follows:

- **Sham Shui Kok Anchorage (Ref. No. 1)** – This designated anchorage had featured two anchorage buoys (A79, A80) for Ocean-Going (OG) vessels; however these were withdrawn in October 2008. The facility still serves as an anchorage area for Ocean-Going vessels.

- **Airport Fire Service Contingent Sea Rescue (Ref. No. 2)** – Harbour and base for catamaran command vessel and support Rigid Inflatable rescue craft.

- **SkyPier (Ref. No. 3)** – Operations started in 29 September 2003 with three berths in its initial phase of operation, with an addition of two berths in its second stage of operation. It supports high-speed ferry services to a variety of ports across the PRD. Commissioning is currently underway of "SkyPier II" a purpose built passenger/ baggage interface terminal.

- **Marine Cargo Terminal (Ref. No. 4)** – Transhipment berth for air cargo transiting by boat into the Pearl River Delta.

- **Tung Chung Ferry Piers (Ref. No. 5)** – supporting a ferry service from Tuen Mun to Tung Chung and on to/from Tuen Mun, Sha Lo Wan and Tai O.

- **Tung Chung Barging Point (Ref. No. 6)** – The barging facility near Tung Chung Ferry Pier has served the short-term construction requirements of Tung Chung but is currently inactive. CEDD has advised that it will be operated for removal of surcharge materials currently stockpiled at Tung Chung Areas 53 and 54 currently scheduled for end 2011 to end 2012.

- **Urmston Road (Ref. No. 7)** – The major conduit for Ocean-Going Vessel and Rivertrade transits east-west between Hong Kong waters and the Pearl River Delta.

- **Government mooring buoy off Siu Ho Wan (Ref. No. 14) –** a buoy off Siu Ho Wan for mooring of Ocean-Going vessels.

- **Submarine power cable off Sham Shui Kok (Ref. No. 15) -** the electrical power transmitting cables running subsea off from Sham Shui Kok Traction Substation to Siu Mo To and Tuen Mun.

- **Submarine outfall off Siu Ho Wan (Ref. No. 16)** – pipeline for discharge municipal or industrial wastewater from Siu Ho Wan Sewerage Treatment Plant to the sea.

- **North Lantau Refuse Transfer Station at Sham Shui Kok (Ref. No. 17) –** The station S located at Sham Shui Kok. It was commissioned since June 1998 and mainly on service of delivering waste to West New Territories Landfill.

- **Chlorine Transshipment Dock at Sham Shui Kok (Ref. No. 18) –** the chlorine trans-shipment dock at Sham Shui Kok for unloading of chlorine drums and cylinders used by Water Supplies Department (WSD) at various water treatment works and chlorination station and other Government Departments.

- **Mud Pits at East Sha Chau (Ref. No. 19) –** similar to proposed mud pits at South of Brothers, which is a contaminated sediment disposal facility for construction works in Hong Kong.

Key local marine water spaces/facilities/constraints include:

- **Airport Restricted Areas at Airport and Siu Mo To (Ref. No. 8)** – a series of height restrictions for transit of marine craft are in place around the airport with limits restricting vessels of 30m+ airdraft, to total exclusions.

- **Tung Chung Navigation Channel (Ref. No. 9)** – 200m wide access channel to Tung Chung pier.

Future facilities that may potentially impact marine transport access requirements are associated with:

- **Lantau Logistics Park (Ref. No. 10)** – This is a proposed logistics park featuring roll-on roll-off jetties. An Environmental Impact Assessment Study Brief was issued in 2004 (1) but no EIA has been delivered, accepted or permits provided. It is understood that the project status is subject to further review in due course and the programme of this project is not certain.

- **Tung Chung Further Development (Ref. No. 11)** – This is a proposal for further reclamation and development; the reclamation demarcation is shown on the Revised Concept Plan for Lantau; however no further details have been developed to date.

- **Hong Kong Boundary Crossing Facilities (HKBCF) (Ref. No. 12) –** Starting construction from 2010 and to be tentatively finished by 2016, this reclamation provides land for boundary crossing support facilities.

- **Tuen Mun – Chek Lap Kok Link (TM-CLKL) (Ref. No. 13)** – Starting from 2010 and to be tentatively finished by 2016, the proposed Tuen Mun – Chek Lap Kok Link comprises of a tunnel section from Tuen Mun to HKBCF and viaduct section from HKBCF to North Lantau. It will provide the most direct route between the Northwest New Territories (NWNT) and Lantau.

- **Proposed Marine Park at Brothers Islands (Ref. No. 20)** –the proposed marine park will be situated at north east of the International Airport

(1) http://www.epd.gov.hk/eia/register/study/ latest/esb-121.htm

(around the Brothers region), is a marine ecology, environment protected areas (MPAs).

- **Proposed Hong Kong Link Road (HKLR) (Ref. No. 21) –** Proposed to be constructed from 2011 to 2016, the HKLR is a dual 3-lane carriageway connecting the proposed HZMB at the HKSAR boundary with the HKBCF with Tunnel section passing under the Scenic Hill and Airport Railway, and connecting to the at-grade road along the eastern coast of Airport Island.

In summary:

- The study area is located at the North of Lantau Island but no overlap to any existing marine facilities,
- No new marine facilities development planned across the study area, but cumulative marine traffic impact was anticipated during the construction phase with HKBCF which has been further studied in Chapter 3 of this report.

10.2.3 Metocean Environment

This section reviews the "Metocean" physical environment of wind generated waves, tidal currents and wind which all posses the potential to impact operations at the site.

Wave

The presence of Lantau Island to the south and the airport island (and the new HKBCF) to the west provides significant shelter from local wind driven waves, while the "fetch" from the north (at Tuen Mun) is short (< 6 km). Hence, it is anticipated that wave exposure will have very limited to nil impact on the motions of vessels anticipated to pass within the Study Area.

Current

Current data may be reviewed with respect to data from the Marine Department's Digital Tidal Atlas (DTA) for the Study Area; this is illustrated in *Figures 10.3* and *10.4*. It is apparent that while currents at the north of Study Area (within Urmston Road) can be strong, currents at the SB facility site are moderate and not likely to impact the construction operations.

Figure 10.3 Current Distribution near Site (Peak Flood Current)

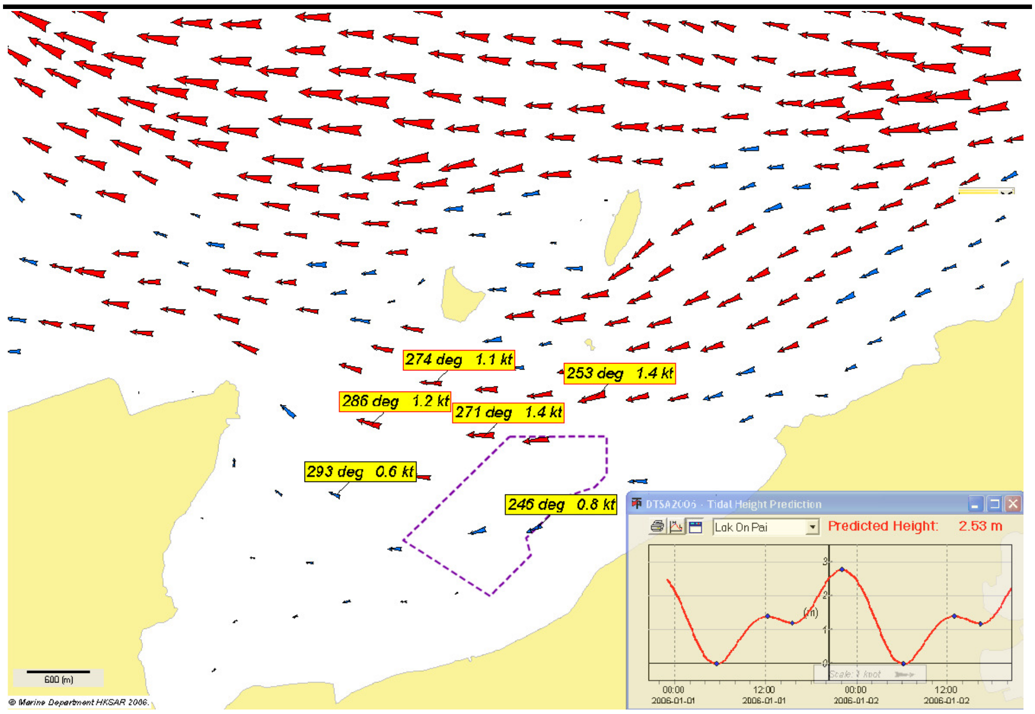
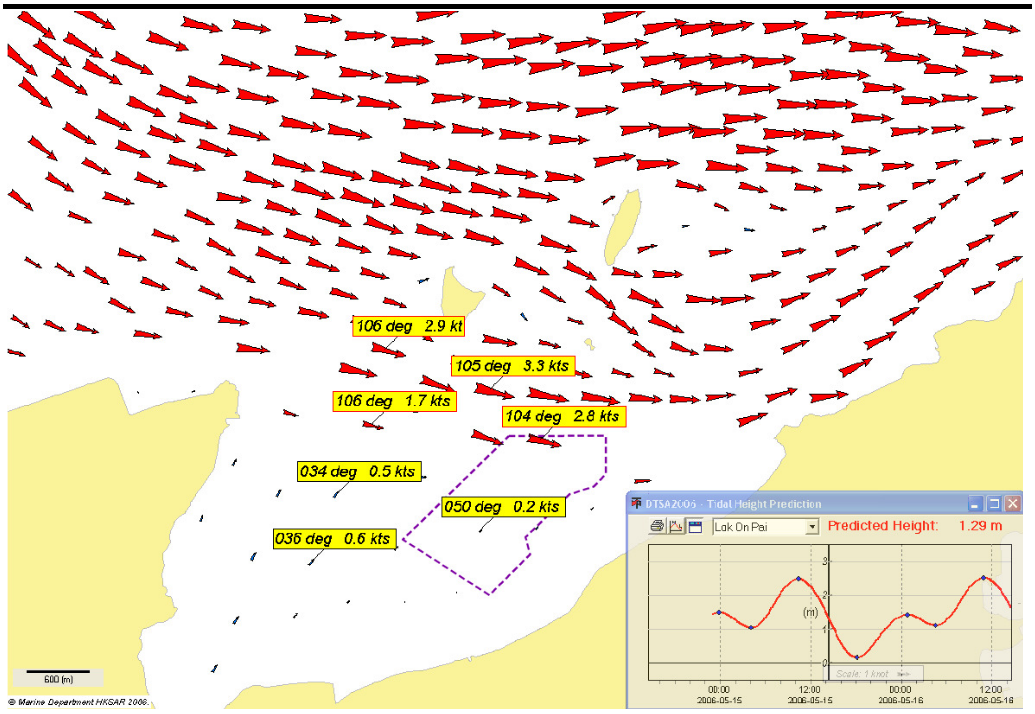


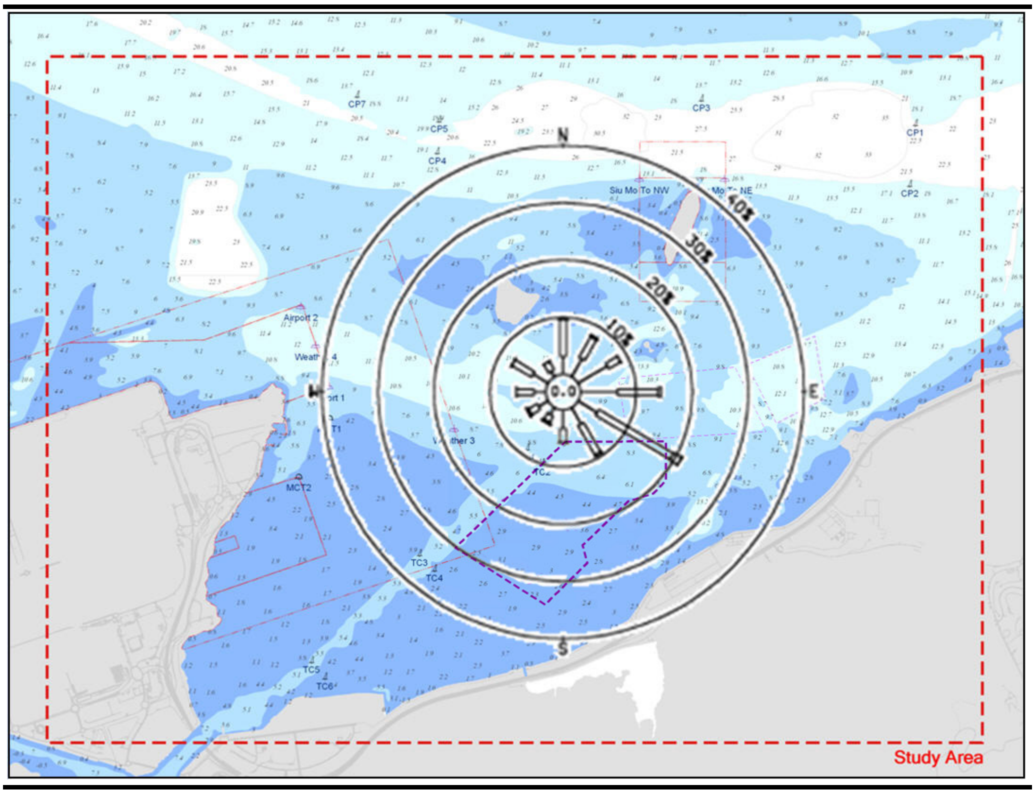
Figure 10.4 Current Distribution near Site (Peak Ebb Current)



Wind Environment

The wind environment at the site can be illustrated with reference to data directly sourced from the Hong Kong Observatory. Annual wind rose for the Tai Mo To within the Brothers in 2008 has also been obtained from Hong Kong Observatory's *Summary of Meteorological Observations in Hong Kong 2008* and is illustrated in *Figure 10.5*.

Figure 10.5 Wind Rose at Tai Mo To within the Brothers in 2008



From the wind rose it can be identified that the most dominant wind direction is from north, through to predominant south-easterlies, consistent with conditions across Hong Kong.

Visibility

The transhipment of the contaminated mud to the SB facility will be impacted, like all other craft in Hong Kong, by changes in the visibility within the approach channel and along the transit routes. *Table 10.1* provides the details on percentage frequency of visibility within Hong Kong Waters during 2004-2008.

Table 10.10.1 Annual Percentage of Restricted Visibility during 2004-2008

Month	1.0km	3.0 km	5.0 km	10.0 km
Year	0.1%	2.5%	10.7%	47.8%

Source: Summary of Meteorological Observations in Hong Kong 2004-2008, Hong Kong Observatory

It is identified that periods of very low visibility (< 1.0 km) are rare with only 0.4 days per year being impacted in such a manner. This is not anticipated to hazard Project operations.

10.2.4 Present Marine Traffic Review

Existing information on traffic levels within the HKSAR western waters has been collated from a number of data sets to assist in the risk assessment of barging operations. Principal details were extracted from the following available sources:

- Radar track data on the traffic activities in HKSAR Western Waters, June 2003;

- 12 day time-lapse visual survey data were taken reference from the TM-CLKL and HKBCF investigation project which data were collected in August/September 2008, with camera location at Fire Services Department (HKIA, at of East Sea Rescue Station) directed towards South-east to identify the Study Area traffic that may pass over the future SB facility sites. (*Annex F*)

- Review of regular domestic ferry schedules from Tuen Mun to Tung Chung.

The visual survey has adopted a series of traffic gates to collect vessel movements individually enabling the analysis of traffic distribution within the Study Area on the basis of a series of classes. The traffic activity was summarized and compiled by vessel class based on the average pattern of routes. The traffic data for the Study Area has been presented in the form of traffic route and traffic density, in *Figures 10.6* and *10.7* respectively.

The figures also indicate the concurrent project such as the Hong Kong Boundary Crossing Facilities (HKBCF) and Tuen Mun – Chek Lap Kok Link (TM-CLKL) within the vicinity water area.

Figure 10.6 Distribution of Traffic Routes within the Study Area

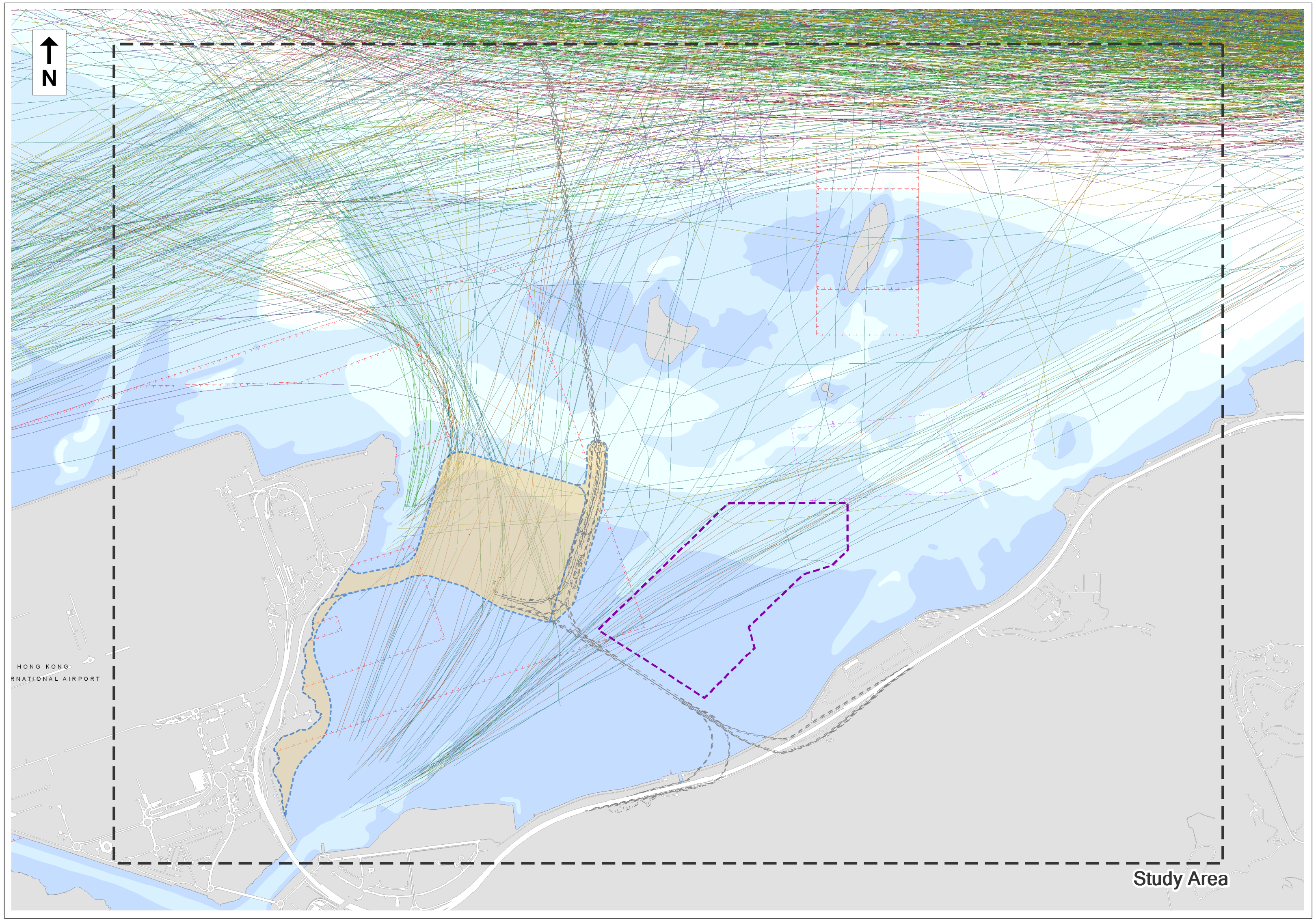
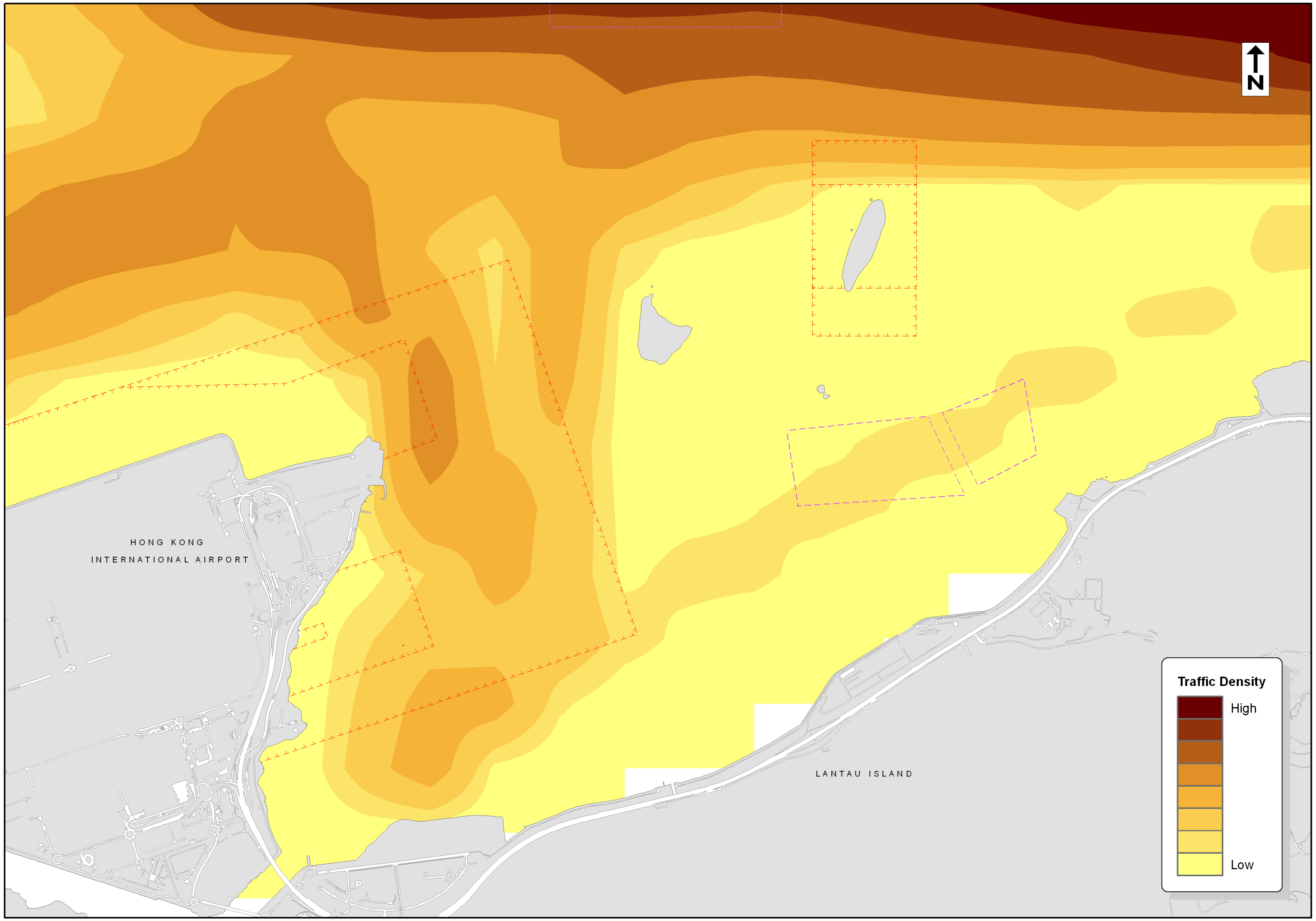


Figure 10.7   Relative Traffic Density



The dominant traffic activity within the Focussed Study Area is set to the north-east of the existing airport platform and is associated with SkyPier and Marine Cargo Terminal traffic. The traffic density that may be most directly impacted by the project Works is located east of the future HKBCF, and is associated with constraints within narrow approaches to Tung Chung.

Figure 10.8 illustrates the distribution of vessel activity surveyed across the Project Area. It is developed on the basis of a series of classes, as identified in *Table 10.2* below.

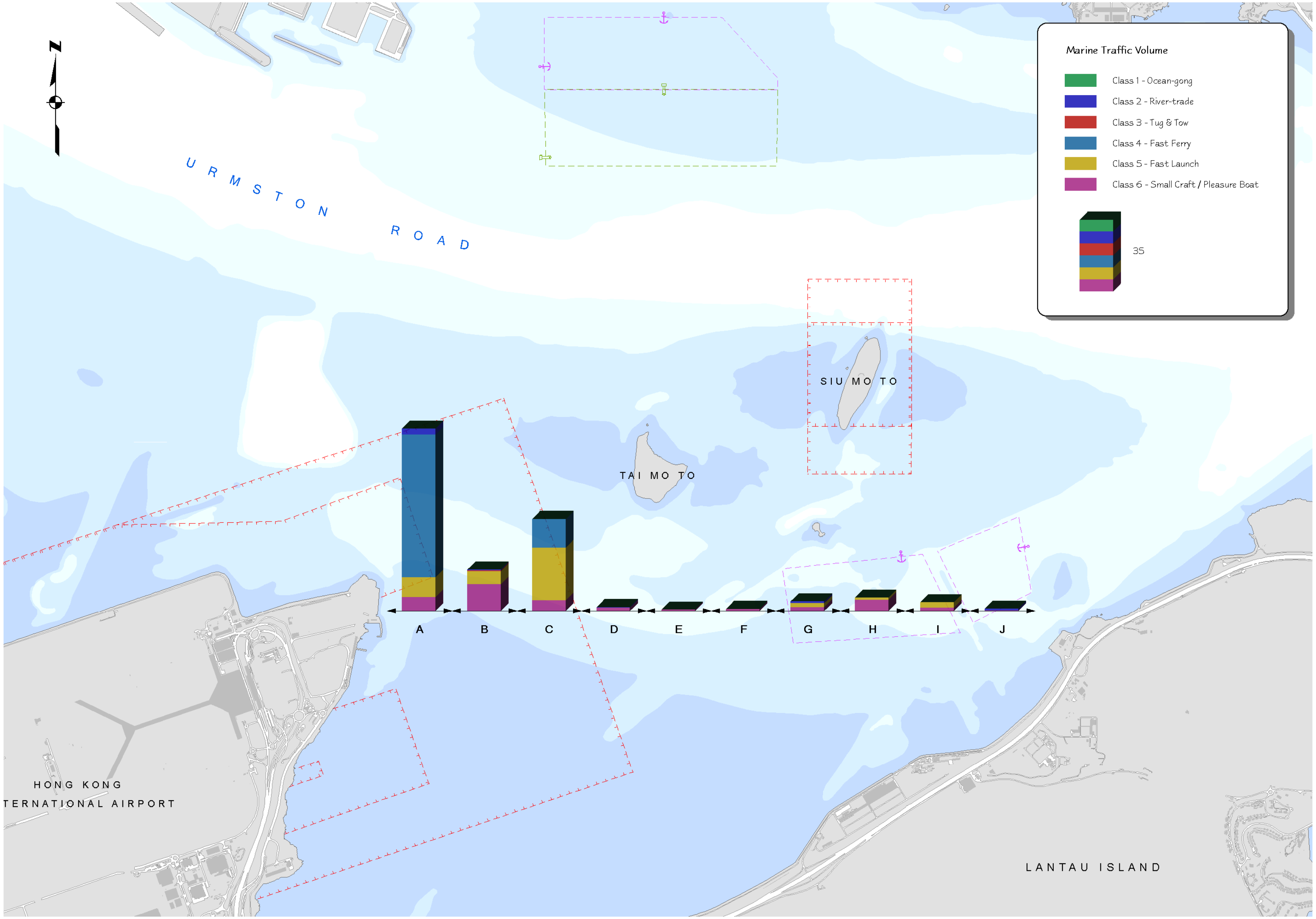
Table 10.10.2 Traffic in Project Area

Vessel Class	Daily Traffic Volume (2008)
Class 1 – Ocean-going	0
Class 2 – River-trade	4
Class 3 – Tug & Tow	1
Class 4 – Fast Ferry	70
Class 5 – Fast Launch	4
Class 6 – Small Craft	5
Total	***84***

The Project Area is crossed by a variety of vessels, the predominate vessels are:

- Fast ferries associated with SkyPier activity
- Domestic Ferry Service from Tuen Mun to Tai O via the Tung Chung & Airport Sea Channels
- Small local fishing vessels

Figure 10.8 Traffic Distribution across Study Area



10.2.5 *Historic Hazards within the Study Area*

The principal hazard posed by marine traffic is the potential for collision between barges associated with mud transport operations, or the target barge, and other traffic.

The consequences of collision incidents within the HKSAR water as a whole, and what may be assumed for the present assessment, has been summarised in *Table 10.3* where it is identified that an average injury rate per collision is approximately 20%, while the fatality rate per collision is 2%.

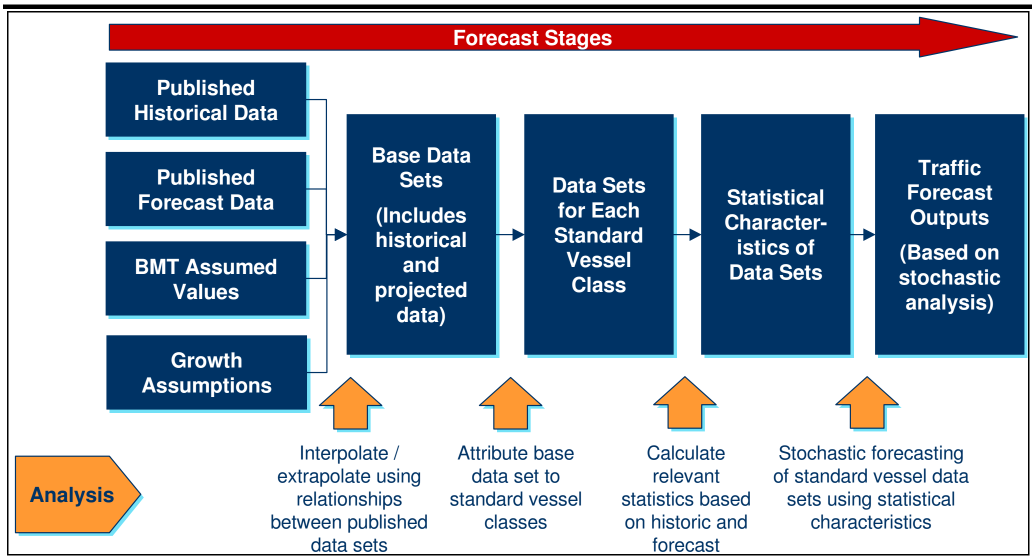
Table 10.10.3 Consequence of Vessel Collisions (within HKSAR waters)

Incident		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Ave
Collision /Contact	Incident	246	302	242	236	263	259	239	253	181	206	243
	Injury	34	48	33	27	56	27	148	7	20	38	44
	Fatality	12	0	1	14	0	0	3	2	1	18	5
Injury/Collision or Contact		0.14	0.16	0.14	0.11	0.21	0.10	0.62	0.03	0.11	0.18	0.18
Fatality/Collision or Contact		0.05	0.00	0.01	0.06	0.00	0.00	0.01	0.01	0.01	0.09	0.02

10.2.6 *Marine Traffic Forecast*

The MTIA requires forecasts of future densities and types of traffic. The methodology adopted is consistent with past techniques developed and applied in HKSAR waters, notably the MARA Study and is summarised in *Figure 10.9*.

Figure 10.9 Forecast Methodology



The methodology takes account of international and local factors and makes reference to a number of data sources. The forecast traffic increases within the focused project area have been projected considering the SB facility scenarios (2012 for construction case and 2021 for future operation case) as below in *Table 10.4*.

Table 10.10.4 Forecast Vessel Growth

Vessel Type	2012	2021
Ocean-Going Vessel	24%	29%
River-trade	4%	19%
Tug & Tow	4%	19%
Fast Ferry	-6%	10%
Fast Launch	2%	5%
Small Craft	-9%	-22%

10.2.7 Contaminated Mud Pit Construction Proposed Stages & Work

Key Construction Works

The proposed SB facility is illustrated in *Figure 2.1* and the main construction and barging activities for Pit 1 and Pit 2 can be summarized as below:

- Dredging Construction (Stage 1) – The dredging operations would be done by grab dredgers. The work amount within the project boundary shall not exceed 100,000m^3 per week, approximately 125 barges activities per week - 18 activities per day.

- Backfilling Operations (Stage 2) – This operation would be done by both hopper barge and TSHD and the works within the project boundary shall not exceed a disposal rate of 26,700m^3 per day - approximately 33.3 hopper barges activities or 6 TSHD activities per day.

- Capping Operations (Stage 3) – Similar as Stage 2, this operation will be adopted by only hopper barge and the work amount is same with Stage 2. Approximately 33 hopper barges activities per day are anticipated.

It was identified in *Figure 10.2* and *Section 10.2.2* that the boundary of study area is surrounded by numbers of Marine Facilities. To minimize the impact to the facilities, no barge shall be allowed to work outside the mud pit boundary especially the Tung Chung Navigation Channel during construction and operation stage.

Construction and operation vessels activities details and programming stages could be summarized in *Tables 10.5* and *10.6*. The projected maximum daily barges activities are summarized in *Table 10.7*.

Table 10.10.5 Construction & Operation Activities (within HKSAR waters)

Dredging			
Grab Dredging			
Dredging Rate		50,000 m^3 wk^{-1}	
No of Dredgers		2	
Total Volume Dredged		100,000 m^3 wk^{-1}	
Barge Capacity		800 m^3	
Total Barges per Week		**125**	
Backfilling			
Hopper Barge Disposal		TSHD Disposal	
Disposal Rate	26,700 m^3 day^{-1}	Disposal Rate	26,700 m^3 day^{-1}
Barge Capacity	800 m^3	Dredger Capacity	4,500 m^3
Total Barges per day	33.3	Total Dredgers per day	5.9
Total Barges per Week	**233**	**Total Dredgers per week**	**41**
Capping			
Hopper Barge Capping			
Disposal Rate		26,700 m^3 day^{-1}	
Barge Capacity		800 m^3	
Total Barges per day		33.3	
Total Barges per Week		**233**	

Table 10.10.6 Proposed Construction Stages

Pit	**Operation**	**2011**		**2012**		**2013**		**2014**		**2015**	
		Jan-Jun	**July-Dec**	**Jan-Jun**	**July-Dec**	**Jan-Jun**	**July-Dec**	**Jan-Jun**	**July-Dec**	**Jan-Jun**	**July-Dec**
2	Dredging										
	Backfilling										
	Capping										
1	Dredging										
	Backfilling										
	Capping										

Table 10.10.7 Projected Maximum Daily Barges Activity

Operational Years	**Marine Operation**	**Pit 2**	**Pit 1**	**Total**
July 2011 – June 2012	Dredging Stage	36	--	36
July 2012 – June 2013	Backfilling Stage	68	--	104
	Dredging Stage	--	36	
July 2013 – June 2014	Capping Stage	68	--	136
	Backfilling Stage	--	68	
July 2014 – June 2015	Capping Stage	--	68	68

Average construction activity will be 86 vessels per day during the Works.

The values assumed for barge activity are very much upper bound (assuming peak activity of major projects). *Table 10.7* suggests that the maximum activity appearing in 2013/2014 is 136; however the greater constraint to navigation will occur during the dredging stage when a large volume of dredgers are present at the site and traffic must divert into Tung Chung navigation channel. In consequence the critical timeframe is considered between July 2012 – June 2013 when up to 104 vessel movements may occur. Given this value exceeds the annual average it will be adopted for assessment.

Construction Vessels

The variety of construction vessels that may operate in study water area is illustrated in *Figure 10.10* and *10.11* (grab dredgers, split hopper barge and Trailing Suction Hopper Dredger (TSHD)).

Figure 10.10 Grab Dredger and Split Hopper

Figure 10.11 Grab Dredgers with Hopper Barges Barge and Trailing Suction Hopper Barge

10.2.8 *Summary*

A review of the existing constraints and hazards has been conducted and the following summary developed:

- Metocean (currents, wind, wave and visibility) impacts within the SB sites will not be significant;
- A summary of current traffic has been conducted. Collating visual survey and radar data it is identified that there are approximately 84 vessel movements within the Study Area per day;
- Key construction vessels have been identified as Grab Dredger, Hopper Barge, Split hopper barge and TSHD.
- There will be a significant local increase of marine traffic due to the dredging, backfilling and capping operations, a value of slightly over 100 movements per day has been adopted for risk assessment.

10.3 *STUDY AREA MARINE TRAFFIC ACTIVITY & RISK PROFILE*

This section presents a review of the Study Area's marine traffic activity and risk profile. The baseline risk profile is developed together with an assessment of construction impacts and future operation phase.

10.3.1 *Scenarios*

The following scenarios are reviewed:

- Baseline - 2008
- Construction Stage – 2012 with Project stages
- Operational Stage – 2021 with / without Project stages

10.3.2 *Risk Potential Assessment Methodology*

BMT's Vessel Encounter Risk Assessment model was used to predict risk levels in the Study Area based upon the mapping of traffic routes, and the requirement for these routes to be manipulated around the SB facility construction and operation area as the development of the Project.

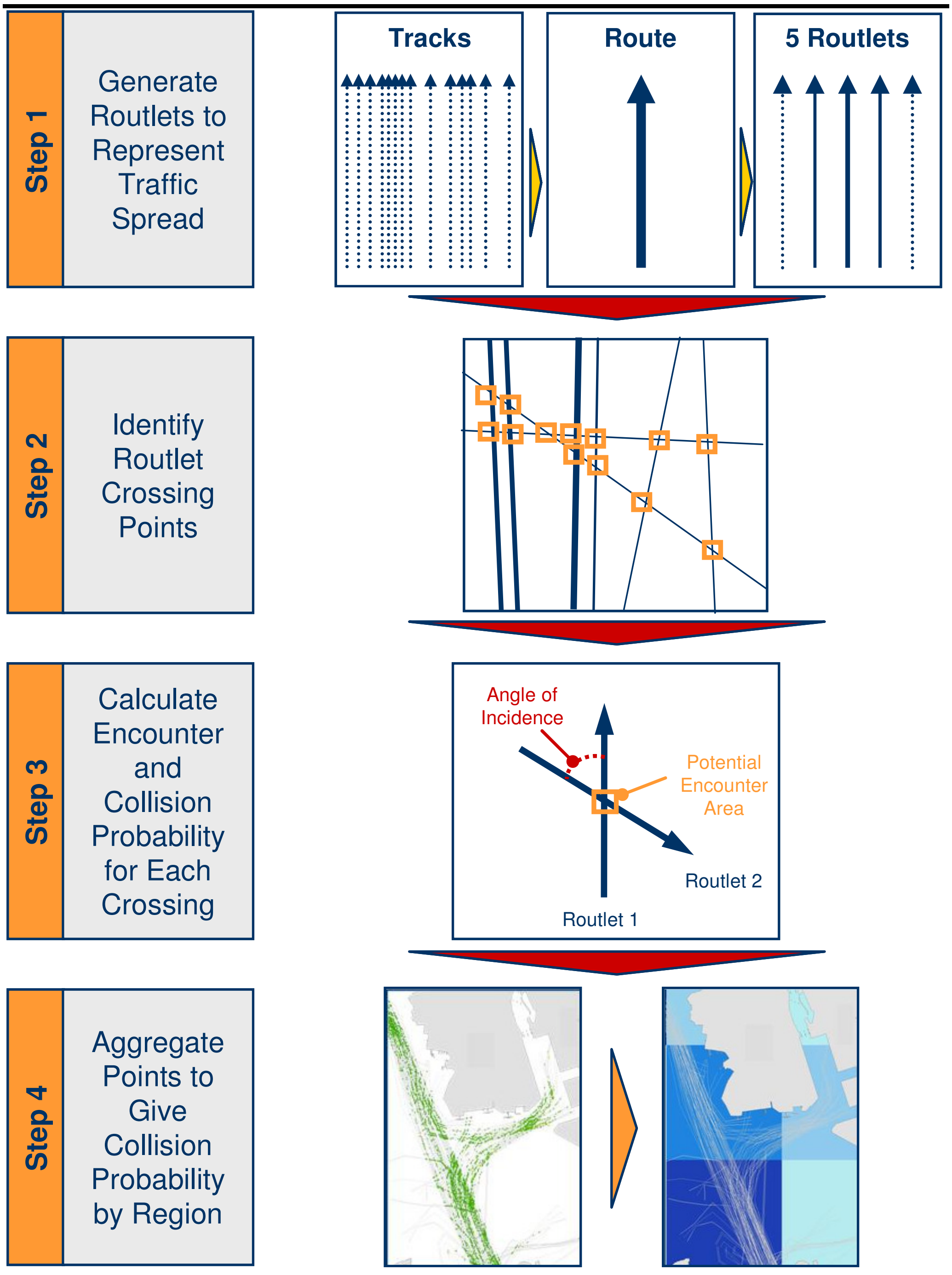
An overview of the methodology is presented in *Figure 10.12*, and is a "frequency domain" approach to collision risk assessment that allows rapid review of results. The model maps "encounters" – risk potential and the chance for incidents to occur as a result of traffic interaction.

Having first identified the location of traffic routes the model identifies all route intersection points. For each point, it then examines the traffic volume along the two constituent routlets at each hour through the day (with each route representing a specific vessel class). From this it identifies the probability of vessels from both routes being at the intersection point concurrently (a function of vessel size, traffic volume and speed). This is referred to as the 'encounter probability'.

An angle factor is then applied to each intersection point to calculate a 'collision probability' based on both the probability of encounter and relative bearing of the two routes – this factor draws on BMT's long experience with time-domain models. Collision probabilities are then aggregated to describe the risk potential environment by region.

As the model is based on a Graphical Information System (GIS) the output of changes in risk profile may be rapidly made and presented.

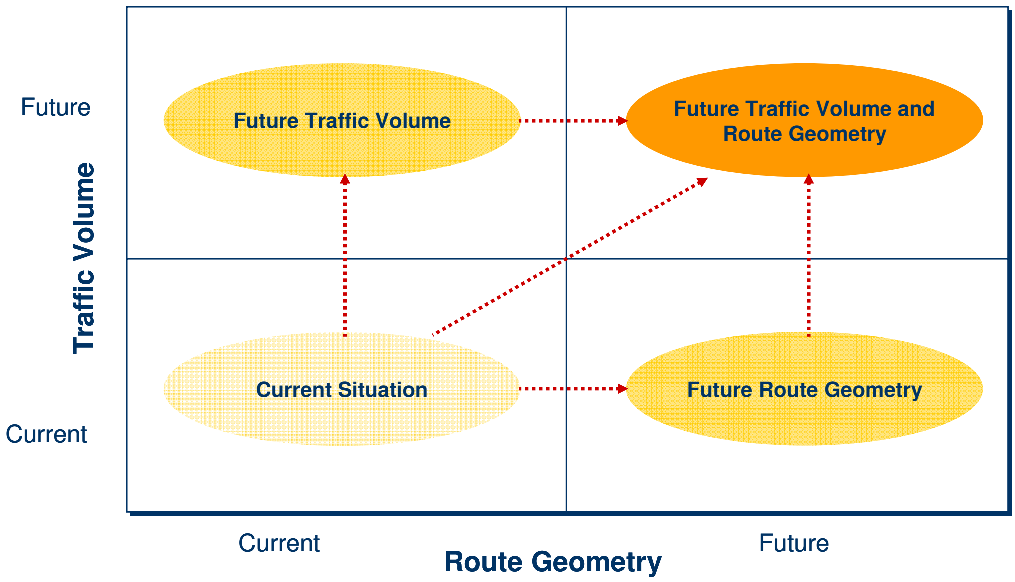
Figure 10.12 Vessel Encounter Risk Assessment Methodology



The steps taken to map and assess risk potential are presented in *Figure 10.13*. The analysis involved making changes to both traffic volume and route geometry and assessing the individual and cumulative effects on traffic density and risk. This allows the key contributors of risk to be isolated.

In this case 2008 represents the current case, while a 2021 timeframe represents the future. An interim 2012 construction case has also been examined.

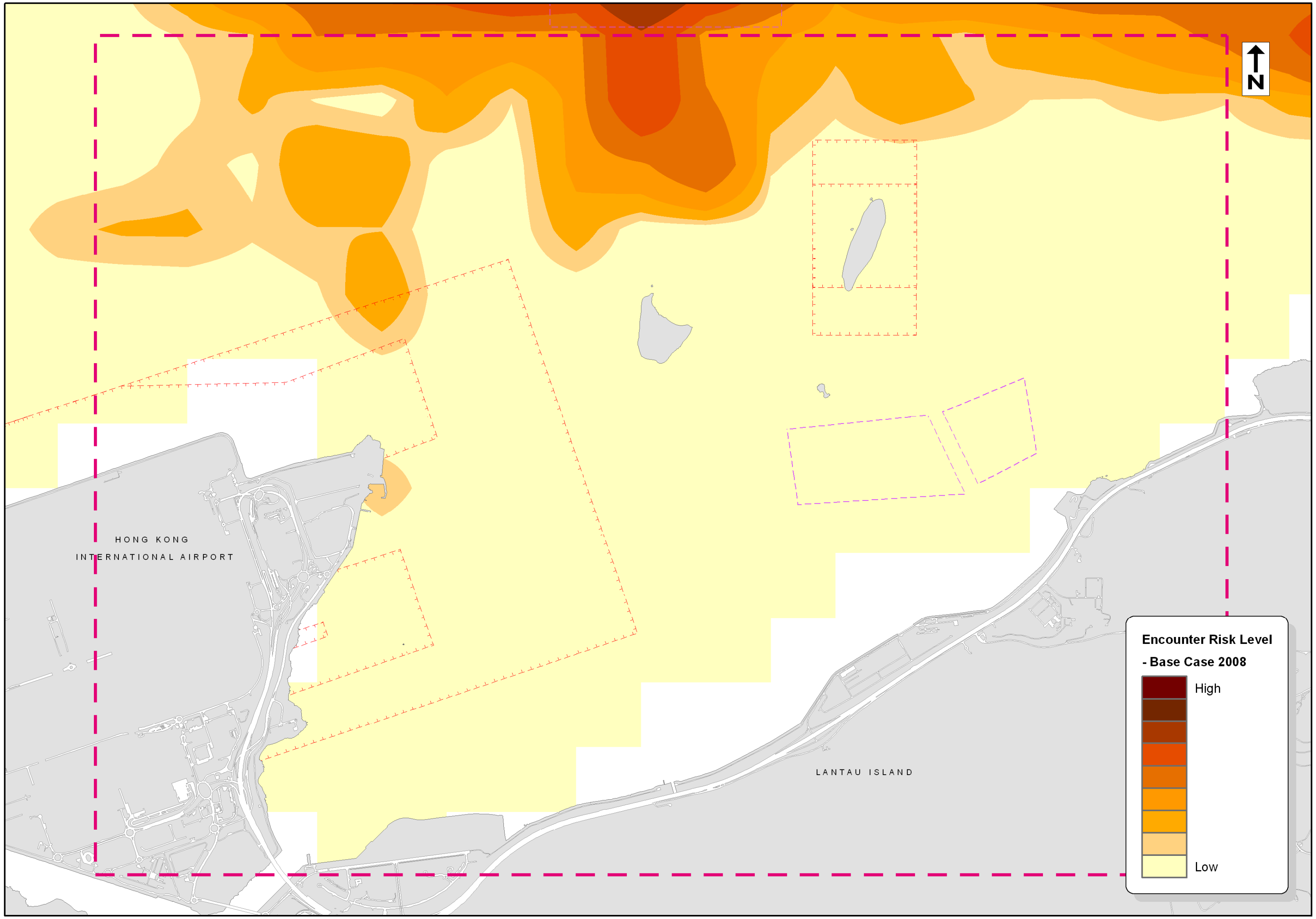
Figure 10.13 Methodology for Future Vessel Routing and Risk Assessment



10.3.3 2008 Baseline Risk Profile

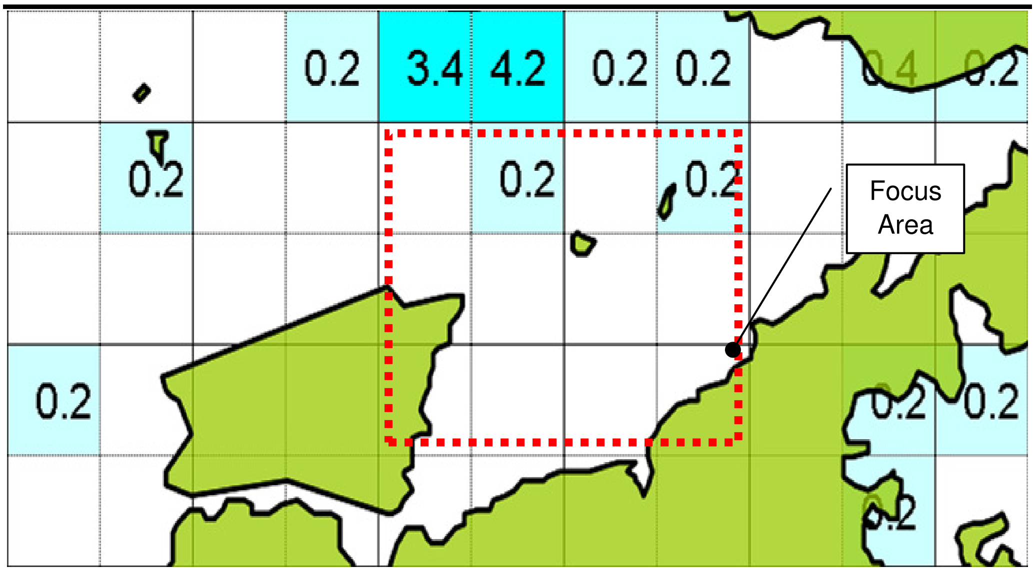
The Baseline 2008 Risk Distribution has been developed from the traffic activity mapped in *Figure 10.6* and is illustrated in *Figure 10.14*.

Figure 10.14 Baseline 2008 Risk Distributions



This risk distribution may be compared with the collision incident density distribution (*Figure 10.7*). *Figure 10.15* illustrates the average annual reported collision within the Study Area for average of 5 years.

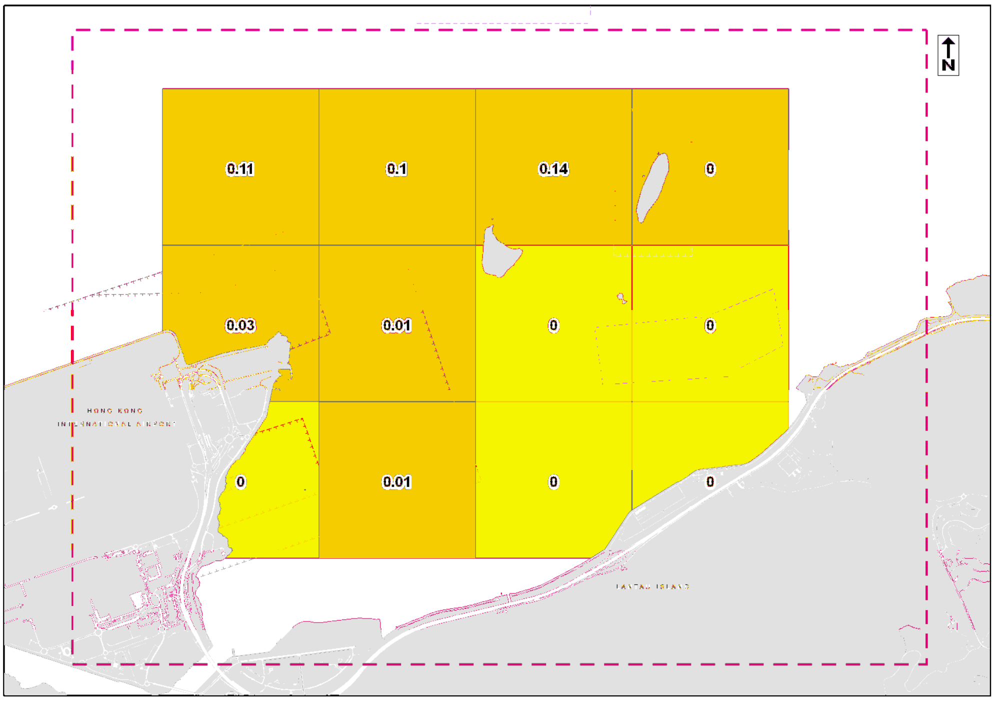
Figure 10.15 Average (from 5 years 2003 to 2007) Collision Distribution



There were total of eight incidents within the focused Study Area from Year 2003 to Year 2007, involving collision, grounding and flooding, of which seven of them occurred near to the Urmston Road, and one of them was at the east of the proposed mud pit. Two incidents were reported as collisions; therefore 0.4 collisions per year (2 collision / 5 years) were identified within the Study Area (Area of red dotted line in *Figure 10.15*).

There was no casualty report associated with the two collision incidents. The model output for this area is illustrated in *Figure 10.16* which illustrates a total of 0.4 collisions in year 2008, good agreement which provides confidence in the model being used for forecast purposes.

Figure 10.16 *2008 Baseline Focus Area Collision Distribution*



10.3.4 *2012 Construction Stage Impacts*

The barge movements based on the construction programme associated with the SB facility and other concurrent projects activity (TM-CLKL and HKBCF) in the Study Area has been identified in *Figure 10.17*.

The construction stage 2012 Risk Distribution has been developed from the traffic activity mapped in *Figure 10.17* (uplifted to 2012 levels, based on the methodology of the MARA Study, see *Section 10.1.2*).

Figure 10.18 illustrates the full network of the existing relocated local traffic routes due to the construction activities within the Study Area, and the risk distribution is illustrated in *Figure 10.19*.

Figure 10.19 illustrates the risk during the construction phases in the waters directly surrounding the project Works Area. In addition, the traffic model has been used to predict collisions during the construction stage, which can be seen in *Figure 10.20*.

During the construction stage, the model output predicts for this area a total of 0.93 collisions per year, compared to the current 0.4 collisions per year (*Figure 10.16*), an increase of 0.53 collisions per year.

Figure 10.21 illustrates the change in risk as a result of the construction activity of the SB facility and other concurrent projects activity (TM-CLKL and HKBCF) in vicinity area. It is identified that there is increased risk (1) west and north of the SB facility, proximity along the entrance of the Tung Chung channel, and (2) at the corner of the Marine Restricted Areas. These increased risk levels may be attributable to a general increase in marine traffic in the vicinity, and specifically (1) disposal traffic from north to mud pit crossing the Tung Chung channel, and (2) construction traffic from HKBCF to/from the east.

It is likely that precautionary measures should be made through identification of traffic lanes for disposal vessel, and clearly demarcated and nominated Works craft anchorages. Access lanes must be aligned clear of the barges transit lanes as best possible. This may aid in controlling the risk of collisions throughout the construction process.

Figure 10.117 2012 Backfilling Stage Case Barge Distribution

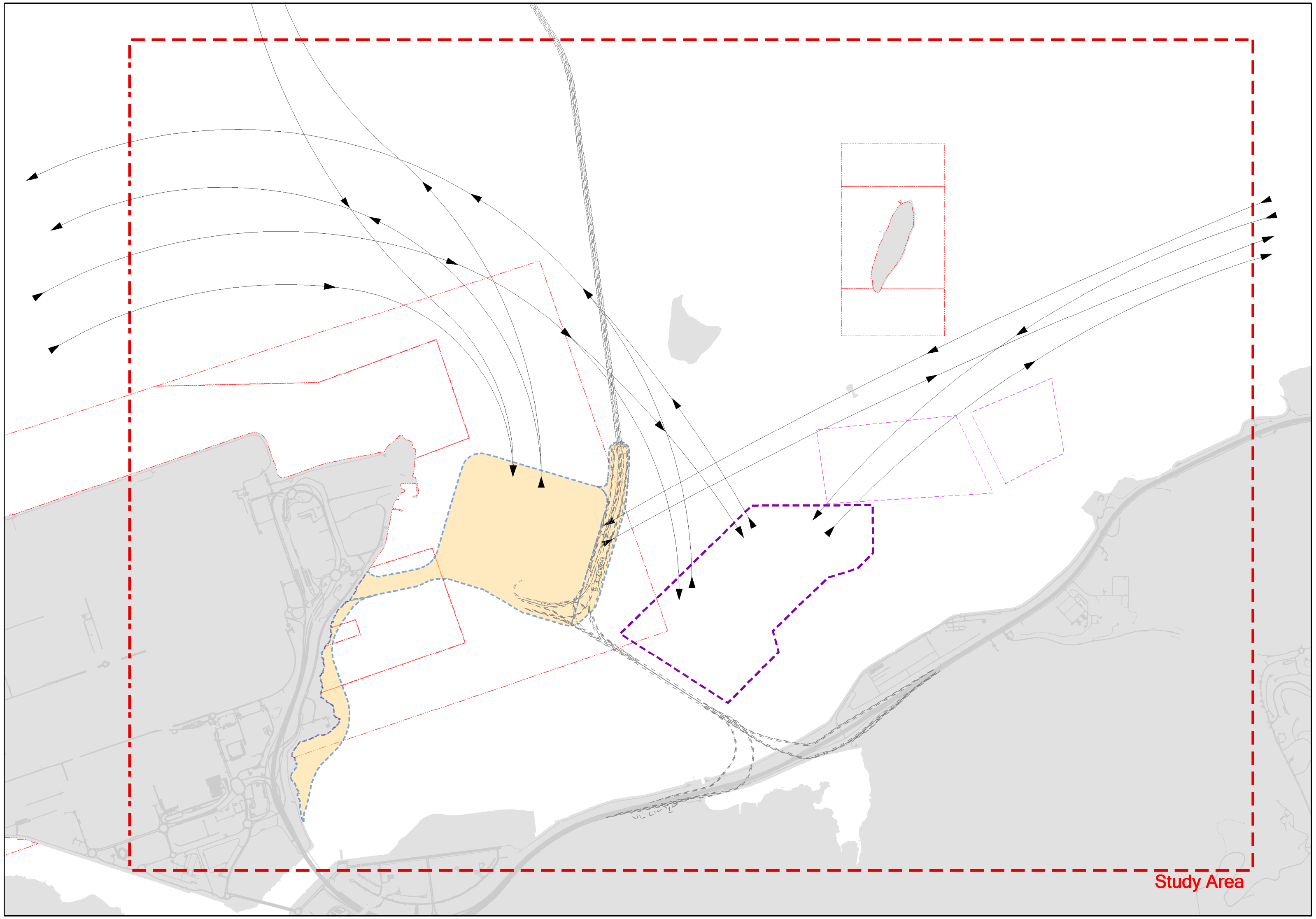


Figure 10.218 2012 Construction Case Route Network

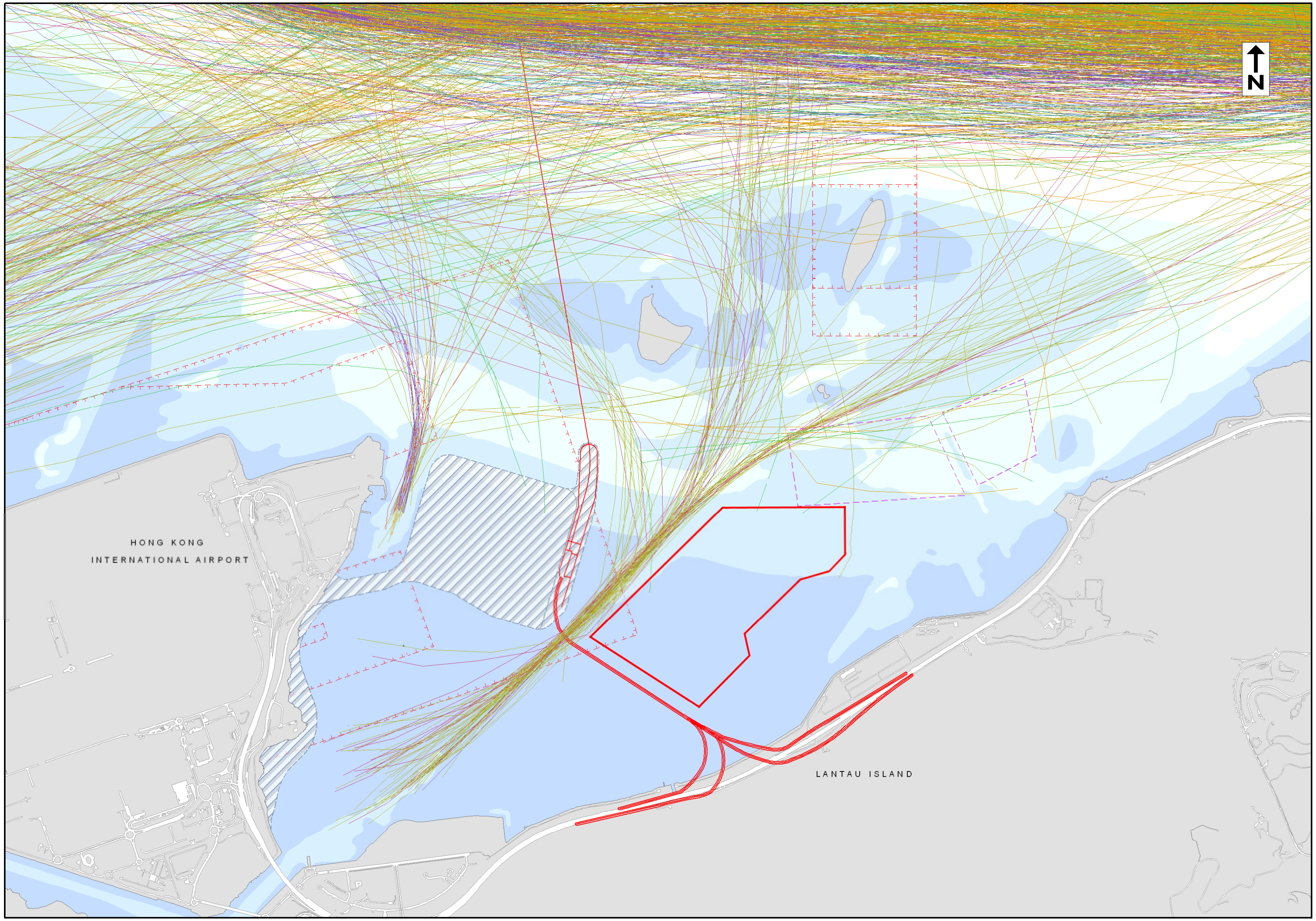


Figure 10.319 2012 Construction Stage Risk Distribution

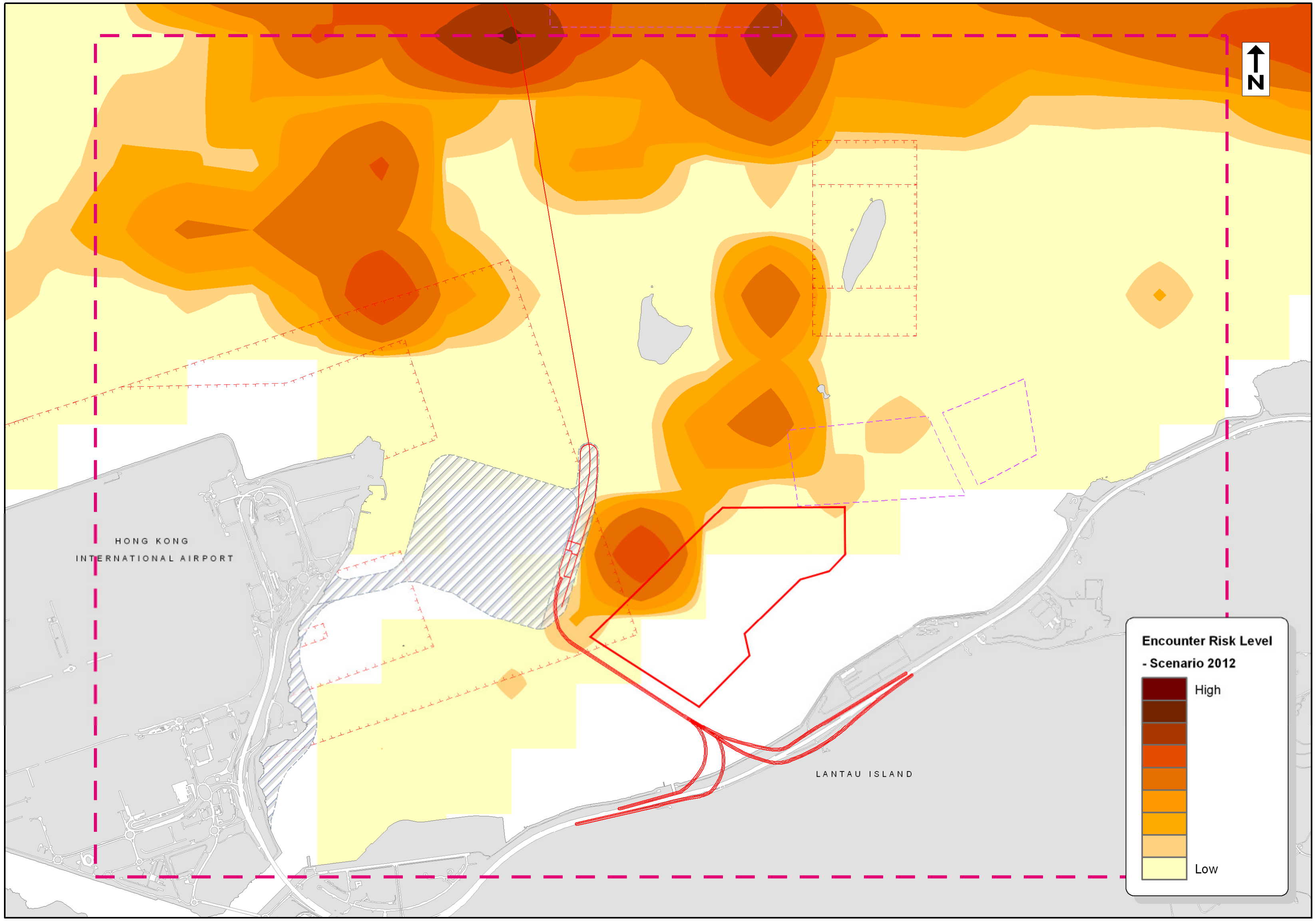


Figure 10.420   2012 Construction Stage Case Focus Area Collision Distribution

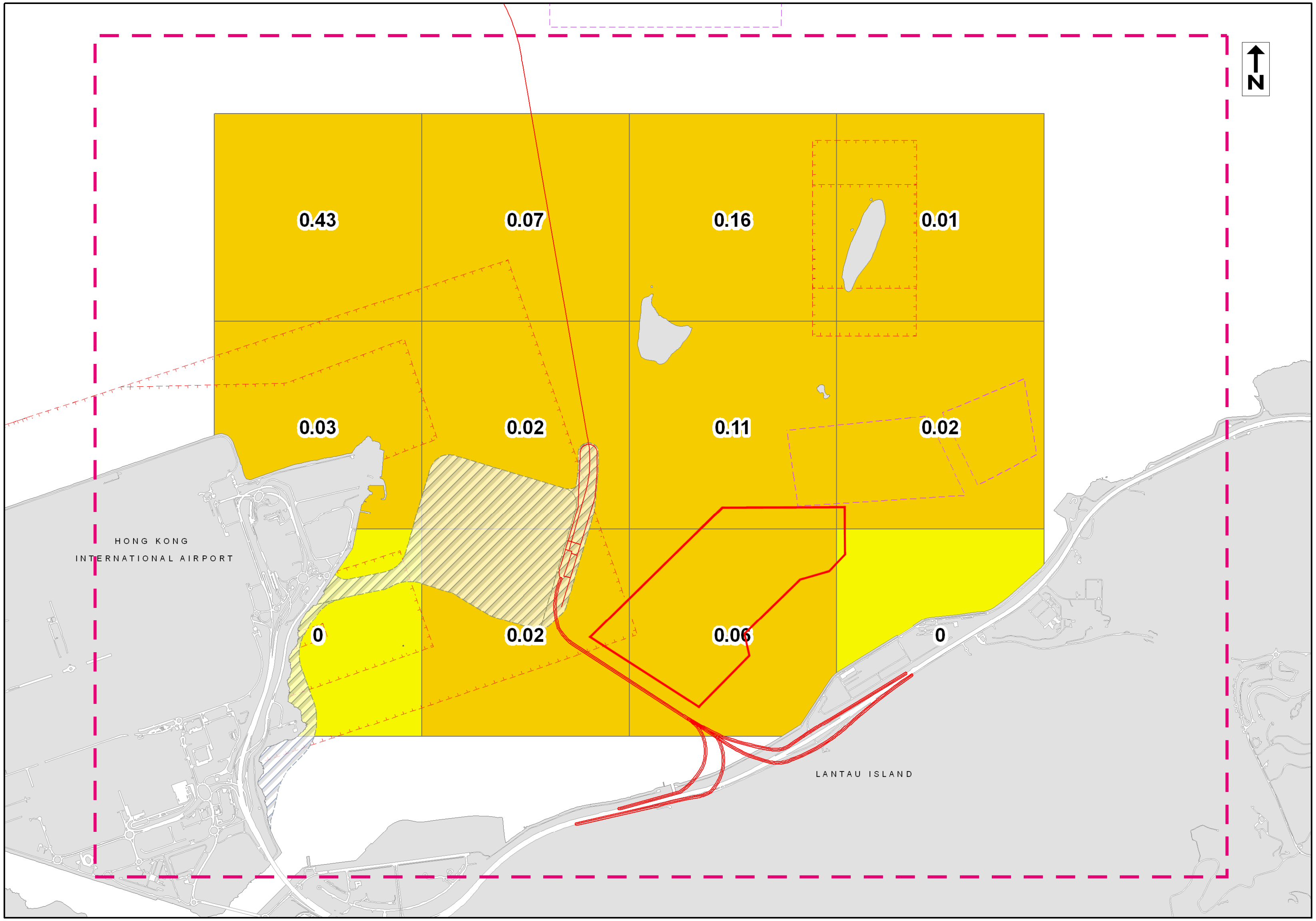
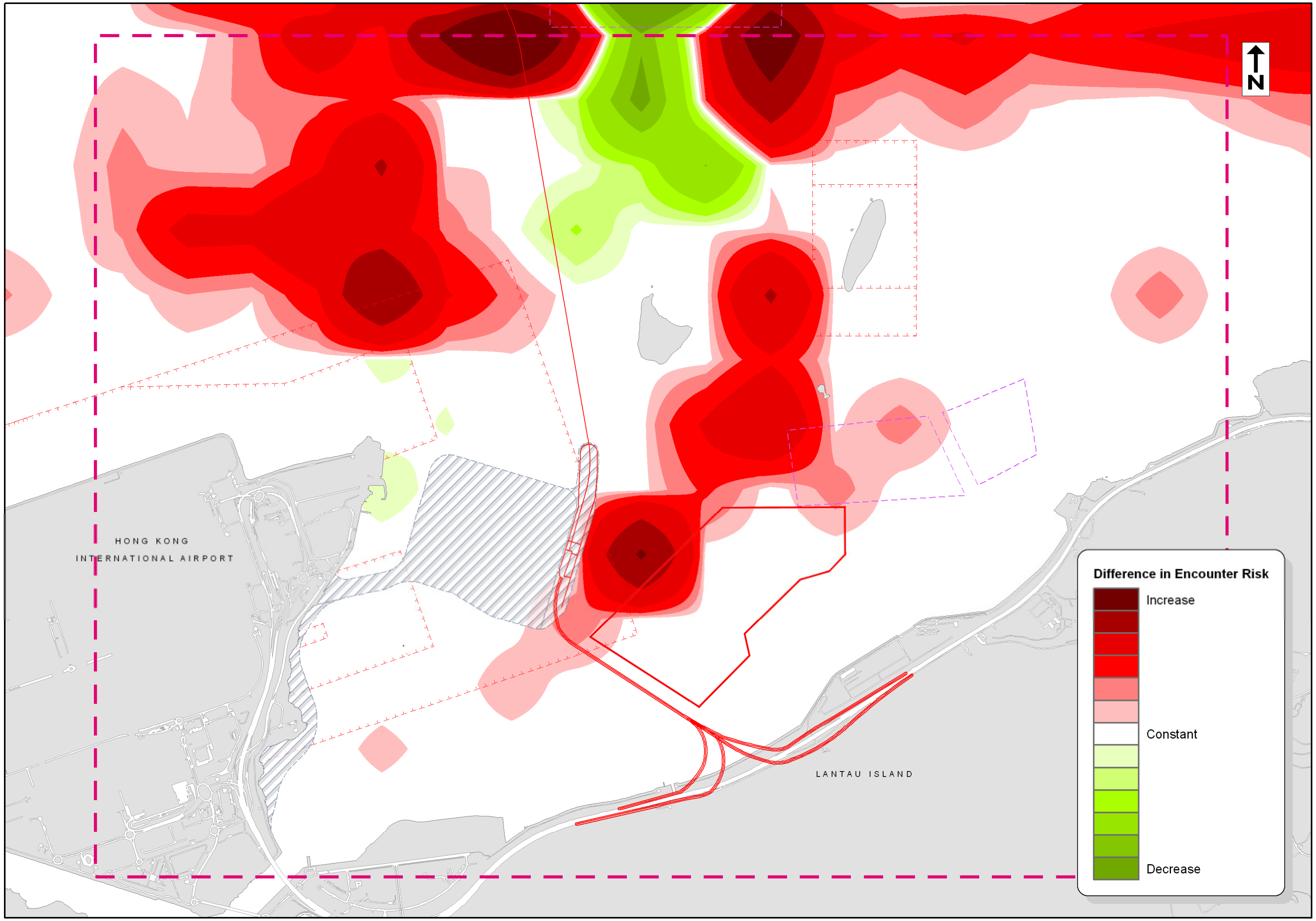


Figure 10.521 Changes in Risk from 2008 - 2012 due to increases in Background Traffic & Barging



10.3.5 *2021 Future Project Impacts*

As there may be relocation/restoration of routes within the Study Area due to completion of mud pit and concurrent project such as HKBCF and TM-CLKL in 2021, the operation impact of the SB facility should be considered with reference to both the future relocated routes network and changes in traffic volumes (*Figure 10.22*).

The future case routes identified in *Figure 10.23* were used to predict the future risk distribution (*Figure 10.23*) and to forecast collision frequencies (*Figure 10.24*).

In *Figure 10.23*, comparing with the risk distribution in 2012, risk density on north of the SB facility area significantly reduces as vessel routes are restored and allowed to pass through the SB facility area during the operational stages, which leads to less interaction.

From *Figure 10.24* and *Figure 10.16*, it is observed that the model predicts an increase of 0.22 collisions between 2008 and 2021. The risk levels in the direct HKIA vicinity remain the same, while the increased risk levels are projected within and on the north of the SB facility area also the northwest corner of the focused risk area. This result however must be viewed with caution, as it is a combination of risk influences which includes both traffic increases and routing changes (due to the disposal operation and completion of the TM-CLKL and HKBCF).

In order to isolate the impact of the future traffic environment it is necessary to develop a control set of 2021 traffic without the risk influence from the SB facility's operation routes (model of the top left corner in *Figure 10.3*). The control set of forecast collisions is illustrated in *Figure 10.25*.

The 2021 control set forecasted 0.36 annual collisions in the focus risk area. This result is approximately the same as the baseline (2008) annual collision rate of 0.4 with reference with the future traffic increases. *Figure 10.26* illustrates the change in risk as a result of the introduction of the new SB Facilities. It is apparent that the focus for the risk increase is set west and north of the SB facility during the future operation stages.

A comparison of collision risk is summarised in *Table 10.8*.

Table 10.8 Vessel Collision Potential

Case	**Disposal Facilities**	**Traffic Level**	**Collisions in Focus Area**
2008 Baseline	No	2008	0.4
2012 Construction Stage	Yes	2012	0.93
2021 Future Case	Yes	2021	0.62
Control	No	2021	0.62

Figure 10.622 2021 Future Route Distribution

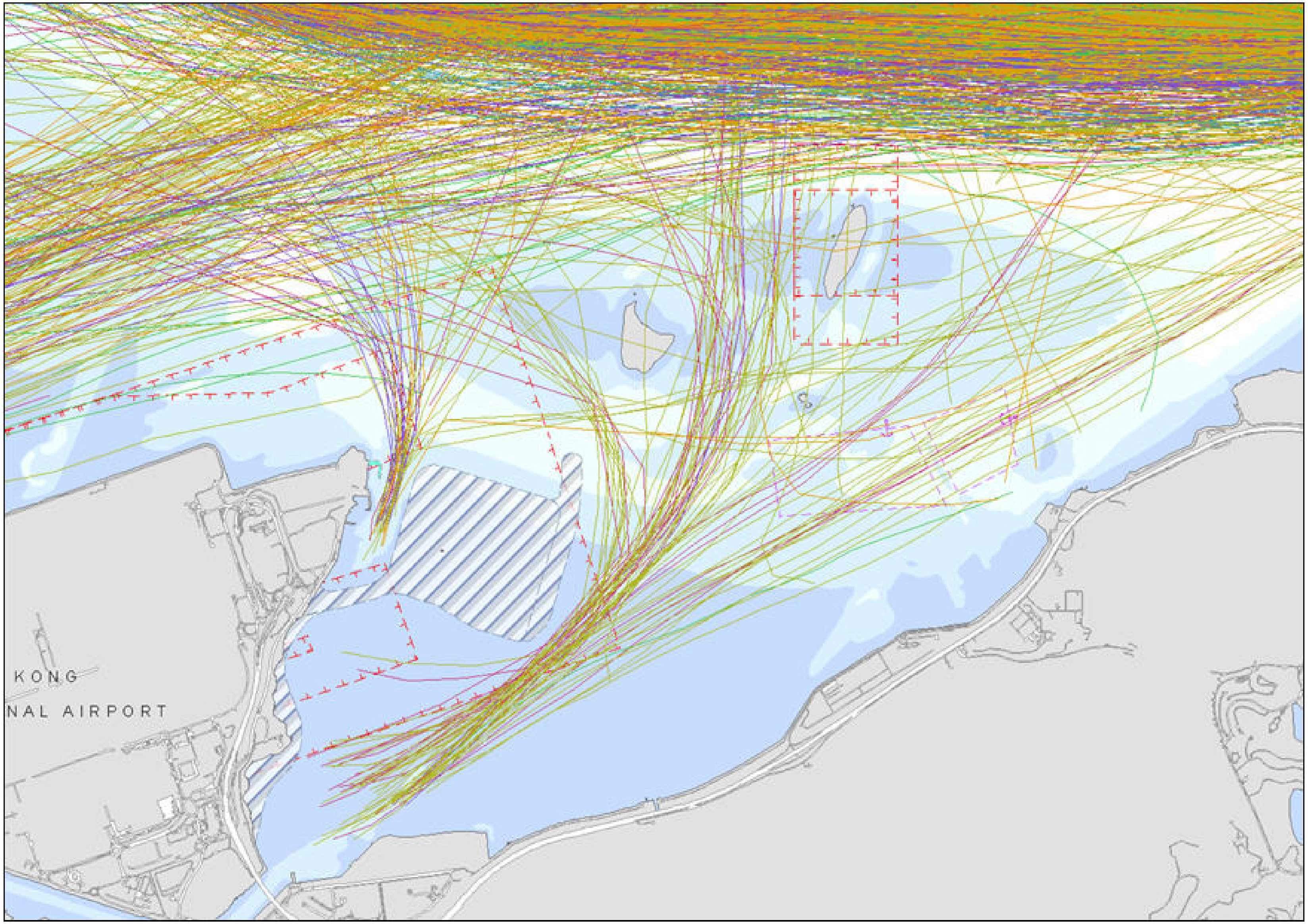


Figure 10.723 2021 Future Case Risk Distribution

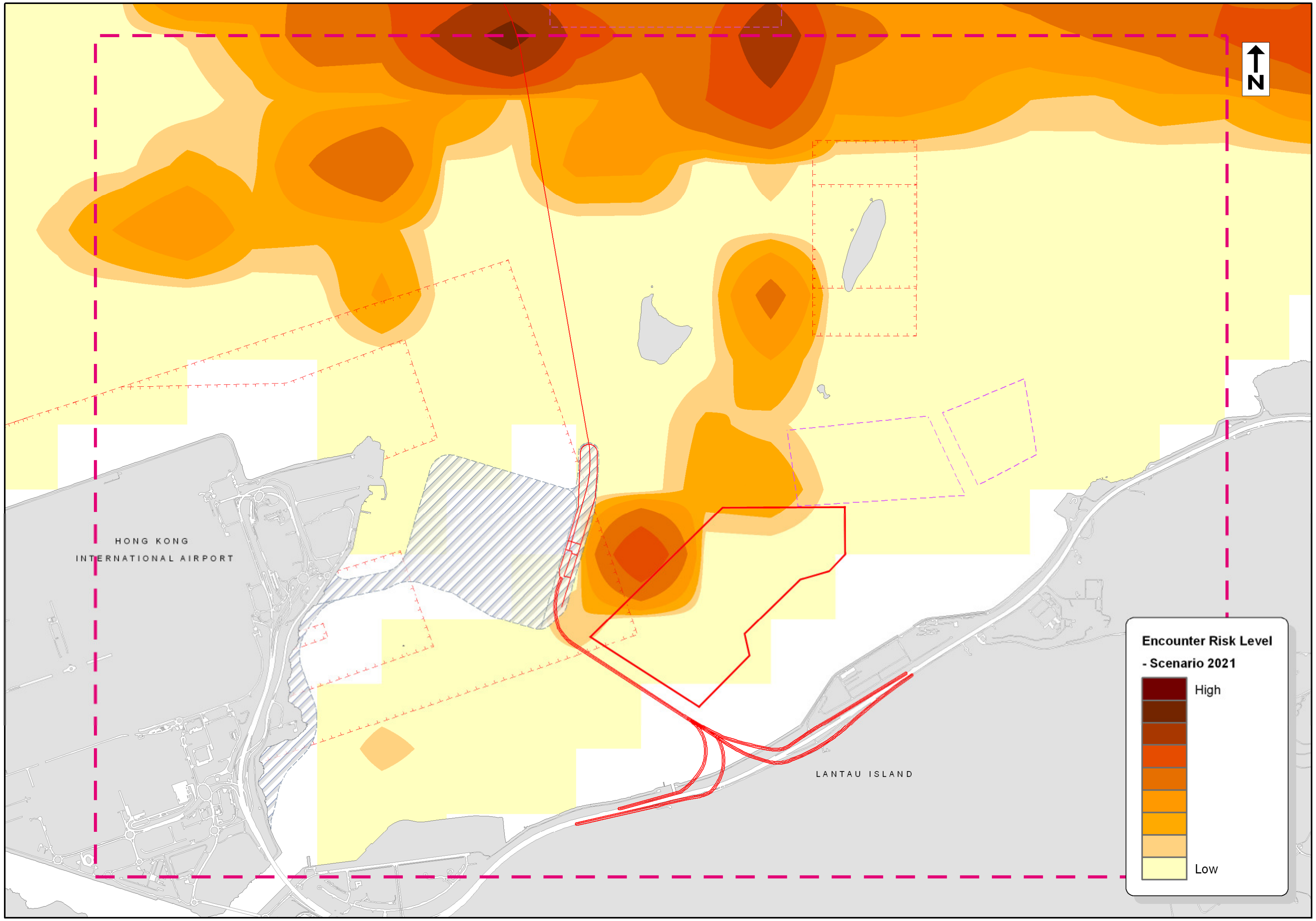


Figure 10.824 2021 Future Case Focus Area Collision Distribution

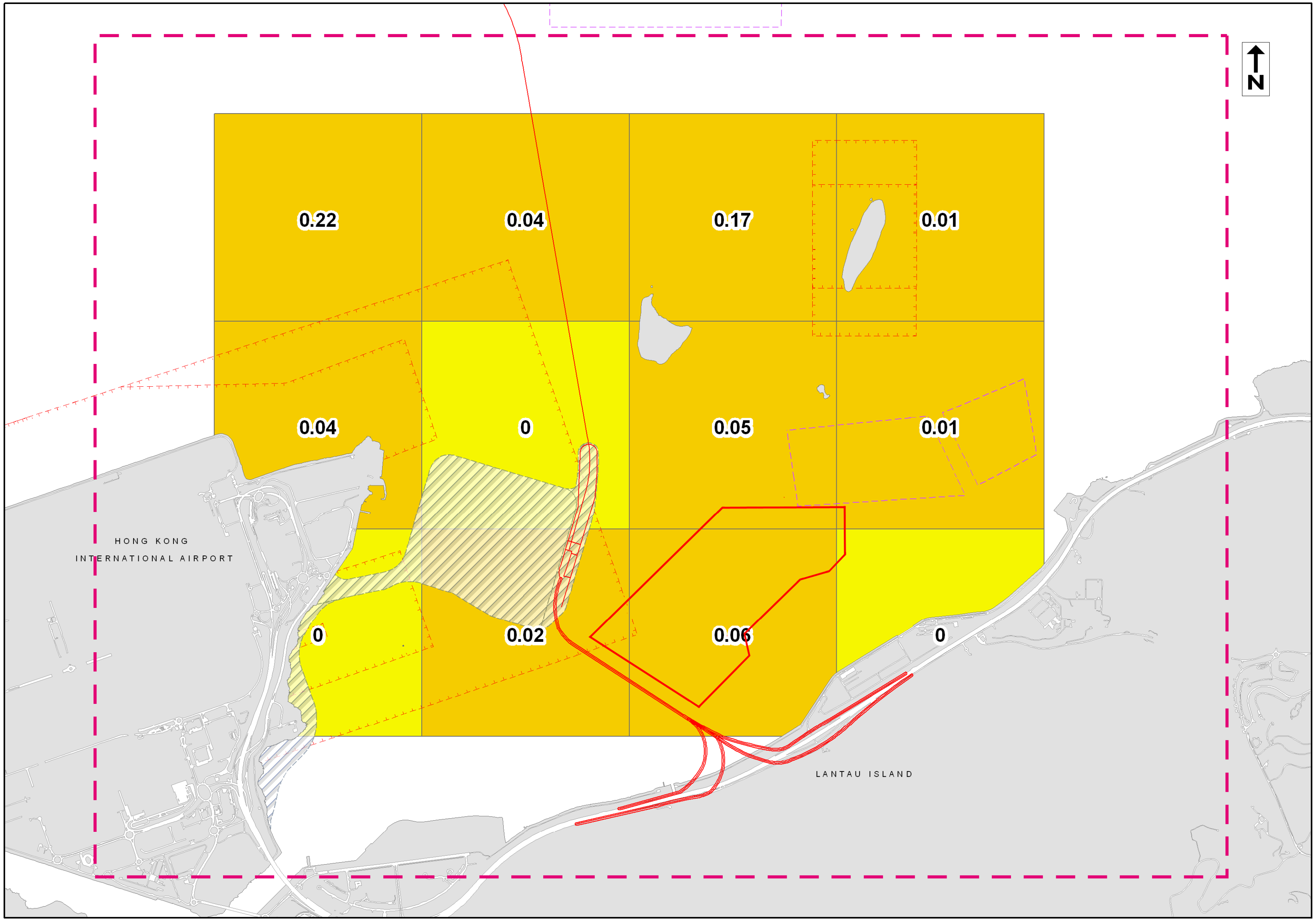


Figure 10.925 Control Set, 2021 Traffic Rate NO Disposal Facilities

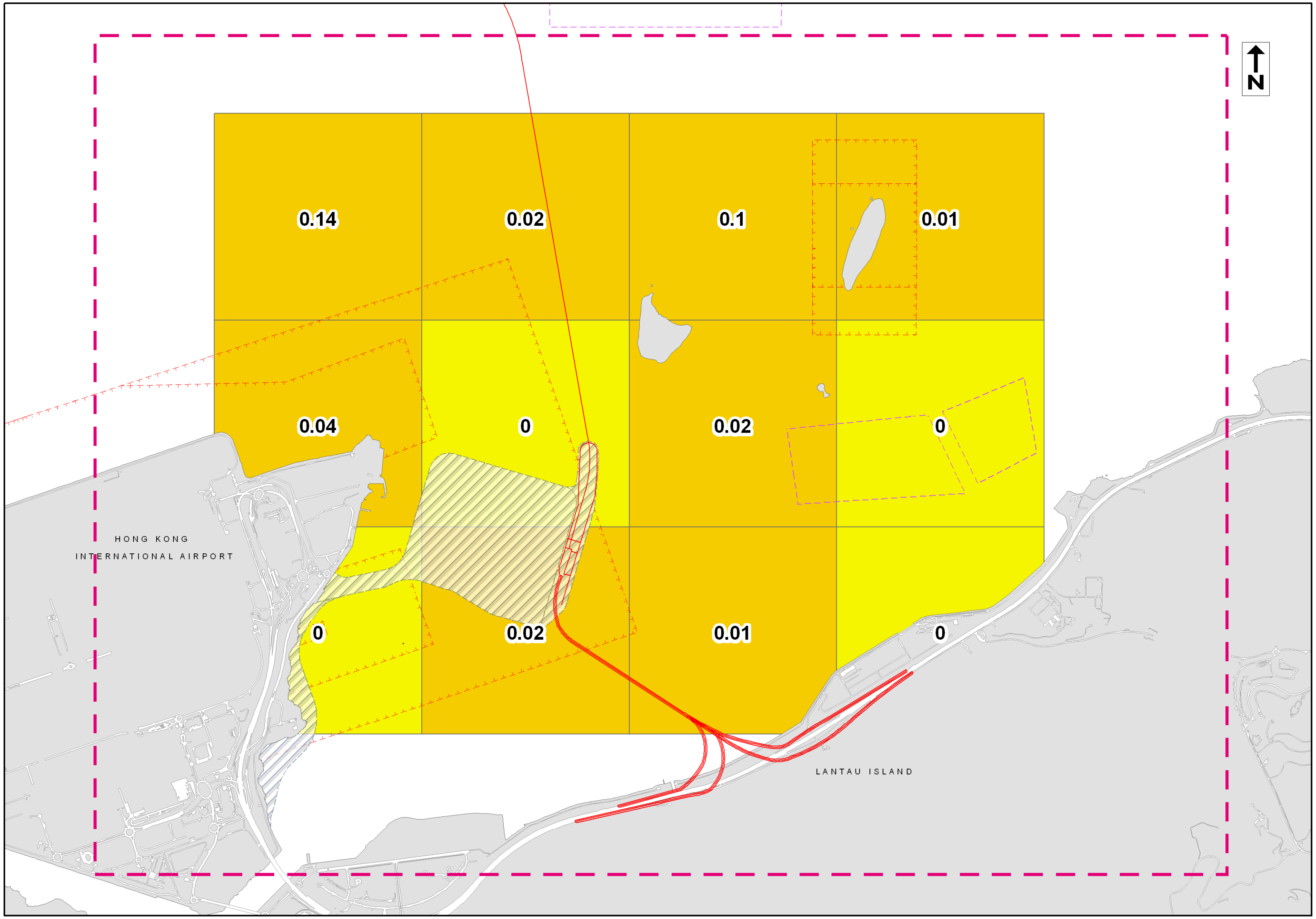
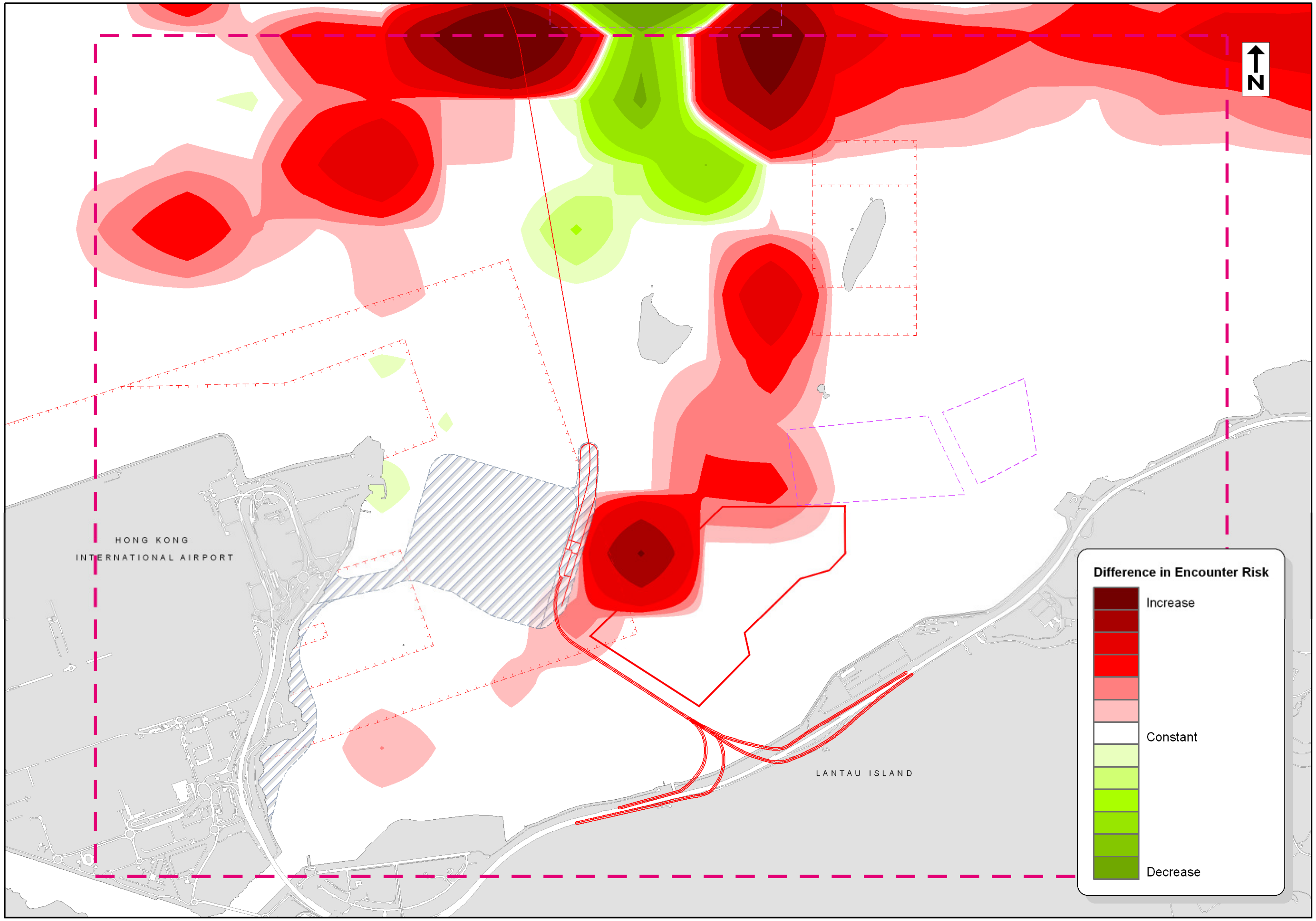


Figure 10.1026 Spatial Redistribution of Risk Within Study Area



10.3.6 *Disposal Facilities Impacts & Acceptability in future case*

It can be identified that the most significant increases in risk are being driven by the Project Works construction and the new barging routes at 0.93 collisions per year, with 0.53 per year increase in collision. The long-term operational impact reduces by 0.04 to 0.36 per year, which reflects the reduction in risk because of the separation of SkyPier ferries from local domestic ferries.

If 100 vessels are involved within the Works and there is potentially 0.5 collisions per year, this results in a 1 in 100 year risk of a fatality to an annual population of 182,500 (100 vessels x 365 x 5 crew). This represents a risk of 5 x 10^{-8} (0.01 / 182,500) which falls within Acceptable levels.

Review of the historic incidents in the Study Area indicates that low speed operations does not result in casualties from the incidents so the focus is not specifically on hazard to life. The key issue considered is the need to develop Works access lanes and designated mooring areas to manage craft interactions and congestion.

10.3.7 *Summary*

An assessment of the existing, construction and operational stage risk profiles have been developed for the waters around the SB facility. It is identified that:

- The construction and operation impacts, combined with future traffic growth to 2012 have the potential to significantly increase traffic risks locally around the Works area, however the increased risk falls within Acceptable levels; and

- There will be a requirement to plan the location of Works anchorages and access lanes to ensure congestion and collision risks are minimised. To ensure the potential risks could be minimize, notify Marine Department in 14 days prior to commencement of construction to enable the department in preparing the Marine Department Notice would be essential, so the local marine stakeholder will aware of the construction boundary and will avoid travel across the vicinity if not necessary.

In addition, the following operation and monitoring requirements would be adopted for the SB facility:

- No working barges and their associated equipment will be intruded into the Tung Chung Channel during the construction and operation of the mud pits.

- Regular sounding surveys will be conducted by CEDD to ensure that the water depth of the Tung Chung Channel will not be reduced during the construction and operation of the mud pits.

- There will be a complaint-handling system established by the project proponent for handling the possible complaints of noise or similar nature associated with the construction and operation of the mud pits.

10.4 CONCLUSION & RECOMMENDATION

A Marine Traffic Impact Assessment (MTIA) has been conducted for the construction/operation phase of proposed contaminated mud disposal facility at SB, which has reviewed and updated the marine traffic impact assessment conducted in the previous study taking into account the latest traffic activity from adjacent developments.

The following summary and conclusions have been identified:

Hazard Identification

A review of the existing constraints and hazards has been conducted and the following summary has been developed:

- The proposed South Brothers Facility is set south of busy marine channels of the Urmston Road, adjacent to restricted waterspaces associated with HKIA, the new HKBCF and local navigation channels to Tung Chung;
- No overlap to the surrounded existing and future marine facilities is identified.
- Metocean (currents, wind, wave and visibility) impacts within the South Brothers sites will not be significant;
- A summary of current traffic has been conducted. Collating visual survey and radar data it is identified that there are approximately 84 vessel movements within the Study Area per day;
- Key construction vessels have been identified as Grab Dredger, Hopper Barge, Split hopper barge and TSHD.
- No barges will be working outside the site boundary during construction and operation stage.
- Construction and operation vessels activities details and programming stages have been summarized. There will be a significant local increase of marine traffic due to the disposal and capping operations, a value of slightly over 100 movements per day has been adopted for risk assessment.

Risk Assessment

An assessment of the existing, construction and operational stage risk profiles have been developed for the waters around the Disposal Facilities. It is identified that:

- The construction and operation impacts, combined with future traffic growth to 2012 have the potential to significantly increase traffic risks locally around the Works area, however the increased risk falls within Acceptable levels; and

- There will be a requirement to plan the location of Works anchorages and access lanes to ensure congestion and collision risks are minimised. To ensure the potential risks could be minimize, notify Marine Department in 14 days prior to commencement of construction to enable the department in preparing the Marine Department Notice would be essential, so the local marine stakeholder will aware of the construction boundary and will avoid travel across the vicinity if not necessary.

In addition, the following operation and monitoring requirements would be adopted for the SB facility:

- No working barges and their associated equipment will be intruded into the Tung Chung Channel during the construction and operation of the mud pits.

- Regular sounding surveys will be conducted by CEDD to ensure that the water depth of the Tung Chung Channel will not be reduced during the construction and operation of the mud pits.

- There will be a complaint-handling system established by the project proponent for handling the possible complaints of noise or similar nature associated with the construction and operation of the mud pits.

10.5 CONCLUSION

It is identified that the future risk levels fall well within Acceptable levels. There will be a requirement to plan the location of Works anchorages within the site boundary and access lanes to ensure congestion and collision risks are minimised

The risk assessment anticipated that future risks will be acceptable. However, as in any marine activity, this is dependent upon the continued vigilance of the operator in the safe conduct of the disposal activity.

11 SUMMARY OF ENVIRONMENTAL OUTCOMES

11.1 INTRODUCTION

This *Section* presents a summary of the key potential environmental outcomes associated with the construction and operation of the proposed SB facility. The purpose of the assessment was to thoroughly evaluate the SB facility in terms of predicted impacts to the environment from dredging, backfilling and capping of the pits and also concurrent activities. It should be noted that the facility is proposed to be developed in close proximity to the existing ESC facility which has been demonstrated to operate in an acceptable manner as indicated by the findings of an intensive EM&A programme (1) .

11.2 WATER QUALITY

The previously approved EIA for SB demonstrated the loss of sediment to suspension during dredging, backfilling and capping operations from computer modelling. The assessment concluded that any sediment disturbed by the works would settle rapidly back onto the seabed and the suspended sediment elevations would be of short duration. This indicates that there would be little transport of suspended sediment away from the pits and that the sediment would not impact upon sensitive receivers. In general, the sediment plumes generated by the works remain in open waters.

The current assessment has used findings of the water quality modelling from the previously approved EIAs from the TM-CLKL, HKBCF and HKLR projects to show that, even with multiple concurrent projects and alterations in the coastline, there will still be no unacceptable exceedances of assessment criteria, given all proposed mitigation measures are applied.

No residual environmental impacts, in terms of exceedances of applicable criteria, were predicted to occur as a result of the dredging, backfilling and capping of the SB facility and with concurrent projects in the area, provided that the recommended mitigation measures are implemented. An EM&A programme has been devised to confirm that the works would be environmentally acceptable.

11.3 MARINE ECOLOGY

Through the application of criteria utilised in previous EIAs in Hong Kong, impacts arising from the proposed dredging, backfilling and capping operations at the SB facility are predicted to be within acceptable levels (as defined by the WQOs) and are not expected to cause adverse impacts to

(1) ERM (2010) *Op cit*.

marine sensitive receivers of either high or medium ecological value (habitats or species). The temporary loss of the subtidal habitats present within the pit boundaries is considered to be acceptable, as the habitats are of low ecological value. Furthermore, recolonisation of the capped pits by infaunal organisms and epibenthic fauna is expected to occur following the completion of capping operations. Impacts to marine mammals are likely to be avoided, as sightings of the Indo-Pacific Humpback Dolphin, *Sousa chinensis*, are relatively infrequent in the waters of the proposed SB Facility in comparison to other waters in the north and west of Lantau.

The residual impacts occurring as a result of the construction and operation of the SB facility are confined to the temporary loss of the low ecological value subtidal habitats present within the pit boundaries. The residual impacts are considered to be acceptable as the habitats are of low ecological value and because infaunal organisms and epibenthic fauna are expected to recolonise the sediments.

Water quality modelling of the cumulative impacts of projects planned to be constructed simultaneously has been conducted by a review of the TM-CLKL, HKBCF and HKLR EIA reports. The findings indicated that no adverse impacts would be expected to water quality sensitive receivers when compared the allowable increases as defined by the WQO, given that appropriate mitigation is conducted. Unacceptable cumulative impacts as a result of concurrent project construction and operational activities are, therefore, unlikely to occur and hence cumulative impacts to marine ecology are not anticipated.

To protect against unacceptable impacts to marine ecological resources, an EM&A programme has been designed to specifically detect and mitigate any unacceptable impacts to marine ecological resources.

11.4 FISHERIES

Reviews of existing information on commercial fisheries resources and fishing operations located within the Study Area have been undertaken. Information from a study on fishing operations in Hong Kong and the AFCD Port Surveys indicate that fisheries production values in the vicinity of the SB facility vary but are low to moderate.

The construction of the SB facility will result in the direct short-term disturbance of approximately 141 ha of low to moderate importance fishing ground. The construction and operation of the SB facility with concurrent projects in the vicinity may give rise to temporary fisheries impacts from disturbances to benthic habitats, changes in water quality and contaminant release. Disturbances to benthic habitats are predicted to be confined within the pit boundaries of the SB facility, and recolonisation of sediments is expected to occur following completion of works. As changes in water quality are minimal and transient, significant adverse impacts to fisheries resources are not predicted to arise. Assessment of contaminant release has indicated that the concentrations will be minimal and well within the relevant criteria.

While no special mitigation measures are required for fisheries resources, mitigation measures recommended to reduce impacts to water quality are also expected to mitigate any impacts to fisheries resources.

11.5 *HAZARDS TO HEALTH*

This Study updated the human health and marine mammal risk assessments for the SB facility. These assessments were undertaken using findings of an updated bioaccumulation assessment which provided predictions of concentrations of contaminants of concern (COCs) in seafood. Methodology for the risk assessment was described and it follows the approach currently adopted in the EM&A programme of the ESC facilities.

Results of the human health risk assessment indicate that both the lifetime carcinogenic risk and non-carcinogenic hazard associated with consumption of seafood collected at south of The Brothers are predicted to be within the relevant acceptability criteria. Unacceptable public health risks are thus not anticipated.

Results of the marine mammal risk assessment indicate that the risks of an adverse effect in Indo-Pacific humpback dolphins associated with the consumption of prey items collected at south of The Brothers are predicted to be low and within the relevant acceptability criteria. Unacceptable risks and systematic toxicity to dolphins are thus not anticipated.

11.6 *NOISE*

Noise impact associated with the dredging, backfilling and capping works at the SB facility have been assessed. Potential cumulative impacts associated with the nearby concurrent projects, ie. TMCLKL, part of HKLR along east of the HKIA and HKBCF have also been examined.

The results indicated that daytime and evening works within the SB facility will comply with the noise criterion at all representative NSRs. Cumulative impact due to construction of the identified concurrent projects is not anticipated. However, exceedance of the night-time noise criteria has been predicted at NSRs N4, N6 and N8 during construction works.

It is recommended to reduce the number of PMEs for dredging at both Pits and backfilling at Pit 1 during night-time activities, and also to restrict the dredging works area during night-time activities at Pit 1. Should the planned housing developments at NSR N6 be occupied prior to dredging of Pit 1, further mitigation measures will be recommended. With implementation of the mitigation measures, the predicted night-time noise levels at all NSRs comply with the night-time criterion. No residual impact is anticipated.

With implementation of mitigation measures, no adverse noise impact is expected; noise monitoring is therefore not required during the construction or operational stage of the SB facility.

11.7 *CULTURAL HERITAGE*

The review of the literature indicated that the region adjacent to the SB facility had been occupied for over 4,000 years and had been a focal point for Chinese and international maritime trade. However this review supplemented by geophysical surveys has concluded that no marine resources of archaeological potential have been identified within the proposed SB facility. The proposed Project is thus not expected to impose any archaeological impact and no mitigation measures are considered necessary. No cumulative impact or residual impact is expected.

11.8 *MARINE TRAFFIC*

A Marine Traffic Impact Assessment (MTIA) has been conducted for the construction/operation phase of proposed contaminated mud disposal facility at SB, which has reviewed and updated the marine traffic impact assessment conducted in the previous study taking into account the latest traffic activity from adjacent developments.

An assessment of the existing, construction and operational stage risk profiles have been developed for the waters around the SB facility. It is identified that the construction and operation impacts, combined with future traffic growth to 2012 have the potential to significantly increase traffic risks locally around the Works area, however the increased risk falls within Acceptable levels. In addition, there will be a requirement to plan the location of Works anchorages and access lanes to ensure congestion and collision risks are minimised. Measures to minimise potential risks may involve providing conventional yellow flashing light buoys to demarcate the construction works area to provide separation between local vessels and construction barges; and notifying Marine Department in 14 days prior to commencement of construction to enable the department in preparing the Marine Department Notice, so the local marine stakeholder will aware of the construction boundary and will not travel across the vicinity.

12 ENVIRONMENTAL MONITORING & AUDIT (EM&A) MEASURES

12.1 INTRODUCTION

This EIA Review Report has updated the findings of the previously approved *EIA* report, focusing on the prediction and mitigation of the potential impacts associated with the construction and operation of the SB facility, taking into consideration the concurrent projects proposed in the area. One of the key outputs has been recommendations on the mitigation measures to be adopted in order to ensure that residual impacts comply with regulatory requirements plus the requirements of the *EIAO TM*. The findings and recommendations of this EIA will form the basis on which CEDD's environmental performance will be judged during the detailed design, construction and operation of the Project. To ensure effective and timely implementation of the mitigation measures, it is considered necessary to develop Environmental Monitoring and Audit (EM&A) procedures and mechanisms by which the Implementation Schedule may be tracked and its effectiveness assessed.

12.1.1 *Implementation of EIA Findings and Recommendations*

This *EIA Review Report* has, where appropriate, identified and recommended the implementation of mitigation measures in order to minimise the potential construction and operational impacts of the Project. Some of these mitigation measures have been proposed by other concurrent projects in the Study Area and will not be discussed under this Assignment. Mitigation and recommendations form the primary deliverable from the whole EIA process. Once endorsed by the EPD, they will form an agreement between the Project Proponent (ie CEDD) and the EPD as to the measures and standards that are to be achieved. It is, therefore, essential that mechanisms are put in place to ensure that the mitigation measures prescribed in the Implementation Schedule are fully and effectively implemented during dredging, backfilling and capping.

Apart from the mitigation measures defined in the EIA, there is also scope for other requirements to be included within the finalised Implementation Schedule. Prior to the issue of an Environmental Permit, there is an EIA Determination Period, taken as being the public exhibition of the report. During this period the EIA Report is reviewed and commented upon by both the public and professional bodies. Where recommendations are made and accepted by either the Advisory Council on the Environment (ACE) or its EIA Subcommittee, these measures will be included within the Implementation Schedule, where appropriate.

12.1.2 *Statutory Requirements*

As the Project constitutes a Designated Project under the *EIAO* by virtue of Item C (Reclamation, Hydraulic and Marine Facilities, Dredging and

Dumping), Item C.10 (A Marine Dumping Area) and C.12 (A Dredging Operation Exceeding 500,000 m^3) of Part I of Schedule 2, an Environmental Permit must be obtained before construction or operation of the facility.

Upon approval of this *EIA Review Report*, CEDD can apply for an Environmental Permit. If the application is successful, the Environmental Permit will, in most circumstances, have conditions attached to it, which must be complied with. In addition, CEDD and its appointed Contractors must also comply with all other controlling environmental legislation and guidelines, which are discussed within the specific technical chapters of this report. Failing to comply with these legislative requirements could lead to prosecution under the various *Pollution Control Ordinances*.

12.2 ENVIRONMENTAL MANAGEMENT PLAN

For construction and operation of the Contaminated Mud Disposal facility at South Brothers, it is envisaged that the contractual documentation will require CEDD's Contractors to define mechanisms for achieving the environmental requirements. This will most likely be achieved by requiring the Contractor to produce and implement an Environmental Management Plan (EMP).

EMP's are similar in nature to safety or quality plans and provide details of the means by which the Contractor (and all subcontractors working for the Contractor) will implement the recommended mitigation measures and achieve the environmental performance standards defined both in Hong Kong environmental legislation and in the Implementation Schedule. A primary reason for adopting the EMP approach is to make sure that the Contractor is fully aware of his environmental responsibilities and to ensure his commitment to achieving the specified standards.

The EMP approach is grounded on the principle that the Contractor shall define the means by which the environmental requirements of the EIA process, and the contractual documentation shall be met. In the first instance, each Tenderer shall be required to produce a preliminary EMP for submission as part of the tendering process; the skeletal EMP will demonstrate the determination and commitment of the organisation and indicate how the environmental performance requirements laid out in the available EIA documentation will be met. It is recommended that this aspect be included as a specific criterion in the assessment of tender documents; this will act as a clear indication to all Tenderers of CEDD's commitment to the minimisation and management of environmental impacts. Upon Contract Award, the successful Tenderer shall be required to submit a draft and final version of the EMP for the approval of CEDD prior to the commencement of the works.

12.3 EM&A MANUAL

The EPD requires the submittal for approval of an EM&A Manual prior to the commencement of construction. The EM&A Manual has the same purpose of defining the mechanisms for implementing the EM&A requirements specific to each phase of the work.

The EM&A Manual provides a description of the organisational arrangements and resources required for the EM&A programme based on the conclusions and recommendations of this EIA. The EM&A Manual stipulates details of the monitoring required, and actions that shall be taken in the event of exceedances of the environmental criteria. In effect, the EM&A Manual forms a handbook for the on-going environmental management during construction and operation of the proposed contaminated mud disposal facility.

The EM&A Manual comprises descriptions of the key elements of the EM&A programme including:

- appropriate background information on the construction of the Project with reference to relevant technical reports;
- organisational arrangements, hierarchy and responsibilities with regard to the management of environmental performance functions during the construction phase to include the EM&A team, the Contractor's team and the CEDD's representatives;
- a broad works programme indicating those activities for which specific mitigation is required, as recommended in the EIA, and providing a schedule for their timely implementation;
- descriptions of the parameters to be monitored and criteria through which performance will be assessed including: monitoring frequency and methodology, monitoring locations (in the first instance, the location of sensitive receivers as listed in the EIA), monitoring equipment lists, event contingency plans for exceedances of established criteria and schedule of mitigation and best practice methods for minimising adverse environmental impacts;
- procedures for undertaking on-site environmental performance audits as a means of ensuring compliance with environmental criteria; and
- reporting procedures.

The EM&A Manual will be a dynamic document which will undergo a series of revisions to accommodate the progression of the works programme.

12.3.1 *Objectives of EM&A*

The objectives of carrying out EM&A for the Project include:

- to provide baseline information against which any short or long term environmental impacts of the projects can be determined;

- to provide an early indication should any of the environmental control measures or practices fail to achieve the acceptable standards;
- to monitor the performance of the Project and the effectiveness of mitigation measures;
- to verify the environmental impacts predicted in the EIA Study;
- to determine Project compliance with regulatory requirements, standards and government policies;
- to take remedial action if unexpected problems or unacceptable impacts arise; and
- to provide data to enable an environmental audit to be undertaken at regular intervals.

The following sections summarise the recommended EM&A requirements, further details are provided in the separate EM&A Manual.

12.4 WATER QUALITY

Water quality monitoring will be required for the following activities:

- Dredging of each Pit;
- Backfilling of each Pit; and,
- Capping of each Pit.

Water quality monitoring results will be compared to Action and Limit levels to determine whether impacts associated with the works are acceptable. An Event and Action Plan provides procedures to be undertaken when monitoring results exceed Action or Limit levels. The procedures are designed to ensure that if any significant exceedances occur (either accidentally or through inadequate implementation of mitigation measures on the part of the Contractor), the cause is quickly identified and remedied, and that the risk of a similar event re-occurring is reduced.

Action and Limit levels will be used to determine whether modifications to the works activities are required. Action and Limit levels are environmental quality standards chosen such that their exceedance indicates potential deterioration of the environment. Exceedance of Action levels can result in an increase in the frequency of environmental monitoring, modification of operations and implementation of the proposed mitigation measures. Exceedance of Limit levels indicates a greater potential deterioration in environmental conditions and may require the cessation of works unless appropriate remedial actions, including a critical review of plant and working methods, are undertaken. Before works commence one month of baseline monitoring should be undertaken at stations in the vicinity of the Pits and in Reference areas.

A monitoring programme examining sediment quality will also be instituted to verify the EIA predictions and ensure that there is no build-up in contamination adjacent to the pits.

The full details of the EM&A programme for water and sediment quality is presented in the EM&A Manual for this Project.

12.5 *MARINE ECOLOGY*

The dredging and disposal operations have been shown to proceed at rates that maintain environmental impacts to within acceptable levels. Actual impacts during the lifetime of the facility will be monitored by recording impacts to water quality. Monitoring and audit activities designed to detect and mitigate any unacceptable impacts to water quality will also serve to protect against unacceptable impacts to marine ecological resources.

In addition to the water quality monitoring programme, monitoring of sediment toxicity is recommended to ensure that the disposal activities are not causing sediments adjacent to the pits to become toxic to marine life. This programme will employ standard techniques for sediment toxicity testing which are detailed in full in the EM&A Manual.

The EIA has indicated that benthic fauna are expected to recolonise the pits following capping with uncontaminated mud and/or public fill. In order to verify this assessment a benthic recolonisation programme has also been recommended. The full details of the EM&A programme for marine ecology are presented in the EM&A Manual.

12.6 *FISHERIES*

The water quality monitoring programme will provide management actions and supplemental mitigation measures to be employed should impacts arise, thereby ensuring the environmental acceptability of the Project. As impacts to the fisheries resources and fishing operations are small and of short duration, the development and implementation of a monitoring and audit programme specifically designed to assess the effects on commercial fisheries resources is not deemed necessary.

12.7 *HAZARD TO HEALTH*

The EIA has indicated that the consumption of seafood collected within the vicinity of the pits does not pose an unacceptable public health risk to any of the sub-populations of concern. In order to verify the predictions of the EIA a programme of monitoring the concentration of contaminants of concern in seafood is recommended. The data from such a programme would also be of value to determining the risks to the Indo-Pacific Humpback Dolphin.

Consequently, a risk assessment should be performed at least on an annual basis to verify that no unacceptable risk are occurring to either human health or marine mammals as a result of consuming prey species from the waters in the vicinity of the pits of North Lantau.

The full details of the EM&A programme for assessing hazard to the health of humans and marine mammals are presented in the EM&A Manual.

12.8 NOISE

As no adverse noise impact is expected, noise EM&A is not considered necessary.

12.9 CULTURAL HERITAGE

As no cultural heritage impact is expected, EM&A for cultural heritage is not considered necessary.

13 CONCLUSIONS

13.1 OVERALL

This report presents a detailed assessment of the potential environmental impacts of the construction and operation of the SB facility, taking into account potential synergistic impacts with other concurrent projects in the area.

13.2 ENVIRONMENTAL OUTCOME

No unacceptable residual impacts are predicted for the construction and operation of the facility at the South Brothers site.

13.2.1 *Population and Environmentally Sensitive Areas Protected*

The EIA study has facilitated the integration of environmental considerations into the design process for the Project. The principal measures identified are those achieved through pit and dredging design, and backfilling and capping working rates. In addition, a number of mitigation measures have been identified to minimise the potential for adverse environmental impacts. These mitigation measures are mostly being conducted by other concurrent projects in the Study Area. Indeed, no additional concurrent impacts, other than those predicted in the TM-CLKL, HKBCF and HKLR EIA reports are predicted. The mitigation measures will be detailed in full in the Implementation Schedule and will be implemented by the Contractor under enforcement by the EPD.

One of the key environmental outcomes has been the ability to plan, design and ultimately carry out the project so that direct impacts to sensitive receivers are avoided, as far as practically possible. A detailed assessment of alternative sites within the Study Area has been conducted. Through this assessment, environmentally sensitive areas have been protected by the following means.

- **Avoidance of Direct Impacts to Ecologically Sensitive Habitats:** The site for the SB facility has been selected based on a review of the environmental considerations of the area and the most environmentally preferable site within the Study Area has been selected to avoid direct impacts to ecologically sensitive habitats and species.

- **Avoidance of Indirect Impacts to Ecologically Sensitive Habitats:** The site for the SB facility has been selected so that it is located at a sufficient distance from ecological sensitive receivers so that dispersion of sediments from dredging, backfilling and capping operations does not affect the receivers. By locating the SB facility in an area of low hydrodynamic energy the horizontal dispersion of suspended sediment is restricted to a confined area in close proximity to the pit boundary.

As a result, the assessments for this EIA have indicated that it is not expected that the construction and operation of the South Brothers Facility will result in adverse impacts to environmentally sensitive areas. Further, there will be no addition impacts from concurrent projects in the area, other than those defined and mitigated against in the TM-CLKL, HKBCF and HKLR EIA reports.

13.2.2 *Environmentally Friendly Designs Recommended*

A key concern in the final site and disposal option design was to take steps to ensure that both direct and indirect impacts through dredging, backfilling and capping operations were avoided or minimised. Consequently, the following approaches were adopted.

- **Adoption of Current Practices**: A review of all environmental monitoring data collected since the commencement of operations at ESC Contaminated Mud Disposal Facility has demonstrated that mud disposal activities at the ESC area have remained within environmentally acceptable levels (1). As all dredging, backfilling and capping operations proposed for the SB facility have been designed to follow the current practices, no adverse unacceptable impacts are expected to occur.

- **CMP Design:** The SB disposal facility have been designed as two separate pits, which minimises the exposure time of contaminated mud to the marine environment and consequently reduces the magnitude of any potential impacts.

- **Adoption of Acceptable Working Rates**: The modelling work has demonstrated that the selected working rates for the dredging, backfilling and capping operations will not cause unacceptable impacts to the receiving water quality. Consequently, unacceptable indirect impacts have been avoided.

- **Reinstatement of the seabed to natural condition:** As with all previous contaminated mud disposal pits in this area, the seabed is expected to return to its original natural condition after the filling and capping works are complete.

13.2.3 *Key Environmental Problems Avoided*

Key environmental problems have been avoided through the detailed site selection process that, as discussed above, allowed environmentally sensitive areas and populations to be avoided. In addition, through the employment of practices that have been demonstrated to be environmentally acceptable, no

(1) ERM-Hong Kong, Ltd (2010) *Op cit.*

unacceptable environmental problems are expected to occur as a result of the construction and operation of the proposed SB facility.

13.2.4 *Compensation Areas*

The construction and operation of the proposed SB facility will result in only the temporary loss of low ecological value soft bottom habitat. Following the completion of capping operations, the seabed will be reinstated and is expected to return to pre-dredging conditions. As a result, compensation areas are not deemed necessary.

13.2.5 *Environmental Benefits of Environmental Protection Measures Recommended*

The design of the SB Facility will involve the dredging of purpose-dredged pits, backfilling with contaminated mud and subsequent capping with uncontaminated mud and/or public fill to return the seabed and hydrodynamic regime to their original condition. A review of long term monitoring data from in and around the existing capped pits at ESC has demonstrated that within a relatively short period of time, recolonisation of sediments occurs returning the site to a pre-dredged state. The employment of such environmental protection methods in the design of the SB facility will, therefore, act as an environmental benefit.

13.3 *OVERALL CONCLUSION*

This *EIA Review Report* has critically assessed the overall acceptability of any environmental impacts likely to arise as a result of the construction and operation of the proposed contaminated mud disposal facility at South Brothers. Where necessary and practicable, the EIA has specified the conditions and requirements for the detailed design, construction and operation of the Project in order to mitigate environmental impacts to acceptable levels.

This EIA Study has predicted that the Project will comply with all environmental standards and legislation following the implementation of the recommended mitigation measures. The EIA has thus demonstrated the acceptability of any residual impacts from the Project and the protection of environmentally sensitive receivers and populations. Where appropriate, EM&A mechanisms have been recommended to verify the accuracy of the EIA predictions and the effectiveness of the recommended mitigation measures.

In conclusion, it is considered that the EIA provides a suitable basis for the Director of Environmental Protection to consider granting the Environmental Permit to allow the construction and operation of the Project.

Annex A

Water Quality Modelling Results

A1 WATER QUALITY MODELLING RESULTS

These water quality modelling results have been sourced directly from Appendix D11 of the Tuen Mun - Chek Lap Kok Link (TM-CLKL) EIA Report. Readers are referred to this report as well as the Hong Kong - Zhuhai - Macao Bridge Hong Kong Boundary Crossing Facilities (HKBCF) and the Hong Kong - Zhuhai - Macao Bridge Hong Kong Link Road (HKLR) EIA Reports, which contain the same water quality modelling, for specific details, including methodologies and output. A list of the tables present in this *Annex* is presented below.

Table A1 ***Predicted Maximum SS (mg/l) Elevations at Selected Observation Points for the Scenario Year 2011 (Mitigated with Concurrent Projects)***

Observation Points	Point SR	Name	Associated EPD	Maximum SS (mg/L) Dry Season S	M	B	DA	Wet Season S	M	B	DA	Percentage of Time Exceedances Predicted Dry Season S	M	B	DA	Wet Season S	M	B	DA	WQO / WQC Dry Season S	M	B	DA	Wet Season S	M	B	DA
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	NM5,6,8	0.1	1.4	1.9	1.1	0.1	0.2	0.7	0.3	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 09a	No	Urmston Road (Main Channel)	NM5,6,8	6.1	10.5	15.0	8.3	0.4	2.4	10.7	3.6	1%	4%	2%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	NM5,6,8	0.6	2.3	4.9	2.0	0.2	0.9	4.1	1.6	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake (Note 1	-	1.1	3.2	4.9	3.0	0.3	2.5	7.8	3.5	0%	0%	0%	0%	0%	0%	0%	0%	764	764	764	764	764	764	764	764
WSR 12	Yes	Butterfly Beach (gazetted beach)	NM1,2,3	0.3	0.7	1.4	0.8	0.1	0.3	0.6	0.3	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	NM1,2,3	0.7	0.8	1.0	0.8	0.1	0.3	0.5	0.2	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 15	Yes	Gazetted Beaches at Tuen Mun	NM1,2,3	0.1	0.1	0.2	0.1	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	NM1,2,3	1.3	2.0	2.4	1.8	0.6	0.7	1.2	0.7	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 19	Yes	Gazetted Beaches at Ma Wan	WM4	0.6	0.8	0.9	0.8	0.2	0.3	0.3	0.2	0%	0%	0%	0%	0%	0%	0%	0%	3.9	6.0	9.0	6.1	1.7	2.8	6.0	3.4
WSR 20	Yes	Ma Wan Fish Culture Zone (Note 2)	-	2.8	2.9	2.9	2.9	0.6	1.3	1.6	1.1	0%	0%	0%	0%	0%	0%	0%	0%	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	NM1,2,3	3.9	4.3	4.8	4.3	1.8	2.0	2.3	1.9	2%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22a	No	Tai Ho Wan Outlet (inside)	NM1,2,3	0.4	0.5	0.6	0.5	0.1	0.4	0.7	0.4	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	NM1,2,3	1.1	1.4	1.6	1.4	0.4	0.8	1.5	0.8	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Yes	Airport Cooling Water Intake (NE)	NM1,2,3	6.2	8.1	9.2	7.5	2.9	7.8	13.6	7.3	5%	11%	2%	5%	1%	16%	9%	8%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	Yes	San Tau Beach SSSI	NM5,6,8	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat	NM5,6,8	0.0	0.1	0.1	0.1	0.0	0.2	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 32	Yes	Tai O (Mangrove Habitat)	NM5,6,8	0.0	0.0	0.1	0.0	0.0	0.1	0.3	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.2	0.3	0.2	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Yes	Artificial Reef at NE Airport	NM1,2,3	4.7	6.1	27.7	10.4	3.7	10.9	35.6	13.1	6%	3%	9%	2%	3%	19%	11%	9%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 42	Yes	Artificial Reef at Sha Chau	NM5,6,8	1.3	1.4	1.6	1.5	0.3	0.3	0.5	0.3	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 45c	No	Sham Shui Kok (CWD habitat range)	NM1,2,3	4.2	6.0	6.6	5.0	2.3	3.6	10.1	3.5	2%	1%	0%	0%	0%	0%	4%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	NM1,2,3	17.4	18.6	29.5	18.7	16.0	17.4	21.6	17.5	7%	8%	5%	7%	2%	3%	2%	2%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47a	No	River Trade Terminal	NM1,2,3	1.7	2.9	4.7	2.7	0.5	1.9	7.9	3.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47b	Yes	River Trade Terminal (near coral site)	NM1,2,3	0.5	0.7	1.5	0.8	0.2	0.7	1.7	0.8	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 48	No	Airport Channel western end	NM5,6,8	0.0	0.1	0.1	0.1	0.0	0.1	0.3	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	NM1,2,3	9.9	11.0	13.0	11.1	7.3	8.4	9.7	8.4	5%	5%	1%	3%	1%	2%	2%	1%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Note:

WQO = Water Quality Objective; WQC = Water Quality Criteria; S = Surface level; M = Mid-depth; B = Bottom level; DA=Depth-averaged.

Grey cell = Values with WQO/WQC Exceedances

1 WQC based on the specific requirement for the Black Point / Castle Peak Power Station intake and the SS should be mantained at below 764 mg/L (ERM, 2006)

2 WQC based on general water quality protection guideline for FCZ (CityU, 2001)

3 The "Point SR" column indicate if the site is considered as specific stationary sensitive receiver by the nature of its use (e.g., beaches, existing intakes, SSSI or habitats for less mobile species).

Table A2 ***Predicted Maximum SS (mg/l) Elevations at Selected Observation Points for the Scenario Year 2012 (Mitigated with Concurrent Projects)***

Observation Points	Point SR	Name	Associated EPD	Maximum SS (mg/L)								Percentage of Time Exceedances Predicted								WQO / WQC							
				Dry Season				Wet Season				Dry Season				Wet Season				Dry Season				Wet Season			
				S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	NM5,6,8	0.2	1.5	2.2	1.3	0.1	0.2	0.7	0.3	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 09a	No	Urmston Road (Main Channel)	NM5,6,8	7.4	9.7	12.5	8.7	0.8	4.2	9.2	4.0	4%	4%	1%	1%	0%	1%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	NM5,6,8	0.7	2.5	5.2	2.4	0.7	1.8	6.4	2.8	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake (Note 1	-	1.4	3.5	5.5	3.3	0.4	2.3	8.4	3.6	0%	0%	0%	0%	0%	0%	0%	0%	764	764	764	764	764	764	764	764
WSR 12	Yes	Butterfly Beach (gazetted beach)	NM1,2,3	0.7	1.7	2.0	1.3	0.6	1.2	1.9	1.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	NM1,2,3	1.2	1.6	2.0	1.5	0.6	1.0	1.5	0.9	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 15	Yes	Gazetted Beaches at Tuen Mun	NM1,2,3	0.1	0.2	0.3	0.2	0.0	0.1	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	NM1,2,3	1.7	2.4	2.9	2.0	0.7	0.8	1.3	0.9	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 19	Yes	Gazetted Beaches at Ma Wan	WM4	0.7	0.8	0.9	0.8	0.2	0.4	0.3	0.3	0%	0%	0%	0%	0%	0%	0%	0%	3.9	6.0	9.0	6.1	1.7	2.8	6.0	3.4
WSR 20	Yes	Ma Wan Fish Culture Zone (Note 2)	-	2.7	2.6	2.6	2.6	0.6	1.5	1.6	1.2	0%	0%	0%	0%	0%	0%	0%	0%	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	NM1,2,3	1.9	2.4	2.8	2.3	0.3	1.2	2.2	1.2	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22a	No	Tai Ho Wan Outlet (inside)	NM1,2,3	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	NM1,2,3	0.2	0.2	0.2	0.2	0.0	0.1	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Yes	Airport Cooling Water Intake (NE)	NM1,2,3	2.9	4.3	5.3	3.3	2.3	4.6	5.9	3.6	0%	0%	0%	0%	1%	4%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	Yes	San Tau Beach SSSI	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 32	Yes	Tai O (Mangrove Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Yes	Artificial Reef at NE Airport	NM1,2,3	3.9	4.7	9.0	5.1	2.7	4.1	7.8	3.9	0%	0%	0%	0%	0%	4%	1%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 42	Yes	Artificial Reef at Sha Chau	NM5,6,8	1.5	1.7	1.9	1.7	0.3	0.4	1.0	0.4	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 45c	No	Sham Shui Kok (CWD habitat range)	NM1,2,3	1.9	2.5	2.8	2.3	0.5	0.8	1.7	0.9	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	NM1,2,3	6.8	7.5	8.1	7.4	3.3	4.1	7.4	3.6	1%	1%	0%	1%	1%	1%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47a	No	River Trade Terminal	NM1,2,3	7.0	9.2	14.9	6.4	4.2	9.7	12.5	5.1	2%	2%	1%	1%	4%	6%	2%	4%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47b	Yes	River Trade Terminal (near coral site)	NM1,2,3	0.8	1.1	2.7	1.2	1.0	2.5	2.7	1.3	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 48	No	Airport Channel western end	NM5,6,8	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	NM1,2,3	4.2	4.8	5.2	4.7	2.0	2.2	3.1	2.2	1%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Note:

WQO = Water Quality Objective; WQC = Water Quality Criteria; S = Surface level; M = Mid-depth; B = Bottom level; DA=Depth-averaged.

Grey cell = Values with WQO/WQC Exceedances

1 WQC based on the specific requirement for the Black Point / Castle Peak Power Station intake and the SS should be mantained at below 764 mg/L (ERM, 2006)

2 WQC based on general water quality protection guideline for FCZ (CityU, 2001)

3 The "Point SR" column indicate if the site is considered as specific stationary sensitive receiver by the nature of its use (e.g., beaches, existing intakes, SSSI or habitats for less mobile species).

Table A3 ***Predicted Maximum SS (mg/l) Elevations at Selected Observation Points for the Scenario Year 2013 (Mitigated with Concurrent Projects)***

Observation Points	Point SR	Name	Associated EPD	Maximum SS (mg/L)								Percentage of Time Exceedances Predicted								WQO / WQC							
				Dry Season				Wet Season				Dry Season				Wet Season				Dry Season				Wet Season			
				S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	NM5,6,8	0.2	1.9	2.9	1.7	0.0	0.4	1.0	0.5	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 09a	No	Urmston Road (Main Channel)	NM5,6,8	8.9	12.4	15.4	10.0	0.5	5.1	11.9	5.3	2%	3%	2%	2%	0%	2%	1%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	NM5,6,8	0.6	1.8	3.6	1.5	0.2	1.6	4.4	2.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake (Note 1	-	1.9	6.1	8.1	5.4	0.3	1.7	5.9	2.6	0%	0%	0%	0%	0%	0%	0%	0%	764	764	764	764	764	764	764	764
WSR 12	Yes	Butterfly Beach (gazetted beach)	NM1,2,3	0.2	0.6	0.6	0.4	0.3	0.9	1.1	0.7	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	NM1,2,3	0.9	1.0	1.2	1.0	0.2	0.5	0.9	0.5	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 15	Yes	Gazetted Beaches at Tuen Mun	NM1,2,3	0.1	0.2	0.3	0.2	0.0	0.1	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	NM1,2,3	1.6	2.3	3.0	2.1	0.9	1.0	1.4	1.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 19	Yes	Gazetted Beaches at Ma Wan	WM4	0.7	0.9	1.0	0.8	0.2	0.3	0.3	0.3	0%	0%	0%	0%	0%	0%	0%	0%	3.9	6.0	9.0	6.1	1.7	2.8	6.0	3.4
WSR 20	Yes	Ma Wan Fish Culture Zone (Note 2)	-	3.0	2.7	2.9	2.7	0.8	1.3	1.6	1.1	0%	0%	0%	0%	0%	0%	0%	0%	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	NM1,2,3	2.0	2.5	3.0	2.5	0.6	1.2	2.0	1.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22a	No	Tai Ho Wan Outlet (inside)	NM1,2,3	0.2	0.2	0.3	0.2	0.0	0.2	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	NM1,2,3	0.4	0.5	0.6	0.5	0.1	0.4	0.6	0.3	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Yes	Airport Cooling Water Intake (NE)	NM1,2,3	5.1	6.4	7.3	5.8	1.9	5.7	4.1	3.5	2%	5%	0%	0%	0%	4%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	Yes	San Tau Beach SSSI	NM5,6,8	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 32	Yes	Tai O (Mangrove Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Yes	Artificial Reef at NE Airport	NM1,2,3	5.4	6.9	8.2	5.7	7.2	5.7	4.0	4.1	3%	4%	1%	1%	12%	3%	0%	1%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 42	Yes	Artificial Reef at Sha Chau	NM5,6,8	1.2	1.3	1.4	1.3	0.3	0.3	0.7	0.3	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 45c	No	Sham Shui Kok (CWD habitat range)	NM1,2,3	2.2	3.4	4.1	2.7	0.7	1.7	1.8	1.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	NM1,2,3	2.0	3.0	3.6	2.3	1.5	1.9	2.7	1.3	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47a	No	River Trade Terminal	NM1,2,3	1.3	4.3	5.4	3.6	0.2	2.3	4.9	2.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47b	Yes	River Trade Terminal (near coral site)	NM1,2,3	2.6	5.9	10.5	5.2	4.0	8.9	11.8	6.0	0%	1%	1%	0%	6%	19%	9%	11%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 48	No	Airport Channel western end	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	NM1,2,3	2.1	3.0	4.2	2.4	1.0	1.7	3.5	1.4	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Note:

WQO = Water Quality Objective; WQC = Water Quality Criteria; S = Surface level; M = Mid-depth; B = Bottom level; DA=Depth-averaged.

Grey cell = Values with WQO/WQC Exceedances

1 WQC based on the specific requirement for the Black Point / Castle Peak Power Station intake and the SS should be mantained at below 764 mg/L (ERM, 2006)

2 WQC based on general water quality protection guideline for FCZ (CityU, 2001)

3 The "Point SR" column indicate if the site is considered as specific stationary sensitive receiver by the nature of its use (e.g., beaches, existing intakes, SSSI or habitats for less mobile species).

Table A4 Predicted Maximum Metals Elevations and DO depletion Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2011 Dry Season (Mitigated with Concurrent Projects)

Observation Points	Point SR	Name	Max. SS (mg/L) Dry	Max. SS (mg/L) Wet	Dry Season Maximum Elevation (ug/L) Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As
			DA	DA									
UCEL					4	160	110	1	40	110	2	270	42
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.1	0.3	0.00	0.18	0.12	0.00	0.04	0.12	0.00	0.30	0.05
WSR 09a	No	Urmston Road (Main Channel)	8.3	3.6	0.03	1.33	0.91	0.01	0.33	0.91	0.02	2.24	0.35
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	2.0	1.6	0.01	0.32	0.22	0.00	0.08	0.22	0.00	0.54	0.08
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	3.0	3.5	0.01	0.48	0.33	0.00	0.12	0.33	0.01	0.81	0.13
WSR 12	Yes	Butterfly Beach (gazetted beach)	0.8	0.3	0.00	0.13	0.09	0.00	0.03	0.09	0.00	0.22	0.03
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	0.8	0.2	0.00	0.13	0.09	0.00	0.03	0.09	0.00	0.22	0.03
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.1	0.0	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	1.8	0.7	0.01	0.29	0.20	0.00	0.07	0.20	0.00	0.49	0.08
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.2	0.00	0.13	0.09	0.00	0.03	0.09	0.00	0.22	0.03
WSR 20	Yes	Ma Wan Fish Culture Zone	2.9	1.1	0.01	0.46	0.32	0.00	0.12	0.32	0.01	0.78	0.12
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	4.3	1.9	0.02	0.69	0.47	0.00	0.17	0.47	0.01	1.16	0.18
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.5	0.4	0.00	0.08	0.06	0.00	0.02	0.06	0.00	0.14	0.02
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	1.4	0.8	0.01	0.22	0.15	0.00	0.06	0.15	0.00	0.38	0.06
WSR 25	Yes	Airport Cooling Water Intake (NE)	7.5	7.3	0.03	1.20	0.83	0.01	0.30	0.83	0.02	2.03	0.32
WSR 27	Yes	San Tau Beach SSSI	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.1	0.1	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 41	Yes	Artificial Reef at NE Airport	10.4	13.1	0.04	1.66	1.14	0.01	0.42	1.14	0.02	2.81	0.44
WSR 42	Yes	Artificial Reef at Sha Chau	1.5	0.3	0.01	0.24	0.17	0.00	0.06	0.17	0.00	0.41	0.06
WSR 45c	No	Sham Shui Kok (CWD habitat range)	5.0	3.5	0.02	0.80	0.55	0.01	0.20	0.55	0.01	1.35	0.21
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	18.7	17.5	0.07	2.99	2.06	0.02	0.75	2.06	0.04	5.05	0.79
WSR 47a	No	River Trade Terminal	2.7	3.1	0.01	0.43	0.30	0.00	0.11	0.30	0.01	0.73	0.11
WSR 47b	Yes	River Trade Terminal (near coral site)	0.8	0.8	0.00	0.13	0.09	0.00	0.03	0.09	0.00	0.22	0.03
WSR 48	No	Airport Channel western end	0.1	0.1	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	11.1	8.4	0.04	1.78	1.22	0.01	0.44	1.22	0.02	3.00	0.47

Observation Points	% of EQS Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	Maximum DO depletion
EQS (ug/L)	2.5	15	5	0.3	30	25	N/A	40	25	mg/L
WSR 08	0.2%	1.2%	2.4%	0.4%	0.1%	0.5%	-	0.7%	0.2%	0.0
WSR 09a	1.3%	8.9%	18.3%	2.8%	1.1%	3.7%	-	5.6%	1.4%	0.1
WSR 10	0.3%	2.1%	4.4%	0.7%	0.3%	0.9%	-	1.4%	0.3%	0.0
WSR 11	0.5%	3.2%	6.6%	1.0%	0.4%	1.3%	-	2.0%	0.5%	0.0
WSR 12	0.1%	0.9%	1.8%	0.3%	0.1%	0.4%	-	0.5%	0.1%	0.0
WSR 13	0.1%	0.9%	1.8%	0.3%	0.1%	0.4%	-	0.5%	0.1%	0.0
WSR 15	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 18	0.3%	1.9%	4.0%	0.6%	0.2%	0.8%	-	1.2%	0.3%	0.0
WSR 19	0.1%	0.9%	1.8%	0.3%	0.1%	0.4%	-	0.5%	0.1%	0.0
WSR 20	0.5%	3.1%	6.4%	1.0%	0.4%	1.3%	-	2.0%	0.5%	0.0
WSR 21	0.7%	4.6%	9.5%	1.4%	0.6%	1.9%	-	2.9%	0.7%	0.1
WSR 22a	0.1%	0.5%	1.1%	0.2%	0.1%	0.2%	-	0.3%	0.1%	0.0
WSR 22b	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 22c	0.2%	1.5%	3.1%	0.5%	0.2%	0.6%	-	0.9%	0.2%	0.0
WSR 25	1.2%	8.0%	17%	2.5%	1.0%	3.3%	-	5.1%	1.3%	0.1
WSR 27	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 28	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 29	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 30	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 31	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 32	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 34	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 41	1.7%	11.1%	22.9%	3.5%	1.4%	4.6%	-	7.0%	1.7%	0.2
WSR 42	0.2%	1.6%	3.3%	0.5%	0.2%	0.7%	-	1.0%	0.3%	0.0
WSR 45c	0.8%	5.3%	11.0%	1.7%	0.7%	2.2%	-	3.4%	0.8%	0.1
WSR 46	3.0%	19.9%	41.1%	6.2%	2.5%	8.2%	-	12.6%	3.1%	0.3
WSR 47a	0.4%	2.9%	5.9%	0.9%	0.4%	1.2%	-	1.8%	0.5%	0.0
WSR 47b	0.1%	0.9%	1.8%	0.3%	0.1%	0.4%	-	0.5%	0.1%	0.0
WSR 48	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 49	1.8%	11.8%	24.4%	3.7%	1.5%	4.9%	-	7.5%	1.9%	0.2

Table A5 Predicted Maximum Metals Elevations and DO depletion Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2011 Wet Season (Mitigated with Concurrent Projects)

Observation Points	Point SR	Name	Max. SS (mg/L) Dry	Max. SS (mg/L) Wet		Wet Season Maximum Elevation (ug/L)								
			Dry	Wet		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As
			DA	DA	UCEL	4	160	110	1	40	110	2	270	42
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.1	0.3		0.00	0.05	0.03	0.00	0.01	0.03	0.00	0.08	0.01
WSR 09a	No	Urmston Road (Main Channel)	8.3	3.6		0.01	0.58	0.40	0.00	0.14	0.40	0.01	0.97	0.15
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	2.0	1.6		0.01	0.26	0.18	0.00	0.06	0.18	0.00	0.43	0.07
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	3.0	3.5		0.01	0.56	0.39	0.00	0.14	0.39	0.01	0.95	0.15
WSR 12	Yes	Butterfly Beach (gazetted beach)	0.8	0.3		0.00	0.05	0.03	0.00	0.01	0.03	0.00	0.08	0.01
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	0.8	0.2		0.00	0.03	0.02	0.00	0.01	0.02	0.00	0.05	0.01
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.1	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	1.8	0.7		0.00	0.11	0.08	0.00	0.03	0.08	0.00	0.19	0.03
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.2		0.00	0.03	0.02	0.00	0.01	0.02	0.00	0.05	0.01
WSR 20	Yes	Ma Wan Fish Culture Zone	2.9	1.1		0.00	0.18	0.12	0.00	0.04	0.12	0.00	0.30	0.05
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	4.3	1.9		0.01	0.30	0.21	0.00	0.08	0.21	0.00	0.51	0.08
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.5	0.4		0.00	0.06	0.04	0.00	0.02	0.04	0.00	0.11	0.02
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	1.4	0.8		0.00	0.13	0.09	0.00	0.03	0.09	0.00	0.22	0.03
WSR 25	Yes	Airport Cooling Water Intake (NE)	7.5	7.3		0.03	1.17	0.80	0.01	0.29	0.80	0.01	1.97	0.31
WSR 27	Yes	San Tau Beach SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.1	0.1		0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.1		0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.2		0.00	0.03	0.02	0.00	0.01	0.02	0.00	0.05	0.01
WSR 41	Yes	Artificial Reef at NE Airport	10.4	13.1		0.05	2.10	1.44	0.01	0.52	1.44	0.03	3.54	0.55
WSR 42	Yes	Artificial Reef at Sha Chau	1.5	0.3		0.00	0.05	0.03	0.00	0.01	0.03	0.00	0.08	0.01
WSR 45c	No	Sham Shui Kok (CWD habitat range)	5.0	3.5		0.01	0.56	0.39	0.00	0.14	0.39	0.01	0.95	0.15
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	18.7	17.5		0.07	2.80	1.93	0.02	0.70	1.93	0.04	4.73	0.74
WSR 47a	No	River Trade Terminal	2.7	3.1		0.01	0.50	0.34	0.00	0.12	0.34	0.01	0.84	0.13
WSR 47b	Yes	River Trade Terminal (near coral site)	0.8	0.8		0.00	0.13	0.09	0.00	0.03	0.09	0.00	0.22	0.03
WSR 48	No	Airport Channel western end	0.1	0.1		0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	11.1	8.4		0.03	1.34	0.92	0.01	0.34	0.92	0.02	2.27	0.35

Observation Points		% of EQS									Maximum DO depletion
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	
	EQS (ug/L)	2.5	15	5	0.3	30	25	N/A	40	25	mg/L
WSR 08		0.0%	0.3%	0.7%	0.1%	0.0%	0.1%	-	0.2%	0.1%	0.0
WSR 09a		0.6%	3.8%	7.9%	1.2%	0.5%	1.6%	-	2.4%	0.6%	0.1
WSR 10		0.3%	1.7%	3.5%	0.5%	0.2%	0.7%	-	1.1%	0.3%	0.0
WSR 11		0.6%	3.7%	7.7%	1.2%	0.5%	1.5%	-	2.4%	0.6%	0.1
WSR 12		0.0%	0.3%	0.7%	0.1%	0.0%	0.1%	-	0.2%	0.1%	0.0
WSR 13		0.0%	0.2%	0.4%	0.1%	0.0%	0.1%	-	0.1%	0.0%	0.0
WSR 15		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 18		0.1%	0.7%	1.5%	0.2%	0.1%	0.3%	-	0.5%	0.1%	0.0
WSR 19		0.0%	0.2%	0.4%	0.1%	0.0%	0.1%	-	0.1%	0.0%	0.0
WSR 20		0.2%	1.2%	2.4%	0.4%	0.1%	0.5%	-	0.7%	0.2%	0.0
WSR 21		0.3%	2.0%	4.2%	0.6%	0.3%	0.8%	-	1.3%	0.3%	0.0
WSR 22a		0.1%	0.4%	0.9%	0.1%	0.1%	0.2%	-	0.3%	0.1%	0.0
WSR 22b		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 22c		0.1%	0.9%	1.8%	0.3%	0.1%	0.4%	-	0.5%	0.1%	0.0
WSR 25		1.2%	7.8%	16%	2.4%	1.0%	3.2%	-	4.9%	1.2%	0.1
WSR 27		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 28		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 29		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 30		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 31		0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 32		0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 34		0.0%	0.2%	0.4%	0.1%	0.0%	0.1%	-	0.1%	0.0%	0.0
WSR 41		2.1%	14.0%	28.8%	4.4%	1.7%	5.8%	-	8.8%	2.2%	0.2
WSR 42		0.0%	0.3%	0.7%	0.1%	0.0%	0.1%	-	0.2%	0.1%	0.0
WSR 45c		0.6%	3.7%	7.7%	1.2%	0.5%	1.5%	-	2.4%	0.6%	0.1
WSR 46		2.8%	18.7%	38.5%	5.8%	2.3%	7.7%	-	11.8%	2.9%	0.3
WSR 47a		0.5%	3.3%	6.8%	1.0%	0.4%	1.4%	-	2.1%	0.5%	0.0
WSR 47b		0.1%	0.9%	1.8%	0.3%	0.1%	0.4%	-	0.5%	0.1%	0.0
WSR 48		0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 49		1.3%	9.0%	18.5%	2.8%	1.1%	3.7%	-	5.7%	1.4%	0.1

Notes:

1 The maximum elevation assumed high concentrations of sediment bound metals just at UCEL (mg/kg dry wt.) level.

Table A6 Predicted Maximum Metals Elevations and DO depletion Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2012 Dry Season (Mitigated with Concurrent Projects)

			Max. SS (mg/L)		Dry Season Maximum Elevation (ug/L)								
			Dry	Wet	Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As
Observation Points	Point SR	Name	DA	DA	UCEL 4	160	110	1	40	110	2	270	42
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.3	0.3	0.01	0.21	0.14	0.00	0.05	0.14	0.00	0.35	0.05
WSR 09a	No	Urmston Road (Main Channel)	8.7	4.0	0.03	1.39	0.96	0.01	0.35	0.96	0.02	2.35	0.37
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	2.4	2.8	0.01	0.38	0.26	0.00	0.10	0.26	0.00	0.65	0.10
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	3.3	3.6	0.01	0.53	0.36	0.00	0.13	0.36	0.01	0.89	0.14
WSR 12	Yes	Butterfly Beach (gazetted beach)	1.3	1.0	0.01	0.21	0.14	0.00	0.05	0.14	0.00	0.35	0.05
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	1.5	0.9	0.01	0.24	0.17	0.00	0.06	0.17	0.00	0.41	0.06
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.2	0.0	0.00	0.03	0.02	0.00	0.01	0.02	0.00	0.05	0.01
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	2.0	0.9	0.01	0.32	0.22	0.00	0.08	0.22	0.00	0.54	0.08
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.3	0.00	0.13	0.09	0.00	0.03	0.09	0.00	0.22	0.03
WSR 20	Yes	Ma Wan Fish Culture Zone	2.6	1.2	0.01	0.42	0.29	0.00	0.10	0.29	0.01	0.70	0.11
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	2.3	1.2	0.01	0.37	0.25	0.00	0.09	0.25	0.00	0.62	0.10
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.1	0.0	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	0.2	0.1	0.00	0.03	0.02	0.00	0.01	0.02	0.00	0.05	0.01
WSR 25	Yes	Airport Cooling Water Intake (NE)	3.3	3.6	0.01	0.53	0.36	0.00	0.13	0.36	0.01	0.89	0.14
WSR 27	Yes	San Tau Beach SSSI	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.0	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 41	Yes	Artificial Reef at NE Airport	5.1	3.9	0.02	0.82	0.56	0.01	0.20	0.56	0.01	1.38	0.21
WSR 42	Yes	Artificial Reef at Sha Chau	1.7	0.4	0.01	0.27	0.19	0.00	0.07	0.19	0.00	0.46	0.07
WSR 45c	No	Sham Shui Kok (CWD habitat range)	2.3	0.9	0.01	0.37	0.25	0.00	0.09	0.25	0.00	0.62	0.10
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	7.4	3.6	0.03	1.18	0.81	0.01	0.30	0.81	0.01	2.00	0.31
WSR 47a	No	River Trade Terminal	6.4	5.1	0.03	1.02	0.70	0.01	0.26	0.70	0.01	1.73	0.27
WSR 47b	Yes	River Trade Terminal (near coral site)	1.2	1.3	0.00	0.19	0.13	0.00	0.05	0.13	0.00	0.32	0.05
WSR 48	No	Airport Channel western end	0.0	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	4.7	2.2	0.02	0.75	0.52	0.00	0.19	0.52	0.01	1.27	0.20

	% of EQS									Maximum DO depletion
	Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	
Observation Points	EQS (ug/L) 2.5	15	5	0.3	30	25	N/A	40	25	mg/L
WSR 08	0.2%	1.4%	2.9%	0.4%	0.2%	0.6%	-	0.9%	0.2%	0.0
WSR 09a	1.4%	9.3%	19.1%	2.9%	1.2%	3.8%	-	5.9%	1.5%	0.1
WSR 10	0.4%	2.6%	5.3%	0.8%	0.3%	1.1%	-	1.6%	0.4%	0.0
WSR 11	0.5%	3.5%	7.3%	1.1%	0.4%	1.5%	-	2.2%	0.6%	0.0
WSR 12	0.2%	1.4%	2.9%	0.4%	0.2%	0.6%	-	0.9%	0.2%	0.0
WSR 13	0.2%	1.6%	3.3%	0.5%	0.2%	0.7%	-	1.0%	0.3%	0.0
WSR 15	0.0%	0.2%	0.4%	0.1%	0.0%	0.1%	-	0.1%	0.0%	0.0
WSR 18	0.3%	2.1%	4.4%	0.7%	0.3%	0.9%	-	1.4%	0.3%	0.0
WSR 19	0.1%	0.9%	1.8%	0.3%	0.1%	0.4%	-	0.5%	0.1%	0.0
WSR 20	0.4%	2.8%	5.7%	0.9%	0.3%	1.1%	-	1.8%	0.4%	0.0
WSR 21	0.4%	2.5%	5.1%	0.8%	0.3%	1.0%	-	1.6%	0.4%	0.0
WSR 22a	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 22b	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 22c	0.0%	0.2%	0.4%	0.1%	0.0%	0.1%	-	0.1%	0.0%	0.0
WSR 25	0.5%	3.5%	7%	1.1%	0.4%	1.5%	-	2.2%	0.6%	0.0
WSR 27	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 28	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 29	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 30	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 31	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 32	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 34	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 41	0.8%	5.4%	11.2%	1.7%	0.7%	2.2%	-	3.4%	0.9%	0.1
WSR 42	0.3%	1.8%	3.7%	0.6%	0.2%	0.7%	-	1.1%	0.3%	0.0
WSR 45c	0.4%	2.5%	5.1%	0.8%	0.3%	1.0%	-	1.6%	0.4%	0.0
WSR 46	1.2%	7.9%	16.3%	2.5%	1.0%	3.3%	-	5.0%	1.2%	0.1
WSR 47a	1.0%	6.8%	14.1%	2.1%	0.9%	2.8%	-	4.3%	1.1%	0.1
WSR 47b	0.2%	1.3%	2.6%	0.4%	0.2%	0.5%	-	0.8%	0.2%	0.0
WSR 48	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 49	0.8%	5.0%	10.3%	1.6%	0.6%	2.1%	-	3.2%	0.8%	0.1

Table A7 Predicted Maximum Metals Elevations and DO depletion Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2012 Wet Season (Mitigated with Concurrent Projects)

Observation Points	Point SR	Name	Max. SS (mg/L)			Wet Season Maximum Elevation (ug/L)								
			Dry	Wet		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As
			DA	DA	UCEL	4	160	110	1	40	110	2	270	42
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.3	0.3		0.00	0.05	0.03	0.00	0.01	0.03	0.00	0.08	0.01
WSR 09a	No	Urmston Road (Main Channel)	8.7	4.0		0.02	0.64	0.44	0.00	0.16	0.44	0.01	1.08	0.17
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	2.4	2.8		0.01	0.45	0.31	0.00	0.11	0.31	0.01	0.76	0.12
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	3.3	3.6		0.01	0.58	0.40	0.00	0.14	0.40	0.01	0.97	0.15
WSR 12	Yes	Butterfly Beach (gazetted beach)	1.3	1.0		0.00	0.16	0.11	0.00	0.04	0.11	0.00	0.27	0.04
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	1.5	0.9		0.00	0.14	0.10	0.00	0.04	0.10	0.00	0.24	0.04
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.2	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	2.0	0.9		0.00	0.14	0.10	0.00	0.04	0.10	0.00	0.24	0.04
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.3		0.00	0.05	0.03	0.00	0.01	0.03	0.00	0.08	0.01
WSR 20	Yes	Ma Wan Fish Culture Zone	2.6	1.2		0.00	0.19	0.13	0.00	0.05	0.13	0.00	0.32	0.05
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	2.3	1.2		0.00	0.19	0.13	0.00	0.05	0.13	0.00	0.32	0.05
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.1	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	0.2	0.1		0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00
WSR 25	Yes	Airport Cooling Water Intake (NE)	3.3	3.6		0.01	0.58	0.40	0.00	0.14	0.40	0.01	0.97	0.15
WSR 27	Yes	San Tau Beach SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.0	0.1		0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 41	Yes	Artificial Reef at NE Airport	5.1	3.9		0.02	0.62	0.43	0.00	0.16	0.43	0.01	1.05	0.16
WSR 42	Yes	Artificial Reef at Sha Chau	1.7	0.4		0.00	0.06	0.04	0.00	0.02	0.04	0.00	0.11	0.02
WSR 45c	No	Sham Shui Kok (CWD habitat range)	2.3	0.9		0.00	0.14	0.10	0.00	0.04	0.10	0.00	0.24	0.04
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	7.4	3.6		0.01	0.58	0.40	0.00	0.14	0.40	0.01	0.97	0.15
WSR 47a	No	River Trade Terminal	6.4	5.1		0.02	0.82	0.56	0.01	0.20	0.56	0.01	1.38	0.21
WSR 47b	Yes	River Trade Terminal (near coral site)	1.2	1.3		0.01	0.21	0.14	0.00	0.05	0.14	0.00	0.35	0.05
WSR 48	No	Airport Channel western end	0.0	0.1		0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	4.7	2.2		0.01	0.35	0.24	0.00	0.09	0.24	0.00	0.59	0.09

Observation Points		% of EQS									Maximum DO depletion
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	
	EQS (ug/L)	2.5	15	5	0.3	30	25	N/A	40	25	mg/L
WSR 08		0.0%	0.3%	0.7%	0.1%	0.0%	0.1%	-	0.2%	0.1%	0.0
WSR 09a		0.6%	4.3%	8.8%	1.3%	0.5%	1.8%	-	2.7%	0.7%	0.1
WSR 10		0.4%	3.0%	6.2%	0.9%	0.4%	1.2%	-	1.9%	0.5%	0.0
WSR 11		0.6%	3.8%	7.9%	1.2%	0.5%	1.6%	-	2.4%	0.6%	0.1
WSR 12		0.2%	1.1%	2.2%	0.3%	0.1%	0.4%	-	0.7%	0.2%	0.0
WSR 13		0.1%	1.0%	2.0%	0.3%	0.1%	0.4%	-	0.6%	0.2%	0.0
WSR 15		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 18		0.1%	1.0%	2.0%	0.3%	0.1%	0.4%	-	0.6%	0.2%	0.0
WSR 19		0.0%	0.3%	0.7%	0.1%	0.0%	0.1%	-	0.2%	0.1%	0.0
WSR 20		0.2%	1.3%	2.6%	0.4%	0.2%	0.5%	-	0.8%	0.2%	0.0
WSR 21		0.2%	1.3%	2.6%	0.4%	0.2%	0.5%	-	0.8%	0.2%	0.0
WSR 22a		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 22b		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 22c		0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 25		0.6%	3.8%	8%	1.2%	0.5%	1.6%	-	2.4%	0.6%	0.1
WSR 27		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 28		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 29		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 30		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 31		0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 32		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 34		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 41		0.6%	4.2%	8.6%	1.3%	0.5%	1.7%	-	2.6%	0.7%	0.1
WSR 42		0.1%	0.4%	0.9%	0.1%	0.1%	0.2%	-	0.3%	0.1%	0.0
WSR 45c		0.1%	1.0%	2.0%	0.3%	0.1%	0.4%	-	0.6%	0.2%	0.0
WSR 46		0.6%	3.8%	7.9%	1.2%	0.5%	1.6%	-	2.4%	0.6%	0.1
WSR 47a		0.8%	5.4%	11.2%	1.7%	0.7%	2.2%	-	3.4%	0.9%	0.1
WSR 47b		0.2%	1.4%	2.9%	0.4%	0.2%	0.6%	-	0.9%	0.2%	0.0
WSR 48		0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 49		0.4%	2.3%	4.8%	0.7%	0.3%	1.0%	-	1.5%	0.4%	0.0

Notes:

1 The maximum elevation assumed high concentrations of sediment bound metals just at UCEL (mg/kg dry wt.) level.

Table A8 Predicted Maximum Metals Elevations and DO depletion Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2013 Dry Season (Mitigated with Concurrent Projects)

Observation Points	Point SR	Name	Max. SS (mg/L)		Dry Season Maximum Elevation (ug/L)								
			Dry	Wet	Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As
			DA	DA									
UCEL					4	160	110	1	40	110	2	270	42
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.7	0.5	0.01	0.27	0.19	0.00	0.07	0.19	0.00	0.46	0.07
WSR 09a	No	Urmston Road (Main Channel)	10.0	5.3	0.04	1.60	1.10	0.01	0.40	1.10	0.02	2.70	0.42
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	1.5	2.0	0.01	0.24	0.17	0.00	0.06	0.17	0.00	0.41	0.06
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	5.4	2.6	0.02	0.86	0.59	0.01	0.22	0.59	0.01	1.46	0.23
WSR 12	Yes	Butterfly Beach (gazetted beach)	0.4	0.7	0.00	0.06	0.04	0.00	0.02	0.04	0.00	0.11	0.02
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	1.0	0.5	0.00	0.16	0.11	0.00	0.04	0.11	0.00	0.27	0.04
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.2	0.0	0.00	0.03	0.02	0.00	0.01	0.02	0.00	0.05	0.01
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	2.1	1.0	0.01	0.34	0.23	0.00	0.08	0.23	0.00	0.57	0.09
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.3	0.00	0.13	0.09	0.00	0.03	0.09	0.00	0.22	0.03
WSR 20	Yes	Ma Wan Fish Culture Zone	2.7	1.1	0.01	0.43	0.30	0.00	0.11	0.30	0.01	0.73	0.11
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	2.5	1.1	0.01	0.40	0.28	0.00	0.10	0.28	0.01	0.68	0.11
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.2	0.1	0.00	0.03	0.02	0.00	0.01	0.02	0.00	0.05	0.01
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	0.5	0.3	0.00	0.08	0.06	0.00	0.02	0.06	0.00	0.14	0.02
WSR 25	Yes	Airport Cooling Water Intake (NE)	5.8	3.5	0.02	0.93	0.64	0.01	0.23	0.64	0.01	1.57	0.24
WSR 27	Yes	San Tau Beach SSSI	0.1	0.0	0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 41	Yes	Artificial Reef at NE Airport	5.7	4.1	0.02	0.91	0.63	0.01	0.23	0.63	0.01	1.54	0.24
WSR 42	Yes	Artificial Reef at Sha Chau	1.3	0.3	0.01	0.21	0.14	0.00	0.05	0.14	0.00	0.35	0.05
WSR 45c	No	Sham Shui Kok (CWD habitat range)	2.7	1.1	0.01	0.43	0.30	0.00	0.11	0.30	0.01	0.73	0.11
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	2.3	1.3	0.01	0.37	0.25	0.00	0.09	0.25	0.00	0.62	0.10
WSR 47a	No	River Trade Terminal	3.6	2.1	0.01	0.58	0.40	0.00	0.14	0.40	0.01	0.97	0.15
WSR 47b	Yes	River Trade Terminal (near coral site)	5.2	6.0	0.02	0.83	0.57	0.01	0.21	0.57	0.01	1.40	0.22
WSR 48	No	Airport Channel western end	0.0	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	2.4	1.4	0.01	0.38	0.26	0.00	0.10	0.26	0.00	0.65	0.10

Observation Points	% of EQS									Maximum DO depletion
	Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	
EQS (ug/L)	2.5	15	5	0.3	30	25	N/A	40	25	mg/L
WSR 08	0.3%	1.8%	3.7%	0.6%	0.2%	0.7%	-	1.1%	0.3%	0.0
WSR 09a	1.6%	10.7%	22.0%	3.3%	1.3%	4.4%	-	6.8%	1.7%	0.2
WSR 10	0.2%	1.6%	3.3%	0.5%	0.2%	0.7%	-	1.0%	0.3%	0.0
WSR 11	0.9%	5.8%	11.9%	1.8%	0.7%	2.4%	-	3.6%	0.9%	0.1
WSR 12	0.1%	0.4%	0.9%	0.1%	0.1%	0.2%	-	0.3%	0.1%	0.0
WSR 13	0.2%	1.1%	2.2%	0.3%	0.1%	0.4%	-	0.7%	0.2%	0.0
WSR 15	0.0%	0.2%	0.4%	0.1%	0.0%	0.1%	-	0.1%	0.0%	0.0
WSR 18	0.3%	2.2%	4.6%	0.7%	0.3%	0.9%	-	1.4%	0.4%	0.0
WSR 19	0.1%	0.9%	1.8%	0.3%	0.1%	0.4%	-	0.5%	0.1%	0.0
WSR 20	0.4%	2.9%	5.9%	0.9%	0.4%	1.2%	-	1.8%	0.5%	0.0
WSR 21	0.4%	2.7%	5.5%	0.8%	0.3%	1.1%	-	1.7%	0.4%	0.0
WSR 22a	0.0%	0.2%	0.4%	0.1%	0.0%	0.1%	-	0.1%	0.0%	0.0
WSR 22b	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 22c	0.1%	0.5%	1.1%	0.2%	0.1%	0.2%	-	0.3%	0.1%	0.0
WSR 25	0.9%	6.2%	13%	1.9%	0.8%	2.6%	-	3.9%	1.0%	0.1
WSR 27	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 28	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 29	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 30	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 31	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 32	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 34	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 41	0.9%	6.1%	12.5%	1.9%	0.8%	2.5%	-	3.8%	1.0%	0.1
WSR 42	0.2%	1.4%	2.9%	0.4%	0.2%	0.6%	-	0.9%	0.2%	0.0
WSR 45c	0.4%	2.9%	5.9%	0.9%	0.4%	1.2%	-	1.8%	0.5%	0.0
WSR 46	0.4%	2.5%	5.1%	0.8%	0.3%	1.0%	-	1.6%	0.4%	0.0
WSR 47a	0.6%	3.8%	7.9%	1.2%	0.5%	1.6%	-	2.4%	0.6%	0.1
WSR 47b	0.8%	5.5%	11.4%	1.7%	0.7%	2.3%	-	3.5%	0.9%	0.1
WSR 48	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 49	0.4%	2.6%	5.3%	0.8%	0.3%	1.1%	-	1.6%	0.4%	0.0

Table A9 Predicted Maximum Metals Elevations and DO depletion Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2013 Wet Season (Mitigated with Concurrent Projects)

			Max. SS (mg/L)			Wet Season Maximum Elevation (ug/L)										% of EQS									Maximum DO depletion
			Dry	Wet		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	
Observation Points	Point SR	Name	DA	DA	UCEL	4	160	110	1	40	110	2	270	42	EQS (ug/L)	2.5	15	5	0.3	30	25	N/A	40	25	mg/L
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.7	0.5		0.00	0.08	0.06	0.00	0.02	0.06	0.00	0.14	0.02		0.1%	0.5%	1.1%	0.2%	0.1%	0.2%	-	0.3%	0.1%	0.0
WSR 09a	No	Urmston Road (Main Channel)	10.0	5.3		0.02	0.85	0.58	0.01	0.21	0.58	0.01	1.43	0.22		0.8%	5.7%	11.7%	1.8%	0.7%	2.3%	-	3.6%	0.9%	0.1
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	1.5	2.0		0.01	0.32	0.22	0.00	0.08	0.22	0.00	0.54	0.08		0.3%	2.1%	4.4%	0.7%	0.3%	0.9%	-	1.4%	0.3%	0.0
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	5.4	2.6		0.01	0.42	0.29	0.00	0.10	0.29	0.01	0.70	0.11		0.4%	2.8%	5.7%	0.9%	0.3%	1.1%	-	1.8%	0.4%	0.0
WSR 12	Yes	Butterfly Beach (gazetted beach)	0.4	0.7		0.00	0.11	0.08	0.00	0.03	0.08	0.00	0.19	0.03		0.1%	0.7%	1.5%	0.2%	0.1%	0.3%	-	0.5%	0.1%	0.0
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	1.0	0.5		0.00	0.08	0.06	0.00	0.02	0.06	0.00	0.14	0.02		0.1%	0.5%	1.1%	0.2%	0.1%	0.2%	-	0.3%	0.1%	0.0
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.2	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	2.1	1.0		0.00	0.16	0.11	0.00	0.04	0.11	0.00	0.27	0.04		0.2%	1.1%	2.2%	0.3%	0.1%	0.4%	-	0.7%	0.2%	0.0
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.3		0.00	0.05	0.03	0.00	0.01	0.03	0.00	0.08	0.01		0.0%	0.3%	0.7%	0.1%	0.0%	0.1%	-	0.2%	0.1%	0.0
WSR 20	Yes	Ma Wan Fish Culture Zone	2.7	1.1		0.00	0.18	0.12	0.00	0.04	0.12	0.00	0.30	0.05		0.2%	1.2%	2.4%	0.4%	0.1%	0.5%	-	0.7%	0.2%	0.0
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	2.5	1.1		0.00	0.18	0.12	0.00	0.04	0.12	0.00	0.30	0.05		0.2%	1.2%	2.4%	0.4%	0.1%	0.5%	-	0.7%	0.2%	0.0
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.2	0.1		0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00		0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	0.5	0.3		0.00	0.05	0.03	0.00	0.01	0.03	0.00	0.08	0.01		0.0%	0.3%	0.7%	0.1%	0.0%	0.1%	-	0.2%	0.1%	0.0
WSR 25	Yes	Airport Cooling Water Intake (NE)	5.8	3.5		0.01	0.56	0.39	0.00	0.14	0.39	0.01	0.95	0.15		0.6%	3.7%	8%	1.2%	0.5%	1.5%	-	2.4%	0.6%	0.1
WSR 27	Yes	San Tau Beach SSSI	0.1	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-	0.0%	0.0%	0.0
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.1		0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00		0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.1		0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00		0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 41	Yes	Artificial Reef at NE Airport	5.7	4.1		0.02	0.66	0.45	0.00	0.16	0.45	0.01	1.11	0.17		0.7%	4.4%	9.0%	1.4%	0.5%	1.8%	-	2.8%	0.7%	0.1
WSR 42	Yes	Artificial Reef at Sha Chau	1.3	0.3		0.00	0.05	0.03	0.00	0.01	0.03	0.00	0.08	0.01		0.0%	0.3%	0.7%	0.1%	0.0%	0.1%	-	0.2%	0.1%	0.0
WSR 45c	No	Sham Shui Kok (CWD habitat range)	2.7	1.1		0.00	0.18	0.12	0.00	0.04	0.12	0.00	0.30	0.05		0.2%	1.2%	2.4%	0.4%	0.1%	0.5%	-	0.7%	0.2%	0.0
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	2.3	1.3		0.01	0.21	0.14	0.00	0.05	0.14	0.00	0.35	0.05		0.2%	1.4%	2.9%	0.4%	0.2%	0.6%	-	0.9%	0.2%	0.0
WSR 47a	No	River Trade Terminal	3.6	2.1		0.01	0.34	0.23	0.00	0.08	0.23	0.00	0.57	0.09		0.3%	2.2%	4.6%	0.7%	0.3%	0.9%	-	1.4%	0.4%	0.0
WSR 47b	Yes	River Trade Terminal (near coral site)	5.2	6.0		0.02	0.96	0.66	0.01	0.24	0.66	0.01	1.62	0.25		1.0%	6.4%	13.2%	2.0%	0.8%	2.6%	-	4.1%	1.0%	0.1
WSR 48	No	Airport Channel western end	0.0	0.1		0.00	0.02	0.01	0.00	0.00	0.01	0.00	0.03	0.00		0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	-	0.1%	0.0%	0.0
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	2.4	1.4		0.01	0.22	0.15	0.00	0.06	0.15	0.00	0.38	0.06		0.2%	1.5%	3.1%	0.5%	0.2%	0.6%	-	0.9%	0.2%	0.0

Notes:

1 The maximum elevation assumed high concentrations of sediment bound metals just at UCEL (mg/kg dry wt.) level.

Table A10 Predicted Maximum Nutrient Elevations Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2011 Dry Season (Mitigated with Concurrent Projects)

			Max. SS (mg/L)			Dry Season Maximum Elevation (mg/L)								% of WQO/WQC						
			Dry	Wet		TKN	NH4	NH3	NO3	NO2	TIN	TP		Cd	Cr	Cu	Hg	Ni	Pb	As
Observation Points	Point SR	Name	DA	DA	Max. in Sediment	1100	58	55	2.4	4.7	1107.1	680	WQO/WQC mg/L	0.12	0.021	0.29	0.06	0.5	25	0.05
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.1	0.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.0%	0.3%	0.0%	0.0%	0.0%	0.0%	1.5%
WSR 09a	No	Urmston Road (Main Channel)	8.3	3.6		0.01	0.00	0.00	0.00	0.00	0.01	0.01		7.6%	2.3%	0.2%	0.0%	0.0%	0.0%	11.3%
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	2.0	1.6		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.8%	0.6%	0.0%	0.0%	0.0%	0.0%	2.7%
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	3.0	3.5		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.8%	0.8%	0.1%	0.0%	0.0%	0.0%	4.1%
WSR 12	Yes	Butterfly Beach (gazetted beach)	0.8	0.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.7%	0.2%	0.0%	0.0%	0.0%	0.0%	1.1%
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	0.8	0.2		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.7%	0.2%	0.0%	0.0%	0.0%	0.0%	1.1%
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.1	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	1.8	0.7		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.7%	0.5%	0.0%	0.0%	0.0%	0.0%	2.4%
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.2		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.7%	0.2%	0.0%	0.0%	0.0%	0.0%	1.1%
WSR 20	Yes	Ma Wan Fish Culture Zone	2.9	1.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.7%	0.8%	0.1%	0.0%	0.0%	0.0%	3.9%
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	4.3	1.9		0.00	0.00	0.00	0.00	0.00	0.00	0.00		3.9%	1.2%	0.1%	0.0%	0.0%	0.0%	5.8%
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.5	0.4		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.7%
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	1.4	0.8		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.3%	0.4%	0.0%	0.0%	0.0%	0.0%	1.9%
WSR 25	Yes	Airport Cooling Water Intake (NE)	7.5	7.3		0.01	0.00	0.00	0.00	0.00	0.01	0.01		6.9%	2.1%	0%	0.0%	0.0%	0.0%	10.2%
WSR 27	Yes	San Tau Beach SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.1	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.2		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 41	Yes	Artificial Reef at NE Airport	10.4	13.1		0.01	0.00	0.00	0.00	0.00	0.01	0.01		9.5%	2.9%	0.2%	0.0%	0.0%	0.0%	14.1%
WSR 42	Yes	Artificial Reef at Sha Chau	1.5	0.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.4%	0.4%	0.0%	0.0%	0.0%	0.0%	2.0%
WSR 45c	No	Sham Shui Kok (CWD habitat range)	5.0	3.5		0.01	0.00	0.00	0.00	0.00	0.01	0.00		4.6%	1.4%	0.1%	0.0%	0.0%	0.0%	6.8%
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	18.7	17.5		0.02	0.00	0.00	0.00	0.00	0.02	0.01		17.1%	5.2%	0.4%	0.1%	0.0%	0.1%	25.4%
WSR 47a	No	River Trade Terminal	2.7	3.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.5%	0.7%	0.1%	0.0%	0.0%	0.0%	3.7%
WSR 47b	Yes	River Trade Terminal (near coral site)	0.8	0.8		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.7%	0.2%	0.0%	0.0%	0.0%	0.0%	1.1%
WSR 48	No	Airport Channel western end	0.1	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	11.1	8.4		0.01	0.00	0.00	0.00	0.00	0.01	0.01		10.2%	3.1%	0.2%	0.0%	0.0%	0.0%	15.1%

Table A11 Predicted Maximum Nutrient Elevations Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2011 Wet Season (Mitigated with Concurrent Projects)

Observation Points	Point SR	Name	Max. SS (mg/L)		Wet Season Maximum Elevation (mg/L)							% of WQO/WQC						
			Dry	Wet	TKN	NH4	NH3	NO3	NO2	TIN	TP	Cd	Cr	Cu	Hg	Ni	Pb	As
			DA	DA														
		Max. in Sediment			1100	58	55	2.4	4.7	1107.1	680							
		WQO/WQC mg/L										0.12	0.021	0.29	0.06	0.5	25	0.05
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.1	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.4%
WSR 09a	No	Urmston Road (Main Channel)	8.3	3.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.3%	1.0%	0.1%	0.0%	0.0%	0.0%	4.9%
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	2.0	1.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.5%	0.4%	0.0%	0.0%	0.0%	0.0%	2.2%
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	3.0	3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.2%	1.0%	0.1%	0.0%	0.0%	0.0%	4.8%
WSR 12	Yes	Butterfly Beach (gazetted beach)	0.8	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.4%
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	0.8	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.3%
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.1	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	1.8	0.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.6%	0.2%	0.0%	0.0%	0.0%	0.0%	1.0%
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.3%
WSR 20	Yes	Ma Wan Fish Culture Zone	2.9	1.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0%	0.3%	0.0%	0.0%	0.0%	0.0%	1.5%
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	4.3	1.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.7%	0.5%	0.0%	0.0%	0.0%	0.0%	2.6%
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.5	0.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.4%	0.1%	0.0%	0.0%	0.0%	0.0%	0.5%
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	1.4	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.7%	0.2%	0.0%	0.0%	0.0%	0.0%	1.1%
WSR 25	Yes	Airport Cooling Water Intake (NE)	7.5	7.3	0.01	0.00	0.00	0.00	0.00	0.01	0.00	6.7%	2.0%	0%	0.0%	0.0%	0.0%	9.9%
WSR 27	Yes	San Tau Beach SSSI	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.1	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.3%
WSR 41	Yes	Artificial Reef at NE Airport	10.4	13.1	0.01	0.00	0.00	0.00	0.00	0.01	0.01	12.0%	3.6%	0.2%	0.1%	0.0%	0.1%	17.8%
WSR 42	Yes	Artificial Reef at Sha Chau	1.5	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.4%
WSR 45c	No	Sham Shui Kok (CWD habitat range)	5.0	3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.2%	1.0%	0.1%	0.0%	0.0%	0.0%	4.8%
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	18.7	17.5	0.02	0.00	0.00	0.00	0.00	0.02	0.01	16.0%	4.8%	0.3%	0.1%	0.0%	0.1%	23.8%
WSR 47a	No	River Trade Terminal	2.7	3.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.8%	0.9%	0.1%	0.0%	0.0%	0.0%	4.2%
WSR 47b	Yes	River Trade Terminal (near coral site)	0.8	0.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.7%	0.2%	0.0%	0.0%	0.0%	0.0%	1.1%
WSR 48	No	Airport Channel western end	0.1	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	11.1	8.4	0.01	0.00	0.00	0.00	0.00	0.01	0.01	7.7%	2.3%	0.2%	0.0%	0.0%	0.0%	11.4%

Notes:
1 The maximum elevuation assumed high concentrations of sediment bound nutrient based on sediment sample maximum (mg/kg dry wt.)
2 NH3 is assumed to be 5% of TKN.
3 TIN is estimated as the sum of TKN+NO3+NO2
4 WQO is only set for TIN and NH3. For parameters without WQO, the 10 years EPD annual average is referenced.

Table A12 ***Predicted Maximum Nutrient Elevations Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2012 Dry Season (Mitigated with Concurrent Projects)***

			Max. SS (mg/L)			Dry Season Maximum Elevation (mg/L)								% of WQO/WQC						
			Dry	Wet		TKN	NH4	NH3	NO3	NO2	TIN	TP		Cd	Cr	Cu	Hg	Ni	Pb	As
Observation Points	Point SR	Name	DA	DA	Max. in Sediment	1100	58	55	2.4	4.7	1107.1	680	WQO/WQC mg/L	0.12	0.021	0.29	0.06	0.5	25	0.05
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.3	0.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.2%	0.4%	0.0%	0.0%	0.0%	0.0%	1.8%
WSR 09a	No	Urmston Road (Main Channel)	8.7	4.0		0.01	0.00	0.00	0.00	0.00	0.01	0.01		8.0%	2.4%	0.2%	0.0%	0.0%	0.0%	11.8%
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	2.4	2.8		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.2%	0.7%	0.0%	0.0%	0.0%	0.0%	3.3%
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	3.3	3.6		0.00	0.00	0.00	0.00	0.00	0.00	0.00		3.0%	0.9%	0.1%	0.0%	0.0%	0.0%	4.5%
WSR 12	Yes	Butterfly Beach (gazetted beach)	1.3	1.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.2%	0.4%	0.0%	0.0%	0.0%	0.0%	1.8%
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	1.5	0.9		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.4%	0.4%	0.0%	0.0%	0.0%	0.0%	2.0%
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.2	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.3%
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	2.0	0.9		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.8%	0.6%	0.0%	0.0%	0.0%	0.0%	2.7%
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.7%	0.2%	0.0%	0.0%	0.0%	0.0%	1.1%
WSR 20	Yes	Ma Wan Fish Culture Zone	2.6	1.2		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.4%	0.7%	0.0%	0.0%	0.0%	0.0%	3.5%
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	2.3	1.2		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.1%	0.6%	0.0%	0.0%	0.0%	0.0%	3.1%
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.1	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	0.2	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.3%
WSR 25	Yes	Airport Cooling Water Intake (NE)	3.3	3.6		0.00	0.00	0.00	0.00	0.00	0.00	0.00		3.0%	0.9%	0%	0.0%	0.0%	0.0%	4.5%
WSR 27	Yes	San Tau Beach SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.0	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 41	Yes	Artificial Reef at NE Airport	5.1	3.9		0.01	0.00	0.00	0.00	0.00	0.01	0.00		4.7%	1.4%	0.1%	0.0%	0.0%	0.0%	6.9%
WSR 42	Yes	Artificial Reef at Sha Chau	1.7	0.4		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.6%	0.5%	0.0%	0.0%	0.0%	0.0%	2.3%
WSR 45c	No	Sham Shui Kok (CWD habitat range)	2.3	0.9		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.1%	0.6%	0.0%	0.0%	0.0%	0.0%	3.1%
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	7.4	3.6		0.01	0.00	0.00	0.00	0.00	0.01	0.01		6.8%	2.0%	0.1%	0.0%	0.0%	0.0%	10.1%
WSR 47a	No	River Trade Terminal	6.4	5.1		0.01	0.00	0.00	0.00	0.00	0.01	0.00		5.9%	1.8%	0.1%	0.0%	0.0%	0.0%	8.7%
WSR 47b	Yes	River Trade Terminal (near coral site)	1.2	1.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.1%	0.3%	0.0%	0.0%	0.0%	0.0%	1.6%
WSR 48	No	Airport Channel western end	0.0	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	4.7	2.2		0.01	0.00	0.00	0.00	0.00	0.01	0.00		4.3%	1.3%	0.1%	0.0%	0.0%	0.0%	6.4%

Table A13 Predicted Maximum Nutrient Elevations Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2012 Wet Season (Mitigated with Concurrent Projects)

			Max. SS (mg/L)			Wet Season Maximum Elevation (mg/L)								% of WQO/WQC						
			Dry	Wet		TKN	NH4	NH3	NO3	NO2	TIN	TP		Cd	Cr	Cu	Hg	Ni	Pb	As
Observation Points	Point SR	Name	DA	DA	Max. in Sediment	1100	58	55	2.4	4.7	1107.1	680	WQO/WQC mg/L	0.12	0.021	0.29	0.06	0.5	25	0.05
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.3	0.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.4%
WSR 09a	No	Urmston Road (Main Channel)	8.7	4.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		3.7%	1.1%	0.1%	0.0%	0.0%	0.0%	5.4%
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	2.4	2.8		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.6%	0.8%	0.1%	0.0%	0.0%	0.0%	3.8%
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	3.3	3.6		0.00	0.00	0.00	0.00	0.00	0.00	0.00		3.3%	1.0%	0.1%	0.0%	0.0%	0.0%	4.9%
WSR 12	Yes	Butterfly Beach (gazetted beach)	1.3	1.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.9%	0.3%	0.0%	0.0%	0.0%	0.0%	1.4%
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	1.5	0.9		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.8%	0.2%	0.0%	0.0%	0.0%	0.0%	1.2%
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.2	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	2.0	0.9		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.8%	0.2%	0.0%	0.0%	0.0%	0.0%	1.2%
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.4%
WSR 20	Yes	Ma Wan Fish Culture Zone	2.6	1.2		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.1%	0.3%	0.0%	0.0%	0.0%	0.0%	1.6%
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	2.3	1.2		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.1%	0.3%	0.0%	0.0%	0.0%	0.0%	1.6%
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.1	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	0.2	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 25	Yes	Airport Cooling Water Intake (NE)	3.3	3.6		0.00	0.00	0.00	0.00	0.00	0.00	0.00		3.3%	1.0%	0%	0.0%	0.0%	0.0%	4.9%
WSR 27	Yes	San Tau Beach SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.0	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 41	Yes	Artificial Reef at NE Airport	5.1	3.9		0.00	0.00	0.00	0.00	0.00	0.00	0.00		3.6%	1.1%	0.1%	0.0%	0.0%	0.0%	5.3%
WSR 42	Yes	Artificial Reef at Sha Chau	1.7	0.4		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.4%	0.1%	0.0%	0.0%	0.0%	0.0%	0.5%
WSR 45c	No	Sham Shui Kok (CWD habitat range)	2.3	0.9		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.8%	0.2%	0.0%	0.0%	0.0%	0.0%	1.2%
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	7.4	3.6		0.00	0.00	0.00	0.00	0.00	0.00	0.00		3.3%	1.0%	0.1%	0.0%	0.0%	0.0%	4.9%
WSR 47a	No	River Trade Terminal	6.4	5.1		0.01	0.00	0.00	0.00	0.00	0.01	0.00		4.7%	1.4%	0.1%	0.0%	0.0%	0.0%	6.9%
WSR 47b	Yes	River Trade Terminal (near coral site)	1.2	1.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.2%	0.4%	0.0%	0.0%	0.0%	0.0%	1.8%
WSR 48	No	Airport Channel western end	0.0	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	4.7	2.2		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.0%	0.6%	0.0%	0.0%	0.0%	0.0%	3.0%

Notes:

1 The maximum elevuation assumed high concentrations of sediment bound nutrient based on sediment sample maximum (mg/kg dry wt.)

2 NH3 is assumed to be 5% of TKN.

3 TIN is estimated as the sum of TKN+NO3+NO2

4 WQO is only set for TIN and NH3. For parameters without WQO, the 10 years EPD annual average is referenced.

Table A14 Predicted Maximum Nutrient Elevations Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2013 Dry Season (Mitigated with Concurrent Projects)

			Max. SS (mg/L)			Dry Season Maximum Elevation (mg/L)								% of WQO/WQC						
			Dry	Wet		TKN	NH4	NH3	NO3	NO2	TIN	TP		Cd	Cr	Cu	Hg	Ni	Pb	As
Observation Points	Point SR	Name	DA	DA	Max. in Sediment	1100	58	55	2.4	4.7	1107.1	680	WQO/WQC mg/L	0.12	0.021	0.29	0.06	0.5	25	0.05
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.7	0.5		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.6%	0.5%	0.0%	0.0%	0.0%	0.0%	2.3%
WSR 09a	No	Urmston Road (Main Channel)	10.0	5.3		0.01	0.00	0.00	0.00	0.00	0.01	0.01		9.2%	2.8%	0.2%	0.0%	0.0%	0.0%	13.6%
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	1.5	2.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.4%	0.4%	0.0%	0.0%	0.0%	0.0%	2.0%
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	5.4	2.6		0.01	0.00	0.00	0.00	0.00	0.01	0.00		5.0%	1.5%	0.1%	0.0%	0.0%	0.0%	7.3%
WSR 12	Yes	Butterfly Beach (gazetted beach)	0.4	0.7		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.4%	0.1%	0.0%	0.0%	0.0%	0.0%	0.5%
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	1.0	0.5		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.9%	0.3%	0.0%	0.0%	0.0%	0.0%	1.4%
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.2	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.3%
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	2.1	1.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.9%	0.6%	0.0%	0.0%	0.0%	0.0%	2.9%
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.7%	0.2%	0.0%	0.0%	0.0%	0.0%	1.1%
WSR 20	Yes	Ma Wan Fish Culture Zone	2.7	1.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.5%	0.7%	0.1%	0.0%	0.0%	0.0%	3.7%
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	2.5	1.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.3%	0.7%	0.0%	0.0%	0.0%	0.0%	3.4%
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.2	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.3%
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	0.5	0.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.7%
WSR 25	Yes	Airport Cooling Water Intake (NE)	5.8	3.5		0.01	0.00	0.00	0.00	0.00	0.01	0.00		5.3%	1.6%	0%	0.0%	0.0%	0.0%	7.9%
WSR 27	Yes	San Tau Beach SSSI	0.1	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.0	0.0		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 41	Yes	Artificial Reef at NE Airport	5.7	4.1		0.01	0.00	0.00	0.00	0.00	0.01	0.00		5.2%	1.6%	0.1%	0.0%	0.0%	0.0%	7.8%
WSR 42	Yes	Artificial Reef at Sha Chau	1.3	0.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		1.2%	0.4%	0.0%	0.0%	0.0%	0.0%	1.8%
WSR 45c	No	Sham Shui Kok (CWD habitat range)	2.7	1.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.5%	0.7%	0.1%	0.0%	0.0%	0.0%	3.7%
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	2.3	1.3		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.1%	0.6%	0.0%	0.0%	0.0%	0.0%	3.1%
WSR 47a	No	River Trade Terminal	3.6	2.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		3.3%	1.0%	0.1%	0.0%	0.0%	0.0%	4.9%
WSR 47b	Yes	River Trade Terminal (near coral site)	5.2	6.0		0.01	0.00	0.00	0.00	0.00	0.01	0.00		4.8%	1.4%	0.1%	0.0%	0.0%	0.0%	7.1%
WSR 48	No	Airport Channel western end	0.0	0.1		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	2.4	1.4		0.00	0.00	0.00	0.00	0.00	0.00	0.00		2.2%	0.7%	0.0%	0.0%	0.0%	0.0%	3.3%

Table A15 Predicted Maximum Nutrient Elevations Based on Maximum Depth-Averaged SS Elevation at Selected Observation Points for the Scenario Year 2013 Wet Season (Mitigated with Concurrent Projects

Observation Points	Point SR	Name	Max. SS (mg/L) Dry	Max. SS (mg/L) Wet	Wet Season Maximum Elevation (mg/L) TKN	NH4	NH3	NO3	NO2	TIN	TP	% of WQO/WQC Cd	Cr	Cu	Hg	Ni	Pb	As
			DA	DA	Max. in Sediment: 1100	58	55	2.4	4.7	1107.1	680	WQO/WQC mg/L: 0.12	0.021	0.29	0.06	0.5	25	0.05
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	1.7	0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.7%
WSR 09a	No	Urmston Road (Main Channel)	10.0	5.3	0.01	0.00	0.00	0.00	0.00	0.01	0.00	4.9%	1.5%	0.1%	0.0%	0.0%	0.0%	7.2%
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	1.5	2.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.8%	0.6%	0.0%	0.0%	0.0%	0.0%	2.7%
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake	5.4	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.4%	0.7%	0.0%	0.0%	0.0%	0.0%	3.5%
WSR 12	Yes	Butterfly Beach (gazetted beach)	0.4	0.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.6%	0.2%	0.0%	0.0%	0.0%	0.0%	1.0%
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	1.0	0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5%	0.1%	0.0%	0.0%	0.0%	0.0%	0.7%
WSR 15	Yes	Gazetted Beaches at Tuen Mun	0.2	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	2.1	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.9%	0.3%	0.0%	0.0%	0.0%	0.0%	1.4%
WSR 19	Yes	Gazetted Beaches at Ma Wan	0.8	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.4%
WSR 20	Yes	Ma Wan Fish Culture Zone	2.7	1.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0%	0.3%	0.0%	0.0%	0.0%	0.0%	1.5%
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	2.5	1.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0%	0.3%	0.0%	0.0%	0.0%	0.0%	1.5%
WSR 22a	No	Tai Ho Wan Outlet (inside)	0.2	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	0.5	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.4%
WSR 25	Yes	Airport Cooling Water Intake (NE)	5.8	3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.2%	1.0%	0%	0.0%	0.0%	0.0%	4.8%
WSR 27	Yes	San Tau Beach SSSI	0.1	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
WSR 32	Yes	Tai O (Mangrove Habitat)	0.0	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	0.0	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 41	Yes	Artificial Reef at NE Airport	5.7	4.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.8%	1.1%	0.1%	0.0%	0.0%	0.0%	5.6%
WSR 42	Yes	Artificial Reef at Sha Chau	1.3	0.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.4%
WSR 45c	No	Sham Shui Kok (CWD habitat range)	2.7	1.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0%	0.3%	0.0%	0.0%	0.0%	0.0%	1.5%
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	2.3	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.2%	0.4%	0.0%	0.0%	0.0%	0.0%	1.8%
WSR 47a	No	River Trade Terminal	3.6	2.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.9%	0.6%	0.0%	0.0%	0.0%	0.0%	2.9%
WSR 47b	Yes	River Trade Terminal (near coral site)	5.2	6.0	0.01	0.00	0.00	0.00	0.00	0.01	0.00	5.5%	1.7%	0.1%	0.0%	0.0%	0.0%	8.2%
WSR 48	No	Airport Channel western end	0.0	0.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	2.4	1.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.3%	0.4%	0.0%	0.0%	0.0%	0.0%	1.9%

Notes:

1 The maximum elevuation assumed high concentrations of sediment bound nutrient based on sediment sample maximum (mg/kg dry wt.)

2 NH3 is assumed to be 5% of TKN.

3 TIN is estimated as the sum of TKN+NO3+NO2

4 WQO is only set for TIN and NH3. For parameters without WQO, the 10 years EPD annual average is referenced.

Annex B

Review of available information on marine mammals

B1. INTRODUCTION

This Annex presents an extensive review of available information on marine mammals in the Study Area has been done by Dr Samuel Hung, an expert in marine mammals of Hong Kong.

B2. STUDY TASKS

The construction of a series of contaminated mud pits (CMPs) are proposed by the Civil Engineering and Development Department at South Brothers, and ERM-Hong Kong Limited was appointed as the consultant to conduct marine ecological impact assessment for their construction and operation. As part of the assessment, the present desktop study is conducted to review the baseline information on Chinese white dolphins (also known as Indo-Pacific humpback dolphins, *Sousa chinensis*) at the South Brothers site with the long-term dolphin monitoring data. The baseline information will assist the evaluation of potential of the proposed project that may affect the long-term survival of the dolphin population.

The following study tasks are set for the present study to collate baseline dolphin information at South Brothers:

1) To review and examine distribution (overall and seasonal) and group size of Chinese white dolphins in recent years at the South Brothers site;
2) To examine the spatial patterns of dolphin densities among 1-km^2 grids at and near the South Brothers site using specialized quantitative grid analysis;
3) To examine the distribution patterns and densities of feeding and socializing activities as well as mother-calf pairs at and near the South Brothers site; and
4) To examine the occurrence of identified individuals at the South Brothers site by investigating their ranging patterns as well as core area use.

B2. STUDY APPROACH DATA ANALYSES

B2.1. Baseline Study Approach

Since 1995, a long-term research programme has been established by Hong Kong Cetacean Research Project (HKCRP) to study many aspects of population biology of Chinese white dolphins in Hong Kong waters. Results from these integrated studies commissioned and funded by government departments (primarily by AFCD), environmental consultants and NGOs, have been used to establish several systematic databases (Jefferson 2007; Hung 2009). The present assessment study utilized this long-term monitoring data (e.g. line-transect survey data, dolphin sighting data, photo-identification catalogue of individual dolphins) to provide detailed baseline information on dolphin usage at and near the South Brothers site.

B2.2. Distribution Analysis

The line-transect survey data were integrated with Geographic Information System (GIS) in order to visualize and interpret overall and seasonal distribution of the dolphins using sighting positions. For the present study, location data of dolphin groups from 2002-08 were plotted on map layers of Hong Kong using a desktop GIS (ArcView© 3.1) to examine their distribution patterns in details. The dataset was also stratified into different subsets to examine distribution patterns of dolphin groups with different categories of group sizes, age classes and activities.

B2.3. Quantitative Grid Analysis on Fine-scale Habitat Use

To conduct quantitative grid analysis of habitat use, positions of on-effort sightings of Chinese white dolphins from 2002-08 were retrieved from the long-term sighting database and then plotted onto 1-km^2 grids among the survey areas around Lantau Island on GIS. Sighting densities (number of on-effort sightings per km^2) and dolphin densities (total number of dolphins from on-effort sightings per km^2) were then calculated for each 1 km by 1 km grid with the aid of GIS. Sighting density grids and dolphin density grids were further normalized with the amount of survey effort conducted within each grid. The total amount of survey effort spent on each grid was calculated by examining the survey coverage on each line-transect survey to determine how many times the grid was surveyed during the study period. For example, when the survey boat traversed through a specific grid 50 times, 50 units of survey effort were counted for that grid.

With the amount of survey effort calculated for each grid, the sighting density and dolphin density of each grid were then normalized (i.e. divided by the unit of survey effort). The newly-derived unit for sighting density was termed SPSE, representing the number of on-effort **s**ightings **p**er 100 units of **s**urvey **e**ffort. In addition, the derived unit for actual dolphin density was termed DPSE, representing the number of **d**olphins **p**er 100 units of **s**urvey **e**ffort. The following formulae were used to estimate SPSE and DPSE in each 1-km^2 grid within the study area:

$$SPSE = ((S / E) \times 100) / SA\%$$

$$DPSE = (D / E) \times 100 / SA\%$$

where S = total number of on-effort sightings
D = total number of dolphins from on-effort sightings
E = total number of units of survey effort
SA% = percentage of sea area

Among the 1-km^2 grids that were partially covered by land, the percentage of sea area was calculated using GIS tools, and their SPSE and DPSE values were adjusted accordingly. Both SPSE and DPSE values were useful in examining dolphin usage within a one square kilometre area.

B2.4. Behavioural Data Analysis

When dolphins were sighted during line-transect vessel surveys, their activities were observed. Different activities were categorized (i.e. feeding, socializing, traveling, milling/resting) and recorded on sighting datasheets. These data were then input into a separate database with sighting information for distribution analysis of behavioural data. Distribution of sightings of dolphins engaged in different activities would be plotted on GIS and carefully examined to identify important areas for different activities. The behavioural data were also used in the quantitative analysis on habitat use to identify important dolphin habitats for feeding and socializing activities.

B2.5. Analyses on Ranging Pattern and Residency Pattern

For the ranging pattern analysis, location data of individual dolphins with 15 or more re-sightings during 1995-2009 were obtained from the Chinese white dolphin sighting database and photo-identification catalogue. The present assessment study adopted the fixed kernel method to deduce their individual ranges and examine their core area use. To deduce home ranges for individual dolphins using the fixed kernel methods, the program Animal Movement Analyst Extension, created by the Alaska Biological Science Centre, USGS (Hooge and Eichenlaub 1997), was loaded as an extension with ArcView© 3.1 along with another extension Spatial Analyst 2.0. Using the fixed kernel method, the program calculated kernel density estimates based on all sighting positions, and provided an active interface to display kernel density plots. The kernel estimator then calculated and displayed the overall ranging area at 95% UD level as well as the core areas at 50% and 25% UD levels.

To examine the monthly and annual occurrence patterns of individual dolphins, their residency patterns in Hong Kong during the past 14 years were carefully evaluated. "Residents" were defined as individuals that were regularly sighted in

Hong Kong for at least eight years during 1995-2009, or five years in a row within the same period. Other individuals that were intermittently sighted during the past 14 years were defined as "Visitors". In addition, monthly matrix of occurrence were also examined to differentiate individuals that occurred year-round (i.e. individuals that occur in every month of the year) or seasonally (i.e. individuals that occur only in certain months of the year). Using both yearly and monthly matrices of occurrence, "year-round residents" can be defined as the individual dolphins that were regularly sighted in Hong Kong throughout the year, while "seasonal visitors" can be defined as the ones that were sighted sporadically in Hong Kong and only during certain months of the year during the study period.

B3. RESULTS AND DISCUSSIONS

B3.1. Distribution

During 2002-08, a total of 1,447 groups of Chinese white dolphins, numbering 5,601 individuals, were sighted during vessel and helicopter surveys in North Lantau waters, and the distribution of these dolphin sightings is shown in Figure 1. At the South Brothers area, a number of dolphin sightings overlapped with the proposed CMP site, and more dolphin groups were sighted adjacent to the site, especially between the Brothers Islands and near Sham Shui Kok (Figure 1). Notably, much fewer dolphin sightings were made near the southwestern end of the proposed CMP site, and dolphins were rarely sighted between the proposed site and Tung Chung during 2002-08.

Seasonal patterns of dolphin distribution at and near the proposed CMP site at South Brothers were examined. Dolphins occurred in this area throughout most of the year, except during spring months (i.e. March through May), when they occurred less frequently in Northeast Lantau waters (Figure 2). It appeared that the peak dolphin occurrence at South Brothers site occurred during summer months (i.e. June through August), when dolphins were frequently sighted between the Brothers Islands (Figure 2). Such seasonal shift in dolphin distribution should be related to the influence of freshwater outflow from the Pearl River to the peripheral range of the population during the rainy season, and the associated prey movement during summer months (Hung 2008).

B3.2. Group Size

Examining the distribution patterns of different group sizes can provide information on where small or large dolphin groups would aggregate at certain locations. And the areas with large aggregations of dolphins may imply that they present favourable habitats for dolphins to gather for feeding and socializing activities. During 2002-08, most dolphin groups in North Lantau waters tended to be small, with 44.7% of the total composed of 1-2 animals, and only 4.6% of the groups composed of more than 10 animals. At South Brothers, the dolphin sightings overlapped with the proposed CMP site were mostly small (1-4 animals per group) and medium groups (5-9 animals per group), and only one large group (>10 animals) were sighted there (Figure 3). However, a number of large groups were also sighted adjacent to the CMP site, just between the Brothers Islands (Figure 3). Moreover, most of the larger dolphin groups in North Lantau were concentrated to the north of Lung Kwu Chau, and the occurrence of these large groups was relatively less frequent in Northeast Lantau waters (Figure 3).

B3.3. Fine-scale Habitat Use

For the present study, both SPSE values (number of on-effort sightings per 100 units of survey effort) and DPSE values (number of dolphins from on-effort sightings per 100 units of survey effort) were calculated among 1-km^2 grids in the Northeast and Northwest survey areas. Both SPSE and DPSE values for grids overlapped with and adjacent to the proposed CMP site (14 grids in total) were compared with the overall mean SPSE/DPSE values per grid of all 356 grids around Lantau Island (Figure 4). The derived quantitative information on sighting density and dolphin density can show the area of importance to the dolphins more accurately than merely observing their distribution patterns without acknowledging the uneven survey effort coverage between and within survey areas.

During 2002-08, the mean SPSE values per grid of all 356 grids around Lantau Island was 4.1 ± 6.12, while the mean DPSE values per grid was 16.0 ± 25.77. A total of four grids in Northeast Lantau survey overlapped with the CMP site, and the mean SPSE and DPSE values among them were 4.8 and 22.4 respectively, which were both slightly higher than the overall means around Lantau (Figures 5-6). Moreover, the mean SPSE and DPSE values of the 14 grids overlapped with and adjacent to the proposed CMP site were 4.9 and 20.4 respectively, which were also slightly higher than the overall means. Notably, only one grid within the proposed CMP site had moderately high SPSE/DPSE values (Grid Q16), while the other 13 grids mostly recorded moderately low SPSE/DPSE values (Figures 5-6).

B3.4. Calves

The areas with frequent occurrences of mother-calf pairs in certain areas should deserve particular attention, as these areas can be important for nursing activity. Chinese white dolphins in Hong Kong have been classified into six age classes in relation to their colour pattern development, but the sequence of this development has yet to be confirmed with the exception of young calves (Jefferson 2000). The calves of Chinese white dolphins in Hong Kong are categorized into unspotted calves (newborn calves up to six months old that have not been weaned) and unspotted juveniles (older calves up to 1-2 years old but still dependent on their mothers). The age classes of unspotted calves (UCs) and unspotted juveniles (UJs) should be reliable; these are small, non-weaned young animals that are still dependent on their mother.

During 2002-08, a total of 52 UCs and 242 UJs were sighted in North Lantau waters. At the proposed CMP site, only a few UCs and UJs were sighted there, but a larger number of these calves were also sighted in the nearby Brothers Islands and Sham Shui Kok area (Figure 7). In the North Lantau region, a lot more UCs were sighted around Lung Kwu Chau when compared to the Brothers Islands, but it appeared that both areas have similar occurrence of UJs (Figure 7).

To locate the important habitats of nursing activities where mother-calf pairs were frequently occurred, the on-effort data on UCs and UJs from 2002-08 were pooled to calculate their total number among the grids in North Lantau, which were further normalized by amount of survey effort to deduce DPSE values of UCs and UJs for each grid. Overall, the DPSE values of UCs and UJs per grid of all 356 grids around Lantau Island was 0.2 ± 0.47 and 0.9 ± 1.84 respectively. The mean DPSE values of UCs and UJs among the 14 grids overlapped with and adjacent to the proposed CMP were 0.2 and 1.1 respectively, which were very similar to the overall means around Lantau (Figures 8-9). Most of these grids recorded only moderately low densities of calves, indicating that this area is not particularly important for mother-calf pairs.

B3.5. Activities

The most predominant daytime activity of Chinese white dolphins in Hong Kong appears to be feeding, in which they spend a significant amount of time to look for prey (Hung 2008). Socializing activity was another important daytime activity, in which dolphins socialize to create and reinforce social bonds. During 2002-08, a total of 288 and 141 sightings were associated with feeding and socializing activities respectively in North Lantau waters. In comparison, during the same period, dolphins rarely engaged in traveling and milling/resting activities, with only 26 and

21 sightings associated with these two activities respectively.

At the proposed CMP site, only a few sightings were associated with feeding and socializing activities (Figures 10-11). But these sightings were frequently made near the Brothers Islands and Sham Shui Kok, adjacent to the northeastern end of the proposed CMP (Figures 10-11). It appears that the occurrence of feeding and socializing activities was similar between the Brothers Islands and around Lung Kwu Chau (Figures 10-11).

To identify important habitats for feeding and socializing activities, the subset of on-effort dolphin sightings engaged in these two activities during 2002-08 was used to calculate their SPSE values for grids in North Lantau waters. Overall, the SPSE values for feeding and socializing activities per grid of all 356 grids around Lantau was 0.9 ± 1.65 and 0.3 ± 0.72 respectively. Among the 14 grids overlapped with and adjacent to the proposed CMP, the mean SPSE value of feeding activities was 1.2, which was slightly higher than the overall means. In addition, the mean SPSE value of socializing activities among the 14 grids was 0.7, which was much higher than the overall means, indicating the importance of this area for dolphins to be engaged in socializing activities.

B3.6. Individual Range Use

Currently, the photo-identification catalogue of the Pearl River Estuary Chinese white dolphin population contained information of over 650 individuals identified in Hong Kong and the rest of the Pearl River Estuary since 1995, with 347 dolphins being first identified within Hong Kong territorial waters. A total of 58 individual dolphins were seen 15 times or more during 1995-2009, and their ranging patterns in North Lantau waters were examined in details, to determine whether their overall ranges as well as core areas have overlapped with the proposed CMP site at South Brothers. The fixed kernel method was used to deduce their overall ranges (95%UD) and core areas (50%UD and 25%UD).

Of these 58 individuals that were re-sighted 15-125 times since 1995, 34 of them (59%) had their ranges overlapped with the proposed CMP site (Table 1; Appendix I). Moreover, 40% and 21% of the 58 individuals had their 50%UD and 25%UD core areas overlapped with the proposed CMP site respectively (Table 1; Appendix II), implying that these individuals have used the South Brothers area intensively during the study period. In addition, among the 34 individuals that had their ranges overlapped with the proposed CMP site, 85% of them were either year-round or seasonal residents, while only five dolphins were considered year-round or seasonal visitors. Therefore, the present ranging pattern analysis indicated that a large proportion of regularly-sighted individuals in Hong Kong have used the proposed CMP site (with some intensively using this area), and this area is particularly important to many resident dolphins.

B3.7. Summary of Dolphin Baseline Information at South Brothers

- *General Distribution*: A number of dolphin sightings overlapped with the CMP site, and more dolphins groups were sighted at the northeastern end near the Brothers Islands while much fewer were sighted at the southwestern end.
- *Seasonal Distribution*: Dolphins occurred at the site throughout most of the year, except during spring months. It appeared their peak occurrence at the site occurred during summer months.
- *Group Size*: Most dolphin sightings overlapped with the site were small- and medium-sized groups, and the larger groups were mostly sighted adjacent to the site between the Brothers Islands.
- *Habitat Use*: Sighting and dolphin densities at the site were slightly higher than the overall means, and only one of the 14 grids within the site recorded moderately high densities.
- *Calves*: The site is not particularly important for mother-calf pairs, and the mean densities of calves were very similar to the overall means with most grids recorded moderately low densities.
- *Activities*: The site is an important area for socializing activities, with the mean sighting densities of these activities much higher than the overall means.
- *Individual Range Use*: The site is an important area for many resident dolphins, with the ranges of a large proportion of individuals overlapped with the CMP site, most of them being considered Hong Kong residents.

B4. LITERATURE CITED

Hooge, P. N. and Eichenlaub, B. 1997. Animal movement extension to ArcView (version 1.1). Alaska Biological Science Center, United States Geological Survey, Anchorage.

Hung, S. K. 2008. Habitat use of Indo-Pacific humpback dolphins (*Sousa chinensis*) in Hong Kong. Ph.D. dissertation. University of Hong Kong, Hong Kong, 266 p.

Hung, S. K. 2009. Monitoring of Marine Mammals in Hong Kong waters –

data collection: final report (2008-09). An unpublished report submitted to the Agriculture, Fisheries and Conservation Department of Hong Kong SAR Government, 128 pp.

Jefferson, T. A. 2007. Monitoring of Chinese white dolphins (*Sousa chinensis*) in Hong Kong waters – biopsy sampling and population data analysis: final report. An unpublished report prepared for the Agriculture, Fisheries and Conservation Department.

Table 1. Kernel ranges of 34 individuals with 15+ sightings from the PRE Chinese white dolphin photo-ID catalogue that overlapped with the proposed CMP during 1995-2009

ID#	# STG	Age Class	Gender	Residency	Kernel Range Overlap with CMP		
					95%UD	50%UD	25%UD
CH03	17	SJ	?	Seasonal Visitor	√	√	
CH34	29	UA	F	Year-round Visitor	√	√	√
CH101	17	SS	?	Seasonal Visitor	√		
EL01	55	UA	M	Year-round Resident	√	√	√
EL07	62	SJ	M	Year-round Resident	√	√	√
NL16	23	SJ	?	Seasonal Visitor	√	√	
NL18	62	SA	F	Year-round Resident	√	√	√
NL19	31	SA	F?	Seasonal Resident	√	√	
NL20	38	UA	F	Seasonal Resident	√		
NL24	125	SA	?	Year-round Resident	√		
NL32	21	SS	?	Seasonal Resident	√	√	
NL33	33	SS	?	Year-round Resident	√	√	
NL37	41	SJ	?	Year-round Resident	√	√	√
NL48	28	SA	?	Seasonal Resident	√		
NL49	16	SA	F	Seasonal Resident	√		
NL57	27	SA	F	Year-round Resident	√	√	
NL81	15	SJ	?	Seasonal Visitor	√	√	√
NL93	18	SS	?	Seasonal Resident	√	√	√
NL98	62	SS	F	Year-round Resident	√	√	
NL104	41	SA	?	Year-round Resident	√	√	
NL111	41	SJ	?	Seasonal Resident	√		
NL118	30	SS	F	Seasonal Resident	√	√	
NL120	46	SJ	F	Year-round Resident	√	√	
NL123	63	SS	F	Year-round Resident	√	√	√
NL136	17	UA	F	Seasonal Resident	√		
NL139	59	UA	F	Year-round Resident	√	√	√
NL145	17	SS	?	Seasonal Resident	√		
NL165	23	SS	?	Year-round Resident	√	√	
NL176	31	SS	F	Seasonal Resident	√	√	√
NL179	19	SJ	?	Seasonal Resident	√	√	√
NL188	22	SJ	?	Seasonal Resident	√		
NL191	24	SJ	?	Seasonal Resident	√	√	√
WL11	32	SS	F	Year-round Resident	√		
WL15	30	SS	M	Seasonal Resident	√		

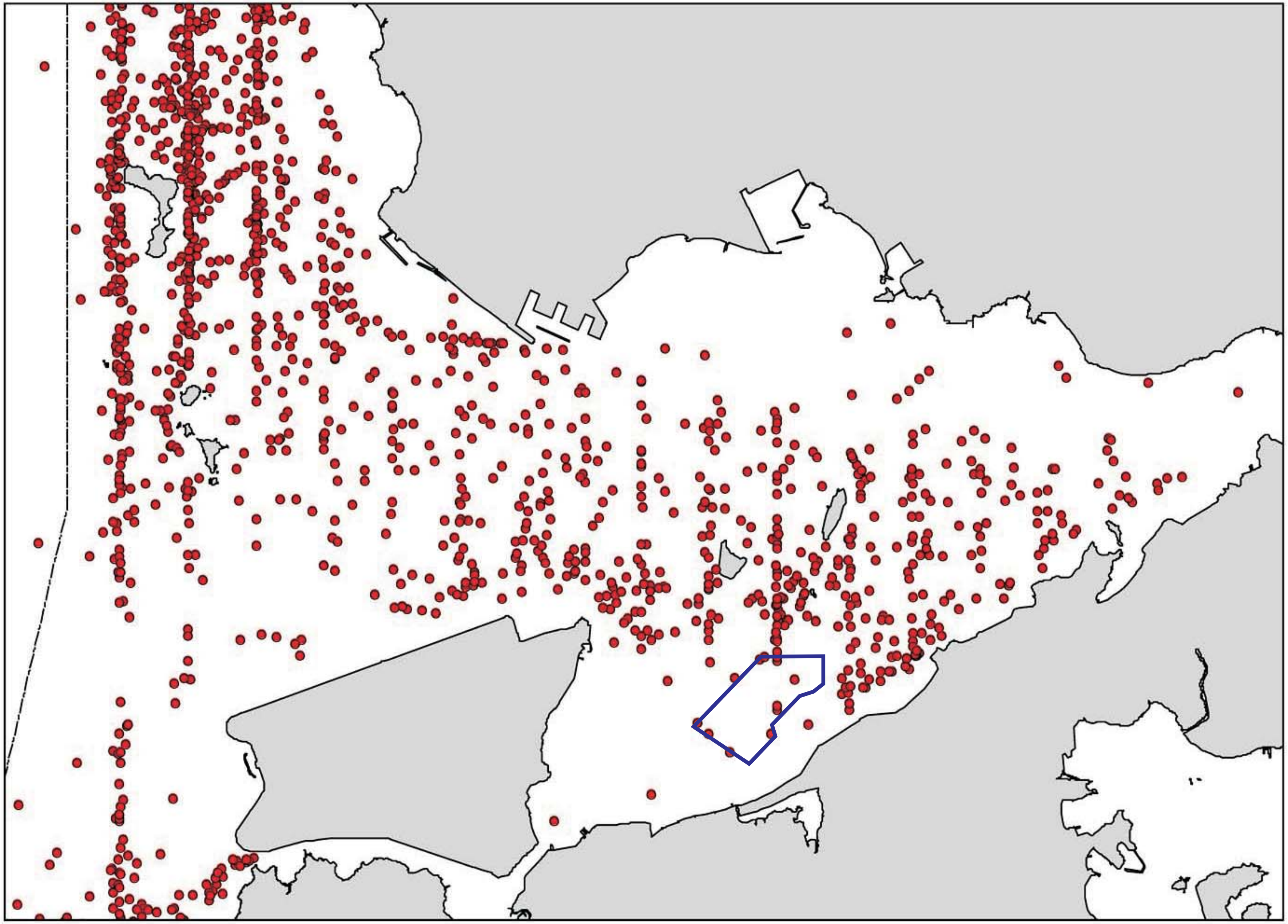


Figure 1. Distribution of Chinese white dolphin sightings in North Lantau waters during 2002-08, showing overlaps with the proposed CMP at South Brothers

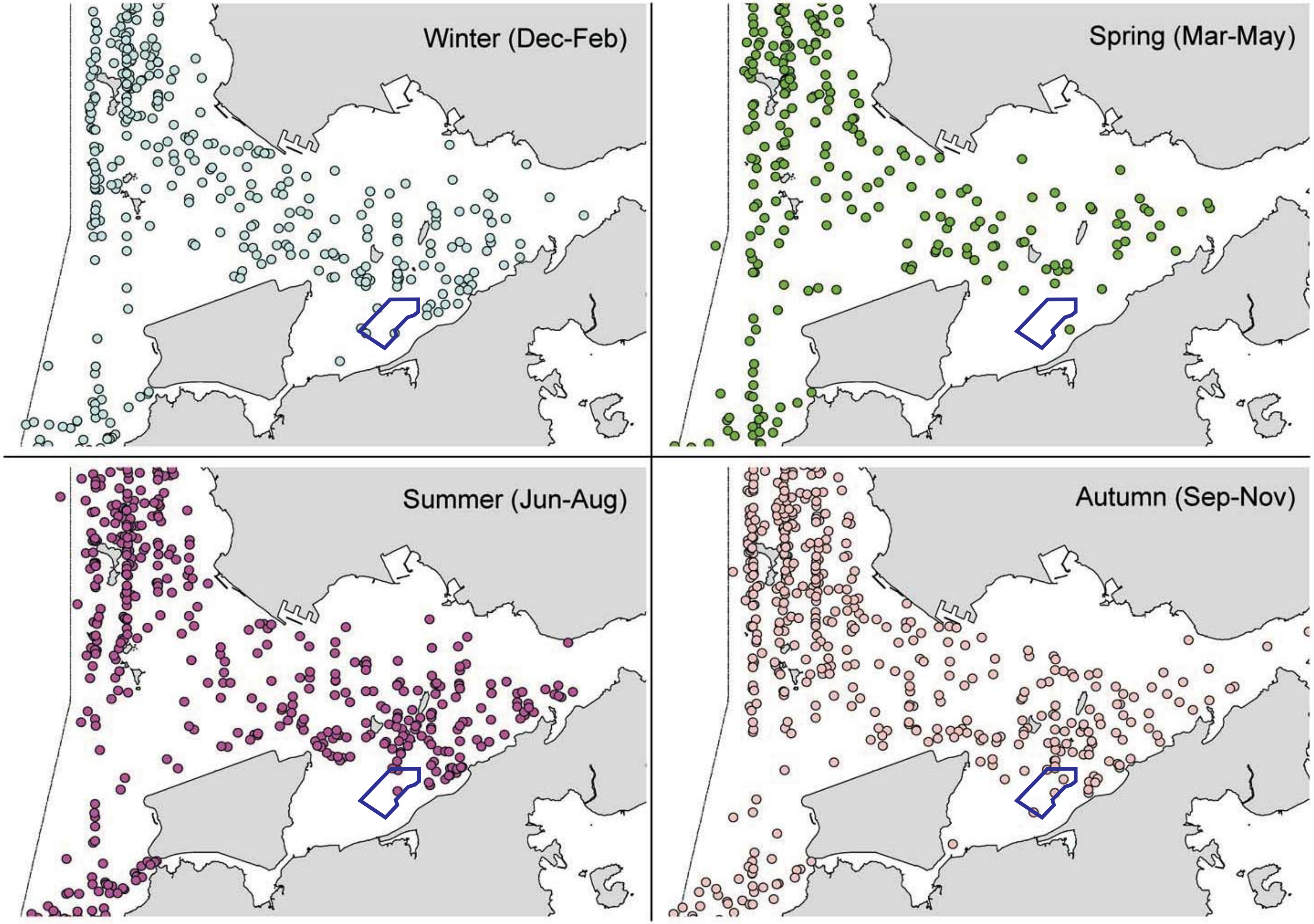


Figure 2. Seasonal Distribution of Chinese white dolphin sightings in North Lantau waters during 2002-08, showing overlaps with the proposed CMP at South Brothers

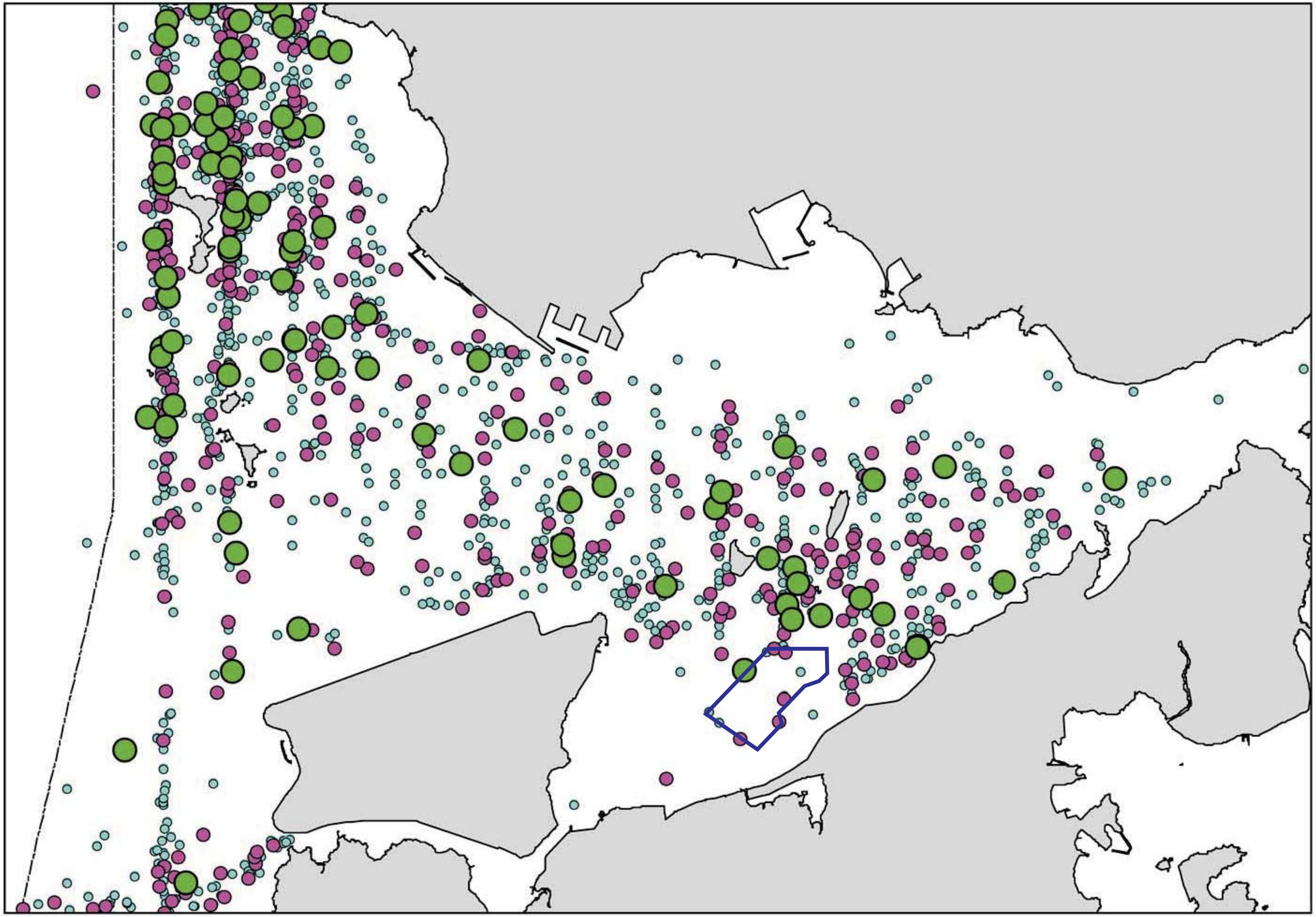


Figure 3. Distribution of Chinese white dolphin sightings with different group sizes during 2002-08, showing overlaps with the proposed CMP at South Brothers (group size of 1-4: blue; group size of 5-9: purple; group size of 10 or above: green)

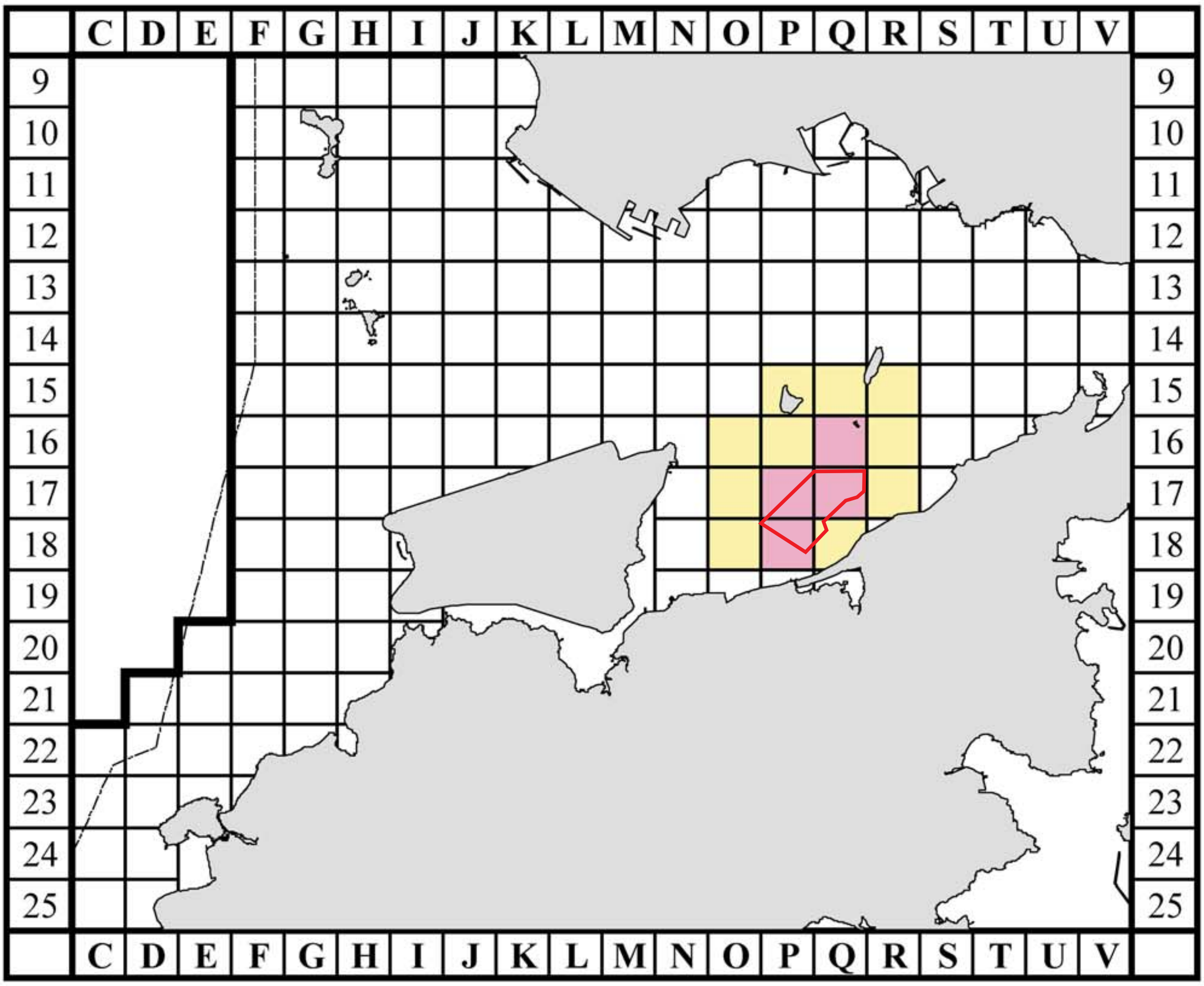


Figure 4. Locations and boundaries of 1 km^2 grids at and near the proposed CMP at South Brothers (pink grids: grids that overlap with the proposed CMP at South Brothers; yellow grids: grids that are near the proposed CMP)

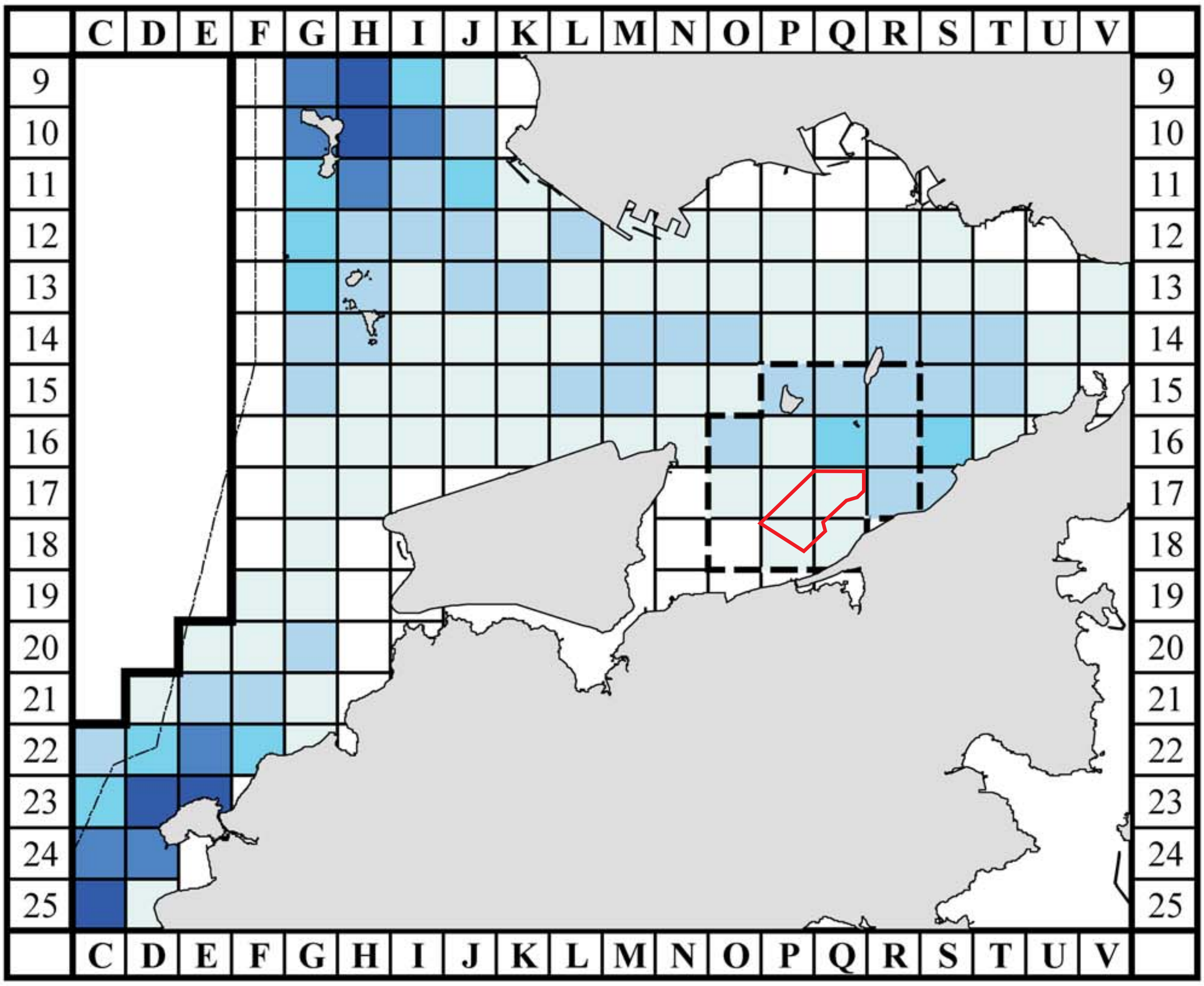


Figure 5. Sighting density of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau island, showing overlaps with the proposed CMP at South Brothers, using data collected during 2002-08 (SPSE = no. of on-effort dolphin sightingsper 100 units of survey effort)

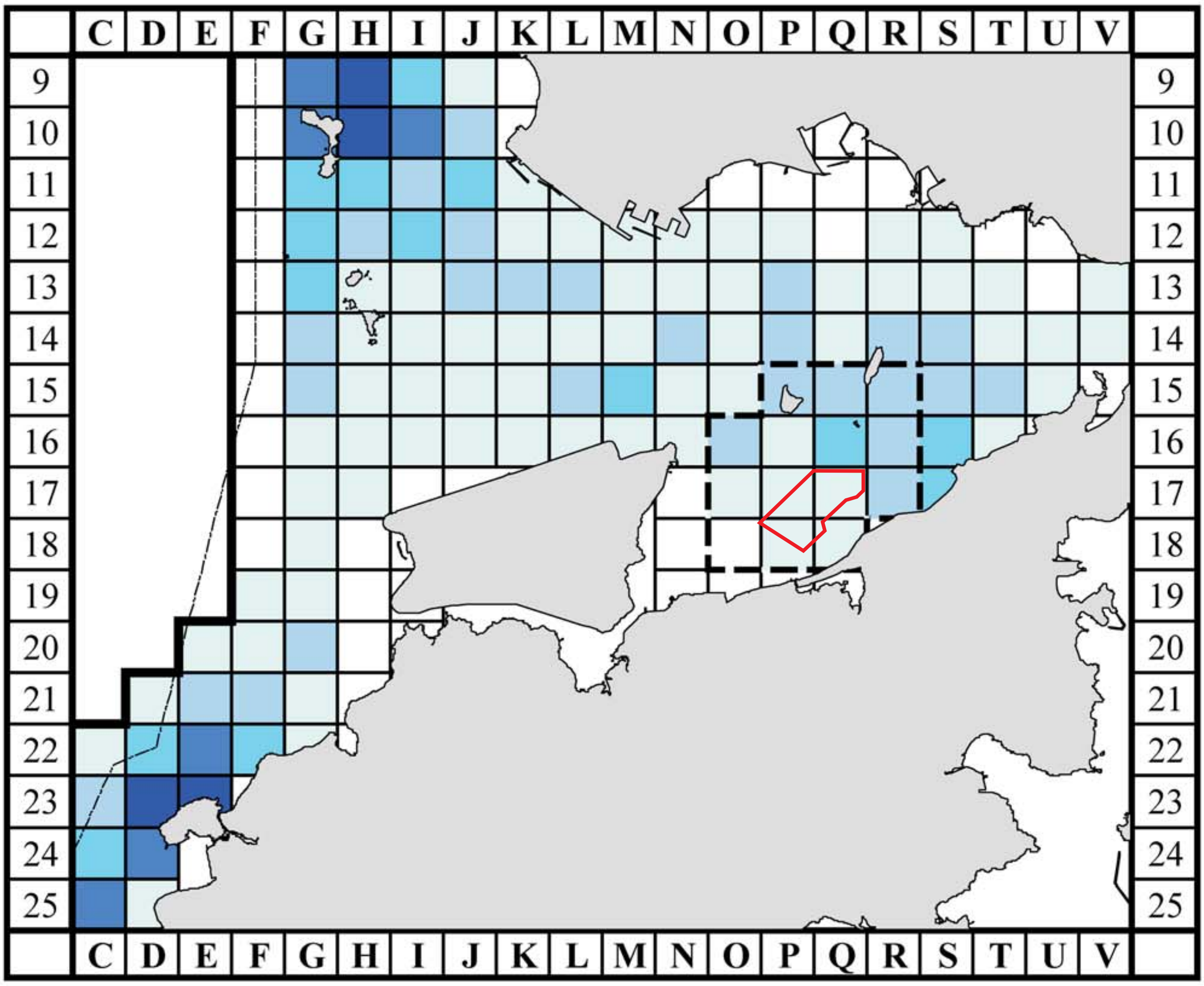


Figure 6. Density of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau island, showing overlaps with the proposed CMP at South Brothers, using data collected during 2002-08 (DPSE = no. of dolphins per 100 units of survey effort)

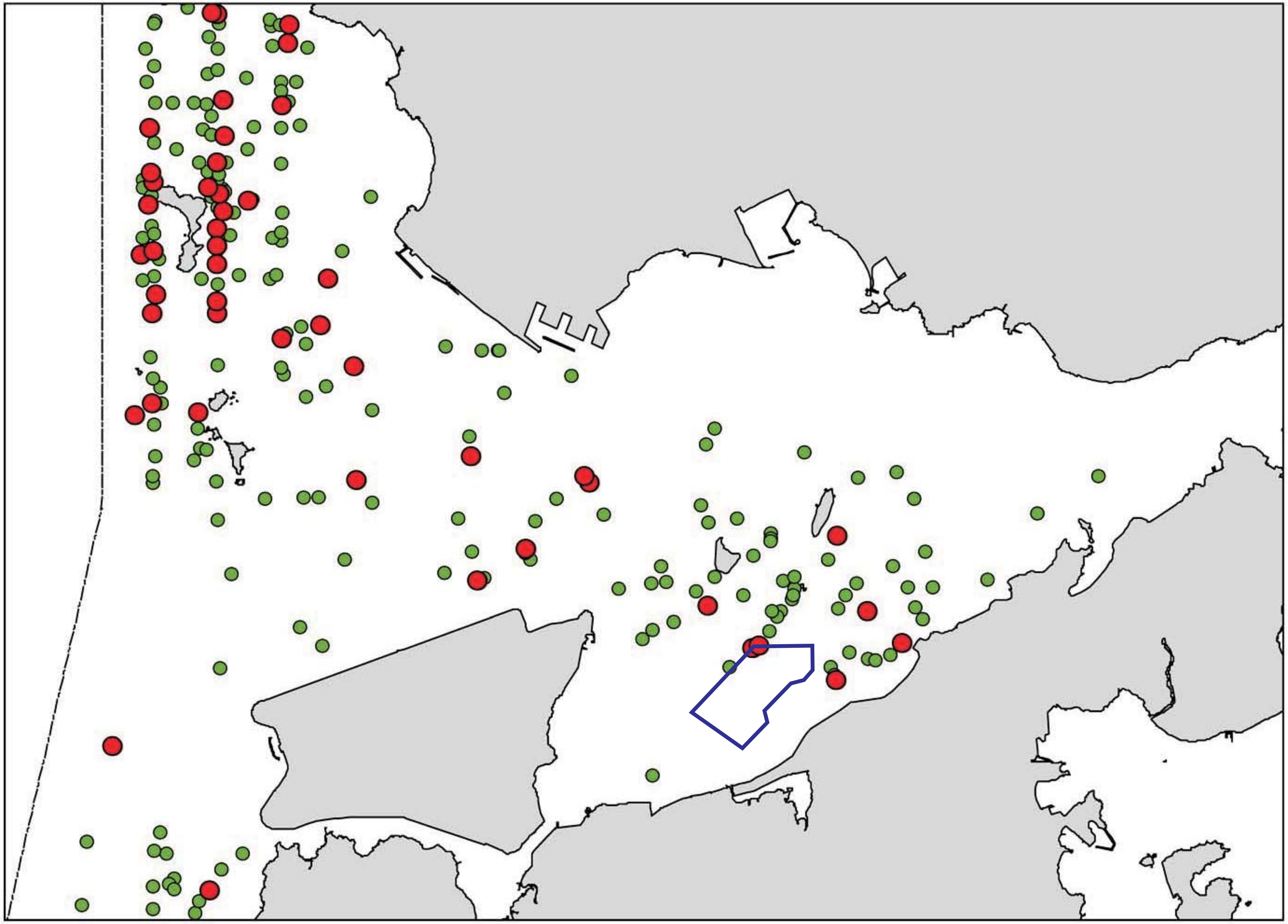


Figure 7. Distribution of unspotted calves (red) and unspotted juveniles (green) during 2002-08, showing overlaps with the proposed CMP at South Brothers

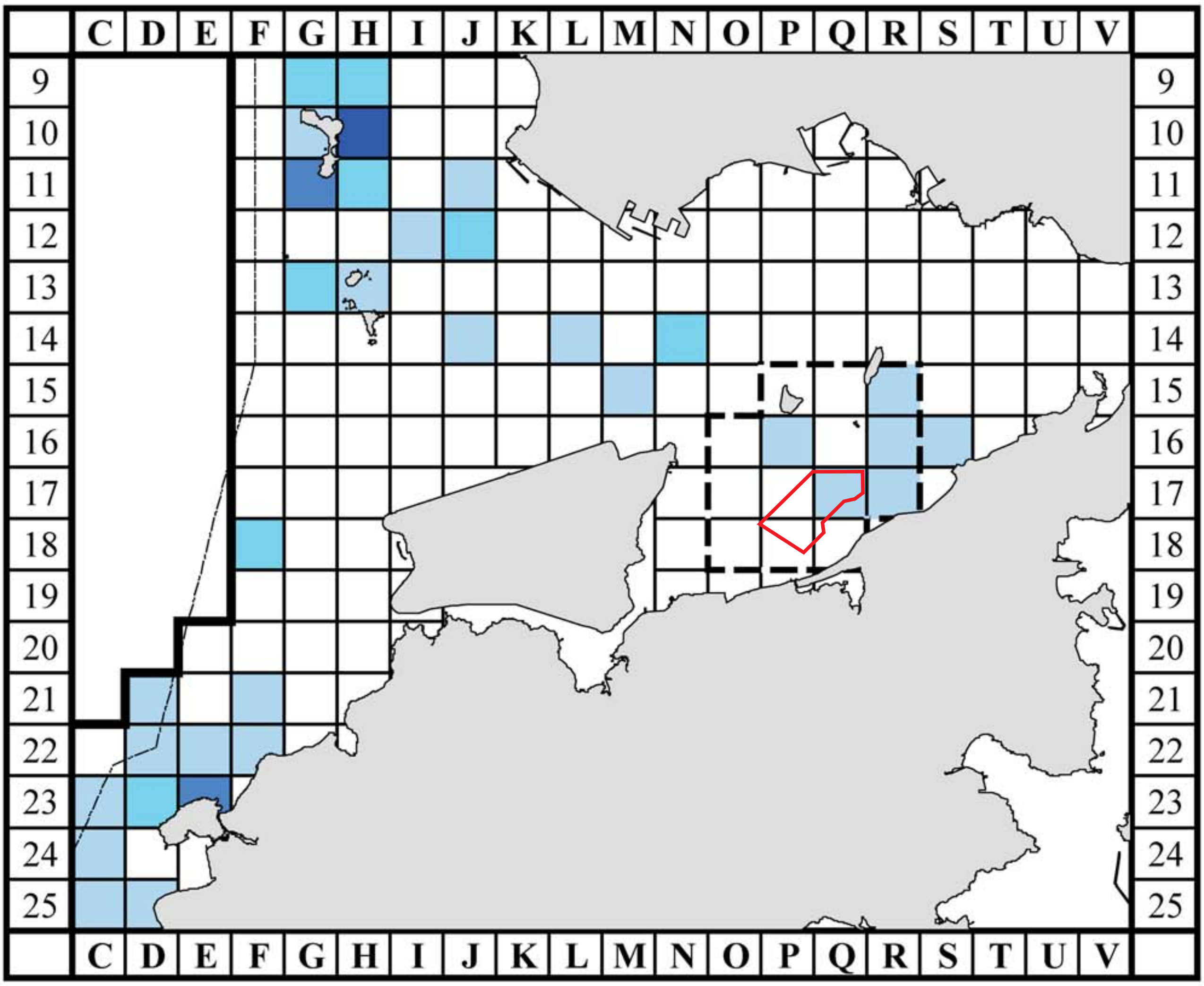


Figure 8. Density of unspotted calves of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau island, showing overlaps with the proposed CMP at South Brothers, using data collected during 2002-08 (DPSE = no. of unspotted calves per 100 units of survey effort)

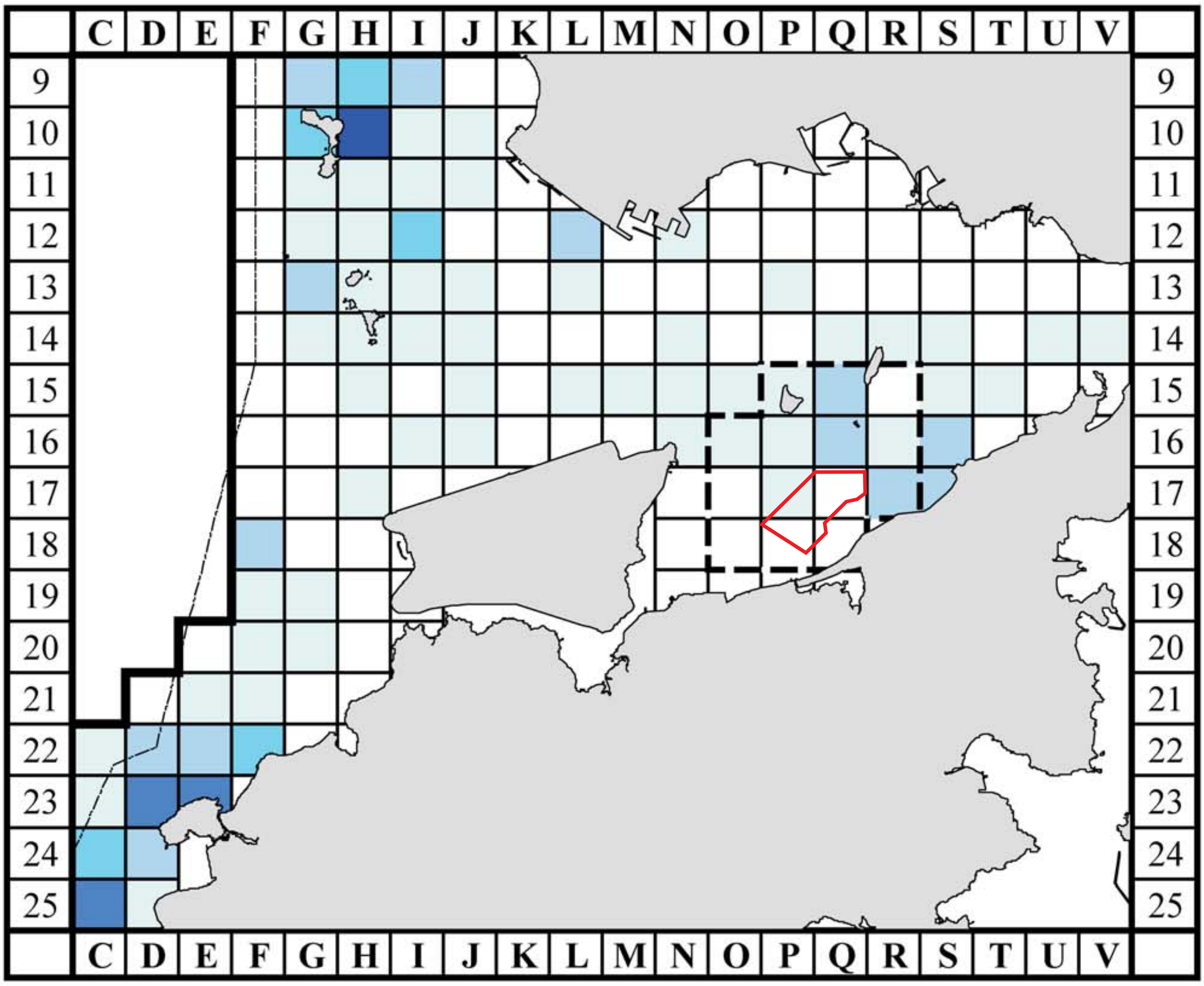


Figure 9. Density of unspotted juveniles of Chinese white dolphins with corrected survey effort per km^2 in waters around Lantau island, showing overlaps with the proposed CMP at South Brothers, using data collected during 2002-08 (DPSE = no. of unspotted calves per 100 units of survey effort)

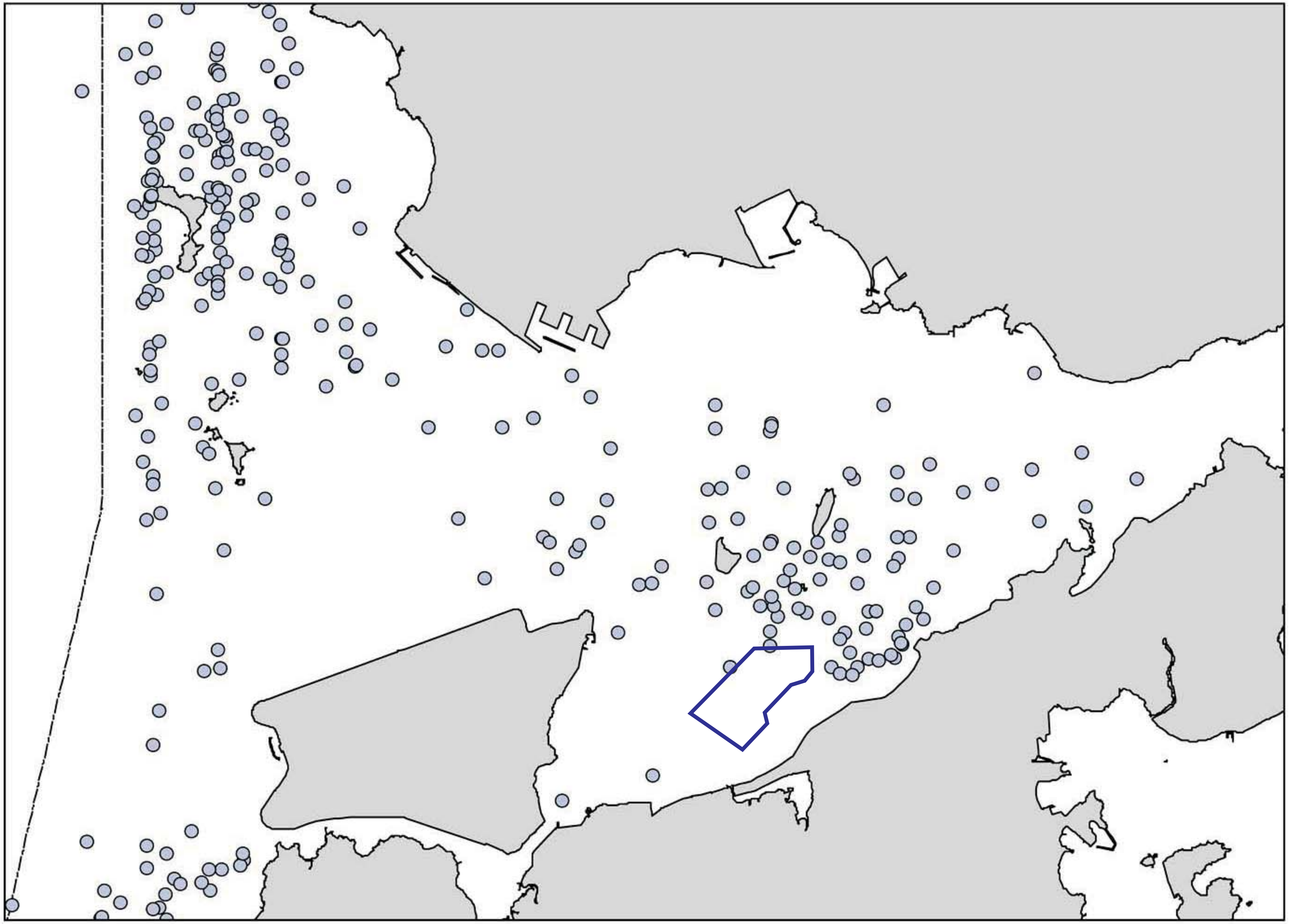


Figure 10. Distribution of Chinese white dolphin sightings engaged in feeding activities during 2002-08, showing overlaps with the proposed CMP at South Brothers

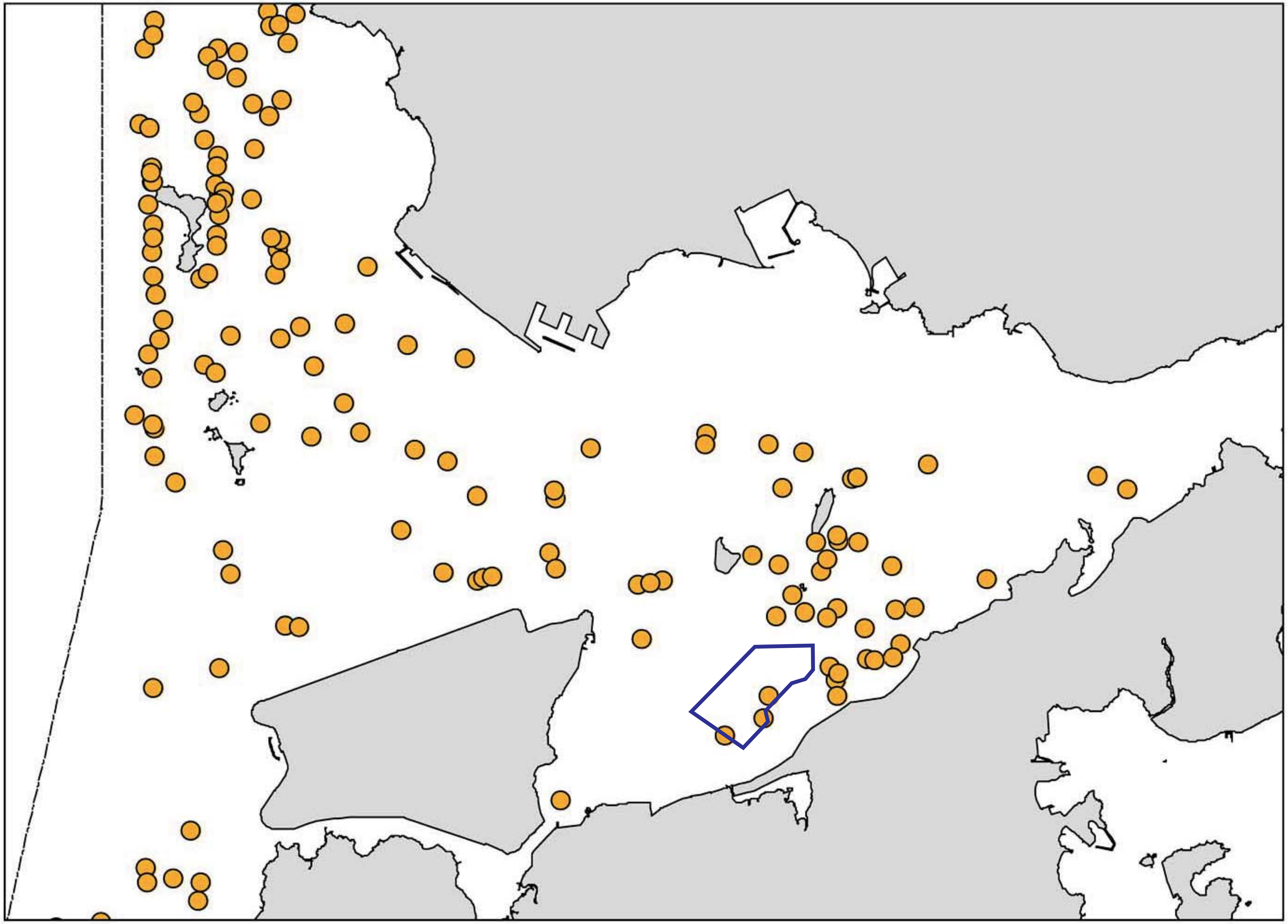


Figure 11. Distribution of Chinese white dolphin sightings engaged in socializing activities during 2002-08, showing overlaps with the proposed CMP at South Brothers

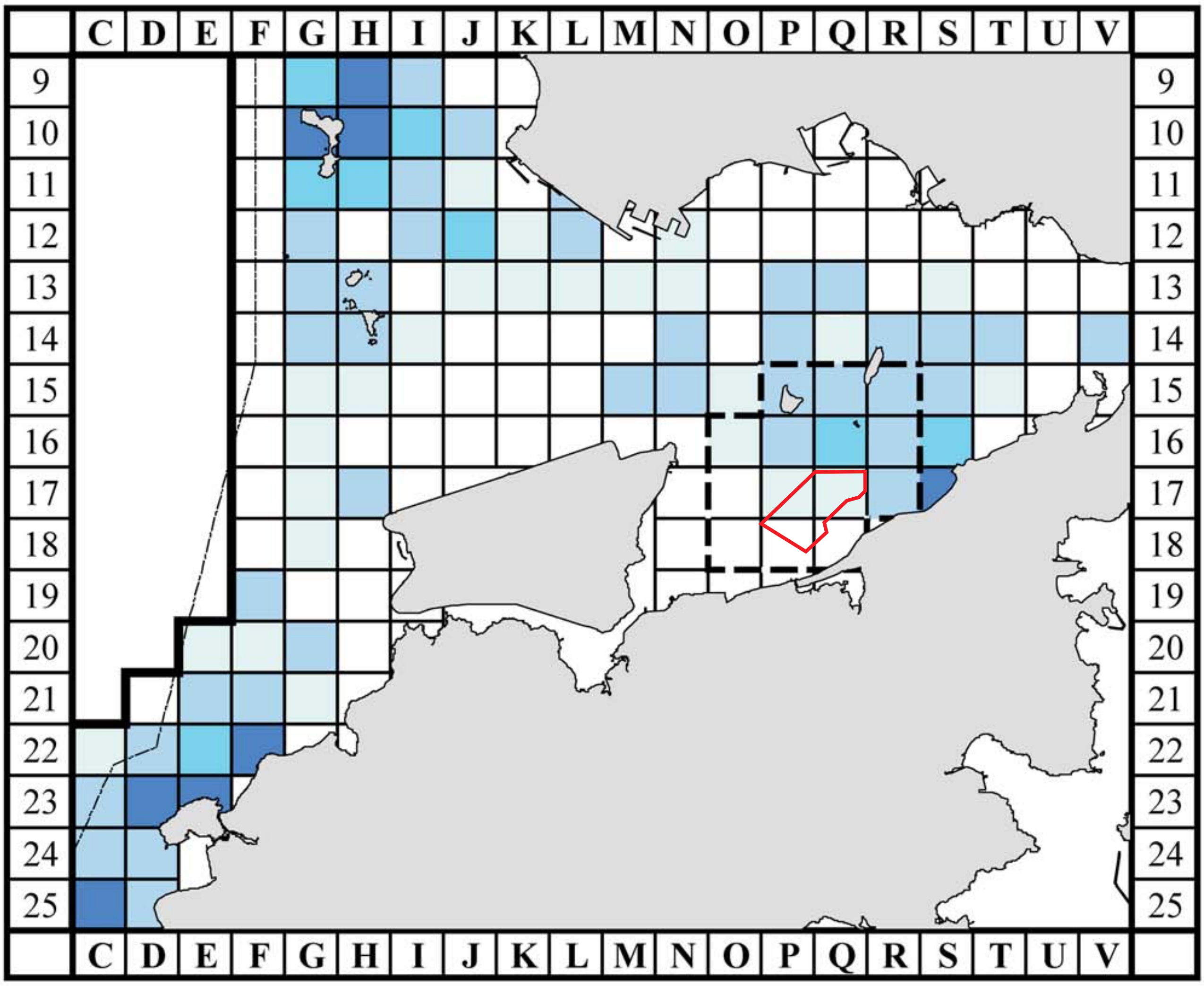


Figure 12. Sighting density of Chinese white dolphins with corrected survey effort per km^2 engaged in feeding activities in waters around Lantau island, showing overlaps with the proposed CMP at South Brothers, using data collected during 2002-08 (SPSE = no. of on-effort dolphin sightings per 100 units of survey effort)

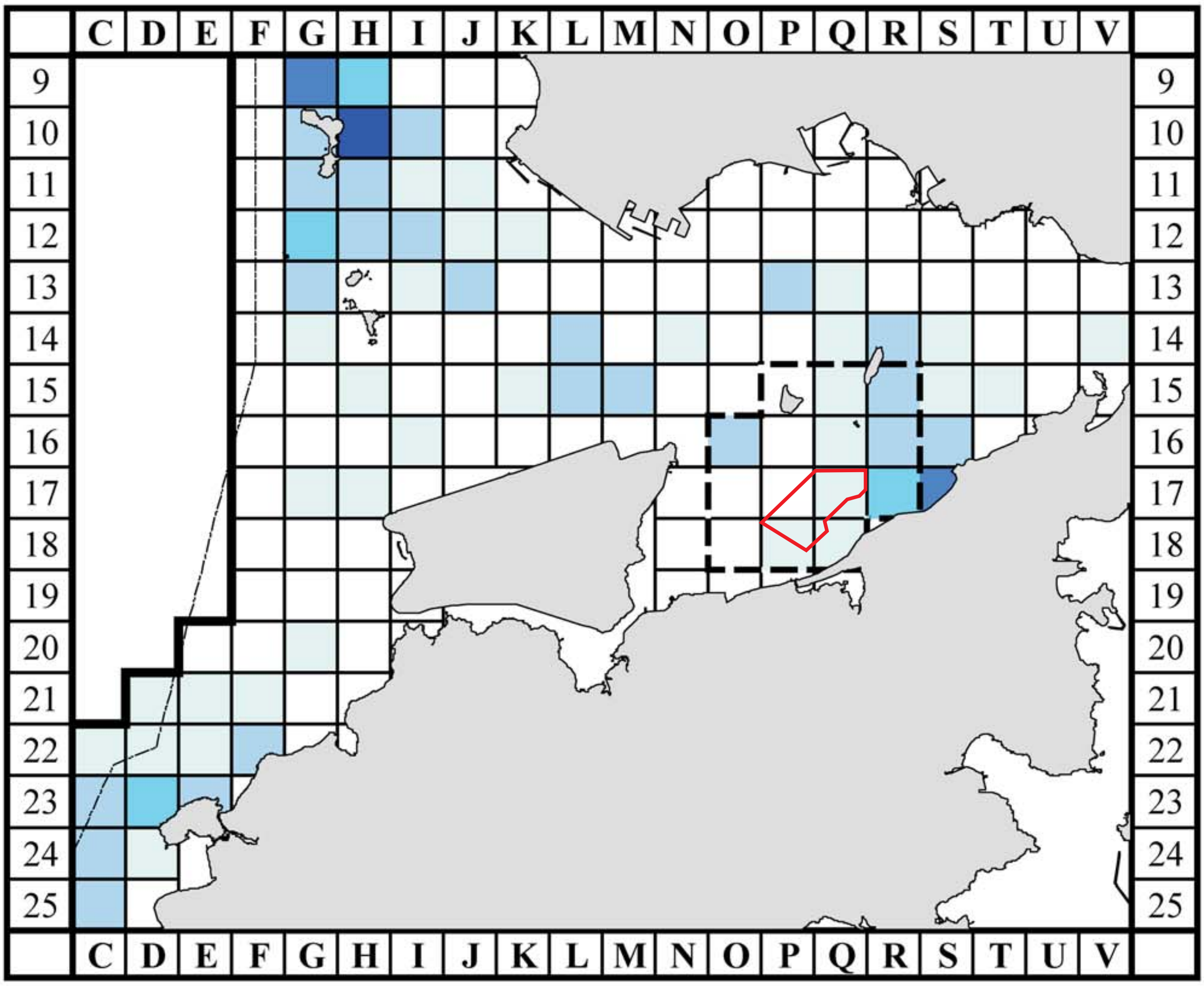
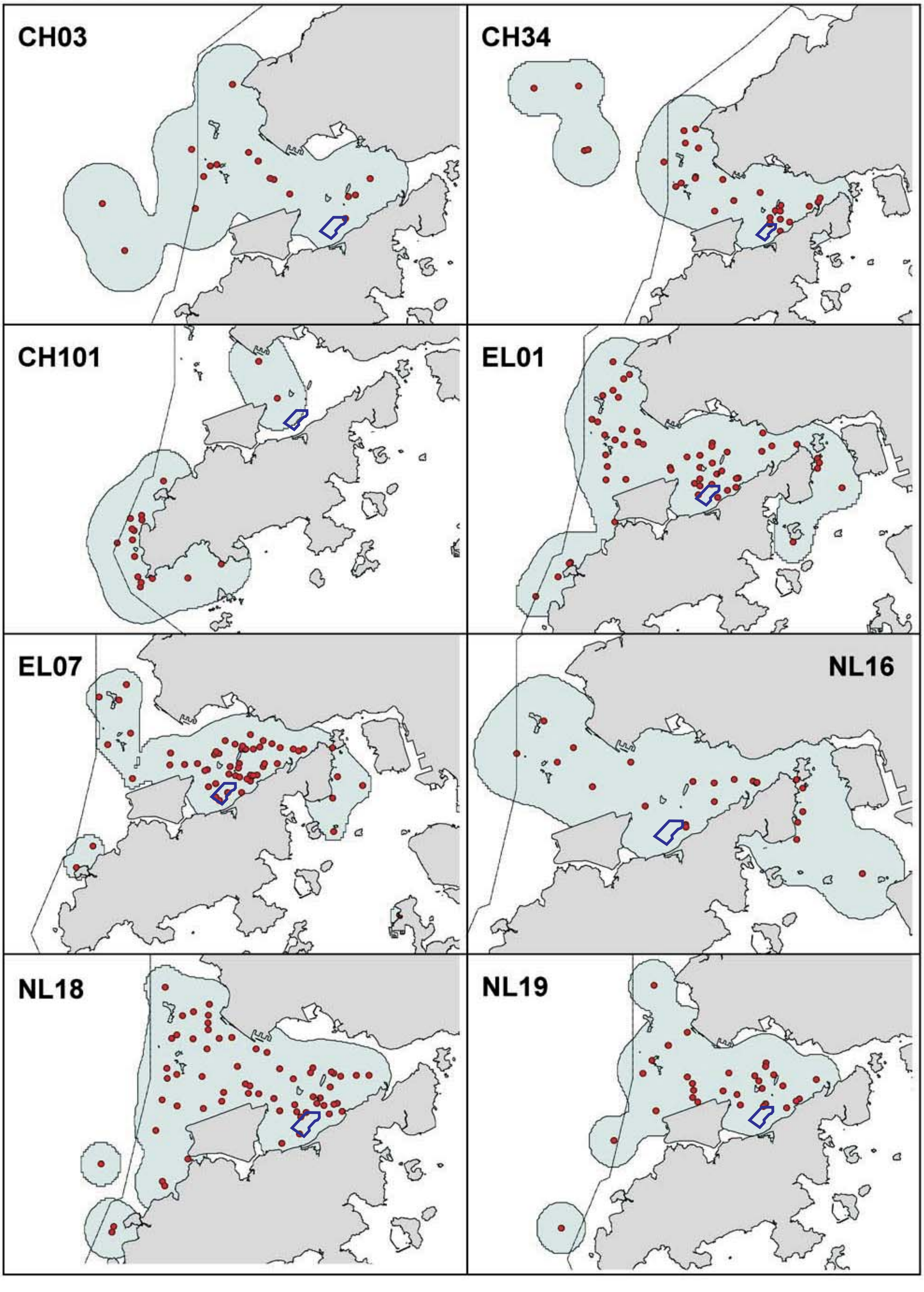
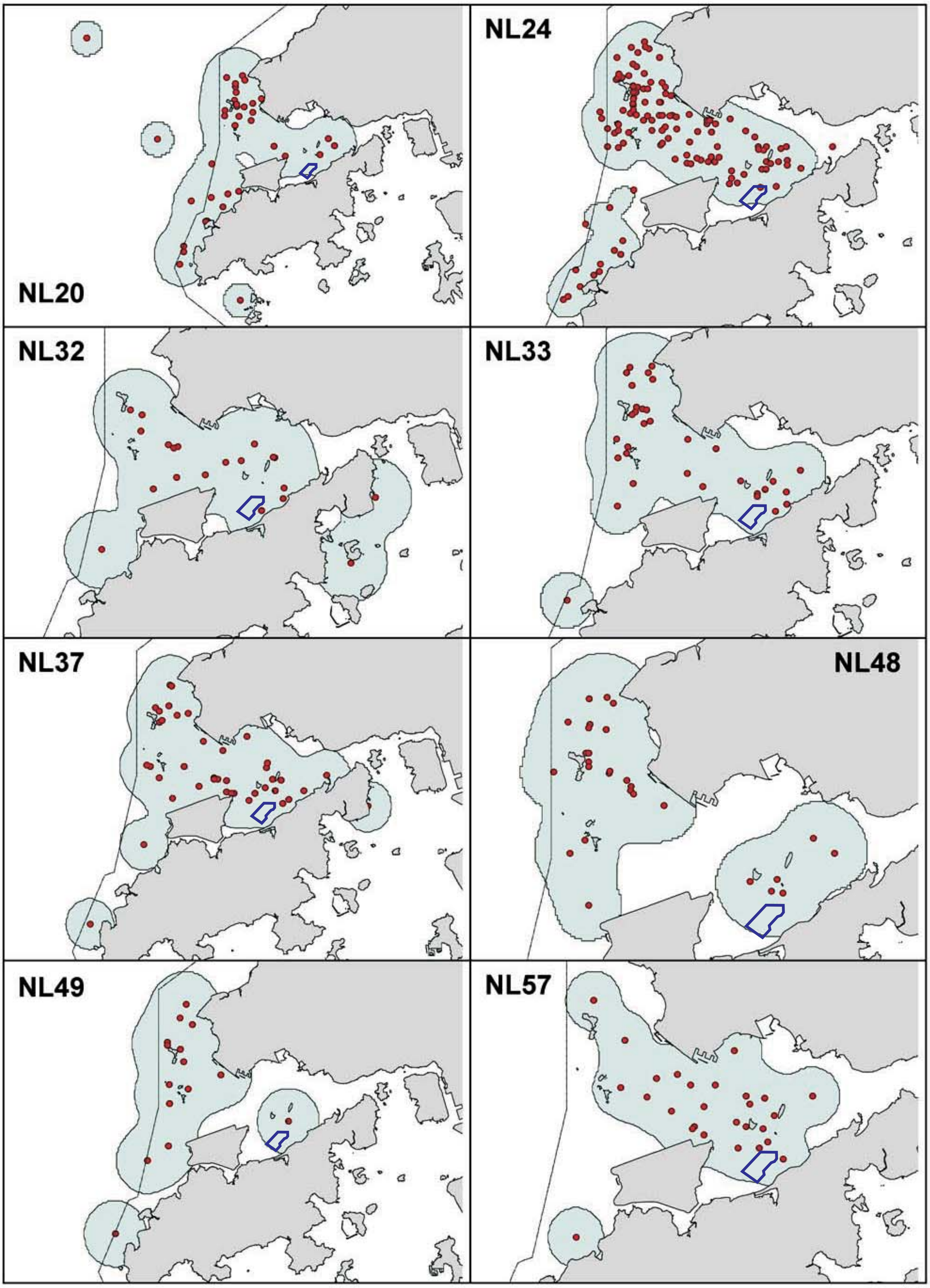


Figure 13. Sighting density of Chinese white dolphins with corrected survey effort per km^2 engaged in socializing activities in waters around Lantau island, showing overlaps with the proposed CMP at South Brothers, using data collected during 2002-08 (SPSE = no. of on-effort dolphin sightings per 100 units of survey effort)

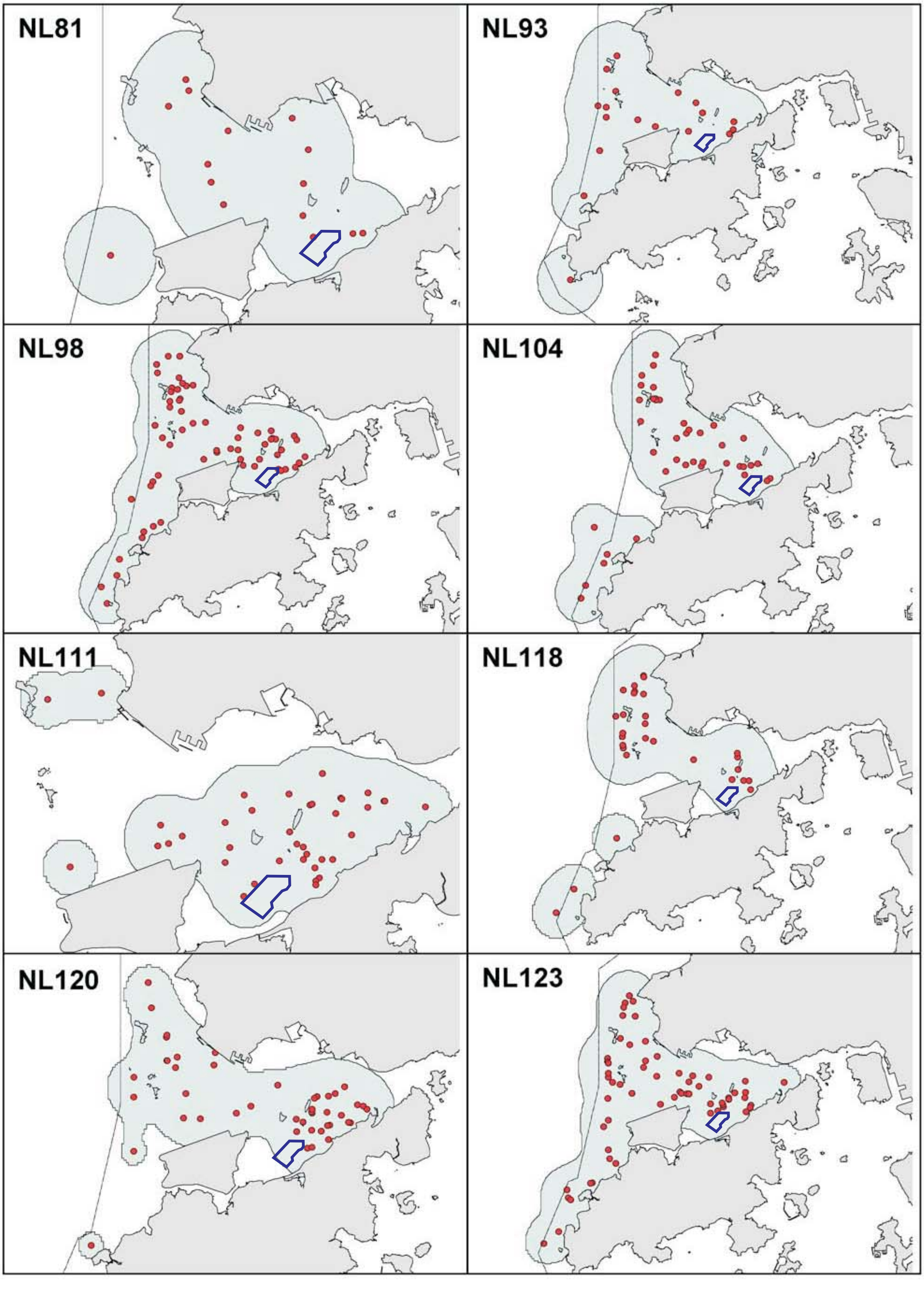
Appendix I. Ranging patterns (95% kernel ranges) of individual Chinese white dolphins with 15+ re-sightings that overlaps with the proposed CMP site at South Brothers



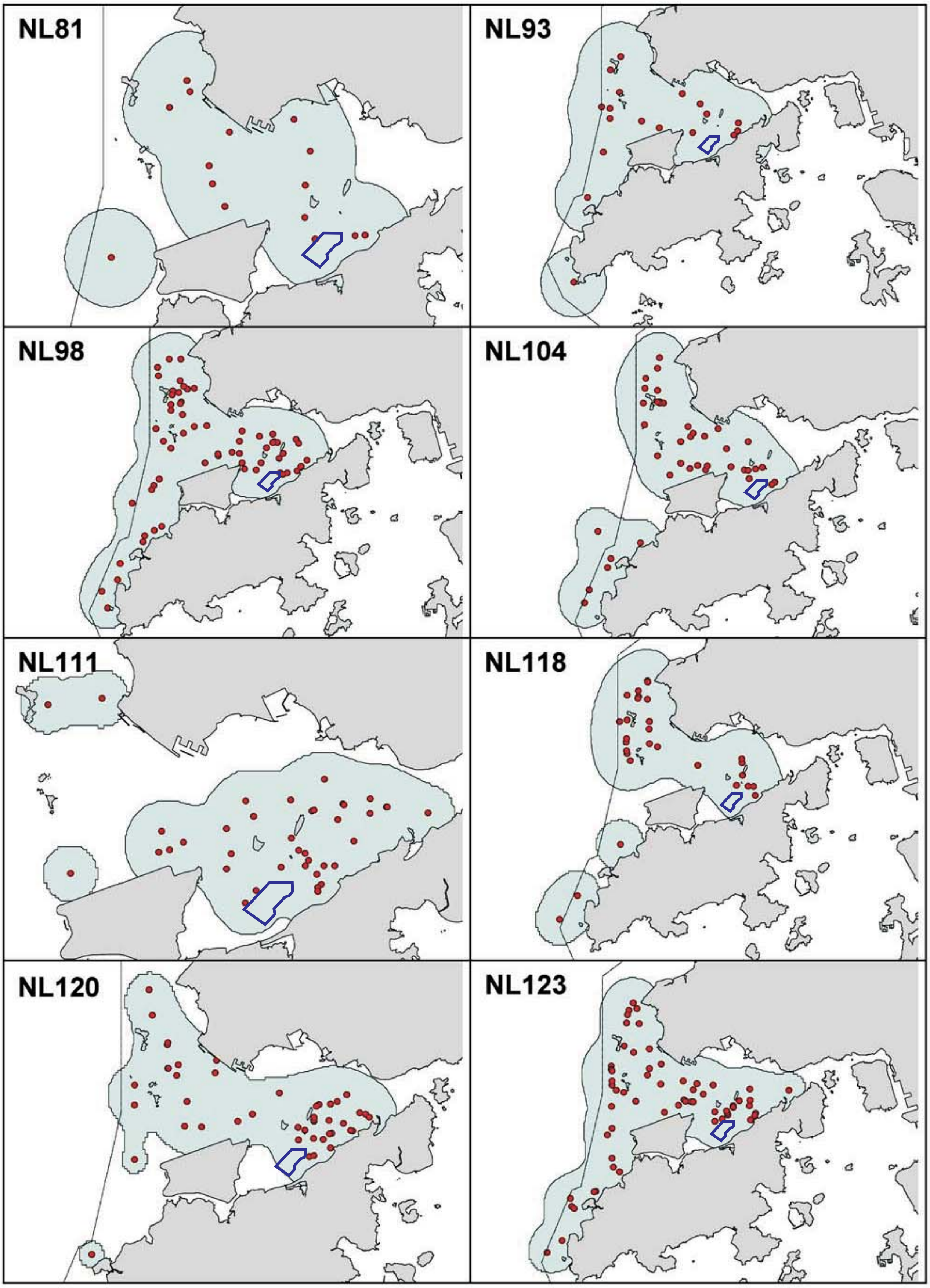
Appendix I (cont'd).



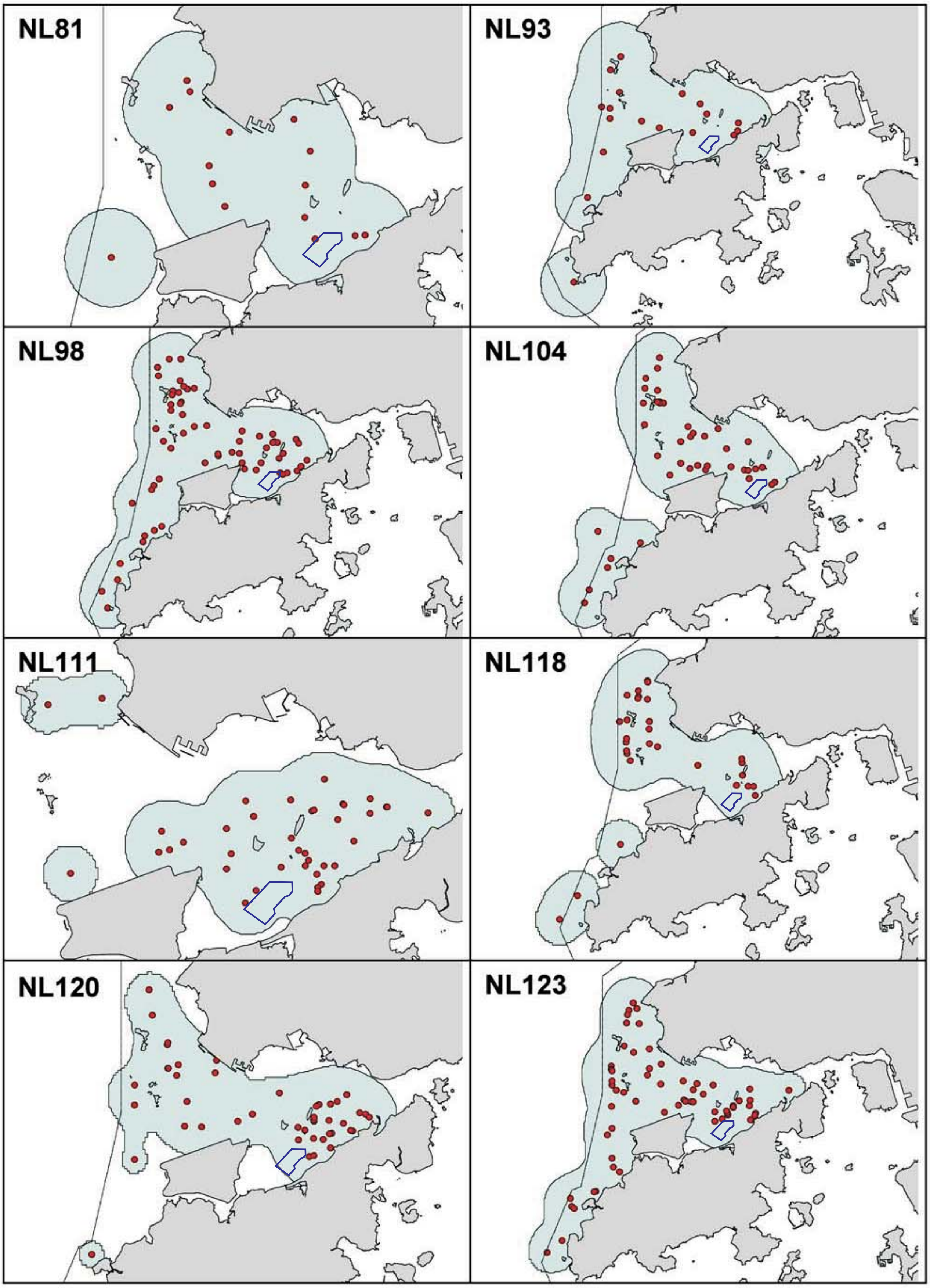
Appendix I (cont'd).



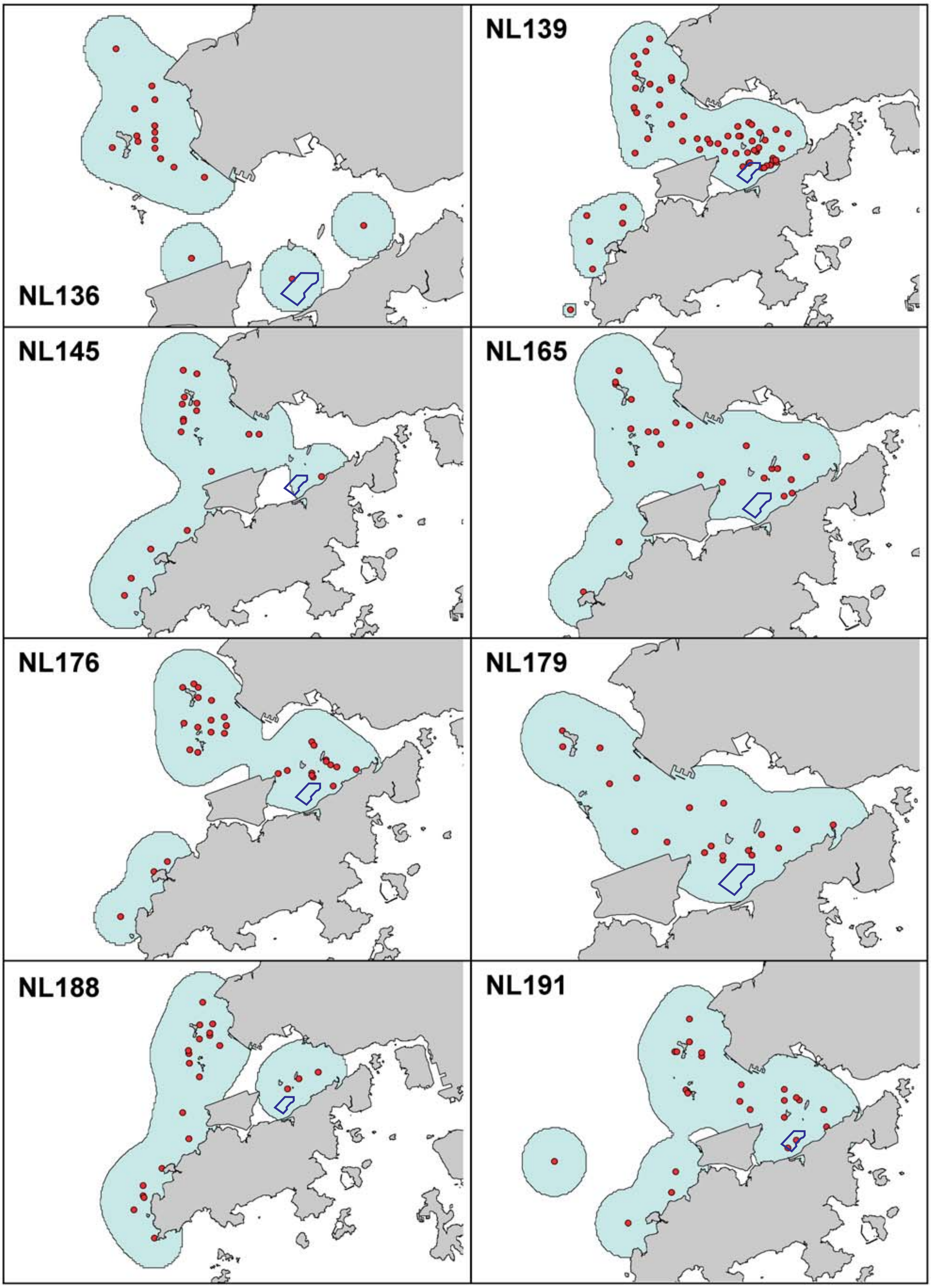
Appendix I (cont'd).



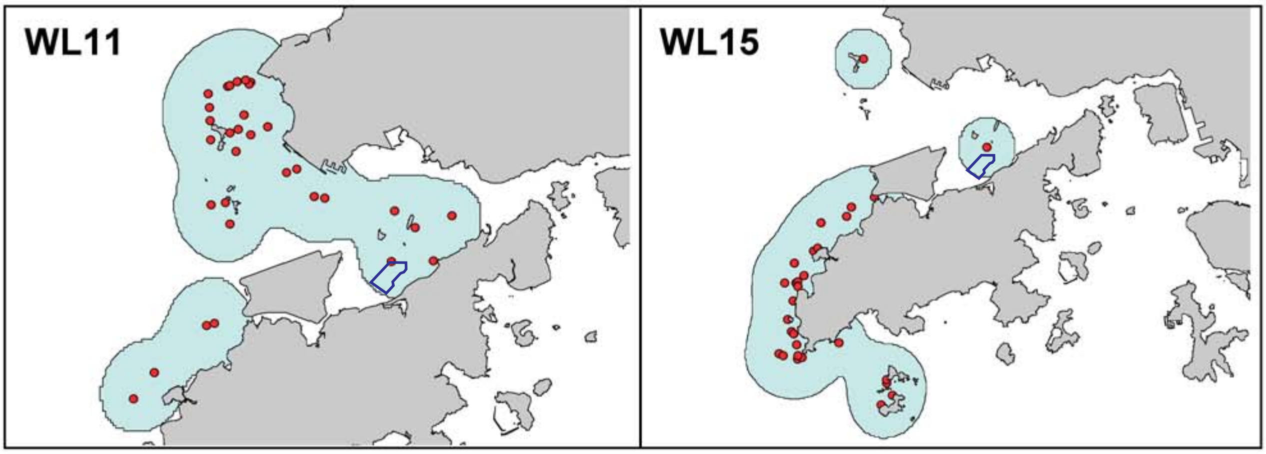
Appendix I (cont'd).

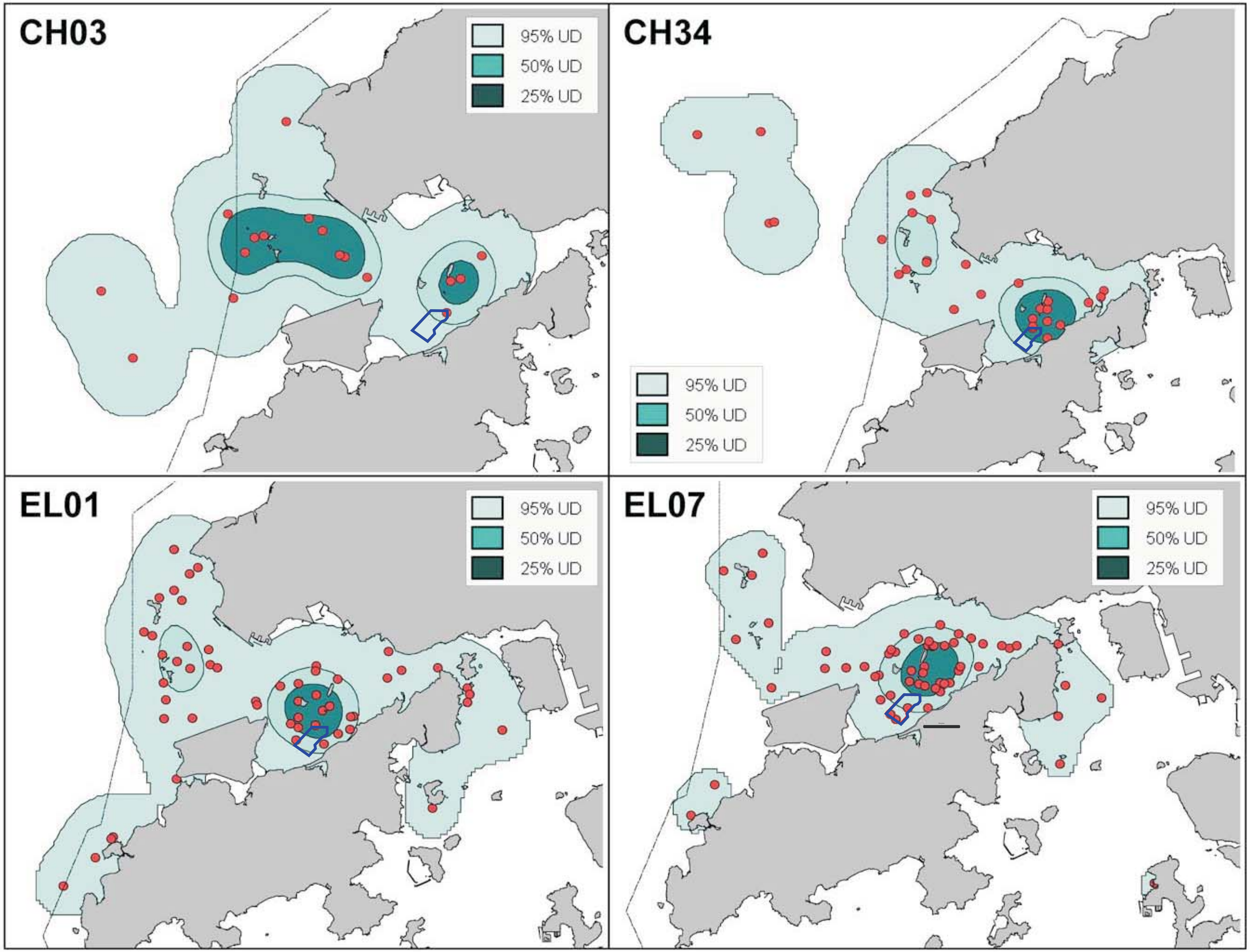


Appendix I (cont'd).

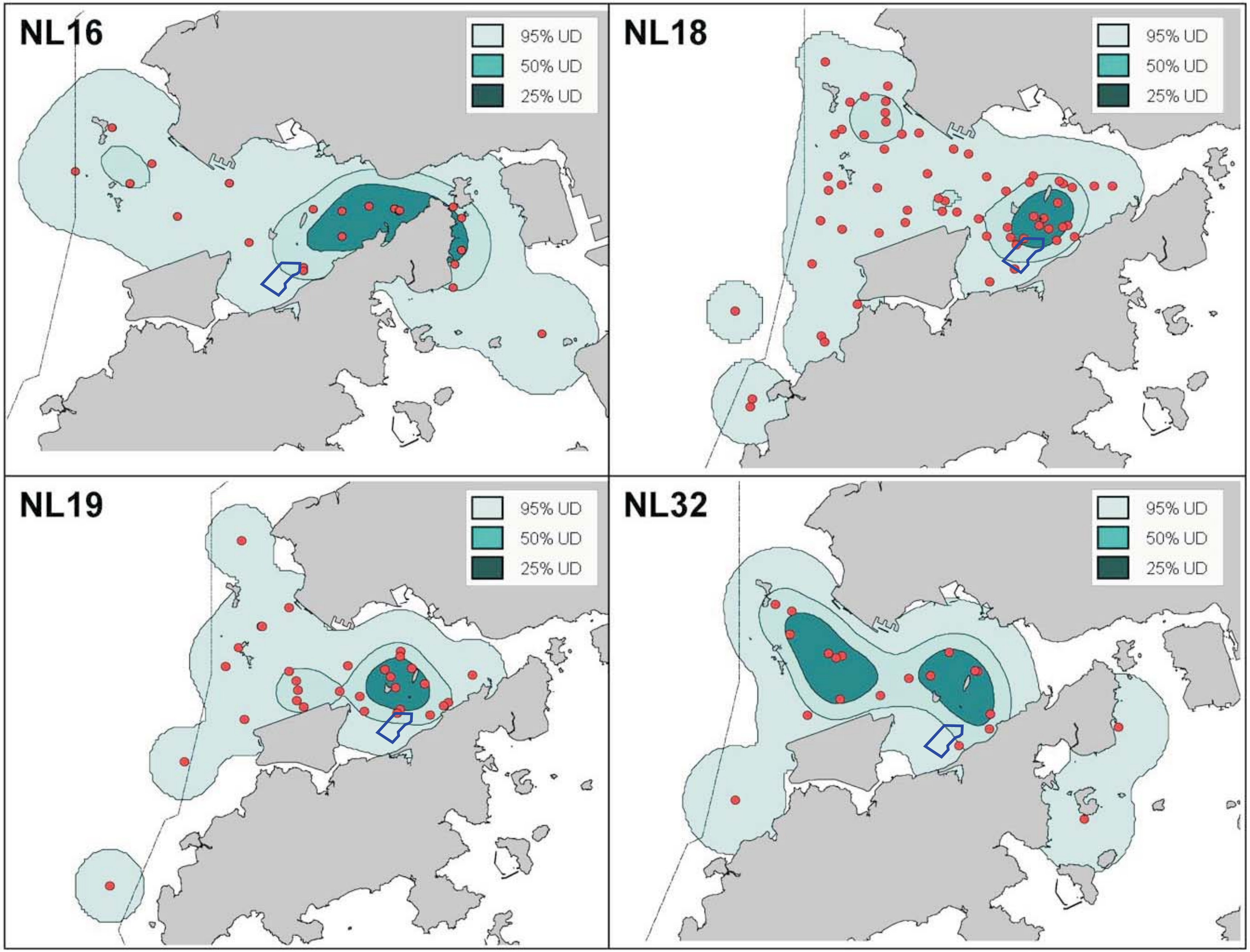


Appendix I (cont'd).

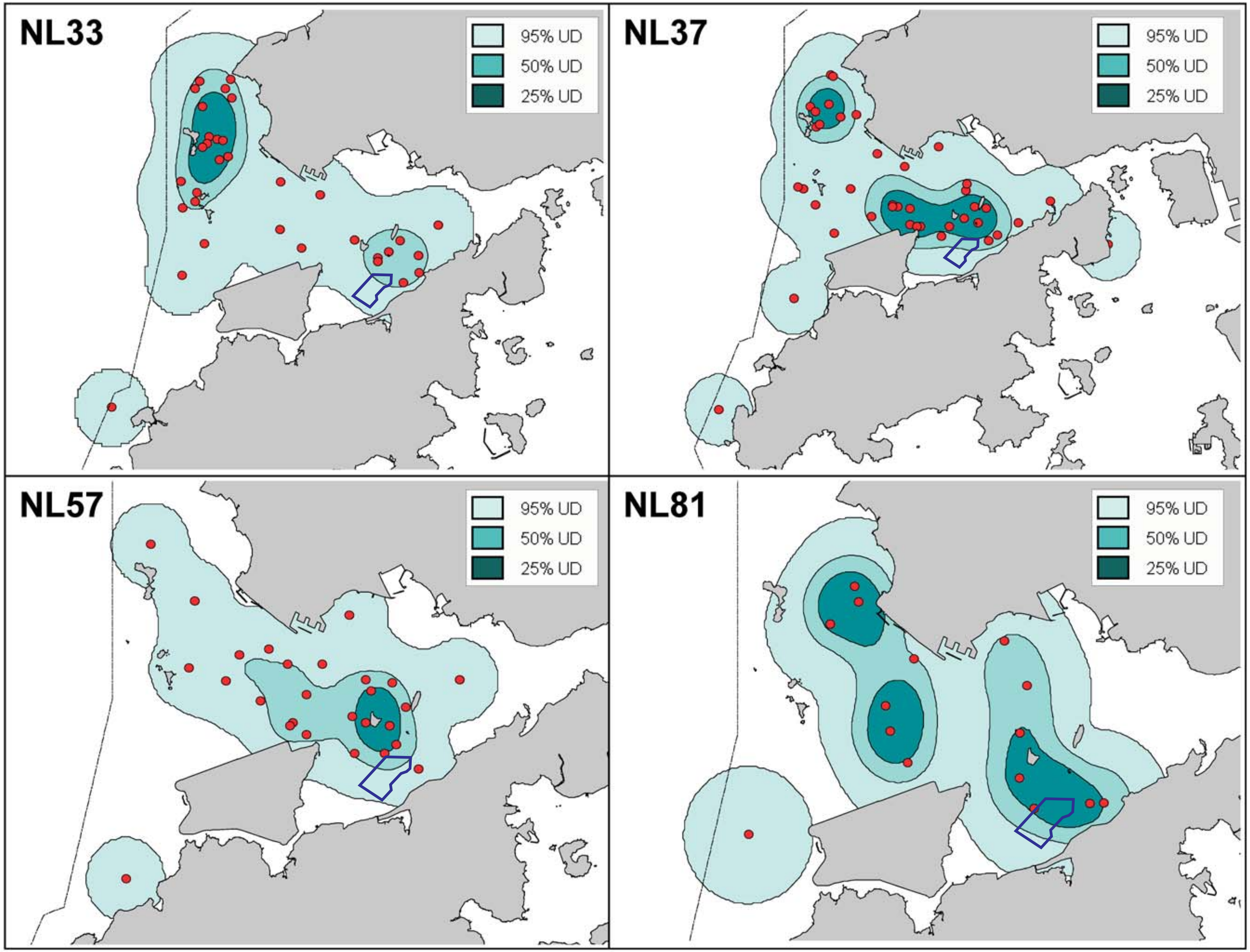




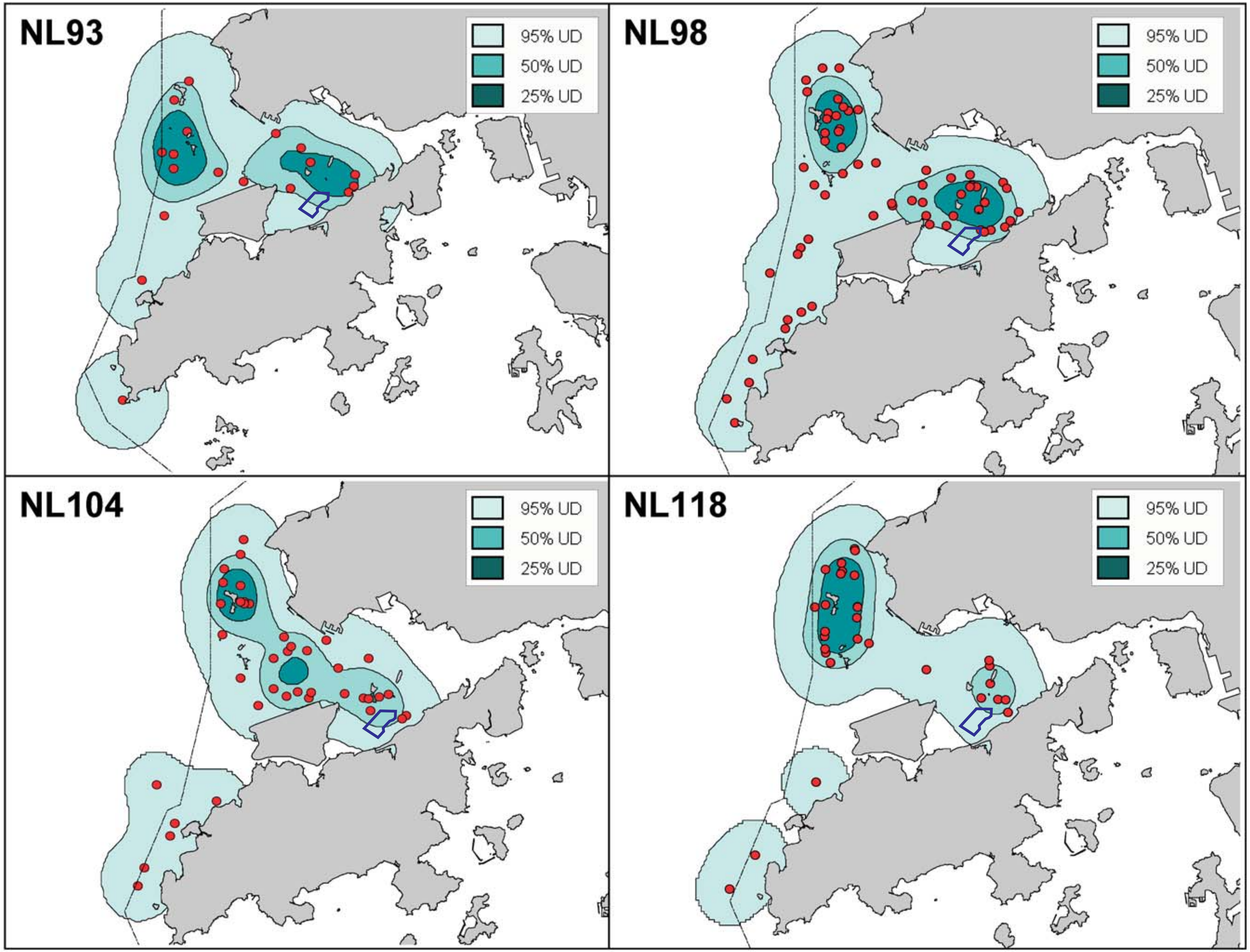
Appendix II. Ranging patterns of 23 dolphins that overlapped with CMP at 95%, 50% & 25% UD levels using kernel estimator



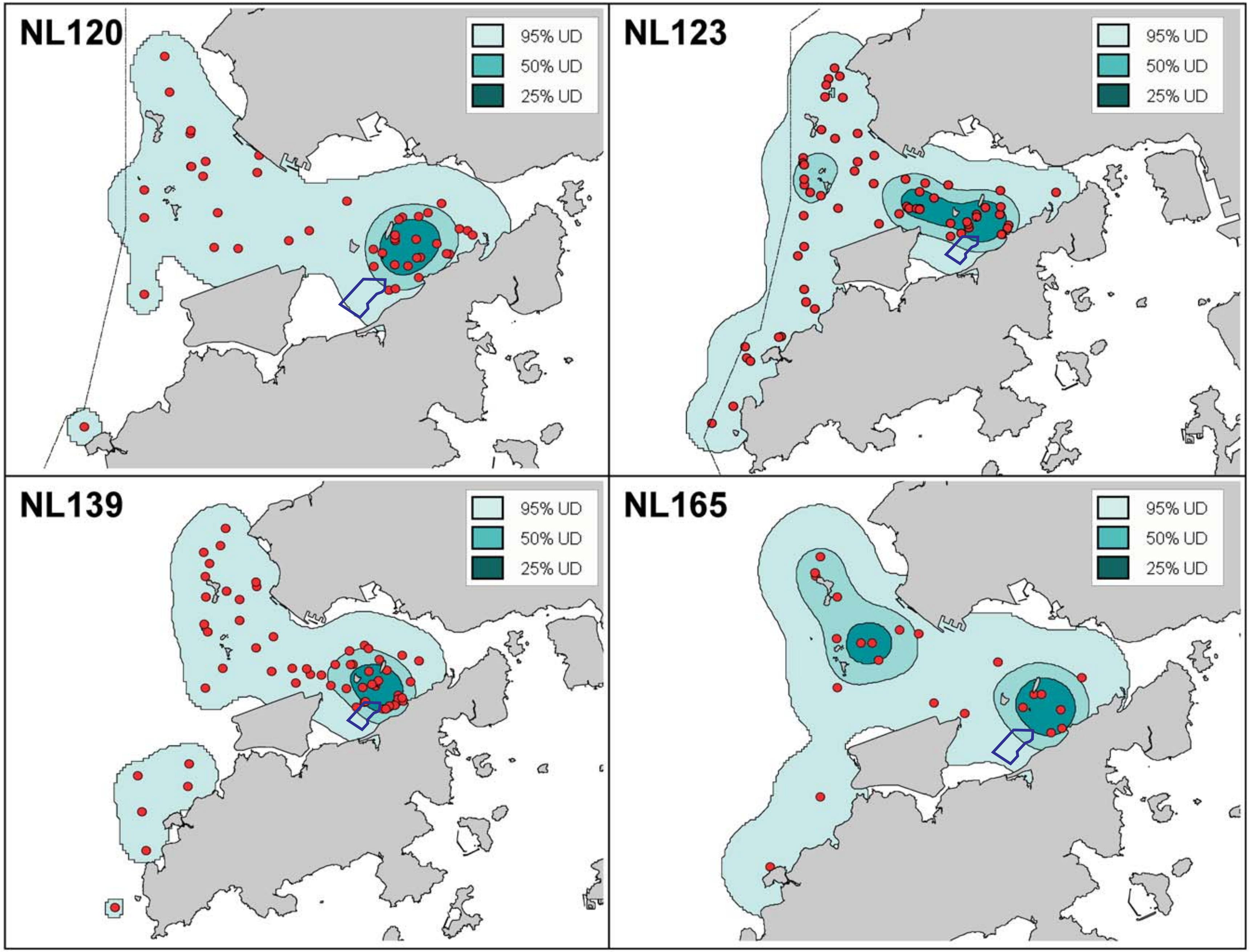
Appendix II (cont'd).



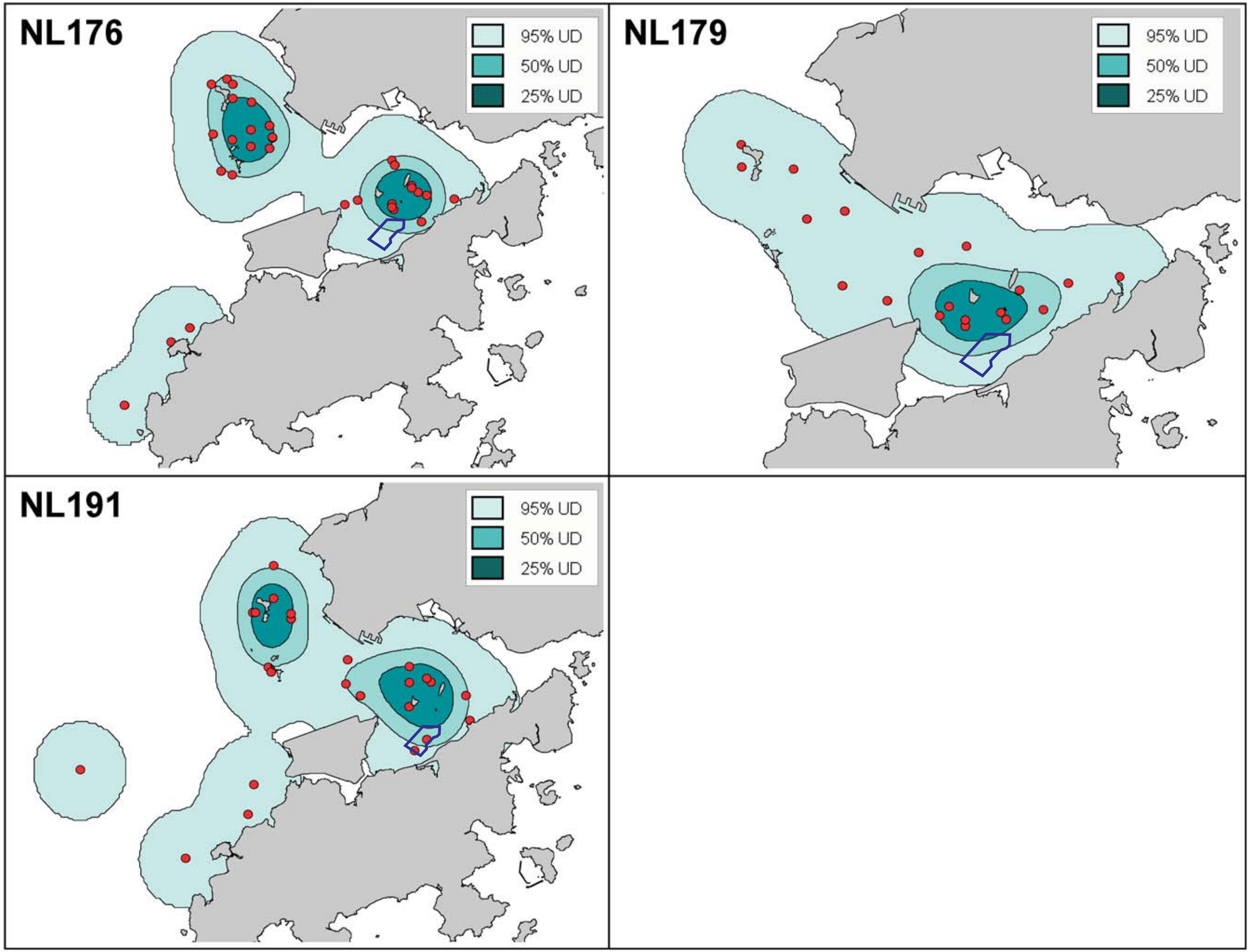
Appendix II (cont'd).



Appendix II (cont'd).



Appendix II (cont'd).



Appendix II (cont'd).

Annex C

Methodology for Risk Assessments

CONTENTS

1 HUMAN HEALTH & MARINE MAMMAL RISK ASSESSMENT METHODOLOGY

1.1 INTRODUCTION

This *Annex* presents the methodology utilised in the risk assessments performed on data gathered as part of the bioaccumulation assessment. Included in this *Annex* are the detailed methods of the Human Health Risk Assessment and the Ecological Risk Assessment.

1.2 BASIC CONCEPTS OF RISK ASSESSMENT

Risk assessment is the means of evaluating the toxic properties of a substance, and the exposure to it, in order to ascertain the likelihood that exposed humans, or other organisms, will be adversely affected, and to characterise the nature of the effects. Risk is the probability of injury, disease, or death under specific exposure circumstances. Almost all human activities carry some degree of risk. Many risks are known with a relatively high degree of accuracy, because data have been collected on their historical occurrence. *Table 1.1* lists the risks of some common human activities.

Table 1.1 Example of Individuals Risks

Causes	Risk per million per year	
All causes (mainly illness from natural causes)	11,490	(1.14×10^{-2})
Cancer	2,880	(2.88×10^{-3})
The figures below vary greatly with age		
All violent causes (accident, homicide, suicide etc)	365	(3.65×10^{-4})
Road accidents	98	(0.98×10^{-4})
Accidents in private homes (average for occupants only)*	93	(9.30×10^{-5})
Fire or flame (all types)*	15	(1.50×10^{-5})
Drowning*	6	(6.00×10^{-6})
Gas incident (fire, explosion or carbon monoxide poisoning)	0.9	(0.90×10^{-6})
Excessive cold*	8	(8.00×10^{-6})
Lightning	0.1	(1.00×10^{-7})
Accidents at work - risks to employees		
Deep-sea fishing (UK vessels)	1340	(13.4×10^{-4})
Coal extraction and manufacture of solid fuels	141	(1.41×10^{-4})
Construction	98	(9.80×10^{-5})
All manufacturing industry	19	(1.90×10^{-5})
Offices, shops, warehouse etc inspected by local authorities	4.5	(4.50×10^{-6})
Leisure-risks to participants during active years		
Rock climbing (assumes 200 hours climbing per year)	8,000	(8.00×10^{-3})
Canoeing (assumes 200 hours per year)	2,000	(2.00×10^{-3})
Hang-gliding (average participant)	1,500	(1.50×10^{-3})

Source: HSE document on The Tolerability of Risk from Nuclear Power Stations (1992) (except*: from OPS Monitor series DH4 No 11, 1985 and Registrar-General for Scotland, Annual Report, 1985).

The risk statistics specified in *Table 1.1* are given as the average over the whole population of the UK except where there is a specific small group exposed (eg, rock climbers). The figures are given as the chance in a million that a person will die from that cause in any given year, averaged over a whole lifetime (except where otherwise stated).

The risks associated with many other activities, including the exposure to various chemical substances, cannot be precisely assessed and quantified. Although there are considerable historical data on the risks of human exposure to high doses of chemicals and some types of exposure (eg, the annual risk of death from intentional overdoses or accidental exposures to drugs, pesticides, and industrial chemicals), such data are generally restricted to those situations in which an exposure resulted in an observable form of injury.

Assessment of the risks of levels of chemical exposure that do not cause an immediately observable form of injury of disease (or only minor forms such as transient eye or skin irritation), is far more complex and may vary based on whether the exposures have been brief, extended but intermittent, or extended and continuous. It is the latter type of risk assessment activity that is considered in this risk assessment.

A commonly asked question of the results of risk assessments is "how safe are the risks?" The term "safe", in its common usage, means "without risk". In technical terms this common usage is misleading because science cannot ascertain the conditions under which a given chemical exposure is likely to be absolutely without a risk of any type. Science can however, describe the conditions under which risks are so low that they would generally be considered to be of no practical consequence to members of a population. As a technical matter, the safety of chemical substances, whether in food, water, sediment or air, has always been defined as a condition of exposure under which there is a "practical certainty" that no harm will result in exposed individuals. Internationally and in Hong Kong there are criteria to assist in determining what acceptable levels of risk are. These criteria are discussed later in the risk assessment.

Exposure conditions usually incorporate large safety factors, so that even more intense exposures than those defined as safe may also carry extremely low risks. It should be noted that most "safe" exposure levels established in this manner are probably very low risk, but science has no tools to prove the existence of what is essentially a negative condition.

Another concept concerns the classification of chemical substances as either "safe" or "unsafe" (or as "toxic" and "non-toxic"). This type of classification, while common, is highly problematic and potentially misleading. All substances, even those which are consumed in large amounts every day, may be made to produce a toxic response under some conditions of exposure. In this sense, many substances are toxic. The important question is not simply that of toxicity, but rather that of risk, ie, the probability that the toxic properties of a chemical will be realised under actual or anticipated conditions of exposure. This issue is addressed in this risk assessment by incorporating information such as the pathways of exposure, duration of exposure and frequency, rather than a simple characterisation of toxicity.

The assessment methodology and statistics associated with risks to humans are relatively well developed when compared with those for assessing risks to other species. In this instance we are concerned with identifying a pragmatic approach to the evaluation of risks to the Chinese White Dolphin (also known as the Indo-Pacific humpback dolphin) *Sousa chinensis*. The evaluation methodology outlined in this risk assessment will build upon the assessments previously undertaken (1) (2) (3).

1.3 COMPONENTS OF RISK ASSESSMENT

Risk assessment can be divided into four major steps:

- hazard identification;
- dose-response evaluation;
- exposure assessment; and
- risk characterization.

Each is discussed in the following sections.

1.4 HAZARD IDENTIFICATION

1.4.1 Introduction

Hazard identification is the process of determining whether exposure to a chemical could cause an increase in adverse health effects. It involves characterizing the nature and quantity of possible contaminant releases to the environment, selecting a set of Contaminants of Concern (COCs), gathering and evaluating data on the types of health injury or disease that may be produced by a contaminant, and gathering and evaluating data on the conditions of exposure under which injury or disease is produced.

This section presents a framework for the evaluation of the potential human health and ecological effects resulting from ingestion of contaminants contained within the edible portion of organisms. The estimation of contaminant levels within the edible portion of organisms has been conducted as part of the bioaccumulation assessment, which is detailed in *Appendix A* of this *Annex*.

(1) EVS (1996) *Classification and Testing of Sediments from Marine Disposal*. Prepared for Hong Kong Civil Engineering Department

(2) ERM (2005) *Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area (Agreement No. CE 12/2002(EP)): Environmental Impact Assessment (EIA) and Final Site Selection Report*. Prepared for Civil Engineering and Development Department

(3) ERM (2007, 2008, 2009) *Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau (2005–2008) – Investigation (Agreement No. CE 19/2004 (EP)): Risk Assessment Reports*. Prepared for Civil Engineering and Development Department

Some of the COC are known carcinogens, whereas, others are not considered to be carcinogenic but cause other toxic effects. There are also COC that cause both toxic responses and are known to be carcinogenic. Assessment criteria have been developed for each type of toxicological effect and are discussed in later sections.

1.4.2 Contaminants of Concern

The contaminants of concern adopted for use in this Study are those included in *ETWB TC(W) 34/2002* [(1)] and the Study Brief. Information on the toxic effects of each of the COCs is presented below in *Table 1.2*.

Table 1.2 Contaminants of Concern for the East of Sha Chau CMP IV Monitoring Programme along with Information on Toxic Effects

Contaminant	Potential Toxic Effects
Arsenic (As) [(a)]	Inorganic forms have greater toxicity than organic forms, and inorganic Arsenic is a known carcinogen. Bioaccumulated by organisms (bioaccumulation occurs more readily in invertebrates than in fish). Teratogenic, fetotoxic and embryotoxic in several animal species. Effects in humans from exposure to high levels include skin and lung cancers, hearing loss, birth defects and liver, kidney and heart damage. Arsenobetaine, the principal arsenic compound in seafood, is not carcinogenic to mammals.
Cadmium (Cd)	Potential carcinogen (based on limited evidence) and teratogen. Bioaccumulated by organisms. Effects in fish include reduced survival, growth and reproduction, decreased oxygen consumption, enzyme disruption, kidney dysfunction and altered blood chemistry. Effects in mammals include reduced haemoglobin levels, decreased growth, immunotoxicity, histopathology, birth defects, and leukaemia. Effects in humans include kidney damage, possible increased risk of cancer, and skeletal disorders.
Chromium (Cr)	Considered to be mutagenic and teratogenic at elevated concentrations. Effects in fish include reduced growth and survival, altered plasma cortisol metabolism and locomotor activity. Effects in mammals include adverse effects on blood chemistry and morphological changes in liver, teratogenic effects and genotoxicity. Effects in humans include respiratory disease due to inhalation, and possible carcinogenicity (inhalation route for Cr VI only). Chromium can exist in many chemical forms although it is usually present as either III or VI oxidation states. Chromium (III) is an essential element whereas Cr (VI) is a potential carcinogen with bronchogenic carcinoma (ie lung cancer) being its principal deleterious effect reported in mammals.
Copper (Cu)	Can be acutely toxic to animals but is also an essential nutrient at lower doses. Little tendency to bioaccumulate. Effects in fish include mortality and behavioural changes. Effects in mammals include mortality, growth retardation and teratogenicity. Toxic effects to humans are uncommon; however it is a known teratogen.

(1) Environment, Transport and Works Bureau Technical Circular (Works) No. 34/2002: *Management of Dredged/Excavated Sediment*

Contaminant	Potential Toxic Effects
Lead (Pb)	Organic lead compounds are usually more toxic than inorganic compounds. Invertebrates are more sensitive than fish to elevated levels. Effects in fish include anaemia, enzyme inhibition, paralysis, teratogenicity, growth reduction, and reduced survival. Effects in mammals include mortality, behavioural effects, paralysis, development effects, weight loss and reduced reproduction. Effects in humans include loss of appetite, cramps, headache, fatigue, paralysis, lead encephalopathy and death. It is also a likely mutagen in humans.
Mercury (Hg)	Organic compounds, especially methyl mercury, are more toxic than inorganic forms. Strongly bioaccumulated in aquatic biota and known to biomagnify within the food chain. Effects to fish include mortality, reproductive impairment, behavioural effects, lesions, enzyme disruption and neurotoxicity. Effects in humans include motor and mental impairment, blindness, deafness, microcephaly, intestinal disturbances, tremors and tissue pathology.
Nickel (Ni)	Bioaccumulates in aquatic organisms, although organisms can naturally regulate levels through increased excretion or decreased uptake. Effects in fish include mortality, deformities, and reduced growth and reproduction. Established teratogen and carcinogen in mammals through inhalation of Nickel dust, not through ingestion. Also potential mortality, genotoxicity, and immunological, neurological, developmental, and reproductive effects in mammals. High doses in humans result in intoxication and nausea.
Silver (Ag)	Bioacummulates in invertebrates and vertebrates. Effects in mammals include cardiac enlargement, vascular hypertension, hepatic necrosis, anaemia, lowered immunological activity, enzyme inhibition, growth retardation, and a shortened life span. No evidence of cancer in humans has been reported.
Zinc (Zn)	Strongly bioaccumulated in all organisms. Minor biomagnification through the food chain. Effects in fish include mortality, deformities and reduced growth, teratogenicity and reproductive impairment. In mammals only very high doses are considered to be toxic; potential immunological, neurological, developmental, genotoxic, and reproductive effects. Effects in humans include digestive disorders, altered immune system, headache, muscular incoordination, renal failure and death.
PCBs	Bioaccumulated in fatty tissues. Biomagnification in higher trophic levels. In humans, symptoms include irritation and lacerations of the skin and mucous membranes, neurological disorders, immunosuppression and carcinogenicity. In addition, reproductive impairment, birth defects and development abnormalities are known to occur when women are exposed before or during pregnancy.

Contaminant	Potential Toxic Effects
Tributyltin (TBT)	High bioconcentration potential, especially in fish and molluscs. Major impact on marine organisms, in particular shellfish at very low concentrations. Effects in fish include disruption of enzyme activity, decreased growth, behavioural abnormalities, increased liver weight, histopathological changes to the liver, kidney and gills, thymus atrophy, reduced hatchability of eggs, decreased embryo viability and vertebral malfunctions in larvae. Much less is known about the toxic effects to humans; very high levels of exposure have resulted in death, but exposure at very low levels has not yet been correlated with specific health effects. Medium level exposure may result in disruption of the endocrine system.

(a) Measured as total Arsenic

Sources:

EVS (1996a) *Classification and Testing of Sediments for Marine Disposal*. Prepared for CED.

EVS (1996b) *Contaminated Mud Disposal at East of Sha Chau: Comparative Integrated Risk Assessment*. Prepared for CED.

Aspinwall Clouston Ltd (1998) *A Study of Tributyltin Contamination of the Marine Environment of Hong Kong*. Prepared for EPD.

Irwin RJ, VanMouwerik M, Stevens L, Seese MD, Basham W (1998) *Environmental Contaminants Encyclopaedia*. National Park Service, Water Resources Division, Water Operations Branch, Colorado.

United States Environmental Protection Agency (US EPA) *Integrated Risk Information System (IRIS)*

ERM (2002) *Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau*. Final Report submitted to the Civil Engineering Department.

ERM (2007, 2008, 2009) *Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau (2005–2008) – Investigation (Agreement No. CE 19/2004 (EP)): Risk Assessment Reports*. Prepared for Civil Engineering and Development Department

1.5 *DOSE RESPONSE EVALUATION*

Dose-response evaluation involves quantifying the relationship between the degree of exposure to a substance and the extent of toxic injury or disease. The majority of data are derived from animal studies in the laboratory or, less frequently, from studies in exposed human populations. There may be many different dose-response relationships for a substance if it produces different toxic effects under different conditions of exposure. The risks of a substance cannot be ascertained with any degree of confidence unless dose-response relationships are quantified, even if the substance is known to be "toxic". Such dose-response relationships have been established for various COC for exposures to humans but with varying degrees of certainty. Exposures to species such as *Sousa chinensis* are less accurately quantified and few published dose-response relationships are available for marine mammals.

1.5.1 *Categorization of Human Health Effects*

For the purpose of this risk assessment, the effects of the substances listed in *Section 1.4.2* have been classified into two categories, ie, non-carcinogenic effects or carcinogenic effects to humans. Substances are included within both categories if they exhibit both types of effect.

Non-Carcinogenic Health Effects

One of the fundamental principles of toxicology is the *dose-response relationship*. For virtually all toxic substances, there is a direct relationship between the exposure level (and duration) and the severity of the effects produced. As the exposure level (and/or duration period) is lowered, for the great majority of toxic effects, a point is reached at which no detectable effect occurs. This is termed the threshold dose or **No Adverse Effects Level** (NOAEL).

In laboratory experiments non-carcinogens display NOAELs as the animals under testing can tolerate doses below a certain finite value, with only a limited chance of the expression of toxic effects. NOAELs themselves are not directly used for human health criteria as the NOAELs relate to toxicity observed in animal bioassays and may not adequately protect the most sensitive receivers in human populations (eg, embryos). In order to develop criteria for human health **Uncertainty Factors** (UFs) (1) are applied to the NOAEL data in order to insure that risks are over-estimated rather than underestimated. For example, extrapolation of animal toxicity response doses to humans utilises two safety factors of ten, the first for animal-to-human extrapolation and the second for variation of sensitivities within the human population.

The human health criteria developed after application of the UFs are referred to as **Reference Doses** (RfDs). The RfD, promulgated by the United States Environmental Protection Agency (US EPA), is an estimate of the daily exposure which appears to present a low risk of adverse effects during an exposure to the most sensitive members of the receiving population. The purpose of the RfD is to provide a benchmark against which other doses might be compared. Doses which are less than the RfD are not likely to be of concern. Doses which are significantly greater (ie at least one order of magnitude) than the RfD may indicate that inadequate margins of safety could exist for exposure to that chemical. The RfD is an approximate number, and while doses higher than the RfD have a higher probability of producing an adverse effect, it should not be inferred that such doses are, by definition, unacceptable or of concern. For the ingestion route, the RfD is expressed in units of mg kg (body weight)$^{-1}$ day^{-1}, ie, mg kg^{-1} day $^{-1}$.

A summary of RfDs for the COCs is presented in *Table 1.3*. *Table 1.3* also indicates the carcinogenic class of each COC according to the US EPA classification system (2) which comprises the following categories:

- Class A human carcinogen
- Class B probable human carcinogen:
  B1 indicates limited human evidence;

(1) US EPA (1989) Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish. A Guidance Manual. EPA-503/8-89/002

(2) US EPA (1986) Guidelines for the Health Risk Assessment of Chemical Mixtures (PDF) EPA/630/R-98/002, Sep 1986.

B2 indicates sufficient evidence in animals and inadequate or no evidence in humans

- Class C possible human carcinogen
- Class D Not classifiable as to human carcinogenicity
- Class E evidence of non-carcinogenicity for humans

Figure 1.1 illustrates how RfDs and NOAELs differ from each other.

Figure 1.1 ***Hypothetical example of a dose response curve for a non-carcinogen***

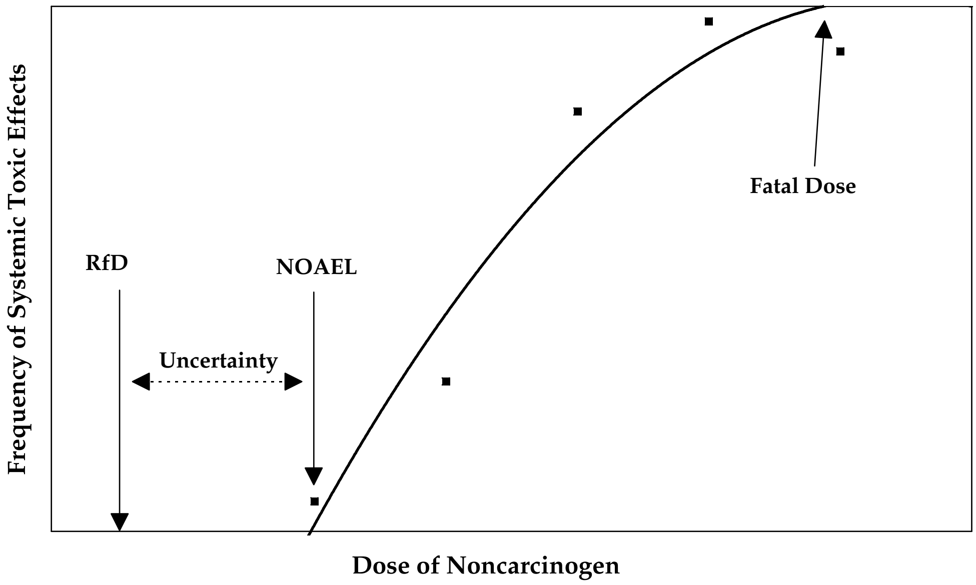


Table 1.3 ***Toxicity Information Taken from Integrated Risk Information System (IRIS)*** *(1)*

Substance	**Oral RfD mg kg-1 day-1**	**Oral Slope Factor mg kg-1 day-1**	**US EPA Carcinogenic Class**
Arsenic (a)	0.0003	1.5	Class A, human carcinogen
Cadmium (b)	0.001		Class B1, probable human carcinogen
Chromium (VI) (c) Chromium (III) (d)	0.003 1.5		Class D, not classifiable as to human carcinogenicity for oral exposure of Cr (VI) and Cr (III)
Copper (e)	0.043		Class D, not classifiable as to human carcinogenicity
Lead	0.00143	0.0085	Class B2, probable human carcinogen for lead and compounds (inorganic)

(1) United States Environmental Protection Agency (US EPA) Integrated Risk Information System (IRIS) < http://www.epa.gov/ncea/iris/>

Substance	Oral RfD mg kg-1 day-1	Oral Slope Factor mg kg-1 day-1	US EPA Carcinogenic Class
Mercury (f)	0.00022		Class C for methyl mercury and mercuric chloride, Class D for elemental mercury
Nickel (g)	0.02		Class A for nickel refinery dust and nickel subsulphide via inhalation, Class B2 for nickel carbonyl.
Silver	0.005		Class D, not classifiable as to human carcinogenicity
Zinc	0.3		Class D, not classifiable as to human carcinogenicity
Total PCBs		2.0	Class B2, probable human carcinogen
Tributyltin (h)	0.0003		Class D, not classifiable as to human carcinogenicity

Notes:
(a) as inorganic arsenic, (b) specific RfD for food intake, (c) Cr (VI) was used in the risk assessment, (d) Cr (III), (e) value derived from HEAST reported water quality criteria, (f) no IRIS or HEAST for Hg, converted 0.0003 for $HgCl_2$ by * 0.739, RfD for MeHg is 0.0001, (g) as soluble salts, (h) as tributyltin oxide.

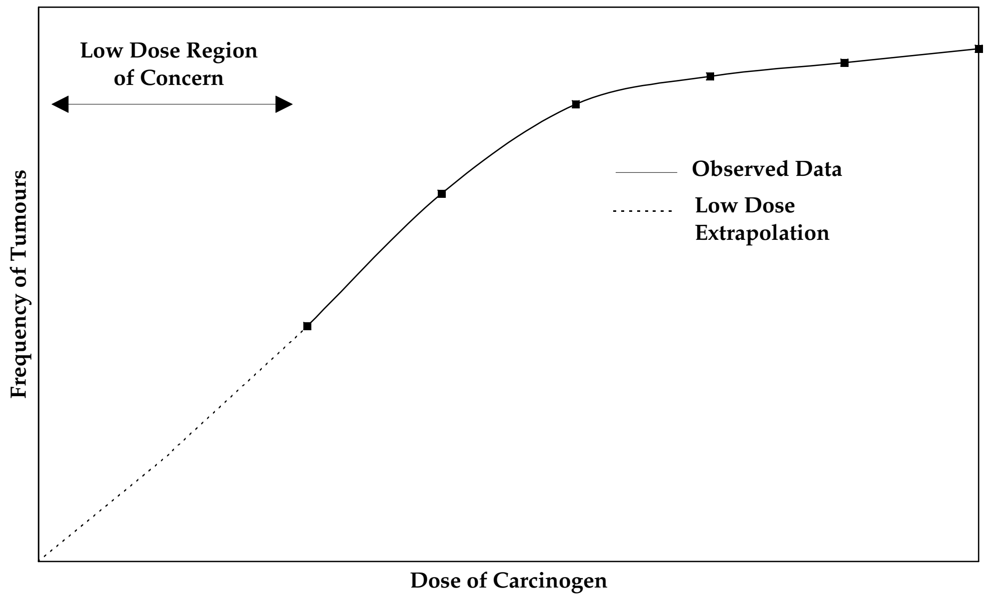
Carcinogenic Health Effects

For carcinogenic contaminants there are theoretical grounds for presuming that there may not be a true NOAEL. A carcinogenic health effect can be produced through the mechanisms of initiation or promotion. Genotoxic substances induce cancers by causing mutations in DNA, whereas non-genotoxic substances cause initiated cells to proliferate or differentiate. The two mechanisms differ in that their modes of action lead to fundamentally different techniques of risk assessment. On one hand, genotoxic substances are generally treated as carcinogens for which there is no threshold below which carcinogenic effects are not manifested; in other words, zero risk is only associated with zero exposure. However, non-genotoxic substances are treated as substances which can be tolerated by the receptor up to some finite concentration or dose, beyond which toxic effects are then manifested. In this Study, we have assumed a non-threshold approach for all carcinogens, ie, all carcinogens are considered to be genotoxic. This is a conservative assumption.

Where no effect cannot be demonstrated experimentally, mathematical models have been developed, particularly in the US, to enable a worst case extrapolation from high doses to much lower exposures to be made. Using such calculations, the US EPA has also ranked substances causing cancer in animals using so called **Slope Factors** (SF) (formerly known as Cancer Potency Factors).

The SFs can be used to estimate the excess lifetime cancer risks associated with various levels of exposure to potential human carcinogens. The SF is a number which when multiplied by the lifetime average daily dose per kilogram body weight of a potential carcinogen, yields the lifetime cancer risk resulting from exposure at that dose. In practice, slope factors are derived from the results of human epidemiological studies or chronic animal bioassays. The data from animal studies are fitted to linearized multistage models and a dose-response curve is obtained. The slope in the low dose range is subjected to various adjustments, and an interspecies scaling factor is applied to derive the slope factor for humans. *Figure 1.2* illustrates a hypothetical dose response curve for a carcinogen. The SF is used to determine the number of tumours likely to occur at low doses below which experimental data do not exist. The extrapolation is forced through the origin since for carcinogens NOAELs are not predicted to occur, ie, only zero exposure equals zero risk.

Figure 1.2 ***Hypothetical example of a dose response curve for a carcinogen***



Among the potential COCs are several substances that exhibit route-specific toxicity. Inhalation of Cadmium, Chromium VI and Nickel has been associated with increased incidence of cancer in animals and/or humans. There is no adequate evidence, however, of systematic carcinogenic effects following oral exposure to these compounds, because the substances may not be available for absorption through the gastrointestinal tract, or may cause lung cancer by a mechanism which has no parallel in the gastrointestinal tract. In this assessment we are mainly concerned with evaluating risks associated with the ingestion of seafood and hence only the oral SFs are of interest. Oral SFs are summarised above in *Table 1.3*.

1.5.2 Categorization of Effects to Marine Mammals

In general, the toxic effects of metals in marine organisms may include mortality, carcinogenicity, growth retardation, reduced reproduction, effects on blood chemistry, neurological and developmental effects, and behavioural effects. Various organic contaminants may cause reproductive impairment, systemic pathology, and cancer in cetaceans, including *Sousa chinensis* (1) (2).

Although some of the metals (Arsenic, Cadmium, Chromium, and Nickel) and some forms of DDT and PCBs are considered possible human carcinogens, information is not available for deriving non-human carcinogenicity factors (SFs). Therefore, this assessment is based on risks of systemic toxicity, including reproductive effects. Estimated doses from the ingestion of contaminated prey species were compared to **Toxicity Reference Values** (TRV) to determine the potential risk to Indo-Pacific humpback dolphins associated with the consumption of contaminated prey. The TRV is a maximum acceptable ingestion rate in mg kg^{-1} day^{-1} of a chemical in food of the species of concern, in this case, the Indo-Pacific humpback dolphin. To derive a TRV, it is necessary to perform a feeding study in which food containing different concentrations of the COC (the doses) is fed to large numbers of test animals, usually mice or rats. Alternatively, a TRV can be estimated from a food chain model if the absorption efficiency of the chemical from the food is known and the critical body residue (the concentration in tissues associated with adverse effects) of the chemical is known or can be estimated.

Although it would be ideal to use TRVs derived for the specific species being evaluated (ie, the Indo-Pacific humpback dolphin), there are currently no available feeding studies on cetaceans from which to estimate a TRV. In addition, only limited data are available on the concentrations of 22 metals and several organochlorine compounds (PCBs and chlorinated pesticides) in tissues of Indo-Pacific humpback dolphins from Hong Kong waters. There is a large published scientific literature on the concentrations of several metals and organic contaminants in tissues of cetaceans throughout the world. In a few cases, the concentrations of contaminants in cetacean tissues are related to various pathological conditions. However, nearly always, the cetaceans with pathological conditions contain several contaminants at high concentrations in their tissues. Thus, it is not possible to derive a cetacean-specific TRV for chemicals in cetacean tissues, based on tissue residue data alone. The TRV values are adjusted for weight and metabolic rate differences between the species of concern and the test species by a scaling factor (see below) following the standard approach used to derive the oral reference doses (RfDs) for toxic chemicals in human food. In essence the TRV values act as RfDs for marine mammals but have been derived using the body weight scaling factor instead of the uncertainty factors used in the human health assessment.

In general, when selecting toxicity studies for use in TRV derivation, the most important information to evaluate (in addition to the overall quality and reliability of the study) is:

(1) Leland HV, Kuwabara (1985) Trace metals. In: Fundamentals of Aquatic Toxicology, Methods and Applications. Rand GM and Petrocelli (eds) Hemisphere Publishers, New York, pp 374-415

(2) Marsili, Casini LC, Marini L, Regoli A, Focardi S (1997) Age, growth and organochlorines (HCH, DDTs and PCBs) in Mediterranean striped dolphins *Stenella coeruleoalba* stranded in 1988-1994 on the coasts of Italy. Mar Ecol Prog Ser 151

- mode of exposure (ie, ingestion vs. inhalation or gavage);
- endpoint evaluated (ie, reproductive effects vs. behavioural effects);
- duration of study (ie, chronic vs. acute); and life stage of test organism evaluated.

It should be noted that the TRVs have been derived to take into account chronic lifetime exposure to contaminants. The TRVs also take into account the potential for bioaccumulation of contaminants (such as mercury, PCBs, DDT) by marine mammals.

Other factors, such as the specific species evaluated, are less important to the overall conclusions regarding toxicity because it is assumed that most chemicals follow a similar mode of action in all mammalian species. Typically, laboratory toxicological studies are conducted using relatively small mammals such as mice, rats, or mink due to the space limitations associated with larger animals. Although as noted, differences in body weight can result in differences in toxic response to chemicals, it has been demonstrated that these differences can be accounted for by using a body weight scaling factor as follows [(1)]:

$$\mathbf{TRV_r = NOAEL_t\ (Bw_t/Bw_r)^{1/4}}$$

where

TRV_r = Toxicity reference value for receptor species (mg kg^{-1} wet wt day^{-1})
$NOAEL_t$ = No observed adverse effect level for test species (mg kg^{-1} wet wt day^{-1})
Bw_r = Body weight of the receptor species (kg wet wt)
Bw_t = Body weight of the test species (kg wet wt)

Using this scaling factor, TRVs were derived for the Indo-Pacific humpback dolphin based on NOAELs from mammalian species used as surrogates (*Table 1.4)*. Sample *et al* (1996) conducted an extensive review of the available mammalian literature, carefully evaluating both the overall quality and reliability of the study as well as the parameters described above. Therefore, the NOAEL values provided are representative and appropriately conservative for the purpose of deriving TRVs.

The NOAEL values of Sample *et al* (1996) are conservative enough that additional uncertainty factors were not applied. Typically, uncertainty factors are applied to provide a more conservative toxicity estimate when essential processes or toxicodynamic factors are not understood. Uncertainty factors can be applied for various reasons, such as deriving no-observed-adverse-effect levels (NOAEL) from less conservative toxicity endpoints such

(1) Sample BE, Opresko DM, Suter GW (1996) Toxicological Benchmarks for Wildlife: 1996 Revision. Report No. ES/ER/TM-86/RE. Prepared by the Risk Assessment Program, Health Sciences Research Division for the US Department of Energy, Office of Environmental Management under budget and reporting code EW-20. Oakridge National Laboratory. Oakridge, TN

as lowest-observed-adverse-effect levels (LOAEL) and acute toxicity values. An uncertainty factor can be applied to a TRV if toxicity data for one species (the test species) is used to evaluate effects in a second species (the wildlife receptor of concern). Specific values of uncertainty factors applied to TRVs generally are not based on science, but are chosen because they are simple (ie usually integer values) and result in conservative risk assessments. The most recent national EPA guidelines for ecological risk assessment [(1)] qualitatively discuss empirical approaches to the use of uncertainty factors, but do not propose a specific approach for uncertainty factor application. The national guidelines also note that "*uncertainty factors can be misused, especially when used in an overly conservative fashion, as when chains of factors are multiplied together without sufficient justification*" [(2)].

In deriving the TRV values used to evaluate risk to the Indo-Pacific humpback dolphin, focus has been placed on studies in which a chronic NOAEL value was reported. In the event that a chronic NOAEL was not available, a chronic LOAEL was selected, and an uncertainty factor of 10 was applied as discussed by Sample *et al* (1996). No acute values were considered, therefore, an additional uncertainty factor is not required. In addition, a body-weight scaling factor was applied to account for interspecies differences [(3)]. Application of an additional uncertainty factor would assume that the Indo-Pacific humpback dolphin is always more sensitive to the chemical of concern than the test species for which the TRV was derived. However, there are no empirical data available to support this assumption. In fact, there is evidence that cetaceans are more tolerant than terrestrial mammals to some metals, such as mercury and cadmium. Therefore, the approach as described is appropriately conservative to be protective of potential adverse effects.

Table 1.4 ***Derivation of toxicity reference values (TRV) for the Indo-Pacific Humpback Dolphin. The TRV is derived by scaling the toxic dose from the test mammal to the dolphin. The unit for NOAELs and TRVs are mg kg^{-1} wet wt day^{-1}***

Chemical	NOAEL	Test Species	Test Species wt (kg)	TRV	Reference
Arsenic	0.13	Mouse	0.03	0.01	Schroeder & Mitchner 1971 Hung et al 2004, 2007
Cadmium	1.00	Rat	0.303	0.20	Sutou et al 1980 Hung et al 2004, 2007
Chromium (Cr^{3+})	2737.00	Rat	0.35	570	Sample et al 1996 Hung et al 2004, 2007
Copper	11.70	Mink	1	3.17	Aulerich et al 1982 Hung et al 2004, 2007
Lead	8.00	Rat	0.35	1.67	Azar et al 1973
Mercury	1.00	Mink	1	0.27	Aulerich et al 1974 Hung et al 2004, 2007
Nickel	40.00	Rat	0.35	8.34	Ambrose et al 1976

(1) US EPA (1998) Guidelines for ecological risk assessment. Washington, DC: US Environmental Protection Agency, Risk Assessment Forum. EPA/630/R095/002F

(2) US EPA (1998) *Op cit*

(3) Sample BE, Opresko DM, Suter GW (1996) *Op cit*

Chemical	NOAEL	Test Species	Test Species wt (kg)	TRV	Reference
Silver [a]	0.01	Human	70	0.04	Hung et al 2004, 2007 USEPA 1999b
Zinc	160.00	Rat	0.35	33.37	Hung et al 2004, 2007 Schlicker & Cox 1968
DDE [b]	0.80	Rat	0.35	0.17	Hung et al 2004, 2007 Fitzhugh 1948
DDT	0.80	Rat	0.35	0.17	Fitzhugh 1948
Total PCBs	0.14	Mink	1	0.04	Aulerich & Ringer 1977
Tributyltin	23.40	Mouse	0.03	2.64	Davis et al 1987
Monobutyltin[c]	23.40	Mouse	0.03	2.64	Davis et al 1987
Dibutyltin[c]	23.40	Mouse	0.03	2.64	Davis et al 1987

[a] A human health RfD was used as the basis for the TRV in the absence of a mammalian NOAEL.

[b] In the absence of data for DDE, values for DDT were applied.

[c] In the absence of chemical-specific data, values for tributyltin were applied.

* All TRV values are consistent with those used in Hung et al (2004) and Hung et al (2007)

References

Ambrose et al (1976) Long-term toxicologic assessment of nickel in rats and dogs. Journal of Food Science and Technology 13:181-187

Aulerich RJ, Ringer RK (1977) Current status of PCB toxicity, including reproduction in mink. Archives of Environmental Contamination and Toxicology 6:279

Aulerich RJ, Ringer RK, Iwamono S (1974) Effects of dietary mercury on mink. Archives of Environmental Contamination and Toxicology 2:43-51

Aulerich RJ et al (1982) Effects of supplemental dietary copper on growth, reproductive performance and kit survival of standard dark mink and the acute toxicity of copper to mink. Journal of Animal Science 55:337-343

Azar A et al (1973) Review of lead studies in animals carried out at Haskell Laboratory: two-year feeding study and response to haemorrhage study. In: Barth D et al (eds) Environmental Health Aspects of Lead: Proceedings of the International Symposium. Commission of European Communities, pp 199-210

Davis A et al (1987) Evaluation of the genetic and embryotoxic effects of bis(tri-n-butyltin) oxide (TBTO), a broad-spectrum pesticide, in multiple in vivo and in vitro short-term tests. Mutation Research 188:65-95

Fitzhugh OG (1948) Use of DDT insecticides on food products. Industrial and Engineering Chemistry 40:704-705

Hung CL, Ridge KFL, James CWL, Jefferson TA, Hung SK, Lam MHW, Lam PKS (2007) Risk Assessment of trace elements in the stomach contents of Indo-Pacific humpback dolphins and Finless Porpoise in Hong Kong. Chemosphere 66(2007) 1175-1182

Hung CLH, So MK, Connell DW, Fung CN, Lam MHW, Nicholson S, Richardson BJ, Lam PKS (2004) A preliminary risk assessment of trace elements accumulated in fish to the Indo-Pacific Humpback dolphin (*Sousa chinensis*) in the Northwestern waters of Hong Kong. Chemosphere 56:643-651

Sample BE, Opresko DM, Suter GW (1996) Toxicological Benchmarks for Wildlife: 1996 Revision. Report No. ES/ER/TM-86/RE. Prepared by the Risk Assessment Program, Health Sciences Research Division for the US Department of Energy, Office of Environmental Management under budget and reporting code EW-20. Oakridge National Laboratory. Oakridge, TN

Schlicker SA, Cox DH (1968) Maternal dietary zinc, and development and zinc, iron, and copper content of the rat fetus. Journal of Nutrition 92:37-45

Schroeder HA, Mitchener M (1971) Toxic effects on trace elements on the reproduction of mice and rats. Archives of Environmental Health 23:102-106

Suton S et al (1980) Toxicity, fertility, teratogenicity and dominant lethal cysts in rats administered cadmium subchronically. I. Fertility teratogenicity, and dominant lethal tests. Ecotoxicology and Environmental Safety 4:51-56

USEPA (1999a) Integrated Risk Information System (IRIS): Naphthalene. US Environmental Protection Agency, Washington DC

USEPA (1999b) Integrated Risk Information System (IRIS): Silver. US Environmental Protection Agency, Washington DC

1.5.3 *Selection of Assessment Endpoints and Measures of Effect (Measurement Endpoints)*

Human Health Endpoints

Measurement endpoints for the human health risk assessment will include:

- Incidence of cancer in humans (for carcinogenic substances); and
- Incidence of chronic conditions in humans (for non-carcinogenic substances).

Sousa chinensis *Endpoints*

In this case, *Sousa chinensis* has been identified as the ecological receptor of concern. As it is a locally protected, CITES Appendix I species, the assessment must be focused on evaluating impacts to individual organisms. Using the criteria presented, two assessment endpoints have been identified for this ecological risk assessment:

- Health of individual Indo-Pacific humpback dolphins frequenting the South Brothers Area; and
- Reproductive viability of the Indo-Pacific humpback dolphins inhabiting the South Brothers Area.

For the purpose of this assessment, exposure parameters representing the "typical" or "average" individual were selected. It is assumed that values protective of this individual will be protective of the majority of the exposed population. Assessment endpoints can be evaluated through either direct or indirect measurements. These measurements are referred to as measures of effect. Measures of effect are measurable responses to stressors that may affect the characteristic component of the assessment endpoint (1) (2). For this assessment, the health and reproductive viability are the specific characteristics of the dolphin that are potentially at risk. While some contaminants may influence both characteristics, other contaminants may affect only health or only reproductive viability (see *Table 1.2*). By assessing the risk associated with each of the contaminants of concern both endpoints are addressed.

1.6 *Exposure Assessment*

1.6.1 *Introduction*

The purpose of an exposure assessment is to determine the intake of each COC by potentially exposed individuals. In this study, this will involve characterisation of the major pathways for contaminant transport leading from the South Brothers Facility to the points of exposure. Exposure

(1) Suter GW (1990) Endpoints for regional ecological risk assessments. Environmental Management 14:19-23

(2) Suter GW (1993) Ecological Risk Assessment. Lewis Publishers, Boca Raton, Florida, USA

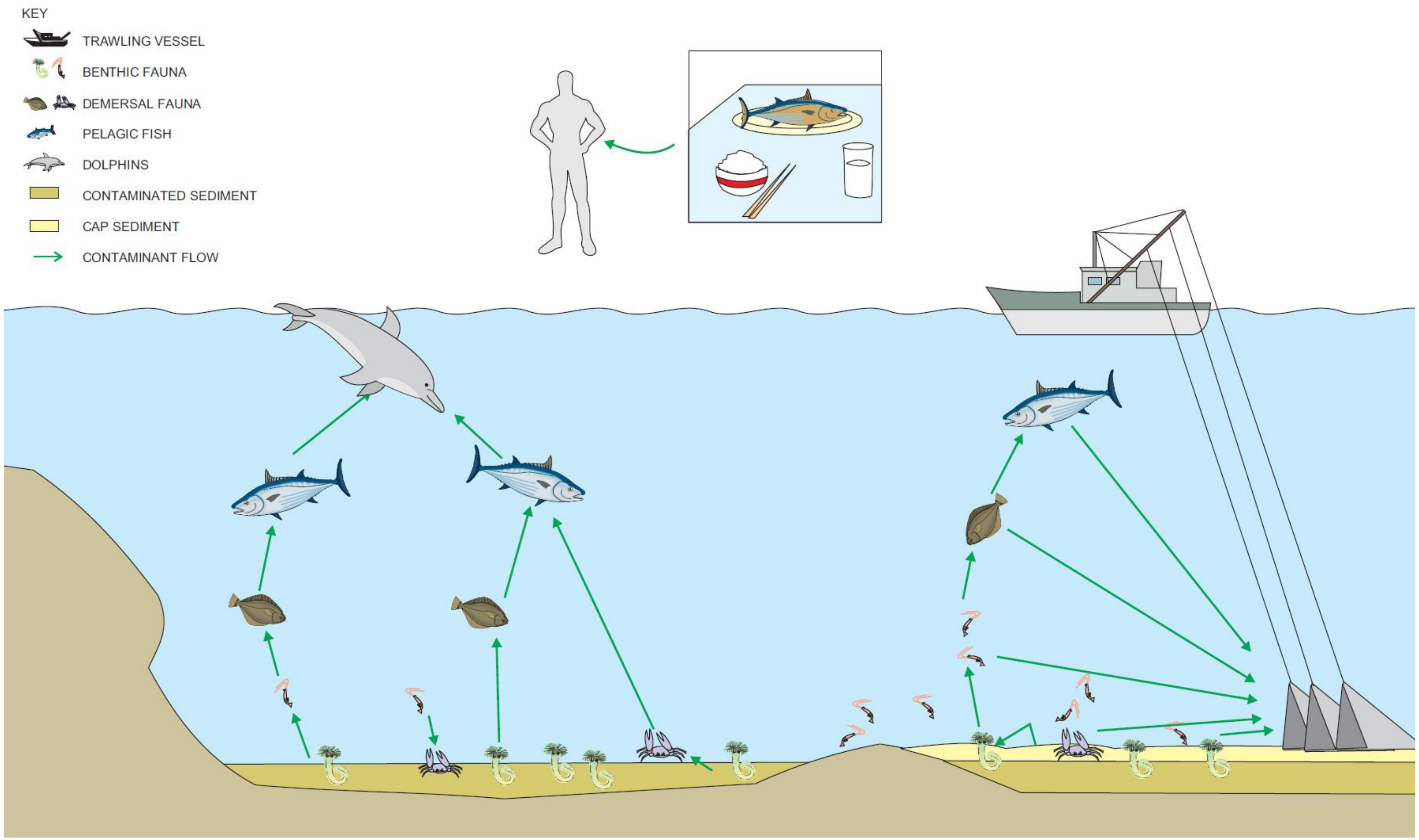
evaluation considers various routes of contaminant release and migration from the South Brothers Facility to targeted populations by:

- evaluating fate and transport processes for the contaminants;
- establishing likely exposure scenarios for each medium (eg water, diet, etc);
- determining the concentrations of the contaminants in each medium;
- determining exposures to potentially affected populations; and
- calculating maximum short-term or average lifetime doses and resultant intakes.

The resultant doses to and intakes by potentially exposed populations are calculated once exposure concentrations in all relevant media have been determined. Dose is defined as the amount of chemical contacting body boundaries (skin, lungs, or gastrointestinal tract) and intake is the amount of chemical absorbed by the body. When the extent of intake from a given dose is unknown, or cannot be estimated defensibly, dose and intake are taken to be the same (ie 100 percent absorption from contact). This is a highly conservative approach and there are very few instances in which 100% of a chemical is absorbed in this manner.

ERM has developed a conceptual model to aid the assessment of contaminant exposures to humans and dolphins (*Figure 1.3*). The model is used to illustrate the relationship between the stressors (ie, COCs), and the receptors of concern (humans and *Sousa chinensis*). The conceptual model integrates the available information to identify exposure pathways. Each exposure pathway will include the stressor source (dredged material disposal activities), the stressor of concern (COCs), the exposure route (ingestion), and the receptor of concern (humans and *Sousa chinensis*). The basic premise of the model is to evaluate the toxicological effects of the contaminants of concern associated with disposal activities at South Brothers.

Figure 1.3 Pathways to Potential Contaminant Release & Uptake



Substances potentially migrating from the pit into the marine environment will be dispersed into the ambient environment and may potentially impact on human and dolphin populations through ingestion of contaminated sediment, ingestion of dissolved and suspended contaminants in water, ingestion of organisms with contaminant residues in their edible portions and through contact with water. Of these four pathways the primary pathway of concern is considered to be that of the ingestion of contaminants contained within the edible portion of marine organisms.

The impact hypotheses for the assessment of human health risks are thus defined as follows:

IH_1: Risks to human health from consumption of commercial species captured adjacent to the proposed South Brothers Facility are no greater than risks associated with consumption of species remote from the proposed facility;

AND

IH_2: Risks to human health from consumption of commercial species captured adjacent to the proposed South Brothers Facility are below the screening risk criterion.

The impact hypotheses for the assessment of ecological risks are defined as follows:

IH_1: Risks to dolphins from consumption of prey species captured adjacent to the proposed South Brothers Facility are no greater than risks associated with consumption of species remote from the proposed facility;

AND

IH_2: Risks to dolphins from consumption of prey species captured adjacent to the proposed South Brothers Facility are below the screening risk criterion.

1.6.2 *Human Health Risk Assessment*

The general equation used to estimate exposure is presented below:

$$\textbf{Intake (mg kg}^{-1}\textbf{ day}^{-1}\textbf{)} = \textbf{(CF} \times \textbf{IR} \times \textbf{FI} \times \textbf{EF} \times \textbf{ED) / (BW} \times \textbf{AT)}$$

where

CF = Contaminant Concentration in Fish and Shellfish (mg kg^{-1} ww)
IR = Ingestion Rate (kg day^{-1})
FI = Fraction Ingested from Contaminated Source (unitless)
EF = Exposure Frequency (day $year^{-1}$)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged - days)

The relative contributions of each dietary item to the total intake are then included in the calculation to give an indication of the overall exposure via fish and shellfish ingestion. Input values have been calculated to reflect local conditions and have been updated since the previously approved South Brothers EIA. This recent information has been sourced from reports and correspondence with AFCD (Fisheries Branch) (1) and is further described below.

Contaminant Concentration

The data incorporated into this assessment are from the bioaccumulation assessment (*Appendix A* of this *Annex*). These values represent the high end of the range and are likely to result in high estimates of risk. These values represent the high end of the range as they are determined from worse case assumptions and are consequently expected to result in high-end estimates of risk.

Ingestion Rate

The rate of ingestion of seafood is a key exposure variable for use in this risk assessment. Seafood is known to be an important component of the diet of Hong Kong residents and it is estimated that the amount consumed daily is an order of magnitude higher than that consumed in other countries, such as the US. The seafood consumed in Hong Kong is derived from a wide variety of sources:

- Imported from overseas as live, fresh, chilled, frozen, canned, preserved, salted, smoked or dried forms;

- Landed by the Hong Kong fishing fleet but caught outside of Hong Kong waters; and

- Landed by the Hong Kong fishing fleet and caught within Hong Kong waters.

According to AFCD's Annual Report (2), the amount of fisheries and seafood products consumed by the Hong Kong populace was 43 kg yr^{-1} $capita^{-1}$. Of this amount, 6.6 kg are freshwater fish which can be eliminated from the total marine seafood consumption for this analysis, consequently the seafood consumption per capita is 36.4 kg yr^{-1} or 0.104 kg day^{-1} (36.4 ÷ 350 days). However, from recent correspondence with AFCD, the consumption has decreased and in 2008 was estimated to be 33.8 kg yr^{-1} or 0.097 kg day^{-1} (33.8 ÷ 350 days). It is assumed that this figure is based on the amount ingested (0.097 kg day^{-1}) comprising the entire seafood product. This figure is used to represent the average consumption of fish products. For sectors of the

(1) Although a Port Survey has now been reported for 2006, the data now published do not contain some of the necessary detail for this assessment. In particular, no current information on the percentage catch of the target species for Hong Kong or the local study area was available. However, other data has been updated with the current (2008) information based on correspondence with AFCD

(2) Agriculture & Fisheries Department (1998) 1996-97 Port Survey

population that consume comparatively more fisheries products, eg, fishermen, the US EPA recommends using a gross consumption rate of 0.3 kg day^{-1}. This rate is considered to be upper bound and is not expected to occur in reality.

The values above are likely to be an overestimate as the amount actually ingested will be lower due to molluscs, crustaceans and fish having shells, viscera and skeletal structures. Conversion factors that can be used to convert gross seafood ingestion rates into tissue specific ingestion rates as presented in Shaw (1995). These values were higher than those suggested for use by the US National Marine Fisheries Service (NMFS) because it was considered that in eastern cultures more of the seafood product is eaten, such as internal organs (eg, swim bladder or crab hepatopancreas) that are not usually part of the western diet. For the purposes of this risk assessment the following factors have been applied to calculate net ingestion rates for each dietary item:

- Shrimps/ Prawns = 0.88 (maximum value from NMFS 1987 [(1)])
- Swimming Crab = 0.22 (NMFS 1987)
- All fish = 0.5 (Shaw 1995 [(2)])
- Molluscs/ Bivalve = 1.0

The risk assessment calculations for ingestion rate were proportioned into the different dietary items. It was assumed that the proportion of each dietary item in catches in Hong Kong would reflect the proportion in the diet of Hong Kong people. The composition of the catch from the East of Sha Chau/ South Brothers area was identified using data from AFCD's Fisheries Study [(3)] presented below in *Table 1.5*. Values are also presented below for the composition of landings at Tuen Mun Port (the main port in the Study Area) and for the composition of catches taken in Hong Kong waters for comparison. As can be seen from *Table 1.5* the composition of catches from East of Sha Chau/ South Brothers is broadly similar to those from the whole of Hong Kong and those landed at Tuen Mun Port.

Table 1.5 Composition of catches (%) from Hong Kong, Tuen Mun Port & East of Sha Chau (ERM 1998)

Type	Hong Kong Catch	Catch Landed at Tuen Mun Port	Catch from East Sha Chau/ South Brothers Area
Pelagic Fish	41.7	43.0	41.6
Predatory Fish	46.8	44.8	44.7
Predatory Crab	3.0	3.1	4.0
Predatory Shrimp	6.1	8.4	8.8

(1) NMFS (National Marine Fisheries Service) (1987) Fisheries of the United States, 1987. Current Fisheries Statistics. No. 8700. US Government Printing Office, Washington DC

(2) Shaw BJ (1995) Evaluation of risks to human health in Hong Kong from consumption of chemically contaminated seafood: a risk assessment approach. MSc Thesis, The University of Hong Kong

(3) ERM (1998) Fisheries Resources and Fishing Operations in Hong Kong Waters. Prepared for the Agriculture and Fisheries Department

Type	Hong Kong Catch	Catch Landed at Tuen Mun Port	Catch from East Sha Chau/ South Brothers Area
Molluscs	2.4	0.7	0.9

After application of the conversion factor data and the catch composition/dietary fraction information presented above to the gross seafood consumption rate (0.097 kg day^{-1}), individual ingestion rates can be calculated for each dietary item in terms of net consumption in kg day^{-1}. The resultant total net seafood consumption rate after application of the conversion factors is 0.050872 kg day^{-1} (*Table 1.6*). Application of the conservation factor and catch composition to the maximum consumption rate of 0.3 kg day^{-1} results in a net consumption of 0.158022 kg day^{-1}.

Table 1.6 ***Ingestion Rates (kg day^{-1}) for Each Dietary Item (for an average consumer) – Average Consumer and Maximum Consumer (South Brothers Fishermen)***

Dietary Item	Average Net Consumption (kg day^{-1})	Maximum Net Consumption (kg day^{-1})
Pelagic Fish	0.020135	0.062400
Predatory Fish	0.022598	0.067050
Predatory Crab	0.000637	0.002640
Predatory Shrimp	0.005184	0.023232
Molluscs	0.002318	0.002700
Total	0.050872	0.158022

Fraction Ingested from Contaminated Source

It is unlikely that 100% of the seafood consumed by an individual will be from the same source. The Fraction Ingested (FI) value represents the fraction of total seafood ingested from the contaminated region of interest (ie the South Brothers area).

The catch from the old AFD fishing zones in the East of Sha Chau/ South Brothers area (0017, 0018, 0019, 0020, 0032, 0033, 0040, 0041, 0042, 0043, 0044, 0045) amounts to a total of 1,894 tonnes per year (1). The total amount of seafood products consumed in Hong Kong per year reported by AFCD to ERM in 1999 was 243,440 tonnes per year. However, recent correspondence with AFCD shows that this figure has decreased to approximately 236,000 tonnes per year in 2008.

The fraction of this amount obtained from the East of Sha Chau/ South Brothers area is therefore 1,894 ÷ 236,000 = **0.0080**. This value is lower than that used by Shaw (1995) who based the fraction ingested on the amount caught in the East of Sha Chau area divided by the total landings (ie 1,894 ÷ 186,000 = 0.01). This number appears to be an overestimate because the consumption rate of 33.8 kg yr^{-1} is based on all seafood products not just that

(1) Agriculture & Fisheries Department (1998) 1996-97 Port Survey

landed by the Hong Kong fleet. The AFCD Annual Report (1) has indicated that the total catch landed in Hong Kong is 186,000 tonnes per year of which 17,681 tonnes per year has been estimated to have been caught in Hong Kong waters (2). Estimates of the FI have been prepared for three exposure populations of concern, which are as follows:

Hong Kong People: It is assumed that this population experience the average exposure to COC in seafood. The FI for this population is represented by the value derived above, ie, **0.008**. This indicates that 0.8% of the seafood consumed by Hong Kong people is obtained in the East of Sha Chau/ South Brothers area. Information on the contribution of seafood to the total diet of Hong Kong People is not needed in this risk assessment as the methodology is concerned with the effects of contaminants in the edible portion of seafood on human health. This population is comparable to the Central Tendency used in previous risk assessments (3) (4) and follows the method used during the CMP IV EM&A Programme (5).

Hong Kong Fishermen: Calculating the values for this population is more speculative due to uncertainties over the amount of a fisherman's diet that is composed of seafood. The US EPA estimate that 75% of a fishermen's diet will originate from within local waters (defined as the whole of Hong Kong). Using the calculation presented above which indicates that 10.7% of the Hong Kong catch comes from East of Sha Chau/ South Brothers (ie 1,894 tonnes ÷ 17,681 tonnes) the FI is set at **0.08** (ie, 10.7% × 75%). This indicates that 8% of the seafood consumed by Hong Kong Fishermen is obtained in the East of Sha Chau/ South Brothers area. This population is comparable to the Reasonable Maximum Exposure used in previous risk assessments (6) (7).

South Brothers Fishermen: For this population it is assumed again that 75% of the diet is obtained in local waters, but this time local refers to catches landed at the home port within the Study area (Tuen Mun). The fishing fleet that operate from Tuen Mun obtain 65% of their catch within the East of Sha Chau/ South Brothers area. Hence the FI for these fishermen is estimated at **0.49** (65% x 75%). This indicates that 49% of the seafood consumed by South Brothers Fishermen is obtained in the East of Sha Chau/ South Brothers area. This population is comparable to the Sensitive Subpopulation used in previous risk assessments (8) (1).

(1) Agriculture & Fisheries Department (1998) 1996-97 Port Survey

(2) ERM (1998) Fisheries Resources and Fishing Operations in Hong Kong Waters. Prepared for the Agriculture and Fisheries Department

(3) Shaw BJ (1995) Evaluation of risks to human health in Hong Kong from consumption of chemically contaminated seafood: a risk assessment approach. MSc Thesis, The University of Hong Kong

(4) EVS (1996) Review of Contaminated Strategy and Status Report on Contaminated Mud Disposal Facility at East Sha Chau. Report to Civil Engineering Department of Hong Kong Government, May 1996

(5) ERM (2007, 2008, 2009) *Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau (2005–2008) – Investigation (Agreement No. CE 19/2004 (EP)): Risk Assessment Reports*. Prepared for Civil Engineering and Development Department

(6) Shaw BJ (1995) *Ibid*

(7) EVS (1996) *Ibid*

(8) Shaw BJ (1995) *Ibid*

Combining the FI values for each population of concern with the information on catch breakdown provides FI estimates for each food type. These values are presented below in *Table 1.7*.

Table 1.7 ***Fraction Ingested from the East of Sha Chau/ South Brothers Area for the Three Populations of Concern***

Dietary Item	**% of Catch from East Sha Chau/ South Brothers Area**	**HK people FI = 0.0080**	**HK Fishermen FI = 0.08**	**Tuen Mun Fishermen FI = 0.49**
Pelagic Fish	41.6	0.003339	0.033422	0.202800
Predatory Fish	44.7	0.003587	0.035912	0.217913
Predatory Crab	4.0	0.000321	0.003214	0.019500
Predatory Shrimp	8.8	0.000706	0.007070	0.042900
Molluscs	0.9	0.000072	0.000723	0.004388

Exposure Frequency

The exposure frequency is the average number of days per year over which an individual is exposed to one or more COC via ingestion of seafood. A value of 350 days, as specified by the US EPA (2) for long term average contact, has been assumed for this assessment.

Exposure Duration

The exposure duration is the time period in years over which an individual is exposed to one or more contaminants in seafood from South Brothers/ East of Sha Chau. For the purposes of this assessment we have adopted the lifetime of the proposed South Brothers Facility, i.e. 4 years.

Body Weight

US EPA guidelines for risk assessment (3) indicate that the default value recommended for body weight (BW) is 70 kg. However, Asians are in general smaller in stature than their Caucasian counterparts, so it is considered that the US EPA default value would not be representative of the Hong Kong population. A value of 60 kg was assumed for body weight to represent the local Hong Kong population as determined by Shaw (1995) (4).

Averaging Time

The averaging time (AT) is another important parameter of the intake equation. The AT selected will depend on the type of constituent being

(1) EVS (1996) *Ibid*

(2) US EPA (1991) Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. Office of Solid Waste and Emergency Response. OSWER Directive 9285.6-3-3. Washington, DC

(3) US EPA (1989) Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish. A Guidance Manual. EPA-503/8-89/002

(4) Shaw BJ (1995) Evaluation of risks to human health in Hong Kong from consumption of chemically contaminated seafood: a risk assessment approach. MSc Thesis, The University of Hong Kong

evaluated, for example, to assess long term or chronic effects associated with exposure to non-carcinogens, the intake is averaged over the exposure duration (expressed in days). Exposure to carcinogens, however, is averaged over a lifetime in order to be consistent with the approach used to develop Slope Factors (SFs). A value of 70 years was assumed for mean life expectancy according to the default value used by the US EPA.

Summary

A summary of the values incorporated into the human health risk assessment are presented below in *Table 1.8*.

Table 1.8 Summary of Input Parameters for the Intake Equation for Human Health Risk Assessment

Variable	Values
Contaminant Concentration in Seafood (mg kg^{-1} ww) (CF)	From the updated South Brothers Bioaccumulation Assessment (*Section 3 of Appendix A*)
Ingestion Rate (IR)	Average Net Consumption: 0.050872 kg day^{-1} Maximum Net Consumption: 0.158022 kg day^{-1}
Fraction Ingested from South Brothers/ East of Sha Chau (FI)	Values for each population presented in *Table 1.7*
Exposure Frequency (EF)	350 days yr^{-1}
Exposure Duration (ED)	4 years
Body Weight (BW)	60 kg
Averaging Time (AT)	1,460 days (4 years x 365 days = 1,460 days) non-carcinogens 25,550 days (carcinogen - assuming a 70 year life expectancy)

1.6.3 Dolphin Risk Assessment

Data collected as part of the bioaccumulation assessment of COCs in potential prey species of the Indo-Pacific humpback dolphins (*Appendix A* of this *Annex*) were used to estimate doses received via the dolphin diet. An average dose from the total diet was estimated by determining the fraction of the total dolphin diet derived of each category of food (eg, pelagic fish, molluscs, predatory fish, predatory crab and predatory shrimp) and summing the tissue concentration values for each category multiplied by the fraction of that category in the dolphin diet.

As previously discussed, this evaluation intends to provide a determination of the potential risks to the Indo-Pacific humpback dolphin population in the South Brothers/ North Lantau waters of Hong Kong, resulting from dredged material disposal in the proposed South Brothers Facility. The exposure pathway is assumed to be consumption of contaminated food by dolphins residing in potentially impacted areas near the mud pits, and in reference areas. The methodology is designed to provide a conservative estimate of the risks to Indo-Pacific humpback dolphins. For the purpose of this assessment, dose estimates were derived for the Indo-Pacific humpback dolphins according to the following equation:

Dose = (PC x IR x SRT x FI x ED) / (BW x AT)

Where

Dose = Chemical-specific ingested dose (mg kg^{-1} day^{-1})
PC = Concentration of chemical in prey item (mg kg^{-1})
IR = Ingestion Rate (kg day^{-1})
BW = Body weight of dolphin (kg)
SRT = Site Residency Time (day $year^{-1}$)
FI = Fraction Ingested (unitless)
ED = Exposure Duration (years)
AT = Averaging Time (period over which exposure is averaged – days)

Prey Concentration

It was assumed that dolphins may consume a variety of species. Therefore, PC is a function of the concentration of each contaminant in the various prey species as well as the fraction of the dolphin's diet comprised of the individual species, as described in the following equation:

$$PC = (C_{pelagic} * F_{pelagic}) + (C_f * F_f) + (C_{cr} * F_{cr}) + (C_s * F_s) + (C_m * F_m)$$

Where,
$C_{pelagic}$ = Concentration in pelagic fish
$F_{pelagic}$ = Fraction of diet comprised of pelagic fish
C_f = Concentration in predatory fish
F_f = Fraction of diet comprised of predatory fish
C_{cr} = Concentration in predatory crab
F_{cr} = Fraction of diet comprised of predatory crab
C_s = Concentration in predatory shrimp
F_s = Fraction of diet comprised of predatory shrimp
C_m = Concentration in molluscs
F_m = Fraction of diet comprised of molluscs

Based on this information, two dietary scenarios were evaluated, PC_{exp} and PC_{ave}. The first, PC_{exp}, assumes that 50 % of the Indo-Pacific humpback dolphin's diet is composed of pelagic fish ($F_{pelagic}$ is 0.5), and that the remaining 50 % is composed of predatory fish (F_f is 0.5). This represents the expected diet of Indo-Pacific humpback dolphins in the Background and South Brothers areas, based on the data available. PC_{ave} is based on the assumption that the taxonomic groups evaluated (pelagic fish, predatory fish, predatory crab, predatory shrimp and mollusc) comprise an equivalent portion of the Indo-Pacific humpback dolphin diet and thus, this PC represents an average concentration of all the species evaluated. As there were five taxonomic groups of prey in both the Background and South Brothers areas, the percentage contribution of each group was 20 %.

Concentrations of contaminants in the prey items are presented in the Bioaccumulation Assessment (*Appendix A* of this *Annex*). These values were used to calculate PC_{exp} and PC_{ave} as described above.

Site Residency Time (SRT) & Fraction Ingested (FI)

Due to the lack of data previous risk assessments have assumed that the dolphins spend 100% of their time feeding at the mud pits throughout their lifespan. Hung (2008) [(1)] investigated the distribution of Indo-Pacific humpback dolphins in Hong Kong from 1996 to 2005 and it was found that dolphins mainly used the waters north and west of Lantau Island. In addition information presented in this *EIA Review Report* would indicate that the two proposed pits area are not as frequently used as other areas to the north and around Lung Kwu Chau. Data from Hung (2008) and another EIA study [(2)] both indicated that CMP IV is not as frequently used as reference areas to the north around Lung Kwu Chau. Consequently we have adopted values as follows:

- Reference Area site residency time = 100 % = 365 days (FI = 1)
- South Brothers site residency time = 50 % = 182.5 days (FI = 0.5)

Body Weight (BW)

Available data on the body weight of the Indo-Pacific humpback dolphin is variable. Zongguo (1996) [(3)] reported adult body weights ranging from 120 to 240 kg for females, and from 110 to 230 for males. These data were based on 36 dolphins collected in Xiamen Harbour in 1961. In southern African waters, average adult body weights for humpback dolphins range from 170 kg for females to 260 kg for males [(4)]. Based on these data, an average body weight of 185 kg was assumed for the purpose of this assessment. This weight represents a high estimate of the average body weight of all age classes in the South Brothers dolphin population.

Ingestion Rate

For the purpose of this evaluation, the ingestion rate of the Indo-Pacific humpback dolphin was assumed to be similar to that of humpback and bottlenose dolphins. Data for these species indicate that they consume approximately 4% to 6% of their body weight per day [(5)]. An ingestion rate of

(1) Hung SK (2008) Habitat Use of Info-Pacific Humpback Dolphins (*Sousa chinensis)* in Hong Kong. Thesis submitted for the PhD degree at The University of Hong Kong

(2) AECOM (2009) Tuen Mun - Chek Lap Kok Link – Investigation. EIA report submitted to EPD.

(3) Zongguo (1996) Chinese White Dolphin in Xiamen, China. Proceedings of a Colloquium for Development of a Management Strategy for Chinese White Dolphin. Agriculture and Fisheries Department, The Government of the Hong Kong Special Administrative Region

(4) Cockroft VG (1996) Conservation Biology of Humpback Dolphins in South & Eastern Africa. Proceedings of a Colloquium for Development of a Management Strategy for Chinese White Dolphin. Agriculture and Fisheries Department, The Government of the Hong Kong Special Administrative Region

(5) Parsons ECM (1996) Trace metal levels in north Lantau fishes: Implications for the health of Hong Kong's Indo-Pacific Humpbacked Dolphin (*Sousa chinensis*) population. The Swire Institute of Marine Science, The University of Hong Kong, Cape d'Aguilar, Shek O, Hong Kong

9.25 kg day^{-1} was used for this assessment, assuming a body weight of 185 kg and an average ingestion rate of 5% of body weight per day. The values for the ingestion rate and body weight were selected based on the available literature. It is important to note that the risk assessment methodology is designed to evaluate potential risks to a representative individual of an affected population. For the purpose of this assessment, exposure parameters representing the 'typical' or 'average' individual were selected. It is assumed that values protective of this individual will be protective of the majority of the exposed population.

Averaging Time & Exposure Duration

Exposure duration (ED) is calculated as the lifetime of the proposed South Brother Facility, ie, 4 years. The averaging time (AT) is another important parameter of the intake equation. The AT is expressed in days, ie 4 years for the lifetime of the proposed facility, multiplied by the days in the year, ie, 4 x 365 = 1,460 days).

Summary

A summary of the values incorporated into the marine mammal risk assessment are presented below in *Table 1.9*.

Table 1.9 Summary of Input Parameters for the Dose Equation for Marine Mammal Risk Assessment

Variable	Values
Concentration of chemical in prey item (mg kg^{-1}) (PC)	From the updated South Brothers Bioaccumulation Assessment (*Section 3 of Appendix A*)
Ingestion Rate (IR)	9.25 kg day^{-1} (assuming 5% of body weight)
Body Weight of Dolphin (BW)	185 kg
Site Residency Time (SRT)	Reference Area = 365 day $year^{-1}$ South Brothers = 182.5 day $year^{-1}$
Fraction Ingested from South Brothers/ East of Sha Chau (FI)	Reference Area = 1 South Brothers = 0.5
Exposure Duration (ED)	4 years
Averaging Time (AT)	1,460 days (4 years x 365 days = 1,460 days)

1.6.4 *Arsenic in Marine Organisms*

The dose calculations have been modified to account for the level of organic Arsenic present in seafood. The RfD and TRV values for Arsenic are based on the toxic effect of inorganic arsenic. Arsenic in marine cephalopod, crustacean, and fish tissues is, however, predominantly in the form of organo-arsenic compounds, primarily arsenobetaine (1) (2). These organo-arsenic

(1) Neff JM (1997) Ecotoxicology of arsenic in the marine environment. Environmental Toxicology and Chemistry 16:917-927

(2) Seixa, S, Bustamante, P and Pierce, G.J. (2005). Interannual patterns of variation in concentrations of trace elements in arms of *Octopus vulgaris*, Chemosphere 1113-1124.

compounds are not accumulated in tissues of mammalian consumers, including dolphins and humans, and are not toxic. Arsenobetaine was excreted unmetabolized in the urine of male mice [(1)]. The median lethal dose (LD_{50}) of arsenobetaine in the mice was greater than 10 g kg^{-1} body wt (10,000 ppm). Other organo-arsenic compounds evaluated had LD_{50} values ranging from 1.2 to 10.6 g kg^{-1}. By comparison, the acute toxicity of arsenic trioxide (the form of arsenic used to derive both the Human Health RfD and the Marine Mammal TRV) was 34.5 mg kg^{-1}.

Therefore, the naturally high concentrations of Arsenic in the tissues of marine organisms do not pose a risk to either humans or Indo-Pacific humpback dolphins. It is rapidly excreted unchanged in the urine of mammals and so does not bioaccumulate. Arsenobetaine is not easily converted to the inorganic arsenite form which is of concern due to cancer risk. It can therefore be considered that the results of the risk assessment for Arsenic may be an overestimation of the likely risks associated with the consumption of seafood given that the Arsenic consumed is in a toxic form.

Estimations of the inorganic Arsenic fraction of seafood components of the risk assessment have previously been determined during the monitoring works at CMP IV [(2) (3)]. The mean percentage of total Arsenic that is represented by the inorganic fraction was calculated for each of the human health risk assessment groupings. At that time no tissue samples were collected for prawns and hence the ratio from mantis shrimps was used. This is considered to be an appropriate assumption given the ecological and taxonomic similarity between the two organisms. The following ratios were applied to the total Arsenic data [(4)]:

- Shrimps = Total Arsenic (mg kg^{-1}) x 0.535 %
- Crabs = Total Arsenic (mg kg^{-1}) x 0.285 %
- Predatory Fish = Total Arsenic (mg kg^{-1}) x 1.895 % [(5)]
- Pelagic Fish = Total Arsenic (mg kg^{-1}) x 0.650 %
- Molluscs = Total Arsenic (mg kg^{-1}) x 5.215 %

(1) Kaise T, Fukui S (1992) The chemical form and acute toxicity of arsenic compounds in marine organisms. Appl Organomet Chem 6:155-160

(2) ERM (2000) Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau. 10th Quarterly Report for Civil Engineering Department

(3) ERM (2007): Environmental Monitoring and Audit for Contaminated Mud Pit IV at East Sha Chau (2005-2006). Report for the Civil Engineering and Development Department.

(4) ERM (2005) Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area (CE12/2002). Prepared for Civil Engineering and Development Department

(5) Two values were reported in ERM (2000): for Flatfish (= Total Arsenic (mg kg-1) x 0.265 %) and for Burrowing Fish (= Total Arsenic (mg kg-1) x 1.895 %). For the purposes of this risk assessment the higher value from Burrowing Fish has been applied.

For the purposes of this risk assessment the values have been applied to the Arsenic values from the Bioaccumulation Assessment (*Appendix A* of this *Annex*). The corrected data were then used in the risk assessment.

It is important to note that relatively high natural levels of Arsenic are present in Hong Kong's marine sediments. Whilst the average concentration of Arsenic in the Earth's crust is generally ~ 2 ppm, significantly higher Arsenic concentrations (median = 14 ppm) have been recorded in Hong Kong's onshore sediments [(1)]. It is presumed that the natural concentrations of Arsenic are similar in onshore and offshore sediments [(2)], and relatively high Arsenic levels may therefore occur throughout Hong Kong in marine fauna which are directly or indirectly dependent on benthic flora, epifaunal and infaunal prey.

1.7 *RISK CALCULATION*

1.7.1 *Introduction*

Risk characterisation generally involves the integration of the information and analysis of the first three components of the assessment, as discussed in *Sections 1.4*, *1.5* and 1.6. Risk is generally characterised as follows:

- For non-carcinogens, and for the non-carcinogenic effects of carcinogens, the margin of exposure is estimated by dividing an estimated daily dose by a derived "safe" dose to form a ratio. This ratio is referred to as a Hazard Quotient and if it is greater than one there is sufficient concern for further analysis.

- For carcinogens, risk is estimated by multiplying the estimated dose by the risk per unit of dose. A range of risks might be produced, using different models and assumptions about dose-response curves and the relative susceptibilities of humans and animals.

Although this step can be more complex than is indicated above, especially if issues of the timing and duration of exposure are introduced, the hazard quotient and the carcinogenic risk are the ultimate measures of the likelihood of injury or disease from a given exposure or range of exposures. This section describes the approach used to assess the overall risks of fish and shellfish ingestion to humans and dolphins. The approaches used are independent of each other to a large degree, and are presented separately.

(1) Sewell RJ (1999) Geochemical Atlas of Hong Kong. Geotechnical Engineering Office, Government of the Hong Kong Special Administrative Region

(2) Whiteside PGD (2000) Natural geochemistry and contamination of marine sediments in Hong Kong. In: The Urban Geology of Hong Kong (ed Page A & Reels SJ). Geological Society of Hong Kong Bulletin No. 6, p109-121

1.7.2 *Human Exposure*

Non-carcinogens

The intakes, calculated using the data presented in *Table 1.8* and the equation in *Section 1.6.2,* will be compared with the Reference Doses (RfD) (see *Table 1.3)* as a means of calculating non-carcinogenic hazards, which are expressed as the **Hazard Quotient (HQ)**.

Hazard Quotient = Intake / Reference Dose

HQs can be summed to provide an estimate of the cumulative non-carcinogenic hazard which is known as the **Hazard Index (HI)**. This is a conservative approach and assumes that all of the COCs exert an effect on the same target organ.

Carcinogens

Carcinogenic risks will be calculated using the following equation:

Risk = Intake x Slope Factor

This equation will provide an estimate of the lifetime carcinogenic risk associated with the estimated intake.

Additive effects

Concern is often expressed about the hazard to health from exposure to mixtures of substances, rather than individual substances. There is no agreed procedure among toxicologists for estimating such a hazard. The toxic effects of two substances in combination may be the sum of the individual toxicities (ie additive), more than the sum (ie synergistic), or less than the sum (ie antagonistic). Synergism appears to be, in practice, a very much less common phenomenon than a noticeable combined effect or an additive effect. However, since there is a lack of direct data on most chemical combinations, the most reasonable strategy is to assume that chemicals which affect the same target organisms, in a similar manner, will have additive toxicities.

The available literature on such effects is very limited and, where it does exist, is largely restricted to the behaviour of metals in experimental animals. The application of such data to human studies is, at best, questionable. In the absence of any reasonable scientific basis for predicting antagonistic or synergistic reactions in complex mixtures, only examination of an additive model of toxicity is considered to be justified.

There are two related methods of making some quantitative assessment of the toxic impact of a mixture. The first that is recommended by the UK Health and Safety Executive (HSE) is to use the following equation:

$$\frac{C_1}{L_1} + \frac{C_2}{L_2} + \frac{C_3}{L_3} + \dots \frac{C_n}{L_n} = X$$

where C_1, C_2, C_3...C_n are the concentrations of each contaminant in food and L_1, L_2, L_3...L_n = the "safe levels" of each, ie the reference dose RfD. If the total X is less than one, the mixture is considered not to represent a health hazard; whereas if X is greater than one, steps should be taken to reduce the concentrations of one or more of the contaminants.

For carcinogens, a conservative approach is achieved using the "response-addition" process, which simply sums the individual lifetime risks linearly to reflect the combined potential of cancer should a person be exposed to all of the substances over a lifetime.

Total Excess Cancer Risk = Risk 1 + Risk 2 + Risk 3 + ... Risk" n"

where

Risk 1 = Individual excess cancer risk from a lifetime exposure from the first substance;
Risk "n" = Individual risk of additional substances.

While the "response-addition" process is encouraged as a "first-cut" or screen to indicate that a cancer may occur from the exposure to multiple substances, it should be remembered that the conservative nature of risk assessments for individual substances can be exaggerated by this additive approach.

1.7.3 Exposure to Dolphins

For each contaminant, a hazard quotient will be calculated using the following ratios (1):

HQ = Dose / TRV

where

HQ	hazard quotient for individual chemicals
Dose	estimated contaminant concentration ingested through consumption of prey items (mg contaminant kg wet body weight^{-1} day^{-1}), derived from data presented in *Table 1.9* and the equation in *Section 1.6*.3; and
TRV	the toxicity reference value (defined in *Section 1.5.2*, *Table 1.4*) mg kg^{-1} wet weight day^{-1}

1.8 ASSUMPTIONS & UNCERTAINTIES

The risk estimates generated in this investigation are based on a considerable number of assumptions, uncertainties and variability associated with each step in the risk assessment process. According to US EPA guidelines these assumptions and uncertainties should be presented along with the results so

(1) US EPA (1997) Exposure Factors Handbook (Final Report). Washington DC, EPA/600/P-95/002F a-c. August 1997

that a fully informed picture is given to decision makers (1) (2). The uncertainties associated with each step of the risk assessment are detailed below:

Hazard Identification: This stage is based on data for which detection, identification and quantification limits could introduce errors. The selection of COC in this assessment was made according to the list presented in Study Brief which, though not an exhaustive list appears sufficiently comprehensive for the purposes of this assessment. Other chemicals may pose a threat to human and/or dolphin health and exclusion from this investigation does not infer that they are not of concern.

Dose-Response Evaluation: The toxicity assessment stage has a very high degree of uncertainty associated with the slope factors and reference doses. In future assessments the toxicological information should be revisited and updated using the latest available information.

Exposure Assessment: This stage depends heavily on the assumptions made about the pathways, frequency and duration of exposure to COC. It should be noted that this risk assessment is focussing only on the exposure pathway concerning with consumption of seafood from within a specific area and seafood from other sources and exposures from foods other than seafood have not been taken into account. Although this is not the complete exposure pathway it is, for the most sensitive sub-population (Fishermen at East of Sha Chau), likely to be the major pathway for exposure to the COC of interest to this study. Exposure to the COC via other pathways, such as via air (inhalation), water (drinking) and dermal contact are minor and are not expected to be a major source of the COC.

Risk Characterization: The computation of screening-level risk is an exercise in applied probability of extremely rare events, therefore not every conceivable outcome can be evaluated. This introduces an inherent conservatism which often results in assessing a scenario that will never be experienced.

In summary, risk assessment by design is very protective of human and ecological health by ensuring that potential exposures and risks are not understated. Despite varying degrees on uncertainty surrounding risk assessments, they represent the most useful tool that can be used to determine and protectively manage the risk to human and ecological health.

(1) US EPA (1989) Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish. A Guidance Manual. EPA-503/8-89/002

(2) LaGrega MD, Buckingham PL, Evans JC, ERM Group (1994) Hazardous Waste Management. McGraw-Hill Inc 1146pp

Appendix A

Bioaccumulation Assessment

CONTENTS

1 BIOACCUMULATION ASSESSMENT

1.1 INTRODUCTION

This *Annex* presents the methodology for the bioaccumulation assessment and the results. The product of this assessment is concentrations of contaminants of concern (COCs) in seafood.

1.2 BACKGROUND

The objective of the bioaccumulation assessment is to predict the likely concentrations of Contaminants of Concern (COCs) in selected marine organisms due to contaminant exposure through disposal operations at the proposed contaminated sediment disposal facility at South Brothers.

1.3 LITERATURE REVIEW OF BIOACCUMULATION OF COC

Contamination in aquatic ecosystems has become one of the major environmental concerns worldwide. COCs are released from point sources to freshwater, estuarine and coastal waters as a result of increased anthropogenic activities. Sediment is a potentially important source of COC for the overlying water, due to sediment resuspension (contributing to the particulate load) or sediment remobilization and diagenesis (contributing to the dissolved load). Once in the water column, COCs are then partitioned between the dissolved and particulate phases and this is controlled by adsorption/ desorption and precipitation/ dissolution. Many physico-chemical and biological factors (e.g., particle type/concentration, salinity, dissolved organic carbon concentration, and biological uptake) can influence the COC partitioning in the water column. COCs can become available to marine benthic invertebrates through uptake from the dissolved phase and ingestion of suspended particles and sediments (i.e. particulate phase).

The bioaccumulation of COCs in aquatic organisms has received extensive attention over the last several decades because toxicity is dependent on their accumulation. Bioavailability is defined as the fraction of total COC in the environment that is available for accumulation in organisms. Many factors can control COC bioavailability, including the biological characteristics of the organisms (e.g., assimilation, feeding rate and pattern, size/ age, and reproductive condition) and the geochemistry of the COC (e.g., contaminant partitioning in the water column and speciation). Further, these can be influenced by physico-chemical factors, such as temperature, salinity, dissolved organic carbon (DOC) concentration, and total suspended solids (TSS) load.

Generally there are two approaches to predict pollutant concentrations in aquatic organisms (Landrum et al. 1992, Luoma and Fisher 1997):

1) equilibrium partitioning (EqP); and

2) kinetic modeling.

These approaches are well developed and have been used in the development of water quality criteria and sediment quality criteria in the US and elsewhere (i.e. using the equilibrium partitioning method and the bioconcentration factor to predict the concentrations in aquatic organisms) (Connell DW 1989, EPA 2000). The approach has been applied to the situation in southern China where marine organisms are exposed to contaminated sediment (Wang et al. 2002) and is thus applicable and relevant to the Hong Kong situation. Although there has been no experimental validation of these models in the Hong Kong context, the Trophic Trace model which is a comparable bioconcentration modelling tool, is endorsed by the USEPA and the US Army Corps of Engineers and is an internationally accepted standard for modeling bioconcentration in aquatic and marine environments (ERDC 2003). The approach adopted here is therefore considered appropriate and scientifically valid.

1.3.1 Equilibrium Partitioning (EqP) Approach

The EqP approach assumes only one phase (waterborne) of uptake and a constant exposure. Mathematically, this can be expressed by:

$$BCF = C/C_w \qquad (1)$$

Where BCF is the COC bioconcentration factor (L g^{-1}); C is the COC concentration (mg g^{-1}) in the animals; and C_w is the COC concentration in the dissolved phase (mg L^{-1}). Thus, the likely concentration of COC in the animals due to uptake of desorbed COC can be directly calculated by:

$$C = BCF * C_w \qquad (2)$$

A more complicated EqP model has been developed for sediment quality criteria by assuming equilibrium partitioning of chemicals (mainly non-ionic organic) among the aqueous phase, sediment and organisms (Di Toro et al. 1991). Sediments in aquatic systems presently contain large amounts of contaminants and can be a potentially significant source for COC accumulation in benthic fauna. Correlations based on sediment concentration are now viewed as better predictors of tissue residues than predictions based on water (Di Toro et al. 1991). This approach is normally exploited by normalizing chemical concentrations based on the lipid content of organisms and the organic carbon content of sediments. Thus the biota-sediment accumulation factor (BSAF) can be calculated by:

$$BSAF = C_a(l)/C_s(c) \qquad (3)$$

where, $C_a(l)$ is the chemical concentration in the animals normalized to their lipid content, $C_s(c)$ is the chemical concentration in sediments normalized to organic carbon content. These BSAF values are considered to be independent of the type of sediments (Thomann et al. 1995).

1.3.2 *Kinetic Modelling Approach*

Kinetic models are required for non-steady state, non-equilibrium accumulation due to varying exposure in the field. Such an approach is not constrained by assuming constant exposure/thermodynamic equilibrium. Landrum et al. (1992) reviewed various kinetic models used in aquatic systems and hazard assessments, including the physiologically-based pharmacokinetic model (PBPK) and bioenergetic-based toxicokinetic model (BE). BE models describe toxicant accumulation and loss in terms of an animals' energy requirements and usually treat the animal as a single compartment (Landrum et al. 1992).

Assuming that the COC is accumulated only from the water, the accumulation of COC can be described by a simple kinetic equation:

$$dC/dt = k_u*C_w - k_e*C \quad (4)$$

where C is the COC concentration in the animals at time t; k_u is the uptake rate constant from the dissolved phase; k_e is the efflux rate constant (d^{-1}). Under steady-state condition, C can be directly calculated as:

$$C = k_u*C_w / k_e \quad (5)$$

In this model, the BCF can similarly be calculated as:

$$BCF = k_u / k_e \quad (6)$$

For sediment-ingesting animals, the accumulation of COC can be similarly modeled using the kinetic equation:

$$dC/dt = AE*IR*C_s - k_e*C \quad (7)$$

Where AE is the COC assimilation efficiency from the ingested sediment, IR is the ingestion rate ($g\ g^{-1}\ d^{-1}$); C_s is the COC concentration in the ingested sediment ($mg\ g^{-1}$). Under steady-state condition, C can be directly calculated as:

$$C = AE*IR*C_s / k_e \quad (8)$$

Thus, to assess the possible COC accumulation (due to desorption from sediments) by bivalves and fish, parameters required in the modeling calculation are the BCFs or the uptake rate constant k_u, efflux rate constant k_e, and COC concentrations in the water. To assess the possible COC accumulation by sediment- ingesting animals, parameters required in the modeling calculation are the assimilation efficiency (AE), ingestion rate (IR) of the animals, COC concentration in the sediment (C_s), and efflux rate constant k_e. If these parameters are not available for the animals, another approach will be to use the BSAF, as described in Eq. 3.

To further predict the COC concentration in the predators, the trophic transfer factor (TTF) needs to be introduced:

$$C_n = C_{n-1} \times TTF \quad (9)$$

Where C_n is the COC concentration in the predator, and C_{n-1} is the COC concentration in the prey.

1.4 *SELECTION OF CONTAMINANTS OF CONCERN (COCS) AND SPECIES FOR BIOACCUMULATION ASSESSMENT*

The bioaccumulation assessment is based on the water quality modeling simulation of the release (i.e., desorption) of pollutants from the sediments disturbed during disposal. The COCs investigated are those used in the water quality modeling.

There is a lack of bioaccumulation and bioconcentration factors available in the literature for TBT and it is therefore not included in the Risk Assessment. This limitation does not limit the conservative nature of the assessment because background levels of TBT in sediment and dredged materials around the North Lantau area are generally undetectable or very low. This statement is backed up by monitoring data collected at CMP IV since 1997 which has consistently recorded TBT in sediment and tissue samples below levels of concern.

There are two possible pathways for the accumulation of contaminants due to sediment resuspension:

(1) desorption of contaminants into the water column following sediment resuspension followed by uptake from water; and

(2) ingestion of contaminated sediments.

Thus, the selection of species for assessment is based on the availability of parameters to quantify the exposure pathways as well as the ecological significance. They can be separated into the following feeding groups:

1) Pelagic fish – to assess the potential uptake of desorbed contaminants in the water column;

2) A filter-feeding mollusc – to assess the potential uptake of desorbed contaminants in overlying waters and from contaminated sediments;

3) A deposit-feeding worm (polychaete or sipunculan) - to assess the potential uptake of contaminants from sediment ingestion; and

4) Predatory fish, crab and shrimp that specifically prey on the above animals.

The selection of the species under these feeding groups is based on available literature and experience in bioaccumulation assessment. Where possible, local species are selected. There have been a number of studies on the bioaccumulation of COCs in local species such as green mussels, clams, seabream and mangrove snapper (fish). However, there is a lack of information on the uptake of contaminants by local polychaete species, but studies on other deposit-feeding invertebrates such as the sipunculans are available. Where data gaps appear, information is supplemented with reference to international studies. It should be noted that, where no information is available on the uptake of the COCs in marine organisms within either local or international literature, an assessment of bioaccumulation potential of this parameter is not possible. In the later risk assessment work that has been conducted ambient values have been substituted where these data gaps occur.

1.5 *MODELLING OF CONTAMINANT RELEASE*

Concentrations of the COCs in water (i.e. dissolved phase) and in sediment (i.e. particulate phase) are determined from the results of the water quality modeling.

1.5.1 *Dissolved Phase*

Contaminants adsorbed to sediment particles can be expected to either remain adsorbed to the sediment, settling or dispersing in direct proportion to suspended sediment concentrations, or desorb from the sediment particles and enter solution.

Values of the partition coefficients (Kd) have been determined. The majority of the Kd values have been derived from the Chemical Database developed by the Dutch Ministry for Transport, Public Works and Water Management with the remainder taken from the Kellett Bank EIA and the East Sha Chau CMP IV EIA. For the organic compounds the Kd value is related to Total Organic Carbon (TOC) rather than Total Particulate Matter (TPM). In those cases a reference ratio TOC:TPM needs to be used. Since this ratio is highly variable both in space and in time, it is proposed to derive this value from the model output, rather than to prescribe a value. The selected Kd values are shown in *Table 1.1*.

Table 1.1 Partition Coefficients Utilised in the Bioaccumulation Assessment

Contaminant of Concern (COC)	Kd	Unit	UCEL Max. sediment conc.	Unit
Arsenic	130	l/g	42	mg/kg
Cadmium	100	l/g	4	mg/kg
Chromium	290	l/g	160	mg/kg
Copper	122	l/g	110	mg/kg
Lead	130	l/g	110	mg/kg
Mercury	700	l/g	1	mg/kg
Nickel	40	l/g	40	mg/kg
Silver (1)	200	l/g	2	mg/kg
Zinc	100	l/g	270	mg/kg
Total PCBs	1585	l/gOC	0.18	mg/kg

Contaminant of Concern (COC)	Kd	Unit	UCEL Max. sediment conc.	Unit
LMW PAH	0.075	l/g	3.16	mg/kg
HMW PAH	1.14	l/g	9.6	mg/kg

OC = 0.012 gOC/g

(1) Wen LS, Santschi PH, Paternostro CL, Lehman RD (1997) Colloidal and particulate silver in river and estuarine waters of Texas. Environ Sci Technol 31: 723-731

The data on SS values have been taken from the modelling works. The input data for SS are determined as the depth averaged value within an area 400 m from the modelled pit boundary. The 400 m value is taken from the review of environmental monitoring data, which have indicated that the majority of the previous monitoring programmes regarded the "impact" area to be from 400m of the pit boundary. The SS data were taken from the worse case backfilling scenarios, those involving the use of trailer dredgers, which makes the assessment conservative. For South Brothers this value was 1.41 mg L^{-1}. Average values have been used in the assessment because the risk assessment presented in *Annex C* focuses on chronic risk and not acute. The use of maximum SS levels would bring an unwarranted level of conservativeness to this assessment, which would result in misleading results.

Application of the Kd values to the Upper Chemical Exceedance Level (UCEL) of contaminant levels in sediments and SS value (i.e. 1.41 mg L^{-1}) results in the dissolved concentrations listed in *Table 1.2*. It is assumed that COCs in the dissolved phase originate from desorption from the re-suspended sediments with 100% desorption.

Table 1.2 *Concentrations of COCs in Dissolved Phase (μg L^{-1}) in the South Brothers Area. COCs in the Dissolved Phase Originate from Desorption from the Re-suspended Sediments (Assuming 100% Desorption)*

Contaminant of Concern (COC)	Concentrations of COCs in Dissolved Phase (μg L^{-1})
Arsenic	0.0076986
Cadmium	0.000564
Chromium	0.065424
Copper	0.0189222
Lead	0.020163
Mercury	0.000987
Nickel	0.002256
Silver	0.000564
Zinc	0.03807
Total PCBs	0.000402273
LMW PAH	0.00000033417
HMW PAH	0.000015431

1.5.2 *Particulate Phase (Sediment Ingestion)*

The water quality modeling provides estimates of sediment deposition in and around the pits. Although Kd values have been used to determine desorption, for the purposes of the sediment ingestion assessment it was assumed that 0% of contaminants desorb. Such an assumption indicates that the bioaccumulation assessment is inherently conservative.

Following a similar approach to that for determining average SS values across the "impact area" adjacent to the pits the average rate of sediment deposition was determined. This value was then fed into a series of equations, which are detailed in *Table 1.3*. The end result of the calculations was a series of values for COC elevation in sediment in the South Brothers area.

Table 1.3 Methodology for Predicting Increase in Sediment Concentrations of COCs

	Unit	Ref.	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Silver	Zinc	Total PCBs	LMW PAH	HMW PAH
Deposition Rate (SS)	$kg/m^2/day^{-1}$	A	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
Concentration in Disposal Material (UCEL)	mg/kg	B	42	4	160	110	110	1	40	2	270	0.18	3.16	9.6
Bioturbation Depth	M	C	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Volume of Sediment	m^3	D	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Typical Density of Sediment	kg/m^3	E	750	750	750	750	750	750	750	750	750	750	750	750
Ambient Sediment Concentration	mg/kg	F	9.700	0.114	28.140	29.520	37.860	0.082	18.620	1.700	105.560	0.018	0.01028	0.00956
In situ Sediment Mass	kg	D x E = G	75	75	75	75	75	75	75	75	75	75	75	75
In situ COC Mass	mg	G x F = H	727.500	8.550	2110.500	2214.000	2839.500	6.150	1396.500	127.500	7917.000	1.350	0.771	0.717
Deposition of COC	$kg/m^2/day^{-1}$	A x B = I	2.0160	0.1920	7.6800	5.2800	5.2800	0.0480	1.9200	0.0960	12.9600	0.0086	0.1517	0.4608
Day 1 in situ COC Mass	mg	H + I = J	729.5160	8.7420	2118.1800	2219.2800	2844.7800	6.1980	1398.4200	127.5960	7929.9600	1.3586	0.9227	1.1778
Day 1 in situ COC Concentration	mg/kg	J/G = K	9.7269	0.1166	28.2424	29.5904	37.9304	0.0826	18.6456	1.7013	105.7328	0.0181	0.0123	0.0157
Total Disposal Days (5Mm3 for 26,700m3/day)	days	L	187.2659	187.2659	187.2659	187.2659	187.2659	187.2659	187.2659	187.2659	187.2659	187.2659	187.2659	187.2659
Deposition of COC over Facility Lifetime	mg/m^2	L x I = M	377.5281	35.9551	1438.2022	988.7640	988.7640	8.9888	359.5506	17.9775	2426.9663	1.6180	28.4045	86.2921
Lifetime in situ COC Mass	mg	H + M = N	1105.0281	44.5051	3548.7022	3202.7640	3828.2640	15.1388	1756.0506	145.4775	10343.9663	2.9680	29.1755	87.0091
In situ Lifetime Sediment Mass	kg	(L*A) + G = P	83.9888	83.9888	83.9888	83.9888	83.9888	83.9888	83.9888	83.9888	83.9888	83.9888	83.9888	83.9888
Change in Volume	m^3	P/E = Q	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112
Change in Height	cm	Q/1m/1m = R	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112	0.112
Overall Lifetime In situ COC Concentration (mg/kg)	mg/kg	N/P = S	13.1569	0.5299	42.2521	38.1332	45.5807	0.1802	20.9082	1.7321	123.1589	0.0353	0.3474	1.0360

2 DETAILED ASSESSMENT OF BIOACCUMULATION

2.1 PELAGIC FISH

In assessing COC bioaccumulation by marine pelagic fish, it is assumed that the COCs are predominantly accumulated from the dissolved phase and uptake from the sediment particles is negligible. It is thus assumed that COCs in the dissolved phase originate from desorption from the re-suspended sediments with 100% desorption (see *Table 1.2*). Two approaches are therefore used to predict the likely COC concentrations in marine pelagic fish, including the EqP approach and the kinetic modeling approach.

For the EqP approach, the COC concentration is directly calculated as the BCF times the desorbed COC concentration using Eq. 2. The mean BCFs of metals (Cr, Pb and Ni) are referred from International Atomic Energy Agency (IAEA 2000). For other metals, the BCF is calculated by the kinetic equation (Eq. 6) with known uptake rate constant k_u and efflux rate constant k_e from the local fish species (mangrove snappers, sweetlips and seabreams) (Xu and Wang 2002, Wang and Wong 2003, Long and Wang 2005). The BCF of Cu is calculated from the field data of Gibbs and Miskowicz (1995).

Using these two approaches, the predicted COC concentrations in pelagic fish as a result of uptake of desorbed metals are shown in *Table 2.2*, together with the BCFs used in the calculations. The predictions were made based on the shortnose ponyfish *Leiognathus brevirostris*.

Ambient concentrations have been calculated from a review of marine biota data collected in Reference Areas between 2005 and 2009 as part of the biomonitoring programme under the CMP IVc monitoring programmes [1] (*Table 2.1*).

(1) Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau (2005-2008) - Investigation (Agreement No. CE 19/2004 (EP)). For Civil Engineering and Development Department

Table 2.1 Ambient Concentrations, i.e. Annual Mean Concentrations of Contaminants of Concern (COCs) in Tissues of Marine Biota Collected in Reference Areas between 2005 and 2009 as part of CE 19/2004 (EP)

Contaminant of Concern (mg/kg)	Pelagic Fish	Molluscs	Predatory Crab	Predatory Fish		Predatory Fish Mean	Predatory Shrimp			Predatory Shrimp Mean
	Leiognathus brevirostris	*Turritella* sp.	*Charybdis* sp.	*Cynoglossus* sp.	*Trypauchen vagina*		*Metapenaeus affinis*	*Metapenaeus ensis*	*Oratosquilla oratoria*	
Arsenic	1.262	3.410	5.518	3.378	5.892	4.635	2.752	5.542	5.766	4.687
Cadmium	0.010	0.282	0.038	0.010	0.010	0.010	0.012	0.010	0.366	0.129
Chromium	0.022	0.604	0.016	0.022	0.026	0.024	0.014	0.032	0.026	0.024
Copper	0.466	32.140	8.794	0.374	0.488	0.431	7.004	5.314	19.046	10.455
Lead	0.120	1.270	0.068	0.036	0.034	0.035	0.024	0.100	0.078	0.067
Mercury	0.046	0.018	0.028	0.016	0.046	0.031	0.012	0.010	0.014	0.012
Nickel	0.058	38.242	0.044	0.030	0.056	0.043	0.076	0.084	0.268	0.143
Silver	0.010	0.756	0.124	0.014	0.012	0.013	0.022	0.020	0.286	0.109
Zinc	9.896	80.970	29.146	3.390	6.752	5.071	14.100	13.588	23.828	17.172
Total PCBs	0.004686	0.001046	0.001	0.001082	0.001062	0.001072	0.001	0.001	0.001972	0.001324
Low M Wt PAHs	0.0275	0.0275	0.0275	0.0275	0.0275	0.0275	0.0275	0.0275	0.0275	0.0275
High M Wt PAHs	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085	0.085

Table 2.2 Predicted COC Concentrations in Pelagic Fish as a result of Uptake of Desorbed Metals (i.e. from Dissolved Phase). The bioconcentration factor (BCF) used in the calculations is also shown

Contaminant of Concern (COC)	Concentrations of COCs in Dissolved Phase (μg L^{-1})	BCF (L kg^{-1})	Elevated Concentration in fish (mg kg^{-1})	Ambient Concentration in fish (mg kg^{-1})	Total Concentration in Fish (mg kg^{-1})
Arsenic	0.0076986	350	0.00269451	1.262	1.2647
Cadmium	0.000564	200	0.0001128	0.010	0.0101
Chromium	0.065424	200	0.0130848	0.022	0.0351
Copper	0.0189222	2200	0.04162884	0.466	0.5076
Lead	0.020163	200	0.0040326	0.120	0.1240
Mercury	0.000987	6800	0.0067116	0.046	0.0527
Nickel	0.002256	1000	0.002256	0.058	0.0603
Silver	0.000564	500	0.000282	0.010	0.0103
Zinc	0.03807	700	0.026649	9.896	9.9226
Total PCBs	0.000402273	100000	0.0402273	0.004686	0.0449
LMW PAH	0.00000033417	1000	0.00000033417	0.0275	0.0275
HMW PAH	0.000015431	10000	0.00015431	0.085	0.0852

Note:
BCF of Arsenic is from EPA 1980. BCFs of Cd and Zn from Xu and Wang (2002) and are calculated from the kinetic equation. BCF of Hg from Wang and Wong (2003) and is calculated from the kinetic equation. BCF of Ag from Long and Wang (2005) and is calculated from the kinetic equation. BCFs of Cu from Gibbs and Miskowicz (1995). BCFs of Cr, Pb and Ni from IAEA (2000). BCFs of PAHs and PCBs from Veith & Kosian (1983).

2.2 MOLLUSCS

In assessing the bioaccumulation by filter-feeding molluscs, only the uptake from the dissolved uptake was modeling and sediment ingestion was not modelled. The kinetic equation of Eq. 6 is used to predict the accumulation from the dissolved phase as a result of COC desorption from sediment. The k_u and k_e measured in the local green mussels (*Perna viridis*) are used to calculate the likely BCF. Alternatively, the BCF is directly referred from IAEA (2000).

The predicted COC concentrations in filter-feeding molluscs due to uptake of desorbed COCs are shown in *Table 2.3*. The predictions were made based on the gastropod *Turritella* sp..

Table 2.3 Predicted COC Concentrations in Filter-feeding Molluscs as a result of Uptake of Desorbed Metals (i.e. from Dissolved Phase). The bioconcentration factor (BCF) used in the calculations is also shown

Contaminant of Concern (COC)	Concentrations of COCs in Dissolved Phase (μg L^{-1})	BCF (L kg^{-1})	Elevated Concentration in Molluscs (mg kg^{-1})	Ambient Concentration in Molluscs (mg kg^{-1})	Total Concentration in Molluscs (mg kg^{-1})
Arsenic	0.0076986	350	0.00269451	3.410	3.4127
Cadmium	0.000564	10000	0.00564	0.282	0.2876
Chromium	0.065424	1000	0.065424	0.604	0.6694
Copper	0.0189222	2000	0.0378444	32.140	32.1778
Lead	0.020163	2570	0.05181891	1.270	1.3218
Mercury	0.000987	2000	0.001974	0.018	0.0200
Nickel	0.002256	2000	0.004512	38.242	38.2465
Silver	0.000564	60000	0.03384	0.756	0.7898
Zinc	0.03807	22000	0.83754	80.970	81.8075
Total PCBs	0.000402273	100000	0.0402273	0.001046	0.0413
LMW PAH	0.00000033417	1000	3.3417E-07	0.0275	0.0275
HMW PAH	0.000015431	10000	0.00015431	0.085	0.0852

Note:
BCF of Arsenic is from EPA 1980. BCFs of Cd, Cr(VI), and Zn from Wang (2003), calculated from the kinetic equation (Eq. 6). To convert the BCF of Cr(VI) to Cr(III), it is assumed that the uptake of Cr(III) is 3 times lower than the uptake of Cr(VI) (Wang et al. 1997). BCF of Ag from Wang et al. (1996) calculated from the kinetic equation (Eq. 6). BCFs of other metals (Cu, Pb, Hg, Ni) from IAEA (2000). BCFs of PAHs and PCBs from Pruell et al. (1987).

2.3 *POLYCHAETE & OTHER DEPOSIT-FEEDING WORMS (SIPUNCULANS)*

Similar to marine molluscs ingesting sediments, the accumulation of COCs by deposit-feeding polychaetes and other worms such as sipunculans is predicted using the kinetic equation (Eq. 8). However, the AE of COCs has been measured only for a few metals with good techniques (e.g., Cd, Cr and Zn). The extraction of metals (e.g., Cu, Pb, Ni and Hg) from the sediments by the gut juices has been measured in a few polychaete species. In order to predict the likely accumulation of these metals in polychaetes, it is inherently assumed that the AE of these metals is comparable to the extraction efficiency. Such assumption is based that all the extracted metals are assimilated by the animals, and extraction represents the maximum rate of uptake. Thus, prediction of metal accumulation based on the extraction efficiency can be considered as a conservative estimate of the metal accumulation in deposit-feeding animals. For these animals, the maximum ingestion rate is assumed to be 200% of the tissue dry weight each day (Cammen 1980, Wang et al. 1999). The influx rate of the metals from ingested sediments is then calculated using Eq. 7.

To predict the accumulation of organic contaminants such as PAH and PCBs, again the approach of BSAF is used. In these calculations, the lipid content of the animals and the organic carbon content of the sediments are also considered. The BSAFs of PAHs (0.2) and PCBs (0.68) have been quantified in marine polychaetes in several previous studies (Maruya et al. 1997, Kaag et al. 1997), and these measurements were based on the lipid content and the sediment organic carbon content. To convert these values for the total sediments and the whole individual animal, it is assumed that the organic carbon content in the sediment is 2% and the lipid content of the polychaetes is 1.6% (Maruya et al. 1997). These predictions are shown in *Table 2.4*.

Table 2.4 ***Predicted COC Concentrations in Deposit-feeding Polychaetes/ Worms as a result of Uptake of Sediments (i.e. COC from Particulate Phase). AE: assimilation efficiency, IR: ingestion rate, ke: efflux rate constant, BSAF: Biota-sediment bioaccumulation factor.***

Contaminant of Concern (COC)	Concentrations of COCs in Sediment (i.e. Particulate Phase) (mg kg^{-1})	AE x IR/k_e	BSAF	Elevated Concentration in Polychaetes (mg kg^{-1})
Arsenic	13.15685619	0.25		3.2892
Cadmium	0.529892977	1		0.5299
Chromium	42.25210702	0.5		21.1261
Copper	38.13324415	1		38.1332
Lead	45.5806689	0.5		22.7903
Mercury	0.180247492	2		0.3605
Nickel	20.90816054	0.5		10.4541
Silver	1.732107023	0.5		0.8661
Zinc	123.1589298	1		123.1589
Total PCBs	0.035337793		0.68	0.0239
LMW PAH	0.347373779		0.2	0.0692
HMW PAH	1.035961605		0.2	0.2064

Note:
AEs of Cd, Cr, Zn: Wang et al. (2002). Extraction of Cu, Pb, and Ni: Peng et al. (2004). Extraction of Hg: Lawrence et al. 1999. Assuming that extraction=assimilation, ke=0.02 d-1, and IR=2 g g-1 d-1. BSAF of PAHs from Maruya et al. (1997). BSAF of PCBs from Kaag et al. (1997).

2.4 *PREDATORY FISH, CRABS & SHRIMPS*

To predict the likely COC concentrations in the predatory fish, crabs, and shrimps, the trophic transfer factor is used (Eq. 9). Specifically, the TTF is the ratio of COC concentrations in the predator to those in the preys. The TTF has been measured in a few specific predator-prey systems, but the data are relatively scattered. Suedel et al. (1994) have summarized the TTF of COCs in aquatic ecosystems; these values are then used in the model calculation.

To predict the COC concentrations in predatory fish, the prey fish is assumed. To predict the COC concentrations in predatory crabs and shrimps, the prey polychaetes are assumed. The COC concentrations in the prey fish and prey polychaetes are referred from the model calculations, again assuming that the COCs are accumulated in the prey fish from the dissolved phase (due to desorption, see *Table 2.2*), and in the prey polychaetes from ingested sediments (due to contaminated sediment deposition, see *Table 2.4*). *Table 2.5* shows the model predictions.

Table 2.5 Predicted COC Concentrations in Predatory Fish, Crab and Shrimp as a result of trophic transfer of COCs from the prey species. TTF = Trophic Transfer Factor. Empty Cells are when no data are present

Contaminant of Concern (COC)	TTF in Fish	TTF in Crab	TTF in Shrimp	Elevated Concentration in Fish (mg kg^{-1})	Elevated Concentration in Crab (mg kg^{-1})	Elevated Concentration in Shrimp (mg kg^{-1})	Ambient Concentration in Fish (mg kg^{-1})	Ambient Concentration in Crab (mg kg^{-1})	Ambient Concentration in Shrimp (mg kg^{-1})	Total Concentration in Fish (mg kg^{-1})	Total Concentration in Crab (mg kg^{-1})	Total Concentration in Shrimp (mg kg^{-1})
Arsenic							4.635	5.518	4.687	4.6350	5.5180	4.6867
Cadmium	0.1	0.01	2.4	0.00001	0.00530	1.27174	0.010	0.038	0.129	0.0100	0.0433	1.4011
Chromium	0.7			0.00916			0.024	0.016	0.024	0.0332	0.0160	0.0240
Copper	0.5			0.02081			0.431	8.794	10.455	0.4518	8.7940	10.4547
Lead	0.7			0.00282			0.035	0.068	0.067	0.0378	0.0680	0.0673
Mercury	0.4	0.8	0.8	0.00268	0.28840	0.28840	0.031	0.028	0.012	0.0337	0.3164	0.3004
Nickel	0.7			0.00158			0.043	0.044	0.143	0.0446	0.0440	0.1427
Silver	0.5			0.00014			0.013	0.124	0.109	0.0131	0.1240	0.1093
Zinc	1	1.2	0.7	0.02665	147.79072	86.21125	5.071	29.146	17.172	5.0976	176.9367	103.3833
Total PCBs	4	1.2	1.2	0.16091	0.02872	0.02872	0.001072	0.001	0.001324	0.1620	0.0297	0.0300
LMW PAH	0.2	0.2	0.2	0.000000067	0.01384	0.01384	0.0275	0.0275	0.0275	0.0275	0.0413	0.0413
HMW PAH	0.2	0.2	0.2	0.000030862	0.04127	0.04127	0.085	0.085	0.085	0.0850	0.1263	0.1263

Note: TTFs from Suedel et al. (1994) and USEPA (2000).

3 SUMMARY

A summary of predicted body burden (i.e. tissue) COC concentrations from the above exercise is presented in *Table 3.1*.

Table 3.1 Summary of Predicted Body Burden (i.e. Tissue) COC Concentrations in the Target Species

Contaminant of Concern (COC)	Total Concentration in Pelagic Fish (mg kg^{-1})	Total Concentration in Filter-feeding Molluscs (mg kg^{-1})	Total Concentration in Predatory Fish (mg kg^{-1})	Total Concentration in Predatory Crab (mg kg^{-1})	Total Concentration in Predatory Shrimp (mg kg^{-1})
South Brothers					
Arsenic	1.2647	3.4127	4.6350	5.5180	4.6867
Cadmium	0.0101	0.2876	0.0100	0.0433	1.4011
Chromium	0.0351	0.6694	0.0332	0.0160	0.0240
Copper	0.5076	32.1778	0.4518	8.7940	10.4547
Lead	0.1240	1.3218	0.0378	0.0680	0.0673
Mercury	0.0527	0.0200	0.0337	0.3164	0.3004
Nickel	0.0603	38.2465	0.0446	0.0440	0.1427
Silver	0.0103	0.7898	0.0131	0.1240	0.1093
Zinc	9.9226	81.8075	5.0976	176.9367	103.3833
Total PCBs	0.0449	0.0413	0.1620	0.0297	0.0300
LMW PAH	0.0275	0.0275	0.0275	0.0413	0.0413
HMW PAH	0.0852	0.0852	0.0850	0.1263	0.1263
Ambient					
Arsenic	1.262	3.410	4.635	5.518	4.687
Cadmium	0.010	0.282	0.010	0.038	0.129
Chromium	0.022	0.604	0.024	0.016	0.024
Copper	0.466	32.140	0.431	8.794	10.455
Lead	0.120	1.270	0.035	0.068	0.067
Mercury	0.046	0.018	0.031	0.028	0.012
Nickel	0.058	38.242	0.043	0.044	0.143
Silver	0.010	0.756	0.013	0.124	0.109
Zinc	9.896	80.970	5.071	29.146	17.172
Total PCBs	0.004686	0.001046	0.001072	0.001	0.001324
LMW PAH	0.0275	0.0275	0.0275	0.0275	0.0275
HMW PAH	0.085	0.085	0.085	0.085	0.085

4 REFERENCES

Boese BL, Lee II H, Specht DT, Pelletier J, Randall R (1996) Evaluation of PCB and hexachlorobenzene biota-sediment accumulation factors based on ingested sediment in a deposit-feeding clam. Environ Toxicol Chem 1584-1589.

Cammen LM (1980) Ingestion rate: An empirical model for aquatic deposit feeders and detritivores. Oecologia 44: 303-310.

Chong I, Wang W-X (2001) Comparative studies on the biokinetics of Cd, Cr, and Zn in the green mussel *Perna viridis* and the Manila clam *Ruditapes philippinarum*. Environ Pollut 115: 107-121.

Connell DW (1989) Bioaccumulation of xenobiotic compounds. CRC Press,Boca Raton, FL.

Di Toro DM et al. (1991) Technical basis for establishing sediment quality criteria for nonionic organic chemicals using equilibrium partitioning. Environ Toxicol Chem 10: 1541-1583.

EPA. (1980) Ambient water quality criteria for Arsenic. Washington DC, US EPA, Office of Water Regulations and Standards. EPA 440/5-80-021

EPA (2000) Bioaccumulation testing and interpretation for the purpose of sediment quality assessment. EPA-823-R-00-001. Office of Water (4305) and Office of solid waste (5307W).

ERM (2004) Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area – Agreement No. CE 12/2002 (EP). Environmental Monitoring Data Review. For the Civil Engineering Department, Hong Kong SAR Government.

Fan W, Wang W-X, Chen J (2002) Speciation of Cd, Cr, and Zn in highly contaminated sediments and its influences on assimilation by marine bivalves. Environ Sci Technol 36: 5164-5171.

Gibbs PJ, Miskiewicz AG (1992) Heavy metals in fish near a major primary treatment sewage plant outfall. Mar Pollut Bull 30: 667-675.

Gagnon C, Fisher NS (1997) The bioavailability of sediment-bound Cd, Co, and Ag to the mussel *Mytilus edulis*. Can J Fish Aquat Sci 54: 147-156.

Griscom SB, Fisher NS, Luoma SN (2000) Geochemical influences on assimilation of sediment-bound metals in clams and mussels. Environ Sci Technol 34: 91-99.

IAEA (International Atomic Energy Agency) (2000) Sediment k_ds and concentration factors for radionuclides in the marine environment. Technical report series, No. 247 Vienna

Kaag NHBM, Foekema EM, Scholten MCTh, Van Straalen NM (1997) Comparison of contaminant accumulation in three species of marine invertebrates with different feeding habits. Environ Toxicol Chem 16: 837-842.

Landrum PF, Lee H II, Lydy MJ (1992) Toxicokinetics in aquatic systems: model comparisons and use in hazard assessment. Environ Toxicol Chem 11:1709-1725

Lawrence AL, Mcaloon KM, Mason RP, Mayer LM (1999) Intestinal solubilization of particle-associated organic and inorganic mercury as a measure of bioavailability to benthic invertebrates. Environ Sci Technol 33: 1871-1876.

Long A, Wang W-X (2005) Assimilation and bioconcentration of Ag and Cd by the marine black bream after waterborne and dietary metal exposure. Environ Toxicol Chem 24(3): 709-16.

Luoma SN, Fisher NS (1997) Uncertainties in assessing contaminant exposure from sediments. In: Ingersoll CG, Dillon T, Biddinger GR (eds) Ecological risk assessment of contaminated sediments. SETAC Special Publication Series, Pensacola, FL, p 211-237

Maruya KA, Risebrough RW, Horne AJ (1997) The bioaccumulation of polynuclear aromatic hydrocarbons by benthic invertebrtes in an intertidal marsh. Environ Toxicol Chem 16: 1087-1097.

Peng S-H, Wang W-X, Li X, Yen YF (2004) Metal partitioning in river sediments measured by sequential extraction and biomimetic approaches. Chemosphere 57: 839-851.

Pruell RJ, Quinn JG, Lake JL, Davis WR (1987) Availability of PCBs and PAHs to Mytilus edulis from artificially resuspended sediments. In Capuzzo JM, Kester DR (eds) Oceanic Processes in Marine Pollution. Vol. 1. R Krieger Pub, Malabar, FL. pp. 97-108.

Suedel BC, Boraczek JA, Peddicord RK, Clifford PA, Dillon TM (1994) Trophic transfer and biomagnification potential of contaminants in aquatic ecosystems. Rev Environ Contam Toxicol 136: 21-89

Thomann RV, Mahony JD, Mueller R (1995) Steady-state model of biota sediment accumulation factor for metals in two marine bivalves. Environ Toxicol Chem 14: 1989-1998.

Veith GD, Kosian P (1983) Estimating bioconcentration potential from octanol/water partition coefficients. In: Mackay D, Patterson S, Eisenreich SJ (eds) Physical behabior of PCBs in the Great Lakes. Ann Arbor Sci Publ, Ann Arbor, MI. pp 269-282.

Wang W-X (2002) Cd and Se aqueous uptake and exposure of green mussels *Perna viridis*: influences of seston quantity. Mar Ecol Prog Ser 226: 211-221.

Wang W-X (2003) Metal bioaccumulation in bivalve mollusks: Recent progress. In: Molluscan Shellfish Safety. A. Villalba, B. Reguera, J. L. Romalde and R. Beiras (eds), Intergovernmental Oceanographic Commission of UNESCO and Conselleria de Pesca e Asuntos Maritimos da Xunta de Galicia. Santiago de Compostela, Spain. pp 503-520.

Wang W-X, Wong RSK (2003) Bioaccumulation kinetics and exposure pathways of inorganic mercury and methylmercury in a marine fish, the sweetlips *Plectorhinchus gibbosus*. Mar Ecol Prog Ser 261: 257-268.

Wang W-X, Fisher NS, Luoma SN (1996) Kinetic determinations of trace element bioaccumulation in the mussel, *Mytilus edulis*. Mar Ecol Prog Ser 140: 91-113.

Wang W-X, Griscom SB, Fisher, NS (1997) Bioavailability of Cr(III) and Cr(VI) to marine mussels from solute and particulate pathways. Environ Sci Technol 31: 603-611.

Wang W-X, Stupakoff I, Fisher NS (1999) Bioavailability of dissolved and sediment-bound metals to a marine deposit-feeding polychaete. Mar Ecol Prog Ser 178: 281-293.

Wang W-X, Yan Q, Fan W, Xu Y (2002) Bioavailability of sedimentary metals from a contaminated bay. Mar Ecol Prog Ser 240: 27-38.

Widdows J, Fieth P, Worrall CM (1979) Relationships between seston, available food and feeding activity in the common mussel *Mytilus edulis*. Mar Biol 50, 195-207.

Xu Y, Wang W-X. (2002) Exposure and food chain transfer factor of Cd, Se, and Zn in a marine fish, *Lutjanus argentimaculatus*. Mar Ecol Prog Ser 238: 173-186.

Yan Q-L, Wang W-X (2002) Metal exposure and bioavailability to a marine deposit-feeding sipuncula *Sipunculus nudus*. Environ Sci Technol 36: 40-47

Annex D

Noise Calculations – Unmitigated Scenario

Contaminated Sediment Disposal Facility at South of Brothers

Annex D-1 Preliminary Construction Programme - Unmitigated

Year	2011						2012												2013												2014												2015					
	Jul-Dec						Jan-Jun						Jul-Dec						Jan-Jun						Jul-Dec						Jan-Jun						Jul-Dec						Jan-Jun					
No. Activity Description / Month	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Daytime Period (Normal days 0700 - 1900 hrs)																																																
I) South Brothers Mud Pit																																																
A Construction / Operation																																																
Pit 1																																																
1 Dredging													Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																								
2 Backfilling																									Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y												
3 Capping																																					Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pit 2																																																
1 Dredging	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																				
2 Backfilling													Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																								
3 Capping																									Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y												
II) Concurrent Projects																																																
B TM-CLKL [1]																																																
4 Pile Cap 1																																											Y	Y	Y	Y		
5 Pile Cap 2																																											Y	Y	Y	Y		
6 Pile Cap 3																																											Y	Y	Y	Y		
7 Pile Cap 4																																											Y	Y	Y	Y	Y	Y
8 Pile Cap 5																																											Y	Y	Y	Y	Y	Y
9 Pile Cap 6																																									Y	Y	Y	Y			Y	Y
10 Pile Cap 7																																									Y	Y	Y	Y			Y	Y
11 Pile Cap 8											Y	Y	Y	Y																																		
12 Pile Cap 9																																			Y	Y												
13 Pile Cap 10													Y	Y	Y	Y					Y	Y																										
14 Pile Cap 11											Y	Y	Y	Y									Y	Y																								
15 Pile Cap 12													Y	Y	Y	Y									Y	Y																						
16 Pile Cap 13											Y	Y	Y	Y													Y	Y																				
17 Pile Cap 14 (Marine)							Y	Y	Y	Y	Y	Y																																				
18 Pile Cap 15 (Marine)							Y	Y	Y	Y	Y	Y																																				
19 Viaduct section in Area A																																								Y	Y							
20 Viaduct section in Area B																																							Y	Y	Y							
21 Cheung Tung Road																						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y								
C HKBCF / HKLR [2][3]																																																
22 S9										Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																			
23 S10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y									
24 S12	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y									
25 S13	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																				
26 S14	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																		
27 S15																	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y									
28 S16	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y									
29 S17									Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y									
30 S18									Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y									
31 S19	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
32 S20	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y									
33 S21							Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y									
34 S22		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Evening time Period (Normal days 1900 - 2300 hrs & PH 0700 - 2300 hrs)																																																
I) South Brothers Mud Pit																																																
A Construction / Operation																																																
Pit 1																																																
1 Dredging													Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																								
2 Backfilling																									Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y												
3 Capping																																					Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pit 2																																																
1 Dredging	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																				
2 Backfilling													Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																								
3 Capping																									Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y												
Night-time Period (All days 2300 - 0700 hrs)																																																
I) South Brothers Mud Pit																																																
A Construction / Operation																																																
Pit 1																																																
1 Dredging													Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																								
2 Backfilling																									Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y												
3 Capping																																					Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Pit 2																																																
1 Dredging	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																				
2 Backfilling													Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																								
3 Capping																									Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y												

Notes:

[1] Approved TM-CLKL EIA (*Register No.: AEIAR-146/2009*)

[2] Approved HKBCF EIA (*Register No.: AEIAR-145/2009*)

[3] S2-S4, S6-S8 of HKLR located more than 5km away from the SB facility and therefore not included in the assessment.
S1, S5 and S11 of HKLR is not concurrent with the programme of the SB facility and therefore not included in the assessment.

Annex D-2a Construction Plant Inventory - Unmitigated

No.	Activities	Plant	TM	No. of PME	On-time %	Unit SWL, dB(A)	SWL, dB(A)	Total SWL, dB(A)[1]
	Daytime Period (Normal days 0700 - 1900 hrs)							
I)	**South Brothers Mud Pit**							
A	**Construction / Operation**							
	Pit 1							
1	Dredging	Dredger, grab	CNP 063	6	100%	112	120	**123**
		Hopper barge	CNP 061	7	100%	104	112	
		Tug boat	CNP 221	7	100%	110	118	
2	Backfilling	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
3	Capping	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
	Pit 2							
1	Dredging	Dredger, grab	CNP 063	6	100%	112	120	**123**
		Hopper barge	CNP 061	7	100%	104	112	
		Tug boat	CNP 221	7	100%	110	118	
2	Backfilling	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
3	Capping	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
	Evening time Period (Normal days 1900 - 2300 hrs & PH 0700 - 2300 hrs)							
I)	**South Brothers Mud Pit**							
A	**Construction / Operation**							
	Pit 1							
1	Dredging	Dredger, grab	CNP 063	6	100%	112	120	**123**
		Hopper barge	CNP 061	7	100%	104	112	
		Tug boat	CNP 221	7	100%	110	118	
2	Backfilling	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
3	Capping	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
	Pit 2							
1	Dredging	Dredger, grab	CNP 063	6	100%	112	120	**123**
		Hopper barge	CNP 061	7	100%	104	112	
		Tug boat	CNP 221	7	100%	110	118	
2	Backfilling	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
3	Capping	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
	Night-time Period (All days 2300 - 0700 hrs)							
I)	**South Brothers Mud Pit**							
A	**Construction / Operation**							
	Pit 1							
1	Dredging	Dredger, grab	CNP 063	6	100%	112	120	**123**
		Hopper barge	CNP 061	7	100%	104	112	
		Tug boat	CNP 221	7	100%	110	118	
2	Backfilling	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
3	Capping	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
	Pit 2							
1	Dredging	Dredger, grab	CNP 063	6	100%	112	120	**123**
		Hopper barge	CNP 061	7	100%	104	112	
		Tug boat	CNP 221	7	100%	110	118	
2	Backfilling	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
3	Capping	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	

Notes:

[1] The figures are rounded-off to a whole number.

Annex D-3a Summary of Predicted Noise Levels during Daytime Period - Unmitigated

		EIAO-TM Noise Criteria, dB(A)	Predicted Construction Noise Level (dB(A))																	
			2011						2012											
	NSR Location		7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
N2	Tung Chung Crescent III - Seaview Crescent	75	34	34	34	34	34	34	34	34	34	34	34	34	40	40	40	40	40	40
N3	Caribbean Coast Phase 1 - Monterey Cove	75	39	39	39	39	39	39	39	39	39	39	39	39	45	45	45	45	45	45
N4	Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	75	45	45	45	45	45	45	45	45	45	45	45	45	53	53	53	53	53	53
N5	Ho Yu Secondary School	70/65	38	38	38	38	38	38	38	38	38	38	38	38	44	44	44	44	44	44
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	75	48	48	48	48	48	48	48	48	48	48	48	48	59	59	59	59	59	59
N7	Coastal Skyline Phase 4 - Le Bleu Deux	75	36	36	36	36	36	36	36	36	36	36	36	36	42	42	42	42	42	42
N8	Pak Mong Village House	75	47	47	47	47	47	47	47	47	47	47	47	47	54	54	54	54	54	54

		2013												2014												2015						Max. CNL, dB(A)
	NSR Location	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
N2	Tung Chung Crescent III - Seaview Crescent	40	40	40	40	40	40	32	32	32	32	32	32	32	32	32	32	32	32	31	31	31	31	31	31	31	31	31	31	31	31	40
N3	Caribbean Coast Phase 1 - Monterey Cove	45	45	45	45	45	45	38	38	38	38	38	38	38	38	38	38	38	38	37	37	37	37	37	37	37	37	37	37	37	37	45
N4	Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	53	53	53	53	53	53	45	45	45	45	45	45	45	45	45	45	45	45	44	44	44	44	44	44	44	44	44	44	44	44	53
N5	Ho Yu Secondary School	44	44	44	44	44	44	36	36	36	36	36	36	36	36	36	36	36	36	35	35	35	35	35	35	35	35	35	35	35	35	44
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	59	59	59	59	59	59	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	59
N7	Coastal Skyline Phase 4 - Le Bleu Deux	42	42	42	42	42	42	34	34	34	34	34	34	34	34	34	34	34	34	33	33	33	33	33	33	33	33	33	33	33	33	42
N8	Pak Mong Village House	54	54	54	54	54	54	46	46	46	46	46	46	46	46	46	46	46	46	45	45	45	45	45	45	45	45	45	45	45	45	54

Annex D-3b Summary of Predicted Cumulative Noise Levels during Daytime Period - Unmitigated

Predicted Construction Noise Level (dB(A)) — 2011–2012

	NSR Location	EIAO-TM Noise Criteria, dB(A)	2011-7	2011-8	2011-9	2011-10	2011-11	2011-12	2012-1	2012-2	2012-3	2012-4	2012-5	2012-6	2012-7	2012-8	2012-9	2012-10	2012-11	2012-12
N2	Tung Chung Crescent III - Seaview Crescent	75	70	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71
N3	Caribbean Coast Phase 1 - Monterey Cove	75	64	66	66	66	66	66	66	66	66	67	67	67	67	67	67	66	66	66
N4	Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	75	61	62	62	62	62	62	64	64	65	65	65	65	66	66	66	65	64	64
N5	Ho Yu Secondary School	70/65	63	65	65	65	65	65	65	65	65	65	65	65	**66**	**66**	**66**	65	65	65
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	75	59	61	61	61	61	61	64	64	65	65	65	65	69	69	68	68	64	64
N7	Coastal Skyline Phase 4 - Le Bleu Deux	75	67	68	68	68	68	68	68	68	68	69	68	68	69	69	68	68	68	68
N8	Pak Mong Village House	75	58	59	59	59	59	59	64	64	67	67	67	67	72	72	69	69	61	61

Predicted Construction Noise Level (dB(A)) — 2013–2015

	NSR Location	2013-1	2013-2	2013-3	2013-4	2013-5	2013-6	2013-7	2013-8	2013-9	2013-10	2013-11	2013-12	2014-1	2014-2	2014-3	2014-4	2014-5	2014-6	2014-7	2014-8	2014-9	2014-10	2014-11	2014-12	2015-1	2015-2	2015-3	2015-4	2015-5	2015-6	Max. CNL, dB(A)
N2	Tung Chung Crescent III - Seaview Crescent	71	71	71	71	71	71	71	71	71	71	71	71	69	69	69	69	69	69	69	69	69	65	59	59	60	60	60	60	59	59	71
N3	Caribbean Coast Phase 1 - Monterey Cove	66	66	66	66	66	66	66	66	66	66	66	66	65	65	65	65	65	65	65	65	65	61	56	56	60	60	61	61	56	56	67
N4	Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	64	64	64	65	65	65	64	64	65	65	64	64	63	63	64	64	64	64	63	63	63	59	57	56	62	62	64	64	57	57	66
N5	Ho Yu Secondary School	65	65	65	65	65	65	65	65	65	65	65	65	64	64	64	64	64	64	64	64	64	60	55	54	58	58	60	60	55	55	**66**
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	64	64	65	66	66	66	65	65	66	66	65	65	65	65	66	66	66	65	64	62	62	61	61	59	67	67	69	69	61	61	69
N7	Coastal Skyline Phase 4 - Le Bleu Deux	68	68	69	68	68	68	68	68	68	68	68	68	66	66	66	66	67	67	67	67	67	63	57	57	59	59	60	60	57	57	69
N8	Pak Mong Village House	61	61	63	66	67	67	67	67	68	68	67	66	67	67	68	68	69	67	66	61	64	65	68	66	73	73	74	74	68	68	74

Note:

66 Predicted Noise Level exceeded the EIAO-TM noise criteria.

Annex D-3c Summary of Predicted Noise Levels during Evening Time Period - Unmitigated

		GW-TM Noise Criteria, dB(A)	Predicted Construction Noise Level (dB(A))																																															Max. CNL, dB(A)
			2011						2012												2013												2014												2015						
	NSR Location		7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
N2	Tung Chung Crescent III - Seaview Crescent	65	34	34	34	34	34	34	34	34	34	34	34	34	40	40	40	40	40	40	40	40	40	40	40	40	32	32	32	32	32	32	32	32	32	32	32	32	31	31	31	31	31	31	31	31	31	31	31	31	40
N3	Caribbean Coast Phase 1 - Monterey Cove	65	39	39	39	39	39	39	39	39	39	39	39	39	45	45	45	45	45	45	45	45	45	45	45	45	38	38	38	38	38	38	38	38	38	38	38	38	37	37	37	37	37	37	37	37	37	37	37	37	45
N4	Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	65	45	45	45	45	45	45	45	45	45	45	45	45	53	53	53	53	53	53	53	53	53	53	53	53	45	45	45	45	45	45	45	45	45	45	45	45	44	44	44	44	44	44	44	44	44	44	44	44	53
N5	Ho Yu Secondary School	-	38	38	38	38	38	38	38	38	38	38	38	38	44	44	44	44	44	44	44	44	44	44	44	44	36	36	36	36	36	36	36	36	36	36	36	36	35	35	35	35	35	35	35	35	35	35	35	35	44
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	65	48	48	48	48	48	48	48	48	48	48	48	48	59	59	59	59	59	59	59	59	59	59	59	59	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	59
N7	Coastal Skyline Phase 4 - Le Bleu Deux	65	36	36	36	36	36	36	36	36	36	36	36	36	42	42	42	42	42	42	42	42	42	42	42	42	34	34	34	34	34	34	34	34	34	34	34	34	33	33	33	33	33	33	33	33	33	33	33	33	42
N8	Pak Mong Village House	60	47	47	47	47	47	47	47	47	47	47	47	47	54	54	54	54	54	54	54	54	54	54	54	54	46	46	46	46	46	46	46	46	46	46	46	46	45	45	45	45	45	45	45	45	45	45	45	45	54

Annex D-3d Summary of Predicted Noise Levels during Night-time Period - Unmitigated

		GW-TM Noise Criteria, dB(A)	Predicted Construction Noise Level (dB(A))																																															Max. CNL, dB(A)
			2011						**2012**												**2013**												**2014**												**2015**						
	NSR Location		**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	
N2	Tung Chung Crescent III - Seaview Crescent	50	34	34	34	34	34	34	34	34	34	34	34	34	40	40	40	40	40	40	40	40	40	40	40	40	32	32	32	32	32	32	32	32	32	32	32	32	31	31	31	31	31	31	31	31	31	31	31	31	40
N3	Caribbean Coast Phase 1 - Monterey Cove	50	39	39	39	39	39	39	39	39	39	39	39	39	45	45	45	45	45	45	45	45	45	45	45	45	38	38	38	38	38	38	38	38	38	38	38	38	37	37	37	37	37	37	37	37	37	37	37	37	45
N4	Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	50	45	45	45	45	45	45	45	45	45	45	45	45	53	53	53	53	53	53	53	53	53	53	53	53	45	45	45	45	45	45	45	45	45	45	45	45	44	44	44	44	44	44	44	44	44	44	44	44	53
N5	Ho Yu Secondary School	-	38	38	38	38	38	38	38	38	38	38	38	38	44	44	44	44	44	44	44	44	44	44	44	44	36	36	36	36	36	36	36	36	36	36	36	36	35	35	35	35	35	35	35	35	35	35	35	35	44
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	50	48	48	48	48	48	48	48	48	48	48	48	48	59	59	59	59	59	59	59	59	59	59	59	59	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	59
N7	Coastal Skyline Phase 4 - Le Bleu Deux	50	36	36	36	36	36	36	36	36	36	36	36	36	42	42	42	42	42	42	42	42	42	42	42	42	34	34	34	34	34	34	34	34	34	34	34	34	33	33	33	33	33	33	33	33	33	33	33	33	42
N8	Pak Mong Village House	45	47	47	47	47	47	47	47	47	47	47	47	47	54	54	54	54	54	54	54	54	54	54	54	54	46	46	46	46	46	46	46	46	46	46	46	46	45	45	45	45	45	45	45	45	45	45	45	45	54

Note:

53 Predicted Noise Level exceeded the corresponding GW-TM noise criteria.

Contaminated Sediment Disposal Facility at South of Brothers

Annex D-4a ***Construction Airborne Noise Impact Assessment - Unmitigated***

NSR: N2 Tung Chung Crescent III - Seaview Crescent

No.	Activity Description	SWL	Distance	Corr. for distance	Atm. Absorption	Corr. for façade	Predicted Construction Noise Level (dB(A))																																																Max.
							2011						2012												2013												2014												2015						CNL
No.	Activity Description	dB(A)[2]	m	dB(A)[1][2]	dB(A)[3]	dB(A)	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	dB(A)
	Daytime Period (Normal days 0700 - 1900 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	3010	-78	-8.4	3													40	40	40	40	40	40	40	40	40	40	40	40																									
2	Backfilling	114	3010	-78	-8.4	3																									31	31	31	31	31	31	31	31	31	31	31	31													
3	Capping	114	3010	-78	-8.4	3																																					31	31	31	31	31	31	31	31	31	31	31	31	
	Pit 2																																																						
1	Dredging	123	3992	-80	-11.2	3	34	34	34	34	34	34	34	34	34	34	34	34																																					
2	Backfilling	114	3992	-80	-11.2	3													26	26	26	26	26	26	26	26	26	26	26	26																									
3	Capping	114	3992	-80	-11.2	3																									26	26	26	26	26	26	26	26	26	26	26	26													
II)	**Concurrent Projects**																																																						
B	**TM-CLKL [4]**																																																						
4	Pile Cap 1	-	2757	-77	0.0	3																																											44	44	50	50			
5	Pile Cap 2	-	2791	-77	0.0	3																																											44	44	50	50			
6	Pile Cap 3	-	2881	-77	0.0	3																																											44	44	49	49			
7	Pile Cap 4	-	2941	-77	0.0	3																																											44	44	49	49	43	43	
8	Pile Cap 5	-	3001	-78	0.0	3																																											43	43	49	49	42	42	
9	Pile Cap 6	-	3061	-78	0.0	3																																									43	43	49	49			42	42	
10	Pile Cap 7	-	3128	-78	0.0	3																																									43	43	49	49			42	42	
11	Pile Cap 8	-	3189	-78	0.0	3											43	43	48	48																											42	42												
12	Pile Cap 9	-	3231	-78	0.0	3																																					40	40												
13	Pile Cap 10	-	2757	-77	0.0	3													44	44	50	50							43	43																											
14	Pile Cap 11	-	2818	-77	0.0	3											44	44	49	49											43	43																									
15	Pile Cap 12	-	2897	-77	0.0	3													44	44	49	49													43	43																						
16	Pile Cap 13	-	2979	-77	0.0	3											44	44	49	49																	43	43																				
17	Pile Cap 14 (Marine)	-	3031	-78	0.0	3							43	43	47	47	40	40																																					
18	Pile Cap 15 (Marine)	-	3069	-78	0.0	3							43	43	47	47	40	40																																					
19	Viaduct section in Area A	-	2881	-77	0.0	3																																									41	42								
20	Viaduct section in Area B	-	3061	-78	0.0	3																																								40	41	41								
21	Cheung Tung Road	-	2979	-77	0.0	3																									47	48	48	48	48	50	50	50	48	50	50	51	51	51	48	48	42	42	42									
C	**HKBCF / HKLR [4]**																																																						
22	S9	-	2540	-76	0.0	3										41	41	41	41	41	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43																				
23	S10	-	920	-67	0.0	3	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	51	54	54	54	51	51	51	51	51	51	51	51	51										
24	S12	-	560	-63	0.0	3	59	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	60	60	60	60	60	60	60	60	60	60	60	60	57	57	57	57	57	57	57	57	57										
25	S13	-	600	-64	0.0	3	36	59	59	59	59	60	60	48	48	48	48	48	48	48	48	48	48	48	48	48						48	48	48																					
26	S14	-	620	-64	0.0	3	56	56	56	55	55	55	55	55	55	61	61	61	61	61	61	59	59	59	59	59	59	48	48	48	48	48	48	48	48	48																			
27	S15	-	640	-64	0.0	3																	57	57	59	59	59	59	59	59	59	54	54	54	54	54	54	54	54	54	54	54	54	52	52										
28	S16	-	570	-63	0.0	3	58	58	58	59	59	59	59	59	59	58	57	57																55	55	55	55	55	55	55	55	55	55	55	55										
29	S17	-	1010	-68	0.0	3									52	52	52	52	52	53	53	46	49	49	49	49	49	49	46								48	48	48	48	48	48	48	48	48										
30	S18	-	1440	-71	0.0	3									49	49	49	49	49	50	50	43	46	46	46	46	51	51	50	49	49	49	49	49																				
31	S19	-	1660	-72	0.0	3	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	
32	S20	-	1050	-68	0.0	3	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	69	66	66	66	66	66	66	66	66	66										
33	S21	-	2510	-76	0.0	3							52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52										
34	S22	-	970	-68	0.0	3		64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	65	65	65	65	65	65	58	58	58	58	58	58	58	58	
	Evening time Period (Normal days 1900 - 2300 hrs & PH 0700 - 2300 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	3010	-78	-8.4	3													40	40	40	40	40	40	40	40	40	40	40	40																									
2	Backfilling	114	3010	-78	-8.4	3																									31	31	31	31	31	31	31	31	31	31	31	31													
3	Capping	114	3010	-78	-8.4	3																																					31	31	31	31	31	31	31	31	31	31	31	31	
	Pit 2																																																						
1	Dredging	123	3992	-80	-11.2	3	34	34	34	34	34	34	34	34	34	34	34	34																																					
2	Backfilling	114	3992	-80	-11.2	3													26	26	26	26	26	26	26	26	26	26	26	26																									
3	Capping	114	3992	-80	-11.2	3																									26	26	26	26	26	26	26	26	26	26	26	26													
	Night-time Period (All days 2300 - 0700 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	3010	-78	-8.4	3													40	40	40	40	40	40	40	40	40	40	40	40																									
2	Backfilling	114	3010	-78	-8.4	3																									31	31	31	31	31	31	31	31	31	31	31	31													
3	Capping	114	3010	-78	-8.4	3																																					31	31	31	31	31	31	31	31	31	31	31	31	
	Pit 2																																																						
1	Dredging	123	3992	-80	-11.2	3	34	34	34	34	34	34	34	34	34	34	34	34																																					
2	Backfilling	114	3992	-80	-11.2	3													26	26	26	26	26	26	26	26	26	26	26	26																									
3	Capping	114	3992	-80	-11.2	3																									26	26	26	26	26	26	26	26	26	26	26	26													
	Predicted Noise Level during Daytime Period, dB(A)						34	34	34	34	34	34	34	34	34	34	34	34	40	40	40	40	40	40	40	40	40	40	40	40	32	32	32	32	32	32	32	32	32	32	32	32	31	31	31	31	31	31	31	31	31	31	31	31	40
	Predicted Noise Level during Evening Time Period, dB(A)						34	34	34	34	34	34	34	34	34	34	34	34	40	40	40	40	40	40	40	40	40	40	40	40	32	32	32	32	32	32	32	32	32	32	32	32	31	31	31	31	31	31	31	31	31	31	31	31	40
	Predicted Noise Level during Night-time Period, dB(A)						34	34	34	34	34	34	34	34	34	34	34	34	40	40	40	40	40	40	40	40	40	40	40	40	32	32	32	32	32	32	32	32	32	32	32	32	31	31	31	31	31	31	31	31	31	31	31	31	40
	Predicted Cumulative Noise Level during Daytime Period, dB(A)						70	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	69	69	69	69	69	69	69	69	69	65	59	59	60	60	60	60	59	59	71

Notes:

[1] Distance Correction for PMEs = 10*log(2*PI*r²)

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

[4] Refer to ***Annex D-2b*** for correponding SWL of each month.

Contaminated Sediment Disposal Facility at South of Brothers

Annex D-4b ***Construction Airborne Noise Impact Assessment - Unmitigated***

NSR: N3 Caribbean Coast Phase 1 - Monterey Cove

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)	Predicted Construction Noise Level (dB(A))																																																Max. CNL dB(A)
							2011						2012												2013												2014												2015						
							7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
	Daytime Period (Normal days 0700 - 1900 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	2117	-74	-5.9	3													45	45	45	45	45	45	45	45	45	45	45	45																									
2	Backfilling	114	2117	-74	-5.9	3																									37	37	37	37	37	37	37	37	37	37	37	37												
3	Capping	114	2117	-74	-5.9	3																																					37	37	37	37	37	37	37	37	37	37	37	37	
	Pit 2																																																						
1	Dredging	123	3099	-78	-8.7	3	39	39	39	39	39	39	39	39	39	39	39	39																																					
2	Backfilling	114	3099	-78	-8.7	3													31	31	31	31	31	31	31	31	31	31	31	31																									
3	Capping	114	3099	-78	-8.7	3																									31	31	31	31	31	31	31	31	31	31	31	31												
II)	**Concurrent Projects**																																																						
B	**TM-CLKL [4]**																																																						
4	Pile Cap 1	-	1695	-73	0.0	3																																											48	48	54	54			
5	Pile Cap 2	-	1729	-73	0.0	3																																											48	48	54	54			
6	Pile Cap 3	-	1819	-73	0.0	3																																											48	48	53	53			
7	Pile Cap 4	-	1879	-73	0.0	3																																											48	48	53	53	47	47	
8	Pile Cap 5	-	1939	-74	0.0	3																																											47	47	53	53	46	46	
9	Pile Cap 6	-	1998	-74	0.0	3																																									47	47	52	52			46	46	
10	Pile Cap 7	-	2067	-74	0.0	3																																									47	47	52	52			46	46	
11	Pile Cap 8	-	2131	-75	0.0	3											46	46	52	52																					45	45													
12	Pile Cap 9	-	2178	-75	0.0	3																																			43	43													
13	Pile Cap 10	-	1700	-73	0.0	3													48	48	54	54					47	47																											
14	Pile Cap 11	-	1760	-73	0.0	3											48	48	54	54									47	47																									
15	Pile Cap 12	-	1840	-73	0.0	3													48	48	53	53									47	47																							
16	Pile Cap 13	-	1926	-74	0.0	3											47	47	53	53													46	46																					
17	Pile Cap 14 (Marine)	-	1980	-74	0.0	3							47	47	51	51	44	44																																					
18	Pile Cap 15 (Marine)	-	2020	-74	0.0	3							47	47	50	50	44	44																																					
19	Viaduct section in Area A	-	1819	-73	0.0	3																																								45	46								
20	Viaduct section in Area B	-	1998	-74	0.0	3																																							44	45	45								
21	Cheung Tung Road	-	1926	-74	0.0	3																						50	52	52	52	52	53	53	53	52	53	53	54	54	54	52	52	45	45	45									
C	**HKBCF / HKLR [4]**																																																						
22	S9	-	-	-	0.0	3																																																	
23	S10	-	1720	-73	0.0	3	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	48	48	48	45	45	45	45	45	45	45	45	45										
24	S12	-	1290	-70	0.0	3	52	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	53	53	53	53	53	53	53	53	53	53	53	53	50	50	50	50	50	50	50	50	50										
25	S13	-	1350	-71	0.0	3	29	52	52	52	52	53	53	41	41	41	41	41	41	41	41	41	41	41	41	41						41	41	41																					
26	S14	-	1280	-70	0.0	3	50	50	50	49	49	49	49	49	49	55	55	55	55	55	55	53	53	53	53	53	53	42	42	42	42	42	42	42	42	42																			
27	S15	-	1270	-70	0.0	3																	51	51	53	53	53	53	53	53	53	48	48	48	48	48	48	48	48	48	48	48	48	46	46										
28	S16	-	1300	-70	0.0	3	51	51	51	52	52	52	52	52	52	51	50	50																48	48	48	48	48	48	48	48	48	48	48	48										
29	S17	-	1290	-70	0.0	3									50	50	50	50	50	51	51	44	47	47	47	47	47	47	44								46	46	46	46	46	46	46	46	46										
30	S18	-	1430	-71	0.0	3									49	49	49	49	49	50	50	43	46	46	46	46	51	51	50	49	49	49	49	49																					
31	S19	-	1620	-72	0.0	3	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	
32	S20	-	1850	-73	0.0	3	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	61	61	61	61	61	61	61	61	61										
33	S21	-	2190	-75	0.0	3							53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53										
34	S22	-	1560	-72	0.0	3		60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	61	61	61	61	61	61	54	54	54	54	54	54	54	54	
	Evening time Period (Normal days 1900 - 2300 hrs & PH 0700 - 2300 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	2117	-74	-5.9	3													45	45	45	45	45	45	45	45	45	45	45	45																									
2	Backfilling	114	2117	-74	-5.9	3																									37	37	37	37	37	37	37	37	37	37	37	37												
3	Capping	114	2117	-74	-5.9	3																																					37	37	37	37	37	37	37	37	37	37	37	37	
	Pit 2																																																						
1	Dredging	123	3099	-78	-8.7	3	39	39	39	39	39	39	39	39	39	39	39	39																																					
2	Backfilling	114	3099	-78	-8.7	3													31	31	31	31	31	31	31	31	31	31	31	31																									
3	Capping	114	3099	-78	-8.7	3																									31	31	31	31	31	31	31	31	31	31	31	31												
	Night-time Period (All days 2300 - 0700 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	2117	-74	-5.9	3													45	45	45	45	45	45	45	45	45	45	45	45																									
2	Backfilling	114	2117	-74	-5.9	3																									37	37	37	37	37	37	37	37	37	37	37	37												
3	Capping	114	2117	-74	-5.9	3																																					37	37	37	37	37	37	37	37	37	37	37	37	
	Pit 2																																																						
1	Dredging	123	3099	-78	-8.7	3	39	39	39	39	39	39	39	39	39	39	39	39																																					
2	Backfilling	114	3099	-78	-8.7	3													31	31	31	31	31	31	31	31	31	31	31	31																									
3	Capping	114	3099	-78	-8.7	3																									31	31	31	31	31	31	31	31	31	31	31	31												
	Predicted Noise Level during Daytime Period, dB(A)						39	39	39	39	39	39	39	39	39	39	39	39	45	45	45	45	45	45	45	45	45	45	45	45	38	38	38	38	38	38	38	38	38	38	38	38	37	37	37	37	37	37	37	37	37	37	37	37	45
	Predicted Noise Level during Evening Time Period, dB(A)						39	39	39	39	39	39	39	39	39	39	39	39	45	45	45	45	45	45	45	45	45	45	45	45	38	38	38	38	38	38	38	38	38	38	38	38	37	37	37	37	37	37	37	37	37	37	37	37	45
	Predicted Noise Level during Night-time Period, dB(A)						39	39	39	39	39	39	39	39	39	39	39	39	45	45	45	45	45	45	45	45	45	45	45	45	38	38	38	38	38	38	38	38	38	38	38	38	37	37	37	37	37	37	37	37	37	37	37	37	45
	Predicted Cumulative Noise Level during Daytime Period, dB(A)						64	66	66	66	66	66	66	66	66	67	67	67	67	67	67	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	65	65	65	65	65	65	65	65	65	61	56	56	60	60	61	61	56	56	67

Notes:

[1] Distance Correction for PMEs = 10*log(2*PI*r^2)

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

[4] Refer to ***Annex D-2b*** for correponding SWL of each month.

Contaminated Sediment Disposal Facility at South of Brothers

Annex D-4c ***Construction Airborne Noise Impact Assessment - Unmitigated***

NSR: N4 Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)	Predicted Construction Noise Level (dB(A)) 2011						2012												2013												2014												2015						Max. CNL dB(A)
							7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
	Daytime Period (Normal days 0700 - 1900 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	1216	-70	-3.4	3													53	53	53	53	53	53	53	53	53	53	53	53																									
2	Backfilling	114	1216	-70	-3.4	3																									44	44	44	44	44	44	44	44	44	44	44	44													
3	Capping	114	1216	-70	-3.4	3																																					44	44	44	44	44	44	44	44	44	44	44	44	
	Pit 2																																																						
1	Dredging	123	2200	-75	-6.2	3	45	45	45	45	45	45	45	45	45	45	45	45																																			
2	Backfilling	114	2200	-75	-6.2	3													36	36	36	36	36	36	36	36	36	36	36	36																									
3	Capping	114	2200	-75	-6.2	3																									36	36	36	36	36	36	36	36	36	36	36	36													
II)	**Concurrent Projects**																																																						
B	**TM-CLKL [4]**																																																						
4	Pile Cap 1	-	1085	-69	0.0	3																																											52	52	58	58			
5	Pile Cap 2	-	1117	-69	0.0	3																																											52	52	57	57			
6	Pile Cap 3	-	1198	-70	0.0	3																																											51	51	57	57			
7	Pile Cap 4	-	1252	-70	0.0	3																																											51	51	56	56	50	50	
8	Pile Cap 5	-	1306	-70	0.0	3																																											51	51	56	56	50	50	
9	Pile Cap 6	-	1360	-71	0.0	3																																									50	50	56	56			49	49	
10	Pile Cap 7	-	1415	-71	0.0	3																																									50	50	55	55			49	49	
11	Pile Cap 8	-	1456	-71	0.0	3											50	50	55	55																					49	49													
12	Pile Cap 9	-	1475	-71	0.0	3																																			47	47													
13	Pile Cap 10	-	1059	-68	0.0	3													53	53	58	58					52	52																											
14	Pile Cap 11	-	1113	-69	0.0	3											52	52	57	57									51	51																									
15	Pile Cap 12	-	1183	-69	0.0	3													52	52	57	57											51	51																					
16	Pile Cap 13	-	1243	-70	0.0	3											51	51	57	57															50	50																			
17	Pile Cap 14 (Marine)	-	1280	-70	0.0	3							51	51	54	54	48	48																																			
18	Pile Cap 15 (Marine)	-	1308	-70	0.0	3							51	51	54	54	48	48																																			
19	Viaduct section in Area A	-	1198	-70	0.0	3																																								48	49								
20	Viaduct section in Area B	-	1360	-71	0.0	3																																							47	48	48								
21	Cheung Tung Road	-	1243	-70	0.0	3																							54	56	56	56	56	57	57	57	56	57	57	58	58	58	56	56	49	49	49									
C	**HKBCF / HKLR [4]**																																																						
22	S9	-	4154	-80	0.0	3										37	37	37	37	37	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39																				
23	S10	-	2622	-76	0.0	3	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42	45	45	45	42	42	42	42	42	42	42	42	42										
24	S12	-	2171	-75	0.0	3	47	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	48	48	48	48	48	48	48	48	48	48	48	48	45	45	45	45	45	45	45	45	45										
25	S13	-	2216	-75	0.0	3	25	48	48	48	48	49	49	37	37	37	37	37	37	37	37	37	37	37	37	37						37	37	37																					
26	S14	-	2149	-75	0.0	3	45	45	45	44	44	44	44	44	44	50	50	50	50	50	50	48	48	48	48	48	48	37	37	37	37	37	37	37	37	37																			
27	S15	-	2111	-74	0.0	3																	47	47	49	49	49	49	49	49	49	44	44	44	44	44	44	44	44	44	44	44	44	42	42										
28	S16	-	2060	-74	0.0	3	47	47	47	48	48	48	48	48	48	47	46	46																44	44	44	44	44	44	44	44	44	44	44	44										
29	S17	-	1884	-73	0.0	3									47	47	47	47	47	48	48	41	44	44	44	44	44	44	41								43	43	43	43	43	43	43	43	43										
30	S18	-	1737	-73	0.0	3									47	47	47	47	47	48	48	41	44	44	44	44	49	49	48	47	47	47	47	47																					
31	S19	-	1947	-74	0.0	3	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	
32	S20	-	2803	-77	0.0	3	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	57	57	57	57	57	57	57	57	57										
33	S21	-	1424	-71	0.0	3							57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57										
34	S22	-	2222	-75	0.0	3		57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	58	58	58	58	58	58	51	51	51	51	51	51	51	51	
	Evening time Period (Normal days 1900 - 2300 hrs & PH 0700 - 2300 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	1216	-70	-3.4	3													53	53	53	53	53	53	53	53	53	53	53	53																									
2	Backfilling	114	1216	-70	-3.4	3																									44	44	44	44	44	44	44	44	44	44	44	44													
3	Capping	114	1216	-70	-3.4	3																																					44	44	44	44	44	44	44	44	44	44	44	44	
	Pit 2																																																						
1	Dredging	123	2200	-75	-6.2	3	45	45	45	45	45	45	45	45	45	45	45	45																																			
2	Backfilling	114	2200	-75	-6.2	3													36	36	36	36	36	36	36	36	36	36	36	36																									
3	Capping	114	2200	-75	-6.2	3																									36	36	36	36	36	36	36	36	36	36	36	36													
	Night-time Period (All days 2300 - 0700 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	1216	-70	-3.4	3													53	53	53	53	53	53	53	53	53	53	53	53																									
2	Backfilling	114	1216	-70	-3.4	3																									44	44	44	44	44	44	44	44	44	44	44	44													
3	Capping	114	1216	-70	-3.4	3																																					44	44	44	44	44	44	44	44	44	44	44	44	
	Pit 2																																																						
1	Dredging	123	2200	-75	-6.2	3	45	45	45	45	45	45	45	45	45	45	45	45																																			
2	Backfilling	114	2200	-75	-6.2	3													36	36	36	36	36	36	36	36	36	36	36	36																									
3	Capping	114	2200	-75	-6.2	3																									36	36	36	36	36	36	36	36	36	36	36	36													
	Predicted Noise Level during Daytime Period, dB(A)						45	45	45	45	45	45	45	45	45	45	45	45	53	53	53	53	53	53	53	53	53	53	53	53	45	45	45	45	45	45	45	45	45	45	45	45	44	44	44	44	44	44	44	44	44	44	44	44	53
	Predicted Noise Level during Evening Time Period, dB(A)						45	45	45	45	45	45	45	45	45	45	45	45	53	53	53	53	53	53	53	53	53	53	53	53	45	45	45	45	45	45	45	45	45	45	45	45	44	44	44	44	44	44	44	44	44	44	44	44	53
	Predicted Noise Level during Night-time Period, dB(A)						45	45	45	45	45	45	45	45	45	45	45	45	53	53	53	53	53	53	53	53	53	53	53	53	45	45	45	45	45	45	45	45	45	45	45	45	44	44	44	44	44	44	44	44	44	44	44	44	53
	Predicted Cumulative Noise Level during Daytime Period, dB(A)						61	62	62	62	62	62	64	64	65	65	65	65	66	66	66	65	64	64	64	64	64	65	65	65	64	64	65	65	64	64	63	63	64	64	64	64	63	63	63	59	57	56	62	62	64	64	57	57	66

Notes:

[1] Distance Correction for PMEs = 10*log(2*PI*r^2)

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

[4] Refer to ***Annex D-2b*** for correponding SWL of each month.

Contaminated Sediment Disposal Facility at South of Brothers

Annex D-4d Construction Airborne Noise Impact Assessment - Unmitigated

NSR: N5 Ho Yu Secondary School

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)	Predicted Construction Noise Level (dB(A))																																																	Max. CNL dB(A)
							2011						2012												2013												2014												2015						
							7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
	Daytime Period (Normal days 0700 - 1900 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	2322	-75	-6.5	3													44	44	44	44	44	44	44	44	44	44	44	44																									
2	Backfilling	114	2322	-75	-6.5	3																									35	35	35	35	35	35	35	35	35	35	35	35													
3	Capping	114	2322	-75	-6.5	3																																					35	35	35	35	35	35	35	35	35	35	35	35	
	Pit 2																																																						
1	Dredging	123	3306	-78	-9.3	3	38	38	38	38	38	38	38	38	38	38	38	38																																					
2	Backfilling	114	3306	-78	-9.3	3													29	29	29	29	29	29	29	29	29	29	29	29																									
3	Capping	114	3306	-78	-9.3	3																									29	29	29	29	29	29	29	29	29	29	29	29													
II)	**Concurrent Projects**																																																						
B	**TM-CLKL** [4]																																																						
4	Pile Cap 1	-	1973	-74	0.0	3																																											47	47	53	53			
5	Pile Cap 2	-	2007	-74	0.0	3																																											47	47	52	52			
6	Pile Cap 3	-	2097	-74	0.0	3																																											47	47	52	52			
7	Pile Cap 4	-	2157	-75	0.0	3																																											46	46	52	52	45	45	
8	Pile Cap 5	-	2217	-75	0.0	3																																											46	46	52	52	45	45	
9	Pile Cap 6	-	2277	-75	0.0	3																																									46	46	51	51			45	45	
10	Pile Cap 7	-	2345	-75	0.0	3																																									46	46	51	51			45	45	
11	Pile Cap 8	-	2408	-76	0.0	3											45	45	51	51																					44	44													
12	Pile Cap 9	-	2453	-76	0.0	3																																			42	42													
13	Pile Cap 10	-	1976	-74	0.0	3													47	47	53	53					46	46																											
14	Pile Cap 11	-	2037	-74	0.0	3											47	47	52	52									46	46																									
15	Pile Cap 12	-	2116	-74	0.0	3													47	47	52	52									46	46																							
16	Pile Cap 13	-	2201	-75	0.0	3											46	46	52	52													45	45																					
17	Pile Cap 14 (Marine)	-	2254	-75	0.0	3							46	46	49	49	43	43																																					
18	Pile Cap 15 (Marine)	-	2293	-75	0.0	3							46	46	49	49	43	43																																					
19	Viaduct section in Area A	-	2097	-74	0.0	3																																									44	45								
20	Viaduct section in Area B	-	2277	-75	0.0	3																																								43	44	44								
21	Cheung Tung Road	-	2201	-75	0.0	3																						49	51	51	51	51	52	52	52	51	52	52	53	53	53	51	51	44	44	44									
C	**HKBCF / HKLR** [4]																																																						
22	S9	-	-	-	0.0	3																																																	
23	S10	-	1980	-74	0.0	3	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	47	47	47	44	44	44	44	44	44	44	44	44										
24	S12	-	1550	-72	0.0	3	50	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	51	51	51	51	51	51	51	51	51	51	51	51	48	48	48	48	48	48	48	48	48										
25	S13	-	1600	-72	0.0	3	28	51	51	51	51	52	52	40	40	40	40	40	40	40	40	40	40	40	40	40						40	40	40																					
26	S14	-	1540	-72	0.0	3	48	48	48	47	47	47	47	47	47	53	53	53	53	53	53	51	51	51	51	51	51	40	40	40	40	40	40	40	40	40																			
27	S15	-	1520	-72	0.0	3																	49	49	51	51	51	51	51	51	51	46	46	46	46	46	46	46	46	46	46	46	46	44	44										
28	S16	-	1550	-72	0.0	3	49	49	49	50	50	50	50	50	50	49	48	48																46	46	46	46	46	46	46	46	46	46	46	46										
29	S17	-	1500	-72	0.0	3									48	48	48	48	48	49	49	42	45	45	45	45	45	45	42								44	44	44	44	44	44	44	44	44										
30	S18	-	1580	-72	0.0	3									48	48	48	48	48	49	49	42	45	45	45	45	50	50	49	48	48	48	48																					
31	S19	-	1760	-73	0.0	3	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	
32	S20	-	2110	-74	0.0	3	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	60	60	60	60	60	60	60	60	60										
33	S21	-	2070	-74	0.0	3							54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54										
34	S22	-	1790	-73	0.0	3		59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	60	60	60	60	60	60	53	53	53	53	53	53	53	53	
	Evening time Period (Normal days 1900 - 2300 hrs & PH 0700 - 2300 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	2322	-75	-6.5	3													44	44	44	44	44	44	44	44	44	44	44	44																									
2	Backfilling	114	2322	-75	-6.5	3																									35	35	35	35	35	35	35	35	35	35	35	35													
3	Capping	114	2322	-75	-6.5	3																																					35	35	35	35	35	35	35	35	35	35	35	35	
	Pit 2																																																						
1	Dredging	123	3306	-78	-9.3	3	38	38	38	38	38	38	38	38	38	38	38	38																																					
2	Backfilling	114	3306	-78	-9.3	3													29	29	29	29	29	29	29	29	29	29	29	29																									
3	Capping	114	3306	-78	-9.3	3																									29	29	29	29	29	29	29	29	29	29	29	29													
	Night-time Period (All days 2300 - 0700 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	2322	-75	-6.5	3													44	44	44	44	44	44	44	44	44	44	44	44																									
2	Backfilling	114	2322	-75	-6.5	3																									35	35	35	35	35	35	35	35	35	35	35	35													
3	Capping	114	2322	-75	-6.5	3																																					35	35	35	35	35	35	35	35	35	35	35	35	
	Pit 2																																																						
1	Dredging	123	3306	-78	-9.3	3	38	38	38	38	38	38	38	38	38	38	38	38																																					
2	Backfilling	114	3306	-78	-9.3	3													29	29	29	29	29	29	29	29	29	29	29	29																									
3	Capping	114	3306	-78	-9.3	3																									29	29	29	29	29	29	29	29	29	29	29	29													
	Predicted Noise Level during Daytime Period, dB(A)						38	38	38	38	38	38	38	38	38	38	38	38	44	44	44	44	44	44	44	44	44	44	44	44	36	36	36	36	36	36	36	36	36	36	36	36	35	35	35	35	35	35	35	35	35	35	35	35	44
	Predicted Noise Level during Evening Time Period, dB(A)						38	38	38	38	38	38	38	38	38	38	38	38	44	44	44	44	44	44	44	44	44	44	44	44	36	36	36	36	36	36	36	36	36	36	36	36	35	35	35	35	35	35	35	35	35	35	35	35	44
	Predicted Noise Level during Night-time Period, dB(A)						38	38	38	38	38	38	38	38	38	38	38	38	44	44	44	44	44	44	44	44	44	44	44	44	36	36	36	36	36	36	36	36	36	36	36	36	35	35	35	35	35	35	35	35	35	35	35	35	44
	Predicted Cumulative Noise Level during Daytime Period, dB(A)						63	65	65	65	65	65	65	65	65	65	65	65	66	66	66	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	64	64	64	64	64	64	64	64	64	60	55	54	58	58	60	60	55	55	66

Notes:

[1] Distance Correction for PMEs = 10*log(2*PI*r²)

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

[4] Refer to ***Annex D-2b*** for correponding SWL of each month.

Contaminated Sediment Disposal Facility at South of Brothers

Annex D-4e ***Construction Airborne Noise Impact Assessment - Unmitigated***

NSR: N6 Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)	Predicted Construction Noise Level (dB(A)) 2011						2012												2013												2014												2015						Max. CNL dB(A)
							7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
	Daytime Period (Normal days 0700 - 1900 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	706	-65	-2.0	3													59	59	59	59	59	59	59	59	59	59	59	59																									
2	Backfilling	114	706	-65	-2.0	3																									50	50	50	50	50	50	50	50	50	50	50	50													
3	Capping	114	706	-65	-2.0	3																																					50	50	50	50	50	50	50	50	50	50	50	50	
	Pit 2																																																						
1	Dredging	123	1679	-72	-4.7	3	48	48	48	48	48	48	48	48	48	48	48	48																																					
2	Backfilling	114	1679	-72	-4.7	3													40	40	40	40	40	40	40	40	40	40	40	40																									
3	Capping	114	1679	-72	-4.7	3																									40	40	40	40	40	40	40	40	40	40	40	40													
II)	**Concurrent Projects**																																																						
B	**TM-CLKL [4]**																																																						
4	Pile Cap 1	-	575	-63	0.0	3																																					58	58	63	63			
5	Pile Cap 2	-	597	-63	0.0	3																																					58	58	63	63			
6	Pile Cap 3	-	655	-64	0.0	3																																					57	57	62	62			
7	Pile Cap 4	-	695	-65	0.0	3																																					56	56	62	62	55	55	
8	Pile Cap 5	-	738	-65	0.0	3																																					56	56	61	61	55	55	
9	Pile Cap 6	-	782	-66	0.0	3																																			55	55	61	61			54	54	
10	Pile Cap 7	-	824	-66	0.0	3																																			55	55	60	60			54	54	
11	Pile Cap 8	-	849	-67	0.0	3											54	54	60	60																					53	53													
12	Pile Cap 9	-	854	-67	0.0	3																																			51	51													
13	Pile Cap 10	-	527	-62	0.0	3													59	59	64	64					58	58																											
14	Pile Cap 11	-	564	-63	0.0	3											58	58	63	63									57	57																									
15	Pile Cap 12	-	614	-64	0.0	3													57	57	63	63									56	56																							
16	Pile Cap 13	-	648	-64	0.0	3											57	57	62	62													56	56																					
17	Pile Cap 14 (Marine)	-	671	-65	0.0	3							56	56	60	60	53	53																																					
18	Pile Cap 15 (Marine)	-	690	-65	0.0	3							56	56	60	60	53	53																																					
19	Viaduct section in Area A	-	655	-64	0.0	3																																									54	55								
20	Viaduct section in Area B	-	782	-66	0.0	3																																								52	53	53								
21	Cheung Tung Road	-	648	-64	0.0	3																								60	62	62	62	62	63	63	63	62	63	63	64	64	64	62	62	55	55	55									
C	**HKBCF / HKLR [4]**																																																						
22	S9	-	4799	-82	0.0	3										35	35	35	35	35	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37																			
23	S10	-	3259	-78	0.0	3	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	43	43	43	40	40	40	40	40	40	40	40	40										
24	S12	-	2813	-77	0.0	3	45	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	46	46	46	46	46	46	46	46	46	46	46	46	43	43	43	43	43	43	43	43	43										
25	S13	-	2859	-77	0.0	3	23	46	46	46	46	47	47	35	35	35	35	35	35	35	35	35	35	35	35	35						35	35	35																					
26	S14	-	2792	-77	0.0	3	43	43	43	42	42	42	42	42	42	48	48	48	48	48	48	46	46	46	46	46	46	35	35	35	35	35	35	35	35	35																			
27	S15	-	2755	-77	0.0	3																	44	44	46	46	46	46	46	46	46	41	41	41	41	41	41	41	41	41	41	41	41	39	39									
28	S16	-	2705	-77	0.0	3	44	44	44	45	45	45	45	45	45	44	43	43																41	41	41	41	41	41	41	41	41	41	41	41										
29	S17	-	2523	-76	0.0	3									44	44	44	44	44	45	45	38	41	41	41	41	41	41	38								40	40	40	40	40	40	40	40	40										
30	S18	-	2348	-75	0.0	3									45	45	45	45	45	46	46	39	42	42	42	42	47	47	46	45	45	45	45	45																					
31	S19	-	2518	-76	0.0	3	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	
32	S20	-	3436	-79	0.0	3	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	55	55	55	55	55	55	55	55	55										
33	S21	-	1637	-72	0.0	3							56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56										
34	S22	-	2865	-77	0.0	3		55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	56	56	56	56	56	56	49	49	49	49	49	49	49	49	
	Evening time Period (Normal days 1900 - 2300 hrs & PH 0700 - 2300 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	706	-65	-2.0	3													59	59	59	59	59	59	59	59	59	59	59	59																									
2	Backfilling	114	706	-65	-2.0	3																									50	50	50	50	50	50	50	50	50	50	50	50													
3	Capping	114	706	-65	-2.0	3																																					50	50	50	50	50	50	50	50	50	50	50	50	
	Pit 2																																																						
1	Dredging	123	1679	-72	-4.7	3	48	48	48	48	48	48	48	48	48	48	48	48																																					
2	Backfilling	114	1679	-72	-4.7	3													40	40	40	40	40	40	40	40	40	40	40	40																									
3	Capping	114	1679	-72	-4.7	3																									40	40	40	40	40	40	40	40	40	40	40	40													
	Night-time Period (All days 2300 - 0700 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	706	-65	-2.0	3													59	59	59	59	59	59	59	59	59	59	59	59																									
2	Backfilling	114	706	-65	-2.0	3																									50	50	50	50	50	50	50	50	50	50	50	50													
3	Capping	114	706	-65	-2.0	3																																					50	50	50	50	50	50	50	50	50	50	50	50	
	Pit 2																																																						
1	Dredging	123	1679	-72	-4.7	3	48	48	48	48	48	48	48	48	48	48	48	48																																					
2	Backfilling	114	1679	-72	-4.7	3													40	40	40	40	40	40	40	40	40	40	40	40																									
3	Capping	114	1679	-72	-4.7	3																									40	40	40	40	40	40	40	40	40	40	40	40													
	Predicted Noise Level during Daytime Period, dB(A)						48	48	48	48	48	48	48	48	48	48	48	48	59	59	59	59	59	59	59	59	59	59	59	59	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	59
	Predicted Noise Level during Evening Time Period, dB(A)						48	48	48	48	48	48	48	48	48	48	48	48	59	59	59	59	59	59	59	59	59	59	59	59	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	59
	Predicted Noise Level during Night-time Period, dB(A)						48	48	48	48	48	48	48	48	48	48	48	48	59	59	59	59	59	59	59	59	59	59	59	59	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	59
	Predicted Cumulative Noise Level during Daytime Period, dB(A)						59	61	61	61	61	61	64	64	65	65	65	65	69	69	68	68	64	64	64	64	65	66	66	66	65	65	66	66	65	65	65	65	66	66	66	65	64	62	62	61	61	59	67	67	69	69	61	61	69

Notes:

[1] Distance Correction for PMEs = 10*log(2*PI*r^2)

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

[4] Refer to ***Annex D-2b*** for correponding SWL of each month.

Contaminated Sediment Disposal Facility at South of Brothers

Annex D-4f ***Construction Airborne Noise Impact Assessment - Unmitigated***

NSR: N7 Coastal Skyline Phase 4 - Le Bleu Deux

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)	Predicted Construction Noise Level (dB(A))																																																Max. CNL dB(A)
							2011						2012												2013												2014												2015						
							7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
	Daytime Period (Normal days 0700 - 1900 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																							
1	Dredging	123	2674	-77	-7.5	3													42	42	42	42	42	42	42	42	42	42	42	42																									
2	Backfilling	114	2674	-77	-7.5	3																									33	33	33	33	33	33	33	33	33	33	33	33													
3	Capping	114	2674	-77	-7.5	3																																					33	33	33	33	33	33	33	33	33	33	33	33	
	Pit 2																																																						
1	Dredging	123	3658	-79	-10.2	3	36	36	36	36	36	36	36	36	36	36	36	36																																					
2	Backfilling	114	3658	-79	-10.2	3													27	27	27	27	27	27	27	27	27	27	27	27																									
3	Capping	114	3658	-79	-10.2	3																									27	27	27	27	27	27	27	27	27	27	27	27													
II)	**Concurrent Projects**																																																						
B	**TM-CLKL [4]**																																																						
4	Pile Cap 1	-	2315	-75	0.0	3																																											46	46	51	51			
5	Pile Cap 2	-	2349	-75	0.0	3																																											46	46	51	51			
6	Pile Cap 3	-	2440	-76	0.0	3																																											45	45	51	51			
7	Pile Cap 4	-	2500	-76	0.0	3																																											45	45	50	50	44	44	
8	Pile Cap 5	-	2560	-76	0.0	3																																											45	45	50	50	44	44	
9	Pile Cap 6	-	2619	-76	0.0	3																																									45	45	50	50			44	44	
10	Pile Cap 7	-	2687	-77	0.0	3																																									44	44	50	50			43	43	
11	Pile Cap 8	-	2750	-77	0.0	3											44	44	50	50																							43	43													
12	Pile Cap 9	-	2793	-77	0.0	3																																					41	41													
13	Pile Cap 10	-	2318	-75	0.0	3													46	46	51	51					45	45																													
14	Pile Cap 11	-	2378	-76	0.0	3											45	45	51	51									44	44																									
15	Pile Cap 12	-	2458	-76	0.0	3													45	45	51	51											44	44																					
16	Pile Cap 13	-	2541	-76	0.0	3											45	45	50	50															44	44																			
17	Pile Cap 14 (Marine)	-	2594	-76	0.0	3							45	45	48	48	42	42																																					
18	Pile Cap 15 (Marine)	-	2633	-76	0.0	3							45	45	48	48	42	42																																					
19	Viaduct section in Area A	-	2440	-76	0.0	3																																									42	43								
20	Viaduct section in Area B	-	2619	-76	0.0	3																																								42	43	43								
21	Cheung Tung Road	-	2541	-76	0.0	3																							48	50	50	50	50	51	51	51	50	51	51	52	52	52	50	50	43	43	43									
C	**HKBCF / HKLR [4]**																																																						
22	S9	-	2930	-77	0.0	3										40	40	40	40	40	42	42	42	42	42	42	42	42	42	42	42	42	42	42	42																				
23	S10	-	1320	-70	0.0	3	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	51	51	51	48	48	48	48	48	48	48	48	48										
24	S12	-	910	-67	0.0	3	55	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	56	56	56	56	56	56	56	56	56	56	56	56	53	53	53	53	53	53	53	53	53										
25	S13	-	950	-68	0.0	3	32	55	55	55	55	56	56	44	44	44	44	44	44	44	44	44	44	44	44	44						44	44	44																					
26	S14	-	910	-67	0.0	3	53	53	53	52	52	52	52	52	52	58	58	58	58	58	58	56	56	56	56	56	56	45	45	45	45	45	45	45	45	45																			
27	S15	-	910	-67	0.0	3																	54	54	56	56	56	56	56	56	56	51	51	51	51	51	51	51	51	51	51	51	51	49	49										
28	S16	-	960	-68	0.0	3	53	53	53	54	54	54	54	54	54	53	52	52																50	50	50	50	50	50	50	50	50	50	50	50										
29	S17	-	1210	-70	0.0	3									50	50	50	50	50	51	51	44	47	47	47	47	47	47	44								46	46	46	46	46	46	46	46	46										
30	S18	-	1500	-72	0.0	3									48	48	48	48	48	49	49	42	45	45	45	45	50	50	49	48	48	48	48																						
31	S19	-	1720	-73	0.0	3	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	
32	S20	-	1440	-71	0.0	3	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	66	63	63	63	63	63	63	63	63	63										
33	S21	-	2350	-75	0.0	3							53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53										
34	S22	-	1240	-70	0.0	3		62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	63	63	63	63	63	63	56	56	56	56	56	56	56	56	
	Evening time Period (Normal days 1900 - 2300 hrs & PH 0700 - 2300 hrs)																																																							
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																							
1	Dredging	123	2674	-77	-7.5	3													42	42	42	42	42	42	42	42	42	42	42	42																									
2	Backfilling	114	2674	-77	-7.5	3																									33	33	33	33	33	33	33	33	33	33	33	33													
3	Capping	114	2674	-77	-7.5	3																																					33	33	33	33	33	33	33	33	33	33	33	33	
	Pit 2																																																						
1	Dredging	123	3658	-79	-10.2	3	36	36	36	36	36	36	36	36	36	36	36	36																																					
2	Backfilling	114	3658	-79	-10.2	3													27	27	27	27	27	27	27	27	27	27	27	27																									
3	Capping	114	3658	-79	-10.2	3																									27	27	27	27	27	27	27	27	27	27	27	27													
	Night-time Period (All days 2300 - 0700 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																							
1	Dredging	123	2674	-77	-7.5	3													42	42	42	42	42	42	42	42	42	42	42	42																									
2	Backfilling	114	2674	-77	-7.5	3																									33	33	33	33	33	33	33	33	33	33	33	33													
3	Capping	114	2674	-77	-7.5	3																																					33	33	33	33	33	33	33	33	33	33	33	33	
	Pit 2																																																						
1	Dredging	123	3658	-79	-10.2	3	36	36	36	36	36	36	36	36	36	36	36	36																																					
2	Backfilling	114	3658	-79	-10.2	3													27	27	27	27	27	27	27	27	27	27	27	27																									
3	Capping	114	3658	-79	-10.2	3																									27	27	27	27	27	27	27	27	27	27	27	27													
Predicted Noise Level during Daytime Period, dB(A)							36	36	36	36	36	36	36	36	36	36	36	36	42	42	42	42	42	42	42	42	42	42	42	42	34	34	34	34	34	34	34	34	34	34	34	34	33	33	33	33	33	33	33	33	33	33	33	33	42
Predicted Noise Level during Evening Time Period, dB(A)							36	36	36	36	36	36	36	36	36	36	36	36	42	42	42	42	42	42	42	42	42	42	42	42	34	34	34	34	34	34	34	34	34	34	34	34	33	33	33	33	33	33	33	33	33	33	33	33	42
Predicted Noise Level during Night-time Period, dB(A)							36	36	36	36	36	36	36	36	36	36	36	36	42	42	42	42	42	42	42	42	42	42	42	42	34	34	34	34	34	34	34	34	34	34	34	34	33	33	33	33	33	33	33	33	33	33	33	33	42
Predicted Cumulative Noise Level during Daytime Period, dB(A)							67	68	68	68	68	68	68	68	68	69	68	68	69	69	68	68	68	68	68	68	69	68	68	68	68	68	68	68	68	68	66	66	66	66	67	67	67	67	67	63	57	57	59	59	60	60	57	57	69

Notes:

[1] Distance Correction for PMEs = 10*log(2*PI*r^2)

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

[4] Refer to ***Annex D-2b*** for correponding SWL of each month.

Contaminated Sediment Disposal Facility at South of Brothers

Annex D-4g Construction Airborne Noise Impact Assessment - Unmitigated

NSR: N8 Pak Mong Village House

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)	Predicted Construction Noise Level (dB(A))																																																Max. CNL dB(A)
							2011						2012												2013												2014												2015						
							7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
	Daytime Period (Normal days 0700 - 1900 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																						
	Pit 1																																																						
1	Dredging	123	1073	-69	-3.0	3													54	54	54	54	54	54	54	54	54	54	54	54																									
2	Backfilling	114	1073	-69	-3.0	3																									45	45	45	45	45	45	45	45	45	45	45	45													
3	Capping	114	1073	-69	-3.0	3																																					45	45	45	45	45	45	45	45	45	45	45	45	
	Pit 2																																																						
1	Dredging	123	1847	-73	-5.2	3	47	47	47	47	47	47	47	47	47	47	47	47																																					
2	Backfilling	114	1847	-73	-5.2	3													38	38	38	38	38	38	38	38	38	38	38	38																									
3	Capping	114	1847	-73	-5.2	3																									38	38	38	38	38	38	38	38	38	38	38	38													
II)	**Concurrent Projects**																																																						
B	**TM-CLKL [4]**																																																						
4	Pile Cap 1	-	462	-61	0.0	3																																											60	60	65	65			
5	Pile Cap 2	-	420	-60	0.0	3																																											61	61	66	66			
6	Pile Cap 3	-	384	-60	0.0	3																																											61	61	67	67			
7	Pile Cap 4	-	350	-59	0.0	3																																											62	62	68	68	61	61	
8	Pile Cap 5	-	328	-58	0.0	3																																											63	63	68	68	62	62	
9	Pile Cap 6	-	318	-58	0.0	3																																									63	63	68	68			62	62	
10	Pile Cap 7	-	330	-58	0.0	3																																									63	63	68	68			62	62	
11	Pile Cap 8	-	396	-60	0.0	3											61	61	66	66																							60	60													
12	Pile Cap 9	-	480	-62	0.0	3																																					56	56													
13	Pile Cap 10	-	500	-62	0.0	3													59	59	64	64					58	58																													
14	Pile Cap 11	-	462	-61	0.0	3											60	60	65	65									59	59																											
15	Pile Cap 12	-	430	-61	0.0	3													60	60	66	66									59	59																									
16	Pile Cap 13	-	440	-61	0.0	3											60	60	66	66													59	59																					
17	Pile Cap 14 (Marine)	-	456	-61	0.0	3							60	60	63	63	57	57																																							
18	Pile Cap 15 (Marine)	-	484	-62	0.0	3							59	59	63	63	56	56																																							
19	Viaduct section in Area A	-	384	-60	0.0	3																																									58	59								
20	Viaduct section in Area B	-	318	-58	0.0	3																																								60	61	61								
21	Cheung Tung Road	-	445	-61	0.0	3																						63	65	65	65	65	66	66	66	65	66	66	67	67	67	65	65	58	58	58									
C	**HKBCF / HKLR [4]**																																																						
22	S9	-	5550	-83	0.0	3										34	34	34	34	34	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36																				
23	S10	-	3919	-80	0.0	3	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	38	41	41	41	38	38	38	38	38	38	38	38	38										
24	S12	-	3524	-79	0.0	3	43	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	44	44	44	44	44	44	44	44	44	44	44	44	41	41	41	41	41	41	41	41	41										
25	S13	-	3572	-79	0.0	3	21	44	44	44	44	45	45	33	33	33	33	33	33	33	33	33	33	33	33	33						33	33	33																					
26	S14	-	3506	-79	0.0	3	41	41	41	40	40	40	40	40	40	46	46	46	46	46	46	44	44	44	44	44	44	33	33	33	33	33	33	33	33	33																			
27	S15	-	3486	-79	0.0	3																	42	42	44	44	44	44	44	44	44	39	39	39	39	39	39	39	39	39	39	39	39	37	37										
28	S16	-	3464	-79	0.0	3	42	42	42	43	43	43	43	43	43	42	41	41																39	39	39	39	39	39	39	39	39	39	39	39										
29	S17	-	3356	-78	0.0	3									42	42	42	42	42	43	43	36	39	39	39	39	39	39	36								38	38	38	38	38	38	38	38	38										
30	S18	-	3261	-78	0.0	3									42	42	42	42	42	43	43	36	39	39	39	39	44	44	43	42	42	42	42	42																				
31	S19	-	3478	-79	0.0	3	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	
32	S20	-	4068	-80	0.0	3	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	54	54	54	54	54	54	54	54	54										
33	S21	-	2649	-76	0.0	3							52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52	52										
34	S22	-	3673	-79	0.0	3		53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	53	54	54	54	54	54	54	54	47	47	47	47	47	47	47	47	
	Evening time Period (Normal days 1900 - 2300 hrs & PH 0700 - 2300 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																							
	Pit 1																																																						
1	Dredging	123	1073	-69	-3.0	3													54	54	54	54	54	54	54	54	54	54	54	54																									
2	Backfilling	114	1073	-69	-3.0	3																									45	45	45	45	45	45	45	45	45	45	45	45													
3	Capping	114	1073	-69	-3.0	3																																					45	45	45	45	45	45	45	45	45	45	45	45	
	Pit 2																																																						
1	Dredging	123	1847	-73	-5.2	3	47	47	47	47	47	47	47	47	47	47	47	47																																					
2	Backfilling	114	1847	-73	-5.2	3													38	38	38	38	38	38	38	38	38	38	38	38																									
3	Capping	114	1847	-73	-5.2	3																									38	38	38	38	38	38	38	38	38	38	38	38													
	Night-time Period (All days 2300 - 0700 hrs)																																																						
I)	**South Brothers Mud Pit**																																																						
A	**Construction / Operation**																																																							
	Pit 1																																																						
1	Dredging	123	1073	-69	-3.0	3													54	54	54	54	54	54	54	54	54	54	54	54																									
2	Backfilling	114	1073	-69	-3.0	3																									45	45	45	45	45	45	45	45	45	45	45	45													
3	Capping	114	1073	-69	-3.0	3																																					45	45	45	45	45	45	45	45	45	45	45	45	
	Pit 2																																																						
1	Dredging	123	1847	-73	-5.2	3	47	47	47	47	47	47	47	47	47	47	47	47																																					
2	Backfilling	114	1847	-73	-5.2	3													38	38	38	38	38	38	38	38	38	38	38	38																									
3	Capping	114	1847	-73	-5.2	3																									38	38	38	38	38	38	38	38	38	38	38	38													
Predicted Noise Level during Daytime Period, dB(A)							47	47	47	47	47	47	47	47	47	47	47	47	54	54	54	54	54	54	54	54	54	54	54	54	46	46	46	46	46	46	46	46	46	46	46	46	45	45	45	45	45	45	45	45	45	45	45	45	54
Predicted Noise Level during Evening Time Period, dB(A)							47	47	47	47	47	47	47	47	47	47	47	47	54	54	54	54	54	54	54	54	54	54	54	54	46	46	46	46	46	46	46	46	46	46	46	46	45	45	45	45	45	45	45	45	45	45	45	45	54
Predicted Noise Level during Night-time Period, dB(A)							47	47	47	47	47	47	47	47	47	47	47	47	54	54	54	54	54	54	54	54	54	54	54	54	46	46	46	46	46	46	46	46	46	46	46	46	45	45	45	45	45	45	45	45	45	45	45	45	54
Predicted Cumulative Noise Level during Daytime Period, dB(A)							58	59	59	59	59	59	64	64	67	67	67	67	72	72	69	69	61	61	61	61	63	66	67	67	67	67	68	68	67	66	67	67	68	68	69	67	66	61	64	65	68	66	73	73	74	74	68	68	74

Notes:

[1] Distance Correction for PMEs = 10*log(2*PI*r²)

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

[4] Refer to ***Annex D-2b*** for correponding SWL of each month.

Annex E

Noise Calculations – Mitigated Scenario

Contaminated Sediment Disposal Facility at South of Brothers

__Annex E-1 Preliminary Construction Programme - Mitigated__

	Year	2011						2012												2013												2014												2015					
		Jul-Dec						Jan-Jun						Jul-Dec						Jan-Jun						Jul-Dec						Jan-Jun						Jul-Dec						Jan-Jun					
No.	**Activity Description** / **Month**	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
	Night-time Period (All days 2300 - 0700 hrs)																																																
I)	**South Brothers Mud Pit**																																																
A	**Construction / Operation**																																																
	Pit 1																																																
1	Dredging													Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																								
2	Backfilling																									Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y												
3	Capping																																					Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Pit 2																																																
1	Dredging	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																				
2	Backfilling													Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																								
3	Capping																									Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y												

Notes:

[1] Approved TM-CLKL EIA (*Register No.: AEIAR-146/2009*)

[2] Approved HKBCF EIA (*Register No.: AEIAR-145/2009*)

[3] S2-S4, S6-S8 of HKLR located more than 5km away from the SB facility and therefore not included in the assessment.
S1, S5 and S11 of HKLR is not concurrent with the programme of the SB facility and therefore not included in the assessment.

Annex E-2 Construction Plant Inventory - Mitigated

No.	Activities	Plant	TM	No. of PME	On-time %	Unit SWL, dB(A)	SWL, dB(A)	Total SWL, dB(A)[1]
	Night-time Period (All days 2300 - 0700 hrs)							
I)	**South Brothers Mud Pit**							
A	**Construction / Operation**							
	Pit 1							
1	Dredging	Dredger, grab	CNP 063	2	100%	112	115	**118**
		Hopper barge	CNP 061	3	100%	104	109	
		Tug boat	CNP 221	3	100%	110	115	
2	Backfilling	Hopper barge	CNP 061	1	100%	104	104	**111**
		Tug boat	CNP 221	1	100%	110	110	
3	Capping	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
	Pit 2							
1	Dredging	Dredger, grab	CNP 063	3	100%	112	117	**120**
		Hopper barge	CNP 061	4	100%	104	110	
		Tug boat	CNP 221	4	100%	110	116	
2	Backfilling	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	
3	Capping	Hopper barge	CNP 061	2	100%	104	107	**114**
		Tug boat	CNP 221	2	100%	110	113	

Notes:

[1] The figures are rounded-off to a whole number.

Annex E-3 Summary of Predicted Noise Levels during Night-time Period - Mitigated

Predicted Construction Noise Level (dB(A)) — 2011 to 2012

	NSR Location	GW-TM Noise Criteria, dB(A)	2011						2012											
			7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
N2	Tung Chung Crescent III - Seaview Crescent	50	32	32	32	32	32	32	32	32	32	32	32	32	36	36	36	36	36	36
N3	Caribbean Coast Phase 1 - Monterey Cove	50	36	36	36	36	36	36	36	36	36	36	36	36	41	41	41	41	41	41
N4	Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	50	42	42	42	42	42	42	42	42	42	42	42	42	49	49	49	49	49	49
N5	Ho Yu Secondary School	-	35	35	35	35	35	35	35	35	35	35	35	35	40	40	40	40	40	40
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	50	46	46	46	46	46	46	46	46	46	46	46	46	**54**	**54**	**54**	**54**	**54**	**54**
N7	Coastal Skyline Phase 4 - Le Bleu Deux	50	33	33	33	33	33	33	33	33	33	33	33	33	38	38	38	38	38	38
N8	Pak Mong Village House	45	44	44	44	44	44	44	44	44	44	44	44	44	45	45	45	45	45	45

Predicted Construction Noise Level (dB(A)) — 2013 to 2015

	NSR Location	2013												2014												2015						Max. CNL, dB(A)
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
N2	Tung Chung Crescent III - Seaview Crescent	36	36	36	36	36	36	30	30	30	30	30	30	30	30	30	30	30	30	31	31	31	31	31	31	31	31	31	31	31	31	36
N3	Caribbean Coast Phase 1 - Monterey Cove	41	41	41	41	41	41	35	35	35	35	35	35	35	35	35	35	35	35	36	36	36	36	36	36	36	36	36	36	36	36	41
N4	Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)	49	49	49	49	49	49	42	42	42	42	42	42	42	42	42	42	42	42	44	44	44	44	44	44	44	44	44	44	44	44	49
N5	Ho Yu Secondary School	40	40	40	40	40	40	34	34	34	34	34	34	34	34	34	34	34	34	35	35	35	35	35	35	35	35	35	35	35	35	40
N6	Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)	**54**	**54**	**54**	**54**	**54**	**54**	47	47	47	47	47	47	47	47	47	47	47	47	49	49	49	49	49	49	49	49	49	49	49	49	54
N7	Coastal Skyline Phase 4 - Le Bleu Deux	38	38	38	38	38	38	32	32	32	32	32	32	32	32	32	32	32	32	33	33	33	33	33	33	33	33	33	33	33	33	38
N8	Pak Mong Village House	45	45	45	45	45	45	44	44	44	44	44	44	44	44	44	44	44	44	45	45	45	45	45	45	45	45	45	45	45	45	45

Note:

55 Predicted Noise Level exceeded the corresponding GW-TM noise criteria.

Contaminated Sediment Disposal Facility at South of Brothers

Annex E-4a *Construction Airborne Noise Impact Assessment - Unmitigated*

NSR: N2 Tung Chung Crescent III - Seaview Crescent

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Corr. For Topo dB(A)[3]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)	Predicted Construction Noise Level (dB(A))																																																Max. CNL dB(A)
								2011						2012												2013												2014												2015						
								7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
	Night-time Period (All days 2300 - 0700 hrs)																																																							
I)	**South Brothers Mud Pit**																																																							
A	**Construction / Operation**																																																							
	Pit 1																																																							
1	Dredging	118	3019	-78	0.0	-8.5	3													35	35	35	35	35	35	35	35	35	35	35	35																									
2	Backfilling	111	3019	-78	0.0	-8.5	3																									28	28	28	28	28	28	28	28	28	28	28	28													
3	Capping	114	3019	-78	0.0	-8.5	3																																					31	31	31	31	31	31	31	31	31	31	31	31	
	Pit 2																																																							
1	Dredging	120	3992	-80	0.0	-11.2	3	32	32	32	32	32	32	32	32	32	32	32	32																																					
2	Backfilling	114	3992	-80	0.0	-11.2	3													26	26	26	26	26	26	26	26	26	26	26	26																									
3	Capping	114	3992	-80	0.0	-11.2	3																									26	26	26	26	26	26	26	26	26	26	26	26													
	Predicted Noise Level during Night-time Period, dB(A)							32	32	32	32	32	32	32	32	32	32	32	32	36	36	36	36	36	36	36	36	36	36	36	36	30	30	30	30	30	30	30	30	30	30	30	30	31	31	31	31	31	31	31	31	31	31	31	31	36

Notes:

[1] Distance Correction for PMEs = $10*\log(2*PI*r^2)$

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

Contaminated Sediment Disposal Facility at South of Brothers

Annex E-4b *Construction Airborne Noise Impact Assessment - Unmitigated*

NSR: N3 Caribbean Coast Phase 1 - Monterey Cove

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Corr. For Topo dB(A)[3]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)
	Night-time Period (All days 2300 - 0700 hrs)						
I)	**South Brothers Mud Pit**						
A	**Construction / Operation**						
	Pit 1						
1	Dredging	118	2180	-75	0.0	-6.1	3
2	Backfilling	111	2180	-75	0.0	-6.1	3
3	Capping	114	2180	-75	0.0	-6.1	3
	Pit 2						
1	Dredging	120	3099	-78	0.0	-8.7	3
2	Backfilling	114	3099	-78	0.0	-8.7	3
3	Capping	114	3099	-78	0.0	-8.7	3

Predicted Construction Noise Level (dB(A))

2011

No.	Activity Description	7	8	9	10	11	12
	Pit 1						
1	Dredging						
2	Backfilling						
3	Capping						
	Pit 2						
1	Dredging	36	36	36	36	36	36
2	Backfilling						
3	Capping						
	Predicted Noise Level during Night-time Period, dB(A)	36	36	36	36	36	36

2012

No.	Activity Description	1	2	3	4	5	6	7	8	9	10	11	12
	Pit 1												
1	Dredging							41	41	41	41	41	41
2	Backfilling												
3	Capping												
	Pit 2												
1	Dredging	36	36	36	36	36	36						
2	Backfilling							31	31	31	31	31	31
3	Capping												
	Predicted Noise Level during Night-time Period, dB(A)	36	36	36	36	36	36	41	41	41	41	41	41

2013

No.	Activity Description	1	2	3	4	5	6	7	8	9	10	11	12
	Pit 1												
1	Dredging	41	41	41	41	41	41						
2	Backfilling							33	33	33	33	33	33
3	Capping												
	Pit 2												
1	Dredging												
2	Backfilling	31	31	31	31	31	31						
3	Capping							31	31	31	31	31	31
	Predicted Noise Level during Night-time Period, dB(A)	41	41	41	41	41	41	35	35	35	35	35	35

2014

No.	Activity Description	1	2	3	4	5	6	7	8	9	10	11	12
	Pit 1												
1	Dredging												
2	Backfilling	33	33	33	33	33	33						
3	Capping							36	36	36	36	36	36
	Pit 2												
1	Dredging												
2	Backfilling												
3	Capping	31	31	31	31	31	31						
	Predicted Noise Level during Night-time Period, dB(A)	35	35	35	35	35	35	36	36	36	36	36	36

2015

No.	Activity Description	1	2	3	4	5	6	Max. CNL dB(A)
	Pit 1							
1	Dredging							
2	Backfilling							
3	Capping	36	36	36	36	36	36	
	Pit 2							
1	Dredging							
2	Backfilling							
3	Capping							
	Predicted Noise Level during Night-time Period, dB(A)	36	36	36	36	36	36	41

Notes:

[1] Distance Correction for PMEs = $10*\log(2*PI*r^2)$

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

Contaminated Sediment Disposal Facility at South of Brothers

Annex E-4c *Construction Airborne Noise Impact Assessment - Unmitigated*

NSR: N4 Planned R(B)6 Residential Area at Area 77b (in future Kei Tau Kok reclamation area)

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Corr. For Topo dB(A)[3]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)	Max. CNL dB(A)
	Night-time Period (All days 2300 - 0700 hrs)							
I)	**South Brothers Mud Pit**							
A	**Construction / Operation**							
	Pit 1							
1	Dredging	118	1222	-70	0.0	-3.4	3	
2	Backfilling	111	1222	-70	0.0	-3.4	3	
3	Capping	114	1222	-70	0.0	-3.4	3	
	Pit 2							
1	Dredging	120	2200	-75	0.0	-6.2	3	
2	Backfilling	114	2200	-75	0.0	-6.2	3	
3	Capping	114	2200	-75	0.0	-6.2	3	
	Predicted Noise Level during Night-time Period, dB(A)							49

Predicted Construction Noise Level (dB(A))

Activity	2011						2012											
	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Pit 1 Dredging													48	48	48	48	48	48
Pit 1 Backfilling																		
Pit 1 Capping																		
Pit 2 Dredging	42	42	42	42	42	42	42	42	42	42	42	42						
Pit 2 Backfilling													36	36	36	36	36	36
Pit 2 Capping																		
Predicted Noise Level during Night-time Period, dB(A)	42	42	42	42	42	42	42	42	42	42	42	42	49	49	49	49	49	49

Activity	2013												2014											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Pit 1 Dredging	48	48	48	48	48	48																		
Pit 1 Backfilling							41	41	41	41	41	41	41	41	41	41	41	41						
Pit 1 Capping																			44	44	44	44	44	44
Pit 2 Dredging																								
Pit 2 Backfilling	36	36	36	36	36	36																		
Pit 2 Capping							36	36	36	36	36	36	36	36	36	36	36	36						
Predicted Noise Level during Night-time Period, dB(A)	49	49	49	49	49	49	42	42	42	42	42	42	42	42	42	42	42	42	44	44	44	44	44	44

Activity	2015					
	1	2	3	4	5	6
Pit 1 Dredging						
Pit 1 Backfilling						
Pit 1 Capping	44	44	44	44	44	44
Pit 2 Dredging						
Pit 2 Backfilling						
Pit 2 Capping						
Predicted Noise Level during Night-time Period, dB(A)	44	44	44	44	44	44

Notes:

[1] Distance Correction for PMEs = $10*\log(2*PI*r^2)$

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

Contaminated Sediment Disposal Facility at South of Brothers

Annex E-4d Construction Airborne Noise Impact Assessment - Unmitigated

NSR: N5 Ho Yu Secondary School

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Corr. For Topo dB(A)[3]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)	Max. CNL dB(A)
	Night-time Period (All days 2300 - 0700 hrs)							
I)	**South Brothers Mud Pit**							
A	**Construction / Operation**							
	Pit 1							
1	Dredging	118	2385	-76	0.0	-6.7	3	
2	Backfilling	111	2385	-76	0.0	-6.7	3	
3	Capping	114	2385	-76	0.0	-6.7	3	
	Pit 2							
1	Dredging	120	3306	-78	0.0	-9.3	3	
2	Backfilling	114	3306	-78	0.0	-9.3	3	
3	Capping	114	3306	-78	0.0	-9.3	3	
	Predicted Noise Level during Night-time Period, dB(A)							40

Predicted Construction Noise Level (dB(A)) – 2011 to 2012

Activity Description	2011						2012											
	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Pit 1 Dredging													39	39	39	39	39	39
Pit 1 Backfilling																		
Pit 1 Capping																		
Pit 2 Dredging	35	35	35	35	35	35	35	35	35	35	35	35						
Pit 2 Backfilling													29	29	29	29	29	29
Pit 2 Capping																		
Predicted Noise Level during Night-time Period, dB(A)	35	35	35	35	35	35	35	35	35	35	35	35	40	40	40	40	40	40

Predicted Construction Noise Level (dB(A)) – 2013 to 2015

Activity Description	2013												2014												2015					
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Pit 1 Dredging	39	39	39	39	39	39																								
Pit 1 Backfilling							32	32	32	32	32	32	32	32	32	32	32	32												
Pit 1 Capping																			35	35	35	35	35	35	35	35	35	35	35	35
Pit 2 Dredging																														
Pit 2 Backfilling	29	29	29	29	29	29																								
Pit 2 Capping							29	29	29	29	29	29	29	29	29	29	29	29												
Predicted Noise Level during Night-time Period, dB(A)	40	40	40	40	40	40	34	34	34	34	34	34	34	34	34	34	34	34	35	35	35	35	35	35	35	35	35	35	35	35

Notes:

[1] Distance Correction for PMEs = $10*\log(2*PI*r^2)$

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

Contaminated Sediment Disposal Facility at South of Brothers

Annex E-4e *Construction Airborne Noise Impact Assessment - Unmitigated*

NSR: N6 Planned Residential Area at Area 77 (in future Kei Tau Kok reclamation area)

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Corr. For Topo dB(A)[3]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)
	Night-time Period (All days 2300 - 0700 hrs)						
I)	**South Brothers Mud Pit**						
A	**Construction / Operation**						
	Pit 1						
1	Dredging	118	753	-66	0.0	-2.1	3
2	Backfilling	111	753	-66	0.0	-2.1	3
3	Capping	114	753	-66	0.0	-2.1	3
	Pit 2						
1	Dredging	120	1679	-72	0.0	-4.7	3
2	Backfilling	114	1679	-72	0.0	-4.7	3
3	Capping	114	1679	-72	0.0	-4.7	3

Predicted Construction Noise Level (dB(A)) — 2011–2012

No.	Activity Description	2011-7	8	9	10	11	12	2012-1	2	3	4	5	6	7	8	9	10	11	12
	Pit 1																		
1	Dredging													54	54	54	54	54	54
2	Backfilling																		
3	Capping																		
	Pit 2																		
1	Dredging	46	46	46	46	46	46	46	46	46	46	46	46						
2	Backfilling													40	40	40	40	40	40
3	Capping																		
	Predicted Noise Level during Night-time Period, dB(A)	46	46	46	46	46	46	46	46	46	46	46	46	54	54	54	54	54	54

Predicted Construction Noise Level (dB(A)) — 2013

No.	Activity Description	2013-1	2	3	4	5	6	7	8	9	10	11	12
	Pit 1												
1	Dredging	54	54	54	54	54	54						
2	Backfilling							46	46	46	46	46	46
3	Capping												
	Pit 2												
1	Dredging												
2	Backfilling	40	40	40	40	40	40						
3	Capping							40	40	40	40	40	40
	Predicted Noise Level during Night-time Period, dB(A)	54	54	54	54	54	54	47	47	47	47	47	47

Predicted Construction Noise Level (dB(A)) — 2014–2015

No.	Activity Description	2014-1	2	3	4	5	6	7	8	9	10	11	12	2015-1	2	3	4	5	6	Max. CNL dB(A)
	Pit 1																			
1	Dredging																			
2	Backfilling	46	46	46	46	46	46													
3	Capping							49	49	49	49	49	49	49	49	49	49	49	49	
	Pit 2																			
1	Dredging																			
2	Backfilling																			
3	Capping	40	40	40	40	40	40													
	Predicted Noise Level during Night-time Period, dB(A)	47	47	47	47	47	47	49	49	49	49	49	49	49	49	49	49	49	49	54

Notes:

[1] Distance Correction for PMEs = $10*\log(2*PI*r^2)$

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

Contaminated Sediment Disposal Facility at South of Brothers

Annex E-4f Construction Airborne Noise Impact Assessment - Unmitigated

NSR: N7 Coastal Skyline Phase 4 - Le Bleu Deux

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Corr. For Topo dB(A)[3]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)	Max. CNL dB(A)
	Night-time Period (All days 2300 - 0700 hrs)							
I)	**South Brothers Mud Pit**							
A	**Construction / Operation**							
	Pit 1							
1	Dredging	118	2662	-76	0.0	-7.5	3	
2	Backfilling	111	2662	-76	0.0	-7.5	3	
3	Capping	114	2662	-76	0.0	-7.5	3	
	Pit 2							
1	Dredging	120	3658	-79	0.0	-10.2	3	
2	Backfilling	114	3658	-79	0.0	-10.2	3	
3	Capping	114	3658	-79	0.0	-10.2	3	
	Predicted Noise Level during Night-time Period, dB(A)							38

Predicted Construction Noise Level (dB(A)) — 2011

No.	Activity Description	7	8	9	10	11	12
	Pit 1						
1	Dredging						
2	Backfilling						
3	Capping						
	Pit 2						
1	Dredging	33	33	33	33	33	33
2	Backfilling						
3	Capping						
	Predicted Noise Level during Night-time Period, dB(A)	33	33	33	33	33	33

Predicted Construction Noise Level (dB(A)) — 2012

No.	Activity Description	1	2	3	4	5	6	7	8	9	10	11	12
	Pit 1												
1	Dredging							37	37	37	37	37	37
2	Backfilling												
3	Capping												
	Pit 2												
1	Dredging	33	33	33	33	33	33						
2	Backfilling							27	27	27	27	27	27
3	Capping												
	Predicted Noise Level during Night-time Period, dB(A)	33	33	33	33	33	33	38	38	38	38	38	38

Predicted Construction Noise Level (dB(A)) — 2013

No.	Activity Description	1	2	3	4	5	6	7	8	9	10	11	12
	Pit 1												
1	Dredging	37	37	37	37	37	37						
2	Backfilling							30	30	30	30	30	30
3	Capping												
	Pit 2												
1	Dredging												
2	Backfilling	27	27	27	27	27	27						
3	Capping							27	27	27	27	27	27
	Predicted Noise Level during Night-time Period, dB(A)	38	38	38	38	38	38	32	32	32	32	32	32

Predicted Construction Noise Level (dB(A)) — 2014

No.	Activity Description	1	2	3	4	5	6	7	8	9	10	11	12
	Pit 1												
1	Dredging												
2	Backfilling	30	30	30	30	30	30						
3	Capping							33	33	33	33	33	33
	Pit 2												
1	Dredging												
2	Backfilling												
3	Capping	27	27	27	27	27	27						
	Predicted Noise Level during Night-time Period, dB(A)	32	32	32	32	32	32	33	33	33	33	33	33

Predicted Construction Noise Level (dB(A)) — 2015

No.	Activity Description	1	2	3	4	5	6
	Pit 1						
1	Dredging						
2	Backfilling						
3	Capping	33	33	33	33	33	33
	Pit 2						
1	Dredging						
2	Backfilling						
3	Capping						
	Predicted Noise Level during Night-time Period, dB(A)	33	33	33	33	33	33

Notes:

[1] Distance Correction for PMEs = $10*\log(2*PI*r^2)$

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

Contaminated Sediment Disposal Facility at South of Brothers

Annex E-4g *Construction Airborne Noise Impact Assessment - Unmitigated*

NSR: N8 Pak Mong Village House

No.	Activity Description	SWL dB(A)[2]	Distance m	Corr. for distance dB(A)[1][2]	Corr. For Topo dB(A)[3]	Atm. Absorption dB(A)[3]	Corr. for façade dB(A)	Max. CNL dB(A)
	Night-time Period (All days 2300 - 0700 hrs)							
I)	**South Brothers Mud Pit**							
A	**Construction / Operation**							
	Pit 1							
1	Dredging	118	1640	-72	0.0	-4.6	3	
2	Backfilling	111	1073	-69	0.0	-3.0	3	
3	Capping	114	1073	-69	0.0	-3.0	3	
	Pit 2							
1	Dredging	120	1847	-73	0.0	-5.2	3	
2	Backfilling	114	1847	-73	0.0	-5.2	3	
3	Capping	114	1847	-73	0.0	-5.2	3	
	Predicted Noise Level during Night-time Period, dB(A)							45

Predicted Construction Noise Level (dB(A))

Activity	2011						2012											
	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Pit 1 – 1 Dredging													45	45	45	45	45	45
Pit 1 – 2 Backfilling																		
Pit 1 – 3 Capping																		
Pit 2 – 1 Dredging	44	44	44	44	44	44	44	44	44	44	44	44						
Pit 2 – 2 Backfilling													38	38	38	38	38	38
Pit 2 – 3 Capping																		
Predicted Noise Level during Night-time Period, dB(A)	44	44	44	44	44	44	44	44	44	44	44	44	45	45	45	45	45	45

Activity	2013												2014												2015					
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6
Pit 1 – 1 Dredging	45	45	45	45	45	45																								
Pit 1 – 2 Backfilling							42	42	42	42	42	42	42	42	42	42	42	42												
Pit 1 – 3 Capping																			45	45	45	45	45	45	45	45	45	45	45	45
Pit 2 – 1 Dredging																														
Pit 2 – 2 Backfilling	38	38	38	38	38	38																								
Pit 2 – 3 Capping							38	38	38	38	38	38	38	38	38	38	38	38												
Predicted Noise Level during Night-time Period, dB(A)	45	45	45	45	45	45	44	44	44	44	44	44	44	44	44	44	44	44	45	45	45	45	45	45	45	45	45	45	45	45

Notes:

[1] Distance Correction for PMEs = 10*log(2*PI*r^2)

[2] The figures are rounded-off to a whole number.

[3] ISO9613, 20°C, RH70%, 500Hz: 2.8dB/1km

Annex F

12 day Time-lapse Visual Survey Data from the TM-CLKL and HKBCF projects, August/September 2008

Survey Date: 13-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel																Leaving Airport Channel													
Cargo			Passenger				Others									Cargo			Passenger				Others						
O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified	Derrick Barge	TOTAL	DAY	HOUR STARTING	O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified	Derrick Barge	TOTAL
	1					1		1					3	1	07-08		1			1		1		2					5
				1				3					4	1	08-09					1	1	1		3					6
	1			2		2		2					7	1	09-10					3		2		3					8
				3	1			1					5	1	10-11					5				3	1				9
				3		2		2					7	1	11-12					4		3		1					8
				4		1		1					6	1	12-13					3		1		2					6
				3		2		1					6	1	13-14					3				1					4
				1		2		2					5	1	14-15					3	1	1		2					7
				3		1		1					5	1	15-16		1			3		1		1		1			7
				3	1	1		2		1			8	1	16-17					2		2		2					6
				3		2		1					6	1	17-18		1			3				2					6
	1			2				2					5	1	18-19		1			1		1		2					5
	3			28	2	14		19		1			67				4			32	2	13		24	1	1			77
																	7			60	4	27		43	1	2			144

Survey Date: 14-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel

DAY	HOUR STARTING	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
1	07-08		1							3					4
1	08-09							2		3					5
1	09-10					3		1		3					7
1	10-11					2		2		3					7
1	11-12		1			4		2		1					8
1	12-13					4		1		2					7
1	13-14					1		1		2					4
1	14-15					4		1		2		1			8
1	15-16					3		1		1					5
1	16-17					2		1		2					5
1	17-18					3		2		1					6
1	18-19					1		1		2					4
			2			27		15		25		1			70

Leaving Airport Channel

DAY	HOUR STARTING	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
1	07-08									3					3
1	08-09					3		2		2		1			8
1	09-10					2		1		3					6
1	10-11					5				2	1				8
1	11-12					4				1					5
1	12-13					3		2		1	1	1			8
1	13-14					3		1		2					6
1	14-15					2		1		2					5
1	15-16					2		2		1					5
1	16-17					2		1		2					5
1	17-18					3		1		1					5
1	18-19					3		1		2					6
						32		12		22	2	2			70
			2			59		27		47	2	3			140

Survey Date: 15-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

Entering Airport Channel																Leaving Airport Channel													
Cargo			Passenger				Others									Cargo			Passenger				Others						
O-G Cargo	River Trade	Tug & Tow	O-G Passenger遠	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified	Derrick Barge	TOTAL	DAY	HOUR STARTING	O-G Cargo	River Trade	Tug & Tow	O-G Passenger遠	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified	Derrick Barge	TOTAL
						1		2					3	1	07-08							1		1					2
				1		2		1					4	1	08-09					2				2					4
				3		2		3					8	1	09-10					3		2		4					9
				4		2		3		1			10	1	10-11					6		1		3					10
				3		1		3					7	1	11-12					3		2		3					8
				2		2		1					5	1	12-13					2				1		1			4
				2		1		2					5	1	13-14					2		1		2					5
				3		2		3					8	1	14-15					3		1		3					7
				3		1	1	3					8	1	15-16					3		2		3		1			9
				2		1		1					4	1	16-17					2		1		1					4
				3		1		2					6	1	17-18					2		1		2					5
				2									2	1	18-19					3									3
				28		16	1	24		1			70							31		12		25		2			70
																				59		28	1	49		3			140

Survey Date: 16-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel

DAY	HOUR STARTING	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
1	07-08		1					1		2					4
1	08-09					1		2		3					6
1	09-10					3		1		4					8
1	10-11					3		2		3		1			9
1	11-12		1			3		1		3					8
1	12-13		1			3		1		2					7
1	13-14					2		2		3					7
1	14-15					4		1		5					10
1	15-16					4		1		3					8
1	16-17					5		2		4					11
1	17-18					3				3					6
1	18-19					2				2					4
			3			33		14		37		1			88

Leaving Airport Channel

HOUR STARTING	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
07-08		2					1		2					5
08-09					2		1		2					5
09-10					3		2		2					7
10-11					3		2		3	1				9
11-12		1			3		3		3					10
12-13					3		1		3					7
13-14					3		1		4					8
14-15					4		2		4					10
15-16					3		1		3					7
16-17					4		1		3					8
17-18					3		2		2					7
18-19					3		1		2					6
		3			34		18		33	1				89
		6			67		32		70	1	1			177

Survey Date: 17-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel ← | → Leaving Airport Channel

Cargo			Passenger				Others										Cargo			Passenger				Others							
O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified	Derrick Barge	TOTAL	DAY	HOUR STARTING	O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified	Derrick Barge	TOTAL
								3					3	1	05-06							1		2					3
				2		1		3					6	1	06-07					2		1		3					6
				3		2		2					7	1	07-08					3		1		4					8
	1			4		1		3					9	1	08-09		1			4				4					9
				4		2		2					8	1	09-10					3		1		3					7
				3		1		3					7	1	10-11					3									3
	1			4				5					10	1	11-12		1			4									5
				2		1		2					5	1	12-13					5									5
				5		2		3					10	1	13-14														
				2		1		2					5	1	14-15														
				2		2		1					5	1	15-16														
				2				2					4	1	16-17														
	2			33		13		31					79				2			24		4		16					46
																	4			57		17		47					125

Survey Date: 18-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel																Leaving Airport Channel													
Cargo			Passenger				Others									Cargo			Passenger				Others						
O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified	Derrick Barge	TOTAL	DAY	HOUR STARTING	O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified	Derrick Barge	TOTAL
						1		3					4	1	05-06							1		1					2
				2	1			1					4	1	06-07					3		1		2					6
				2		1		2					5	1	07-08					2		1		1					4
				3		1		3					7	1	08-09		1			2	1	1		3					8
				3		1		1					5	1	09-10					3		1		2					6
				2		1		2					5	1	10-11					2		1		2					5
				3		2		3					8	1	11-12					3		2		4					9
				2		2		4					8	1	12-13					3		1		3					7
	1			3		1		2					7	1	13-14					4		1		3					8
				4		1		3					8	1	14-15					3				4					7
				3		2		3					8	1	15-16					2		1		3					6
														1	16-17									2					2
	1			27	1	13		27					69				1			27	1	11		30					70
																	2			54	2	24		57					139

Survey Date: 19-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel

DAY	HOUR STARTING	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
1	05-06		1					1		2					4
1	06-07					1				1					2
1	07-08					1		1		2					4
1	08-09					3	1			1		1			6
1	09-10					3		1		2					6
1	10-11					3		1		1					5
1	11-12					1				2		1			4
1	12-13		1			3		1		1		1			7
1	13-14					3				3		1			7
1	14-15					3		1		2		1			7
1	15-16					5				1					6
1	16-17					1		1		1					3
			2			27	1	7		19		5			61

Leaving Airport Channel

DAY	HOUR STARTING	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
1	05-06							1		2					3
1	06-07					1		1		2		1			5
1	07-08					1				2					3
1	08-09			1		3		1		1		1			7
1	09-10					3				2					5
1	10-11		1			3		1		2					7
1	11-12					1				2					3
1	12-13					4		1		2		1			8
1	13-14					2		1		3		2			8
1	14-15					4		1		2					7
1	15-16					2				2					4
1	16-17		1			3				1			1		6
			2	1		27		7		23		5	1		66
			4	1		54	1	14		42		10	1		127

Survey Date: 20-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel

	Cargo			Passenger				Others							
DAY	O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified	Derrick Barge	TOTAL	HOUR STARTING
1		1					1		1					3	05-06
1					1				2					3	06-07
1					3		1		1					5	07-08
1					2				1					3	08-09
1					2		1		1					4	09-10
1					5				2					7	10-11
1					2		1		2					5	11-12
1					3				2		1			6	12-13
1					2				4					6	13-14
1					3		1		2					6	14-15
1					3				2					5	15-16
1					1				1					2	16-17
		1			27		5		21		1			55	

Leaving Airport Channel

	Cargo			Passenger				Others							
DAY	HOUR STARTING	O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified	Derrick Barge	TOTAL
1	05-06		1					1		2					4
1	06-07					1		1		2					4
1	07-08					2				2					4
1	08-09					3		1		2	1				7
1	09-10					3		1		3					7
1	10-11					4		2		2		1			9
1	11-12					2				3					5
1	12-13					3		1		2					6
1	13-14					2		1	1	2		1			7
1	14-15					3		1		2					6
1	15-16					2				2					4
1	16-17					1				2					3
			1			26		9	1	26	1	2			66
			2			53		14	1	47	1	3			121

Survey Date: 21-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel

DAY	HOUR STARTING	Cargo			Passenger				Others					Derrick Barge	TOTAL
		O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified		
1	05-06							1		2					3
1	06-07		1			1				3					5
1	07-08					3		1		4					8
1	08-09					2		1		2					5
1	09-10					3				1					4
1	10-11		1			3		1		1					6
1	11-12					2				1					3
1	12-13					3		1		3		1			8
1	13-14					3		1		1					5
1	14-15					3		1		1					5
1	15-16					4				2					6
1	16-17					1				2					3
			2			28		7		23		1			61

Leaving Airport Channel

DAY	HOUR STARTING	Cargo			Passenger				Others					Derrick Barge	TOTAL
		O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified		
1	05-06									3					3
1	06-07							1		2					3
1	07-08					4				3					7
1	08-09					5	1	1		3	1				11
1	09-10					3				1		1			5
1	10-11					2		1		2		1			6
1	11-12					1		1		3					5
1	12-13					3		2		1		1			7
1	13-14					4		2		2		1			9
1	14-15		1			3				2					6
1	15-16					2		1		2					5
1	16-17					1		1		2		1			5
			1			28	1	10		26	1	5			72
			3			56	1	17		49	1	6			133

Survey Date: 22-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel

DAY	HOUR STARTING	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
1	05-06		1							3					4
1	06-07					2		1		2					5
1	07-08					2		1		1					4
1	08-09					2				2					4
1	09-10					1		1		1					3
1	10-11		1			2		1		2					6
1	11-12					1				2					3
1	12-13		1	1		3		2		2					9
1	13-14					3		1		1					5
1	14-15					3				2					5
1	15-16					2		1		3					6
1	16-17					1				1					2
			3	1		22		8		22					56

Leaving Airport Channel

DAY	HOUR STARTING	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
1	05-06		1							2					3
1	06-07					3		1		2	1				7
1	07-08					1		1		1					3
1	08-09		1			5				3					9
1	09-10					2		1		2					5
1	10-11					1	1			2					4
1	11-12					2				2					4
1	12-13		1			2			1	3					7
1	13-14					5		1		1			1		8
1	14-15					3				2					5
1	15-16					2		1		1					4
1	16-17					1				2					3
			3			27	1	5	1	23	1		1		62
			6	1		49	1	13	1	45	1		1		118

Survey Date: 24-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel																Leaving Airport Channel													
Cargo			Passenger				Others					Derrick Barge	TOTAL	DAY	HOUR STARTING	Cargo			Passenger				Others					Derrick Barge	TOTAL
O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified					O-G Cargo	River Trade	Tug & Tow	O-G Passenger	Fast Ferry	Conventional Ferry	Fast Launch	Tugboat	Fishing Vessel	Local DG	Pleasure Vessels	Unclassified		
								1					1	1	05-06		1						2						3
						1	2	1					4	1	06-07								5						5
				1				1					2	1	07-08			1					1						2
				1	1		2	1					5	1	08-09		1			2			1						4
	1			2		1		1					5	1	09-10					1			4		1				6
				1		1		2					4	1	10-11					2		1	3			1			7
				2		1		2					5	1	11-12					2	1	1	2						6
				3		1		3					7	1	12-13					2			2						4
				3		1		2					6	1	13-14					4		1	3			1			9
				2			1	3	1				7	1	14-15		1			2			1		1				5
				2				3					5	1	15-16					3			3			1			7
				1				3					4	1	16-17		1			2		1	1						5
	1			18	1	6	5	23	1				55				4	1		20	1	4	28		2	3			63
																	5	1		38	2	10	33	23	3	3			118

BMT Asia Pacific

Survey Date: 25-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

Entering Airport Channel

DAY	HOUR STARTING	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
1	05-06									1					1
1	06-07									2					2
1	07-08					2		1		1					4
1	08-09		1			2				2					5
1	09-10					2				1					3
1	10-11					4				2					6
1	11-12					3		1		2					6
1	12-13					3		1		2					6
1	13-14					2		1		1					4
1	14-15					3				2					5
1	15-16					2		1		1					4
1	16-17					1				2					3
			1			24		5		19					49

Leaving Airport Channel

DAY	HOUR STARTING	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
1	05-06		2							1					3
1	06-07							1		2					3
1	07-08					3				2					5
1	08-09					4		1		1	1				7
1	09-10					3				1	1				5
1	10-11					1		1		4		1	1		8
1	11-12					2				3					5
1	12-13					1				3					4
1	13-14					4		1		2		1			8
1	14-15					2				2					4
1	15-16		1			3		1		1					6
1	16-17					2				2					4
			3			25		5		24	2	2	1		62
			4			49		10		43	2	2	1		111

Survey Date: 26-Aug-08

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel

Day	Hour Starting	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
1	05-06					1				2					3
1	06-07									3					3
1	07-08					2		1		2					5
1	08-09					3		2		3					8
1	09-10					2		1		2					5
1	10-11					4				2					6
1	11-12		1			3				2					6
1	12-13					2		2		1		1			6
1	13-14					2	1			2		1			6
1	14-15					2				1					3
1	15-16					3				2					5
1	16-17					2				2					4
			1			26	1	6		24		2			60

Leaving Airport Channel

Day	Hour Starting	Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Conventional Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassified	Derrick Barge	TOTAL
1	05-06									2		1			3
1	06-07					1		1		1					3
1	07-08					2				2					4
1	08-09					4		1		2					7
1	09-10					2		1		3					6
1	10-11		1			2		1		2					6
1	11-12		1			3				2					6
1	12-13					3		1		2					6
1	13-14					5		1		2		1			9
1	14-15		1			3				1					5
1	15-16					2				3					5
1	16-17		1			2				5		1			9
			4			29		6		27		3			69
			5			55	1	12		51		5			129

Daily Traffic: ** Aug 13, 2008 - Aug 26, 2008

Site Place: HKIA East FSD

Camera Direction: FSD towards Tze Kan Chau

BMT Asia Pacific

Entering Airport Channel

DATE		Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Convention Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassfied	Derrick Barge	TOTAL
Total Days	13														
08/13/08	Wed		3			28	2	14		19		1			67
08/14/08	Thu		2			27		15		25		1			70
08/15/08	Fri					28		16	1	24		1			70
08/16/08	Sat		3			33		14		37		1			88
08/17/08	Sun		2			33		13		31					79
08/18/08	Mon		1			27	1	13		27					69
08/19/08	Tue		2			27	1	7		19		5			61
08/20/08	Wed		1			27		5		21		1			55
08/21/08	Thu		2			28		7		23		1			61
08/22/08	Fri		3	1		22		8		22					
08/24/08	Sun		1			18	1	6	5	23	1				
08/25/08	Mon		1			24		5		19					49
08/26/08	Tue		1			26	1	6		24		2			60
One-way	Ave		1.7	0.1		26.8	0.5	9.9	0.5	24.2	0.1	1.0			56.1
	Sum		22	1		348	6	129	6	314	1	13			729

Leaving Airport Channel

DATE		Cargo: O-G Cargo	Cargo: River Trade	Cargo: Tug & Tow	Passenger: O-G Passenger	Passenger: Fast Ferry	Passenger: Convention Ferry	Passenger: Fast Launch	Others: Tugboat	Others: Fishing Vessel	Others: Local DG	Others: Pleasure Vessels	Others: Unclassfied	Derrick Barge	TOTAL
08/13/08	Wed		4			32	2	13		24	1	1			77
08/14/08	Thu					32		12		22	2	2			70
08/15/08	Fri					31		12		25		2			70
08/16/08	Sat		3			34		18		33	1				89
08/17/08	Sun		2			24		4		16					46
08/18/08	Mon		1			27	1	11		30					70
08/19/08	Tue		2	1		27		7		23		5	1		66
08/20/08	Wed		1			26		9	1	26	1	2			66
08/21/08	Thu		1			28	1	10		26	1	5			72
08/22/08	Fri		3			27	1	5	1	23	1		1		
08/24/08	Sun		4	1		20	1	4	28		2	3			
08/25/08	Mon		3			25		5		24	2	2	1		62
08/26/08	Tue		4			29		6		27		3			69
One-way	Ave		2.2	0.2		27.8	0.5	8.9	2.3	23.0	0.8	1.9	0.2		58.2
	Sum.		28	2		362	6	116	30	299	11	25	3		757
Two-way Total	Ave		4	0		55	1	19	3	47	1	3	0		114
	Sum.		50	3		710	12	245	36	613	12	38	3		1486