路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong - Zhuhai - Macao Bridge
Hong Kong Project Management Office

## Contract No. HY/2011/03

# Hong Kong-Zhuhai-Macao Bridge Hong Kong Link Road Section between Scenic Hill and Hong Kong Boundary Crossing Facilities

# Quarterly EM&A Report No. 18 (December 2016 to February 2017)

**27 July 2017**

**Revision 1**

**Main Contractor**

中國建築工程(香港)有限公司
CHINA STATE CONSTRUCTION ENGINEERING (HONG KONG) LTD.

**Designer**

ATKINS

Contains *sensitive* information

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## Executive Summary

The Hong Kong-Zhuhai-Macao Bridge (HZMB) Hong Kong Link Road (HKLR) serves to connect the HZMB Main Bridge at the Hong Kong Special Administrative Region (HKSAR) Boundary and the HZMB Hong Kong Boundary Crossing Facilities (HKBCF) located at the north eastern waters of the Hong Kong International Airport (HKIA).

The HKLR project has been separated into two contracts. They are Contract No. HY/2011/03 Hong Kong-Zhuhai-Macao Bridge Hong Kong Link Road-Section between Scenic Hill and Hong Kong Boundary Crossing Facilities (hereafter referred to as the Contract) and Contract No. HY/2011/09 Hong Kong-Zhuhai-Macao Bridge Hong Kong Link Road-Section between HKSAR Boundary and Scenic Hill.

China State Construction Engineering (Hong Kong) Ltd. was awarded by Highways Department as the Contractor to undertake the construction works of Contract No. HY/2011/03. The main works of the Contract include land tunnel at Scenic Hill, tunnel underneath Airport Road and Airport Express Line, reclamation and tunnel to the east coast of the Airport Island, at-grade road connecting to the HKBCF and highway works of the HKBCF within the Airport Island and in the vicinity of the HKLR reclamation. The Contract is part of the HKLR Project and HKBCF Project, these projects are considered to be "Designated Projects", under Schedule 2 of the Environmental Impact Assessment (EIA) Ordinance (Cap 499) and EIA Reports (Register No. AEIAR-144/2009 and AEIAR-145/2009) were prepared for the Project. The current Environmental Permit (EP) EP-352/2009/D for HKLR and EP-353/2009/K for HKBCF were issued on 22 December 2014 and 11 April 2016, respectively. These documents are available through the EIA Ordinance Register. The construction phase of Contract was commenced on 17 October 2012.

BMT Asia Pacific Limited has been appointed by the Contractor to implement the Environmental Monitoring & Audit (EM&A) programme for the Contract in accordance with the Updated EM&A Manual for HKLR (Version 1.0) and will be providing environmental team services to the Contract.

This is the eighteenth Quarterly EM&A report for the Contract which summarizes the monitoring results and audit findings of the EM&A programme during the reporting period from 1 December 2016 to 28 February 2017.

## Environmental Monitoring and Audit Progress

The EM&A programme were undertaken in accordance with the Updated EM&A Manual for HKLR (Version 1.0). A summary of the monitoring activities during this reporting period is presented as below:

| Monitoring Activity | | Monitoring Date | | |
|---|---|---|---|---|
| | | **December 2016** | **January 2017** | **February 2017** |
| Air Quality | 1-hr TSP | 6, 12, 16, 22 and 28 | 3, 9, 13, 19, 24 and 27 | 2, 7, 13, 17 and 23 |
| | 24-hr TSP | 5, 9, 15, 21, 24 and 30 | 5, 10, 16, 20 and 26 | 1, 6, 10, 16, 22 and 28 |
| Noise | | 6, 12, 22 and 28 | 3, 9, 19 and 24 | 2, 7, 13 and 23 |
| Water Quality | | 2, 5, 7, 9, 12, 14, 16, 19, 21, 23, 26, 28 and 30 | 2, 4, 6, 9, 11, 13, 16, 18, 20, 23, 25, 27 and 30 | 1, 3, 6, 8, 10, 13, 15, 17, 20, 22, 24 and 27 |
| Chinese White Dolphin | | 1, 6, 16 and 19 | 10, 12, 16 and 20 | 7, 9, 16 and 21 |
| Mudflat Monitoring (Ecology) | | 3, 4, 5, 17, 18 and 19 | -- | -- |
| Mudflat Monitoring (Sedimentation rate) | | 7 | -- | -- |
| Site Inspection | | 7, 14, 21 and 30 | 4, 11, 18 and 27 | 3, 8, 15, 22 and 28 |

Due to boat availability, the dolphin monitoring schedule was rescheduled from 9 December 2016 to 16 December 2016 and from 12 December 2016 to 19 December 2016.

Due to boat availability, the dolphin monitoring schedule was rescheduled from 19 January 2017 to 16 January 2017 and from 23 January 2017 to 20 January 2017.

Due to weather condition, the dolphin monitoring schedule was rescheduled from 14 February 2017 to 16 February 2017. Due to boat availability, the dolphin monitoring schedule was rescheduled from 20 February 2017 to 21 February 2017.

**Breaches of Action and Limit Levels**

A summary of environmental exceedances for this reporting period is as follows:

| Environmental Monitoring | Parameters | Action Level (AL) | Limit Level (LL) |
|---|---|---|---|
| Air Quality | 1-hr TSP | 0 | 0 |
| | 24-hr TSP | 0 | 0 |
| Noise | $L_{eq\ (30\ min)}$ | 0 | 0 |
| Water Quality | Suspended solids level (SS) | 4 | 0 |
| | Turbidity level | 0 | 0 |
| | Dissolved oxygen level (DO) | 0 | 0 |
| Dolphin Monitoring | Quarterly Analysis (Dec 2016 to Feb 2017) | 0 | 1 |

The Environmental Team investigated all exceedances and found that they were not project related.

All investigation reports for exceedances of the Contract have been submitted to ENPO/IEC for comments and/or follow up to identify whether the exceedances occurred related to other HZMB contracts.

**Implementation of Mitigation Measures**

Site inspections were carried out on a weekly basis to monitor the implementation of proper environmental pollution control and mitigation measures for the Project. Potential environmental impacts due to the construction activities were monitored and reviewed.

**Complaint Log**

There were five complaints received in relation to the environmental impacts during the reporting period.

A summary of environmental complaints for this reporting period s as follows:

| Environmental Complaint No. | Date of Complaint Received | Description of Environmental Complaints |
|---|---|---|
| COM-2016-099 | 2 December 2016 | Slurry on public road |
| COM-2016-100 | 14 December 2016 | Mud/debris on public road |
| COM-2016-103 (See Remark 1) | 14 December 2016 | Noise |
| COM-2017-104 (See Remark 2) | 9 January 2017 | Cleanliness problem at East Coast Road and Tung Fai Road |
| COM-2017-108 | 23 February 2017 and 2 March 2017 | Cleanliness problem at East Coast Road |

Remarks:

1.Based on updated information received in February 2017, the environmental complaint no. COM-2016-104 mentioned in Monthly EM&A Report for December 2016 and January 2017 should be COM-2016-103.

2. Based on updated information received in February 2017, the environmental complaint no. COM-2016-105 mentioned in Monthly EM&A Report for January 2017 should be COM-2016-104.

**Notifications of Summons and Prosecutions**

There were no notifications of summons or prosecutions received during this reporting period.

**Reporting Changes**

This report has been developed in compliance with the reporting requirements for the quarterly summary EM&A reports as required by the Updated EM&A Manual for HKLR (Version 1.0).

The proposal for the change of Action Level and Limit Level for suspended solid and turbidity was approved by EPD on 25 March 2013.

The revised Event and Action Plan for dolphin monitoring was approved by EPD on 6 May 2013.

The original monitoring station at IS(Mf)9 (Coordinate- East:813273, North 818850) was observed inside the perimeter silt curtain of Contract HY/2010/02 on 1 July 2013, as such the original impact water quality monitoring location at IS(Mf)9 was temporarily shifted outside the silt curtain. As advised by the Contractor of HY/2010/02 in August 2013, the perimeter silt curtain was shifted to facilitate safe anchorage zone of construction barges/vessels until end of 2013 subject to construction progress. Therefore, water quality monitoring station IS(Mf)9 was shifted to 813226E and 818708N since 1 July 2013. According to the water quality monitoring team's observation on 24 March 2014, the original monitoring location of IS(Mf)9 was no longer enclosed by the perimeter silt curtain of Contract HY/2010/02. Thus, the impact water quality monitoring works at the original monitoring location of IS(Mf)9 has been resumed since 24 March 2014.

Transect lines 1, 2, 7, 8, 9 and 11 for dolphin monitoring have been revised due to the obstruction of the permanent structures associated with the construction works of HKLR and the southern viaduct of TM-CLKL, as well as provision of adequate buffer distance from the Airport Restricted Areas. The EPD issued a memo and confirmed that they had no objection on the revised transect lines on 19 August 2015.

The water quality monitoring locations at IS10 (Coordinate: 812577E, 820670N) and SR5 (811489E, 820455N) are located inside Hong Kong International Airport (HKIA) Approach Restricted Areas. The previously granted Vessel's Entry Permit for accessing stations IS10 and SR5 was expired on 31 December 2016. Renewal of the permit was applied in mid of December 2016. As the application was still under Civil Aviation Department's review on 2 January 2017 to determine whether the proposed water quality monitoring at locations IS10 and SR5 would affect airport's operation and their permission is one of consideration for Marine Department to issue the Permit. Therefore, accessing monitoring locations at IS10 and SR5 was temporarily prohibited on 2, 4 and 6 January 2017. During the permit renewing process, the water quality monitoring location was shifted to IS10(N) (Coordinate: 813060E, 820540N) and SR5(N) (Coordinate: 811430E, 820978N) on 2, 4 and 6 January 2017 temporarily. IS10(N) and SR5(N) were located outside the restricted area but close to the original monitoring location. So, the monitoring results obtained at IS10(N) and SR5(N) are still representative and the baseline monitoring results are still applicable. The permit has been granted by Marine Department on 6 January 2017. Thus, the impact water quality monitoring works at original monitoring locations at IS10 and SR5 has been resumed since 9 January 2017.

# 1 Introduction

## 1.1 Basic Project Information

1.1.1 The Hong Kong-Zhuhai-Macao Bridge (HZMB) Hong Kong Link Road (HKLR) serves to connect the HZMB Main Bridge at the Hong Kong Special Administrative Region (HKSAR) Boundary and the HZMB Hong Kong Boundary Crossing Facilities (HKBCF) located at the north eastern waters of the Hong Kong International Airport (HKIA).

1.1.2 The HKLR project has been separated into two contracts. They are Contract No. HY/2011/03 Hong Kong-Zhuhai-Macao Bridge Hong Kong Link Road-Section between Scenic Hill and Hong Kong Boundary Crossing Facilities (hereafter referred to as the Contract) and Contract No. HY/2011/09 Hong Kong-Zhuhai-Macao Bridge Hong Kong Link Road-Section between HKSAR Boundary and Scenic Hill.

1.1.3 China State Construction Engineering (Hong Kong) Ltd. was awarded by Highways Department (HyD) as the Contractor to undertake the construction works of Contract No. HY/2011/03. The Contract is part of the HKLR Project and HKBCF Project, these projects are considered to be "Designated Projects", under Schedule 2 of the Environmental Impact Assessment (EIA) Ordinance (Cap 499) and EIA Reports (Register No. AEIAR-144/2009 and AEIAR-145/2009) were prepared for the Project. The current Environmental Permit (EP) EP-352/2009/D for HKLR and EP-353/2009/K for HKBCF were issued on 22 December 2014 and 11 April 2016, respectively. These documents are available through the EIA Ordinance Register. The construction phase of Contract was commenced on 17 October 2012. **Figure 1.1** shows the project site boundary.

1.1.4 BMT Asia Pacific Limited has been appointed by the Contractor to implement the EM&A programme for the Contract in accordance with the Updated EM&A Manual for HKLR (Version 1.0) for HKLR and will be providing environmental team services to the Contract. Ramboll Environ Hong Kong Ltd. was employed by HyD as the Independent Environmental Checker (IEC) and Environmental Project Office (ENPO) for the Project. The project organization with regard to the environmental works is provided in **Appendix A**.

1.1.5 This is the eighteenth Quarterly Environmental Monitoring and Audit (EM&A) report for the Contract which summarizes the monitoring results and audit findings of the EM&A programme during the reporting period from 1 December 2016 to 28 February 2017.

## 1.2 Project Organisation

1.2.1 The project organization structure and lines of communication with respect to the on-site environmental management structure with the key personnel contact names and numbers are shown in **Appendix A**.

## 1.3 Construction Programme

1.3.1 A copy of the Contractor's construction programme is provided in **Appendix B**.

## 1.4 Construction Works Undertaken During the Reporting Period

1.4.1 A summary of the construction activities undertaken during this reporting period is shown in **Table 1.1**. The Works areas of the Contract are showed in **Appendix C**.

### Table 1.1 Construction Activities during Reporting Period

| Description of Activities | Site Area |
|---|---|
| Stockpiling | WA7 |
| Dismantling/Trimming of Temporary 40mm Stone Platform for Construction of Seawall | Portion X |
| Construction of Seawall | Portion X |
| Pipe Piling | Portion X |
| Loading and Unloading of Filling Materials | Portion X |
| Backfilling at Scenic Hill Tunnel (Cut & Cover Tunnel) | Portion X |
| Construction of Tunnel Box Structure at Scenic Hill Tunnel (Cut & Cover Tunnel) | Portion X |
| Excavation for HKBCF to Airport Tunnel & construction of tunnel box structure | Portion X |
| Excavation for Diversion of culvert PR9 and PR14 | Portion X |
| Works for Diversion of Airport Road | Airport Road |
| Utilities Detection | Airport Road / Airport Express Line / East Coast Road |
| Establishment of Site Access | Airport Road / Airport Express Line/ East Coast Road |
| Mined Tunnel Excavation / Box Jacking underneath Airport Road and Airport Express Line | Airport Road / Airport Express Line |
| Excavation and lateral support works at shaft 3 extension north shaft (Package T1.12.1) | Near Kwo Lo Wan Road |
| Construction of Tunnel box structure (Package T1.12.1) | Near Kwo Lo Wan Road |
| Construction of Tunnel box structure | Shaft 3 Extension South Shaft |
| Excavation and Lateral Support Works & Construction of Tunnel Box Structure for HKBCF to Airport Tunnel West (Cut & Cover Tunnel) | Airport Road |
| Excavation and Lateral Support Works & Construction of Tunnel Box Structure for HKBCF to Airport Tunnel West (Cut & Cover Tunnel) | Portion X |
| Sub-structure & superstructure works for Highway Operation and Maintenance Area Building | Portion X |
| Superstructure works for Scenic Hill Tunnel West Portal Ventilation Buildingilding | West Portal |
| Excavation for Scenic Hill Tunnel | West Portal |

# 2 EM&A Requirement

## 2.1 Summary of EM&A Requirements

2.1.1 The EM&A programme requires environmental monitoring of air quality, noise, water quality, dolphin monitoring and mudflat monitoring as specified in the approved EM&A Manual.

2.1.2 A summary of Impact EM&A requirements is presented in **Table 2.1**. The locations of air quality, noise and water quality monitoring stations are shown as in **Figure 2.1**. The transect line layout in Northwest and Northeast Lantau Survey Areas is presented in **Figure 2.2**.

**Table 2.1 Summary of Impact EM&A Requirements**

| Environmental Monitoring | Description | Monitoring Station | Frequencies | Remarks |
|---|---|---|---|---|
| Air Quality | 1-hr TSP | AMS 5 & AMS 6 | At least 3 times every 6 days | While the highest dust impact was expected. |
| | 24-hr TSP | | At least once every 6 days | -- |
| Noise | $L_{eq\ (30mins)}$, $L_{10\ (30mins)}$ and $L_{90\ (30mins)}$ | NMS5 | At least once per week | Daytime on normal weekdays (0700-1900 hrs). |
| Water Quality | • Depth<br>• Temperature<br>• Salinity<br>• Dissolved Oxygen (DO)<br>• Suspended Solids (SS)<br>• DO Saturation<br>• Turbidity<br>• pH | • Impact Stations: IS5, IS(Mf)6, IS7, IS8, IS(Mf)9 & IS10,<br>• Control/Far Field Stations: CS2 & CS(Mf)5,<br>• Sensitive Receiver Stations: SR3, SR4, SR5, SR10A & SR10B | Three times per week during mid-ebb and mid-flood tides (within ± 1.75 hour of the predicted time) | 3 (1 m below water surface, mid-depth and 1 m above sea bed, except where the water depth is less than 6 m, in which case the mid-depth station may be omitted. Should the water depth be less than 3 m, only the mid-depth station will be monitored). |
| Dolphin | Line-transect Methods | Northeast Lantau survey area and Northwest Lantau survey area | Twice per month | -- |
| Mudflat | Horseshoe crabs, seagrass beds, intertidal soft shore communities, sedimentation rates and water quality | San Tau and Tung Chung Bay | Once every 3 months | -- |

## 2.2 Action and Limit Levels

2.2.1 **Table 2.2** presents the Action and Limit Levels for the 1-hour TSP, 24-hour TSP and noise level.

**Table 2.2 Action and Limit Levels for 1-hour TSP, 24-hour TSP and Noise**

| Environmental Monitoring | Parameters | Monitoring Station | Action Level | Limit Level |
|---|---|---|---|---|
| Air Quality | 1-hr TSP | AMS 5 | 352 μg/m$^3$ | 500 μg/m$^3$ |
| | | AMS 6 | 360 μg/m$^3$ | |
| | 24-hr TSP | AMS 5 | 164 μg/m$^3$ | 260 μg/m$^3$ |
| | | AMS 6 | 173 μg/m$^3$ | |
| Noise | $L_{eq\ (30\ min)}$ | NMS 5 | When one documented complaint is received | 75 dB(A) |

2.2.2 The Action and Limit Levels for water quality monitoring are given as in **Table 2.3**.

**Table 2.3 Action and Limit Levels for Water Quality**

| Parameter (unit) | Water Depth | Action Level | Limit Level |
|---|---|---|---|
| Dissolved Oxygen (mg/L) | Surface and Middle | 5.0 | 4.2 except 5 for Fish Culture Zone |
| | Bottom | 4.7 | 3.6 |
| Turbidity (NTU) | Depth average | 27.5 or 120% of upstream control station's turbidity at the same tide of the same day;<br>The action level has been amended to "27.5 ***and*** 120% of upstream control station's turbidity at the same tide of the same day" since 25 March 2013. | 47.0 or 130% of turbidity at the upstream control station at the same tide of same day;<br>The limit level has been amended to "47.0 ***and*** 130% of turbidity at the upstream control station at the same tide of same day" since 25 March 2013. |
| Suspended Solid (SS) (mg/L) | Depth average | 23.5 or 120% of upstream control station's SS at the same tide of the same day;<br>The action level has been amended to "23.5 ***and*** 120% of upstream control station's SS at the same tide of the same day" since 25 March 2013. | 34.4 or 130% of SS at the upstream control station at the same tide of same day and 10mg/L for Water Services Department Seawater Intakes;<br>The limit level has been amended to "34.4 ***and*** 130% of SS at the upstream control station at the same tide of same day and 10mg/L for Water Services Department Seawater Intakes" since 25 March 2013 |

Notes:
(1) Depth-averaged is calculated by taking the arithmetic means of reading of all three depths.
(2) For DO, non-compliance of the water quality limit occurs when monitoring result is lower that the limit.
(3) For SS & turbidity non-compliance of the water quality limits occur when monitoring result is higher than the limits.
(4) The change to the Action and limit Levels for Water Quality Monitoring for the EM&A works was approved by EPD on 25 March 2013. Therefore, the amended Action and Limit Levels are applied for the water monitoring results obtained on and after 25 March 2013.

2.2.3 The Action and Limit Levels for dolphin monitoring are shown in **Tables 2.4 and 2.5**.

**Table 2.4 Action and Limit Level for Dolphin Impact Monitoring**

| | North Lantau Social Cluster | |
|---|---|---|
| | **NEL** | **NWL** |
| Action Level | STG < 70% of baseline & ANI < 70% of baseline | STG < 70% of baseline & ANI < 70% of baseline |
| Limit Level | STG < 40% of baseline & ANI < 40% of baseline | |

Remarks:

(1) STG means quarterly average encounter rate of number of dolphin sightings.
(2) ANI means quarterly average encounter rate of total number of dolphins.
(3) For North Lantau Social Cluster, AL will be triggered if either NEL or NWL fall below the criteria; LL will be triggered if both NEL and NWL fall below the criteria.

**Table 2.5 Derived Value of Action Level (AL) and Limit Level (LL)**

| | North Lantau Social Cluster | |
|---|---|---|
| | **NEL** | **NWL** |
| Action Level | STG < 4.2 & ANI < 15.5 | STG < 6.9 & ANI < 31.3 |
| Limit Level | (STG < 2.4 & ANI < 8.9) and (STG < 3.9 & ANI < 17.9) | |

Remarks:

(1) STG means quarterly average encounter rate of number of dolphin sightings.
(2) ANI means quarterly average encounter rate of total number of dolphins.
(3) For North Lantau Social Cluster, AL will be triggered if either NEL or NWL fall below the criteria; LL will be triggered if both NEL and NWL fall below the criteria.

## 2.3 Event Action Plans

2.3.1 The Event Actions Plans for air quality, noise, water quality and dolphin monitoring are annexed in **Appendix D.**

## 2.4 Mitigation Measures

2.4.1 Environmental mitigation measures for the contract were recommended in the approved EIA Report. **Appendix E** lists the recommended mitigation measures and the implementation status.

# 3 Environmental Monitoring and Audit

## 3.1 Implementation of Environmental Measures

3.1.1 In response to the site audit findings, the Contractor have rectified all observations identified in environmental site inspections undertaken during the reporting period. Details of site audit findings and the corrective actions during the reporting period are presented in **Appendix F**.

3.1.2 A summary of the Implementation Schedule of Environmental Mitigation Measures (EMIS) is presented in **Appendix E**.

3.1.3 Regular marine travel route for marine vessels were implemented properly in accordance to the submitted plan and relevant records were kept properly.

3.1.4 Dolphin Watching Plan was implemented during the reporting period. No dolphins inside the silt curtain were observed. The relevant records were kept properly.

## 3.2 Air Quality Monitoring Results

3.2.1 The monitoring results for 1-hour TSP and 24-hour TSP are summarized in **Tables 3.1** and **3.2** respectively. Detailed impact air quality monitoring results and relevant graphical plots are presented in **Appendix G**.

**Table 3.1 Summary of 1-hour TSP Monitoring Results Obtained During the Reporting Period**

| Reporting Period | Monitoring Station | Average (µg/m$^3$) | Range (µg/m$^3$) | Action Level (µg/m$^3$) | Limit Level (µg/m$^3$) |
|---|---|---|---|---|---|
| December 2016 | AMS5 | 75 | 32 – 168 | 352 | 500 |
| | AMS6 | 72 | 30 – 136 | 360 | |
| January 2017 | AMS5 | 101 | 19 – 286 | 352 | |
| | AMS6 | 91 | 38 – 205 | 360 | |
| February 2017 | AMS5 | 107 | 32 – 191 | 352 | |
| | AMS6 | 138 | 54 – 329 | 360 | |

**Table 3.2 Summary of 24-hour TSP Monitoring Results Obtained During the Reporting Period**

| Reporting Period | Monitoring Station | Average (µg/m$^3$) | Range (µg/m$^3$) | Action Level (µg/m$^3$) | Limit Level (µg/m$^3$) |
|---|---|---|---|---|---|
| December 2016 | AMS5 | 117 | 52 – 148 | 164 | 260 |
| | AMS6 | 111 | 79 – 167 | 173 | |
| January 2017 | AMS5 | 65 | 45 – 89 | 164 | |
| | AMS6 | 74 | 45 – 98 | 173 | |
| February 2017 | AMS5 | 72 | 36 – 98 | 164 | |
| | AMS6 | 75 | 52 – 104 | 173 | |

3.2.2 No Action/ Limit Level exceedances of 1-hr TSP and 24-hr TSP were recorded at AMS5 and AMS6 during the reporting period.

## 3.3 Noise Monitoring Results

3.3.1 The monitoring results for construction noise are summarized in **Table 3.3** and the monitoring results and relevant graphical plots for this reporting period are provided in **Appendix H.**

**Table 3.3 Summary of Construction Noise Monitoring Results Obtained During the Reporting Period**

| Reporting period | Monitoring Station | Average $L_{eq\ (30\ mins)}$, dB(A)* | Range of $L_{eq}$ (30 mins), dB(A)* | Action Level | Limit Level $L_{eq\ (30\ mins)}$, dB(A) |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| December 2016 | NMS5 | 61 | 60 – 61 | When one documented complaint is received | 75 |
| January 2017 | | 59 | 58 – 60 | | |
| February 2017 | | 61 | 58 – 63 | | |

*A correction factor of +3dB(A) from free field to facade measurement was included.

3.3.2 There were no Action and Limit Level exceedances for noise during daytime on normal weekdays of the reporting period.

3.3.3 Major noise sources during the noise monitoring included construction activities of the Contract and nearby traffic noise and insect noise.

## 3.4 Water Quality Monitoring Results

3.4.1 Impact water quality monitoring was conducted at all designated monitoring stations during the reporting period. Impact water quality monitoring results and relevant graphical plots are provided in **Appendix I**.

3.4.2 During the reporting period, three Action Level exceedances of suspended solids were recorded at stations IS(Mf)6, IS7 and SR4 during mid-flood tide on 14 December 2016 respectively. An Action Level exceedance of suspended solids was recorded at station SR10B during mid-ebb tide on 15 February 2017. Record of "Notification of Environmental Quality Limit Exceedances" is provided in **Appendix M**. No Action/ Limit Level exceedances of turbidity and dissolved oxygen level were recorded during the reporting period. No Limit Level exceedances of suspended solids level were recorded during the reporting period.

3.4.3 Water quality impact sources during the water quality monitoring were the construction activities of the Contract, nearby construction activities by other parties and nearby operating vessels by other parties.

## 3.5 Dolphin Monitoring Results

**Data Analysis**

3.5.1 Distribution Analysis – The line-transect survey data was integrated with the Geographic Information System (GIS) in order to visualize and interpret different spatial and temporal patterns of dolphin distribution using sighting positions. Location data of dolphin groups 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, young calves and activities.

3.5.2 Encounter rate analysis – Encounter rates of Chinese white dolphins (number of on-effort sightings per 100 km of survey effort, and total number of dolphins sighted on-effort per 100 km of survey effort) were calculated in NEL and NWL survey areas in relation to the amount of survey effort conducted during each month of monitoring survey. Dolphin encounter rates were calculated in two ways for comparisons with the HZMB baseline monitoring results as well as to AFCD long-term marine mammal monitoring results.

3.5.3 Firstly, for the comparison with the HZMB baseline monitoring results, the encounter rates were calculated using primary survey effort alone, and only data collected under Beaufort 3 or below condition would be used for encounter rate analysis. The average encounter rate of sightings (STG) and average encounter rate of dolphins (ANI) were deduced based on the encounter rates from six events during the present quarter (i.e. six sets of line-transect surveys in North Lantau), which was also compared with the one deduced from the six events during the baseline period (i.e. six sets of line-transect surveys in North Lantau).

3.5.4 Secondly, the encounter rates were calculated using both primary and secondary survey effort collected under Beaufort 3 or below condition as in AFCD long-term monitoring study. The encounter rate of sightings and dolphins were deduced by dividing the total number of on-effort sightings (STG) and total number of dolphins (ANI) by the amount of survey effort for the present quarterly period.

3.5.5 Quantitative grid analysis on habitat use – To conduct quantitative grid analysis of habitat use, positions of on-effort sightings of Chinese White Dolphins collected during the quarterly impact phase monitoring period were plotted onto 1-km$^2$ grids among NWL and NEL survey areas 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 then 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).

3.5.6 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. 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. 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

3.5.7 Behavioural analysis – When dolphins were sighted during vessel surveys, their behaviour was observed. Different activities were categorized (i.e. feeding, milling/resting, traveling, socializing) and recorded on sighting datasheets. This data was then input into a separate database with sighting information, which can be used to determine the distribution of behavioural data with a desktop GIS. Distribution of sightings of dolphins engaged in different activities and behaviours would then be plotted on GIS and carefully examined to identify important areas for different activities of the dolphins.

3.5.8 Ranging pattern analysis – Location data of individual dolphins that occurred during the 3-month baseline monitoring period were obtained from the dolphin sighting database and photo-identification catalogue. To deduce home ranges for individual dolphins using the fixed kernel methods, the program Animal Movement Analyst Extension, 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.

### Summary of Survey Effort and Dolphin Sightings

3.5.9 During the period of December 2016 to February 2017, six sets of systematic line-transect vessel surveys were conducted to cover all transect lines in NWL and NEL survey areas twice per month.

3.5.10 From these surveys, a total of 878.35 km of survey effort was collected, with 86.5% of the total survey effort being conducted under favourable weather conditions (i.e. Beaufort Sea State 3 or below with good visibility). Among the two areas, 340.00 km and 538.35 km of survey effort were conducted in NEL and NWL survey areas respectively.

3.5.11 The total survey effort conducted on primary lines was 632.39 km, while the effort on secondary lines was 245.96 km. Survey effort conducted on both primary and secondary lines were considered as on-effort survey data. A summary table of the survey effort is shown in **Annex I of Appendix J**.

3.5.12 During the six sets of monitoring surveys in December 2016 to February 2017, a total of 17 groups of 62 Chinese White Dolphins were sighted. A summary table of the dolphin sightings is shown in **Annex II of Appendix J**.

3.5.13 For the present quarterly period, 14 of the 17 dolphin sightings were made during on-effort search, while all except one on-effort dolphin sightings were made on primary lines. In addition, all dolphin groups were sighted in NWL, and no dolphin was sighted at all in NEL. In fact, since August 2014, only two sightings of two lone dolphins were made respectively in NEL during HKLR03 monitoring surveys.

**Distribution**

3.5.14 Distribution of dolphin sightings made during monitoring surveys in December 2016 to February 2017 is shown in **Figure 1 of Appendix J**.

3.5.15 Dolphin sightings made in the present quarter were mainly located to the north of Lung Kwu Chau and at the northwestern end of NWL survey area (**Figure 1 of Appendix J**). A few sightings were also made to the west of airport platform adjacent to the western territorial boundary (**Figure 1 of Appendix J**). On the other hand, the dolphins were completely absent from the central and western portions of North Lantau waters as in previous quarters (**Figure 1 of Appendix J**).

3.5.16 All dolphin sightings were located far away from the HKBCF and HKLR03 reclamation sites as well as along the alignment of Tuen Mun-Chek Lap Kok Link (TMCLKL). However, two dolphin groups were sighted adjacent to the HKLR09 alignment near Sham Wat (**Figure 1 of Appendix J**).

3.5.17 Sighting distribution of dolphins during the present impact phase monitoring period (December 2016 to February 2017) was drastically different from the one during the baseline monitoring period (September to November 2011) (**Figure 1 of Appendix J**). In the present quarter, dolphins have disappeared from the NEL region, which was in stark contrast to their frequent occurrence around the Brothers Islands, near Shum Shui Kok and in the vicinity of HKBCF reclamation site during the baseline period (Figure 1). The nearly complete abandonment of NEL region by the dolphins has been consistently recorded in the past 16 quarters of HKLR03 monitoring, which has resulted in zero to extremely low dolphin encounter rates in this area.

3.5.18 In NWL survey area, dolphin occurrence was also significantly different between the baseline and impact phase periods. During the present impact monitoring period, much fewer dolphins occurred in this survey area (mostly to the north of Lung Kwu Chau at the northwestern corner of the survey area) than during the baseline period, when many dolphin groups were frequently sighted between Lung Kwu Chau and Black Point, around Sha Chau, near Pillar Point and to the west of the Chek Lap Kok Airport (**Figure 1 of Appendix J**).

3.5.19 Another comparison in dolphin distribution was made between the five quarterly periods of winter months in 2012-17 (**Figure 2 of Appendix J**). Among the five winter periods, dolphins were regularly sighted in NWL waters in 2012-13 and 2013-14, but their usage there has gradually diminished in the three subsequent winter periods, with the only occurrences mostly concentrated within and around the Sha Chau and Lung Kwu Chau Marine Park (**Figure 2 of Appendix J**).

### Encounter Rate

3.5.20 During the present three-month study period, the encounter rates of Chinese White Dolphins deduced from the survey effort and on-effort sighting data from the primary transect lines under favourable conditions (Beaufort 3 or below) for each set of the surveys in NEL and NWL are shown in **Table 3.4**. The average encounter rates deduced from the six sets of surveys were also compared with the ones deduced from the baseline monitoring period (September – November 2011) (See **Table 3.5**).

3.5.21 To facilitate the comparison with the AFCD long-term monitoring results, the encounter rates were also calculated for the present quarter using both primary and secondary survey effort. The encounter rates of sightings (STG) and dolphins (ANI) in NWL were 2.91 sightings and 10.73 dolphins per 100 km of survey effort respectively, while the encounter rates of sightings (STG) and dolphins (ANI) in NEL were both nil for this quarter.

**Table 3.4 Dolphin Encounter Rates (Sightings Per 100 km of Survey Effort) During Reporting Period (December 2016 – February 2017)**

| Survey Area | Dolphin Monitoring | Encounter rate (STG) (no. of on-effort dolphin sightings per 100 km of survey effort) | Encounter rate (ANI) (no. of dolphins from all on-effort sightings per 100 km of survey effort) |
|---|---|---|---|
| | | Primary Lines Only | Primary Lines Only |
| Northeast Lantau | Set 1 (1 & 6 Dec 2016) | 0.00 | 0.00 |
| | Set 2 (16 & 19 Dec 2016) | 0.00 | 0.00 |
| | Set 3 (10 & 12 Jan 2017) | 0.00 | 0.00 |
| | Set 4 (16 & 20 Jan 2017) | 0.00 | 0.00 |
| | Set 5 (7 & 9 Feb 2017) | 0.00 | 0.00 |
| | Set 6 (16 & 21 Feb 2017) | 0.00 | 0.00 |
| Northwest Lantau | Set 1 (1 & 6 Dec 2016) | 1.58 | 1.58 |
| | Set 2 (16 & 19 Dec 2016) | 5.99 | 22.45 |
| | Set 3 (10 & 12 Jan 2017) | 0.00 | 0.00 |
| | Set 4 (16 & 20 Jan 2017) | 6.27 | 20.38 |
| | Set 5 (7 & 9 Feb 2017) | 0.00 | 0.00 |
| | Set 6 (16 & 21 Feb 2017) | 8.99 | 42.71 |

**Table 3.5 Comparison of average dolphin encounter rates from impact monitoring period (December 2016 – February 2017) and baseline monitoring period (September – November 2011)**

| Survey Area | Encounter rate (STG) (no. of on-effort dolphin sightings per 100 km of survey effort) | | Encounter rate (ANI) (no. of dolphins from all on-effort sightings per 100 km of survey effort) | |
|---|---|---|---|---|
| | December 2016 – February 2017 | September – November 2011 | December 2016 – February 2017 | September – November 2011 |
| **Northeast Lantau** | 0.0 | 6.00 ± 5.05 | 0.0 | 22.19 ± 26.81 |
| **Northwest Lantau** | 3.80 ± 3.79 | 9.85 ± 5.85 | 14.52 ± 17.21 | 44.66 ± 29.85 |

Notes:
1) The encounter rates deduced from the baseline monitoring period have been recalculated based only on the survey effort and on-effort sighting data made along the primary transect lines under favourable conditions.
2) ± denotes the standard deviation of the average encounter rates.

3.5.22 In NEL, the average dolphin encounter rates (both STG and ANI) in the present three-month impact monitoring period were both zero with no on-effort sighting being made, and such extremely low occurrence of dolphins in NEL have been consistently recorded in the past 16 quarters of HKLR03 monitoring (**Table 3.6**). This is a serious concern as the dolphin occurrence in NEL in the past few years (0.0-1.0 for ER(STG) and 0.0-3.9 for ER(ANI)) have remained exceptionally low when compared to the baseline period (**Table 3.6**). Dolphins have been virtually absent from NEL waters since January 2014, with only three groups of six dolphins sighted there since then despite consistent and intensive survey effort being conducted in this survey area.

**Table 3.6 Comparison of Average Dolphin Encounter Rates in Northeast Lantau Survey Area from All Quarters of Impact Monitoring Period and Baseline Monitoring Period (Sep – Nov 2011)**

| Monitoring Period | Encounter rate (STG) (no. of on-effort dolphin sightings per 100 km of survey effort) | Encounter rate (ANI) (no. of dolphins from all on-effort sightings per 100 km of survey effort) |
|---|---|---|
| **September-November 2011 (Baseline)** | 6.00 ± 5.05 | 22.19 ± 26.81 |
| **December 2012-February 2013 (Impact)** | 3.14 ± 3.21* | 6.33 ± 8.64* |
| **March-May 2013 (Impact)** | 0.42 ± 1.03 | 0.42 ± 1.03 |
| **June-August 2013 (Impact)** | 0.88 ± 1.36 | 3.91 ± 8.36 |
| **September-November 2013 (Impact)** | 1.01 ± 1.59 | 3.77 ± 6.49 |
| **December 2013-February 2014 (Impact)** | 0.45 ± 1.10* | 1.34 ± 3.29* |
| **March-May 2014 (Impact)** | 0.00 | 0.00 |
| **June-August 2014 (Impact)** | 0.42 ± 1.04 | 1.69 ± 4.15 |
| **September-November 2014 (Impact)** | 0.00 | 0.00 |
| **December 2014-February 2015 (Impact)** | 0.00* | 0.00* |
| **March-May 2015 (Impact)** | 0.00 | 0.00 |
| **June-August 2015 (Impact)** | 0.44 ± 1.08 | 0.44 ± 1.08 |

| Monitoring Period | Encounter rate (STG) (no. of on-effort dolphin sightings per 100 km of survey effort) | Encounter rate (ANI) (no. of dolphins from all on-effort sightings per 100 km of survey effort) |
|---|---|---|
| **September-November 2015 (Impact)** | 0.00 | 0.00 |
| **December 2015-February 2016 (Impact)** | 0.00* | 0.00* |
| **March-May 2016 (Impact)** | 0.00 | 0.00 |
| **June-August 2016 (Impact)** | 0.00 | 0.00 |
| **September-November 2016 (Impact)** | 0.00 | 0.00 |
| **December 2016-February 2017 (Impact)** | 0.00* | 0.00* |

Notes:
1) The encounter rates deduced from the baseline monitoring period have been recalculated based only on survey effort and on-effort sighting data made along the primary transect lines under favourable conditions.
2) ± denotes the standard deviation of the average encounter rates.
3) The encounter rates in winter months were in blue and marked with asterisk.

3.5.23 On the other hand, the average dolphin encounter rates (STG and ANI) in NWL during the present impact phase monitoring period (reductions of 61.4% and 67.5% respectively) were only small fractions of the ones recorded during the three-month baseline period, indicating a dramatic decline in dolphin usage of this survey area as well during the present impact phase period (**Table 3.7**).

3.5.24 During the same winter quarters, dolphin encounter rates in NWL during 2016-17 was slightly higher than the previous two winter periods, but was still much lower than the ones in the winter periods of 2012-13 and 2013-14 (**Table 3.7**). Such temporal trend should be closely monitored in the upcoming monitoring quarters whether the dolphin occurrence would continue to increase as the construction activities of HZMB works have been mostly completed in coming months.

**Table 3.7 Comparison of Average Dolphin Encounter Rates in Northwest Lantau Survey Area from All Quarters of Impact Monitoring Period and Baseline Monitoring Period (Sep – Nov 2011)**

| Monitoring Period | Encounter rate (STG) (no. of on-effort dolphin sightings per 100 km of survey effort) | Encounter rate (ANI) (no. of dolphins from all on-effort sightings per 100 km of survey effort) |
|---|---|---|
| **September-November 2011 (Baseline)** | 9.85 ± 5.85 | 44.66 ± 29.85 |
| **December 2012-February 2013 (Impact)** | 8.36 ± 5.03* | 35.90 ± 23.10* |
| **March-May 2013 (Impact)** | 7.75 ± 3.96 | 24.23 ± 18.05 |
| **June-August 2013 (Impact)** | 6.56 ± 3.68 | 27.00 ± 18.71 |
| **September-November 2013 (Impact)** | 8.04 ± 1.10 | 32.48 ± 26.51 |
| **December 2013-February 2014 (Impact)** | 8.21 ± 2.21* | 32.58 ± 11.21* |
| **March-May 2014 (Impact)** | 6.51 ± 3.34 | 19.14 ± 7.19 |
| **June-August 2014 (Impact)** | 4.74 ± 3.84 | 17.52 ± 15.12 |
| **September-November 2014 (Impact)** | 5.10 ± 4.40 | 20.52 ± 15.10 |

| | | |
|---|---|---|
| **December 2014-February 2015 (Impact)** | 2.91 ± 2.69* | 11.27 ± 15.19* |
| **March-May 2015 (Impact)** | 0.47 ± 0.73 | 2.36 ± 4.07 |
| **June-August 2015 (Impact)** | 2.53 ± 3.20 | 9.21 ± 11.57 |
| **September-November 2015 (Impact)** | 3.94 ± 1.57 | 21.05 ± 17.19 |
| **December 2015-February 2016 (Impact)** | 2.64 ± 1.52* | 10.98 ± 3.81* |
| **March-May 2016 (Impact)** | 0.98 ± 1.10 | 4.78 ± 6.85 |
| **June-August 2016 (Impact)** | 1.72 ± 2.17 | 7.48 ± 10.98 |
| **September-November 2016 (Impact)** | 2.86 ± 1.98 | 10.89 ± 10.98 |
| **December 2016-February 2017 (Impact)** | 3.80 ± 3.79* | 14.52 ± 17.21* |

Notes:
1) The encounter rates deduced from the baseline monitoring period have been recalculated based only on survey effort and on-effort sighting data made along the primary transect lines under favourable conditions.
2) ± denotes the standard deviation of the average encounter rates.
3) The encounter rates in winter months were in blue and marked with asterisk.

3.5.25 As recently discussed in Hung (2016), the dramatic decline in dolphin usage of NEL waters in the past few years (including the declines in abundance, encounter rate and habitat use in NEL, as well as shifts of individual core areas and ranges away from NEL waters) was possibly related to the HZMB construction works that were commenced since 2012. It appeared that such noticeable decline has already extended to NWL waters progressively in the past few years, and with no sign of recovery even the HZMB-related construction activities has well past the peak.

3.5.26 A two-way ANOVA with repeated measures and unequal sample size was conducted to examine whether there were any significant differences in the average encounter rates between the baseline and impact monitoring periods. The two variables that were examined included the two periods (baseline and impact phases) and two locations (NEL and NWL).

3.5.27 For the comparison between the baseline period and the present quarter (17th quarter of the impact phase being assessed), the p-values for the differences in average dolphin encounter rates of STG and ANI were 0.0110 and 0.0440 respectively. If the alpha value is set at 0.05, significant differences were detected between the baseline and present quarters in both the average dolphin encounter rates of STG and ANI.

3.5.28 For the comparison between the baseline period and the cumulative quarters in impact phase (i.e. the first 17 quarters of the impact phase being assessed), the p-values for the differences in average dolphin encounter rates of STG and ANI were 0.000003 and 0.000001 respectively. Even if the alpha value is set at 0.00001, significant differences were still detected in both the average dolphin encounter rates of STG and ANI (i.e. between the two periods and the locations).

3.5.29 As indicated in both dolphin distribution patterns and encounter rates, dolphin usage has been significantly reduced in both NEL and NWL survey areas during the present quarterly period, and such low occurrence of dolphins has also been consistently documented in previous quarters. This raises serious concern, as the timing of the decline in dolphin usage in North Lantau waters coincided well with the construction schedule of the HZMB-related projects (Hung 2016).

3.5.30 To ensure the continuous usage of North Lantau waters by the dolphins, every possible measure should be implemented by the contractors and relevant authorities of HZMB-related works to minimize all disturbances to the dolphins.

**Group Size**

3.5.31 Group size of Chinese White Dolphins ranged from one to eight individuals per group in North Lantau region during December 2016 to February 2017. The average dolphin group sizes from these three months were compared with the ones deduced from the baseline period in September to November 2011, as shown in **Table 3.8**.

**Table 3.8 Comparison of Average Dolphin Group Sizes between Reporting Period (Dec 2016 – Feb 2017) and Baseline Monitoring Period (Sep – Nov 2011)**

| Survey Area | Average Dolphin Group Size | |
|---|---|---|
| | Reporting Period | Baseline Monitoring Period |
| Overall | 3.65 ± 2.37 (n = 17) | 3.72 ± 3.13 (n = 66) |
| Northeast Lantau | --- | 3.18 ± 2.16 (n = 17) |
| Northwest Lantau | 3.65 ± 2.37 (n = 17) | 3.92 ± 3.40 (n = 49) |

Note:

1) ± denotes the standard deviation of the average group size.

3.5.32 The average dolphin group size in NWL waters during December 2016 to February 2017 was slightly lower than the one recorded during the three-month baseline period (**Table 3.8**). Most of these dolphin groups were composed of 1-4 individuals only, while there were five medium-sized groups of 5-8 individuals.

3.5.33 Distribution of the larger dolphin groups (i.e. five individuals or more per group) during the present quarter is shown in **Figure 3 of Appendix J**, with comparison to the one in baseline period. During the winter months of 2016-17, the five medium-sized groups were sighted to the north of Lung Kwu Chau, near Sha Chau, and to the west of the airport platform (**Figure 3 of Appendix J**). Such distribution pattern was very different from the baseline period, when the larger dolphin groups were more frequently sighted and more evenly distributed in NWL waters, with a few more sighted in NEL waters (**Figure 3 of Appendix J**).

**Habitat Use**

3.5.34 From December 2016 to February 2017, the more important habitats utilized by Chinese White Dolphins were mostly concentrated around Lung Kwu Chau and to the north of the island (**Figures 4a and 4b of Appendix J**). Two grids located to the west of the airport platform and adjacent to HKLR09 alignment also recorded moderate to high densities of dolphins. On the contrary, all grids near HKLR03/ HKBCF reclamation sites as well as TMCLKL alignment did not record any presence of dolphins at all during on-effort search in the present quarterly period (**Figures 4a and 4b of Appendix J**).

3.5.35 However, it should be emphasized that the amount of survey effort collected in each grid during the three-month period was fairly low (6-12 units of survey effort for most grids), and therefore the habitat use pattern derived from the three-month dataset should be treated with caution. A more complete picture of dolphin habitat use pattern should be examined when more survey effort for each grid will be collected throughout the impact phase monitoring programme.

3.5.36 When compared with the habitat use patterns during the baseline period, dolphin usage in NEL and NWL has drastically diminished in both areas during the present impact monitoring period (**Figure 5 of Appendix J**). During the baseline period, many grids between Siu Mo To and Shum Shui Kok in NEL recorded moderately high to high dolphin densities, which was in stark contrast to the complete absence of dolphins there during the present impact phase period (**Figure 5 of Appendix J**).

3.5.37 The density patterns were also very different in NWL between the baseline and impact phase monitoring periods, with higher dolphin usage throughout the area, especially around Sha Chau, near Black Point, to the west of the airport, as well as between Pillar Point and airport platform during the baseline period. In contrast, the only areas with moderate to high dolphin densities were restricted to the waters near Lung Kwu Chau during the present impact phase period (Figure 5 of Appendix J).

**Mother-calf Pairs**

3.5.38 During the present quarterly period, three unspotted juveniles were sighted with their mothers in the North Lantau region. These sightings of young calves were located near Sha Chau and to the west of the airport platform (**Figure 6 of Appendix J**).

3.5.39 The infrequent occurrence of young calves in the present quarter was very different from their regular occurrence in North Lantau waters during the baseline period (**Figure 6 of Appendix J**). This should be of a serious concern, and the occurrence of young calves in North Lantau waters should be closely monitored in the upcoming quarters.

**Activities and Associations with Fishing Boats**

3.5.40 Four of the 17 dolphin groups were engaged in feeding activities, while none of them was engaged in socializing, traveling or milling/resting activity during the three-month study period.

3.5.41 The percentage of sightings associated with feeding activities (23.5%) was much higher than the one recorded during the baseline period (11.6%). However, it should be noted the sample size on total numbers of dolphin sightings during the present quarter (17 dolphin groups) was much lower than the baseline period (66 dolphin groups).

3.5.42 Distribution of dolphins engaged in various activities during the present impact phase period and the baseline period is shown in **Figure 6 of Appendix J**. The four dolphin groups engaged in feeding activities were sighted around Lung Kwu Chau, Sha Chau as well as to the west of Shum Wat adjacent to the HKLR09 alignment during the present quarterly period, which was very different from the baseline period when various dolphin activities occurred throughout the North Lantau region (**Figure 6 of Appendix J**).

3.5.43 Notably, none of the 17 dolphin groups was found to be associated with any operating fishing vessel during the present impact phase period.

## Summary Photo-identification works

3.5.44 From December 2016 to February 2017, over 2,100 digital photographs of Chinese White Dolphins were taken during the impact phase monitoring surveys for the photo-identification work.

3.5.45 In total, 26 individuals sighted 43 times altogether were identified (see summary table in Appendix III and photographs of identified individuals in **Annex IV of Appendix J**). All of these re-sightings were made in NWL. Nine individuals (NL46, NL98, NL104, NL136, NL182, NL210, NL321 WL145 and WL275) were re-sighted twice, while two individuals (NL202 and NL286) were both re-sighted five times during the three-month period (**Annex III of Appendix J**).

3.5.46 Notably, six of these 26 individuals (CH105, NL98, NL120, NL123, NL182 and NL226) were also sighted in West Lantau waters during the HKLR09 monitoring surveys from December 2016 to February 2017, showing their extensive individual movements across different survey areas.

**Individual range use**

3.5.47 Ranging patterns of the 26 individuals identified during the three-month study period were determined by fixed kernel method, and are shown in **Annex V of Appendix J**.

3.5.48 All identified dolphins sighted in the present quarter were utilizing NWL waters only, but have completely avoided NEL waters where many of them have utilized as their core areas in the

past (**Annex V of Appendix J**). This is in contrary to the extensive movements between NEL and NWL survey areas observed in the earlier impact monitoring quarters as well as the baseline period.

3.5.49 On the other hand, several individuals (NL98, NL120, NL123, NL182 and NL226) consistently utilized North Lantau waters in the past have extended their range use to WL during the present quarter. In the upcoming quarters, individual range use and movements should be continuously monitored to examine whether there has been any consistent shifts of individual home ranges from North Lantau to West or Southwest Lantau, as such shift could possibly be related to the HZMB-related construction works (see Hung 2015, 2016).

**Conclusion**

3.5.50 During the present quarter of dolphin monitoring, no adverse impact from the activities of this construction project on Chinese White Dolphins was noticeable from general observations.

3.5.51 Although dolphins rarely occurred in the area of HKLR03 construction in the past and during the baseline monitoring period, it is apparent that dolphin usage has been dramatically reduced in NEL since 2012, and many individuals have shifted away completely from the important habitat around the Brothers Islands.

3.5.52 It is critical to continuously monitor the dolphin usage in North Lantau region in the upcoming quarters, to determine whether the dolphins are continuously affected by the various construction activities in relation to the HZMB-related works, and whether suitable mitigation measure can be applied to revert the situation.

**References**

3.5.53 Buckland, S. T., Anderson, D. R., Burnham, K. P., Laake, J. L., Borchers, D. L., and Thomas, L. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press, London.

3.5.54 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.

3.5.55 Hung, S. K. 2015. Monitoring of marine mammals in Hong Kong waters – data collection: final report (2014-15). An unpublished report submitted to the Agriculture, Fisheries and Conservation Department of Hong Kong SAR Government, 198 pp.

3.5.56 Hung, S. K. 2016. Monitoring of marine mammals in Hong Kong waters – data collection: final report (2015-16). An unpublished report submitted to the Agriculture, Fisheries and Conservation Department of Hong Kong SAR Government, 163 pp.

3.5.57 Jefferson, T. A. 2000. Population biology of the Indo-Pacific hump-backed dolphin in Hong Kong waters. Wildlife Monographs 144:1-65.

## 3.6 Mudflat Monitoring Results

**Sedimentation Rate Monitoring**

3.6.1 The baseline sedimentation rate monitoring was in September 2012 and impact sedimentation rate monitoring was undertaken on 7 December 2016. The mudflat surface levels at the four established monitoring stations and the corresponding XYZ HK1980 GRID coordinates are presented in **Table 3.9** and **Table 3.10.**

**Table 3.9 Measured Mudflat Surface Level Results**

| | Baseline Monitoring (September 2012) | | | Impact Monitoring (December 2016) | | |
|---|---|---|---|---|---|---|
| **Monitoring Station** | **Easting (m)** | **Northing (m)** | **Surface Level (mPD)** | **Easting (m)** | **Northing (m)** | **Surface Level (mPD)** |
| S1 | 810291.160 | 816678.727 | 0.950 | 810291.174 | 816678.732 | 1.102 |
| S2 | 810958.272 | 815831.531 | 0.864 | 810958.273 | 815831.508 | 0.961 |
| S3 | 810716.585 | 815953.308 | 1.341 | 810716.583 | 815953.287 | 1.456 |
| S4 | 811221.433 | 816151.381 | 0.931 | 811221.428 | 816151.395 | 1.058 |

**Table 3.10 Comparison of Measurement**

| | Comparison of measurement | | | Remarks and Recommendation |
|---|---|---|---|---|
| **Monitoring Station** | **Easting (m)** | **Northing (m)** | **Surface Level (mPD)** | |
| S1 | 0.0014 | 0.005 | 0.152 | Level continuously increased |
| S2 | 0.0001 | -0.023 | 0.097 | Level continuously increased |
| S3 | -0.002 | -0.021 | 0.115 | Level continuously increased |
| S4 | -0.005 | 0.014 | 0.127 | Level continuously increased |

3.6.2 This measurement result was generally and relatively higher than the baseline measurement at S1, S2, S3 and S4. The mudflat level is continuously increased.

**Water Quality Monitoring**

3.6.3 The mudflat monitoring covered water quality monitoring data. Reference was made to the water quality monitoring data of the representative water quality monitoring station (i.e. SR3) as in the EM&A Manual. The water quality monitoring location (SR3) is shown in **Figure 2.1**.

3.6.4 Impact water quality monitoring in San Tau (monitoring station SR3) was conducted in December 2016. The monitoring parameters included dissolved oxygen (DO), turbidity and suspended solids (SS).

3.6.5 The Impact monitoring result for SR3 were extracted and summarised below:

**Table 3.11 Impact Water Quality Monitoring Results (Depth Average)**

| **Date** | **Mid Ebb Tide** | | | **Mid Flood Tide** | | |
|---|---|---|---|---|---|---|
| | **DO (mg/L)** | **Turbidity (NTU)** | **SS (mg/L)** | **DO (mg/L)** | **Turbidity (NTU)** | **SS (mg/L)** |
| 2-Dec-16 | 7.19 | 6.55 | 4.95 | 6.90 | 7.20 | 11.60 |
| 5-Dec-16 | 7.14 | 7.10 | 7.50 | 6.80 | 7.05 | 9.00 |
| 7-Dec-16 | 6.90 | 7.35 | 16.50 | 7.30 | 10.15 | 19.50 |
| 9-Dec-16 | 6.98 | 4.35 | 8.85 | 7.22 | 5.20 | 7.45 |
| 12-Dec-16 | 7.27 | 3.80 | 5.15 | 7.51 | 7.15 | 8.00 |
| 14-Dec-16 | 7.69 | 2.55 | 7.15 | 7.65 | 2.20 | 14.30 |
| 16-Dec-16 | 8.30 | 3.10 | 7.45 | 7.81 | 3.60 | 8.40 |

| Date | Mid Ebb Tide | | | Mid Flood Tide | | |
|---|---|---|---|---|---|---|
| | DO (mg/L) | Turbidity (NTU) | SS (mg/L) | DO (mg/L) | Turbidity (NTU) | SS (mg/L) |
| 19-Dec-16 | 7.74 | 4.30 | 7.15 | 8.04 | 4.40 | 6.75 |
| 21-Dec-16 | 7.53 | 6.85 | 9.85 | 7.64 | 6.90 | 8.25 |
| 23-Dec-16 | 7.56 | 3.70 | 5.10 | 7.88 | 5.15 | 4.20 |
| 26-Dec-16 | 7.96 | 3.45 | 4.75 | 8.37 | 3.20 | 5.90 |
| 28-Dec-16 | 8.55 | 3.85 | 7.50 | 8.51 | 5.20 | 7.90 |
| 30-Dec-16 | 8.68 | 4.35 | 10.50 | 8.53 | 6.10 | 11.00 |
| Average | 7.65 | 4.72 | 7.88 | 7.70 | 5.65 | 9.40 |

## Mudflat Ecology Monitoring

### Sampling Zone

3.6.6 In order to collect baseline information of mudflats in the study site, the study site was divided into three sampling zones (labeled as TC1, TC2, TC3) in Tung Chung Bay and one zone in San Tau (labeled as ST) (**Figure 2.1 of Appendix O**). The horizontal shoreline of sampling zones TC1, TC2, TC3 and ST were about 250 m, 300 m, 300 m and 250 m respectively. Survey of horseshoe crabs, seagrass beds and intertidal communities were conducted in every sampling zone. The present survey was conducted in December 2016 (totally 6 sampling days between 3rd and 19th December 2016).

### Horseshoe Crabs

3.6.7 Active search method was conducted for horseshoe crab monitoring by two experienced surveyors in every sampling zone. During the search period, any accessible and potential area would be investigated for any horseshoe crab individuals within 2-3 hours of low tide period (tidal level below 1.2 m above Chart Datum (C.D.)). Once a horseshoe crab individual was found, the species was identified referencing to Li (2008). The prosomal width, inhabiting substratum and respective GPS coordinate were recorded. A photographic record was taken for future investigation. Any grouping behavior of individuals, if found, was recorded. The horseshoe crab surveys were conducted on 5th (for TC3 and ST) and 19th (for TC1 and TC2) December 2016. The weather was generally warm and sunny on 5th December while it was cloudy and windy on 19th December.

### Seagrass Beds

3.6.8 Active search method was conducted for seagrass bed monitoring by two experienced surveyors in every sampling zone. During the search period, any accessible and potential area would be investigated for any seagrass beds within 2-3 hours of low tide period. Once seagrass bed was found, the species, estimated area, estimated coverage percentage and respective GPS coordinates were recorded. The seagrass beds surveys were conducted on 5th (for TC3 and ST) and 19th (for TC1 and TC2) December 2016. The weather was generally warm and sunny on 5th December while it was cloudy and windy on 19th December.

### Intertidal Soft Shore Communities

3.6.9 The intertidal soft shore community surveys were conducted in low tide period on 3rd (for TC2), 4th (for TC3), 17th (for ST) and 18th (for TC1) December 2016. In every sampling zone, three 100m horizontal transect lines were laid at high tidal level (H: 2.0 m above C.D.), mid tidal level (M: 1.5 m above C.D.) and low tidal level (L: 1.0 m above C.D.). Along every horizontal transect line, ten random quadrats (0.5 m x 0.5 m) were placed.

3.6.10 Inside a quadrat, any visible epifauna were collected and were in-situ identified to the lowest practical taxonomical resolution. Whenever possible a hand core sample (10 cm internal diameter × 20 cm depth) of sediments was collected in the quadrat. The core sample was gently washed through a sieve of mesh size 2.0 mm in-situ. Any visible infauna were collected and identified. Finally the top 5 cm surface sediments was dug for visible infauna in the quadrat regardless of hand core sample was taken.

3.6.11 All collected fauna were released after recording except some tiny individuals that are too small to be identified on site. These tiny individuals were taken to laboratory for identification under dissecting microscope.

3.6.12 The taxonomic classification was conducted in accordance to the following references: Polychaetes: Fauchald (1977), Yang and Sun (1988); Arthropods: Dai and Yang (1991), Dong (1991); Mollusks: Chan and Caley (2003), Qi (2004).

**Data Analysis**

3.6.13 Data collected from direct search and core sampling was pooled in every quadrat for data analysis. Shannon-Weaver Diversity Index (H') and Pielou's Species Evenness (J) were calculated for every quadrat using the formulae below,

$H' = -\Sigma ( Ni / N ) \ln ( Ni / N )$ (Shannon and Weaver, 1963)
$J = H' / \ln S$, (Pielou, 1966)

where S is the total number of species in the sample, N is the total number of individuals, and Ni is the number of individuals of the $i^{th}$ species.

**Mudflat Ecology Monitoring Results and Conclusion**

**Horseshoe Crabs**

3.6.14 In the present survey, two species of horseshoe crab *Carcinoscorpius rotundicauda* (total 70 ind.) and *Tachypleus tridentatus* (total 24 ind.) were recorded in TC3 and ST only. For one sight record, grouping of 2-19 individuals was observed at same locations with similar substratum (fine sand or soft mud). Photo records were shown in **Figure 3.1 of Appendix O** while the complete survey records were listed in **Annex II of Appendix O**.

3.6.15 **Table 3.1 of Appendix O** summarizes the survey results of horseshoe crab in present survey. For Carcinoscorpius rotundicauda, there were 27 and 43 individuals in TC3 and ST respectively. For ST, the search record was the higher (7.2 ind. hr-1 person-1) while the average body size was 44.05 mm (prosomal width ranged 25.61-66.22 mm). The search record of TC3 was 4.5 ind. hr-1 person-1 with average body size 41.68 mm (prosomal width ranged 16.85-65.73 mm).

3.6.16 For *Tachypleus tridentatus*, there were 17 and 7 individuals in TC3 and ST respectively. For TC3, the search record was higher (2.8 ind. $hr^{-1}$ $person^{-1}$) while the average body size was 39.13 mm (prosomal width ranged 20.40-64.24 mm). For ST, the search record was 1.2 ind. $hr^{-1}$ $person^{-1}$ while the average body size was 44.79 mm (prosomal width ranged 41.50-52.57 mm).

3.6.17 In the previous survey of March 2015, there was one important finding that a mating pair of *Carcinoscorpius rotundicauda* was found in ST (prosomal width: male 155.1 mm, female 138.2 mm) **(Figure 3.2 of Appendix O)**. It indicated the importance of ST as a breeding ground of horseshoe crab. Moreover, two moults of *Carcinoscorpius rotundicauda* were found in TC1 with similar prosomal width 130-140 mm **(Figure 3.2 of Appendix O)**. It reflected that a certain numbers of moderately sized individuals inhabited the sub-tidal habitat of Tung Chung Wan after its nursery period on soft shore. These individuals might move onto soft shore during high tide for foraging, moulting and breeding. Then it would return to sub-tidal habitat during ebb tide. Because the mating pair should be inhabiting sub-tidal habitat in most of the time. The record was excluded from the data analysis to avoid mixing up with juvenile population living on soft shore. In another previous survey of Jun. 2016, the records of the two big individuals of *Carcinoscorpius rotundicauda* (prosomal width 117.37 mm and 178.17 mm) in TC1 were excluded from data analysis according to the same principle.

3.6.18 No marked individual of horseshoe crab was recorded in present survey. Some marked individuals were found in previous surveys conducted in Sep. 2013, Mar. 2014 and Sep. 2014. All of them were released through a conservation programme conducted by Prof. Paul Shin (Department of Biology and Chemistry, The City University of Hong Kong (CityU)). It was a re-introduction trial of artificial bred horseshoe crab juvenile at selected sites. So that the horseshoe crabs population might be restored in the natural habitat. Through a personal conversation with Prof. Shin, about 100 individuals were released in the sampling zone ST on 20 June 2013. All of them were marked with color tape and internal chip detected by specific chip sensor. There should be second round of release between June and September 2014 since new marked individuals were found in the survey of September 2014.

3.6.19 The artificial bred individuals, if found, would be excluded from the results of present monitoring programme in order to reflect the changes of natural population. However, the mark on their prosoma might have been detached during moulting after a certain period of release. The artificially released individuals were no longer distinguishable from the natural population without the specific chip sensor. The survey data collected would possibly cover both natural population and artificially bred individuals.

Population difference among the sampling zones

3.6.20 **Figures 3.3 and 3.4 of Appendix O** show the changes of number of individuals, mean prosomal width and search record of horseshoe crabs *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* respectively in every sampling zone throughout the monitoring period.

3.6.21 Throughout the monitoring conducted, it was obvious that TC3 and ST (western shore of Tung Chung Wan) was an important nursery ground for horseshoe crab especially newly hatched individuals due to larger area of suitable substratum (fine sand or soft mud) and less human disturbance (far from urban district). Relatively, other sampling zones were not a suitable nursery ground especially TC2. Possible factors were less area of suitable substratum (especially TC1) and higher human disturbance (TC1 and TC2: close to urban district and easily accessible). In TC2, large daily salinity fluctuation was a possible factor either since it was flushed by two rivers under tidal inundation. The individuals inhabiting TC1 and TC2 were confined in small foraging area due to limited area of suitable substrata.

3.6.22 For TC3 and ST, high to medium search records (i.e. number of individuals) of both species were always found. The search record of ST was higher from Sep. 2012 to Jun. 2014 while it was replaced by TC3 from Sep. 2014 to Jun. 2015. The search records were similar between two sampling zones from Sep. 2015 to Jun. 2016. In Sep. 2016, the search record of *Carcinoscorpius rotundicauda* in ST was much higher than TC3. In the present survey (Dec. 2016), the search records of both species were similar again between two sampling zones. It reflected a natural variation of horseshoe crab population in these two zones due to weather condition and tidal effect during the survey.

3.6.23 For TC1, the search record was at low to medium level throughout the monitoring period. The change of *Carcinoscorpius rotundicauda* was relatively more variable than that of *Tachypleus tridentatus.* Relatively, the search record was very low in TC2 (2 ind. in Sep. 2013; 1 ind. in Mar., Jun., Sep. 2014, Mar. and Jun. 2015; 4 ind. in Sep. 2015; 6 ind. in Jun. 2016; 1 ind. in Sep. 2016).

3.6.24 About the body size, larger individuals of *Carcinoscorpius rotundicauda* were usually found in ST and TC1 relative to those in TC3. For *Tachypleus tridentatus*, larger individuals were usually found in ST followed by TC3 and TC1.

3.6.25 Throughout the monitoring period, it was obvious that TC3 and ST (western shore of Tung Chung Wan) was an important nursery ground for horseshoe crab especially newly hatched individuals due to larger area of suitable substratum (fine sand or soft mud) and less human disturbance (far from urban district). Relatively, other sampling zones were not a suitable nursery ground especially TC2. Possible factors were less area of suitable substratum (especially TC1) and higher human disturbance (TC1 and TC2: close to urban district and easily accessible). In TC2, large daily salinity fluctuation was a possible factor either since it was

flushed by two rivers under tidal inundation. The individuals inhabiting TC1 and TC2 were confined in small foraging area due to limited area of suitable substrata.

Seasonal variation of horseshoe crab population

3.6.26 Throughout the monitoring period conducted, the search record of horseshoe crab declined obviously during dry season especially December (**Figures 3.3 and 3.4 of Appendix O**). In Dec. 2012, 4 individuals of *Carcinoscorpius rotundicauda* and 12 individuals of *Tachypleus tridentatus* were found only. In Dec. 2013, no individual of horseshoe crab was found. In Dec. 2014, 2 individuals of *Carcinoscorpius rotundicauda* and 8 individuals of *Tachypleus tridentatus* were found only. In Dec. 2015, 2 individuals of Carcinoscorpius rotundicauda, 6 individuals of *Tachypleus tridentatus* and one newly hatched, unidentified individual were found only. The horseshoe crabs were inactive and burrowed in the sediments during cold weather (<15 ºC). Similar results of low search record in dry season were reported in a previous territory-wide survey of horseshoe crab. For example, the search records in Tung Chung Wan were 0.17 ind. $hr^{-1}$ $person^{-1}$ and 0.00 ind. $hr^{-1}$ $person^{-1}$ in wet season and dry season respectively (details see Li, 2008). Relatively the serach records were much higher in the present survey (Dec. 2016). There were totally 70 individuals of *Carcinoscorpius rotundicauda* and 24 individuals of *Tachypleus tridentatus* in TC3 and ST. Because the survey was arranged in early December while the weather was warm with sunlight (~22 °C during dawn according to Hong Kong Observatory database, Chek Lap Kok station on 5 Dec). In contrast, there was no search record in TC1 and TC2 because the survey was conducted in mid December with colder and cloudy weather (~20 °C during dawn on 19 Dec). The horseshoe crab activity would decrease gradually during December and would increase with the warmer climate during March to April.

3.6.27 From Sep. 2012 to Dec. 2013, *Carcinoscorpius rotundicauda* was a less common species relative to *Tachypleus tridentatus*. Only 4 individuals were ever recorded in ST in Dec. 2012. This species had ever been believed of very low density in ST hence the encounter rate was very low. Since Mar. 2014, it was found in all sampling zones with higher abundance in ST. Based on its average size (mean prosomal width 39.28-49.81 mm), it indicated that breeding and spawning of this species had occurred about 3 years ago along the coastline of Tung Chun Wan. However, these individuals were still small while their walking trails were inconspicuous. Hence there was no search record in previous sampling months. Since Mar. 2014, more individuals were recorded due to larger size and higher activity (i.e. more conspicuous walking trail).

3.6.28 For *Tachypleus tridentatus*, sharp increase of number of individuals was recorded in ST during the wet season of 2013 (from Mar. to Sep.). According to a personal conversation with Prof. Shin (CityU), his monitoring team had recorded similar increase of horseshoe crab population during wet season. It was believed that the suitable ambient temperature increased its conspicuousness. However similar pattern was not recorded in the following wet seasons. The number of individuals increased in Mar. and Jun. 2014 followed by a rapid decline in Sep. 2014. Then the number of individuals fluctuated slightly in TC3 and ST until Dec. 2016 (present survey). Apart from natural mortality, migration from nursery soft shore to subtidal habitat was another possible cause. Since the mean prosomal width of *Tachypleus tridentatus* continued to grow and reached about 50 mm since Mar. 2014. Then it varied slightly between 35-65 mm from Sep. 2014 to Jun. 2016. Most of the individuals might have reached a suitable size strong enough to forage in sub-tidal habitat.

3.6.29 Since TC3 and ST were regarded as important nursery ground for horseshoe crab, box plots of prosomal width of two horseshoe crab species were constructed to investigate the changes of population in details.

Box plot of horseshoe crab populations in TC3

3.6.30 **Figure 3.5 of Appendix O** shows the changes of prosomal width of *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* in TC3. As mentioned above, *Carcinoscorpius rotundicauda* was rarely found between Sep. 2012 and Dec. 2013 hence the data were lacking. In Mar 2014, the major size (50% of individual records between upper and lower quartile) ranged

40-60 mm while only few individuals were found. From Mar. 2014 to Dec. 2016 (present survey), the size of major population decreased and more small individuals were recorded after Mar. of every year. It indicated new rounds of successful breeding and spawning of *Carcinoscorpius rotundicauda* in TC3. It matched with the previous mating record in ST in Mar. 2015. Also there were slight increasing trends of body size from Jun. to Dec. in years 2015 and 2016. It indicated a stable growth of individuals. Focused on much larger individuals (circle dots above the box in the box plots), the size range was quite variable (prosmal width 60-90 mm) along the sampling months. It was yet to determine their size of migrating to sub-tidal habitat in TC3.

3.6.31 For *Tachypleus tridentatus*,the major size ranged 20-50 mm while the number of individuals fluctuated from Sep. 2012 to Jun. 2014. Then a slight but consistent growing trend was observed from Sep. 2014 to Jun. 2015. The prosomal width increased from 25-35 mm to 35-65 mm. As mentioned, the large individuals might have reached a suitable size for migrating from the nursery soft shore to subtidal habitat. It accounted for the declined population in TC3. From Mar. to Sep. 2016, slight increasing trend of major size was noticed again. In Dec. 2016 (present survey), the major size decreased to 25-45 mm. Across the monitoring period, the maximum prosomal width of major population ranged 60-70 mm. It reflected individuals reaching this size would gradually migrate to sub-tidal habitats.

Box plot of horseshoe crab populations in ST

3.6.32 **Figure 3.6 of Appendix O** shows the changes of prosomal width of *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* in ST. As mentioned above, *Carcinoscorpius rotundicauda* was rarely found between Sep. 2012 and Dec. 2013 hence the data were lacking. From Mar. 2014 to Sep. 2016, the size of major population decreased and more small individuals (i.e. circle dots below the box in the box plots) were recorded after Jun. of every year. It indicated new round of successful spawning in ST. It matched with the previous mating record in ST in Mar. 2015. Also there were slight increasing trends of body size from Sep. to Jun. from 2014 to 2016. It indicated a stable growth of individuals. Across the whole monitoring period, the maximum prosomal width (i.e. circle dots above the box in the box plots) usually ranged 70-80 mm. It reflected individuals reaching this size would gradually migrate to sub-tidal habitats.

3.6.33 For *Tachypleus tridentatus*, a consistent growing trend was observed for the major population from Dec. 2012 to Dec. 2014 regardless of change of search record. The prosomal width increased from 15-30 mm to 55-70 mm. As mentioned, the large individuals might have reached a suitable size for migrating from the nursery soft shore to subtidal habitat. From Mar. to Sep. 2015, the size of major population decreased slightly to a prosomal width 40-60 mm. At the same time, the number of individuals decreased gradually. It further indicated some of large individuals might have migrated to sub-tidal habitat, leaving the smaller individuals on shore. There was an overall growth trend. In Dec. 2015, two big individuals (prosomal width 89.27 mm and 98.89 mm) were recorded only while it could not represent the major population. From Dec. 2015 to Mar. 2016, the number of individual was very few in ST that no boxplot could be produced. In Jun. 2016, the prosomal width of major population ranged 50-70 mm. But it dropped clearly to 30-40 mm in Sep. 2016 followed by an increase to 40-50 mm in Dec. 2016 (present survey). Based on overall higher number of small individuals recorded in Jun. and Sep. 2016, it indicated new round of successful spawning in ST. Throughout the monitoring period, the maximum prosomal width of major population ranged 60-70 mm. It reflected individuals reaching this size would gradually migrate to sub-tidal habitats, similar to the finding in TC3.

3.6.34 As a summary for horseshoe crab populations in TC3 and ST, there was successful spawning of *Carcinoscorpius rotundicauda* from 2014 to 2016 while the spawning time should be in spring. There were consistent, increasing trends of population size in these two sampling zones. For *Tachypleus tridentatus*, small individuals were rarely found in TC3 and ST from 2014 to 2015. It was believed no occurrence of successful spawning. The existing individuals (that recorded since 2012) grew to a mature size and migrated to sub-tidal habitat. Hence the number of individuals decreased gradually. In 2016, new round of successful spawning was recorded in ST while increasing number of individuals and body size was noticed.

Impact of the HKLR project

3.6.35 It was the 17th survey of the EM&A programme during the construction period. Based on the results, impact of the HKLR project could not be detected on horseshoe crabs. The population change was mainly determined by seasonal variation while successful spawnings were observed for both species. In case, abnormal phenomenon (e.g. very few numbers of horseshoe crab individuals in wet season, large number of dead individuals on the shore) is found, it would be reported as soon as possible.

**Seagrass Beds**

3.6.36 In the present survey, seagrass species *Halophila ovalis* and *Zostera japonica* were recorded in TC3 and ST. Photo records were shown in **Figure 3.7 of Appendix O** while the complete records of seagrass beds survey were shown in **Annex III of Appendix O.**

3.6.37 **Table 3.2 of Appendix O** summarizes the results of seagrass beds survey. In TC3, three small patches of *Halophila ovalis* were found in soft mud area at 0.5-1.0 m above C.D. while the total seagrass bed area and vegetation coverage were about 55.1 $m^2$ (average area 18.4 $m^2$) and 80%.

3.6.38 In ST, eleven patches of *Halophila ovalis* were found while the total seagrass bed area was about 12550.4 $m^2$. The seagrass bed area was highly variable among patches. In the soft mud area at 0.5-1.5 m above C.D., the largest patch was an extensive, horizontal strand with area ~10838.3 $m^2$ and vegetation coverage 70%. It had covered significant portion of the mud flat area in ST (Fig. 3.7). At vicinity, there were seven small-medium, irregular patches (total area 8.1-62.7 $m^2$, coverage 80-90%). At higher tidal level (2.0 m above C.D.), there were three seagrass patches in the sandy area nearby the seaward mangrove boundary. The largest patch was a horizontal strand with area ~796 $m^2$ and vegetation coverage 50-70% followed by other two medium patches (area ~135.7-448.8 $m^2$, coverage 50-80%).

3.6.39 For *Zostera japonica*, there was one medium, horizontal strand only in the sandy area nearby the seaward mangrove boundary. The seagrass bed area and vegetation coverage were about 64.5 $m^2$ and 50-70%.

3.6.40 Since majority of seagrass bed was confined in ST, the temporal change of both seagrass species were investigated in details.

Temporal variation of seagrass beds

3.6.41 **Figure 3.8 of Appendix O** shows the changes of estimated total area of seagrass beds in ST along the sampling months. For *Zostera japonica*, it was not recorded in the 1st and 2nd surveys of monitoring programme. Seasonal recruitment of few, small patches (total seagrass area: 10 $m^2$) was found in Mar. 2013 that grew within the large patch of seagrass Halophila ovalis. Then the patch size increased and merged gradually with the warmer climate from Mar. to Jun. 2013 (15 $m^2$). However the patch size decreased and remained similar from Sep. 2013 (4 $m^2$) to Mar. 2014 (3 $m^2$). In Jun. 2014, the patch size increased obviously again (41 $m^2$) with warmer climate followed by a decrease between Sep. 2014 (2 $m^2$) and Dec. 2014 (5 $m^2$). From Mar. to Jun. 2015, the patch size increased sharply again (90 $m^2$). It might be due to the disappearance of the originally dominant seagrass *Halophila ovalis* resulting in less competition for substratum and nutrients. From Sep.2015 to Jun.2016, it was found coexisting with seagrass *Halophila ovalis* with steady increasing patch size (from 44 $m^2$ to 115 $m^2$) and variable coverage. In Sep. 2016, the patch size decreased again to (38 $m^2$) followed by an increase to a horizontal strand (65 $m^2$) in Dec. 2016. And it was no longer co-exisitng with Halophila ovalis. From Sep. 2014 to Dec. 2016, an increasing trend was noticed from Sep. to Jun. followed by a rapid decline to Sep. It was possibly the causes of heat stress, typhoon and stronger grazing pressure during wet season.

3.6.42 For *Halophila ovalis*, it was recorded as 3-4 medium to large patches (area 18.9-251.7 $m^2$; vegetation coverage 50-80%) beside the mangrove vegetation at tidal level 2 m above C.D. in Sep. 2012 (first survey). The total seagrass bed area grew steadily from 332.3 $m^2$ in Sep. 2012 to 727.4 $m^2$ in Dec. 2013. Flowers were observed in the largest patch during its flowering period.

In Mar. 2014, 31 small to medium patches were newly recorded (variable area 1-72 $m^2$ per patch, vegetation coverage 40-80% per patch) in lower tidal zone between 1.0 and 1.5 m above C.D. The total seagrass area increased further to 1350 $m^2$. In Jun. 2014, these small and medium patches grew and extended to each other. These patches were no longer distinguishable and were covering a significant mudflat area of ST. It was generally grouped into 4 large patches (1116 – 2443 $m^2$) of seagrass beds characterized of patchy distribution, variable vegetable coverage (40-80%) and smaller leaves. The total seagrass bed area increased sharply to 7629 $m^2$. In Sep. 2014, the total seagrass area declined sharply to 1111 $m^2$. There were only 3-4 small to large patches (6-253 $m^2$) at high tidal level and 1 patch at low tidal level (786 $m^2$). Typhoon or strong water current was a possible cause (Fong, 1998). In Sep. 2014, there were two tropical cyclone records in Hong Kong (7th-8th Sep.: no cyclone name, maximum signal number 1; 14th-17th Sep.: Kalmaegi, maximum signal number 8SE) before the seagrass survey dated 21st Sep. 2014. The strong water current caused by the cyclone, Kalmaegi especially, might have given damage to the seagrass beds. In addition, natural heat stress and grazing force were other possible causes reducing seagrass beds area. Besides, very small patches of *Halophila ovalis* could be found in other mud flat area in addition to the recorded patches. But it was hardly distinguished due to very low coverage (10-20%) and small leaves.

3.6.43 In Dec. 2014, all the seagrass patches of *Halophila ovalis* disappeared in ST. **Figure 3.9 of Appendix O** shows the difference of the original seagrass beds area nearby the mangrove vegetation at high tidal level between Jun. 2014 and Dec. 2014. Such rapid loss would not be seasonal phenomenon because the seagrass beds at higher tidal level (2.0 m above C.D.) were present and normal in December 2012 and 2013. According to Fong (1998), similar incident had occurred in ST in the past. The original seagrass area had declined significantly during the commencement of the construction and reclamation works for the international airport at Chek Lap Kok in 1992. The seagrass almost disappeared in 1995 and recovered gradually after the completion of reclamation works. Moreover, incident of rapid loss of seagrass area was also recorded in another intertidal mudflat in Lai Chi Wo in 1998 with unknown reason. Hence *Halophila ovalis* was regarded as a short-lived and r-strategy seagrass that could colonize areas in short period but disappears quickly under unfavourable conditions (Fong, 1998).

Unfavourable conditions to seagrass *Halophila ovalis*

3.6.44 Typhoon or strong water current was suggested as one unfavourable condition to *Halophila ovalis* (Fong, 1998). As mentioned above, there were two tropical cyclone records in Hong Kong in September 2014. The strong water current caused by the cyclones might have given damage to the seagrass beds.

3.6.45 Prolonged light deprivation due to turbid water would be another unfavourable condition. Previous studies reported that *Halophila ovalis* had little tolerance to light deprivation. During experimental darkness, seagrass biomass declined rapidly after 3-6 days and seagrass died completely after 30 days. The rapid death might be due to shortage of available carbohydrate under limited photosynthesis or accumulation of phytotoxic end products of anaerobic respiration (details see Longstaff *et al*., 1999). Hence the seagrass bed of this species was susceptible to temporary light deprivation events such as flooding river runoff (Longstaff and Dennison, 1999).

3.6.46 In order to investigate any deterioration of water quality (e.g. more turbid) in ST, the water quality measurement results at two closest monitoring stations SR3 and IS5 of the EM&A programmewere obtained from the water quality monitoring team. Based on the results from June to December 2014, the overall water quality was in normal fluctuation except there was one exceedance of suspended solids (SS) at both stations in September. On 10th Sep., 2014, the SS concentrations measured during mid-ebb tide at stations SR3 (27.5 mg/L) and IS5 (34.5 mg/L) exceeded the Action Level (≤23.5 mg/L and 120% of upstream control station's reading) and Limit Level (≤34.4 mg/L and 130% of upstream control station's reading) respectively. The turbidity readings at SR3 and IS5 reached 24.8-25.3 NTU and 22.3-22.5 NTU respectively. The temporary turbid water should not be caused by the runoff from upstream rivers. Because there

was no rain or slight rain from 1st to 10th Sep. 2014 (daily total rainfall at the Hong Kong International Airport: 0-2.1 mm; extracted from the climatological data of Hong Kong Observatory). The effect of upstream runoff on water quality should be neglectable in that period. Moreover the exceedance of water quality was considered unlikely to be related to the contract works of HKLR according to the 'Notifications of Environmental Quality Limits Exceedances' provided by the respective environmental team. The respective construction of seawall and stone column works, which possibly caused turbid water, were carried out within silt curtain as recommended in the EIA report. Moreover there was no leakage of turbid water, abnormity or malpractice recorded during water sampling. In general, the exceedance of suspended solids concentration was considered to be attributed to other external factors, rather than the contract works.

3.6.47 Based on the weather condition and water quality results in ST, the co-occurrence of cyclone hit and turbid waters in Sep. 2014 might have combined the adverse effects on *Halophila ovalis* that leaded to disappearance of this short-lived and r-strategy seagrass species. Fortunately *Halophila ovalis* was a fast-growing species (Vermaat et al., 1995). Previous studies showed that the seagrass bed could be recovered to the original sizes in 2 months through vegetative propagation after experimental clearance (Supanwanid, 1996). Moreover it was reported to recover rapidly in less than 20 days after dugong herbivory (Nakaoka and Aioi, 1999). As mentioned, the disappeared seagrass in ST in 1995 could recover gradually after the completion of reclamation works for international airport (Fong, 1998). The seagrass beds of *Halophila ovalis* might recolonize the mudflat of ST through seed reproduction as long as there was no unfavourable condition in the coming months.

Recolonization of seagrass beds

3.6.48 **Figure 3.9 of Appendix O** shows the recolonization of seagrass bed area in ST from Dec. 2014 to Dec. 2016 (present survey). From Mar. to Jun. 2015, 2-3 small patches of *Halophila ovalis* were newly found coinhabiting with another seagrass species *Zostera japonica*. But its total patch area was still very low relative to the previous records. The recolonization rate was low while cold weather and insufficient sunlight were possible factors between Dec. 2014 and Mar. 2015. Moreover, it would need to compete with seagrass *Zostera japonica* for substratum and nutrient. Since *Zostera japonica* had extended and had covered the original seagrass bed of *Halophila ovalis* at certain degree. From Jun. 2015 to Mar. 2016, the total seagrass area of *Halophila ovalis* had increased rapidly from 6.8 $m^2$ to 230.63 $m^2$. It had recolonized its original patch locations and covered *Zostera japonica*. In Jun. 2016, the total seagrass area increased sharply to 4707.3 $m^2$. Similar to the previous records of Mar to Jun. 2014, the original patch area increased further to a horizontally long strand. Another large seagrass beds colonized the lower tidal zone (1.0-1.5 m above C.D.). In Sep. 2016, this patch extended much and covered significant soft mud area of ST, resulting in sharp increase of total area (24245 $m^2$). It indicated the second extensive colonization of this r-strategy seagrass. In Dec. 2016 (present survey), this extensive seagrass patch decreased in size and had separated into few, smaller patches. Moreover, the horizontal strand nearby the mangrove vegetation decreased in size (Fig. 3.9). The total seagrass bed decreased to 12550 $m^2$. Such decline of seagrass bed area might be similar to the results in Sep-Dec. 2014.

Impact of the HKLR project

3.6.49 It was the 17th survey of the EM&A programme during the construction period. According to the results of present survey, there was clear recolonization of both seagrass species *Halophila ovalis* and *Zostera japonica* in ST. Hence the negative impact of HKLR project on the seagrass was not significant. In Dec. 2016 (present survey), a decline of seagrass bed was noted again but it was yet to deduce the presence of stress factors. In case unfavourable phenomenon (e.g. reduction of seagrass patch size, abnormal change of leave colour) is found presistent, it would be reported as soon as possible.

**Intertidal Soft Shore Communities**

3.6.50 **Table 3.3 and Figure 3.10 of Appendix O** show the types of substratum along the horizontal transect at every tidal level in all sampling zones. The relative distribution of different substrata

was estimated by categorizing the substratum types (Gravels & Boulders / Sands / Soft mud) of the ten random quadrats along the horizontal transect. The distribution of substratum types varied among tidal levels and sampling zones:

- In TC1, the major substratum type was 'Gravels and Boulders' (60%) followed by 'Sands' (40%) at high tidal level. High percentage of 'Gravels and Boulders'(90%) was recorded at the mid and low tidal levels.
- In TC2, the major substrata types were 'Sands' (50-60%) and 'Soft mud' (30-50%) at the high and mid tidal levels. 'Soft mud' was the major substratum type (90%) at the low tidal level.
- In TC3, 'Sands' was the substratum type at the high and mid tidal levels (100%). At low tidal level, 'Gravels and Boulders' (70%) was mainly recorded followed by 'Soft mud' (20%).
- In ST, high percentage of 'Gravels and Boulders' (90-100%) was recorded at high and mid tidal levels. The major substrata types were 'Gravels and Boulders' (50%) and 'Soft mud' (30%) at the low tidal level.

3.6.51 There was neither consistent vertical nor horizontal zonation pattern of substratum type in all sampling zones. Such heterogeneous variation should be caused by different hydrology (e.g. wave in different direction and intensity) received by the four sampling zones.

3.6.52 **Table 3.4 of Appendix O** lists the total abundance, density and number of taxon of every phylum in this survey. A total of 9725 individuals were recorded. Mollusca was clearly the most abundant phylum (total individuals 9231, density 308 ind. $m^{-2}$, relative abundance 94.9%). The second and third abundant phya were Arthropoda (383 ind., 13 ind. $m^{-2}$, 3.9%) and Annelida (60 ind., 2 ind. $m^{-2}$, 0.6%) respectively. Relatively other phyla were very low in abundances (density ≤1 ind. $m^{-2}$, relative abundance ≤0.2%). Moreover, the most diverse phylum was Mollusca (36 taxa) followed by Arthropoda (13 taxa) and Annelida (9 taxa). There was 1 taxon recorded only for other phyla. The taxonomic resolution and complete list of collected specimens are shown in **Annex IV and V of Appendix O** respectively.

3.6.53 **Table 3.5 of Appendix O** shows the number of individual, relative abundance and density of each phylum in every sampling zone. The total abundance (1650-3245 ind.) varied among the four sampling zones while the phyla distributions were similar. In general, Mollusca was the most dominant phylum (no. of individuals: 1446-3129 ind.; relative abundance 87.6-97.5%; density 193-417 ind. $m^{-2}$). Other phyla were significantly lower in number of individuals. Arthropoda was the second abundant phylum (28-171 ind.; 1.7-10.4%; 4-23 ind. $m^{-2}$). Annelida was the third abundant phylum in TC2 and TC3 (19-29 ind.; 0.6-1.8%; 3-4 ind. $m^{-2}$). Relatively other phyla were low in abundance in all sampling zones (≤ 0.5%).

Dominant species in every sampling zone

3.6.54 **Table 3.6 of Appendix O** lists the abundant species (relative abundance >10%) in every sampling zone. In the present survey, most of the listed abundant species were of low to moderate densities (50-200 ind. $m^{-2}$). Other listed species of lower density (< 50 ind. $m^{-2}$) were regared as common species.

3.6.55 In TC1, gastropod *Batillaria multiformis* was highly dominant at very high density (524 ind. $m^{-2}$, relative abundance 85%) at high tidal level (major substratum: 'Gravels and Boulders'). At mid tidal level (major substratum: 'Gravels and Boulders'), gastropods *Batillaria multiformis* (136 ind. $m^{-2}$, 37%), *Monodonta labio* (74 ind. $m^{-2}$, 20%) and rock oyster *Saccostrea cucullata* (95 ind. $m^{-2}$, 26%, attached on boulders) were abundant at low-moderate densities. At low tidal level (major substratum: 'Gravels and Boulders'), rock oyster *Saccostrea cucullata* (110 ind. $m^{-2}$, 38%) was the abundant at moderate density followed by common gastropod *Batillaria multiformis* (29 ind. $m^{-2}$, 10%).

3.6.56 In TC2, gastropods *Cerithidea djadjariensis* (144 ind. $m^{-2}$, 47%) and *Cerithidea cingulata* (84 ind. $m^{-2}$, 28%) were abundant at moderate densities at high tidal level (major substratum:

'Sands'). Rock oyster *Saccostrea cucullata* (33 ind. $m^{-2}$, 11%) was a common species. There was no clearly abundant species at mid and low tidal levels. Rock oyster *Saccostrea cucullata* (64 ind. $m^{-2}$, 27-53%) and gastropod *Batillaria zonalis* (18-50 ind. $m^{-2}$, 15-21%) were common at mid (major substratum: 'Sands') and low tidal levels (major substratum: 'Soft mud'). Besides fiddler crab *Uca. sp* (38 ind. $m^{-2}$, 16%) and gastropod *Cerithidea djadjariensis* (30 ind. $m^{-2}$, 13%) were also common at mid tidal level.

3.6.57 In TC3, gastropods *Batillaria multiformis* (216 ind. $m^{-2}$, 44%) and *Cerithidea djadjariensis* (183 ind. $m^{-2}$, 38%) were abundant at moderate densities at high tidal level (major substrata: 'Sands' and 'Soft mud'). And gastropod *Cerithidea cingulata* (66 ind. $m^{-2}$,13%) was common species. At mid tidal level (major substratum: 'Sands'), gastropod *Cerithidea djadjariensis* (140 ind. $m^{-2}$, 56%) was abundant at moderate density followed by common gastropods *Batillaria multiformis* (33 ind. $m^{-2}$, 13%) and *Cerithidea cingulata* (32 ind. $m^{-2}$, 13%). At low tidal level (major substratum: 'Gravels and Boulders'), rock oyster *Saccostrea cucullata* (262 ind. $m^{-2}$, 47%) was the most abundant at moderate-high density. Other less abundant species were gastropods *Monodonta labio* (98 ind. $m^{-2}$, 17%) and *Batillaria multiformis* (67 ind. $m^{-2}$, 12%).

3.6.58 In ST, no single species was clearly abundant at high tidal level (major substratum: 'Gravels and Boulders'). The relatively abundant species included gastropods *Monodonta labio* (83 ind. $m^{-2}$, 31%) and *Batillaria multiformis* (62 ind. $m^{-2}$, 23%). Other common species were gastropod *Lunella coronata* (36 ind. $m^{-2}$, 13%) and rock oyster *Saccostrea cucullata* (41 ind. $m^{-2}$, 15%). At mid tidal level (major substratum: 'Gravels and Boulders'), rock oyster *Saccostrea cucullata* (146 ind. $m^{-2}$, 43%) was abundant at moderate density followed by common gastropods *Lunella coronata* (44 ind. $m^{-2}$, 13%) and *Monodonta labio* (40 ind. $m^{-2}$, 12%). At low tidal level (major substratum: 'Sands'), rock oyster *Saccostrea cucullata* (30 ind. $m^{-2}$, 53%) was the common species only.

3.6.59 In general, there was no consistent zonation pattern of species distribution across all sampling zones and tidal levels. The species distribution should be determined by the type of substratum primarily. In general, gastropods *Batillaria multiformis* (total number of individuals: 2758 ind., relative abundance 28.4%), *Cerithidea djadjariensis* (1409 ind., 14.5%) and *Cerithidea cingulata* (590 ind., 6.1%) were the most commonly occurring species on sandy and soft mud substrata. Rock oyster *Saccostrea cucullata* (2163 ind., 22.2%) and gastropod *Monodonta labio* (855 ind., 8.8%) were commonly occurring species inhabiting gravel and boulders substratum.

Biodiversity and abundance of soft shore communities

3.6.60 **Table 3.7 of Appendix O** shows the mean values of species number, density, biodiversity index (*H'*) and species evenness (*J*) of soft shore communities at every tidal level and in every sampling zone. The variations among sampling zones and tidal levels were determined by the type of substratum primarily mentioned above.

3.6.61 Among the sampling zones, the mean species number of TC1 (10 spp. 0.25 $m^{-2}$) were slightly higher than that of TC2, TC3 and ST (7-8 spp. 0.25 $m^{-2}$). It was different from previous survey results that the mean species number of ST was usually higher. The mean densities of TC3 and TC1 (422-433 ind. $m^{-2}$) were higher than TC2 and ST (220-222 ind. $m^{-2}$). Since the species distribution of ST was more even relatively, the mean *H'* (1.4) and *J* (0.8) were slightly higher than that of TC1, TC2 and TC3 (*H'*: 1.2-1.3, *J*: 0.6-0.7).

3.6.62 Across the tidal levels, there was no consistent difference of the mean species number, density and *H'* in all sampling zones. For the mean *J*, there was a slightly increasing trend from high to low tidal level.

3.6.63 **Figures 3.11 to 3.14 of Appendix O** show the temporal changes of mean species number, mean density, *H'* and *J* at every tidal level and in every sampling zone along the sampling months. In general, all the biological parameters fluctuated seasonally throughout the monitoring period. Lower mean species number and density were recorded in dry season (Dec.) but the mean *H'* and *J* fluctuated within a stable range. There was no unfavourable change observed until the present survey.

**Impact of the HKLR project**

3.6.64 It was the 17th survey of the EM&A programme during the construction period. Based on the results, impacts of the HKLR project were not detected on intertidal soft shore community. In case, abnormal phenomenon (e.g. rapid or consistent decline of fauna densities and species number) is observed, it would be reported as soon as possible.

## 3.7 Solid and Liquid Waste Management Status

3.7.1 The Contractor registered with EPD as a Chemical Waste Producer on 12 July 2012 for the Contract. Sufficient numbers of receptacles were available for general refuse collection and sorting.

3.7.2 The summary of waste flow table is detailed in **Appendix K**.

3.7.3 The Contractor was reminded that chemical waste containers should be properly treated and stored temporarily in designated chemical waste storage area on site in accordance with the Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes.

## 3.8 Environmental Licenses and Permits

3.8.1 The valid environmental licenses and permits during the reporting period are summarized in **Appendix L.**

# 4 Environmental Complaint and Non-compliance

## 4.1 Environmental Exceedances

4.1.1 The detailed air quality, noise, water quality and dolphin exceedances are provided in **Appendix M**. Also, the summaries of the environmental exceedances are presented as follows:

**Air Quality**

4.1.2 No Action / Limit Level exceedances of 1-hr TSP and 24-hr TSP were recorded at AMS5 and AMS6 during the reporting period.

**Noise**

4.1.3 No Action/ Limit Level exceedances for noise were recorded during daytime on normal weekdays of the reporting period.

**Water Quality**

4.1.4 For marine water quality monitoring, three Action Level exceedances of suspended solids were recorded at stations IS(Mf)6, IS7, and SR4 during mid-flood tide on 14 December 2016 respectively. An Action Level exceedance of suspended solids was recorded at station SR10B during mid-ebb tide on 15 February 2017. Record of "Notification of Environmental Quality Limit Exceedances" is provided in **Appendix M**. No Action/ Limit Level exceedances of turbidity and dissolved oxygen level were recorded during the reporting period. No Limit Level exceedances of suspended solids level were recorded during the reporting period.

**Dolphin**

4.1.5 There was one Limit Level exceedance of dolphin monitoring for the quarterly monitoring data (between December 2016 and February 2017). According to the contractor's information, the marine activities undertaken for HKLR03 during the quarter of December 2016 – February 2017 included piling works, removal of surcharge materials, road and drainage works, temporary drainage diversion, ground investigation, box culvert diversion, construction of permanent sea wall and maintenance of silt curtain.

4.1.6 There is no evidence showing the current LL non-compliance directly related to the construction works of HKLR03 (where the amounts of working vessels for HKLR03 have been decreasing), although the generally increased amount of vessel traffic in NEL during the impact phase has been partly contributed by HKLR03 works since October 2012. It should also be noted that reclamation work under HKLR03 (adjoining the Airport Island) situates in waters which has rarely been used by dolphins in the past, and the working vessels under HKLR03 have been travelling from source to destination in accordance with the Marine Travel Route to minimize impacts on Chinese White Dolphin (CWD). In addition, the contractor will implement proactive mitigation measures such as avoiding anchoring at Marine Department's designated anchorage site – Sham Shui Kok Anchorage (near Brothers Island) as far as practicable.

4.1.7 All dolphin protective measures are fully and properly implemented in accordance with the EM&A Manual. According to the Marine Travel Route Plan, the travelling speed of vessels must not exceed 5 knots when crossing the edge of the proposed marine park. The Contractor will continue to provide training for skippers to ensure that their working vessels travel from source to destination to minimize impacts on Chinese White Dolphin and avoid anchoring at Marine Department's designated anchorage site - Sham Shui Kok Anchorage (near Brothers Island) as far as practicable. Also, it is recommended to complete the marine works of the Contract as soon as possible so as to reduce the overall duration of impacts and allow the dolphins population to recover as early as possible. Record of "Notification of Environmental Quality Limit Exceedances" is provided in **Appendix M**.

## 4.2 Summary of Environmental Complaint, Notification of Summons and Successful Prosecution

4.2.1 There were five complaints received in relation to the environmental impacts during the reporting period. The summary of environmental complaint is presented in **Table 4.1**. Complaint investigations were undertaken and the complaints were unlikely related to Contract No. HY/2011/03. The details of cumulative statistics of Environmental Complaints are provided in **Appendix N**.

**Table 4.1 A Summary of Environmental Complaint for the Reporting Period**

| Environmental Complaint No. | Date of Complaint Received | Description of Environmental Complaint |
|---|---|---|
| COM-2016-099 | 2 December 2016 | Slurry on public road |
| COM-2016-100 | 14 December 2016 | Mud/debris on public road |
| COM-2016-103 (See Remark 1) | 14 December 2016 | Noise |
| COM-2017-104 (See Remark 2) | 9 January 2017 | Cleanliness problem at East Coast Road and Tung Fai Road |
| COM-2017-108 | 23 February 2017 and 2 March 2017 | Cleanliness problem at East Coast Road |

Remarks:

1.Based on updated information received in February 2017, the environmental complaint no. COM-2016-104 mentioned in Monthly EM&A Report for December 2016 and January 2017 should be COM-2016-103.

2. Based on updated information received in February 2017, the environmental complaint no. COM-2016-105 mentioned in Monthly EM&A Report for January 2017 should be COM-2016-104.

4.2.2 No notification of summons and prosecution was received during the reporting period.

4.2.3 Statistics on notifications of summons and successful prosecutions are summarized in **Appendix M**.

# 5 Comments, Recommendations and Conclusion

## 5.1 Comments

5.1.1 According to the environmental site inspections undertaken during the reporting period, the following recommendations were provided:

- The Contractor was reminded to maintain the earth bund at the seafront of S7, S11 properly.
- The Contractor was reminded to maintain the silt curtain properly at Portion X.
- The Contractor was reminded to provide drip tray for the chemical containers at HMA, SHT, S11, S15, S23, S25, N1, N26, N30 and HyD Workshop.
- The Contractor was reminded to remove the stagnant water at S15, N30 and PR9.
- The Contractor was reminded to remove the oil stains on the ground of S25 and in the holes at Shaft 2.
- The Contractor was reminded to remove the accumulated waste at S15, S16, S19, S25 HMA, N1, N30, PR9, and HyD Workshop.
- The Contractor was reminded to cover the cement bags entirely by impervious sheeting at West Portal, HMA and S25.
- The Contractor was reminded to cover the truck properly at S15 and S25.
- The Contractor was reminded not to overload the dump truck at S15.
- The Contractor was reminded to label the chemical waste containers at S25.
- The Contractor was reminded to provide water spraying during concrete breaking at Shaft 3.
- The Contractor was reminded to clean the wastewater treatment facility at S23.
- The Contractor was reminded to remove the mud next to the water-filled barriers at S25 and N1 and the mud storage pit at S16.
- The Contractor was reminded to install filtering material at the discharge of pipe at S16 and S25.
- The Contractor was reminded to provide properly sealed earth bund at S7, S11 and PR9.
- The Contractor was reminded to maintain the broken pipe of the wastewater treatment facility at N1.
- The Contractor was reminded to remove the concrete disposed of on the construction area of S15.
- The Contractor was reminded to maintain the wheel washing facilities and provide cleaning for each vehicle before they leave the construction site at S25.
- The Contractor was reminded to undertake watering on the unpaved road regularly at S25.
- The Contractor was reminded to seal the toe of water-filled barrier properly at N30.
- The Contractor was reminded to remove the sand next to the water-filled barriers on East Coast Road.

## 5.2 Recommendations

5.2.1 The impact monitoring programme for air quality, noise, water quality and dolphin ensured that any deterioration in environmental condition was readily detected and timely actions taken to rectify any non-compliance. Assessment and analysis of monitoring results collected demonstrated the environmental impacts of the contract. With implementation of the recommended environmental mitigation measures, the contract's environmental impacts were considered environmentally acceptable. The weekly environmental site inspections ensured that all the environmental mitigation measures recommended were effectively implemented.

5.2.2 The recommended environmental mitigation measures, as included in the EM&A programme, effectively minimize the potential environmental impacts from the contract. Also, the EM&A programme effectively monitored the environmental impacts from the construction activities and ensure the proper implementation of mitigation measures. No particular recommendation was advised for the improvement of the programme.

## 5.3 Conclusions

5.3.1 The construction phase and EM&A programme of the Contract commenced on 17 October 2012. This is the eighteenth Quarterly EM&A Report which summarizes the monitoring results and audit findings of the EM&A programme during the reporting period from 1 December 2016 to 28 February 2017.

Air Quality

5.3.2 No Action / Limit Level exceedances of 1-hr TSP and 24-hr TSP were recorded at AMS5 and AMS6 during the reporting period.

Noise

5.3.3 No Action/Limit Level exceedances for noise were recorded during daytime on normal weekdays of the reporting period.

Water Quality

For marine water quality monitoring, three Action Level exceedances of suspended solids were recorded at stations IS(Mf)6, IS7, and SR4 during mid-flood tide on 14 December 2016 respectively. An Action Level exceedance of suspended solids was recorded at station SR10B during mid-ebb tide on 15 February 2017 No Action/ Limit Level exceedances of turbidity and dissolved oxygen level were recorded during the reporting period. No Limit Level exceedances of suspended solids level were recorded during the reporting period.

Dolphin

5.3.4 There was a Limit Level exceedance of dolphin monitoring for the quarterly monitoring data between December 2016 to February 2017.

5.3.5 During the present quarter of dolphin monitoring, no adverse impact from the activities of this construction project on Chinese White Dolphins was noticeable from general observations.

5.3.6 Although dolphins rarely occurred in the area of HKLR03 construction in the past and during the baseline monitoring period, it is apparent that dolphin usage has been dramatically reduced in NEL since 2012, and many individuals have shifted away completely from the important habitat around the Brothers Islands.

5.3.7 It is critical to continuously monitor the dolphin usage in North Lantau region in the upcoming quarters, to determine whether the dolphins are continuously affected by the various construction activities in relation to the HZMB-related works, and whether suitable mitigation measure can be applied to revert the situation.

Mudflat -Sedimentation Rate

5.3.8 This measurement result was generally and relatively higher than the baseline measurement at S1, S2, S3 and S4. The mudflat level is continuously increased.

Mudflat - Ecology

5.3.9 The December 2016 survey was the seventeenth survey of the EM&A programme during the construction period. Based on the results, impacts of the HKLR project could not be detected on horseshoe crabs, seagrass and intertidal soft shore community.

Environmental Site Inspection and Audit

5.3.10 Environmental site inspection was carried out on 7, 14, 21 and 30 December 2016; 4, 11, 18 and 27 January 2017; and 3, 8, 15, 22 and 28 February 2017. Recommendations on remedial actions were given to the Contractors for the deficiencies identified during the site inspections.

5.3.11 There were five complaints received in relation to the environmental impacts during the reporting period. Complaint investigations were undertaken and the complaints were unlikely related to Contract No. HY/2011/03.

5.3.12 No notification of summons and prosecution was received during the reporting period.

# FIGURES

# APPENDIX A

## Environmental Management Structure

# APPENDIX B

## Construction Programme

# APPENDIX C

Location of Works Areas

# APPENDIX D

## Event and Action Plan

# APPENDIX E

## Implementation Schedule of Environmental Mitigation Measures

# APPENDIX F

Site Audit Findings and Corrective Actions

# APPENDIX G

Air Quality Monitoring Data and Graphical Plots

# APPENDIX H

## Noise Monitoring Data and Graphical Plots

# APPENDIX I

Water Quality Monitoring Data and Graphical Plots

# APPENDIX J

## Dolphin Monitoring Results

# APPENDIX K

Waste Flow Table

# APPENDIX L

Summary of Environmental Licenses and Permits

# APPENDIX M

Record of "Notification of Environmental Quality Limit Exceedances

# APPENDIX N

## Cumulative Statistic on Complaints

# APPENDIX O

Mudflat Monitoring Results