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CEDD Civil Engineering and Development Department

Agreement No. CE 63/2016 (EP) Environmental Monitoring and Audit for Disposal Facility to the East of Sha Chau (2017-2020) – Investigation

Quarterly EM&A Report for Contaminated Mud Pits to the East of Sha Chau – April to June 2020

Revision 0

August 2020

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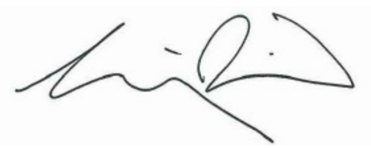
Client:	Project No:
Civil Engineering and Development Department (CEDD)	0400720

Summary:

This document presents the Quarterly EM&A Report for *Environmental Monitoring and Audit for Disposal Facility to the East of Sha Chau*.

Date:
18 August 2020

Approved by:



Craig A. Reid
Partner

v0	Quarterly EM&A Report for ESC CMPs	GS	RC	CAR	18/8/20
Revision	Description	By	Checked	Approved	Date

Distribution

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Dredging, Management and Capping of Contaminated Sediment Disposal Facility at Sha Chau

Environmental Certification Sheet
EP-312/2008/A

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Quarterly EM&A Report for Contaminated Mud Pits to the East of Sha Chau – April to June 2020
Date of Report:	18 August 2020
Date prepared by ET:	18 August 2020
Date received by IA:	18 August 2020

Reference EP Condition

Environmental Permit Condition:

Condition 3.1 of EP-312/2008/A
The EM&A programme shall be implemented in accordance with the procedures and requirements in the EM&A Manual. Any changes to the monitoring and audit requirements shall be justified by the ET leader and verified by the Independent Auditor as conforming to the requirements set out in the EM&A Manual, and shall seek the prior approval from the Director before implementation.

ET Certification

I hereby certify that the above referenced document/ ~~plan~~ complies with the above referenced condition of EP-312/2008/A.

Craig A. Reid,
Environmental Team Leader: [signature] Date: 18/8/2020

IA Verification

I hereby verify that the above referenced document/ ~~plan~~ complies with the above referenced condition of EP-312/2008/A.

Dr Wang Wen Xiong,
Independent Auditor: [signature] Date: 18/8/2020

CONTENTS

Agreement No. CE 63/2016 (EP)
Environmental Monitoring and Audit
for Disposal Facility to the East of Sha Chau (2017-2020) - Investigation

Quarterly Environmental Monitoring and Audit (EM&A) Report for April to June 2020

EXECUTIVE SUMMARY

Water Column Profiling, Routine Water Quality Monitoring, Water Quality Monitoring during Capping Operation, Pit Specific Sediment Chemistry and *Cumulative Impact Sediment Chemistry* were carried out for the Contaminated Mud Pits (CMPs) to the East of Sha Chau (ESC) during the quarterly period of April to June 2020. This report presents the results of these monitoring activities to identify whether the disposal and capping operations at ESC CMP V are causing any unacceptable impact(s) to the surrounding aquatic environment or to those marine organisms that utilize these habitats.

Water Quality Monitoring for ESC CMPs

Water Column Profiling of ESC CMP Vb – April to June 2020

Results indicated that levels of Salinity, pH and Dissolved Oxygen (DO) complied with the Water Quality Objectives (WQOs) at both Upstream and Downstream stations. Levels of DO, Turbidity and Suspended Solids (SS) complied with the Action and Limit Levels at all stations. Overall, the results indicated that the mud disposal operation at ESC CMP Vb did not appear to cause any unacceptable impact in water quality during this quarterly period.

Routine Water Quality Monitoring of ESC CMPs – April and May 2020

Results of Routine Water Quality Monitoring conducted in April and May 2020 showed that levels of DO, Salinity and pH generally complied with the WQOs at most stations. The levels of DO, Turbidity and SS generally complied with the Action and Limit Levels at most stations. From the monitoring results and statistical analysis, there were no trends indicating any increase in the concentrations of contaminants with proximity to the pit or with time. Thus, it appears that mud disposal operations at ESC CMPs have not caused any unacceptable impact in water quality during the reporting period.

Water Quality Monitoring during Capping Operation of ESC CMPs – June 2020

Concentrations of DO, Turbidity and SS complied with the Action and Limit Levels at most stations in June 2020. From the statistical analysis, there were no trends indicating any increase in the concentrations of contaminants with proximity to the pit or with time. Overall, the results indicated that capping operations at ESC CMPs did not appear to cause any unacceptable water quality impact during the reporting period.

Sediment Quality Monitoring for ESC CMPs

Pit Specific Sediment Chemistry of ESC CMP Vb – April to June 2020

Monitoring results showed that the concentrations of inorganic contaminants were generally below the Lower Chemical Exceedance Levels (LCELs) at most monitoring stations. Statistical analysis indicated that there did not appear any trend of increasing sediment contaminants' concentrations with proximity to the pit or with time. Thus, it appears that mud disposal operation did not cause any unacceptable impact in sediment quality of ESC CMP Vb during the reporting period.

Cumulative Impact Sediment Chemistry of ESC CMPs – June 2020

Monitoring results showed that the concentrations of inorganic contaminants were generally below the LCELs at all monitoring stations. Statistical analysis indicated that there did not appear to be any significant trend of increasing concentrations of contaminants with proximity to the pit or with time. Thus, it is considered that mud disposal operations at ESC CMP Vb have not caused any unacceptable impact in sediment quality during the reporting period.

合約編號 第CE 63/2016（EP）號

沙洲以東海泥卸置設施的環境監察及審核（2017–2020）–勘查研究

環境監察及審核季度報告（二零二零年四月至六月）

行政摘要

在2020年4月至6月的季度報告期內，環境小組在沙洲以東海泥卸置設施進行了水層質量監察、例行水質監察、泥坑覆蓋過程之水質監察、指定污泥坑沉積物化學監察及沉積物化學累積性影響監察。本報告詳述以上的環境監察結果，從而分析在沙洲以東海泥卸置設施CMP V的卸置及覆蓋作業有否對鄰近水體環境及利用這水體為棲身地的海洋生物造成不可接受的環境影響。

沙洲以東海泥卸置設施 (ESC CMPs)之水質監察

水層質量監察–2020年4月至6月

監察結果顯示上游及下游監測站的鹽度、酸鹼值及溶解氧含量均符合海水水質指標。上游及下游監測站的溶解氧含量、混濁度及懸浮固體含量也符合行動及極限水平。總體而言，水層質量監察結果表明報告期內沙洲以東海泥卸置設施CMP Vb 的污泥卸置活動沒有引致任何不可接受的水質影響。

例行水質監察–2020年4月和5月

2020年4月和5月的例行水質監察結果顯示受影響監測站、中距離監測站、參考監測站和馬灣監測站的溶解氧含量、鹽度及酸鹼值大致符合海水水質指標。大部份監測站的溶解氧含量、混濁度及懸浮固體含量也符合行動及極限水平。從監察數據和統計結果顯示，海水的污染物濃度沒有因越接近泥坑而趨向增加，亦沒有隨著時間而增加。總體而言，沒有證據顯示在報告期內沙洲以東海泥卸置運作對周邊水體環境產生任何不可接受的水質影響。

泥坑覆蓋過程之水質監察–2020年6月

在2020年6月，大部份監測站的溶解氧濃度、渾濁度及懸浮固體含量均符合行動及極限水平。從統計結果顯示，海水的污染物濃度並沒有因越接近污泥坑而趨向增加，亦沒有隨著時間而增加。總括而言，結果顯示在報告期內泥坑的覆蓋運作並沒有引致任何不可接受的水質影響。

沙洲以東海泥卸置設施 (ESC CMPs)之沉積物監察

指定污泥坑沉積物化學監察–2020年4月至6月

監察結果顯示，大部分監測站的無機污染物含量均大致低於化學物質低量值。從統計結果顯示，沉積物的污染物濃度沒有因越接近泥坑而趨向增加，亦沒有隨著時間而增加。總體而言，沒有證據顯示在報告期內沙洲以東海泥卸置運作對沉積物質素造成任何不可接受的影響。

沉積物化學累積性影響監察–2020年6月

監察結果顯示，所有監測站的無機污染物含量均大致低於化學物質低量值。從統計結果顯示，沉積物的污染物濃度沒有因越接近泥坑而趨向增加，亦沒有隨著時間而增加。總體而言，沒有證據顯示在報告期內沙洲以東海泥卸置運作對沉積物質素造成任何不可接受的影響。

1 INTRODUCTION

1.1 PROJECT DESCRIPTION

1.1.1 The Civil Engineering and Development Department (CEDD) is managing a number of marine disposal facilities in Hong Kong waters, including the Contaminated Mud Pits (CMPs) to the South of The Brothers (SB) and to the East of Sha Chau (ESC) for the disposal of contaminated sediment, and open-sea disposal grounds located to the South of Cheung Chau (SCC), East of Tung Lung Chau (ETLC) and East of Ninepins (ENP) for the disposal of uncontaminated sediment. Two Environmental Permits (EPs), EP-312/2008/A and EP-427/2011/A, were issued by the Environmental Protection Department (EPD) to the CEDD, the Permit Holder, on 28 November 2008 and 23 December 2011 for the Dredging, Management and Capping of Contaminated Sediment Disposal Facilities at ESC CMP V and SB CMPs, respectively.

1.1.2 Under the requirements of the two EPs for ESC CMP V and SB CMPs, Environmental Monitoring and Audit (EM&A) programmes which encompass water and sediment chemistry, fisheries assessment, tissue and whole body analysis, sediment toxicity and benthic recolonisation studies as set out in the EM&A Manuals are required to be implemented. EM&A programmes have been continuously carried out during the operation of the CMPs at ESC and SB. A review of the collection and analysis of such environmental data from the monitoring programme demonstrated that there had not been any adverse environmental impacts resulting from disposal activities (1)(2). The current programme will assess the impacts resulting from dredging, disposal and capping operations of CMP V as well as capping operations of SB CMPs.

1.1.3 The present EM&A programme under *Agreement No. CE 63/2016 (EP)* ("the Study") covers the dredging, disposal and capping operations of the ESC CMP V as well as the capping operations of the SB CMPs (see *Annex A* for the EM&A programme). The scheduled EM&A programme for SB CMPs was completed in December 2018.

(1) ERM (2013). Environmental Monitoring and Audit for Contaminated Mud Pit V at East of Sha Chau. Final Report. For CEDD.

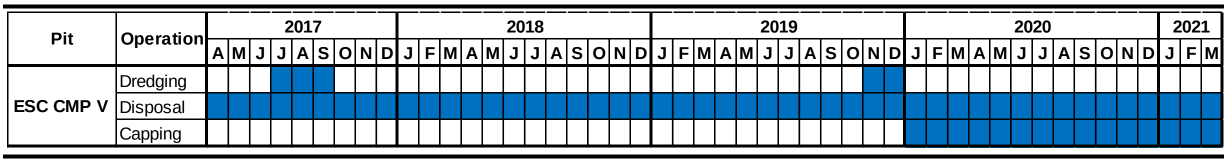
(2) ERM (2017). Environmental Monitoring and Audit for Contaminated Mud Pit V at East of Sha Chau (2012 - 2017). Final Report. For CEDD.

1.2 *Activities Conducted during the Reporting Period*

1.2.1 Detailed works schedule for ESC CMP V and SB CMPs is shown in *Figure 1.1*. During the reporting period of April to June 2020, the following works were being undertaken at the CMPs:

- Disposal of contaminated mud at ESC CMP Vb; and
- Capping operations at ESC CMP Vd.

Figure 1.1 Works Schedule for ESC CMPs



1.2.2 The record for contaminated mud disposal at ESC CMP Vb during the reporting period are presented in *Annex B1*, and the record for capping operation at ESC CMP Vd during the reporting period is presented in *Annex B2*.

1.3 *Objectives of the Monitoring and Audit Programme*

1.3.1 The objectives of the EM&A programme are as follows:

1) To monitor and report on the environmental impacts of the dredging operations associated with the construction of the disposal pits;

2) To monitor and report on the environmental impacts due to capping operations of the exhausted pits;

3) To monitor and report on the environmental impacts of the disposal of contaminated marine sediments in the active pits and specifically to determine:

   a. changes/trends caused by disposal activities in the concentrations of contaminants in sediments adjacent to the pits;

   b. changes/trends caused by disposal activities in the toxicity of sediment adjacent to the pits;

   c. changes/trends caused by disposal activities in the concentrations of contaminants in tissues of demersal marine life adjacent to and remote from the pits;

   d. impacts on water quality and benthic ecology caused by the disposal activities; and

   e. the risks to human health and dolphin of eating seafood taken in the marine area around the active pits.

4) To monitor and report on the environmental impacts of the disposal operation and specifically to determine whether the methods of disposal are effective in reducing the risks of unacceptable environmental impacts.

5) To monitor and report on the benthic recolonisation of the capped pits and specifically to determine the difference in infauna between the capped pits and adjacent sites.

6) To assess the impact of a major storm (Typhoon Signal No. 8 or above) on the containment of any uncapped or partially capped pits.

7) To design and continually review the operation and monitoring programme and:

   a. to make recommendations for changes to the operation that will rectify any unacceptable environmental impacts; and

   b. to make recommendations for changes to the monitoring programme that will improve the ability to cost effectively detect environmental changes caused by the disposal activities.

8) To establish numerical decision criteria for defining impacts for each monitoring component.

9) To provide supervision on the field works and laboratory works to be carried out by contractors/laboratories.

1.3.2 The purpose of this *Quarterly EM&A Report for April to June 2020* is to provide information regarding the findings in the quarterly reporting period of April to June 2020 on the environmental impacts resulting from backfilling operation at ESC CMP Vb and capping operation at ESC CMP Vd. Although the EM&A programme has been conducted since 1997, this report presents the analytical and statistical results of the quarterly reporting period. Results from previous monitoring will be presented and discussed in the Annual Review Report. Readers are referred to the *Monthly EM&A Reports* for this Study for graphical and tabular presentations of the monitoring results.

1.3.3 The objectives of this report are to:

- Confirm that all activities, tests, analyses, assessments etc. have been carried out as stated in the *EM&A Manual*; and,

- Report on any trend resulting from dredging, backfilling and capping operations at the CMPs.

2 *ENVIRONMENTAL MONITORING & AUDITING PROGRAMME*

2.1 *ENVIRONMENTAL MONITORING & AUDITING TASKS*

2.1.1 Six key elements were designed for the EM&A Programme for assessing whether key environmental parameters are being affected by dredging, backfilling and capping operations at the CMPs. Key tasks are as follows:

- Sediment Quality Monitoring;
- Sediment Toxicity Testing;
- Trawling & Tissue/ Whole Body Contaminant Testing;
- Water Quality Monitoring;
- Human Health and Ecological Risk Assessment; and
- Benthic Recolonisation.

2.2 *EM&A SAMPLING AND ANALYSES*

2.2.1 Details regarding the methodologies for the field sampling and laboratory analyses of the monitoring tasks listed in *Section 2.1* are presented in the *EM&A Manual* (1) as well as in *Contract No. CV/2017/04 (Sediment Disposal Facilities to the East of Sha Chau and East of Tung Lung Chau – Sampling (2018-2022))* and *Contract No. CV/2017/05 (Sediment Disposal Facilities to the East of Sha Chau and East of Tung Lung Chau – Testing (2018-2022)).* Lam Geotechnics Limited and Wellab Limited were responsible for sampling under *Contract No. CV/2017/04* and laboratory analyses under *Contract No. CV/2017/05*, respectively, during the quarterly period.

(1) ERM (2017). Updated EM&A Manual for ESC CMP V. Environmental Monitoring and Audit for Disposal Facility to the East of Sha Chau (2017-2020) – Investigation. Agreement No. CE 63/2016 (EP).

3 MONITORING & AUDITING RESULTS

3.1 OVERVIEW OF THE MONITORING & AUDITING ACTIVITIES

3.1.1 *Sampling & Laboratory Analysis*

3.1.2 Schedules of the EM&A programme are presented in *Annex A*. The samplings, *in-situ* measurements and analyses of samples were conducted in accordance with the *EM&A Manual* during this reporting period. The samplings conducted as well as the monitoring results received from the Contractors for this reporting period are shown in *Table 3.1*.

Table 3.1 Samplings Conducted and Monitoring Results Received from the Contractors for the Reporting Period of April to June 2020

Key Task	Date of Sampling & *in-situ* Measurement	Date of Results Received from the Contractors
ESC CMPs		
Water Column Profiling of ESC CMP Vb	3 April 2020 7 May 2020 11 June 2020	27 April 2020 27 May 2020 3 July 2020
Routine Water Quality Monitoring of ESC CMPs	8 April 2020 6 May 2020	27 April 2020 27 May 2020
Pit Specific Sediment Chemistry of ESC CMP Vb	2 April 2020 5 May 2020 3 June 2020	27 April 2020 27 May 2020 3 July 2020
Cumulative Impact Sediment Chemistry of ESC CMPs	4 & 5 June 2020	3 July 2020
Water Quality Monitoring during Capping Operation of ESC CMPs	12 June 2020	3 July 2020

3.1.3 The monitoring results of the above environmental monitoring components for ESC CMPs have been presented in the respective *Monthly EM&A Reports* for this Study. The statistical analyses of these environmental monitoring components, where applicable, are presented in the following sections to report any trends caused by disposal activities at ESC CMPs during the reporting period. It should be noted that statistical analysis was not conducted for *Water Column Profiling for ESC CMP Vb* as the monitoring stations were mobile depending on the location of backfilling operation during the monitoring event.

3.2 *SUMMARY OF MONITORING RESULTS AND STATISTICAL ANALYSES FOR ESC CMPS*

3.2.1 ***Water Column Profiling of ESC CMP Vb***

3.2.2 *Water Column Profiling* for ESC CMP Vb was conducted once every month from April to June 2020 as presented in *Table 3.1*. A total of two (2) stations were sampled, one located 100 m Upstream and one located 100 m Downstream of the disposal area. The monitoring results indicated that levels of Salinity, pH and Dissolved Oxygen (DO) complied with the Water Quality Objectives (WQOs) at both Upstream and Downstream stations in April, May and June 2020. Levels of DO, Turbidity and Suspended Solids (SS) also complied with the Action and Limit Levels at all stations during the quarterly period.

3.2.3 Overall, the results indicated that the mud disposal operation at ESC CMP Vb did not appear to cause any unacceptable deterioration in water quality during this quarterly period.

3.2.4 ***Routine Water Quality Monitoring of ESC CMPs***

Background

3.2.5 *Routine Water Quality Monitoring* for ESC CMPs was conducted in April and May 2020 as presented in *Table 3.1*. A total of sixteen (16) stations were sampled in April and May 2020 and locations of the monitoring stations are presented in *Figure 3.1*. The disposal volume during the reporting period is detailed in *Annex B1*. The monitoring results showed that levels of DO, Salinity and pH complied with the WQOs at most stations, except the Salinity in Ma Wan was higher than WQO in April 2020. The higher Salinities recorded at Ma Wan station are likely to be caused by the larger separation distance to Pearl River mouth, which release a large amount of freshwater runoff in the area during wet season, when compared to the Reference stations. The levels of DO, Turbidity and SS complied with the Action and Limit Levels at most stations, except the levels of Turbidity were higher than Action level at Impact stations in April 2020. Upon further investigation, it is noticed that capping activities at ESC CMP Vd were conducted during the time of sampling on 8 April 2020 and thus the higher levels of Turbidity recorded at Impact stations might be related to the capping operation. Considering that the action level exceedance of Turbidity occurred within Impact stations only but not at the Intermediate and Ma Wan stations, there is no evidence indicating any unacceptable environmental impacts to nearby water sensitive receivers as a result of the mud disposal operations at ESC CMPs in the reporting period.

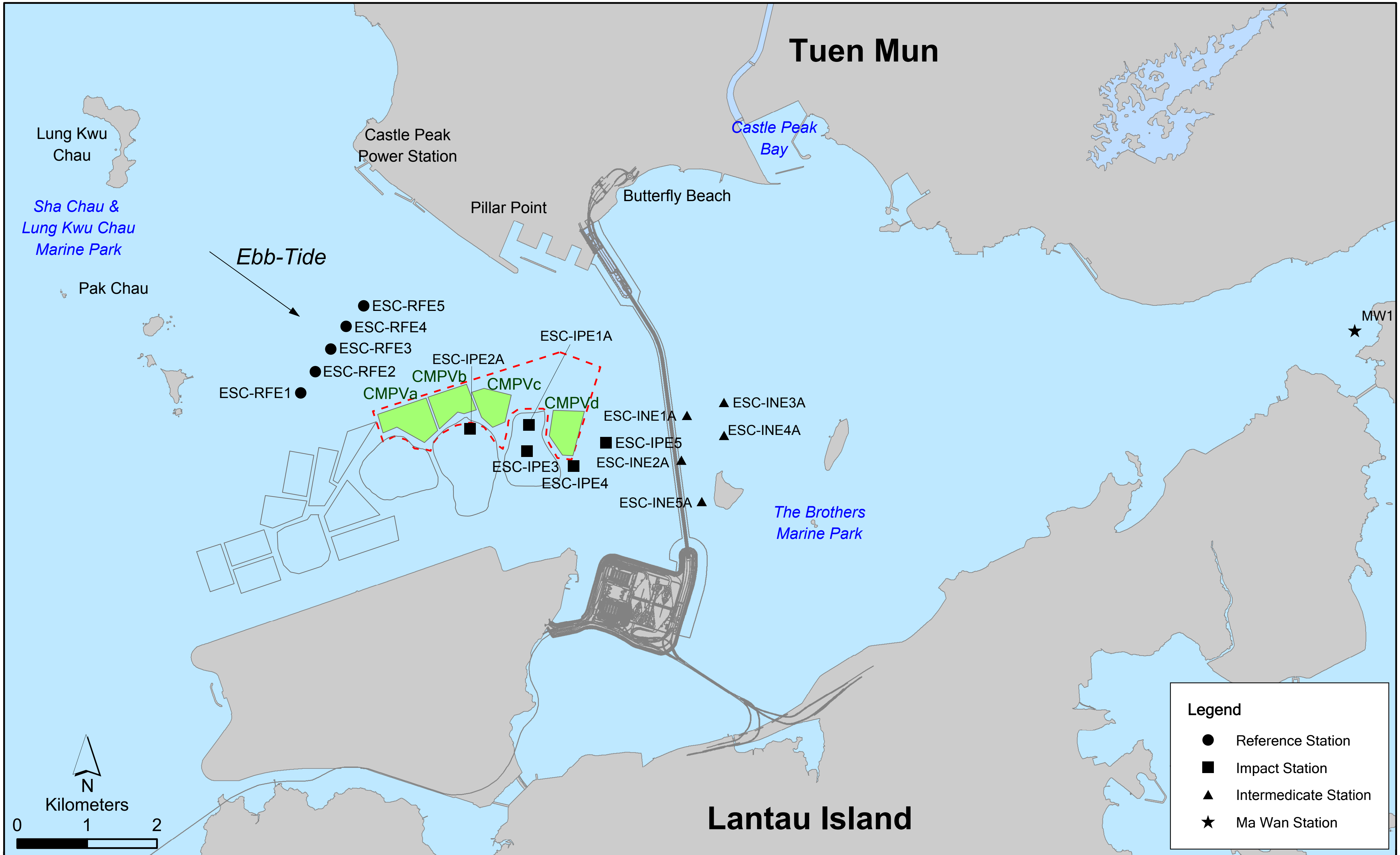


Figure 3.1

Routine & Capping Water Quality Sampling Stations (Ebb-Tide) for ESC CMPs

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Date: 19/4/2017

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Summary of Statistical Analyses

3.2.6 The aim of the statistical analysis is to reveal any trends of increasing concentration of contaminants with proximity to the pit or with time. Data obtained during this reporting period were statistically compared with data obtained since monitoring began at CMP V in February 2012. For most parameters, only low concentrations were measured from February 2012 to February 2020 and some parameters have majority of their recorded values below the limit of reporting. Statistical analysis was performed on parameters for which at least 60% of data were above the limit of reporting since monitoring of CMP V began in February 2012. Spatio-temporal differences in *in-situ* parameters, dissolved metal, inorganic and organic contaminant contents were then tested by three-factor partially-nested Analysis of Variance (ANOVA). Area, Period and Station were treated as fixed factors under investigation with Station nested within Area.

3.2.7 Should spatial or temporal trend of potential concern (i.e. increasing contaminant concentration with proximity to the pit or over time) be detected by ANOVA, linear regression analyses would be performed to examine the significance of the trend. Linear regression analysis makes assumptions of equal variance and normal distribution of data. Therefore, the significance level of the test was set at 1 % (i.e. $p = 0.01$) to reduce the chance of committing a Type 1 error. If a significant regression relationship was found between contaminant concentration and time (i.e. $p < 0.01$), r^2 value from the analysis would be further assessed. This value represents the proportion of the total variation in the dependent variable (i.e. contaminant concentration) that is accounted for by the fitted regression line and is referred to as the coefficient of determination. An r^2 value of 1 indicates a perfect relationship (or fit) whereas a value of 0 indicates that there is no relationship (or no fit) between the dependent and independent variables.

3.2.8 As there are no specific criteria to indicate how meaningful an r^2 value is, for the purposes of this EM&A programme a value of 0.60 was adopted to indicate a meaningful regression. If $r^2 < 0.60$ then it was considered that there was a weak relationship between contaminant concentration and time or proximity to the pit, or none at all. If the regression analysis indicated $r^2 > 0.60$ then it had been interpreted that there was in fact a strong relationship between the dependent and independent variables (i.e. a strong temporal trend of increasing contaminant concentration with time or strong spatial trend of increasing contaminant concentration with proximity to the pit). Details regarding the statistical analyses results are presented in *Annex C*.

In-situ Measurement

Dissolved Oxygen (DO)

3.2.9 DO levels varied significantly with sampling periods and areas. There was no consistent spatial trend of decreasing concentrations of DO with proximity to the pit or consistent temporal trend of decreasing concentrations of DO over time. DO levels were the highest in February 2017 and were the lowest in July 2013, August 2016 and July 2019. DO levels were the highest at Intermediate and Impact stations.

Turbidity

3.2.10 Turbidity levels varied significantly with sampling periods and areas. There was no consistent spatial trend of increasing concentrations of Turbidity with proximity to the pit or consistent temporal trend of increasing concentrations of Turbidity over time. Turbidity levels were the highest in April 2020 and November 2017 and were the lowest in February 2017. Turbidity was the highest at Impact and Reference stations.

Metals and Metalloid

3.2.11 The majority of dissolved metals had high percentage of their values below the limit of reporting (i.e. > 60% of values were below the limit of reporting during February 2012 to May 2020). Copper, Nickel and Zinc were the exceptions, and all varied significantly over area and time as indicated by results of the ANOVA tests (*Annex C*), but without any consistent spatial or temporal trends. The concentration of Copper was the highest in August 2013 when compared to all other sampling periods. The concentration of Nickel was significantly higher in April 2012, August 2013 and May 2013. The concentration of Zinc was the highest in November 2017 when compared to all other sampling periods. The concentrations of Copper were the highest at Reference stations. The concentrations of Nickel were the highest at Reference stations. The concentrations of Zinc were the highest at Ma Wan station.

Inorganic Contaminants

Ammonia Nitrogen (NH_3-N)

3.2.12 NH_3-N concentrations varied significantly with sampling periods and areas. There was no consistent spatial trend of increasing concentrations of NH_3-N with proximity to the pit or consistent temporal trend of increasing concentrations of NH_3-N over time. Concentrations of NH_3-N were the highest in April 2012. Concentrations of NH_3-N were the highest at Reference and Ma Wan station.

Total Inorganic Nitrogen (TIN)

3.2.13 TIN concentrations varied significantly with sampling periods and stations. There was no consistent spatial trend of increasing concentrations of TIN with proximity to the pit or consistent temporal trend of increasing concentrations of TIN over time. Concentrations of TIN were the highest in April 2012 and May 2018. Concentrations of TIN were the highest at Reference and Impact stations.

5-Day Biochemical Oxygen Demand (BOD_5)

3.2.14 Levels of BOD_5 varied significantly with sampling area and periods. There was no consistent spatial trend of increasing concentrations of BOD_5 with proximity to the pit or consistent temporal trend of increasing concentrations of BOD_5 over time. Levels of BOD_5 were the highest in August 2016. Levels of BOD_5 were the highest at Ma Wan and Reference stations.

Suspended Solids (SS)

3.2.15 SS levels varied significantly with sampling areas and periods. There was no consistent temporal trend of increasing concentrations of SS over time. SS levels were the highest in April 2020 and November 2017. SS levels were the highest at Impact stations, then at Intermediate stations and in turn higher than at Reference stations. Subsequent regression analysis between SS levels and proximity to the pit (i.e. Area) indicated that there was significant spatial trend of increasing SS level with proximity to the pit ($p < 0.01$), but there was a weak relationship between SS level and proximity to the pit ($r^2 < 0.60$).

3.2.16 Overall, results of statistical analyses for the water quality data did not appear to provide any evidence of unacceptable water quality impacts caused by the mud disposal operations at CMP Vb of the ESC area.

3.2.17 ***Water Quality Monitoring during Capping of ESC CMPs – June 2020***

Background

3.2.18 Water Quality Monitoring during Capping of ESC CMPs was conducted in June 2020 as presented in *Table 3.1*. A total of ten (10) stations were sampled in June 2020, and locations of the monitoring stations are presented in *Figure 3.2*. The capping volume during the reporting period is detailed in *Annex B2*. The monitoring results showed that levels of DO, Turbidity and SS complied with the Action and Limit Levels at most stations in June 2020, except the averaged levels of DO recorded for surface and mid-depth waters at Ma Wan station was below Action level. Since Ma Wan is located further away from ESC CMPs comparing to other stations where levels of DO compiled with the Action and Limit Levels, the action level exceedance of DO (surface and mid-depth water) is unlikely to be caused by the capping operations at ESC CMPs.

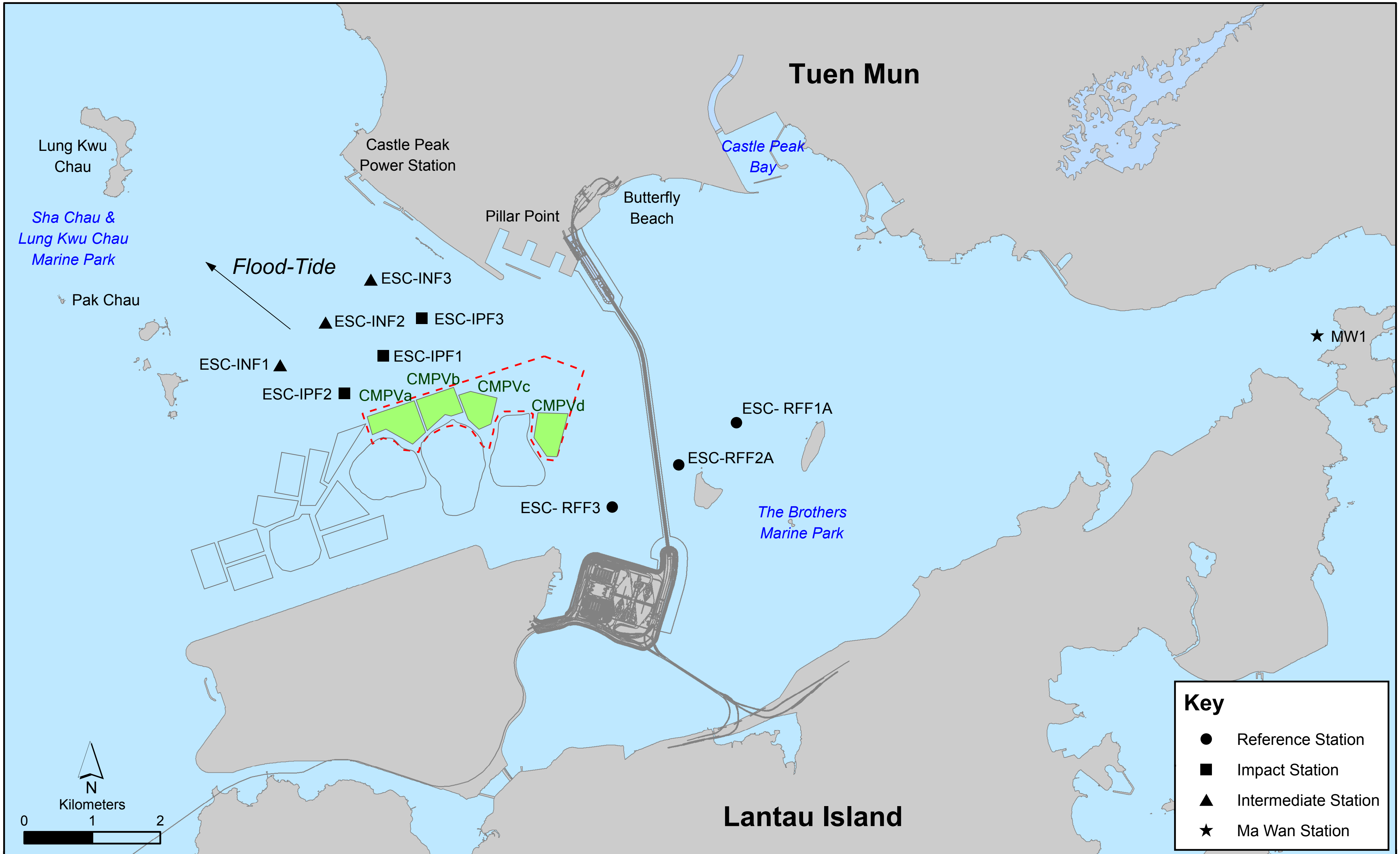

Figure 3.2

Routine & Capping Water Quality Sampling Stations (Flood-Tide) for ESC CMPs

File: T:\GIS\CONTRACT\0175086\Mxd\updated_20170419\0175086_R_C_WQMS_flood.mxd
Date: 25/4/2017

Environmental Resources Management

ERM

Summary of Statistical Analyses

3.2.19 The aim of the statistical analysis is to reveal any trends of increasing concentration of contaminants with proximity to the pit or with time. Data obtained during this reporting period were statistically compared with data obtained since monitoring began at ESC CMPs in December 2013. Spatio-temporal differences in DO, Turbidity and SS were tested by two-factor partially-nested ANOVA. Area and Period were treated as fixed factors under investigation with Station nested within Area.

3.2.20 Should spatial or temporal trend of potential concern (i.e. increasing contaminant concentration with proximity to the pit or over time) be detected by ANOVA, linear regression analyses would be performed to examine the significance of the trend. The assumptions of the linear regression analyses are discussed in *Sections 3.2.7* and *3.2.8*. Detailed results of statistical analyses are presented in *Annex C*.

Dissolved Oxygen (DO)

3.2.21 DO levels varied significantly with sampling areas and periods. However, there was no consistent spatial trend of decreasing concentrations of DO with proximity to the pit or consistent temporal trend of decreasing concentrations of DO over time.

Turbidity

3.2.22 Turbidity levels varied significantly with sampling areas and periods. However, there was no consistent spatial trend of increasing concentrations of Turbidity with proximity to the pit or consistent temporal trend of increasing concentrations of Turbidity over time.

Suspended Solids (SS)

3.2.23 SS levels varied significantly with sampling areas and periods. However, there was no consistent spatial trend of increasing concentrations of SS with proximity to the pit or consistent temporal trend of increasing concentrations of SS over time.

3.2.24 Overall, results of statistical analyses for the water quality data did not appear to provide any evidence of unacceptable water quality impacts caused by the capping operations at ESC CMPs.

3.2.25 ***Pit Specific Sediment Chemistry of ESC CMP Vb***

Background

3.2.26 *Pit Specific Sediment Chemistry of ESC CMP Vb* was conducted once every month from April to June 2020 as presented in *Table 3.1*. A total of six (6) monitoring stations for ESC CMP Vb were sampled in each monitoring event and the monitoring locations are shown in *Figure 3.3*. The monitoring results showed that the concentrations of most inorganic contaminants were below the Lower Chemical Exceedance Levels (LCELs) at most stations from April to June 2020, except the concentrations of some inorganic contaminants were higher than LCELs or Upper Chemical Exceedance Levels (UCELs) at Active Pit stations (Arsenic, Copper, Silver and Zinc), Pit-Edge stations (Arsenic) and Near-Pit (Arsenic) stations from April to June 2020.

Summary of Statistical Analyses

3.2.27 Statistical analyses were performed for data obtained from *Pit Specific Sediment Chemistry of ESC CMP Vb* since February 2020. Statistical tests were run to examine the difference in contaminant concentrations amongst Active-Pit, Pit-Edge and Near-Pit stations and amongst sampling periods. ANOVA was employed as the statistical test, with Area, Period and Station as fixed factors and Station nested within Area.

3.2.28 Should spatial or temporal trend of potential concern (i.e. increasing contaminant concentration with proximity to the pit or over time) be detected by ANOVA, linear regression analyses would be performed to examine the significance of the trend. The assumptions of the linear regression analyses are discussed in *Sections 3.2.7* and *3.2.8*. Detailed results of statistical analyses are presented in *Annex C*.

Metals and Metalloids

3.2.29 There were significant spatial and temporal variations in the concentrations of all metal and metalloid contaminants (Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Mercury, Silver and Zinc). The concentrations of all measured metals and metalloids did not appear to increase over time. Subsequent linear regression analysis for Cadmium, Chromium, Lead, Mercury and Zinc levels and proximity to the pit (i.e. Area) indicated that there were significant spatial trends ($p < 0.01$), but there was a weak relationship between Cadmium, Chromium, Lead, Mercury and Zinc levels and proximity to the pit ($r^2 < 0.60$).

Organic Contaminants

3.2.30 Concentrations of majority of organic contaminants were below their limits of reporting. Statistical analyses were only performed for contaminants for which 60% of data were over their limits of reporting.

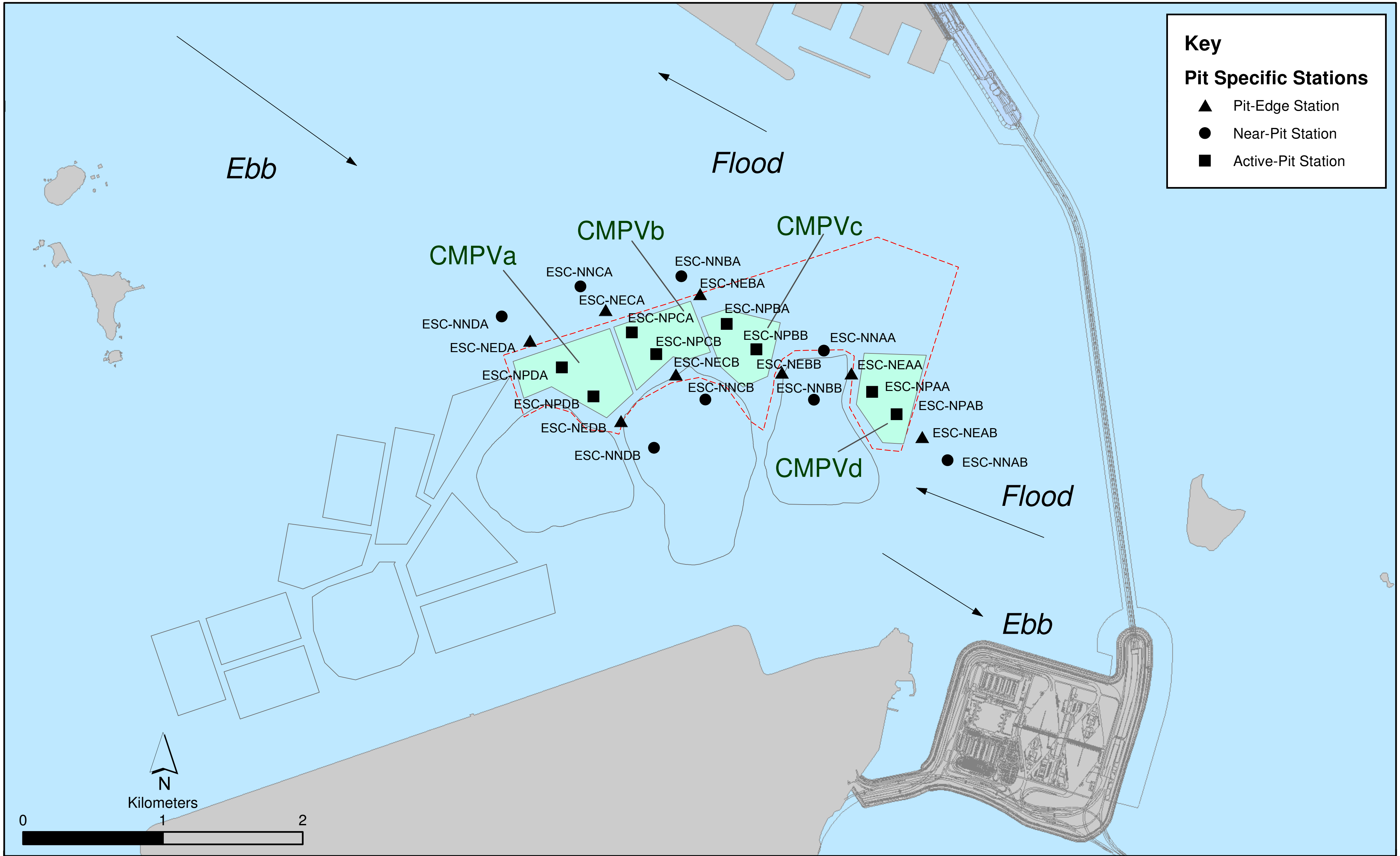

Figure 3.3

Pit Specific Sediment Quality Monitoring Stations for CMPV

File: T:\GIS\CONTRACT\0400720\Mxd\0400720_SQMS_pit specific.mxd
Date: 9/5/2017

Environmental Resources Management

ERM

3.2.31 In this reporting period, only Total Organic Carbon (TOC) concentrations were statistically analysed. Levels of TOC varied significantly with sampling area and time, but the concentrations of TOC did not appear to increase over time or increase with proximity to the pit.

3.2.32 From the results of the above statistical analyses, there did not appear to be any significant trend of increasing sediment contaminants' concentrations with proximity to the pit or with time. Therefore, there is no evidence indicating any unacceptable environmental impacts to sediment quality as a result of the contaminated mud disposal operations at ESC CMP Vb.

3.2.33 ***Cumulative Impact Sediment Chemistry of ESC CMPs***

Background

3.2.34 *Cumulative Impact Sediment Chemistry of ESC CMPs* was conducted in June 2020 as presented in *Table 3.1*. A total of nine (9) monitoring stations were sampled and the monitoring locations are shown in *Figure 3.4*. The monitoring results showed that the concentrations of all inorganic contaminants were generally below the LCELs at all monitoring stations in June 2020, except concentrations of Arsenic were higher than the LCEL at Mid-field stations ESC-RMA, ESC-RMB and Capped Pit station ESC-RCB1.

Summary of Statistical Analysis

3.2.35 Data obtained during this reporting period were statistically compared with previous data obtained since monitoring began for ESC CMPs in June 2016. Statistical tests were run to examine the difference in contaminant concentrations amongst Near-Field, Mid-Field, Far-Field stations. ANOVA was employed as the statistical test, with Area and Station as fixed factors and Station nested within Area.

3.2.36 Should spatial or temporal trend of potential concern (i.e. increasing contaminant concentration with proximity to the pit or over time) be detected by ANOVA, linear regression analyses would be performed to examine the significance of the trend. The assumptions of the linear regression analyses are discussed in *Sections 3.2.7* and *3.2.8*. Detailed results of statistical analyses are presented in *Annex C*.

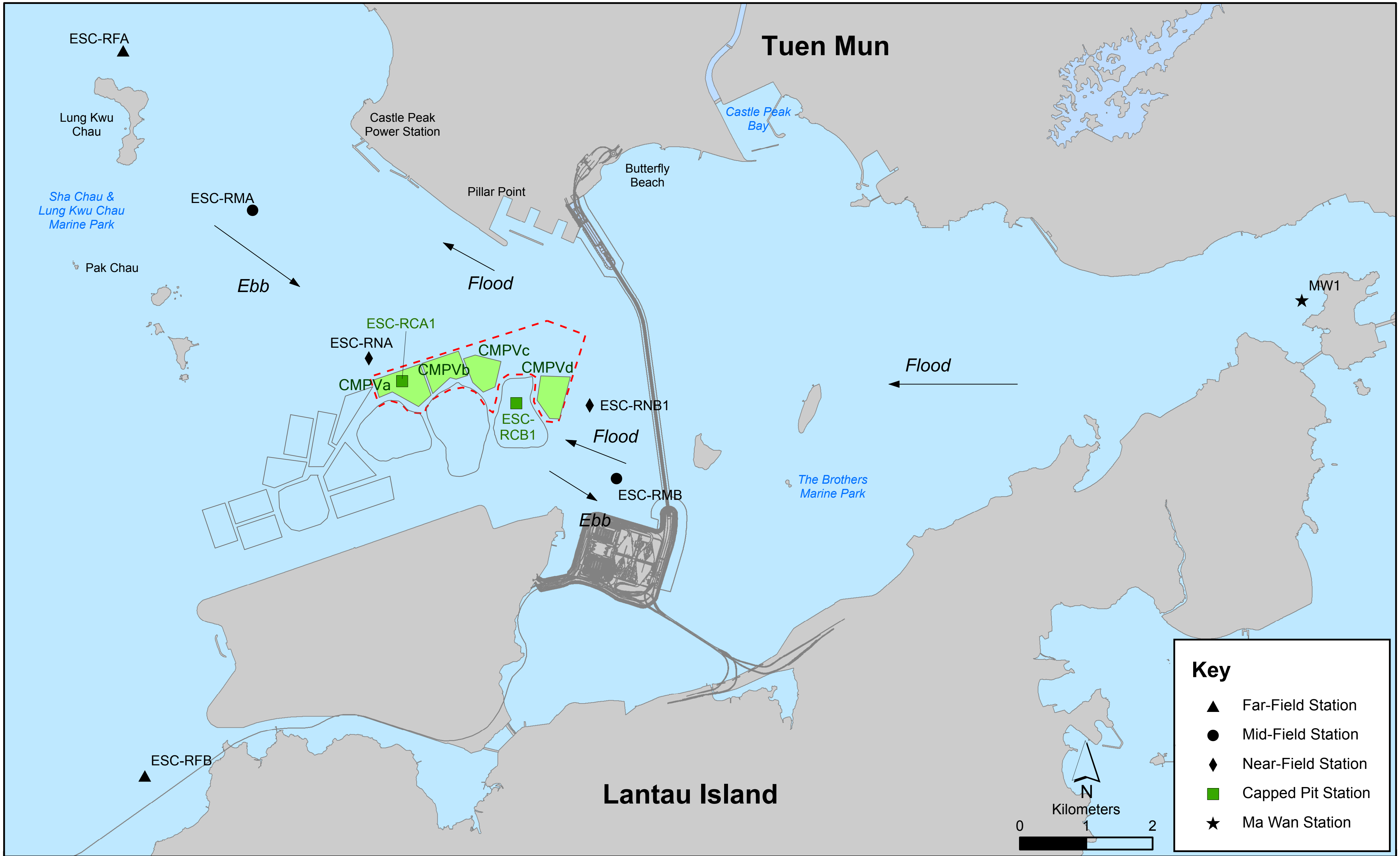

Figure 3.4

Cumulative Impacts Sediment Quality Monitoring Stations for ESC CMPs

File: T:\GIS\CONTRACT\0175086\Mxd\updated_20170419\0175086_SQMS_cum_impact.mxd
Date: 19/4/2017

Environmental Resources Management

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Metals and Metalloid

3.2.37 There were significant spatial variations in the concentrations of all metal and metalloid contaminants (Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Mercury, Silver and Zinc), but no consistent trend (i.e. Near-Field > Mid-Field > Far-Field) was observed. In most cases, metal concentrations were highest at Mid-Field or Ma Wan stations. The concentrations of all measured metals and metalloids varied significantly with sampling time, but did not appear to increase over time.

Organic Contaminants

3.2.38 Concentrations of majority of organic contaminants were below their limits of reporting. Statistical analyses were only performed for contaminants for which 60% of data were over their limits of reporting.

3.2.39 In this reporting period, only TOC and Tributyltin (TBT) concentrations were statistically analysed. Levels of TOC and TBT varied significantly with sampling area and time and were the highest at Ma Wan station. There was no consistent spatial trend of increasing concentrations of TOC/TBT with proximity to the pit or consistent temporal trend of increasing concentrations of TOC/TBT over time.

3.2.40 From the results of the above statistical analyses, there did not appear to be any significant trend of increasing sediment contaminants' concentrations with proximity to the pit or over time. Therefore, there is no evidence indicating any unacceptable environmental impacts to sediment quality as a result of the contaminated mud disposal operations at ESC CMP Vb during the quarterly period.

4 *FINDINGS OF THE FIELD EVENTS AND LABORATORY TESTS AND ANALYSES BY THE INDEPENDENT AUDITOR*

4.1.1 During the reporting period of April to June 2020, the Independent Auditor (IA) conducted an inspection on Routine Water Quality Monitoring on 8 April 2020. A total of 16 stations were sampled that day. In situ measurements were conducted and water samples were collected and delivered to testing laboratory afterwards. The IA was satisfied with the sample collection and confirmed that the requirements as stated in the EM&A Manual were followed.

5 *ACTIVITIES SCHEDULED FOR THE NEXT REPORTING PERIOD*

5.1.1 The monitoring activities to be conducted in the next quarterly period of July to September 2020 for ESC CMPs include:

- *Water Column Profiling of ESC CMP Vb* in July, August and September 2020;
- *Routine Water Quality Monitoring of ESC CMPs* in July and August 2020;
- *Pit Specific Sediment Chemistry of ESC CMP Vb* in July, August and September 2020;
- *Cumulative Impact Sediment Chemistry of ESC CMPs* in August 2020;
- *Demersal Trawling for ESC CMPs* in July and August 2020;
- *Sediment Toxicity Test of ESC CMPs* in August 2020; and
- *Water Quality Monitoring for Capping Operation of ESC CMPs* in August 2020.

5.1.2 The sampling schedule for ESC CMPs is presented in *Annex A*.

Annex A

Sampling Schedule

Annex A1 - East of Sha Chau Environmental Monitoring and Audit Sampling Schedule for CMP (April 2017 - March 2021)

			2017									2018												2019												2020												2021		
Pit Specific Sediment Chemistry	**Code**	**Frequency**	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Active-Pit																																																		
	ESC-NPAA	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	ESC-NPAB	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Pit-Edge																																																		
	ESC-NEAA	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	ESC-NEAB	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Near-Pit																																																		
	ESC-NNAA	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	ESC-NNAB	Monthly	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

Cumulative Impact Sediment Chemistry			A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Near-field Stations																																																		
	ESC-RNA	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
	ESC-RNB1	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
Mid-field Stations																																																		
	ESC-RMA	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
	ESC-RMB	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
Capped Pit Stations																																																		
	ESC-RCA1	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
	ESC-RCB1	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
Far-Field Stations																																																		
	ESC-RFA	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
	ESC-RFB	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	
Ma Wan Station																																																		
	MW1	4 times per year			12		12				12		12				12		12				12		12				12		12				12		12				12		12				12		12	

Sediment Toxicity Tests			A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Near-Pit Stations																																																		
	ESC-TDA	2 times per year					5						5						5						5						5						5						5						5	
	ESC-TDB1	2 times per year					5						5						5						5						5						5						5						5	
Reference Stations																																																		
	ESC-TRA	2 times per year					5						5						5						5						5						5						5						5	
	ESC-TRB	2 times per year					5						5						5						5						5						5						5						5	
Ma Wan Station																																																		
	MW1	2 times per year					5						5						5						5						5						5						5						5	

Tissue/ Whole Body Sampling			A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Near-Pit Stations																																																		
	ESC-INA	2 times per year					*						*						*						*						*						*						*						*	
	ESC-INB	2 times per year					*						*						*						*						*						*						*						*	
Reference North																																																		
	TNA	2 times per year					*						*						*						*						*						*						*						*	
	TNB	2 times per year					*						*						*						*						*						*						*						*	
Reference South																																																		
	TSA	2 times per year					*						*						*						*						*						*						*						*	
	TSB	2 times per year					*						*						*						*						*						*						*						*	

Demersal Trawling			A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Near Pit Stations																																																		
	ESC-INA	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	
	ESC-INB	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	
Reference North																																																		
	TNA	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	
	TNB	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	
Reference South																																																		
	TSA	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	
	TSB	4 times per year				5	5					5	5					5	5					5	5					5	5					5	5					5	5					5	5	

Capping			A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Ebb Tide																																																		
Impact Station Downcurrent																																																		
	ESC-IPE1A	4 times per year																																			3				3		3				3		3	
	ESC-IPE2A	4 times per year																																			3				3		3				3		3	
	ESC-IPE3	4 times per year																																			3				3		3				3		3	
	ESC-IPE4	4 times per year																																			3				3		3				3		3	
	ESC-IPE5	4 times per year																																			3				3		3				3		3	
Intermediate Station Downcurrent																																																		
	ESC-INE1A	4 times per year																																			3				3		3				3		3	
	ESC-INE2A	4 times per year																																			3				3		3				3		3	
	ESC-INE3A	4 times per year																																			3				3		3				3		3	
	ESC-INE4A	4 times per year																																			3				3		3				3		3	
	ESC-INE5A	4 times per year																																			3				3		3				3		3	
Reference Station Upcurrent																																																		
	ESC-RFE1	4 times per year																																			3				3		3				3		3	
	ESC-RFE2	4 times per year																																			3				3		3				3		3	
	ESC-RFE3	4 times per year																																			3				3		3				3		3	
	ESC-RFE4	4 times per year																																			3				3		3				3		3	
	ESC-RFE5	4 times per year																																			3				3		3				3		3	
Ma Wan Station																																																		
	MW1	4 times per year																																			3				3		3				3		3	
Flood Tide																																																		
Impact Station Downcurrent																																																		
	ESC-IPF1	4 times per year																																			3				3		3				3		3	
	ESC-IPF2	4 times per year																																			3				3		3				3		3	
	ESC-IPF3	4 times per year																																			3				3		3				3		3	
Intermediate Station Downcurrent																																																		
	ESC-INF1	4 times per year																																			3				3		3				3		3	
	ESC-INF2	4 times per year																																			3				3		3				3		3	
	ESC-INF3	4 times per year																																			3				3		3				3		3	
Reference Station Upcurrent																																																		
	ESC-RFF1A	4 times per year																																			3				3		3				3		3	
	ESC-RFF2A	4 times per year																																			3				3		3				3		3	
	ESC-RFF3	4 times per year																																			3				3		3				3		3	
Ma Wan Station																																																		
	MW1	4 times per year																																			3				3		3				3		3	

Routine Water Quality Monitoring			A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Ebb Tide																																																		
Impact Station Downcurrent																																																		
	ESC-IPE1A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPE2A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPE3	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPE4	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPE5	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Intermediate Station Downcurrent																																																		
	ESC-INE1A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INE2A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INE3A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INE4A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INE5A	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Reference Station Upcurrent																																																		
	ESC-RFE1	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFE2	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFE3	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFE4	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFE5	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Ma Wan Station																																																		
	MW1	8 times per year	8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Flood Tide																																																		
Impact Station Downcurrent																																																		
	ESC-IPF1	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPF2	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-IPF3	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Intermediate Station Downcurrent																																																		
	ESC-INF1	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INF2	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-INF3	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Reference Station Upcurrent																																																		
	ESC-RFF1A	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFF2A	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
	ESC-RFF3	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	
Ma Wan Station																																																		
	MW1	8 times per year	8	8		8	8		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	

Water Column Profiling			A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Plume Stations	WCP1	Monthly	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	WCP2	Monthly	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Benthic Recolonisation Studies			A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Capped Stations at CMPV																																																		
	ESCV-CPA	2 times per year																																																
	ESCV-CPB	2 times per year																																																
	ESCV-CPC	2 times per year																																																
	ESCV-CPD	2 times per year																																																
Reference Stations																																																		
	RBA	2 times per year																																																
	RBB	2 times per year																																																
	RBC1	2 times per year																																																

Impact Monitoring for Dredging			A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Upstream Stations																																																		
	US1	3 times per week				2	2	2																										2	2															
	US2	3 times per week				2	2	2																										2	2															
Downstream Stations																																																		
	DS1	3 times per week				2	2	2																										2	2															
	DS2	3 times per week				2	2	2																										2	2															
	DS3	3 times per week				2	2	2																										2	2															
	DS4	3 times per week				2	2	2																										2	2															
	DS5	3 times per week				2	2	2																										2	2															
Ma Wan Station																																																		
	MW1	3 times per week				2	2	2																										2	2															

Notes:
The number shown in each cell represents the numbers of replicates per monitoring station
Impact Monitoring for Dredging will be scheduled when dredging operations commence.
Benthic Recolonisation Studies for CMP V will be scheduled when capping operation for CMP V is completed.

Annex B

Disposal & Capping Records

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
1-Apr-2020	2765	140901
2-Apr-2020	2900	143801
3-Apr-2020	3677	147478
4-Apr-2020	903	148381
5-Apr-2020	0	148381
6-Apr-2020	1500	149881
7-Apr-2020	2000	151881
8-Apr-2020	3198	155079
9-Apr-2020	2023	157102
10-Apr-2020	1636	158738
11-Apr-2020	278	159016
12-Apr-2020	0	159016
13-Apr-2020	0	159016
14-Apr-2020	1500	160516
15-Apr-2020	2503	163019
16-Apr-2020	858	163877
17-Apr-2020	500	164377
18-Apr-2020	1000	165377
19-Apr-2020	0	165377
20-Apr-2020	0	165377
21-Apr-2020	400	165777
22-Apr-2020	600	166377
23-Apr-2020	194	166571
24-Apr-2020	1363	167934
25-Apr-2020	1298	169232
26-Apr-2020	1354	170586
27-Apr-2020	0	170586
28-Apr-2020	1078	171664
29-Apr-2020	857	172521
30-Apr-2020	762	173283
1-May-2020	0	173283
2-May-2020	1316	174599
3-May-2020	562	175161
4-May-2020	1200	176361
5-May-2020	400	176761
6-May-2020	0	176761
7-May-2020	0	176761
8-May-2020	0	176761
9-May-2020	332	177093
10-May-2020	0	177093
11-May-2020	0	177093
12-May-2020	0	177093
13-May-2020	0	177093
14-May-2020	0	177093
15-May-2020	0	177093
16-May-2020	0	177093
17-May-2020	0	177093
18-May-2020	0	177093
19-May-2020	0	177093
20-May-2020	0	177093
21-May-2020	243	177336
22-May-2020	440	177776
23-May-2020	767	178543

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
24-May-2020	0	178543
25-May-2020	526	179069
26-May-2020	443	179512
27-May-2020	549	180061
28-May-2020	546	180607
29-May-2020	1069	181676
30-May-2020	887	182563
31-May-2020	0	182563
1-Jun-2020	1102	183665
2-Jun-2020	1334	184999
3-Jun-2020	595	185594
4-Jun-2020	480	186074
5-Jun-2020	1142	187216
6-Jun-2020	348	187564
7-Jun-2020	510	188074
8-Jun-2020	0	188074
9-Jun-2020	0	188074
10-Jun-2020	480	188554
11-Jun-2020	0	188554
12-Jun-2020	301	188855
13-Jun-2020	0	188855
14-Jun-2020	0	188855
15-Jun-2020	0	188855
16-Jun-2020	0	188855
17-Jun-2020	0	188855
18-Jun-2020	0	188855
19-Jun-2020	0	188855
20-Jun-2020	0	188855
21-Jun-2020	0	188855
22-Jun-2020	0	188855
23-Jun-2020	0	188855
24-Jun-2020	0	188855
25-Jun-2020	0	188855
26-Jun-2020	546	189401
27-Jun-2020	372	189773
28-Jun-2020	0	189773
29-Jun-2020	0	189773
30-Jun-2020	0	189773

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
1-Apr-2020	0	79400
2-Apr-2020	0	79400
3-Apr-2020	1200	80600
4-Apr-2020	2400	83000
5-Apr-2020	2400	85400
6-Apr-2020	1600	87000
7-Apr-2020	2000	89000
8-Apr-2020	1600	90600
9-Apr-2020	800	91400
10-Apr-2020	1200	92600
11-Apr-2020	2000	94600
12-Apr-2020	2400	97000
13-Apr-2020	2000	99000
14-Apr-2020	2800	101800
15-Apr-2020	2800	104600
16-Apr-2020	1600	106200
17-Apr-2020	800	107000
18-Apr-2020	1400	108400
19-Apr-2020	2000	110400
20-Apr-2020	0	110400
21-Apr-2020	0	110400
22-Apr-2020	0	110400
23-Apr-2020	400	110800
24-Apr-2020	800	111600
25-Apr-2020	1400	113000
26-Apr-2020	1200	114200
27-Apr-2020	800	115000
28-Apr-2020	1600	116600
29-Apr-2020	1200	117800
30-Apr-2020	800	118600
1-May-2020	1200	119800
2-May-2020	0	119800
3-May-2020	800	120600
4-May-2020	0	120600
5-May-2020	0	120600
6-May-2020	500	121100
7-May-2020	1200	122300
8-May-2020	0	122300
9-May-2020	0	122300
10-May-2020	0	122300
11-May-2020	0	122300
12-May-2020	0	122300
13-May-2020	0	122300
14-May-2020	0	122300
15-May-2020	0	122300
16-May-2020	0	122300
17-May-2020	0	122300
18-May-2020	0	122300
19-May-2020	0	122300
20-May-2020	0	122300
21-May-2020	0	122300
22-May-2020	0	122300
23-May-2020	0	122300

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
24-May-2020	0	122300
25-May-2020	0	122300
26-May-2020	0	122300
27-May-2020	400	122700
28-May-2020	0	122700
29-May-2020	0	122700
30-May-2020	0	122700
31-May-2020	0	122700
1-Jun-2020	0	122700
2-Jun-2020	0	122700
3-Jun-2020	0	122700
4-Jun-2020	0	122700
5-Jun-2020	0	122700
6-Jun-2020	0	122700
7-Jun-2020	0	122700
8-Jun-2020	0	122700
9-Jun-2020	0	122700
10-Jun-2020	0	122700
11-Jun-2020	0	122700
12-Jun-2020	0	122700
13-Jun-2020	0	122700
14-Jun-2020	0	122700
15-Jun-2020	0	122700
16-Jun-2020	0	122700
17-Jun-2020	0	122700
18-Jun-2020	0	122700
19-Jun-2020	0	122700
20-Jun-2020	0	122700
21-Jun-2020	0	122700
22-Jun-2020	0	122700
23-Jun-2020	0	122700
24-Jun-2020	0	122700
25-Jun-2020	0	122700
26-Jun-2020	0	122700
27-Jun-2020	0	122700
28-Jun-2020	0	122700
29-Jun-2020	0	122700
30-Jun-2020	0	122700

Annex C

Statistical Analysis

Routine Water Quality Monitoring for ESC CMPs – Analysis of Variance and Linear Regression Analysis up to May 2020

Dissolved Oxygen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	6313581.965	3	2104527.322	33.342	**
Period	3271796589	46	71126012.81	1126.838	**
Area * Period	165296606.9	138	1197801.499	18.977	**
Error	237709859.1	3766	63119.984		
Total	20613523284	3954			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Feb 17 ≥ Feb 13 ≥ Apr 16 ≥ Jan 17 > Feb 18 = Jan 13 > Jan 18 ≥ Feb 12 = Feb 19 ≥ Nov 18 ≥ Feb 20 > Jan 19 > Apr 13 > Apr 17> Jan 20 > Apr 18 = Nov 16 = Apr 19 > **Apr 20** > Nov 17 = Nov 19 > Apr 12 ≥ May 13 ≥ **May 20** ≥ Nov 12 = May 18 = May 19 ≥ May 16 > Oct 16 = Oct 12 = Jul 12 > May 17 = May 12 = Jul 18 ≥ Oct 19 > Jul 16 = Aug 17 = Oct 18 = Oct 17 > Aug 12 > Aug 13 ≥ Aug 18 = Aug 19 = Jul 17 ≥ Aug 16 = Jul 19 = Jul 13
- Impact = Intermediate > Reference > Ma Wan Station

Turbidity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	135804959.5	3	45268319.84	172.725	**
Period	2299384972	46	49986629.82	190.728	**
Area * Period	453355519	138	3285184.92	12.535	**
Error	987004085.8	3766	262082.869		
Total	20613334260	3954			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- **Apr 20** = Nov 17 > **May 20** > Oct 17 = Aug 13 ≥ Jan 19 ≥ Apr 17 = Apr 12 = Aug 18 = Aug 12 = May 19 = Nov 18 = Nov 16 ≥ Oct 16 ≥ Jul 18 ≥ Nov 12 = Jul 16 ≥ Jul 17 ≥ May 16 = Oct 18 = Aug 19 ≥ Apr 13 ≥ Feb 12 ≥ Oct 19 ≥ Apr 16 > Jul 19 = Jan 17 ≥ May 18 = Oct 12 ≥ Apr 19 = Jul 12 ≥ Jan 18 = Aug 17 ≥ Aug 16 ≥ Feb 13 ≥ Feb 18 = May 12 ≥ Jan 13 = Jan 20 ≥ Feb 19 = Apr 18 ≥ Jul 13 ≥ Nov 19 = Feb 20 ≥ May 17 = May 13 > Feb 17
- Impact = Reference > Intermediate > Ma Wan Station

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	5364815647	45	119218125.5	641.837	**
Area	29019021.7	3	9673007.232	52.077	**
Station(Area)	70212098.1	24	2925504.088	15.75	**
Period * Area	887661114.7	132	6724705.415	36.204	**
Period * Station(Area)	1186987582	402	2952705.429	15.897	**
Error	798332795.3	4298	185745.183		
Total	39473758624	4912			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Aug 13 > May 18 > Feb 12 > Nov 18 = Jul 18 = Aug 19 = **May 20** ≥ Nov 19 = Jul 13 ≥ Apr 12 = Feb 20 ≥ Oct 19 > Feb 19 = Oct 18 = Aug 18 = Jan 13 > Jan 20 = Jan 19 = May 16 = Apr 13 ≥ Apr 18 = May 19 = Nov 12 ≥ Apr 17 > May 12 > Apr 16 = Oct 12 > Jan 18 = Jul 16 = May 13 ≥ May 17 = Apr 19 > **Apr 20** = Aug 16 > Aug 12 = Jul 19 ≥ Jul 12 = Nov 17 ≥ Feb 13 ≥ Feb 18 ≥ Aug 17 = Oct 17 > Oct 16 = Jan 17 = Jul 17 ≥ Feb 17 ≥ Nov 16
- Reference > Ma Wan Station = Impact > Intermediate

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	5226803083	45	116151179.6	396.332	**
Area	50631428.53	3	16877142.85	57.588	**
Station(Area)	138665538.4	24	5777730.767	19.715	**
Period * Area	994317883.8	132	7532711.241	25.703	**
Period * Station(Area)	717376281.8	402	1784518.114	6.089	**
Error	1259010281	4296	293065.708		
Total	39347872819	4910			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Apr 12 = Aug 13 = May 13 > May 12 ≥ Apr 13 = Aug 16 = Jul 13 ≥ Oct 12 = Jan 13 ≥ **May 20** = Aug 12 = Feb 12 = Nov 12 > Jul 17 = Jul 12 = Apr 18 > Aug 17 = Feb 17 > Apr 17 = **Apr 20** = May 18 = Feb 18 = Jan 20 = Nov 18 = Jul 18 > Oct 18 = Jan 18 = Aug 18 = May 19 = Feb 13 = Oct 19 ≥ Apr 19 ≥ Oct 17 = Aug 19 > May 17 = Oct 16 ≥ Jul 16 ≥ Nov 17 = Feb 20 = Nov 19 > Jul 19 = Jan 17 > Apr 16 ≥ Jan 19 = Nov 16 = Feb 19 ≥ May 16
- Reference > Impact > Intermediate > Ma Wan Station

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	5761069569	45	128023768.2	426.608	**
Area	99210969.97	3	33070323.32	110.199	**
Station(Area)	100753718.1	24	4198071.587	13.989	**
Period * Area	674248399	132	5107942.417	17.021	**
Period * Station(Area)	1032148591	402	2567533.808	8.556	**
Error	1289817085	4298	300097.042		
Total	39515686198	4912			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Nov 17 ≥ Jul 17 = Oct 17 ≥ Feb 17 = Apr 17 = Feb 18 = Aug 17 ≥ Jan 18 = May 17 = Nov 18 = Jul 18 ≥ Apr 18 > Aug 19 > Nov 19 ≥ May 18 ≥ **May 20** > Apr 12 = Feb 12 = Aug 13 > Oct 19 ≥ Oct 18 = Aug 18 ≥ **Apr 20** = Jul 12 ≥ Nov 12 = Apr 19 ≥ Jul 13 = Feb 20 = Feb 19 = Jan 20 ≥ May 16 ≥ May 12 = Jan 19 ≥ Jan 17 ≥ Jan 13 = Apr 13 = Apr 16 = Oct 16 = Oct 12 = May 19 > Jul 16 = Nov 16 > Jul 19 > May 13 = Aug 12 > Aug 16 = Feb 13
- Ma Wan Station > Reference > Impact > Intermediate

Ammonia Nitrogen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	6551160239	45	145581338.6	620.056	**
Area	6479401.492	3	2159800.497	9.199	**
Station(Area)	29780555.29	24	1240856.471	5.285	**
Period * Area	409145658.2	132	3099588.32	13.202	**
Period * Station(Area)	352375127.9	402	876555.045	3.733	**
Error	1009116048	4298	234787.354		
Total	39498334440	4912			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Apr 12 > Apr 13 = Jan 20 = Apr 16 > May 13 = **May 20** = Feb 19 = Jan 18 = Apr 17 > **Apr 20** = May 19 ≥ Feb 17 ≥ May 17 ≥ Feb 12 = Apr 19 ≥ Apr 18 > Feb 18 = May 16 ≥ Jan 13 ≥ Jan 17 ≥ Nov 17 = Jul 16 > Jul 18 = May 18 > Oct 17 = Jan 19 > Oct 19 ≥ Jul 13 ≥ Nov 16 ≥ Aug 19 = Feb 20 = Nov 19 = Aug 16 ≥ Jul 19 ≥ Aug 12 ≥ Aug 17 ≥ May 12 > Oct 16 = Jul 17 = Aug 18 > Oct 12 = Oct 18 = Aug 13 > Nov 12 > Jul 12 = Feb 13 > Nov 18
- Ma Wan Station = Reference > Impact > Intermediate

Total Inorganic Nitrogen

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	6354284180	45	141206315.1	1114.049	**
Area	121748610.3	3	40582870.09	320.179	**
Station(Area)	153389271.4	24	6391219.643	50.424	**
Period * Area	553103291.1	132	4190176.448	33.058	**
Period * Station(Area)	538721022.2	402	1340102.045	10.573	**
Error	544773984	4298	126750.578		
Total	39515353350	4912			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Apr 12 = May 18 > Aug 13 > Apr 17 > Aug 19 = Jul 16 = May 13 > Jul 12 ≥ Nov 18 ≥ Aug 17 ≥ Jul 17 > May 12 = Aug 16 > Jul 19 = May 17 = Aug 12 = Apr 18 = Jul 18 > Jul 13 = May 16 = Jan 20 > **Apr 20** = May 19 > Aug 18 = **May 20** = Oct 17 > Apr 13 > Feb 17 = Apr 16 = Jan 18 > Oct 12 = Apr 19 ≥ Feb 19 ≥ Feb 12 > Nov 16 > Oct 18 = Jan 17 = Oct 19 = Oct 16 > Nov 12 > Feb 18 > Jan 19 = Nov 19 > Nov 17 = Jan 13 > Feb 13 = Feb 20
- Impact = Reference > Intermediate > Ma Wan Station

BOD_5

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	3878104529	45	86180100.64	221.268	**
Area	113322794.6	3	37774264.87	96.986	**
Station(Area)	81784720.33	24	3407696.68	8.749	**
Period * Area	1573148449	132	11917791.28	30.599	**
Period * Station(Area)	1297753120	402	3228241.592	8.289	**
Error	1673999928	4298	389483.464		
Total	39487758534	4912			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- Aug 16 > Aug 19 = Nov 16 = Apr 16 > Jan 17 ≥ Apr 19 = May 12 ≥ Oct 19 ≥ Jan 20 ≥ Jan 13 = Aug 18 = **May 20** ≥ May 18 ≥ Jul 17 = Nov 17 ≥ May 17 = May 16 ≥ Feb 20 > Apr 18 = Jul 19 = Oct 18 = Feb 12 = Nov 18 = Jul 18 = May 19 = Feb 18 = Apr 17 = Oct 16 > Nov 19 ≥ Oct 17 = Feb 19 ≥ Apr 13 ≥ Nov 12 ≥ Jan 19 = Apr 12 = Jul 12 ≥ Feb 13 = Oct 12 > Feb 17 > May 13 = Jul 16 = Aug 17 > Aug 12 = Jan 18 > Aug 13 = **Apr 20** > Jul 13
- Reference = Ma Wan Station > Impact > Intermediate

Suspended Solids

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	5371425780	45	119365017.3	1501.114	**
Area	41314088.44	3	13771362.81	173.186	**
Station(Area)	264959319	24	11039971.63	138.837	**
Period * Area	963055464.8	132	7295874.733	91.752	**
Period * Station(Area)	1787366960	402	4446186.467	55.914	**
Error	341766782.8	4298	79517.632		
Total	39514924633	4912			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:

- **Apr 20** = Nov 17 > **May 20** > Jul 12 > Nov 12 = Jan 19 > Nov 16 = Jul 16 = Oct 16 = Aug 12 > Apr 12 ≥ Apr 17 = Oct 17 ≥ May 16 ≥ May 19 = Oct 12 > Aug 13 > Nov 18 = Jan 17 = Jul 18 ≥ Apr 16 = Aug 18 ≥ Jul 17 = Oct 18 ≥ Apr 13 > Aug 19 = Feb 12 > Jan 18 > Oct 19 = Aug 16 > May 18 > Feb 13 = Jan 20 > Apr 19 = Feb 18 = Feb 20 = Apr 18 = Jan 13 > Aug 17 > Feb 19 = Nov 19 ≥ May 13 = Jul 19 ≥ Jul 13 ≥ May 12 > May 17 > Feb 17
- Impact > Intermediate > Reference > Ma Wan Station

Linear Regression Analysis

Source	df	Slope	r	r^2	P
Area	1	-175.232	0.117	0.014	**

Note: Linear regression analysis on spatial changes of contaminant concentrations.

Water Quality Monitoring during Capping of ESC CMPs – Analysis of Variance up to June 2020

Dissolved Oxygen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	2272032.078	3	757344	52.661	**
Period	147683558.4	11	13425778	933.546	**
Area * Period	6138198.473	33	186006	12.934	**
Error	18695923.51	1300	14381.48		
Total	817389349	1348			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:
- Feb 16 > Feb 15 > Feb 14 > Feb 20 > Dec 14 = Dec 15 > Dec 13 > Jun 15 > Jun 14 = Aug 15 > Aug 14 > **Jun 20**
- Impact ≥ Reference ≥ Intermediate > Ma Wan Station

Turbidity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	8702702.439	3	2900901	78.872	**
Period	118440738.3	11	10767340	292.751	**
Area * Period	9478853.985	33	287238	7.81	**
Error	47813848.48	1300	36779.88		
Total	817377255.5	1348			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:
- Dec 13 > Feb 20 ≥ Jun 15 ≥ Dec 15 > Dec 14 = Aug 14 = Aug 15 > **Jun 20** > Feb 15 > Feb 14 > Jun 14 > Feb 16
- Impact > Reference > Intermediate > Ma Wan Station

Suspended Solids

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	210082.793	3	70027.598	13.121	**
Period	4354670.156	11	395879.105	74.178	**
Area * Period	819568.039	33	24835.395	4.654	**
Error	2337563.5	438	5336.903		
Total	38379930.5	486			

Note:
1. Data are rank-transformed;
2. NS: No significant different;
3. **: Significant difference

SNK Results:
- Dec 13 > Jun 15 = Feb 20 = Dec 15 > Ag 14 = Feb 15 > Aug 15 = Dec 14 > **Jun 20** > Feb 14 = Jun 14 = Feb 16
- Impact > Intermediate = Reference > Ma Wan Station

Pit Specific Sediment Chemistry for ESC CMP Vd – Analysis of Variance up to June 2020

Arsenic

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	137132.743	4	34283.186	15.829	**
Area	871346.629	2	435673.315	201.162	**
Station(Area)	957363.688	3	319121.229	147.347	**
Period * Area	499465.419	8	62433.177	28.827	**
Period * Station(Area)	707173.063	12	58931.089	27.21	**
Error	714709.458	330	2165.786		
Total	15616081	360			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Mar 20 > Feb 20 ≥ **Apr 20** ≥ **May 20** ≥ **Jun 20**
- Pit Edge > Near Pit = Active Pit

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	617397.382	4	154349.345	44.141	**
Area	835515.113	2	417757.556	119.471	**
Station(Area)	422940.188	3	140980.063	40.318	**
Period * Area	279035.776	8	34879.472	9.975	**
Period * Station(Area)	557360.542	12	46446.712	13.283	**
Error	1153922.5	330	3496.735		
Total	15595061.5	360			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Mar 20 > **Apr 20** > **Jun 20** = Feb 20 ≥ **May 20**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-58.894	0.464	0.215	**

Note: Linear regression analysis on spatial changes of contaminant concentrations.

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	347387.861	4	86846.965	37.567	**
Area	1079583.079	2	539791.54	233.498	**
Station(Area)	1392300.313	3	464100.104	200.756	**
Period * Area	121559.456	8	15194.932	6.573	**
Period * Station(Area)	184229.75	12	15352.479	6.641	**
Error	762881.542	330	2311.762		
Total	15616832	360			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 > Mar 20 > **May 20** = **Jun 20** = **Apr 20**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-62.065	0.488	0.238	**

Note: Linear regression analysis on spatial changes of contaminant concentrations.

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	396897.438	4	99224.359	100.23	**
Area	1219953.204	2	609976.602	616.161	**
Station(Area)	1244617.871	3	414872.624	419.079	**
Period * Area	182040.817	8	22755.102	22.986	**
Period * Station(Area)	517763.379	12	43146.948	43.584	**
Error	326687.792	330	989.963		
Total	15616850.5	360			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 > Mar 20 > **Jun20** = **Apr 20** > **May 20**
- Active Pit > Near Pit > Pit Edge

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	319168.528	4	79792.132	29.595	**
Area	884209.963	2	442104.981	163.977	**
Station(Area)	961428.346	3	320476.115	118.865	**
Period * Area	407706.864	8	50963.358	18.902	**
Period * Station(Area)	425722.092	12	35476.841	13.158	**
Error	889723.708	330	2696.132		
Total	15616849.5	360			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 > Mar 20 = **Jun 20** > **Apr 20** > **May 20**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-59.644	0.220	0.217	**

Note: Linear regression analysis on spatial changes of contaminant concentrations.

Mercury

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	251816.958	4	62954.24	17.44	**
Area	590499.688	2	295249.844	81.79	**
Station(Area)	1141845.429	3	380615.143	105.438	**
Period * Area	240258.438	8	30032.305	8.32	**
Period * Station(Area)	453196.196	12	37766.35	10.462	**
Error	1191251.792	330	3609.854		
Total	15597758.5	360			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 > Mar 20 = **Apr 20** > **May 20** = **Jun 20**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-48.188	0.144	0.142	**

Note: Linear regression analysis on spatial changes of contaminant concentrations.

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	544825.507	4	136206.377	92.639	**
Area	1014927.654	2	507463.827	345.144	**
Station(Area)	1568702.004	3	522900.668	355.643	**
Period * Area	139808.485	8	17476.061	11.886	**
Period * Station(Area)	134481.475	12	11206.79	7.622	**
Error	485197.375	330	1470.295		
Total	15616832.5	360			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 > Mar 20 > **Jun 20** = **May 20** > **Apr 20**
- Active Pit > Pit Edge = Near Pit

Silver

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	82865.215	4	20716.304	10.181	**
Area	1467704.904	2	733852.452	360.645	**
Station(Area)	774836.263	3	258278.754	126.929	**
Period * Area	346028.818	8	43253.602	21.257	**
Period * Station(Area)	536315.05	12	44692.921	21.964	**
Error	671494.75	330	2034.833		
Total	15608135	360			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Mar 20 > Feb 20 = **May 20** = **Apr 20** =**Jun 20**
- Active Pit > Near Pit > Pit Edge

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	569377.125	4	142344.281	50.992	**
Area	1083880.117	2	541940.058	194.14	**
Station(Area)	611657.008	3	203885.669	73.038	**
Period * Area	386337.446	8	48292.181	17.3	**
Period * Station(Area)	315453.263	12	26287.772	9.417	**
Error	921190.042	330	2791.485		
Total	15616785	360			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 > Mar 20 > **Jun 20** > **May 20** = **Apr 20**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-51.796	0.166	0.163	**

Note: Linear regression analysis on spatial changes of contaminant concentrations.

Total Organic Carbon

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	981687.979	4	245421.995	135.45	**
Area	1258643.954	2	629321.977	347.328	**
Station(Area)	607932.538	3	202644.179	111.841	**
Period * Area	174143.983	8	21767.998	12.014	**
Period * Station(Area)	266443.713	12	22203.643	12.254	**
Error	597925.833	330	1811.896		
Total	15615668	360			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Mar 20 > Feb 20 = **May 20** > **Apr 20** > **Jun 20**
- Active Pit > Near Pit = Pit Edge

Cumulative Impact Sediment Chemistry for ESC CMPs – Analysis of Variance (up to June 2020)

Arsenic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	135857835.2	16	8491115	478.444	**
Area	86233225.34	4	21558306	1214.734	**
Area * Station	8265385.346	4	2066346	116.431	**
Period * Area	224835176.3	63	3568812	201.09	**
Period * Area * Station	21830073.91	64	341094.9	19.219	**
Error	29868782.08	1683	17747.35		
Total	2064634121	1836			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Dec 19 ≥ Jun 19 ≥ Aug 19 ≥ **Jun 20** > Jun 18 > Feb 20 > Dec 18 = Feb 19 = Dec 17 = Feb 18 > Aug 18 = Jun 17 > Jun 16 = Aug 17 > Dec 16 > Feb 17 = Aug 16
- Mid-Field > Ma Wan > Far-Field = Near-Field > Capped-Pit

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	59284845.74	16	3705303	42.427	**
Area	44505633.02	4	11126408	127.401	**
Area * Station	84827118.79	4	21206780	242.825	**
Period * Area	108777924.5	63	1726634	19.771	**
Period * Area * Station	62718607.87	64	979978.2	11.221	**
Error	146720298.7	1680	87333.51		
Total	2049797774	1833			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Jun 16 ≥ Aug 16 ≥ Feb 20 = Aug 19 = Aug 17 = Jun 18 = Feb 18 ≥ Dec 17 ≥ Dec 19 = Dec 18 > Jun 17 = Aug 18 = Feb 19 > **Jun 20** = Feb 17 = Jun 19 > Dec 16
- Mid-Field > Ma Wan > Far-Field > Capped-Pit = Near-Field

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	23438262.2	16	1464891.388	60.68	**
Area	217965933.9	4	54491483.48	2257.195	**
Area * Station	32983782.71	4	8245945.677	341.571	**
Period * Area	142483476.9	63	2261642.49	93.684	**
Period * Area * Station	48751283.31	64	761738.802	31.553	**
Error	40629712.29	1683	24141.243		
Total	2064673745	1836			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Jun 16 > Aug 16 ≥ Feb 20 = Dec 19 = Aug 19 = Aug 17 ≥ Dec 17 ≥ Jun 18 = Jun 17 ≥ Jun 19 ≥ Feb 19 = Feb 18 ≥ Dec 16 ≥ **Jun 20** > Dec 18 = Feb 17 > Aug 18
- Ma Wan > Mid-Field > Near-Field = Far-Field > Capped-Pit

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	21461393.06	16	1341337	49.358	**
Area	168816674.9	4	42204169	1553.007	**
Area * Station	136956574.7	4	34239144	1259.914	**
Period * Area	104908877.1	63	1665220	61.276	**
Period * Area * Station	27302890.78	64	426607.7	15.698	**
Error	45736829.71	1683	27175.78		
Total	2064673804	1836			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 = Dec 17 > Dec 19 > Aug 17 = Jun 18 ≥ Feb 19 = Jun 16 = Jun 19 = Aug 16 = Aug 19 = Jun 17 ≥ **Jun 20** ≥ Dec 18 > Aug 18 = Dec 16 = Feb 18 = Feb 17
- Ma Wan > Mid-Field > Near-Field = Far-Field > Capped-Pit

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	118153330.1	16	7384583.134	248.676	**
Area	148992610.2	4	37248152.54	1254.33	**
Area * Station	23302167.93	4	5825541.981	196.175	**
Period * Area	135316643.4	63	2147883.229	72.33	**
Period * Area * Station	37739949.17	64	589686.706	19.858	**
Error	49977788.17	1683	29695.655		
Total	2064673738	1836			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Aug 18 > Dec 18 > Aug 16 > Aug 19 = Dec 19 = Feb 19 = Aug 17 = Jun 18 > Jun 19 = Jun 16 = Feb 20 = **Jun 20** ≥ Feb 18 ≥ Dec 17 > Dec 16 > Jun 17 > Feb 17
- Ma Wan > Mid-Field > Near-Field > Far-Field > Capped-Pit

Mercury

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	195585471.9	16	12224091.99	144.188	**
Area	31406823.4	4	7851705.85	92.614	**
Area * Station	20232545.46	4	5058136.364	59.663	**
Period * Area	72069093.35	63	1143953.863	13.493	**
Period * Area * Station	26634797.4	64	416168.709	4.909	**
Error	142259058.8	1678	84778.939		
Total	2041344956	1831			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Jun 16 > Aug 16 > Feb 20 > Dec 18 = Aug 18 = Dec 19 = Dec 16 > Feb 19 ≥ Feb 17 = **Jun 20** ≥ Aug 17 = Jun 19 = Jun 17 ≥ Dec 17 ≥ Jun 18 = Aug 19 > Feb 18
- Ma Wan > Far-Field = Capped-Pit ≥ Mid-Field ≥ Near-Field

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	23293020.47	16	1455814	61.887	**
Area	191949882.6	4	47987471	2039.953	**
Area * Station	39874571.35	4	9968643	423.768	**
Period * Area	162044295.3	63	2572132	109.342	**
Period * Area * Station	53406097.41	64	834470.3	35.473	**
Error	39590573.29	1683	23523.81		
Total	2064673438	1836			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Jun 16 > Aug 18 > Dec 18 ≥ Dec 19 = Aug 17 = Feb 20 = Dec 17 ≥ Aug 19 ≥ Dec 16 ≥ Jun 18 ≥ Jun 19 ≥ Jun 17 = Feb 18 = **Jun 20** = Feb 19 > Aug 16 > Feb 17
- Ma Wan > Mid-Field > Far-Field > Near-Field > Capped-Pit

Silver

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	64124806.09	16	4007800	105.419	**
Area	164893667.7	4	41223417	1084.319	**
Area * Station	132453861.9	4	33113465	870.999	**
Period * Area	37771780.72	63	599552.1	15.77	**
Period * Area * Station	45863601.76	64	716618.8	18.85	**
Error	63983937.83	1683	38017.79		
Total	2064069357	1836			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Aug 18 > Dec 18 > Dec 17 = Aug 16 = Feb 18 = Aug 17 > Feb 19 = Feb 17 = Feb 20 = Aug 19 = Dec 16 = Dec 19 = Jun 17 > Jun 19 = **Jun 20** > Jun 16 > Jun 18
- Ma Wan > Mid-Field > Near-Field > Far-Field > Capped-Pit

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	32244331.4	16	2015271	93.163	**
Area	165402920.9	4	41350730	1911.592	**
Area * Station	85355827.19	4	21338957	986.473	**
Period * Area	151685083.4	63	2407700	111.305	**
Period * Area * Station	30908118.01	64	482939.3	22.326	**
Error	36405932.08	1683	21631.57		
Total	2064671811	1836			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 20 = Dec 19 > Aug 16 > Aug 19 ≥ Jun 19 = Jun 18 ≥ Jun 16 = Aug 17 ≥ Dec 17 ≥ Jun 17 = Feb 19 ≥ Feb 18 = Dec 16 > **Jun 20** = Feb 17 > Dec 18 > Aug 18
- Ma Wan > Mid-Field > Near-Field > Far-Field > Capped-Pit

TOC

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	74461722.99	16	4653858	115.401	**
Area	128065487.9	4	32016372	793.908	**
Area * Station	18649759.91	4	4662440	115.614	**
Period * Area	149974060.5	63	2380541	59.03	**
Period * Area * Station	66246693.22	64	1035105	25.667	**
Error	67871292.75	1683	40327.57		
Total	2064508850	1836			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Jun 16 > Dec 19 = Feb 20 > Dec 16 = Aug 19 = Aug 16 > Dec 17 ≥ Feb 19 ≥ Jun 17 = Jun 18 ≥ Jun 19 ≥ Dec 18 = Feb 18 > Aug 17 ≥ Aug 18 ≥ **Jun 20** = Feb 17
- Ma Wan > Mid-Field > Far-Field > Capped-Pit > Near-Field

TBT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	125657996.8	16	7853625	99.995	**
Area	91545838.18	4	22886460	291.398	**
Area * Station	7053336.396	4	1763334	22.451	**
Period * Area	47832032.04	63	759238.6	9.667	**
Period * Area * Station	28112930.53	64	439264.5	5.593	**
Error	132183268.1	1683	78540.27		
Total	1997244078	1836			

Note:
1. Data are rank-transformed;
2. NS: No significant difference;
3. **: Significant difference

SNK Results:

- Feb 17 = Dec 16 = Aug 17 = Jun 17 = Aug 18 > Jun 16 ≥ Feb 18 = Dec 18 ≥ Feb 19 = Aug 16 = Dec 19 ≥ Dec 17 = Aug 19 = Jun 19 = **Jun 20** > Jun 18 = Feb 20
- Ma Wan > Capped-Pit > Near-Field = Far-Field > Mid Field