土木工程拓展署
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 – January to March 2021

Revision 0

April 2021

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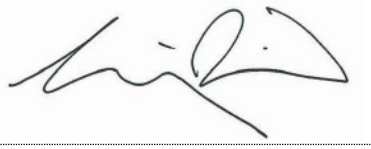
Client:	Project No:
Civil Engineering and Development Department (CEDD)	0400720
Summary: This document presents the Quarterly EM&A Report for *Environmental Monitoring and Audit for Disposal Facility to the East of Sha Chau*.	Date: 21 April 2021 Approved by:  Craig A. Reid *Partner*

Revision	Description	By	Checked	Approved	Date
v0	Quarterly EM&A Report for ESC CMPs	GS	RC	CAR	21/4/21

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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 - January to March 2021
Date of Report:	21 April 2021
Date prepared by ET:	21 April 2021
Date received by IA:	21 April 2021

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.

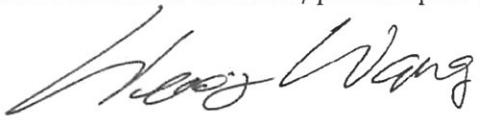
ET Certification

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:  Date: 21/4/2021

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:  Date: 21 April 2021

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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 January to March 2021

EXECUTIVE SUMMARY

Water Column Profiling, Routine Water Quality Monitoring, Pit Specific Sediment Chemistry, Cumulative Impact Sediment Chemistry, Sediment Toxicity Test and *Demersal Trawling* were carried out for the Contaminated Mud Pits (CMPs) to the East of Sha Chau (ESC) during the quarterly period of July to September 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 – January to March 2021

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 – January to March 2021

Results of Routine Water Quality Monitoring conducted in January, February and March 2021 showed that the levels of DO, Turbidity and SS complied with the Action and Limit Levels at all 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.

Sediment Quality Monitoring for ESC CMPs

Pit Specific Sediment Chemistry of ESC CMP Vb – January to March 2021

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 at ESC CMP Vb have not caused any unacceptable impact in sediment quality during the reporting period.

Cumulative Impact Sediment Chemistry of ESC CMPs – February 2021

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 appears that mud disposal operation at ESC CMP Vb have not caused any unacceptable impact in sediment quality during the reporting period.

Sediment Toxicity Test of ESC CMPs – February 2021

The test results at Reference and Impact stations for the reporting period were similar to with those obtained from the previous sediment toxicity tests. Overall, there did not appear to be any evidence of unacceptable impacts to sediment toxicity due to the mud disposal operations at ESC CMPs.

Demersal Trawling for ESC CMPs – January and February 2021

During the sampling period in January and February 2021, the mean number of faunal species caught was generally lower at Impact stations in January and February 2021. Biotic abundance, biomass, Catch per Unit Effort (CPUE) and Yield per Unit Effort (YPUE) were generally lower at Impact stations ESC-INA and ESC-INB.

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（二零二一年一月至三月）

行政摘要

在2021年1月至3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、指定污泥坑沉積物化學監察、沉積物化學累積性影響監察、沉積物毒性測試及底棲漁業資源監察。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–2021年1月至3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–2021年1月至3月

2021年1月至3月的例行水質監察結果顯示所有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。

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–2021年1月至3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–2021年2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。

沙洲以東污泥坑之沉積物毒性測試–2021年2月

在報告期的監察結果表示參考站和受影響監測站的結果與以前沉積物毒性測試結果相近。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毒性造成任何不可接受的影響。

沙洲以東污泥坑之底棲漁業資源監察–2021年1月和2月

監察結果顯示，2021年1月和2月的底棲漁業資源在受影響監測站普遍錄得較低的品種數量。而在2021年1月及2月受影響監測站的生物量、生物重量、單位努力漁獲量及單位努力生產量普遍錄得較低的數值。

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 A proposal on the change of number of sample replication of water quality & sediment monitoring and combination of routine water quality monitoring and water quality monitoring during capping operation was submitted to EPD and agreed by EPD on 3 December 2020. The proposed changes have been effective for the EM&A activities since December 2020.

1.1.4 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.

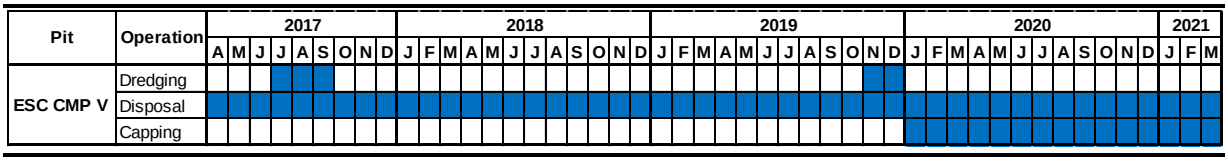
(2) ERM (2017). Environmental Monitoring and Audit for Contaminated Mud Pit V at East of Sha Chau (2012 - 2017). Final Report. For CEDD.

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 January to March 2021, 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*. No capping operation was conducted at ESC CMP Vd during the reporting period.

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 January to March 2021* is to provide information regarding the findings in the quarterly reporting period of January to March 2021 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 January to March 2021

Key Task	Date of Sampling & *in-situ* Measurement	Date of Results Received from the Contractors
ESC CMPs		
Water Column Profiling of ESC CMP Vb	6 January 2021 11 February 2021 5 March 2021	26 January 2021 9 March 2021 1 April 2021
Routine Water Quality Monitoring of ESC CMPs	5 January 2021 4 February 2021 4 March 2021	26 January 2021 9 March 2021 1 April 2021
Pit Specific Sediment Chemistry of ESC CMP Vb	4 January 2021 8 February 2021 3 March 2021	26 January 2021 9 March 2021 1 April 2021
Cumulative Impact Sediment Chemistry of ESC CMPs	9 & 10 February 2021	9 March 2021
Sediment Toxicity Test of ESC CMPs	9 & 10 February 2021	9 March 2021
Demersal Trawling of ESC CMPs	7 & 8 January 2021 22 & 23 February 2021	4 February 2021 1 April 2021

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 January to March 2021 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 January, February and March 2021. 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 once every month from January to March 2021 as presented in *Table 3.1*. A total of ten (10) stations were sampled in January, February and March 2021 with locations of the monitoring stations presented in *Figure 3.1*. The disposal and capping volumes during the reporting period is detailed in *Annex B1* and *B2*, respectively. The monitoring results showed that levels of DO, Salinity and pH complied with the WQOs at all stations. The levels of DO, Turbidity and SS complied with the Action and Limit Levels at all stations during the monitoring period.

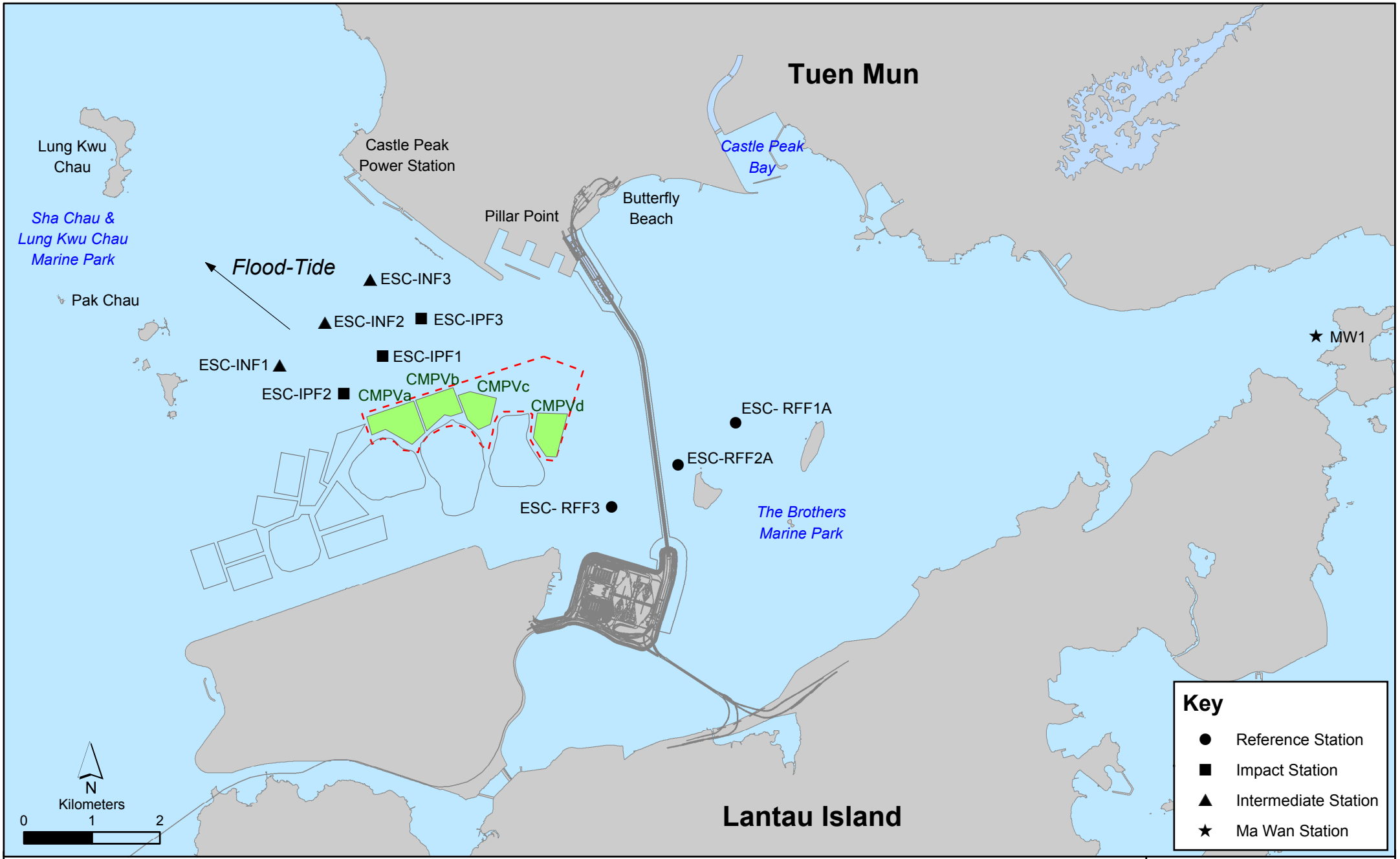


Figure 3.1

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

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Date: 25/4/2017

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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 March 2021 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 March 2021). 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 highest in April 2012, August 2013 and May 2013. The concentration of Zinc was the highest in January 2021 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 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 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 and capping operations at CMP V of the ESC area.

3.2.17 *Pit Specific Sediment Chemistry of ESC CMP Vb*

Background

3.2.18 *Pit Specific Sediment Chemistry of ESC CMP Vb* was conducted once every month from January to March 2021 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 3.2*. The monitoring results showed that the concentrations of most inorganic contaminants were below the Lower Chemical Exceedance Levels (LCELs) at most stations from January to March 2021, except the concentrations of Arsenic were higher than LCEL at Active Pit stations, Pit-Edge stations and Near-Pit stations; and the concentrations of Copper was higher than LECL at Active-Pit station ESC-NPCB.

Summary of Statistical Analyses

3.2.19 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.

3.2.20 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*.

Metals and Metalloids

3.2.21 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 Nickel 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 Nickel levels and proximity to the pit ($r^2 < 0.60$).

Organic Contaminants

3.2.22 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.

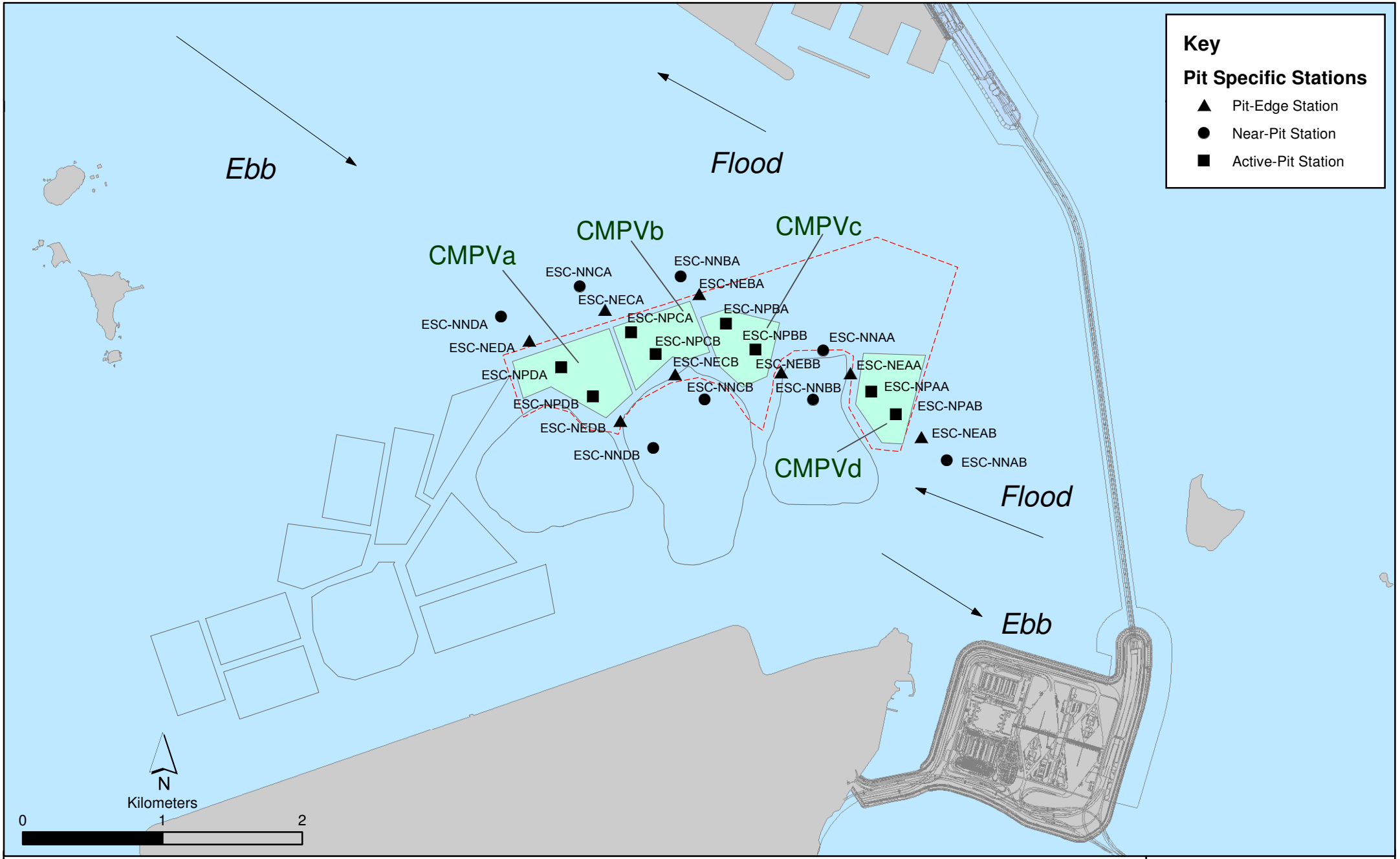

Figure 3.2

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

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3.2.23 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.

3.2.24 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.

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

Background

3.2.26 *Cumulative Impact Sediment Chemistry of ESC CMPs* was conducted in February 2021 as presented in *Table 3.1*. A total of nine (9) monitoring stations were sampled and the monitoring locations are shown in *Figure 3.3*. The monitoring results showed that the concentrations of all inorganic contaminants were generally below the LCELs at all monitoring stations in February 2021, except concentrations of Arsenic were higher than the LCEL at Mid-field stations ESC-RMA, ESC-RMB, Near-field station ESC-RNB1, Capped Pit stations ESC-RCA1 and ESC-RCB1.

Summary of Statistical Analysis

3.2.27 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.

3.2.28 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*.

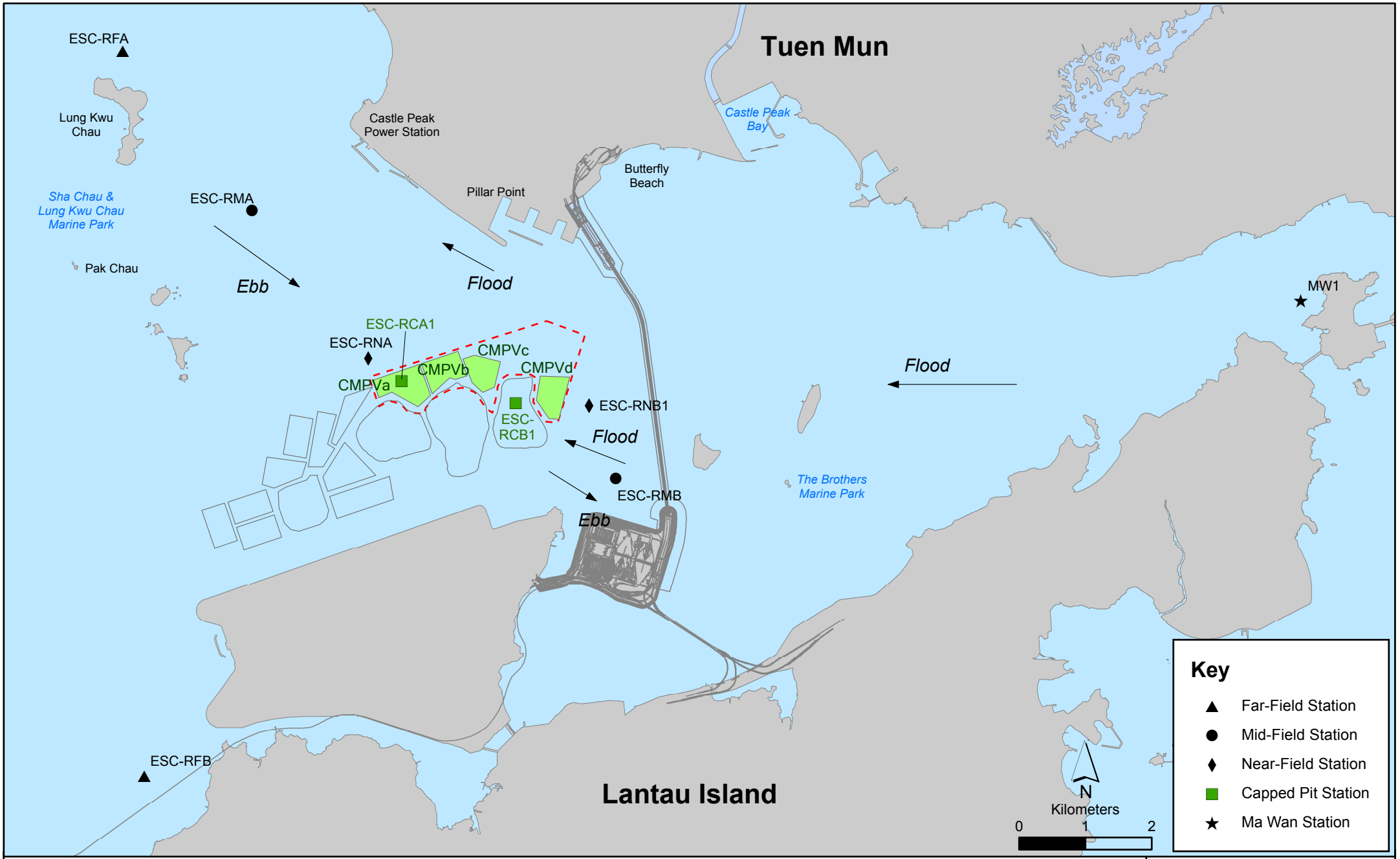

Figure 3.3

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

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Metals and Metalloid

3.2.29 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

3.2.30 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.

3.2.31 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.

3.2.32 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 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.

3.2.33 ***Sediment Toxicity Test – February 2021***

3.2.34 Sediment Toxicity Tests were undertaken for sediments collected from the Impact (Near Pit), Reference and Ma Wan stations (see *Figure 3.4* for the sampling locations) in February 2021 using three international species (burrowing amphipod *Leptocheirus plumulosus*, marine benthic polychaete *Neanthes arenaceodentata* and marine bivalve *Crassostrea gigas*) and two local species (barnacles *Balanus amphitrite* and shrimp *Penaeus vannaamei*).

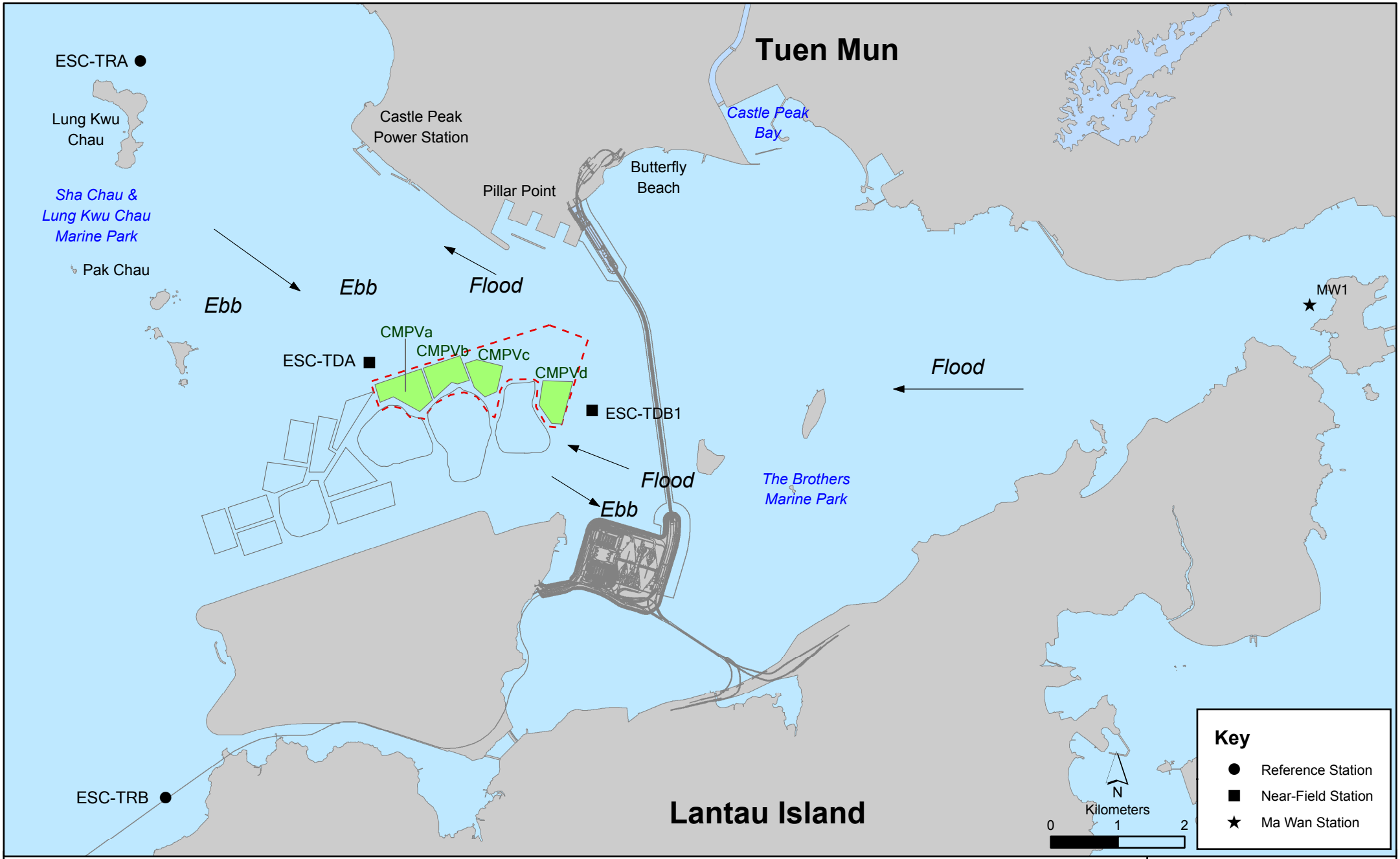

Figure 3.4

Sediment Toxicity Monitoring Stations for ESC CMPs

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

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3.2.35 Appropriate statistical test, i.e. ANOVA, was applied for comparing and determining the level of significance in the results in February 2021. For all of the ANOVA techniques, initial analyses were performed to ensure that the data are independent of each other, normally distributed and homogeneous. Should the data not comply with these assumptions then the appropriate transformation would be applied to the data. Data transformation (e.g. natural logarithm of chemical concentrations, square-root of a count and arcsine square-root of a proportion or percentage) would be used to reduce the within class heterogeneity of variance. If, after transformation, the data are still non-compliant (i.e. the residual errors are not normally distributed or variances are still heterogeneous) then rank transformed data would be applied to parametric or non-parametric equivalents to ANOVA such as Kruskal-Wallis tests. When significant difference are detected then multiple comparison procedures would be used (e.g. Student Newman Keuls Test or Turkey's HSD or Dunn's Test) to isolate where the differences is occurring.

3.2.36 Results of the Sediment Toxicity Tests in February 2021 showed that there were no significant differences between Impact and Reference stations in the toxicity tests for the mortality rate for barnacles. Significant differences between Impact and Reference stations in the toxicity tests were recorded for the survival rate for burrowing amphipod, the growth rate of benthic polychaete, the survival rate for marine bivalve and the mortality rate for shrimp. However, clear spatial patterns were not observed in general (i.e. all Reference stations > all Impact stations) and there was no observable difference against the results obtained from the previous sediment toxicity tests. Therefore, there did not appear to be any evidence of unacceptable impacts to sediment toxicity due to the mud disposal operations at ESC CMPs.

3.2.37 ***Demersal Trawling – January and February 2021***

3.2.38 Fishery resources monitoring by demersal trawling was carried out at two (2) impact and four (4) reference stations (see *Figure 3.5* for locations) in January and February 2021. Monitoring results are presented in the following sections.

Abundance and Biomass

3.2.39 The average number of species collected in January and February 2021 is presented in *Table 3.2*. Mean number of faunal species caught at Impact stations was generally lower than at Reference stations in January and February 2021.

3.2.40 Biotic abundance, Biomass, Catch per Unit Effort (CPUE) and Yield per Unit Effort (YPUE) were generally lower at Impact stations ESC-INA and ESC-INB in January and February 2021 (*Table 3.3*). Annual trend and statistical analyses will be conducted in the Annual EM&A Review Report to determine whether there is any evidence of unacceptable impact to fishery resources caused by the mud disposal operations at ESC CMP Vb.

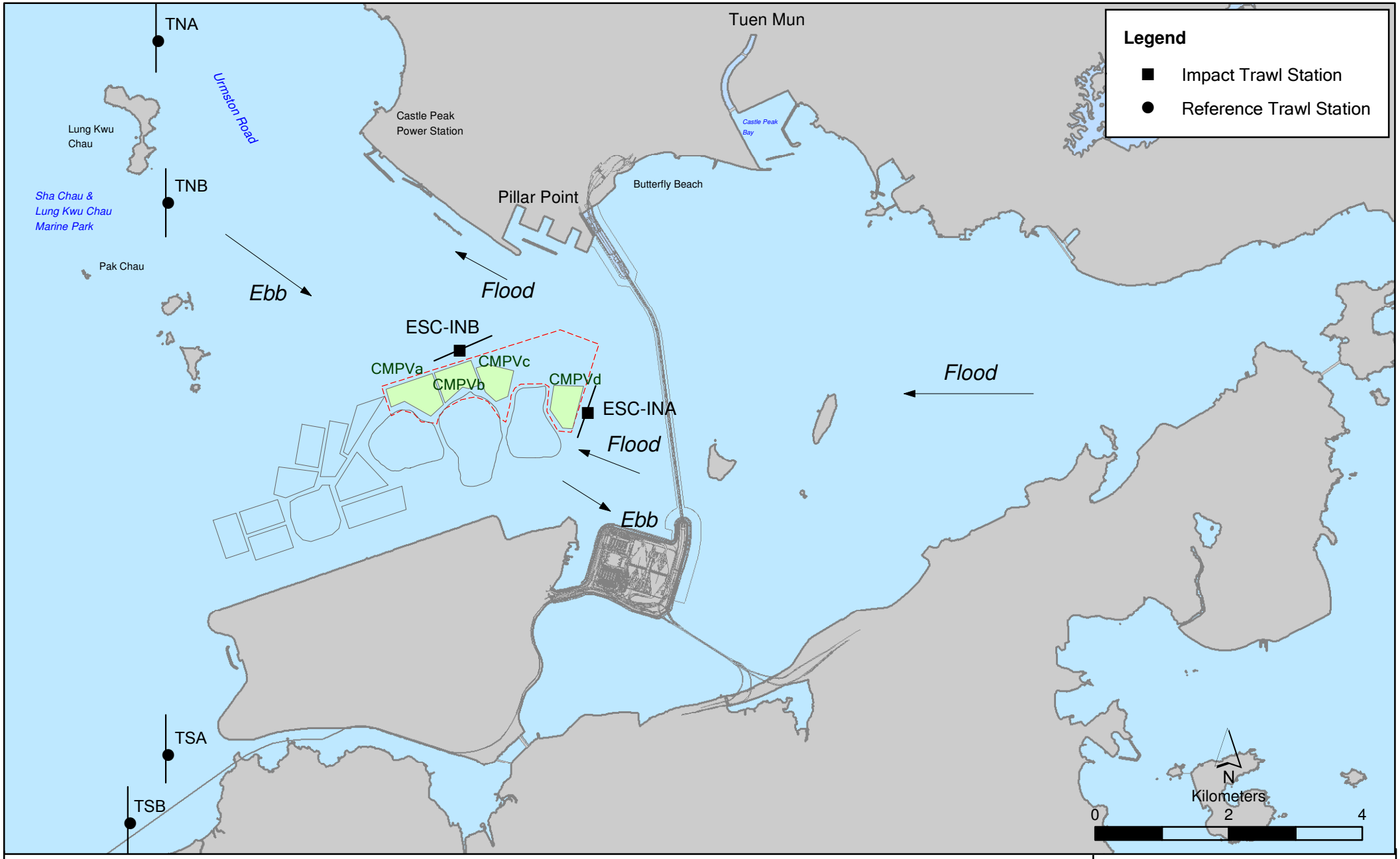

Figure 3.5

Marine Biota Monitoring Stations for CMPV

File: T:\GIS\CONTRACT\0400720\Mxd\0400720_Marine_Biota_2017.mxd
Date: 2/6/2017

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Table 3.2 *Summary of the Mean Number of Faunal Species Caught during January and February 2021 Monitoring*

Mean Number of Faunal Species	Impact Stations		Reference Stations			
	ESC-INA	ESC-INB	TNA	TNB	TSA	TSB
January 2021	22.6	17.6	23.2	23.4	31.4	27.4
February 2021	20.8	18.6	22.2	30.0	42.6	35.4

Table 3.3 **Summary of CPUE and YPUE during January and February 2021 Monitoring**

Date	Stations	Stations	No. of Individuals per Station	Total Biomass per Station (g)	Mean CPUE#1 per Tow (No. / hr / net)	Mean YPUE#2 per Tow (g / hr / net)
Jan 2021	ESC-INA	Impact	1380	11171.2	276.0	2234.24
Jan 2021	ESC-INB	Impact	808	4001	161.6	800.2
Jan 2021	TNA	Reference	2288	45818.2	457.6	9163.64
Jan 2021	TNB	Reference	1771	39887.7	354.2	7977.5
Jan 2021	TSA	Reference	2838	56314.5	567.6	11262.9
Jan 2021	TSB	Reference	8232	35032.5	1646.4	7006.5
Feb 2021	ESC-INA	Impact	946	8415.3	189.2	1683.1
Feb 2021	ESC-INB	Impact	1069	12805.9	213.8	2561.2
Feb 2021	TNA	Reference	1575	24948.4	315.0	4989.7
Feb 2021	TNB	Reference	2058	44168.4	411.6	8833.7
Feb 2021	TSA	Reference	2735	73119.1	547.0	14623.8
Feb 2021	TSB	Reference	3061	51397.9	612.2	10279.6

Notes:

#1 CPUE is calculated by dividing the number of individuals with the trawling time and number of nets (in hour and number of nets)

#2 YPUE is calculated by dividing the weight (g) of fish with trawling effort (in hour and number of nets)

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

4.1.1 During the reporting period, the Independent Auditor (IA) conducted an inspection for Pit Specific Sediment Chemistry at CMP Vb on 4 January 2021. Sediments were collected at 6 stations and stored in glass bottles and plastic bags for laboratory analysis. The IA was generally 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 April to June 2021 for ESC CMPs include:

- *Water Column Profiling of ESC CMP Vb* in April, May and June 2021;
- *Routine Water Quality Monitoring of ESC CMPs* in April, May and June 2021;
- *Pit Specific Sediment Chemistry of ESC CMP Vb* in April, May and June 2021; and
- *Cumulative Impact Sediment Chemistry of ESC CMPs* in June 2021.

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**	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	6	6	6	6
	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	6	6	6	6
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	6	6	6	6
	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	6	6	6	6
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	6	6	6	6
	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	6	6	6	6

Cumulative Impact Sediment Chemistry *			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				6		6	
	ESC-RNB1	4 times per year				12		12				12		12				12		12				12		12				12		12				12		12				6		6	
Mid-field Stations																																														
	ESC-RMA	4 times per year				12		12				12		12				12		12				12		12				12		12				12		12				6		6	
	ESC-RMB	4 times per year				12		12				12		12				12		12				12		12				12		12				12		12				6		6	
Capped Pit Stations																																														
	ESC-RCA1	4 times per year				12		12				12		12				12		12				12		12				12		12				12		12				6		6	
	ESC-RCB1	4 times per year				12		12				12		12				12		12				12		12				12		12				12		12				6		6	
Far-Field Stations																																														
	ESC-RFA	4 times per year				12		12				12		12				12		12				12		12				12		12				12		12				6		6	
	ESC-RFB	4 times per year				12		12				12		12				12		12				12		12				12		12				12		12				6		6	
Ma Wan Station																																														
	MW1	4 times per year				12		12				12		12				12		12				12		12				12		12				12		12				6		6	

Sediment Toxicity Tests			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	
	ESC-TDB1	2 times per year						5						5						5						5						5						5						5	
Reference Stations																																														
	ESC-TRA	2 times per year						5						5						5						5						5						5						5	
	ESC-TRB	2 times per year						5						5						5						5						5						5						5	
Ma Wan Station																																														
	MW1	2 times per year						5						5						5						5						5						5						5	

Tissue/ Whole Body Sampling			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			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	
	ESC-INB	4 times per year					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	
	TNB	4 times per year					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	
	TSB	4 times per year					5	5					5	5					5	5					5	5					5	5					5	5					5	5	

Capping *			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							
	ESC-IPE2A	4 times per year *																														3				3		3							
	ESC-IPE3	4 times per year *																														3				3		3							
	ESC-IPE4	4 times per year *																														3				3		3							
	ESC-IPE5	4 times per year *																														3				3		3							
Intermediate Station Downcurrent																																														
	ESC-INE1A	4 times per year *																														3				3		3							
	ESC-INE2A	4 times per year *																														3				3		3							
	ESC-INE3A	4 times per year *																														3				3		3							
	ESC-INE4A	4 times per year *																														3				3		3							
	ESC-INE5A	4 times per year *																														3				3		3							
Reference Station Upcurrent																																														
	ESC-RFE1	4 times per year *																														3				3		3							
	ESC-RFE2	4 times per year *																														3				3		3							
	ESC-RFE3	4 times per year *																														3				3		3							
	ESC-RFE4	4 times per year *																														3				3		3							
	ESC-RFE5	4 times per year *																														3				3		3							
Ma Wan Station																																														
	MW1	4 times per year *																														3				3		3							
Flood Tide																																														
Impact Station Downcurrent																																														
	ESC-IPF1	4 times per year *																														3				3		3							
	ESC-IPF2	4 times per year *																														3				3		3							
	ESC-IPF3	4 times per year *																														3				3		3							
Intermediate Station Downcurrent																																														
	ESC-INF1	4 times per year *																														3				3		3							
	ESC-INF2	4 times per year *																														3				3		3							
	ESC-INF3	4 times per year *																														3				3		3							
Reference Station Upcurrent																																														
	ESC-RFF1A	4 times per year *																														3				3		3							
	ESC-RFF2A	4 times per year *																														3				3		3							
	ESC-RFF3	4 times per year *																														3				3		3							
Ma Wan Station																																														
	MW1	4 times per year *																														3				3		3							

Routine Water Quality Monitoring *			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	Monthly *		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	4	4	4	4
	ESC-IPE2A	Monthly *		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	4	4	4	4
	ESC-IPE3	Monthly *		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	4	4	4	4
	ESC-IPE4	Monthly *		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	4	4	4	4
	ESC-IPE5	Monthly *		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	4	4	4	4
Intermediate Station Downcurrent																																														
	ESC-INE1A	Monthly *		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	4	4	4	4
	ESC-INE2A	Monthly *		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	4	4	4	4
	ESC-INE3A	Monthly *		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	4	4	4	4
	ESC-INE4A	Monthly *		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	4	4	4	4
	ESC-INE5A	Monthly *		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	4	4	4	4
Reference Station Upcurrent																																														
	ESC-RFE1	Monthly *		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	4	4	4	4
	ESC-RFE2	Monthly *		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	4	4	4	4
	ESC-RFE3	Monthly *		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	4	4	4	4
	ESC-RFE4	Monthly *		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	4	4	4	4
	ESC-RFE5	Monthly *		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	4	4	4	4
Ma Wan Station																																														
	MW1	Monthly *		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	4	4	4	4
Flood Tide																																														
Impact Station Downcurrent																																														
	ESC-IPF1	Monthly *		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	4	4	4	4
	ESC-IPF2	Monthly *		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	4	4	4	4
	ESC-IPF3	Monthly *		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	4	4	4	4
Intermediate Station Downcurrent																																														
	ESC-INF1	Monthly *		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	4	4	4	4
	ESC-INF2	Monthly *		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	4	4	4	4
	ESC-INF3	Monthly *		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	4	4	4	4
Reference Station Upcurrent																																														
	ESC-RFF1A	Monthly *		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	4	4	4	4
	ESC-RFF2A	Monthly *		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	4	4	4	4
	ESC-RFF3	Monthly *		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	4	4	4	4
Ma Wan Station																																														
	MW1	Monthly *		8	8					8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8		8	8	4	4	4	4

Water Column Profiling *			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	2	2	2	2
	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	2	2	2	2

Benthic Recolonisation Studies			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			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															
	US2	3 times per week	2																										2	2															
Downstream Stations																																														
	DS1	3 times per week	2																										2	2															
	DS2	3 times per week	2																										2	2															
	DS3	3 times per week	2																										2	2															
	DS4	3 times per week	2																										2	2															
	DS5	3 times per week	2																										2	2															
Ma Wan Station																																														
	MW1	3 times per week	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.

* A proposal on the change of number of sample replication of water quality & sediment monitoring and combination of routine water quality monitoring and water quality monitoring during capping operation was submitted to EPD and agreed by EPD on 3 December 2020. The proposed changes will be effective for the EM&A activities since December 2020. Water Quality Monitoring during Capping Operation and Routine Water Quality Monitoring are combined such that Routine Water Quality Monitoring will be conducted monthly starting in December 2020.

Annex B

Disposal & Capping Records

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
1-Jan-2021	2500	329126
2-Jan-2021	3500	332626
3-Jan-2021	2500	335126
4-Jan-2021	3500	338626
5-Jan-2021	3000	341626
6-Jan-2021	4000	345626
7-Jan-2021	3500	349126
8-Jan-2021	4435	353561
9-Jan-2021	1500	355061
10-Jan-2021	0	355061
11-Jan-2021	500	355561
12-Jan-2021	500	356061
13-Jan-2021	2500	358561
14-Jan-2021	3000	361561
15-Jan-2021	2000	363561
16-Jan-2021	2500	366061
17-Jan-2021	1000	367061
18-Jan-2021	1000	368061
19-Jan-2021	1500	369561
20-Jan-2021	3400	372961
21-Jan-2021	4500	377461
22-Jan-2021	4500	381961
23-Jan-2021	1000	382961
24-Jan-2021	500	383461
25-Jan-2021	500	383961
26-Jan-2021	900	384861
27-Jan-2021	1300	386161
28-Jan-2021	900	387061
29-Jan-2021	1500	388561
30-Jan-2021	1000	389561
31-Jan-2021	500	390061
1-Feb-2021	1000	391061
2-Feb-2021	900	391961
3-Feb-2021	2100	394061
4-Feb-2021	1600	395661
5-Feb-2021	1580	397241
6-Feb-2021	1000	398241
7-Feb-2021	0	398241
8-Feb-2021	0	398241
9-Feb-2021	0	398241
10-Feb-2021	360	398601
11-Feb-2021	0	398601
12-Feb-2021	0	398601
13-Feb-2021	0	398601
14-Feb-2021	0	398601
15-Feb-2021	0	398601
16-Feb-2021	1500	400101
17-Feb-2021	3000	403101
18-Feb-2021	3000	406101
19-Feb-2021	500	406601
20-Feb-2021	395	406996
21-Feb-2021	1000	407996
22-Feb-2021	2000	409996
23-Feb-2021	2000	411996
24-Feb-2021	1500	413496
25-Feb-2021	700	414196
26-Feb-2021	1300	415496

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
27-Feb-2021	900	416396
28-Feb-2021	0	416396
1-Mar-2021	0	416396
2-Mar-2021	0	416396
3-Mar-2021	400	416796
4-Mar-2021	3100	419896
5-Mar-2021	1400	421296
6-Mar-2021	1500	422796
7-Mar-2021	0	422796
8-Mar-2021	500	423296
9-Mar-2021	1000	424296
10-Mar-2021	500	424796
11-Mar-2021	1000	425796
12-Mar-2021	500	426296
13-Mar-2021	500	426796
14-Mar-2021	0	426796
15-Mar-2021	500	427296
16-Mar-2021	900	428196
17-Mar-2021	2100	430296
18-Mar-2021	1000	431296
19-Mar-2021	500	431796
20-Mar-2021	0	431796
21-Mar-2021	0	431796
22-Mar-2021	900	432696
23-Mar-2021	2100	434796
24-Mar-2021	1300	436096
25-Mar-2021	500	436596
26-Mar-2021	500	437096
27-Mar-2021	0	437096
28-Mar-2021	0	437096
29-Mar-2021	500	437596
30-Mar-2021	500	438096
31-Mar-2021	0	438096

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
1-Jan-2021	0	165300
2-Jan-2021	0	165300
3-Jan-2021	0	165300
4-Jan-2021	0	165300
5-Jan-2021	0	165300
6-Jan-2021	0	165300
7-Jan-2021	0	165300
8-Jan-2021	0	165300
9-Jan-2021	0	165300
10-Jan-2021	0	165300
11-Jan-2021	0	165300
12-Jan-2021	0	165300
13-Jan-2021	0	165300
14-Jan-2021	0	165300
15-Jan-2021	0	165300
16-Jan-2021	0	165300
17-Jan-2021	0	165300
18-Jan-2021	0	165300
19-Jan-2021	0	165300
20-Jan-2021	0	165300
21-Jan-2021	0	165300
22-Jan-2021	0	165300
23-Jan-2021	0	165300
24-Jan-2021	0	165300
25-Jan-2021	0	165300
26-Jan-2021	0	165300
27-Jan-2021	0	165300
28-Jan-2021	0	165300
29-Jan-2021	0	165300
30-Jan-2021	0	165300
31-Jan-2021	0	165300
1-Feb-2021	0	165300
2-Feb-2021	0	165300
3-Feb-2021	0	165300
4-Feb-2021	0	165300
5-Feb-2021	0	165300
6-Feb-2021	0	165300
7-Feb-2021	0	165300
8-Feb-2021	0	165300
9-Feb-2021	0	165300
10-Feb-2021	0	165300
11-Feb-2021	0	165300
12-Feb-2021	0	165300
13-Feb-2021	0	165300
14-Feb-2021	0	165300
15-Feb-2021	0	165300
16-Feb-2021	0	165300
17-Feb-2021	0	165300
18-Feb-2021	0	165300
19-Feb-2021	0	165300
20-Feb-2021	0	165300
21-Feb-2021	0	165300
22-Feb-2021	0	165300
23-Feb-2021	0	165300
24-Feb-2021	0	165300
25-Feb-2021	0	165300
26-Feb-2021	0	165300

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
27-Feb-2021	0	165300
28-Feb-2021	0	165300
1-Mar-2021	0	165300
2-Mar-2021	0	165300
3-Mar-2021	0	165300
4-Mar-2021	0	165300
5-Mar-2021	0	165300
6-Mar-2021	0	165300
7-Mar-2021	0	165300
8-Mar-2021	0	165300
9-Mar-2021	0	165300
10-Mar-2021	0	165300
11-Mar-2021	0	165300
12-Mar-2021	0	165300
13-Mar-2021	0	165300
14-Mar-2021	0	165300
15-Mar-2021	0	165300
16-Mar-2021	0	165300
17-Mar-2021	0	165300
18-Mar-2021	0	165300
19-Mar-2021	0	165300
20-Mar-2021	0	165300
21-Mar-2021	0	165300
22-Mar-2021	0	165300
23-Mar-2021	0	165300
24-Mar-2021	0	165300
25-Mar-2021	0	165300
26-Mar-2021	0	165300
27-Mar-2021	0	165300
28-Mar-2021	0	165300
29-Mar-2021	0	165300
30-Mar-2021	0	165300
31-Mar-2021	0	165300

Annex C

Statistical Analysis

Routine Water Quality Monitoring for ESC CMPs – Analysis of Variance and Linear Regression Analysis up to March 2021

Dissolved Oxygen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	18146487.89	3	6048829.3	69.221	**
Period	6194553146	54	114713947	1312.745	**
Area * Period	264540243.8	162	1632964.47	18.687	**
Error	400484465.1	4583	87384.784		
Total	36944598284	4803			

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

SNK Results:

- Feb 17 ≥ Feb 13 = **Feb 21** ≥ Apr 16 ≥ Jan 17 > Feb 18 = Jan 13 = **Jan 21** > Jan 18 ≥ Feb 12 = Feb 19 ≥ Nov 18 ≥ Feb 20 > Jan 19 > Apr 13 > Apr 17 > Jan 20 = Dec 20 > Nov 20 ≥ Apr 18 ≥ Nov 16 ≥ Apr 19 > Apr 20 > **Mar 21** = Nov 17 = Nov 19 > Apr 12 ≥ May 13 ≥ May 20 ≥ Nov 12 ≥ May 18 = May 19 = May 16 > Oct 16 = Oct 12 = Jul 12 > Jul 20 ≥ Aug 20 ≥ May 12 = May 17 = Oct 20 ≥ 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 13 = Jul 19
- Impact = Intermediate > Reference > Ma Wan Station

Turbidity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	252131110.1	3	84043703.4	205.046	**
Period	4228171937	54	78299480.3	191.031	**
Area * Period	801405379.9	162	4946946.79	12.069	**
Error	1878472237	4583	409878.297		
Total	36944380342	4803			

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

SNK Results:

- Apr 20 = Nov 17 > May 20 > Oct 17 = Dec 20 = Aug 13 ≥ Jan 19 ≥ Apr 17 = Apr 12 = Aug 12 = Aug 18 = May 19 = Nov 18 = Nov 16 ≥ Oct 16 = **Mar 21** ≥ 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 20 = Aug 20 ≥ **Jan 21** = Oct 12 ≥ Apr 19 = Jul 12 ≥ Aug 17 = Jan 18 ≥ Jul 20 ≥ Aug 16 ≥ Feb 13 ≥ Feb 18 = May 12 ≥ Jan 13 = Nov 20 = Jan 20 ≥ Feb 19 = Apr 18 ≥ Jul 13 ≥ Nov 19 = Feb 20 = May 17 = May 13 = **Feb 21** > Feb 17
- Impact = Reference > Intermediate > Ma Wan Station

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	7496598527	53	141445255.2	602.933	**
Area	33983934.23	3	11327978.08	48.287	**
Station(Area)	99770885.52	24	4157120.23	17.72	**
Period * Area	1143550849	156	7330454.163	31.247	**
Period * Station(Area)	1599133723	456	3506872.199	14.949	**
Error	1111512351	4738	234595.262		
Total	53575021748	5438			

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

SNK Results:

- Aug 13 > Aug 20 = May 18 > Feb 12 = Jul 20 > Nov 18 = Jul 18 ≥ Aug 19 ≥ May 20 ≥ Nov 19 ≥ Jul 13 ≥ **Jan 21** ≥ Apr 12 ≥ Feb 20 ≥ Oct 20 = Oct 19 ≥ Nov 20 ≥ Feb 19 ≥ Oct 18 = Aug 18 = Jan 13 ≥ **Feb 21** ≥ Jan 19 = Jan 20 ≥ Apr 13 = May 16 ≥ Apr 18 = May 19 = Nov 12 ≥ Apr 17 > May 12 > Apr 16 = Oct 12 > Jan 18 = May 13 = Jul 16 = May 17 ≥ Apr 19 ≥ Apr 20 = Aug 16 > Dec 20 > Aug 12 = Jul 19 = Jul 12 = **Mar 21** = Nov 17 ≥ Feb 13 ≥ Feb 18 ≥ Aug 17 = Oct 17 > Jul 17 = Oct 16 = Jan 17 = Feb 17 = Nov 16
- Reference > Ma Wan Station > Impact > Intermediate

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	7202783173	53	135901569	378.73	**
Area	57477095.86	3	19159032	53.392	**
Station(Area)	146152936.9	24	6089705.71	16.971	**
Period * Area	1305671587	156	8369689.66	23.325	**
Period * Station(Area)	931079740.5	456	2041841.54	5.69	**
Error	1700159584	4738	358834.864		
Total	53410536112	5438			

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 20 = May 18 = Apr 17 = Jan 20 = Nov 18 = Jul 18 = Feb 18 > Oct 18 ≥ Aug 18 = Jan 18 = May 19 = Oct 19 ≥ Feb 13 = Apr 19 ≥ Aug 20 ≥ Oct 17 = Aug 19 ≥ **Feb 21** ≥ May 17 ≥ Oct 16 ≥ Jul 16 = **Jan 21** ≥ Nov 17 = Nov 20 ≥ Feb 20 = Nov 19 ≥ Dec 20 > **Mar 21** = Jul 19 = Jan 17 > Apr 16 ≥ Nov 16 = Jan 19 = Feb 19 = Jul 20 ≥ Oct 20 = May 16
- Reference > Impact > Intermediate > Ma Wan Station

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	8051554132	53	151916115.7	417.774	**
Area	125147948.4	3	41715982.79	114.72	**
Station(Area)	120543184.3	24	5022632.678	13.812	**
Period * Area	838592157.6	156	5375590.754	14.783	**
Period * Station(Area)	1260292277	456	2763798.854	7.601	**
Error	1720345352	4731	363632.499		
Total	53410332347	5431			

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

SNK Results:

- **Jan 21** > **Feb 21** ≥ Nov 17 ≥ Jul 17 = Dec 20 = Oct 17 ≥ Nov 20 = Feb 17 = **Mar 21** = Oct 20 = Apr 17 = Aug 17 = Feb 18 ≥ Jan 18 = May 17 = Nov 18 = Jul 18 ≥ Aug 20 = Apr 18 > Aug 19 > Nov 19 ≥ May 18 ≥ May 20 > Apr 12 ≥ Feb 12 = Aug 13 ≥ Oct 19 ≥ Oct 18 = Aug 18 ≥ Jul 20 ≥ Apr 20 = Jul 12 ≥ Nov 12 ≥ Apr 19 ≥ Jul 13 = Feb 20 = Jan 20 = Feb 19 ≥ 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	8837918559	53	166753180	512.687	**
Area	12242444.08	3	4080814.69	12.547	**
Station(Area)	53801017.38	24	2241709.06	6.892	**
Period * Area	574637626.1	156	3683574.53	11.325	**
Period * Station(Area)	520279595.5	456	1140964.03	3.508	**
Error	1541701903	4740	325253.566		
Total	53652972910	5440			

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

SNK Results:

- Apr 12 > Apr 13 = Jan 20 = Apr 16 > **Mar 21** = May 13 = May 20 = Feb 19 = Jan 18 = Apr 17 > Apr 20 ≥ May 19 = Oct 20 = **Feb 21** = Feb 17 = Dec 20 ≥ May 17 = Feb 12 ≥ Apr 19 ≥ Apr 18 > Feb 18 = Aug 20 = Nov 20 = May 16 ≥ Jan 13 ≥ Jan 17 ≥ Nov 17 = Jul 16 > Jul 20 = Jul 18 = May 18 > **Jan 21** = 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	8444054279	53	159321778.9	906.485	**
Area	139825137.6	3	46608379.21	265.185	**
Station(Area)	170177955.3	24	7090748.139	40.344	**
Period * Area	707313931.2	156	4534063.661	25.797	**
Period * Station(Area)	689819750.4	456	1512762.61	8.607	**
Error	833091750.2	4740	175757.753		
Total	53675603554	5440			

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

SNK Results:

- Apr 12 = May 18 > Aug 13 > Apr 17 > Jul 16 = Aug 19 = May 13 > Jul 12 ≥ Nov 18 ≥ Aug 17 ≥ Jul 17 > May 12 = Aug 16 > Jul 20 > May 17 =Jul 19 = 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 = Aug 20 > Nov 16 = **Feb 21** > Oct 18 = Jan 17 ≥ Oct 16 = Oct 19 ≥ **Jan 21** ≥ Nov 20 = Nov 12 = **Mar 21** = Oct 20 > Feb 18 > Jan 19 = Nov 19 > Nov 17 ≥ Jan 13 ≥ Dec 20 > Feb 13 = Feb 20
- Reference = Impact > Intermediate > Ma Wan Station

BOD_5

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	5732597680	53	108162220	236.403	**
Area	156928391.6	3	52309463.9	114.329	**
Station(Area)	86378777.27	24	3599115.72	7.866	**
Period * Area	2002137308	156	12834213.5	28.051	**
Period * Station(Area)	1712651217	456	3755814.07	8.209	**
Error	2168252387	4739	457533.738		
Total	53609970874	5439			

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

SNK Results:

- Aug 16 > Jul 20 = **Jan 21** =Aug 19 = Nov 16 = Apr 16 > Jan 17 ≥ Apr 19 = May 12 ≥ Oct 19 ≥ Jan 20 ≥ Aug 18 = Jan 13 = May 20 ≥ May 18 = **Feb 21** ≥ 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 = Aug 20 ≥ Nov 12 ≥ Jan 19 = Apr 12 = Jul 12 ≥ Feb 13 = Oct 12 = Oct 20 > Feb 17 ≥ Nov 20 = May 13 ≥ Aug 17 = Jul 16 > Aug 12 ≥ Jan 18 ≥ Dec 20 ≥ Aug 13 ≥ Apr 20 > Jul 13 = **Mar 21**
- Reference > Ma Wan Station > Impact > Intermediate

Suspended Solids

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	7126863351	53	134469120	1180.123	**
Area	53436252.93	3	17812084.3	156.322	**
Station(Area)	319010037.2	24	13292084.9	116.653	**
Period * Area	1323106647	156	8481452.87	74.435	**
Period * Station(Area)	2593739541	456	5688025.31	49.919	**
Error	540099455	4740	113945.033		
Total	53675230647	5440			

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

SNK Results:

- Apr 20 = Nov 17 > Dec 20 = May 20 > Jul 12 > Nov 12 = Jan 19 > Nov 16 = **Mar 21** = Jul 16 = Oct 16 = Aug 12 > Apr 12 ≥ Apr 17 = Oct 17 = May 16 ≥ Oct 12 = May 19 > Aug 13 ≥ Nov 20 ≥ **Jan 21** > Aug 20 ≥ Jan 17 = Nov 18 ≥ Jul 18 = Aug 18 = Apr 16 ≥ Jul 17 ≥ Oct 18 ≥ Apr 13 > Oct 20 > Aug 19 = Feb 12 > Jan 18 > Oct 19 = Aug 16 > Jul 20 > May 18 ≥ Feb 13 ≥ Jan 20 > Apr 19 = Feb 18 = Feb 20 = Apr 18 = Jan 13 > **Feb 21** = Aug 17 > Nov 19 = Feb 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	-199.085	0.120	0.015	**

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

Pit Specific Sediment Chemistry for ESC CMP Vb – Analysis of Variance up to March 2021

Arsenic

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	1981198.309	13	152399.87	9.912	**
Area	4264529.003	2	2132264.501	138.687	**
Station(Area)	14119313.94	3	4706437.98	306.117	**
Period * Area	9451581.314	26	363522.358	23.644	**
Period * Station(Area)	8123281.172	39	208289.261	13.548	**
Error	11992214.27	780	15374.634		
Total	215355543.5	864			

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

SNK Results:

- **Jan 21** ≥ **Feb 21** ≥ Mar 20 ≥ Dec 20 ≥ Jul 20 ≥ Feb 20 = Nov 20 ≥ Oct 20 ≥ Sep 20 = Apr 20 ≥ May 20 = Aug 20 ≥ Jun 20 ≥ **Mar 21**
- Pit Edge > Active Pit > Near Pit

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	9048358.983	13	696027.614	43.573	**
Area	15971371.09	2	7985685.55	499.921	**
Station(Area)	4190094.005	3	1396698	87.436	**
Period * Area	5264986.616	26	202499.485	12.677	**
Period * Station(Area)	4554132.717	39	116772.634	7.31	**
Error	12459629.06	780	15973.883		
Total	215066697	864			

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

SNK Results:

- Mar 20 > Apr 20 = Oct 20 = Feb 20 = Sep 20 = Jun 20 = **Mar 21** = Nov 20 > Aug 20 = Dec 20 = May 20 = **Feb 21** = Jul 20 > **Jan 21**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis					
Source	Df	Slope	r	r^2	P
Area	1	-171.414	0.563	0.317	**
Note: Linear regression analysis on spatial changes of contaminant concentrations.					

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	5072423.455	13	390186.42	30.684	**
Area	9804843.939	2	4902421.97	385.528	**
Station(Area)	16882631.33	3	5627543.78	442.552	**
Period * Area	4373869.231	26	168225.74	13.229	**
Period * Station(Area)	3265458.286	39	83729.7	6.585	**
Error	9918574.938	780	12716.122		
Total	215364120	864			

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

SNK Results:

- Feb 20 = Mar 20 = **Feb 21** = Oct 20 = Nov 20 > Dec 20 = Sep 20 = May 20 = Aug 20 ≥ Jun 20 = Apr 20 = Jul 20 ≥ **Jan 21** > **Mar 21**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis					
Source	Df	Slope	r	r^2	P
Area	1	-135.405	0.443	0.196	**
Note: Linear regression analysis on spatial changes of contaminant concentrations.					

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	3988634.337	13	306818.026	48.371	**
Area	18876800.02	2	9438400.008	1488.004	**
Station(Area)	12928286	3	4309428.665	679.4	**
Period * Area	4037343.87	26	155282.457	24.481	**
Period * Station(Area)	4614523.016	39	118321.103	18.654	**
Error	4947533.896	780	6342.992		
Total	215364155	864			

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

SNK Results:

- Feb 20 ≥ Mar 20 ≥ **Feb 21** > Sep 20 = Oct 20 ≥ Nov 20 = Aug 20 ≥ Jun20 ≥ Jul 20 ≥ Apr 20 = Dec 20 > May 20 > **Mar 21** = **Jan 21**
- Active Pit > Near Pit > Pit Edge

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	3817430.059	13	293648.466	21.953	**
Area	14298523.58	2	7149261.79	534.479	**
Station(Area)	10409864.33	3	3469954.78	259.414	**
Period * Area	6960410.731	26	267708.105	20.014	**
Period * Station(Area)	3013768.783	39	77276.123	5.777	**
Error	10433385.15	780	13376.135		
Total	215364153	864			

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

SNK Results:

- Feb 20 > **Feb 21**= Mar 20 ≥ Sep 20 ≥ Jun 20 ≥ Oct 20 ≥ Nov 20 = Apr 20 ≥ Jul 20 ≥ Dec 20 ≥ Aug 20 ≥ May 20 ≥ **Jan 21** > **Mar 21**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis					
Source	Df	Slope	r	r^2	P
Area	1	-166.713	0.546	0.298	**
Note: Linear regression analysis on spatial changes of contaminant concentrations.					

Mercury

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	10739432.21	13	826110.17	53.597	**
Area	7186749.294	2	3593374.65	233.136	**
Station(Area)	10998002.08	3	3666000.69	237.848	**
Period * Area	4245175.457	26	163275.979	10.593	**
Period * Station(Area)	4132211.575	39	105954.143	6.874	**
Error	12022315.94	780	15413.226		
Total	214942019.5	864			

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

SNK Results:

- Feb 20 ≥ Aug 20 = Jul 20 ≥ Sep 20 ≥ Mar 20 = Apr 20 ≥ May 20 = Oct 20 ≥ Jun 20 = Dec 20 > Nov 20 > **Mar 21** > **Feb 21** > **Jan 21**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis					
Source	Df	Slope	r	r^2	P
Area	1	-121.596	0.400	0.160	**
Note: Linear regression analysis on spatial changes of contaminant concentrations.					

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	6647630.063	13	511356.159	57.107	**
Area	7977406.755	2	3988703.377	445.452	**
Station(Area)	18918580.69	3	6306193.564	704.266	**
Period * Area	5092379.644	26	195860.756	21.873	**
Period * Station(Area)	3609449.293	39	92549.982	10.336	**
Error	6984341.125	780	8954.283		
Total	215364065.5	864			

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

SNK Results:

- Feb 20 > Oct 20 = **Feb 21** = Mar 20 = Nov 20 > Sep 20 = Aug 20 = Jun 20 = Dec 20 = Jul 20 = May 20 > Apr 20 = **Jan 21** > **Mar 21**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-123.621	0.405	0.164	**

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

Silver

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	4428156.427	13	340627.417	29.881	**
Area	19821354.66	2	9910677.33	869.397	**
Station(Area)	6005139.034	3	2001713.01	175.597	**
Period * Area	4899345.639	26	188436.371	16.53	**
Period * Station(Area)	6047180.083	39	155055.9	13.602	**
Error	8891598.688	780	11399.485		
Total	215277825	864			

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

SNK Results:

- Sep 20 = Mar 20 = Oct 20 = Nov 20 = Aug 20 ≥ Jul 20 ≥ Feb 20 = May 20 = Apr 20 = **Feb 21** ≥ Jun 20 ≥ **Mar 21** ≥ Dec 20 > **Jan 21**
- Active Pit > Near Pit > Pit Edge

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	6508248.861	13	500634.528	44.537	**
Area	16667667.54	2	8333833.77	741.387	**
Station(Area)	7361201.406	3	2453733.8	218.287	**
Period * Area	7001498.194	26	269288.392	23.956	**
Period * Station(Area)	3506357.337	39	89906.598	7.998	**
Error	8767875.292	780	11240.866		
Total	215363746	864			

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

SNK Results:

- **Feb 2**1 = Feb 20 > Mar 20 ≥ Oct 20 ≥ Nov 20 ≥ Sep 20 ≥ Jun 20 ≥ Dec 20 = Jul 20 = Aug 20 ≥ Apr 20 = May 20 > **Jan 21** = **Mar 21**
- Active Pit > Near Pit > Pit Edge

Total Organic Carbon

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	20051423.65	13	1542417.2	194.095	**
Area	12071268.02	2	6035634.01	759.512	**
Station(Area)	4855411.03	3	1618470.34	203.665	**
Period * Area	2991254.042	26	115048.232	14.477	**
Period * Station(Area)	4686090.976	39	120156.179	15.12	**
Error	6198444.563	780	7946.724		
Total	215348299.5	864			

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

SNK Results:

- Oct 20 = Nov 20 = Mar 20 > Sep 20 > Dec 20 ≥ Feb 20 ≥ May 20 = Jul 20 ≥ **Feb 21** = Aug 20 > Apr 20 > Jun 20 = **Mar 21** > **Jan 21**
- Active Pit > Near Pit > Pit Edge

Cumulative Impact Sediment Chemistry for ESC CMPs – Analysis of Variance up to February 2021

Arsenic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	175850726.7	19	9255301.41	394.423	**
Area	108109284	4	27027321	1151.795	**
Area * Station	14007794.78	4	3501948.7	149.239	**
Period * Area	328399574.7	75	4378661	186.601	**
Period * Area * Station	31645330.9	76	416385.933	17.745	**
Error	43927230.63	1872	23465.401		
Total	2882173642	2052			

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

SNK Results:

- Dec 19 ≥ Dec 20 = Jun 19 = Aug 19 = **Feb 21** ≥ Jun 20 > Jun 18 = Aug 20 = 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 > Near-Field > Far-Field > Capped-Pit

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	119275586.7	19	6277662.46	59.156	**
Area	60834867.19	4	15208716.8	143.314	**
Area * Station	82291195.41	4	20572798.9	193.861	**
Period * Area	147174702.1	75	1962329.36	18.491	**
Period * Area * Station	88279138.72	76	1161567.62	10.946	**
Error	198340726.2	1869	106121.309		
Total	2862914056	2049			

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 ≥ Aug 20 ≥ Jun 20 = Feb 17 = Jun 19 > Dec 16 = **Feb 21** > Dec 20
- Mid-Field > Ma Wan > Far-Field = Capped-Pit = Near-Field

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	28336545.22	19	1491397.12	49.972	**
Area	299077271.9	4	74769318	2505.287	**
Area * Station	38893984.08	4	9723496.02	325.804	**
Period * Area	215750043.6	75	2876667.25	96.388	**
Period * Area * Station	61877609.07	76	814179.067	27.281	**
Error	55869110.75	1872	29844.61		
Total	2882226757	2052			

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 = **Feb 21** ≥ Dec 17 ≥ Jun 18 ≥ Jun 17 ≥ Jun 19 ≥ Dec 20 = Aug 20 = Feb 19 = Feb 18 ≥ Dec 16 ≥ Jun 20 > Dec 18 = Feb 17 > Aug 18
- Ma Wan > Mid-Field > Near-Field > Capped-Pit > Far-Field

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	27937365.45	19	1470387.66	45.314	**
Area	231851199.3	4	57962799.8	1786.268	**
Area * Station	172721104	4	43180276	1330.708	**
Period * Area	166287507.8	75	2217166.77	68.328	**
Period * Area * Station	35022295.26	76	460819.675	14.201	**
Error	60744732.19	1872	32449.109		
Total	2882226864	2052			

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 ≥ **Feb 21** ≥ Dec 18 ≥ Dec 20 ≥ Aug 20 ≥ 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	147370152	19	7756323.792	208.942	**
Area	196387323	4	49096830.75	1322.582	**
Area * Station	36115502.4	4	9028875.601	243.222	**
Period * Area	204771459.3	75	2730286.124	73.549	**
Period * Area * Station	53841908.1	76	708446.159	19.084	**
Error	69492301.1	1872	37121.956		
Total	2882226728	2052			

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 ≥ **Feb 21** ≥ Jun 19 = Feb 20 = Jun 16 = Jun 20 ≥ Dec 20 = Feb 18 ≥ Aug 20 = 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	263888633.5	19	13888875.45	127.006	**
Area	39309887.04	4	9827471.761	89.867	**
Area * Station	24781933.92	4	6195483.48	56.654	**
Period * Area	109055468.9	75	1454072.919	13.297	**
Period * Area * Station	38834339.28	76	510978.148	4.673	**
Error	204167974.3	1867	109356.173		
Total	2852334593	2047			

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

SNK Results:

- Jun 16 > Aug 16 > Feb 20 ≥ Aug 20 ≥ Dec 18 = Aug 18 ≥ Dec 19 = Dec 16 > **Feb 21** ≥ Feb 19 ≥ Feb 17 = Jun 20 ≥ Aug 17 = Jun 19 = Jun 17 ≥ Dec 17 ≥ Jun 18 = Aug 19 ≥ Dec 20 > Feb 18
- Ma Wan > Capped-Pit ≥ Mid-Field = Far-Field ≥ Near-Field

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	29229971.2	19	1538419.537	51.597	**
Area	261034829.6	4	65258707.4	2188.715	**
Area * Station	48963054.6	4	12240763.65	410.544	**
Period * Area	239717521.3	75	3196233.618	107.199	**
Period * Area * Station	68844240.03	76	905845.264	30.381	**
Error	55815534.77	1872	29815.991		
Total	2882226322	2052			

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 ≥ **Feb 21** = Aug 19 ≥ Dec 16 ≥ Jun 18 ≥ Dec 20 ≥ Jun 19 = Aug 20 = Jun 17 = Feb 18 ≥ Jun 20 = Feb 19 ≥ Aug 16 > Feb 17
- Ma Wan > Mid-Field > Near-Field > Far-Field = Capped-Pit

Silver

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	99805618.87	19	5252927.31	117.741	**
Area	226630907.9	4	56657727	1269.948	**
Area * Station	163844731.3	4	40961182.8	918.12	**
Period * Area	64796403.09	75	863952.041	19.365	**
Period * Area * Station	60693069.27	76	798593.017	17.9	**
Error	83517799.54	1872	44614.209		
Total	2881327790	2052			

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 = Aug 20 > Jun 16 = **Feb 21** = Dec 20 > 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	40357448.64	19	2124076.24	77.614	**
Area	232862325.6	4	58215581.4	2127.217	**
Area * Station	109540083.2	4	27385020.8	1000.658	**
Period * Area	221432554.9	75	2952434.07	107.883	**
Period * Area * Station	40184455.09	76	528742.83	19.32	**
Error	51231060.46	1872	27367.019		
Total	2882224114	2052			

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 ≥ **Feb 21** ≥ Jun 17 ≥ Feb 19 ≥ Feb 18 = Dec 20 = Dec 16 ≥ Aug 20 ≥ Jun 20 = Feb 17 > Dec 18 > Aug 18
- Ma Wan > Mid-Field > Near-Field > Capped-Pit > Far-Field

TOC

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	118894359	19	6257597.85	125.695	**
Area	152930310.1	4	38232577.5	767.971	**
Area * Station	18709880.93	4	4677470.23	93.956	**
Period * Area	217454192.3	75	2899389.23	58.24	**
Period * Area * Station	91979503.31	76	1210256.62	24.31	**
Error	93195433.48	1872	49783.885		
Total	2882005603	2052			

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

SNK Results:

- Jun 16 > Dec 19 = Feb 20 > Dec 16 = Dec 20 = Aug 19 = Aug 16 > Dec 17 = **Feb 21** ≥ Feb 19 ≥ Jun 18 = Jun 17 = Jun 19 ≥ Feb 18 ≥ Dec 18 > Aug 17 ≥ Aug 18 ≥ Jun 20 = Feb 17 > Aug 20
- Ma Wan > Mid-Field > Far-Field > Capped-Pit > Near-Field

TBT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	167447860.4	19	8813045.29	89.355	**
Area	129919650.5	4	32479912.6	329.314	**
Area * Station	11466223.86	4	2866555.97	29.064	**
Period * Area	69828659.76	75	931048.797	9.44	**
Period * Area * Station	38142833.93	76	501879.394	5.089	**
Error	184633703.2	1872	98629.115		
Total	2784268032	2052			

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

SNK Results:

- **Feb 21** = Feb 17 = Dec 16 = Aug 17 = Jun 17 = Aug 18 > Jun 16 ≥ Dec 20 ≥ Feb 18 = Dec 18 ≥ Aug 20 = 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

Sediment Toxicity for ESC CMP Vb – February 2021

Survival rate for burrowing amphipod Leptochirus plumulosus

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Between Groups	44916.74	4	11229.19	12.199	**
Within Groups	110456.76	120	920.473		
Total	155373.5	124			

Note:
1. NS: No significant difference;
2. **: Significant difference

SNK Results:

- ESC-TRB = MW1 = ESC-TRA > ESC-TDA = ESC-TDB1

Growth rate for benthic polychaete Neanthes arenaceodentata

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.178	4	0.044	8.41	**
Within Groups	0.635	120	0.005		
Total	0.813	124			

Note:
1. NS: No significant difference;
2. **: Significant difference

SNK Results:

- MW1 = ESC-TRB = ESC-TDA = ESC-TDB1 > ESC-TRA

Survival rate for marine bivalve Crassostrea gigas

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Between Groups	303.712	4	75.928	3.784	**
Within Groups	2407.766	120	20.065		
Total	2711.479	124			

Note:
1. NS: No significant difference;
2. **: Significant difference

SNK Results:

- ESC-TRA= MW1 = ESC-TRB = ESC-TDA > ESC-TDB1

Mortality rate for barnacles Balanus Amphitrite

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4766.02	4	1191.505	1.088	NS
Within Groups	131390.48	120	1094.921		
Total	136156.5	124			

Note:
1. NS: No significant difference;
2. **: Significant difference

Mortality rate for shrimp Penaeus vannaamei

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Between Groups	30410.46	4	7602.615	8.671	**
Within Groups	105219.54	120	876.83		
Total	135630	124			

Note:
1. NS: No significant difference;
2. **: Significant difference

SNK Results:

- MW1 = ESC-TDA ≥ ESC-TDB1 ≥ ESC-TRB > ESC-TRA