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 and the South of The Brothers – April to June 2018

Revision 0

October 2018

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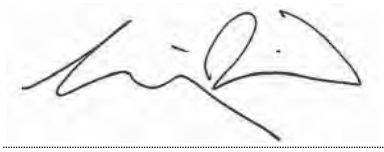
Client:	Project No:
Civil Engineering and Development Department (CEDD)	0400720
Summary: This document presents the Quarterly EM&A Report for *Environmental Monitoring and Audit for Disposal Facility to the East of Sha Chau and the South of The Brothers*.	Date: 29 October 2018 Approved by:  Craig A. Reid *Partner*

Revision	Description	By	Checked	Approved	Date
v0	Quarterly EM&A Report for ESC CMPs and SB CMPs	TT	RC	CAR	29/10/18

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Dredging, Management and Capping of Contaminated Sediment Disposal Facility at Sha Chau and to the South of The Brothers

Environmental Certification Sheet
EP-312/2008/A & EP-427/2011/A

Reference Document/Plan

Document/~~Plan~~ to be ~~Certified~~/ Verified:	Quarterly EM&A Report for Contaminated Mud Pits to the East of Sha Chau and the South of The Brothers – April to June 2018
Date of Report:	29 October 2018
Date prepared by ET:	29 October 2018
Date received by IA:	29 October 2018

Reference EP Condition

Environmental Permit Condition:

Condition 3.1 of EP-312/2008/A and Condition 4.1 of EP-427/2011/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 and EP-427/2011/A

Craig A. Reid,
Environmental Team Leader:  Date: 29/10/2018

IA Verification

I hereby verify that the above referenced document/~~plan~~ complies with the above referenced condition of EP-312/2008/A and EP-427/2011/A

Dr Wang Wen Xiong,
Independent Auditor:  Date: 29/10/2018

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 2018

EXECUTIVE SUMMARY

Water Column Profiling, Routine Water Quality Monitoring, Pit Specific Sediment Chemistry and Cumulative Impact Sediment Chemistry were carried out for Contaminated Mud Pits (CMPs) at East of Sha Chau (ESC) during the quarterly period of April to June 2018. This report presents the results of these monitoring activities to identify whether the dredging and disposal 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 Vd – April to June 2018

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

Routine Water Quality Monitoring of ESC CMPs – April and May 2018

Results of Routine Water Quality Monitoring conducted in April and May 2018 showed that levels of DO, Salinity and pH generally complied with the WQOs at the Impact, Intermediate and Reference stations. 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 CMP Vd have not caused any unacceptable deterioration in water quality during the reporting period.

Sediment Quality Monitoring for ESC CMPs

Pit Specific Sediment Chemistry of ESC CMP Vd – April to June 2018

Monitoring results showed that the concentrations of inorganic contaminants were generally below the Lower Chemical Exceedance Levels (LCELs) at all 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 deterioration in sediment quality of ESC CMP Vd during the reporting period.

Cumulative Impact Sediment Chemistry of ESC CMPs – June 2018

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 Vd have not caused any unacceptable deterioration 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（二零一八年四月至六月）

行政摘要

在2018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、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的挖掘及卸置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－2018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大致符合海水水質指標。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 Vd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 － 2018年4月和5月

2018年4月和5月的例行水質監察結果顯示受影響監測站、中距離監測站及參考監測站的溶解氧含量、鹽度及酸鹼值均大致符合海水水質指標。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－2018年4月至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。

沉積物化學累積性影響監察－2018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).

1.2 ACTIVITIES CONDUCTED DURING THE REPORTING PERIOD

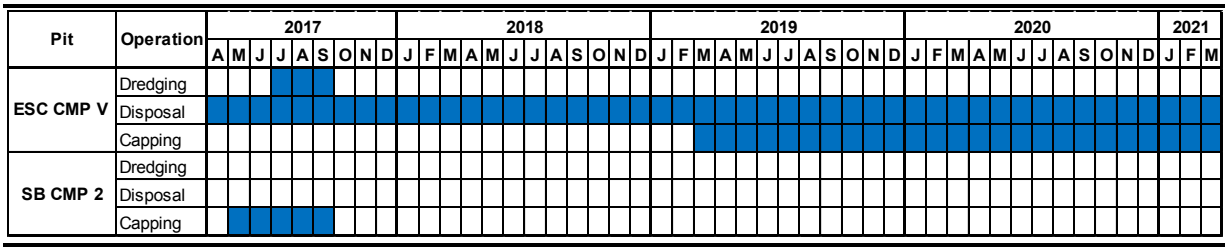
1.2.1 Detailed works schedule for ESC CMP V and SB CMPs is shown in *Figure 1.1*. During the reporting period of April to June 2018, the following works were being undertaken at the CMPs:

- Disposal of contaminated mud at ESC CMP Vd

(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.

Figure 1.1 Works Schedule for ESC CMPs



1.2.2 The records for contaminated mud disposal at ESC CMP Vd during the reporting period are presented in *Annex B* respectively.

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 2018* is to provide information regarding the findings in the quarterly reporting period of April to June 2018 on the environmental impacts resulting from backfilling 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 disposal, 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 CMPs of ESC and SB. 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 Manuals* (1) (2) as well as in *Contract Nos. CV/2013/11 (Sediment Disposal Facilities to the South of The Brothers, East of Sha Chau and East of Tung Lung Chau – Sampling) & CV/2017/04 (Sediment Disposal Facilities to the East of Sha Chau and East of Tung Lung Chau – Sampling (2018-2022))* and *Contract Nos. CV/2013/12 (Sediment Disposal Facilities to South of The Brothers, East of Sha Chau and East of Tung Lung Chau – Testing) & 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 Nos. CV/2013/11 & CV/2017/04* and laboratory analyses under *Contract Nos. CV/2013/12 & 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).

(2) ERM (2015). Final Second Review of the EM&A Manual for SB CMPs. Prepared for CEDD for EM&A for Contaminated Mud Pit to the South of The Brothers and at East Sha Chau (2012-2017) – Investigation. Agreement No. CE 23/2012 (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 2018

Key Task	Date of Sampling & *in-situ* Measurement	Date of Results Received from the Contractors
ESC CMPs		
Water Column Profiling of ESC CMP Vd	10 April 2018 26 May 2018 29 June 2018	3 May 2018 11 June 2018 6 July 2018
Routine Water Quality Monitoring of ESC CMPs	11 April 2018 23 May 2018	3 May 2018 11 June 2018
Pit Specific Sediment Chemistry of ESC CMP Vd	9 April 2018 29 May 2018 27 June 2018	3 May 2018 25 June 2018 9 August 2018
Cumulative Impact Sediment Chemistry of ESC CMPs	27 and 28 June 2018	9 August 2018

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 Vd* 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 Vd

3.2.2 *Water Column Profiling* for ESC CMP Vd was conducted once every month from April to June 2018 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, except for slightly lower salinity recorded at the Downstream station in June 2018. Levels of DO, Turbidity and Suspended Solids (SS) also complied with the Action and Limit Levels at all stations.

3.2.3 Overall, the results indicated that the mud disposal operation at ESC CMP Vd 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 2018 as presented in *Table 3.1*. A total of sixteen (16) and ten (10) stations were sampled in April and May 2018 respectively, and locations of the monitoring stations are presented in *Figures 3.1* and *3.2*. The disposal volume during the reporting period is detailed in *Annex B*. The monitoring results showed that levels of DO, Salinity and pH generally complied with the WQOs at the Impact, Intermediate and Reference stations, except for slightly higher Salinity recorded at Ma Wan station in April and May 2018. Ma Wan station is located further away from other monitoring stations located closer to the ESC CMP Vd where levels of Salinity complied with WQO requirements. It is thus considered that higher levels of Salinity recorded in Ma Wan station was not related to the disposal operation at ESC CMP Vd. Levels of DO, Turbidity and SS complied with the Action and Limit Levels at all stations in April and May 2018.

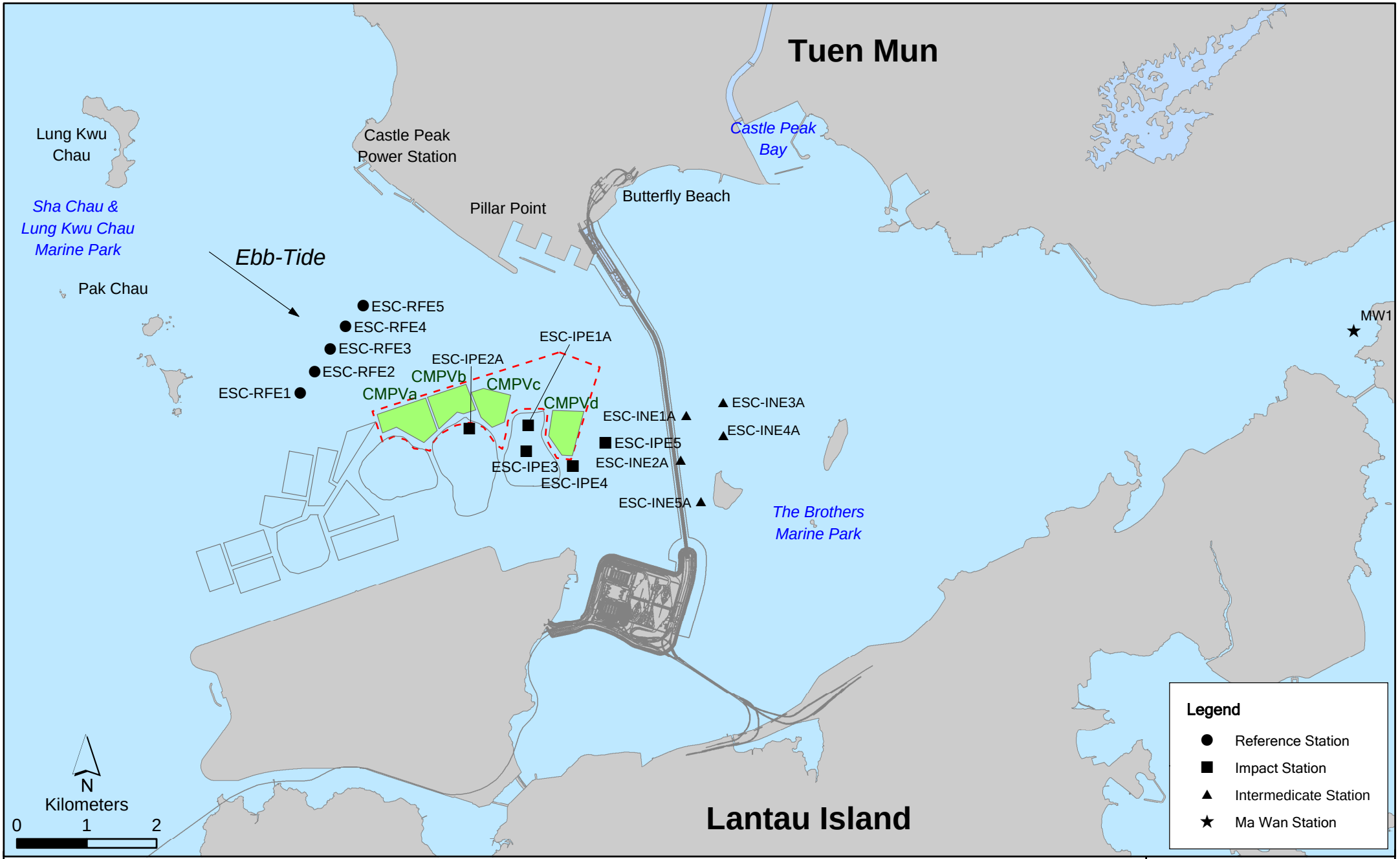


Figure 3.1

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

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Date: 19/4/2017

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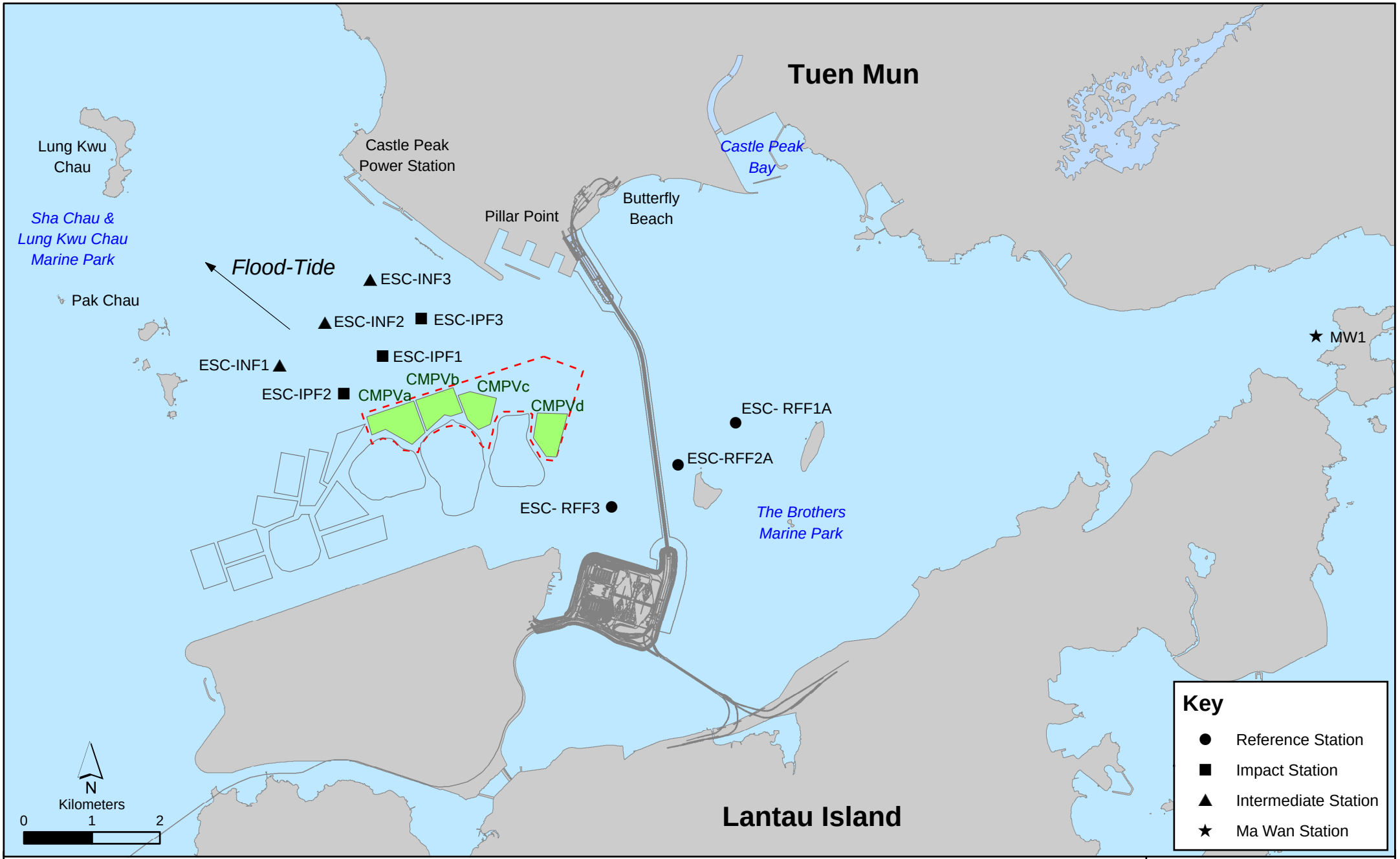

Figure 3.2

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 May 2018 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 significantly higher in February 2017 and were the lowest in July 2013, August 2016 and July 2017. DO levels were significantly higher at Intermediate stations than at other 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 significantly higher in November 2017 than in other sampling periods. Ma Wan station had the significantly lowest Turbidity than at other 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 2018). 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 significantly higher in August 2013 when compared to all other sampling periods. The concentration of Nickel was significantly higher in April 2012 and August 2013. The concentration of Zinc was significantly higher in November 2017 when compared to all other sampling periods. Concentrations of Copper and Zinc were significantly lower at Intermediate stations than at other stations while concentrations of Nickel were significantly higher at Reference stations than other stations.

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 significantly higher in April 2012. Concentrations of NH_3-N were significantly lower at Intermediate stations than at other stations.

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 significantly higher in April 2012 and May 2018. Concentrations of TIN were significantly lower at Ma Wan station than at other 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 significantly higher in August 2016. Levels of BOD_5 were significantly lower at the Intermediate stations and Impact stations than at other 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 significantly higher in November 2017. SS levels were significantly higher 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 Vd of the ESC area.

3.2.17 *Pit Specific Sediment Chemistry of ESC CMP Vd*

Background

3.2.18 *Pit Specific Sediment Chemistry of ESC CMP Vd* was conducted once every month from April to June 2018 as presented in *Table 3.1*. A total of six (6) monitoring stations for ESC CMP Vd 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 generally below the Lower Chemical Exceedance Levels (LCELs) at all monitoring stations from April to June 2018, except for the concentration of Arsenic which exceeded the LCEL at the Active Pit stations ESC-NPAA and ESC-NPAB in June 2018.

Summary of Statistical Analyses

3.2.19 Statistical analyses were performed for data obtained from *Pit Specific Sediment Chemistry of ESC CMP Vd* since March 2016. 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. The concentrations of Cadmium, Lead, Mercury and Zinc were significantly higher at the Active Pit stations than at the Pit Edge stations than at Near Pit stations. Subsequent linear regression analysis for Cadmium, 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, Lead, Mercury and Zinc 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.

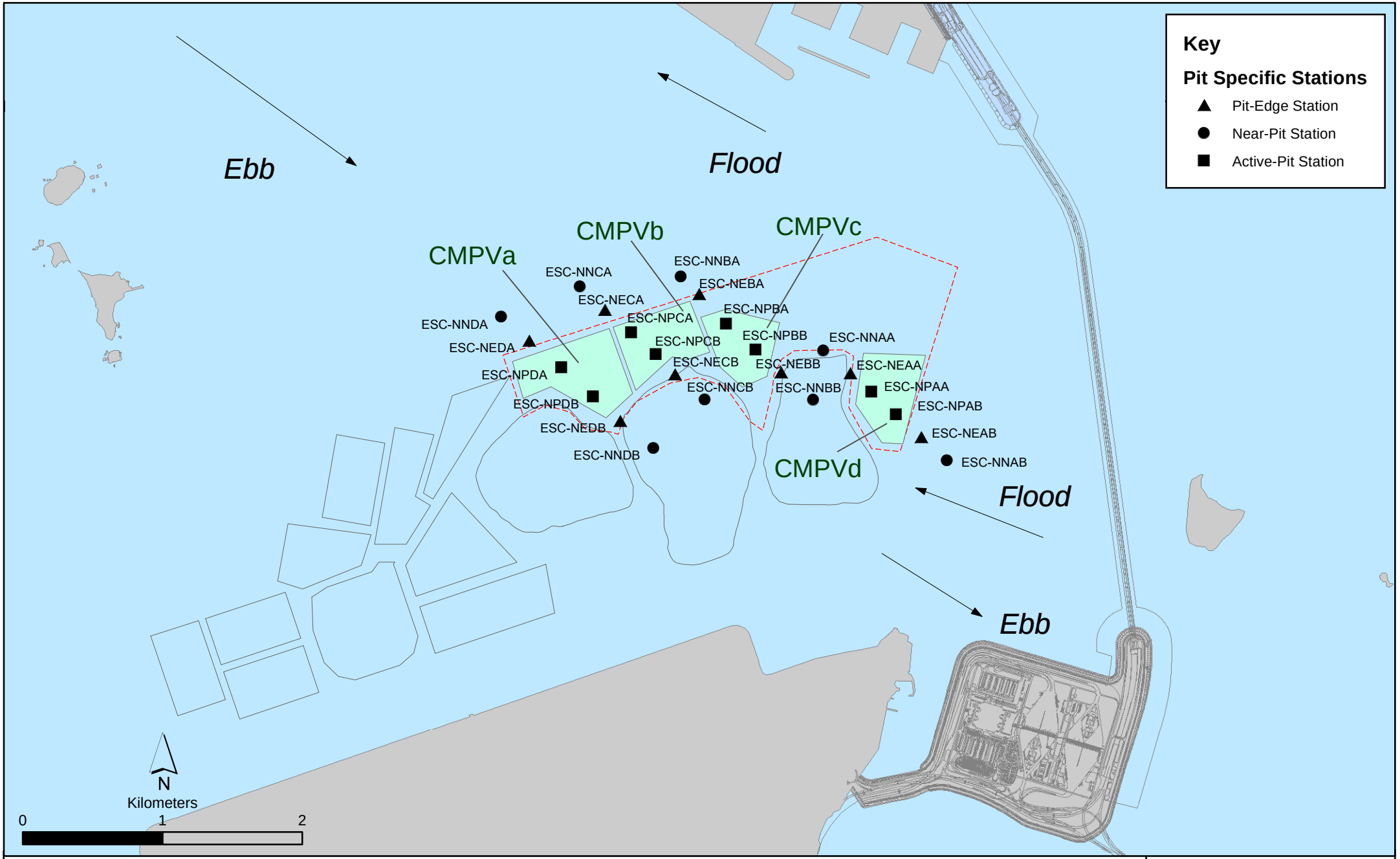

Figure 3.3

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

3.2.23 In this reporting period, only Total Organic Carbon (TOC) concentrations were statistically analysed. Levels of TOC varied significantly with sampling area and time. It was significantly higher at the Pit Edge and Active Pit stations than Near Pit stations. There was no consistent spatial trend of increasing concentrations of TOC with proximity to the pit or consistent temporal trend of increasing concentrations of TOC over time.

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 Vd.

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

Background

3.2.26 *Cumulative Impact Sediment Chemistry of ESC CMPs* was conducted in June 2018 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 2018, except for the concentration of Arsenic which exceeded the LCEL at Mid-field stations ESC-RMA and ESC-RMB as well as the Far-field stations ESC-RFA and ESC-RFB.

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*.

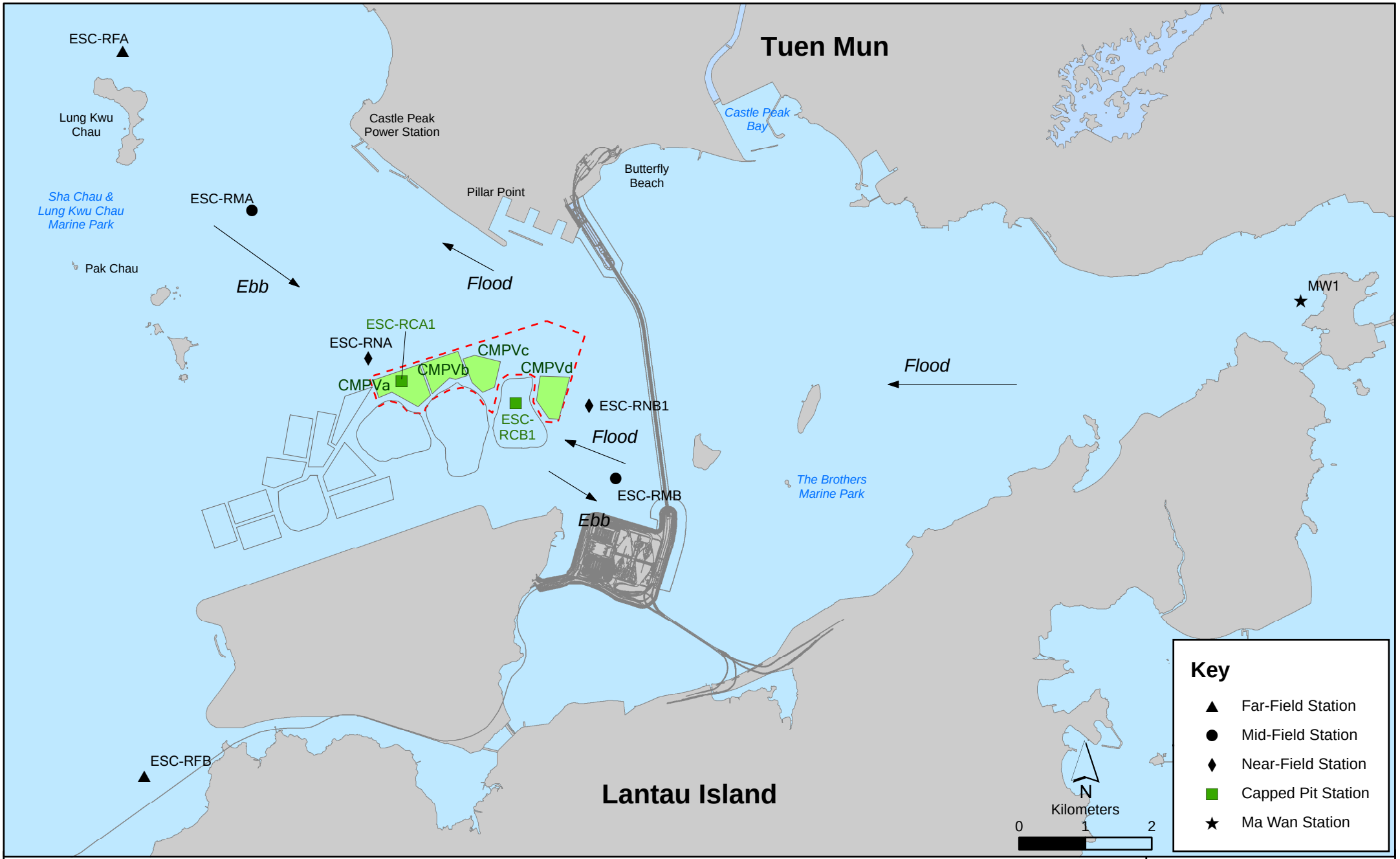

Figure 3.4

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

ERM

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 significantly higher at Mid-Field or Ma Wan stations. The concentrations of all measured metals and metalloids 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. They were significantly higher at Ma Wan station than at other stations. 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 Vd during the quarterly period.

4.1.1 During the reporting period, the Independent Auditor (IA) conducted audit on EM&A results as well as a surprise visit on 16 April 2018. The IA was generally satisfied with the laboratory facilities, the procedures of water sample preparation and metal measurements of water samples. The metal concentrations for water quality, however, were observed to be high for Zinc in April 2018 and both Zinc and Copper in May 2018. It was suggested that the laboratory should soak sample bottles with acids for 1-2 days followed by water rinsing before sample collection and avoid any possible contamination when handling samples to obtain reliable metal measurements. Overall, the EM&A Programme of the Project was undertaken with good performance.

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 2018 for ESC CMPs include:

- *Water Column Profiling of ESC CMP Vd* in July, August and September 2018;
- *Routine Water Quality Monitoring of ESC CMPs* in July and August 2018;
- *Pit Specific Sediment Chemistry of ESC CMP Vd* in July, August and September 2018;
- *Cumulative Impact Sediment Chemistry of ESC CMPs* in August 2018;
- *Sediment Toxicity Tests of ESC CMPs* in August 2018;
- *Demersal Trawling for ESC CMPs* in July and August 2018; and
- *Benthic Recolonisation Studies for SB CMPs* in August 2018.

5.1.2 The sampling schedules for ESC CMPs and SB CMPs are 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				3		3				3		3	
	ESC-IPE2A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-IPE3	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-IPE4	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-IPE5	4 times per year																							3				3		3				3		3				3		3				3		3	
Intermediate Station Downcurrent																																																		
	ESC-INE1A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INE2A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INE3A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INE4A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INE5A	4 times per year																							3				3		3				3		3				3		3				3		3	
Reference Station Upcurrent																																																		
	ESC-RFE1	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFE2	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFE3	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFE4	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFE5	4 times per year																							3				3		3				3		3				3		3				3		3	
Ma Wan Station																																																		
	MW1	4 times per year																							3				3		3				3		3				3		3				3		3	
Flood Tide																																																		
Impact Station Downcurrent																																																		
	ESC-IPF1	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-IPF2	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-IPF3	4 times per year																							3				3		3				3		3				3		3				3		3	
Intermediate Station Downcurrent																																																		
	ESC-INF1	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INF2	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-INF3	4 times per year																							3				3		3				3		3				3		3				3		3	
Reference Station Upcurrent																																																		
	ESC-RFF1A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFF2A	4 times per year																							3				3		3				3		3				3		3				3		3	
	ESC-RFF3	4 times per year																							3				3		3				3		3				3		3				3		3	
Ma Wan Station																																																		
	MW1	4 times per year																							3				3		3				3		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																																								
	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.

Annex A2 - Environmental Monitoring and Audit Sampling Schedule for South of The Brothers (April 2017 - December 2018)

			2017									2018										
Capping Water Quality Monitoring			**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Ebb Tide																							
Impact Stations Downcurrent																							
	SB-IPE1	4 times per year		3	3		3	3															
	SB-IPE2	4 times per year		3	3		3	3															
	SB-IPE3	4 times per year		3	3		3	3															
	SB-IPE4	4 times per year		3	3		3	3															
	SB-IPE5	4 times per year		3	3		3	3															
Intermediate Stations Downcurrent																							
	SB-INE1	4 times per year		3	3		3	3															
	SB-INE2	4 times per year		3	3		3	3															
	SB-INE3	4 times per year		3	3		3	3															
	SB-INE4	4 times per year		3	3		3	3															
	SB-INE5	4 times per year		3	3		3	3															
Reference Stations Upcurrent																							
	SB-RFE1	4 times per year		3	3		3	3															
	SB-RFE2	4 times per year		3	3		3	3															
	SB-RFE3	4 times per year		3	3		3	3															
	SB-RFE4	4 times per year		3	3		3	3															
	SB-RFE5	4 times per year		3	3		3	3															
Sensitive Receiver Stations																							
	MW1	4 times per year		3	3		3	3															
	THB1	4 times per year		3	3		3	3															
	THB2	4 times per year		3	3		3	3															
	WSR45C	4 times per year		3	3		3	3															
	WSR46	4 times per year		3	3		3	3															
Flood Tide																							
Impact Stations Downcurrent																							
	SB-IPF1	4 times per year		3	3		3	3															
	SB-IPF2	4 times per year		3	3		3	3															
	SB-IPF3	4 times per year		3	3		3	3															
Intermediate Stations Downcurrent																							
	SB-INF1	4 times per year		3	3		3	3															
	SB-INF2	4 times per year		3	3		3	3															
	SB-INF3	4 times per year		3	3		3	3															
Reference Stations Upcurrent																							
	SB-RFF1	4 times per year		3	3		3	3															
	SB-RFF2	4 times per year		3	3		3	3															
	SB-RFF3	4 times per year		3	3		3	3															
Sensitive Receiver Stations																							
	MW1	4 times per year		3	3		3	3															
	THB1	4 times per year		3	3		3	3															
	THB2	4 times per year		3	3		3	3															
	WSR45C	4 times per year		3	3		3	3															
	WSR46	4 times per year		3	3		3	3															

Benthic Recolonisation Studies			**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Capped Contaminated Mud Pits																							
	SB-CPA	2 times per year					12				12								12				12
	SB-CPB	2 times per year					12				12								12				12
Reference Stations																							
	RBA	2 times per year					12				12								12				12
	RBB	2 times per year					12				12								12				12
	RBC	2 times per year					12				12								12				12

Notes:
The number shown in each cell represents the numbers of replicates per monitoring station
Capping works are planned to be conducted between May and December 2017.

Annex B

Disposal Records

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
1-Apr-2018	0	1,040,292
2-Apr-2018	0	1,040,292
3-Apr-2018	0	1,040,292
4-Apr-2018	383	1,040,675
5-Apr-2018	0	1,040,675
6-Apr-2018	0	1,040,675
7-Apr-2018	315	1,040,990
8-Apr-2018	400	1,041,390
9-Apr-2018	980	1,042,370
10-Apr-2018	1061	1,043,431
11-Apr-2018	605	1,044,036
12-Apr-2018	554	1,044,590
13-Apr-2018	525	1,045,115
14-Apr-2018	780	1,045,895
15-Apr-2018	0	1,045,895
16-Apr-2018	567	1,046,462
17-Apr-2018	361	1,046,823
18-Apr-2018	0	1,046,823
19-Apr-2018	765	1,047,588
20-Apr-2018	0	1,047,588
21-Apr-2018	130	1,047,718
22-Apr-2018	0	1,047,718
23-Apr-2018	740	1,048,458
24-Apr-2018	0	1,048,458
25-Apr-2018	500	1,048,958
26-Apr-2018	0	1,048,958
27-Apr-2018	500	1,049,458
28-Apr-2018	0	1,049,458
29-Apr-2018	0	1,049,458
30-Apr-2018	1124	1,050,582
1-May-2018	0	1,050,582
2-May-2018	601	1,051,183
3-May-2018	596	1,051,779
4-May-2018	1226	1,053,005
5-May-2018	585	1,053,590
6-May-2018	0	1,053,590
7-May-2018	56	1,053,646
8-May-2018	500	1,054,146
9-May-2018	567	1,054,713
10-May-2018	594	1,055,307
11-May-2018	1109	1,056,416
12-May-2018	0	1,056,416
13-May-2018	0	1,056,416
14-May-2018	1102	1,057,518
15-May-2018	0	1,057,518
16-May-2018	500	1,058,018
17-May-2018	601	1,058,619
18-May-2018	1097	1,059,716
19-May-2018	609	1,060,325
20-May-2018	0	1,060,325
21-May-2018	500	1,060,825
22-May-2018	0	1,060,825
23-May-2018	0	1,060,825
24-May-2018	500	1,061,325
25-May-2018	200	1,061,525
26-May-2018	0	1,061,525
27-May-2018	0	1,061,525

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
28-May-2018	0	1,061,525
29-May-2018	592	1,062,117
30-May-2018	0	1,062,117
31-May-2018	0	1,062,117
1-Jun-2018	0	1,062,117
2-Jun-2018	0	1,062,117
3-Jun-2018	0	1,062,117
4-Jun-2018	0	1,062,117
5-Jun-2018	2158	1,064,275
6-Jun-2018	0	1,064,275
7-Jun-2018	547	1,064,822
8-Jun-2018	0	1,064,822
9-Jun-2018	0	1,064,822
10-Jun-2018	0	1,064,822
11-Jun-2018	0	1,064,822
12-Jun-2018	526	1,065,348
13-Jun-2018	0	1,065,348
14-Jun-2018	300	1,065,648
15-Jun-2018	0	1,065,648
16-Jun-2018	0	1,065,648
17-Jun-2018	0	1,065,648
18-Jun-2018	0	1,065,648
19-Jun-2018	608	1,066,256
20-Jun-2018	0	1,066,256
21-Jun-2018	0	1,066,256
22-Jun-2018	0	1,066,256
23-Jun-2018	751	1,067,007
24-Jun-2018	377	1,067,384
25-Jun-2018	334	1,067,718
26-Jun-2018	0	1,067,718
27-Jun-2018	0	1,067,718
28-Jun-2018	0	1,067,718
29-Jun-2018	0	1,067,718
30-Jun-2018	0	1,067,718

Annex C

Statistical Analysis

Routine Water Quality Monitoring for ESC CMPs – Analysis of Variance and Linear Regression Analysis up to May 2018

Dissolved Oxygen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	587351.881	3	195783.960	8.139	**
Period	553112278.226	30	18437075.941	766.437	**
Area * Period	36986088.910	90	410956.543	17.084	**
Error	49795049.741	2070	24055.580		
Total	3522769211.000	2194			

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

Turbidity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	23103830.624	3	7701276.875	74.891	**
Period	369316989.661	30	12310566.322	119.714	**
Area * Period	87935620.621	90	977062.451	9.501	**
Error	212865167.665	2070	102833.414		
Total	3522714500.500	2194			

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

SNK Results:

- Nov 17 > Oct 17 = Aug 13 > Apr 17 ≥ Apr 12 = Aug 12 ≥ Nov 16 = Oct 16 ≥ Nov 12 = Jul 16 ≥ Jul 17 = May 16 ≥ Apr 13 = Feb 12 ≥ Apr 16 ≥ Jan 17 = **May 18** ≥ Oct 12 ≥ Jul 12 ≥ Aug 17 = Jan 18 ≥ Aug 16 ≥ Feb 13 = Feb 18 = May 12 ≥ Jan 13 = **Apr 18** ≥ Jul 13 = 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	1370320384.726	29	47252427.060	724.569	**
Area	16763314.740	3	5587771.580	85.683	**
Station(Area)	19692248.341	24	820510.348	12.582	**
Period * Area	268554753.040	84	3197080.393	49.024	**
Period * Station(Area)	217336091.755	246	883480.048	13.547	**
Error	179861735.375	2758	65214.552		
Total	10406142297.000	3152			

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

SNK Results:

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

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1359112557.999	29	46865950.276	410.752	**
Area	27179293.428	3	9059764.476	79.403	**
Station(Area)	48836769.595	24	2034865.400	17.834	**
Period * Area	226406802.668	84	2695319.079	23.623	**
Period * Station(Area)	189341796.393	246	769682.099	6.746	**
Error	314682371.250	2758	114098.032		
Total	10401416133.000	3152			

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

SNK Results:

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

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1730035273.913	29	59656388.756	823.399	**
Area	29298447.006	3	9766149.002	134.796	**
Station(Area)	36859544.407	24	1535814.350	21.198	**
Period * Area	178212543.253	84	2121577.896	29.283	**
Period * Station(Area)	217944110.597	246	885951.669	12.228	**
Error	199820878.688	2758	72451.370		
Total	10442229985.500	3152			

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 = Aug 17 = Feb 18 = Jan 18 = May 17 > **Apr 18** > **May 18** > Apr 12 = Feb 12 = Aug 13 > Jul 12 ≥ Nov 12 = Jul 13 > May 16 = May 12 > Jan 17 ≥ Jan 13 = Apr 13 = Oct 16 = Apr 16 = Oct 12 > Nov 16 = Jul 16 > 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	1792907524.145	29	61824397.384	880.863	**
Area	5646521.591	3	1882173.864	26.817	**
Station(Area)	15960991.434	24	665041.310	9.475	**
Period * Area	102671947.742	84	1222285.092	17.415	**
Period * Station(Area)	90958433.403	246	369749.729	5.268	**
Error	193573482.813	2758	70186.179		
Total	10437968277.500	3152			

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

SNK Results:

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

Total Inorganic Nitrogen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1700200394.120	29	58627599.797	1426.178	**
Area	41052551.645	3	13684183.882	332.882	**
Station(Area)	50096704.161	24	2087362.673	50.777	**
Period * Area	125349376.666	84	1492254.484	36.301	**
Period * Station(Area)	125938177.393	246	511943.811	12.454	**
Error	113376425.688	2758	41108.204		
Total	10443050476.000	3152			

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

SNK Results:

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

BOD_5

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	984389143.977	29	33944453.241	196.680	**
Area	28904112.378	3	9634704.126	55.825	**
Station(Area)	15852880.257	24	660536.677	3.827	**
Period * Area	390513234.086	84	4648967.072	26.937	**
Period * Station(Area)	322358102.255	246	1310398.790	7.593	**
Error	475995976.125	2758	172587.374		
Total	10435416609.000	3152			

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

SNK Results:

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

Suspended Solids

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1276895585.139	29	44030882.246	1426.616	**
Area	9419142.406	3	3139714.135	101.728	**
Station(Area)	134099849.255	24	5587493.719	181.037	**
Period * Area	289159439.316	84	3442374.278	111.534	**
Period * Station(Area)	491951107.220	246	1999801.249	64.794	**
Error	85122542.188	2758	30863.866		
Total	10442249357.500	3152			

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

SNK Results:

- Nov 17 > Jul 12 > Nov 12 > Nov 16 = Jul 16 = Oct 16 = Aug 12 > Apr 12 ≥ Apr 17 = Oct 17 ≥ May 16 = Oct 12 > Aug 13 > Jan 17 = Apr 16 ≥ Jul 17 = Apr 13 > Feb 12 > Jan 18 > Aug 16 > **May 18** = Feb 13 > Feb 18 = **Apr 18** = Jan 13 > Aug 17 > May 13 > 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	-0.104	0.104	0.011	**

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

Pit Specific Sediment Chemistry for ESC CMP Vd – Analysis of Variance (up to June 2018)

Arsenic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	386760281.761	27	14324454.880	337.334	**
Area	6099615.187	2	3049807.593	71.822	**
Station(Area)	68042001.905	3	22680667.302	534.120	**
Period * Area	57813357.922	54	1070617.739	25.213	**
Period * Station(Area)	69127883.325	80	864098.542	20.349	**
Error	77878346.993	1834	42463.657		
Total	2672619955.000	2001			

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

SNK Results:

- Oct 17 = **Jun 18** > **May 18** = Jul 17 = Nov 17 = Mar 18 > Aug 16 = Sep 17 = Aug 17 > Dec 17 = **Apr 18** = Feb 18 = Mar 16 = Jan 18 > May 17 = Jun 17 > Jul 16 ≥ Apr 16 = Feb 17 = Apr 17 > Oct 16 = May 16 = Nov 16 > Mar 17 = Jun 16 = Jan 17 = Sep 16 > Dec 16
- Pit Edge = Near Pit > Active Pit

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	157395377.595	27	5829458.429	72.903	**
Area	174868917.765	2	87434458.882	1093.448	**
Station(Area)	14636781.952	3	4878927.317	61.015	**
Period * Area	76956769.120	54	1425125.354	17.823	**
Period * Station(Area)	85079358.964	80	1063491.987	13.300	**
Error	146410654.970	1831	79962.127		
Total	2656605660.000	1998			

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

SNK Results:

- **Jun 18** > Jun 16 = May 17 ≥ Dec 17 = Jul 17 = Mar 18 ≥ **May 18** ≥ Nov 17 ≥ Oct 17 ≥ Sep 17 = Aug 17 = Apr 16 ≥ **Apr 18** ≥ May 16 = Sep 16 = Aug 16 = Feb 17 = Jun 17 = Feb 18 = Jan 18 = Dec 16 > Mar 17 ≥ Nov 16 = Mar 16 = Apr 17 = Jan 17 = Jul 16 > Oct 16
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis					
Source	df	Slope	r	r^2	P
Area	1	-0.506	0.506	0.256	**
Note: Linear regression analysis on spatial changes of contaminant concentrations.					

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	243170249.775	27	9006305.547	116.998	**
Area	19991749.906	2	9995874.953	129.853	**
Station(Area)	45763269.469	3	15254423.156	198.165	**
Period * Area	108895863.346	54	2016590.062	26.197	**
Period * Station(Area)	107501592.726	80	1343769.909	17.456	**
Error	141178235.260	1834	76978.318		
Total	2672670523.500	2001			

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

SNK Results:

- **J**ul 17 > Oct 17 > Mar 16 > **Jun 18** > Nov 17 ≥ Sep 17 = Aug 17 = Jun 16 = Mar 18 = Apr 16 > **May 18** > Aug 16 = Feb 18 = Jan 18 = Jul 16 > Sep 16 = **Apr 18** > Nov 16 = May 16 = Dec 16 = Feb 17 = Oct 16 > May 17 = Dec 17 = Jan 17 > Jun 17 = Mar 17 > Apr 17
- Pit Edge > Active Pit > Near Pit

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	103608460.178	27	3837350.377	71.544	**
Area	197327562.534	2	98663781.267	1839.502	**
Station(Area)	41695639.472	3	13898546.491	259.126	**
Period * Area	107890651.726	54	1997975.032	37.251	**
Period * Station(Area)	119395656.233	80	1492445.703	27.825	**
Error	98368699.196	1834	53636.150		
Total	2672670716.500	2001			

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

SNK Results:

- Oct 17 > Nov 17 ≥ Mar 18 = **Jun 18** ≥ **May 18** ≥ Dec 17 ≥ Feb 18 ≥ Aug 16 = **Apr 18** = Sep 17 = Aug 17 = Sep 16 = Feb 17 = Jan 18 = Jun 16 > Apr 16 = Jun 17 ≥ Mar 16 ≥ Dec 16 = May 16 ≥ Mar 17 = May 17 = Oct 16 = Jan 17 = Nov 16 = Jul 17 = Jul 16 > Apr 17
- Active Pit > Pit Edge = Near Pit

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	212128655.968	27	7856616.888	158.806	**
Area	45171664.792	2	22585832.396	456.527	**
Station(Area)	94201668.728	3	31400556.243	634.700	**
Period * Area	101215040.484	54	1874352.602	37.886	**
Period * Station(Area)	123311650.704	80	1541395.634	31.156	**
Error	90733676.816	1834	49473.106		
Total	2672670235.500	2001			

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

SNK Results:

- Jul 17 = Oct 17 > **Jun 18** ≥ Mar 16 = May 17 = Jun 17 ≥ Nov 17 ≥ Sep 17 = Aug 17 = Apr 16 = Jul 16 = Jun 16 > **May 18** = Mar 18 = Jan 18 ≥ Nov 16 ≥ Feb 18 = May 16 ≥ Aug 16 ≥ Sep 16 = **Apr 18** = Dec 17 = Feb 17 = Dec 16 = Jan 17 = Apr 17 > Mar 17 > Oct 16
- Pit edge > Active Pit > Near Pit

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	167755806.827	27	6213178.031	63.611	**
Area	35525228.530	2	17762614.265	181.854	**
Station(Area)	84008397.265	3	28002799.088	286.693	**
Period * Area	80059709.321	54	1482587.210	15.179	**
Period * Station(Area)	120637482.886	80	1507968.536	15.439	**
Error	179136034.834	1834	97675.046		
Total	2672670585.000	2001			

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

SNK Results:

- Mar 17 > Jul 17 ≥ **Jun 18** = Oct 17 = May 17 > Jun 17 ≥ Sep 17 = Aug 17 = **May 18** = Mar 18 = Nov 17 ≥ Apr 16 ≥ Mar 16 = Jan 18 = Jun 16 = Jul 16 = Aug 16 ≥ Nov 16 = Apr 17 ≥ Feb 18 = May 16 = Dec 17 = **Apr 18** = Oct 16 = Feb 17 > Dec 16 > Sep 16 > Jan 17
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis					
Source	df	Slope	r	r^2	P
Area	1	-0.226	0.226	0.051	**
Note: Linear regression analysis on spatial changes of contaminant concentrations.					

Mercury

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	464038214.860	27	17186600.550	305.088	**
Area	9195313.054	2	4597656.527	81.615	**
Station(Area)	1294938.221	3	431646.074	7.662	**
Period * Area	42990900.244	54	796127.782	14.132	**
Period * Station(Area)	26193539.683	80	327419.246	5.812	**
Error	103315309.056	1834	56333.320		
Total	2655865934.500	2001			

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

SNK Results:

- Apr 16 = Mar 16 > May 16 = Jun 16 > Sep 16 = Jul 16 = Aug 16 ≥ Oct 16 = Jun 17 = Nov 16 > Dec 16 = May 17 ≥ **May 18** = Nov 17 = Jan 17 > Mar 17 = Apr 17 = Feb 17 = **Jun 18** = Jul 17 = Oct 17 > Dec 17 = Sep 17 = Aug 17 > Mar 18 = Jan 18 = Feb 18 = **Apr 18**
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	df	Slope	r	r^2	P
Area	1	-0.123	0.123	0.015	**

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

Silver

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	83248669.767	27	3083284.065	50.242	**
Area	220010654.254	2	110005327.127	1792.534	**
Station(Area)	13989798.637	3	4663266.212	75.988	**
Period * Area	125076926.578	54	2316239.381	37.743	**
Period * Station(Area)	108237156.489	80	1352964.456	22.047	**
Error	112488657.079	1833	61368.607		
Total	2668085929.000	2000			

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

SNK Results:

- Dec 17 ≥ Nov 17 ≥ May 17 ≥ Apr 17 ≥ Jun 16 = **May 18** = Aug 16 = **Jun 18** = Mar 18 = Jun 17 ≥ Mar 17 = Feb 17 = Jul 17 = Sep 16 = Oct 17 ≥ **Apr 18** ≥ Feb 18 = Sep 17 = Aug 17 = Jan 18 = Mar 16 = Apr 16 = May 16 ≥ Dec 16 = Jul 16 ≥ Nov 16 = Jan 17 > Oct 16
- Active Pit > Near Pit > Pit Edge

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	239694457.603	27	8877572.504	178.990	**
Area	46538639.812	2	23269319.906	469.158	**
Station(Area)	79237653.814	3	26412551.271	532.532	**
Period * Area	112104972.936	54	2076018.017	41.857	**
Period * Station(Area)	97446977.686	80	1218087.221	24.559	**
Error	90962754.100	1834	49598.012		
Total	2672668865.000	2001			

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

SNK Results:

- Jul 17 = Oct 17 = **Jun 18** > Nov 17 = **May 18** = Mar 18 > **Apr 18** = Mar 16 = Feb 18 ≥ Sep 17 = Aug 17 = Apr 16 = Jan 18 = Aug 16 = Dec 17 = Jun 16 > Jul 16 > Nov 16 ≥ May 16 = Oct 16 = May 17 > Feb 17 = Dec 16 > Mar 17 ≥ Jan 17 ≥ Jun 17 = Sep 16 = Apr 17
- Active Pit > Pit Edge > Near Pit

Linear Regression Analysis

Source	df	Slope	r	r^2	P
Area	1	-0.262	0.262	0.069	**

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	251190239.954	27	9303342.221	192.876	**
Area	25349229.615	2	12674614.808	262.768	**
Station(Area)	37683944.859	3	12561314.953	260.419	**
Period * Area	127112062.403	54	2353927.082	48.801	**
Period * Station(Area)	137697574.113	80	1721219.676	35.684	**
Error	88462864.966	1834	48234.932		
Total	2672477469.500	2001			

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

SNK Results:

- Oct 17 = Feb 18 = **Jun 18** > Apr 16 > Jul 17 = **May 18** = Mar 16 = Mar 18 = Dec 17 > Jun 16 ≥ Aug 16 = Jul 16 = Nov 17 = Nov 16 = Jan 17 > May 17 ≥ Sep 16 = Oct 16 = Dec 16 = May 16 = **Apr 18** = Sep 17 = Aug 17 = Jun 17 > Jan 18 > Mar 17 ≥ Apr 17 = Feb 17
- Pit Edge = Active Pit > Near Pit

Cumulative Impact Sediment Chemistry for ESC CMPs – Analysis of Variance (up to June 2018)

Arsenic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	22021923.765	8	2752740.471	502.031	**
Area	6135948.661	4	1533987.165	279.761	**
Area * Station	779169.065	4	194792.266	35.525	**
Period * Area	39129839.905	31	1262252.900	230.203	**
Period * Area * Station	2817586.789	32	88049.587	16.058	**
Error	4885543.000	891	5483.213		
Total	306575571.000	972			

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

SNK Results:

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

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	13627085.653	8	1703385.707	70.717	**
Area	6879877.181	4	1719969.295	71.405	**
Area * Station	14687157.994	4	3671789.499	152.436	**
Period * Area	14372377.435	31	463625.079	19.248	**
Period * Area * Station	4517464.829	32	141170.776	5.861	**
Error	21461896.167	891	24087.426		
Total	306008747.500	972			

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

SNK Results:

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

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	3294246.815	8	411780.852	53.848	**
Area	23728624.760	4	5932156.190	775.743	**
Area * Station	8271570.863	4	2067892.716	270.416	**
Period * Area	20785860.497	31	670511.629	87.682	**
Period * Area * Station	7917057.407	32	247408.044	32.353	**
Error	6813537.875	891	7647.068		
Total	306582487.500	972			

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

SNK Results:

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

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	3518606.238	8	439825.780	52.812	**
Area	18127476.062	4	4531869.016	544.163	**
Area * Station	21905945.719	4	5476486.430	657.588	**
Period * Area	15736056.537	31	507614.727	60.952	**
Period * Area * Station	4271934.521	32	133497.954	16.030	**
Error	7420372.667	891	8328.140		
Total	306582511.000	972			

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

SNK Results:

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

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	6128023.807	8	766002.976	119.653	**
Area	14740782.656	4	3685195.664	575.642	**
Area * Station	10343076.042	4	2585769.010	403.907	**
Period * Area	25662636.544	31	827826.985	129.310	**
Period * Area * Station	9457882.333	32	295558.823	46.167	**
Error	5704084.375	891	6401.890		
Total	306582436.000	972			

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

SNK Results:

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

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	21788379.065	8	2723547.383	404.289	**
Area	14516456.429	4	3629114.107	538.713	**
Area * Station	4942641.427	4	1235660.357	183.424	**
Period * Area	22169656.215	31	715150.200	106.158	**
Period * Area * Station	4762013.271	32	148812.915	22.090	**
Error	6002346.125	891	6736.640		
Total	306582492.500	972			

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

SNK Results:

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

Mercury

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	37940379.474	8	4742547.434	222.932	**
Area	1941496.691	4	485374.173	22.816	**
Area * Station	969867.674	4	242466.918	11.398	**
Period * Area	9349262.798	31	301589.123	14.177	**
Period * Area * Station	2412776.451	32	75399.264	3.544	**
Error	18954676.250	891	21273.486		
Total	304006688.500	972			

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

SNK Results:

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

Silver

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	9793219.074	8	1224152.384	110.423	**
Area	21099982.088	4	5274995.522	475.824	**
Area * Station	21135366.671	4	5283841.668	476.622	**
Period * Area	4758505.557	31	153500.179	13.846	**
Period * Area * Station	6613837.787	32	206682.431	18.644	**
Error	9877644.542	891	11086.021		
Total	306512876.500	972			

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

SNK Results:

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

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1205055.969	8	150631.996	31.013	**
Area	17306897.420	4	4326724.355	890.813	**
Area * Station	18167674.508	4	4541918.627	935.119	**
Period * Area	24275766.733	31	783089.249	161.227	**
Period * Area * Station	5062420.106	32	158200.628	32.571	**
Error	4327630.333	891	4857.049		
Total	306582163.000	972			

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

SNK Results:

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

TOC

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	11599372.508	8	1449921.563	144.453	**
Area	14121007.031	4	3530251.758	351.712	**
Area * Station	4345072.169	4	1086268.042	108.223	**
Period * Area	21767048.190	31	702162.845	69.955	**
Period * Area * Station	9413803.956	32	294181.374	29.309	**
Error	8943278.042	891	10037.349		
Total	306555327.500	972			

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

SNK Results:

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

TBT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	15142517.179	8	1892814.647	77.285	**
Area	16892795.157	4	4223198.789	172.435	**
Area * Station	3660987.339	4	915246.835	37.370	**
Period * Area	4696144.379	31	151488.528	6.185	**
Period * Area * Station	4964306.088	32	155134.565	6.334	**
Error	21821911.417	891	24491.483		
Total	302562482.500	972			

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

SNK Results:

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