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 – October to December 2018

Revision 0

April 2019

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Client:	Project No:
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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: 30 April 2019 Approved by:  Craig A. Reid *Partner*

Revision	Description	By	Checked	Approved	Date
v0	Quarterly EM&A Report for ESC CMPs and SB CMPs	EL	RC	CAR	30/4/19

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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 – October to December 2018
Date of Report:	30 April 2019
Date prepared by ET:	30 April 2019
Date received by IA:	30 April 2019

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.

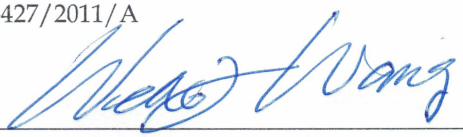
ET Certification

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: 30/4/2019

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: 30/4/2019

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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 October to December 2018

EXECUTIVE SUMMARY

Water Column Profiling, Routine Water Quality Monitoring, Pit Specific Sediment Chemistry and *Cumulative Impact Sediment Chemistry* were carried out for the Contaminated Mud Pits (CMPs) to the East of Sha Chau (ESC) while *Benthic Recolonisation Studies* were conducted for the CMPs to the South of The Brothers (SB) during the quarterly period of October to December 2018. This report presents the results of these monitoring activities to identify whether the disposal operations at ESC CMP V and the capping operations of the SB CMPs 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 – October to December 2018

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 Vd did not appear to cause any unacceptable impact in water quality during this quarterly period.

Routine Water Quality Monitoring of ESC CMPs – October and November 2018

Results of Routine Water Quality Monitoring conducted in October and November 2018 showed that levels of DO, Salinity and pH complied with the WQOs at all 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 impact in water quality during the reporting period.

Sediment Quality Monitoring for ESC CMPs

Pit Specific Sediment Chemistry of ESC CMP Vd – October to December 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 impact in sediment quality of ESC CMP Vd during the reporting period.

Cumulative Impact Sediment Chemistry of ESC CMPs – December 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 impact in sediment quality during the reporting period.

Benthic Recolonisation Studies for SB CMPs

There is an increasing trend of macrobenthos infauna in terms of biomass over time at the Capped Pit stations since Year 2016. The faunal diversity at the Capped Pit stations also appears to increase over time and the majority of the infauna species identified were polychaetes, crustaceans and bivalves, which were similar to the species found in the adjacent reference stations in North Lantau waters. Based on the monitoring results, it is considered that the benthic communities at the Capped Pit stations have started to be re-established and resemble that of the surrounding areas. It is concluded that the capped pits have been proven to be colonised by macrobenthos infauna. Thus, benthic recolonisation monitoring at SB CMP should be regarded as complete and therefore should not continue into the next monitoring 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（二零一八年十月至十二月）

行政摘要

在2018年10月至12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。此外，環境小組也在大小磨刀以南海泥卸置設施進行了底棲生物群落研究。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的卸置作業及大小磨刀以南海泥卸置設施的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－2018年10月至12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10月和11月

2018年10月和11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10月至12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12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。

自2016年以來，已覆蓋污泥坑監測站的底棲生物生物量隨著時間而增加，而底棲生物的多樣性也隨著時間趨向增加，主要的底棲生物品種為多毛綱動物、甲殼類動物及雙殼類動物，並與鄰近在北大嶼山水域的參考站找到的品種相似。基於監察結果，環境小組認為已覆蓋污泥坑監測站的底棲生物群落已經開始建立並與鄰近地方相近，已覆蓋污泥坑已確認被底棲生物所使用。因此，監察小組認為大小磨刀以南污泥坑之底棲生物群落研究已經完成而不需繼續進行監測。

1 INTRODUCTION

1.1 PROJECT DESCRIPTION

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

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

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

1.2 ACTIVITIES CONDUCTED DURING THE REPORTING PERIOD

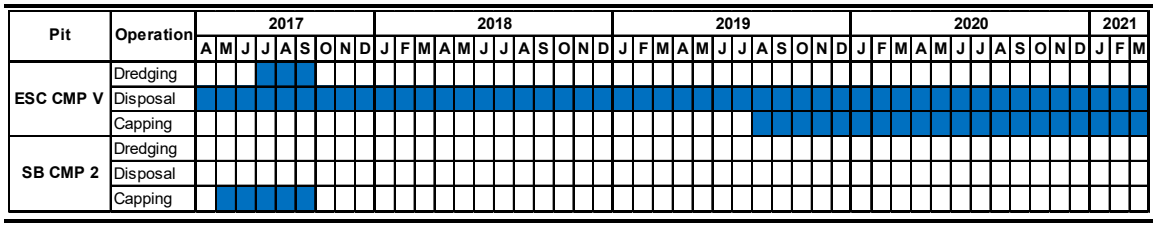
1.2.1 Detailed works schedule for ESC CMP V and SB CMPs is shown in *Figure 1.1*. During the reporting period of July to September 2018, the following works were being undertaken at the CMPs:

- 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 October to December 2018* is to provide information regarding the findings in the quarterly reporting period of October to December 2018 on the environmental impacts resulting from backfilling operation at ESC CMP Vd and the capping operations of the SB CMPs. 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 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).

(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 October to December 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	3 October 2018 5 November 2018 6 December 2018	23 October 2018 7 December 2018 13 October 2018
Routine Water Quality Monitoring of ESC CMPs	2 October 2018 7 November 2018	23 October 2018 7 December 2018
Pit Specific Sediment Chemistry of ESC CMP Vd	4 October 2018 6 November 2018 3 December 2018	12 November 2018 7 December 2018 3 January 2019
Cumulative Impact Sediment Chemistry of ESC CMPs	3 & 4 December 2018	3 January 2019
SB CMPs		
Benthic Recolonisation Studies of SB CMPs	7 December 2018	14 February 2019

3.1.3 The monitoring results of the above environmental monitoring components for ESC and SB 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 and SB 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 October to December 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 in October, November and December 2018, except for lower DO levels recorded at all stations in September 2018. 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 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 October and November 2018 as presented in *Table 3.1*. A total of ten (10) and sixteen (16) stations were sampled in October and November 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 complied with the WQOs and the levels of DO, Turbidity and SS also complied with the Action and Limit Levels at all stations in October and November 2018.

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 November 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.

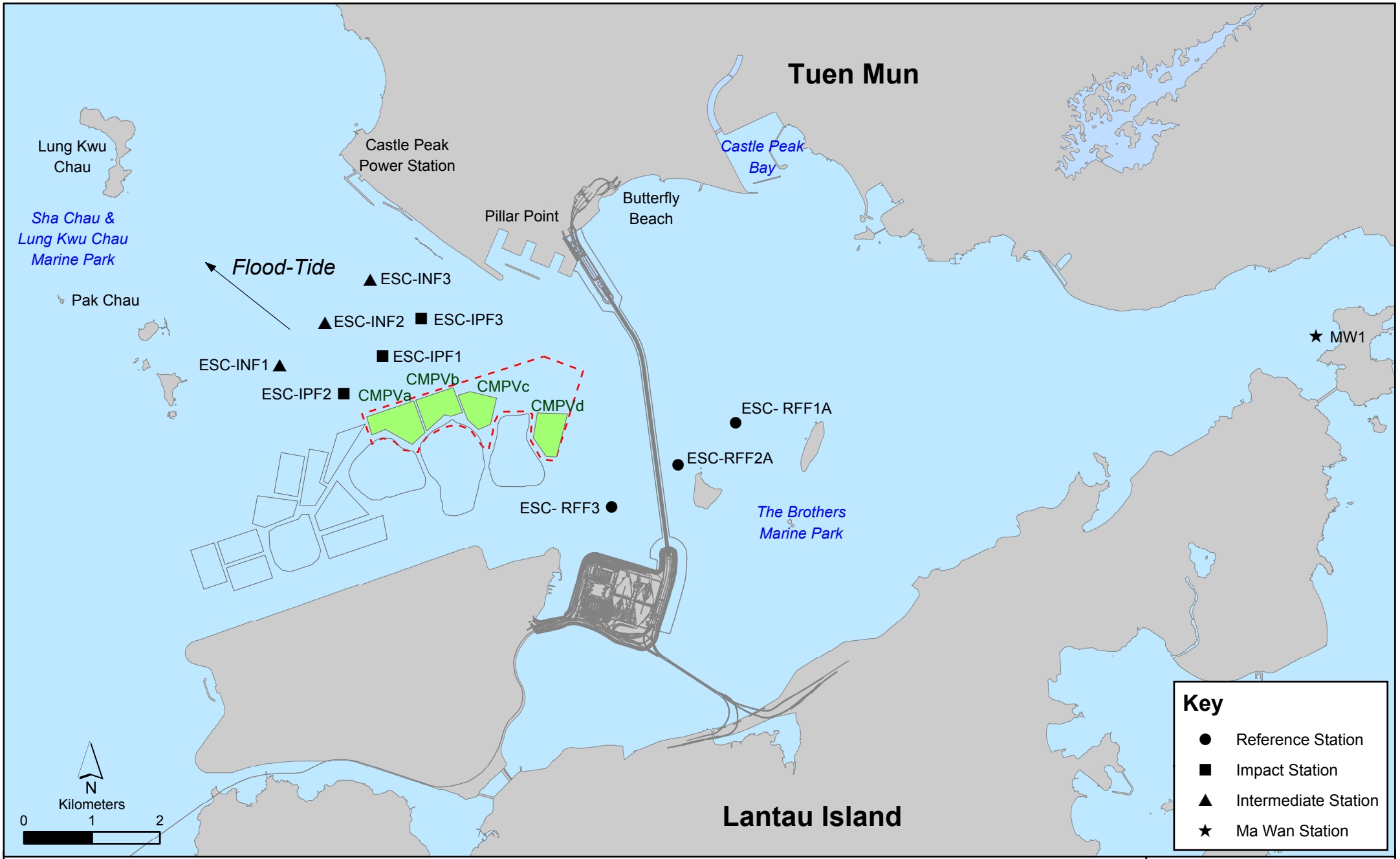


Figure 3.1

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

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Date: 25/4/2017

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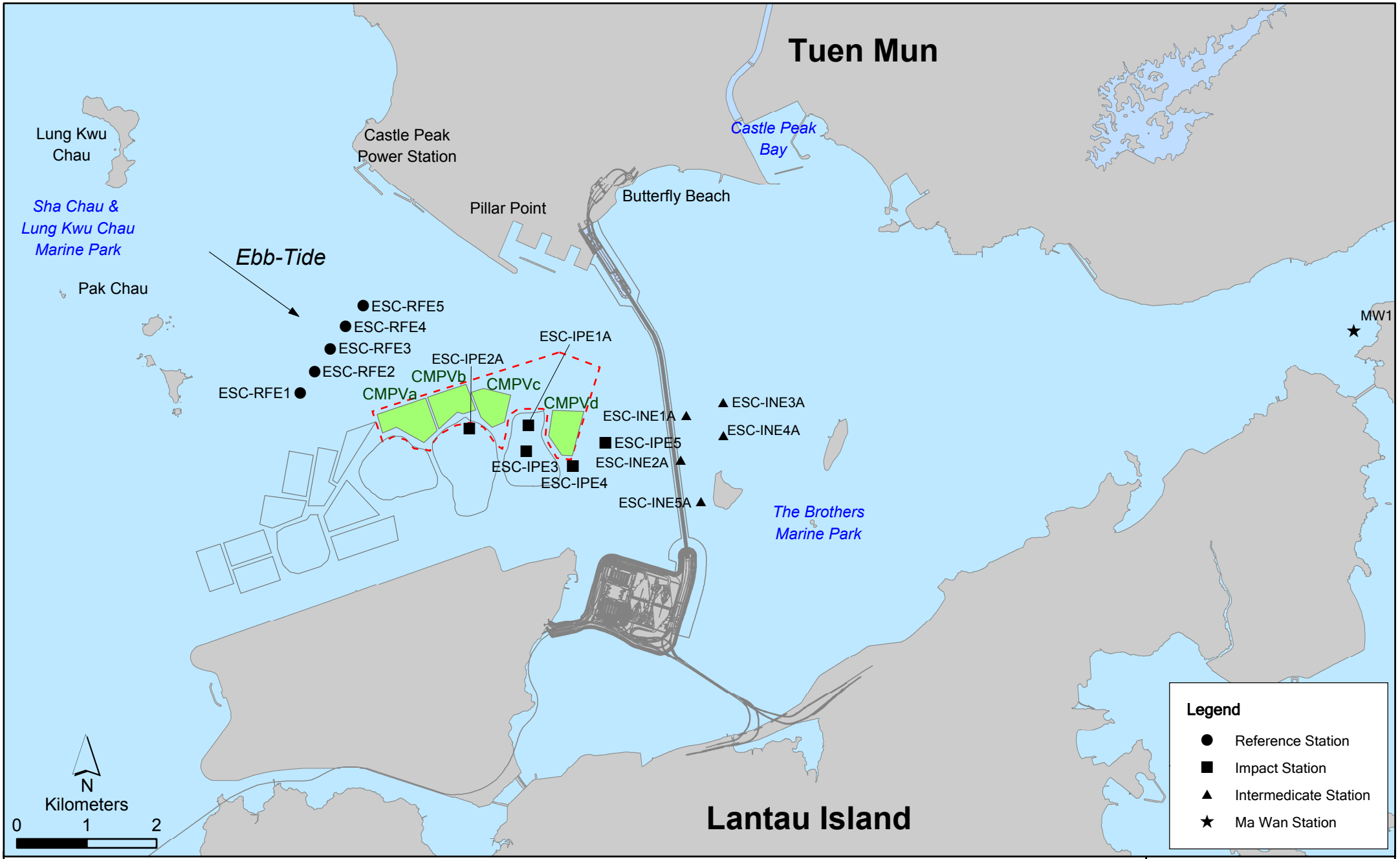

Figure 3.2

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

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Date: 19/4/2017

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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, July 2017 and August 2018. 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 November 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 Impact and Intermediate 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 October to December 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 October to December 2018, except for Arsenic which was slightly higher than LCEL at Active Pit stations ESC-NPAA and ESC-NPAB in both October and November 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*.

<u>*Metals and Metalloids*</u>

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, Chromium, 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, Chromium, Lead, Mercury and Zinc levels and proximity to the pit (i.e. Area) indicated that there were significant spatial trends ($p < 0.01$), but there was a weak relationship between Cadmium, Chromium, Lead, Mercury and Zinc levels and proximity to the pit ($r^2 < 0.60$).

<u>*Organic Contaminants*</u>

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.

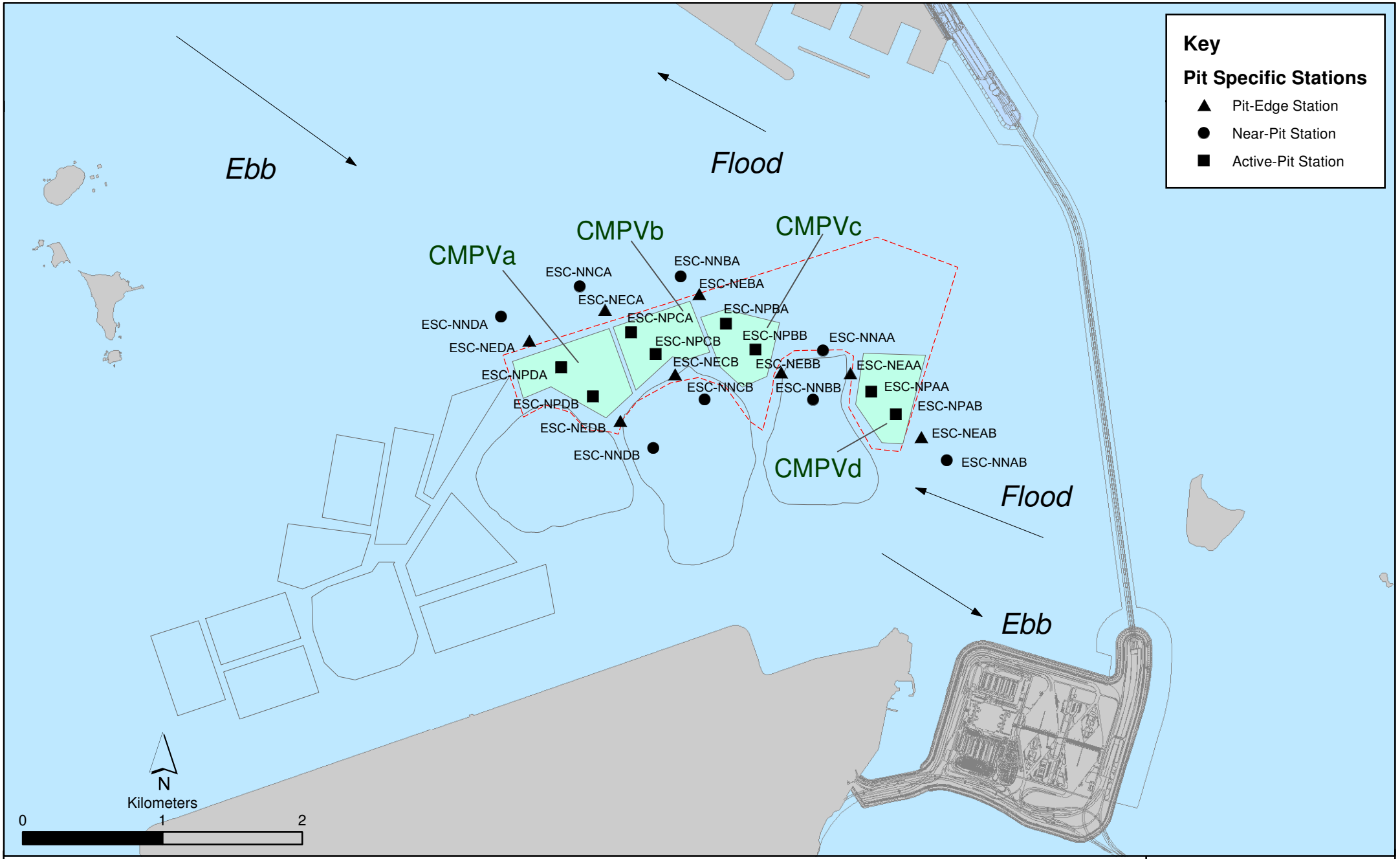

Figure 3.3

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 Active Pit stations than at the Pit Edge stations than at Near Pit stations. Subsequent linear regression analysis for TOC 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 TOC levels and proximity to the pit ($r^2 < 0.60$). There was no 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 December 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 December 2018, except concentrations of Arsenic were higher than the LCEL at Mid-field stations ESC-RMA and ESC-RMB.

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*.

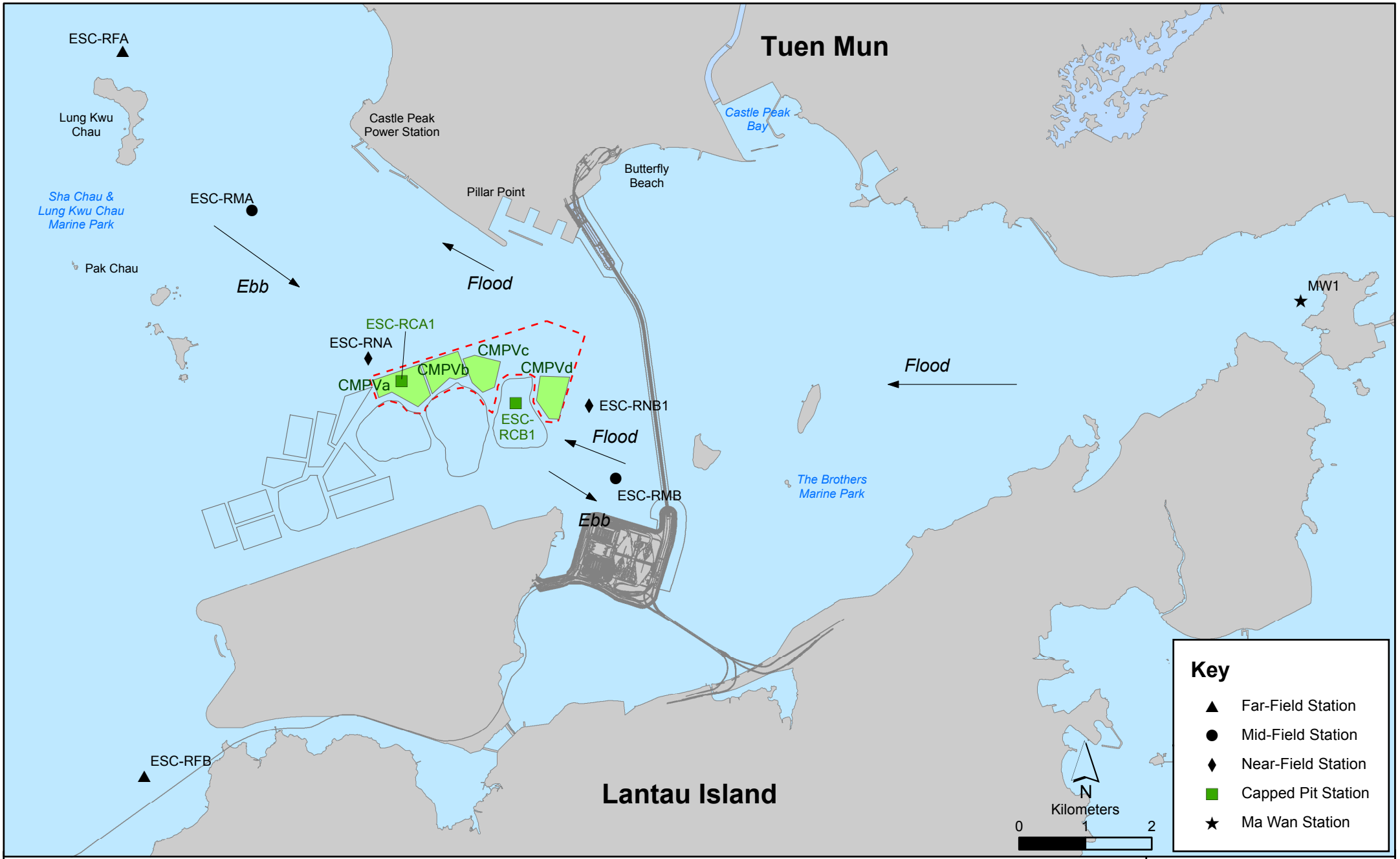

Figure 3.4

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.

3.3 SUMMARY OF MONITORING RESULTS FOR SB CMPS

3.3.1 Benthic Recolonisation Studies for SB CMPs

3.3.2 A benthic survey was conducted at the SB Capped Mud Pit stations (SB-CPA and SB-CPB) and at the Reference stations to the south of Sha Chau in December 2018 (see *Figure 3.5* for the locations of the stations). A total of 898 individuals, belonging to 7 animal phyla, comprising of 39 families and 53 genera were obtained from all the monitoring stations. *Table 3.4* summarises the results of the benthic survey.

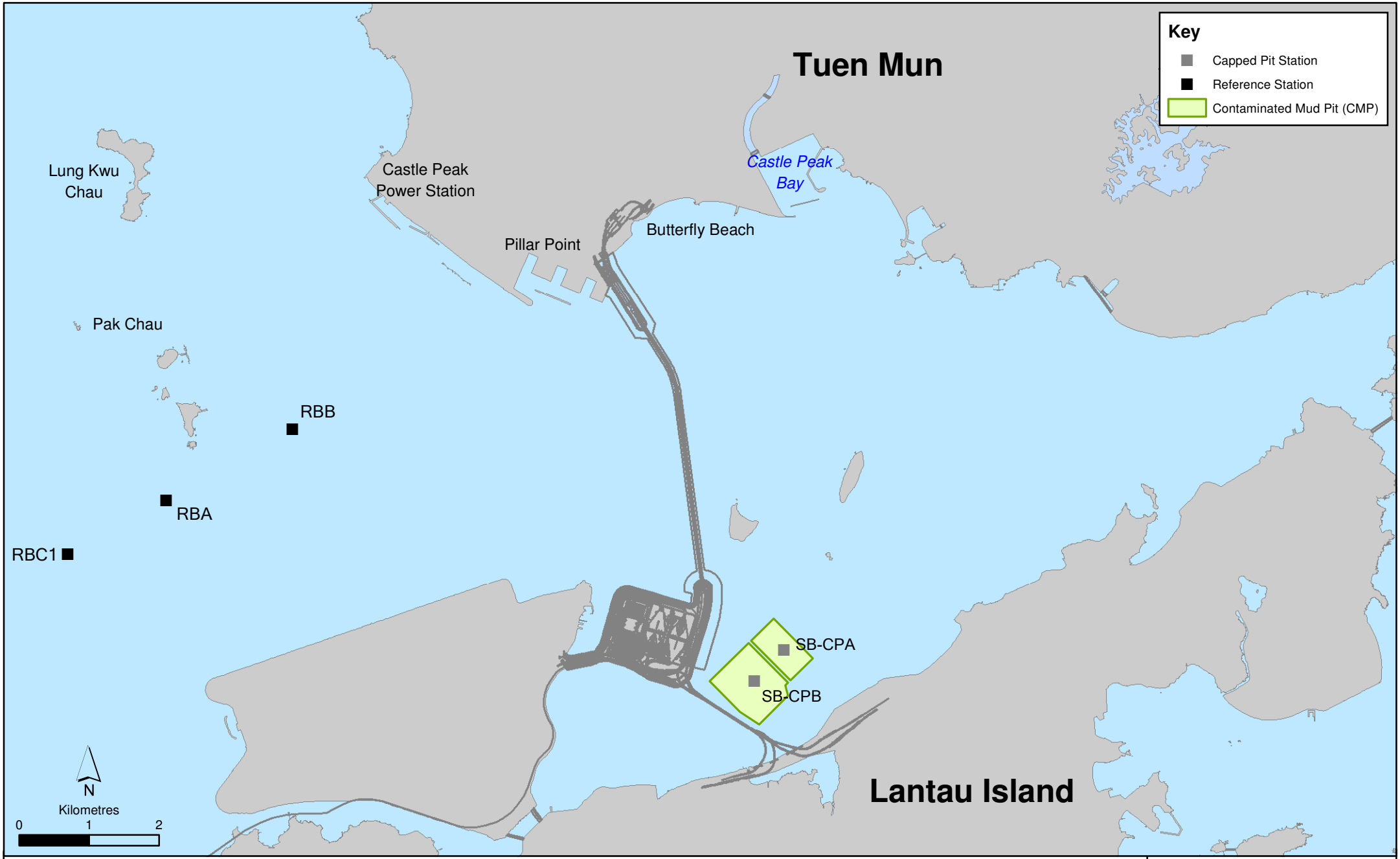

Figure 3.5

Benthic Monitoring Stations for SB CMPs

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Date: 27/11/2017

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Table 3.4 Summary of Benthic Survey Results during December 2018 Monitoring

Area	No. of Samples	No. of Individuals (Total)	Biomass (g) (Total)	Average No. of Individuals (Per Station)	Biomass (g) (Per Station)	Average Biomass (g) (Per Individual) (g)	Average No. of Genera (Per Station)	Average Diversity H' (Per Station)
Capped Pit Station								
SB-CPA	12	74	131.32	6.17	10.94	1.77	3.50	1.02
SB-CPB	12	125	343.83	10.42	28.65	2.75	5.25	1.28
(Total)	-	*199*	*475.15*	-	-	-	-	-
Reference Stations								
SB-RBA	12	234	932.49	19.50	77.71	3.98	6.58	1.38
SB-RBB	12	109	411.22	9.08	34.27	3.77	4.75	1.32
SB-RBC	12	356	1663.34	29.67	138.61	4.67	6.42	1.22
(Total)	-	*699*	*3007.05*		-	-	-	-
Total	**60**	**898**	**3482.20**	**-**	**-**	**-**	**-**	**-**

3.3.3 The average number of individuals, average biomass per area and diversity were generally lower at the Capped Pit stations than at the Reference stations. Samples contained a variety of species, but each species was often in low abundance. The most dominant species recorded were mainly bivalve mollusks at both Capped Pit and Reference stations during the reporting period.

Summary of Statistical Analysis

3.3.4 Data obtained during this reporting period were statistically compared with data obtained since August 2015. Details of the statistical analyses are presented in *Annex C*.

3.3.5 Spatial and temporal differences in means of species diversity indices, number of individuals and biomass were statistically tested using two-factor ANOVA with sampling period and stations as the fixed factors under investigation. Results of the statistical analysis showed that the Number of Genera, Number of Individuals, Genus Richness, Shannon-Weiner Diversity Index and Biomass were significantly higher at Reference than at Capped Pit stations, while Pielou's Evenness was similar among all stations, except lower at Reference Station SB-RBC. However, all parameters did not show any consistent temporal variations.

3.3.6 Overall, although the results indicated that the abundance and diversity at the Capped Pit stations were lower than those at the Reference stations, there is an increasing trend of macrobenthos infauna in terms of biomass over time at the Capped Pit stations since Year 2016. The faunal diversity at the Capped Pit stations also appears to increase over time and the majority of the infauna species identified were polychaetes, crustaceans and bivalves, which were similar to the species found in the adjacent reference stations in North Lantau waters. Based on the monitoring results, it is considered that the benthic communities at the Capped Pit stations have started to be re-established and resemble that of the surrounding areas.

3.3.7 Based on the results of the benthic recolonisation studies for SB CMP, it is concluded that the capped pits have been proven to be colonised by macrobenthos infauna. Thus, benthic recolonisation monitoring at SB CMP should be regarded as complete and therefore should not continue into the next monitoring period.

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 at the laboratory facility on 12 December 2018. The procedures of measurements of metals in water and sediment samples were inspected. The IA was generally satisfied with the laboratory facilities and the whole procedures of sample preparation and measurements. The IA reminded the use of clean sampling bottles and clean laboratory testing environments to avoid cross contamination in metal analysis. Overall, the IA satisfied with the monitoring procedures 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 January to March 2019 for ESC CMPs include:

- *Water Column Profiling of ESC CMP Vd* in January, February and March 2019;
- *Routine Water Quality Monitoring of ESC CMPs* in January and February 2019;
- *Pit Specific Sediment Chemistry of ESC CMP Vd* in January, February and March 2019;
- *Cumulative Impact Sediment Chemistry of ESC CMPs* in February 2019;
- *Demersal Trawling for ESC CMPs* in January and February 2019; and
- *Sediment Toxicity Test of ESC CMPs* in February 2019.

5.1.2 Further to the recommendation discussed in Section *3.3.6 and 3.3.7* above, no further monitoring activities will be conducted for SB CMPs.

5.1.3 The sampling schedule for ESC CMPs is presented in *Annex A1*.

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-Oct-2018	0	1,180,928
2-Oct-2018	1,079	1,182,007
3-Oct-2018	1,438	1,183,445
4-Oct-2018	461	1,183,906
5-Oct-2018	607	1,184,513
6-Oct-2018	1,616	1,186,129
7-Oct-2018	0	1,186,129
8-Oct-2018	500	1,186,629
9-Oct-2018	1,086	1,187,715
10-Oct-2018	2,034	1,189,749
11-Oct-2018	1,086	1,190,835
12-Oct-2018	1,647	1,192,482
13-Oct-2018	1,581	1,194,063
14-Oct-2018	0	1,194,063
15-Oct-2018	2,038	1,196,101
16-Oct-2018	2,504	1,198,605
17-Oct-2018	0	1,198,605
18-Oct-2018	1,006	1,199,611
19-Oct-2018	1,006	1,200,617
20-Oct-2018	978	1,201,595
21-Oct-2018	0	1,201,595
22-Oct-2018	1,000	1,202,595
23-Oct-2018	500	1,203,095
24-Oct-2018	879	1,203,974
25-Oct-2018	1,538	1,205,512
26-Oct-2018	611	1,206,123
27-Oct-2018	164	1,206,287
28-Oct-2018	0	1,206,287
29-Oct-2018	0	1,206,287
30-Oct-2018	290	1,206,577
31-Oct-2018	1,126	1,207,703
1-Nov-2018	0	1,207,703
2-Nov-2018	982	1,208,685
3-Nov-2018	1,897	1,210,582
4-Nov-2018	0	1,210,582
5-Nov-2018	500	1,211,082
6-Nov-2018	1,840	1,212,922
7-Nov-2018	2,764	1,215,686
8-Nov-2018	2,834	1,218,520
9-Nov-2018	2,065	1,220,585
10-Nov-2018	1,575	1,222,160
11-Nov-2018	0	1,222,160
12-Nov-2018	0	1,222,160
13-Nov-2018	1,000	1,223,160
14-Nov-2018	1,531	1,224,691
15-Nov-2018	1,048	1,225,739

Date	Daily Disposal Volume (m^3)	Accumulative Disposal Volume (m^3)
16-Nov-2018	0	1,225,739
17-Nov-2018	1,000	1,226,739
18-Nov-2018	626	1,227,365
19-Nov-2018	1,000	1,228,365
20-Nov-2018	781	1,229,146
21-Nov-2018	1,000	1,230,146
22-Nov-2018	1,103	1,231,249
23-Nov-2018	2,114	1,233,363
24-Nov-2018	1,107	1,234,470
25-Nov-2018	306	1,234,776
26-Nov-2018	1,000	1,235,776
27-Nov-2018	500	1,236,276
28-Nov-2018	1,000	1,237,276
29-Nov-2018	500	1,237,776
30-Nov-2018	500	1,238,276
1-Dec-2018	0	1,238,276
2-Dec-2018	0	1,238,276
3-Dec-2018	0	1,238,276
4-Dec-2018	0	1,238,276
5-Dec-2018	0	1,238,276
6-Dec-2018	1,000	1,239,276
7-Dec-2018	635	1,239,911
8-Dec-2018	500	1,240,411
9-Dec-2018	0	1,240,411
10-Dec-2018	500	1,240,911
11-Dec-2018	851	1,241,762
12-Dec-2018	1,000	1,242,762
13-Dec-2018	1,294	1,244,056
14-Dec-2018	500	1,244,556
15-Dec-2018	1,000	1,245,556
16-Dec-2018	0	1,245,556
17-Dec-2018	0	1,245,556
18-Dec-2018	0	1,245,556
19-Dec-2018	766	1,246,322
20-Dec-2018	656	1,246,978
21-Dec-2018	1,115	1,248,093
22-Dec-2018	2,690	1,250,783
23-Dec-2018	2,400	1,253,183
24-Dec-2018	2,400	1,255,583
25-Dec-2018	1,600	1,257,183
26-Dec-2018	0	1,257,183
27-Dec-2018	1,000	1,258,183
28-Dec-2018	546	1,258,729
29-Dec-2018	815	1,259,544
30-Dec-2018	0	1,259,544
31-Dec-2018	1,298	1,260,842

Annex C

Statistical Analysis

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

Dissolved Oxygen

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Area	944339.069	3	314779.690	9.603	**
Period	936811958.479	34	27553292.896	840.529	**
Area * Period	59219464.694	102	580582.987	17.711	**
Error	80968792.493	2470	32780.888		
Total	5929916590.500	2610			

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 = **Nov 18** > 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 = Jul 18 = May 12 > = Aug 17 = Jul 16 = **Oct 18** = Oct 17 > Aug 12 > Aug 13 ≥ Aug 18 = 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	41638860.431	3	13879620.144	88.651	**
Period	581815672.680	34	17112225.667	109.298	**
Area * Period	159158164.310	102	1560374.160	9.966	**
Error	386715014.106	2470	156564.783		
Total	5929845184.500	2610			

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

SNK Results:

- Nov 17 > Oct 17 = Aug 13 > Apr 17 ≥ Aug 18 = Apr 12 = Aug 12 = **Nov 18** = Nov 16 ≥ Oct 16 ≥ Jul 18 = Nov 12 ≥ Jul 16 ≥ Jul 17 = May 16 = **Oct 18** ≥ Apr 13 = Feb 12 ≥ Apr 16 ≥ Jan 17 = May 18 = Oct 12 ≥ Jul 12 ≥ Jan 18 = Aug 17 = 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	2082656053.915	33	63110789.513	844.372	**
Area	19217964.287	3	6405988.096	85.707	**
Station(Area)	32758712.460	24	1364946.353	18.262	**
Period * Area	348008507.038	96	3625088.615	48.501	**
Period * Station(Area)	358534652.686	282	1271399.478	17.010	**
Error	233347115.813	3122	74742.830		
Total	15109980102.000	3568			

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

SNK Results:

- Aug 13 > May 18 > Feb 12 > **Nov 18** = Jul 18 > Jul 13 = Apr 12 > **Oct 18** = Aug 18 = 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	1937881779.446	33	58723690.286	401.674	**
Area	30253028.018	3	10084342.673	68.978	**
Station(Area)	69173176.344	24	2882215.681	19.715	**
Period * Area	406404923.439	96	4233384.619	28.957	**
Period * Station(Area)	283266689.956	282	1004491.808	6.871	**
Error	456428411.438	3122	146197.441		
Total	15102074804.500	3568			

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

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	2436947648.320	33	73846898.434	852.594	**
Area	45163425.336	3	15054475.112	173.810	**
Station(Area)	50290245.184	24	2095426.883	24.193	**
Period * Area	235975246.025	96	2458075.479	28.380	**
Period * Station(Area)	394643098.054	282	1399443.610	16.157	**
Error	270410114.875	3122	86614.387		
Total	15146077771.000	3568			

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 = **Nov 18** = Jul 18 > Apr 18 > May 18 > Apr 12 > Feb 12 = Aug 13 > **Oct 18** = Aug 18 ≥ Jul 12 = Nov 12 > Jul 13 = May 16 = May 12 > Jan 17 = Jan 13 = Apr 13 = Oct 16 = Apr 16 = Oct 12 > Jul 16 = Nov 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	2655689746.907	33	80475446.876	811.525	**
Area	6583408.246	3	2194469.415	22.129	**
Station(Area)	20794714.455	24	866446.436	8.737	**
Period * Area	128961840.971	96	1343352.510	13.547	**
Period * Station(Area)	122886514.249	282	435767.781	4.394	**
Error	309595313.688	3122	99165.699		
Total	15139630063.000	3568			

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

Total Inorganic Nitrogen

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	2411879934.167	33	73087270.732	1287.906	**
Area	54604236.899	3	18201412.300	320.736	**
Station(Area)	70019972.162	24	2917498.840	51.411	**
Period * Area	182429363.305	96	1900305.868	33.486	**
Period * Station(Area)	191204012.475	282	678028.413	11.948	**
Error	177170075.375	3122	56748.903		
Total	15146108720.500	3568			

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 = May 13 > Jul 12 > **Nov 18** = Aug 17 > Jul 17 > May 12 = Aug 16 > May 17 ≥ Aug 12 = Apr 18 = Jul 18 > Jul 13 = May 16 > Aug 18 = Oct 17 > Apr 13 > Feb 17 = Apr 16 = Jan 18 > Oct 12 > Feb 12 > Nov 16 > Jan 17 = **Oct 18** = 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	1339685391.733	33	40596527.022	183.318	**
Area	49624822.847	3	16541607.616	74.695	**
Station(Area)	32441999.347	24	1351749.973	6.104	**
Period * Area	622345314.707	96	6482763.695	29.274	**
Period * Station(Area)	506327805.153	282	1795488.671	8.108	**
Error	691379045.313	3122	221453.890		
Total	15135852095.500	3568			

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

Suspended Solids

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	1742781189.603	33	52811551.200	1348.536	**
Area	18604532.654	3	6201510.885	158.355	**
Station(Area)	189249624.559	24	7885401.023	201.353	**
Period * Area	423637243.950	96	4412887.958	112.683	**
Period * Station(Area)	837009840.174	282	2968120.001	75.791	**
Error	122264167.125	3122	39162.129		
Total	15145691216.500	3568			

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 = **Nov 18** = Aug 18 = Jul 18 = Apr 16 ≥ Jul 17 = **Oct 18** = Apr 13 > Feb 12 > Jan 18 > Aug 16 > May 18 = Feb 13 > Feb 18 = Jan 13 = Apr 18 > 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	-0.856	0.132	0.017	**

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

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

Arsenic

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	697719914.265	33	21143027.705	344.950	**
Area	1157475.595	2	578737.798	9.442	**
Station(Area)	111568064.890	3	37189354.963	606.747	**
Period * Area	136498333.118	66	2068156.562	33.742	**
Period * Station(Area)	114672490.005	98	1170127.449	19.091	**
Error	136683369.789	2230	61292.991		
Total	4803582087.000	2433			

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

SNK Results:

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

Cadmium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	356278089.080	33	10796305.730	96.120	**
Area	280115083.110	2	140057541.555	1246.940	**
Station(Area)	16986550.913	3	5662183.638	50.411	**
Period * Area	131501119.326	66	1992441.202	17.739	**
Period * Station(Area)	145621730.884	98	1485936.029	13.229	**
Error	250138812.706	2227	112320.976		
Total	4777900635.000	2430			

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

SNK Results:

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

Linear Regression Analysis					
Source	Df	Slope	r	r^2	P
Area	1	-0.037	0.443	0.196	**
Note: Linear regression analysis on spatial changes of contaminant concentrations.					

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	405834970.744	33	12298029.416	108.063	**
Area	57950214.272	2	28975107.136	254.606	**
Station(Area)	62489401.312	3	20829800.437	183.033	**
Period * Area	221127600.641	66	3350418.192	29.440	**
Period * Station(Area)	197232475.941	98	2012576.285	17.685	**
Error	253782465.309	2230	113803.796		
Total	4803664991.500	2433			

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

SNK Results:

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

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-1.538	0.196	0.038	**

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

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	206408789.592	33	6254811.806	80.604	**
Area	377595961.503	2	188797980.752	2432.981	**
Station(Area)	55388030.129	3	18462676.710	237.923	**
Period * Area	185688817.626	66	2813466.934	36.256	**
Period * Station(Area)	203946923.988	98	2081091.061	26.818	**
Error	173046773.815	2230	77599.450		
Total	4803665298.000	2433			

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

SNK Results:

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

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	306019130.458	33	9273306.984	68.264	**
Area	97845256.816	2	48922628.408	360.137	**
Station(Area)	135228563.157	3	45076187.719	331.822	**
Period * Area	151951867.446	66	2302301.022	16.948	**
Period * Station(Area)	205736780.676	98	2099354.905	15.454	**
Error	302933356.794	2230	135844.555		
Total	4803665087.500	2433			

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

SNK Results:

- Mar 17 > **Nov 18** ≥ **Oct 18** = Jul 17 ≥ Jun 18 = Oct 17 ≥ May 17 ≥ Jul 18 ≥ Jun 17 = Sep 17 = Aug 17 ≥ May 18 = Mar 18 = Nov 17 ≥ Apr 16 ≥ Mar 16 = **Dec 18** = Jan 18 = Jul 16 = Jun 16 = Aug 16 ≥ Nov 16 = Apr 17 = Aug 18 ≥ Sep 18 = 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	-2.075	0.219	0.048	**

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

Mercury

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	784933868.335	33	23785874.798	245.575	**
Area	24104474.750	2	12052237.375	124.432	**
Station(Area)	3501614.787	3	1167204.929	12.051	**
Period * Area	78578218.152	66	1190579.063	12.292	**
Period * Station(Area)	54378412.273	98	554881.758	5.729	**
Error	215992766.472	2230	96857.743		
Total	4771979346.000	2433			

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 = **Oct 18** = Nov 17 = Jan 17 > Mar 17 = Jun 18 = Apr 17 = Feb 17 = Sep 18 = Jul 17 = Oct 17 = Jul 18 > Aug 18 ≥ Dec 17 = Sep 17 = Aug 17 = **Nov 18** > **Dec 18** > 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	-0.012	0.063	0.004	**

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

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	343972142.825	33	10423398.267	148.131	**
Area	103165256.068	2	51582628.034	733.063	**
Station(Area)	150974943.075	3	50324981.025	715.190	**
Period * Area	225058185.557	66	3409972.508	48.461	**
Period * Station(Area)	218645445.328	98	2231075.973	31.707	**
Error	156915957.432	2230	70365.900		
Total	4803664577.000	2433			

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

SNK Results:

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

Silver

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	157859344.168	33	4783616.490	52.719	**
Area	384969495.019	2	192484747.510	2121.313	**
Station(Area)	13285359.751	3	4428453.250	48.805	**
Period * Area	221457977.838	66	3355423.907	36.979	**
Period * Station(Area)	213562827.618	98	2179212.527	24.016	**
Error	202256121.152	2229	90738.502		
Total	4796367687.000	2432			

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

SNK Results:

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

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	422060497.300	33	12789712.039	177.513	**
Area	125647778.631	2	62823889.315	871.953	**
Station(Area)	123212466.830	3	41070822.277	570.035	**
Period * Area	201589898.142	66	3054392.396	42.393	**
Period * Station(Area)	165168727.771	98	1685395.181	23.392	**
Error	160670688.821	2230	72049.636		
Total	4803662081.500	2433			

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

SNK Results:

- **Nov 18** > Jul 17 = Oct 17 = Jun 18 = **Oct 18** > Nov 17 = May 18 = Mar 18 > Apr 18 = Jul 18 = Mar 16 = Feb 18 ≥ Sep 17 = Aug 17 = Apr 16 = Jan 18 = Aug 16 = Dec 17 ≥ Jun 16 = Sep 18 = Aug 18 ≥ **Dec 18** = 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	-11.396	0.310	0.096	**

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	417941584.842	33	12664896.510	174.642	**
Area	49516146.897	2	24758073.448	341.400	**
Station(Area)	52830707.902	3	17610235.967	242.835	**
Period * Area	229470898.968	66	3476831.803	47.944	**
Period * Station(Area)	288967188.869	98	2948644.784	40.660	**
Error	161718062.718	2230	72519.311		
Total	4803320006.500	2433			

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

SNK Results:

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

Linear Regression Analysis

Source	Df	Slope	r	r^2	P
Area	1	-641.109	0.181	0.033	**

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

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

Arsenic

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	38493025.993	10	3849302.599	478.914	**
Area	20028984.322	4	5007246.080	622.981	**
Area * Station	1068731.063	4	267182.766	33.242	**
Period * Area	65490551.579	39	1679244.912	208.925	**
Period * Area * Station	4459011.021	40	111475.276	13.869	**
Error	8752904.542	1089	8037.562		
Total	559584685.000	1188			

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

SNK Results:

- Jun 18 > **Dec 18** = Dec 17 = Feb 18 > Aug 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	21045175.126	10	2104517.513	60.974	**
Area	10293785.873	4	2573446.468	74.561	**
Area * Station	33621236.226	4	8405309.057	243.528	**
Period * Area	25503355.550	39	653932.194	18.946	**
Period * Area * Station	10194019.909	40	254850.498	7.384	**
Error	37586600.000	1089	34514.784		
Total	558373943.500	1188			

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

Chromium

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	10547790.616	10	1054779.062	98.404	**
Area	42192128.643	4	10548032.161	984.065	**
Area * Station	11213566.415	4	2803391.604	261.539	**
Period * Area	36881477.822	39	945678.919	88.226	**
Period * Area * Station	13619224.189	40	340480.605	31.765	**
Error	11672818.667	1089	10718.842		
Total	559597962.000	1188			

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

Copper

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	6134611.133	10	613461.113	55.554	**
Area	32369135.673	4	8092283.918	732.817	**
Area * Station	39778748.459	4	9944687.115	900.566	**
Period * Area	29245619.585	39	749887.682	67.908	**
Period * Area * Station	7342186.301	40	183554.658	16.622	**
Error	12025503.667	1089	11042.703		
Total	559597997.000	1188			

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

Lead

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	48647931.872	10	4864793.187	503.008	**
Area	26857419.322	4	6714354.830	694.248	**
Area * Station	5626392.733	4	1406598.183	145.439	**
Period * Area	34718099.458	39	890207.678	92.045	**
Period * Area * Station	7278678.642	40	181966.966	18.815	**
Error	10532154.750	1089	9671.400		
Total	559597975.500	1188			

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

SNK Results:

- Aug 18 > Dec 18 > Aug 16 > Aug 17 = Jun 18 > 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	68653827.943	10	6865382.794	201.152	**
Area	2634172.803	4	658543.201	19.295	**
Area * Station	3275298.954	4	818824.739	23.991	**
Period * Area	16251467.528	39	416704.296	12.209	**
Period * Area * Station	4731871.998	40	118296.800	3.466	**
Error	37133699.597	1088	34130.239		
Total	555428132.000	1187			

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

SNK Results:

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

Nickel

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	10630199.801	10	1063019.980	113.610	**
Area	32206523.934	4	8051630.984	860.512	**
Area * Station	14985101.184	4	3746275.296	400.381	**
Period * Area	44493865.365	39	1140868.343	121.930	**
Period * Area * Station	17062903.983	40	426572.600	45.590	**
Error	10189540.625	1089	9356.787		
Total	559597852.000	1188			

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

SNK Results:

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

Silver

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Period	23725251.733	10	2372525.173	154.714	**
Area	37948458.582	4	9487114.645	618.662	**
Area * Station	31612004.019	4	7903001.005	515.361	**
Period * Area	10044850.980	39	257560.282	16.796	**
Period * Area * Station	11207704.669	40	280192.617	18.272	**
Error	16699692.583	1089	15334.888		
Total	559494434.000	1188			

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

SNK Results:

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

Zinc

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	9076024.257	10	907602.426	139.256	**
Area	29960886.751	4	7490221.688	1149.247	**
Area * Station	26493513.772	4	6623378.443	1016.245	**
Period * Area	43522491.138	39	1115961.311	171.225	**
Period * Area * Station	8689186.759	40	217229.669	33.330	**
Error	7097561.125	1089	6517.503		
Total	559597389.500	1188			

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

SNK Results:

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

TOC

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	19868805.633	10	1986880.563	144.946	**
Area	27323008.726	4	6830752.182	498.312	**
Area * Station	6229058.244	4	1557264.561	113.605	**
Period * Area	42555342.386	39	1091162.625	79.602	**
Period * Area * Station	17390765.235	40	434769.131	31.717	**
Error	14927762.833	1089	13707.771		
Total	559553295.500	1188			

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

TBT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Period	27051286.017	10	2705128.602	72.146	**
Area	27356998.094	4	6839249.523	182.403	**
Area * Station	3925811.518	4	981452.879	26.175	**
Period * Area	11245479.201	39	288345.621	7.690	**
Period * Area * Station	11921526.492	40	298038.162	7.949	**
Error	40832249.333	1089	37495.178		
Total	551704672.500	1188			

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

SNK Results:

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

Benthic Macro-infauna Recolonisation Study for SB CMPs – Analysis of Variance Analysis up to December 2018

Number of Genera

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	2173954.917	4	543488.729	93.298	**
Period	1742414.131	7	248916.304	42.730	**
Period * Station	1025961.321	25	41038.453	7.045	**
Error	2370896.125	407	5825.298		
Total	29191563.000	444			

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

SNK Results:

- SB-RBC > SB-RBA > SB-RBB > SB-CPA = SB-CPB
- Aug 17 > Aug 16 > Dec 16 = **Dec 18** = Aug 18 = Aug 15 > Dec 15 = Dec 17

Number of Individuals

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	2324491.103	4	581122.776	96.775	**
Period	1334465.509	7	190637.930	31.747	**
Period * Station	1223835.646	25	48953.426	8.152	**
Error	2443980.917	407	6004.867		
Total	29256067.500	444			

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

SNK Results:

- SB-RBC > SB-RBA = SB-RBB > SB-CPB = SB-CPA
- Aug 17 = Aug 16 > **Dec 18** = Aug 18 ≥ Dec 16 ≥ Dec 15 = Aug 15 > Dec 17

Genus Richness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	1170263.297	4	292565.824	34.705	**
Period	1377715.015	7	196816.431	23.347	**
Period * Station	854515.620	25	34180.625	4.055	**
Error	3321414.294	394	8429.986		
Total	26775736.500	431			

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

SNK Results:

- SB-RBA = SB-RBC > SB-RBB > SB-CPA = SB-CPB
- Aug 17 > Aug 16 ≥ Dec 16 = Aug 15 = Aug 18 = **Dec 18** > Dec 15 = Dec 17

Pielou's Evenness

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	341674.417	4	85418.604	7.375	**
Period	556407.080	7	79486.726	6.863	**
Period * Station	753526.748	25	30141.070	2.602	**
Error	4436132.143	383	11582.590		
Total	24756943.000	420			

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

SNK Results:

- SB-CPA = SB-CPB = SB-RBA = SB-RBB > SB-RBC
- Aug 15 = Aug 17 = Dec17 ≥ Dec 16 ≥ Aug 18 = Aug 16 = **Dec 18** = Dec 15

Shannon-Weiner Diversity Index

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	1495760.351	4	373940.088	51.757	**
Period	1886130.080	7	269447.154	37.294	**
Period * Station	1055175.713	25	42207.029	5.842	**
Error	2940527.250	407	7224.883		
Total	29270827.000	444			

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

SNK Results:

- SB-RBC = SB-RBA > SB-RBB > SB-CPB = SB-CPA
- Aug 17 > Aug 16 ≥ Dec 16 ≥ Aug 15 = Aug 18 = **Dec 18** > Dec 15 = Dec 17

Biomass

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Station	1923889.609	4	480972.402	72.580	**
Period	2181471.472	7	311638.782	47.027	**
Period * Station	684002.186	25	27360.087	4.129	**
Error	2697121.625	407	6626.834		
Total	29274475.500	444			

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

SNK Results:

- SB-RBC = SB-RBB > SB-RBA > SB-CPB > SB-CPA
- **Dec 18** = Aug 18 = Aug 16 > Aug 17 = Dec 16 = Dec 17 = Aug 15 > Dec 15