

Environmental Monitoring and Audit for Contaminated Mud Pits to the South of The Brothers and at East Sha Chau (2012-2017) – Investigation Agreement No. CE 23/2012(EP)

47th Monthly Progress Report for Contaminated Mud Pits to the South of The Brothers and at East Sha Chau – July 2016

Draft (Revision 0)

11 August 2016

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Client: Civil Engineering and Development Department (CEDD)		Project No: 0175086			
Summary: This document presents the 47 th monthly progress report for Contaminated Mud Pits at the South of The Brothers and at East Sha Chau.		Date: 11 August 2016			
		Approved by: 			
		Craig A. Reid Partner			
v0	47 th Monthly Progress Report for ESC CMPs and SB CMPs	RC	JT	CAR	11/8/16
Revision	Description	By	Checked	Approved	Date
<p>This report has been prepared by Environmental Resources Management the trading name of 'ERM Hong-Kong, Limited', with all reasonable skill, care and diligence within the terms of the Contract with the client, incorporating our General Terms and Conditions of Business and taking account of the resources devoted to it by agreement with the client.</p> <p>We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.</p> <p>This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.</p>		<p>Distribution</p> <p><input type="checkbox"/> Internal</p> <p><input checked="" type="checkbox"/> Public</p> <p><input type="checkbox"/> Confidential</p>			
		 			

**Dredging, Management and Capping of Contaminated Sediment Disposal
Facility to the South of The Brothers**

**Environmental Certification Sheet
EP-427/2011/A**

Reference Document/Plan

Document/ Plan to be Certified/ Verified:	47 th Monthly Progress Report for Contaminated Mud Pits to the South of The Brothers and at East Sha Chau - July 2016
Date of Report:	11 August 2016
Date prepared by ET:	11 August 2016
Date received by IA:	11 August 2016

Reference EP Condition

Environmental Permit Condition:	Condition No.: 4.4
4 hard copies and 1 electronic copy of monthly EM&A Report shall be submitted to the Director within 2 weeks after the end of the reporting month. The EM&A Reports shall include a summary of all non-compliance (exceedances) of the environmental quality performance limits (Action and Limit Levels). The submissions shall be certified by the ET Leader and verified by the Independent Auditor. Additional copies of the submission shall be provided to the Director upon request by the Director.	

ET Certification

I hereby certify that the above referenced document/ plan complies with the above referenced condition of EP-427/2011/A	
Craig A. Reid, Environmental Team Leader:	 Date: 11/8/2016

IA Verification

I hereby verify that the above referenced document/ plan complies with the above referenced condition of EP-427/2011/A	
Dr Wang Wen Xiong, Independent Auditor:	 Date: 11/8/2016

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Agreement No. CE 23/2012 (EP)
Environmental Monitoring and Audit
for Contaminated Mud Pits to the South of The Brothers and at East Sha
Chau (2012-2017) - Investigation

47TH MONTHLY PROGRESS REPORT FOR JULY 2016

1.1 BACKGROUND

1.1.1 Since early 1990s, contaminated sediment ⁽¹⁾ arising from various construction works (e.g. dredging and reclamation projects) in Hong Kong has been disposed of at a series of seabed pits at East of Sha Chau (ESC). In late 2008, a review indicated that the existing and planned facilities at ESC would not be able to meet the disposal demand after 2012. In order to meet this demand, the Hong Kong Special Administrative Region Government (HKSARG) decided to implement a new contained aquatic disposal (CAD) ⁽²⁾ facility at the South of The Brothers (SB CMPs) which had been under consideration for a number of years.

1.1.2 The environmental acceptability of the construction and operation of the Project had been confirmed by findings of the associated Environmental Impact Assessment (EIA) study completed in 2005 under *Agreement No. CE 12/2002(EP)* ⁽³⁾. The Director of Environmental Protection (DEP) approved this EIA report under the *Environmental Impact Assessment Ordinance (Cap. 499) (EIAO)* in September 2005 (*EIA Register No.: AEIAR-089/2005*).

1.1.3 In accordance with the EIA recommendation, prior to commencement of construction works for the SB CMPs, the Civil Engineering and Development Department (CEDD) undertook a detailed review and update of the EIA findings for the SB site ⁽⁴⁾. Findings of the EIA review undertaken in 2009/2010 confirmed that the construction and operation of the SB site had been predicted to be environmentally acceptable.

(1) According to the Management Framework of Dredged/ Excavated Sediment of ETWB TC(W) No. 34/2002, contaminated sediment in general shall mean those sediment requiring Type 2 – Confined Marine Disposal as determined according to this TC(W).

(2) CAD options may involve use of excavated borrow pits, or may involve purpose-built excavated pits. CAD sites are those which involve filling a seabed pit with contaminated mud and capping it with uncontaminated material such that the original seabed level is restored and the contaminated material is isolated from the surrounding marine environment.⁷

(3) Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/ East of Sha Chau Area (*Agreement No. CE 12/2002(EP)*)

(4) Under the CEDD study *Contaminated Sediment Disposal Facility to the South of The Brothers (Agreement No. FM 2/2009)*

- *Pit Specific Sediment Chemistry of ESC CMP Vd* was undertaken on 6 July 2016; and
- *Demersal Trawling of ESC CMP Vd* was undertaken on 27 and 28 July 2016.

1.3.2 No monitoring activities were scheduled to be undertaken for SB CMPs in July 2016.

1.4 *DETAILS OF OUTSTANDING SAMPLING AND/OR ANALYSIS*

1.4.1 No outstanding sampling remained for July 2016.

1.4.2 A summary of field activities conducted are presented in *Annex A*. The following analyses are in progress and will be presented in the corresponding quarterly report:

- Species identification of the biota samples collected from *Demersal Trawling for ESC CMP Vd* in July 2016.

1.5 *BRIEF DISCUSSION OF THE MONITORING RESULTS FOR ESC CMPs*

1.5.1 Brief discussion of the monitoring results of the following activities for ESC CMPs is presented in this 47th *Monthly Progress Report*:

- *Routine Water Quality Monitoring of ESC CMP Vd* in July 2016;
- *Water Column Profiling of ESC CMP Vd* in July 2016; and
- *Pit Specific Sediment Chemistry of ESC CMP Vd* in July 2016.

1.5.2 *Routine Water Quality Monitoring of ESC CMP Vd – July 2016*

1.5.3 *Routine Water Quality Monitoring* was undertaken on 4 July 2016. The monitoring results have been assessed for compliance with the Water Quality Objectives (WQOs) set by Environmental Protection Department (EPD). This consists of a review of the EPD routine water quality monitoring data for the wet season period (April to October) of 2005 - 2014 from stations in the Northwestern Water Control Zone (WCZ), where the ESC CMPs are located⁽¹⁾. For Salinity, the averaged value obtained from the Reference stations was used for the basis as the WQO. Levels of Dissolved Oxygen (DO) and Turbidity were also assessed for compliance with the Action and Limit Levels (see *Table B1 of Annex B* for details). The monitoring results are shown in *Tables B2 and B3 of Annex B* and *Figures 1 - 10 of Annex C*. A total of sixteen (16) monitoring stations were sampled in July 2016 as shown in *Figure 1.2*.

In-situ Measurements

1.5.4 Graphical presentation of the monitoring results (Temperature, DO, pH, Salinity and Turbidity) is shown in *Figures 1 - 6 of Annex C*. Analyses of results for July 2016 indicated that the levels of pH and DO complied with the WQOs at all stations (Impact, Intermediate, Reference and Ma Wan stations) in *July 2016 (Table B2 of Annex B; Figures 1, 2, 3 and 4 of Annex C)*. Levels of Salinity at Impact and Intermediate stations exceeded the WQOs (*Table B2 of Annex B; Figure 5 of Annex C*). The lower Salinities recorded at these stations is likely to be caused by the freshwater discharged from the Pearl River Delta during the summer months which tend to form a surface layer of lower salinity water at these stations with shallower depth when compared with the Reference stations.

1.5.5 The levels of DO and Turbidity complied with the Action and Limit Levels at all stations (*Table B2 of Annex B; Figures 2, 3 and 6 of Annex C*).

1.5.6 Overall, *in-situ* measurement results of the *Routine Water Quality Monitoring* indicated that the disposal operation at ESC CMP Vd did not appear to cause any unacceptable impacts in water quality in July 2016.

Laboratory Measurements

1.5.7 Laboratory analysis of July 2016 results indicated that concentrations of Cadmium, Chromium, Silver and Mercury were below their limit of reporting at all stations. Arsenic, Lead, Nickel, Copper and Zinc were detected in July 2016 samples and the concentrations of these metals and metalloid were similar amongst stations, except higher concentration of Zinc was recorded at Impact stations (*Table B3 of Annex B; Figure 7 of Annex C*).

(1) <http://epic.epd.gov.hk/EPICRIVER/marine/?lang=en>

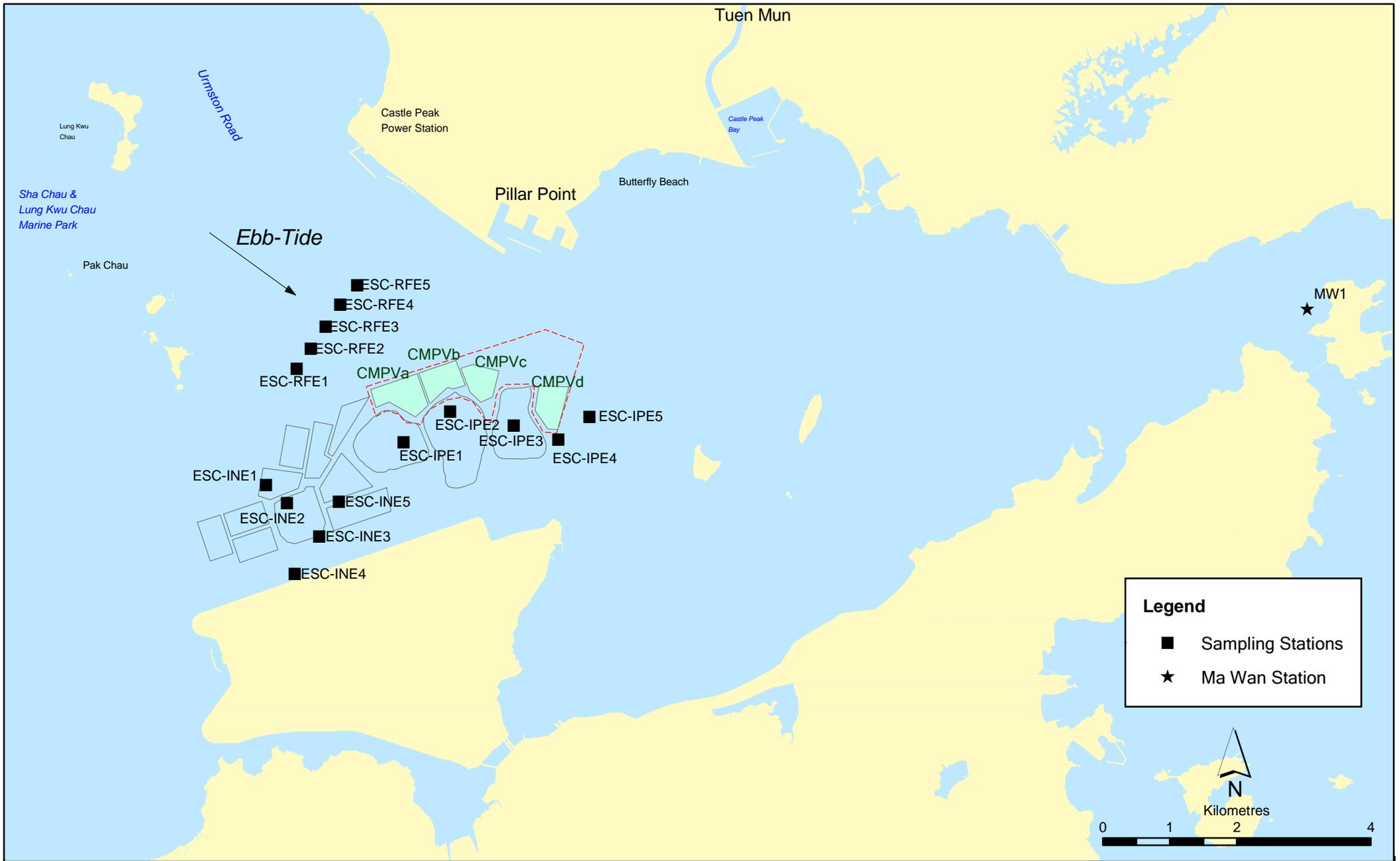


Figure 1.2

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

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Date: 29/10/2009

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- 1.5.8 For nutrients, concentrations of Total Inorganic Nitrogen (TIN) at all stations in July 2016 exceeded the WQO (0.5 mg/L) (*Table B3 of Annex B; Figure 8 of Annex C*). It should be noted that due to effect of Pearl River, the North Western WCZ has historically experienced higher levels of TIN⁽¹⁾. Since TIN concentrations were recorded to be similar amongst all stations, the exceedances of TIN WQO at all stations are unlikely to be caused by the disposal operation at ESC CMP Vd. Concentrations of Ammonia Nitrogen (NH₃-N) were relatively similar amongst all stations (*Table B3 of Annex B; Figure 8 of Annex C*). Levels of 5-day Biochemical Oxygen Demand (BOD₅) appear to be higher at Reference station in July 2016 (*Table B3 of Annex B; Figure 9 of Annex C*).
- 1.5.9 Concentrations of SS were higher than the WQO (11.1 mg/L for wet season) at Impact and Reference stations. However, concentrations of SS complied with the Action and Limit Levels at all stations in July 2016 (*Table B3 of Annex B; Figure 10 of Annex C*).
- 1.5.10 Overall, results of the *Routine Water Quality Monitoring* indicated that the disposal operation at ESC CMP Vd did not appear to cause any unacceptable deterioration in water quality in July 2016. Detailed statistical analysis will be presented in the Quarterly Report to investigate any spatial and temporal trends of potential concern.
- 1.5.11 ***Water Column Profiling of ESC CMP Vd – July 2016***
- 1.5.12 *Water Column Profiling* was undertaken on 5 July 2016. The monitoring results have been assessed for compliance with the WQOs (see *Section 1.5.3* for details). Levels of DO and Turbidity were also assessed for compliance with the Action and Limit Levels (see *Table B1 of Annex B* for details).

In-situ Measurements

- 1.5.13 Analyses of results for July 2016 indicated that levels of Salinity, DO and pH complied with the WQOs at both Downstream and Upstream stations (*Table B4 of Annex B*). In addition, DO and Turbidity at all stations complied with the Action and Limit Levels (*Table B4 of Annex B*).

Laboratory Measurements for Suspended Solids (SS)

- 1.5.14 Analyses of results for July 2016 indicated that the SS levels were higher than the WQO at both Upstream and Downstream stations. Both Upstream and Downstream stations complied with the Action and Limit Levels (*Table B4 of Annex B*).

Overall, the monitoring results indicated that the mud disposal operation at ESC CMP Vd did not appear to cause any deterioration in water quality during this reporting period.

(1) http://www.epd.gov.hk/epd/misc/marine_quality/1986-2005/textonly/eng/index.htm

- 1.5.15 *Pit Specific Sediment Chemistry of ESC CMP Vd - July 2016*
- 1.5.16 Monitoring locations for *Pit Specific Sediment Chemistry for ESC CMP Vd* are shown in *Figure 1.3*. A total of six (6) monitoring stations were sampled in July 2016.
- 1.5.17 The concentrations of most inorganic contaminants were lower than the Lower Chemical Exceedance Level (LCEL) at all stations, except Arsenic (*Figures 11 and 12 of Annex C*). In July 2016, concentration of Arsenic at Active Pit station ESC-NPAB exceeded the LCEL (*Figure 11 of Annex C*).
- 1.5.18 Whilst the average concentration of Arsenic in the Earth's crust is generally ~2mg/kg, significantly higher Arsenic concentrations (median = 14 mg/kg) have been recorded in Hong Kong's onshore sediments ⁽¹⁾. It is presumed that the natural concentrations of Arsenic are similar in onshore and offshore sediments ⁽²⁾, and relatively high Arsenic levels may thus occur throughout Hong Kong. Therefore, the LECL exceedances of Arsenic are unlikely to be caused by the disposal operations at ESC CMP Vd but rather as a result of naturally occurring deposits.
- 1.5.19 For organic contaminants, the concentrations of Total Organic Carbon (TOC) were similar amongst the stations in July 2016 (*Figure 13 of Annex C*). In July 2016, Tributyltin (TBT) concentrations were higher at Active Pit station ESC-NPAB (*Figure 14 of Annex C*). Low and High Molecular Weight Polycyclic Aromatic Hydrocarbons (PAHs), Total Polychlorinated Biphenyls (PCBs), Total dichlorodiphenyltrichloroethane (DDT) and 4,4'-dichlorodiphenyldichloroethylene (DDE) concentrations were below the limit of reporting at all stations in July 2016.
- 1.5.20 Overall, 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 in July 2016. Statistical analysis will be undertaken and presented in the quarterly report to investigate whether there are any unacceptable impacts in the area caused by the contaminated mud disposal.

(1) Sewell RJ (1999) *Geochemical Atlas of Hong Kong*. Geotechnical Engineering Office, Government of the Hong Kong Special Administrative Region

(2) Whiteside PGD (2000) Natural geochemistry and contamination of marine sediments in Hong Kong. In: *The Urban Geology of Hong Kong* (ed Page A & Reels SJ). Geological Society of Hong Kong Bulletin No. 6, p109-121

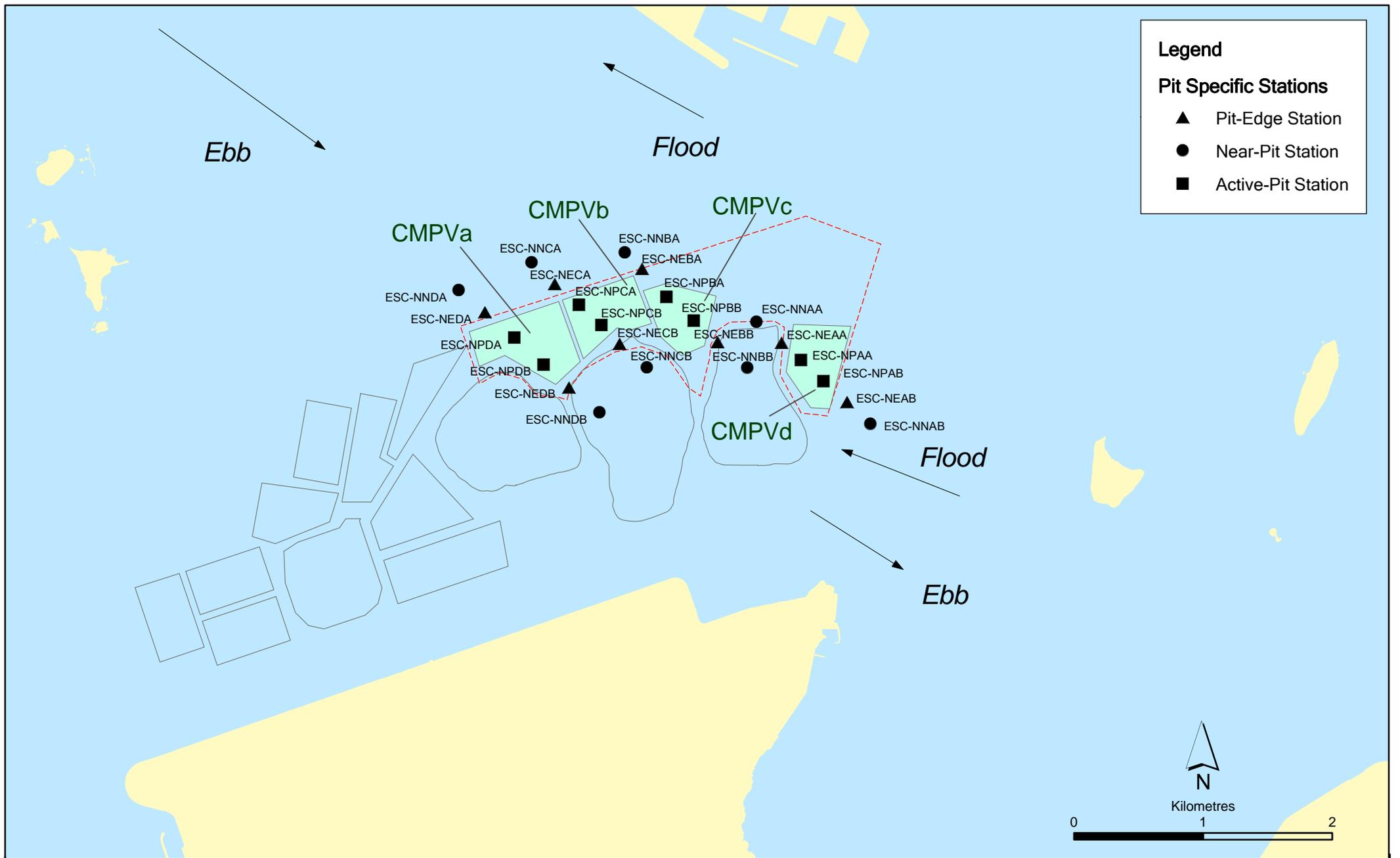


Figure 1.3

Pit Specific Sediment Quality Monitoring Stations for CMPV

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Date: 29/10/2009

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1.6 *ACTIVITIES SCHEDULED FOR THE NEXT MONTH*

1.6.1 The following monitoring activities will be conducted in the next monthly period of August 2016 for ESC CMPs:

- *Water Column Profiling of ESC CMP Vd;*
- *Routine Water Quality Monitoring of ESC CMPs;*
- *Pit Specific Sediment Chemistry of ESC CMP Vd;*
- *Cumulative Impact Sediment Chemistry of ESC CMPs;*
- *Sediment Toxicity Test of ESC CMPs;*
- *Benthic Recolonisation Studies of ESC CMP IV; and*
- *Demersal Trawling of ESC CMPs.*

1.6.2 The following monitoring activities will be conducted in the next monthly period of August 2016 for SB CMPs:

- *Water Quality Monitoring During Capping of SB CMPs; and*
- *Benthic Recolonisation Studies of SB CMPs.*

1.6.3 The sampling schedule is presented in *Annex A*.

1.7 *STUDY PROGRAMME*

1.7.1 A summary of the Study programme is presented in *Annex D*.

Annex A

Sampling Schedule

Annex B

Water Quality Monitoring Results

Table B1 *Action and Limit Levels of Water Quality for Dredging, Backfilling and Capping Activities at ESC CMPs*

Parameter	Action Level	Limit Level
Dissolved Oxygen (DO) ⁽¹⁾	<u>Surface and Mid-depth</u> ⁽²⁾ 5%-ile of baseline data for surface and middle layer = 3.76 mg L⁻¹	<u>Surface and Mid-depth</u> ⁽²⁾ 1%-ile of baseline data for surface and middle layer = 3.11 mg L⁻¹ ⁽³⁾
	and	and
	Significantly less than the reference stations mean DO (at the same tide of the same day)	Significantly less than the reference stations mean DO (at the same tide of the same day)
	<u>Bottom</u> 5%-ile of baseline data for bottom layers = 2.96 mg L⁻¹	<u>Bottom</u> The average of the impact station readings are <2 mg/L⁻¹
	and	and
	Significantly less than the reference stations mean DO (at the same tide of the same day)	Significantly less than the reference stations mean DO (at the same tide of the same day)
Depth-averaged Suspended Solids (SS) ⁽⁴⁾⁽⁵⁾	95%-ile of baseline data for depth average = 37.88 mg L⁻¹	99%-ile of baseline data for depth average = 61.92 mg L⁻¹
	and	and
	120% of control station's SS at the same tide of the same day	130% of control station's SS at the same tide of the same day
Depth-averaged Turbidity (Tby) ⁽⁴⁾⁽⁵⁾	95%-ile of baseline data = 28.14 NTU	99%-ile of baseline data = 38.32 NTU
	and	and
	120% of control station's Tby at the same tide of the same day	130% of control station's Tby at the same tide of the same day

Notes:

- (1) For DO, non-compliance of the water quality limits occurs when monitoring result is lower than the limits.
- (2) The Action and Limit Levels for DO for Surface & Middle layers were calculated from the combined pool of baseline surface layer data and baseline middle layer data.
- (3) Given the Action Level for DO for Surface & Middle layers has already been lower than 4 mg L⁻¹, it is proposed to set the Limit Level at 3.11 mg L⁻¹ which is the first percentile of the baseline data.
- (4) "Depth-averaged" is calculated by taking the arithmetic means of reading of all three depths.
- (5) For turbidity and SS, non-compliance of the water quality limits occurs when monitoring result is higher than the limits.

Table B2 *In-situ Monitoring Results for Routine Water Quality Monitoring of ESC Vd in July 2016*

Sampling Period	Stations	Temp (°C)	Salinity (ppt)	Turbidity (NTU)	Dissolved Oxygen (%)	Dissolved Oxygen (mg L ⁻¹)	pH (mg L ⁻¹)
July 2016	RFE (Reference)	27.81	18.55	16.16	68.54	4.86	7.73
	IPE (Impact)	28.22	16.42	13.22	74.33	5.33	7.73
	INE (Intermediate)	28.39	15.90	5.44	81.91	5.83	7.78
	Ma Wan	28.15	17.27	4.86	76.91	5.46	7.81
	WQO	N/A	16.70 – 20.41 [#]	N/A	N/A	>4	6.5-8.5

Notes:

[#]Not exceeding 10% of natural ambient level which is the result obtained from the Reference Station.

Cell shaded yellow / red indicate value exceeding the Action/Limit levels.

Cell shaded grey indicate value exceeding the WQO.

Table B3 *Laboratory Results for Routine Water Quality Monitoring of ESC Vd in July 2016*

Sampling Period	Stations	As (µg/L)	Cd (µg/L)	Cr (µg/L)	Cu (µg/L)	Pb (µg/L)	Hg (µg/L)	Ni (µg/L)	Ag (µg/L)	Zn (µg/L)	NH ₃ (mg/L)	TIN (mg/L)	BOD ₅ (mg/L)	SS (mg/L)
July 2016	RFE	2.51	<LOR	<LOR	2.74	0.92	0.25	0.92	0.50	5.16	0.15	1.04	1.50	18.52
	IPE	2.29	<LOR	<LOR	4.66	1.45	0.25	1.62	0.50	18.12	0.12	1.13	0.47	20.86
	INE	2.36	<LOR	<LOR	3.00	1.04	0.25	0.91	0.50	5.61	0.11	1.12	0.56	9.78
	Ma Wan	2.43	<LOR	<LOR	4.10	0.57	0.25	0.99	0.50	5.63	0.13	1.03	0.68	5.94

WQO of TIN: 0.5 mg/L

Wet Season WQO of SS : 11.1 mg/L

Notes:

Cell shaded yellow / red indicate value exceeding the Action/Limit levels.

Cell shaded grey indicate value exceeding the WQO.

Table B4 *Water Column Profiling Results for ESC CMP Vd in July 2016*

Stations	Temp (°C)	Salinity (ppt)	Turbidity (NTU)	Dissolved Oxygen (%)	Dissolved Oxygen (mg L ⁻¹)	pH (mg L ⁻¹)	Suspended Solids (mg L ⁻¹)
WCP 1 (Downstream)	26.96	20.88	14.05	60.42	4.29	7.71	18.12
WCP 2 (Upstream)	27.45	19.20	14.52	64.00	4.55	7.72	12.70
WQO (Wet season)	N/A	18.03 – 22.04 [#]	N/A	N/A	>4	6.5-8.5	11.1

Note:

[#]Not exceeding 10% of natural ambient level which is the result obtained from the Reference Station.

Cell shaded yellow / red indicate value exceeding the Action/Limit levels.

Cell shaded grey indicate value exceeding the WQO.

Annex C

Graphical Presentations

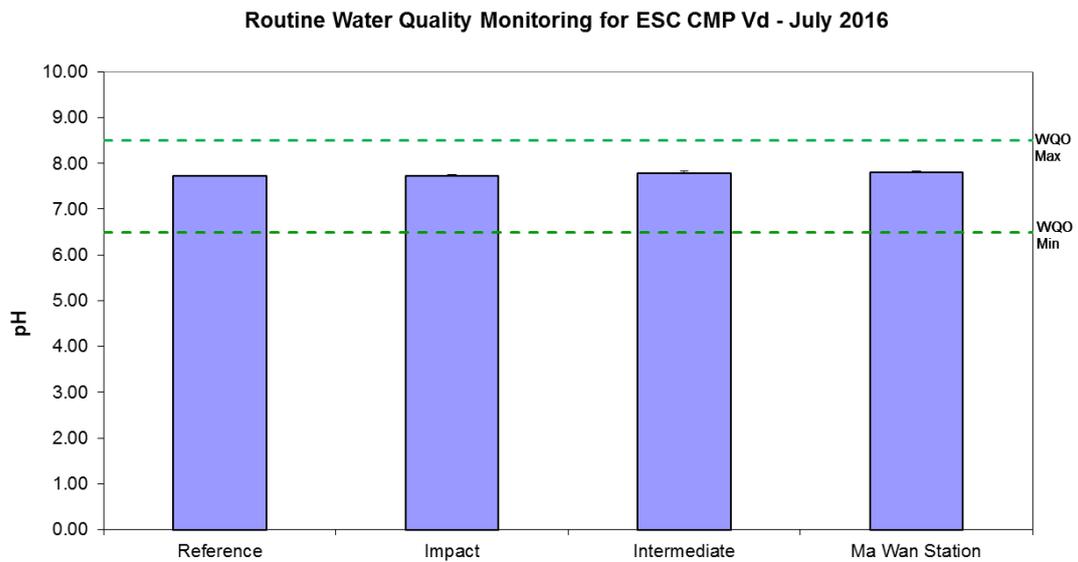


Figure 1: Level of pH recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in July 2016.

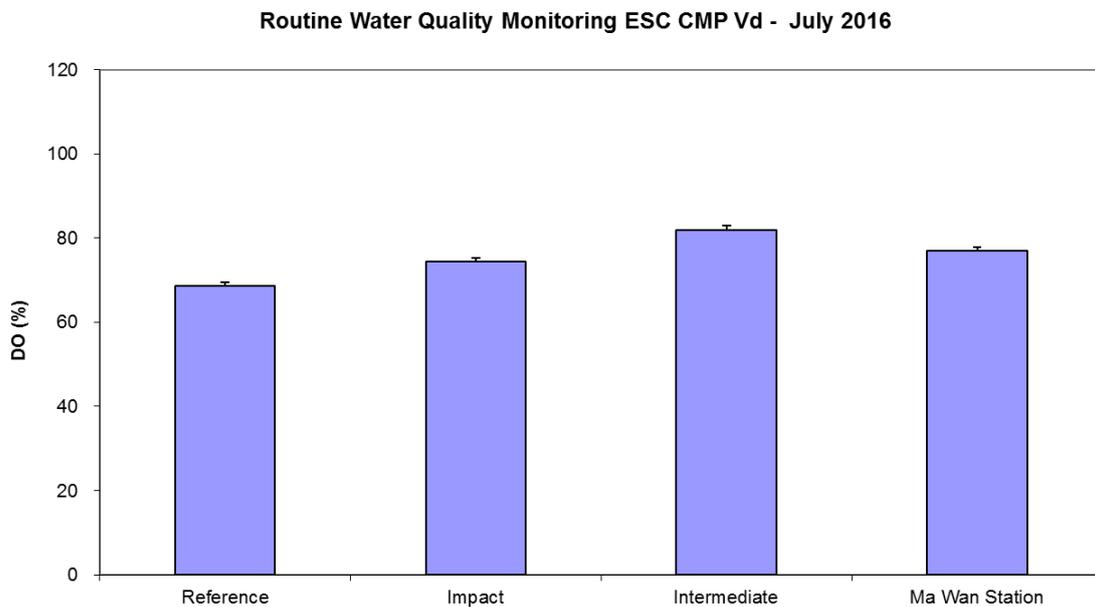


Figure 2: Level of Dissolved Oxygen (DO) (% saturation; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in July 2016.

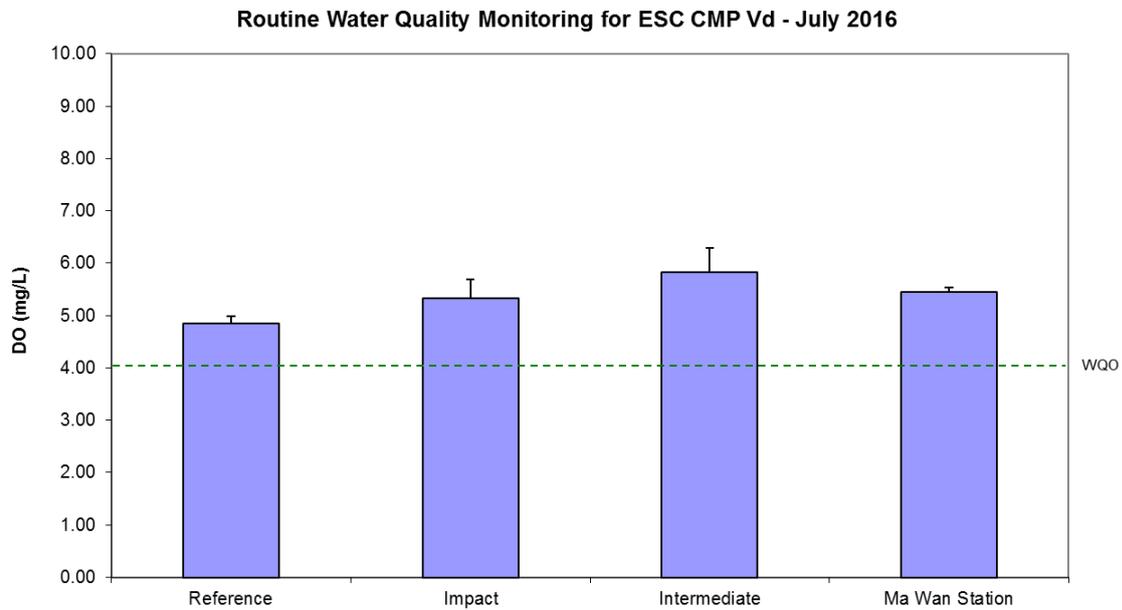


Figure 3: Concentration of Dissolved Oxygen (DO) (mg/L; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in July 2016.

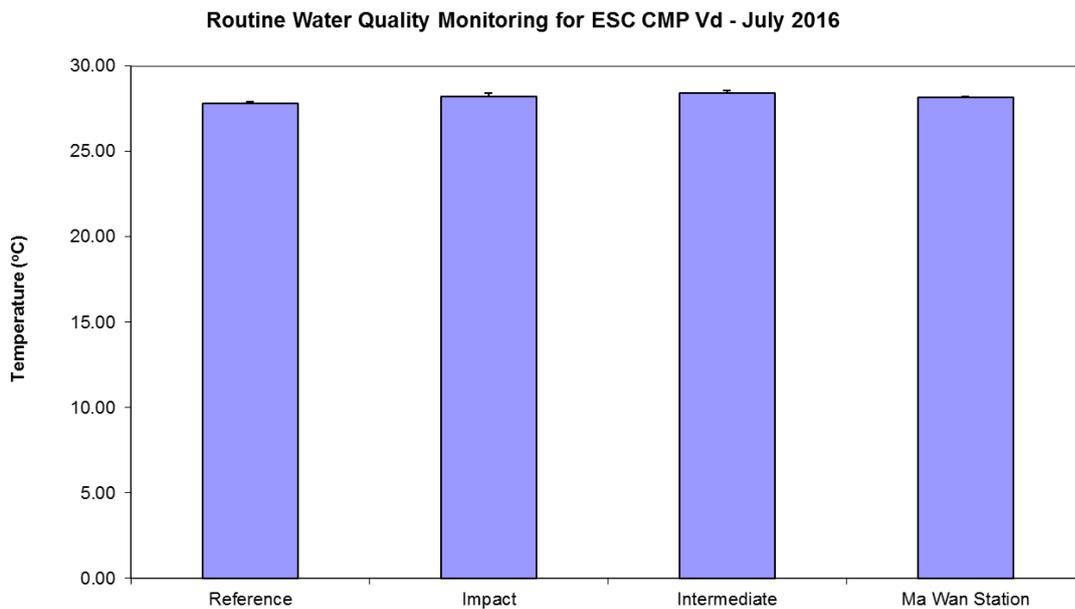


Figure 4: Level of Temperature (°C; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in July 2016.

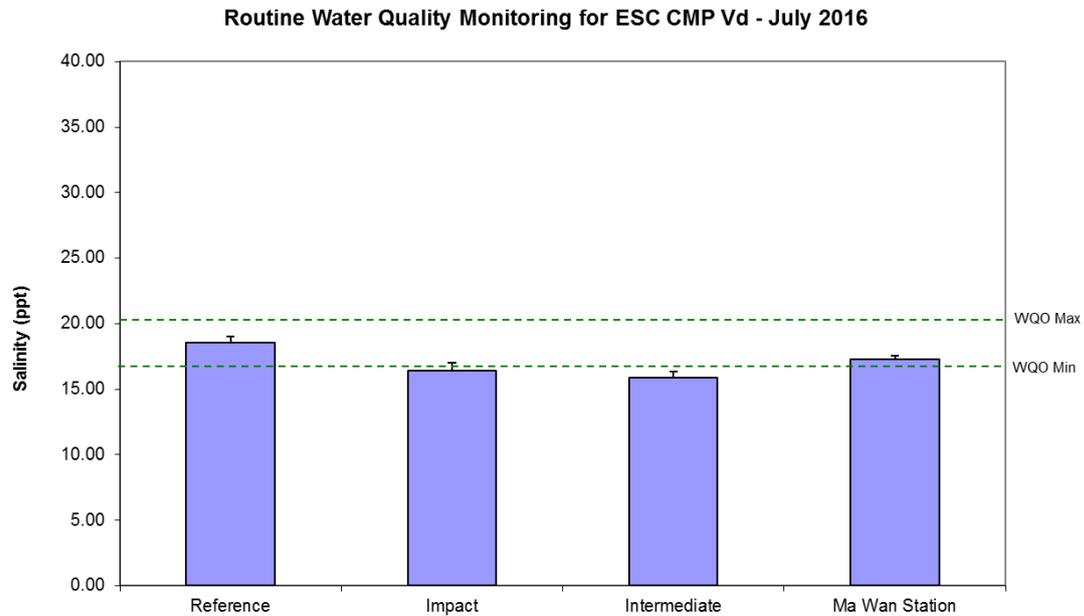


Figure 5: Level of Salinity (ppt; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in July 2016.

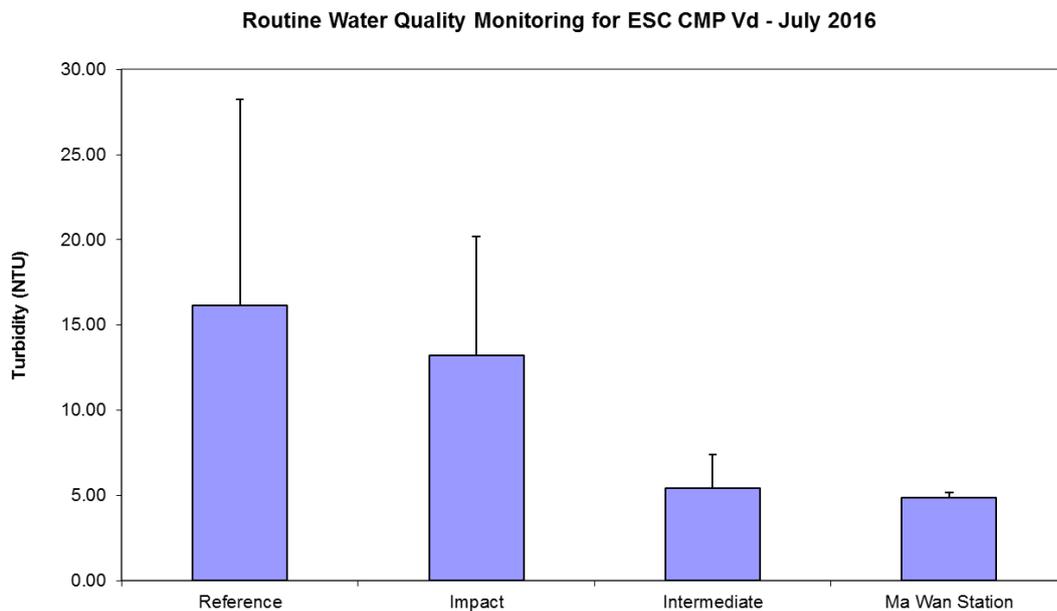


Figure 6: Levels of Turbidity (NTU; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in July 2016.

**Routine Water Quality Monitoring for metals
July 2016**

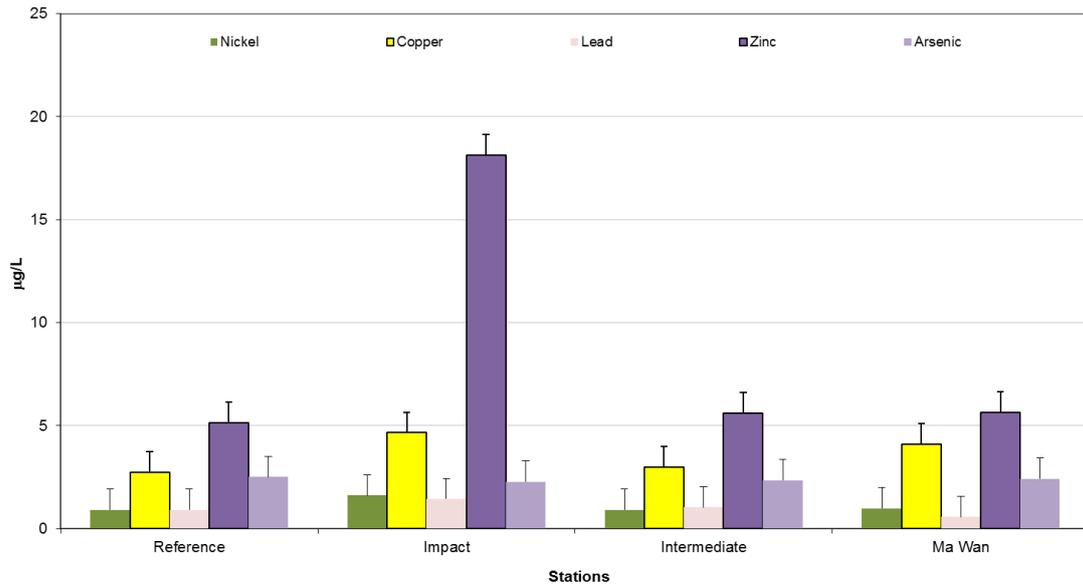


Figure 7: Concentration of Copper, Zinc, Arsenic and Lead ($\mu\text{g/L}$; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in July 2016.

**Routine Water Quality Monitoring Results for Nutrients
July 2016**

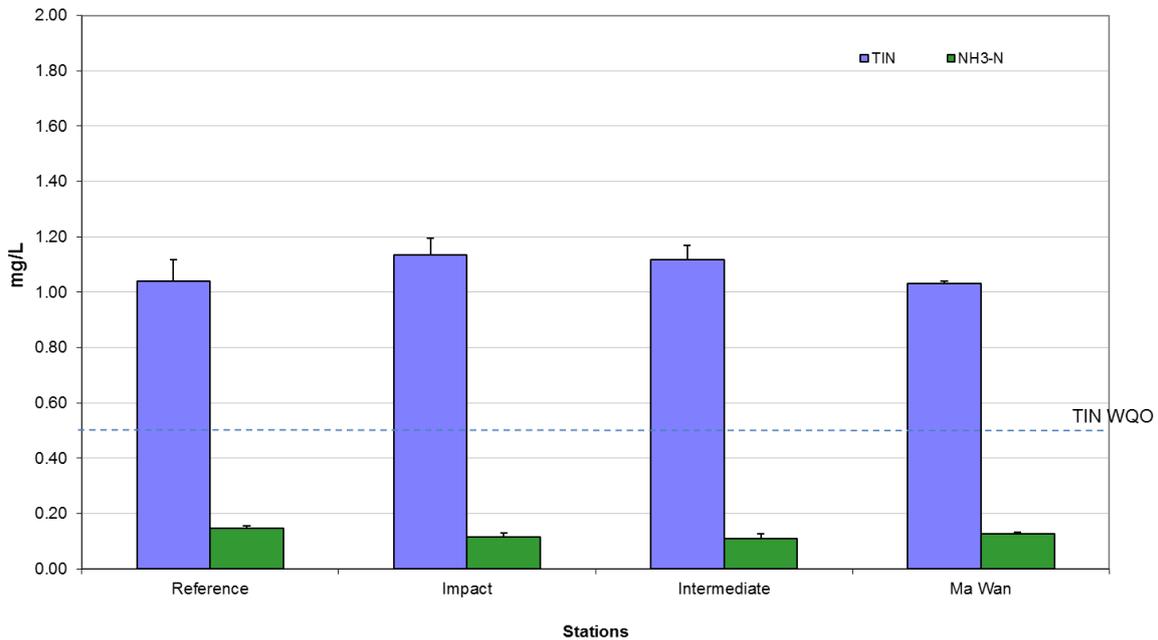


Figure 8: Concentration of Total Inorganic Nitrogen (TIN) and Ammonia Nitrogen ($\text{NH}_3\text{-N}$) ($\mu\text{g/L}$; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in July 2016.

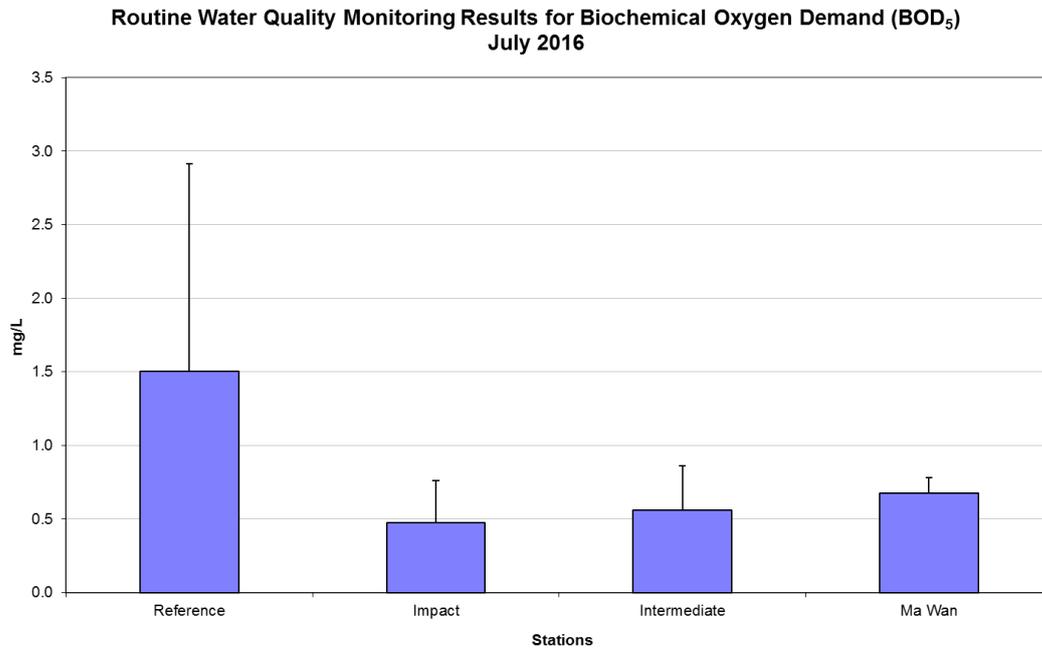


Figure 9: Level of Biochemical Oxygen Demand (BOD₅) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in July 2016.

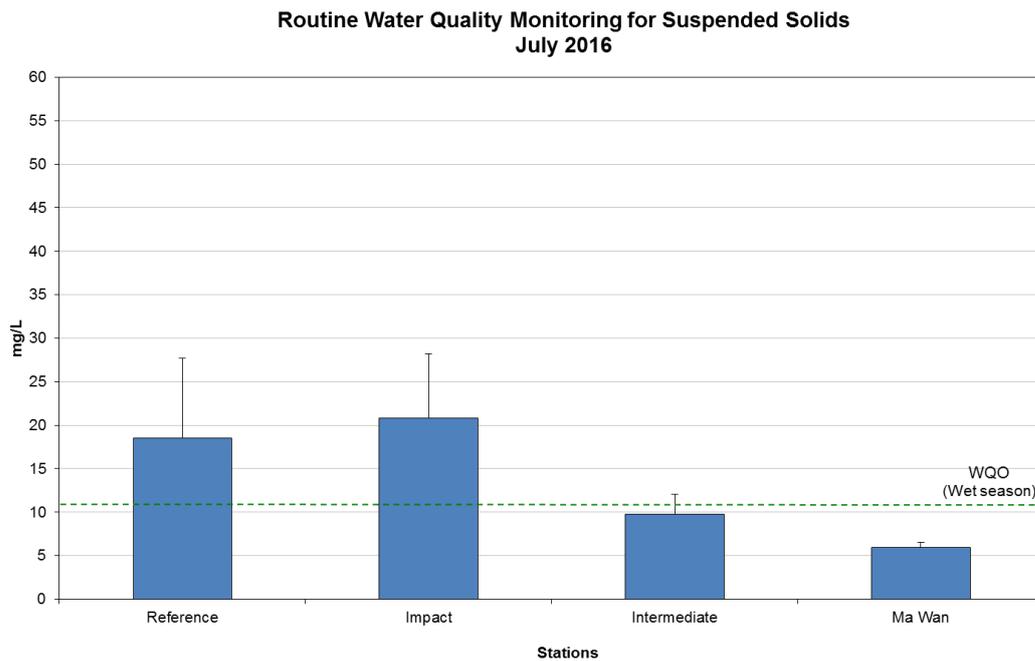


Figure 10: Concentration of Suspended Solids (SS) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in July 2016.

**Pit Specific Sediment Chemistry for Metal and Metalloid Contaminants at ESC CMP Vd
July 2016**

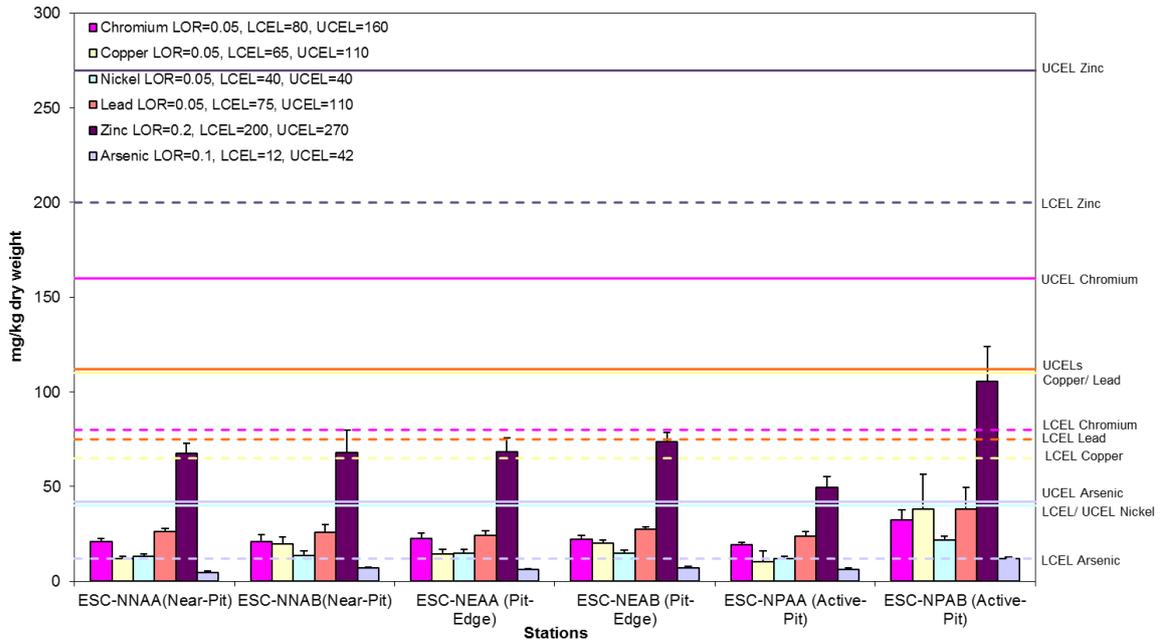


Figure 11: Concentration of Metals (Cr, Cu, Ni, Pb, Zn, As; mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in July 2016.

**Pit Specific Sediment Chemistry for Metal Contaminants at ESC CMP Vd
July 2016**

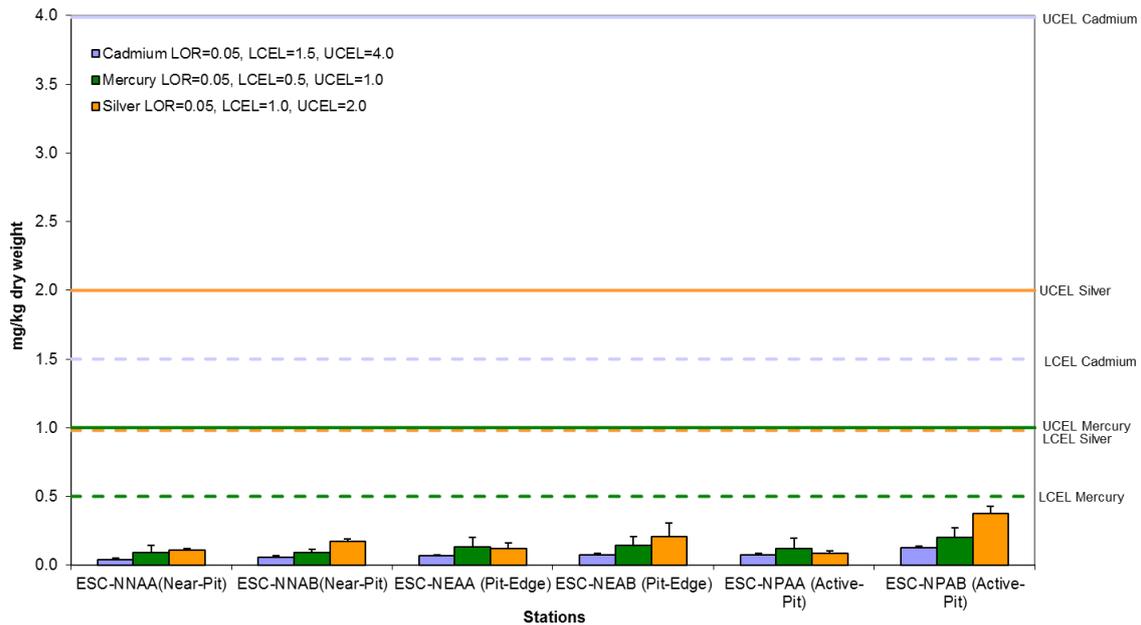


Figure 12: Concentration of Metals (Cd, Hg, Ag; mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in July 2016.

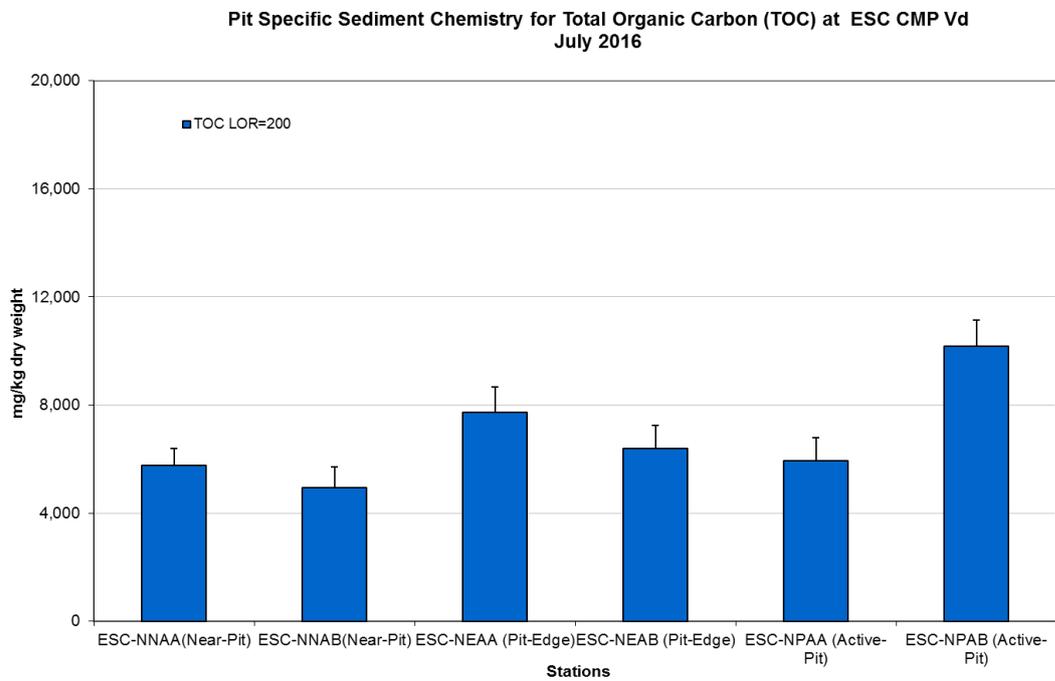


Figure 13: Concentration of Total Organic Carbon (TOC) (mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in July 2016.

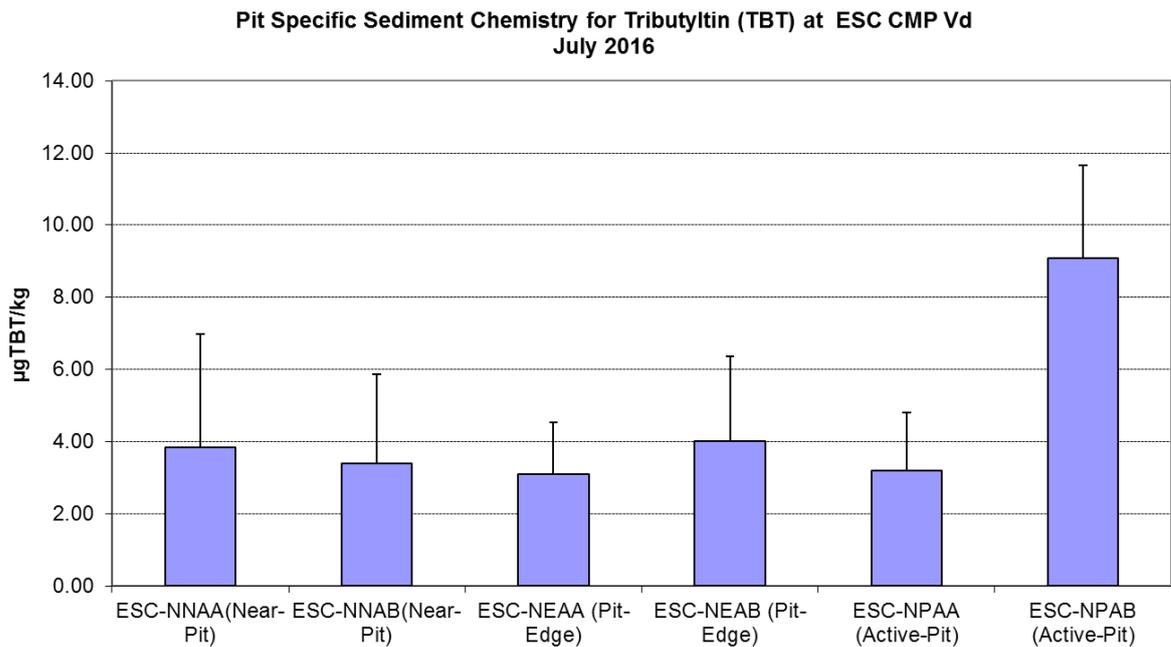


Figure 14: Concentration of Tributyltin (TBT) (µg TBT/kg; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in July 2016.

Annex D

Study Programme

