



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

Monthly EM&A Report for Contaminated Mud Pits to the East of Sha Chau and the South of The Brothers – May 2017

Revision 0

14 June 2017

**Environmental Resources Management** 

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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:

Monthly EM&A Report for Contaminated Mud Pits to the

East of Sha Chau and the South of The Brothers - May 2017

Date of Report:

14 June 2017

Date prepared by ET:

14 June 2017

Date received by IA:

14 June 2017

#### Reference EP Condition

#### Environmental Permit Condition:

Condition 3.4 of EP-312/2008/A and Condition 4.4 of EP-427/2011/A:

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/ $\frac{plan}{plan}$  complies with the above referenced condition of EP-312/2008/A and EP-427/2011/A

Jovy Tam,

Environmental Team Leader:

Date:

14/6/2017

#### IA Verification

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

Untlang

Dr Wang Wen Xiong, Independent Auditor: Date:

14/6/2017

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We disclaim scope of the	any responsibility to the client and others in respect of any matters outside the above.	⊠ F	Public		BSI
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#### **CONTENTS**

1.1	BACKGROU	ND	1
1.2	REPORTING	PERIOD	2
1.3	<b>D</b> ETAILS OF	SAMPLING AND LABORATORY TESTING ACTIVITIES	2
1.4	<b>D</b> ETAILS OF	OUTSTANDING SAMPLING AND/OR ANALYSIS	3
1.5	BRIEF DISC	ISSION OF THE MONITORING RESULTS FOR ESC CMPS	3
1.6	<b>ACTIVITIES</b>	SCHEDULED FOR THE NEXT MONTH	6
1.7	STUDY PRO	GRAMME	7
	ANNEXES		
	ANNEX A	SAMPLING SCHEDULE	
	ANNEX $B$	WATER QUALITY MONITORING RESULTS	
	ANNEY C	GRAPHICAL PRESENTATIONS	

ANNEX D STUDY PROGRAMME

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

#### **MONTHLY EM&A REPORT FOR MAY 2017**

#### 1.1 BACKGROUND

- 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 opensea 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, 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)(3)(4)(5). 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.

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

<sup>(2)</sup> ERM (2014) Environmental Monitoring and Audit for Contaminated Mud Pit V at East of Sha Chau (2012 - 2017). Final First Annual Review Report. For CEDD.

<sup>(3)</sup> ERM (2015) Environmental Monitoring and Audit for Contaminated Mud Pit V at East of Sha Chau (2012 - 2017). Final Second Annual Review Report. For CEDD.

<sup>(4)</sup> ERM (2016) Environmental Monitoring and Audit for Contaminated Mud Pit V at East of Sha Chau (2012 - 2017). Final Third Annual Review Report. For CEDD.

<sup>(5)</sup> ERM (2017) Environmental Monitoring and Audit for Contaminated Mud Pit V at East of Sha Chau (2012 - 2017). Final Fourth Annual Review Report. For CEDD.

- 1.1.3 The present EM&A programme under *Agreement No. CE 63/2016 (EP)* 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). Detailed works schedule for ESC CMP V and SB CMPs is shown in *Figure 1.1*. In May 2017, the following works were being undertaken:
  - Disposal of contaminated mud at ESC CMP Vd.

Figure 1.1 Works Schedule for ESC CMP V and SB CMPs

Pit	Onorotion				_2	017	7									20	018	3										20	19				_						:	202	0					:	202	21
Pit	Operation	Α	M	J	J	Α	s	0	N	D	7	F	M	Α	M	IJ	J	Α	S	C	N	D	J	F	М	Α	М	J	7	Α	s	0	Ν	D	J	F	VI A	A 1	И.	J,	J A	S	C	N	D	J	F	M
	Dredging																																															
ESC CMP V	Disposal																																															
	Capping																																															
	Dredging																																															
SB CMP 2	Disposal																																															
	Capping																																															

#### 1.2 REPORTING PERIOD

1.2.1 This *Monthly EM&A Report for May 2017* covers the EM&A activities for the reporting month of May 2017.

#### 1.3 DETAILS OF SAMPLING AND LABORATORY TESTING ACTIVITIES

- 1.3.1 The following monitoring activities were undertaken for ESC CMP V in May 2017:
  - Water Column Profiling of ESC CMP Vd was undertaken on 16 May 2017;
  - *Pit Specific Sediment Chemistry of ESC CMP Vd* was undertaken on 17 May 2017; and
  - Routine Water Quality Monitoring of ESC CMP V was undertaken on 18 May 2017.
- 1.3.2 The following monitoring activity was undertaken for SB CMP 2 in May 2017:
  - Water Quality Monitoring During Capping of SB CMPs was undertaken on 31 May 2017.

- 1.4 DETAILS OF OUTSTANDING SAMPLING AND/OR ANALYSIS
- 1.4.1 No outstanding sampling remained for May 2017.
- 1.4.2 The following laboratory analyses are in progress during the preparation of this monthly report and will be presented in the next monthly report once the data are available:
  - Laboratory analyses of sediment samples collected for *Pit Specific Sediment Chemistry of ESC CMP Vd* in May 2017.
- 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 *Monthly EM&A Report for May* 2017:
  - Water Column Profiling of ESC CMP Vd in May 2017; and
  - Routine Water Quality Monitoring of ESC CMP V in May 2017.
- 1.5.2 Water Column Profiling of ESC CMP Vd May 2017
- 1.5.3 Water Column Profiling was undertaken at a total of two sampling stations (Upstream and Downstream stations) on 16 May 2017. 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 2006 2015 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 (Upstream) station 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).

In-situ Measurements

1.5.4 Analyses of results for May 2017 indicated that levels of DO and pH complied with the WQOs at both Downstream and Upstream stations (*Table B2* of *Annex B*). In addition, DO and Turbidity at all stations complied with the Action and Limit Levels (*Tables B1* and *B2* of *Annex B*).

Laboratory Measurements for Suspended Solids (SS)

- 1.5.5 Analyses of results for May 2017 indicated that the SS levels complied with the WQO and the Action and Limit Levels at both Upstream and Downstream stations (*Tables B1* and *B2* of *Annex B*).
  - (1) http://epic.epd.gov.hk/EPICRIVER/marine/?lang=en

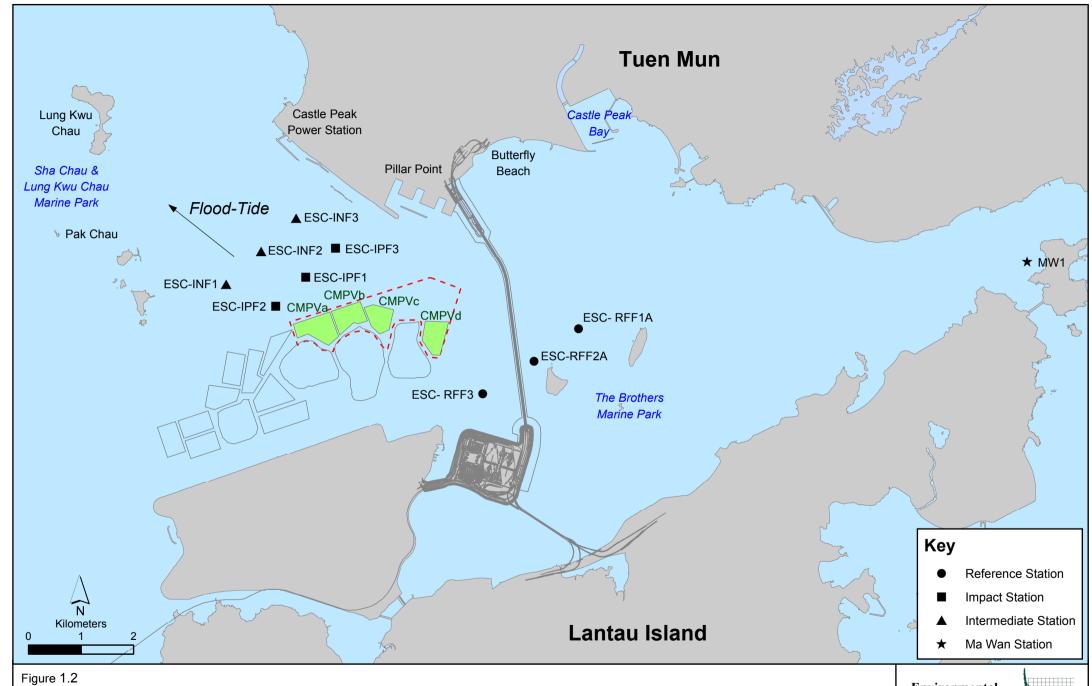
- 1.5.6 Overall, the monitoring results indicated that the mud disposal operation at ESC CMP Vd did not appear to cause any deterioration in water quality during this reporting period.
- 1.5.7 Routine Water Quality Monitoring of ESC CMP V May 2017
- 1.5.8 Routine Water Quality Monitoring of ESC CMP V was undertaken on 18 May 2017. The monitoring results have been assessed for compliance with the WQOs (see Section 1.5.3 for details). The monitoring results are shown in Tables B3 and B4 of Annex B and Figures 1 10 of Annex C. A total of ten (10) monitoring stations were sampled in May 2017 as shown in Figure 1.2.

In-situ Measurements

- 1.5.9 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 May 2017 indicated that the levels of pH and DO complied with the WQOs at all stations (Impact, Intermediate, Reference and Ma Wan stations) in May 2017 (*Table B3* of *Annex B*; *Figures 1* and 3 of *Annex C*). Levels of Salinity at most stations also complied with WQO, except for Ma Wan station (*Table B3* of *Annex B*; *Figure 5* of *Annex C*). The higher Salinities recorded at Ma Wan station are likely to be caused by the larger separation distance to Pearl River mouth, which release a large amount of freshwater runoff in the area during flooding, when compared to the Reference stations.
- 1.5.10 The levels of DO and Turbidity complied with the Action and Limit Levels at all stations (*Table B3* of *Annex B*; *Figures 3* and 6 of *Annex C*).
- 1.5.11 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 May 2017.

Laboratory Measurements

1.5.12 Laboratory analysis of May 2017 results indicated that concentrations of Cadmium, Silver and Mercury were below their limit of reporting at all stations. Arsenic, Chromium, Nickel, Lead, Copper and Zinc were detected in May 2017 samples and the concentrations of these metals and metalloids were similar amongst stations (*Table B4* of *Annex B*; *Figure 7* of *Annex C*).



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



- 1.5.13 For nutrients, concentrations of Total Inorganic Nitrogen (TIN) at all stations in May 2017 were higher than the WQO (0.5 mg/L) (*Table B4* of *Annex B*; *Figure 8* of *Annex C*). It should be noted that due to the effect of Pearl River, the North Western WCZ has historically experienced higher levels of TIN (1). Therefore, the exceedances of TIN WQO at these stations are unlikely to be caused by the disposal operation at ESC CMP Vd. Concentrations of Ammonia Nitrogen (NH<sub>3</sub>-N) were relatively similar amongst all stations in May 2017 (*Table B4* of *Annex B*; *Figure 8* of *Annex C*). Levels of 5-day Biochemical Oxygen Demand (BOD<sub>5</sub>) were relatively similar amongst all stations in May 2017 (*Table B4* of *Annex B*; *Figure 9* of *Annex C*).
- 1.5.14 Analyses of results for May 2017 indicated that the SS levels complied with the WQO (11.0 mg/L for wet season) and the Action and Limit Levels at all stations (*Tables B1 and B4* of *Annex B*; *Figure 10* of *Annex C*).
- 1.5.15 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 May 2017. Detailed statistical analysis will be presented in the Quarterly Report to investigate any spatial and temporal trends of potential concern.

#### 1.6 Brief Discussion of the Monitoring Results for SB CMPs

- 1.6.1 Brief discussion of the monitoring results of the following activities for SB CMPs is presented in this *Monthly EM&A Report for May 2017*:
  - Water Quality Monitoring during Capping Operations of SB CMPs in May 2017.

#### 1.6.2 Water Quality Monitoring during Capping of SB CMPs - May 2017

1.6.3 Capping works at SB CMP 2 were conducted in May 2017 to supplement and revert the portion of consolidated capping layer to design level and is expected to be completed by December 2017. The monitoring results obtained during May 2017 sampling in the wet season 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 B5* of *Annex B* for details). A total of fourteen (14) monitoring stations were sampled in May 2017 as shown in *Figure 1.3*. Graphical presentation of the monitoring results is shown in *Figures 11 - 20* of *Annex C*.

<sup>(1)</sup> http://www.epd.gov.hk/epd/misc/marine\_quality/1986-2005/textonly/eng/index.htm

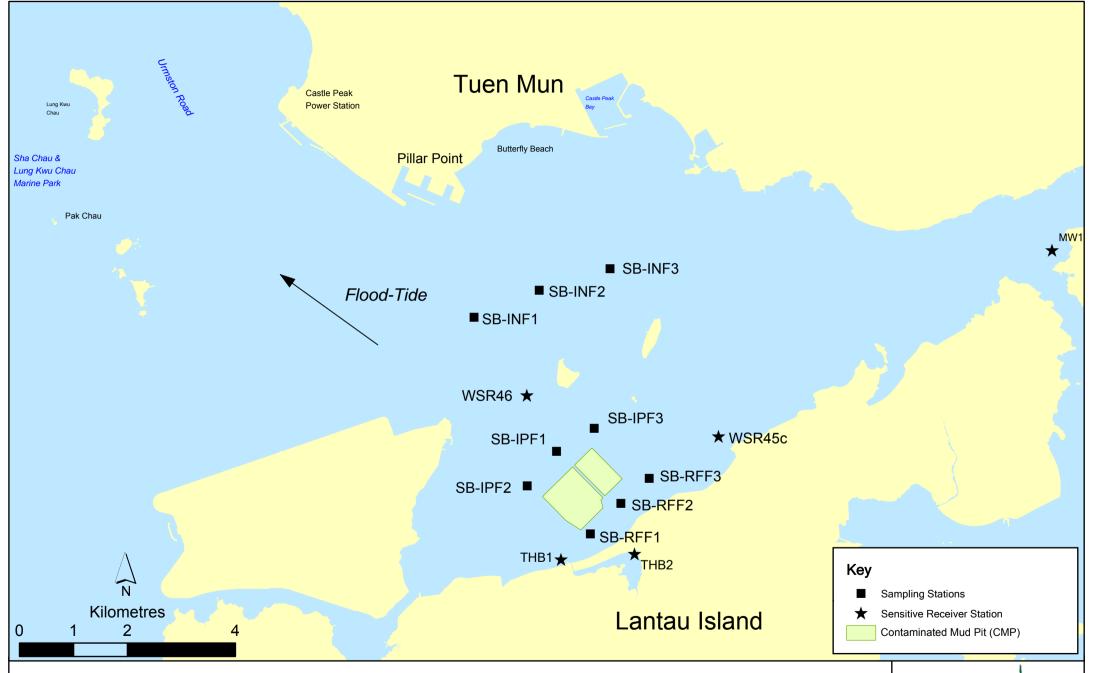


Figure 1.3

Routine & Capping Water Quality Sampling Stations (Flood-Tide) for South Brothers Facility



#### *In-situ Measurements*

1.6.4 The levels of pH at all stations in May 2017 complied with the WQO (*Table B6* of *Annex B*; *Figure 11* of *Annex C*). The levels of Turbidity at all stations complied with the Action and Limit levels in May 2017 (*Table B6* of *Annex B*; *Figure 12* of *Annex C*). The levels of DO at all stations complied with the WQO and the Action and Limit levels in May 2017 (*Table B6* of *Annex B*; *Figure 14* of *Annex C*). The levels of Salinity at Impact, Intermediate, Ma Wan, Sham Shui Kok and Tai Mo To stations are higher than the WQO in May 2017 (*Table B6* of *Annex B*; *Figure 16* of *Annex C*). The Salinities at these stations were higher or above the WQO as they were located further away from the Tai Ho Bay and Reference stations which experienced less freshwater runoff from the nearby streams and Pearl River mouth.

#### Laboratory Measurements

- 1.6.5 The concentrations of SS were higher than the WQO (11.0 mg/L for wet season) at Tai Mo To station in May 2017 (*Table B6* of *Annex B*; *Figure 17* of *Annex C*). However, levels of SS at all stations complied with the Action and Limit Levels (*Table B5 and B6* of *Annex B*).
- 1.6.6 For nutrients, concentrations of NH<sub>3</sub>-N were relatively similar amongst all stations (*Table B6* of *Annex B*; *Figure 18* of *Annex C*). The levels of TIN at all stations were higher the WQO of 0.5 mg/L (*Table B6* of *Annex B*; *Figure 19* of *Annex C*). As discussed in *Section 1.5.13*, the North Western WCZ has historically experienced higher levels of TIN and such exceedances of TIN WQO at all stations are unlikely to be caused by the capping operation at CMP 2. Levels of BOD<sub>5</sub> were relatively similar amongst all stations (*Table B6* of *Annex B*; *Figure 20* of *Annex C*).
- 1.6.7 Overall, the monitoring results indicated that the capping operation at CMP 2 did not appear to cause any unacceptable deterioration in water quality in May 2017. Statistical analysis will be undertaken and presented in the quarterly report to investigate whether the capping operations at CMP 2 is causing any unacceptable impacts in water quality of the area.

#### 1.7 ACTIVITIES SCHEDULED FOR THE NEXT MONTH

- 1.7.1 The following monitoring activities will be conducted in the next monthly period of June 2017 for ESC CMP V (see *Annex A* for the sampling schedule):
  - Water Column Profiling of ESC CMP Vd;
  - Cumulative Impact Sediment Chemistry of ESC CMPs; and.
  - Pit Specific Sediment Chemistry of ESC CMP Vd.

- 1.7.2 The following monitoring activities will be conducted in the next monthly period of June 2017 for SB CMPs (see *Annex A* for the sampling schedule):
  - Water Quality Monitoring During Capping of SB CMPs.
- 1.8 STUDY PROGRAMME
- 1.8.1 A summary of the Study programme is presented in *Annex D*.

#### Annex A

## Sampling Schedule

Pit Specific Sediment Chemistry	Code	Frequency	A	M J	J	A	S O I	N I	D J	F M	A	M J	J A	SO	N	D J	F M	A		J A	SC	N	D	J ]	F M	A M	J	20 J A	S O	N		2021 F
Active-Pit	ESC-NPAA ESC-NPAB	Monthly Monthly								12 12 12 12																						
it-Edge	ESC-NEAA ESC-NEAB	Monthly Monthly								12 12 12 12																					12 12 12 12	
Near-Pit	ESC-NNAA ESC-NNAB	-		12 1 12 1						12 12 12 12											12 12 12 12											
Cumulative Impact Sediment Cho	emistry		A	M J	J J	A	S O I	N I	D J	F M	A	M J	J A	SO	N	D J	F M	A	M J	J A	SC	N	D	J I	F M	A M	J	J A	S O	N	D J	F
Mid-field Stations	ESC-RNA ESC-RNB1	4 times per year 4 times per year		1	2 2	12 12			12	12 12		12 12				12 12	12		12 12	12 12			12 12		.2		12 12	12 12		-	12 12	12 12
Capped Pit Stations	ESC-RMA ESC-RMB	4 times per year 4 times per year		_	2 2	12 12		_	12	12 12		12 12				12 12	12		12 12	12 12			12 12		2		12 12	12 12			12 12	12 12
	ESC-RCA1 ESC-RCB1	4 times per year 4 times per year		1	2 2	12 12			12	12 12		12 12				12 12	12 12		12 12	12 12			12 12		.2		12 12	12 12			12 12	12 12
Far-Field Stations	ESC-RFA ESC-RFB	4 times per year 4 times per year		1 1	2 2	12 12		_	12	12 12		12 12				12 12	12 12		12 12	12 12			12 12		2 2		12 12	12 12			12 12	12 12
Ma Wan Station	MW1	4 times per year		1	2	12		1	12	12		12	12			12	12		12	12			12	1	2		12	12			12	12
Sediment Toxicity Tests Near-Pit Stations	ESC-TDA	21:000000000000000000000000000000000000	A	M J	J	A	SO	N I	D J	F M	A	M J	J A 5	SC	N	D J	F M	A	M J	J A	SC	N	D	J I	F M	A M	J	<b>J A</b> 5	S O	N	D J	F
Reference Stations	ESC-TDB1	2 times per year 2 times per year				5				5			5				5			5					5			5				5
Ma Wan Station	ESC-TRA ESC-TRB	2 times per year 2 times per year				5				5			5				5 5			5				,	5			5				5
Γissue/ Whole Body Sampling	MW1	2 times per year	A	M J	ı J	5 <b>A</b>	S O 1	N I	D J	5 <b>F M</b>	A	M J	<b>J A</b>	SC	N	D J	5 F M		M J	<b>J A</b>	S	N	D	J I	5 <b>M</b>	A M	J	5 <b>J A</b>	S O	N	D J	<b>F</b>
Near-Pit Stations	ESC-INA ESC-INB	2 times per year 2 times per year				*				*			*				*			*				,	*			*				*
Reference North	TNA TNB	2 times per year 2 times per year				*				*			*				*			*				,	*			*				*
Reference South	TSA	2 times per year				*				*			*				*			*				_	*			*				*
Demersal Trawling	TSB	2 times per year	A	M J	J	_	S O	N I	D J	F M	A	M J	JA	S C	N	D J	F M	A 1	М Ј	JA	SC	N	D		F M	A M	J	J A	S O	N	D J	F
Near Pit Stations	ESC-INA ESC-INB	4 times per year 4 times per year			5 5	5 5			5	5 5			5 5 5 5			5 5	5 5			5 5 5 5			_	-	5 5			5 5 5 5			5	5 5
Reference North	TNA TNB	4 times per year 4 times per year			5 5	5			5	+			5 5 5 5			5 5				5 5 5 5					5 5			5 5 5 5			5	5
Reference South	TSA TSB	4 times per year			5 5	5 5			5 5	5			5 5 5			5 5	5			5 5 5				5	5			5 5 5 5			5	5 5
Capping	עט	4 times per year	A	M J			S 0 1	N I		<b>F M</b>	A	M J		S C	N			AI	M J	J A	SC	N				A M	J		S O	N	о D J	<b>F</b>
Ebb Tide Impact Station Downcurrent	ESC-IPE1A	4 times per year										3	3			3	3		3	3			3	,	3		3	3			3	3
	ESC-IPE2A ESC-IPE3 ESC-IPE4	4 times per year 4 times per year 4 times per year	H	<del> </del>							H	3 3 3	3			3 3	3 3	+	3 3 3	3 3 3	H	+	3 3 3		3 3		3 3 3	3 3 3		$\vdash$	3 3 3	3 3
Intermediate Station Downcurrent	ESC-IPE5	4 times per year  4 times per year						+				3				3	3		3	3			3	,	3		3	3			3	3
	ESC-INE2A ESC-INE3A	4 times per year 4 times per year		+								3 3 3	3			3 3	3 3		3 3	3 3			3 3	,	3 3		3 3 3	3 3			3 3	3 3
Reference Station Upcurrent		4 times per year 4 times per year										3	3			3	3		3	3			3	;	3		3	3			3	3
	ESC-RFE1 ESC-RFE2 ESC-RFE3	4 times per year 4 times per year 4 times per year		+				+	+			3 3 3				3 3	3 3 3		3 3	3 3 3		+	3 3 3	;	3 3 3		3 3 3	3 3 3			3 3 3	3 3
Ma Wan Station	ESC-RFE4 ESC-RFE5	4 times per year 4 times per year										3	3			3 3	3 3		3	3 3			3 3		3		3	3			3	3
Flood Tide Impact Station Downcurrent	MW1	4 times per year										3	3			3	3		3	3			3	,	3		3	3			3	3
	ESC-IPF1 ESC-IPF2	4 times per year 4 times per year										3 3				3 3	3 3		3 3	3 3			3 3		3		3 3 3	3 3			3 3	3
Intermediate Station Downcurrent	ESC-INF1	4 times per year 4 times per year										3	3			3	3		3	3			3	,	3		3	3			3	3
Reference Station Upcurrent	ESC-INF2 ESC-INF3	4 times per year 4 times per year										3				3	3		3	3			3	,	3		3	3			3	3
	ESC-RFF1A ESC-RFF2A ESC-RFF3	4 times per year 4 times per year 4 times per year	H									3 3	3 3			3 3	3 3		3 3	3 3			3 3 3		3 3 3		3 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	3			3	3
Routine Water Quality Monitorin	ıg		A	M J	J	A	S O	N I	D J	F M	A	M J	J A	SC	N	D J	F M	A	М Ј	J A	SC	N	D	J I	F M	A M	J	J A	S O	N	D J	F
Impact Station Downcurrent	ESC-IPE1A ESC-IPE2A	8 times per year 8 times per year	$\vdash$	8	8 8	8 8		8	8	+ -	8	8 8	8 8 8 8	8	+	8	8	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 ESC-IPE4 ESC-IPE5	8 times per year 8 times per year 8 times per year	8 8 8	8	8 8 8	8 8 8	8	8 8 8	8 8 8	<u> </u>	8	8 8 8	8     8       8     8       8     8	8 8 8	8	8 8 8	8	8 8 8	8	8     8       8     8       8     8	8	8		8	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 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 8 8	8	_			8 8	8 8 8 8		8 8 8 8	8 8	8 8	8 8	8
	ESC-INE3A ESC-INE4A	8 times per year 8 times per year 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 8	8	8 8 8 8 8 8	8	8		8 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
	ESC-RFE2 ESC-RFE3 ESC-RFE4	8 times per year 8 times per year 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     8	8	8		8 8	8	8 8 8 8		8 8 8 8	8 8 8	8	8 8	8
Ma Wan Station	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
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
Intermediate Station Downcurrent	ESC-IPF2 ESC-IPF3	8 times per year 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		8 8 8 8	8 8	8	8 8	8 8
James James Downcurrent	ESC-INF1 ESC-INF2 ESC-INF3	8 times per year 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 8 8	8	8		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
Ma Wan Station	ESC-RFF2A ESC-RFF3	8 times per year 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	8	8 8	8 8
Water Column Profiling	MW1	8 times per year	8 A	<u>'</u>	8 J	8 A		8 N I	D J	F M		8 M J	8 8 J A	8   S   C	1 0	8 D J	1 - 1	8 A I	1	8 8 J A	8   S   C				8   F   M	8 8 A M		8 8 J <b>A</b>	8 S O		8 D J	8 <b>F</b>
Plume Stations	WCP1 WCP2	Monthly 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
Benthic Recolonisation Studies Capped Stations at CMPV	ECOLORA	2 times nor weer	A	M J	J	A	S O I	N I	D J	F M	A	M J	J A	SC	N	D J	F M	A	M J	J A	SC	N	D	J I	F M	A M	J	J A	S O	N	D J	F
	ESCV-CPA ESCV-CPC	2 times per year 2 times per year 2 times per year		+				+																							+	
Reference Stations	ESCV-CPD RBA	<ul><li>2 times per year</li><li>2 times per year</li></ul>						+																								
	RBB RBC1	2 times per year 2 times per year																														
Impact Monitoring for Dredging Upstream Stations		2	A	M J	J	A	S O	N I	D J	F M	A	M J	J A	SC	N	D J	F M	A	M J	J A	SC	N	D	J	F M	A M	J	J A	S O	N	D J	F
Downstream Stations	US1 US2	3 times per week 3 times per week		<u> </u>																												
	DS1 DS2 DS3	3 times per week 3 times per week 3 times per week		+				+																+								
	DS4	3 times per week		$\perp$		+			1						1																	
Ma Wan Station	DS5	3 times per week	-	+	+		++		+	+ +	<del>                                     </del>		<del>                                     </del>	-	+	+	+	++		<del>                                     </del>		+	+ +		+		++			-		-

### 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	т	T	A	S	0	N	D	T	F	M	A	M	т	т	A	S	0	N
Ebb Tide			А	IVI	J	J	A	3	U	14	D	J	Г	IVI	A	IVI	J	J	A	3	U	11
			$\vdash$	+														⊢				
mpact Stations Downcurrent	CD IDE1	4.6	-	1	2		_				2				-			⊢				
	SB-IPE1	4 times per year	-	3	3		3	_	-		3		_	-	_		-	├				
	SB-IPE2	4 times per year	$\vdash$	3	3		3	_			3						-	-				
	SB-IPE3	4 times per year	$\vdash$	3	3		3				3							<u> </u>				
	SB-IPE4	4 times per year		3	3		3				3		_		_	_		├				
	SB-IPE5	4 times per year		3	3		3				3							<u> </u>				
Intermediate Stations Downcurrent	CD D W		<u> </u>	<del>                                     </del>			_		-					-				├				
	SB-INE1	4 times per year		3	3		3				3							<u> </u>				
	SB-INE2	4 times per year		3	3		3				3							<u> </u>				
	SB-INE3	4 times per year		3	3		3				3							┞				
	SB-INE4	4 times per year		3	3		3				3							<u> </u>				
	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							t				
	SB-IPF2	4 times per year		3	3		3				3											
	SB-IPF3	4 times per year		3	3		3				3											
Intermediate Stations Downcurrent		r times per year		+ -														$\vdash$				
memerate stations bownearies	SB-INF1	4 times per year		3	3		3				3							<del>                                     </del>				
	SB-INF2	4 times per year		3	3		3				3							$\vdash$				
	SB-INF3	4 times per year		3	3		3				3							$\vdash$				
Reference Stations Upcurrent	3 <b>D</b> -11 <b>V</b> 13	4 times per year	$\vdash$	+ 5	3		-	┢			3		$\vdash$		$\vdash$	$\vdash$	1	┢				
Reference stations opeument	SB-RFF1	4 times per year		3	3		3				3							┢				
	SB-RFF2	4 times per year	-	3	3		3				3							<del> </del>				
	SB-RFF3	4 times per year	$\vdash$	3	3		3				3							$\vdash$				
Sensitive Receiver Stations	SD-KITS	4 times per year	$\vdash$	3	3		3	$\vdash$		$\vdash$	3		$\vdash$		$\vdash$	<del>                                     </del>	-	⊢				
bensitive Receiver Stations	MW1	4 6	$\vdash$	2	3		3	┢		Н	3		$\vdash$		$\vdash$	$\vdash$	-	⊢				
		4 times per year	$\vdash$	3	_		-	_									-	┢				
	THB1	4 times per year	$\vdash$	3	3		3	_		$\vdash$	3				_			⊢				
	THB2	4 times per year	_	3	3		3	_			3		<u> </u>		<u> </u>		-	⊢				
	WSR45C	4 times per year	$\vdash$	3	3		3	_			3						_	┢				
	WSR46	4 times per year		3	3		3				3											
Double Book of the				2.6	· ·	¥				3.7	Б	<b>T</b>	r	3.5		3.4	Ψ.	¥		C	0	3.7
Benthic Recolonisation Studies			A	M	J	J	Α	S	О	N	D	J	F	M	Α	M	J	J	Α	S	О	N
Capped Contaminated Mud Pits	CD CDA	2 times =======	$\vdash$	+			10	$\vdash$	$\vdash$	$\vdash$	10		_		_			$\vdash$	10	$\vdash\vdash$		_
	SB-CPA	2 times per year		1	l		12		1		12		l	I	I	I	I	1	12			
	SB-CPB	2 times per year		1			12			$\Box$	12								12			

Note

Reference Stations

RBA RBB

RBC

2 times per year

2 times per year

2 times per year

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

## Water Quality Monitoring Results

Table B1 Action and Limit Levels of Water Quality for Dredging, Disposal and Capping Activities at ESC CMP V

Parameter	Action Level	Limit Level
Dissolved Oxygen (DO) (1)	Surface and Mid-depth (2)	Surface and Mid-depth (2)
	5%-ile of baseline data for surface and	1%-ile of baseline data for surface and
	middle layer = 3.76 mg L <sup>-1</sup>	middle layer = 3.11 mg $L^{-1}$ (3)
	and	and
	Significantly less than the reference	Significantly less than the reference
	stations mean DO (at the same tide of	stations mean DO (at the same tide of
	the same day)	the same day)
	Bottom	Bottom
	5%-ile of baseline data for bottom	The average of the impact station
	layers = <b>2.96 mg L</b> -1	readings are <2 mg/L <sup>-1</sup>
	and	and
	Significantly less than the reference	Significantly less than the reference
	stations mean DO (at the same tide of the same day)	stations mean DO (at the same tide of the same day)
Depth-averaged Suspended	95%-ile of baseline data for depth	99%-ile of baseline data for depth
Solids (SS) (4) (5)	average = 37.88 mg L-1	average = <b>61.92 mg L</b> -1
	and	
		and
	120% of control station's SS at the same	130% of control station's SS at the same
	tide of the same day	tide of the same day
Depth-averaged Turbidity (Tby) (4) (5)	95%-ile of baseline data = <b>28.14 NTU</b>	99%-ile of baseline data = <b>38.32 NTU</b>
•	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 Water Column Profiling Results for ESC CMP Vd in May 2017

Stations	Temp	Salinity	Turbidity		solved Tygen	pН	Suspended Solids
	(°C)	(ppt)	(NTU)	(%)	(mg L-1)	(mg L-1)	(mg L-1)
WCP 1 (Downstream)	25.90	26.31	4.82	81.39	5.70	7.88	5.35
WCP 2 (Upstream)	25.96	25.72	3.95	82.77	5.82	7.91	4.68
WQO (Wet season)	N/A	23.14 - 28.29#	N/A	N/A	>4	6.5-8.5	11.0

#### 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.

Table B3 In-situ Monitoring Results for Routine Water Quality Monitoring of ESC CMPs in May 2017

Sampling	Stations	Temp	Salinity	Turbidity	Dissolve	d Oxygen	pН
Period	Stations	(°C)	(ppt)	(NTU)	(%)	(mg L-1)	(mg L-1)
Mary 2017	RFE (Reference)	26.09	25.87	2.78	83.14	5.82	7.95
May 2017	IPE (Impact)	26.02	25.93	2.73	81.75	5.73	7.93
	INE (Intermediate)	26.04	25.75	2.43	81.02	5.68	7.92
	Ma Wan	25.40	30.25	1.81	76.72	5.30	7.87
	WQO	N/A	23.28 - 28.46#	N/A	N/A	>4	6.5-8.5

#### Notes:

Cell shaded yellow / red indicate value exceeding the  $\mbox{\it Action/Limit}$  levels.

Cell shaded grey indicate value exceeding the WQO.

Table B4 Laboratory Results for Routine Water Quality Monitoring of ESC CMPs in May 2017

Sampling	Stations	As	Cd	Cr	Cu	Pb	Hg	Ni	Ag	Zn	NH <sub>3</sub>	TIN	BOD <sub>5</sub>	SS
Period	Stations	(μg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)								
May	RFE	2.32	0.25	0.64	12.96	0.90	0.25	2.02	0.50	35.90	0.16	0.84	1.37	4.81
2017	IPE	2.24	0.25	0.50	2.49	0.89	0.25	0.72	0.50	28.06	0.17	0.93	1.90	3.45
	INE	2.38	0.25	0.50	0.50	0.62	0.25	0.50	0.50	30.27	0.16	0.95	1.20	3.65
	Ma Wan	2.44	0.25	0.50	4.01	1.86	0.25	2.00	0.50	59.64	0.18	0.62	1.66	3.82

WQO of TIN: 0.5 mg/L

Wet Season WQO of SS: 11.0 mg/L

#### Notes:

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

Cell shaded grey indicate value exceeding the WQO.

 $<sup>{}^\</sup>sharp Not$  exceeding 10% of natural ambient level which is the result obtained from the Reference Station.

Table B5 Action and Limit Levels of Water Quality for Dredging, Backfilling and Capping Activities for SB CMPs

Parameter	Action Level	Limit Level
Dissolved Oxygen (DO) (1)	Surface and Mid-depth (2)	Surface and Mid-depth (2)
	The average of the impact, WSR 45C	The average of the impact, WSR 45C
	and WSR 46 station readings are < 5%-	and WSR 46 station readings are < 4
	ile of baseline data for surface and	mg L-1
	middle layer = $4.32 \text{ mg L}^{-1}$	
		and
	and	
		Significantly less than the reference
	Significantly less than the reference	stations mean DO (at the same tide of
	stations mean DO (at the same tide of	the same day)
	the same day)	
	Bottom	Bottom
	The average of the impact, WSR 45C	The average of the impact station,
	and WSR 46 station readings are < 5%-	WSR 45C and WSR 46 readings are < 2
	ile of baseline data for bottom layers =	mg L-1
	3.12 mg L <sup>-1</sup>	O .
	o de la companya de	and
	and	
		Significantly less than the reference
	Significantly less than the reference	stations mean DO (at the same tide of
	stations mean DO (at the same tide of	the same day)
	the same day)	•
Depth-averaged Suspended	The average of the impact, WSR 45C	The average of the impact, WSR 45C
Solids (SS) (3) (4)	and WSR 46 station readings are >	and WSR 46 station readings are >
	95%-ile of baseline data for depth	99%-ile of baseline data for depth
	average = <b>21.60 mg</b> L-1	average = 40.10 mg L-1
	and	and
	120% of control station's SS at the same	130% of control station's SS at the same
	tide of the same day	tide of the same day
D d 1m 1:1:		(1)
Depth-averaged Turbidity	The average of the impact, WSR 45C	The average of the impact, WSR 45C
(Tby) (3) (4)	and WSR 46 station readings are >	and WSR 46 station readings are >
	95%-ile of baseline data = <b>25.04 NTU</b>	99%-ile of baseline data = <b>32.68 NTU</b>
	and	and
	120% of control station's Tby at the	130% of control station's Tby at the
	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) "Depth-averaged" is calculated by taking the arithmetic means of reading of all three depths.
- (4) For turbidity and SS, non-compliance of the water quality limits occurs when monitoring result is higher than the limits.

Table B6 Monitoring Results for Water Quality Monitoring during Capping of SB CMP in May 2017

Sampling	Stations	Temp	Salin ity	Turbid ity		solved tygen	pН	SS	NH3	TIN	$BOD_5$
Period	Stations	(°C)	(ppt)	(NTU )	(%)	(mg L- 1)	(mg L- 1)	(mg L- 1)	(mg L- 1)	(mg L- 1)	(mg L-1)
May 2017	RFF (Reference)	27.13	22.87	2.95	90.83	6.35	7.85	2.75	0.13	1.07	0.77
Way 2017	IPF (Impact)	26.40	28.89	7.02	83.51	5.72	7.74	5.47	0.13	0.80	0.83
	INF (Intermediate)	26.86	25.49	5.01	90.18	6.25	7.60	7.72	0.13	0.53	0.76
	Ma Wan	26.53	27.55	5.95	85.31	5.89	7.65	4.77	0.13	0.65	0.73
	Sham Shui Kok	26.64	26.56	13.72	86.47	5.97	7.82	6.73	0.13	0.68	0.70
	Tai Mo To	26.72	26.25	4.37	93.01	6.55	7.73	15.95	0.13	0.80	0.80
	Tai Ho Bay 1	27.36	20.90	3.50	93.62	6.53	7.83	5.17	0.13	1.10	0.90
	Tai Ho Bay 2	27.34	22.83	2.53	86.49	5.95	7.81	3.07	0.10	0.90	1.00
	WQO	N/A	20.59- 25.16*	N/A	N/A	>4	6.5-8.5	11.0	N/A	0.50	N/A

#### Notes:

<sup>#</sup> Not exceeding 2°C of change of the results from the Reference Station.

<sup>\*</sup>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**

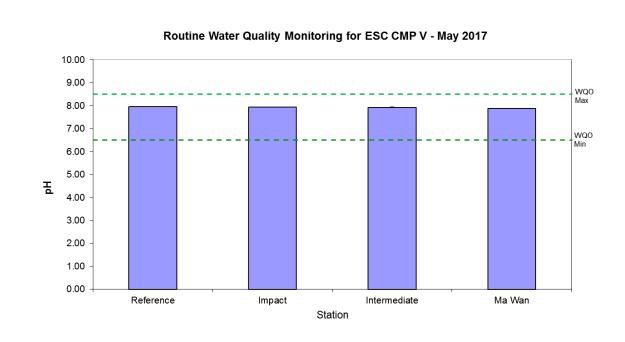


Figure 1: Level of pH recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in May 2017.

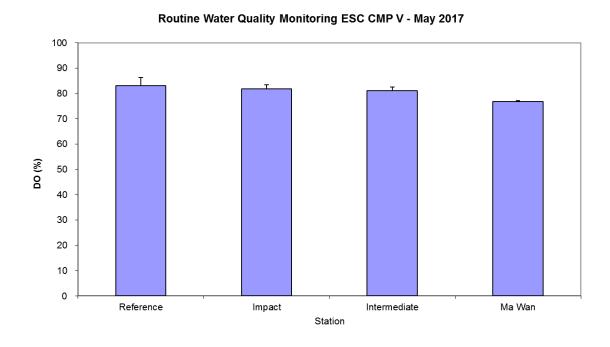


Figure 2: Level of Dissolved Oxygen (DO) (% saturation; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in May 2017.

Source: H:\Team\EM\GMS Projects\0400720 CEDD CMP EM&A 2017-2020\02 Deliverable\05 CMP Monthly Report\2nd (May 2017)

Date: June 2017



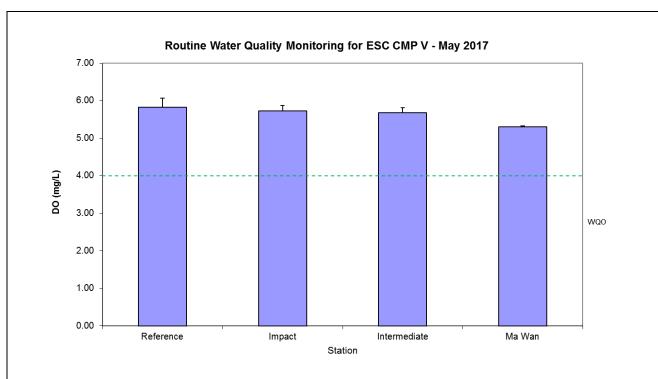


Figure 3: Concentration of Dissolved Oxygen (DO) (mg/L; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in May 2017.

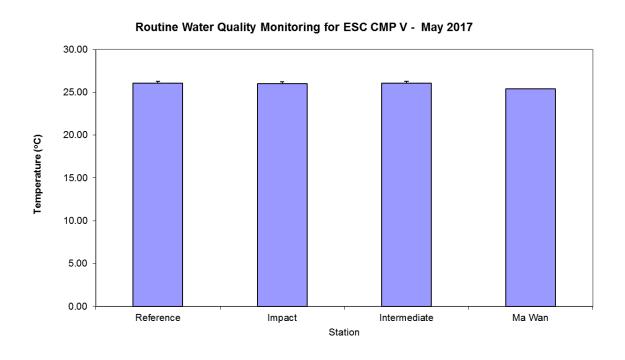


Figure 4: Level of Temperature (°C; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in May 2017.

Source: H:\Team\EM\GMS Projects\0400720 CEDD CMP EM&A 2017-2020\02 Deliverable\05 CMP Monthly Report\2nd (May 2017)

Date: June 2017



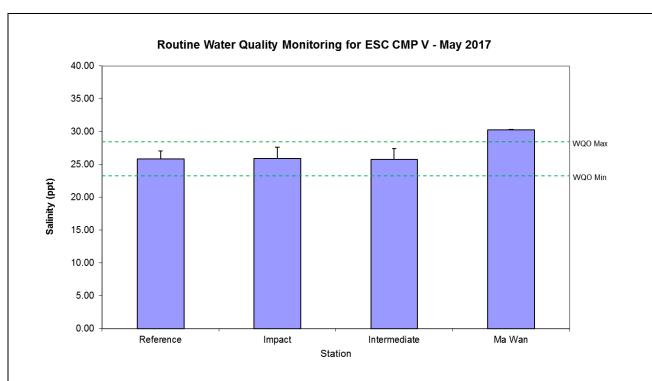


Figure 5: Level of Salinity (ppt; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in May 2017.

#### Routine Water Quality Monitoring for ESC CMP V - May 2017 4.00 3.50 3.00 Turbidity (NTU) 2.50 2.00 1.50 1.00 0.50 0.00 Reference Impact Intermediate Ma Wan Station

Figure 6: Levels of Turbidity (NTU; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in May 2017.

Source: H:\Team\EM\GMS Projects\0400720 CEDD CMP EM&A 2017-2020\02 Deliverable\05 CMP Monthly Report\2nd (May 2017)

Date: June 2017



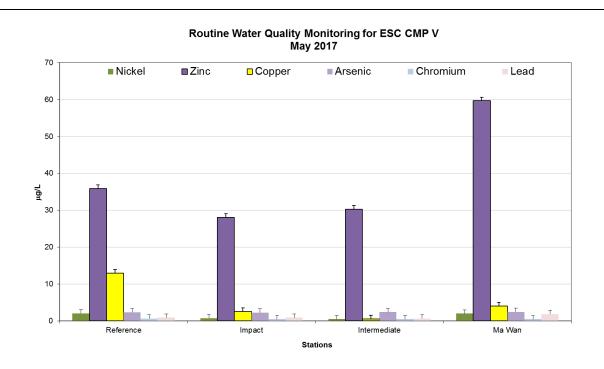


Figure 7: Concentration of Arsenic, Chromium, Nickel, Lead, Copper and Zinc (µg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in May 2017.

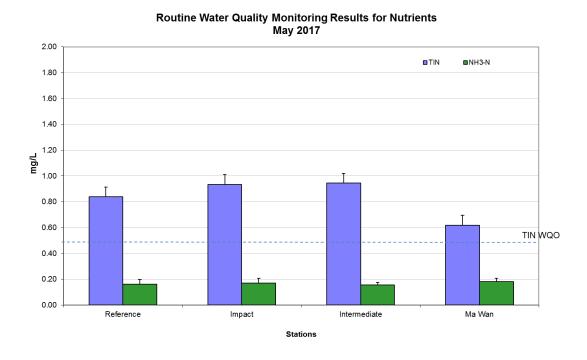


Figure 8: Concentration of Total Inorganic Nitrogen (TIN) and Ammonia Nitrogen (NH3-N) ( $\mu$ g/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in May 2017.

Source: H:\Team\EM\GMS Projects\0400720 CEDD CMP EM&A 2017-2020\02 Deliverable\05 CMP Monthly Report\2nd (May 2017)

Date: June 2017



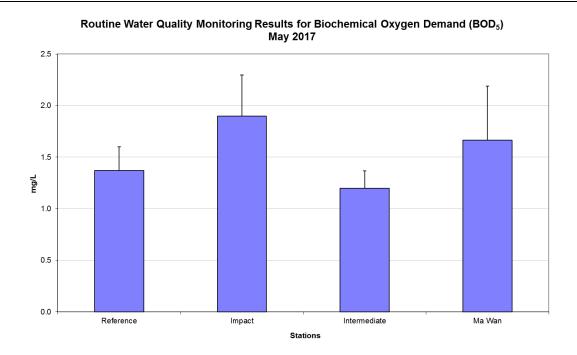


Figure 9: Level of Biochemical Oxygen Demand (BOD5) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in May 2017.

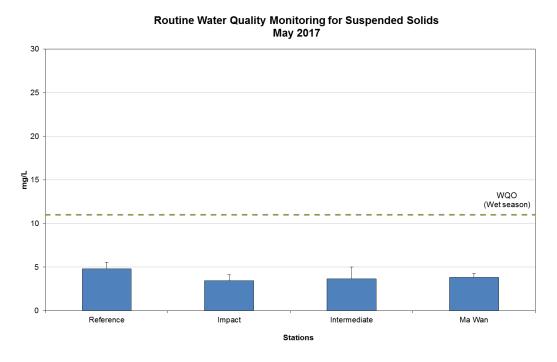


Figure 10: Concentration of Suspended Solids (SS) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in May 2017.

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Date: June 2017



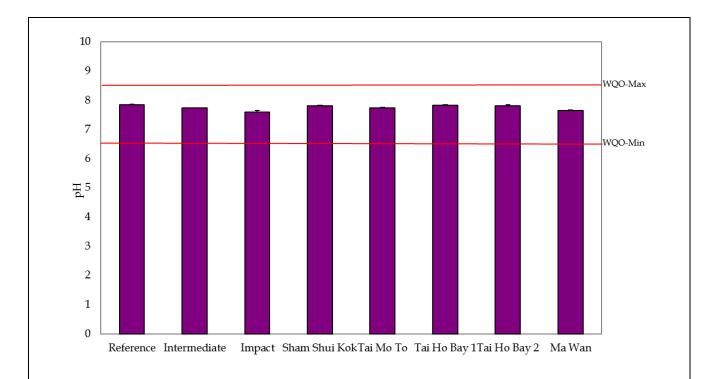


Figure 11: Levels of pH (mean +SD) recorded from Water Quality Monitoring during Capping of SB CMP 2 in May 2017.

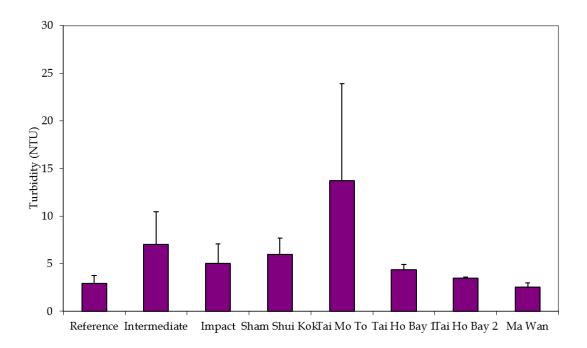


Figure 12: Levels of Turbidity (NTU; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMP 2 in May 2017

Deliverable \05 CMP Monthly Report \2nd (May 2017)

Date: June 2017



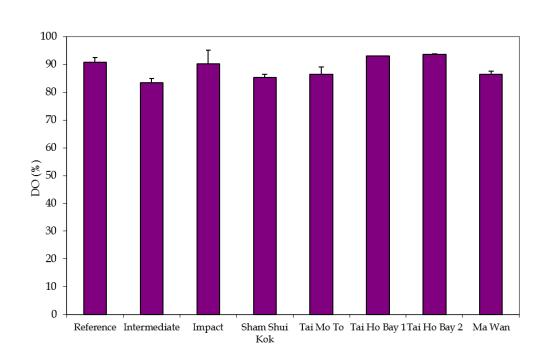


Figure 13: Levels of Dissolved Oxygen (% saturation; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMP 2 in May 2017

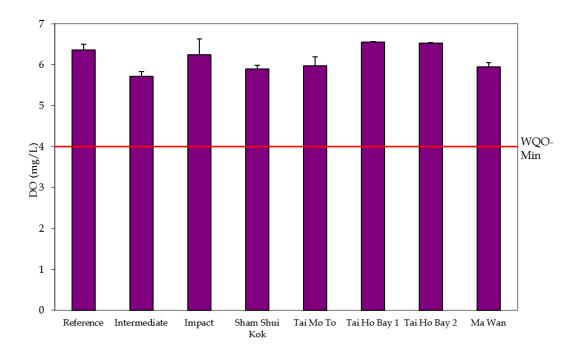


Figure 14: Levels of Dissolved Oxygen (mg/L; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMP 2 in May 2017

Deliverable \05 CMP Monthly Report \2nd (May 2017)

Date: June 2017



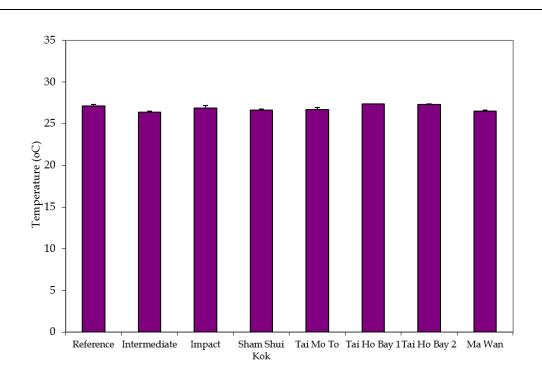


Figure 15: Levels of Temperature (°C; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMP 2 in May 2017.

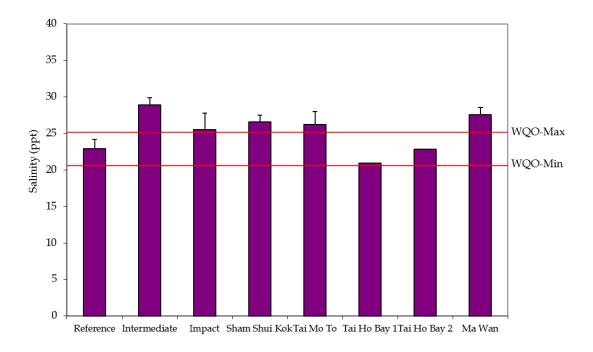


Figure 16: Levels of Salinity (ppt; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMP 2 in May 2017.

Deliverable\05 CMP Monthly Report\2nd (May 2017)

Date: June 2017



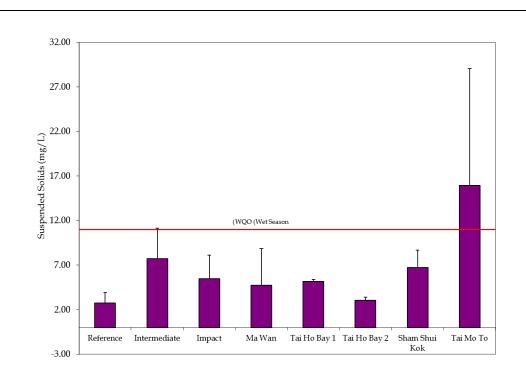


Figure 17: Levels of Suspended Solids (mg/L; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMP 2 in May 2017

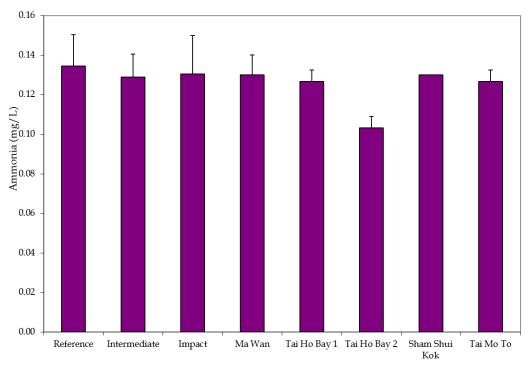


Figure 18: Level of Ammonia (mg/L; mean + SD) recorded from Water Quality Monitoring during Capping for SB CMP 2 in May 2017.

Deliverable \05 CMP Monthly Report \2nd (May 2017)

Date: June 2017



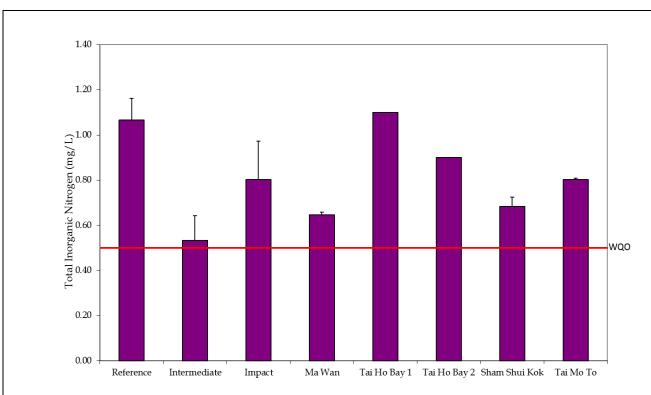


Figure 19: Level of TIN (mg/L; mean + SD) recorded from Water Quality Monitoring during Capping for SB CMP 2 in May 2017

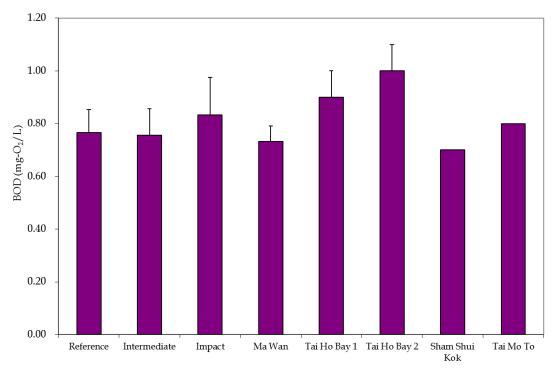


Figure 20: Level of BOD<sub>5</sub> (mg-O<sub>2</sub>/L; mean + SD) recorded from Water Quality Monitoring during Capping for SB CMP 2 in May 2017.

Deliverable \05 CMP Monthly Report \2nd (May 2017)

June 2017 Date:



#### Annex D

## Study Programme

