



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)*

48th Monthly Progress Report for Contaminated Mud Pits to the South of The Brothers and at East Sha Chau – August 2016

Final (Revision 1)

30 September 2016

Environmental Resources Management

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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:

 $48^{\rm th}\,{\rm Monthly}\,{\rm Progress}\,{\rm Report}\,{\rm for}\,{\rm Contaminated}\,{\rm Mud}\,{\rm Pits}\,{\rm to}$

the South of The Brothers and at East Sha Chau - August

2016

Date of Report:

12 September 2016

Date prepared by ET:

12 September 2016

Date received by IA:

12 September 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/ $\frac{1}{plan}$ complies with the above referenced condition of EP-427/2011/A

Craig A. Reid,

Environmental Team Leader:

Date:

12/9/2016

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:

12/9/2016

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Client:		Project No	o:		
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v1	48 th Monthly Progress Report for ESC CMPs and SB CMPs	RC	JT	CAR	30/9/16
v0	48 th Monthly Progress Report for ESC CMPs and SB CMPs	RC	JT	CAR	12/9/16
Revision	Description	Ву	Checked	Approved	Date
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WATER QUALITY MONITORING RESULTS

GRAPHICAL PRESENTATIONS

STUDY PROGRAMME

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

48TH MONTHLY PROGRESS REPORT FOR AUGUST 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.

- 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)

- 1.1.4 Environmental Permits (EPs) (EP-312/2008/A and EP-427/2011A) were issued by the Environmental Protection Department (EPD) to the CEDD, the Permit Holder, on 28 November 2008 for ESC CMP V and on 23 December 2011 for SB CMPs, respectively. Under the requirements of the EPs, an Environmental Monitoring and Audit (EM&A) programme as set out in the EM&A Manuals (1) (2) is required to be implemented for the CMPs.
- 1.1.5 The present EM&A programme under *Agreement No. CE 23/2012 (EP)* covers the dredging, disposal and capping operations of the SB CMPs as well as ESC CMPs. Detailed works schedule for ESC CMPs and SB CMPs is shown in *Figure 1.1.* In August 2016, the following works were being undertaken:
 - Disposal of contaminated mud at ESC CMP Vd; and
 - Capping operation at SB CMP 2.

Figure 1.1 Works Schedule for ESC CMPs and SB CMPs

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	Capping																																																											
	Dredging																																																											
SB CMP 2	Backfilling																																																											
	Capping																																														Ī													

1.2 REPORTING PERIOD

1.2.1 This 48th Monthly Progress Report covers the EM&A activities for the reporting month of August 2016.

1.3 DETAILS OF SAMPLING AND LABORATORY TESTING ACTIVITIES

- 1.3.1 The following monitoring activities have been undertaken for ESC CMPs in August 2016:
 - Benthic Recolonisation Studies of ESC CMP IV was undertaken on 5 August 2016;
 - Sediment Chemistry after a Major Storm of ESC CMPs was undertaken on 5 August 2016;
 - (1) ERM (2012) Environmental Monitoring and Audit (EM&A) Manual. Final First Review. 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). Submitted to EPD in November 2012.
 - (2) ERM (2010) Environmental Monitoring and Audit (EM&A) Manual. Final Second Review. Environmental Monitoring and Audit for Contaminated Mud Pit at Sha Chau (2009-2013) Investigation. Agreement No. CE 4/2009(EP). Submitted to EPD in November 2010.

- Routine Water Quality Monitoring of ESC CMPs was undertaken on 8
 August 2016;
- Pit Specific Sediment Chemistry of ESC CMP Vd was undertaken on 9 August 2016;
- Demersal Trawling of ESC CMPs was undertaken on 10 and 11 August 2016.
- Water Column Profiling of ESC CMP Vd was undertaken on 15 August 2016;
- Cumulative Impact Sediment Chemistry of ESC CMPs was undertaken on 11 and 12 August 2016;
- Sediment Toxicity Test of ESC CMPs was undertaken on 11 and 12 August 2016; and
- 1.3.2 The following monitoring activities have been undertaken for SB CMPs in August 2016:
 - Water Quality Monitoring During Capping of SB CMPs was undertaken on 20 August 2016; and
 - *Benthic Recolonisation Studies of SB CMP 1* was undertaken on 23 August 2016.
- 1.4 DETAILS OF OUTSTANDING SAMPLING AND/OR ANALYSIS
- 1.4.1 No outstanding sampling remained for August 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 CMPs* in July and August 2016;
 - Laboratory analyses of sediment samples collected for *Benthic Recolonisation Studies of ESC CMPs and SB CMP 1* in August 2016; and
 - Laboratory analyses for *Sediment Toxicity Test of ESC CMPs* in August 2016.
- 1.4.3 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 August 2016; and

• Laboratory analyses of sediment samples collected for *Cumulative Impact Sediment Chemistry of ESC CMP Vd* in August 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 *48th Monthly Progress Report*:
 - Routine Water Quality Monitoring of ESC CMPs in August 2016;
 - Water Column Profiling of ESC CMP Vd in August 2016; and
 - Sediment Chemistry after a Major Storm of ESC CMPs in August 2016.

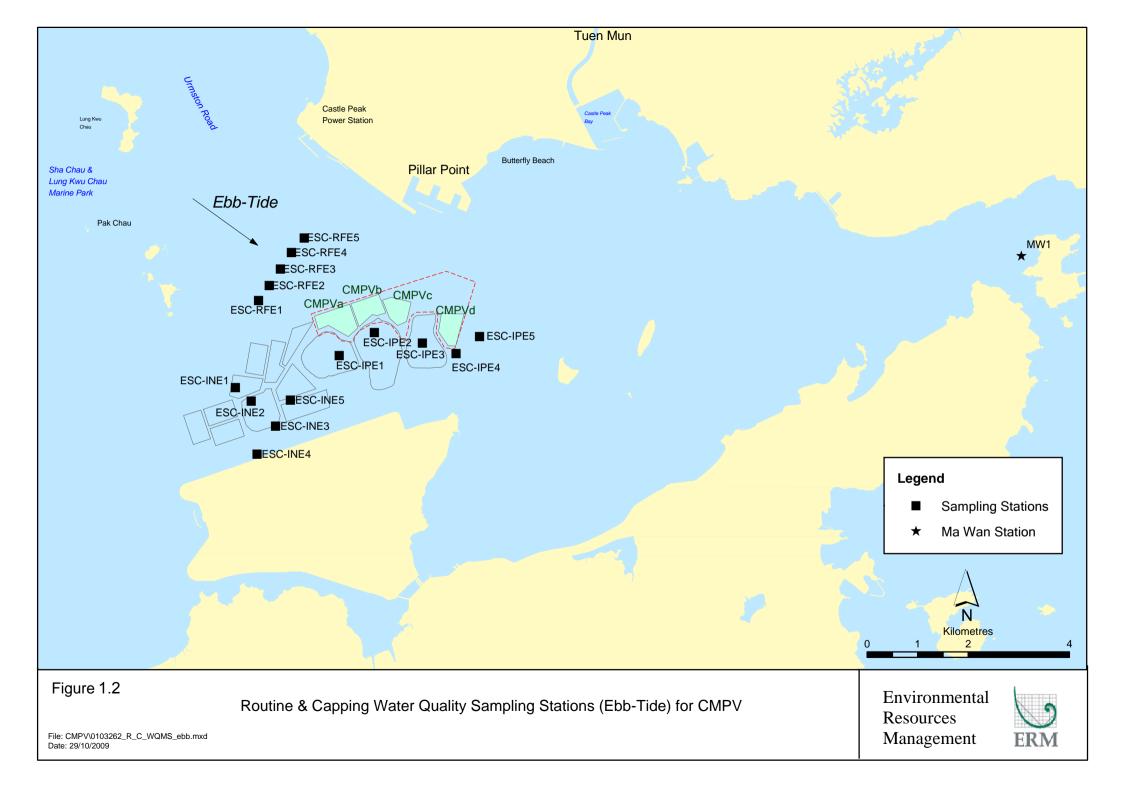
1.5.2 Routine Water Quality Monitoring of ESC CMPs - August 2016

1.5.3 Routine Water Quality Monitoring of ESC CMPs was undertaken on 8 August 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 August 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 August 2016 indicated that the levels of pH and DO complied with the WQOs at all stations (Impact, Intermediate, Reference and Ma Wan stations) in August 2016 (*Table B2* of *Annex B*; *Figures 1* and 3 of *Annex C*). Levels of Salinity at most stations complied with the WQOs, except for Ma Wan station (*Table B2* 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.
- 1.5.5 The levels of DO and Turbidity complied with the Action and Limit Levels at all stations (*Table B2* of *Annex B*; *Figures 3* and 6 of *Annex C*).

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



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 August 2016.

Laboratory Measurements

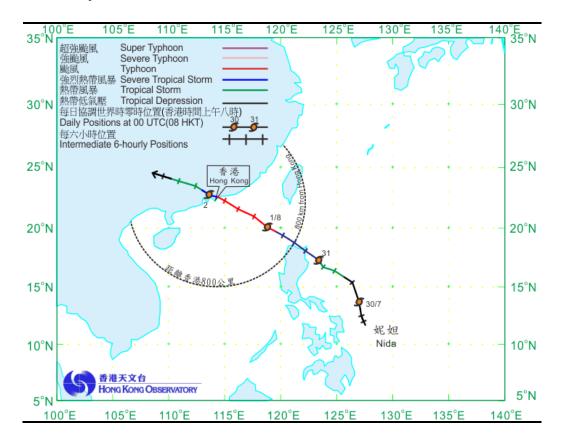
- 1.5.7 Laboratory analysis of August 2016 results indicated that concentrations of Cadmium, Lead, Silver and Mercury were below their limit of reporting at all stations. Arsenic, Chromium, Nickel, Copper and Zinc were detected in August 2016 samples and the concentrations of these metals and metalloid were similar amongst stations (*Table B3* of *Annex B*; *Figure 7* of *Annex C*).
- 1.5.8 For nutrients, concentrations of Total Inorganic Nitrogen (TIN) at all stations in August 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 the 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 Ma Wan station in August 2016 (*Table B3* of *Annex B*; *Figure 9* of *Annex C*).
- 1.5.9 Analyses of results for August 2016 indicated that the SS levels complied with the WQO (11.1 mg/L for wet season) and the Action and Limit Levels at all stations (*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 August 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 August 2016
- 1.5.12 Water Column Profiling was undertaken at a total of two sampling stations (Upstream and Downstream stations) on 15 August 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).

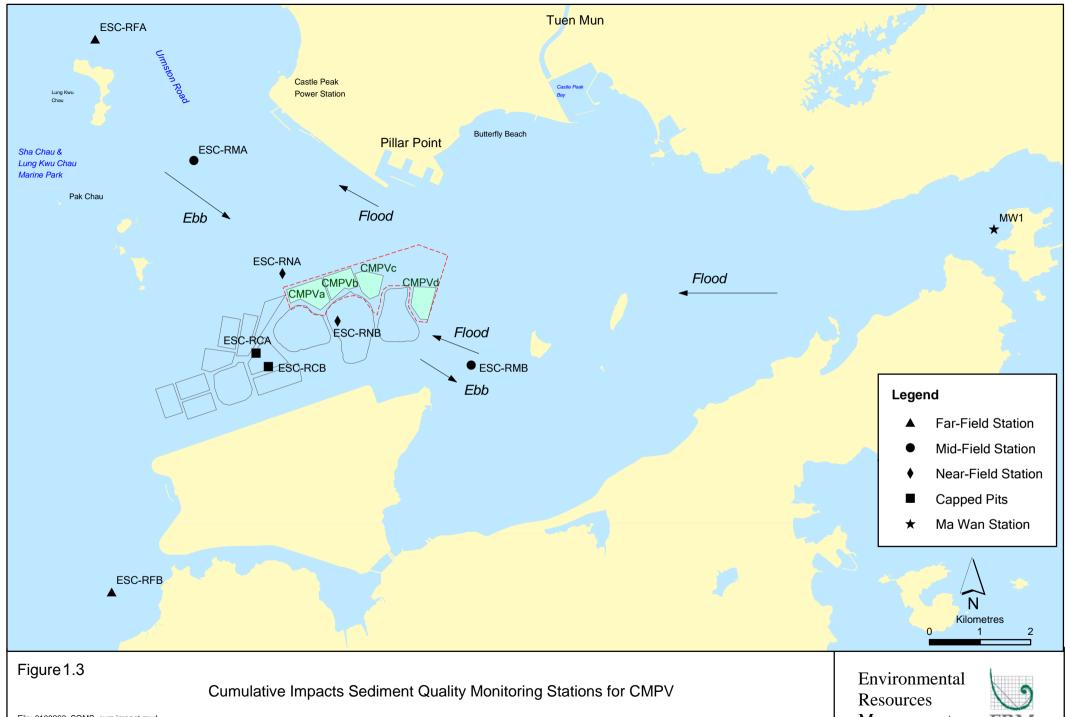
1.5.13 Analyses of results for August 2016 indicated that levels of Salinity and pH complied with the WQOs at both Downstream and Upstream stations (*Table B4* of *Annex B*). Levels of DO at Upstream station was lower than the WQO (4 mg/L for wet season). However, DO and Turbidity at all stations complied with the Action and Limit Levels (*Table B4* of *Annex B*).

Laboratory Measurements for Suspended Solids (SS)

- 1.5.14 Analyses of results for August 2016 indicated that the SS levels were higher than the WQO at Downstream station. However, both Upstream and Downstream stations complied with the Action and Limit Levels (*Table B4* of *Annex B*).
- 1.5.15 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.
- 1.5.16 Sediment Chemistry after a Major Storm of ESC CMPs August 2016
- 1.5.17 Sampling for Sediment Chemistry after a Major Storm Event was conducted at nine (9) monitoring stations (*Figure 1.3*) on 5 August 2016 after the visit of Typhoon Nida, which led to the issue of Gale or Storm Wind Signal No.8 on 1 August 2016. The track of Nida is shown in *Figure 1.4*.

Figure 1.4 Track of Typhoon Nida from 29 July to 3 August 2016 (Source: Hong Kong Observatory)





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Management



- 1.5.18 Analyses of results for the *Sediment Chemistry after a Major Storm* indicated that the concentrations of all inorganic contaminants were below the LCEL (*Figures* 11 and 12 of *Annex B*).
- 1.5.19 Overall, there appeared to be no evidence showing the failure of CMPs in retaining disposed mud or causing contamination of sediments after the major storm event in August 2016.

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 48th Monthly Progress Report:
 - Water Quality Monitoring during Capping Operations of SB CMPs in August 2016.
- 1.6.2 Water Quality Monitoring during Capping of SB CMPs August 2016
- 1.6.3 The monitoring results obtained during August 2016 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 twenty (20) monitoring stations were sampled in August 2016 as shown in *Figure 1.5*. Graphical presentation of the monitoring results is provided in *Annex C*.

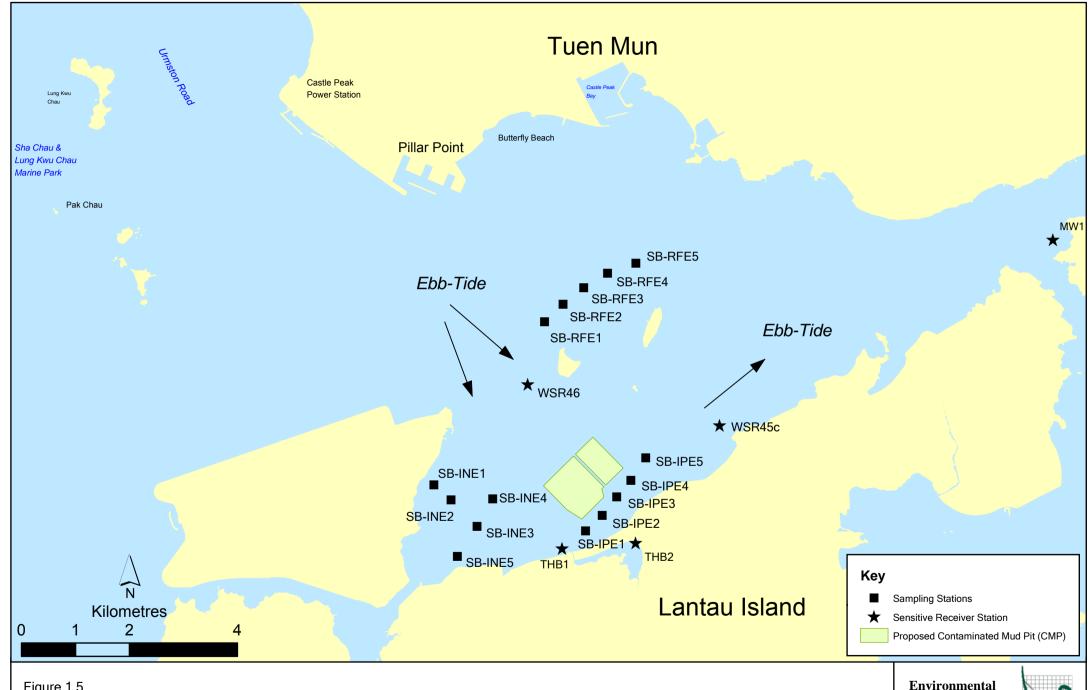


Figure 1.5

Routine Water Quality Sampling Stations (Ebb-Tide) for South Brothers Facility

Environmental Resources Management



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In-situ Measurements

- 1.6.4 Graphical presentation of the monitoring results (Temperature, DO, pH, Salinity and Turbidity) is shown in *Figures 13 18* of *Annex C*. Levels of pH at all stations in August 2016 complied with the WQO (*Table B6* of *Annex B*; *Figure 13* of *Annex C*). The levels of Turbidity at all stations complied with the Action and Limit levels in August 2016 (*Table B6* of *Annex B*; *Figure 14* of *Annex C*). DO at all stations also complied with the WQO and the Action and Limit levels in August 2016 (*Table B6* of *Annex B*; *Figure 16* of *Annex C*).
- 1.6.5 Levels of Salinity at most stations complied with the WQO except at Tai Ho Bay 2 station (*Table B6 of Annex B*; *Figure 18 of Annex C*). The lower Salinities recorded at Tai Ho Bay 2 are likely due to the close proximity of the nearby streams, which release large amount of freshwater runoff in the area during flooding.

Laboratory Measurement

- 1.6.6 Concentrations of SS were recorded higher than the WQO (11.1 mg/L for wet season) at Reference, Intermediate, Ma Wan and Tai Mo To stations in August 2016 (*Table B6* of *Annex B*; *Figure 19* of *Annex C*). However, levels of SS at all stations complied with the Action and Limit Levels (*Table B4* of *Annex B*).
- 1.6.7 For nutrients, concentrations of NH₃ were relatively similar amongst all stations (*Table B6* of *Annex B*; *Figure 20* of *Annex C*). TIN at all stations exceeded the WQO of 0.5 mg/L (*Table B6* of *Annex B*; *Figure 21* of *Annex C*). As discussed in *Section 1.5.8*, 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 disposal operation at CMP 2. Levels of BOD₅ appeared to be higher at Tai Ho Bay 1 station in August 2016 (*Table B6* of *Annex B*; *Figure 22* of *Annex C*).
- 1.6.8 Overall, the monitoring results indicated that the capping operation at CMP 2 did not appear to cause any unacceptable deterioration in water quality in August 2016. 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 September 2016 for ESC CMPs:
 - Water Column Profiling of ESC CMP Vd; and
 - Pit Specific Sediment Chemistry of ESC CMP Vd.
- 1.7.2 No monitoring activities will be scheduled in the next monthly period of September 2016 for SB CMPs.
- 1.7.3 The sampling schedule is presented in *Annex A*.
- 1.8 STUDY PROGRAMME
- 1.8.1 A summary of the Study programme is presented in *Annex D*.

Annex A

Sampling Schedule

Annex A1 - Environmental Monitoring and Audit Sampling Schedule for East of Sha Chau (September 2012 - February 2017) 2012 2013 2014 2015 2016 2017 Pit Specific Sediment Chemistry Code 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 A M J J A S O N D J F M A M J J A S O N D J F Active-Pit ESC-NPDA ESC-NPDB Pit-Edge ESC-NEDA **ESC-NEDB** Near-Pit ESC-NNDA ESC-NNDB **Cumulative Impact Sediment Chemistry** SONDJFMAMJJASONDJFMAAMJJJASONDJFMAAMJJJASONDJFFMAAMJJJASONDJFMAAMJJJASONDJFFMAAAMJJJASONDJF Near-field Stations ESC-RNA ESC-RNB Mid-field Stations ESC-RMA ESC-RMB Capped Pit Stations ESC-RCA ESC-RCB Far-Field Stations ESC-RFA ESC-RFB Ma Wan Station MW1 **Sediment Toxicity Tests** Near-Field Stations ESC-TDA ESC-TDB Reference Stations ESC-TRA ESC-TRB Ma Wan Station MW1 Tissue/Whole Body Sampling Impact Stations ESC-INA ESC-INB Reference ESC-TNA ESC-TNB ESC-TSA ESC-TSB

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	WCP2	* *	*	*	*	* *	*	*	*	*	*																										*	k	*	*	*	*	*	*	*	*	*	*

Annex A1 - Environmental Monito	ring ana Auait S			or East o	j Sna C			z - Feorua	ry 2011	/)					204.4								2015							•						2015
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Capped Contaminated Mud Pits I'	va-c ESC-CPA		*					*		*					*			*						*		*					-+	+	+-+	+	\dashv	 '
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Ebb Tide																																				
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Annex A1 - Environmental Monitoring and Audit Sampling Schedule for East of Sha Chau (September 2012 - February 2017)

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Routine Water Quality Monit	toring	S O	N D	J	F M	I A M	J	J	A S	0	NI) J	F M	[A	. M	J	JA	S	ON	D	J	F	M A	M	J J	A	$S \mid O$	N D	J	F N	I A M	J	J	A 5	5 O	N	D]	F
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	ESC-INE3	*	*	*	*	* *		*	*																						* *		* *	•	*	*		* *
	ESC-INE4	*	*	*	*	* *		*	*																						* *		* *	f	*	*		* *
	ESC-INE5	*	*	*	*	* *		*	*																						* *		* *	f	*	*	*	* *
Reference Station																																						
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	ESC-RFE2	*	*	*	*	* *		*	*																						* *		* *	f	*	*		* *
	ESC-RFE3	*	*	*	*	* *		*	*																						* *		* *	f	*	*		*
	ESC-RFE4	*	*	*	*	* *		*	*																						* *		* *	f	*	*		* *
	ESC-RFE5	*	*	*	*	* *		*	*																						* *		* *	f	*	*	*	* *
Ma Wan Station																																						
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Flood Tide																																						
Impact Station																																						
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Intermediate Station																																	$\perp \perp$		\bot			
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	ESC-INF3	*	*	*	*	* *		*	*																						* *		* *	*	*	*	*	* *
Reference Station																																	$\perp \perp$		\bot			
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Annex A2 - Environmental Monitoring and Audit Sampling Schedule for South of The Brothers (July 2012 - February 2017)

				2012							2013									203	14									2015										20	016					
Baseline Monitoring Prior to Dredging	Code	Frequency	I A	S 0		D	J F	M	Α				S	0 1	N D	J	F	M A	M			A	$\mathbf{S} \mid \mathbf{O}$	O N	D	J	FIN	и А	M		A	S	0	N	D	Ţ	FIN	Л А	M		010 J	A	$\mathbf{s} \mid \mathbf{o}$	N	D	
ar Field Stations	2000		, ,				-				, ,									,	,					, -				, .						,				+	+	—	+	+-	_	一
	SB-WFA	3 days per week for 4 weeks	* *	1																																			+	+	\vdash	\neg	+	+	+	十
	SB-WFB	3 days per week for 4 weeks	* *																																				\top	+	\vdash	-	\top	+		十
Mid Field Stations		T T T T T T T T T T T T T T T T T T T											t																1 1			1							+	+	+	-	+	+	+	十
	SB-WMA	3 days per week for 4 weeks	* *																								_		1 1			1							+	+	+	-	+	+	+	十
	SB-WMB	3 days per week for 4 weeks	* *	+ +				+			+		t														_					+					_		+	+	+	-	+	+	+	十
Near Field Stations	OD WIND	5 days per week for 1 weeks		+ +	+			1	\vdash		+		+		+		-+	-	+			-	+	+	+		-					╁	1	\vdash			-	-	+	+-	+	-	+	+	+	十
vear rela stations	SR_W/NI A A	3 days per week for 4 weeks	* *					+			+		\vdash		\dashv		-+	-	+			-	+				+		1 1	-		╁	<u> </u>	\vdash			+	-	+	+-	+	-+	+	+	+	+
			* *	+ + -							-		\vdash				-										+					1					+	-	+	+-	+-+	-+	$\overline{}$	+	+	+
	SB-WNBA	3 days per week for 4 weeks	* *						\vdash		-		+		+		-		-				-	+	+		-					+	<u> </u>	\vdash				-	+	+	+	-+	+	+	+	+
		3 days per week for 4 weeks	* *		+	\vdash					-		\vdash			-	-					-	_	+	+		-					-		\vdash			-	-	+	+	+	-	+	+	+	+
Reference Stations	3D-WINDD	3 days per week for 4 weeks	\vdash	+	+						-		\vdash			-	-					-	_	+	+		-					+		\vdash			-	-	+	+	+	-+	+	+	+	+
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	NM2	3 days per week for 4 weeks	* *								_		\vdash									_		-	-		_		1			<u> </u>					_		+	+	+	-	+	$+\!\!-$	—	+
	NM3	3 days per week for 4 weeks	* *																					_					1 1										—		+	$-\!\!\!+$	+			_
	NM5	3 days per week for 4 weeks	* *										\sqcup														_					<u> </u>					_			┷	\bot			—		4
	NM6	3 days per week for 4 weeks	* *	\bot	1	$oxed{oldsymbol{eta}}$		1	\sqcup				\sqcup			$\downarrow \downarrow \downarrow$			1						$oxed{igspace}$		\perp		+			<u> </u>	1				\perp		4	—	+		\bot		4	
Sensitive Receiver Stations									igsquare				\sqcup																					igsqcut						\bot	\sqcup	\bot	\bot	Д_		
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	THB1	3 days per week for 4 weeks	* *																																											
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	WSR45C	3 days per week for 4 weeks	* *										\sqcap																										\top		\Box	\top	\top	\top	T	\top
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mpact Monitoring for Dredging			JA	SO	N	D	J F	M	A	M	JI	Α	S	0	N D	J	F 1	M A	M	J	J	A S	$\mathbf{S} \mid \mathbf{C}$	O N	D	JI	FIN	И А	M	J	A	S	О	N	D	J	FIN	Л А	M	[]	I	A	$S \mid O$	N	D	
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	DS5	3 days per week			*	*	* *	*	*	*	* *	*	*	*	* *	*	*	* *	*	*	*	* :	* *	* *																						
Sensitive Receiver Stations																																														
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	THB1	3 days per week			*	*	* *	*	*	*	* *	*	*	*	* *	*	*	* *	*	*	*	* :	* *	* *															\top	\top	1			\top	\top	十
	THB2	3 days per week			*	*	* *	*	*	*	* *	*	*	*	* *	*	*							* *															\top		\vdash	\neg	\top	\top	_	\top
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Annex A2 - Environmental Monitoring and Audit Sampling Schedule for South of The Brothers (July 2012 - February 2017)

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Far-Field Stations																																	
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Capped Pit Stations																																	
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Annex A2 - Environmental Monitoring and Audit Sampling Schedule for South of The Brothers (July 2012 - February 2017)

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Annex A2 - Environmental Monitoring and Audit Sampling Schedule for South of The Brothers (July 2012 - February 2017)

				201	2				2013	3							201	14							2015							2016	}				2017
Capping Water Quality Monitoring			ΤΔ			DI	F M	А М			S	0 N	ı D	I F	М				A S (D I	F	M A	М		Δ	s o	N	D 1	I F M				S) N	D	
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	SB-IPE2	4 times per year																			3	3			3	3			3	3	+	3	3			3	
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	SB-IPE4	4 times per year																			3	3			3	3		1 1	3	3	+	3	3			3	
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	SB-RFE5	4 times per year																			3	3			3	3			3	3		3	3			3	
Sensitive Receiver Stations																																					
	MW1	4 times per year																			3	3			3	3			3	3		3	3			3	
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	WSR46	4 times per year		+ +	-		+ + +		-		+ +		+ +				+ +			+ +	3	3		1	3	3		+ +	3	3	++	3	3			3	
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	SB-INF3	4 times per year																			3	3			3	3			3	3		3	3			3	
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	SB-RFF2	4 times per year																			3	3			3	3			3	3		3	3			3	
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[&]quot;*" = Number of replicates depends on parameters

Naming of stations are tentative only and will be subjected to changes

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)	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-1	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 = 2.96 mg L-1	readings are <2 mg/L-1
	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 = 61.92 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
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

- (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 CMPs in August 2016

Sampling	Stations	Temp	Salinity	Turbidity	Dissolve	pН		
Period	Stations	(°C)	(ppt)	(NTU)	(%)	(mg L-1)	(mg L-1)	
August	RFE (Reference)	27.72	21.45	7.12	68.81	4.80	7.62	
2016	2016 IPE (Impact)		23.46	5.56	64.87	4.52	7.66	
	INE (Intermediate)	27.45	22.45	3.47	64.28	4.48	7.62	
	Ma Wan	25.93	27.49	2.10	59.32	4.13	7.61	
	WOO	NT/A	19.20 -	NT / A	NT / A	S 1	6.5-8.5	
WÇ		N/A	23.59#	N/A	N/A	>4	6.5-8.5	

Cell shaded grey indicate value exceeding the WQO.

Table B3 Laboratory Results for Routine Water Quality Monitoring of ESC CMPs in August 2016

Sampling	Stations	As	Cd	Cr	Cu	Pb	Hg	Ni	Ag	Zn	NH ₃	TIN	BOD ₅	SS
Period		(μg/L)	(μg/L)	(μg/L)	(μg/L)	(μg/L)	(μg/L)	(μg/L)	(μg/L)	(μg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
August	RFE	2.66	<lor< td=""><td>0.70</td><td>3.43</td><td><lor< td=""><td><lor< td=""><td>3.37</td><td><lor< td=""><td>4.15</td><td>0.07</td><td>1.05</td><td>2.84</td><td>11.09</td></lor<></td></lor<></td></lor<></td></lor<>	0.70	3.43	<lor< td=""><td><lor< td=""><td>3.37</td><td><lor< td=""><td>4.15</td><td>0.07</td><td>1.05</td><td>2.84</td><td>11.09</td></lor<></td></lor<></td></lor<>	<lor< td=""><td>3.37</td><td><lor< td=""><td>4.15</td><td>0.07</td><td>1.05</td><td>2.84</td><td>11.09</td></lor<></td></lor<>	3.37	<lor< td=""><td>4.15</td><td>0.07</td><td>1.05</td><td>2.84</td><td>11.09</td></lor<>	4.15	0.07	1.05	2.84	11.09
2016	IPE	2.77	<lor< td=""><td>1.37</td><td>2.41</td><td><lor< td=""><td><lor< td=""><td>2.26</td><td><lor< td=""><td>3.51</td><td>0.08</td><td>0.94</td><td>2.70</td><td>10.75</td></lor<></td></lor<></td></lor<></td></lor<>	1.37	2.41	<lor< td=""><td><lor< td=""><td>2.26</td><td><lor< td=""><td>3.51</td><td>0.08</td><td>0.94</td><td>2.70</td><td>10.75</td></lor<></td></lor<></td></lor<>	<lor< td=""><td>2.26</td><td><lor< td=""><td>3.51</td><td>0.08</td><td>0.94</td><td>2.70</td><td>10.75</td></lor<></td></lor<>	2.26	<lor< td=""><td>3.51</td><td>0.08</td><td>0.94</td><td>2.70</td><td>10.75</td></lor<>	3.51	0.08	0.94	2.70	10.75
	INE	2.86	<lor< td=""><td>2.18</td><td>2.86</td><td><lor< td=""><td><lor< td=""><td>2.96</td><td><lor< td=""><td>4.13</td><td>0.08</td><td>0.99</td><td>2.51</td><td>6.23</td></lor<></td></lor<></td></lor<></td></lor<>	2.18	2.86	<lor< td=""><td><lor< td=""><td>2.96</td><td><lor< td=""><td>4.13</td><td>0.08</td><td>0.99</td><td>2.51</td><td>6.23</td></lor<></td></lor<></td></lor<>	<lor< td=""><td>2.96</td><td><lor< td=""><td>4.13</td><td>0.08</td><td>0.99</td><td>2.51</td><td>6.23</td></lor<></td></lor<>	2.96	<lor< td=""><td>4.13</td><td>0.08</td><td>0.99</td><td>2.51</td><td>6.23</td></lor<>	4.13	0.08	0.99	2.51	6.23
	Ma Wan	2.49	<lor< td=""><td>0.50</td><td>3.31</td><td><lor< td=""><td><lor< td=""><td>2.22</td><td><lor< td=""><td>4.58</td><td>0.08</td><td>0.74</td><td>3.45</td><td>3.98</td></lor<></td></lor<></td></lor<></td></lor<>	0.50	3.31	<lor< td=""><td><lor< td=""><td>2.22</td><td><lor< td=""><td>4.58</td><td>0.08</td><td>0.74</td><td>3.45</td><td>3.98</td></lor<></td></lor<></td></lor<>	<lor< td=""><td>2.22</td><td><lor< td=""><td>4.58</td><td>0.08</td><td>0.74</td><td>3.45</td><td>3.98</td></lor<></td></lor<>	2.22	<lor< td=""><td>4.58</td><td>0.08</td><td>0.74</td><td>3.45</td><td>3.98</td></lor<>	4.58	0.08	0.74	3.45	3.98

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 August 2016

Stations	Temp	Salinity	Turbidity		solved ygen	pН	Suspended Solids	
	(°C)	(ppt)	(NTU)	(%)	(mg L-1)	(mg L-1)	(mg L-1)	
WCP 1								
(Downstream)	26.23	25.48	4.87	57.95	4.06	7.61	12.25	
WCP 2								
(Upstream)	25.33	28.57	7.93	48.12	3.36	7.59	10.25	
WQO (Wet season)	N/A	24.32 - 31.43#	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.

^{*}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.

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) The average of the impact, WSR 45C and WSR 46 station readings are < 5%-ile of baseline data for surface and	Surface and Mid-depth (2) The average of the impact, WSR 45C and WSR 46 station readings are < 4 mg L-1
	middle layer = 4.32 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)
	Bottom The average of the impact, WSR 45C and WSR 46 station readings are < 5%-ile of baseline data for bottom layers = 3.12 mg L-1	$\frac{\text{Bottom}}{\text{The average of the impact station,}}$ WSR 45C and WSR 46 readings are < 2 mg L^{-1}
	and Significantly less than the reference	and 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 Solids (SS) (3) (4)	The average of the impact, WSR 45C and WSR 46 station readings are > 95%-ile of baseline data for depth average = 21.60 mg L-1	The average of the impact, WSR 45C and WSR 46 station readings are > 99%-ile of baseline data for depth average = 40.10 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) (3) (4)	The average of the impact, WSR 45C and WSR 46 station readings are > 95%-ile of baseline data = 25.04 NTU	The average of the impact, WSR 45C and WSR 46 station readings are > 99%-ile of baseline data = 32.68 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

- (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 August 2016

Sampling Period	Stations	Temp	Salin ity	Turbid ity		solved ygen	pН	SS	NH3	TIN	BOD_5
		(°C)	(ppt)	(NTU)	(%)	(mg L- 1)	(mg L- 1)	(mg L- 1)	(mg L- 1)	(mg L- 1)	(mg L-1)
August	RFE (Reference)	26.54	26.13	29.24	63.87	4.43	7.57	25.80	0.15	0.97	1.05
2016	IPE (Impact)	27.05	24.34	7.45	72.05	5.00	7.60	10.81	0.20	1.10	1.37
	INE (Intermediate)	27.21	24.02	9.45	73.59	5.11	7.60	11.32	0.19	1.08	1.37
	Ma Wan	26.75	25.93	5.92	66.40	4.60	7.57	11.35	0.18	0.94	0.90
	Sham Shui Kok	27.14	24.28	5.30	71.67	4.97	7.59	10.22	0.18	1.04	1.17
	Tai Mo To	26.42	26.19	13.34	62.83	4.37	7.03	17.45	0.18	1.01	1.50
	Tai Ho Bay 1	26.96	24.33	4.49	77.98	5.43	7.59	9.93	0.12	0.92	1.73
	Tai Ho Bay 2	27.34	23.26	4.07	65.12	4.53	7.37	5.80	0.16	0.92	1.30
	WQO	N/A	23.52- 28.74*	N/A	N/A	>4	6.5-8.5	11.1	N/A	0.50	N/A

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

Cell shaded grey indicate value exceeding the WQO.

[#] Not exceeding 2°C of change of the results from the Reference Station.

^{*}Not exceeding 10% of natural ambient level which is the result obtained from the Reference Station.

Annex C

Graphical Presentations

Routine Water Quality Monitoring for ESC CMP Vd - August 2016 10.00 9.00 WQO Max 8.00 7.00 WQO Min 6.00 5.00 펍 4.00 3.00 2.00 1.00 0.00 Reference Impact Intermediate Ma Wan Station

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

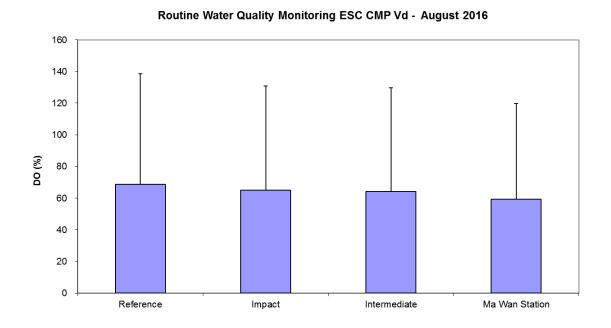


Figure 2: Level of Dissolved Oxygen (DO) (% saturation; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

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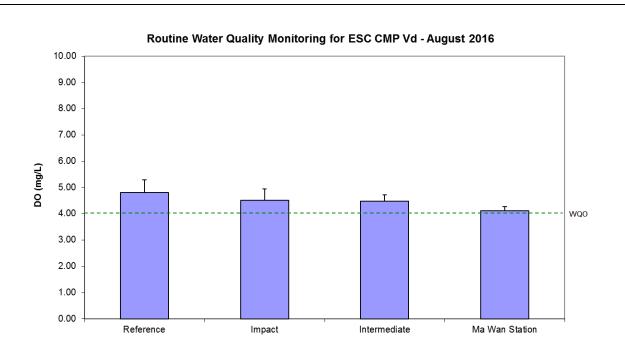


Figure 3: Concentration of Dissolved Oxygen (DO) (mg/L; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

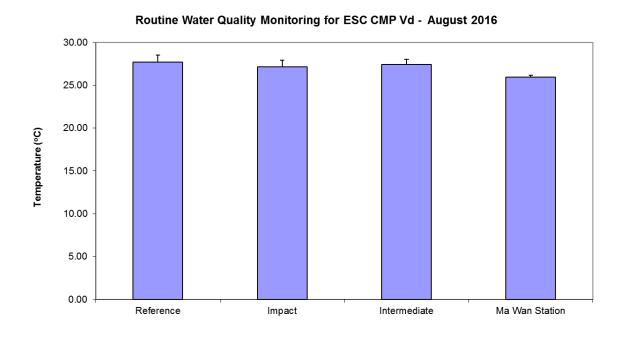


Figure 4: Level of Temperature (°C; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

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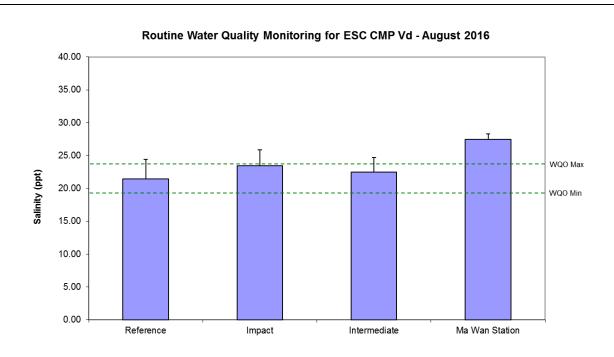
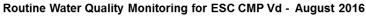


Figure 5: Level of Salinity (ppt; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.



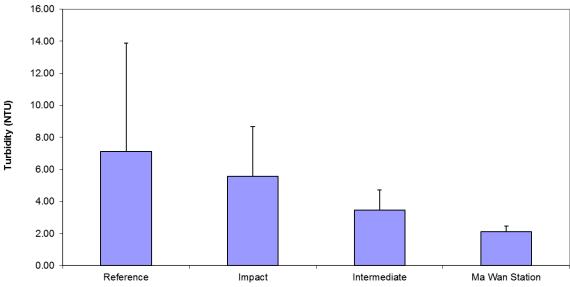


Figure 6: Levels of Turbidity (NTU; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

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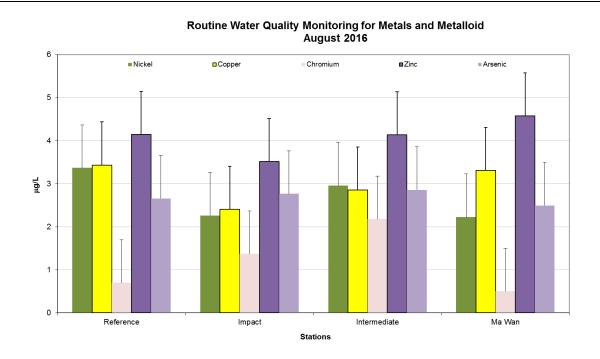


Figure 7: Concentration of Copper, Chromium, Zinc, Arsenic and Nickel (μ g/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

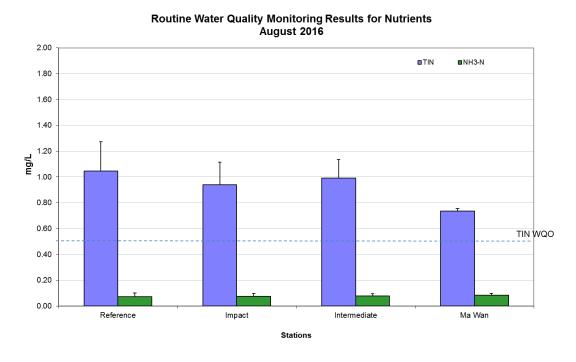


Figure 8: Concentration of Total Inorganic Nitrogen (TIN) and Ammonia Nitrogen (NH3-N) $(\mu g/L; mean + SD)$ in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

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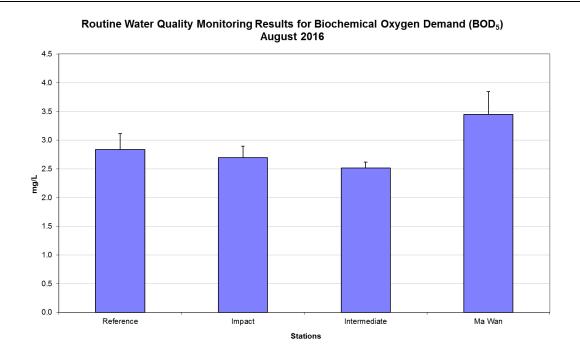


Figure 9: Level of Biochemical Oxygen Demand (BOD5) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

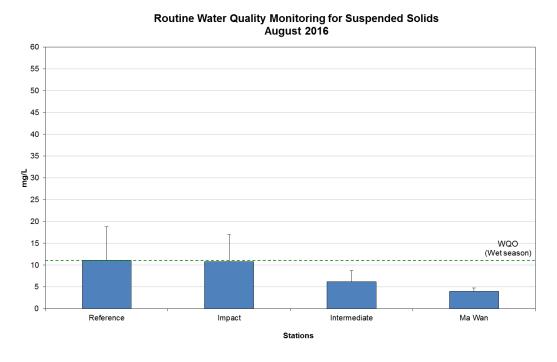


Figure 10: Concentration of Suspended Solids (SS) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP Vd in August 2016.

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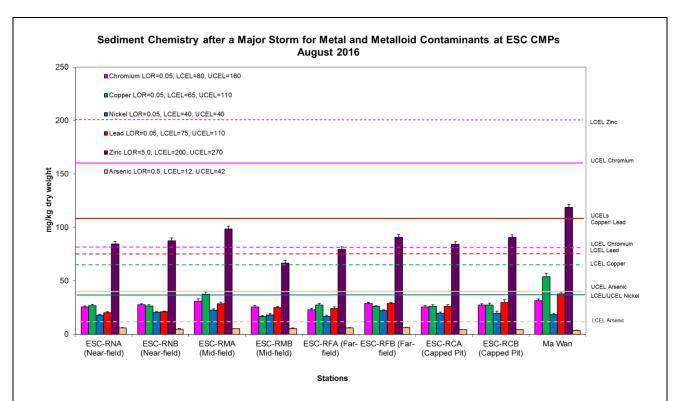


Figure 11: Concentration of Metals (Cr, Cu, Ni, Pb, Zn, As; mean +SD) in sediment samples collected from *Sediment Chemistry after a Major Storm* for SB CMPs in August 2016.

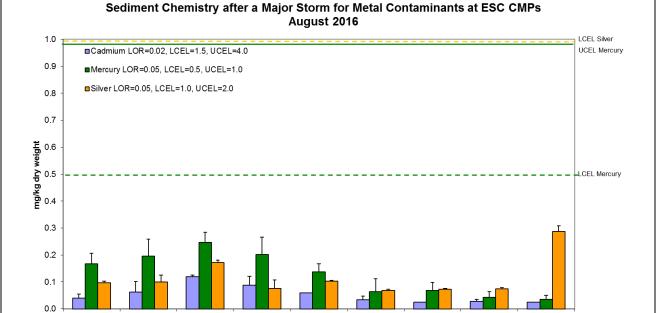


Figure 12: Concentration of Metals (Cd, Hg, Ag; mean +SD) in sediment samples collected from *Sediment Chemistry after a Major Storm* for SB CMPs in August 2016.

ESC-RFA

(Far-field)

ESC-RMB

(Mid-field)

ESC-RFB

(Far-field)

ESC-RCA

(Capped Pit)

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ESC-RMA

(Mid-field)

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ESC-RNA

(Near-field)

ESC-RNR

(Near-field)

Environmental Resources Management

ESC-RCB

(Capped Pit)

Ma Wan



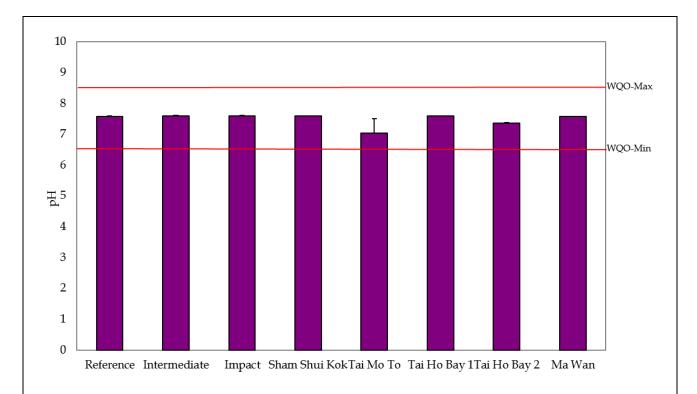


Figure 13: Levels of pH (mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016.

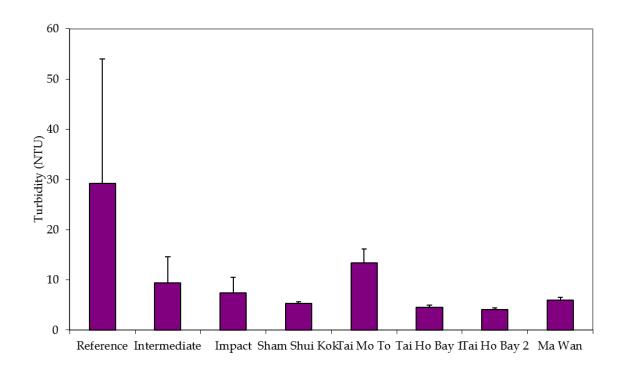


Figure 14: Levels of Turbidity (NTU; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016

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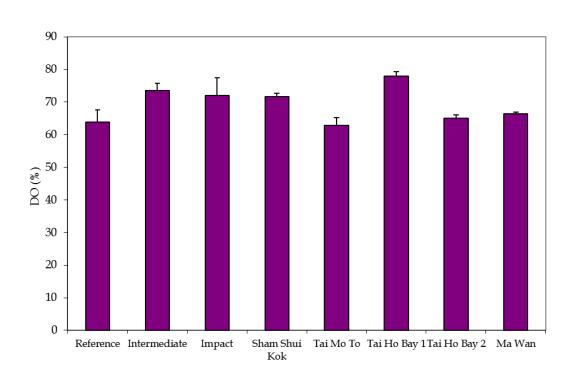


Figure 15: Levels of Dissolved Oxygen (% saturation; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016

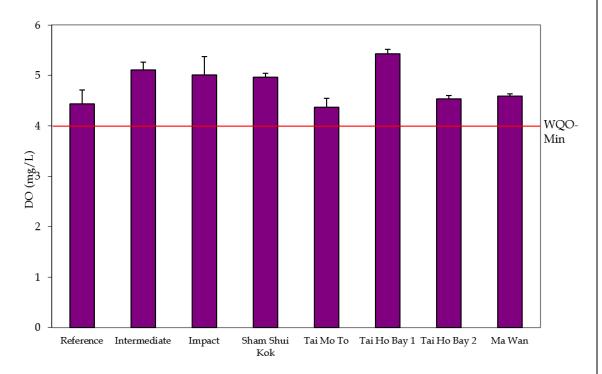


Figure 16: Levels of Dissolved Oxygen (mg/L; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016

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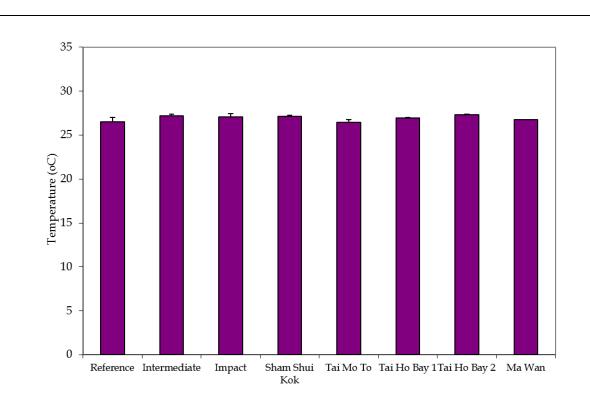


Figure 17: Levels of Temperature (°C; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016.

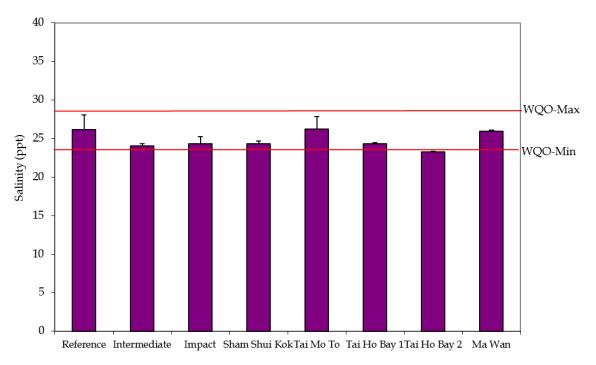


Figure 18: Levels of Salinity (ppt; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016.

Source: H:\Team\EM\GMS Projects\0175086 CEDD EM&A for South Brothers\02

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10/9/2016 Date:



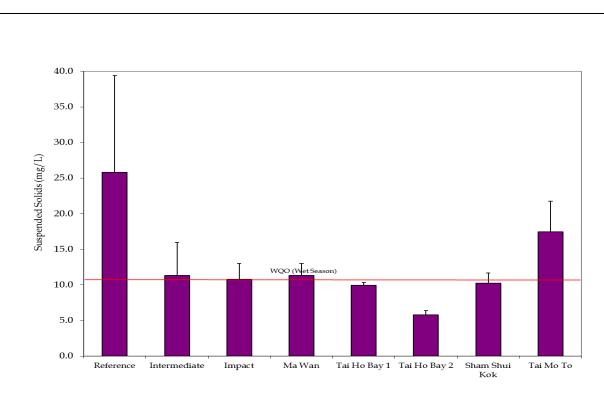


Figure 19: Levels of Suspended Solids (mg/L; mean +SD) recorded from Water Quality Monitoring during Capping of SB CMPs in August 2016

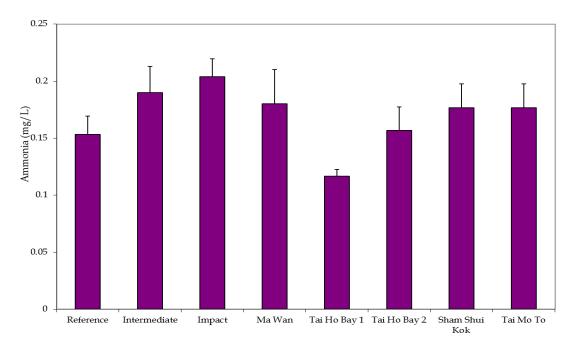


Figure 20: Level of Ammonia (mg/L; mean + SD) recorded from Water Quality Monitoring during Capping for SB CMPs in August 2016.

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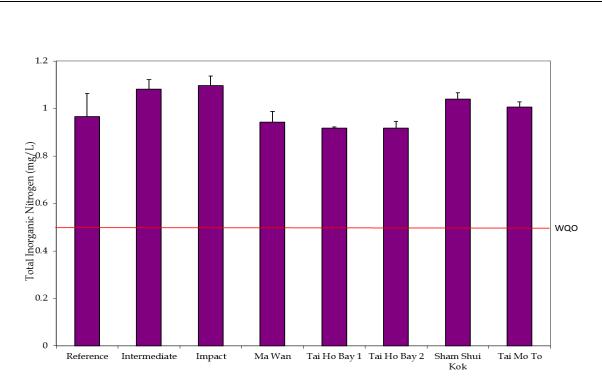


Figure 21: Level of TIN (mg/L; mean + SD) recorded from Water Quality Monitoring during Capping for SB CMPs in August 2016

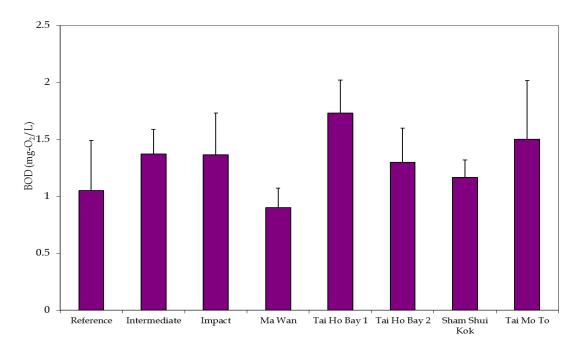


Figure 22: Level of BOD₅ (mg-O₂/L; mean + SD) recorded from Water Quality Monitoring during Capping for SB CMPs in August 2016.

10/9/2016 Date:



Annex D

Study Programme

