



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 – November 2018

Revision 0

December 2018

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Client:		Project	No:		
Civil En	gineering and Development Department (CEDD)	04007	20		
Environn	ument presents the Monthly EM&A Report for nental Monitoring and Audit for Disposal Facility to the East Thau and the South of The Brothers.	Approve	cember 20 ed by:	018	
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v0	Monthly EM&A Report for ESC CMPs and SB CMPs	TT	RC	CAR	14/12/18
Revision	Description	Ву	Checked	Approved	Date
'ERM Hong- Contract wit	has been prepared by Environmental Resources Management the trading name of Kong, Limited', with all reasonable skill, care and diligence within the terms of the h the client, incorporating our General Terms and Conditions of Business and ant of the resources devoted to it by agreement with the client.	Distribu	tion ternal		5 18001:2007 No. OHS 515956
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third parties	s confidential to the client and we accept no responsibility of whatsoever nature to to whom this report, or any part thereof, is made known. Any such party relies on their own risk.	c	onfidential	ISO 9 Certificat	0001 : 2008 e No. FS 32515







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 -

November 2018

Date of Report:

14 December 2018

Date prepared by ET:

14 December 2018

Date received by IA:

14 December 2018

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/plan complies with the above referenced condition of EP-312/2008/A and EP-427/2011/A

Craig Reid,

Environmental Team Leader:

Date:

14/12/2018

IA Verification

I hereby verify that the above referenced document/plan complies with the above referenced condition of

EP-312/2008/A and EP-427/2011/A

Dr Wang Wen Xiong, Independent Auditor: Date:

14/12/2018

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

MONTHLY EM&A REPORT FOR NOVEMBER 2018

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). The current programme will assess the impacts resulting from dredging, disposal and capping operations of CMP V as well as capping operations of SB CMPs.
- 1.1.3 The present EM&A programme under *Agreement No. CE 63/2016 (EP)* 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 November 2018, the following work was being undertaken:
 - Disposal of contaminated mud at ESC CMP Vd.

ERM (2013) Final Report. Submitted under Agreement No. CE 4/2009 (EP) Environmental Monitoring and Audit for Contaminated Mud Pit at East Sha Chau. For CEDD.

⁽²⁾ ERM (2017) Final Report. Submitted under 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). For CEDD.

Figure 1.1 Works Schedule for ESC CMP V and SB CMPs

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	Dredging]
ESC CMP V	Disposal																																																
	Capping																																																
	Dredging]
SB CMP 2	Disposal																																														Ι		
	Capping																																																

1.2 REPORTING PERIOD

1.2.1 This *Monthly EM&A Report for November 2018* covers the EM&A activities for the reporting month of November 2018.

1.3 DETAILS OF SAMPLING AND LABORATORY TESTING ACTIVITIES

- 1.3.1 The following monitoring activities were undertaken for ESC CMP V in November 2018:
 - Water Column Profiling of ESC CMP Vd;
 - Routine Water Quality Monitoring of ESC CMPs; and
 - Pit Specific Sediment Chemistry of ESC CMP Vd.
- 1.3.2 No monitoring activities were scheduled to be undertaken for SB CMP in November 2018.

1.4 DETAILS OF OUTSTANDING SAMPLING AND/OR ANALYSIS

1.4.1 No outstanding sampling remained for November 2018.

1.5 Brief Discussion of the Monitoring Results for ESC CMP V

- 1.5.1 Brief discussion of the monitoring results of the following activities for ESC CMP V is presented in this *Monthly EM&A Report for November 2018*:
 - Water Column Profiling of ESC CMP Vd in November 2018;
 - Routine Water Quality Monitoring of ESC CMPs in November 2018; and
 - *Pit Specific Sediment Chemistry of ESC CMP Vd* in October and November 2018.

1.5.2 Water Column Profiling of ESC CMP Vd - November 2018

1.5.3 Water Column Profiling was undertaken at a total of two sampling stations (Upstream and Downstream stations) on 5 November 2018. 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 dry season period (November to March) of 2007 - 2016 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 November 2018 indicated that levels of Salinity, pH and DO complied with the WQOs at both Downstream and Upstream stations (*Table B2* of *Annex B*). Levels of DO and Turbidity at all stations complied with the Action and Limit Levels (*Tables B1* and *B2* of *Annex B*).

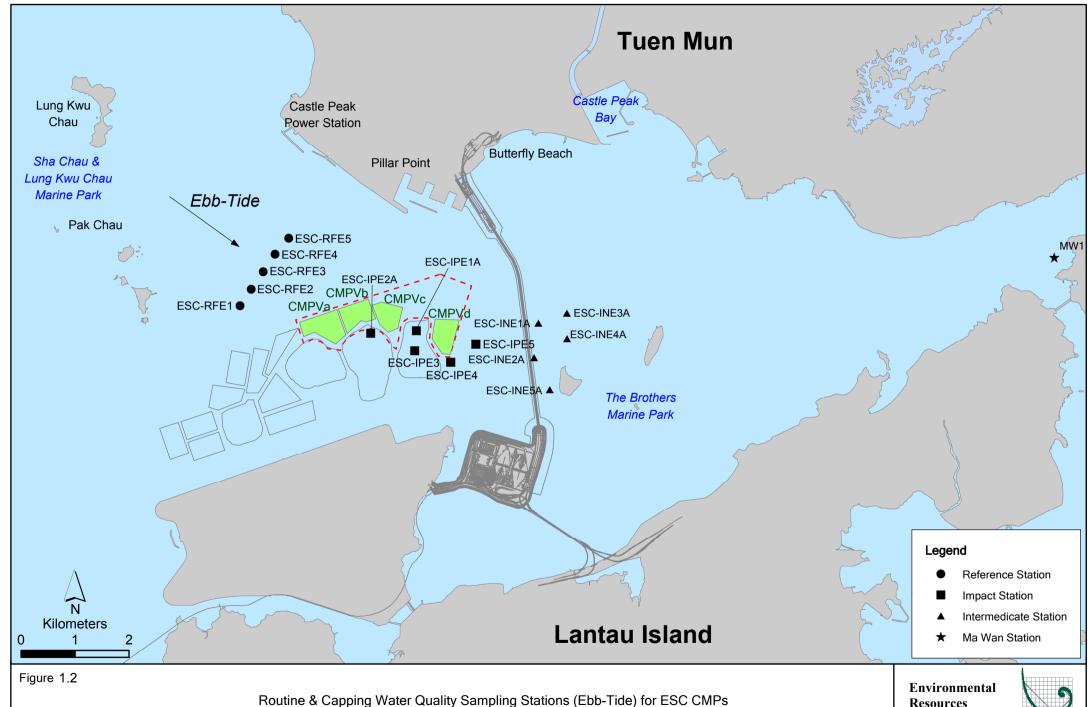
Laboratory Measurements for Suspended Solids (SS)

1.5.5 Analyses of results for November 2018 indicated that the SS levels at both Downstream and Upstream stations were higher than the WQO. However, the SS levels complied with the Action and Limit Level at both Downstream and Upstream stations (*Tables B1* and *B2* of *Annex B*).

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

1.5.6 Routine Water Quality Monitoring of ESC CMPs - November 2018

1.5.7 Routine Water Quality Monitoring of ESC CMPs was undertaken on 7 November 2018. 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 sixteen (16) monitoring stations were sampled in November 2018 as shown in Figure 1.2.



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Resources Management



In-situ Measurements

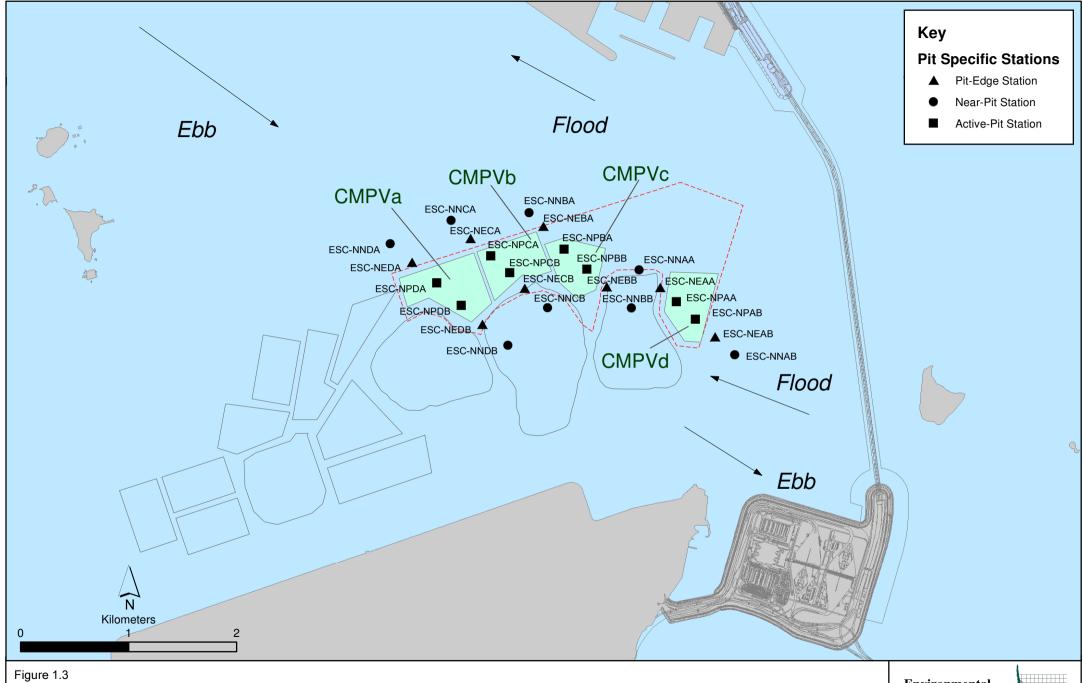
- 1.5.8 Graphical presentation of the monitoring results (Temperature, DO, pH, Salinity and Turbidity) is shown in *Figures 1 6* of *Annex C*. Analyses of results for November 2018 indicated that the levels of pH, Salinity and DO complied with the WQOs at all stations (Impact, Intermediate, Reference and Ma Wan stations) in November 2018.
- 1.5.9 The levels of DO and Turbidity also complied with the Action and Limit Levels at all stations (*Table B3* of *Annex B*; *Figures 3* and 6 of *Annex C*).
- 1.5.10 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 November 2018.

Laboratory Measurements

- 1.5.11 Laboratory analysis of November 2018 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 November 2018 samples at most stations and the concentrations of these metals and metalloids were similar amongst the stations (*Table B4* of *Annex B*; *Figure 7* of *Annex C*).
- 1.5.12 For nutrients, concentrations of Total Inorganic Nitrogen (TIN) at all stations in November 2018 complied with the WQO (*Table B4* of *Annex B*; *Figure 8* of *Annex C*). Concentrations of Ammonia Nitrogen (NH₃-N) and 5-day Biochemical Oxygen Demand (BOD₅) were generally similar amongst the stations in November 2018 (*Table B4* of *Annex B*; *Figure 8 and 9* of *Annex C*).
- 1.5.13 Analyses of results for November 2018 indicated that the SS levels complied with the WQO (12.8 mg/L for dry season) and the Action and Limit Levels at all stations (*Tables B1 and B4* of *Annex B*; *Figure 10* of *Annex C*).

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 November 2018. Detailed statistical analysis will be presented in the Quarterly Report to investigate any spatial and temporal trends of potential concern.

- 1.5.14 Pit Specific Sediment Chemistry of ESC CMP Vd October and November 2018
- 1.5.15 Monitoring locations for *Pit Specific Sediment Chemistry for ESC CMP Vd* are shown in *Figure 1.3*. A total of six (6) monitoring stations were sampled monthly on 4 October 2018 and 6 November 2018.



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Pit Specific Sediment Quality Monitoring Stations for CMPV



- 1.5.16 The concentrations of all inorganic contaminants were lower than the Lower Chemical Exceedance Level (LCEL) at all stations, except for Arsenic which was slightly higher than LCEL at Active Pit stations ESC-NPAA and ESC-NPAB in both October and November 2018 (*Figures 11, 12, 15 and 16* of *Annex C*).
- 1.5.17 For organic contaminants, the concentrations of Total Organic Carbon (TOC) were generally similar in October and November 2018 (*Figures 13 and 17* of *Annex C*). The concentration of Tributyltin (TBT) was generally similar amongst stations in October and November 2018 (*Figures 14 and 18* of *Annex C*). Low and High Molecular Weight Polycyclic Aromatic Hydrocarbons (PAHs), Total Polychlorinated Biphenyls (PCBs), Total dichloro-diphenyl-trichloroethane (DDT) and 4,4′-dichlorodiphenyldichloroethylene (DDE) concentrations were below the limit of reporting at all stations in October and November 2018.
- 1.5.18 Overall, there is no evidence indicating any unacceptable environmental impacts to sediment quality as a result of the contaminated mud disposal operations at ESC CMP Vd in October and November 2018. Statistical analysis will be undertaken and presented in the corresponding quarterly report to investigate whether there are any unacceptable impacts in the area caused by the contaminated mud disposal.

1.6 ACTIVITIES SCHEDULED FOR THE NEXT MONTH

- 1.6.1 The following monitoring activities will be conducted in the next monthly period of December 2018 for ESC CMP V (see *Annex A* for the sampling schedule):
 - Water Column Profiling of ESC CMP Vd;
 - Pit Specific Sediment Chemistry of ESC CMP Vd; and
 - Cumulative Impact Sediment Chemistry of ESC CMP Vd.
- 1.6.2 The following monitoring activities will be conducted in the next monthly period of December 2018 for SB CMPs (see *Annex A* for the sampling schedule):
 - Benthic Recolonisation Studies of SB CMPs.

1.7 STUDY PROGRAMME

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

Annex A

Sampling Schedule

Annex A1 - East of Sha Chau Envir	ronmental Mon	toring and Audit Sampling	Schedule	for C		April 2 2017	017 - N	nuren 2					20	018								2019								202	0				2	2021
Pit Specific Sediment Chemistry Active-Pit		Frequency			J	A :		П	1	F			1 J	J	\top					M A		J J								П						
Pit-Edge	ESC-NPAA ESC-NPAB	Monthly Monthly	12 12 12 12	12	12		2 12	_	12 1	2 12	_	12 1	_	_	_	2 12				12 12 12 12							2 12 1		2 12				12 1 12 1			12 12 12 12
The Edge	ESC-NEAA ESC-NEAB	Monthly Monthly	12 12 12 12				2 12 2 12		12 1 12 1	2 12				12 12		2 12				12 12 12 12							2 12 1			12		2 12 2 12			_	12 12 12 12
Near-Pit	ESC-NNAA ESC-NNAB																			12 12 12 12																
Cumulative Impact Sediment Che		Monuny	A M			A :						A								M A																F M
Near-field Stations	ESC-RNA	4 times per year		12		12			12	12			12		12		Е	12	12			12	12	Е	1	2	12		E	12	12	2		12	Н	12
Mid-field Stations	ESC-RNB1 ESC-RMA	4 times per year		12		12			12	12			12		12			12	12			12	12			2	12		L	12	12			12		12
Capped Pit Stations	ESC-RMB	4 times per year 4 times per year		12		12			12	12			12		12			12	12			12	12			2	12			12	12			12		12
	ESC-RCA1 ESC-RCB1	4 times per year 4 times per year		12 12		12 12			12 12	12	_		12 12		12 12			12 12	12 12			12 12	12 12		1	2	12 12			12 12	12 12			12 12		12 12
Far-Field Stations	ESC-RFA ESC-RFB	4 times per year 4 times per year		12		12			12 12	12			12		12			12	12			12	12			2	12		-	12	12			12		12
Ma Wan Station	MW1	4 times per year		12		12			12	12			12		12			12	12			12	12		1		12			12	12			12		12
Sediment Toxicity Tests			A M	J	J	A :	6 0	N	D	F	M	A N	1 J	J	A 5	s O	N	D J	F	M A	M	J J	A S	0	N I) J	F	M A	. M	J	J A	S	0 1	l D	J	F M
Near-Pit Stations	ESC-TDA ESC-TDB1	2 times per year 2 times per year				5				5					5				5				5			+	5				5					5
Reference Stations	ESC-TRA	2 times per year				5				5			F	_	5				5				5				5				5					5
Ma Wan Station	ESC-TRB MW1	2 times per year 2 times per year				5			4	5					5				5				5			ŀ	5				5					5
Tissue/Whole Body Sampling	IVIVVI	2 times per year	A M	J	J		6 0	N	D		_	A N	1 J			s o	N	D J		M A	M	J J		0	N I	o J		M A	. M	J			0 1	l D		
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Reference South	TNB	2 times per year				*	Ŧ	\exists	1	*				Ħ	*		E		*				*	Е	1	1	*		L		*		Ħ	I		*
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Reference North	TNA TNB	4 times per year 4 times per year			5	5		\vdash		5 5	_		+		5			5				5		H	+	5	5	+	+		5 5 5 5					5
Reference South	TSA	4 times per year			5	5				5 5				5	5			5	5 5			5	5			5	5		E		5 5	5			5	5
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	ESC-IPE3 ESC-IPE4	4 times per year 4 times per year																	3			3	3 3			3 3	3			3	3	3		3 3		3 3
Intermediate Station Downcurrent	ESC-IPE5 ESC-INE1A	4 times per year 4 times per year						H		t			+						3			3	3	Н		3	3		F	3	3			3	H	3
	ESC-INE2A ESC-INE3A	4 times per year 4 times per year																	3			3	3			3	3			3	3	3		3		3
Reference Station Upcurrent	ESC-INE4A ESC-INE5A	4 times per year 4 times per year																	3			3	3			3	3			3	3			3		3
receive station operation	ESC-RFE1 ESC-RFE2	4 times per year 4 times per year						Н		F									3			3	3		_	3	3		F	3	3	_		3		3
	ESC-RFE3 ESC-RFE4 ESC-RFE5	4 times per year 4 times per year							1	t					+				3 3			3 3	3 3			3 3	3 3		t	3 3	3 3	3		3 3		3 3
Ma Wan Station	MW1	4 times per year 4 times per year						H	-				-						3			3	3			3	3			3	3			3		3
Flood Tide Impact Station Downcurrent																																				
	ESC-IPF1 ESC-IPF2 ESC-IPF3	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
Intermediate Station Downcurrent	ESC-INF1	4 times per year								Ė									3			3	3			3	3		Ė	3	3	3		3	Н	3
Defended Chating University	ESC-INF2 ESC-INF3	4 times per year 4 times per year																	3			3	3			3	3			3	3			3		3
Reference Station Upcurrent	ESC-RFF1A ESC-RFF2A	4 times per year 4 times per year						H					F						3			3	3			3	3		F	3	3			3	_	3
Ma Wan Station	ESC-RFF3	4 times per year																	3			3	3			3	3		F	3	3			3		3
Routine Water Quality Monitoring	MW1	4 times per year	A M	ī	ī	A :	6 0	N	n l	I F	M	AN	1 J	I	A 5	s o	N	пП	3 F	M A	M	3 I	3 A S	0	N I	3	3 F 7	M A	М	3	J A		0 1	3 I D		3 F M
Ebb Tide Impact Station Downcurrent	5		AM	,	,	A	, 0		D .	_	141	A	1)	,	Α	3 0	14	D		MA	141	, ,	A J			,		VI A	. 141	,) A	. 3	0 1			1 1/1
	ESC-IPE1A ESC-IPE2A ESC-IPE3	8 times per year 8 times per year	8 8 8 8 8 8		8 8 8	8 8	8 8 8	8 8	1	3 8		8 8		8	8 8	8 8 8	8	8 8	8	8 8 8	8 8	8 8 8	-	8 8	_	8 8		8 8 8	8		8 8 8 8	3	8 8	3	8	8 8
	ESC-IPE4 ESC-IPE5	8 times per year 8 times per year 8 times per year	8 8		8	8	8	8	1	3 8	_	8 1		8	8	8	8	8	8	8	8	8	8	8	8	8		8			8 8 8 8	3	8 8	3	8	8
Intermediate Station Downcurrent	ESC-INE1A	8 times per year	8 8	F	8	8	8	8		3 8	F	8 1		8	8	8	8	8	8 8	8	8	8	8	8	8	8	8	8	8		8 8	3	8 8	3	8	8
	ESC-INE2A ESC-INE3A ESC-INE4A	8 times per year 8 times per year 8 times per year	8 8 8 8 8 8	H	8 8	8 8	8 8 8	8	1	3 8		8 1 8 1 8 1		8	8 8	8 8 8	8	8 8 8	8	8 8 8	8 8	8 8 8	8	8 8	8	8 8	8	8 8 8	8		8 8 8 8 8 8	3	8 8 8	3	8	8 8
Reference Station Upcurrent	ESC-INE5A	8 times per year	8 8		8	8	8	8	-	8	_	8 8		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8		8 8	3	8 8	3	8	8
	ESC-RFE1 ESC-RFE2 ESC-RFE3	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	3	8 8 8	3	8	8 8
	ESC-RFE4 ESC-RFE5	8 times per year 8 times per year	8 8	E	8	8	8	8	1	3 8	_	8 8		8	8	8	-	8	8	8	8	8		8	8	8	8	8	8		8 8	3	8 8	3	8	8
Ma Wan Station Flood Tide	MW1	8 times per year	8 8		8	8	8	8		3 8		8 8		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	H	8 8	3	8 8	3	8	8
Flood Tide Impact Station Downcurrent	ESC-IPF1	8 times per year	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	1 1	8 8	3_	8 8	3_	8	8
	ESC-IPF2 ESC-IPF3	8 times per year 8 times per year	8 8		8	8	8	_	#	Ŧ	F	8 8	_	_	8	8	_	8	8	8	8	8		8	8		8	8	8		8 8 8 8	3	8 8	_	8	
Intermediate Station Downcurrent	ESC-INF1 ESC-INF2	8 times per year 8 times per year	8 8	H	8	8	8	-	#	#	F	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-INF3	8 times per year 8 times per year	8 8	H	8	8	8		_	-	+	8 1			8	8	_	8		8	8	8		8	8	8		8			8 8		8 8	_		8
	ESC-RFF1A ESC-RFF2A	8 times per year 8 times per year	8 8	F	8	8 8	8	8	Ŧ	F	F	8 8	:	8	8	8 8	8	8	8	8	8	8	8		8	8	8	8	8		8 8	3	8 8	3	8	8
	ESC-RFF3	8 times per year 8 times per year	8 8	H	8	8	8	8	+	ŧ	F	8 8			8	8	8	8		8	8	8	8	8	8	8		8			8 8		8 8			8
Ma Wan Station	MW1		A M		J	A						A				s o		D J	F	M A	M	J J	A S	0	N I))]	F	M A	. M	J	J A	S	0 1	N D	J	
Water Column Profiling																				4 4																
	WCP1 WCP2	Monthly Monthly	4 4	4	4					, T	M	AN	1 J	J	A S	s o	N	D J	F	M A	M	J J	AS		NI I) I	r 1	_	_							
Water Column Profiling	WCP1				J	A :	6 0	N	D [Г				\Box	_ !		_	-	$\overline{}$		_ '		11 0	0		, ,	F	M A	. M	J	J A	S	0 1	N D	J	F M
Water Column Profiling Plume Stations Benthic Recolonisation Studies	WCP1 WCP2 ESCV-CPA ESCV-CPB	Monthly 2 times per year 2 times per year	4 4		J	A :	6 0	N	D	F					‡								1 0	U		, ,	F	M A	. M	J	J A	A S	0 1	N D	J	F M
Water Column Profiling Plume Stations Benthic Recolonisation Studies Capped Stations at CMPV	WCP1 WCP2 ESCV-CPA ESCV-CPB ESCV-CPC	Monthly 2 times per year	4 4		J	A	6 0	N	D	F														O			F	M A	. M	J	J A	A S	0 1	N D	J	F M
Water Column Profiling Plume Stations Benthic Recolonisation Studies	WCP1 WCP2 ESCV-CPA ESCV-CPB ESCV-CPC	2 times per year 2 times per year 2 times per year	4 4		J	A	6 0	N	D																			M A	M	J	J A	A S	0 1	N D	J	F M
Water Column Profiling Plume Stations Benthic Recolonisation Studies Capped Stations at CMPV Reference Stations	WCPI WCP2 ESCV-CPA ESCV-CPB ESCV-CPC ESCV-CPD	Monthly 2 times per year	4 4 M	J	J				D																											F M
Water Column Profiling Plume Stations Benthic Recolonisation Studies Capped Stations at CMPV	WCPI WCP2 ESCV-CPA ESCV-CPC ESCV-CPC RBA RBB RBC1	Monthly 2 times per year	4 4	J	1	A :	6 0		D	J F	M	AM	1 J	J	A 5	S O	N	D J	F	M A	M	1 1			N I		F		. M		J A		0 1			F M
Water Column Profiling Plume Stations Benthic Recolonisation Studies Capped Stations at CMPV Reference Stations	WCP1 WCP2 ESCV-CPA ESCV-CPC ESCV-CPC RBA RBB	Monthly 2 times per year	4 4 M	J	J 2		6 O		D	I F	M	A	1 J	J	A 5	S O	N	D J	F	M A	M]]														FM
Water Column Profiling Plume Stations Benthic Recolonisation Studies Capped Stations at CMPV Reference Stations Impact Monitoring for Dredging Upstream Stations	WCPI WCP2 ESCV-CPA ESCV-CPB ESCV-CPD ESCV-CPD RBA RBB RBC1 USI US2 DSI DSI	Monthly 2 times per year 3 times per week 3 times per week 3 times per week 3 times per week	4 4 M	J	J 2 2 2 2 2 2	A 3	6 O		D	J F	M	A	1 J	J	A !	S O	N	D J	F	M A	M	1 1														F M
Water Column Profiling Plume Stations Benthic Recolonisation Studies Capped Stations at CMPV Reference Stations Impact Monitoring for Dredging Upstream Stations	WCP1 WCP2 BSCV-CPA ESCV-CPB ESCV-CPC ESCV-CPD ESCV-CPD US1 US2 US2 DS1 DS2 DS3	Monthly 2 times per year 3 times per year 3 times per week	4 4 M	J	J 2 2 2 2 2 2 2 2	A :	S O		D	J F	M	A	1]	J	A ! !	SS O	N	D J	F	M A	M	J J														FM
Water Column Profiling Plume Stations Benthic Recolonisation Studies Capped Stations at CMPV Reference Stations Impact Monitoring for Dredging Upstream Stations	WCP1 WCP2 ESCV-CPA ESCV-CPE ESCV-CPC ESCV-CPD RBA RBB RBC1 US1 US2 DS1 DS2 DS2	Monthly 2 times per year 3 times per year 3 times per week	4 4 M	J	J 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	A !	S O		D	J F	M	A	1 J	J	A 5	S O	N	D J	F	M A	M]]														F M

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

							2017												2018				
Capping Water Quality Monitoring			Α	M	J	J	A	S	0	N	D	J	F	M	A	M	J	J	A	S	О	N	D
Ebb Tide																							\neg
Impact Stations Downcurrent																							
	SB-IPE1	4 times per year		3	3		3	3															
	SB-IPE2	4 times per year		3	3		3	3															
	SB-IPE3	4 times per year		3	3		3	3															
	SB-IPE4	4 times per year		3	3		3	3															
	SB-IPE5	4 times per year		3	3		3	3															
Intermediate Stations Downcurrent																							
	SB-INE1	4 times per year		3	3		3	3	Ь														
	SB-INE2	4 times per year		3	3		3	3	ــــــ														
	SB-INE3	4 times per year		3	3		3	3	Ь_														
	SB-INE4	4 times per year		3	3		3	3	┞														
	SB-INE5	4 times per year		3	3		3	3	┞														
Reference Stations Upcurrent					_				┞														
	SB-RFE1	4 times per year		3	3		3	3	┞														
	SB-RFE2	4 times per year	<u> </u>	3	3		3	3	ऻ														
	SB-RFE3	4 times per year	<u> </u>	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			<u> </u>	<u> </u>	<u> </u>			_	Ь—	_		_											
	MW1	4 times per year	\vdash	3	3		3	3	├														
	THB1	4 times per year		3	3		3	3	ـــــ														
	THB2	4 times per year		3	3		3	3	ـــــ														
	WSR45C	4 times per year		3	3		3	3	├														
	WSR46	4 times per year		3	3		3	3															
Flood Tide					_				┞														
Impact Stations Downcurrent	OD IDEA				<u> </u>				ـــــ														
	SB-IPF1	4 times per year		3	3		3	3	ـــــ														
	SB-IPF2	4 times per year	<u> </u>	3	3		3	3	ـــــ	_		_											
	SB-IPF3	4 times per year	<u> </u>	3	3		3	3	▙														
Intermediate Stations Downcurrent	CD INIE1		<u> </u>		_			_	├														
	SB-INF1 SB-INF2	4 times per year		3	3	_	3	3	┝	_													
		4 times per year	-	3	3		3	3	┢	_		_											
	SB-INF3	4 times per year	-	3	3		3	3	┢														
Reference Stations Upcurrent	CD DEE1	4.0	-			_	_	_	⊢	_		_	_										
	SB-RFF1 SB-RFF2	4 times per year	\vdash	3	3		3	3	┢				_										
		4 times per year	-	3	3		3	3	⊢	_		_	_										
Constitue Bassis of Civilian	SB-RFF3	4 times per year	\vdash	3	3	_	3	3	₩	_		_										\vdash	
Sensitive Receiver Stations	N 47474	4 Kinnan man	\vdash	_	_	-	_	2	\vdash	-	\vdash	\vdash	<u> </u>			_							
	MW1	4 times per year	\vdash	3	3	-	3	3	\vdash	-	\vdash	\vdash	\vdash			_							
	THB1	4 times per year	\vdash	3	3		3	3	\vdash	_		\vdash	\vdash			_						\vdash	
	THB2	4 times per year	\vdash	3	3	-	3	3	\vdash	-	\vdash	\vdash	\vdash			\vdash	\vdash		\vdash				
	WSR45C WSR46	4 times per year	\vdash	3	3		3	3	\vdash			\vdash	_			_							
	VV5K46	4 times per year		3	3		3	3	1							<u> </u>							
Posthia Postlania Ct. 1				3.5	т	т	Α	C		N.T.	D	т	Г	3.4	A	3.4	T	т	A	C	0	N.T	В
Benthic Recolonisation Studies			Α	M	J	J	Α	S	0	N	D	J	F	M	Α	M	J	J	Α	S	О	N	D
Capped Contaminated Mud Pits	OD 05:	0.11	<u> </u>		\vdash				├			_	<u> </u>										13
	SB-CPA	2 times per year	<u> </u>		\vdash		12		├		12	_	<u> </u>						12				12
	SB-CPB	2 times per year	_	<u> </u>	├		12		├		12	<u> </u>	<u> </u>			<u> </u>			12				12
			_	 	├		<u> </u>	<u> </u>	├		-	<u> </u>	<u> </u>			<u> </u>							
Reference Stations	pp	0.11	<u> </u>		\vdash				├			_	<u> </u>										13
	RBA	2 times per year	<u> </u>		\vdash		12		├		12	_	<u> </u>						12				12
	RBB	2 times per year	<u> </u>	<u> </u>	├		12				12	_	<u> </u>				<u> </u>		12				12
	RBC	2 times per year	1	I	I	I	12	l	1	I	12	I	I	ı	I	I	l	Ī	12			ıl	12

Notes:

The number shown in each cell represents the numbers of replicates per monitoring station

Capping works are planned to be conducted between May and December 2017.

Annex B

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 ⁻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

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 November 2018

Stations	Temp	Salinity	Turbidity	Dissolved	Oxygen	pН	Suspended Solids
	(°C)	(ppt)	(NTU)	(%)	(mg L-1)		(mg L-1)
WCP 1	24.41	31.88	6.34	106.75	7.43	8.03	16.1
(Downstream)							
WCP 2	24.57	31.60	5.75	108.18	7.52	8.01	14.8
(Upstream)							
WQO (Dry Season)	N/A	28.44- 34.76#	N/A	N/A	>4	6.5-8.5	12.8

Note:

Cell shaded grey indicate value exceeding the WQO.

Table B3 In-situ Monitoring Results for Routine Water Quality Monitoring of ESC CMPs in November 2018

Sampling	Stations	Temp	Salinity	Turbidity	Dissolved	d Oxygen	pН
Period	Stations	(°C)	(ppt)	(NTU)	(%)	(mg L-1)	(mg L-1)
November	RFF (Reference)	24.81	31.19	6.93	105.44	7.32	8.02
2018	IPF (Impact)	24.97	30.95	9.38	108.22	7.50	8.10
	INF (Intermediate)	24.95	31.34	12.12	107.68	7.45	8.10
	Ma Wan	25.04	32.22	5.91	106.85	7.35	8.07
	WQO	N/A	28.08 - 34.31#	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 November 2018

Sampling	Stations	$\mathbf{A}\mathbf{s}$	Cd	Cr	Cu	Pb	Hg	Ni	Ag	Zn	NH_3	TIN	BOD_5	SS
Period	Stations	(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)
November	RFE	2.00	< 0.5	0.67	8.25	1.44	< 0.5	1.04	<1.0	47.94	0.08	0.40	1.33	7.48
2018	IPE	2.13	< 0.5	0.53	11.79	1.47	< 0.5	1.00	<1.0	33.75	0.05	0.39	1.29	9.36
	INE	2.06	< 0.5	0.53	13.73	2.18	< 0.5	0.81	<1.0	34.13	0.04	0.24	1.16	10.94
	Ma	2.03	< 0.5	<1.0	5.84	1.34	< 0.5	1.40	<1.0	36.65	0.08	0.26	1.09	8.58
	Wan													

 $WQO \ of \ TIN: 0.5 \ mg/L$ Dry Season WQO of SS : 12.8 mg/L

Notes:

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

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

Annex C

Graphical Presentations

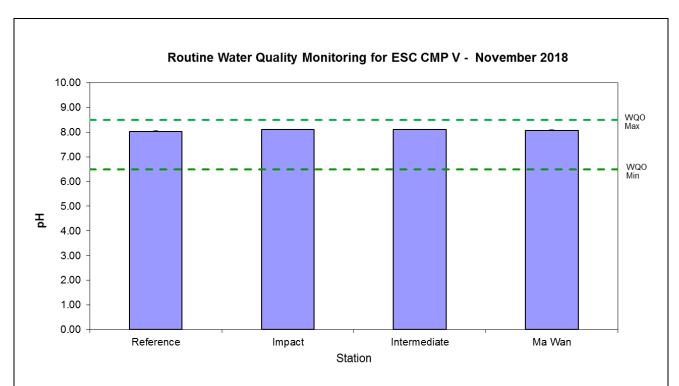


Figure 1: Level of pH recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in November 2018.

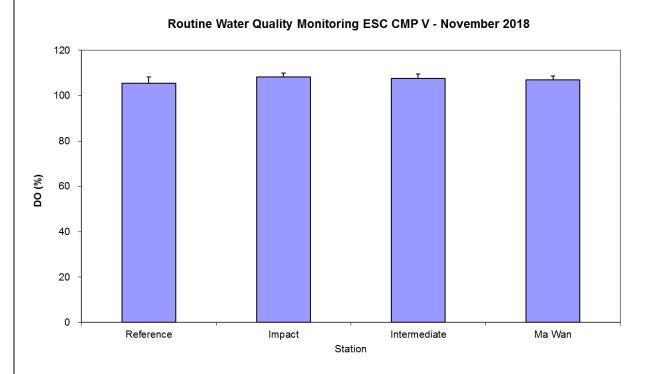


Figure 2: Level of Dissolved Oxygen (DO) (% saturation; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in November 2018.

Date: December 2018



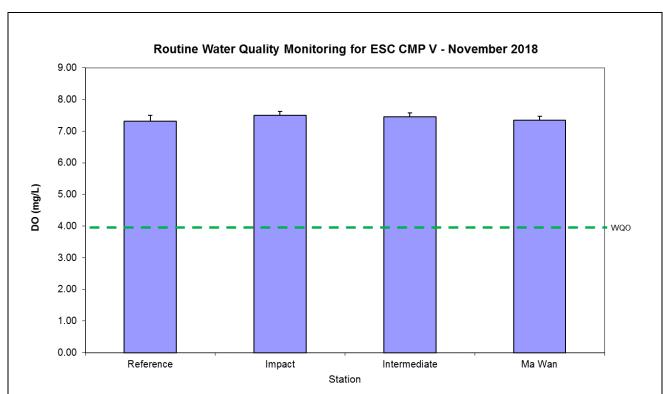


Figure 3: Concentration of Dissolved Oxygen (DO) (mg/L; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in November 2018.

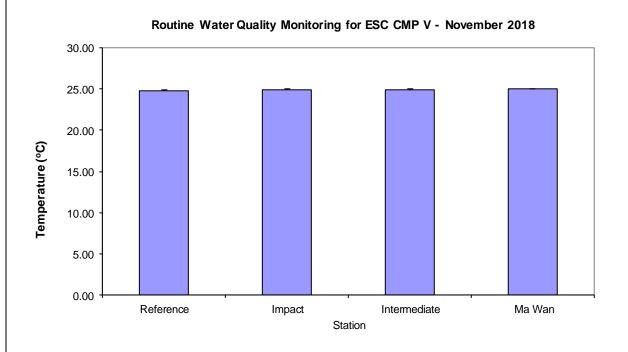


Figure 4: Level of Temperature (°C; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in November 2018.

Date: December 2018



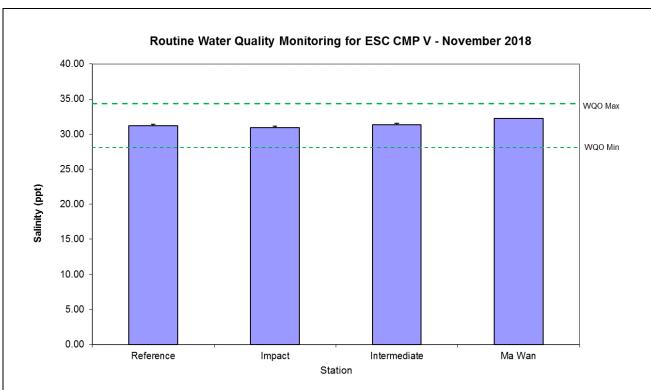


Figure 5: Level of Salinity (ppt; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in November 2018.

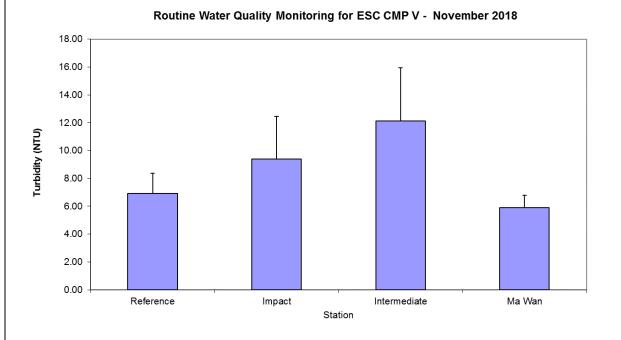


Figure 6: Levels of Turbidity (NTU; mean + SD) recorded during Routine Water Quality Monitoring for disposal operations at ESC CMP V in November 2018.

Date: December 2018



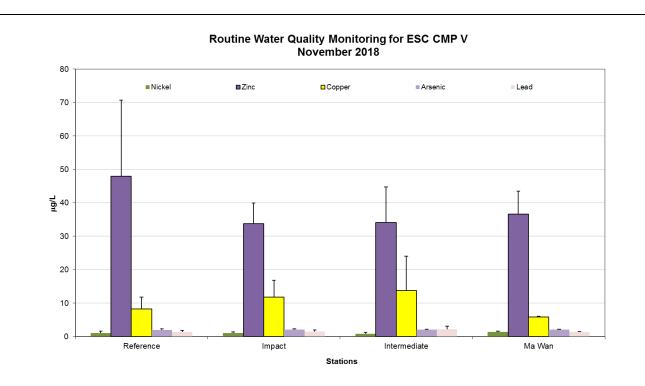


Figure 7: Concentration of Arsenic, Nickel, Lead, Copper and Zinc (μg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in November 2018.

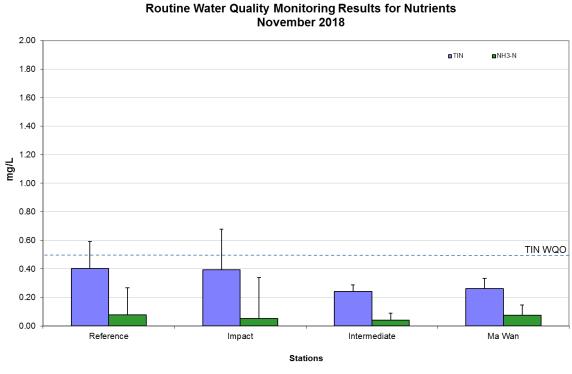


Figure 8: Concentration of Total Inorganic Nitrogen (TIN) and Ammonia Nitrogen (NH3-N) $(\mu g/L; mean + SD)$ in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in November 2018.

Source: H:\Team\EM\GMS Projects\0400720 CEDD CMP EM&A 2017-2020\02
Deliverable\05 CMP Monthly Report\November 2018)

Date: December 2018

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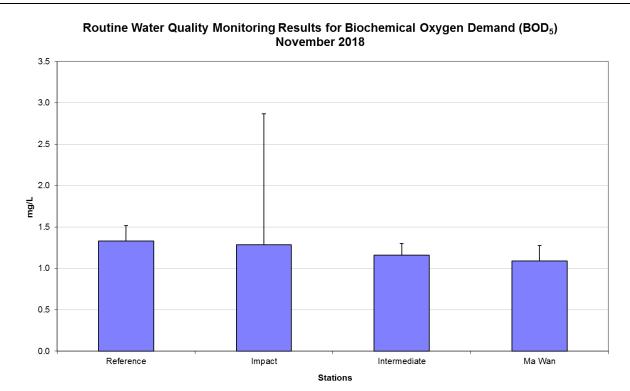


Figure 9: Level of Biochemical Oxygen Demand (BOD₅) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in November 2018.

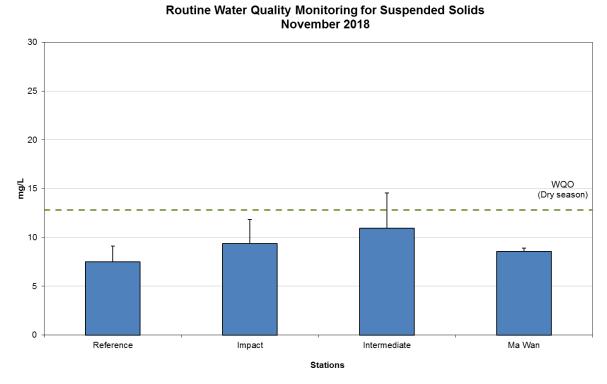


Figure 10: Concentration of Suspended Solids (SS) (mg/L; mean + SD) in water samples collected from Routine Water Quality Monitoring for disposal operations at ESC CMP V in November 2018.

Date: December 2018



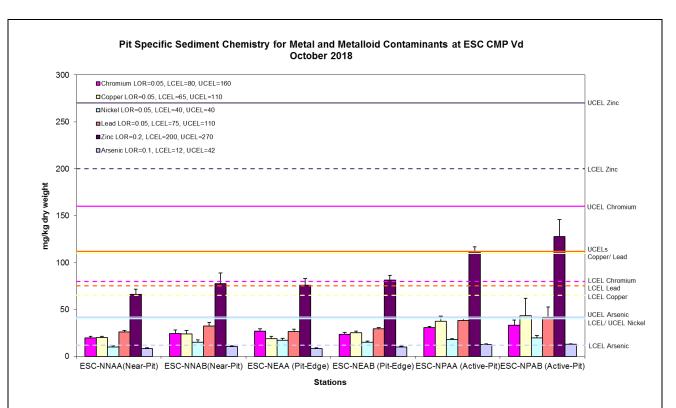


Figure 11: Concentration of Metals and Metalloid (Cr, Cu, Ni, Pb, Zn, As; mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in October 2018.

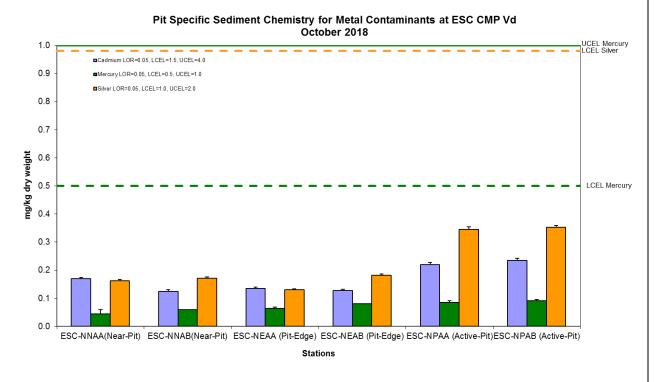


Figure 12: Concentration of Metals (Cd, Hg, Ag; mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in October 2018.

Date: December 2018



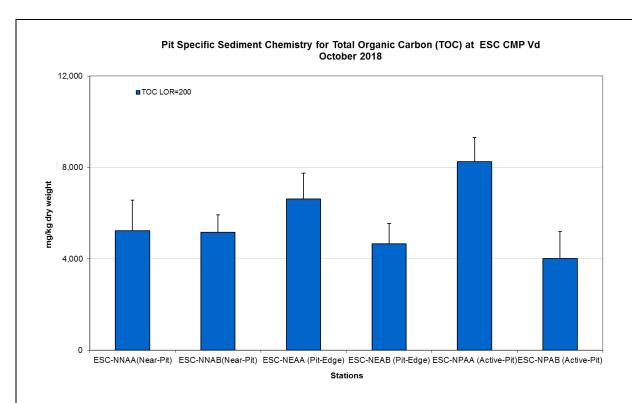


Figure 13: Concentration of Total Organic Carbon (TOC) (mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in October 2018.

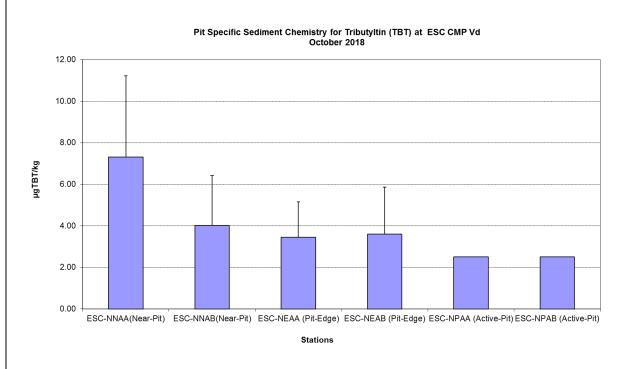


Figure 14: Concentration of Tributyltin (TBT) (µg TBT/kg; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in October 2018.

Date: December 2018



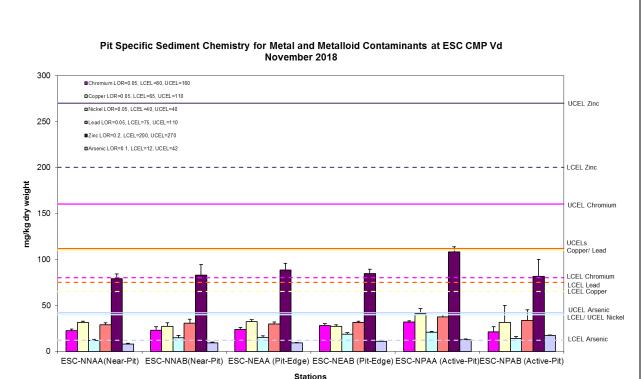


Figure 15: Concentration of Metals and Metalloid (Cr, Cu, Ni, Pb, Zn, As; mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in November 2018.

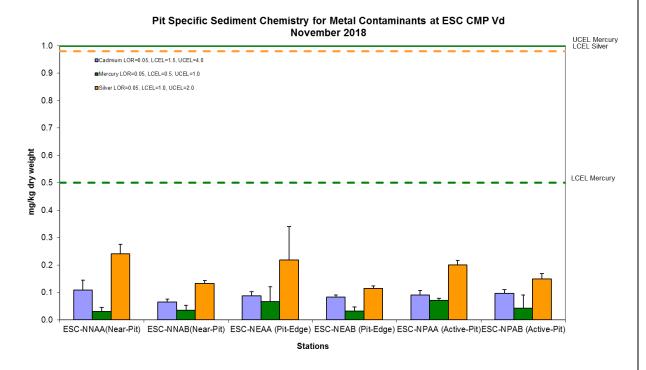


Figure 16: Concentration of Metals (Cd, Hg, Ag; mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in November 2018.

Date: December 2018



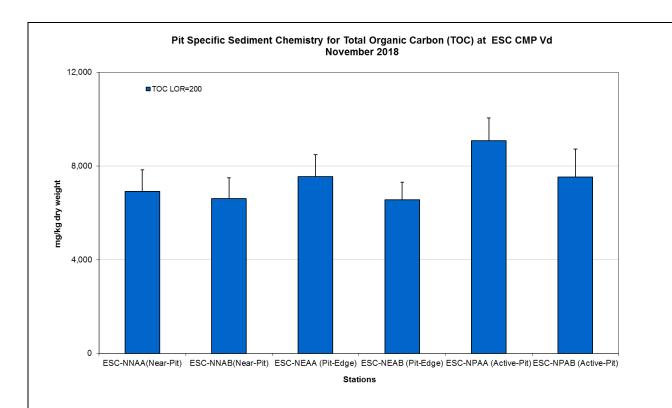


Figure 17: Concentration of Total Organic Carbon (TOC) (mg/kg dry weight; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in November 2018.

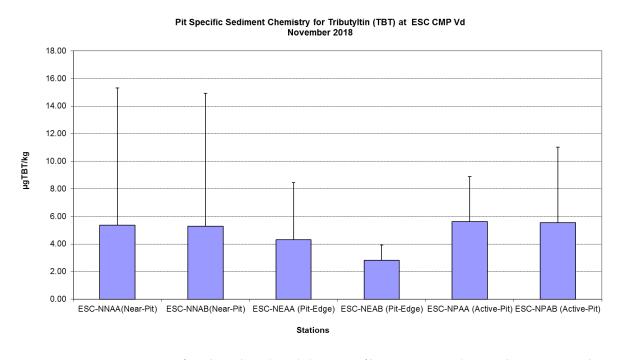


Figure 18: Concentration of Tributyltin (TBT) (μg TBT/kg; mean +SD) in sediment samples collected from Pit Specific Sediment Chemistry Monitoring for ESC CMP Vd in November 2018.

Date: December 2018



Annex D

Study Programme

