3 Water Quality Impact Assessment

3.1 Introduction

This section presents an assessment of the potential water quality impacts associated with the proposed improvement dredging works at Lamma Power Station navigation channel. Restrictions on the dredging activities and recommendations for mitigation measures have been made, where necessary, to reduce identified water quality impacts to within acceptable levels. The assessment has been conducted in accordance with Annexes 6 and 14 of EIAO-TM as well as the technical requirements stipulated in Clause 3.4.2 and Appendix B of the EIA Study Brief (ESB-282/2014).

3.2 Environmental Legislation, Standards, Guidelines and Criteria

Relevant legislations, standards and guidelines governing water quality in Hong Kong include the following:

- Environmental Impact Assessment Ordinance Cap. 499 (and associated Technical Memorandum on Environmental Impact Assessment Process Annexes 6 and 14)
- Water Pollution Control Ordinance Cap. 358 (and associated Water Quality Objectives)
- Dumping at Sea Ordinance Cap. 466 (and associated Environment, Transport and Works Bureau Technical Circular (Works) No. 34/2002 Management of Dredged/Excavated Sediment)
- Water Services Department Standards for Seawater Intakes

3.2.1 Environmental Impact Assessment Ordinance (EIAO)

The Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM) is issued by the Environmental Protection Department under Section 16 of the EIAO. It specifies the assessment method and criteria that needs to be followed in EIA studies. Reference sections in the EIAO-TM provide the details of the assessment criteria and guidelines that are relevant to the water quality impact assessment, including:

- Annex 6 Criteria for Evaluating Water Pollution
- Annex 14 Guidelines for Assessment of Water Pollution

3.2.2 Water Pollution Control Ordinance (WPCO)

The Water Pollution Control Ordinance (Cap. 358) provides the statutory framework for the protection and control of water quality in Hong Kong. According to the WPCO and its subsidiary legislation, Hong Kong waters are divided into ten Water Control Zones (WCZs). Corresponding Water Quality Objectives (WQOs) are stipulated for different types of waters and water sensitive receivers (including marine waters, inland waters, gazetted beaches subzones, secondary contact recreation subzones, and fish culture subzones) in the WCZs. The WQOs for the Western Buffer and Southern WCZs are presented in **Table 3-1** and **Table 3-2**.

Table 3-1: Water Quality Objectives for Western Buffer WCZ

Parameters	Objectives	Sub-Zone
Offensive Odour, Tints	Not to be present	Whole zone

Parameters	Objectives	Sub-Zone
Visible foam, oil scum, litter	Not to be present	Whole zone
E. coli	Not exceed 610 cfu per 100 mL, calculated as the geometric mean of all samples collected in a calendar year	Secondary Contact Recreation Subzones and Fish Culture Subzones
	Not exceed 180 cfu per 100 mL, calculated as the geometric mean of all samples collected from March to October inclusive in 1 calendar year. Samples should be taken at least 3 times in 1 calendar month at intervals of between 3 and 14 days	Recreation Subzones
	Less than 1 cfu per 100 mL, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Water Gathering Ground Subzones
	Not exceed 1000 cfu per 100 mL, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Other inland waters
Colour	Not to cause the colour of water to exceed 30 Hazen units due to human activity	Water Gathering Ground Subzones
	Not to cause the colour of water to exceed 50 Hazen units due to human activity	Other inland waters
Depth-averaged Dissolved Oxygen (DO)	Not less than 4 mg L^{-1} for 90% of the sampling occasions during the whole year; values should be calculated as the water column average (arithmetic mean of at least 3 measurements at 1m below surface, mid depth and 1m above the seabed	Marine waters except Fish Culture Subzones
	Not less than 5 mg L^{-1} for 90% of the sampling occasions during the years; values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed)	Fish Culture Subzones
	Not be less than 4 mg L^{-1}	Water Gathering Ground Subzones and other inland waters
DO within 2 m of the seabed	Not be less than 2 mg L^{-1} within 2 m of the seabed for 90% of the sampling occasions during the whole year	Marine waters and Fish Culture Subzones
pH	To be in the range of 6.5 - 8.5, change due to human activity not to exceed 0.2	Marine waters
	Not to exceed the range of 6.5-8.5 units due to human activity	Water Gathering Ground Subzones
	Not to exceed the range of 6.5-9.0 units due to human activity	Other inland waters
Salinity	Not to exceed 10% change due to human activity	Whole zone
Temperature	Not to exceed 2 ^{o}C change due to human activity	Whole zone
Suspended Solids (SS)	Not to be raised by more than 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities	Marine waters
	Not to exceed 20 mg L^{-1} of annual median due to human activity	Water Gathering Ground Subzones
	Not to exceed 25 mg L^{-1} annual median due to human activity	Other inland waters
Unionised Ammonia (UIA)	Not to exceed 0.021 mg L^{-1}, calculated as the annual average (arithmetic mean)	Whole zone

Parameters	Objectives	Sub-Zone
Nutrients	Not present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants	Marine waters
	Inorganic nitrogen not to exceed 0.4 mg L^{-1} expressed as annual water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed)	Marine waters
5-Day Biochemical Oxygen Demand	Not to exceed 3 mg L^{-1} due to human activity	Water Gathering Ground Subzones
	Not to exceed 5 mg L^{-1} due to human activity	Other inland waters
Chemical Oxygen Demand	Not to exceed 15 mg L^{-1} due to human activity	Water Gathering Ground Subzones
	Not to exceed 30 mg L^{-1} due to human activity	Other inland waters
Toxic substances	Not to attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms	Whole zone
	Not to cause a risk to any beneficial use of the aquatic environment due to human activity	Whole zone
Turbidity	Not to reduce light transmission substantially from the normal level due to waste discharges	Bathing Beach Subzones

Source: Statement of Water Quality Objectives (Western Buffer Water Control Zone)

Table 3-2: Water Quality Objectives for Southern WCZ

Parameters	Objectives	Sub-Zone
Offensive Odour, Tints	Not to be present	Whole zone
Visible foam, oil scum, litter	Not to be present	Whole zone
E. coli	Not exceed 610 cfu per 100 mL, calculated as the geometric mean of all samples collected in a calendar year	Secondary Contact Recreation Subzones and Fish Culture Subzones
	Not exceed 180 cfu per 100 mL, calculated as the geometric mean of all samples collected from March to October inclusive in 1 calendar year. Samples should be taken at least 3 times in 1 calendar month at intervals of between 3 and 14 days	Bathing Beach Subzones
Depth-averaged DO	Not less than 4 mg L^{-1} for 90% of the sampling occasions during the year; values should be calculated as the water column average (arithmetic mean of at least 3 measurements at 1m below surface, mid depth and 1m above the seabed)	Marine waters except Fish Culture Subzones
	Not less than 5 mg L^{-1} for 90% of the sampling occasions during the year; values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed)	Fish Culture Subzones
	Not less than 4 mg L^{-1}	Inland waters of the Zone
DO within 2 m of the seabed	Not be less than 2 mg L^{-1} within 2 m of the seabed for 90% of the sampling occasions during the year	Marine waters and Fish Culture Subzones

Parameters	Objectives	Sub-Zone
pH	To be in the range of 6.5 - 8.5, change due to human activity not to exceed 0.2 units	Marine waters except Bathing Beach Subzones; Mui Wo (A), Mui Wo (B), Mui Wo (C), Mui Wo (E) and Mui Wo (F) Subzones.
	To be in the range of 6.0 - 9.0	Mui Wo (D) Sub-zone and other inland waters
	To be in the in the range of 6.0 - 9.0 for 95% of samples, change due to human activity not to exceed 0.5 units	Bathing Beach Subzones.
Salinity	Not to exceed 10% change due to human activity	Whole zone
Temperature	Not to exceed 2 ºC change due to human activity	Whole zone
SS	Not to be raised by 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities	Marine waters
	Not to exceed 20 mg L^{-1} of annual median due to human activity	Mui Wo (A), Mui Wo (B), Mui Wo (C), Mui Wo (E) and Mui Wo (F) Subzones
	Not to exceed 25 mg L^{-1} annual median due to human activity	Mui Wo (D) Subzone and other inland waters
Unionised Ammonia (UIA)	Not to exceed 0.021 mg L^{-1}, calculated as the annual average (arithmetic mean)	Whole zone
Nutrients	Not present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants	Marine waters
	Inorganic nitrogen not to exceed 0.1 mg L^{-1} expressed as annual water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed)	Marine waters
5-Day Biochemical Oxygen Demand	Not to exceed 5 mg L^{-1} due to human activity	Inland waters of the Zone
Chemical Oxygen Demand	Not to exceed 30 mg L^{-1} due to human activity	Inland waters of the Zone
Dangerous substances	Not to attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms	Whole zone
	Not to cause a risk to any beneficial use of the aquatic environment due to human activity	Whole zone

Source: Statement of Water Quality Objectives (Southern Buffer Water Control Zone)

3.2.3 Dumping at Sea Ordinance (DASO)

Marine disposal of dredged materials is controlled under the Dumping at Sea Ordinance (DASO). The requirements for marine disposal of sediment are specified in ETWB TCW No. 34/2002: Management of Dredged/Excavated Sediment. Dredged sediment is classified according to a set of regulatory guidelines with sediment quality criteria, which include organic pollutants and other toxic substances. Sediments are categorised as either ‘L’ (all contaminant levels not exceeding the LCEL), ‘M’ (one or more contaminant levels exceeding the LCEL and none exceeding the UCEL), and ‘H’ (one or more contaminant levels exceeding the UCEL). The LCEL and UCEL criteria limits are shown in **Table 3-3**.

Table 3-3: Sediment Quality Criteria under ETWB TCW No. 34/2002

Parameters (in mg/ kg dry weight unless otherwise stated)	Sediment Quality Criteria	
	LCEL	UCEL
Cadmium (Cd)	1.5	4
Chromium (Cr)	80	160
Copper (Cu)	65	110
Mercury (Hg)	0.5	1
Nickel (Ni)	40	40
Lead (Pb)	75	110
Silver (Ag)	1	2
Zinc (Zn)	200	270
Arsenic (As)	12	42
PAHs (LMW) (µg/ kg dry weight)	550	3160
PAHs (HMW) (µg/ kg dry weight)	1700	9600
Total PCBs (µg/ kg dry weight)	23	180

Note: LCEL = Lower Chemical Exceedance Level
UCEL = Upper Chemical Exceedance Level

3.2.4 Water Services Department Standards for Seawater Intakes

Water Services Department (WSD) has specified a set of objectives for water quality at their flushing water intakes as shown in **Table 3-4**.

Table 3-4: WSD’s Water Quality Criteria for Flushing Water at Sea Water Intakes

Parameter (in mg L^{-1} unless otherwise stated)	Target Limit
Colour (HU)	< 20
Turbidity (NTU)	< 10
Threshold Odour Number (odour unit)	< 100
Ammonia Nitrogen	< 1
SS	< 10
DO	> 2
5-day Biochemical Oxygen Demand	< 10
Synthetic Detergents	< 5
E. coli (no. per 100 mL)	< 20,000

It should be noted that according to EPD’s regular marine water quality monitoring data, ambient levels of SS in both Western Buffer and Southern WCZs often exceed the WSD requirement for SS.

3.3 Baseline Conditions

3.3.1 Study Area and Water Sensitive Receivers

The Project is located wholly within the Southern WCZ. This part of Hong Kong is partly influenced by discharges from the Pearl River (the effects of which are stronger during the wet season) and by the monsoon-induced coastal currents (the effects of which are stronger during the dry season). The dominant current direction near the Project area is generally north-south. The Channel is located at the western side of the Lamma Power Station and extends southwards along the outskirt of Ha Mei Wan. The bathymetry within the Channel has historically been maintained at between -15.5 to -16.5 mPD except for the southernmost parts of the Channel where the bathymetry is naturally lower than -16.5 mPD.

For the water quality impact assessment, the study area covers the Western Buffer and Southern WCZs. Water sensitive receivers (WSRs) have been identified within this study area and are listed in **Table 3-5** and shown in **Figure 3.1**.

Table 3-5: Water Sensitive Receivers

WSR ID	Name
Seawater Intakes	
S1	HK Electric Power Station Intake
S2	WSD Seawater Intake at Ap Lei Chau
S3	Wah Fu Estate
S4	Cyber Port
S5	Queen Mary Hospital
S6	Sha Wan Drive
Beaches	
B1	Hung Shing Yeh
B2	Lo So Shing
B3	Deep Water Bay
B4	Tung Wan, Cheung Chau
B5	Kwun Yam Wan
B6	Silvermine Bay
Corals	
CR1	Pak Kok
CR2	Shek Kok Tsui
CR3	Luk Chau
CR4	Wong Chuk Kok (North)
CR5	Wong Chuk Kok (South)
CR6	Sham Wan
CR7	Round Island
CR8	Ap Lei Chau
CR9	Sandy Bay

WSR ID	Name
CR10	Kau Yi Chau
CR11	Siu Kau Yi Chau
CR12	Peng Chau
CR13	Sunshine Island
CR14	Hei Ling Chau
CR15	Cheung Chau (North)
CR16	Cheung Chau (South)
CR17	Chi Ma Wan Peninsula
CR18	Northern Hung Shing Yeh
CR19	Ha Mei Wan (North)
Fish Culture Zones	
F1	Lo Tik Wan Fish Culture Zone
F2	Sok Kwu Wan Fish Culture Zone
F3	Cheung Sha Wan Fish Culture Zone
Ecologically Sensitive Areas and Areas of Conservation Importance	
FP1	East of Cheung Chau - Finless Porpoise Habitat
FP3	Southwest of Lamma - Finless Porpoise Habitat
FP4	East of Lamma - Finless Porpoise Habitat
GT1	Ha Mei Wan (North) - Green Turtle Inter-nesting Habitat
GT2	Ha Mei Wan (South) - Green Turtle Inter-nesting Habitat
GT3	South Lamma - Green Turtle Inter-nesting Habitat
GT4	Southeast of Lamma - Green Turtle Inter-nesting Habitat
GT5	Tung O Wan - Green Turtle Inter-nesting Habitat
SS1	Sham Wan SSSI (Nesting of Green Turtle)
PMP1	South Lamma - Potential Marine Park

3.3.2 Baseline Water Quality

Environmental Protection Department (EPD) has conducted regular marine water and sediment quality monitoring since 1986. For the key water quality parameters of relevance to this Project, a summary of the long term marine water quality data collected by EPD at their monitoring stations within the Western Buffer and Southern WCZs that are in the vicinity of the Project are summarised in **Table 3-6** and **Table 3-7** respectively.

Table 3-6: Baseline Marine Water Quality in Western Buffer WCZ (1986 to 2015)

Monitoring Stations		Baseline Marine Water Quality (mg L^{-1} unless otherwise specified)									
		Temperature (°C)	Dissolved Oxygen	Dissolved Oxygen (%saturation)	pH (pH Units)	5-day Biochemical Oxygen Demand	Suspended Solids	Total Nitrogen	Total Inorganic Nitrogen	Unionised Ammonia	Ammonia Nitrogen
WM1	Min	14.7	1.6	23	6.5	<0.1	<0.5	0.06	0.02	<0.001	<0.005
	Max	29.4	13.1	185	8.9	4.9	53.0	3.11	1.08	0.044	0.340
	Avg	22.8	6.1	85	8.1	0.7	5.5	0.42	0.18	0.003	0.063
WM2	Min	14.7	2.3	30	7.0	<0.1	<0.5	0.11	0.03	<0.001	<0.005
	Max	30.4	11.5	157	8.9	4.1	62.0	1.82	1.12	0.026	0.625
	Avg	23.0	6.0	84	8.0	0.7	6.4	0.53	0.28	0.004	0.101

Note: All averages represent depth averaged values. The max and min values represent the highest and lowest values on record for the entire data period.

According to the Marine Water Quality Report in Hong Kong in 2015, the Western Buffer WCZ achieved 92% overall compliance with the WQOs in 2015, with full compliance with the WQOs for Total Inorganic Nitrogen (TIN) and Unionised Ammonia Nitrogen (NH_3-N). The overall annual average level of TIN increased in 2015 compared to 2014 but is similar to the levels in 2013. In addition, all 8 gazetted beaches located within this WCZ (in Tsuen Wan District) complied with the water quality objective for swimming in 2015.

Table 3-7: Baseline Marine Water Quality in Southern WCZ (1986 to 2015)

Monitoring Stations		Baseline Marine Water Quality (mg L^{-1} unless otherwise specified)									
		Temperature (°C)	Dissolved Oxygen	Dissolved Oxygen (%saturation)	pH (pH Units)	5-day Biochemical Oxygen Demand	Suspended Solids	Total Nitrogen	Total Inorganic Nitrogen	Unionised Ammonia	Ammonia Nitrogen
SM2	Min	14.0	1.6	22	7.4	<0.1	<0.5	0.07	0.01	<0.001	<0.005
	Max	30.0	11.8	164	8.9	8.0	28.0	1.42	1.10	0.034	0.200
	Avg	23.1	6.4	89	8.1	0.8	4.4	0.33	0.13	0.002	0.037
SM3	Min	14.0	1.3	18	6.1	<0.1	<0.5	0.07	0.01	<0.001	<0.005
	Max	29.5	13.8	190	8.9	8.0	48.0	1.74	1.00	0.060	0.550
	Avg	22.9	6.2	86	8.0	0.7	4.9	0.35	0.15	0.002	0.043
SM4	Min	14.2	1.5	21	7.1	<0.1	<0.5	0.07	0.02	<0.001	<0.005
	Max	29.7	12.9	169	8.9	8.0	46.0	2.37	2.24	0.024	0.210

Monitoring Stations		Baseline Marine Water Quality (mg L^{-1} unless otherwise specified)									
		Temperature (°C)	Dissolved Oxygen	Dissolved Oxygen (%saturation)	pH (pH Units)	5-day Biochemical Oxygen Demand	Suspended Solids	Total Nitrogen	Total Inorganic Nitrogen	Unionised Ammonia	Ammonia Nitrogen
	Avg	23.2	6.3	89	8.1	0.8	3.9	0.39	0.18	0.003	0.057
SM5	Min	14.2	2.0	27	7.5	<0.1	<0.5	0.07	0.01	<0.001	<0.005
	Max	31.0	13.4	195	9.2	9.0	30.0	1.59	1.27	0.045	0.300
	Avg	23.5	6.8	95	8.1	0.9	5.5	0.36	0.16	0.002	0.035
SM6	Min	14.0	0.3	4	7.3	<0.1	<0.5	0.06	0.01	<0.001	<0.005
	Max	30.2	12.6	191	9.0	10.0	32.0	1.80	1.50	0.056	0.249
	Avg	23.2	6.6	92	8.1	0.9	5.2	0.37	0.17	0.002	0.039
SM7	Min	14.2	2.2	31	7.4	<0.1	<0.5	0.07	0.01	<0.001	<0.005
	Max	31.0	11.5	166	8.9	7.0	76.0	1.54	1.35	0.021	0.260
	Avg	23.4	6.5	91	8.1	1.0	6.4	0.47	0.25	0.004	0.069
SM9	Min	14.1	2.3	33	7.1	<0.1	<0.5	0.15	0.02	0.001	<0.005
	Max	29.5	12.0	176	8.6	5.6	90.0	1.49	1.21	0.023	0.300
	Avg	23.3	6.1	85	8.0	0.8	8.4	0.55	0.33	0.004	0.103
SM11	Min	13.4	0.5	8	7.3	<0.1	<0.5	0.13	0.01	<0.001	<0.005
	Max	30.3	12.6	186	9.1	6.4	110.0	1.53	1.28	0.031	0.348
	Avg	23.6	6.9	97	8.1	1.1	7.7	0.51	0.27	0.004	0.081
SM12	Min	13.6	2.4	32	7.5	<0.1	<0.5	0.08	0.02	<0.001	<0.005
	Max	31.2	11.6	169	9.0	5.5	110.0	1.65	1.38	0.032	0.300
	Avg	23.6	7.0	98	8.1	1.0	8.5	0.46	0.24	0.003	0.063
SM18	Min	13.9	0.4	1	7.4	<0.1	<0.5	0.06	0.01	<0.001	<0.005
	Max	31.3	16.3	188	9.1	4.8	44.0	1.97	1.41	0.035	0.410
	Avg	23.1	6.5	90	8.1	0.7	4.7	0.32	0.13	0.002	0.030

Note: All averages represent depth averaged values. The max and min values represent the highest and lowest values on record for the entire data period.

The Southern Buffer WCZ attained an overall compliance of 69% with the WQOs in 2015. All 16 stations in the WCZ fully complied with the DO and NH_3-N objective, but due to the higher background level of the Pearl River flow, all stations did not meet the TIN objective. Besides, full compliance (100%) with the *E. coli* objective was attained in the secondary contact recreation subzones within the Southern WCZ in 2015. In addition, all 21 gazetted beaches in the southern waters complied with the water quality objective for swimming in 2015.

3.3.3 Baseline Sediment Quality

Sediment quality investigation studies have been conducted prior to each of the historic dredging works in the Channel (six sediment quality studies in total), and in all instances, all measured contaminant levels of the samples are below the Lower Chemical Exceedance Level (LCEL) as defined in the ETWB TCW No. 34/2002 (presented in **Table 3-3**). The results of the sediment quality studies are summarised in **Table 3-8**.

Table 3-8: Summary of Past Sediment Quality Testing Results within the Channel

Parameter	2014		2008		2003		1998		1997		1994	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Metals and Metalloids (mg/kg)												
Cd	<0.2	<0.2	<0.2	0.21	0.23	0.39	<0.5	<0.5	<0.5	<0.5	<0.02	<0.02
Cr	34	52	20	53	26	39	7	46	13	43	27	45
Cu	14	36	<7.0	37	18	24	<10	24	<10	24	7.2	36
Ni	21	32	15	31	18	24	<6	23	<6	24	13	19
Pb	32	50	27	61	38	45	<15	39	<15	29	17	43
Zn	85	142	47	130	98	120	15	130	37	86	53	100
Hg	0.05	0.32	0.09	0.4	0.07	0.13	<0.4	<0.4	<0.4	<0.4	<0.05	0.23
As	8	12	5.4	10	7	9	-	-	-	-	-	-
Ag	0.1	0.4	<0.1	0.39	0.2	0.2	-	-	-	-	-	-
Other Contaminants (µg/kg)												
LMW PAHs ^	<50	<50	<55	<55	30	31	-	-	-	-	-	-
HMW PAHs ^	<150	<150	<170	<170	55	103	-	-	-	-	-	-
Total PCB^	<3	<3	<3	<3	<3	<3	-	-	-	-	-	-

Note:
^ For every individual compound.
LMW = Low Molecular Weight
HMW = High Molecular Weight
PAHs = Polycyclic Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls

Based on these past sediment quality studies, there have been no significant changes in sediment quality over the past 20 years, and the sediment in and around the Channel belongs to Category L.

3.3.3.1 Sediment Sampling and Elutriation Test

Sediment sampling was carried out as part of this EIA study to assess the elutriation potential of various contaminants in the sediment during dredging, and to determine the sediment oxygen demand. Sediment samples were collected in December 2015 at three locations as shown in **Figure 3.2** using grab samplers.

Representative blank marine water samples were also collected. The results of the elutriation tests are summarised in **Table 3-9**.

Table 3-9: Summary of Sediment Sampling and Elutriation Test Results

Parameter		LOR	Sample A	Sample B	Sample C	Marine Water
Nutrients						
Ammonia as N	mg/L	0.01	1.04	1.41	0.57	<0.01
Inorganic Nitrogen as N	mg/L	0.02	1.11	1.52	0.69	0.14
Metals and Metalloids						
Arsenic	µg/L	1	5	5	6	3
Cadmium	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Chromium	µg/L	1	<1	<1	<1	<1
Copper	µg/L	1	1	1	1	2
Lead	µg/L	1	<1	<1	<1	<1
Nickel	µg/L	1	2	<1	1	1
Silver	µg/L	0.2	<0.2	<0.2	<0.2	<0.2
Zinc	µg/L	10	<10	<10	<10	<10
Mercury	µg/L	0.05	<0.05	<0.05	<0.05	<0.05
Polychlorinated Biphenyls (PCBs)						
PCB 8	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 18	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 28	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 44	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 52	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 66	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 77	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 101	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 105	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 118	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 126	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 128	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 138	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 153	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 169	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 170	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 180	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
PCB 187	µg/L	0.01	<0.01	<0.01	<0.01	<0.01
Total Polychlorinated biphenyls	µg/L	0.18	<0.18	<0.18	<0.18	<0.18
Polycyclic Aromatic Hydrocarbons (PAHs)						
Naphthalene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1

Parameter		LOR	Sample A	Sample B	Sample C	Marine Water
Acenaphthylene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Benz(a)anthracene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Benzo(b)fluoranthene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1.2.3.cd)pyrene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Dibenz(a.h)anthracene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g.h.i)perylene	µg/L	0.1	<0.1	<0.1	<0.1	<0.1
Low M.W. PAHs	µg/L	2.2	<2.2	<2.2	<2.2	<2.2
High M.W. PAHs	µg/L	6.8	<6.8	<6.8	<6.8	<6.8
Sediment						
Sediment Oxygen Demand (5 Days)	mg/kg	10	760	750	690	-

LOR = Limit of Reporting

3.4 Assessment Criteria

Assessment criteria are based on the relevant water quality standards specified in **Section 3.2**. The specific criteria levels applied to SS, DO, metals and other contaminants are detailed as follows.

3.4.1 Suspended Solids

The WQO for SS is defined as an allowable elevation of 30% above the background level. The reference background level is taken to be the 90th percentile of the reported long-term concentrations at EPD's marine water quality monitoring stations. WSRs were matched to the nearest EPD monitoring station in the Western Buffer and Southern WCZs, and data from these monitoring stations were collated into dry season (October to March) and wet season (April to September). The 90th percentile concentration for the entire period of monitoring data (1986 to 2015) and the associated tolerance elevation are presented in **Table 3-10** below.

Table 3-10: Assessment Criteria for Suspended Solids

				Background SS (90th percentile)		Tolerance Elevation (mg L^{-1})	
WSR ID	**Name**	**Representative EPD station**		**Wet Season**	**Dry Season**	**Wet Season**	**Dry Season**
Seawater Intakes (Non-WSD)							
S1	HK Electric Power Station Intake[1]	SM5	DA	8.6	13.0	91.4	87.0
			S	5.8	9.3	94.2	90.7
S3 S4 S5 S6	Wah Fu Estate Cyber Port Queen Mary Hospital Sha Wan Drive	WM1	DA	8.1	11.1	2.4	3.3
			S	4.7	8.2	1.4	2.4
Beaches							
B1 B2	Hung Shing Yeh Lo So Shing	SM5	DA	8.6	13.0	2.6	3.9
			S	5.8	9.3	1.7	2.8
			B	12.4	16.0	3.7	4.8
B3	Deep Water Bay	SM2	DA	5.5	10.8	1.7	3.2
			S	4.8	7.4	1.4	2.2
			B	8.3	15.0	2.5	4.5
B4 B5	Tung Wan, Cheung Chau Kwun Yam Wan	SM12	DA	11.0	20.3	3.3	6.1
			S	9.1	19.0	2.7	5.7
			B	15.6	22.4	4.7	6.7
B6	Silvermine Bay	SM11	DA	10.3	15.0	3.1	4.5
			S	8.0	13.4	2.4	4.0
			B	15.0	20.0	4.5	6.0
Corals							
CR1 CR9	Pak Kok Sandy Bay	WM1	DA	8.1	11.1	2.4	3.3
			B	16.0	16.0	4.8	4.8
CR2 CR14	Shek Kok Tsui Hei Ling Chau	SM7	DA	10.2	11.2	3.1	3.3
			B	18.2	15.0	5.5	4.5
CR3 CR4 CR5 CR8	Luk Chau Wong Chuk Kok (North) Wong Chuk Kok (South) Ap Lei Chau	SM3	DA	7.2	10.3	2.2	3.1
			B	11.2	15.0	3.4	4.5
CR6 CR18 CR19	Shan Wan Northern Hung Shing Yeh Ha Mei Wan (North)	SM5	DA	8.6	13.0	2.6	3.9
			B	12.4	16.0	3.7	4.8
CR7	Round Island	SM2	DA	5.5	10.8	1.7	3.2
			B	8.3	15.0	2.5	4.5
CR10 CR11 CR12 CR13	Kau Yi Chau Siu Kau Yi Chau Peng Chau Sunshine Island	SM9	DA	18.9	12.8	5.7	3.8
			B	30.0	15.0	9.0	4.5
CR15	Cheung Chau (North)	SM12	DA	11.0	20.3	3.3	6.1

				Background SS (90th percentile)		Tolerance Elevation (mg L-1)	
WSR ID	Name	Representative EPD station		Wet Season	Dry Season	Wet Season	Dry Season
CR16	Cheung Chau (South)		B	15.6	20.0	4.5	6.0
CR17	Chi Ma Wan Peninsula	SM11	DA	10.3	15.0	3.1	4.5
			B	15.0	20.0	4.5	6.0
Marine Ecology							
FP4	East of Lamma - Finless Porpoise Habitat	SM2	DA	5.5	10.8	1.7	3.2
			S	4.8	7.4	1.4	2.2
			B	8.3	15.0	2.5	4.5
F1	Lo Tik Wan Fish Culture Zone	SM3	DA	7.2	10.3	2.2	3.1
			S	4.6	6.9	1.4	2.1
			B	11.2	15.0	3.4	4.5
F2 GT5	Sok Kwu Wan Fish Culture Zone Tung O Wan - Green Turtle Inter-nesting Habitat	SM4	DA	5.9	7.0	1.8	2.1
			S	4.5	6.0	1.4	1.8
			B	8.2	8.4	2.4	2.5
GT1 GT2 GT3 GT4 FP3 SS1 PMP1	Ha Mei Wan (North) - Green Turtle Inter-nesting Habitat Ha Mei Wan (South) - Green Turtle Inter-nesting Habitat South of Lamma - Green Turtle Inter-nesting Habitat Southeast of Lamma - Green Turtle Inter-nesting Habitat Southwest of Lamma - Finless Porpoise Habitat Sham Wan SSSI (Nesting of Green Turtle) South Lamma – Potential Marine Park	SM5	DA	8.6	13.0	2.6	3.9
			S	5.8	9.3	1.7	2.8
			B	12.4	16.0	3.7	4.8
FP1	East of Cheung Chau - Finless Porpoise Habitat	SM7	DA	10.2	11.2	3.1	3.3
			S	7.0	9.2	2.1	2.7
			B	18.2	15.0	5.5	4.5
F3	Cheung Sha Wan Fish Culture Zone	SM11	DA	10.3	15.0	3.1	4.5
			S	8.0	13.4	2.4	4.0
			B	15.0	20.0	4.5	6.0

Note:
DA = Depth-averaged
S = Surface
B = Bottom
[1] HK Electric Power Station cooling water intake can tolerate a SS level of up to 100 mg/l according to HK Electric.
For seawater intakes, bottom layer is not applicable. For corals, surface layer is not applicable.

For WSD's seawater intakes, the allowable elevation of 30% above the background level is not applicable, as the criteria for WSD's seawater intakes is capped at 10 mg/l. In this case, the average background level is used to determine the tolerance elevation for assessment purpose (see **Table 3-11**).

Table 3-11: Assessment Criteria for Suspended Solids (WSD Seawater Intakes)

				Background SS (Average)		Tolerance Elevation (mg L^{-1})	
WSR ID	Name	Representative EPD station		Wet Season	Dry Season	Wet Season	Dry Season
S2	WSD Seawater Intake at Ap Lei Chau	SM3	DA	4.4	5.3	5.6	4.7
			S	2.9	3.8	7.1	6.2

Note:
DA = Depth-averaged
S = Surface

3.4.2 Dissolved Oxygen

The criteria limits for DO are specified in the WQOs and in WSD's standards (refer to **Table 3-1**, **Table 3-2** and **Table 3-4**). For assessment of construction phase water quality impacts due to DO depletion, the predicted DO depletion will be compared with 10th percentile of the long-term (1986 to 2015) DO from EPD's baseline monitoring stations (presented in **Table 3-12** below) in order to determine whether the predicted DO levels at WSRs are below the relevant criteria limits set in the WQOs and WSD's standards.

Table 3-12: 10th Percentile Dissolved Oxygen Levels from EPD's Monitoring Stations

	10th Percentile DO (Wet Season) mg L^{-1}		10th Percentile DO (Dry Season) mg L^{-1}	
EPD Station	Bottom Layer	Depth-averaged	Bottom Layer	Depth-averaged
SM2	3.3	4.8	5.7	5.7
SM3	2.8	4.3	5.8	5.7
SM4	3.7	4.6	5.7	5.6
SM5	3.8	5.4	5.9	5.9
SM6	2.5	4.9	5.9	5.8
SM7	3.8	4.7	5.6	5.6
SM9	3.8	4.4	5.5	5.4
SM11	4.2	5.0	5.8	5.6
SM12	4.7	5.4	5.8	5.8
SM18	2.7	4.7	5.8	5.9
WM1	2.5	4.1	5.6	5.4
WM2	3.4	4.3	5.2	5.2

Note:
The DO as shown represents the baseline DO. The 'Predicted DO' is calculated by ('Baseline DO' – 'DO Depletion'), whereby DO Depletion is determined by the water quality model (see **Section 3.6.4**). The Predicted DO are compared against the WQOs and WSD's standard to determine whether there would be any adverse impacts due to oxygen depletion.

3.4.3 Unionised Ammonia and Total Inorganic Nitrogen

For unionised ammonia (UIA) and total inorganic nitrogen (TIN), the criteria limits specified in the WQOs for Southern WCZ (refer to **Table 3-2**) shall apply.

3.4.4 Metals and Other Contaminants

Reference is made to international criteria and guidelines to identify the criteria limits for metals and other contaminants. As shown in **Table 3-13**, international criteria limits vary widely between different countries, and some are below the limits of reporting (LOR) by HOKLAS laboratory. Based on these international references, the criteria adopted for assessment of metals and other contaminants is taken to be the most conservative of the international reference criteria, except in instances when this limit is below laboratory's LOR, whereby the laboratory LOR is taken as the lowest practicable limit instead.

Table 3-13: Water Quality Criteria for Metals and Other Contaminants

Parameter ($\mu g\ L^{-1}$)	Lab LOR	USEPA[1] CCC	USEPA[1] CMC	EU EQS[2]	ANZ[3] Aquatic	ANZ[3] Rec	Criteria Limit
Chromium	1	50	1100	-	0.14	50	**1**
Cadmium	0.2	8.8	40	0.2	0.7	5	**0.2**
Copper	1	3.1	4.8	-	0.3	1,000	**1**
Nickel	1	8.2	74	20	7	100	**7**
Lead	1	8.1	210	7.2	2.2	50	**2.2**
Silver	0.2	-	1.9	-	0.8	50	**0.8**
Arsenic	1	36	69	-	-	50	**36**
Zinc	10	81	90	-	7	5,000	**10**
Mercury	0.05	0.94	1.8	0.05	0.1	1	**0.05**
Polychlorinated Biphenyls (PCB)	0.01	0.03	-	-	-	0.1	**0.03**
Polyaromatic Hydrocarbon (PAH)	0.1	-	-	0.05 (based on benzo-a-pyrene)	50 (based on naphthalene)	0.01 (based on benzo-a-pyrene)	**0.1**

Note:
[1] USEPA criteria based on the criteria continuous concentration (CCC) and criteria maximum concentration (CMC).
[2] European Union Environmental Quality Standards (EU EQS) based on annual average criteria for 'other surface waters'.
[3] Australian and New Zealand (ANZ) guidelines for aquatic ecosystems (Aquatic) based on trigger values for marine waters, and guidelines for recreational purposes (Rec).
Shaded cells denote criteria values that are below laboratory's LOR (the LOR is with reference to the elutriation test shown in **Table 3-9**).

3.4.5 Sedimentation

Sedimentation can affect benthic organisms such as corals, by blocking the respiratory and feeding organs of these organisms. According to Hawker and Connell (1992), a sedimentation rate higher than 0.1 kg m^{-2} per day would introduce moderate to severe impact upon corals. As such, this limit is adopted as the assessment criterion for protecting coral sensitive receivers.

3.5 Identification of Pollution Sources

3.5.1 Construction Phase Water Quality Impact

The key potential water quality impacts arising from construction activities of the Project include:

- Suspended sediment release and potential increase in turbidity due to dredging activities
- Release of contaminants and/or impact on dissolved oxygen due to disturbance of sediment.

Aside from the key water quality impacts identified above, other general activities related to operation of dredging vessels/plant are not considered to be associated with significant water quality impacts.

3.5.1.1 Suspended Sediment Release and Potential Increase in Turbidity

As a result of dredging activities during construction phase, fine sediment (diameter less than 63 µm) will be lost to suspension. The suspended sediment (SS) will be transported by currents to form sediment plumes, which will gradually resettle. Sediment plumes can increase the SS concentrations and turbidity in the receiving water body, which could cause non-compliance with the relevant WQOs and other criteria at WSRs. The SS will also eventually settle back on the seabed and can cause a smothering effect on corals if the rate of sedimentation exceeds the rate of natural attenuation.

3.5.1.2 Release of Contaminants and Impact on Dissolved Oxygen

Contaminants are often adsorbed onto marine sediment as part of natural attenuation processes, and would remain firmly bound to the sediment in the seabed. However, mechanical actions such as dredging activities can agitate the sediments and result in release of these contaminants into the marine water, thus affecting the ambient marine water quality. The release of sediment contaminants into the water column also consumes DO in the ambient water, which can adversely affect WSRs such as fish culture zones.

3.5.2 Operation Phase Water Quality Impact

During operation phase, improvement dredging will be required periodically to maintain the required depth of the Channel. The potential water quality impacts associated with this recurring improvement dredging is the same as that for construction phase (i.e. release of SS and contaminants from disturbance of the accumulated sediment). The change in bathymetry of the Channel may also affect existing hydrodynamics and flows in the surrounding areas, though it should be noted that similar changes have occurred in the past due to historical improvement dredging works at the Channel.

Aside from the aforementioned, no other potential impacts due to recurring improvement dredging is anticipated given that the nature of the operation phase water quality impacts will be the same as that for construction phase.

3.5.3 Concurrent Projects

Concurrent projects in the vicinity with potential for cumulative water quality impacts have been identified. Where sufficient information is available, the relevant activities of these concurrent projects have been incorporated as part of the cumulative water quality impact assessment. A summary of the identified concurrent projects for cumulative impact assessment is presented in **Table 3-14**.

Table 3-14: Summary of Concurrent Projects for Cumulative Water Quality Impact Assessment

Concurrent Project	Project Status	Relevant Marine Works	Reference Information
Providing Sufficient Water Depth for Kwai Tsing Container Basin and its Approach Channel (KTCB)	Construction in progress. Expected to be completed before 2017	Operation phase maintenance dredging of container basin and approach channel	AEIAR-156/2010
Development of a 100MW Offshore Wind Farm in Hong Kong (OWF)	In planning stage – no updated construction programme available	Marine piling and scour protection for wind farm Dredging and seawall removal / reinstatement for the submarine cable	AEIAR-152/2010
Integrated Waste Management Facilities at an Artificial Island near Shek Kwu Chau (IWMF)	In pre-construction stage	Reclamation of about 11.8ha, with artificial seawall and breakwater	AEIAR-167/2012
Planning and Engineering Study on Future Land Use at Ex-Lamma Quarry Area at Sok Kwu Wan, Lamma Island - Feasibility Study	Construction works are planned to commence in 2019 for completion in 2024. The programme is subject to change at a later stage.	Construction of a public pier, a refuse transfer station / fireboat pier, a submarine outfall from sewage treatment works and modification works to existing seawall.	Based on information received from the project proponent in May 2016

3.6 Water Quality Assessment Methodology

3.6.1 Hydrodynamic Model

To assess the key potential water quality impacts due to the project, hydrodynamic modelling was undertaken to quantify SS and contaminant release. The 3-dimensional model adopted for the quantitative assessment is based on the Delft3D Updated Model which covers the whole of Hong Kong waters, the Pearl Estuary and the Dangan Channel. This model has been successfully applied in past approved EIAs and is considered to be suitable for application in this project with some refinement.

3.6.1.1 Model Grid Refinement and Validation

To obtain the desired resolution for this project, a domain decomposition model (refined grid) was generated from the original Updated Model. An 8x8 domain decomposition grid was created covering the greater Lamma waters area including Shek Kwu Chau to the West, Hong Kong Island to the East, Hei Ling Chau to the North and Dadong Bay to the South. Details of the grid refinement and model validation results are shown in **Appendix 3.1**.

3.6.2 Suspended Sediment

3.6.2.1 Improvement Dredging Scenarios

To model the dredging activities of the Project, the Project area (which covers the potential dredging areas within the Channel as well as dredging of any slopes required outside the Channel) is divided into four working zones (Zone 1, 2, 3 and 4). While the dredging activities will be moving all the time within the Project area, the most adverse impact of the whole dredging operation can be represented by dredging at either Location A, B, C or D within each zone as shown in **Figure 3.3**, as these are the locations within each zone that is nearest to WSRs. As the highest concentration of SS arises when all dredgers are located at the same location, the worst case scenarios at each working zone would be when all dredgers are located at the same location nearest to WSRs.

As shown in **Figure 3.3**, dredging at Location A represents the worst case scenario for WSRs located to the north of the Project area, while dredging at Location D represents the worst case scenario for WSRs located to the south of the Project area. Dredging at Locations B and C represent the worst case scenario for WSRs located in between, such as those WSRs along the west coast of Lamma Island.

3.6.2.2 Modelling Approach

For this Project, the marine activities (improvement dredging) to be conducted during construction phase and the recurring improvement dredging to be conducted during operation phase are the same, though there may be differences in the dredgers and quantity of dredged sediment each time. To enable the findings of the water quality impact assessment to be applicable to all recurring improvement dredging operations, a 'backwards' modelling approach is adopted, which estimates the maximum dredging rates which would ensure no unacceptable environmental impacts, rather than the conventional 'forward' modelling approach that would require a fixed detailed plant inventory and dredging location scenario on which to base the worst case assessment. This approach is consistent with the approach adopted in AEIAR-069/2003.

SS release was simulated using the Delft3D-WAQ model. A settling velocity of 0.5 mm/s was adopted, which is consistent with similar past EIA studies (e.g. AEIAR-156/2010).

For each worst case dredging location (Location A, B, C and D), the maximum allowable SS release is predicted by modelling a unit sediment discharge rate at each location separately. The process for determining the maximum allowable SS release for each working zone follows the steps below.

1. Model a unit continuous sediment discharge rate at the worst case dredging location for a full spring-neap cycle (15 days).
2. Identify the WSR with the highest predicted concentration. This WSR represents the worst affected WSR from which the maximum allowable SS release is based.
3. Use the highest predicted concentration from the worst affected WSR to determine the dilution factor between the worst affected WSR and the worst case dredging location.

4. Calculate the maximum allowable SS release at each WSR by scaling up to the allowed elevation (i.e. the criteria limit).
5. Calculate the maximum permitted dredging rates for each type of dredger taking into account their sediment loss rates (see **Section 3.6.2.3**).

Using the aforementioned approach, the maximum allowable SS release / dredging rate is determined for each working zone individually and the results are presented in **Table 3-18**. This limit applies when all dredgers are working within the same zone. For instances when dredgers are working concurrently in different zones in any day, the zone with the lowest maximum allowable dredging rate would apply in total to all dredgers that day as a conservative measure.

3.6.2.3 Types of Dredgers

As specified in **Chapter 2**, two types of dredgers, i.e. grab dredgers and/or trailer suction hopper dredgers (TSHD) will be deployed depending on the dredging requirements during each improvement dredging works. For the grab dredger option, in view of the relatively large quantity of sediment to be dredged each time, medium to large sized grabs with a grab capacity of no less than 8 m^3 will be deployed (except near the submarine pipeline where smaller grabs are recommended to minimise risks of accidental damage to the pipeline during dredging works). The water quality modelling assumptions for those two types of dredgers are summarised in **Table 3-15** below.

Table 3-15: Summary of Assumptions for Dredgers

Type	Unmitigated Sediment Loss Rate (kg/m^3)	Reduction due to Mitigation (silt curtain)	Sediment Loss Rate Adopted (kg/m^3)	Modelled Release	Reference
Closed grab dredger	11 – 20 (20 adopted as worst case)	75%	5 (based on worst case)	Continuous / Throughout the water column	Contaminated Spoil Management Study, 1991 AEIAR-163/2012
Trailer suction hopper dredger	4	n/a	4	Continuous / Near seabed	AEIAR-069/2003

Using the approach described in **Section 3.6.2.2**, the maximum permitted dredging rates have been determined for each type of dredger and are presented in **Table 3-19**. The number of same-type dredgers concurrently in operation is not important from a water quality perspective provided that the combined dredging rates of all dredgers are within the calculated maximum permitted rates for each working zone (or the lowest maximum permitted rate in total for concurrent working zones). Nevertheless, it is expected that there will be no more than five of each type of dredger operating concurrently due to reasons of practicality. As grab dredgers and TSHDs are modelled separately, the grab dredgers shall not be operating at the same time as the TSHDs.

3.6.2.4 Concurrent Projects

SS generated by the identified concurrent projects are modelled separately from the 'project only' scenarios, based on available information. The individual scenarios for the identified concurrent projects as presented in **Appendix 3.2** are combined to form one concurrent projects model. The results from the concurrent projects model is used to determine the allowable contribution by the project, whereby:

Allowable contribution by the project = Criteria Limit – Contribution by concurrent projects

The results are presented in **Appendix 3.4**. Following step 4 described in **Section 3.6.2.2**, the dilution factor results for the project are scaled up to the allowable contribution by the project to determine the maximum allowable SS release at each WSR. The results are presented in **Table 3-21** and **Appendix 3.6**. The subsequent maximum allowable SS release rates as presented in **Table 3-22** was used to re-run the model (as a 'forwards' model under the cumulative scenario) to check that the predicted maximum SS levels at the WSRs are within criteria limits. The results are summarised in **Table 3.23** and **Table 3.24**.

3.6.2.5 Impacts due to Sedimentation

For coral sensitive receivers, the maximum sedimentation results from the 'forwards' model under the cumulative scenario for each working zone is extracted and summarised in **Table 3.25** and **Table 3.26**.

3.6.3 Release of Contaminants from Sediment

To identify whether any contaminants may be released due to the dredging activities, the results of the elutriation tests are used as an initial screening against the relevant water quality criteria specified in **Table 3-2** and **Table 3-13**. The comparison between the elutriation test results and the criteria limits is shown in **Table 3-16**.

Table 3-16: Comparison of Elutriation Test Results against Criteria Limits

Parameter	Unit	Criteria Limit	Sample A	Sample B	Sample C	Samples exceed criteria?
Arsenic	µg/L	36	5	5	6	No
Cadmium	µg/L	0.2	<0.2	<0.2	<0.2	No
Chromium	µg/L	1	<1	<1	<1	No
Copper	µg/L	1	1	1	1	No (Samples at criteria limit but not exceeded)
Lead	µg/L	2.2	<1	<1	<1	No
Nickel	µg/L	7	2	<1	1	No
Silver	µg/L	0.8	<0.2	<0.2	<0.2	No
Zinc	µg/L	10	<10	<10	<10	No
Mercury	µg/L	0.05	<0.05	<0.05	<0.05	No

Parameter	Unit	Criteria Limit	Sample A	Sample B	Sample C	Samples exceed criteria?
Polychlorinated Biphenyls (PCB)	µg/L	0.03	<0.01	<0.01	<0.01	No
Polyaromatic Hydrocarbon (PAH)	µg/L	0.1	<0.01	<0.01	<0.01	No
TIN	mg/L	0.1	**1.11**	**1.52**	**0.69**	Yes
Ammonia-N	mg/L	N/A	1.04	1.41	0.57	N/A
UIA (calculated)*	mg/L	0.021	**0.118**	**0.160**	**0.065**	Yes (by conversion of ammonia-N to UIA)

Bold values denote samples showing exceedances of the criteria limit. Marine
* The formula for calculating UIA is taken from the approved EIA report for Providing Sufficient Water Depth for Kwai Tsing Container Basin and its Approach Channel. A UIA factor (F) of 11.3% was adopted based on EPD's 10 year (2006-2015) monitoring data at SM5 for ambient pH, temperature and salinity. This F value was adopted to calculate UIA from NH_3-N.

As shown in **Table 3-16**, only UIA and TIN show results that exceeds the relevant water quality criteria, hence there may be potential impacts at WSRs due to the improvement dredging works. For these parameters, a Gaussian Dispersion Model[1] (GDM) was adopted to determine the dilution potential at representative nearest WSRs.

The representative nearest WSRs located downstream of the Project during flood and ebb tides, and the corresponding sediment sampling locations adopted, are identified in **Table 3-17**.

Table 3-17: WSRs and Sediment Sampling Locations Assessed using the Gaussian Dispersion Model

	Nearest WSRs (downstream of the Project)	Source Sediment Sampling Locations Assessed	Remarks
Flood Tide	S1	C	Result based on source C only, as A and B are located downstream of S1 during flood tide
	CR2	A	Source C is not presented as the worst case (nearest distance and highest source concentration) is already represented by source A and B
		B	
Ebb Tide	S1	A	Result based on source A only, as B and C are located downstream of S1 during ebb tide
	GT1/CR19	B	Source A is not presented as the worst case (nearest distance and highest source concentration) is already represented by source B and C
		C	
	PMP1	B	
		C	
	GT2	B	
		C	
	FP3	B	
		C	

Note: Refer to **Figure 3.2** for the sediment sampling locations.

[1] CIRIA (2000), Scoping the Assessment of Sediment Plumes from Dredging

With reference to the past approved EIA undertaken within the Channel (AEIAR-069/2003), the model parameters adopted for the GDM are as follows:

- Local velocity = 0.5 m/s
- Dispersion coefficient = 1 m^2/s
- Local water depth = 15 m

Given that the area and marine waters surrounding the Project has remained almost completely unchanged since the time of the past EIA study, it is considered that the parameters adopted in the previous study are applicable for use in this study.

For TIN, baseline concentrations in the marine environment already exceeds the WQO (based on EPD's long term marine water quality monitoring data as well as the ambient marine water sample obtained as part of the elutriation test). The dilution potential results of the GDM was used to determine the concentration of TIN at the WSRs that is linked to Project activities. This calculated TIN concentration is then compared to the concentration of the ambient marine water sample obtained as part of the elutriation test to determine the significance of TIN released from sediment due to activities of the Project.

For UIA, baseline concentrations are typically low and well below the WQO. Thus for conservative estimate, it can be assumed that the concentration of UIA in the ambient marine water sample obtained as part of the elutriation test is zero. However, for assessing the contribution of the UIA released from sediment to the long term ambient UIA concentration in marine waters, reference is made to EPD's long term marine water quality monitoring data, which shows average UIA concentrations ranging from 0.002 to 0.004 mg/L. To be conservative, the ambient UIA concentration is assumed to be 0.004 mg/L. This ambient concentration was tallied with the UIA concentrations at WSRs determined by the GDM to determine any exceedances of the WQO.

The results for TIN and UIA are presented in **Table 3.27**.

3.6.4 Impacts on Dissolved Oxygen

Impacts associated with DO depletion due to the Project's activities is calculated from the following equation:

$DO_{Dep} = C * SOD * K * 0.001$

where DO_{Dep} =dissolved oxygen depletion (mg/L)

C = suspended solids concentration (kg/m^3)

SOD = sediment oxygen demand

K = daily oxygen uptake factor (set at 1.0 for worst case estimate)

C is taken from the results of the sediment plume model (using the worst case scenario and maximum allowable SS release results presented in **Table 3-18**), while SOD is based on the sediment test results obtained for the Project, which ranges from 690 to 760 mg/kg. The higher value was adopted to provide a more conservative estimate. The calculated DO_{Dep} results are summarised in **Table 3.28**.

3.6.5 Recurrent Improvement Dredging

As stated in **Section 3.6.2.2**, the marine activities to be conducted during construction phase and the recurring improvement dredging to be conducted during operation phase are the same, hence a 'backwards' modelling approach is adopted which caps the maximum dredging rates for the Project. An evaluation of the applicability of this approach to all future recurrent improvement dredging is presented in **Section 3.7.5**.

Tidal flows, direction and speed for before and after improvement dredging of the Channel have been modelled and the findings are presented and compared in **Table 3.30**.

3.7 Evaluation and Assessment of Water Quality Impacts

3.7.1 Suspended Sediment

3.7.1.1 Predicted Maximum Allowable SS Release Due to Project Only

Using the 'backwards modelling' approach described in **Section 3.6.2**, the dilution factor at each WSR has been predicted and the maximum allowable SS release at each WSR has been calculated by scaling up to the criteria limit. The full results of the dilution model and calculation of maximum allowable SS release are presented in **Appendix 3.3**. The WSRs with the lowest maximum allowable SS release at each dredging location represents the worst affected WSR. These are highlighted in Table A3.3.3 and Table A3.3.4 in **Appendix 3.3**. These worst affected WSRs for each dredging location for grab dredger and TSHD respectively and the associated maximum allowable SS release is summarised in **Table 3-18**.

Table 3-18: Predicted Worst Affected WSRs and Maximum Allowable SS Release Rates

	Dry Season				Wet Season			
Dredging Location	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Grab Dredger								
Critical Sensitive Receiver	CR2 (DA)	CR2 (DA)	FP3 (S)	FP3 (S)	CR2 (B)	GT2 (B)	FP3 (B)	FP3 (B)
Maximum allowable release rate (kg/s)	3.65	6.61	5.98	3.86	5.21	5.15	4.58	2.77
TSHD								
Critical Sensitive Receiver	CR2 (DA)	CR2 (DA)	FP3 (S)	FP3 (B)	CR2 (B)	GT2 (B)	GT2 (B)	FP3 (B)
Maximum allowable release rate (kg/s)	4.62	8.05	9.17	3.33	7.65	4.41	3.64	1.28

Note: DA represents depth-averaged, S represents surface layer, B represents bottom layer.

As shown by the results, the worst affected WSRs generally lie along the north-south direction of the dredging site, as this is the dominant direction of current flow through the project area, hence these locations are more likely to be affected by any sediment plumes generated by the project. CR2 is the worst affected WSR to the north of the project site, while FP3 and GT2 are the worst affected WSRs to the south. During dry season, the dominant current flow is the tide. During wet season, the Pearl River Delta flows will have a larger influence and counter-act the tidal flow during flood tide.

At Zone A where the worst affected WSR is CR2, which is in close proximity to Zone A, the current is affected by both tidal and Pearl River Delta flows. The greater influence of Pearl River Delta flows during wet season reduces the flood flow of the tide that carries the SS from the project to CR2. Hence the potential SS impact of the project on CR2 during dry season is greater than wet season, giving rise to a more stringent maximum allowable SS release limit during dry season. At Zone B, the worst affected WSR is CR2 (in the north) in dry season and GT2 (in the south) in wet season. The modelled results show that the maximum allowable SS release during wet season is more stringent in comparison. At Zones C and D, the worst affected WSR is FP3 for dry season and FP3 or GT2 for wet season. All these WSRs are located to the south of the dredging site, which is more influenced by the Pearl river flow during the tide that carries the SS from the project to FP3 / GT2, in particular during wet season, hence the maximum allowable SS release during dry season is less stringent than wet season.

The results in **Table 3-18** show that CR2 (corals at Shek Kok Tsui), FP3 (Finless Porpoise habitat at southwest of Lamma) and GT2 (Green Turtle Inter-nesting Habitat at Ha Mei Wan South) are the worst affected WSRs that will impose the most constraints to the Project in terms of allowable SS release rates.

To convert the maximum allowable SS release rate into equivalent maximum allowable dredging rates, the sediment loss rates specified in **Table 3-15** are applied. The resultant predicted maximum allowable dredging rates (due to Project only) are presented in **Table 3-19**.

Table 3-19: Predicted Maximum Allowable Dredging Rates

Predicted Maximum Dredging Rates	Dry Season				Wet Season			
	A	B	C	D	A	B	C	D
Grab Dredger								
m^3/s	0.73	1.32	1.20	0.77	1.04	1.03	0.92	0.55
m^3/day	63,030	114,290	103,252	66,621	89,946	89,058	79,135	47,915
TSHD								
m^3/s	1.15	2.01	2.29	0.83	1.91	1.10	0.91	0.32
m^3/day	99,705	173,918	198,065	71,827	165,304	95,243	78,709	27,705

Note: Daily dredging rates represent the maximum over a 24-hour working period

3.7.1.2 Implications Due to Concurrent Projects

Sediment release due to concurrent projects only was modelled according to the assumptions presented in **Appendix 3.2**. The results of the maximum predicted SS at WSRs due to concurrent projects are presented in **Appendix 3.4** alongside the criteria limit for individual WSRs. The maximum percentage contribution of SS by concurrent projects compared to the total allowable SS elevation (i.e. the criteria limit) is summarised in **Table 3-20** for each WSR group.

Table 3-20: Summary of SS Contributions to Allowable Elevations due to Concurrent Projects

	Dry Season		Wet Season	
WSR Groups	**Min**	**Max**	**Min**	**Max**
Seawater Intakes	0%	4%	0%	7%
Beaches	0%	0%	0%	0%
Corals	0%	12%	0%	11%
Fish Culture Zones	0%	0%	0%	0%
Finless Porpoise Habitat	2%	7%	0%	11%
Green Turtle Habitat	0%	5%	0%	8%
SSSI	0%	0%	0%	0%
Potential Marine Park	2%	4%	0%	5%

As shown in the modelled results, the maximum SS contributions by concurrent projects will take up at most 12% of the total allowable SS elevation at individual WSRs. The contribution by concurrent projects will be deducted from the total maximum allowable SS contribution in order to derive the maximum allowable SS contribution by this Project.

Contour plots of the maximum predicted SS due to concurrent projects only are presented in **Appendix 3.5**.

3.7.1.3 Recommended Maximum Allowable SS Release

Based on the results presented in **Appendix 3.4**, the worst affected WSRs due to concurrent projects only are CR2, FP3 and GT2. These were also identified to be the worst affected WSRs due to project only scenario as summarised in **Table 3-18**. Using the approach specified in **Section 3.6.2.4**, the maximum allowable SS release by the Project, taking into account cumulative impacts, has been calculated and is summarised in **Table 3-21**. The full results are presented in **Appendix 3.6**.

Table 3-21: Predicted Worst Affected WSRs and Maximum Allowable SS Release Rates (Cumulative)

	Dry Season				Wet Season			
Dredging Location	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Grab Dredger								
Critical Sensitive Receiver	CR2 (DA)	CR2 (DA)	FP3 (S)	FP3 (S)	CR2 (B)	GT2 (B)	FP3 (B)	FP3 (B)

Maximum allowable release rate (kg/s)	3.20	5.81	5.76	3.72	4.64	4.74	4.08	2.47
TSHD								
Critical Sensitive Receiver	CR2 (DA)	CR2 (DA)	FP3 (S)	FP3 (B)	CR2 (B)	GT2 (B)	GT2 (B)	FP3 (B)
Maximum allowable release rate (kg/s)	4.06	7.08	8.84	3.26	6.82	4.05	3.35	1.14

Note: DA represents depth-averaged, S represents surface layer, B represents bottom layer.

The predicted maximum allowable SS release rates taking into account cumulative impacts show between 2% to 12% reduction in the original maximum allowable SS release rates from the ‘project only’ scenario. These predictions which are based on the worst affected WSRs and their most conservative (worst case) results from the ‘concurrent project only’ scenario represent a very conservative approach that is aimed at maximising the protection of WSRs due to cumulative impacts. Nevertheless it is noted that the status of concurrent projects will change over time and while it is not possible to pre-empt the SS release from all future concurrent projects that may arise in the vicinity of the Project, an additional reduction of 10% on the predicted maximum allowable SS release rates is recommended to provide a buffer for future concurrent works. The recommended maximum allowable SS release rates and the associated maximum allowable dredging rates are summarised in **Table 3-22**.

Table 3-22: Recommended Maximum Allowable SS Release Rates and Maximum Allowable Dredging Rates

	Dry Season				Wet Season			
Dredging Location	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Grab Dredger								
Maximum allowable release rate (kg/s)	2.88	5.23	5.19	3.35	4.17	4.26	3.68	2.23
Maximum allowable dredging rate (m^3/s)	0.58	1.05	1.04	0.67	0.83	0.85	0.74	0.45
Maximum allowable dredging rate* (m^3/day)	49,800	90,400	89,600	57,800	72,100	73,700	63,500	38,500
TSHD								
Maximum allowable release rate (kg/s)	3.65	6.37	7.96	2.93	6.14	3.65	3.01	1.03
Maximum allowable dredging rate (m^3/s)	0.91	1.59	1.99	0.73	1.53	0.91	0.75	0.26
Maximum allowable dredging rate* (m^3/day)	78,900	137,600	171,900	63,300	132,500	78,800	65,100	22,200

*Values are rounded to the nearest hundred. The daily rate refers to total dredging over a 24 hour period. The maximum hourly dredging rate is equal to the maximum allowable daily rate / 24.

Based on the recommended maximum allowable release rates presented in **Table 3-22**, a conventional cumulative ‘forwards’ model (which models the recommended maximum allowable release rates from the Project with the SS contribution from concurrent projects) was run to check that the predicted cumulative maximum SS levels at the WSRs are within criteria limits. The results are presented in **Table 3.23** and

Table 3.24. Contour plots of the maximum SS release based on these recommended maximum allowable release rates from the Project are presented in **Appendix 3.7**.

Table 3.23: Predicted Cumulative Maximum SS Elevation at WSRs based on the Recommended Maximum Allowable Release Rates (Grab Dredger)

		Dry Season					Wet Season				
			Dredging Location (Zone)					Dredging Location (Zone)			
WSR	**Depth**	**Criteria**	**A**	**B**	**C**	**D**	**Criteria**	**A**	**B**	**C**	**D**
S1	DA	87.0	2.9	3.1	2.2	2.0	91.4	1.9	1.1	0.8	0.7
	S	90.7	2.3	2.6	1.8	1.7	94.2	1.4	0.9	0.7	0.6
S2	DA	4.7	0.1	0.1	0.1	0.1	5.6	0.1	0.1	0.0	0.0
	S	6.2	0.0	0.0	0.0	0.0	7.1	0.1	0.1	0.1	0.1
S3	DA	3.3	0.1	0.1	0.1	0.1	2.4	0.1	0.1	0.1	0.1
	S	2.4	0.1	0.1	0.1	0.1	1.4	0.1	0.1	0.1	0.1
S4	DA	3.3	0.1	0.1	0.1	0.1	2.4	0.2	0.1	0.1	0.1
	S	2.4	0.0	0.0	0.0	0.0	1.4	0.1	0.1	0.1	0.1
S5	DA	3.3	0.1	0.1	0.1	0.1	2.4	0.1	0.1	0.1	0.1
	S	2.4	0.1	0.1	0.1	0.0	1.4	0.1	0.1	0.1	0.1
S6	DA	3.3	0.1	0.1	0.1	0.1	2.4	0.1	0.1	0.1	0.1
	S	2.4	0.1	0.1	0.1	0.0	1.4	0.1	0.1	0.1	0.1
B1	DA	3.9	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
	S	2.8	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0
	B	4.8	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0
B2	DA	3.9	0.0	0.4	0.2	0.1	2.6	0.1	0.1	0.2	0.1
	S	2.8	0.0	0.2	0.1	0.0	1.7	0.1	0.1	0.1	0.1
	B	4.8	0.0	0.7	0.3	0.1	3.7	0.3	0.2	0.3	0.1
B3	DA	3.2	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0
	S	2.2	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0
	B	4.5	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0
B4	DA	6.1	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0
	S	5.7	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0
	B	6.7	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0
B5	DA	6.1	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0
	S	5.7	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0
	B	6.7	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0
B6	DA	4.5	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0
	S	4.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0
	B	6.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
CR1	DA	3.3	1.1	1.5	1.4	0.6	2.4	0.8	0.5	0.4	0.2
	B	4.8	1.5	1.8	1.7	0.8	4.8	1.9	1.4	0.9	0.6

		Dry Season					Wet Season				
			Dredging Location (Zone)					Dredging Location (Zone)			
WSR	Depth	Criteria	A	B	C	D	Criteria	A	B	C	D
CR2	DA	3.3	2.6	2.6	1.9	0.9	3.1	2.4	1.4	0.7	0.3
	B	4.5	3.5	3.0	2.1	1.0	5.5	4.4	2.6	1.6	1.0
CR3	DA	3.1	0.4	0.6	0.6	0.3	2.2	0.2	0.2	0.2	0.2
	B	4.5	0.5	0.7	0.6	0.4	3.4	0.3	0.3	0.2	0.1
CR4	DA	3.1	0.4	0.5	0.5	0.3	2.2	0.1	0.1	0.1	0.1
	B	4.5	0.4	0.6	0.6	0.3	3.4	0.1	0.1	0.1	0.1
CR5	DA	3.1	0.1	0.2	0.1	0.1	2.2	0.0	0.0	0.1	0.1
	B	4.5	0.1	0.2	0.1	0.1	3.4	0.0	0.1	0.2	0.1
CR6	DA	3.9	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
	B	4.8	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0
CR7	DA	3.2	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0
	B	4.5	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0
CR8	DA	3.1	0.1	0.2	0.1	0.1	2.2	0.1	0.1	0.1	0.0
	B	4.5	0.1	0.1	0.1	0.1	3.4	0.1	0.1	0.1	0.1
CR9	DA	3.3	0.1	0.1	0.1	0.1	2.4	0.1	0.1	0.1	0.1
	B	4.8	0.1	0.1	0.1	0.1	4.8	0.1	0.1	0.1	0.1
CR10	DA	3.8	0.1	0.1	0.1	0.1	5.7	0.1	0.1	0.1	0.1
	B	4.5	0.1	0.1	0.1	0.1	9.0	0.1	0.1	0.1	0.1
CR11	DA	3.8	0.1	0.1	0.0	0.0	5.7	0.1	0.1	0.1	0.1
	B	4.5	0.1	0.1	0.1	0.0	9.0	0.2	0.2	0.1	0.1
CR12	DA	3.8	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0
	B	4.5	0.0	0.0	0.0	0.0	9.0	0.1	0.1	0.1	0.1
CR13	DA	3.8	0.0	0.0	0.0	0.0	5.7	0.1	0.1	0.1	0.1
	B	4.5	0.0	0.0	0.0	0.0	9.0	0.1	0.1	0.1	0.1
CR14	DA	3.3	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0
	B	4.5	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0	0.0
CR15	DA	6.1	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0
	B	6.7	0.0	0.0	0.0	0.0	4.7	0.1	0.1	0.1	0.1
CR16	DA	6.1	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0
	B	6.7	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0
CR17	DA	4.5	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0
	B	6.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
CR18	DA	3.9	0.0	0.0	0.0	0.0	2.6	0.0	0.1	0.0	0.0
	B	4.8	0.0	0.0	0.0	0.0	3.7	0.1	0.1	0.1	0.0
CR19	DA	3.9	0.1	0.6	0.2	0.1	2.6	0.2	0.3	0.3	0.1
	B	4.8	0.1	1.4	0.5	0.2	3.7	0.3	0.6	0.5	0.2
F1	DA	3.1	0.1	0.1	0.1	0.0	2.2	0.1	0.0	0.0	0.0

WSR	Depth	Dry Season Criteria	Dry A	Dry B	Dry C	Dry D	Wet Season Criteria	Wet A	Wet B	Wet C	Wet D
	S	2.1	0.1	0.1	0.1	0.0	1.4	0.0	0.0	0.0	0.0
	B	4.5	0.1	0.1	0.1	0.0	3.4	0.1	0.1	0.0	0.0
F2	DA	2.1	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0
	S	1.8	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0
	B	2.5	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0
F3	DA	4.5	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0
	S	4.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0
	B	6.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
FP1	DA	3.3	0.2	0.2	0.2	0.2	3.1	0.1	0.1	0.1	0.1
	S	2.7	0.2	0.2	0.2	0.2	2.1	0.0	0.1	0.0	0.0
	B	4.5	0.3	0.3	0.3	0.3	5.5	0.2	0.3	0.1	0.1
FP3	DA	3.9	0.6	1.1	2.5	2.7	2.6	0.6	0.7	1.5	1.2
	S	2.8	0.5	0.9	2.4	2.4	1.7	0.3	0.1	1.0	1.1
	B	4.8	0.6	1.3	2.6	3.3	3.7	0.7	1.1	3.0	3.0
FP4	DA	3.2	0.2	0.2	0.2	0.1	1.7	0.0	0.0	0.1	0.0
	S	2.2	0.2	0.2	0.2	0.1	1.4	0.0	0.0	0.0	0.0
	B	4.5	0.2	0.3	0.3	0.1	2.5	0.0	0.0	0.1	0.1
GT1	DA	3.9	0.1	0.6	0.2	0.1	2.6	0.2	0.3	0.3	0.1
	S	2.8	0.1	0.2	0.1	0.0	1.7	0.0	0.4	0.1	0.1
	B	4.8	0.1	1.4	0.5	0.2	3.7	0.3	0.6	0.5	0.2
GT2	DA	3.9	0.7	2.3	1.8	1.0	2.6	0.8	0.9	1.1	0.9
	S	2.8	0.5	1.9	1.3	0.5	1.7	0.3	0.2	0.9	1.3
	B	4.8	0.8	2.7	3.3	1.6	3.7	1.3	3.1	2.2	0.9
GT3	DA	3.9	0.1	0.4	1.7	1.3	2.6	0.1	0.7	1.3	0.9
	S	2.8	0.1	0.3	1.4	0.9	1.7	0.1	0.3	0.5	0.4
	B	4.8	0.1	0.4	1.9	1.6	3.7	0.2	1.1	2.2	1.7
GT4	DA	3.9	0.2	0.2	0.3	0.4	2.6	0.0	0.1	0.3	0.3
	S	2.8	0.1	0.2	0.2	0.3	1.7	0.0	0.0	0.1	0.1
	B	4.8	0.2	0.2	0.3	0.4	3.7	0.0	0.1	0.5	0.5
GT5	DA	2.1	0.1	0.1	0.1	0.0	1.8	0.0	0.0	0.0	0.0
	S	1.8	0.1	0.1	0.1	0.0	1.4	0.0	0.0	0.0	0.0
	B	2.5	0.1	0.1	0.1	0.0	2.4	0.0	0.0	0.1	0.0
PMP1	DA	3.9	0.4	1.1	0.9	0.4	2.6	0.7	0.5	0.8	0.6
	S	2.8	0.3	0.7	0.4	0.2	1.7	0.2	0.2	0.4	0.7
	B	4.8	0.5	1.5	1.6	0.9	3.7	1.2	1.1	1.4	0.7
SS1	DA	3.9	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
	S	2.8	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0

Note: Dry A–D and Wet A–D are Dredging Location (Zone).

WSR	Depth	Dry Season Criteria	Dry Dredging Location (Zone) A	B	C	D	Wet Season Criteria	Wet Dredging Location (Zone) A	B	C	D
	B	4.8	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0

Note: DA represents depth-averaged, S represents surface layer, B represents bottom layer. Bold values represent values exceeding the criteria. Results are rounded to one decimal point.

Table 3.24: Predicted Cumulative Maximum SS Elevation at WSRs based on the Recommended Maximum Allowable Release Rates (TSHD)

WSR	Depth	Dry Season Criteria	Dry Dredging Location (Zone) A	B	C	D	Wet Season Criteria	Wet Dredging Location (Zone) A	B	C	D
S1	DA	87.0	5.2	3.4	2.4	1.9	91.4	1.1	0.8	0.7	0.6
	S	90.7	4.1	2.8	2.0	1.6	94.2	0.6	0.6	0.6	0.6
S2	DA	4.7	0.1	0.1	0.1	0.1	5.6	0.0	0.0	0.0	0.0
	S	6.2	0.0	0.0	0.0	0.0	7.1	0.1	0.1	0.1	0.1
S3	DA	3.3	0.1	0.1	0.1	0.1	2.4	0.1	0.1	0.1	0.0
	S	2.4	0.1	0.1	0.1	0.1	1.4	0.1	0.1	0.1	0.1
S4	DA	3.3	0.1	0.1	0.1	0.1	2.4	0.1	0.1	0.1	0.1
	S	2.4	0.0	0.0	0.0	0.0	1.4	0.1	0.1	0.1	0.1
S5	DA	3.3	0.1	0.1	0.1	0.1	2.4	0.1	0.1	0.1	0.1
	S	2.4	0.1	0.1	0.1	0.0	1.4	0.1	0.1	0.1	0.1
S6	DA	3.3	0.1	0.1	0.1	0.1	2.4	0.1	0.1	0.1	0.1
	S	2.4	0.1	0.1	0.1	0.0	1.4	0.1	0.1	0.1	0.1
B1	DA	3.9	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
	S	2.8	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0
	B	4.8	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0
B2	DA	3.9	0.0	0.4	0.2	0.1	2.6	0.1	0.0	0.0	0.0
	S	2.8	0.0	0.2	0.1	0.0	1.7	0.1	0.0	0.0	0.0
	B	4.8	0.1	0.7	0.3	0.1	3.7	0.2	0.0	0.0	0.0
B3	DA	3.2	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0
	S	2.2	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0
	B	4.5	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0
B4	DA	6.1	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0
	S	5.7	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0
	B	6.7	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0
B5	DA	6.1	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0
	S	5.7	0.0	0.0	0.0	0.0	2.7	0.0	0.0	0.0	0.0
	B	6.7	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0
B6	DA	4.5	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0

WSR	Depth	Dry Season					Wet Season				
		Criteria	Dredging Location (Zone)				Criteria	Dredging Location (Zone)			
			A	B	C	D		A	B	C	D
	S	4.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0
	B	6.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
CR1	DA	3.3	1.1	1.6	1.8	0.5	2.4	0.8	0.5	0.3	0.2
	B	4.8	1.5	1.9	2.1	0.6	4.8	1.9	1.1	0.9	0.5
CR2	DA	3.3	2.6	2.6	2.4	0.7	3.1	2.0	0.9	0.5	0.3
	B	4.5	3.3	2.9	2.7	0.9	5.5	4.4	2.1	1.6	0.9
CR3	DA	3.1	0.4	0.6	0.7	0.3	2.2	0.2	0.2	0.2	0.2
	B	4.5	0.5	0.7	0.8	0.4	3.4	0.2	0.2	0.2	0.1
CR4	DA	3.1	0.4	0.5	0.5	0.3	2.2	0.1	0.1	0.1	0.1
	B	4.5	0.5	0.6	0.7	0.3	3.4	0.0	0.0	0.1	0.0
CR5	DA	3.1	0.1	0.2	0.2	0.1	2.2	0.0	0.0	0.0	0.0
	B	4.5	0.1	0.2	0.2	0.1	3.4	0.0	0.0	0.1	0.0
CR6	DA	3.9	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
	B	4.8	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0
CR7	DA	3.2	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0
	B	4.5	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0
CR8	DA	3.1	0.1	0.2	0.1	0.1	2.2	0.1	0.1	0.0	0.0
	B	4.5	0.1	0.1	0.1	0.1	3.4	0.1	0.1	0.1	0.0
CR9	DA	3.3	0.1	0.1	0.1	0.1	2.4	0.1	0.1	0.1	0.1
	B	4.8	0.1	0.1	0.1	0.1	4.8	0.1	0.1	0.1	0.1
CR10	DA	3.8	0.1	0.1	0.1	0.1	5.7	0.1	0.1	0.1	0.1
	B	4.5	0.1	0.1	0.1	0.1	9.0	0.1	0.1	0.1	0.1
CR11	DA	3.8	0.1	0.1	0.1	0.0	5.7	0.1	0.1	0.1	0.1
	B	4.5	0.1	0.1	0.1	0.0	9.0	0.1	0.1	0.1	0.1
CR12	DA	3.8	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0
	B	4.5	0.0	0.0	0.0	0.0	9.0	0.1	0.1	0.1	0.0
CR13	DA	3.8	0.0	0.0	0.0	0.0	5.7	0.1	0.1	0.1	0.1
	B	4.5	0.0	0.0	0.0	0.0	9.0	0.1	0.1	0.1	0.1
CR14	DA	3.3	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0
	B	4.5	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0	0.0
CR15	DA	6.1	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0
	B	6.7	0.0	0.0	0.0	0.0	4.7	0.1	0.1	0.1	0.1
CR16	DA	6.1	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0
	B	6.7	0.0	0.0	0.0	0.0	4.7	0.0	0.0	0.0	0.0
CR17	DA	4.5	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0
	B	6.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
CR18	DA	3.9	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0

WSR	Depth	Dry Season					Wet Season				
		Criteria	Dredging Location (Zone)				Criteria	Dredging Location (Zone)			
			A	B	C	D		A	B	C	D
	B	4.8	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0
CR19	DA	3.9	0.1	0.7	0.3	0.1	2.6	0.1	0.1	0.0	0.0
	B	4.8	0.1	1.8	0.7	0.2	3.7	0.3	0.3	0.1	0.0
F1	DA	3.1	0.1	0.1	0.1	0.0	2.2	0.0	0.0	0.0	0.0
	S	2.1	0.1	0.1	0.1	0.0	1.4	0.0	0.0	0.0	0.0
	B	4.5	0.1	0.1	0.1	0.0	3.4	0.1	0.1	0.0	0.0
F2	DA	2.1	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0
	S	1.8	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0
	B	2.5	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0
F3	DA	4.5	0.0	0.0	0.0	0.0	3.1	0.0	0.0	0.0	0.0
	S	4.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0
	B	6.0	0.0	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
FP1	DA	3.3	0.2	0.2	0.2	0.2	3.1	0.2	0.1	0.1	0.1
	S	2.7	0.2	0.2	0.2	0.2	2.1	0.0	0.0	0.0	0.0
	B	4.5	0.3	0.3	0.3	0.3	5.5	0.3	0.2	0.1	0.1
FP3	DA	3.9	0.5	1.2	2.9	2.1	2.6	0.4	0.7	1.1	0.8
	S	2.8	0.4	1.0	2.4	0.9	1.7	0.3	0.1	0.1	0.0
	B	4.8	0.5	1.3	3.6	4.2	3.7	0.5	1.2	2.7	3.0
FP4	DA	3.2	0.2	0.2	0.3	0.1	1.7	0.0	0.0	0.0	0.0
	S	2.2	0.2	0.2	0.2	0.1	1.4	0.0	0.0	0.0	0.0
	B	4.5	0.2	0.3	0.3	0.1	2.5	0.0	0.0	0.0	0.0
GT1	DA	3.9	0.1	0.7	0.3	0.1	2.6	0.1	0.1	0.0	0.0
	S	2.8	0.1	0.2	0.1	0.0	1.7	0.0	0.0	0.0	0.0
	B	4.8	0.1	1.8	0.7	0.2	3.7	0.3	0.3	0.1	0.0
GT2	DA	3.9	0.8	2.5	2.1	0.9	2.6	0.7	0.7	0.8	0.3
	S	2.8	0.6	2.0	1.6	0.5	1.7	0.2	0.0	0.0	0.0
	B	4.8	0.8	2.8	3.7	1.6	3.7	1.4	3.1	3.1	1.1
GT3	DA	3.9	0.1	0.3	2.2	1.3	2.6	0.1	0.6	1.0	0.5
	S	2.8	0.1	0.2	1.8	0.9	1.7	0.1	0.2	0.2	0.1
	B	4.8	0.1	0.3	2.5	1.5	3.7	0.2	0.9	2.0	1.3
GT4	DA	3.9	0.2	0.2	0.3	0.3	2.6	0.0	0.0	0.2	0.2
	S	2.8	0.1	0.2	0.2	0.2	1.7	0.0	0.0	0.0	0.0
	B	4.8	0.2	0.2	0.4	0.3	3.7	0.0	0.1	0.3	0.3
GT5	DA	2.1	0.1	0.1	0.1	0.0	1.8	0.0	0.0	0.0	0.0
	S	1.8	0.1	0.1	0.1	0.0	1.4	0.0	0.0	0.0	0.0
	B	2.5	0.1	0.1	0.1	0.0	2.4	0.0	0.0	0.0	0.0
PMP1	DA	3.9	0.4	1.2	0.9	0.4	2.6	0.6	0.2	0.2	0.1

WSR	Depth	Dry Season Criteria	Dry Season Dredging Location (Zone) A	B	C	D	Wet Season Criteria	Wet Season Dredging Location (Zone) A	B	C	D
	S	2.8	0.3	0.8	0.5	0.2	1.7	0.1	0.0	0.0	0.0
	B	4.8	0.5	1.6	1.7	0.7	3.7	1.1	0.7	0.7	0.4
SS1	DA	3.9	0.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0
	S	2.8	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0
	B	4.8	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0

Note: DA represents depth-averaged, S represents surface layer, B represents bottom layer. Bold values represent values exceeding the criteria. Results are rounded to one decimal point.

The results show that all WSRs will comply with the criteria, hence with the adoption of the recommended maximum allowable release / dredging rates during construction phase and operation phase recurrent dredging, no adverse water quality impacts due to SS release from the Project is expected.

Potential increase in turbidity due to this Project is considered to be primarily linked to SS release from dredging activities, hence the control of SS through the adoption of the recommended maximum allowable release / dredging rates will similarly control and limit turbidity levels at WSRs.

3.7.2 Sedimentation

Sedimentation results from the 'forwards' model under the cumulative scenario was extracted for the WSRs representing coral sensitive receivers. The maximum sedimentation results at these WSRs is summarised in **Table 3.25** and **Table 3.26**.

Table 3.25: Maximum Sedimentation Rate at WSRs Representing Corals (g/m^2/day) due to Grab Dredging

WSR	Dredging Location (Dry Season) A	B	C	D	Dredging Location (Wet Season) A	B	C	D
CR1	12	15	13	7	9	6	5	3
CR2	25	23	22	11	36	13	7	2
CR3	5	6	5	3	3	3	2	2
CR4	3	4	3	2	0	0	1	1
CR5	2	2	2	1	0	1	1	1
CR6	0	1	1	0	0	0	0	1
CR7	0	0	0	0	0	0	0	0
CR8	2	2	2	1	1	1	1	1
CR9	2	2	2	2	1	1	1	1
CR10	0	0	0	0	1	1	1	1
CR11	0	0	0	0	1	1	1	1
CR12	0	0	0	0	1	1	1	1
CR13	0	0	0	0	1	1	1	1

	Dredging Location (Dry Season)				Dredging Location (Wet Season)			
WSR	A	B	C	D	A	B	C	D
CR14	0	0	0	0	1	1	0	0
CR15	0	0	0	0	0	0	0	0
CR16	0	0	0	0	0	0	0	0
CR17	0	0	0	0	0	0	0	0
CR18	0	0	0	0	0	1	0	0
CR19	1	18	6	3	1	5	5	2

Note: The results have been rounded to the nearest integer value.

Table 3.26: Maximum Sedimentation Rate at WSRs Representing Corals (g/m^2/day) due to TSHD

	Dredging Location (Dry Season)				Dredging Location (Wet Season)			
WSR	A	B	C	D	A	B	C	D
CR1	13	15	16	7	8	6	4	3
CR2	24	22	27	9	30	11	5	2
CR3	5	6	6	2	2	2	2	2
CR4	3	4	3	2	0	0	0	0
CR5	2	2	2	1	0	0	0	0
CR6	0	1	1	0	0	0	0	0
CR7	0	0	0	0	0	0	0	0
CR8	2	2	2	1	1	1	1	1
CR9	2	2	2	2	1	1	1	1
CR10	0	0	0	0	1	1	1	1
CR11	0	0	0	0	1	1	1	1
CR12	0	0	0	0	1	1	1	0
CR13	0	0	0	0	1	1	1	1
CR14	0	0	0	0	1	0	0	0
CR15	0	0	0	0	0	0	0	0
CR16	0	0	0	0	0	0	0	0
CR17	0	0	0	0	0	0	0	0
CR18	0	0	0	0	0	0	0	0
CR19	1	20	7	2	1	1	0	0

Note: The results have been rounded to the nearest integer value.

The results show that predicted sedimentation rates at WSRs representing corals are all well below the criteria limit of 0.1 kg m^{-2} per day, hence no adverse impacts to corals due to sedimentation is expected during construction phase and operation phase recurrent dredging for the Project.

3.7.3 Release of Contaminants from Sediment

As presented in **Section 3.6.3**, the elutriation test results for TIN and the calculated UIA show exceedance of the relevant water quality criteria, hence the potential for water quality impacts at WSRs due to TIN and UIA release was further evaluated.

Using the method specified in **Section 3.6.3**, the concentration of TIN and UIA at the representative nearest WSRs were calculated from the GDM. The results are presented in **Table 3.27**.

Table 3.27: Summary of Results for TIN and UIA at the Representative Nearest WSRs during Flood and Ebb Tide

Nearest Downstream WSRs	Source Sediment Sampling Location	Dilution Potential at WSR (from GDM)	TIN Concentration			UIA Concentration	
			Project only*	Project + Ambient	% of ambient TIN	Project only*	Project + Ambient
Flood Tide							
S1	C	1.6E+56	3.4E-57	0.14	0.00%	4.1E-58	4.0E-03
CR2	A	8.3E+07	1.2E-08	0.14	0.00%	1.4E-09	4.0E-03
	B	2.0E+04	6.9E-05	0.14	0.05%	8.0E-06	4.0E-03
Ebb Tide							
S1	A	3.2E+68	3.0E-69	0.14	0.00%	3.7E-70	4.0E-03
GT1/CR19	B	3.4E+111	4.1E-112	0.14	0.00%	4.7E-113	4.0E-03
	C	6.2E+133	8.9E-135	0.14	0.00%	1.0E-135	4.0E-03
PMP1	B	1.1E+32	1.3E-32	0.14	0.00%	1.5E-33	4.0E-03
	C	5.0E+25	1.1E-26	0.14	0.00%	1.3E-27	4.0E-03
GT2	B	5.9E+06	2.3E-07	0.14	0.00%	2.7E-08	4.0E-03
	C	1.4E+05	3.9E-06	0.14	0.00%	4.6E-07	4.0E-03
FP3	B	1.3E+02	1.1E-02	0.15	7.58%	1.2E-03	5.2E-03
	C	1.2E+02	4.6E-03	0.14	3.27%	5.4E-04	4.5E-03

* Calculated by the following equation:
For TIN, Concentration at WSR = [Elutriation test result - Ambient marine water concentration] / Dilution Potential result from GDM
For UIA, Concentration at WSR = Elutriation test result / Dilution Potential result from GDM
Note: For TIN, the ambient marine water concentration was 0.14 mg/L based on marine water samples taken at the time of the sediment sampling for elutriate tests (refer to **Table 3-9**). Hence the ambient concentration needs to be deducted from the elutriation test result before deriving the TIN concentration that is contributed by the sediment. For UIA, no ambient concentration is assumed from the elutriation test as a conservative estimate. However, an ambient marine water concentration of 0.004 mg/L (based on EPD's long term marine water quality monitoring data as stated in **Section 3.6.3**) is assumed for assessing any exceedance of WQO in the 'Project + Ambient' column.

For TIN, as can be expected, all results exceed the WQO as the ambient marine concentration already shows exceedance. However, the release of TIN from sediment disturbed by the Project is negligible at all of the representative nearest WSRs except for FP3. At FP3, the TIN released from sediment disturbed by the Project as determined by the GDM is up to 7.6%, and this increases the ambient concentration by about 0.01 mg/L.

It should be noted that the GDM assumes the highest concentration (with least dilution) along a centreline following the direction of flow from the source, whereby both source location and flow direction is fixed, and source release occurs continuously over an infinite period of time. Thus the GDM results represent an impact which is both spatially and temporally transient (i.e. highly dependent on source location, flow direction, and duration of Project activities). As the dredging source and duration will keep changing during the Project's dredging activities and tidal direction changes semi-diurnally each day, the results of the GDM represent a worst case that may only arise temporarily at individual WSRs.

Given the temporary nature of the impact and the small change in TIN levels relative to ambient concentrations, the potential impact on FP3 is considered to be low and acceptable.

For UIA, the results show that there is no exceedance of the WQO due to the combined Project + Ambient concentration at all the representative nearest WSRs. Hence no adverse impacts due to UIA is anticipated.

3.7.4 Impact on Dissolved Oxygen

Oxygen depletion from release of SS due to Project activities was calculated using the maximum allowable SS release results presented in **Table 3-18** and the equation presented in **Section 3.6.4**. The calculated maximum DO depletion due to the Project and the resultant DO concentrations at individual WSRs due to grab dredging and TSHD respectively are presented in **Table 3.28**. The full calculated DO depletion results at individual working zones are presented in **Appendix 3.10**.

Table 3.28: Calculated Changes to DO Concentration at WSRs due to the Project

					Grab Dredger				TSHD			
			Baseline DO (mg/L)		Max DO Depletion (All Zones) (mg/L)		Calculated DO at WSR (mg/L)		Max DO Depletion (All Zones) (mg/L)		Calculated DO at WSR (mg/L)	
WSR	Depth	Criteria (mg/L)	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
S1	DA	>2	5.9	5.4	2.7E-03	1.7E-03	5.9	5.4	4.9E-03	2.4E-03	5.9	5.4
S2	DA	>2	5.7	4.3	2.8E-05	2.0E-05	5.7	4.3	2.5E-05	2.7E-05	5.7	4.3
S3	DA	>2	5.4	4.1	1.8E-05	1.5E-05	5.4	4.1	1.9E-05	1.8E-05	5.4	4.1
S4	DA	>2	5.4	4.1	1.9E-05	4.1E-05	5.4	4.1	2.1E-05	1.8E-05	5.4	4.1
S5	DA	>2	5.4	4.1	2.3E-05	5.1E-05	5.4	4.1	2.4E-05	2.2E-05	5.4	4.1
S6	DA	>2	5.4	4.1	2.8E-05	5.3E-05	5.4	4.1	2.8E-05	2.6E-05	5.4	4.1
B1	DA	>4	5.9	5.4	2.5E-06	2.1E-05	5.9	5.4	3.5E-06	3.2E-06	5.9	5.4
	B	>2	5.9	3.8	3.5E-06	2.4E-05	5.9	3.8	5.6E-06	4.6E-06	5.9	3.8
B2	DA	>4	5.9	5.4	4.1E-04	1.7E-04	5.9	5.4	1.6E-04	4.0E-04	5.9	5.4
	B	>2	5.9	3.8	6.8E-04	3.1E-04	5.9	3.8	2.5E-04	6.6E-04	5.9	3.8
B3	DA	>4	5.7	4.8	3.1E-09	8.6E-08	5.7	4.8	2.8E-08	1.5E-08	5.7	4.8
	B	>2	5.7	3.3	7.0E-09	8.0E-08	5.7	3.3	2.3E-08	1.4E-08	5.7	3.3
B4	DA	>4	5.8	5.4	2.3E-08	2.6E-06	5.8	5.4	3.5E-06	6.7E-07	5.8	5.4
	B	>2	5.8	4.7	5.4E-08	6.2E-06	5.8	4.7	8.6E-06	1.4E-06	5.8	4.7
B5	DA	>4	5.8	5.4	5.7E-08	3.1E-06	5.8	5.4	3.9E-06	8.8E-07	5.8	5.4
	B	>2	5.8	4.7	1.2E-07	5.3E-06	5.8	4.7	6.8E-06	1.5E-06	5.8	4.7
B6	DA	>4	5.6	5.0	1.9E-10	1.4E-10	5.6	5.0	2.0E-10	2.2E-10	5.6	5.0
	B	>2	5.8	4.2	2.5E-10	3.6E-10	5.8	4.2	4.7E-10	2.9E-10	5.8	4.2
CR1	DA	>4	5.4	4.1	1.4E-03	7.8E-04	5.4	4.1	1.4E-03	1.4E-03	5.4	4.1
	B	>2	5.6	2.5	1.8E-03	1.7E-03	5.6	2.5	2.0E-03	1.8E-03	5.6	2.5
CR2	DA	>4	5.6	4.7	2.5E-03	2.3E-03	5.6	4.7	2.5E-03	2.4E-03	5.6	4.7
	B	>2	5.6	3.8	3.4E-03	4.2E-03	5.6	3.8	5.0E-03	2.7E-03	5.6	3.8
CR3	DA	>4	5.7	4.3	5.7E-04	1.6E-04	5.7	4.3	5.0E-04	5.6E-04	5.7	4.3
	B	>2	5.8	2.8	6.4E-04	2.8E-04	5.8	2.8	5.7E-04	6.4E-04	5.8	2.8

					Grab Dredger				TSHD			
			Baseline DO (mg/L)		Max DO Depletion (All Zones) (mg/L)		Calculated DO at WSR (mg/L)		Max DO Depletion (All Zones) (mg/L)		Calculated DO at WSR (mg/L)	
WSR	Depth	Criteria (mg/L)	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
CR4	DA	>4	5.7	4.3	4.0E-04	6.4E-05	5.7	4.3	3.4E-04	3.9E-04	5.7	4.3
	B	>2	5.8	2.8	5.3E-04	1.1E-04	5.8	2.8	5.0E-04	5.2E-04	5.8	2.8
CR5	DA	>4	5.7	4.3	1.1E-04	6.7E-05	5.7	4.3	9.4E-05	1.1E-04	5.7	4.3
	B	>2	5.8	2.8	1.2E-04	1.6E-04	5.8	2.8	9.7E-05	1.1E-04	5.8	2.8
CR6	DA	>4	5.9	5.4	1.6E-05	1.9E-05	5.9	5.4	1.4E-05	1.6E-05	5.9	5.4
	B	>2	5.9	3.8	2.2E-05	3.2E-05	5.9	3.8	1.9E-05	2.1E-05	5.9	3.8
CR7	DA	>4	5.7	4.8	9.3E-06	1.9E-05	5.7	4.8	1.1E-05	9.0E-06	5.7	4.8
	B	>2	5.7	3.3	8.9E-06	1.8E-05	5.7	3.3	1.1E-05	8.6E-06	5.7	3.3
CR8	DA	>4	5.7	4.3	5.1E-05	2.0E-05	5.7	4.3	4.3E-05	4.9E-05	5.7	4.3
	B	>2	5.8	2.8	6.1E-05	3.3E-05	5.8	2.8	5.1E-05	5.9E-05	5.8	2.8
CR9	DA	>4	5.4	4.1	2.2E-05	4.2E-05	5.4	4.1	2.2E-05	2.1E-05	5.4	4.1
	B	>2	5.6	2.5	3.2E-05	4.0E-05	5.6	2.5	3.3E-05	3.0E-05	5.6	2.5
CR10	DA	>4	5.4	4.4	1.2E-05	2.3E-05	5.4	4.4	3.1E-05	9.4E-06	5.4	4.4
	B	>2	5.5	3.8	1.4E-05	2.8E-05	5.5	3.8	3.7E-05	1.1E-05	5.5	3.8
CR11	DA	>4	5.4	4.4	2.1E-06	9.4E-06	5.4	4.4	8.8E-06	5.0E-06	5.4	4.4
	B	>2	5.5	3.8	2.4E-06	1.2E-05	5.5	3.8	1.1E-05	6.5E-06	5.5	3.8
CR12	DA	>4	5.4	4.4	6.6E-07	2.6E-06	5.4	4.4	2.4E-06	1.3E-06	5.4	4.4
	B	>2	5.5	3.8	7.3E-07	4.4E-06	5.5	3.8	4.2E-06	2.3E-06	5.5	3.8
CR13	DA	>4	5.4	4.4	1.3E-06	9.4E-06	5.4	4.4	1.2E-05	4.4E-06	5.4	4.4
	B	>2	5.5	3.8	1.4E-06	2.4E-05	5.5	3.8	2.0E-05	1.1E-05	5.5	3.8
CR14	DA	>4	5.6	4.7	6.1E-07	6.0E-06	5.6	4.7	3.6E-06	1.2E-06	5.6	4.7
	B	>2	5.6	3.8	7.2E-07	1.2E-05	5.6	3.8	5.8E-06	2.0E-06	5.6	3.8
CR15	DA	>4	5.8	5.4	9.7E-08	5.1E-06	5.8	5.4	6.5E-06	1.4E-06	5.8	5.4
	B	>2	5.8	4.7	2.4E-07	1.1E-05	5.8	4.7	1.4E-05	2.7E-06	5.8	4.7
CR16	DA	>4	5.8	5.4	5.6E-08	3.6E-06	5.8	5.4	5.2E-06	7.1E-07	5.8	5.4

WSR	Depth	Criteria (mg/L)	Baseline DO (mg/L)		Grab Dredger				TSHD			
					Max DO Depletion (All Zones) (mg/L)		Calculated DO at WSR (mg/L)		Max DO Depletion (All Zones) (mg/L)		Calculated DO at WSR (mg/L)	
			Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
	B	>2	5.8	4.7	1.6E-07	1.0E-05	5.8	4.7	1.6E-05	2.1E-06	5.8	4.7
CR17	DA	>4	5.6	5.0	3.6E-08	5.4E-08	5.6	5.0	5.1E-08	3.2E-08	5.6	5.0
	B	>2	5.8	4.2	4.1E-08	9.6E-08	5.8	4.2	9.1E-08	4.4E-08	5.8	4.2
CR18	DA	>4	5.9	5.4	9.7E-06	5.8E-05	5.9	5.4	2.6E-05	1.3E-05	5.9	5.4
	B	>2	5.9	3.8	2.2E-05	6.1E-05	5.9	3.8	5.1E-05	3.0E-05	5.9	3.8
CR19	DA	>4	5.9	5.4	5.6E-04	3.1E-04	5.9	5.4	2.2E-04	6.6E-04	5.9	5.4
	B	>2	5.9	3.8	1.4E-03	5.4E-04	5.9	3.8	5.0E-04	1.6E-03	5.9	3.8
F1	DA	>5	5.7	**4.3**	8.9E-05	4.4E-05	5.7	**4.3**	7.7E-05	8.8E-05	5.7	**4.3**
	B	>2	5.8	2.8	1.0E-04	6.6E-05	5.8	2.8	8.7E-05	9.9E-05	5.8	2.8
F2	DA	>5	5.6	**4.6**	5.1E-07	3.6E-06	5.6	**4.6**	2.2E-06	1.4E-06	5.6	**4.6**
	B	>2	5.7	3.7	5.6E-07	7.3E-06	5.7	3.7	3.7E-06	2.5E-06	5.7	3.7
F3	DA	>5	5.6	5.0	5.1E-08	8.8E-08	5.6	5.0	8.4E-08	4.6E-08	5.6	5.0
	B	>2	5.8	4.2	5.8E-08	1.5E-07	5.8	4.2	1.4E-07	7.2E-08	5.8	4.2
FP1	DA	>4	5.6	4.7	1.0E-05	8.5E-05	5.6	4.7	1.1E-04	1.9E-05	5.6	4.7
	B	>2	5.6	3.8	1.1E-05	1.3E-04	5.6	3.8	2.3E-04	3.1E-05	5.6	3.8
FP3	DA	>4	5.9	5.4	2.4E-03	1.4E-03	5.9	5.4	2.2E-03	2.4E-03	5.9	5.4
	B	>2	5.9	3.8	2.9E-03	2.8E-03	5.9	3.8	2.7E-03	4.8E-03	5.9	3.8
FP4	DA	>4	5.7	4.8	2.1E-04	4.2E-05	5.7	4.8	1.6E-04	2.0E-04	5.7	4.8
	B	>2	5.7	3.3	2.2E-04	1.1E-04	5.7	3.3	1.6E-04	2.2E-04	5.7	3.3
GT1	DA	>4	5.9	5.4	5.6E-04	3.1E-04	5.9	5.4	2.2E-04	6.6E-04	5.9	5.4
	B	>2	5.9	3.8	1.4E-03	5.4E-04	5.9	3.8	5.0E-04	1.6E-03	5.9	3.8
GT2	DA	>4	5.9	5.4	2.1E-03	1.0E-03	5.9	5.4	1.6E-03	2.2E-03	5.9	5.4
	B	>2	5.9	3.8	2.9E-03	2.8E-03	5.9	3.8	2.8E-03	2.5E-03	5.9	3.8
GT3	DA	>4	5.9	5.4	1.5E-03	1.2E-03	5.9	5.4	1.7E-03	1.5E-03	5.9	5.4
	B	>2	5.9	3.8	1.7E-03	2.0E-03	5.9	3.8	1.9E-03	1.7E-03	5.9	3.8

WSR	Depth	Criteria (mg/L)	Baseline DO (mg/L)		Grab Dredger				TSHD			
					Max DO Depletion (All Zones) (mg/L)		Calculated DO at WSR (mg/L)		Max DO Depletion (All Zones) (mg/L)		Calculated DO at WSR (mg/L)	
			Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
GT4	DA	>4	5.9	5.4	3.2E-04	3.2E-04	5.9	5.4	2.5E-04	3.3E-04	5.9	5.4
	B	>2	5.9	3.8	3.5E-04	5.0E-04	5.9	3.8	2.6E-04	3.7E-04	5.9	3.8
GT5	DA	>4	5.6	4.6	7.6E-05	2.5E-05	5.6	4.6	6.4E-05	7.3E-05	5.6	4.6
	B	>2	5.7	3.7	6.2E-05	6.0E-05	5.7	3.7	5.0E-05	5.9E-05	5.7	3.7
PMP1	DA	>4	5.9	5.4	9.9E-04	7.3E-04	5.9	5.4	7.3E-04	1.1E-03	5.9	5.4
	B	>2	5.9	3.8	1.4E-03	1.3E-03	5.9	3.8	1.3E-03	1.4E-03	5.9	3.8
SS1	DA	>4	5.9	5.4	1.2E-07	3.2E-06	5.9	5.4	8.4E-07	5.0E-07	5.9	5.4
	B	>2	5.9	3.8	1.5E-07	4.3E-06	5.9	3.8	1.3E-06	9.3E-07	5.9	3.8

Note: DA represents depth-averaged, B represents bottom layer. Bold values represent values exceeding the criteria.

The results show that there is no significant DO depletion due to the Project, and all WSRs comply with the DO criteria except for F1 and F2, whereby the baseline 10th percentile depth-averaged DO concentration at these WSRs is already below criteria limits. As there is no exceedance of criteria limits due to the Project, no adverse impacts on DO at WSRs is anticipated due to Project activities.

3.7.5 Recurrent Improvement Dredging

3.7.5.1 Suspended Sediment and Contaminant Release

Operation phase recurrent improvement dredging is targeted to be conducted approximately once every 4 to 10 years while the rate of maintenance dredging will be capped by the recommended maximum allowable dredging rates specified in **Table 3-22**. For impacts associated with SS, turbidity and release of contaminants during operation phase recurrent improvement dredging, the applicability of the 'backwards' modelling approach and the calculated maximum allowable dredging rates summarised in **Table 3-22** are dependent on the following factors:

- Prevailing hydrodynamic conditions
- Prevailing (long term) ambient water quality
- Changes to WSRs
- Concurrent projects in the vicinity
- Sediment quality

These factors, which are due to natural or induced changes to the marine environment, are neither caused by, nor within the control of the Project, and thus cannot be anticipated or pre-empted in the long term. However, the potential implications of these factors to the operation phase recurrent improvement dredging of the Project has been reviewed and is summarised in **Table 3.29** below.

Table 3.29: Factors Affecting Operation Phase Recurrent Dredging

Key Factors	Background Review	Evaluation of Potential Implications
Prevailing hydrodynamic conditions	The current prevailing flow direction in the vicinity of the Project is primarily north-south and is driven by both Pearl River discharges and by the monsoon-induced coastal currents. Both are regional / macro-scale phenomena forming the primary drivers of the hydrodynamic conditions experienced in Hong Kong. In future, climate change may alter the balance of these two driving forces, however there is currently no reliable climate model with which to base predictions for future hydrodynamic conditions.	The Project has adopted the Delft3D Updated Model for replicating hydrodynamic conditions, with local refinements to the Project area. This macro-scale model covers the whole of Hong Kong waters, the Pearl Estuary and the Dangan Channel. Notwithstanding uncertainties on future impacts due to climate change, the hydrodynamic conditions adopted for assessment purpose are considered to be robust. The risk of major changes to prevailing hydrodynamic conditions is also considered to be low.
Prevailing (long term) ambient water quality	EPD's marine water quality monitoring data spans approx. 30 years. This already represents and provides a long term record of the ambient water quality surrounding the Project area. Results for SS at the monitoring stations surrounding the project shows that there has been no appreciable pattern or trend in SS over the long term.	Given that 29 years' of EPD's marine water quality monitoring data (1986 to 2015) was used to form the baseline water quality for assessment purpose for this Project, the baseline condition assumptions for assessment purpose are considered to be robust.

Key Factors	Background Review	Evaluation of Potential Implications
Changes to WSRs	The main WSRs that may change over time are those representing more mobile marine ecology such as Green Turtles and Finless Porpoise. Distribution of these WSRs can be highly variable and unpredictable, however their hotspots tend to be of a longer term nature, provided there is no abrupt change in the marine environment. Coral distribution and abundance can also change, primarily through spreading from existing locales, but in the absence of certain extreme physical changes in the marine environment, new coral communities are unlikely to become established where previously there was none.	For WSRs such as Green Turtles and Finless Porpoise which do not have gills that may be clogged by suspended sediment, the potential water quality impacts due to the Project are limited to more indirect impacts on their prey and food sources. The maximum allowable dredging rates for the Project already caps the potential SS release due to the Project, hence the potential impact to their prey and food sources are relatively unaffected. As such, these WSRs would not be subject to water quality impacts that are any greater than that which is already predicted. Corals are sensitive primarily to sedimentation, for which the sedimentation results of the Project has shown that there remains a very large buffer (between predicted and criteria sedimentation rates) even with the maximum allowable dredging rates adopted. Thus there is considered to be adequate contingency for localised changes to coral distribution and abundance.
Concurrent projects in the vicinity	The southern and central marine waters of Hong Kong in the vicinity of the Project area has historically not been the focus of major development projects, with relatively few numbers of such projects listed in the EIAO register. However, as Hong Kong continues to develop, new projects will always be in the pipeline. With the requirements under the EIAO, all Designated Projects would be required to undergo their own environmental impact assessment, with due consideration of other projects in the vicinity.	Concurrent projects that are planned / committed have been incorporated and assessed. For those future concurrent projects that are not directly covered in the assessment, it is not possible to predict or pre-empt their contribution to water pollution loading. However, given that these future concurrent projects would need to consider this Project's cumulative impact as part of their own environmental impact assessments, the onus would be on the future concurrent projects to liaise with HK Electric (on the future dredging schedules for the Project) to avoid any adverse cumulative impacts to WSRs in the vicinity.
Sediment Quality	The navigation channel has been dredged in the past, and sediment samples have been taken before each dredging. Based on these past sediment quality studies, there have been no significant changes in sediment quality over the past 20 years, and the sediment in and around the Channel belongs to Category L.	Sediment quality affects the potential release of contaminants from the dredged sediment, however, given the long history of dredging in the Channel and in the absence of significant change to the activities which occur at the Channel, the risk of increases in contaminant concentrations is low. The results of the GDM has shown the key contaminants at the representative nearest WSRs due to sediment disturbed by Project's activities to be either low or negligible (concentrations are dominated by ambient marine water quality rather than Project's activities). Any impact would also be temporary and transient in nature. Given the above, adverse impacts due to contaminant release from sediment during future dredging activities of the Project are unlikely.

As summarised in **Table 3.29**, while there remain uncertainties in the key factors affecting future water quality of the study area for the Project, such uncertainties are not considered to have major impacts on the validity of the maximum allowable dredging rates recommended for the Project during operation phase. Nevertheless, additional controls may be implemented on the Project to enable better coverage of future uncertainties posed by these outside factors, and thereby improve the robustness of the Project's safeguards on water quality during operation phase recurrent improvement dredging. One such control is the blanket 10% reduction in the calculated maximum allowable dredging rates that has already been incorporated in the recommended maximum allowable dredging rates of the Project (refer to **Section 3.7.1.3**), which helps to buffer against uncertainties due to future hydrodynamic conditions as well as concurrent projects' activities in the vicinity of this Project.

For most of the key factors identified, the environmental monitoring and audit programme provides the best means of ascertaining the environmental conditions at the time of each recurrent improvement dredging event, in order to instigate further controls which are appropriate for addressing the changes if any. Further controls to safeguard water quality during operation phase recurrent improvement dredging are specified in the Environmental Monitoring and Audit Manual and would be implemented as part of the environmental monitoring and audit programme for the Project.

3.7.5.2 Change in Hydrology and Flow Regime

Tidal flow conditions for 'Before dredging' and 'After dredging'[2] scenarios have been modelled to identify the potential changes in hydrology and flow regime resulting from the Project. A comparison between the two scenarios provides an indication of whether the Project will induce any significant changes to the future marine environment. Graphical plots comparing the results from the two scenarios are shown in **Appendix 3.11**.

For assessing the difference in tidal circulation on the regional scale, tidal discharges have been obtained from the computed velocities across selected cross-sections representing main channels. These cross-sections are shown in Figure 031 of **Appendix 3.11**.

A summary of the tidal discharges and percentages of change at key areas are presented in **Table 3.30** for residual, peak flood, peak ebb for both the wet and dry seasons.

Table 3.30: Wet and Dry Season Tidal Discharges (m^3/s)

Section	Season	Dry		Wet	
	Flow Direction	Before dredging	After dredging	Before dredging	After dredging
West Lamma Channel	Flood	26,270	26,370	29,749	29,605
	% change		0.4%		-0.5%
	Ebb	33,442	33,521	40,900	40,665
	% change		0.2%		-0.6%
	Residual (+ve flood)	-688	-681	-2,171	-2,142
	% change		-1.0%		-1.3%
Lantau-	Flood	131,685	131,738	115,964	115,229

[2] 'After dredging' scenario assumes the seabed within the Channel has been re-profiled to -16.8 mPD (based on a target dredge depth of -16.5 mPD plus an overdredge assumption of 0.3 m) as a conservative approach.

Section	Season	Dry		Wet	
	Flow Direction	Before dredging	After dredging	Before dredging	After dredging
Wailingding	% change		0.0%		-0.6%
	Ebb	131,551	131,533	161,547	161,271
	% change		0.0%		-0.2%
	Residual (+ve flood)	16,649	16,652	-4,199	-4,259
	% change		0.0%		1.4%
Lamma South	Flood	52,909	52,910	37,475	37,306
	% change		0.0%		-0.5%
	Ebb	31,543	31,527	57,226	57,102
	% change		-0.1%		-0.2%
	Residual (-ve flood)	-17,011	-17,013	4,849	4,910
	% change		0.0%		1.3%

Based on **Table 3.30** and **Appendix 3.11**, it can be seen that the changes in peak tidal discharges and flow velocity is minimal, but are slightly more pronounced during the wet season.

The peak flood and ebb flow are found to change by less than 1% throughout both wet and dry seasons. The residual flows in the dry season changes by 1% or less, which suggested that the Project's impact on local hydrology and flow regime during the dry season is insignificant.

For wet season, residual flows differ by no more than 1.4% while the flow vector plots show only marginal shifting of flows within and adjacent to the Project area (see **Appendix 3.11** Figures 25 to 30). Given the very limited changes observed from the modelled results, the impact on the overall hydrology and flow regime in the study area due to the Project is insignificant.

3.8 Mitigation Measures

To minimise the potential water quality impacts associated with the Project, mitigation measures are recommended for both construction and operation (recurrent dredging) phase.

The following specific mitigation measures shall be applied to all dredging activities for the Project:
- Dredging shall be conducted by either closed grab dredgers and/or TSHDs. The grab dredgers shall not be operating at the same time as the TSHDs.
- The dredging rates for the Project shall not exceed the maximum allowable dredging rates specified in **Table 3-22** for each respective working zone and for the respective dredging method.
- If dredging work is carried out in more than one working zone in any day, the lowest maximum rate in the affected zones should apply in total for that day.
- Cage-type silt curtains (at least 10 m depth) should be used for the grab dredger options.

- Where grab dredger is used, the closed grab capacity should not be less than 8 m^3 (except near the submarine pipeline where smaller grabs may be used).

In addition to the specific mitigation measures, the following good site practices shall be adopted to minimise potential water quality impacts:

General
- Works should not cause foam, oil, grease or litter or other objectionable matter to be present in the water within and adjacent to the works site.
- Vessels should be sized to maintain adequate clearance of the seabed during all states of the tide in order to reduce undue turbidity generated by turbulence from vessel movement or propeller wash.
- Vessel speeds should be reduced to no more than 10 knots within the Project site boundary

Grab dredger
- Care should be taken during lowering and lifting grabs to minimise unnecessary disturbance to the seabed.
- The Contractor should ensure that grabs are tightly closed.

TSHD
- No overflow is permitted and use of lean mixture overboard (LMOB) system is prohibited.
- Any pipe leakages should be repaired quickly.
- Plant should not be operated with leaking pipes.

Barges and Hoppers
- Fitted with tight fitting seals to their bottom openings to prevent leakage of material.
- Should not be filled to a level which will cause overflow of materials during loading and transportation.
- Loading should be controlled to prevent splashing of dredged material into the surrounding waters.
- Excess materials should be cleaned from decks and exposed fitting before the vessel is moved.
- Adequate freeboard should be maintained to ensure that decks are not washed by wave action.

3.9 Evaluation of Residual Impacts

With the implementation of the recommended mitigation measures, all WSRs will comply with the relevant water quality criteria, and there would be no residual water quality impacts due to the Project.

3.10 Environmental Monitoring and Audit Requirements

During construction phase dredging and operation phase recurrent dredging, specific mitigation measures as well as good site practices have been specified. An environmental monitoring and audit (EM&A) programme is recommended to check and review the effectiveness of these mitigation measures during construction phase dredging and operation phase recurrent dredging.

In addition, a water quality monitoring programme is recommended to be implemented during construction phase dredging and operation phase recurrent dredging. Details of the EM&A requirements and the water quality monitoring programme are specified in the EM&A Manual.

3.11 Conclusion

The main potential water quality impact associated with the Project is SS release during construction phase dredging and operation phase recurrent dredging. A 'backwards' modelling approach has been adopted to determine the maximum allowable SS release from the dredging activities and the associated maximum allowable dredging rates for each working zone within the Project area. The results were then verified with a 'forwards' model taking into account concurrent projects. Mitigation measures have been recommended to control potential water quality impacts. With implementation of the recommended mitigation measures and provided the dredging rates for the Project are below the recommended maximum allowable dredging rates determined by the quantitative assessment, there would be no adverse water quality impacts to WSRs due to Project activities.