5 WATER QUALITY IMPACT

5.1 Introduction

5.1.1 This section presents an assessment of the potential hydrodynamic and water quality impacts associated with the construction and operation phases of the Project. Mitigation measures are also recommended to minimise the potential adverse impacts and to ensure the acceptability of any residual impact (that is, after mitigation).

5.2 Environmental Legislation, Standard and Criteria

Environmental Impact Assessment Ordinance (EIAO), Cap. 499, Section 16

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

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

Marine Water Quality Objectives under WPCO

5.2.2 The Water Pollution Control Ordinance (WPCO) (Cap. 358) provides the major statutory framework for the protection and control of water quality in Hong Kong. According to the Ordinance and its subsidiary legislation, Hong Kong waters are divided into ten Water Control Zones (WCZs). Corresponding statements of Water Quality Objectives (WQOs) are stipulated for different water regimes (marine waters, inland waters, bathing beaches subzones, secondary contact recreation subzones and fish culture subzones) in the WCZs based on their beneficial uses. A summary of WQOs for Junk Bay, Victoria Harbour and Eastern Buffer WCZs are listed in **Table 5.1**, **Table 5.2** and **Table 5.3** respectively.

Table 5.1 Summary of Water Quality Objectives for Junk Bay 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
Dissolved Oxygen (DO) within 2m of the seabed	Not less than 2.0mg/L for 90% of samples	Marine waters
Depth-averaged DO	Not less than 4.0mg/L for 90% of samples	Marine waters, excepting fish culture subzones
	Not less than 5.0mg/L for 90% of samples	Fish culture subzones
	Not less than 4.0mg/L	Inland waters
5-Day Biochemical Oxygen Demand (BOD_5)	Change due to waste discharges not to exceed 5mg/L	Inland waters
Chemical Oxygen Demand (COD)	Change due to waste discharges not to exceed 30mg/L	Inland waters
pH	To be in the range of 6.5 – 8.5, change due to waste discharges not to exceed 0.2	Marine waters

Parameters	Objectives	Sub-Zone
	To be in the range of 6.0 – 9.0	Inland waters
Salinity	Change due to waste discharges not to exceed 10% of ambient	Whole zone
Temperature	Change due to waste discharges not to exceed 2°C	Whole zone
Suspended Solids (SS)	Not to raise the ambient level by 30% caused by waste discharges and shall not affect aquatic communities	Marine waters
	Change due to waste discharges not to exceed 25mg/L of annual median	Inland waters
Unionised Ammonia (UIA)	Annual mean not to exceed 0.021mg/L as unionised form	Whole zone
Nutrients	Shall not cause excessive algal growth	Marine waters
Total Inorganic Nitrogen (TIN)	Annual mean depth-averaged inorganic nitrogen not to exceed 0.3mg/L	Marine waters
Dangerous substances	Should not attain such levels as to produce significant toxic effects in humans, fish or any other aquatic organisms	Whole zone
	Waste discharge should not cause a risk to any beneficial use of the aquatic environment	Whole zone
Bacteria	Not exceed 610 per 100mL, calculated as the geometric mean of all samples collected in one calendar year	Secondary contact recreation subzones and fish culture subzones
	Not exceed 1000 per 100mL, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Inland waters
Colour	Change due to waste discharges not to exceed 50 Hazen units	Inland waters

Source: Statement of Water Quality Objectives (Junk Bay Water Control Zone).

Table 5.2 Summary of Water Quality Objectives for Victoria Harbour 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
Dissolved Oxygen (DO) within 2m of the seabed	Not less than 2.0mg/L for 90% of samples	Marine waters
Depth-averaged DO	Not less than 4.0mg/L for 90% of samples	Marine waters
	Not less than 4.0mg/L	Inland waters
5-Day Biochemical Oxygen Demand (BOD_5)	Change due to waste discharges not to exceed 5mg/L	Inland waters
Chemical Oxygen Demand (COD)	Change due to waste discharges not to exceed 30mg/L	Inland waters
pH	To be in the range of 6.5 – 8.5, change due to waste discharges not to exceed 0.2	Marine waters
	To be in the range of 6.0 – 9.0	Inland waters

Parameters	Objectives	Sub-Zone
Salinity	Change due to human activity not to exceed 10% of ambient	Whole zone
Temperature	Change due to human activity not to exceed 2°C	Whole zone
Suspended Solids (SS)	Not to raise the ambient level by 30% caused by human activity	Marine waters
	Change due to waste discharges not to exceed 25mg/L of annual median	Inland waters
Unionised Ammonia (UIA)	Annual mean not to exceed 0.021mg/L as unionised form	Whole zone
Nutrients	Shall not cause excessive algal growth	Marine waters
Total Inorganic Nitrogen (TIN)	Annual mean depth-averaged inorganic nitrogen not to exceed 0.4mg/L	Marine waters
Toxic substances	Should not attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms	Whole zone
	Human activity should not cause a risk to any beneficial use of the aquatic environment.	Whole zone
Bacteria	Not exceed 1000 per 100mL, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Inland waters
Colour	Change due to waste discharges not to exceed 50 Hazen units	Inland waters

Source: *Statement of Water Quality Objectives (Victoria Harbour (Phases One, Two and Three) Water Control Zone).*

Table 5.3 Summary of Water Quality Objectives for Eastern Buffer 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
Dissolved Oxygen (DO) within 2m of the seabed	Not less than 2.0mg/L for 90% of samples	Marine waters
Depth-averaged DO	Not less than 4.0mg/L for 90% of samples	Marine waters, excepting fish culture subzones
	Not less than 5.0mg/L for 90% of samples	Fish culture subzones
	Not less than 4.0mg/L	Water gathering ground and Other inland waters
5-Day Biochemical Oxygen Demand (BOD_5)	Change due to waste discharges not to exceed 3mg/L	Water gathering ground subzones
	Change due to waste discharges not to exceed 5mg/L	Other inland waters
Chemical Oxygen Demand (COD)	Change due to waste discharges not to exceed 15mg/L	Water gathering ground subzones
	Change due to waste discharges not	Other inland waters

Parameters	**Objectives**	**Sub-Zone**
	to exceed 30mg/L	
pH	To be in the range of 6.5 – 8.5, change due to waste discharges not to exceed 0.2	Marine waters
	To be in the range of 6.5 – 8.5	Water gathering ground subzones
	To be in the range of 6.0 – 9.0	Other inland waters
Salinity	Change due to waste discharges not to exceed 10% of ambient	Whole zone
Temperature	Change due to waste discharges not to exceed 2°C	Whole zone
Suspended Solids (SS)	Not to raise the ambient level by 30% caused by waste discharges and shall not affect aquatic communities	Marine waters
	Change due to waste discharges not to exceed 20mg/L of annual median	Water gathering ground subzones
	Change due to waste discharges not to exceed 25mg/L of annual median	Other inland waters
Unionised Ammonia (UIA)	Annual mean not to exceed 0.021mg/L as unionised form	Whole zone
Nutrients	Shall not cause excessive algal growth	Marine waters
Total Inorganic Nitrogen (TIN)	Annual mean depth-averaged inorganic nitrogen not to exceed 0.4mg/L	Marine waters
Toxic substances	Should not attain such levels as to produce significant toxic effects in humans, fish or any other aquatic organisms	Whole zone
	Waste discharge should not cause a risk to any beneficial use of the aquatic environment	Whole zone
Bacteria	Not exceed 610 per 100mL, calculated as the geometric mean of all samples collected in one calendar year	Fish culture subzones
	Less than 1 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 per 100mL, 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	Change due to waste discharges not to exceed 30 Hazen units	Water gathering ground subzones
	Change due to waste discharges not to exceed 50 Hazen units	Other inland waters

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

Hong Kong Planning Standards and Guidelines (HKPSG)

5.2.3 The HKPSG, Chapter 9 (Environment), provides additional information on regulatory guidelines against water pollution for sensitive uses such as aquaculture and fisheries zones, bathing waters and other contact recreational waters.

Water Supplies Department Water Quality Criteria

5.2.4 Besides the WQO set under the WPCO, the Water Supplies Department (WSD) has also specified a set of seawater quality criteria for flushing water at the seawater intakes. The list is shown in **Table 5.4**. The target limit for suspended solids (SS) at these intakes is 10 mg/L or less.

Table 5.4 WSD Standards for Flushing Water at Seawater Intakes

Parameters (in mg/L unless otherwise stated)	WSD Target Limit
Colour (HU)	< 20
Turbidity (NTU)	< 10
Threshold Odour Number (odour unit)	< 100
Ammoniacal Nitrogen	< 1
Suspended Solids	< 10
Dissolved Oxygen	> 2
Biochemical Oxygen Demand	< 10
Synthetic Detergents	< 5
E.coli (no./100mL)	< 20,000

Cooling Water Intake Standards

5.2.5 Based on the information provided by the individual cooling water intake operators (Dairy Farm Ice Plant and Pamela Youde Nethersole Eastern Hospital), no specific requirement on seawater quality at these two cooling water abstraction points was identified.

Technical Memorandum

5.2.6 Besides setting the WQOs, the WPCO controls effluent discharges into any WCZ through a licensing system. The "*Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters*" (TM-DSS), issued under Section 21 of the WPCO, gives guidance on permissible effluent discharges based on the type of receiving waters (foul sewers, storm water drains, inland and coastal waters). The limits control the physical, chemical and microbial quality of effluent. Any sewage from the proposed construction and operational activities should comply with the standards for effluent discharged into the foul sewers, inshore waters or marine waters of the Junk Bay WCZ, as given in the TM-DSS.

Practice Note

5.2.7 A practice note for professional persons was issued by the EPD to provide guidelines for handling and disposal of construction site discharges. The ProPECC PN 1/94 "Construction Site Drainage" provides good practice guidelines for dealing with ten types of discharge from a construction site. These include surface run-off, groundwater, boring and drilling water, wastewater from concrete batching and precast concrete casting, wheel washing water, bentonite slurries, water for testing and sterilization of water retaining structures and water pipes, wastewater from building construction, acid cleaning, etching and pickling wastewater, and wastewater from site facilities. Practices given in the ProPECC PN 1/94 should be followed as far as possible during construction to minimize the water quality impact due to construction site drainage.

Assessment Criteria for Coral

5.2.8 Potential impacts on benthic organisms, including corals, may arise through excessive sediment deposition. The magnitude of impacts on marine ecological sensitive receivers was assessed based on the predicted sedimentation rate.

5.2.9 According to Pastorok and Bilyard(1) and Hawker and Connell(2), a sedimentation rate higher than $100g/m^2/day$ would introduce moderate to severe impact upon corals. This criterion has been adopted for protecting the corals in Hong Kong under other approved EIAs such as Tai Po Sewage Treatment Works Stage 5 EIA(3), Further Development of Tseung Kwan O Feasibility Study (TKOFS) EIA, Wan Chai Reclamation Phase II EIA, Eastern Waters MBA Study(4), West Po Toi MBA Study(5) and Tai Po Gas Pipeline Study(6). This sedimentation rate criterion is considered to offer sufficient protection to marine ecological sensitive receivers and is anticipated to guard against unacceptable impacts. This protection has been confirmed by previous EM&A results which have indicated no adverse impacts to corals have occurred when this assessment criterion has been adopted.

5.3 Description of the Environment

Marine Water Quality

5.3.1 The marine water quality monitoring data routinely collected by EPD were used to establish the baseline condition. The EPD monitoring stations in Junk Bay WCZ (JM3 and JM4), Eastern Buffer WCZ (EM1 and EM2) and Victoria Harbour WCZ (VM1 and VM2) are shown in **Appendix 5.5**. A summary of EPD monitoring data collected in 2009 and 2010 is presented in **Table 5.5**, **Table 5.6** and **Table 5.7** for Junk Bay, Victoria Harbour and Eastern Buffer WCZs respectively. As the Harbour Area Treatment Scheme (HATS) Stage 1 was commissioned in late 2001, the data shown in **Table 5.5**, **Table 5.6** and **Table 5.7** represent the situation after operation of the HATS Stage 1.

1. Pastorok, R.A. and Bilyard, G.R. (1985), "*Effects of sewage pollution on coral-reef communities*", Marine Ecology Progress Series 21: 175-189.
2. Hawker, D. W. and Connell, D. W. (1992), "*Standards and Criteria for Pollution Control in Coral Reef Areas*" in Connell, D. W and Hawker, D. W. (eds.), Pollution in Tropical Aquatic Systems, CRC Press, Inc.
3. Maunsell Consultants Asia Limited (2003). *Tai Po Sewage Treatment Works Stage 5, EIA Report*, Drainage Services Department, 2003
4. Hyder (1997). *Sand Dredging and Backfilling of Borrow Pits at the Potential Eastern Waters Marine Borrow Area, EIA Report*, CED, 1997
5. ERM-Hong Kong, Limited (2001). *Focused Cumulative Water Quality Impact Assessment of Sand Dredging at the West Po Toi Marine Borrow Area Final Report*
6. ERM-Hong Kong, Limited (2003). *The Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong, EIA Report*, The Hong Kong and China Gas Company Limited, 2003

Table 5.5 Summary Statistics of 2009 and 2010 Marine Water Quality in Junk Bay WCZ

Parameter		EPD Monitoring station				WPCO WQOs for Junk Bay WCZ (in marine waters)
		JM3		JM4		
		2009	2010	2009	2010	
Temperature (℃)		23.5 (16.8 - 28.4)	22.5 (16.3 - 28.7)	23.3 (17.0 - 28.4)	22.4 (16.3 - 27.6)	Change due to water discharges not to exceed 2℃
Salinity		32.1 (27.7 - 33.6)	32.4 (30.8 - 33.8)	32.5 (29.5 - 33.8)	32.6 (30.9 - 33.9)	Change due to water discharges not to exceed 10% of ambient
Dissolved Oxygen (DO) (mg/L)	Depth-averaged	6.0 (4.9 - 7.3)	6.2 (4.9 - 7.6)	5.8 (4.8 - 7.0)	6.3 (4.5 - 7.9)	Not less than 4mg/L for 90% of samples
	Bottom	5.6 (3.5 - 7.0)	6.0 (3.9 - 7.7)	5.3 (2.7 - 7.1)	5.9 (2.9 - 8.0)	Not less than 2mg/L for 90% of samples
Dissolved Oxygen (DO) (% Saturation)	Depth-averaged	86 (71 - 112)	86 (71 - 96)	83 (69 - 102)	87 (68 - 100)	N / A
	Bottom	79 (50 - 100)	82 (56 - 98)	74 (39 - 101)	81 (42 - 100)	N / A
pH		8.0 (7.7 - 8.3)	7.9 (7.6 - 8.2)	8.0 (7.7 - 8.3)	7.9 (7.6 - 8.2)	6.5 - 8.5 (±0.2 from natural range)
Secchi Disc Depth (m)		2.7 (1.8 - 3.5)	2.9 (1.8 - 4.2)	2.8 (1.8 - 3.5)	3.0 (1.8 - 5.6)	N / A
Turbidity (NTU)		4.0 (1.2 - 9.1)	2.8 (0.7 - 6.4)	4.6 (2.0 - 9.9)	3.2 (1.3 - 7.2)	N / A
Suspended Solids (SS) (mg/L)		4.3 (2.2 - 7.9)	2.5 (0.8 - 4.6)	5.0 (2.5 - 8.6)	2.8 (1.7 - 5.3)	Not more than 30% increase
5-day Biochemical Oxygen Demand (BOD_5) (mg/L)		0.8 (0.2 - 1.7)	0.7 (0.3 - 1.5)	0.8 (<0.1 - 1.8)	0.6 (0.1 - 1.5)	N / A
Ammonia Nitrogen (NH_3-N) (mg/L)		0.05 (0.017 - 0.089)	0.058 (0.027 - 0.097)	0.04 (0.021 - 0.068)	0.047 (0.020 - 0.082)	N / A
Unionised Ammonia (UIA) (mg/L)		0.002 (<0.001 - 0.003)	0.002 (<0.001 - 0.006)	0.001 (<0.001 - 0.003)	0.002 (<0.001 - 0.005)	Not more than annual average of 0.021mg/L
Nitrite Nitrogen (NO_2-N) (mg/L)		0.019 (0.003 - 0.091)	0.021 (0.006 - 0.051)	0.015 (0.002 - 0.057)	0.019 (0.005 - 0.048)	N / A
Nitrate Nitrogen (NO_3-N) (mg/L)		0.064 (0.029 - 0.174)	0.068 (0.017 - 0.111)	0.056 (0.020 - 0.147)	0.056 (0.007 - 0.099)	N / A
Total Inorganic Nitrogen (TIN) (mg/L)		0.13 (0.05 - 0.29)	0.15 (0.07 - 0.20)	0.11 (0.05 - 0.24)	0.12 (0.04 - 0.19)	Not more than annual water column average of 0.3mg/L
Total Kjeldahl Nitrogen (TKN) (mg/L)		0.18 (0.08 - 0.29)	0.18 (0.10 - 0.26)	0.15 (0.06 - 0.22)	0.16 (0.10 - 0.22)	N / A
Total Nitrogen (Total-N) (mg/L)		0.26 (0.14 - 0.41)	0.27 (0.14 - 0.35)	0.23 (0.11 - 0.33)	0.23 (0.12 - 0.32)	N / A
Orthophosphate Phosphorus (Ortho-P) (mg/L)		0.013 (0.004 - 0.022)	0.014 (0.006 - 0.019)	0.012 (0.007 - 0.018)	0.012 (0.004 - 0.023)	N / A
Total Phosphorus (Total-P) (mg/L)		0.03 (<0.02 - 0.04)	0.03 (<0.02 - 0.05)	0.03 (0.02 - 0.03)	0.03 (<0.02 - 0.05)	N / A
Silica (as SiO_2) (mg/L)		0.6 (0.09 - 1.77)	0.63 (0.15 - 0.97)	0.59 (0.15 - 1.40)	0.61 (0.13 - 0.89)	N / A
Chlorophyll-*a* (μg/L)		4.4 (0.8 - 11.5)	3.9 (0.5 - 21.4)	4.0 (0.6 - 13.0)	3.3 (0.5 - 14.3)	N / A
E.coli (count/100mL)		49 (11 - 430)	46 (5 - 140)	55 (11 - 150)	30 (4 - 240)	N / A
Faecal Coliforms (count/100mL)		140 (59 - 770)	110 (10 - 400)	140 (18 - 380)	66 (12 - 720)	N / A

Note: 1. Except as specified, data presented are depth-averaged values calculated by taking the means of three depths: Surface, Mid-depth, Bottom.

2. Data presented are annual arithmetic means of depth-averaged results except for *E.coli* and faecal coliforms that are annual geometric means
3. Data in brackets indicate the ranges.

Table 5.6 Summary Statistics of 2009 and 2010 Marine Water Quality in Victoria Harbour WCZ

Parameter		EPD Monitoring station				WPCO WQOs for Victoria Harbour WCZ (in marine waters)
		VM1		VM2		
		2009	2010	2009	2010	
Temperature (℃)		23.6 (18.6 - 28.4)	22.8 (16.5 - 27.3)	23.8 (18.7 - 28.5)	23.0 (16.5 - 27.3)	Change due to water discharges not to exceed 2℃
Salinity		32.3 (27.0 - 33.6)	32.0 (29.2 - 33.6)	31.7 (22.5 - 33.5)	31.7 (29.1 - 33.7)	Change due to water discharges not to exceed 10% of ambient
Dissolved Oxygen (DO) (mg/L)	Depth-averaged	5.5 (3.5 - 7.0)	5.6 (3.3 - 7.6)	5.6 (4.1 - 7.0)	5.4 (3.5 - 6.7)	Not less than 4mg/L for 90% of samples
	Bottom	5.4 (3.3 - 7.1)	4.8 (1.1 - 6.3)	5.5 (4.2 - 7.0)	4.8 (1.2 - 6.4)	Not less than 2mg/L for 90% of samples
Dissolved Oxygen (DO) (% Saturation)	Depth-averaged	78 (53 - 102)	77 (49 - 95)	79 (61 - 102)	74 (53 - 90)	N / A
	Bottom	76 (48 - 102)	67 (16 - 84)	78 (61 - 102)	67 (17 - 93)	N / A
pH		8.0 (7.8 - 8.3)	7.9 (7.6 - 8.2)	8.0 (7.6 - 8.3)	7.9 (7.6 - 8.2)	6.5 - 8.5 (±0.2 from natural range)
Secchi Disc Depth (m)		2.5 (1.5 - 3.4)	3.0 (1.9 - 4.1)	2.3 (1.5 - 3.2)	2.9 (2.0 - 4.6)	N / A
Turbidity (NTU)		5.6 (2.6 - 11.3)	4.0 (1.5 - 12.1)	4.9 (2.2 - 9.9)	3.2 (1.1 - 5.9)	N / A
Suspended Solids (SS) (mg/L)		7.2 (3.5 - 17.9)	4.0 (1.4 - 8.1)	5.2 (2.7 - 8.3)	3.6 (0.9 - 7.6)	Not more than 30% increase
5-day Biochemical Oxygen Demand (BOD_5) (mg/L)		0.6 (0.2 - 1.0)	0.7 (<0.1 - 1.2)	0.7 (<0.1 - 1.2)	0.9 (<0.1 - 1.6)	N / A
Ammonia Nitrogen (NH_3-N) (mg/L)		0.06 (0.029 - 0.190)	0.083 (0.042 - 0.187)	0.08 (0.041 - 0.200)	0.120 (0.063 - 0.197)	N / A
Unionised Ammonia (UIA) (mg/L)		0.002 (0.001 - 0.005)	0.003 (<0.001 - 0.010)	0.003 (0.002 - 0.006)	0.004 (<0.001 - 0.011)	Not more than annual average of 0.021mg/L
Nitrite Nitrogen (NO_2-N) (mg/L)		0.021 (0.004 - 0.102)	0.024 (0.008 - 0.055)	0.027 (0.004 - 0.154)	0.027 (0.007 - 0.053)	N / A
Nitrate Nitrogen (NO_3-N) (mg/L)		0.076 (0.022 - 0.201)	0.097 (0.027 - 0.203)	0.097 (0.020 - 0.313)	0.123 (0.029 - 0.257)	N / A
Total Inorganic Nitrogen (TIN) (mg/L)		0.16 (0.07 - 0.34)	0.20 (0.09 - 0.32)	0.21 (0.07 - 0.60)	0.27 (0.10 - 0.40)	Not more than annual water column average of 0.4mg/L
Total Kjeldahl Nitrogen (TKN) (mg/L)		0.19 (0.09 - 0.33)	0.21 (0.12 - 0.32)	0.21 (0.10 - 0.35)	0.25 (0.15 - 0.32)	N / A
Total Nitrogen (Total-N) (mg/L)		0.29 (0.19 - 0.48)	0.33 (0.16 - 0.45)	0.33 (0.18 - 0.75)	0.40 (0.19 - 0.59)	N / A
Orthophosphate Phosphorus (Ortho-P) (mg/L)		0.016 (0.008 - 0.030)	0.020 (0.010 - 0.036)	0.019 (0.008 - 0.041)	0.024 (0.011 - 0.039)	N / A
Total Phosphorus (Total-P) (mg/L)		0.03 (0.02 - 0.05)	0.03 (0.02 - 0.06)	0.03 (0.02 - 0.06)	0.04 (0.02 - 0.05)	N / A
Silica (as SiO_2) (mg/L)		0.65 (0.18 - 1.80)	0.74 (0.25 - 1.30)	0.72 (0.21 - 2.60)	0.79 (0.22 - 1.50)	N / A
Chlorophyll-*a* (μg/L)		2.8 (0.4 - 7.3)	2.8 (0.5 - 12.2)	3.1 (0.7 - 9.1)	3.3 (0.5 - 15.4)	N / A

Parameter	EPD Monitoring station				WPCO WQOs for Victoria Harbour WCZ (in marine waters)
	VM1		VM2		
	2009	2010	2009	2010	
E.coli (count/100mL)	210 (53 - 950)	710 (180 - 4400)	710 (100 - 9400)	2000 (420 - 17000)	N / A
Faecal Coliforms (count/100mL)	490 (69 - 3400)	1600 (410 - 9400)	1400 (150 - 21000)	4500 (680 - 27000)	N / A

Note:
1. Except as specified, data presented are depth-averaged values calculated by taking the means of three depths: Surface, Mid-depth, Bottom.
2. Data presented are annual arithmetic means of depth-averaged results except for *E.coli* and faecal coliforms that are annual geometric means
3. Data in brackets indicate the ranges.

Table 5.7 Summary Statistics of 2009 and 2010 Marine Water Quality in Eastern Buffer WCZ

Parameter		EPD Monitoring station				WPCO WQOs for Eastern Buffer WCZ (in marine waters)
		EM1		EM2		
		2009	2010	2009	2010	
Temperature (℃)		23.2 (17.4 - 28.5)	22.4 (16.5 - 27.5)	23.4 (17.5 - 28.5)	22.4 (16.4 - 27.7)	Change due to water discharges not to exceed 2℃
Salinity		32.7 (30.8 - 33.9)	32.6 (30.8 - 33.9)	32.2 (25.7 - 33.9)	32.7 (30.9 - 33.9)	Change due to water discharges not to exceed 10% of ambient
Dissolved Oxygen (DO) (mg/L)	Depth-averaged	5.6 (3.7 - 7.1)	6.3 (4.2 - 7.7)	5.8 (4.5 - 7.3)	6.3 (4.5 - 8.0)	Not less than 4mg/L for 90% of samples
	Bottom	5.3 (2.7 - 7.1)	5.9 (3.0 - 8.0)	5.4 (3.1 - 7.2)	6.0 (3.1 - 8.0)	Not less than 2mg/L for 90% of samples
Dissolved Oxygen (DO) (% Saturation)	Depth-averaged	79 (53 - 103)	88 (64 - 98)	82 (66 - 106)	87 (69 - 101)	N / A
	Bottom	75 (38 - 102)	81 (44 - 100)	76 (44 - 102)	83 (45 - 101)	N / A
pH		8.0 (7.6 - 8.2)	7.9 (7.6 - 8.2)	8.0 (7.6 - 8.3)	8.0 (7.7 - 8.1)	6.5 - 8.5 (±0.2 from natural range)
Secchi Disc Depth (m)		2.6 (2.0 - 3.2)	2.9 (1.8 - 4.5)	2.7 (1.8 - 4.0)	3.0 (1.9 - 4.5)	N / A
Turbidity (NTU)		4.4 (2.0 - 9.9)	3.5 (1.4 - 7.2)	4.4 (2.3 - 9.3)	3.6 (1.0 - 6.8)	N / A
Suspended Solids (SS) (mg/L)		4.5 (2.8 - 6.9)	3.2 (1.0 - 7.5)	4.0 (2.8 - 6.6)	3.2 (1.3 - 7.7)	Not more than 30% increase
5-day Biochemical Oxygen Demand (BOD_5) (mg/L)		0.6 (<0.1 - 1.6)	0.7 (0.2 - 1.7)	0.6 (<0.1 - 1.6)	0.5 (0.1 - 1.0)	N / A
Ammonia Nitrogen (NH_3-N) (mg/L)		0.039 (0.014 - 0.063)	0.051 (0.012 - 0.101)	0.029 (0.008 - 0.055)	0.041 (0.009 - 0.099)	N / A
Unionised Ammonia (UIA) (mg/L)		0.001 (<0.001 - 0.003)	0.002 (<0.001 - 0.006)	0.001 (<0.001 - 0.003)	0.002 (<0.001 - 0.005)	Not more than annual average of 0.021mg/L
Nitrite Nitrogen (NO_2-N) (mg/L)		0.016 (0.003 - 0.073)	0.018 (0.005 - 0.047)	0.015 (<0.002 - 0.087)	0.018 (0.005 - 0.044)	N / A
Nitrate Nitrogen (NO_3-N) (mg/L)		0.062 (0.019 - 0.197)	0.058 (0.007 - 0.113)	0.055 (0.009 - 0.217)	0.054 (0.006 - 0.108)	N / A
Total Inorganic Nitrogen (TIN) (mg/L)		0.12 (0.04 - 0.30)	0.13 (0.03 - 0.23)	0.10 (0.02 - 0.34)	0.11 (0.03 - 0.22)	Not more than annual water column average of 0.4mg/L
Total Kjeldahl Nitrogen (TKN) (mg/L)		0.15 (0.11 - 0.23)	0.16 (0.09 - 0.31)	0.15 (0.09 - 0.20)	0.13 (0.08 - 0.25)	N / A
Total Nitrogen (Total-N) (mg/L)		0.23 (0.14 - 0.40)	0.24 (0.12 - 0.41)	0.22 (0.11 - 0.47)	0.21 (0.12 - 0.37)	N / A

Parameter	EPD Monitoring station				WPCO WQOs for Eastern Buffer WCZ (in marine waters)
	EM1		EM2		
	2009	2010	2009	2010	
Orthophosphate Phosphorus (Ortho-P) (mg/L)	0.012 (0.008 - 0.018)	0.013 (0.003 - 0.029)	0.01 (0.005 - 0.019)	0.013 (0.004 - 0.027)	N / A
Total Phosphorus (Total-P) (mg/L)	0.03 (0.02 - 0.03)	0.03 (<0.02 - 0.04)	0.02 (<0.02 - 0.03)	0.03 (<0.02 - 0.05)	N / A
Silica (as SiO_2) (mg/L)	0.62 (0.23 - 1.76)	0.61 (0.15 - 0.85)	0.58 (0.20 - 1.87)	0.61 (0.25 - 0.94)	N / A
Chlorophyll-*a* (μg/L)	3.5 (0.8 - 8.6)	4.8 (0.5 - 24.3)	3.4 (0.6 - 10.7)	1.9 (0.5 - 9.5)	N / A
E.coli (count/100mL)	65 (6 - 470)	25 (1 - 330)	19 (3 - 240)	15 (1 - 180)	N / A
Faecal Coliforms (count/100mL)	140 (7 - 1400)	61 (7 - 1400)	46 (5 - 970)	33 (2 - 1100)	N / A

Note:
1. Except as specified, data presented are depth-averaged values calculated by taking the means of three depths: Surface, Mid-depth, Bottom.
2. Data presented are annual arithmetic means of depth-averaged results except for *E.coli* and faecal coliforms that are annual geometric means
3. Data in brackets indicate the ranges.

5.3.2 With reference to the EPD's publication "*Marine Water Quality in Hong Kong 2010*", with the implementation of the HATS Stage 1, about 75% of the sewage around Victoria Harbour are diverted to the Stonecutters Island Sewage Treatment Works for chemically enhanced primary treatment (CEPT), resulting in a 70% reduction of the pollution load (in terms of organic pollutants) into the harbor. In 2009 and 2010, the Eastern Buffer and Junk Bay WCZs achieved full compliance (100%) with the WQOs (based on Dissolved Oxygen (DO), Total Inorganic Nitrogen (TIN) and Unionised Ammonia (UIA).

5.3.3 Full compliance with the WQOs for bottom DO, TIN and UIA was also achieved in eastern Victoria Harbour (VM1 and VM2) in 2009 and 2010. However, non-compliance with the WQO for depth-averaged DO was recorded in the eastern Victoria Habour in both 2009 and 2010.

5.3.4 In general, the water quality improvements (i.e. increase in DO, decreases in nutrients and *E.coli*) in Junk Bay, Eastern Buffer and eastern Victoria Harbour waters have been maintained since the commissioning of HATS Stage 1 in 2002.

5.4 Water Sensitive Receivers

5.4.1 **Appendix 5.5** shows the existing and planned marine sensitive receivers that may be affected by the Project. The main marine water sensitive receivers (WSRs) and beneficial uses include:

- Cooling Water Intakes
- WSD Salt Water Intakes
- Gazetted Beaches
- Fish Culture Zones
- Coral Communities
- Site of Special Scientific Interest (SSSI)

- Benthic Communities, in particular Amphioxus (Spotted Occurrence of Amphioxus)

5.4.2 The key WSRs that are potentially affected during the construction and operational phases of the Project are listed in **Table 5.8**. Locations of benthic and coral sites as shown in **Appendix 5.5** are based on the results of latest ecological / dive surveys conducted under this Project.

Table 5.8 Water Sensitive Receivers

WSR ID	Description
SWI1	WSD's Salt Water Intakes at Tseung Kwan O
SWI2	WSD's Salt Water Intakes at Yau Tong
SWI3	WSD's Salt Water Intakes at Tai Wan, Potential Salt Water Intakes for Kai Tak Development
SWI4	WSD's Salt Water Intakes at Cha Kwo Lang
SWI5	WSD's Salt Water Intakes at North Point
SWI6	WSD's Salt Water Intakes at Quarry Bay
SWI7	WSD's Salt Water Intakes at Sai Wan Ho
SWI8	WSD's Salt Water Intakes at Heng Fa Chuen
SWI9	WSD's Salt Water Intakes at Siu Sai Wan
SWI10	Salt Water Intakes at Cape D'Aguilar for Swire Institute of Marine Science, The University of Hong Kong
CWI1	Cooling Water Intakes for Dairy Farm Ice Plant
CWI2	Cooling Water Intakes for Pamela Youde Nethersole Eastern Hospital
CWI3	Future Kai Tak Cooling Water Intakes
CC1	Coral Sites at Chiu Keng Wan
CC2	Coral Sites at Junk Bay
CC3	Coral Sites at Junk Island
CC4	Coral Sites at Fat Tong Chau West
CC5	Coral Sites at Tso Tui Wan North
CC6	Coral Sites at Joss House Bay
CC7	Coral Sites at Tung Lung Chau West
CC8	Coral Sites at Tung Lung Chau East
CC9	Coral Sites at Shek Mei Tau
CC10	Coral Sites at So Shi Tau
CC11	Coral Sites at Tai Wang Tau
CC12	Coral Sites at Po Keng Teng
CC13	Coral Sites at Junk Bay near Chiu Keng Wan
SS1	SSSI at Shek O Headland
SS2	SSSI at Cape D'Aguilar
FCZ1	Fish Culture Zone at Po Toi O
FCZ2	Fish Culture Zone at Tung Lung Chau
AM1	Spotted Occurrence of Amphioxus (historical record of summer survey)
AM2	Spotted Occurrence of Amphioxus (Yr 2006 record of summer survey)
AM3	Spotted Occurrence of Amphioxus (Yr 2006 record of summer survey)
GB1	Shek O Rocky Bay
GB2	Shek O Beach
GB3	Big Wave Bay Beach
GB4	Clear Water Bay First Beach
GB5	Clear Water Bay Second Beach

5.5 Identification of Environmental Impacts

5.5.1 Key water quality concerns associated with the Project are identified as follows:

Marine-Based Construction Works

Reclamation for Road P2

5.5.2 Reclamation is required to provide sufficient land for construction of Road P2 and its associated facilities connecting to both CBL and TKO Town Centre. According to **Section 2.7**, a non-dredged method by constructing steel cellular caisson structure with stone column is proposed for seawall foundation of the proposed reclamation area. Rock fill will be used for the foundation core of seawall with rock armour protection at the top. General fill will be used to form the reclamation and the marine deposits at the reclamation area behind the proposed seawalls will be remained as non-dredged. The marine deposits shall be treated by vertical band drains with surcharging. As the vertical band drains cannot be installed through the general fill, the vertical band drains must be installed using marine plant before placing general fill.

5.5.3 The proposed reclamation method will adopt an approach where seawalls will first be formed to enclose the reclamation. Containment of fill within the reclamation area by seawalls is proposed, with the seawalls constructed first (above high water mark). Filling will be carried out behind the seawalls, which would be fully completed except for an opening of about 50m wide for marine access (as shown in **Appendix 5.10**).

5.5.4 As non-dredged method would be adopted for seawall foundation, potential water quality impact could only arise due to loss of filling material from the reclamation area. The quantities of fine sediment lost to suspension during reclamation will primarily depend on production rate. Impact from suspended solids (SS) may be caused by sediment plumes being transported to sensitive areas.

5.5.5 Construction of seawalls will involve rock fill only with negligible fine content, which would not create significant SS impact.

TKO Interchange

5.5.6 The piers of TKO Interchange are generally supported on piled foundations. As mentioned in **Section 2.7.70**, the pile caps will be constructed below sea level and above sea bed level for the mainline viaduct, while the pile caps will be constructed above sea level for the slip roads. As construction of pile caps for TKO Interchange would not disturb the sea bed, no adverse construction phase water quality impacts would therefore be expected.

Land-Based Construction Works

Construction Runoff and Drainage

5.5.7 Surface runoff generated from the construction site may contain increased loads of SS and contaminants. Potential water quality impacts from site run-off may come from:

- contaminated ground water from any dewatering activities as a result of excavation and disturbance of contaminated sediments;
- pore water discharging through band drains installed in the reclamation during surcharging;
- release of any bentonite slurries and other grouting materials with construction run-off, storm water or ground water dewatering process;

- wash water from dust suppression sprays and wheel washing facilities; and
- fuel, oil and lubricants from maintenance of construction vehicles and equipment.

Stormwater Discharges

5.5.8 Stormwater and drainage discharges from the construction sites may contain considerable loads of SS and contaminants during construction activities. Potential water quality impact includes run-off and erosion of exposed bare soil and earth, drainage channels, earth working area and stockpiles. Local and coastal water pollution impact may be substantial if the construction site run-off is allowed to discharge into the storm drains or natural drainage without mitigation.

Groundwater Level

5.5.9 According to Section 2.7, the construction method of the tunnel section for this TKO-LT Tunnel project would adopt the Drill and Blast (D&B) method. Groundwater monitoring has been conducted under this project and the measured groundwater levels have been identified (as shown in **Appendix 5.12**). The proposed tunnel alignment would be located under the groundwater level. Groundwater drawdown may occur if construction of the tunnel section is not properly controlled. With the implementation of appropriate measures as described in **Sections 5.8**, it is considered that disturbance of groundwater levels would be avoided and deterioration in groundwater quality would be minimal. No adverse construction phase groundwater quality impacts would therefore be expected.

General Construction Activities

5.5.10 The general construction works that will be undertaken for the roads and infrastructure including the proposed drainage and sewerage construction works will be primarily land-based and may have the potential to cause water pollution. These could result from the accumulation of solid waste such as construction materials, and liquid waste such as sewage effluent from the construction work force, spillage of oil, diesel or solvents by vessels and vehicles involved during dredging and transport. If uncontrolled, any of these could lead to deterioration in water quality. Increased nutrient levels result from contaminated discharges and sewage effluent could also lead to a number of secondary water quality impacts including decreases in DO concentrations and localized increase in ammonia nitrogen (NH_3-N) concentrations which could stimulate algal growth and reduction in oxygen levels.

5.5.11 Sewage will arise from sanitary facilities provided for the on-site construction work force. It is characterized by high level of BOD, NH_3-N and *E.coli* counts. There will be no public sewers available for domestic sewage discharge on-site.

<u>Operational Phase</u>

5.5.12 Based on the review of the proposed land uses for the operation, potential water quality impacts are identified in the following areas:

- changes of tidal current patterns due to the proposed change of coastline;
- surface runoff from new roads proposed under this Project;
- floating refuse;
- Sewage from the proposed Administration Building at Lam Tin; and
- Sewage from the proposed ventilation/portal building at Tseung Kwan O.

Hydrodynamics Impact

5.5.13 The proposed reclamation area for Road P2 may affect the water levels, current velocity, and tidal flushing in the Junk Bay and, potentially, in the Victoria Harbour. In addition, the changes in the hydrodynamics in Junk Bay and Victoria Harbour may affect the pollutant distribution patterns from sewage outfalls and stormwater culverts into the surrounding waters.

Road Runoff

5.5.14 Surface runoff from new roads proposed under this Project may be contaminated by oils leaked from passing vehicles. It is considered that impacts upon water quality will be minimal provided that the road works are designed with adequate drainage systems and appropriate oil interceptors, as required.

Floating Refuse

5.5.15 The formation of reclaimed area for Road P2 may create areas susceptible to floating refuse accumulation, affecting the aesthetic quality of the marine water. However, it is considered that the impact of floating refuse can be effectively controlled by regular refuse scavenging.

Sewage Effluent from the Proposed Buildings

5.5.16 All the sewage flow generated from the Administration Building and the Training Ground within the Lam Tin Interchange would be collected and conveyed to the sewerage system. The sewage flows generated from the ventilation buildings and kiosks at Lam Tin Interchange and TKO section would be collected by a proposed holding tank and transferred by tanker to Kwun Tong Preliminary Treatment Plant (KTPTW). No adverse water quality impacts would therefore be anticipated.

5.6 Assessment Methodology

<u>**Modelling Scenarios**</u>

Marine-Based Construction Phase

5.6.1 To assess the potential water quality impacts due to the marine-based activities, the sources and natures of water pollution to be generated have been identified and their impacts have been quantified where practicable. Based on the tentative construction programme as shown in **Appendix 2.1** and the information from other concurrent projects / project teams, the following assessment scenarios were modelled:

- **Scenario 1a – Filling behind the seawall for TKO-LT Tunnel Reclamation and CBL Dredging and Filling Works (in considering the highway connectivity, both TKO-LT Tunnel and CBL marine works are considered together in this worst scenario)**
- **Scenario 1c – Filling behind the seawall for TKO-LT Tunnel Reclamation and CBL Dredging and Filling Works with other concurrent projects including construction of Road T2 and CLP Offshore Windfarm (N.B. Although there might be no concurrent works with those projects, Scenario 1c is done to allow hypothesis and potential programme change.)**

5.6.2 Details of the maximum dredging and filling rates and the associated sediment loss rates are discussed in **Section 5.6.24 to 5.6.26**.

Operational Phase

5.6.3 Hydrodynamic modelling is required to evaluate the change in the hydrodynamic regime due to the TKO-LT Tunnel reclamation and construction of the CBL. The proposed layout of the TKO-LT Tunnel is shown in **Figure 2.2**. The extent of the reclamation has already been minimised to satisfy the Government's requirement and the community's aspiration.

5.6.4 Modelling was carried out for 2 scenarios as follows:

- **Scenario 2a – Ultimate Scenario with TKO-LT Tunnel and CBL**, represents the ultimate condition with the Project (including the proposed developments of TKO-LT Tunnel and CBL).
- **Scenario 2b – Ultimate Scenario without TKO-LT Tunnel and CBL**, represents the ultimate condition without the Project.

5.6.5 The presence of the TKO-LT Tunnel reclamation and the bridge piers of CBL may reduce the flushing of Junk Bay and thus impact upon the water quality. The ultimate scenario, with completion of both TKO-LT Tunnel reclamation and CBL, represents the worst case in terms of impact on tidal flushing. Additional scenario for addressing the hydrodynamic impact during different interim construction stages is considered not necessary.

<u>Modelling Tools</u>

5.6.6 The hydrodynamic and water quality modelling platforms were developed by Delft Hydraulics, namely the Delft3D-FLOW and Delft3D-WAQ respectively.

5.6.7 Delft3D-FLOW is a 3-dimensional hydrodynamic simulation programme with applications for coastal, river and estuarine areas. This model calculates non-steady flow and transport phenomena that result from tidal and meteorological forcing on a curvilinear, boundary fitted grid.

5.6.8 Delft3D-WAQ is a water quality model tool for numerical simulation of various physical, biological and chemical processes including the sedimentation and sediment erosion processes in 3 dimensions. It solves the advection-diffusion-reaction equation for a predefined computational grid and for a wide range of model substances.

5.6.9 The approved 3-dimensional detailed model, namely "Junk Bay Model", has been developed, calibrated and validated under the approved TKOFS EIA report using the Delft3D package and is used to simulate the operation and construction phases of the Project. The grid layout and bathymetry schematization of the Junk Bay Model are shown in **Appendix 5.6** and **Appendix 5.7**.

<u>Simulation Period</u>

5.6.10 For each assessment scenario, the actual simulation period of the hydrodynamic model covers two 15-day full spring-neap cycles (excluding the spin-up period) for dry and wet seasons respectively. For the hydrodynamic simulation, a 7-day spin-up was adopted before the actual model simulations in order to maintain the simulation convergence. For the water quality simulation, two full spring-neap cycles were adopted as spin-up period. After performing the spin-up, the hydrodynamics and water quality conditions at the end of the simulation were adopted as the initial conditions for the actual simulation. Similar to the hydrodynamic model, the actual simulation period (excluding the spin-up period) of the water quality model covers two 15-day full spring-neap cycles for dry and wet seasons respectively. The computational timestep was set to 1 minute.

Meteorological Conditions

5.6.11 The wind conditions adopted in the hydrodynamic simulation are 5m/s NE for the dry season and 5m/s SW for the wet season. The horizontal eddy viscosity and diffusivity to be used are $1m^2/s$. The values for vertical eddy viscosity and diffusivity were computed using the k-ε model. For the vertical eddy viscosity, a minimum value is set at $5 \times 10^{-5}\ m^2/s$. .

5.6.12 The ambient environmental conditions including solar surface radiation and water temperature are closely linked to the process of water quality changes. Meteorological forcing including solar surface radiation and water temperature are required to define in the model for water quality simulation.

5.6.13 Solar radiation is recorded only at King's Park station by Hong Kong Observatory. The monthly averaged solar radiation was calculated based on the hourly data recorded at this station. Average values of solar radiation for the simulation period were adopted in the model.

5.6.14 The ambient water temperature were determined based on the EPD routine monitoring data collected within the Hong Kong Waters. Average water temperature values for both dry and wet seasons were adopted in the water quality model.

Initial Conditions

5.6.15 Hydrodynamic computations were first carried out using the Update Model. A restart file from previous hydrodynamic computations was then used to provide initial conditions to the Update Model. The initial conditions for the Junk Bay Model were selected to be the same as those for the Update Model. This was done by using a utility program to map the information contained in the restart file of the Update Model to the restart file of the Junk Bay model.

Coastline Configurations

5.6.16 The coastline configurations for construction and operational phases have incorporated with the coastal developments due to the major existing / planned projects that might potentially affect the hydrodynamic regime and water quality in Junk Bay. **Table 5.9** summarized the coastal developments that have been incorporated in the coastal configurations under construction and operational phases.

Table 5.9 Coastal Developments Incorporated in the Construction and Operational Phase Coastline Configurations

Coastal Development	Information Source	Effect on Hydrodynamic Regime (Included in Construction Scenarios)	Effect on Hydrodynamic Regime (Included in Operational Scenarios)
Cross Bay Link	Agreement No. 43/2008 (HY) Cross Bay Link – Tseung Kwan O - Investigation	No	Yes
Dredging Works for Proposed Cruise Terminal at Kai Tak	EIA Report for "*Dredging Works for Proposed Cruise Terminal at Kai Tak*" (Register No.: AEIAR-115/2007)	No	Yes
Opening at Kai Tak Runway	EIA Report for "*Kai Tak Development*" (Register No.: AEIAR-157/2008)	No	Yes

Concurrent Marine Works for Cumulative Assessment

5.6.17 The tentative construction programme of marine works (reclamation filling behind seawall) for the TKO-LT Tunnel will be scheduled in 2018, as shown in **Appendix 2.1**. Other possible concurrent dredging and filling activities within the assessment area have been considered in the sediment plume modelling as indicated in **Table 5.10**. Details of the sediment loss rates from the potential concurrent marine works that have been included in this sediment modelling exercise are summarized in **Appendix 5.1**.

Table 5.10 Concurrent Marine Works

Project	Construction Programme	Included in Construction Scenarios	
		1a	1c
Cross Bay Link[(1)]			
Dredging	May 2017 to Aug 2018	Yes	Yes
Filling		Yes	Yes
Shatin Central Link[(2)]			
Dredging at Kai Tak Runway	Jul 2012 to Dec 2012	No	No
Dredging at Open Harbour	2016	No	No
Dredging at Causeway Bay Typhoon Shelter	2016	No	No
Cruise Terminal[(3)]			
Dredging Stage 1 - Seawall 1	2011 to 2012	No	No
Dredging Stage 1 - Seawall 2	2011 to 2012	No	No
Dredging Stage 1 - Manoeuvring Area 1	2011 to 2012	No	No
Dredging Stage 1 - Manoeuvring Area 2	2011 to 2012	No	No
Dredging Stage 1 - Fireboat Berth	2011 to 2012	No	No
Dredging Stage 2 – Phase II Berth 1	2013 to 2014	No	No
Dredging Stage 2 – Phase II Berth 2	2013 to 2014	No	No
Trunk Road T2[(4)]			
Dredging	Mar 2012 to Jan 2014	No	No
Dredging	Feb 2015 to May 2017	No	Yes
Filling – Public Fill	May 2012 to Dec 2012	No	No
Filling – Public Fill	Apr 2013 to Dec 2016	No	Yes
CLP Windfarm[(5)]			
Grab Dredging – Cable	Jan 2017 to Apr 2017	No	Yes
Jetting – Cable	Jan 2017 to Apr 2017	No	Yes
Suction Cassion – Windfarm foundation	Apr 2017 to Sep 2017	No	No
Gas Pipeline[(3)]			
Grab Dredging – TKW to NP	Apr 2012 to Dec 2012	No	No
TKO-LT Tunnel			
Reclamation filling behind seawall	May 2018 to Aug 2018	Yes	Yes

Remarks:
1. *Information from CBL project team.*
2. *Information from MTR and SCL project teams. According to the findings of the EIA study, there will be no impact to Junk Bay from the SCL dredging works.*
3. *EIA reports of Submerged Gas Pipeline and Cruise Terminal.*
4. *Programme of T2 construction is assumed to occur concurrently with this Project for worst-case assessment.*
5. *Information from CLP project team; the Suction Cassion of windfarm are considered far away from site and not included in the model.*

Open Boundary Conditions

5.6.18 The open boundary conditions of Junk Bay Model were regenerated through the nesting process from the Update Model. The coastline and additional pier friction in Update Model were revised based on the projects listed in **Table 5.9**.

5.6.19 During the nesting process, both the water level and velocity boundaries were defined in the Junk Bay Model for both dry and wet seasons. As the Update Model covers the discharges from the major Pearl River estuaries, which include Humen, Jiaomen, Hongqili, Hengmen, Muodaomen and Aimen, the influences on hydrodynamics due to the discharges from Pearl River estuaries were therefore incorporated into the Junk Bay Model.

Pier Friction

5.6.20 The cumulative impact from the TKO-LT Tunnel reclamation together with the CBL was simulated in the ultimate scenario.

5.6.21 As the dimensions of the bridge piers are much smaller than the grid size, the exact pier configurations cannot be adopted in the model simulation. Instead, only the overall influence of the bridge piers on the flow was taken account. This overall influence was modelled by a special feature of the Delft3D-FLOW model, namely porous plate. Porous plates represent transparent structures in the model and are placed along the model gridline where momentum can still be exchanged across the plates. The porosity of the plates is controlled by a quadratic friction term in the momentum to simulate the energy losses due to the presence of the bridge piers. The forces on the flow due to a vertical pile or series of piles are used to determine the magnitude of the energy loss terms.

5.6.22 The mathematical expressions for representation of pier friction were based on the Cross Border Link Study(7) and the Delft3D-FLOW module developed by Delft Hydraulics and are given in **Appendix 5.2**.

Sediment Plume Modelling

5.6.23 Delf3D-WAQ module was used to model dispersion of sediment during dredging activities. The settling velocity adopted in the Junk Bay Model is 0.5mm/s. The hydrodynamic conditions generated from the Delf3D-FLOW module provided basic hydrodynamic information for modelling of sediment plume dispersion. The processes of settling of sediment particles and exchange of sediment particles between the water column and the seabed govern the sediment transport. Sediment deposition and erosion occur when the bed

7. Planning Department, "*Agreement No. CE48/97 Feasibility Study for Additional Cross-border Links Stage 2: Investigations on Environment, Ecology, Land Use Planning, Land Acquisition, Economic/Financial Viability and Preliminary Project Feasibility/Preliminary Design Final Water Quality Impact Assessment Working Paper WP2 Volume 1*", 1999

shear stress is below or above the critical shear stress. The deposition rate and erosion rate were calculated using the following equations:

(1) Bed Shear Stress (τ) < Critical Shear Stress for Deposition (τ_d = 0.2Pascal)
Deposition rate = $V_s C_b (1 – \tau / \tau_d)$
where: V_s = settling velocity (0.5mm/s = 43.2m/d); and
C_b = bottom layer SS concentration.

(2) Bed Shear Stress (τ) > Critical Shear Stress for Erosion (τ_e = 0.3Pascal)
Erosion rate = $R_e (\tau / \tau_e -1)$
where: R_e = erosion coefficient (=0.0002kg/m^2/s).

(3) Water depth of 0.2m has been selected as the minimum depth in which deposition can take place.

Sediment Loss Rate

5.6.24 Assumptions made in the sediment plume modelling simulations for filling activities for TKO-LT Tunnel Reclamation are as follows:

- The dry density of filling material for the TKO-LT Tunnel reclamation is assumed to be 1,900kg/m^3. The fines content of filling material is taken as 25% and the loss of fine portion is assumed to be 5%.
- The filling rate would be about 3,000m^3/day. There would be a total of 3 cycles of filling operation each day with an interval of 3 hours (180 minutes).
- Spilling for filling is assumed to take place uniformly over the water column.
- Silt curtain is adopted to mitigate the potential water quality impact. According to the "*Contaminated Spoil Management Study*" [(8)], the implementation of silt curtain would reduce the dispersion of SS by a factor of 4 (or about 75%).
- According to the EIA report "*Hong Kong - Zhuhai - Macao Bridge Hong Kong Boundary Crossing Facilities*" (HKBCF EIA), filling operation behind seawall would reduce the potential sediment loss by about 80%. With additional use of single silt curtain at the marine access, it is assumed that the potential sediment loss rate would reduce by 95%.

5.6.25 The sediment loss rate for filling is calculated as below:

Working hour = 180 minutes per (filling) event
Sediment release rate = 1,900 × 25% × 5% = 23.75kg/m^3
Maximum filling rate = (3,000 / 3) / (180 × 60) = 0.093m^3/event/s
Sediment loss rate for filling (without mitigated) = 0.093 × 23.75 = 2.20kg/event/s
Sediment loss rate for filling (with mitigated) = 2.20 × (1 – 95%) = 0.11kg/event/s

5.6.26 The sediment loss rates from other major existing / planned projects that might be undertaken concurrently with the Project are summarized in **Appendix 5.1**. The sediment release points for TKO-LT and CBL projects assumed in the sediment plume modeling for Junk Bay Area are presented in **Appendix 5.9** as the worst case scenario[9] for the following reasons:

8. Mott MacDonald (1991), "*Contaminated Spoil Management Study, Final Report, Volume 1*", for EPD, October 1991.
9. Sediment release points for T2 followed those presented in the approved EIA for Dredging Works for Proposed Cruise Terminal at Kai Tak and is therefore not presented in Appendix 5.9.

- **CBL Emission:** Emission Point 1 and 2 have been selected at the largest pier location (Main Bridge Pier Pylon A and B) where the longer dredging period is anticipated. Emission Point 3 has been based on construction separation constraint and closest to SWI1.
- **TKO-LTT Emission:** Emission Point 23 has been selected at the location of seawall opening as worst scenario.
- **Wind Farm Emission:** Emission Point 24 and 25 have been selected according to the representative locations in the EIA-Wind farm.

Ambient and Allowable Elevations of SS

5.6.27 The sediment plumes passing over a sensitive receiver will cause the ambient suspended solids concentrations to be elevated. The level of elevation will determine whether the impact is adverse. The WQO for SS established under the WPCO has been adopted as the assessment criterion, i.e. the SS elevations should be less than 30% of ambient conditions. It is proposed to represent the ambient SS value by the SS concentrations measured under the EPD routine marine water quality monitoring programme at Station JM3, JM4, VM1, VM2, MM19, EM1, EM2 and EM3 (see **Appendix 5.5**). The relevant EPD data in suspended sediment concentration are summarized in **Table 5.11**. The SS values presented in **Table 5.11** were calculated based on the EPD monitoring data collected in the period from year 2001 to year 2010.

Table 5.11 Summary of Suspended Solids Concentrations from EPD Routine Monitoring Stations (from Year 2001 to 2010)

Station	Suspended Solids Concentrations (mg/L)							
	Surface		Middle		Bottom		Depth Averaged	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
JM3	3.1 (0.8-13.0)	2.3 (0.6-7.2)	3.8 (0.6-31.0)	2.8 (0.7-9.9)	4.9 (0.9-14.0)	3.9 (1.0-9.0)	4.0 (1.2-15.2)	3.0 (0.8-8.4)
JM4	2.9 (0.5-7.5)	2.9 (0.7-13.0)	5.2 (1.0-110.0)	3.5 (1.2-17.0)	5.6 (1.1-16.0)	6.5 (1.4-31.0)	4.5 (1.1-38.7)	4.3 (1.6-19.0)
VM1	3.4 (1.0-9.5)	3.2 (1.2-12.0)	4.2 (<0.5-18.0)	5.8 (1.1-19.0)	6.0 (0.8-47.0)	10.1 (2.4-36.0)	4.6 (0.9-17.9)	6.4 (1.9-18.0)
VM2	3.4 (1.0-6.9)	3.8 (0.6-8.3)	4.1 (1.1-9.2)	4.3 (0.8-26.0)	5.0 (1.2-15.0)	5.3 (0.9-20.0)	4.2 (1.3-9.9)	4.5 (0.9-12.8)
MM19	1.9 (<0.5-6.1)	1.6 (<0.5-3.8)	2.5 (<0.5-12.0)	1.9 (<0.5-4.2)	5.5 (0.9-23.0)	5.5 (0.8-13.0)	3.3 (0.8-13.7)	3.0 (0.7-6.4)
EM1	2.8 (0.8-7.7)	2.9 (<0.5-11.0)	3.2 (1.1-9.2)	3.7 (0.8-12.0)	5.3 (1.3-23.0)	5.8 (1.7-21.0)	3.8 (1.2-12.8)	4.1 (1.3-13.2)
EM2	2.8 (0.6-9.0)	2.7 (0.6-11.0)	3.2 (0.8-13.0)	3.1 (0.8-17.0)	6.3 (0.6-64.0)	5.3 (1.2-19.0)	4.1 (0.7-22.9)	3.7 (1.3-15.7)
EM3	3.0 (0.7-10.0)	2.3 (<0.5-11.0)	3.7 (0.8-15.0)	2.7 (0.8-13.0)	5.6 (1.3-21.0)	5.9 (1.2-52.0)	4.1 (1.2-14.2)	3.6 (1.1-25.3)

Note: The data are presented as the arithmetic mean and range (Min. – Max.) of the suspended solids concentrations at each station at the three monitoring levels and as the depth-averaged concentrations.

5.6.28 The WQO for SS is defined as being an allowable elevation of 30% above the ambient. To determine the allowable SS elevation criteria, the study would follow the same approach as adopted in the approved EIA report for Hong Kong Offshore Wind Farm in Southeastern waters. It is proposed that the WQO for each EPD monitoring station should be 30% increment of the 90th percentile SS concentration as summarized in **Table 5.12**.

Table 5.12 Summary of Allowable SS Elevations at EPD Routine Monitoring Stations due to Construction Impacts

Station	Suspended Solids Concentrations (mg/L)							
	Surface		Middle		Bottom		Depth Averaged	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
JM3	1.4	1.2	1.8	1.2	2.9	2.0	1.9	1.6
JM4	1.4	1.4	1.9	1.5	3.3	3.6	2.2	2.6
VM1	1.7	1.6	2.1	2.7	2.7	5.4	2.2	3.6
VM2	1.7	1.9	2.1	2.0	2.6	2.7	2.1	2.2
MM19	0.8	0.8	1.4	0.9	3.6	2.8	2.0	1.9
EM1	1.3	1.4	1.4	1.8	2.7	2.8	2.1	2.3
EM2	1.4	1.3	1.4	1.5	2.8	2.3	1.9	2.0
EM3	2.0	1.2	2.3	1.3	3.3	2.4	2.3	1.9

5.6.29 It is also proposed to assign each sensitive receiver to the nearest EPD water quality monitoring station and to set the WQO at each station as 30% of the 90th percentile at that station. **Table 5.13** summarized the assigned allowable SS elevations at each specific point / sensitive receiver as indicated in **Appendix 5.5**.

Table 5.13 Summary of Allowable SS Elevations at Water Sensitive Receivers due to Construction Impacts

Observation Points	Associated EPD Station	WQO /WQC (mg/L)							
		Dry				Wet			
		S	M	B	DA	S	M	B	DA
SWI1	**JM3**	1.4	1.8	2.9	1.9	1.2	1.2	2.0	1.6
SWI2	**VM1**	1.7	2.1	2.7	2.2	1.6	2.7	5.4	3.6
SWI3	**VM2**	1.7	2.1	2.6	2.1	1.9	2.0	2.7	2.2
SWI4	**VM1**	1.7	2.1	2.7	2.2	1.6	2.7	5.4	3.6
SWI5	**VM2**	1.7	2.1	2.6	2.1	1.9	2.0	2.7	2.2
SWI6	**VM2**	1.7	2.1	2.6	2.1	1.9	2.0	2.7	2.2
SWI7	**VM1**	1.7	2.1	2.7	2.2	1.6	2.7	5.4	3.6
SWI8	**EM1**	1.3	1.4	2.7	2.1	1.4	1.8	2.8	2.3
SWI9	**EM1**	1.3	1.4	2.7	2.1	1.4	1.8	2.8	2.3
SWI10	**EM3**	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
CWI1	**VM1**	1.7	2.1	2.7	2.2	1.6	2.7	5.4	3.6
CWI2	**EM1**	1.3	1.4	2.7	2.1	1.4	1.8	2.8	2.3
CC1	**JM4**	1.4	1.9	3.3	2.2	1.4	1.5	3.6	2.6
CC2	**JM3**	1.4	1.8	2.9	1.9	1.2	1.2	2.0	1.6
CC3	**JM3**	1.4	1.8	2.9	1.9	1.2	1.2	2.0	1.6
CC4	**JM4**	1.4	1.9	3.3	2.2	1.4	1.5	3.6	2.6
CC5	**EM2**	1.4	1.4	2.8	1.9	1.3	1.5	2.3	2.0
CC6	**EM2**	1.4	1.4	2.8	1.9	1.3	1.5	2.3	2.0
CC7	**EM2**	1.4	1.4	2.8	1.9	1.3	1.5	2.3	2.0
CC8	**EM3**	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
CC9	**MM19**	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
CC10	**MM19**	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
CC11	**MM19**	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
CC12	**MM19**	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
CC13	**JM3**	1.4	1.8	2.9	1.9	1.2	1.2	2.0	1.6

Observation Points	Associated EPD Station	WQO /WQC (mg/L)							
		Dry				Wet			
		S	M	B	DA	S	M	B	DA
SS1	**EM3**	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
SS2	**EM3**	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
FCZ1	**MM19**	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
FCZ2	**EM2**	1.4	1.4	2.8	1.9	1.3	1.5	2.3	2.0
AM1	**EM3**	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
AM2	**EM3**	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
AM3	**EM2**	1.4	1.4	2.8	1.9	1.3	1.5	2.3	2.0
GB1	**EM3**	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
GB2	**EM3**	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
GB3	**EM3**	2.0	2.3	3.3	2.3	1.2	1.3	2.4	1.9
GB4	**MM19**	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9
GB5	**MM19**	0.8	1.4	3.6	2.0	0.8	0.9	2.8	1.9

Note: 1. *S – Surface Layer; M – Middle Layer; B – Bottom Layer; DA – Depth Averaged*

5.7 Prediction and Evaluation of Potential Environmental Impacts

<u>Marine-Based Construction Impacts</u>

5.7.1 The predicted SS extents, sedimentation rates and time series plots are shown in **Appendix 5.3**. According to the modelling results of Scenario 1a, it is observed that the plume due to CBL and TKO-LT Tunnel project is highly localized. The envelope of 1 mg/L SS elevation due to CBL and TKO-LT Tunnel project did not reach the coastal areas (Drawings S1a-SS-Dry-Map and S1a-SS-Wet-Map of **Appendix 5.3**) and the affected WSR due to the Project involves CC1 to CC3, CC13 and SWI1 only. Impact to other WSRs such as fish culture zones outside Junk Bay is not anticipated.

5.7.2 The predicted maximum elevations in SS at selected observation points are summarized in **Table 5.14** and **Table 5.15**. Full compliance of SS levels at all identified WSRs were predicted due to CBL and TKO-LT Tunnel project (Scenario 1a) and with other concurrent projects (Scenario 1c).

Table 5.14 Predicted Maximum Suspended Solids Elevations in Dry Season

WSR	Maximum Suspended Solids Elevations (mg/L)												
	Scenario 1a				Scenario 1c				WQO				Compliance in WQO?
	S	M	B	DA	S	M	B	DA	S	M	B	DA	
SWI1	0.1	0.1	0.2	0.1	0.2	0.4	0.6	0.4	1.4	1.8	2.9	1.9	Yes
SWI2	0.0	0.0	0.0	0.0	0.2	0.2	0.3	0.2	1.7	2.1	2.7	2.2	Yes
SWI3	0.0	0.0	0.0	0.0	0.3	0.4	0.5	0.4	1.7	2.1	2.6	2.1	Yes
SWI4	0.0	0.0	0.0	0.0	0.5	0.6	0.7	0.6	1.7	2.1	2.7	2.2	Yes
SWI5	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	1.7	2.1	2.6	2.1	Yes
SWI6	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	1.7	2.1	2.6	2.1	Yes
SWI7	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	1.7	2.1	2.7	2.2	Yes
SWI8	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.1	1.3	1.4	2.7	2.1	Yes
SWI9	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1.3	1.4	2.7	2.1	Yes
SWI10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.3	3.3	2.3	Yes
CWI1	0.0	0.0	0.0	0.0	0.3	0.6	0.8	0.6	1.7	2.1	2.7	2.2	Yes
CWI2	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	1.3	1.4	2.7	2.1	Yes
CC1	0.0	0.0	0.0	0.0	0.2	0.3	0.4	0.3	1.4	1.9	3.3	2.2	Yes
CC2	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.2	1.4	1.8	2.9	1.9	Yes
CC3	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.2	1.4	1.8	2.9	1.9	Yes
CC4	0.1	0.1	0.1	0.1	0.3	0.4	0.6	0.4	1.4	1.9	3.3	2.2	Yes

WSR	Maximum Suspended Solids Elevations (mg/L)												
	Scenario 1a				Scenario 1c				WQO				Compliance in WQO?
	S	M	B	DA	S	M	B	DA	S	M	B	DA	
CC5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	2.8	1.9	Yes
CC6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	2.8	1.9	Yes
CC7	0.0	0.0	0.0	0.0	0.2	0.4	1.4	0.4	1.4	1.4	2.8	1.9	Yes
CC8	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	2.0	2.3	3.3	2.3	Yes
CC9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.4	3.6	2.0	Yes
CC10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.4	3.6	2.0	Yes
CC11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.4	3.6	2.0	Yes
CC12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.4	3.6	2.0	Yes
CC13	0.1	0.2	0.2	0.2	0.3	0.5	0.5	0.5	1.4	1.8	2.9	1.9	Yes
SS1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.3	3.3	2.3	Yes
SS2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.3	3.3	2.3	Yes
FCZ1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.4	3.6	2.0	Yes
FCZ2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1.4	1.4	2.8	1.9	Yes
AM1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	2.0	2.3	3.3	2.3	Yes
AM2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	2.0	2.3	3.3	2.3	Yes
AM3	0.0	0.0	0.0	0.0	0.3	0.4	0.6	0.4	1.4	1.4	2.8	1.9	Yes
GB1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.3	3.3	2.3	Yes
GB2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.3	3.3	2.3	Yes
GB3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.3	3.3	2.3	Yes
GB4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.4	3.6	2.0	Yes
GB5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	1.4	3.6	2.0	Yes

Note: 1. WQO – Water Quality Objectives
2. Values in bold and shaded indicates exceedance in WQO
3. *S – Surface Layer; M – Middle Layer; B – Bottom Layer; DA – Depth Averaged*

Table 5.15 Predicted Maximum Suspended Solids Elevations in Wet Season

WSR	Maximum Suspended Solids Elevations (mg/L)												
	Scenario 1a				Scenario 1c				WQO				Compliance in WQO?
	S	M	B	DA	S	M	B	DA	S	M	B	DA	
SWI1	0.0	0.2	0.4	0.2	0.1	0.2	0.6	0.2	1.2	1.2	2.0	1.6	Yes
SWI2	0.0	0.0	0.0	0.0	0.3	0.3	0.4	0.3	1.6	2.7	5.4	3.6	Yes
SWI3	0.0	0.0	0.0	0.0	0.1	0.5	0.6	0.5	1.9	2.0	2.7	2.2	Yes
SWI4	0.0	0.0	0.0	0.0	0.5	0.6	0.6	0.5	1.6	2.7	5.4	3.6	Yes
SWI5	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	1.9	2.0	2.7	2.2	Yes
SWI6	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	1.9	2.0	2.7	2.2	Yes
SWI7	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.2	1.6	2.7	5.4	3.6	Yes
SWI8	0.0	0.0	0.0	0.0	0.2	0.2	0.4	0.2	1.4	1.8	2.8	2.3	Yes
SWI9	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	1.4	1.8	2.8	2.3	Yes
SWI10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.3	2.4	1.9	Yes
CWI1	0.0	0.0	0.0	0.0	0.5	0.5	0.4	0.4	1.6	2.7	5.4	3.6	Yes
CWI2	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	1.4	1.8	2.8	2.3	Yes
CC1	0.0	0.2	0.3	0.2	0.3	0.5	0.5	0.5	1.4	1.5	3.6	2.6	Yes
CC2	0.3	0.5	0.5	0.3	0.5	1.0	1.5	1.0	1.2	1.2	2.0	1.6	Yes
CC3	0.2	0.2	0.4	0.2	0.1	0.5	1.5	0.5	1.2	1.2	2.0	1.6	Yes
CC4	0.0	0.0	0.0	0.0	0.4	0.7	1.5	0.7	1.4	1.5	3.6	2.6	Yes
CC5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1.3	1.5	2.3	2.0	Yes
CC6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	1.5	2.3	2.0	Yes
CC7	0.0	0.0	0.0	0.0	0.1	0.2	1.6	0.4	1.3	1.5	2.3	2.0	Yes
CC8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.3	2.4	1.9	Yes
CC9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.9	2.8	1.9	Yes
CC10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.9	2.8	1.9	Yes
CC11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.9	2.8	1.9	Yes
CC12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.9	2.8	1.9	Yes
CC13	0.2	0.3	0.4	0.3	0.3	0.5	1.0	0.5	1.2	1.2	2.0	1.6	Yes
SS1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.3	2.4	1.9	Yes
SS2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.3	2.4	1.9	Yes

WSR	Maximum Suspended Solids Elevations (mg/L)												
	Scenario 1a				Scenario 1c				WQO				Compliance in WQO?
	S	M	B	DA	S	M	B	DA	S	M	B	DA	
FCZ1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.9	2.8	1.9	Yes
FCZ2	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	1.3	1.5	2.3	2.0	Yes
AM1	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.1	1.2	1.3	2.4	1.9	Yes
AM2	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1	1.2	1.3	2.4	1.9	Yes
AM3	0.0	0.0	0.0	0.0	0.1	0.1	1.5	0.2	1.3	1.5	2.3	2.0	Yes
GB1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.3	2.4	1.9	Yes
GB2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.3	2.4	1.9	Yes
GB3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.3	2.4	1.9	Yes
GB4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.9	2.8	1.9	Yes
GB5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.9	2.8	1.9	Yes

Note: 1. WQO – Water Quality Objectives
2. Values in bold and shaded indicates exceedance in WQO
3. *S – Surface Layer; M – Middle Layer; B – Bottom Layer; DA – Depth Averaged*

5.7.3 For WSR SWI1, the maximum SS elevation is 0.6 mg/L. According to **Table 5.5**, the baseline total SS levels are within 1.7 to 8.6 mg/L. Non-compliance with the assessment criteria for WSD's salt water intakes for flushing water (10 mg/L) in the vicinity is not anticipated.

5.7.4 Similar to the SS elevations, the plume of daily sedimentation rates due to CBL and TKO-LT Tunnel project is highly localized (Scenario S1a). The envelope of 20 $g/m^2/day$ due to CBL and TKO-LT Tunnel project is constrained within Junk Bay (Drawings S1a-Sed-Dry-Map and S1a-Sed-Wet-Map of **Appendix 5.3**) and the affected ecological sensitive receivers due to the Project will be limited to CC1 to CC3 and CC13 only.

5.7.5 The predicted maximum daily sedimentation rates at affected ecological sensitive receivers are summarised in **Table 5.16**. According to the modelling results, it is clear that the predicted daily sedimentation rates due to CBL and TKO-LT Tunnel project (Scenario 1a) and with cumulative impact (Scenario 1c) at all WSRs are well within the criterion of 100 $g/m^2/day$.

Table 5.16 Predicted Maximum Sedimentation Rates at Major Ecological Sensitive Receivers

Major Ecological Sensitive Receivers	Predicted Maximum Sedimentation Rates ($g/m^2/day$)			
	Dry Season		Wet Season	
	Scenario 1a	Scenario 1c	Scenario 1a	Scenario 1c
CC1	0	16	5	20
CC2	4	12	20	50
CC3	6	13	20	55
CC4	3	26	0	62
CC5	0	1	0	2
CC6	0	1	0	2
CC7	0	53	0	63
CC8	0	8	0	1
CC9	0	0	0	0
CC10	0	0	0	0
CC11	0	0	0	0
CC12	0	0	0	0
CC13	10	20	10	48
SS1	0	1	0	0
SS2	0	2	0	0
AM1	0	6	0	42

Major Ecological Sensitive Receivers	Predicted Maximum Sedimentation Rates (g/m^2/day)			
	Dry Season		Wet Season	
	Scenario 1a	Scenario 1c	Scenario 1a	Scenario 1c
AM2	0	11	0	16
AM3	0	26	0	49

Land-Based Construction Impacts

General Construction Activities

5.7.6 The effects on water quality from general construction activities are likely to be minimal, provided that site drainage would be well maintained and good construction practices would be observed to ensure that litter, fuels, and solvents are managed, stored and handled properly.

5.7.7 Based on the Sewerage Manual, Part I, 1995 of the Drainage Services Department (DSD), the sewage production rate for construction workers is estimated to be 0.35m^3 per worker per day. For every 100 construction workers working simultaneously at the construction site, about 35m^3 of sewage would be generated per day. The sewage should not be allowed to discharge directly into the surrounding water body without treatment. Sufficient chemical toilets should be deployed at the construction site to collect and handle sewage from workers.

Construction Runoff and Drainage

5.7.8 Construction run-off and drainage may cause physical, chemical and biological effects. The physical effects could arise from any increase in SS from the construction site that could cause blockage of drainage channels and associated local flooding when heavy rainfall occurs, as well as local impact on water quality. High concentrations of suspended degradable organic material in marine water could lead to associated reduction in DO levels in the water column.

5.7.9 It is important that proper site practice and good site management to be strictly followed to prevent run-off water and drainage water with high level of SS from entering the surrounding waters. With the implementation of appropriate measures to control run-off and drainage from the construction site, it is considered that disturbance of water bodies would be avoided and deterioration in water quality would be minimal. Thus, unacceptable impacts on the water quality are not expected, provided that the recommended measures described in **Sections 5.8** are properly implemented.

Excess Pore Water from Consolidation of Reclamation

5.7.10 Use of vertical band drains and surcharging is recommended to consolidate the reclaimed area. During primary consolidation of reclamation, dissipation of excess pore water would occur due to the increasing pressure in the compressible soils. Installation of vertical band drains allows the vertical movement of pore water. Use of surcharge accelerates the consolidation process.

5.7.11 Band drains should be extended into the underlying firm to stiff alluvial clay or sand layer to achieve anchorage. A geotextile layer should be placed directly over the soft ground followed by a free draining sand layer of 2m to 3m thickness, through which the pore water would be retained within the soft stratum. Surcharging would then be applied to consolidate the reclaimed area. There would be no direct discharge of pore water into the nearby water body.

5.7.12 Release of pore water during the consolidation process will be controlled to minimise the potential impacts to the surrounding environment. It is expected that the release rate would be low and the consolidation process would take several months to a year. The released pore water may contain contaminants and suspended solids. With suitable site arrangement and control facilities as discussed above, the released pore water would be retained within the reclaimed land. No discharge of untreated pore water extracted from the surcharge site into marine water will be made. It is unlikely that release of excess pore water would cause significant water quality impacts.

Operational Phase

Impact on Hydrodynamics and Water Quality

5.7.13 The modelling results are presented in **Appendix 5.4**. The locations of the EPD marine water sampling stations (JM3 and JM4) are shown in **Appendix 5.5** and the representative cross-sections across Junk Bay, Victoria Harbour (North Point to Hung Hom), Lei Yu Mun and Tathong Channel are shown in **Appendix 5.8**. The graphical presentations for flow velocity vectors and accumulated flows show an insignificant hydrodynamic impact caused by the CBL and TKO-LT Tunnel.

5.7.14 A summary of depth averaged velocities within a whole spring-neap cycle are presented in **Table 5.17** for both dry and wet seasons.

Table 5.17 Depth Averaged Current Velocities in Operational Scenarios

Station (refer to **Appendix 5.9**)	**Depth Averaged Current Velocities (m/s)**			
	Scenario 2a	**Scenario 2b**	**Scenario 2a**	**Scenario 2b**
	Dry Season		**Wet Season**	
JM3	0.04 (0.01 – 0.08)	0.04 (0.01 – 0.08)	0.08 (0.02 – 0.26)	0.08 (0.02 – 0.26)
JM4	0.15 (0.02 – 0.32)	0.14 (0.02 – 0.32)	0.20 (0.05 – 0.43)	0.20 (0.05 – 0.43)
Seashore outside Ocean Shores (Refer to **Appendix 5.9**)	0.01 (0.01 – 0.04)	0.02 (0.01 – 0.04)	0.03 (0.01 – 0.10)	0.04 (0.01 – 0.12)

5.7.15 As the Junk Bay is already a semi-enclosed water body, the existing flow condition is already limited. Based on the model results, there is no significant surface/bottom flow retardation even stagnation of water at the seashore outside Ocean Shores (embayed area formed by TKO-LT Tunnel reclamation) in both dry and wet seasons.

5.7.16 According to the drainage design of Road P2 of TKO-LT Tunnel reclamation, all the stormwater from west TKO will be discharged to the east of Road P2, i.e. open sea of Junk Bay, except a stormwater discharge point was diverted to embayed area formed by TKO-LT Tunnel reclamation. However, the catchment of this stormwater pipe is only 69,200m^2 and the land use is only residential area or park. In ideal case there will be no discharge unless during rainy periods. Nevertheless, there might be minor baseflow in reality and pollutant might be trapped within the embayed area if inadequate flushing capacity.

5.7.17 According to the hydrodynamic modelling results in **Table 5.17**, it is observed that the average velocity within the embayed area will be reduced by 0.01 m/s, compared with the prevailing velocity of 0.01-0.04 m/s and 0.01-0.12 m/s for dry and wet seasons respectively. Given the small change of average velocity, significant change in flushing capacity is not anticipated. In order to further supplement the interpretation, a drogue track analysis has been conducted to investigate the residence time of pollutants within the embayed area and the Junk Bay. As a worst scenario consideration, the model assumes the drogue track starting in neap tide under dry season and hourly drogue track is predicted.

5.7.18 The modelled hourly drogue track is presented in **Appendix 5.11**. It is observed that it takes about 3-4 hours for the pollutants to flush out of the embayment and more than 12 hours to flush out of the Junk Bay. As the residence time is relatively short, accumulation of pollutant (e.g. BOD_5 or DO depletion) within the embayed area and the Junky Bay is not anticipated.

5.8 Mitigation of Environmental Impacts

Marine-Based Construction Works

5.8.1 Non-dredged method by constructing steel cellular caisson structure with stone column shall be adopted for construction of seawall foundation. During the stone column installation (also including the installation of steel cellular caisson), silt curtain shall be employed around the active stone column installation points.

5.8.2 Formation of seawall enclosing the reclamation for Road P2 (notwithstanding an opening of about 50m for marine access) shall be completed prior to the filling activities. The seawall opening of about 50m wide for marine access shall be selected at a location as indicatively shown in **Appendix 5.10.** No more than 3 filling barge trips per day shall be made with a maximum daily rate of 3,000m^3 (i.e. 1,000 m^3 per trip) for the filling operation at the reclamation area for Road P2. All filling works shall be carried out behind the seawall with the use of single silt curtain at the marine access.

5.8.3 Other than the specific mitigation measures as indicated above, it is also recommended that good site practices should be undertaken during filling operation include:

- all marine works should adopt the environmental friendly construction methods as far as practically possible including the use of cofferdams to cover the construction area to separate the construction works from the sea;
- floating single silt curtain shall be employed for all marine works;
- all vessels should be sized so that adequate clearance is maintained between vessels and the seabed in all tide conditions, to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash;
- all hopper barges should be fitted with tight fitting seals to their bottom openings to prevent leakage of material;
- excess material shall be cleaned from the decks and exposed fittings of barges before the vessel is moved;
- adequate freeboard shall be maintained on barges to reduce the likelihood of decks being washed by wave action;
- loading of barges and hoppers should be controlled to prevent splashing of filling material into the surrounding water. Barges or hoppers should not be filled to a level that will cause the overflow of materials or polluted water during loading or transportation;
- any pipe leakages shall be repaired quickly. Plant should not be operated with leaking pipes;
- construction activities should not cause foam, oil, grease, scum, litter or other objectionable matter to be present on the water within the site or dumping grounds; and

- before commencement of the reclamation works, the holder of Environmental Permit has to submit plans showing the phased construction of the reclamation, design and operation of the silt curtain.

5.8.4 It should be noted that site specific mitigation plan for reclamation areas using public fill materials should be submitted for EPD agreement before commencement of construction phase with due consideration of good site practices.

Land-Based Construction Works

5.8.5 It is important that appropriate measures are implemented to control runoff and drainage and prevent high loading of SS from entering the marine environment. Proper site management is essential to minimise surface water runoff, soil erosion and sewage effluents.

5.8.6 Any practical options for the diversion and re-alignment of drainage should comply with both engineering and environmental requirements in order to ensure adequate hydraulic capacity of all drains.

5.8.7 Construction site runoff and drainage should be prevented or minimised in accordance with the guidelines stipulated in the EPD's Practice Note for Professional Persons, Construction Site Drainage (ProPECC PN 1/94). Good housekeeping and stormwater best management practices, as detailed in below, should be implemented to ensure that all construction runoff complies with WPCO standards and no unacceptable impact on the WSRs arises due to construction of the TKO-LT Tunnel. All discharges from the construction site should be controlled to comply with the standards for effluents discharged into the corresponding WCZ under the TM-DSS.

Construction Runoff

5.8.8 Exposed soil areas should be minimised to reduce the potential for increased siltation, contamination of runoff, and erosion. Construction runoff related impacts associated with the above ground construction activities can be readily controlled through the use of appropriate mitigation measures which include:

- use of sediment traps; and
- adequate maintenance of drainage systems to prevent flooding and overflow.

5.8.9 Construction site should be provided with adequately designed perimeter channel and pre-treatment facilities and proper maintenance. The boundaries of critical areas of earthworks should be marked and surrounded by dykes or embankments for flood protection. Temporary ditches should be provided to facilitate runoff discharge into the appropriate watercourses, via a silt retention pond. Permanent drainage channels should incorporate sediment basins or traps and baffles to enhance deposition rates. The design of efficient silt removal facilities should be based on the guidelines in Appendix A1 of ProPECC PN 1/94.

5.8.10 Ideally, construction works should be programmed to minimise surface excavation works during the rainy season (April to September). All exposed earth areas should be completed as soon as possible after earthworks have been completed, or alternatively, within 14 days of the cessation of earthworks where practicable. If excavation of soil cannot be avoided during the rainy season, or at any time of year when rainstorms are likely, exposed slope surfaces should be covered by tarpaulin or other means.

5.8.11 Sedimentation tanks of sufficient capacity, constructed from pre-formed individual cells of approximately 6 to 8m^3 capacity, are recommended as a general mitigation measure which can be used for settling surface runoff prior to disposal. The system capacity is flexible and able to handle multiple inputs from a variety of sources and particularly suited to applications where the influent is pumped.

5.8.12 Earthworks final surfaces should be well compacted and the subsequent permanent work or surface protection should be carried out immediately after the final surfaces are formed to prevent erosion caused by rainstorms. Appropriate drainage like intercepting channels should be provided where necessary.

5.8.13 Measures should be taken to minimize the ingress of rainwater into trenches. If excavation of trenches in wet seasons is necessary, they should be dug and backfilled in short sections. Rainwater pumped out from trenches or foundation excavations should be discharged into storm drains via silt removal facilities.

5.8.14 Open stockpiles of construction materials (for examples, aggregates, sand and fill material) of more than $50m^3$ should be covered with tarpaulin or similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.

5.8.15 Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris being washed into the drainage system and storm runoff being directed into foul sewers. Discharge of surface run-off into foul sewers must always be prevented in order not to unduly overload the foul sewerage system.

5.8.16 Precautions to be taken at any time of year when rainstorms are likely, actions to be taken when a rainstorm is imminent or forecast, and actions to be taken during or after rainstorms are summarised in Appendix A2 of ProPECC PN 1/94. Particular attention should be paid to the control of silty surface runoff during storm events, especially for areas located near steep slopes.

5.8.17 Oil interceptors should be provided in the drainage system and regularly cleaned to prevent the release of oils and grease into the storm water drainage system after accidental spillages. The interceptor should have a bypass to prevent flushing during periods of heavy rain.

5.8.18 All vehicles and plant should be cleaned before leaving a construction site to ensure no earth, mud, debris and the like is deposited by them on roads. An adequately designed and located wheel washing bay should be provided at every site exit, and wash-water should have sand and silt settled out and removed at least on a weekly basis to ensure the continued efficiency of the process. The section of access road leading to, and exiting from, the wheel-wash bay to the public road should be paved with sufficient backfall toward the wheel-wash bay to prevent vehicle tracking of soil and silty water to public roads and drains.

5.8.19 Silt removal facilities, channels and manholes should be maintained and the deposited silt and grit should be removed regularly, at the onset of and after each rainstorm to ensure that these facilities are functioning properly at all times.

Drainage

5.8.20 It is recommended that on-site drainage system should be installed prior to the commencement of other construction activities. Sediment traps should be installed in order to minimise the sediment loading of the effluent prior to discharge into foul sewers. There shall be no direct discharge of effluent from the site into the sea.

5.8.21 All temporary and permanent drainage pipes and culverts provided to facilitate runoff discharge should be adequately designed for the controlled release of storm flows. All sediment control measures should be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rain storms. The temporarily diverted drainage should be reinstated to its original condition when the construction work has finished or the temporary diversion is no longer required.

5.8.22 All fuel tanks and storage areas should be provided with locks and be located on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank, to prevent spilled fuel oils from reaching the coastal waters.

Stormwater Discharges

5.8.23 Minimum distances of 100m shall be maintained between the existing or planned stormwater discharges and the existing or planned seawater intakes during construction and operational phases.

Groundwater

5.8.24 Under normal circumstances, groundwater pumped out of wells, etc. for the lowering of ground water level in basement or foundation construction, and groundwater seepage pumped out of tunnels or caverns under construction should be discharged into storm drains after the removal of silt in silt removal facilities.

Groundwater Level

5.8.25 Grouting would be adopted as measure to reduce the groundwater inflow into the tunnel. During the tunnel excavation, the inflow rate of groundwater into the tunnel will be measured during the excavation. The groundwater levels above the tunnel will also be monitored by piezometers. If the inflow rate exceeds the pre-determined groundwater control criteria or the groundwater drawdown exceeds the required limit, pre-excavation grouting will be required to reduce the groundwater inflow. No significant change of groundwater levels would therefore be expected.

5.8.26 Any chemicals/ foaming agents which would be entrained to the groundwater should be biodegradable and non-toxic throughout the tunnel construction. Potential groundwater quality impact would be minimal as the used material is non-toxic and biodegradable. No adverse groundwater quality would therefore be expected.

5.8.27 Prescriptive measures in the form of an Action Plan with pre-emptive and re-active to preserve the groundwater levels at all times during the tunnel construction are set out in **Table 5.18**.

Table 5.18 Action Plan for Potential Changes in Groundwater Regime during Tunnel Construction

Prescriptive Action	Available Measures	Action Initiated By
Pre-emptive	Install a suite of piezometers (as directed by the Engineer) that straddle the tunnel alignment and monitor groundwater cycles for 24hr periods during peak Spring and Lowest Neap tide cycles at the beginning and end of the Wet and Dry Seasons throughout the year preceeding tunnel construction. Undertake additional monitoring cycles to cover unusual periods of activity such as the passage of a major storm and flood event so as to exclude tidal variation.	Planning Stage Protective Measures

Prescriptive Action	Available Measures	Action Initiated By
Response to significant measured groundwater level changes in the control piezometers	Grouting should be adopted to reduce the groundwater inflow into the tunnel in order to prevent any significant groundwater drawdown.	Engineer under the Contract

Boring and Drilling Water

5.8.28 Water used in ground boring and drilling for site investigation or rock / soil anchoring should as far as practicable be recirculated after sedimentation. When there is a need for final disposal, the wastewater should be discharged into storm drains via silt removal facilities.

Wastewater from Concrete Batching and Precast Concrete Casting

5.8.29 Wastewater generated from the washing down of mixing trucks and drum mixers and similar equipment should whenever practicable be recycled. The discharge of wastewater should be kept to a minimum.

5.8.30 To prevent pollution from wastewater overflow, the pump sump of any water recycling system should be provided with an on-line standby pump of adequate capacity and with automatic alternating devices.

5.8.31 Under normal circumstances, surplus wastewater may be discharged into foul sewers after treatment in silt removal and pH adjustment facilities (to within the pH range of 6 to 10). Disposal of wastewater into storm drains will require more elaborate treatment.

Wheel Washing Water

5.8.32 All vehicles and plant should be cleaned before they leave a construction site to ensure no earth, mud, debris and the like is deposited by them on roads. A wheel washing bay should be provided at every site exit if practicable and wash-water should have sand and silt settled out or removed before discharging into storm drains. The section of construction road between the wheel washing bay and the public road should be paved with backfall to reduce vehicle tracking of soil and to prevent site run-off from entering public road drains.

Bentonite Slurries

5.8.33 Bentonite slurries used in diaphragm wall and bore-pile construction should be reconditioned and reused wherever practicable. If the disposal of a certain residual quantity cannot be avoided, the used slurry may be disposed of at the marine spoil grounds subject to obtaining a marine dumping licence from EPD on a case-by-case basis.

5.8.34 If the used bentonite slurry is intended to be disposed of through the public drainage system, it should be treated to the respective effluent standards applicable to foul sewer, storm drains or the receiving waters as set out in the WPCO Technical Memorandum on Effluent Standards.

Water for Testing & Sterilization of Water Retaining Structures and Water Pipes

5.8.35 Water used in water testing to check leakage of structures and pipes should be reused for other purposes as far as practicable. Surplus unpolluted water could be discharged into storm drains.

5.8.36 Sterilization is commonly accomplished by chlorination. Specific advice from EPD should be sought during the design stage of the works with regard to the disposal of the sterilizing water. The sterilizing water should be reused wherever practicable.

Wastewater from Building Construction

5.8.37 Before commencing any demolition works, all sewer and drainage connections should be sealed to prevent building debris, soil, sand etc. from entering public sewers/drains.

5.8.38 Wastewater generated from building construction activities including concreting, plastering, internal decoration, cleaning of works and similar activities should not be discharged into the stormwater drainage system. If the wastewater is to be discharged into foul sewers, it should undergo the removal of settleable solids in a silt removal facility, and pH adjustment as necessary.

Acid Cleaning, Etching and Pickling Wastewater

5.8.39 Acidic wastewater generated from acid cleaning, etching, pickling and similar activities should be neutralized to within the pH range of 6 to 10 before discharging into foul sewers. If there is no public foul sewer in the vicinity, the neutralized wastewater should be tinkered off site for disposal into foul sewers or treated to a standard acceptable to storm drains and the receiving waters

Wastewater from Site Facilities

5.8.40 Wastewater collected from canteen kitchens, including that from basins, sinks and floor drains, should be discharged into foul sewer via grease traps capable of providing at least 20 minutes retention during peak flow.

5.8.41 Drainage serving an open oil filling point should be connected to storm drains via a petrol interceptor with peak storm bypass.

5.8.42 Vehicle and plant servicing areas, vehicle wash bays and lubrication bays should as far as possible be located within roofed areas. The drainage in these covered areas should be connected to foul sewers via a petrol interceptor. Oil leakage or spillage should be contained and cleaned up immediately. Waste oil should be collected and stored for recycling or disposal in accordance with the Waste Disposal Ordinance.

Sewage Effluent

5.8.43 Construction work force sewage discharges on site are expected to be connected to the existing trunk sewer or sewage treatment facilities. The construction sewage may need to be handled by portable chemical toilets prior to the commission of the on-site sewer system. Appropriate numbers of portable toilets shall be provided by a licensed contractor to serve the large number of construction workers over the construction site. The Contractor shall also be responsible for waste disposal and maintenance practices.

Accidental Spillage of Chemicals

5.8.44 Contractor must register as a chemical waste producer if chemical wastes would be produced from the construction activities. The Waste Disposal Ordinance (Cap 354) and its subsidiary regulations in particular the Waste Disposal (Chemical Waste) (General) Regulation should be observed and complied with for control of chemical wastes.

5.8.45 Any service shop and maintenance facilities should be located on hard standings within a bunded area, and sumps and oil interceptors should be provided. Maintenance of vehicles and equipment involving activities with potential for leakage and spillage should only be undertaken within the areas appropriately equipped to control these discharges.

5.8.46 Disposal of chemical wastes should be carried out in compliance with the Waste Disposal Ordinance. The "*Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*" published under the Waste Disposal Ordinance details the requirements to deal with chemical wastes. General requirements are given as follows:

- suitable containers should be used to hold the chemical wastes to avoid leakage or spillage during storage, handling and transport;
- chemical waste containers should be suitably labelled, to notify and warn the personnel who are handling the wastes, to avoid accidents; and
- storage area should be selected at a safe location on site and adequate space should be allocated to the storage area.

Floating Refuse and Debris

5.8.47 Floating refuse and debris may arise from illegal dumping and littering from marine vessels and runoff from the coastal areas. The accumulation and trapping of floating refuse is a common and inevitable problem, which causes potential impact on the aesthetic appearance of the coastal waters and may lead to potential water quality deterioration. It is recommended that collection and removal of floating refuse should be performed at regular intervals on a daily basis. The contractor should be responsible for keeping the water within the site boundary and the neighbouring water free from rubbish during the TKO-LT Tunnel construction. On-site waste management requirements are described further in **Section 8.6** of this Report.

<u>**Operational Phase**</u>

Impact on Hydrodynamics and Water Quality

5.8.48 No significant change in flow regime and water quality associated with the operation of TKO-LT Tunnel is anticipated. No adverse hydrodynamic and water quality impacts would therefore be expected during the operational phase and no mitigation measures such as maintenance dredging are considered necessary.

Road Runoff

5.8.49 For the operation of road works, a surface water drainage system combined with installation of storm drain rising main for part of road sections at Cha Kwo Ling would be provided to collect road runoff. It is recommended that the road drainage should be provided with adequately designed silt trap and oil interceptors, as necessary. The design of the operational stage mitigation measures for the road works shall take into account the guidelines published in ProPECC PN 5/93 "*Drainage Plans subject to Comment by the EPD*".

Floating Refuse

5.8.50 Regular maintenance and refuse collection are proposed at the embayed waters created by the formation of reclaimed area for Road P2 to mitigate the potential floating refuse entrapment problems.

Sewage from Proposed Administration Buildings

5.8.51 All new sewage effluent generated from the Project should be properly collected and diverted to the public sewers. No direct discharge of sewage effluent into the marine water will be allowed.

Groundwater Level

5.8.52 During the operational phase, contractor responsible for construction of tunnel section will conduct a 1-year post-monitoring (after the completion of the tunnelling works) on the groundwater levels above the tunnel. Details on this post-monitoring will be specified by the engineers during the design and construction stage of the Project. Grouting will be required for any unexpected groundwater drawdown. No significant change of groundwater levels would therefore be expected.

5.9 Evaluation of Residual Impacts

Construction Phase

Marine-Based Construction Impact

5.9.1 The major water quality impact associated with filling activities is the elevation of SS within the marine water column. Provided the recommended mitigation measures as mentioned in **Section 5.8.1 to 5.8.4** are implemented, including the adoption of non-dredged method for construction of seawall foundation, and deployment of silt curtains at the filling areas, no unacceptable residual water quality impact is anticipated.

Land-Based Construction Impact

5.9.2 General construction activities associated with the construction of the TKO-LT Tunnel could lead to site runoff containing elevated concentrations of SS and associated contaminants that may enter into the marine water. However, it is anticipated that the above water quality impacts will generally be temporary and localized during construction. Therefore, no unacceptable residual water quality impacts are anticipated during the construction of the developments of the TKO-LT Tunnel, provided all of the recommended mitigation measures are implemented and all construction site / works area discharges comply with the TM-DSS standards.

Operational Phase

5.9.3 As presented in **Section 5.7.13 to 5.7.15**, adverse hydrodynamic and water quality impacts associated with the operation of TKO-LT Tunnel are not anticipated. Thus, there will be no adverse residual impact associated with the operation of the TKO-LT Tunnel.

5.10 Environmental Monitoring and Audit

Construction Phase

5.10.1 The water quality impact during the reclamation works of TKO-LT Tunnel has been quantitatively assessed using the mathematical modelling. Suspended sediment is identified as the most significant water quality parameter during the reclamation. The scenarios for filling and reclamation have been assessed and it is predicted that potential water quality impacts would be localized within Junk Bay WCZ. The water quality impacts upon the water sensitive receivers could be effectively minimized with the implementation of the proposed mitigation measures. No adverse water quality impacts would therefore be expected from the Project. An environmental monitoring and audit programme is required to ensure the effectiveness of the proposed water quality mitigation measures.

5.10.2 Groundwater level and quality monitoring and audit during tunnel construction will need to be carried out to ensure that the groundwater level would be maintained within the acceptable groundwater envelope and no contamination to the groundwater due to the tunnel construction activities. If the groundwater level and quality monitoring data indicate that the proposed tunnel construction works result in unacceptable groundwater drawdown and groundwater quality impacts, appropriate actions should be taken to review the tunnel construction process and additional measures such as slowing down, or rescheduling of works should be implemented as necessary.

Operational Phase

5.10.3 As adverse water quality impact will not be generated from the operation of the TKO-LT Tunnel, operational water quality monitoring and audit is considered not necessary. However, a four-week post-construction water quality monitoring will be carried out on completion of marine works.

5.10.4 A 1-year post-monitoring (after the completion of the tunnel works) on the groundwater levels above the tunnel will need to be carried out by contractor responsible for tunnel construction to ensure that the groundwater level would be maintained within the acceptable groundwater envelope.

5.11 Conclusion

Construction Phase

5.11.1 The water quality impacts during the marine construction works have been quantitatively assessed by numerical modelling. It is predicted that, with the implementation of the recommended mitigation measures, there would be no unacceptable water quality impacts due to the construction of the Project and due to the cumulative effects from other concurrent marine construction activities. A water quality monitoring and audit programme will be implemented to ensure the effectiveness of the proposed water quality mitigation measures.

5.11.2 The key issue from the land-based construction activities would be the potential water quality impact due to the release of sediment-laden water from surface works areas and discharge of construction site effluent. Minimisation of water quality deterioration could be achieved through implementing adequate mitigation measures. Regular site inspections should be undertaken routinely to inspect the construction activities and works areas in order to ensure the recommended mitigation measures are properly implemented.

Operational Phase

5.11.3 During operational phase, no significant change in hydrodynamic regime is predicted according to the modelling results. No significant change in water quality regime, which associated with the hydrodynamic impact, is anticipated. Therefore no adverse hydrodynamic and water quality impacts are expected.