3 HYDRODYNAMICS, WATER AND SEDIMENT QUALITY IMPACT

3.1 INTRODUCTION

One of the objectives of this Stage 2 EIA is to undertake a detailed assessment of the potential water quality impact from the construction of the STD, and hydrodynamic and water quality impacts from the operation of the STD. This Section also provides the mitigation measures to reduce any unacceptable water quality impacts and indicates the potential residual (that is, after mitigation) water quality impacts.

3.2 ENVIRONMENTAL LEGISLATION POLICIES, PLANS, STANDARDS AND CRITERIA

The criteria for evaluating water quality impacts in this EIA Study include:

- *Technical Memorandum on Environmental Impact Assessment Process (Environmental Impact Assessment Ordinance)* (EIAO-TM);
- *Water Pollution Control Ordinance* (WPCO);
- *Technical Memorandum, Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* (TM-DSS).

Marine bottom sediment classification is described in *Section 6* of this EIA.

3.2.1 Marine Waters

The WPCO is the legislation for the control of water pollution and water quality in Hong Kong. Under the *WPCO*, Hong Kong waters are divided into 10 Water Control Zones (WCZs). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs). The proposed STD falls within the Western Buffer WCZ which was declared in June 1993. The Western Buffer WCZ is an open water body which includes a fish culture zone (FCZ) at Ma Wan and capture fisheries as well as eight gazetted beaches. The WQOs set limits for different parameters that should be achieved in order to maintain the water quality within the Western Buffer WCZ (as indicated in *Annex B*).

Sediment plumes generated from dredging and filling activities of the STD and the discharge from the Ting Kau and Sham Tseng Sewage Treatment Works (TKSTSTW) and the Sewage Treatment Facilities for Sham Tseng Development (STFSTD) during operation may impact the Western Buffer WCZ as well as the adjacent North Western and Victoria Harbour WCZs. The Victoria Harbour WCZ was declared in April 1996. Within Victoria Harbour WCZ, there are seven typhoon shelters and eleven sewage outfalls from screening plants of Hong Kong Island and Kowloon. The urban centres at the western side of this WCZ are Tsuen Wan East, Kwai Chung and Sham Shui Po. The North Western WCZ was declared in 1992. Major development within this WCZ includes Tuen Mun, Castle Peak, Tap Shek Kok, Pillar Point, Tai Lam Chung, Chek Lap Kok, Tung Chung and Tai Ho. Within this WCZ, there are six gazetted beaches and one typhoon shelter. The WQOs for the Western Buffer, North Western and Victoria Harbour WCZs are shown in *Annex B*. These WQOs will comprise the evaluation criteria for assessing compliance of the STD proposals against statutory requirements.

The TM-DSS, issued under *Section 21* of the *WPCO*, defines acceptable discharge limits to different types of receiving waters. Under the TM-DSS, effluents discharged into the marine waters are subject to standards for particular volumes of discharge (as stated in *Annex B*).

At bathing beaches, permissible standards for effluent must be consistent with the Bathing Beach WQOs (which set standards for the indicator bacteria, *Escherishia coli* or *E. coli*) in *Annex B*. The *Hong Kong Planning Standards and Guidelines* (HKPSG) states that no discharge outlet should be located within 100 m of the boundaries of any bathing beach. In addition, *Section 9.1* of the *TM-DSS* states that no new effluent will be permitted within 100 m of the boundaries of a gazetted beach in any direction, including rivers, streams and stormwater drains.

The Water Supplies Department (WSD) will have a salt water intake at STD. The WSD criteria for marine water quality at the intake of salt water pumping station are presented in *Table 3.2a*. The suspended solids (SS) concentration of WSD salt water intake should not be more than 10 mg L^{-1}.

Table 3.2a WSD Criteria of Salt Water Quality for Flushing

Parameters / Units	Target water quality criteria at intake point of salt water pumping stations for flushing
Colour (H.U.)	<20
Turbidity (F.T.U.)	<10
Threshold Odour Number	<100
Ammoniacal Nitrogen (mg L^{-1})	<1
Suspended Solids (mg L^{-1})	<10
Dissolved Oxygen (mg L^{-1})	>2
BOD_5 (mg L^{-1})	<10
Synthetic Detergents (mg L^{-1})	<5
E. Coli (cfu 100 mL^{-1})	<20,000

3.2.2 *Sediment Quality*

Dredged sediments destined for marine disposal are classified according to their level of contamination according to the concentrations of seven heavy metals as stipulated in the EPDTC No. 1-1-92. The seven metals are cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb) and zinc (Zn). Definition of the classification can be found in *Section 6.4*.

A new set of regulatory guidelines for designation of sediments *(Management of Dredged/Excavated Sediment, WBTC No. 3/2000)* has been issued by the Works Bureau and Planning, Environment and Lands Bureau in April 2000. These guidelines include a new set of sediment quality criteria, which include organic pollutants and other toxic substances, as well as a new class of contamination level for highly contaminated sediment which is not suitable for marine disposal. This new set of guidelines are applicable to any reclamation work commencing after 31 December 2001 and, therefore, applicable to this Project. More details are presented in *Section 6*.

The requirement for the marine disposal of sediment is specified in the Works Branch Technical Circular (WBTC) Nos 6/92 and 22/92, and *Buildings Ordinance Office Practice Note of Authorized Persons and Registered Structural Engineers 155* (PNAP155).

Marine disposal of dredged materials is controlled under the *Dumping at Sea Ordinance 1995*.

3.3 *DESCRIPTION OF THE ENVIRONMENT*

According to the specification of the *Brief* Section 6.14.9(c), the Study Area for the purpose of water quality impact assessment *(Figure 2.3a)* covers the eastern part of Pearl River Estuary, East Lamma Channel, West Lamma Channel and Ma Wan Channel to incorporate all major influences on hydrodynamic and water quality.

3.3.1 *Baseline Hydrodynamics*

The hydrodynamic characteristics of the Study Area are determined to a large extent by the influence of tidal currents and flows from the Pearl River Estuary. Ebb tides flow down through the Urmston Road and Ma Wan into the East Lamma Channel, the West Lamma Channel and the Victoria Harbour, and this flow pattern reverses during the flood tides. These circulation patterns combined with the varying Pearl River Estuary discharge cause predictable seasonal patterns in water mixing. Currents at waters near Sham Tseng are governed by the strong tidal currents along Ma Wan Channel. Around the north eastern tip of Ma Wan current speeds are in excess of 1.5 m s^{-1} on the ebb phase of large spring tides. The existing current speed near the proposed coastline of STD is generally more than 1 m s^{-1}, with slower current speed within the waters of the proposed STD.

3.3.2 *Baseline Water Quality*

Marine Water Quality Monitored by EPD

For the purpose of this Stage 2 EIA Report, the EPD marine water quality monitoring data routinely collected in the vicinity of the site, which documents the water quality in Western Buffer, North Western and Victoria Harbour WCZs have been used. The EPD monitoring stations of most relevance (i.e. in the vicinity of STD) include NM1, WM2, WM3, WM4, VM6, VM7, VM8, VM12, VM13 and VM14, as shown in *Figure 3.3a*. A summary of the most recently published EPD monitoring data (for the year 1998) collected at these stations are presented in *Tables 3.3a* and *3.3b*[1].

(1) Marine Water Quality in Hong Kong in 1998, EPD, 1999.

Table 3.3a ***Summary Statistics of 1998 Marine Water Quality in Western Buffer and North Western (NW) Buffer WCZs at the Vicinity of STD***

Parameter		EPD Monitoring Station					
		North Western WCZ (bi-monthly)		Western Buffer WCZ (monthly)			
		NM1	WPCO WQOs (for Marine Waters)	WM2	WM3	WM4	WPCO WQOs (for Marine Waters)
Temperature (°C)		23.6 (18.2-26.8)	natural daily level ± 2 °C	23.1 (16.7-27.7)	23.1 (16.7-27.6)	23.4 (16.7-27.7)	natural daily level ± 2 °C
Salinity (ppt)		29.3 (21.9-32.5)	natural ambient level ± 10 %	31.1 (27.1-33.8)	31.4 (29.4-33.4)	30.9 (25.9-33.6)	natural ambient level ± 10 %
Dissolved Oxygen (DO) (%saturation)		79 (55-106)	-	84 (51-104)	81 (50-102)	79 (42-108)	-
	Bottom	72 (38-105)	-	78 (36-105)	77 (34-101)	76 (32-105)	-
DO (mg L^{-1})		5.5 (3.2-8.4)	≥ 4 mg L^{-1} (all waters)	5.8 (3.6-7.9)	5.6 (3.3-8.2)	5.4 (2.9-8.1)	≥ 4 mg L^{-1} (all waters)
	Bottom	5.0 (2.7-8.3)	≥ 2 mg L^{-1}	5.4 (2.5-8.0)	5.3 (2.4-8.1)	5.2 (2.1-8.1)	≥ 2 mg L^{-1} (marine waters except FCZ)
pH value		8.0 (7.9-8.2)	6.5-8.5 (± 0.2 from natural range)	7.9 (7.5-8.2)	7.9 (7.6-8.1)	8.0 (7.8-8.2)	6.5-8.5 (± 0.2 from natural range)
Secchi disc (m)		2.2 (1.5-3.0)	-	2.5 (1.4-4.0)	2.0 (0.5-3.5)	2.3 (1.0-3.5)	-
Turbidity (NTU)		6.5 (3.1-12.0)	not reduce light transmission substantially from normal level (bathing beaches)	5.6 (3.5-9.2)	5.4 (3.3-7.1)	6.6 (2.8-11.2)	not reduce light transmission substantially from normal level (bathing beaches)
Suspended Solids (SS) (mg L^{-1})		4.0 (1.1-6.7)	≤ natural ambient level + 30%	5.7 (1.1-13.0)	5.7 (1.1-10.8)	7.6 (1.2-17.4)	≤ natural ambient level + 30%
Silica (as SiO_2) (mg L^{-1})		2.0 (0.4-4.0)	-	1.0 (0.3-2.2)	1.0 (0.3-1.7)	1.1 (0.2-1.9)	
BOD_5 (mg L^{-1})		0.9 (0.2-2.0)	Not applicable to marine waters	0.9 (0.2-1.8)	0.9 (0.3-1.9)	0.7 (0.2-1.5)	not applicable to marine waters

Parameter	EPD Monitoring Station					
	North Western WCZ (bi-monthly)		Western Buffer WCZ (monthly)			
	NM1	WPCO WQOs (for Marine Waters)	WM2	WM3	WM4	WPCO WQOs (for Marine Waters)
Nitrite Nitrogen (mg L^{-1})	0.03 (0.02-0.06)	-	0.02 (<0.01 - 0.04)	0.02 (0.01- 0.04)	0.02 (0.01 - 0.04)	-
Nitrate Nitrogen (mg L^{-1})	0.27 (0.10-0.52)	-	0.12 (0.02-0.31)	0.12 (0.05-0.27)	0.15 (0.07-0.30)	-
Ammoniacal Nitrogen (mg L^{-1})	0.13 (0.03-0.30)	-	0.11 (0.04-0.19)	0.16 (0.06-0.29)	0.12 (0.04-0.20)	-
Unionised Ammonia (mg L^{-1})	0.005 (0.002-0.007)	≤ 0.021 mg L^{-1}	0.004 (0.001-0.007)	0.006 (0.002-0.012)	0.005 (0.002-0.007)	≤ 0.021 mg L^{-1}
Total Inorganic Nitrogen (TIN) (mg L^{-1})	0.43 (0.24-0.66)	≤ 0.5 mg L^{-1}	0.25 (0.13-0.39)	0.30 (0.14-0.45)	0.29 (0.17-0.42)	≤ 0.4 mg L^{-1}
Total N (mg L^{-1})	1.14 (0.84-1.55)	-	1.00 (0.61-1.55)	1.07 (0.75-1.58)	1.06 (0.65-1.71)	-
Ortho-Phosphate (mg L^{-1})	0.03 (0.01 - 0.04)	-	0.02 (0.01 - 0.04)	0.03 (0.02 - 0.06)	0.03 (0.01 - 0.04)	-
Total P (mg L^{-1})	0.05 (0.03-0.07)	-	0.05 (0.03-0.07)	0.06 (0.04-0.08)	0.06 (0.04-0.08)	-
Phaeo-pigment (μg L^{-1})	0.9 (0.2-2.7)	-	1.3 (0.3-6.5)	1.1 (0.2-4.2)	1.1 (0.2-5.5)	-
Chlorophyll-a (μg L^{-1})	3.2 (1.5-6.1)	-	3.4 (0.8-11.2)	3.2 (0.8-7.4)	3.4 (0.9-9.9)	-
E. coli (cfu 100 mL^{-1})	110 (6-570)	≤ 610 cfu 100 mL^{-1} (secondary contact) and ≤ 180 cfu 100 mL^{-1} (bathing beaches)	230 (32-1,900)	1,200 (130-13,000)	510 (42-1,900)	≤ 610 cfu 100 mL^{-1} (secondary contact/FCZ) and ≤ 180 cfu 100 mL^{-1} (bathing beaches)
Faecal Coliform (cfu 100 mL^{-1})	600 (20-140)	-	890 (53-4,000)	5,700 (260-24,000)	2,000 (89-7,300)	-

Table 3.3b Summary Statistics of 1998 Marine Water Quality in Victoria Harbour WCZ at the Vicinity of STD

Parameter		EPD Monitoring Station (monthly)						
		VM6	VM7	VM8	VM12	VM13	VM14	WPCO WQOs (in marine waters)
Temperature (°C)		23.3 (17.1-27.6)	23.6 (17.2 - 28.6)	23.2 (17.4-27.2)	23.6 (17.4-28.4)	23.9 (17.6-28.1)	24.1 (17.6-28.5)	natural daily level ± 2 °C
Salinity (ppt)		30.6 (26.8-33.1)	30.4 (26.5 - 33.5)	30.9 (25.3-33.7)	30.5 (24.9-33.6)	30.4 (26.3-34.5)	29.3 (21.3-33.2)	natural ambient level ± 10 %
Dissolved Oxygen (DO) (% saturation)		70 (46-99)	75 (49 - 117)	83 (64-116)	74 (52-115)	72 (54-88)	77 (60-106)	-
	Bottom	59 (29-75)	68 (45 - 96)	80 (45-101)	68 (36-86)	69 (52-84)	75 (61-106)	
DO (mg L^{-1})		4.9 (2.9-6.8)	5.3 (2.9 - 8.1)	5.9 (3.7-8.0)	5.1 (3.1-7.8)	5.1 (2.8-6.6)	5.3 (2.8-7.4)	≥ 4 mg L^{-1}
	Bottom	4.2 (2.0-6.0)	4.8 (2.9 - 7.1)	5.6 (3.2-7.8)	4.8 (2.6-6.7)	4.8 (2.8 – 6.5)	5.2 (2.8-7.3)	≥ 2 mg L^{-1}
pH value		7.8 (7.2-8.2)	7.9 (7.5 - 8.2)	8.0 (7.7-8.2)	7.9 (7.7 - 8.2)	8.0 (7.6-8.2)	8.0 (7.7-8.1)	6.5 - 8.5 (± 0.2 from natural range)
Secchi disc (m)		2.2 (1.0-3.0)	2.3 (1.8 - 3.0)	2.1 (1.5-3.3)	2.0 (1.0-4.0)	2.0 (1.4-3.5)	2.1 (1.0 - 3.0)	-
Turbidity (NTU)		4.4 (2.8-6.1)	4.9 (2.7 - 6.9)	5.2 (3.4-7.0)	7.8 (3.9-23.2)	5.6 (4.3-7.2)	5.2 (3.0-7.9)	-
SS (mg L^{-1})		4.7 (1.9-7.6)	5.2 (2.2 - 7.9)	4.6 (2.7-8.0)	8.5 (2.8-26.1)	7.2 (4.6-9.5)	6.5 (3.0-15.3)	≤ natural ambient level + 30%
Silica (as SiO_2) (mg L^{-1})		1.0 (0.6-1.7)	1.1 (0.7 - 1.8)	1.2 (0.6-2.2)	1.3 (0.6-2.9)	1.6 (0.6 - 4.0)	1.7 (0.6-4.5)	-
BOD_5 (mg L^{-1})		1.2 (0.5-1.8)	1.1 (0.2 - 1.9)	0.9 (0.2 - 1.6)	0.9 (0.1-1.5)	1.2 (0.3-3.0)	1.0 (0.2-1.8)	not applicable to marine waters

Parameter	EPD Monitoring Station (monthly)						
	VM6	**VM7**	**VM8**	**VM12**	**VM13**	**VM14**	**WPCO WQOs (in marine waters)**
Nitrite Nitrogen (mg L^{-1})	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.04)	0.02 (0.01 - 0.05)	0.03 (0.01 - 0.05)	0.03 (0.01 - 0.05)	0.03 (0.01 - 0.06)	-
Nitrate Nitrogen (mg L^{-1})	0.11 (0.04 - 0.25)	0.13 (0.05 - 0.32)	0.13 (0.03 - 0.36)	0.15 (0.04 - 0.41)	0.20 (0.05-0.60)	0.24 (0.08-0.68)	-
Ammoniacal Nitrogen (mg L^{-1})	0.31 (0.12-0.45)	0.28 (0.06 - 0.43)	0.17 (0.05-0.31)	0.25 (0.10-0.37)	0.27 (0.05-0.48)	0.23 (0.03 - 0.37)	-
Unionised Ammonia (mg L^{-1})	0.008 (0.004-0.019)	0.008 (0.002 - 0.018)	0.006 (0.002-0.015)	0.009 (0.002-0.019)	0.010 (0.002-0.022)	0.008 (0.001-0.017)	≤ 0.021 mg L^{-1}
TIN (mg L^{-1})	0.44 (0.24-0.67)	0.43 (0.21 - 0.55)	0.33 (0.21 - 0.48)	0.43 (0.28-0.51)	0.51 (0.27-0.69)	0.49 (0.27-0.74)	≤ 0.4 mg L^{-1}
Total N (mg L^{-1})	1.21 (0.93-1.52)	1.21 (0.85 - 1.63)	1.09 (0.66-1.29)	1.21 (0.81-1.57)	1.28 (0.89-1.73)	1.20 (0.86-1.68)	-
Ortho-Phosphate (mg L^{-1})	0.05 (0.02 - 0.07)	0.05 (0.01 - 0.07)	0.03 (0.01 - 0.05)	0.04 (0.02 - 0.06)	0.05 (0.01-0.08)	0.04 (0.01-0.07)	-
Total P (mg L^{-1})	0.09 (0.07 - 0.11)	0.08 (0.06 - 0.11)	0.06 (0.05-0.08)	0.08 (0.06-0.10)	0.09 (0.06-0.13)	0.08 (0.05-0.11)	-
Phaeo-pigment (µg L^{-1})	1.8 (0.2-7.5)	2.1 (0.2 - 11.5)	1.5 (0.2-6.2)	2.0 (0.2-10.8)	1.5 (0.2-6.6)	1.6 (0.2-6.4)	-
Chlorophyll-a (µg L^{-1})	4.9 (0.9-24.0)	5.7 (0.9 - 29.3)	4.6 (1.2-12.7)	3.7 (0.8-12.6)	3.2 (0.6-10.9)	3.2 (1.0-17.0)	-
E. coli (cfu 100 mL^{-1})	5,100 (1,400-12,000)	3600 (1600 - 13 000)	970 (260-9,400)	7,400 (890-23,000)	11,000 (1,900-130,000)	3,000 (260-36,000)	not applicable to marine waters
Faecal Coliform (cfu 100 mL^{-1})	12,000 (3,700-30,000)	11 000 (3400 - 24 000)	4,200 (910-23,000)	25,000 (1,300-73,000)	47,000 (5,200-240,000)	13,000 (800-60,000)	-

Western Buffer WCZ

The monitoring results in 1998 reveal that the water in the southern part of the Western Buffer WCZ, which is further away from the polluted stormwater and effluent discharges from Tsuen Wan and Tsing Yi, has slightly lower levels of *E. coli* and inorganic nutrients then that in the north. WM3, which is close to Tsing Yi / Kwai Chung sewage outfalls, was generally more turbid, with higher level of faecal bacteria *(E. coli)* and ammoniacal nitrogen. The water at WM2 was less polluted, whereas the quality at WM4 was intermediate of the three stations. The annual geometric mean of *E. coli* at WM3 and WM4 increased compared to data collected in 1997. The total inorganic nitrogen (TIN) concentration in the WCZ was much higher compared to those in 1996. Significant increase of BOD_5 were found in WM2 and WM3 in 1998. In 1998, all the stations in the WCZ failed to comply with the WQO of depth-averaged DO (4 mg L^{-1}), whereas full compliance with the WQO for TIN and unionised ammoniacal nitrogen (0.4 mg-N L^{-1} for TIN and 0.021 mg-N L^{-1} for unionised ammoniacal nitrogen) was achieved.

Victoria Harbour WCZ

The monitoring results in 1998 for Victoria Harbour WCZ showed that the poorest water quality was found near Tsuen Wan at VM13 where water was turbid with high faecal bacterial and nutrient content due to low rate of water exchange in the Rambler Channel and large sewage discharges near Kwai Chung. The water in the western (VM8) entrance to the harbour, where greater dilution takes place and the location is far away from major discharges, showed lower levels of *E. coli*, faecal coliform and nutrients, and a higher bottom DO levels in contrast to other EPD monitoring stations. The water quality at VM6 is subject to direct impact of sewage discharge being located close to Central sewage outfall, while the water quality at VM12 is affected by Tsing Yi and Kwai Chung sewage outfalls.

Full compliance with WQO for bottom DO was achieved at VM6, VM8, VM12, VM13 and VM14 in 1998. However, only VM8 and VM14 depth-averaged DO concentrations comply with the WQO. Non-compliance with the TIN were found at VM6, VM12, VM13 and VM14, but all the stations comply with the unionised ammoniacal nitrogen (NH3-N) criteria.

North Western WCZ

The *E. coli*, faecal coliform and nutrients levels at NM1 were lower when compared with the rest of the monitoring stations in the North Western WCZ in 1998. In long term, a significant increase in *E. coli* was found at NM1 which may related to the increased sewage input from nearby areas including Sham Tseng, Tsing Lung Tau, Tai Lam Chung, Siu Ho Wan and Pillar Point. Full compliance with the WQO for bottom DO at NM1 was found. However, the depth-averaged DO criterion was not achieved due to low readings recorded in July 1998. The WQOs of TIN and unionised NH3-N were complied with.

Inland Water Quality Monitored by EPD

The Pai Min Kok (Anglers') Stream comprises the only watercourse monitored in the Western Buffer WCZ and is within the STD. In 1998, the water quality of Pai Min Kok Stream (EPD monitoring stations AN1 and AN2, as indicated in *Figure 3.3a*) was "good", with high DO and low aggregate organic levels (see *Table 3.3c*). As most of the village houses in the Pai Min Kok Stream catchment are still unsewered, existing septic tanks and soakaways should be managed properly. Long-term improvement measures include the provision of public sewers under the Ting Kau and Sham Tseng Sewerage Scheme (part of the Tsuen Wan, Kwai Chung and Tsing Yi Sewerage Master Plan) for 10 villages and developments for some 48 000 population in the catchment. Installation of this sewerage commenced in 1999. It is anticipated that about 2700 kg per day of BOD will be collected and treated at the planned TKSTSTW to be commissioned in 2003.

Despite the removal of pollution from livestock waste, the relatively high *E. coli* levels in Pai Min Kok Stream remains unsatisfactory and likely affects the water quality of Anglers' Beach.

Table 3.3c Summary of Water Quality Monitoring Results for Pai Min Kok Stream in 1998

Parameter	Pai Min Kok Stream		
	AN1	AN2	WQOs
Dissolved oxygen (mg L^{-1})	6.9 (5.8-9.0)	8.3 (7.5-9.9)	≥ 4
PH	7.7 (7.3-8.2)	7.7 (7.4-8.1)	6.0 - 9.0
Suspended solids (mg L^{-1})	7 (2-46)	4 (1-10)	≤ 25
5-day Biochemical oxygen demand (mg L^{-1})	5 (1-26)	3 (1-19)	≤ 5
Chemical Oxygen demand (mg L^{-1})	18 (6-220)	10 (4–35)	≤ 30
Oil & grease (mg L^{-1})	0.7 (0.5-1.6)	0.5 (0.5 – 1.4)	-
E. coli (cfu per 100 mL)	35,523 (1,200-370,000)	72,550 (16,000-1,200,000)	≤ 1000
Ammoniacal nitrogen (mg L^{-1})	0.18 (0.06-0.68)	0.56 (0.16-1.60)	-
Nitrate-nitrogen (mg L^{-1})	2.70 (1.30-4.50)	2.85 (0.85-5.70)	-
Total Kjeldahl nitrogen, SP (mg L^{-1})	0.72 (0.30-1.70)	1.05 (0.39-2.40)	-
Ortho-phosphate (mg L^{-1})	0.24 (0.11-0.45)	0.24 (0.09-0.76)	-
Total phosphorus, SP (mg L^{-1})	0.33 (0.13-0.55)	0.28 (0.13-0.94)	-
Sulphide, SP (mg L^{-1})	0.02 (0.02-0.02)	0.02 (0.02–0.02)	-

Parameter	Pai Min Kok Stream		
	AN1	AN2	WQOs
Aluminium (μg L^{-1})	145 (70-640)	160 (90-320)	-
Cadmium (μg L^{-1})	0.10 (0.10-0.10)	0.10 (0.10–0.20)	-
Chromium (μg L^{-1})	1.0 (1.0-4.0)	1.0 (1.0–4.0)	-
Copper (μg L^{-1})	5.0 (1.0-42.0)	3.0 (1.0-43.0)	-
Lead (μg L^{-1})	2.0 (1.0-310.0)	1.0 (1.0 – 8.0)	-
Zinc (μg L^{-1})	50 (30–430)	40 (20-150)	-
Flow (L s^{-1})	NM	8 (1 – 24)	-

Notes:
(a) Data presented are annual medians of monthly samples; except those for *E. coli* which are annual geometric means.
(b) Those figures in brackets are the annual ranges.
(c) NM indicates no measurement taken.
(d) cfu - colony forming unit.
(e) SP - soluble and particulate fractions (i.e. total) of the water quality parameter.
(f) Equal values for the annual medians and ranges indicate that the data are equal to or below the reporting limits.

Bathing Beaches

In the vicinity of the Study Area, there are 14 gazetted bathing beaches located at Tsuen Wan and Tuen Mun Districts (as shown in *Figure 3.3b*). Eight gazetted beaches, including Anglers', Approach, Casam, Gemini, Hoi Mei Wan, Lido, Ting Kau and Tung Wan (at Ma Wan) are located within Tsuen Wan District. Whereas six gazetted beaches including Butterfly, Castle Peak, Golden, Kadoorie, New Cafeteria and Old Cafeteria, are located within Tuen Mun District. In addition 2 non-gazetted beaches are in the vicinity of the STD (Dragon Beach and Tsing Lung Tau Beach).

EPD has set up a programme for routinely monitoring the bacteriological water quality these gazetted beaches in Tsuen Wan and Tuen Mun Districts. According to the ranking based on the results of the water quality monitoring during the 1998 bathing season, Tung Wan was classified as fair, Ting Kau was very poor and the rest of the beaches between Sham Tseng and Tsuen Wan were poor(2). The fair to very poor beach water quality in this region appears to be related to the sewage discharges from squatter areas and unsewered developments in the beach hinterlands and the increasing trends of *E. coli* and faecal coliform in the marine water of Western Buffer WCZ. The ranking of Anglers' and Approach Beaches were improved in 1998 compared to 1997. In Tuen Mun District, Castle Peak Beach was classified as poor and the rest were fair(3). The ranking of Butterfly, Golden, Kadoorie, New Cafeteria and Old Cafeteria Beaches were also improved in 1998 compared to 1997. The improvement appears to be related to the implementation of the revised Livestock Waste Control Scheme in July 1995 that reduces livestock

(2) The concentrations of E. coli (in geometric mean) determines the water quality of gazetted bathing beaches. Fair indicate the concentration lies between 24 and 180 counts per 100 mL, poor means concentration lies between 180 to 610 counts per 100 mL, and very poor shows concentration above 610 counts per 100 mL.
(3) Beach Water Quality in Hong Kong 1998, EPD, 1999.

pollution in Tuen Mun, and also the rectification of many industrial expedient connections at Tuen Mun.

Sediment Quality

According to the marine borehole records near the STD, it is estimated that the marine bottom sediment within the STD is essentially marine sand with a thin layer of marine mud (approximately 1-2 m thick) deposited on top of the sea bed. It is estimated that the quantity of marine mud that will need to be excavated for seawall foundation works is small.

Sediment quality data from the site investigation during Stage 2 of the Study is shown in *Annex A.* The results shows that the quality of sediment in the proposed reclamation area is generally uncontaminated except at vibrocore location SQ13, which is located at the mouth of the Sham Tseng Nullah. The sediment samples collected at depths between 0.9 m to 1.8 m at SQ13 show high levels of Zn and Cr, and are classified as Class C seriously contaminated sediment according to the existing *EPDTC 1-1-92,* and exceed the Upper Chemical Exceedance Level of the new sediment classification system proposed under the new regulatory guidelines *(Section 3.2.2).*

Sewage

Existing Conditions

At the end of 1999, village houses in the vicinity of STD are still not yet sewered. To reduce pollution in the river, discharges were required to remove their overflow pipes from the soakaway pits. Long-term improvement measures in the catchment include the provision of public sewers as recommended in the Tsuen Wan, Kwai Chung and Tsing Yi Sewerage Master Plan (SMP) Study, which is presently under construction.

The Sham Tseng Resite Village is situated near the Sham Tseng Nullah. Discharges from the Village are collected into two communal septic tanks and stone filtration tanks. Effluent from the stone filtration tanks is discharged into the Sham Tseng Nullah. Raw sewage and sullage from squatter areas are also discharged directly into the Nullah[(4)].

Future Conditions

The poor water quality at beaches in Tsuen Wan district is more or less related to the sewage discharges from squatter areas and unsewered developments in the beach hinterlands. To rectify this problem, the government is presently providing sewerage along the coastal strip between Tsing Lung Tau in the west and Ting Kau in the east. The sewerage network, when completed, will collect sewage from the currently unsewered areas. The sewage will be conveyed to the planned TKSTSTW, which will be equipped with chemical treatment plus ultra-violet light or chlorine

(4) Beach Water Quality In Hong Kong 1998, EPD, 1999.

disinfection facilities(5) on the reclaimed land in Sham Tseng. The design and built contract for the planned TKSTSTW shall commence in early 2001. The works shall be completed in late 2003 and upon such time the planned TKSTSTW shall be commissioned. The sewer network for the areas between Tsing Lung Tau and Ting Kau shall be completed by early 2005.

Floating Refuse

A wide variety of floating refuse can be found inside the beach boom line and a quantity may be found washed up on the beaches, ranging from aluminium cans, cigarette butts, polystyrene foam, plastic bags, timber strips and boards. This floating refuse constitutes an eyesore to the public and comprises a nuisance to the bathers.

3.3.3 Water Quality Sensitive Receivers

In order to evaluate the water quality impacts during the construction and operational phases, the proximity of Water Sensitive Receivers (WSRs) to the reclamation site must be considered. These have been identified in accordance with the HKPSG and EIAO-TM, which provide guidance for including environmental consideration in the planning of both public and private developments.

Bathing Beaches

There are 13 gazetted bathing beaches and 2 non-gazetted bathing beaches in the vicinity of the Study Area (as shown in *Figure 3.3c*):

Gazetted Bathing Beaches

- Tung Wan, Ma Wan;
- Gemini Beach;
- Ho Mei Wan Beach;
- Casam Beach;
- Lido Beach;
- Ting Kau Beach;
- Approach Beach;
- Golden Beach;
- New Cafeteria Beach;
- Old Cafeteria Beach;
- Kadoorie Beach;
- Castle Peak Beach; and
- Butterfly Beach.

Since Anglers' Beach will be reclaimed as part of the STD, it has not been considered as a WSR.

(5) Chlorine disinfection is undertaken with an on-site generation of sodium hypochlorite solution by electrochlorinator(s). Chlorine gas will neither be stored nor generated on-site.

Non-gazetted Bathing Beaches

- Dragon Beach; and
- Tsing Lung Tau Beach.

The primary concern for safeguarding water quality at those locations is the presence of pollutants which pose risk to health, such as bacteria and other pathogens. Aesthetic factors should also be maintained at the highest possible level of quality in order to protect the amenity value of such areas. These factors include low water SS concentrations as well as absence of surface oil and floating refuse.

Saltwater Intake at the Sham Tseng Development

A salt water pumping station will be provided to serve the STD. The WSD has indicated that the facility should preferably be located close to the water front. Currently the pumping station is planned to be located at the western end of the promenade at Area 1 *(Figure 3.3d)*. A minimum distance of 100 m separation is provided from the intake of the salt water pumping station and nullah outfall / marine basin. More than 500 m distance is given between the salt water pumping station intake and the TKSTSTW sewage outfall *(Figure 3.3d)*.

Fish Culture Zone

The Ma Wan FCZ located south of the STD *(Figure 3.3c)*, has an area of 46 300 m^2, is a WSR to the proposed reclamation. Water quality impact at the FCZ may be affected by the SS elevation within the water column during construction and increased pollution loadings from Sham Tseng after completion of TKSTSTW and STFSTD.

3.4 ASSESSMENT METHODOLOGY

To assess the potential water quality impacts due to the construction and operation of the STD, the sources and natures of effluent to be generated during construction and operation phases have been identified and their impacts are quantified where practicable.

3.4.1 Construction Phase

Marine-based Impact

The impact of sediment plume dispersion during reclamation activities has been modelled by the Delft3D system developed by Delft Hydraulics. The modelling exercise compared the pre-construction baseline with the model prediction of the worst case dredging and filling activities during the STD reclamation to isolate effects of dredging.

Sediment Plume Modelling Methodology

The sediment plume modelling will be based on the Delft3D Upgraded Model which has been set up, calibrated, validated and transferred to the HKSAR Government.

Sediment transport was modelled with the Delft3D-WAQ module which simulates the process of sediment transport, deposition and erosion for plumes generated during dredging and filling activities. The basis of the model is the advection-diffusion transport. The sediment is transported by the flow (advection) and turbulent mixing (diffusion), and additional processes will be included for modelling various water quality parameters. Details of the model set-up are presented in *Annex C2*.

In the horizontal plane the computational grid sizes are 75 m perpendicular to the main flow direction. In the flow direction a larger grid size of 225 m is used. Overall and detail view of the model grid are shown in *Figure 3.4a.* In the vicinity of the STD, the vertical direction of the model for the sediment dispersion comprise 10 layers, each represents 10% of the total water depth. The required flow data are derived from the output of the hydrodynamic model *(Sections 3.4.2* and *3.6.3).* The baseline model was run under 2007 hydrodynamic simulations, with a complete list of developments[(6)] as shown in *Table 3.4a* in place. The model is repeatedly run over the spring and neap periods under the dry and wet seasons, using the 2007 hydrodynamic simulations, with due consideration of the progress of other reclamation projects, including Tsuen Wan Bay Further Reclamation, the Container Terminal No. 9, the Backfilling at the North Lantau and South Tsing Yi Marine Borrow Areas, and Sand Borrowing at the West Sulphur Channel, in Hong Kong.

Table 3.4a ***The Coastal Development Contributing to Changes in the Hong Kong Coastline by 2007***

Reclamation Projects Completed by 2007
Penny's Bay (though the planned location is now reserved for Hong Kong Disneyland rather than the Container Terminals No. 10 and No. 11)
Container Terminal No. 9
Tang Lung Chau Dangerous Goods Anchorage
Tsuen Wan Bay Further Reclamation Phases 2, 3, 4 and 5
Green Island Development Stages I and II (though the scope and layout of the development is currently subject to further revision)
Siu Lam
Peng Chau Typhoon Shelters
Tseung Kwan O Area 52 and Area 131 South Section
The 6 ha gazetted TKSTSTW reclamation
Sham Tseng Link
Northshore Lantau Development Phase III
Tuen Mun Area 38 Phase 2
Tuen Mun Port Development Phases 3 and 4
Central Reclamation Phase III

(6) Hyder Consulting (1998a), Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool. Report R.7, Specification of Coastline and Bathometry.

Reclamation Projects Completed by 2007
Pak Shek Kok Reclamation
Kowloon Point Phases I and II
South East Kowloon Reclamation Stage I
South East Kowloon Reclamation (other areas)
Green Island Link (Dual 3 laned tunnel - north option)

Source: Hyder Consulting (1998a), Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool. Report R.7, Specification of Coastline and Bathometry.

There are two processes governing sediment transport: Settling of sediment particles and sediment exchange between the water column and the seabed. Settling of sediment particles is described by settling velocity. For the sediment exchange between the water column and the seabed, deposition and erosion are involved. Deposition only occurs when the bed shear stress is below a critical value of t_d whereas erosion only occurs when the bed shear stress is above a critical value of t_e.

$$D = W_s C_b (1 - t / t_d) \quad \text{for} \quad t < t_d$$

$$E = M (t / t_e - 1) \quad \text{for} \quad t > t_e$$

where D = deposition rate
E = erosion rate
W_s = settling velocity
C_b = suspended solid concentration in the bottom layer
t_d = critical shear stress for deposition
M = erosion coefficient = 0.0002 kg m^{-2} s^{-1}
t_e = critical bed shear stress for erosion = 0.4 Pascal

The settling velocity (W_s in metres per day (m d^{-1})) for the released sediment is modelled by the following formula:

$$W_s = \max (3 \text{ m d}^{-1}, 0.864 C)$$

Where C (in g m^{-3}) is the concentration of the released sediment. Under this formula, W_s in a large part of the modelled area will be equal to a minimum value of 3 m d^{-1} except for the area close to the dump locations were higher values are expected. The critical shear stress for resuspension of dumped and dredged material is equal to the critical shear stress of other present sediment material, and is equal to:

$$t_d = 0.25 \text{ N m}^{-2}$$

As a result, accumulation of dumped fine sand on the sea-floor over a spring-neap cycle is absent in most areas. The main driving force for this process of re-suspension is current velocity. Thus, suspended material is mainly removed by horizontal transport. Larger fractions of the fine sand might correspond with higher critical shear stresses and therefore accumulate on the sea-floor. Thus, a worst-case condition with respect to water quality is modelled.

Suspended sediment dispersion and its influence on the DO, unionised ammoniacal nitrogen (NH3-N) and total inorganic nitrogen (TIN) concentrations will also be evaluated using the Delft 3D-WAQ module. The model was set up to simulate the baseline case without STD and without the accompanying loading from the planned TKSTSTW. The hydrodynamics and pollution loadings of the year 2007 were used. The modelling was conducted under dry and wet season conditions over a spring-neap tidal cycle.

At the time the water quality modelling was conducted, the ground investigation, sediment sampling and analysis of the STD had not been conducted. Therefore, it has been agreed with EPD that the EPD sediment quality statistics of VS10 monitoring station *(Table 3.4b)* will be used to determine the Delft3D water quality parameters. In general, the VS10 sediment quality appears to be more contaminated, in terms of heavy metals, than the analytical results of STD marine sediment samples shown in *Annex A,* with an exception of SQ11 and SQ13 sediment data, in which high PCB level at SQ11 and high PCB and PAHs levels at SQ13 are observed. Thus, the modelling approach is considered conservative and would not under-estimate the potential water quality impact associated with dredging.

Table 3.4b *Summary Statistics of Bottom Sediment Quality of Rambler Channel and Castle Peak Bay, 1993-1997*

Determinant and Units	VS10	Classification according to new Technical Circular
Particle Size Fractionation (%w/w)	64 (17-97)	
Electrochemical Potential (mV)	-287 [-13-(-497)]	
Specific Gravity	2.4 (2.1-2.8)	
Total Volatile Solids (%w/w)	7 (2-10)	
Total Solids (%w/w)	45 (33-71)	
Dry Wet Ratio (w/w)	0.4 (0.3-0.7)	
Chemical Oxygen Demand (mg kg^{-1})	190000 (5800-31000)	
Total Carbon (%w/w)	0.7 (0.2-1.3)	
Ammoniacal Nitrogen (mg kg^{-1})	34 (11-77)	
Total Kjeldahl Nitrogen (mg kg^{-1})	390 (120-880)	
Total Phosphorus (mg kg^{-1})	200 (47-350)	
Total Sulphide (mg kg^{-1})	210 (8-600)	
Total Cyanide (mg kg^{-1})	0.1 (0.1-0.2)	
Aluminium (mg kg^{-1})	20000 (5100-32000)	
Arsenic (mg kg^{-1})	8.4 (1.8-15.0)	Contaminated
Boron (mg kg^{-1})	23 (11-32)	
Cadmium (mg kg^{-1})	1.2 (0.1-2.9)	Contaminated
Chromium (mg kg^{-1})	143 (31-270)	Contaminated
Copper (mg kg^{-1})	495 (70-1200)	Contaminated
Iron (mg kg^{-1})	28000 (7300-36000)	
Lead (mg kg^{-1})	57 (17-88)	Contaminated
Manganese (mg kg^{-1})	360 (110-460)	
Mercury (mg kg^{-1})	0.3 (0.1-0.8)	Contaminated
Nickel (mg kg^{-1})	70 (12-140)	Contaminated
Zinc (mg kg^{-1})	199 (49-300)	Contaminated
Polycyclic Aromatic Hydrocarbons (µg kg^{-1})	163 (59-433)	Uncontaminated
Polychlorinated Biphenyls (µg kg^{-1})	11 (5-34)	Uncontaminated

Note: 1. Data presented are arithmetic mean; ranges are enclosed in bracket.
2. Results are based on laboratory analysis of bulk sediment samples which are collected twice per year from each sampling location.
3. All determinants are reported on a dry weight basis unless otherwise stated.

In addition, a conservative tracer modelling (associated with dredging only) was included in the water quality model to predict the potential water quality impact of contaminants released from the contaminated sediment. The release time and duration will be equivalent to the release time and duration of the sediment. By assuming a release rate of the conservative tracer of 100 g per gram of sediment, the concentration pattern of the conservative tracer in the water column gives an indication of the dilution factor. Concentrations of, for example heavy metals, can be assessed by scaling the concentration pattern made by a release of 100 g /g sediment to a measured value of, for example, 100 mg per gram of sediment by multiplying the concentration at a certain point with 0.001.

The impact of the construction activities is represented by a release of suspended sediment and pollutants at the dredging and filling sites. The zone of influence of the suspended sediment concentrations from dredging and filling will be examined by comparison of the same simulation with and without the generation of sediment plumes from the construction of STD.

Further details in the model set-up and implementation aspects of construction sediment plume modelling are presented in *Annex C2.*

Derivation of Scenarios

The construction of the STD will involve dredging of the existing marine mud in limited areas and filling of the reclamation using fill comprising marine sand and public fill *(Table 3.5b)*. The tentative programme for the construction of the reclamation, which corresponds to the Preliminary Implementation Programme (March 2000) and from which the modelling scenarios are derived, is shown in *Figure 3.4b.* The programme indicates which areas are to be dredged and filled at any one time. The dredged mud will be disposed of at a suitable disposal site which will be determined in consultation with the Fill Management Committee. Sand fill will be sourced outside Hong Kong. There are two choices of potential sand fill sources, one is from the Pearl River, and the other is the Weilingding Marine Borrow Area (MBA) in Mainland China waters, to the south of Hong Kong. It is considered that the former one is more likely to be used. Public fill will be sourced within Hong Kong.

During the bulk dredging and marine and public sand filling, a quantity of fine sediment will be lost to suspension which may be transported away from the works area, forming suspended sediment plumes. The formation and transport of such sediment plumes have been assessed using computer modelling of sediment dispersion.

Dredging works will be undertaken with grab dredgers. The assumptions made with regards to modelling grab dredging operations are detailed below.

- A grab dredger with a maximum production rate of 4000 m^3 per day, 6 days a week, 12 hours per day equate to a maximum rate of 0.0926 m^3 s^{-1} during dredging operations.

- The maximum loss rate of each dredger is 2.26 kg s^{-1}.

- The material lost during grab dredging will spread throughout the water column and this will be represented by spreading the sediment evenly over all 10 layers of the model.

- For the purpose of modelling, it was assumed that the dredgers would be working continuously over the 12 working hours and the sediment loss rate will be regarded as a continuous sediment loss over the working hours to simulate the worst case scenario.

- No more than 1 grab dredger will operate on the site at any one time.

Sand and public filling could be carried out by a range of plant but would most likely be by bottom dumping from barges for this Project. The assumptions made with regards to modelling of filling operations are as follows:

- Sand filling (about 3 m thick sand blanket from the marine bottom) will introduce higher water quality impact than public filling (from the top of the sand layer to +5.5 mPD) *(Annex C1)*. Thus, the loss rate of sand filling is used for simulation of filling activities to simulate a conservative worst case.

- The maximum practical filling rate of 5000 m^3 per day will be carried out by ten bottom barges, each with a capacity of 500 m^3.

- Based on the engineering information, the fines content (less than 63 µm) in the sand fill will range from 0 - 30 % by weight, and the worst case (that is, 30 % by weight) is used.

- The dry density of 1700 kg m^{-3} is assumed for sand fill.

- About 4.15 % of the fines will be lost during filling operations *(Annex C1)*.

- The material lost during filling will be spread throughout the depth and this will be represented by the model by spreading the sediment evenly over all 10 layers of the model.

- In each phase of reclamation, dumping will take place at two locations simultaneously. Thus, there will be five dumps for each location and one dump every 145 minutes. Each dump lasts for about 5 minutes.

On the basis of the above the following conservative worst case loss rates have been calculated:

- 10 barge dumps will occur at each phase of construction on each working day. A maximum of about 35 275 kg of fines will be lost from each dump.

Annex C1 presents further details about the derivation of sediment loss rates of dredging and filling that have been agreed by the EPD.

Two scenarios of combined filling and dredging have been simulated. They are summarised in *Table 3.4c.*

Table 3.4c ***Summary of Sediment Dispersion Scenarios***

Scenario	Description	Losses	Figure reference
1	Sand filling by barge dumping at Phase 2 and Phase 3	35 275 kg every 145 minutes at each of the four locations of dumping	3.4c
2	1 grab dredger at Phase 2	2.26 kg s^{-1}	3.4d
	Sand filling by barge dumping at Phase 1	35 275 kg every 145 minutes at each of the two locations of dumping	

Construction Scenario 1 simulates the worst case filling activities that will occur simultaneously at Phase 2 and Phase 3 from end of January to end of July 2005 *(Figure 3.4b).* The total loss of fines from dumping will be about 705 500 kg per day from 20 barge dumpings at Phase 2 and Phase 3. The release points of filling are shown in *Figure 3.4c.*

Construction Scenario 2 represents the scenario of filling and dredging that will occur during overlapping filling activities at Phase 1 and dredging activities at Phase 2 that will be undertaken simultaneously from mid-July to mid-September 2004. Construction Scenario 2 was simulated to model the water quality impact associated with dredging. The total loss of fines from dumping will be about 352 750 kg per day from 10 barges dumping at Phase 1 and total sediment loss rate of dredging at Phase 2 will be about 2.26 kg s^{-1} over the 12 working hours. The release points of filling at Phase 1 and dredging at Phase 2 are shown in *Figure 3.4d.*

Both scenarios were simulated over the wet and dry season spring and neap tides, although Construction Scenario 2 is currently scheduled to take place in wet season.

The construction of seawalls will also involve filling of the foundation trenches. The foundation trenches will be filled with rock material which means that there will be no loss of fines to suspension, and no impacts to water quality.

The above scenarios simulated only dredging and filling at the Site. However, there will be other concurrent external dredging and filling projects which may impact the same areas as the works at the Site. An analysis of external projects which could occur at the same time as the reclamation of STD have found that there will be four projects which could contribute to cumulative impacts. These projects are the Backfilling at North Lantau and South Tsing Yi Marine Borrow Areas, construction of the Container Terminal 9 (CT9), Sand Borrowing at the West Sulphur Channel and the construction of Tsuen Wan

Bay Further Reclamation (TWBFR). The cumulative impacts from these concurrent external projects were determined by summing the results of the worst case tide for Construction Scenario 1 with the results of computer modelling of these projects from earlier EIA studies *(Section 3.6.1).* The Northshore Lantau Development and Green Island Reclamations are not considered in assessing the cumulative impact, as the construction programme of the reclamations and the final reclamation layout, respectively, were not available at the time of STD modelling. Route 10 reclamation will only involve relatively smaller scale of dredging and reclamation such that off-site water quality impact is not expected(7).

Uncertainties in Assessment Methodology

Quantitative uncertainties in the sediment dispersion modelling should be considered when making an evaluation of the modelling predictions. Worst case conditions were adopted as model input in order to provide a conservative prediction of environmental impacts. It is therefore possible that the input data for the relevant parameters may cause an overestimation of the environmental impacts. Some examples of the conservative nature of the input parameters are given below:

- The flow model simulations used for generating the flow data for the sediment dispersion modelling represent the baseline case without any structures present which would result in a greater dispersion of suspended sediment than would occur during construction as seawalls are constructed.

- The highest dredging and filling rates were adopted for sediment plume modelling.

Land-based Impact

The extent of development above the STD was reviewed to assess the impact of the land-based construction activities upon the nearby water bodies. Construction activities likely to impact upon identified freshwater and marine water bodies, WSRs and water courses were identified. Practical water pollution control measures / mitigation proposals *(Section 3.7.1)* have been subsequently recommended to prevent local flooding and to ensure that effluent discharged from the Site will comply with the WPCO criteria.

3.4.2 *Operational Phase*

Hydrodynamic and water quality modelling were carried out to assess the potential impact to the WSRs during the operational phase. Where necessary, mitigation measures to control the impacts to acceptable levels have been recommended.

(7) Route 10 EIA Final Assessment Report, Mott Connell / ERM-Hong Kong, Ltd, September 1999.

Hydrodynamic Modelling During Operational Phase

The Delft3D Upgraded model was used to simulate the tidal flows over the Study Area. The computational grid sizes and layers of the model were explained in *Section 3.4.1.* The findings are presented in *Section 3.4.2.*

In order to assess the changes in the tidal flows between the baseline and completed scenarios, two simulations for 2007, baseline (with TKSTSTW and without STD) and operation (with both TKSTSTW and STD), were carried out. The baseline hydrodynamic model was run with a complete list of developments(8) (including, but not limited to: Penny's Bay (though the planned location is now reserved for Hong Kong Disneyland rather than the Container Terminals No. 10 and No. 11), Tang Lung Chau Dangerous Goods Anchorage, Tsuen Wan Bay Further Reclamation, Northshore Lantau Development, Green Island Development Stages I and II (though the scope and layout of the development is currently subject to further revision), Siu Lam, and Peng Chau Typhoon Shelters, Tseung Kwan O and the 6 ha gazetted TKSTSTW reclamation) in place. For assessing impact of the operation simulation, the STD was added *(Figure 3.4e).* Dry and wet season flows were simulated for both with and without the STD.

In all simulations the water levels and current velocities in the vicinity of the reclamation area were compared, as well as the mass fluxes through Ma Wan Channel and other important channels. To assess the effects of a possible change in the residual flow field, in particular the Study Area, and the HKSAR waters in general, the salinity distributions were compared(9).

Water Quality Modelling During Operational Phase

The impact of effluent discharge from the TKSTSTW and STFSTD was modelled using the Delft3D system that have been described in *Section 3.4.1.* The sources and natures of discharges to the receiving waters to be generated during the operation phase was identified and quantified using conservative possible estimates. Two major sources of pollution were included in the water quality modelling: local pollution (which originated from pollution loading discharges from various outfalls and culverts), and sewage effluent from planned TKSTSTW and STFSTD. Background water quality will be represented by simulating all planned discharges in 2007 and 2012 (10).

Assumptions of the Locations of Effluent Discharges

To assess the water quality impact caused by the STD, baseline and operation water quality modelling simulations were undertaken. The difference between the baseline and operation simulations are the sewage loading from the increased population of the STD and, thus, show the impacts directly attributable to the STD. The effluent from the planned TKSTSTW and STFSTD was assumed to discharge at the planned TKSTSTW Outfall or its Emergency

(8) Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool. Report R.7, Specification of Coastline and Bathometry, Hyder Consulting (1998a).
(9) Final Assessment of HD Effects, Planning and Engineering Feasibility Study for Development on Sham Tseng Further Reclamation, CED, November 1998.
(10) *Pollution Loading Inventory Report*, WL Delft Hydraulics, November 1999.

Bypass (during operational failure). The environmental assessment of the proposed combined sewage outfall has been prepared and presented in Annex I.

Modelling Scenarios

- Global Modelling

During the operation of the STD, the major pollution source will be SSDS. Other pollution sources near the STD include sewage discharge from the planned TKSTSTW, and contaminated stormwater and drainage discharges from Sham Tseng East and West Nullahs. The SSDS is divided into four stages. The operation of SSDS Stage I will commence in 2001 and SSDS Stages II, III and IV will be in operation by 2011. The SSDS Stage I Interim Outfall will be closest to the STD whereas the SSDS Stages II, III and IV long submarine outfall (south of Lamma Island) will be much further from the STD. Since the SSDS is divided into two implementation years, two scenarios will be modelled. One (Scenario A) is in 2007 when the SSDS Stage I and STD are in operation. Another (Scenario B) is in 2012 after SSDS Stages I, II, III and IV as well as the STD are in operation. The difference in pollution loadings between the two scenarios are the pollution loadings from the SSDS.

Global modelling will be carried at the planned TKSTSTW Outfall (Start of Diffuser 824739.482E 824869.557 N, -22.3 mCD; End of Diffuser 824746.124E 824820.000N, -22.3 mCD), which make up four simulations (2 baseline and 2 operational). Results of the modelling were presented in contour plots (global and local scale) and statistical results *(Section 3.6.2)*. The scenarios are summarised in *Table 3.4d.* The Delft3D Water Quality Model will be used for global modelling to simulate the water quality impact over the spring-neap tidal cycle of the dry and wet seasons.

- Near Field Modelling

In addition to the planned TKSTSTW Outfall, an Emergency Bypass (824734.519E 824943.893N, -22.3 mCD, located at the seawall) would be used to divert raw sewage in case of any operation failure in the TKSTSTW. Near field modelling was carried out for both outfalls to examine the potential impact to nearby WSRs. Since pollution loading of SSDS would not have major impact on the dispersion pattern of the planned TKSTSTW Outfall and the Emergency Bypass, the near field modelling was carried out using pollution loadings from planned TKSTSTW and STFSTD only. Therefore, 4 simulations (2 baseline and 2 operational) were conducted. The model setting of these simulations are summarised in *Table 3.4d.*

The Delft3D-PART module, which is part of the Delft3D modelling suite, was used for near-field modelling, over the spring-neap tidal cycle of the dry and wet seasons. The initial plume rise was assessed with the Jet3D model. Input for the latter model comprised the ambient salinity, current speed and the physics of the diffuser (flow rate and velocity, nozzle properties). The initial plume rise modelling provides information on the dilution and dispersion of the discharge in the direct vicinity of the planned TKSTSTW Outfall and the Emergency Bypass. The results will specify the location of the planned

TKSTSTW Outfall or the Emergency Bypass in the near-field modelling. Delft3D-PART simulates the dispersion of the plume on a larger scale and makes use of the particle tracking technique. With Delft3D-PART, it is possible to assess concentration patterns on a grid size that is much smaller than the grid size adopted.

Only *E. coli* will be modelled in the near field modelling. *E. coli* is subject to first order decay, which can vary over the day. No light extinction was modelled in the Delft3D-PART, so the mortality of *E. coli* did not depend on extinction of UV radiation. An extinction coefficient varying over the day, partly replaces this.

The impact of residual chlorine discharged with the effluent after the chlorine disinfection process will also be evaluated using the near field modelling result of *E. coli,* although the impact is likely to be minimal as residual chlorine decays rapidly in the marine water.

Output will be generated both for spatial distribution patterns (contour plots) and time-history plots at nearby WSRs.

Model Settings

To evaluate the difference in water quality at Sham Tseng due to implementation of SSDS Stages I, II, III and IV, both Scenarios A and B will adopt the 2007 hydrodynamics (that is, there will no difference between Scenarios A and B in terms of hydrodynamics and the layout of the coastline). However, Scenario B will use the pollution loadings in 2012.
One of the WSR, the Marine Basin within the STD is too small to be included in the hydrodynamics and is therefore not included in the modelling. However, statistics of water quality parameters were computed at the seawall just outside the Marine Basin to indicate possible water quality impact within the Marine Basin.

Table 3.4d provides a summary of all the operational water quality modelling scenarios.

Table 3.4d   STD Operational Water Quality Modelling Scenarios

Details	Scenario A	Scenario B
Base Year	2007 Dry Season (Oct-Feb) 2007 Wet Season (May-Aug)	2012 Dry Season (Oct-Feb) 2012 Wet Season (May-Aug)
Hydrodynamics and Pollution Loading to be used	2007 hydrodynamics, 2007 pollution loadings	2007 hydrodynamics (with coastline same as Scenario A), 2012 pollution loadings
Global Modelling		
Baseline Simulation	Baseline 1 Local pollution loading SSDS Stage I Planned TKSTSTW loading (via TKSTSTW Outfall) (16 500 m^3 per day) STD not included	Baseline 2 Local pollution loading SSDS Stages I, II, III and IV Planned TKSTSTW loading (via TKSTSTW Outfall) (16 500 m^3 per day) STD not included
Operational Simulation	Operational 1 Local pollution loading SSDS Stage I Planned TKSTSTW loading and STFSTD (via TKSTSTW Outfall) (20 092 m^3 per day) STD included	Operational 2 Local pollution loading SSDS Stages I, II, III and IV Planned TKSTSTW loading and STFSTD (via TKSTSTW Outfall) (20 092 m^3 per day) STD included
Modelling Output Parameters	Salinity, SS, BOD, Unionised NH3-N, TIN, Chlorophyll-*a*, DO, and *E. coli*	
***Near Field Modelling (2007 only)**(A)*		
Baseline Simulation	Baseline 3 Planned TKSTSTW loading (via TKSTSTW Outfall) (16 500 m^3 per day) STD not included	-
	Baseline 4 Planned TKSTSTW loading (via Emergency Bypass at seawall) (16 500 m^3 per day) STD not included	-
Operational Simulation	Operational 3 Planned TKSTSTW loading and STFSTD (via TKSTSTW Outfall) (20 092 m^3 per day) STD included	-
	Operational 4 Planned TKSTSTW loading and STFSTD (via Emergency Bypass at seawall) (20 092 m^3 per day) STD included	-
Model Coverage	Waters at Tsuen Wan, Sham Tseng, Tsing Lung Tau and Ma Wan	-
Modelling Output Parameters	*E. coli*	-

Note: (A) Since Near Field Modelling only includes pollution loading from the Planned TKSTSTW and STFSTD, no scenario from 2012 is required.

(B) Due to the increase in target population, the flow rate 20 092 m^3 has been updated after the water quality modelling. The revised flow rate and modelling projection are described in Pg 3-28 under the section "Increase in Population.

Pollution Loadings for Model Inputs

Since the maximum capacity of the planned TKSTSTW and the maximum sewage loadings at the STD to be dealt by the STFSTD are assumed in both 2007 and 2012, the pollution loading from the planned TKSTSTW and STFSTD will be identical in both scenarios. The water quality in the 2012 scenario will be assessed by adopting the 2007 hydrodynamics and 2012 pollution loadings. In this way the effect of the replacement of the SSDS Stage I with the SSDS Stages II, III and IV with a long submarine outfall south of Lamma Island can be evaluated.

The total capacity of the TKSTSTW in baseline and operational simulations are 16 500 m^3 per day (without STFSTD) and 20 092 m^3 per day (with STFSTD), respectively. The derivation of the pollution loadings is shown in *Annex C3*.

The removal efficiency of the TKSTSTW represents the planned treatment of the treatment works. In addition, the pollution loading of *E. coli* was estimated based on the effluent standard specified in the discharge license of the planned TKSTSTW, that is, 4000 counts per 100 mL (monthly geometric mean). Breakdown of each respective effluent pollutant loadings in each simulation are presented in *Table 3.4e*.

Table 3.4e ***Effluent Loading from the TKSTSTW (via TKSTSTW Outfall)***

Loading Factors / Units	**Removal Efficiency (% reduction)**	**Baseline Pollution Loading (Planned TKSTSTW) (Baseline 1, 2 and 3)**	**Operation Pollution Loading (Planned TKSTSTW + STFSTD) (Operational 1, 2 and 3)**
Flow (m^3 per day)	not applicable	16500	20092
SS (kg per day)	75.74	825	965.981
BOD_5 (kg per day)	58.75	1485.0	1777.4
NH_3-N (kg per day)	10	292.5	347.7
Org-N (kg per day)	25	123.8	159.0
PO_4-P (kg per day)	60	17.7	19.6
Total P (kg per day)	60	29.7	33.0
Si (kg per day)	0	297.0	361.7
E. coli (cfu per day)	not applicable	6.600E+11	8.037E+11

Under emergency conditions (Baseline 4 and Operational 4 Scenarios), the removal efficiency of the TKSTSTW is assumed to be zero.

Increase in Population

Following the completion of the Operational Simulation modelling, using the input parameters described above, the estimated population for private developments on the proposed reclamation served by TKSTSTW and STFSTD was increased from 6020 to 8370. This has meant the operational flows from the TKSTSTW and STFSTD will increase from 20 092 m^3 day^{-1} to 21 010 m^3 day^{-1}, which is a 18.5% increase from that assumed previously. It is assumed that the concentrations of pollutants in the treated effluent will remain unchanged and therefore the effluent loading will accordingly increase by the same percentage as the flows.

As the increase in flows and loads is only a small percentage EPD have agreed, it will not be necessary to carry out additional water quality modelling and the assessment has been based on a pro-rata calculation of the existing water quality modelling results for the various water quality modelling parameters. The pro-rata calculation has been carried out as follows.

N = [((21010-16500)/(20092-16500))x(Op - baseline)] + baseline

where N = pro-rata water quality result for increased flow rate
Op = previous operational water quality result
baseline = baseline water quality result

The above described calculation method has been applied to the statistical output at the 26 monitoring stations, shown in *Tables 3.6l* to *3.6o*. The results from the global modelling have also been presented as contours of various water quality parameters. The effects of the increased flows on these contour plots are discussed in a qualitative manner, which is appropriate given the small percentage increase in flows. Similarly the results of the near field modelling are presented as contour plots of *E. coli* concentrations. The changes to these results from the increased flows will be similarly discussed.

Table 3.4f summarises the revised flow and load estimations based on the updated population. Annex C4 shows the revised sewage loading factors of the TKSTSTW.

Table 3.4f *Revised Effluent Flow and Loading from the TKSTSTW (via TKSTSTW Outfall) based on the Updated population.*

Loading Factors / Units	Removal Efficiency (% reduction)	Baseline Pollution Loading (Planned TKSTSTW)	Operation Pollution Loading (Planned TKSTSTW + STFSTD)
Flow (m^3 per day)	not applicable	16500	21028
SS (kg per day)	75.74	825	989.28
BOD_5 (kg per day)	58.75	1485.0	1819.0
NH_3-N (kg per day)	10	292.5	358.5
Org-N (kg per day)	25	123.8	165.3
PO_4-P (kg per day)	60	17.7	20.2
Total P (kg per day)	60	29.7	33.9
Si (kg per day)	0	297.0	378.5
E. coli (cfu per day)	not applicable	6.600E+11	8.411E+11

Uncertainties in Assessment Methodology

Quantitative uncertainties in the modelling should be considered when making an evaluation of the modelling predictions. Worst-case conditions, the maximum discharge rate of the TKSTSTW were adopted as model input in order to provide a conservative prediction of the environmental impacts. It is therefore possible that the input data for the relevant parameters may cause an overestimation of the environmental impacts.

3.5 IDENTIFICATION OF HYDRODYNAMIC, WATER AND SEDIMENT QUALITY IMPACT

3.5.1 Construction Phase

Dredging and Filling

[SJW1]

Potential water quality impacts may occur from dredging and filling activities. According to the tentative reclamation programme is shown in *Figure 2.7a*, the reclamation is divided into four phases and the reclamation programme is shown in *Table 3.5a.*

Table 3.5a *Tentative Reclamation Programme*

Phase	Date by which reclamation works	
	starts	ends
1	November 2004	December 2005
2	December 2005	January 2008
3	March 2006	October 2007
4	December 2005	December 2008

It has been assumed that the public fill material will be applied over the construction site. The fill will be brought in by barges and trucks.

The estimated volume of the dredged uncontaminated marine sediment *(Section 6.4.2)* from seawall foundation and nullah decking, and fill material is listed in *Table 3.5b*.

Table 3.5b *Estimated Volume of Dredged and Fill Material*

Type	Volume (m^3)
Dredged Material	
For seawall foundation works	227 000
For marine basin works	127 000
Fill Material	
Sand Fill	205 000
Public Fill	1 230 000
Rock Fill	622 500

Water quality impacts may arise from the construction activities of the STD by dredging for foundations of seawall and extended nullahs, general filling and public filling due to the following activities:

- dredging and filling works that will disturb the marine bottom sediment, elevate the SS concentrations of the water column and generate sediment plume along the tidal flows;
- stormwater discharges (that may be contaminated with debris and oil / grease left on the ground, and organic matter from expedient connections of the restaurants and local industries near Sham Tseng Tsuen) into the temporary embayed water body formed by partially completed reclamation;
- construction runoff and drainage, with effluents potentially contaminated with silt, oil and grease; and
- poor handling and disposal of refuse generated from construction activities, resulting in floating refuse along the drainage.

Potential impacts on water quality from dredging and filling will vary according to the quantities and level of contamination, as well as the nature and locations of the WSRs at or near the dredging sites. These impacts are summarised as follows:

- suspension of solids in the water column during dredging activities, with possible consequence of reducing DO levels and increasing nutrient levels;

- release of previously bound organic and inorganic constituents such as heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and nutrients into the water column, either via suspension or by disturbance as a result of dredging activities, or depositing of fill materials; and

- release of the same contaminants due to leakage and spillage as a result of poor handling and overflow from barges during dredging and transport.

All of the above can result in deterioration of the receiving marine water quality and may have adverse effects on WSRs.

Suspended Sediment

The depth of the seabed within the proposed reclamation area generally ranges from 0 to 15 m. Although it is presently envisaged that the majority of the contaminated mud will be left in place to minimise disturbance to the marine environment, it is likely that some marine mud will still be dredged along the line of the STD seawalls and extend nullahs for geotechnical stability purposes.

As a result of dredging and filling activities during the construction phase, fine sediment (less than 63 µm) will be lost to suspension. The suspended sediment will be transported by currents to form sediment plumes, which will gradually resettle. The impact from sediment plumes is to increase the suspended sediment concentrations, and cause non-compliance in WQO and other criteria for particular sensitive receivers.

Any sediment plumes will cause the ambient suspended sediment concentrations to be elevated and the extent of elevation will determine whether the impacts is adverse or not. The determination of the acceptability of any elevation is based on the Water Quality Objectives. The WQO is defined as being an allowable elevation of 30% above the background. EPD maintains a flexible approach to the definition of ambient levels, preferring to allow definition on a case-by-case basis rather than designating a specific statistical parameter as representing ambient. As directed in a previous study of the environmental impacts of released SS[11], the ambient value has been assumed to be represented by the 90th percentile of reported concentrations. EPD routine monitoring data has been used as the source of reported concentrations, with the station nearest to each of sensitive receivers being defined as representative of that station. EPD monitoring data and calculated WQOs are summarised in *Table 3.5c.*

Table 3.5c *Ambient and 30% Tolerance Levels for SS (mg L^{-1}) for Sensitive Receivers*

Sensitive Receiver (Relevant EPD Monitoring Station)	**Dry Season**		**Wet Season**	
	90th Percentile	**30% Increase**	**90th Percentile**	**30% Increase**
Tsing Lung Tau Beach (NM1)	8.80	2.6	5.43	1.6
Castle Peak Beach Golden Beach Kadoorie Beach New Cafeteria Beach Old Cafeteria Beach (NM2)	8.07	2.4	10.24	3.1
Butterfly Beach (NM3)	28.51	8.6	8.49	2.6
Castle Peak Power Station Intake 1 Castle Peak Power Station Intake 2 (NM5)	12.63	3.8	12.27	3.7
WSD Tsing Yi Saltwater Intake SSDS Phase I Intake MTRC Tsing Yi Station Intake (VM13)	9.27	2.8	10.56	3.2
WSD Tsuen Wan Saltwater Intake (VM14)	7.88	2.4	6.95	2.1
Rambler Typhoon Shelter (VT7 and VT8)	19.39	5.8	13.73	4.1
Approach Beach Casam Beach Dragon Beach Gemini Beach Hoi Mei Beach Lido Beach Ting Kau Beach Tung Wan Beach Ma Wan Fish Culture Zone (WM4)	19.67	5.9	6.95	2.1

The WQO of SS for a particular site corresponds to the 30% tolerance plus the ambient level. The predicted maximum values from the sediment dispersion modelling will be compared with the 30% tolerance values in the above table to determine the acceptability of the impacts.

In addition to the above criteria for SS, the water intakes which have been defined as sensitive receivers have specified SS criteria to protect abstraction systems and maintain appropriate water quality for the designated use. The SS concentrations at the cooling water intakes for the Castle Peak Power Station should be maintained below 150 mg L^{-1}, while at the Tsing Yi and Tsuen Wan WSD salt water intake a criterion of 10 mg L^{-1} total SS concentration is applied. In addition to these criteria a pragmatic approach of

(11) ERM-Hong Kong Ltd (1997). Environmental Impact Assessment for the Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit. Final Report, under CED Contract No. CE 81/95, January 1997.

controlling SS concentrations to below 20 mg L^{-1} at flushing and cooling water intakes has been used on a number of other projects in and around, the Victoria Harbour. This approach was accepted by WSD and has most recently been adopted for the EIA for *Dredging an Area of Kellett Bank for Reprovisioning of Six Government Mooring Buoys.* For cooling water intakes of SSDS Stage I and MTRC Tsing Yi Station, the threshold of 140 mg L^{-1} SS concentration is used a guide(12). This recommendation has also been proposed in the West Rail Final Assessment Report (West Kowloon to Tuen Mun Centre), February 1998. It should be noted that requirements may vary according to different cooling water users.

Water Quality Impact

Organic and inorganic contaminants may also be released from the sediment to the receiving waters during dredging. Bottom sediments are collected at various locations where dredging will be undertaken for the foundations of seawall and the extended nullahs. The sediment quality analysis of the collected samples are reported in *Annex A.* The results indicated that with the exception of the sediment samples collected near the mouth of the Western Nullah (SQ13), all the sediment samples collected over the Site were uncontaminated (below the lower chemical exceedance level) in accordance with WBTC No. 3/2000, which means that the sediment contained low levels of heavy metals. The SQ13 (0.9 m - 1.8 m) sample was contaminated (above the upper chemical exceedance level) with heavy metals. The sample also contained TIN upto 76 mg per kg of sediment. It is considered that these contaminants originate from the polluted stormwater and expedient connections discharging along the Western Nullah.

Bottom sediments are also collected at four locations where dredging will be undertaken for seawall foundation (SQ5 and SQ7) and for extended nullah construction (SQ11 and SQ13), for elutriate testing which measures the potential of organic micro-pollutants released from marine mud when disturbed. The organic micro-pollutants measured include PCBs and PAHs. Heavy metals, ammoniacal nitrogen, nitrate and nitrite nitrogen (NOx-N), TIN and TBT are also included in the test. The elutriate test results are presented in *Table 3.5d.*

(12) West Rail Final Assessment Report, West Kowloon to Tuen Mun Centre, Environmental Impact Assessment, ERM, 1998

Table 3.5d Elutriate Test Results

Vibrocore	Sampling Depth (m)	Ag (µg L^{-1})	As (µg L^{-1})	Cd (µg L^{-1})	Cr (µg L^{-1})	Cu (µg L^{-1})	Ni (µg L^{-1})	Pb (µg L^{-1})	Zn (µg L^{-1})	Hg (µg L^{-1})	NH3-N (mg L^{-1})	NOx-N (mg L^{-1})	TIN (mg L^{-1})
SQ5	0.0 - 0.4	< 10	< 100	< 2	< 10	< 10	< 10	< 10	< 100	< 2	0.09	0.27	0.36
SQ7	0.0 - 0.9	< 10	< 100	< 2	< 10	< 10	< 10	< 10	< 100	< 2	0.12	0.19	0.31
SQ7	0.9 - 1.8	< 10	< 100	< 2	< 10	< 10	< 10	< 10	< 100	< 2	0.13	0.19	0.32
SQ11	0.6 - 0.9	< 10	< 100	< 2	< 10	< 10	< 10	< 10	< 100	< 2	0.11	0.19	0.3
SQ11	0.9 - 1.8	< 10	< 100	< 2	< 10	< 10	< 10	< 10	< 100	< 2	0.11	0.18	0.29
SQ13	0.46 - 0.9	< 10	< 100	< 2	< 10	< 10	< 10	< 10	< 100	< 2	9.84	0.17	10.0
SQ13	0.9 - 1.8	< 10	< 100	< 2	< 10	< 10	< 10	< 10	< 100	< 2	6.13	0.11	6.24
LOR		10	100	2	10	10	10	10	100	2	0.01	0.01	0.01

Table 3.5d Elutriate Test Results (cont.)

Analysis Description	Units	LOR	SQ5 (0.0 - 0.4 m)	SQ7 (0.0 - 0.9 m)	SQ7 (0.9 - 1.8 m)	SQ 11 (0.6 - 0.9 m)	SQ11 (0.9 - 1.8 m)	SQ13 (0.46 - 0.9 m)	SQ13 (0.9 - 1.8 m)
POLYNUCLEAR ARMOATICS									
Naphthalene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Acenaphthylene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Acenaphthene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Fluorene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Phenanthrene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Anthracene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Fluoranthene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Pyrene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Benz(a)anthracene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Chrysene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Benzo(b) & (k)fluoranthene	µg L^{-1}	4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Benzo(a)pyrene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Indeno(1.2.3-cd)pyrene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Dibenz(a.h)anthracene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Benzo(g.h.i)perylene	µg L^{-1}	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Low M. W. PAHs	µg L^{-1}	20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
High M. W. PAHs	µg L^{-1}	30	< 30	< 30	< 30	< 30	< 30	< 30	< 30
Total PAHs	µg L^{-1}	50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Total Polychlorinated Biphenyl	µg L^{-1}	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Tributyltin - Soluble	ng-Sn L^{-1}	15	< 15	< 15	< 15	< 15	< 15	< 15	< 15

Low concentrations (that is, lower than the detection limit of the test) of PAHs, PCBs, TBT and heavy metals are detected in the elutriates, indicating that these pollutants are not readily released from the sediment even under disturbance. High concentrations of ammoniacal nitrogen (0.09 to 9.84 mg L^{-1}), NOx-N (0.11 to 0.27 mg L^{-1}) and TIN (0.30 to 10.0 mg L^{-1}) are observed, particularly the bottom sediment samples from SQ13 where high content of nitrogen pollutants is also observed *(Annex A).* The results indicate that the nitrogen pollutants have higher potential to be released from the sediment that will be dredged near the mouth of Sham Tseng West Nullah than other locations.

Any elevated sediment suspension levels can lead to oxygen depletion in the water column. This may arise from the oxygen demand of the contaminated bottom sediment that is resuspended during dredging. In addition, elevation of SS will reduce light penetration of marine water, the rate of photosynthesis of algae, and, thus, the rate at which oxygen is produced in the water column. Furthermore, the associated decrease in primary production will reduce the uptake of nutrients from the water column. Similarly, the increase in SS in the water column results in more energy from sunlight being retained, which increases the temperature. This also acts against oxygen levels as oxygen is more soluble in colder water.

Uncontaminated marine sand and inert public fill will be used as filling materials, thus, as discussed earlier in this section, the potential water quality impact associated with sand filling and public fill will be limited to elevated SS levels.

Sediment Pore Water

In areas where marine sediments are not dredged and left in place, pore water may be forced out of the sediment matrix during compaction and consolidation, resulting in the release of contaminants into the water column.

Based on the results of the pore water analysis presented in *Central Reclamation Phase III* (CRIII), TDD (1997), pore water contains relatively much lower concentrations of heavy metals than marine mud. Heavy metals such as mercury, cadmium and copper are strongly chemically associated with the clay fraction and organic material in the sediments and thus do not readily enter the sediment pore water (also shown from the elutriate test results). In addition, the pore water released from marine mud may be absorbed by sandfill layer on the top of the marine mud. It is therefore considered that the impact on the receiving waters from expelled pore water contamination is not a key concern.

Stormwater Discharges

Stormwater discharges from the reclamation will be via the water courses that are fed by the two Sham Tseng Nullahs and Pai Min Kok Stream, which will be properly sewered by 2005 *(Section 3.3.1).*

Stormwater and drainage discharges from construction site 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 sewer or natural drainage without mitigation.

Construction Runoff and Drainage

Sewage generated from construction activities may contain increased loads of SS and contaminants. Potential water quality from site run-off may come from:

- contaminated ground water from any dewatering activities as a result of evacuation and disturbance of contaminated sediments;
- 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.

General Construction Activities

The general construction works which will be undertaken for the roads and infrastructures will be primarily land-based and may have the potential to cause water pollution. These could result from the accumulation of solid and liquid waste such as packaging and construction materials, sewage effluent from the construction workforce, discharge of bilge water and spillage of oil, diesel or solvents by vessels and vehicles involved with the construction. If uncontrolled, any of these could lead to deterioration in water quality. Increased nutrient level result from contaminated discharges and sewage effluent could also lead to a number of secondary water quality impacts including decreases in DO concentrations and localised increase in ammoniacal nitrogen concentrations which would stimulate algal growth and reduction in oxygen levels.

Sewage will arise from sanitary facilities provided for the on-site construction work force. It is characterised by high level of BOD_5, ammoniacal nitrogen and *E. coli* counts. These will be no public sewers available for domestic sewage discharge on-site.

3.5.2 Operation Phase

Based on the review of the proposed operational STD land uses, it has been determined that operational water quality impacts may be found in the following areas:

- changes to tidal current patterns;
- effluent discharge impacts (from drainage and sewage); and
- floating refuse.

Hydrodynamics and Water Quality Impact

The formation of the STD may have impact on the water levels, current velocity, tidal discharge as well as the salinity patterns at the vicinity of STD and, potentially, over a larger area. In addition, the formation of the STD area may change the hydrodynamics that affect the pollutant distribution patterns in surrounding waters.

Drainage and Sewage

The proposed drainage layout is shown in *Figure 3.3b*(13). No cooling water discharge impact is anticipated as no such facilities are located within the STD. Currently there is no record of past flooding in the vicinity of the development site(14). However, the formation of the STD will cause adverse drainage impact, if adequate diversion of the existing drainage and installation of the drainage system above the STD are not carefully planned. To assess whether the STD may have impact on the existing drainage systems, the existing capacity of the Sham Tseng East and West Nullahs *(Figure 3.3b)* were checked. A hydraulic modelling exercise was carried out using the HEC2 programme(15). Hydraulic analysis were undertaken for the Sham Tseng East and West Nullahs.

The planned TKSTSTW is located at the eastern side of the STD, which consists of a submarine outfall extending to the south of the TKSTSTW *(Figure 3.5a)*. The outfall is 160 m long, with five diffuser ports, each with a port diameter of 220 mm at a spacing of 15 m (16). To handle the increased sewage generated by the new population from the STD, additional sewage treatment facilities is required. Sewage discharge from the TKSTSTW will impact the water quality near the outfall and the sensitive receivers adjacent to the STD. For the purpose of this Study, the STFSTD will only cater for the sewage generated by the STD, and will be independent from the planned TKSTSTW, but will share the same outfall and emergency bypass.

Floating Refuse

The formation of STD may create areas for floating refuse accumulation, affecting the aesthetic quality of the marine water.

3.6 PREDICTION AND EVALUATION OF HYDRODYNAMICS, WATER AND SEDIMENT QUALITY IMPACT

3.6.1 Construction Phase

Simulation Results of Dredging and Filling

Two sediment dispersion scenarios were modelled, as defined in *Table 3.4c*, which simulated dredging and filling at the construction site of the STD. Cumulative analysis was carried out based on the results and information

(13) Agreement No. CE 93/97, Planning and Engineering Feasibility Study for Development on Sham Tseng Further Reclamation, Draft Engineering - Final Report, August 1999.
(14) Agreement No. CE 93/97, Planning and Engineering Feasibility Study for Development on Sham Tseng Further Reclamation, Draft Engineering - Final Report, August 1999.
(15) Agreement No. CE 93/97, Planning and Engineering Feasibility Study for Development on Sham Tseng Further Reclamation, Draft Engineering - Final Report, August 1999.

(16) Ting Kau and Sham Tseng Sewerage Scheme, Sewage Treatment and Disposal Facilities, Addition Study on Outfall Alignment Final Report, Agreement No. CE 67/94, Montgomery Watson, DSD, September 1997.

provided from earlier studies [17], [18].
The results of each scenario have been presented as absolute values of maximum and tidal averaged depth-averaged SS concentrations, absolute values of maximum and tidal averaged DO, NH3-N, and TIN. Baseline contours of each parameters are also simulated for comparison. These results are contained within *Annex D1* of this Report. Temporal variations of SS at various sensitive receivers are also contained within *Annex D2* of this Report.

(i) Suspended Solids (SS)

Construction Scenario 1

Construction Scenario 1 simulated the maximum possible filling rate which could occur at the reclamation site. This scenario was simulated for the four representative tide types which could occur in Hong Kong. The maximum concentrations which could occur at the sensitive receivers are shown in *Table 3.6a* for the dry season and wet season.

The results shown in *Table 3.6a* indicate few exceedances of the WQOs at those beaches adjacent to the STD and at Castle Peak Bay. Dragon Beach is about 500 m away from the STD and the water quality impact is predicted to be highest. The results presented in *Table 3.6a* demonstrate that the dry season tides generally produce higher impacts to sensitive receivers than the wet season tides. Thus, mitigation measures such as filling behind the seawall and re-scheduling of construction programme should be considered.

The construction contours presented in *Annex D1* show the SS concentration under tidal average and tidal maximum conditions of the dry and wet seasons. The tidal average represents a general picture of SS concentrations during a complete spring-neap tidal cycle. The tidal maximum represents the maximum SS concentration predicted during the spring-neap tidal cycle. It should be noted that the scenario is simulated without the seawalls of STD. In practice, filling will likely take place behind the seawalls and the simulation results are, therefore, representing the unmitigated construction water quality impact.

As shown from the contours *(Annex D1)*, sediment plumes are predicted to disperse along Ma Wan Channel and Rambler Channel. Temporal variations of SS elevation at various WSRs *(Figures D2-1* to *D2-6* of *Annex D2)* indicate that the SS elevations at Dragon Beach and Gemini Beach, which are closer to the reclamation area, are larger than the SS elevations at Ma Wan FCZ, SSDS intake, Tsuen Wan Salt Water Intake, and Tung Wan Beach which are further away from the reclamation area. Exceedance of WQO SS tolerance level at Dragon Beach and Gemini Beach are predicted. *Figures 4.2b* and *4.2f* of *Annex D2* show the predicted SS levels at WSD salt water intake at Tsuen Wan and SSDS Stage I Intake, respectively. For the temporal variation of SS concentration at WSD Tsuen Wan Salt Water Intake, 'spikes' of SS elevations that exceed the recommended threshold (20 mg L^{-1}) of WSD SS criterion and last for few hours are predicted during the wet season. Mitigation measures during sandfilling *(Section 3.7.1)* are therefore required to minimise the

(17) Environmental Impact Assessment: Dredging an Area of Kellett Bank for Reprovisioning of Six Government Mooring Buoys, ERM, March 1999.
(18) Tsuen Wan Bay Further Reclamation EIA Final Assessment Report, Maunsell Consultants Ltd., January 1998.

impact. The SS concentration at the SSDS intake is predicted to remain below the recommended 140 mg L^{-1} threshold level.

As shown in *Table 3.6a*, exceedances of WQO tolerance levels are predicted with the STD reclamation works alone and considered unacceptable. Thus, mitigation measures during dredging and sandfilling *(Section 3.7.1)* are therefore required to minimise the impact, which will also minimise the cumulative impact of concurrent projects.

Construction Scenario 2

Construction Scenario 2 simulated the filling activities at Phase 1 and dredging activities at Phase 2 that would occur simultaneously during construction. This scenario was simulated for the four representative tide types which could occur in Hong Kong. The maximum concentrations which could occur at the sensitive receivers are shown in *Table 3.6b* for the dry season and wet season.

Table 3.6a Maximum Suspended Sediment Concentrations above Ambient (mg L^{-1}) at Sensitive Receivers for Construction Scenario 1

Sensitive Receiver	Dry Season				Wet Season			
	WQO Tolerance	Maximum SS	Average SS	% of Exceedance (1)	WQO Tolerance	Maximum SS	Average SS	% of Exceedance (1)
Tsing Lung Tau Beach	2.6	8.6	3.0	45.4	1.6	4.9	1.3	47.0
Castle Peak Beach	2.4	1.0	0.7	0	3.1	0.5	0.2	0
Golden Beach	2.4	4.5	2.6	43.0	3.1	2.1	0.9	0
Kadoorie Beach	2.4	3.6	1.7	5.2	3.1	1.8	0.6	0
New Cafeteria Beach	2.4	5.2	2.3	27.5	3.1	1.7	0.9	0
Old Cafeteria Beach	2.4	3.3	2.0	20.6	3.1	1.7	0.8	0
Butterfly Beach	8.6	2.4	1.5	0	2.6	1.3	0.6	0
Castle Peak Power Station Intake 1	3.8	2.0	0.8	0	3.7	1.0	0.4	0
Castle Peak Power Station Intake 2	3.8	2.2	0.9	0	3.7	1.1	0.6	0
WSD Tsing Yi Saltwater Intake	-	3.0	2.0	0	-	2.8	1.5	0
SSDS Phase I Intake	2.8	2.7	2.0	0	3.2	2.7	1.4	0
MTRC Tsing Yi Station Intake	2.8	2.9	2.0	1.0	3.2	2.7	1.6	0
WSD Tsuen Wan Saltwater Intake	-	3.5	2.2	0	-	2.9	1.7	0
Rambler Typhoon Shelter	5.8	2.7	1.9	0	4.1	2.1	1.4	0
Approach Beach	5.9	4.2	2.4	0	2.1	3.5	1.7	14.2
Casam Beach	5.9	4.7	2.4	0	2.1	3.0	1.5	10.4
Dragon Beach	5.9	14.9	3.5	14.9	2.1	13.9	2.0	26.2
Gemini Beach	5.9	9.2	2.6	4.7	2.1	8.0	1.7	11.4
Hoi Mei Wan Beach	5.9	4.7	2.3	0	2.1	2.9	1.5	8.9
Lido Beach	5.9	4.3	2.4	0	2.1	3.1	1.5	11.8
Ting Kau Beach	5.9	3.8	2.5	0	2.1	3.1	1.6	9.3
Tung Wan Beach	5.9	2.5	1.7	0	2.1	1.3	1.0	0
Ma Wan Fish Culture Zone	5.9	3.7	2.0	0	2.1	1.5	1.0	0

Note: Shaded areas indicate exceedance of the WQOs

(1) Percentage of time over a spring-neap period during which WQO tolerance is exceeded.

Table 3.6b Maximum Suspended Sediment Concentrations above Ambient (mg L^{-1}) at Sensitive Receivers for Construction Scenario 2

Sensitive Receiver	Dry Season				Wet Season			
	WQO Tolerance	Maximum SS	Average SS	% of Exceedance (1)	WQO Tolerance	Maximum SS	Average SS	% of Exceedance (1)
Tsing Lung Tau Beach	2.6	8.0	2.1	11.2	1.6	4.2	1.0	1.2
Castle Peak Beach	2.4	0.7	0.4	0	3.1	0.3	0.1	0
Golden Beach	2.4	3.4	1.8	7.8	3.1	1.7	0.8	0
Kadoorie Beach	2.4	2.4	1.1	0	3.1	1.2	0.4	0
New Cafeteria Beach	2.4	3.5	1.6	0.4	3.1	1.4	0.6	0
Old Cafeteria Beach	2.4	2.3	1.3	0	3.1	1.3	0.5	0
Butterfly Beach	8.6	1.6	1.0	0	2.6	0.9	0.4	0
Castle Peak Power Station Intake 1	3.8	1.3	0.5	0	3.7	0.7	0.2	0
Castle Peak Power Station Intake 2	3.8	1.5	0.6	0	3.7	0.8	0.4	0
WSD Tsing Yi Saltwater Intake	-	1.7	1.2	0	-	1.4	0.9	0
SSDS Phase I Intake	2.8	1.5	1.2	0	3.2	1.4	0.9	0
MTRC Tsing Yi Station Intake	2.8	1.7	1.1	0	3.2	1.3	0.9	0
WSD Tsuen Wan Saltwater Intake	-	1.9	1.3	0	-	1.4	1.0	0
Rambler Typhoon Shelter	5.8	1.5	1.1	0	4.1	1.2	0.8	0
Approach Beach	5.9	2.3	1.4	0	2.1	1.7	1.0	0
Casam Beach	5.9	2.2	1.4	0	2.1	1.6	0.9	0
Dragon Beach	5.9	15.4	2.6	5.5	2.1	15.0	1.7	15.6
Gemini Beach	5.9	4.6	1.5	0	2.1	2.7	0.9	2.8
Hoi Mei Wan Beach	5.9	2.3	1.3	0	2.1	1.5	0.9	0
Lido Beach	5.9	2.2	1.4	0	2.1	1.7	0.9	0
Ting Kau Beach	5.9	2.2	1.5	0	2.1	1.5	1.0	0
Tung Wan Beach	5.9	1.4	1.0	0	2.1	0.9	0.7	0
Ma Wan Fish Culture Zone	5.9	2.3	1.3	0	2.1	1.0	0.6	0

Note: Shaded areas indicate exceedance of the WQOs

(1) Percentage of time over a spring-neap period during which WQO tolerance is exceeded.

The results shown in *Table 3.6b* indicate exceedances of the WQOs at Dragon Beach and Tsing Lung Tau Beach, which are adjacent to the STD, and at Golden Beach and New Cafeteria Beach at Castle Peak Bay. As shown by the contour plots of *Annex D1,* the water quality impact appears to be slightly higher during dry season tides than the wet season tides.

Temporal variations of SS elevation at various WSRs *(Figures D2-7* to *D2-12* of *Annex D2)* indicate that the SS elevations at Dragon Beach and Gemini Beach, which are closer to the reclamation area, are larger than the SS elevation at Ma Wan FCZ, SSDS Stage I Intake, Tsuen Wan Salt Water Intake, and Tung Wan Beach which are further away from the reclamation area. Exceedance of WQO SS tolerance level at Dragon Beach is predicted. As shown in *Figures D2-8* to *D2-12* of *Annex D2,* the extent of SS impact at Gemini Beach, Ma Wan FCZ, SSDS intake, Tsuen Wan Salt Water Intake and Tung Wan Beach under Construction Scenario 2 is predicted to be smaller than the impact under Construction Scenario 1. *Figures 4.3b* and *4.3f* of *Annex D2* show the predicted SS levels at WSD salt water intake at Tsuen Wan and SSDS Stage I Intake, respectively. For the temporal variation of SS concentration at WSD Tsuen Wan Salt Water Intake, 'spikes' of SS elevations that exceed the recommended threshold (20 mg L^{-1}) of WSD SS criterion and last for few hours are predicted during the wet season. Mitigation measures during dredging and sandfilling *(Section 3.7.1)* are therefore required to minimise the impact. The SS concentration at the SSDS Stage I Intake is predicted to remain below the recommended 140 mg L^{-1} threshold level.

As shown in *Table 3.6b*, exceedances of WQO tolerance levels with STD reclamation works alone are predicted and are considered unacceptable. Thus, mitigation measures during dredging and sandfilling *(Section 3.7.1)* are therefore required to minimise the impact, which will also minimise the cumulative impact of concurrent projects.

Table 3.6c-1 Summary of Maximum Predicted Elevations in Suspended Solids (mg L^{-1}) at Sensitive Receivers and Potential Cumulative Impacts (Scenario 1)

Sensitive Receiver	WQO Tolerance (DS / WS)	Backfilling at North Lantau and South Tsing Yi Marine Borrow Areas (Scenario 4e) (1)	Sham Tseng Development (Construction Scenario 1)	Maximum Elevation of SS
Gemini Beach	5.9 / 2.1	4.8 (WS)	9.2	14.0
Hoi Mei Wan Beach	5.9 / 2.1	3.6 (WS)	4.7	8.3
Casam Beach	5.9 / 2.1	2.9 (WS)	4.7	7.6
Lido Beach	5.9 / 2.1	1.4	4.3	5.7 (WS)
Ma Wan Fish Culture Zone	5.9 / 2.1	3.2	3.7 (WS)	6.9
WSD Tsing Yi Intake	-	2.5	2.9	5.4
SSDS Stage I Intake	2.8 / 3.2	2.5	2.7	5.2
MTRC Tsing Yi Station Intake	2.8 / 3.2	2.5	2.9 (DS)	5.4
WSD Tsuen Wan Intake	-	0	3.5	3.5
Tung Wan Beach	5.9 / 2.1	0	2.5 (WS)	2.5 (WS)

Note: Shaded areas indicate exceedance of the WQOs
DS - Dry Season; WS - Wet Season
(1) Backfilling of South Tsing Yi and North of Lantau MBAs: *Final Environmental Impact Assessment,* ERM, November 1995.

Table 3.6c-2 Summary of Maximum Predicted Elevations in Suspended Solids (mg L^{-1}) at Sensitive Receivers and Potential Cumulative Impacts (Scenario 2)

Sensitive Receiver	**WQO Tolerance (DS / WS)**	**Backfilling at North Lantau and South Tsing Yi Marine Borrow Areas (Scenario 4e)** [1]	**Sham Tseng Development (Construction Scenario 2)**	**Maximum Elevation of SS**
Gemini Beach	5.9 / 2.1	4.8 (WS)	4.6 (WS)	9.4
Hoi Mei Wan Beach	5.9 / 2.1	3.6 (WS)	2.3 (WS)	5.9 (WS)
Casam Beach	5.9 / 2.1	2.9 (WS)	2.2 (WS)	5.1 (WS)
Lido Beach	5.9 / 2.1	1.4	2.2 (WS)	3.6 (WS)
Ma Wan Fish Culture Zone	5.9 / 2.1	3.2	2.3 (WS)	5.5 (WS)
WSD Tsing Yi Intake	-	2.5	1.9	4.4
SSDS Stage I Intake	2.8 / 3.2	2.5	1.5	4.0
MTRC Tsing Yi Station Intake	2.8 / 3.2	2.5	1.7	4.2
WSD Tsuen Wan Intake	-	0	1.9	1.9
Tung Wan Beach	5.9 / 2.1	0	1.4	1.4

Note: Shaded areas indicate exceedance of the WQOs
DS - Dry Season; WS - Wet Season
(1) Backfilling of South Tsing Yi and North of Lantau MBAs: *Final Environmental Impact Assessment,* ERM, November 1995.

Cumulative Water Quality Impact

Cumulative water quality impact associated with other concurrent dredging and reclamation projects was evaluated. *Figure 3.6-0* indicate the construction / marine works programme of various external projects between 2002 and 2007. Marine works of the Container Terminal No. 9 project will be completed by 2004. The filling activities at the TWBFR and the Penny's Bay Reclamation Stage II will be undertaken behind the constructed seawall, with gaps left for safety access of marine vessels(19). Thus, there will be no SS water quality impact from these two projects upon the WSRs during the marine works of the STD. As the simulation results of DO and TIN (as presented in the following paragraphs) show that the impacts on DO and nutrient are minimal during marine works, the cumulative impact of sediment plume dispersion is considered only. The cumulative impacts from these projects were determined by summing the results of the worst case tide for Construction Scenario 1 and Scenario 2 with the results of computer modelling of these external concurrent projects from earlier studies *(Tables 3.6c-1* and *3.6c-2).*

It can been seen from *Table 3.6c-1* that overlapping of sediment plumes from the construction of STD and the backfilling of North Lantau / South Tsing Yi may occur along the beaches between Sham Tseng and Tsuen Wan and also the Rambler Channel. On average, about 55% of the cumulative SS levels predicted at these beaches will be from the marine works of the STD under Scenario 1. According to the Final EIA Report of Penny's Bay Reclamation(21), only Ma Wan FCZ and Tung Wan Beach at Ma Wan that are close to the reclamation site will be impacted by the sediment plume from Penny's Bay Reclamation works. As shown in *Table 3.6c-1,* the cumulative SS impact at Ma Wan FCZ and Tung Wan Beach at Ma Wan will exceed the WQO tolerance and the STD reclamation (filling) works is a major source of SS (which contributes about 54% and 100% of the predicted SS elevations at Ma Wan FCZ and Tung Wan Beach, respectively). It should be noted that at Gemini Beach, Hoi Mei Wan Beach and Casam Beach, exceedance of WQO tolerance level will occur even without the construction of the STD. The construction of the STD contributes about 66%, 57%, 62% and 75% of the predicted SS elevations at Gemini Beach, Hoi Mei Wan Beach, Casam Beach and Lido Beach respectively.

On the other hand, the total SS levels (that is, the sum of ambient and maximum SS elevations) at WSD Tsing Yi Intake (15.3 mg L^{-1}) and Tsuen Wan Intake (10.2 mg L^{-1}) will be lower than the recommended threshold (20 mg L^{-1}) for saltwater intakes, and the total SS levels at the SSDS Stage I Intake (15.2 mg L^{-1}) and the MTRC Tsing Yi Station Intake (15.2 mg L^{-1}) will be lower than the recommended SS threshold (140 mg L^{-1}) for cooling water intakes.

(19) Tsuen Wan Bay Further Reclamation Area 35, Environmental Impact Assessment Final Assessment Report (January 1998), Maunsell Consultants Asia Ltd and Northshore Lantau Development Feasibility Study, Environmental Impact Assessment, Final Report, Volume, February 2000.

From *Table 3.6c-2*, overlapping of sediment plumes may also occur along the beaches between Sham Tseng and Tsuen Wan and also the Rambler Channel. The marine works of the STD under Scenario 2 will contribute, on average, about 34% of the cumulative SS levels predicted at the beaches. Also shown in *Table 3.6c-2*, the cumulative SS impact at Ma Wan FCZ will exceed the WQO tolerance and the STD reclamation (filling) works is one of the main sources of SS (which contributes about 42.7% of the predicted SS level). With the exception of Tung Wan Beach, all the cumulative SS level at the WSRs other than WSD salt water intakes will be above the WQO tolerance. The construction of the STD contributes about 49%, 39%, 43% and 61% of the predicted SS elevations at Gemini Beach, Hoi Mei Wan Beach,, Casam Beach and Lido Beach respectively.

Nevertheless, the total SS levels at the WSD Tsing Yi Intake (14.4 mg L^{-1}) and Tsuen Wan Intake (9.2 mg L^{-1}) will be lower than the recommended threshold (20 mg L^{-1}) for saltwater intakes, and the total SS levels at the SSDS Stage I Intake (14.3 mg L^{-1}) and the MTRC Tsing Yi Station Intake (14.3 mg L^{-1}) will be lower than the recommended SS threshold (140 mg L^{-1}) for cooling water intakes.

As the STD is found to contribute significantly to cumulative exceedances of WQO at sensitive receivers, mitigation measures will be required to be applied to the STD construction. These measures would serve to not only minimise the impacts from the STD construction alone but reduce the contribution of the STD to the predicted cumulative impacts and are described in *Section 3.7.1.*

(ii) Dissolved Oxygen (DO)

Construction Scenarios 1 and 2

The DO contours under dry and wet seasons indicate that the dissolved oxygen depletion at various depths of waters are small (less than 0.01 mg L^{-1}). The contours also indicate that the DO concentrations will remain above the WQO criteria for all depths at the sensitive receivers under Construction Scenarios 1 and 2. In contrast to the EPD DO data with a range of 4.9 to 5.9 mg L^{-1} depth-averaged DO and 4.2 to 5.6 mg L^{-1} bottom DO *(Table 3.3a* and *Table 3.3b),* the predicted small depletion of the DO during construction will not render exceedance of WQO. The statistics of Construction Scenario 2 *(Tables 3.6d* and *3.6e)* predict that most of the water sensitive receivers will have no change of dissolved oxygen levels during construction.

(iii) Unionised Ammoniacal Nitrogen (NH3-N)

Construction Scenario 2

The impact of unionised NH3-N associated with dredging of potentially contaminated sediment along the seawall and extend nullahs are simulated. The contours and statistics results for unionised NH3-N reveal a very limited effect of dredging (and filling) under Construction Scenario 2 for both dry and wet seasons. For the tidally averaged and maximum results under dry and wet season tides, changes of unionised NH3-N are insignificant (less than 0.001 mg-N L^{-1}) at all sensitive receivers *(Tables 3.6f* and *3.6g).* The unionised NH3-N concentrations at all sensitive receivers are predicted to remain below the WQO (0.021 mg L^{-1}). In contrast to the EPD unionised NH3-N data ranged from 0.004 to 0.010 mg L^{-1} *(Table 3.6a* and *Table 3.6b),* the predicted changes of the unionised NH3-N should not render exceedance of the WQO at each EPD monitoring station near the STD.

(iv) Total Inorganic Nitrogen (TIN)

Construction Scenario 2

The contours and statistics results for TIN reveal a very limited effect of dredging (and filling) under Construction Scenario 2 for both dry and wet seasons. For the tidally averaged results under dry season, changes at all the sensitive receivers are less than 0.01 mg-N L^{-1} above the baseline *(Table 3.6h).* During the wet seasons, no changes are predicted at all sensitive receivers *(Table 3.6i)* in contrast to the baseline. It is concluded that the elevation of TIN due to construction under Construction Scenario 2 is minimal. However, the baseline level of TIN at most of the sensitive receivers will be above the WQO criteria (0.4 mg-N L^{-1} for the Victoria Harbour and Western Buffer WCZs and 0.5 mg-N L^{-1} for the North Western WCZ). In contrast to the EPD TIN data ranged from 0.25 to 0.51 mg L^{-1} *(Table 3.3a* and *Table 3.3b),* the elevation of TIN associated with STD construction will not render exceedance of WQO (although all the EPD monitoring stations at the Victoria Harbour recorded exceedance of TIN in 1998). In addition, the model simulations were undertaken with input data from EPD's sediment data (Table 3.4b) that show contamination of sediment samples in contrast to the relatively uncontaminated sediment samples collected from the reclamation site (Annex A). The predicted TIN levels are therefore conservative. The STD reclamation construction alone would thus not contribute significantly to the background concentrations nor would it prevent the long term recovery of the water quality body should background levels decrease. The predicted increases in TIN levels are therefore considered to be acceptable.

As revealed from the simulation results of TIN, it is predicted that the concentrations of NH3-N (both ionised and unionised) at the WSD marine water intake at Tsuen Wan will comply with the WSD water quality criterion (that is, less than 1 mg L^{-1}), as NH3-N is a component of TIN. In contrast to the existing background level monitored by the EPD (*Table 3.3a* and *Table 3.3b),* exceedance of WSD water quality criterion is not expected.

Potential Release of Contaminants from Disturbed Sediment

The conservative tracer modelling contours *(Figures 3A.8a* to *3A.8d, Figures 3A.9a* to *3A.9d, Figures 3A.10a* to *3A.10d, Figures 3B.8a* to *3B.8d, Figures 3B.9a* to *3B.9d* and *Figures 3B.10a* to *3B.10d* of *Annex D1),* which simulate the dredging activities under Construction Scenario 2, indicate that with a tracer (pollutant) of a release rate 226 000 g s^{-1}, the impact will be essentially confined to the waters within and adjacent to the construction site and the waters at Tsing Lung Tau Beach and Ting Kau Beach. If a pollutant is released at a rate of 226 mg s^{-1} (which corresponds to a 100 mg of pollutant per kilogram of sediment and assuming a 100% loss rate of pollutant under disturbance), the simulation results showing on the contours will be 1 000 000 times smaller. For example: The heavy content of the contaminated sediment at SQ13 vibrocore is 0.26 mg kg^{-1} for Ag, 3.2 mg kg^{-1} for As, 0.3 mg kg^{-1} for Cd, 175 mg kg^{-1} for Cr, 68.6 mg kg^{-1} for Cu, 7.64 mg kg^{-1} for Ni, 81.6 mg kg^{-1} for Pb, 443 mg kg^{-1} for Zn and 0.14 mg kg^{-1} for Hg. Assuming that under the worst case condition, 100% heavy metal content of the contaminated sediment at SQ13 is released to the marine water during dredging. The release rates are 588 μg s^{-1} for Ag, 7.2 mg s^{-1} for As, 678 μg s^{-1} for Cd, 395.5 mg s^{-1} for Cr, 155 mg s^{-1} for Cu, 17 mg s^{-1} for Ni, and 184 mg s^{-1} for Pb, 1 g s^{-1} for Zn and 316 μg s^{-1} for Hg. As indicated from the tracer simulation results, the corresponding heavy metal concentrations per litre of marine water will be 1 000 000 times lower than the value of the heavy metal released per second (for instance, the concentration of Zn at the release point will be 1 μg L^{-1}, which is below the detection limit (100 μg L^{-1}) of the elutriate test). Together with the elutriate test results shown in *Table 3.5d*, which show minimal potential of heavy metals released from disturbed sediment, it is predicted that the water quality impact due to the release of micro-pollutants from the disturbed sediment is minimal.

Land-Based Impact

General Construction Activities

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

Owing to the lack of established guidelines for sewage generation rates in construction sites, the recommended design rate for office, specified in the Guidelines for the *Design of Small Sewage Treatment Plant, EPD Solid Waste Group, March 1990* has been used to estimate the sewage generation. Sewage production of 0.46 m^3 per worker per day is used. Therefore, with about 300 construction workers at the construction site, a total of 138 m^3 of sewage will be generated per day. The sewage should not be allowed to discharge directly into the surrounding water body without treatment. Chemical toilets and subsequently on-site sewer should be deployed at the construction site to collect and handle sewage from workers (see *Section 3.7.1* for recommended mitigation measures).

Construction Runoff and Drainage

Construction run-off and drainage may cause physical, chemical and biological effects. The physical effects could arise from any increase in SS from the Site which could cause blockage of drainage channels and associated local flooding when heavy rainfall occurs, as well as local impact on water quality in Sham Tseng. High SS concentrations in marine water could lead to associated reduction in DO levels.

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 will be localised and deterioration in water quality will be minimal. Thus, unacceptable impacts on the water quality are not expected provided that the recommended measures described in *Section 3.7.1* are properly implemented.

3.6.2 *Operational Phase*

Hydrodynamic Impact

Dry Season

Water Levels and Velocities

The water levels and depth-averaged velocities were modelled under a spring-neap tidal cycle.

WATER LEVELS AND DEPTH-AVERAGED VELOCITIES

Six representative locations were chosen for comparing the difference between the baseline and completed scenarios. Three of these locations (Sham Tseng, ST-Ma-Wan-2 and ST-Ma-Wan-4) are located in front of Sham Tseng, along a line perpendicular to the STD, and the rest are in line with the Tsing Ma Bridge, as shown in *Figure 3.6a*. *Figures B1-B6* in *Annex E1* show the water level and depth-averaged current at these six locations before and after reclamation during spring and neap tides.

The results predicted that, during the dry season the impact of the reclamation on the water levels and depth-averaged current directions is minimal. In front of the reclamation the depth-averaged peak current magnitudes, however, are affected by the land reclamation. At spring tide the impact is greatest with a maximum increase of 4% (from 1.25 m s^{-1} to 1.30 m s^{-1}). Near the Tsing Ma Bridge, the depth-averaged peak current magnitudes are not influenced by the reclamation.

SPATIAL CURRENT VELOCITY AT EBB AND FLOOD SPRING TIDE

For two distinct phases in the spring tide, maximal ebb stream (MES) and maximal flood stream (MFS), the spatial distribution of the velocities before and after the reclamation was modelled. *Figure 3.6b* shows the MES condition for the surface velocities (defined at 5% of the local water depth below the water surface) and for the bottom velocities (defined at 5% of the local water depth above the sea bed). The MFS condition is given in *Figure 3.6c.*

The results show that the local increase in the peak current magnitude due to the STD is minimal. The spatial distribution shows that the current direction will not be changed by STD.

RESIDUAL CURRENT VELOCITIES

The current velocities have been averaged over a spring-neap tidal cycle (9 February 2007 00:00 to 23 February 2007 00:00) to assess the long-term impact and the results are shown in *Figure 3.6d.* Neither the direction nor the peak magnitude of the residual current are significantly affected by the reclamation.

Flow Rate

TOTAL TIDAL FLOW THROUGH MAIN CHANNELS

Analysis of the tidal discharges was carried out at the main channels including Ma Wan Channel 1 and 2, Kap Shui Mun, Rambler Channel, Victoria Harbour, East and West Lamma Channel, and Urmston Road *(Figure 3.6a).* The current velocities are integrated over the cross-sectional area. The resulting fluxes (instantaneous in m^3 s^{-1} and cumulative in m^3) are presented in *Figures B75-82* in *Annex E1*.

The modelling results between before (black line) and after (red line) the STD showed little difference in instantaneous (volume) flux. Another more sensitive parameter called cumulative flux (green line) (plotted in enlarged scale) compares the difference before and after reclamation is also presented in *Figures B75-82* in *Annex E1*. This cumulative flux is a time integrated volume flux which is used for indicating the changes to a new dynamic equilibrium. However, the difference in cumulative fluxes between the two situations (before and after reclamation) are small, indicating that the reclamation does not have any significant impact on the flow regime.

RESIDUAL FLOW THROUGH MAIN CHANNELS

The instantaneous fluxes through the eight main channels have been averaged over the spring-neap tidal cycle (9 February 00:00 - 23 February 00:00). *Table 3.6j* gives the residual fluxes before and after reclamation. The last two columns provide the absolute difference (in m^3 s^{-1}) and the relative percentage change with respect to the baseline situation.

Table 3.6j ***Dry Season Residual Flows (in m^3 s^{-1}) Through Main Channels Before and After STD***

Cross-section	Before STD	After STD	Absolute Difference (m^3 s^{-1})	Percentage Change
Ma Wan Channel 1	1047 W	1042 W	-5	-0.5
Ma Wan Channel 2	722 N	731 N	9	1.2
Kap Shui Mun	783 N	788 N	5	0.6
East Lamma Channel	1267 N	1270 N	3	0.3
West Lamma Channel	135 S	143 S	8	5.4
Rambler Channel	459 S	478 S	19	4.0
Victoria Harbour	33 E	31 E	-2	-5.2
Urmston Road	345 S	341 S	-4	-0.9

Although the percentage difference between residual flow is larger than difference between the instantaneous tidal flows (for Victoria Harbour and West Lamma Channel the residual flows are less than 0.5% of the instantaneous tidal flows), the absolute difference of residual flow before and after the reclamation is not significant. For instance, reference to *Figure B13* in *Annex E1*, the residual flow and instantaneous flow for Victoria Harbour are 33 m^3 s^{-1} and 9000 m^3 s^{-1} respectively, and for West Lamma Channel are 135 $m^3 s^{-1}$ and 30 000 $m^3 s^{-1}$ respectively. The large percentage change of residual flow across West Lamma Channel, Rambler Channel and Victoria Harbour sections before and after the STD are related to the small residual flows across these sections so that small change in residual flows will result in large percentage difference.

Salinities

SPATIAL SALINITY DISTRIBUTION AT EBB AND FLOOD TIDES

Similar to the velocity currents, the spatial distribution of the salinity at the surface and bottom is presented for two key phases of the tide. The salinity differences in MES and MFS between reference and operation simulations are given in *Figures 3.6e* and *3.6f* for MES and MFS, respectively. The operation situation has been subtracted from the reference situation, hence a positive value for the difference means that the salinity concentration has decreased in the operation situation. The results show that during the dry season, salinity differences are less than 0.1 ppt which is negligible. In addition, for most of the area any increases or decreases in salinity are the same at the surface and bottom. In contrast to the EPD background salinity data shown in *Tables 3.3a* and *3.3b,* the variation of the salinity will be within the WQO (less than +/- 10% of ambient level).

SPRING - NEAP AVERAGED SALINITY

To assess the long-term cumulative impact, the salinities have been averaged over a spring-neap cycle (9 February 00:00 - 23 February 00:00). The salinities in the reference and operation situations were modelled and differences between both situations are presented in *Figure 3.6g.* The impact on the salinities is less than 0.1 ppt, indicating that the proposed reclamation has minimal impact on salinity distributions. In contrast to the EPD background salinity data shown in *Tables 3.3a* and *3.3b,* the variation of the salinity will be within the WQO (less than +/- 10% of ambient level).

Wet Season

Water Levels and Velocities

WATER LEVELS AND DEPTH-AVERAGED VELOCITIES

The water levels and depth-averaged velocities for the spring and neap tides during the wet season are given in *Figures B21-B26* in *Annex E1*. Similar to the dry season, the difference in water levels and depth-averaged current directions are minimal when comparing the reference and operation situations. Nevertheless, the depth-averaged peak current magnitude at location Sham-Tseng (just in front of the copeline) increases from 1.34 $m s^{-1}$ to 1.57 $m s^{-1}$ (about 17%) during the ebb stream and only from 1.21 ms^{-1} to 1.28 ms^{-1} (about 6%) during the flood stream, reflecting the impact caused by narrowing the channel width between Sham Tseng and Ma Wan. In the centre of the Ma Wan Strait the impact is marginal; as the increase in peak current magnitude due to the reclamation is from 1.89 $m s^{-1}$ to 1.93 $m s^{-1}$ (less then 2%). This demonstrated that the impact is only localised to the waters close to the reclamation. Along the Tsing Ma Bridge the impact is minimal during both ebb and flood phases of the tide.

SPATIAL CURRENT VELOCITY AT EBB AND FLOOD TIDES

Figure 3.6h shows the MES condition for the surface velocities and the bottom velocities. The MFS condition is given in *Figure 3.6i.*

The spatial distribution, as shown in *Figures 3.6h* and *3.6i*, indicate that the current direction is not changed by the reclamation, with the exception of waters in close proximity to the STD where the current will flow along the new STD coastline rather flowing into the bay at Sham Tseng. Any local increase of the peak current magnitude is also shown from these figures.

RESIDUAL CURRENT VELOCITIES

The current velocities have been averaged over a spring-neap tidal cycle to assess the long-term impact and the results are shown in *Figure 3.6j.*

The residual currents are slightly affected in the vicinity of the copeline. At greater than 100 m from the reclamation the influence on the currents is minimal.

Tidal Discharge

TOTAL TIDAL FLOW THROUGH MAIN CHANNELS

The instantaneous and cumulative fluxes through Ma Wan Channel 1 and 2, Kap Shui Mun, Rambler Channel, Victoria Harbour, East and West Lamma Channel, and Urmston Road *(Figure 3.6a)* are presented in *Figures B93-B90* in *Annex E1*. Cumulative flux in an enlarged scale are also shown. Similar to the dry season, the difference in instantaneous (volume) fluxes is minimal.

The effect of the reclamation on the cumulative fluxes was found to be greater, but the differences tend to be constant which indicates that the main influence is a temporary adjustment of water volumes west and east of Ma Wan Channel rather than a permanent change in volume fluxes.

RESIDUAL FLOW THROUGH MAIN CHANNELS

The instantaneous fluxes through the main channels have been averaged over the spring-neap tidal cycle (26 July 05:00 - 10 August 06:00). The residual wet season flows are given in *Table 3.6k*, together with the absolute difference ($m^3 s^{-1}$) and the relative changes between the reference and operational situations. From this table and *Figures B27* to *B34* in *Annex E1,* it is shown that the STD will not introduce substantial change of residual flows through various cross-sections, with exceptions at Ma Wan Channel 2 which shows a 14.9% reduction of residual flow, and at Victoria Harbour which shows a 6.7% increase of residual flow. The large percentage changes of residual flow at these sections are related to the small residual flow across these sections so that small change in residual flow will result in large percentage change.

Where the residual flows are small compared to the tidal flows, relative differences were larger although absolute differences were still small.

Table 3.6k ***Wet Season Residual Flows (in $m^3 s^{-1}$) through Main Channels before and after STD***

Cross-section	Before STD	After STD	Absolute Difference ($m^3 s^{-1}$)	Percentage Change
Ma Wan Channel 1	1307 E	1349 E	42	3.2
Ma Wan Channel 2	208 N	177 N	-31	-14.9
Kap Shui Mun	664 S	656 S	-8	-1.3
East Lamma Channel	879 N	893 N	14	1.5
West Lamma Channel	2888 S	2939 S	51	1.8
Rambler Channel	851 S	871 S	20	2.3
Victoria Harbour	48 W	51 W	3	6.7
Urmston Road	1967 N	1969 N	2	0.1

Salinities

SPATIAL SALINITY DISTRIBUTION AT EBB AND FLOOD TIDES

For the wet season the spatial distribution of the salinity at the surface and bottom were modelled for MES and MFS conditions. Results in these figures predicted that the fresh water plume from the Pearl River Estuary results in less saline water at the surface throughout the Urmston Road. At the bottom, only the area north of Lantau and Western Harbour were less saline. The stratification in the wet season was clearly seen.

The impact due to the reclamation can be indicated by the salinity differences between the reference situation and the operation situation are given in *Figures 3.6k* and *3.6l* for MES and MFS, respectively. In comparison with the dry season, the differences are larger, the greatest difference, however, is still less than 1.0 ppt. A positive value for the difference means that the salinity concentration has decreased in the operational situation. For the wet season, the salinity differences are less than 1.0 ppt and can be observed only at a few local spots. For most of the area near Sham Tseng, the differences are less then 0.2 ppt. This indicates that the STD does not greatly affect salinity distribution in the wet season. The predicted changes in salinity are considered acceptable in terms of WQO (within +/- 10% of the ambient levels presented in *Tables 3.3a* and *3.3b).*

SPRING-NEAP AVERAGED SALINITY

To assess the long-term cumulative impact, the salinities have been averaged over a spring-neap cycle (26 July 05:00 - 10 August 06:00). The salinities in the reference and operation situations were modelled and the differences between both situations are presented in *Figure 3.6m.* The figure indicates that the impact on the salinities is less then 0.2 ppt. With reference to the larger momentary differences, this indicates that due to the reclamation the salinities may decrease or increase, but on average the differences are small and about the same as in the dry season. The predicted changes in salinity are considered acceptable in terms of WQO (within +/- 10% of the ambient levels presented in *Tables 3.3a* and *3.3b).*

Water Quality Impact

- Global Modelling

Scenario A: Water Quality in 2007 - Dry Season

Contour plots for salinity, SS, BOD_5, unionised NH3-N, TIN, chlorophyll-a, DO and *E. coli* (in geometric mean) in both baseline (Baseline 1) and operation (Operational 1) simulations (*Table 3.4d)* are shown in *Figures B1-1 to B1-9* and *O1-1 to O1-9* in *Annex E2*.

Comparison of the plots indicates the very minor influence of the STD and STFSTD on water quality. The plots are in essence identical. An exception is the BOD_5 concentration near the outfall of the TKSTSTW which shows an increase (less than 0.25 mg L^{-1}) over a small area near the outfall in the operational simulation *(Figures B1-3* and *O1-3*). Total inorganic nitrogen over a small area at the western side of Tsing Yi is predicted to increase by less than 0.1 mg-N L^{-1} in the operational simulation *(Figures B1-5* and *O1-5).* The increases in BOD_5 and TIN in these areas appear to be related to the increased sewage loading from the STFSTD. Nevertheless, no significant difference between the baseline and operational simulation is discerned in other areas. The water quality impact, in terms of the elevations of BOD_5 and TIN in marine waters, associated with the effluent discharge from the STFSTD is therefore minimal.

The effects of the 4.5% increase in flows from the TKSTSTW due to the increase in population is unlikely to change the above conclusions regarding the minimal effects of the STW on water quality. For example the increase in BOD_5 concentrations near the outfall will now show an increase of 0.26 mg L^{-1}, compared to 0.25 mg L^{-1} for the lower flow rate, while increases in total inorganic nitrogen on the western side of Tsing Yi Island will now be approximately 0.105 mg L^{-1} compared to 0.1 mg L^{-1} previously.

Statistical results of key water quality parameters including salinity, SS, unionised NH3-N, TIN, DO (depth averaged and bottom layer), and *E. coli* at various sensitive receivers are presented in *Table 3.6l* to check against the WQOs. The statistics show full compliance of WQOs in salinity, SS, unionised NH3-N and DO at all receivers for both Baseline 1 and Operational 1 Scenarios.
The variation of depth-averaged salinity at all receivers are small (<1% and within +/- 0.1 ppt) between Baseline 1 and Operational 1 Scenarios. The change is well below the WQO (that is, less than +/- 10% from ambient level).
In contrast to the WQO tolerance levels reported in *Table 3.6a* or *3.6b,* the

variation of depth-averaged (90 percentile) SS concentrations between Baseline 1 and Operational 1 Scenarios is less than 0.1 mg L^{-1} from the baseline at all sensitive receivers and, thus complies with the WQO. The predicted SS levels at the WSD intakes at Tsuen Wan, Tsing Yi and the STD (14.4, 14.3 and 15.5 mg L^{-1}, respectively) exceed the WSD water quality criterion (10 mg L^{-1}) for both Baseline 1 and Operational 1 Scenarios but is below the recommended pragmatic threshold (20 mg L^{-1}). The implementation of the Sewerage Master Scheme at Sham Tseng will eliminate most of expedient connections from local industries and restaurants. Thus, the loadings of SS within the Sham Tseng Nullahs will be reduced substantially. As the difference of SS between the baseline and the operational simulations at these WSD intakes is minimal, the loadings of SS from the storm drains of STD and the effluent discharge from the STFSTD appear to have no further adverse impact upon these intakes. The predicted SS levels at Castle Peak Power Station Intakes I and II (22.3 and 22.4 mg L^{-1}, respectively) also comply with the operation standard (150 mg L^{-1}) of the intake facilities. The predicted SS levels at SSDS Phase I Intake and MTRC Tsing Yi Station Intake (14.3 and 14.5 mg L^{-1}, respectively) are also well below the recommended threshold (140 mg L^{-1}) of the cooling water intake. High SS levels are predicted at the receivers along Urmston Road, reflecting the strong influence of SS discharging from the Pearl River tributaries. The STD and the effluent discharge from the STFSTD appear to have no impact on the SS concentration at the sensitive receivers.

The depth-averaged unionised NH3-N concentration is predicted to range from 0.006 to 0.011 mg L^{-1} at all receivers under both Baseline 1 and Operational 1 Scenarios. Minimal changes (less than 0.7% or 0.001 mg L^{-1}) from Baseline 1 to Operational 1 are anticipated. Full compliance with WQO (< 0.021 mg L^{-1}) is predicted at all receivers.

Exceedances of WQO in TIN (0.4 mg-N L^{-1}) at various sensitive receivers are predicted at both Baseline 1 and Operational 1 Scenarios *(Table 3.6l)*. However, when compared with the Baseline 1 Scenario, the STD and the effluent discharge from the TKSTSTW under the Operational 1 Scenario appear to have no effect on the variation of the TIN from the background. The implementation of the Sewerage Master Scheme at Sham Tseng will eliminate most of expedient connections from local industries and restaurants. Thus, the loadings of TIN within the Sham Tseng Nullahs will be reduced substantially. While some of the WSRs show minimal elevations of TIN from the baseline (maximum 0.3%), other WSRs show minimal reductions of TIN (maximum 0.5%). As a whole, the model result shows no deterioration of TIN level in marine water during the operational phase. In other words, the loadings of TIN from the storm drains of STD and the effluent discharge from the STFSTD will not contribute to, increase or perpetuate stressed conditions, nor retard recovery of the water body if levels of pollution from other sources decrease. Thus, the predicted increases are considered acceptable. The predicted levels of TIN at the WSD intakes at Tsing Yi, Tsuen Wan and the STD (0.47, 0.44 and 0.40 mg-N L^{-1}, respectively) show that the NH3-N levels at the intakes are within the WSD water quality criterion (< 1 mg-N L^{-1}) (as NH3-N is a component of TIN).

Table 3.6l STATISTICAL OUTPUT AT 26 MONITORING STATIONS DRY SEASON 2007 (Baseline 1 & Operational 1)

station	Salinity (ppt) depth averaged					Suspended Solids (mg/L) 90 %tile depth averaged					Un-ionised NH3-N (mg-N/L) depth averaged					TIN (mg-N/L) depth averaged					Dissolved oxygen (mg/L) 10 %tile depth averaged					Dissolved oxygen (mg/L) 10 %tile bottom layer					*E. coli* (cfu per 100 mL) depth averaged (geometric mean)				
	basel. 1	oper. 1	change	rev oper	change	basel. 1	oper. 1	change	rev oper	change	basel. 1	oper. 1	change	rev oper	change	basel. 1	oper. 1	change	rev oper	change	basel. 1	oper. 1	change	rev oper	change	basel. 1	oper. 1	change	rev oper	change	basel. 1	oper. 1	change	rev oper	change
Golden Beach	31.4	31.4	0.0%	31.4	0.0%	17.1	17.1	0.1%	17.1	0.1%	0.008	0.008	0.2%	0.008	0.3%	0.39	0.39	0.1%	0.39	0.1%	6.5	6.5	0.0%	6.5	0.0%	6.4	6.4	0.0%	6.4	0.0%	3.39E+02	3.44E+02	1.4%	3.46E+02	1.8%
Old Cafeteria Beach	31.2	31.2	0.0%	31.2	0.0%	17.8	17.8	-0.1%	17.8	-0.1%	0.008	0.008	0.2%	0.008	0.2%	0.39	0.39	0.1%	0.39	0.1%	6.5	6.5	0.0%	6.5	0.0%	6.5	6.5	0.0%	6.5	0.0%	2.48E+02	2.49E+02	0.6%	2.50E+02	0.8%
New Cafeteria Beach	31.3	31.3	0.0%	31.3	0.0%	17.4	17.4	0.1%	17.4	0.1%	0.008	0.008	0.2%	0.008	0.2%	0.39	0.39	0.1%	0.39	0.1%	6.5	6.5	0.0%	6.5	0.0%	6.4	6.4	0.0%	6.4	0.0%	1.88E+02	1.86E+02	-1.1%	1.85E+02	-1.4%
Kadoorie Beach	31.2	31.2	0.0%	31.2	0.0%	17.9	17.9	0.0%	17.9	0.0%	0.008	0.008	0.2%	0.008	0.2%	0.39	0.39	0.1%	0.39	0.1%	6.6	6.6	0.0%	6.6	-0.1%	6.5	6.5	0.0%	6.5	0.0%	1.10E+03	1.11E+03	0.1%	1.11E+03	0.1%
Castle Peak Beach	31.1	31.1	0.0%	31.1	0.0%	9.4	9.4	-0.1%	9.4	-0.1%	0.011	0.011	-0.4%	0.011	-0.4%	0.47	0.47	-0.1%	0.47	-0.2%	6.4	6.5	0.5%	6.5	0.6%	6.1	6.3	2.1%	6.3	2.7%	2.81E+02	2.82E+02	0.3%	2.82E+02	0.4%
Butterfly Beach	31.1	31.1	0.0%	31.1	0.0%	18.9	18.9	-0.2%	18.9	-0.3%	0.007	0.007	0.2%	0.007	0.2%	0.38	0.38	0.2%	0.38	0.3%	6.6	6.6	0.0%	6.6	0.0%	6.6	6.6	0.0%	6.6	0.0%	2.37E+02	2.38E+02	0.3%	2.38E+02	0.4%
Hoi Mei Beach	31.7	31.7	0.0%	31.7	0.0%	14.5	14.5	0.2%	14.5	0.3%	0.009	0.009	0.0%	0.009	0.0%	0.40	0.40	0.0%	0.40	0.0%	6.4	6.4	0.0%	6.4	0.0%	6.3	6.3	-0.2%	6.3	-0.2%	3.38E+02	3.43E+02	1.4%	3.44E+02	1.8%
Casam Beach	31.6	31.6	0.0%	31.6	0.0%	14.7	14.6	-0.5%	14.6	-0.6%	0.009	0.009	0.0%	0.009	0.0%	0.40	0.40	0.0%	0.40	0.0%	6.4	6.4	0.0%	6.4	0.0%	6.3	6.3	0.0%	6.3	0.0%	3.05E+02	3.05E+02	-0.1%	3.05E+02	-0.1%
Lido Beach	31.6	31.6	0.1%	31.6	0.1%	14.9	15.0	0.1%	15.0	0.2%	0.009	0.009	0.1%	0.009	0.1%	0.40	0.40	0.0%	0.40	0.1%	6.4	6.4	-0.1%	6.4	-0.1%	6.3	6.3	-0.2%	6.3	-0.2%	3.04E+02	3.02E+02	-0.7%	3.01E+02	-0.9%
Ting Kau Beach	31.6	31.6	0.0%	31.6	0.0%	15.0	14.9	-0.3%	14.9	-0.4%	0.009	0.009	0.1%	0.009	0.2%	0.41	0.41	0.0%	0.41	0.1%	6.3	6.3	0.1%	6.3	0.1%	6.2	6.2	0.0%	6.2	0.0%	3.10E+02	3.08E+02	-0.8%	3.07E+02	-1.0%
Approach Beach	31.6	31.6	0.0%	31.6	0.0%	14.6	14.6	0.5%	14.6	0.6%	0.009	0.009	-0.1%	0.009	-0.1%	0.41	0.41	0.0%	0.41	0.0%	6.3	6.3	0.0%	6.3	0.1%	6.3	6.3	0.0%	6.3	0.0%	4.85E+02	4.82E+02	-0.8%	4.81E+02	-1.0%
Tsing Lung Tau Beach	31.6	31.6	0.0%	31.6	0.0%	15.2	15.2	0.2%	15.2	0.2%	0.008	0.008	0.2%	0.008	0.3%	0.40	0.40	0.0%	0.40	0.0%	6.4	6.4	-0.1%	6.4	-0.1%	6.4	6.4	0.0%	6.4	0.0%	3.66E+02	3.71E+02	1.4%	3.72E+02	1.8%
Rambler Typhoon Shelter	31.8	31.7	-0.2%	31.7	-0.2%	14.0	14.0	0.3%	14.1	0.4%	0.012	0.012	-0.6%	0.012	-0.8%	0.48	0.48	-0.4%	0.48	-0.5%	6.0	6.0	0.2%	6.0	0.2%	5.9	5.9	0.2%	5.9	0.2%	5.49E+03	5.47E+03	-0.5%	5.46E+03	-0.6%
WSD Tsing Yi Saltwater intake	31.8	31.8	0.0%	31.8	0.0%	14.4	14.4	0.0%	14.4	0.0%	0.011	0.011	-0.2%	0.011	-0.2%	0.47	0.47	-0.3%	0.47	-0.4%	5.9	5.9	0.2%	5.9	0.3%	5.8	5.8	0.3%	5.8	0.4%	1.99E+03	1.98E+03	-0.6%	1.98E+03	-0.8%
SSDS Phase I intake	31.8	31.8	0.0%	31.8	0.0%	14.3	14.3	0.1%	14.3	0.2%	0.012	0.012	-0.1%	0.012	-0.1%	0.49	0.48	-0.4%	0.48	-0.4%	5.9	5.9	0.1%	5.9	0.2%	5.7	5.7	0.0%	5.7	0.0%	1.57E+03	1.55E+03	-0.7%	1.55E+03	-0.9%
Castle Peak PS intake I	30.7	30.7	0.0%	30.7	0.0%	22.4	22.4	0.0%	22.4	-0.1%	0.006	0.006	0.0%	0.006	0.0%	0.34	0.34	0.1%	0.34	0.1%	6.8	6.8	0.0%	6.8	0.0%	6.7	6.7	0.0%	6.7	0.0%	2.55E+02	2.55E+02	0.3%	2.55E+02	0.3%
Castle Peak PS intake II	30.8	30.8	0.0%	30.8	0.0%	22.3	22.3	0.0%	22.3	0.0%	0.007	0.007	0.1%	0.007	0.1%	0.35	0.35	0.1%	0.35	0.1%	6.7	6.7	0.0%	6.7	0.0%	6.7	6.7	0.0%	6.7	0.0%	2.83E+02	2.84E+02	0.4%	2.85E+02	0.4%
MTRC Tsing Yi Station intake	31.8	31.8	0.0%	31.8	0.0%	14.4	14.5	0.5%	14.5	0.6%	0.011	0.011	-0.7%	0.011	-0.9%	0.48	0.48	-0.3%	0.47	-0.3%	5.9	5.9	0.1%	5.9	0.2%	5.8	5.8	0.0%	5.8	0.0%	2.03E+03	2.02E+03	-0.5%	2.02E+03	-0.7%
Southwest of Tsing Yi	31.9	31.9	0.0%	31.9	0.0%	13.4	13.4	0.3%	13.5	0.4%	0.008	0.008	0.1%	0.008	0.2%	0.38	0.38	0.1%	0.38	0.2%	6.4	6.4	0.0%	6.4	0.0%	6.4	6.4	0.0%	6.4	0.0%	1.51E+02	1.53E+02	1.4%	1.54E+02	1.7%
Gemini Beach	31.7	31.7	0.0%	31.7	0.0%	14.9	14.9	0.1%	14.9	0.2%	0.009	0.009	0.0%	0.009	0.1%	0.40	0.40	0.0%	0.40	0.0%	6.3	6.3	0.0%	6.3	0.0%	6.3	6.3	0.2%	6.3	0.2%	4.51E+02	4.55E+02	0.9%	4.56E+02	1.2%
WSD STFR Saltwater intake	31.6	31.6	0.0%	31.6	0.0%	15.5	15.5	0.1%	15.5	0.1%	0.009	0.009	0.4%	0.009	0.5%	0.40	0.40	0.2%	0.40	0.2%	6.4	6.4	0.0%	6.4	0.0%	6.4	6.4	0.2%	6.4	0.2%	4.29E+02	4.44E+02	3.5%	4.48E+02	4.4%
WSD Tsuen Wan Saltwater intake	31.7	31.7	0.0%	31.7	0.0%	14.3	14.4	0.3%	14.4	0.4%	0.010	0.010	-0.3%	0.010	-0.4%	0.44	0.44	-0.3%	0.44	-0.4%	6.1	6.1	0.2%	6.1	0.2%	6.1	6.1	0.2%	6.1	0.2%	1.76E+03	1.75E+03	-0.7%	1.75E+03	-0.9%
Dragon Beach	31.6	31.6	0.0%	31.6	0.0%	15.5	15.5	0.0%	15.5	0.0%	0.008	0.009	0.3%	0.009	0.4%	0.40	0.40	0.2%	0.40	0.2%	6.4	6.4	0.0%	6.4	0.0%	6.4	6.4	0.0%	6.4	0.0%	4.25E+02	4.35E+02	2.4%	4.38E+02	3.0%
Tung Wan Beach	31.8	31.8	0.0%	31.8	0.0%	12.6	12.6	-0.2%	12.6	-0.3%	0.009	0.009	0.2%	0.009	0.3%	0.41	0.41	0.0%	0.41	0.1%	6.4	6.4	-0.1%	6.4	-0.1%	6.3	6.3	-0.2%	6.3	-0.2%	1.58E+02		1.1%		1.4%

																																1.59E+02		1.60E+02	
Ma Wan Fish Culture Zone	31.5	31.5	0.0%	31.5	0.0%	15.6	15.6	0.0%	15.6	0.0%	0.008	0.008	0.1%	0.008	0.1%	0.39	0.39	0.0%	0.39	0.0%	6.5	6.5	0.1%	6.5	0.1%	6.4	6.4	0.0%	6.4	0.0%	2.14E+02	2.15E+02	0.3%	2.15E+02	0.4%
Marine basin at STFR	31.6	31.6	0.0%	31.6	0.0%	15.5	15.5	0.1%	15.5	0.1%	0.009	0.009	0.4%	0.009	0.5%	0.40	0.40	0.2%	0.40	0.2%	6.4	6.4	0.0%	6.4	0.0%	6.4	6.4	0.2%	6.4	0.2%	4.29E+02	4.44E+02	3.5%	4.48E+02	4.4%

Note:
Shaded cells indicate exceedence of the WQOs
All predicted levels of water quality parameters shown below the columns of basel. 1, oper. 1 and rev oper are absolute values (that is, the sum of background and the predicted elevation / reduction)

Table 3.6m STATISTICAL OUTPUT AT 26 MONITORING STATIONS WET SEASON 2007 (Baseline 1 & Operational 1)

	Salinity (ppt)					Suspended Solids (mg/L)					Un-ionised NH3-N (mg-N/L)				
	depth averaged					90 %tile depth averaged					depth averaged				
station	basel. 1	oper. 1	change	rev oper	change	basel. 1	oper. 1	change	rev oper	change	basel. 1	oper. 1	change	rev oper	change
Golden Beach	23.7	23.7	0.0%	23.7	0.0%	16.7	16.8	0.5%	16.8	0.7%	0.010	0.010	0.0%	0.010	0.0%
Old Cafeteria Beach	22.8	22.8	0.0%	22.8	0.0%	17.0	17.1	0.8%	17.1	1.0%	0.010	0.010	0.0%	0.010	0.0%
New Cafeteria Beach	23.0	23.0	0.0%	23.0	0.0%	16.2	16.3	0.2%	16.3	0.3%	0.010	0.010	-0.2%	0.010	-0.3%
Kadoorie Beach	22.0	22.0	0.0%	22.0	0.0%	16.5	16.6	0.2%	16.6	0.3%	0.009	0.009	0.0%	0.009	-0.1%
Castle Peak Beach	21.5	21.5	0.2%	21.5	0.3%	10.7	10.6	-0.7%	10.6	-0.9%	0.012	0.012	0.0%	0.012	0.0%
Butterfly Beach	22.3	22.4	0.1%	22.4	0.2%	17.7	17.8	0.3%	17.8	0.4%	0.009	0.009	0.1%	0.009	0.1%
Hoi Mei Beach	25.1	25.1	0.0%	25.1	0.0%	15.5	15.5	0.3%	15.6	0.3%	0.011	0.011	0.0%	0.011	0.0%
Casam Beach	24.9	24.8	-0.2%	24.8	-0.3%	15.6	15.5	-0.4%	15.5	-0.5%	0.011	0.011	-0.2%	0.011	-0.2%
Lido Beach	24.7	24.7	-0.1%	24.7	-0.2%	15.6	15.6	0.1%	15.6	0.1%	0.011	0.011	0.0%	0.011	0.0%
Ting Kau Beach	24.5	24.5	0.0%	24.5	0.0%	15.7	15.7	0.4%	15.8	0.5%	0.011	0.011	0.0%	0.011	0.0%
Approach Beach	24.7	24.7	0.0%	24.7	0.0%	16.2	16.2	0.2%	16.2	0.2%	0.011	0.011	-0.4%	0.011	-0.6%
Tsing Lung Tau Beach	24.0	24.1	0.1%	24.1	0.1%	15.6	15.7	0.8%	15.8	1.0%	0.011	0.011	0.2%	0.011	0.2%
Rambler Typhoon Shelter	25.1	25.1	0.0%	25.1	0.0%	15.0	15.0	0.2%	15.0	0.3%	0.015	0.015	-0.3%	0.015	-0.3%
WSD Tsing Yi Saltwater Intake	26.2	26.1	-0.1%	26.1	-0.1%	16.5	16.5	0.0%	16.5	0.0%	0.015	0.015	-0.7%	0.015	-0.8%
SSDS Phase I intake	26.5	26.5	0.0%	26.5	0.0%	16.4	16.4	0.1%	16.4	0.1%	0.016	0.016	-0.3%	0.016	-0.4%
Castle Peak PS intake I	22.3	22.3	0.0%	22.3	0.0%	19.0	19.0	-0.1%	19.0	-0.1%	0.007	0.007	0.1%	0.007	0.1%
Castle Peak PS intake II	22.5	22.5	0.0%	22.5	0.0%	18.7	18.8	0.3%	18.8	0.4%	0.008	0.008	0.0%	0.008	0.0%
MTRC Tsing Yi Station Intake	26.4	26.4	-0.1%	26.4	-0.1%	16.6	16.6	0.2%	16.6	0.3%	0.016	0.015	-0.3%	0.015	-0.4%
Southwest of Tsing Yi	26.6	26.6	0.0%	26.6	0.0%	16.5	16.5	0.4%	16.5	0.5%	0.012	0.012	0.0%	0.012	0.0%
Gemini Beach	25.5	25.5	-0.1%	25.5	-0.1%	16.0	16.0	0.1%	16.0	0.1%	0.012	0.012	0.2%	0.012	0.2%
WSD STFR Saltwater Intake	25.4	25.3	-0.2%	25.3	-0.2%	16.0	16.0	0.1%	16.0	0.1%	0.012	0.012	-0.4%	0.012	-0.5%
WSD Tsuen Wan Saltwater Intake	24.9	24.9	-0.1%	24.9	-0.1%	15.9	16.0	0.4%	16.0	0.6%	0.013	0.012	-0.4%	0.012	-0.5%
Dragon Beach	24.9	24.9	0.0%	24.9	0.0%	15.8	15.9	0.9%	15.9	1.1%	0.011	0.011	0.0%	0.011	0.0%
Tung Wan Beach	25.9	25.9	0.0%	25.9	0.0%	15.6	15.7	0.2%	15.7	0.2%	0.013	0.013	-0.2%	0.013	-0.2%
Ma Wan Fish Culture Zone	24.7	24.7	0.0%	24.7	0.0%	16.0	16.0	0.3%	16.0	0.3%	0.011	0.011	0.0%	0.011	0.0%
Marine basin at STFR	25.4	25.3	-0.2%	25.3	-0.2%	16.0	16.0	0.1%	16.0	0.1%	0.012	0.012	-0.4%	0.012	-0.5%

	TIN (mg-N/l)					Dissolved oxygen (mg/L)					Dissolved oxygen (mg/L)					*E. coli* (cfu per 100 mL)				
	depth averaged					10 %tile depth averaged					10 %tile bottom layer					depth averaged (geometric mean)				
station	basel. 1	oper. 1	change	rev oper	change	basel. 1	oper. 1	change	rev oper	change	basel. 1	oper. 1	change	rev oper	change	basel. 1	oper. 1	change	rev oper	change
Golden Beach	0.63	0.63	0.0%	0.63	0.0%	5.0	5.0	-0.1%	5.0	-0.2%	4.8	4.8	-0.2%	4.8	-0.3%	1.79E+02	1.85E+02	3.3%	1.87E+02	4.2%
Old Cafeteria Beach	0.65	0.65	0.0%	0.65	0.0%	5.1	5.1	-0.2%	5.1	-0.2%	4.9	4.9	-0.2%	4.9	-0.3%	1.49E+02	1.51E+02	1.3%	1.52E+02	1.6%
New Cafeteria Beach	0.64	0.64	0.0%	0.64	0.0%	5.1	5.1	-0.2%	5.1	-0.2%	4.8	4.8	0.0%	4.8	0.0%	1.53E+02	1.46E+02	-4.7%	1.44E+02	-5.9%
Kadoorie Beach	0.67	0.67	0.0%	0.66	-0.1%	5.3	5.3	-0.2%	5.3	-0.2%	5.1	5.1	-0.2%	5.1	-0.2%	7.58E+02	7.68E+02	1.4%	7.71E+02	1.7%
Castle Peak Beach	0.71	0.71	0.0%	0.71	0.0%	5.4	5.4	0.3%	5.5	0.3%	3.9	3.9	-0.5%	3.9	-0.6%	3.09E+02	3.10E+02	0.5%	3.11E+02	0.6%
Butterfly Beach	0.66	0.66	0.0%	0.66	0.0%	5.2	5.1	-0.2%	5.1	-0.3%	5.0	5.0	-0.2%	5.0	-0.2%	9.55E+01	9.44E+01	-1.1%	9.41E+01	-1.4%
Hoi Mei Beach	0.60	0.60	0.2%	0.60	0.2%	4.9	4.9	-0.2%	4.9	-0.3%	4.8	4.8	0.0%	4.8	0.0%	1.36E+02	1.34E+02	-1.4%	1.34E+02	-1.8%
Casam Beach	0.60	0.61	0.1%	0.61	0.1%	4.9	4.9	-0.2%	4.9	-0.2%	4.9	4.9	-0.2%	4.8	-0.3%	1.24E+02	1.24E+02	0.3%	1.24E+02	0.3%
Lido Beach	0.61	0.61	0.1%	0.61	0.1%	5.0	5.0	-0.2%	5.0	-0.2%	4.9	4.9	0.0%	4.9	0.0%	1.15E+02	1.18E+02	2.2%	1.18E+02	2.8%
Ting Kau Beach	0.61	0.61	0.0%	0.61	0.1%	5.0	5.0	0.0%	5.0	0.0%	4.9	4.9	0.0%	4.9	0.0%	9.64E+01	9.71E+01	0.7%	9.72E+01	0.9%
Approach Beach	0.61	0.61	0.0%	0.61	0.0%	5.0	5.0	0.0%	5.0	0.0%	4.9	4.9	0.0%	4.9	0.0%	1.34E+02	1.35E+02	1.1%	1.35E+02	1.3%
Tsing Lung Tau Beach	0.62	0.62	-0.1%	0.62	-0.1%	5.0	5.0	-0.2%	5.0	-0.2%	4.9	4.9	-0.2%	4.9	-0.3%	1.98E+02	2.04E+02	3.0%	2.06E+02	3.8%
Rambler Typhoon Shelter	0.65	0.65	0.0%	0.65	0.0%	4.8	4.8	-0.1%	4.8	-0.1%	4.5	4.5	-0.2%	4.5	-0.3%	3.48E+03	3.52E+03	1.2%	3.53E+03	1.5%
WSD Tsing Yi Saltwater Intake	0.62	0.62	0.0%	0.62	0.0%	4.5	4.5	0.1%	4.5	0.1%	4.0	4.0	0.2%	4.0	0.3%	7.61E+02	7.34E+02	-3.5%	7.27E+02	-4.4%
SSDS Phase I intake	0.62	0.62	0.0%	0.62	0.0%	4.5	4.5	-0.2%	4.5	-0.3%	4.0	4.0	-0.2%	4.0	-0.3%	5.56E+02	5.57E+02	0.3%	5.58E+02	0.4%
Castle Peak PS intake I	0.65	0.65	0.0%	0.65	0.0%	5.0	5.0	0.0%	5.0	0.0%	4.8	4.8	0.0%	4.8	0.0%	1.50E+02	1.49E+02	-0.6%	1.48E+02	-0.7%
Castle Peak PS intake II	0.65	0.65	0.0%	0.65	0.0%	5.0	5.0	0.2%	5.0	0.2%	4.8	4.8	-0.2%	4.8	-0.3%	1.42E+02	1.41E+02	-0.9%	1.41E+02	-1.1%
MTRC Tsing Yi Station Intake	0.62	0.62	0.0%	0.62	0.0%	4.5	4.5	-0.1%	4.5	-0.1%	4.0	4.0	-0.2%	4.0	-0.3%	7.89E+02	7.89E+02	0.0%	7.89E+02	0.0%
Southwest of Tsing Yi	0.56	0.56	0.1%	0.56	0.1%	4.8	4.8	-0.1%	4.8	-0.2%	4.7	4.6	-0.4%	4.6	-0.5%	2.55E+02	2.58E+02	1.3%	2.59E+02	1.6%
Gemini Beach	0.59	0.59	0.1%	0.59	0.1%	4.8	4.8	0.0%	4.8	0.0%	4.7	4.7	0.0%	4.7	0.0%	2.16E+02	2.17E+02	0.3%	2.17E+02	0.3%
WSD STFR Saltwater Intake	0.59	0.59	0.3%	0.59	0.4%	4.8	4.8	-0.2%	4.8	-0.3%	4.7	4.7	-0.2%	4.7	-0.3%	2.20E+02	2.32E+02	5.3%	2.35E+02	6.7%
WSD Tsuen Wan Saltwater Intake	0.62	0.62	0.0%	0.62	0.1%	4.9	4.9	-0.1%	4.9	-0.1%	4.6	4.6	0.0%	4.6	0.0%	1.07E+03	9.54E+02	-11.2%	9.23E+02	-14.1%
Dragon Beach	0.60	0.60	-0.1%	0.60	-0.1%	4.9	4.9	-0.2%	4.9	-0.3%	4.8	4.8	0.0%	4.8	0.0%	2.14E+02	2.19E+02	2.4%	2.20E+02	3.0%
Tung Wan Beach	0.59	0.59	0.0%	0.59	0.0%	4.8	4.8	-0.1%	4.7	-0.1%	4.5	4.4	-0.2%	4.4	-0.3%	1.36E+02	1.36E+02	-0.3%	1.36E+02	-0.4%
Ma Wan Fish Culture Zone	0.60	0.60	0.0%	0.60	0.1%	4.9	4.9	-0.2%	4.9	-0.3%	4.8	4.8	0.0%	4.8	0.0%	1.18E+02	1.18E+02	0.3%	1.18E+02	0.4%
Marine basin at STFR	0.59	0.59	0.3%	0.59	0.4%	4.8	4.8	-0.2%	4.8	-0.3%	4.7	4.7	-0.2%	4.7	-0.3%	2.20E+02	2.32E+02	5.3%	2.35E+02	6.7%

Note:

Shaded cells indicate exceedence of the WQOs

All predicted levels of water quality parameters shown below the columns of basel. 1, oper. 1 and rev oper are absolute values (that is, the sum of background and the predicted elevation / reduction)

Table 3.6n STATISTICAL OUTPUT AT 26 MONITORING STATIONS DRY SEASON 2012 (Baseline 2 & Operational 2)

	Salinity (ppt) depth averaged					Suspended Solids (mg/L) 90 %tile depth averaged					Un-ionised NH3-N (mg-N/L) depth averaged				
Station	Basel. 2	oper. 2	change	rev oper	change	basel. 2	oper. 2	change	rev oper	change	basel. 2	oper. 2	change	rev oper	Change
Golden Beach	31.4	31.4	0.0%	31.4	0.0%	17.0	16.9	-0.3%	16.9	-0.4%	0.006	0.006	0.2%	0.006	0.2%
Old Cafeteria Beach	31.2	31.2	0.0%	31.2	0.0%	17.6	17.6	0.1%	17.6	0.1%	0.006	0.006	0.1%	0.006	0.2%
New Cafeteria Beach	31.3	31.3	0.0%	31.3	0.0%	17.2	17.2	0.1%	17.2	0.1%	0.006	0.006	0.2%	0.006	0.2%
Kadoorie Beach	31.2	31.2	0.0%	31.2	0.0%	17.8	17.8	0.0%	17.8	0.0%	0.007	0.007	0.1%	0.007	0.1%
Castle Peak Beach	31.1	31.1	0.0%	31.1	0.0%	9.3	9.3	-0.1%	9.3	-0.1%	0.010	0.010	-0.6%	0.010	-0.8%
Butterfly Beach	31.1	31.1	0.0%	31.1	0.0%	18.7	18.8	0.2%	18.8	0.2%	0.006	0.006	0.1%	0.006	0.1%
Hoi Mei Beach	31.7	31.7	0.0%	31.7	0.0%	14.2	14.3	0.2%	14.3	0.3%	0.006	0.006	0.1%	0.006	0.1%
Casam Beach	31.6	31.6	0.0%	31.6	0.0%	14.4	14.4	-0.2%	14.4	-0.3%	0.007	0.007	0.0%	0.007	0.0%
Lido Beach	31.6	31.6	0.1%	31.6	0.1%	14.6	14.7	0.4%	14.7	0.5%	0.007	0.007	0.2%	0.007	0.2%
Ting Kau Beach	31.6	31.6	0.0%	31.6	0.0%	14.7	14.7	-0.5%	14.6	-0.6%	0.007	0.007	0.2%	0.007	0.2%
Approach Beach	31.6	31.6	0.0%	31.6	0.0%	14.3	14.4	0.3%	14.4	0.3%	0.007	0.007	0.1%	0.007	0.2%
Tsing Lung Tau Beach	31.6	31.6	0.0%	31.6	0.0%	15.0	15.0	0.3%	15.0	0.3%	0.006	0.006	0.1%	0.006	0.2%
Rambler Typhoon Shelter	31.8	31.7	-0.2%	31.7	-0.2%	13.6	13.6	0.1%	13.6	0.1%	0.008	0.008	-0.1%	0.008	-0.1%
WSD Tsing Yi Saltwater intake	31.8	31.8	0.0%	31.8	0.0%	14.0	14.0	0.1%	14.0	0.2%	0.007	0.007	-0.1%	0.007	-0.1%
SSDS Phase I intake	31.8	31.8	0.0%	31.8	0.0%	13.8	13.9	0.3%	13.9	0.4%	0.007	0.007	-0.1%	0.007	-0.1%
Castle Peak PS intake I	30.7	30.7	0.0%	30.7	0.0%	22.3	22.3	0.0%	22.3	0.0%	0.006	0.006	0.1%	0.006	0.1%
Castle Peak PS intake II	30.8	30.8	0.0%	30.8	0.0%	22.3	22.3	0.1%	22.3	0.1%	0.006	0.006	0.0%	0.006	0.0%
MTRC Tsing Yi Station intake	31.8	31.8	0.0%	31.8	0.0%	14.0	14.0	0.3%	14.0	0.4%	0.007	0.007	-0.1%	0.007	-0.1%
Southwest of Tsing Yi	31.9	31.9	0.0%	31.9	0.0%	13.2	13.2	0.1%	13.2	0.1%	0.006	0.006	0.1%	0.006	0.1%
Gemini Beach	31.7	31.7	0.0%	31.7	0.0%	14.6	14.7	0.3%	14.7	0.3%	0.006	0.006	0.2%	0.006	0.3%
WSD STFR Saltwater intake	31.6	31.6	0.0%	31.6	0.0%	15.4	15.3	-0.3%	15.3	-0.3%	0.006	0.006	0.3%	0.006	0.3%
WSD Tsuen Wan Saltwater intake	31.7	31.7	0.0%	31.7	0.0%	14.0	14.0	0.3%	14.1	0.4%	0.007	0.007	-0.1%	0.007	-0.1%
Dragon Beach	31.6	31.6	0.0%	31.6	0.0%	15.3	15.3	-0.1%	15.3	-0.2%	0.006	0.006	0.3%	0.006	0.3%
Tung Wan Beach	31.8	31.8	0.0%	31.8	0.0%	12.4	12.4	0.0%	12.4	0.0%	0.007	0.007	0.2%	0.007	0.3%
Ma Wan Fish Culture Zone	31.5	31.5	0.0%	31.5	0.0%	15.5	15.5	0.1%	15.5	0.2%	0.006	0.006	0.1%	0.006	0.2%
Marine basin at STFR	31.6	31.6	0.0%	31.6	0.0%	15.4	15.3	-0.3%	15.3	-0.3%	0.006	0.006	0.3%	0.006	0.3%

	TIN (mg-N/L) depth averaged					Dissolved oxygen (mg/L) 10 %tile depth averaged					Dissolved oxygen (mg/L) 10 %tile bottom layer					*E. coli* (cfu per 100 mL) depth averaged (geometric mean)				
Station	basel. 2	oper. 2	Change	rev oper	Change	basel. 2	oper. 2	Change	rev oper	Change	basel. 2	oper. 2	change	rev oper	Change	basel. 2	oper. 2	change	rev oper	change
Golden Beach	0.34	0.34	0.0%	0.34	0.0%	6.7	6.7	0.0%	6.7	0.0%	6.7	6.7	0.0%	6.7	0.0%	2.33E+02	2.32E+02	-0.4%	2.32E+02	-0.5%
Old Cafeteria Beach	0.34	0.34	0.0%	0.34	0.0%	6.8	6.8	0.0%	6.8	0.0%	6.7	6.7	0.0%	6.7	0.0%	1.08E+02	1.04E+02	-3.9%	1.03E+02	-4.9%
New Cafeteria Beach	0.34	0.34	0.1%	0.34	0.1%	6.7	6.7	0.0%	6.7	0.0%	6.7	6.7	0.0%	6.7	0.0%	9.96E+01	9.89E+01	-0.7%	9.87E+01	-0.8%
Kadoorie Beach	0.35	0.35	0.1%	0.35	0.1%	6.8	6.8	0.0%	6.8	0.0%	6.8	6.8	0.0%	6.8	0.0%	1.00E+03	1.02E+03	1.6%	1.02E+03	2.1%
Castle Peak Beach	0.43	0.43	-0.1%	0.43	-0.1%	6.6	6.6	0.5%	6.6	0.6%	6.3	6.4	2.1%	6.4	2.6%	2.83E+02	2.84E+02	0.2%	2.84E+02	0.3%
Butterfly Beach	0.34	0.34	0.1%	0.34	0.1%	6.8	6.8	0.0%	6.8	0.0%	6.8	6.8	0.0%	6.8	0.0%	8.82E+01	8.83E+01	0.2%	8.84E+01	0.2%
Hoi Mei Beach	0.34	0.34	0.0%	0.34	0.0%	6.7	6.7	-0.1%	6.7	-0.1%	6.6	6.6	0.0%	6.6	0.0%	5.08E+01	4.99E+01	-1.7%	4.97E+01	-2.1%
Casam Beach	0.34	0.34	0.0%	0.34	0.0%	6.7	6.7	0.0%	6.7	0.0%	6.6	6.6	0.0%	6.6	0.0%	7.09E+01	6.85E+01	-3.4%	6.79E+01	-4.2%
Lido Beach	0.34	0.34	0.0%	0.34	0.0%	6.6	6.6	0.0%	6.6	0.0%	6.6	6.6	0.0%	6.6	0.0%	7.86E+01	7.70E+01	-2.1%	7.65E+01	-2.7%
Ting Kau Beach	0.34	0.35	0.1%	0.35	0.1%	6.6	6.6	0.1%	6.6	0.1%	6.6	6.6	0.2%	6.6	0.2%	1.59E+02	1.59E+02	-0.4%	1.58E+02	-0.6%
Approach Beach	0.34	0.34	0.0%	0.34	0.0%	6.7	6.7	0.0%	6.7	0.0%	6.6	6.6	0.0%	6.6	0.0%	2.37E+02	2.35E+02	-1.1%	2.34E+02	-1.4%
Tsing Lung Tau Beach	0.33	0.33	0.0%	0.33	0.0%	6.7	6.7	0.0%	6.7	0.0%	6.7	6.7	0.0%	6.7	0.0%	4.17E+01	4.35E+01	4.4%	4.40E+01	5.5%
Rambler Typhoon Shelter	0.38	0.38	0.0%	0.38	0.0%	6.5	6.5	0.1%	6.5	0.1%	6.4	6.4	0.0%	6.4	0.0%	5.43E+03	5.41E+03	-0.4%	5.40E+03	-0.6%
WSD Tsing Yi Saltwater intake	0.36	0.36	-0.1%	0.36	-0.1%	6.5	6.5	0.0%	6.5	0.0%	6.5	6.5	0.0%	6.5	0.0%	1.60E+03	1.59E+03	-0.5%	1.59E+03	-0.6%
SSDS Phase I intake	0.36	0.36	0.0%	0.36	0.0%	6.5	6.5	0.0%	6.5	0.0%	6.5	6.5	0.0%	6.5	0.0%	1.05E+03	1.04E+03	-0.5%	1.04E+03	-0.6%
Castle Peak PS intake I	0.32	0.32	0.0%	0.32	0.0%	6.9	6.9	0.0%	6.9	0.0%	6.9	6.9	0.0%	6.9	0.0%	6.84E+01	6.85E+01	0.2%	6.86E+01	0.3%
Castle Peak PS intake II	0.33	0.33	0.1%	0.33	0.1%	6.9	6.9	0.0%	6.9	0.0%	6.8	6.8	0.0%	6.8	0.0%	5.89E+01	5.92E+01	0.6%	5.93E+01	0.7%
MTRC Tsing Yi Station intake	0.36	0.36	-0.1%	0.36	-0.1%	6.5	6.5	0.0%	6.5	0.0%	6.5	6.5	0.0%	6.5	0.0%	1.49E+03	1.49E+03	-0.5%	1.48E+03	-0.7%
Southwest of Tsing Yi	0.32	0.32	0.1%	0.32	0.1%	6.7	6.7	0.0%	6.7	0.0%	6.7	6.7	0.0%	6.7	0.0%	7.35E+00	7.41E+00	0.8%	7.42E+00	1.0%
Gemini Beach	0.33	0.33	0.1%	0.33	0.1%	6.6	6.6	0.0%	6.6	0.0%	6.6	6.6	0.0%	6.6	0.0%	3.44E+01	3.47E+01	0.9%	3.48E+01	1.1%
WSD STFR Saltwater intake	0.33	0.33	0.0%	0.33	0.0%	6.7	6.7	0.0%	6.7	0.0%	6.7	6.7	0.2%	6.7	0.2%	2.96E+01	3.10E+01	4.6%	3.13E+01	5.7%
WSD Tsuen Wan Saltwater intake	0.36	0.36	0.0%	0.36	0.0%	6.6	6.6	0.1%	6.6	0.1%	6.6	6.6	0.2%	6.6	0.2%	1.63E+03	1.62E+03	-0.9%	1.61E+03	-1.2%
Dragon Beach	0.33	0.33	0.1%	0.33	0.1%	6.7	6.7	0.0%	6.7	0.0%	6.7	6.7	0.0%	6.7	0.0%	3.19E+01	3.07E+01	-3.6%	3.04E+01	-4.5%
Tung Wan Beach	0.34	0.34	0.1%	0.34	0.2%	6.7	6.7	0.0%	6.7	0.0%	6.6	6.6	0.0%	6.6	0.0%	5.98E+00	6.03E+00	0.8%	6.04E+00	1.0%
Ma Wan Fish Culture Zone	0.34	0.34	0.1%	0.34	0.1%	6.7	6.7	0.0%	6.7	0.0%	6.7	6.7	0.0%	6.7	0.0%	2.51E+01	2.51E+01	0.2%	2.52E+01	0.2%
Marine basin at STFR	0.33	0.33	0.0%	0.33	0.0%	6.7	6.7	0.0%	6.7	0.0%	6.7	6.7	0.2%	6.7	0.2%	2.96E+01	3.10E+01	4.6%	3.13E+01	5.7%

Note:

Shaded cells indicate exceedence of the WQOs

All predicted levels of water quality parameters shown below the columns of basel. 2, oper. 2 and rev oper are absolute values (that is, the sum of background and the predicted elevation / reduction)

Table 3.6o STATISTICAL OUTPUT AT 26 MONITORING STATIONS WET SEASON 2012 (Baseline 2 & Operational 2)

	Salinity (ppt)					Suspended Solids (mg/L)					Un-ionised NH3-N (mg-N/L)				
	depth averaged					90 %tile depth averaged					depth averaged				
station	basel. 2	oper. 2	change	rev oper	change	basel. 2	oper. 2	change	rev oper	change	basel. 2	oper. 2	change	rev oper	change
Golden Beach	23.7	23.7	0.0%	23.7	0.0%	16.6	16.6	0.2%	16.6	0.3%	0.009	0.009	0.2%	0.009	0.2%
Old Cafeteria Beach	22.8	22.8	0.0%	22.8	0.0%	16.8	17.0	0.9%	17.0	1.1%	0.008	0.008	0.2%	0.008	0.2%
New Cafeteria Beach	23.0	23.0	0.0%	23.0	0.0%	16.1	16.1	0.1%	16.1	0.1%	0.009	0.009	0.1%	0.009	0.1%
Kadoorie Beach	22.0	22.0	0.0%	22.0	0.0%	16.4	16.4	-0.2%	16.4	-0.2%	0.008	0.008	0.1%	0.008	0.1%
Castle Peak Beach	21.5	21.5	0.2%	21.5	0.3%	10.6	10.6	-0.8%	10.5	-1.0%	0.011	0.011	0.0%	0.011	0.0%
Butterfly Beach	22.3	22.4	0.1%	22.4	0.2%	17.6	17.6	-0.1%	17.6	-0.1%	0.008	0.008	0.1%	0.008	0.2%
Hoi Mei Beach	25.1	25.1	0.0%	25.1	0.0%	15.4	15.4	-0.1%	15.4	-0.1%	0.009	0.009	0.1%	0.009	0.1%
Casam Beach	24.9	24.8	-0.2%	24.8	-0.3%	15.4	15.3	-0.3%	15.3	-0.4%	0.009	0.009	0.1%	0.009	0.1%
Lido Beach	24.7	24.7	-0.1%	24.7	-0.2%	15.4	15.5	0.2%	15.5	0.2%	0.009	0.009	0.1%	0.009	0.2%
Ting Kau Beach	24.5	24.5	0.0%	24.5	0.0%	15.5	15.6	0.5%	15.6	0.6%	0.009	0.009	0.1%	0.009	0.2%
Approach Beach	24.7	24.7	0.0%	24.7	0.0%	15.9	16.0	0.3%	16.0	0.4%	0.009	0.009	0.1%	0.009	0.2%
Tsing Lung Tau Beach	24.0	24.1	0.1%	24.1	0.1%	15.5	15.6	0.6%	15.6	0.7%	0.009	0.009	0.3%	0.009	0.3%
Rambler Typhoon Shelter	25.1	25.1	0.0%	25.1	0.0%	14.8	14.7	-0.1%	14.7	-0.2%	0.012	0.012	0.0%	0.012	0.0%
WSD Tsing Yi Saltwater intake	26.2	26.1	-0.1%	26.1	-0.1%	16.1	16.1	-0.1%	16.1	-0.1%	0.010	0.010	0.0%	0.010	0.0%
SSDS Phase I intake	26.5	26.5	0.0%	26.5	0.0%	15.9	15.9	0.3%	15.9	0.4%	0.011	0.011	0.0%	0.011	0.0%
Castle Peak PS intake I	22.3	22.3	0.0%	22.3	0.0%	18.9	18.9	0.1%	18.9	0.1%	0.007	0.007	0.1%	0.007	0.1%
Castle Peak PS intake II	22.5	22.5	0.0%	22.5	0.0%	18.7	18.7	0.2%	18.7	0.3%	0.007	0.007	0.1%	0.007	0.1%
MTRC Tsing Yi Station intake	26.4	26.4	-0.1%	26.4	-0.1%	16.2	16.2	0.1%	16.2	0.1%	0.010	0.010	0.0%	0.010	0.0%
Southwest of Tsing Yi	26.6	26.6	0.0%	26.6	0.0%	16.3	16.3	0.5%	16.4	0.6%	0.010	0.010	0.1%	0.010	0.1%
Gemini Beach	25.5	25.5	-0.1%	25.5	-0.1%	15.8	15.9	0.3%	15.9	0.3%	0.009	0.009	0.2%	0.009	0.3%
WSD STFR Saltwater intake	25.4	25.3	-0.2%	25.3	-0.2%	15.9	15.9	-0.1%	15.9	-0.2%	0.009	0.009	0.1%	0.009	0.1%
WSD Tsuen Wan Saltwater intake	24.9	24.9	-0.1%	24.9	-0.1%	15.7	15.7	0.2%	15.7	0.2%	0.010	0.010	0.0%	0.010	0.0%
Dragon Beach	24.9	24.9	0.0%	24.9	0.0%	15.6	15.7	0.6%	15.7	0.7%	0.009	0.009	0.4%	0.009	0.5%
Tung Wan Beach	25.9	25.9	0.0%	25.9	0.0%	15.4	15.5	0.2%	15.5	0.2%	0.011	0.011	0.1%	0.011	0.2%
Ma Wan Fish Culture Zone	24.7	24.7	0.0%	24.7	0.0%	15.8	15.8	0.1%	15.8	0.1%	0.009	0.009	0.1%	0.009	0.1%
Marine basin at STFR	25.4	25.3	-0.2%	25.3	-0.2%	15.9	15.9	-0.1%	15.9	-0.2%	0.009	0.009	0.1%	0.009	0.1%

	TIN (mg-N/L)					Dissolved oxygen (mg/L)					Dissolved oxygen (mg/L)					*E. coli* (cfu per 100 mL)				
	depth averaged					10 %tile depth averaged					10 %tile bottom layer					depth averaged (geometric mean)				
station	basel. 2	oper. 2	change	rev oper	change	basel. 2	oper. 2	change	rev oper	change	basel. 2	oper. 2	change	rev oper	change	basel. 2	oper. 2	change	rev oper	change
Golden Beach	0.60	0.60	0.0%	0.60	0.0%	5.2	5.2	0.0%	5.2	0.0%	5.0	5.0	-0.2%	5.0	-0.2%	1.32E+02	1.33E+02	0.7%	1.33E+02	0.9%
Old Cafeteria Beach	0.62	0.62	0.0%	0.62	0.0%	5.3	5.2	-0.2%	5.2	-0.2%	5.1	5.1	-0.2%	5.1	-0.2%	5.72E+01	5.71E+01	-0.1%	5.71E+01	-0.1%
New Cafeteria Beach	0.62	0.62	0.1%	0.62	0.2%	5.2	5.2	-0.1%	5.2	-0.2%	5.1	5.0	-0.2%	5.0	-0.2%	5.53E+01	5.25E+01	-5.0%	5.18E+01	-6.3%
Kadoorie Beach	0.65	0.65	0.0%	0.65	0.0%	5.4	5.4	-0.1%	5.4	-0.1%	5.3	5.2	-0.2%	5.2	-0.2%	6.86E+02	6.84E+02	-0.3%	6.84E+02	-0.4%
Castle Peak Beach	0.70	0.70	0.0%	0.70	0.0%	5.5	5.5	-0.1%	5.5	-0.1%	4.0	4.0	-0.7%	4.0	-0.9%	3.06E+02	3.09E+02	0.9%	3.10E+02	1.1%
Butterfly Beach	0.64	0.64	0.0%	0.64	0.0%	5.3	5.3	-0.1%	5.3	-0.1%	5.2	5.2	0.0%	5.2	0.0%	3.62E+01	3.60E+01	-0.5%	3.59E+01	-0.7%
Hoi Mei Beach	0.56	0.56	0.2%	0.56	0.2%	5.1	5.1	-0.2%	5.1	-0.2%	5.0	5.0	0.0%	5.0	0.0%	2.36E+01	2.55E+01	8.0%	2.60E+01	10.0%
Casam Beach	0.57	0.57	0.2%	0.57	0.3%	5.2	5.2	0.0%	5.2	0.0%	5.1	5.1	-0.2%	5.1	-0.2%	2.84E+01	3.00E+01	5.6%	3.04E+01	7.1%
Lido Beach	0.57	0.57	0.2%	0.57	0.2%	5.2	5.2	-0.1%	5.2	-0.1%	5.1	5.1	-0.2%	5.1	-0.2%	4.13E+01	4.23E+01	2.3%	4.25E+01	2.9%
Ting Kau Beach	0.58	0.58	0.1%	0.58	0.2%	5.2	5.2	-0.1%	5.2	-0.1%	5.1	5.1	-0.2%	5.1	-0.2%	3.47E+01	3.53E+01	1.6%	3.54E+01	2.0%
Approach Beach	0.57	0.57	0.2%	0.57	0.2%	5.2	5.2	0.0%	5.2	0.0%	5.1	5.1	0.0%	5.1	0.0%	4.78E+01	4.96E+01	3.8%	5.01E+01	4.8%
Tsing Lung Tau Beach	0.59	0.59	-0.1%	0.59	-0.1%	5.2	5.2	-0.2%	5.2	-0.3%	5.1	5.1	-0.4%	5.1	-0.5%	4.15E+01	4.05E+01	-2.5%	4.02E+01	-3.2%
Rambler Typhoon Shelter	0.60	0.60	0.1%	0.60	0.2%	5.2	5.1	-0.1%	5.1	-0.1%	4.8	4.8	0.0%	4.8	0.0%	3.45E+03	3.42E+03	-0.9%	3.41E+03	-1.1%
WSD Tsing Yi Saltwater intake	0.54	0.55	0.1%	0.55	0.1%	4.9	4.9	0.0%	4.9	0.0%	4.7	4.7	0.0%	4.7	0.0%	6.13E+02	5.85E+02	-4.5%	5.78E+02	-5.6%
SSDS Phase I intake	0.53	0.54	0.1%	0.54	0.1%	4.9	4.9	-0.1%	4.9	-0.1%	4.7	4.7	-0.2%	4.6	-0.3%	2.71E+02	2.71E+02	0.2%	2.71E+02	0.2%
Castle Peak PS intake I	0.64	0.64	0.0%	0.64	-0.1%	5.0	5.0	0.1%	5.0	0.2%	4.8	4.8	-0.2%	4.8	-0.3%	7.23E+01	7.26E+01	0.4%	7.27E+01	0.5%
Castle Peak PS intake II	0.64	0.64	0.0%	0.64	0.0%	5.0	5.0	0.2%	5.0	0.2%	4.9	4.9	-0.2%	4.9	-0.3%	5.49E+01	5.50E+01	0.2%	5.51E+01	0.3%
MTRC Tsing Yi Station intake	0.54	0.54	0.1%	0.54	0.1%	4.9	4.9	-0.1%	4.9	-0.1%	4.7	4.6	-0.4%	4.6	-0.5%	6.37E+02	6.36E+02	-0.2%	6.36E+02	-0.3%
Southwest of Tsing Yi	0.51	0.51	0.1%	0.51	0.1%	5.1	5.1	-0.1%	5.1	-0.1%	4.8	4.8	-0.2%	4.8	-0.3%	6.20E+00	6.20E+00	0.1%	6.20E+00	0.1%
Gemini Beach	0.54	0.55	0.3%	0.55	0.3%	5.0	5.0	0.0%	5.0	0.0%	4.9	4.9	0.0%	4.9	0.0%	1.80E+01	1.88E+01	4.5%	1.90E+01	5.6%
WSD STFR Saltwater intake	0.55	0.55	0.4%	0.55	0.5%	5.1	5.0	-0.3%	5.0	-0.3%	5.0	4.9	-0.6%	4.9	-0.8%	1.78E+01	1.93E+01	7.9%	1.96E+01	9.8%
WSD Tsuen Wan Saltwater intake	0.58	0.58	0.2%	0.58	0.2%	5.2	5.2	-0.1%	5.2	-0.1%	5.0	5.0	0.0%	5.0	0.0%	9.93E+02	8.71E+02	-12.3%	8.40E+02	-15.4%
Dragon Beach	0.57	0.57	-0.2%	0.56	-0.2%	5.1	5.1	-0.2%	5.1	-0.2%	5.0	5.0	-0.2%	5.0	-0.3%	1.94E+01	1.94E+01	0.2%	1.94E+01	0.2%
Tung Wan Beach	0.55	0.55	0.1%	0.55	0.1%	5.0	5.0	-0.2%	5.0	-0.2%	4.7	4.7	0.0%	4.7	0.0%	3.76E+01	3.67E+01	-2.4%	3.65E+01	-3.0%
Ma Wan Fish Culture Zone	0.57	0.57	0.0%	0.57	0.0%	5.1	5.1	-0.2%	5.1	-0.2%	5.0	5.0	0.0%	5.0	0.0%	1.23E+01	1.22E+01	-0.5%	1.22E+01	-0.6%
Marine basin at STFR	0.55	0.55	0.4%	0.55	0.5%	5.1	5.0	-0.3%	5.0	-0.3%	5.0	4.9	-0.6%	4.9	-0.8%	1.78E+01	1.93E+01	7.9%	1.96E+01	9.8%

Note:

Shaded cells indicate exceedence of the WQOs

All predicted levels of water quality parameters shown below the columns of basel. 2, oper. 2 and rev oper are absolute values (that is, the sum of background and the predicted elevation / reduction)

Essentially there is a small change (about +/- 0.2 mg L^{-1}) from the baseline to operation situation in terms of the depth-averaged and bottom layer 10 percentile DO readings at all locations. The predicted depth-averaged (10 percentile) DO is ranged from 5.9 to 6.8 mg L^{-1} at all receivers, while the bottom layer (10 percentile) DO is predicted to be from 5.7 to 6.7 mg L^{-1}. Thus, compliance with the WQOs (that is, > 4 mg L^{-1} for depth-averaged DO and > 2 mg L^{-1} for bottom DO) is predicted at all locations. Compliance with WSD's water criterion of DO (> 2 mg L^{-1}) is also predicted at the WSD saltwater intakes at Tsuen Wan, Tsing Yi and the STD (6.1, 5.9 and 6.4 mg L^{-1} depth-averaged DO, respectively).

Exceedances of WQO in *E. coli* (that is, > 180 cfu per 100 mL for bathing beaches) are predicted at various receivers *(Table 3.6l).* As exceedances of WQO are also predicted for these receivers under Baseline 1 Scenario, the STD and the effluent discharge from the STFSTD under the Operational 1 Scenario is not a factor for WQO exceedance. The predicted *E. coli* values at the WSD intakes at Tsuen Wan, Tsing Yi and the STD (1750, 1980 and 444 cfu per 100 mL, respectively) are within the WSD water quality criterion (< 20 000 cfu per 100 mL).

The model results show that the highest increase of the *E. coli* at the bathing beach is less than 3% (or 13 cfu per 100 mL) following the implementation of the STD and increased effluent discharge from the STFSTD. This shows that the operation of STD and STFSTD has minimal impact on the *E. coli* concentrations at these bathing beaches.

The effects of the increased flow rate from the STFSTD are shown to result in small changes in the impacts, of approximately 0.1 to 0.3%. The total changes in all parameters are still less than 1% thus the increased flows from the STW are not predicted to adversely affect water quality at the 26 monitoring stations.

As a whole, the simulation results indicate that there is no significant changes nor deterioration in water quality from the baseline after the implementation of the STD and the increased effluent discharge from the STFSTD. In addition, there are not predicted to be significant impacts from the further increased flows due to the additional population.

Scenario A: Water Quality in 2007 - Wet Season

The simulation results for salinity, SS, BOD_5, unionised NH3-N, TIN, chlorophyll-a, DO and *E. coli* (in geometric mean) showed marginal difference between the baseline (Baseline 1) and operational (Operational 1) simulations *(Figures B1-10* to *B1-24,* and *O1-10* to *O1-24* in *Annex E2*). Almost no difference between the two situation is found. Exceedances of WQOs in TIN and *E. coli* are predicted along Ma Wan Channel and Rambler Channel, respectively, for both Baseline 1 and Operational 1 Scenarios.

The effects of the 4.5% increase in flows from the TKSTSTW due to the increase in population is unlikely to change the above conclusions regarding the minimal effects of the STW on water quality. For example the increase in SS concentrations near the Dragon Beach will show an increase of 0.105 mg L^{-1}, compared to 0.1 mg L^{-1} for the lower flow rate, while increases in *E. coli* at the WSD STD salt water intake will now be approximately 235 cfu per 100 mL compared to 232 cfu per 100 mL previously.

Statistical results of key water quality parameters including salinity, SS, unionised NH3-N, TIN, DO (depth averaged and bottom layer), and *E. coli* at various sensitive receivers are presented in *Table 3.6m* to check against the WQOs. The statistics show full compliance of WQOs in salinity, SS, unionised NH3-N and DO at all receivers for both Baseline 1 and Operational 1 Scenarios.

The depth averaged salinity at all receivers varies from -0.2% to +0.3% (or from -0.1 mg L^{-1} to +0.1 mg L^{-1}) between Baseline 1 and Operational 1. The variation is well below the WQO (< +/- 10% of the ambient value).

In contrast to the WQO tolerance levels reported in *Table 3.6a* or *3.6b,* the variation of depth-averaged (90 percentile) SS concentrations between Baseline 1 and Operational 1 Scenarios is within +/- 0.2 mg L^{-1} (or +/- 0.9%) from the baseline at the all sensitive receivers and, thus, complies with the WQO. The predicted SS levels at the WSD intakes at Tsuen Wan, Tsing Yi and the STD (16.0, 16.0 and 19.0 mg L^{-1}, respectively) exceed the WSD water quality criterion (10 mg L^{-1}) for both Baseline 1 and Operational 1 Scenarios but is still below the recommended pragmatic threshold (20 mg L^{-1}). The implementation of the Sewerage Master Scheme at Sham Tseng will eliminate most of expedient connections from local industries and restaurants. Thus, the loadings of SS within the Sham Tseng Nullahs will be reduced substantially. As the difference of SS between the baseline and the operational simulations at these WSD intakes is minimal, the loadings of SS from the storm drains of STD and the effluent discharge from the STFSTD appear to have no further adverse impact upon these intakes. The predicted SS levels at Castle Peak Power Station Intakes I and II (19.0 and 18.8 mg L^{-1}, respectively) also comply with the operation standard (150 mg L^{-1}) of the intake facilities. The predicted SS levels at the SSDS Phase I Intake and MTRC Tsing Yi Station Intake (14.3 and 14.5 mg L^{-1}, respectively) are also well below the recommended threshold (140 mg L^{-1}) of the cooling water intake.

The depth-averaged unionised NH3-N concentration is predicted to range from 0.007 to 0.018 mg L^{-1} at all receivers under both Baseline 1 and Operational 1 Scenarios. Minimal changes (less than 0.7% or 0.001 mg L^{-1}) from Baseline 1 to Operational 1 Scenarios are anticipated. Full compliance with WQO (< 0.021 mg L^{-1}) is predicted at all receivers.

Exceedances of WQO in TIN (> 0.4 mg-N L^{-1} for Western Buffer and Victoria Harbour WCZs and > 0.5 mg-N L^{-1} for North Western WCZ) are predicted at all sensitive receivers for both Baseline 1 and Operational 1 Scenarios *(Table 3.6m).* However, when compared with the Baseline 1 Scenario, the STD and the effluent discharge from the STFSTD under the Operational 1 Scenario appear to have no effect on the variation of the TIN from the baseline. While some of the WSRs show minimal elevations of TIN from the baseline (maximum 0.4%), other WSRs show minimal reductions of TIN (about 0.1%). As a whole, the model result shows no deterioration of TIN level in marine water during the operational phase. In other words, the loadings of TIN from the storm drains of STD and the effluent discharge from the STFSTD will not contribute to, increase or perpetuate stressed conditions, nor retard recovery of the water body if levels of pollution from other sources decrease. Thus, the predicted increases are considered acceptable. The predicted levels of TIN at the WSD intakes at Tsing Yi, Tsuen Wan and the STD (0.62, 0.62 and 0.59 mg-N L^{-1}, respectively) show that the NH3-N levels at the intakes are within the WSD water quality criterion (< 1 mg-N L^{-1}), as NH3-N is a component of TIN.

There is only a small change (about 0.1 mg L^{-1} reduction) from the baseline to operation situation in terms of the depth-averaged and bottom layer 10 percentile DO readings at all receivers. The predicted depth-averaged DO is ranged from 4.5 to 5.4 mg L^{-1} at all receivers for Baseline 1 and Operational 1 Scenarios, while the bottom layer DO is predicted to be from 3.9 to 5.1 mg L^{-1}. Thus, compliance with the WQOs (that is, > 4 mg L^{-1} for depth-averaged DO and > 2 mg L^{-1} for bottom DO) is predicted at all locations. Compliance with WSD water quality criterion of DO (> 2 mg L^{-1}) is also predicted at the WSD salt water intakes at Tsuen Wan, Tsing Yi and the STD (4.9, 4.5 and 4.8 mg L^{-1} depth-averaged DO, respectively).

Exceedances of WQO in *E. coli* (that is, > 180 cfu per 100 mL for bathing beaches and > 610 cfu per 100 mL for secondary contact water) are predicted at various receivers *(Table 3.6m)*. As exceedances of WQO are also predicted for these receivers under Baseline 1 Scenario (except the Golden Beach), the STD and the effluent discharge from the STFSTD under the Operational 1 Scenario is not a major factor for WQO exceedance. An exception is the Golden Beach where a 3.3% elevation of *E. coli* (from the baseline level of 179 cfu per 100 mL, which is very close to the 180 cfu per 100 mL WQO level, to the operational level of 185 cfu per 100 mL) is predicted and the beach water WQO will be exceeded (by about 3%). However, the elevation is small and acceptable. The predicted *E. coli* values at the WSD intakes at Tsuen Wan, Tsing Yi and the STD (954, 734 and 232 cfu per 100 mL, respectively) are within the WSD water quality criterion (< 20 000 cfu per 100 mL).

The model results show that the highest increase of the *E. coli* at the bathing beach is about 4.2% (or about 8 cfu per 100 mL) following the implementation of the STD and increased effluent discharge from the STFSTD. This shows that the operation of STD and STFSTD has minimal impact on the *E. coli* concentrations at these bathing beaches.

The effects of the increased flow rate from the TKSTSTW are shown to result in small changes in the impacts, of approximately 0.1 to 0.3%. The total changes in all parameters are still less than 1% thus the increased flows from the STW are not predicted to adversely affect water quality at the 26 monitoring stations.

As a whole, the simulation results indicate that there is no significant changes nor deterioration in water quality from the baseline after the implementation of the STD and the increased effluent discharge from the STFSTD. In addition, there are not predicted to be significant impacts from the further increased flows due to the additional population.

Scenario B: Water Quality in 2012 - Dry Season

Contour plots for salinity, SS, BOD_5, unionised NH3-N, TIN, chlorophyll-a, DO and *E. coli* (in geometric mean) in both simulations of Baseline 2 and Operational 2 Scenarios are provided in *Figures B2-1* to *B2-10* and *O2-1* to *O2-10* in *Annex E2*. No major difference between the baseline and operational simulations is observed. No exceedance of WQOs are identified over the marine waters, except the *E. coli* concentration along the Rambler Channel for both Baseline 2 and Operational 2 Scenarios.

The effects of the 4.5% increase in flows from the TKSTSTW due to the increase in population is unlikely to change the above conclusions regarding the minimal effects of the STW on water quality. For example the increase in SS concentrations near the Gemini Beach will show an increase of 0.105 mg L^{-1}, compared to 0.1 mg L^{-1} for the lower flow rate, while increases in *E. coli* at the WSD STD salt water intake will now be approximately 31.3 cfu per 100 mL compared to 31.0 cfu per 100 mL previously.

Statistical results of key water quality parameters including salinity, SS, unionised NH3-N, TIN, DO (depth averaged and bottom layer), and *E. coli* at various sensitive receivers are presented in *Table 3.6n* to check against the WQOs. The statistics show full compliance of WQOs in salinity, SS, unionised NH3-N, TIN and DO at all receivers for both Baseline 2 and Operational 2 Scenarios.

The depth averaged salinity at all receivers varies from -0.2% to +0.1% (or within +/- 0.1 mg L^{-1}) between Baseline 2 and Operational 2. The variation is well below the WQO (< +/- 10% of the ambient value). In contrast to 2007 dry season simulations results *(Table 3.6l),* the 2012 simulation results show no significant difference.

In contrast to the WQO tolerance levels reported in *Table 3.6a* or *3.6b,* the variation of depth-averaged (90 percentile) SS concentrations between Baseline 2 and Operational 2 Scenarios is within +/- 0.1 mg L^{-1} (or +/- 0.5%) from the baseline at the all sensitive receivers and, thus, complies with the WQO. The predicted SS levels at the WSD intakes at Tsuen Wan, Tsing Yi and the STD (14.0, 14.0 and 15.4 mg L^{-1}) exceed the WSD water quality criterion (10 mg L^{-1}) for both Baseline 1 and Operational 1 Scenarios but is still below the recommended pragmatic threshold (20 mg L^{-1}). The implementation of the Sewerage Master Scheme at Sham Tseng will eliminate most of expedient connections from local industries and restaurants. Thus, the loadings of SS within the Sham Tseng Nullahs will be reduced substantially. As the difference of SS between the baseline and the operational simulations at these WSD intakes is minimal, the loadings of SS from the storm drains of STD and the effluent discharge from the STFSTD appear to have no further adverse impact upon these intakes. The predicted SS levels at Castle Peak Power Station Intakes I and II (22.3 mg L^{-1}) also comply with the operation standard (150 mg L^{-1}) of the intake facilities. The predicted SS levels at SSDS Phase I Intake and MTRC Tsing Yi Station Intake (13.9 and 14.0 mg L^{-1}, respectively) are also well below the recommended threshold (140 mg L^{-1}) of the cooling water intake. In contrast to the 2007 dry season simulation results *(Table 3.6l),* the 2012 simulation results show no significant difference.

The depth-averaged unionised NH3-N concentration is predicted to range from 0.006 to 0.010 mg L^{-1} at all receivers under both Baseline 2 and Operational 2 Scenarios. Minimal changes (less than 0.6% or 0.001 mg L^{-1}) from Baseline 2 to Operational 2 are anticipated. Full compliance with WQO (< 0.021 mg L^{-1}) is predicted at all receivers. In contrast to the 2007 dry season simulation results *(Table 3.6l),* the 2012 simulation results show lower unionised NH3-N (from 0.001 to 0.004 mg L^{-1}) at all receivers.

No exceedances of WQO in TIN (< 0.4 mg-N L^{-1} for Western Buffer and Victoria Harbour WCZ and < 0.5 mg-N L^{-1} for North Western WCZ) are predicted at all sensitive receivers for both Baseline 2 and Operational 2 Scenarios *(Table 3.6n).* When compared with the Baseline 2 Scenario, the STD and the effluent discharge from the TKSTSTW under the Operational 2 Scenario appear to have no effect on the variation of the TIN from the Baseline 2. The predicted levels of TIN at the WSD intakes at Tsing Yi, Tsuen Wan and the STD (0.36, 0.36 and 0.33 mg-N L^{-1}, respectively) show that the NH3-N levels at the intakes are within the WSD water quality criterion (< 1 mg-N L^{-1}), as NH3-N is a component of TIN. In contrast to the 2007 dry season simulation results *(Table 3.6l),* the 2012 simulation results show lower TIN (from 0.02 to 0.12 mg L^{-1}) at all receivers.

There is only a small change (within +/- 0.1 mg L^{-1}) from the baseline to operation situation in terms of the depth-averaged and bottom layer 10 percentile DO concentrations at all receivers. The predicted depth-averaged DO concentration is ranged from 6.5 to 6.9 mg L^{-1} at all receivers for Baseline 2 and Operational 2 Scenarios, while the bottom layer DO is predicted to be from 6.4 to 6.9 mg L^{-1}. Thus, compliance with the WQOs (that is, > 4 mg L^{-1} for depth-averaged DO and > 2 mg L^{-1} for bottom DO) is predicted at all locations. Compliance with WSD water quality criterion of DO (> 2 mg L^{-1}) is also predicted at the WSD salt water intakes at Tsuen Wan, Tsing Yi and the STD (6.6, 6.5 and 6.7 mg L^{-1} depth-averaged DO, respectively). In contrast to the 2007 dry season simulation results *(Table 3.6l),* the 2012 simulation results show higher DO concentrations (from 0.1 to 0.8 mg L^{-1}) at all receivers.

Exceedances of WQO in *E. coli* (that is, > 180 cfu per 100 mL for bathing beaches and > 610 cfu per 100 mL for secondary contact marine water) are predicted at various receivers *(Table 3.6n).* As exceedances of WQO are also predicted for these receivers under Baseline 2 Scenario, the STD and the effluent discharge from the STFSTD under the Operational 1 Scenario is not the cause of the WQO exceedance. The predicted *E. coli* values at the WSD intakes at Tsuen Wan, Tsing Yi and the STD (1620, 1590 and 31 cfu per 100 mL, respectively) are within the WSD water quality criterion (< 20 000 cfu per 100 mL).

The model results show that, while six out of 15 bathing beaches show elevation of *E. coli* (from about 0.2% at Castle Peak Beach (that is, from baseline 283 to operational 284 cfu per 100 mL) to about 5.5% (that is, from baseline 42 to operational 44 cfu per 100 mL) at Tsing Lung Tau Beach), other nine bathing beaches show reduction of *E. coli* (from 0.4% at Golden Beach to 3.9% at Old Cafeteria Beach) following the implementation of the STD and increased effluent discharge from the TKSTSTW. In terms of magnitude, the operational *E. coli* levels vary within -2.4 and +20 cfu per 100 mL from baseline. This shows that the operation of STD and STFSTD has minimal impact on the *E. coli* concentrations at these bathing beaches.

In contrast to the 2007 dry season simulation results *(Table 3.6l),* the 2012 simulation results show lower *E. coli* concentrations (from 1.10% to 96.21% reduction, with a mean of 58.26% reduction) at all receivers (except at Castle Peak Beach where the 2012 simulation result shows about 0.71% elevation in *E. coli* in contrast to 2007 result). In terms of magnitude, the decrease is from 62 to 536 cfu per 100 mL, with a mean of 250 cfu per 100 mL.

The effects of the increased flow rate from the TKSTSTW are shown to result in small changes in the impacts, of approximately 0.1 to 0.3%. The total changes in all parameters are still less than 1% thus the increased flows from the STW are not predicted to adversely affect water quality at the 26 monitoring stations.

As a whole, the simulation results indicate that there is no significant changes nor deterioration in water quality from the baseline after the implementation of the STD and the increased effluent discharge from the STFSTD In addition, there are not predicted to be significant impacts from the further increased flows due to the additional population. In contrast to the 2007 dry season simulation results, the 2012 dry season simulation results show some improvement in water quality in terms of TIN, DO and *E. coli* along the beaches between Tsuen Wan and Sham Tseng.

Scenario B: Water Quality in 2012 - Wet Season

The simulation results for salinity, SS, DO, BOD_5, unionised ammonia, TIN, chlorophyll-a, and *E. coli* (in geometric mean) showed marginal difference before and after the STD *(Figures B2-10* to *B2-24* and *O2-10* to *O2-24* in *Annex E2).* Almost no difference between the two situation is observed. Exceedances of WQO in TIN for both Baseline 2 and Operational 2 Scenarios are observed along the Ma Wan Channel between Ma Wan Island and Tsing Yi Island. Exceedances of WQO in *E. coli* for both Baseline 2 and Operational 2 Scenarios are also observed along the Rambler Channel near the Rambler Channel Typhoon Shelter.

The effects of the 4.5% increase in flows from the TKSTSTW due to the increase in population is unlikely to change the above conclusions regarding the minimal effects of the STW on water quality. For example the increase in SS concentrations near the Gemini Beach will show an increase of 0.105 mg L^{-1}, compared to 0.1 mg L^{-1} for the lower flow rate, while increases in *E. coli* at the WSD STD salt water intake will now be approximately 19.6 cfu per 100 mL compared to 19.3 cfu per 100 mL previously.

Statistical results of key water quality parameters including salinity, SS, unionised NH3-N, TIN, DO (depth averaged and bottom layer), and *E. coli* at various sensitive receivers are presented in *Table 3.6o* to check against the WQOs. The statistics show full compliance of WQOs in salinity, SS, unionised NH3-N and DO at all receivers for both Baseline 2 and Operational 2 Scenarios.

The depth averaged salinity at all receivers varies within +/-0.2% (or within +/- 0.1 mg L^{-1}) between Baseline 2 and Operational 2. The variation is well below the WQO (< +/- 10% of the ambient value). In contrast to 2007 wet season simulations results *(Table 3.6m),* the 2012 simulation results show no significant difference.

In contrast to the WQO tolerance levels reported in *Table 3.6a* or *3.6b,* the variation of depth-averaged (90 percentile) SS concentrations between Baseline 2 and Operational 2 Scenarios is within +/- 0.1 mg L^{-1} (or +/- 0.5%) from the baseline at the all sensitive receivers and, thus, complies with the WQO. The predicted SS levels at the WSD intakes at Tsuen Wan, Tsing Yi and the STD (14.0, 14.0 and 15.4 mg L^{-1}) exceed the WSD water quality criterion (10 mg L^{-1}) for both Baseline 2 and Operational 2 Scenarios but is still below the recommended pragmatic threshold (20 mg L^{-1}). The implementation of the Sewerage Master Scheme at Sham Tseng will eliminate most of expedient connections from local industries and restaurants. Thus, the loadings of SS within the Sham Tseng Nullahs will be reduced substantially. As the difference of SS between the baseline and the operational simulations at these WSD intakes is minimal, the loadings of SS from the storm drains of STD and the effluent discharge from the STFSTD appear to have no further adverse impact upon these intakes. The predicted SS levels at Castle Peak Power Station Intakes I and II (18.9 and 18.7 mg L^{-1}, respectively) also comply with the operation standard (150 mg L^{-1}) of the intake facilities. The predicted SS levels at the SSDS Phase I Intake and MTRC Tsing Yi Station Intake (15.9 and 16.2 mg L^{-1}, respectively) are also well below the recommended threshold (140 mg L^{-1}) of the cooling water intake. In contrast to the 2007 wet season simulation results *(Table 3.6m),* the 2012 simulation results show no significant difference.

The depth-averaged unionised NH3-N concentration is predicted to range from 0.007 to 0.012 mg L^{-1} at all receivers under both Baseline 2 and Operational 2 Scenarios. Minimal increase (not more than 0.4% or 0.001 mg L^{-1}) from Baseline 2 to Operational 2 is anticipated. Full compliance with WQO (< 0.021 mg L^{-1}) is predicted at all receivers. In contrast to the 2007 wet season simulation results *(Table 3.6m),* the 2012 simulation results show lower unionised NH3-N (from 0.001 to 0.005 mg L^{-1}) at all receivers.

Exceedances of WQO in TIN (> 0.4 mg-N L^{-1} for Western Buffer and Victoria Harbour WCZ and > 0.5 mg-N L^{-1} for North Western WCZ) are predicted at all sensitive receivers for both Baseline 2 and Operational 2 Scenarios *(Table 3.6o).* However, when compared with the Baseline 2 Scenario, the STD and the effluent discharge from the TKSTSTW under the Operational 2 Scenario appear to have no effect on the level of the TIN from the Baseline 2. The implementation of the Sewerage Master Scheme at Sham Tseng will eliminate most of expedient connections from local industries and restaurants. Thus, the loadings of TIN within the Sham Tseng Nullahs will be reduced substantially. While some of the WSRs show minimal elevations of TIN from the baseline (maximum 0.5%), other WSRs show minimal reductions of TIN (maximum 0.2%). As a whole, the model result shows no deterioration of TIN level in marine water during the operational phase. In other words the loadings of TIN from the storm drains of STD and the effluent discharge from the STFSTD will not contribute to, increase or perpetuate stressed conditions, nor retard recovery of the water body if levels of pollution from other sources decrease. Thus, the predicted increases are considered acceptable. The predicted levels of TIN at the WSD intakes at Tsing Yi, Tsuen Wan and the STD (0.55, 0.58 and 0.55 mg-N L^{-1}, respectively) show that the NH3-N levels at the intakes are within the WSD water quality criterion (< 1 mg-N L^{-1}), as NH3-N is a component of TIN. In contrast to the 2007 wet season simulation results *(Table 3.6m),* the 2012 simulation results show lower TIN (from 0.01 to 0.08 mg L^{-1}) at all receivers.

There is only a small change (within +/- 0.1 mg L^{-1}) from the baseline to operation situation in terms of the depth-averaged and bottom layer 10 percentile DO concentrations at all receivers. The predicted depth-averaged DO concentration is ranged from 4.9 to 5.5 mg L^{-1} at all receivers for Baseline 2 and Operational 2 Scenarios, while the bottom layer DO is predicted to be from 4.6 to 5.2 mg L^{-1}. Thus, compliance with the WQOs (that is, > 4 mg L^{-1} for depth-averaged DO and > 2 mg L^{-1} for bottom DO) is predicted at all locations. Compliance with WSD water quality criterion of DO (> 2 mg L^{-1}) is also predicted at the WSD saltwater intakes at Tsuen Wan, Tsing Yi and the STD (5.2, 4.9 and 5.0 mg L^{-1} depth-averaged DO, respectively). In contrast to the 2007 wet season simulation results *(Table 3.6m)*, the 2012 simulation results generally show higher DO concentrations (from 0 to 0.8 mg L^{-1}) at all receivers.

Exceedances of WQO in *E. coli* (that is, > 180 cfu per 100 mL for bathing beaches and > 610 cfu per 100 mL for secondary contact water) are predicted at Kadoorie Beach and Castle Peak Beach *(Table 3.6o)*. As exceedances of WQO are also predicted for these receivers under Baseline 2 Scenario, the STD and the effluent discharge from the STFSTD under the Operational 2 Scenario is not the cause of the WQO exceedance. No adverse water quality impact of the STD and the effluent discharge from the STFSTD is predicted at all receivers. The predicted *E. coli* values at the WSD intakes at Tsuen Wan, Tsing Yi and the STD (871, 585 and 19 cfu per 100 mL, respectively) are within the WSD water quality criterion (< 20 000 cfu per 100 mL).

The model results show that, while nine out of 15 bathing beaches show elevation of *E. coli* (from about 0.2% at Dragon Beach to about 4.5% at Gemini Beach), other six bathing beaches show reduction of *E. coli* (from 0.1% at Old Cafeteria Beach to 5.0% at New Cafeteria Beach) following the implementation of the STD and increased effluent discharge from the TKSTSTW. In terms of magnitude, the operational *E. coli* concentrations vary within -2.8 to +3.0 cfu per 100 mL from the baseline. This shows that the operation of STD and STFSTD has minimal impact on the *E. coli* concentrations at these bathing beaches.

In contrast to the 2007 wet season simulation results *(Table 3.6m),* the 2012 simulation results show lower *E. coli* concentrations (from 0.32% to 97.6% reduction, with a mean of 57.55% reduction) at all receivers. In terms of magnitude, the decrease is from 1.5 to 286 cfu per 100 mL, with a mean of 123 cfu per 100 mL.

The effects of the increased flow rate from the TKSTSTW are shown to result in small changes in the impacts, of approximately 0.1 to 0.3%. The total changes in all parameters are still less than 1% thus the increased flows from the STW are not predicted to adversely affect water quality at the 26 monitoring stations.

As a whole, the simulation results indicate that there is no significant changes nor deterioration in water quality from the baseline after the implementation of the STD and the increased effluent discharge from the STFSTD. In addition, there are not predicted to be significant impacts from the further increased flows due to the additional population. In contrast to the 2007 wet season simulation results, the 2012 wet season simulation results show some improvement in water quality in terms of TIN, DO and *E. coli* along the beaches between Tsuen Wan and Sham Tseng.

- Near Field Modelling

The *E. coli* contour plots and temporal changes at selected WSRs are contained in *Annex E3*. Similar to the results of global modelling, the near-field model runs with loading via the TKSTSTW outfall (Baseline 3 and Operational 3 Scenarios) show only marginal increased levels of *E. coli* concentration at the WSRs. At the WSD STD Salt Water Intake and the STD Marine Basin, decrease in *E. coli* concentration is predicted, particularly during the wet season condition *(Figures A27* and *A33* of *Annex E3).* For the Baseline 3 Scenario (with the STD not in place), the plume from the outfall is transported into the more sheltered area of the future STD. For the Operational 3 Scenario (with the STD), the local flow patterns and hydrodynamics have been varied and the plume is transported more along the coast. As both the STD Marine Basin and the Sham Tseng Salt Water Intake are situated near the coast of the STD, they lie in the centre of the plume in the Baseline 3 Scenario. Under the Operational 3 Scenario, however, the centre of the plume is situated somewhat outside the coast. As a result, higher *E. coli* concentrations at the STD Salt Water Intake and Marine Basin are predicted under the Baseline 3 Scenario. Nevertheless, the predicted *E. coli* concentration levels at the STD Salt Water Intake is still within the WSD water criterion (less than 20,000 cfu per 100 mL) under Baseline 3 and Operational 3 Scenarios.

For the impact of residual chlorine, both Baseline 3 and Operational 3 Scenarios modelling results indicate that more than 800 times dilution of pollutant can be achieved near the outfall. Assuming that the 0.5 mg L^{-1} of the residual chlorine standard specified in the discharge license of the planned TKSTSTW can be achieved, the concentration of residual chlorine at the outfall will be less than 0.625 µg L^{-1}, which is below the United States Environmental Protection Agency (USEPA) standard of 10 µg L^{-1} residual chlorine in marine water. As the residual chlorine will also decay rapidly in the marine water, it is considered that the impact of residual chlorine upon the marine water quality and the water sensitive receivers is minimal.

The runs with loading via the Emergency Bypass (that is, Baseline 4 and Operational 4 Scenarios) show higher *E. coli* concentration levels above the background than runs with loading via the planned TKSTSTW Outfall (Baseline 3 and Operational 3 Scenarios), mainly because the sewage effluent is not treated prior to discharge. Excluding the effect of the pollution loading from SSDS, the effluent discharge from the Emergency Bypass alone will elevate the *E. coli* concentration above the WQO (180 cfu per 100 mL for beach water and 610 cfu per 100 mL for secondary contact water) at various

WSRs, including Gemini Beach and Dragon Beach where *E. coli* concentrations could reach 10 000 cfu per 100 mL. Exceedance of WSD water quality criterion (20 000 cfu per 100 mL) is also predicted at the WSD STD Salt Water Intake, where the *E. coli* concentration could reach 30 000 cfu per 100 mL, if the sewage effluent is discharged via the Emergency Bypass under the wet season condition *(Figure A27* in *Annex E3).* No exceedance of WSD water quality criterion at WSD Tsuen Wan Salt Water Intake will be generated by the effluent discharge via the Emergency Bypass alone.

In contrast to the simulation results under the Baseline 4 Scenario, the simulation results of Operational 4 Scenario generally show higher *E. coli* concentrations at various sensitive receivers. An exception is at the STD Marine Basin where the *E. coli* concentration will be smaller under the Operational 4 Scenario, which corresponds to the effect of the STD layout on the hydrodynamics described before. As shown in the contour plots *(Figure A4, A5, A7* and *A8* in *Annex E3),* the plume is transported further by the tide in both directions after the implementation of the STD, particularly under the dry season condition, leading to higher *E. coli* concentrations at Dragon Beach and Gemini Beach. The contour plots also reveal that the bacterial plume disperses with the tidal currents along the Ma Wan Channel. They indicate that there is no direct transport of the plume in the direction of Ma Wan Island and beyond. Thus, no exceedances of WQO at Ma Wan WCZ and Tung Wan Beach will be generated by the effluent discharge via the Emergency Bypass alone.

No residual chlorine is expected to discharge with effluent through the Emergency Bypass during failure of treatment / disinfection facilities. Thus, there will be no water quality impact of residual chlorine.
As a whole the near field modelling results reveal that the effluent discharge via the Emergency Bypass is likely to cause substantial water quality impact (in terms of *E. coli*) to the marine water, particularly at the sensitive receivers near the STD and along the tidal flows (including Gemini Beach and Dragon Beach). Minimising the risk and occurrence of the emergency discharge from the TKSTSTW should therefore be considered *(Section 3.7.2).*

The effects of the 4.5% increase in flows from the TKSTSTW due to the increase in population is unlikely to change the above conclusions regarding the minimal effects of the STW on water quality. For example the increase in *E.coli* concentrations near the outfall during the wet season under the emergency condition will show an increase of about 41 800 cfu per 100 mL, compared to about 40 000 cfu per 100 mL for the lower flow rate, while increases in *E. coli* near the outfall during the wet season under normal operation will be now approximately 4.2 cfu per 100 mL compared to 4.0 cfu per 100 mL previously.

Drainage Impact

The hydraulic assessment using the HEC2 programme indicates that there is no significant change of flood storage after the extension of the Sham Tseng East Nullah. The backwater will be raised to an average of 20 mm. Between upstream end of the proposed decked nullah near the former San Miguel Brewery and the Castle Peak Road Bridge, the water level will be slightly raised by 30 mm in 1 in 200 year storm event. Further upstream, between the Castle Peak Road and the 3-cell box culvert underneath the Tuen Mun Road, the water level will remain unaltered.

The hydraulic assessment from the Engineering Study indicates that the low lying areas around Sham Tseng West Nullah between Sham Tseng San Tsuen and Sham Tseng Kau Tsuen is presently susceptible to flooding of 700mm and the additional rise in flood level caused by the reclamation project will be around 100mm, thereby making a total water depth of around 800mm. The extension of the Sham Tseng West Nullah appears to have no significant impact on the hydrodynamics. Under the existing condition, sections of channel cannot provide sufficient capacity to cater for the heavy rainfall events and therefore flooding has occurred in the low lying areas along this watercourse.

Impact from Floating Refuse

Following the construction of the reclamation, the coastline will be streamlined. Thus, no embayment will be formed and the impact from the accumulation of floating refuse will be minimal.

3.7 MITIGATION OF ADVERSE ENVIRONMENTAL IMPACTS

3.7.1 Construction Phase

Marine-based Impact

Construction Design

The water quality impact during the construction phase was assessed with due consideration of the construction programme and identification of the worst-case scenarios of dredging and filling. Phasing of the construction programme has been designed in a way to minimise direct discharge of stormwater from the existing open nullahs into the temporary water embayment formed during filling and, thus, minimise accumulation of pollutants within the embayment. For instance, Phase 2 and its associated drainage diversion will be constructed prior to Phase 3 to avoid direct discharge of more polluted stormwater from the Sham Tseng West Nullah into the embayed water. Although temporary water embayment will be formed at Phase 4 during construction, direct stormwater discharge into the embayed water will only be from a small catchment at Sea Crest Villa Phase I, of which stormwater is considered less polluted.

Filling Operations

The site specific mitigation measures at the STD shall include filling behind the constructed seawall (above the sea level). It is recommended that filling should only be undertaken behind the seawall that is above the sea level. To minimise the duration and accumulation of waterborne pollutants from Sham Tseng Nullahs within the temporary embayed waters behind the seawall, it is recommended that the diversion of the Sham Tseng West Nullahs to the final shoreline should be undertaken prior to the replacement of the seawall blocks of Phase 3.

There are two options to mitigate the potential water quality impact due to filling operations. Both options are considered engineeringly feasible and are effective to minimise the potential SS impact.

Option 1: To alleviate the potential SS impact under Scenario 1, the construction programme should be re-scheduled to avoid simultaneous sandfilling activities of filling rate more than 5000 m^3 per day during Phase 2 and Phase 3 construction. Thus, only sandfilling activity (with a maximum 5000 m^3 per day of sandfilling rate) and public filling activity (with a maximum 5000 m^3 per day of public filling rate) could be undertaken simultaneously.

Option 2: Filling operations could be undertaken within the 'cell' of water body formed by the permanently constructed seawall and the temporary seawall structure(s) perpendicular to the permanent seawall and connected to the existing coastline during each phase of construction, with the minimum required gap for safe marine access. The seawall should be built above the sea level. This measure will effectively contain the sediment plume dispersion within the 'cell' during filling, but it is less preferred from an engineering perspective as the temporary seawall structure formed before filling is required to be re-located after filling at that 'cell'.

In addition to the above measures, transport of filling material to the marine disposal site should, wherever possible, be by split barge of not less than 750 m^3 capacity, well maintained and capable of rapid opening and discharge at the filling site. Moreover, it is also recommended that a silt curtain could be deployed along the reclamation area to minimise potential SS impact in the vicinity.

Dredging

As the majority of marine sediment will be left in place, the reclamation will involve only limited dredging of about 227 000 m^3 and 127 000 m^3 of marine sediment for seawall construction and marine basin construction, respectively. All the dredged material is likely to be uncontaminated *(Table 6.6b).* It is important that appropriate measures are taken to ensure that impacts are kept to a minimum.

Depending on the type of dredgers employed, careful consideration of dredging methods may be necessary. With the small scale nature of the dredging, it is most likely that a closed grab dredger will be employed. With reference to the modelling results of Scenario 2, it is recommended that the maximum dredging rate of a closed grab dredger should be no more than 4000 m^3 per day.

Mitigation measures to minimise the water quality impact of dredging include:

- mechanical grabs, if used, should be designed and maintained to avoid spillage and sealed tightly while being lifted. For dredging of any contaminated mud, closed watertight grabs must be used;

- 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 and dredgers should be fitted with tight fitting seals to their bottom openings to prevent leakage of material;

- 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;

- loading of barges and hoppers should be controlled to prevent splashing of dredged material into the surrounding water. Barges or hoppers should not be filled to a level which will cause the overflow of materials or polluted water during loading or transportation; and

- additional consideration should be given to the transportation and disposal of the dredged material, as discussed in *Section 6.7.*

The use of silt curtains around the dredging location is not recommended as they are not effective to contain sediment plume dispersion under strong tidal currents along Ma Wan Channel. Dredging should be undertaken during the dry season, whenever possible, to minimise the impact upon the WSRs. Further dredging within the reclamation area (other than the foundation works for the seawall) should be undertaken after the completion of the seawall.

Water Quality Impact after the Implementation of Mitigation Measures

- **With Option 1 Mitigation Measure**

Scenario 1:

By re-scheduling the construction programme to avoid simultaneous filling activities at Phase 2 and Phase 3 (that is, by limiting a total rate of sandfilling less than 5000 m^3 per day and a total rate of public filling less than 5000 m^3 per day, or any sand and public filling rates with equivalent total sediment loss rate), sand filling activity at Phase 3 will be undertaken simultaneously with public filling at Phase 2 which will generate less than a quarter of sediment loss in contrast to sandfilling. It is estimated that the generation of SS will be reduced by nearly 40% after re-scheduling the construction programme. *Table 3.7a* summarises the SS impact before and after re-scheduling of the construction programme. All the average SS elevations at the WSRs will comply with the WQOs. Nevertheless, maximum SS after re-scheduling will still lead to exceedance of WQOs.

Table 3.7a ***The Water Quality Impact Before and After Re-scheduling of the Construction Programme***

Sensitive Receiver	WQO Tolerance	Maximum SS (Before / After)	Average SS (Before / After)	% of Time Exceeding WQO (Before / After)
Dry Season				
Tsing Lung Tau Beach	2.6	**8.6** / **5.3**	**3.0** / 1.8	45.4 / 14.1
Golden Beach	2.4	**4.5** / **2.8**	**2.6** / 1.6	43.0 / 1
Kadoorie Beach	2.4	**3.6** / 2.2	1.7 / 1.0	5.2 / 0
New Cafteria Beach	2.4	**5.2** / **3.2**	2.3 / 1.4	27.5 / 10.1
Dragon Beach	5.9	**14.9** / **9.2**	3.5 / 2.2	14.9 / 12.9
Gemini Beach	5.9	**9.2** / 5.7	2.6 / 1.6	4.7 / 0
Old Cafeteria Beach	2.4	**3.3** / 2.0	2.0 / 1.2	20.6 / 0
Wet Season				
Tsing Lung Tau Beach	1.6	**4.9** / **3.0**	1.3 / 0.8	47.0 / 11.2
Approach Beach	2.1	**3.5** / **2.2**	1.7 / 1.0	14.2 / 0.1
Casam Beach	2.1	**3.0** / 1.8	1.5 / 0.9	10.4 / 0
Dragon Beach	2.1	**13.9** / **8.5**	2.0 / 1.2	26.2 / 12.7
Gemini Beach	2.1	**8.0** / **4.9**	1.7 / 1.0	11.4 / 9.0
Hoi Mei Wan	2.1	**2.9** / 1.8	1.5 / 0.9	8.0 / 0
Lido Beach	2.1	**3.1** / 1.9	1.5 / 0.9	11.8 / 0
Ting Kau Beach	2.1	**3.1** / 1.9	1.6 / 1.0	9.3 / 0

Note: "Before / After" stands for before and after re-scheduling of construction programme to avoid overlapping of sandfilling activities at Phase 2 and Phase 3.
Numbers bolded and underlined indicate exceedance of the WQOs

Thus, the proposed mitigation measures and restrictions, including the sandfilling and public filling rates should not be more than 5000m^3 per day respectively, or any sand and public filling rates with equivalent total sediment loss rate is not considered sufficient to minimise the potential water quality impact. Further mitigation measures should be implemented, including

- sandfilling and public filling should be undertaken behind the seawall with the release point of filling at least 200 m from the leading edge of the seawall constructed above the sea level; and
- if exceedances of WQOs at WSRs are observed during the construction, silt curtains should be deployed at the reclamation area to contain sediment plume dispersion.

With the implementation of the above measures, most of the SS generated from the reclamation works will be trapped within the reclamation site and the impact upon the WSRs will be further minimised. It is then considered that water quality impact from the construction of the STD Scenario 1 with Option 1 Mitigation will be environmentally acceptable.

Scenario 2:

To minimise the impact under Scenario 2, it is recommended that sandfilling, with a total rate not more than 5000 m^3 per day (or any sand and public filling rates with equivalent total sediment loss rate), should be undertaken behind the seawall. The release point of filling should be at least 200 m from the leading edge of the constructed seawall. The total rate of dredging should be maintained not more than 4000 m^3 per day. They should be implemented together with other standard mitigation measures for dredging. These measures will retain most of SS generated from the marine works within the reclamation site, thereby reducing Project specific impacts and also the contribution of the STD Project to cumulative impacts.

If exceedances of WQOs at WSRs are observed during the construction, silt curtains should be deployed at the reclamation area to contain sediment plume dispersion.

With the implementation of these measures, it is considered that water quality impact from the construction of the STD Scenario 2, Option 1 Mitigation will be environmentally acceptable.

- **With Option 2 Mitigation Measure**

Scenario 1:

With sandfilling undertaken within the 'cell' of the water body formed by the permanently constructed seawall and the temporary seawall structure, the sediment plume generated from sandfilling / public filling activities will be effectively contained within the 'cell'. Thus, there will be no SS impact upon the WSRs under Scenario 1. Because of the effectiveness of these mitigation measures, control of sandfilling / public filling rates within the 'cell' is not required. With the implementation of this measure, there will be no SS impact upon the WSRs from Scenario 1, Option 2 Mitigation.

Scenario 2:

For Scenario 2, where dredging and sand filling activities are scheduled, the sediment plume generated by filling undertaken within the 'cell' will be effectively contained within the reclamation area. Thus, water quality impact will be from dredging only with Option 2 Mitigation Measure. The water qulaity impact of Scenario 2, after the implementation of the mitigation measure, is shown in Table 3.7b. The residual impact of SS is estimated from the difference between the overall SS elevation SS contribution from sand filling, taking account of the daily loss rates of fines from dredging and from sand filling (Table 3.4c). Exceedance of the maximum SS tolerance level (about 2% of the time over the spring-neap tidal cycle) will only be observed at Dragon Beach. With the implementation of the recommended mitigation measures for dredging, the water quality impact at Dragon Beach should be minimised to acceptable level.

Table 3.7b ***Suspended Sediment Concentrations above Ambient (mg L^{-1}) at Tsing Lung Tau Beach and Dragon Beach under Construction Scenario 2 (with Option 2 Mitigation Measure)***

Sensitive Receiver	WQO Tolerance	Maximum SS (Before / After)	Average SS (Before / After)	% of Exceedance (Before / After)
Dry Season				
Tsing Lung Tau Beach	2.6	**8.0** / 1.1	2.1 / 0.5	11.2 / 0
Golden Beach	2.4	**3.4** / 0.7	1.8 / 0.4	7.8 / 0
New Cafeteria Beach	2.4	**3.5** / 0.8	1.6 / 0.3	0.4 / 0
Dragon Beach	5.9	**14.7** / 3.2	2.6 / 0.6	5.5 / 0
Wet Season				
Tsing Lung Tau Beach	1.6	**3.7** / 0.8	1.0 / 0.2	1.2 / 0
Dragon Beach	2.1	**14.9** / **3.2**	1.7 / 0.4	15.6 / 2.0
Gemini Beach	2.1	**2.7** / 0.6	0.9 / 0.2	2.8 / 0

Note: "Before / After" stands for before and after implementation of Option 2 mitigation measure
Numbers bolded and underlined indicate exceedance of the WQOs

Table 3.7c ***Summary of Maximum Predicted Elevations in Suspended Solids (mg L^{-1}) at Sensitive Receivers and Potential Cumulative Impacts (Scenario 2 with implementation of Option 2 mitigation measure)***

Sensitive Receiver	**WQO Tolerance (DS / WS)**	**Backfilling at North Lantau and South Tsing Yi Marine Borrow Areas (Scenario 4e)** [(1)]	**Sham Tseng Development (Construction Scenario 2)**	**Maximum Elevation of SS**
Gemini Beach	5.9 / 2.1	4.8 (WS)	1.0	5. (WS)
Hoi Mei Wan Beach	5.9 / 2.1	3.6 (WS)	0.5	4.1 (WS)
Casam Beach	5.9 / 2.1	2.9 (WS)	0.5	3.4 (WS)
Lido Beach	5.9 / 2.1	1.4	0.5	1.9
Ma Wan Fish Culture Zone	5.9 / 2.1	3.2 (WS)	0.5	3.7 (WS)
WSD Tsing Yi Intake	-	2.5	0.4	2.9
SSDS Stage I Intake	2.8 / 3.2	2.5	0.3	2.8
MTRC Tsing Yi Station Intake	2.8 / 3.2	2.5	0.4	2.9 (DS)
WSD Tsuen Wan Intake	-	0	0.4	0.4
Tung Wan Beach	5.9 / 2.1	0	0.3	0.3

Note: Shaded areas indicate exceedance of the WQOs

DS - Dry Season; WS - Wet Season

(1) Backfilling of South Tsing Yi and North of Lantau MBAs: *Final Environmental Impact Assessment,* ERM, November 1995.

The cumulative impact of SS upon the WSRs under Scenario 2, after the implementation of Option 2 mitigation measure, is shown in *Table 3.7c*. Exceedance of SS tolerance levels at Gemini Beach, Hoi Mei Wan Beach, Casam Beach, Ma Wan FCZ and MTRC Tsing Yi Station Intake are predicted. However, only about 17% of cumulative SS predicted at Gemini Beach is from the marine works of the STD. As the Gemini Beach is gazetted beach for recreational purposes, the small SS elevation from the STD marine works will not be aesthetically detectable and will not reduce the aesthetic enjoyment of the swimmers and visitors. The predicted SS contributions from the STD reclamation works upon Ho Mei Wan Beach and Casam Beach are minimal and even below the detection limit (1 mg L^{-1}) of the equipment. In addition, the duration of STD dredging works will be about four months over the four year construction period and the potential impact will only occur over a short period over the tidal cycle. It should also be noted that the SS tolerance levels at these receivers (except MTRC Tsing Yi Station Intake) will be exceeded even without the construction of the STD.

With Mitigation Option 2, the SS impact from the STD upon the Ma Wan FCZ will not be detectable (below the 1 mg L^{-1} equipment detection limit of SS). The total predicted SS (including the elevations) at the Ma Wan FCZ is predicted under the worst case scenario to be about 23 mg L^{-1}, to which the construction of the STD contributes about 2%. Literature reviews indicated that lethal responses had not been reported in adult fish at values below 125 mg L^{-1} (22) and that sublethal effects were only observed when levels exceeded 90 mg L^{-1} (23). It should be noted that these tolerance thresholds were taken from international literature as there are no sediment tolerance data specific to Hong Kong species. Taking all of the above into consideration adverse cumulative impacts to culture fisheries resources at the Ma Wan FCZ are not predicted to occur as the values are within reported tolerance levels of fish species.

Thus, after the implementation of mitigation measures, the SS impact from the STD construction works will be effectively minimised and will not be a major contributing factor of the WQO exceedance predicted at these receivers.

In summary, the proposed mitigation measures and restrictions include:

- the maximum dredging rate should be 4000 m^3 per day plus the recommended standard practices to minimise sediment plume generation during dredging; and

- sandfilling and public filling should be undertaken within the waterbody cell formed by the permanently constructed seawall and the temporary seawall structure(s) that is erected above the sea level, perpendicular to the permanent seawall, and connected to the existing coastline during each phase of construction.

(22) Reference in BCL (1994). Marine Ecology of the Ninepin Islands including Peddicord R and McFarland V (1996). Effects of suspended dredged material on the commercial crab), *Cancer magister*. In PA Krenkel, J Harrison and JC Burdick (Eds) Dredging and its Environment Effects. Proc. Speciality Conference American Society of Engineers.

(23) Alabster JS and Lloyd R (1984). Water Quality Criteria for Freshwater Fisheries. Butterworths, London.

With the implementation of these Option 2 mitigation measures, it is considered that water quality impact from the construction of the STD will be environmentally acceptable.

Figure 2.7a shows the revised construction programme that have incorporated the proposed water quality mitigation measures. *Figures 3.7a* to *3.7c* present the sequence of reclamation that corresponds with the revised construction programme. Mitigation Option 1 is recommended for the construction of Phase 1, while Mitigation Option 2 is recommended for the construction of Phases 2, 3 and 4.

Land-based Impact

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.

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

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 STD. All discharges from the construction site should be controlled to comply with the standards for effluents discharged into the Western Buffer WCZs under the TM.

Construction Runoff

Exposed soil areas should be minimised to reduce the potential for increased siltation, contamination of runoff, and erosion. Construction runoff related impacts associated with 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.

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.

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.

Sediment tanks of sufficient capacity, constructed from pre-formed individual cells of approximately 6 to 8 m^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.

Open stockpiles of construction materials (for examples, aggregates, sand and fill material) of more than 50 m^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. 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.

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.

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.

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 backfill toward the wheel-wash bay to prevent vehicle tracking of soil and silty water to public roads and drains.

Drainage

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.
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.

General Construction Activities

Debris and rubbish on site should be collected, handled and disposed of properly to avoid entering the water column to cause water quality impacts. To control floating debris after the deposit of public fill, floating boom shall be installed around the water body to be reclaimed so as to withhold the floating debris. The floating debris shall also be regularly collected by the contractor to avoid accumulation. On-site solid waste management requirements are described further in *Section 6.7* of this Report.

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 coastal waters of the Western Buffer WCZ.

Sewage Effluent

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.

3.7.2 *Operational Phase*

Water Quality Impact

During the operation of the STFSTD, the water quality modelling has predicted that there would be minimal impact upon the marine water quality adjacent to the STD, although small elevation of *E. coli* concentration (about 6 cfu per 100 mL) at the Golden Beach under the wet season tides of Operational 2 Scenario will be sufficient to cause a WQO exceedance. The results indicate that effluent discharge from the STFSTD alone under normal operation is not the cause of the predicted WQO exceedance at the bathing beaches at Tsing Lung Tau Beach, Dragon Beach, and bathing beaches between Sham Tseng and Tsuen Wan.

Based on the operational water quality modelling results reported, it is predicted that, during the operational phase of the STD, water quality (in terms of ammoniacal nitrogen, dissolved oxygen and *E. coli*) at the proposed sea water intake point at the STD will be within the WSD criteria. Suspended solids concentration at the intake point will be about 16 mg L^{-1} and is less than 0.5% or 0.1 mg L^{-1} deviation from the baseline (that is, without the STD). The predicted SS concentration at the intake point will exceed WSD water quality criterion of SS (10 mg L^{-1}). It should be noted that the SS contribution from this Projects to the water intake is negligible, that is, the exceedance is a regional issue that could not be mitigated in this Project nor should it prejudice the feasibility of the proposed further reclamation.

The extent of water quality impact, in terms of *E. coli,* has also been considered under the emergency discharge condition of the TKSTSTW. The modelling results indicate that the substantial water quality impact upon the bathing beaches adjacent to the STD will occur when sewage effluent is discharged via the Emergency Bypass without treatment. It is required that should a failure occur, the necessary repairs should be expedited in order to limit the period of discharge. This would ensure that the water quality impact was limited as far as possible. Other measures include the provision of backup power supply and standby units of key components of the TKSTSTW and STFSTD, and regular maintenance of the treatment facilities to reduce the risk of failure. In addition, adequate public warning shall be given when failure occurs.

Water quality impact will occur when sewage effluent of the underground sewage pumping station is discharged via the emergency bypass. However, the chance of this occurring is extremely remote. To minimize water quality impacts arising from the bypass of sewage, a standby pump will be provided to cater for breakdown and maintenance of the duty pump so as to avoid the need for sewage bypass. In order to minimize the chance of power failure, dual power supplies will be provided by the China Light and Power Co Ltd for the proposed underground sewage pumping station. In addition, a telemetry system will also be provided in order to send signals showing irregularity or any operation problem of the pumping station to the proposed STFSTD such that immediate actions could be taken in case of emergency. Besides, the rising mains are designed as twin so as to facilitate inspection, maintenance and pipe replacement works by closing one main and operating the other. With all these measures incorporated into the design of the pumping station, it is anticipated that the chance of emergency sewage bypass will be extremely remote.

Contingency plans should be prepared for the STFSTD and underground sewage pumping stations and submitted to DSD and EPD for approval prior to commissioning of works.

Drainage Discharge

The hydraulic modelling results carried out under the Engineering Study[24] show that flooding may occur at the Sham Tseng West Nullah between Sham

(24) Agreement No. CE 93/97, Planning and Engineering Feasibility Study for Development on Sham Tseng Further Reclamation, Draft Engineering – Final Report, August 1999.

Tseng Tsuen, though the extension of the Nullah appears to have no significant impact on hydrodynamics. To improve the situation, it is recommended that illegal squatter at that area should be demolished and the open concrete lined channel should be widened or the channel wall should be raised to increase the stormwater holding capacity of the channel.

The following measures are applicable to reduce stormwater run-off pollution within the STD:

- provision of silt traps to reduce the concentration of silt / sediments in stormwater run-off. These silt traps should be cleaned and maintained regularly to ensure that they function properly;

- compliance of the WPCO for Western Buffer WCZ through the issuance of relevant discharge licence for the proposed development within STD; and

- stringent control on the discharge of sewage into Western Buffer WCZ with all expedient connection eliminated and untreated effluent conveyed to the TKSTSTW for treatment and disposal.

It should also be noted that after the commissioning, in early 2005, of the proposed sewerage systems for both the STD and for the villages of Sham Tseng, Ting Kau and Tsing Lung Tau, direct effluent discharge into the drainage and stormwater channel will be substantially reduced, alleviating the water quality impact along the coast of Sham Tseng, Tsing Lung Tau and Ting Kau.

3.8 *EVALUATION OF RESIDUAL IMPACTS*

3.8.1 *Construction Phase*

Marine-based Construction Impact

The major water impact associated with dredging and filling activities are the elevation of suspended solids within the marine water column. Provided the recommended mitigation measures, including filling behind the completed seawall are adopted, the residual water quality impact due to the STD reclamation works alone will be maintained within the WQO acceptable levels.

With the implementation of the recommended mitigation measures, the small SS elevation from the STD marine works at the Gemini Beach (about 1 mg L^{-1}) will not be aesthetically detectable and will not reduce the aesthetic enjoyment of the swimmers and visitors. The predicted SS contributions from the STD reclamation works upon Ho Mei Wan Beach and Casam Beach are minimal and even below the detection limit (1 mg L-1) of monitoring equipment. In addition, the duration of STD dredging works will be about four months over the four year construction period and the potential impact will only occur over a short period over the tidal cycle. hus, it is concluded that the SS generated from the STD reclamation works will not cause an adverse impact upon these beaches and, thus, there will be no residual impacts.

The cumulative assessment of impacts to water quality (Sections 3.6.1 and 3.7.1) from concurrent projects had indicated that SS elevations do exceed the WQO tolerance. The total predicted increases in concentrations at the Ma Wan Fish Culture Zone will be reduced from a value of 7 mg L^{-1} before mitigation, to a value of maximally 4 mg L^{-1} after mitigation, to which the construction of the STD contributes about 2%. The predicted total SS level (that is the sum of ambient and elevated SS levels) after mitigation is about 23mg Lt. Level. The contribution due to the construction of the STD has thus been reduced as much as is practicable by temporary to permanent seawalls (that is, to about 0.5 mg L-1) and any further reductions in the impacts at the Ma Wan FCZ will thus fall to the other concurrent project (that is, backfilling at North Lantau and South Tsing Yi Marine Borrow Areas). It should be noted that in the assessment the contribution of other concurrent project at the Ma Wan FCZ was based on worst case scenario for this project (that is, the concurrent project was assumed to be operating at their highest allowable rates) and that the probability of these worst case scenarios operating concurrently is considered to be low. Furthermore, it has been assumed that the maximum predicted increases in concentrations at the Ma Wan FCZ for the concurrent project occurs at the same time within the tidal cycle, which may not necessarily be the case. It may thus be concluded that the cumulative impacts assessed here are very much worst case and that the actual impacts are likely to be very much lower, which will be determined through monitoring. As described in Section 3.7.1, adverse cumulative impacts to culture fisheries resources at the Ma Wan FCZ are not predicted to occur, it is therefore concluded that the predicted exceedance of the WQO at Ma Wan FCZ is not an adverse impact and there will thus be no residual impacts.

Land-based Construction Impact

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

3.8.2 Operational Phase

From the modelling results of 2007 and 2012, it is concluded that the pollution loadings from the SSDS Stage I Interim Outfall is the main source of pollution in the vicinity of the STD. Also from the comparison between baseline and operation simulation results, it indicates that under the normal operation, the STFSTD has minimal influence upon the water quality in the Study Area. Provided the emergency discharge from the TKSTSTW is mitigated as described in *Section 3.7.2* and is thus controlled to a limited duration, long-term adverse water quality impact is not anticipated.

Following the implementation of the recommended mitigation measures, the residual water quality impact from direct effluent discharge along stormwater and drainage channel will be minimal. The flood holding capacity of Sham Tseng West Nullah will be increased, which will substantially reduce the threat of flooding at Sham Tseng Tsuen and Sham Tseng Kau Tsuen.

3.9 *ENVIRONMENTAL MONITORING AND AUDIT*

3.9.1 *Construction Phase*

Based on the above assessment of the water quality impact, an environmental monitoring and audit (EM&A) programme is considered necessary to obtain a robust, defensible database of baseline information of water quality before the construction, and thereafter, to monitor any variation of water quality from the baseline conditions and exceedances of WQOs at sensitive receivers during construction. The construction EM&A requirements are described in *Section 13.2.* Details of the EM&A are presented in the Project EM&A Manual.

3.9.2 *Operational Phase*

Routine monitoring of the effluent quality from the planned TKSTSTW and the STFSTD shall be undertaken to satisfy EPD's license conditions. Monitoring of the quality of sewage effluent from the planned TKSTSTW and the STFSTD will be undertaken under the WPCO.

The treated sewage from the STFSTD will be subject to a comprehensive performance verification programme, funded by the project vote for the STFSTD and implemented through engagement of consultant[20], to confirm the acceptability of the impact of the effluent discharge on the receiving marine environment. Performance verification monitoring of the STFSTD will follow similar requirements of and take into account the findings of the independent performance verification programme for the planned TSKTSTW. Details of the verification programme for the STFSTD will be subject in EPD's endorsement.

3.10 *CONCLUSION AND RECOMMENDATIONS*

3.10.1 *Construction Phase*

Marine-based Impact

The water quality impact during the reclamation of Sham Tseng development was quantitatively assessed using the Delft3D Water Quality Model. Suspended sediment is identified as the most significant water quality parameter during the reclamation. The worst-case scenario during reclamation was assessed and it was predicted that potential water quality impact would only occur in waters at Gemini Beach, Tsing Lung Tau Beach,

(20) Under the existing arrangement, such consultancy service will be procured by EPD and managed by the designed team under the Water Policy Group of EPD which consists of staff seconded to EPD from DSD. Similar arrangement will be effected for this project with the assumption that the current practice persists.

Golden Beach, Kadoorie Beach, New Cafeteria Beach and Dragon Beach. The water quality impact at these beaches could be effectively minimised with the implementation of the proposed mitigation measures. An environmental monitoring and audit programme is required to ensure the effectiveness of the proposed water quality mitigation measures.

The assessment of cumulative impacts was made by taking the results of previous computer modelling increases in suspended sediment concentrations at sensitive receivers for potentially concurrent projects. The results of the previous computational modelling were summed with the predicted increases in suspended solids concentrations from the STD at the sensitive receivers. It was determined that there would be an exceedance of the WQO for suspended solids at the Ma Wan Fish Culture Zone as well as beaches adjacent to the STD. Through mitigation of the STD construction the contribution of the STD construction to the total suspended solids concentration could be minimised to contribute only a small amount to the total predicted increase in concentrations. It was noted that the cumulative assessment was based on a very conservative assessment methodology, which meant that the likelihood of the predicted cumulative impacts occurring will be very small and that the duration of the contribution of the STD construction to the elevated suspended solids concentrations could be small. Despite the conservative nature of the assessment it was determined that the predicted increases in suspended solids concentrations would not result in adverse effects on the fish stocks as well as aesthetic enjoyment of the swimmers and visitors of the beaches. It was therefore concluded that the predicted exceedance of the WQO would not be considered an adverse impact.

Land-based Impact

Water quality impacts from land-based construction, including the residential development, Sham Tseng Bypass construction, construction of STFSTD and sewage pumping station, are associated with the surface runoff, effluent discharge from the site, and sewage from on-site construction workers. Impacts can be controlled to comply with the WPCO standards by implementing the recommended mitigation measures. No unacceptable residual impact on water quality is anticipated.

3.10.2 *Operational Phase*

Hydrodynamics

An assessment of the hydrodynamic impact due to the STD has been made using the Delft3D Upgraded model. With this quantitative modelling tool the impact has been assessed for the dry and wet seasons over a spring-neap tidal cycle. For both seasons, the baseline and operation simulations have been compared. It is concluded that:

- the influence of the proposed STD on the water level in the Study Area and in the vicinity is marginal;
- the influence on the current magnitude and direction in Ma Wan Channel mainly occurs in the immediate vicinity of the reclamation. In the dry

- season under spring tide conditions, the peak current speed may increase 4% during the ebb stream. The change is smaller for the neap tide and during the flood stream. In the wet season, the impact appears greater. During the ebb stream the increase in peak current magnitude can be 0.23 m s^{-1}, and about 0.07 m s^{-1} during flood stream. Nevertheless, the influence on peak currents is negligible in the centre of the Ma Wan Channel;

- the water fluxes through the Ma Wan Channel and other main channels are not notably affected by the STD;

- in the dry season the impact on the salinity is less than 0.1 ppt throughout the Study Area. In the wet season the short term impact will be about 1.0 ppt but on a long term scale the impact is less than 0.2 ppt; and

- based on the cumulative hydrodynamic impact due to the STD, it is expected that the cumulative water quality impact is minimal.

Therefore, it is concluded that the STD will have minimal impact on the hydrodynamic regime of the Study Area and there will be no insurmountable hydrodynamic impacts.

Water Quality

The modelling results indicate that additional sewage discharge from the STFSTD has minimal impact upon the marine water quality. The results also indicate that the water quality at the WSD sea water intakes at the STD, Tsing Yi and Tsuen Wan will be within the WSD water quality criteria for ammoniacal nitrogen, DO and *E. coli*. Minimal impact of SS (less than 0.5% from the baseline or 0.2 mg L^{-1}) are also predicted at these intakes. The results also indicate that the water quality at the WSD salt water intakes at the STD, Tsing Yi and Tsuen Wan will be within the WSD water quality criteria for ammoniacal nitrogen, DO and *E. coli*. Minimal impact of SS (less than 0.5% above the baseline or 0.2 mg L^{-1}) are also predicted at these intakes.

Based on the operational water quality modelling results reported, it is predicted that the suspended solids concentration at the intake point of the proposed STD salt water pumping station will exceed WSD water quality criterion (10 mgL^{-1}). It is also predicted that the SS contribution from the project to the water intake is negligible (less than 0.1mgL^{-1}), that is, the exceedance is a regional issue that could not be mitigated in this housing project nor should it prejudice the feasibility of the proposed further reclamation.

In the eventuality of failure of the TKSTSTW facilities, sewage discharge via the Emergency Bypass would be required which will cause local substantial water quality impact upon the bathing beaches adjacent to the STD. Failure should therefore be minimised and also kept to a limited duration if they do occur. Risk of failure should be controlled by regular maintenance of treatment facilities, and provision of backup power supply and standby units of key components of the TKSTSTW and STFSTD.

Drainage Discharge

The hydraulic assessment from the Engineering Study indicates that the low lying areas around Sham Tseng West Nullah between Sham Tseng San Tsuen and Sham Tseng Kau Tsuen is presently susceptible to flooding of 700mm and the additional rise in flood level caused by the reclamation project will be around 100mm, thereby making a total water depth of around 800mm. The extension of the Sham Tseng West Nullah appears to have no significant impact on the hydrodynamics. Under the existing condition, sections of channel cannot provide sufficient capacity to cater for the heavy rainfall events and therefore flooding has occurred in the low lying areas along this watercourse.