4 Water Quality Impact

4.1 Introduction

4.1.1 This section presents the findings of the assessment of potential water quality impacts associated with the construction and operation of the Project. Suitable mitigation measures have been recommended to minimize the potential adverse impacts and to ensure the acceptability of any residual impact after mitigation.

4.1.2 Under the existing Tolo Harbour Effluent Export Scheme (THEES), the treated effluent from Tai Po Sewage Treatment Works (TPSTW) is collected in the Tai Po Effluent Pumping Station (TPEPS) and then pumped via a rising main and a submarine pipeline to the existing Sha Tin Effluent Pumping Station (STEPS). The STEPS receives the treated effluent from both TPSTW and Sha Tin Sewage Treatment Works (STSTW) and then pumps the combined effluents to the Sha Tin Portal of the Effluent Export Tunnel of THEES at Ah Kung Kok, which then conveys the effluents to Kai Tak River for discharge into the Kai Tak Approach Channel (KTAC) in Victoria Harbour. In addition, effluent from TPSTW may be discharged via the existing emergency outfall into Tolo Harbour under emergency condition or during the THEES maintenance period. The general layout of the THEES is shown in **Figure 4.1**. The location of the existing emergency outfall is indicatively shown in **Figure 4.2**. As such, the Project would have potential impact on both Victoria Harbour and Tolo Harbour.

4.2 Legislation, Standards, Guidelines and Criteria

Environmental Impact Assessment Ordinance

4.2.1 The Technical Memorandum on EIA Process (EIAO-TM) was issued by EPD under Section 16 of the EIAO. It specifies the assessment method and criteria that are to be followed in an EIA Study. Reference sections in the EIAO-TM provide the details of assessment criteria and guidelines that are relevant to the water quality impact assessment, including:

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

Water Quality Objectives

4.2.2 The Water Pollution Control Ordinance (WPCO) provides major statutory framework for the protection and control of water quality in Hong Kong. According to the Ordinance and its subsidiary legislation, Hong Kong waters are divided into ten Water Control Zones (WCZs). Corresponding statements of Water Quality Objectives (WQOs) are stipulated for different water regimes (marine waters, inland waters, bathing beaches subzones, secondary contact recreation subzones and fish culture subzones) in the WCZs based on their beneficial uses.

4.2.3 The Project site is located in the Tolo Harbour and Channel WCZ. Under normal operation, the existing TPSTW effluent is discharged to the Victoria Harbour (Phase Two) WCZ via the THEES. The Victoria Harbour WCZ has been divided into three phases (namely Phases One, Two and Three respectively) and the associated marine WQOs for all the three phases as defined under the WPCO are the same. WQOs for the Tolo Harbour and Channel WCZ and Victoria Harbour (Phases One, Two and Three) WCZ are listed in **Table 4.1** and **Table 4.2** respectively.

Table 4.1 Water Quality Objectives for Tolo Harbour and Channel WCZ

Parameters	Objectives	Sub-Zone
Offensive odour, tints	Not to be present	Whole zone
Visible foam, oil scum, litter	Not to be present	Whole zone
Colour	Should not cause the colour of waters of the subzone to exceed 50 Hazen units at any time.	Inland Waters in Shing Mun (A, C, D, E, H, I), Tai Po (B, C) subzones and other watercourses
	Should not cause the colour of waters of the subzone to exceed 30 Hazen units at any time.	Inland Waters in Shing Mun (B, F, G), Lam Tsuen (C, D), Tai Po (A)subzones
Dissolved oxygen (DO)	Not less than 2mg/L within two metres of the bottom, or not less than 4mg/L in the remainder of the water column	Marine Waters in Harbour Subzone
	Not less than 3mg/L within two metres of the bottom, or not less than 4mg/L in the remainder of the water column	Marine Waters in Buffer Subzone
	Not less than 4mg/L at any point in the water column	Marine Waters in Channel Subzone
	Not less than 4 mg/L or 40% saturation (at 15^{0}C) at any time	Inland Waters
pH	Not to cause the normal pH range to be extended by more than ±0.5 pH units at any time.	Marine Waters in Harbour Subzone
	Not to cause the normal pH range to be extended by more than ±0.3 pH units at any time.	Marine Waters in Buffer Subzone
	Not to cause the normal pH range to be extended by more than ±0.1 pH units at any time.	Marine Waters in Channel Subzone
	Not exceed the normal pH range of 6.5 – 8.5 at any time	Inland Waters in Shing Mun (A, B, C, F, G, H), Lam Tsuen (C, D) and Tai Po (A, B, C) subzones
	Not exceed the normal pH range of 6.0 – 9.0 at any time	Inland Waters in Shing Mun (D, E, I) subzones and other watercourses
Light Penetration	Should not reduce light transmission by more than 20% of the normal level at any location or any time.	Marine Waters in Harbour Subzone
	Should not reduce light transmission by more than 15% of the normal level at any location or any time.	Marine Waters in Buffer Subzone
	Should not reduce light transmission by more than 10% of the normal level at any location or any time.	Marine Waters in Channel Subzone
Salinity	Not to cause the normal salinity range to be extended by more than ±3 parts per thousand at any time.	Marine Waters
Temperature	Not to cause the natural daily temperature range to be extended by greater than ±1.0 °C at any location or time. The rate of temperature change shall not exceed	Marine Waters

Parameters	Objectives	Sub-Zone
	0.5 °C per hour at any location, unless due to natural phenomena.	
	Not to cause the natural daily temperature range to be extended by greater than ±2.0 °C at any location or time.	Inland Waters
Chemical oxygen demand (COD)	Not exceed 15 mg/L at any time	Inland Waters in Shing Mun (B, F, G), Lam Tsuen (C, D) and Tai Po (A) subzones
	Not exceed 30 mg/L at any time	Inland Waters in Shing Mun (A, C, D, E, H, I), Tai Po (B, C) subzones and other watercourses
5-day biochemical oxygen demand (BOD_5)	Not exceed 3 mg/L at any time	Inland Waters in Shing Mun (B, F, G), Lam Tsuen (C, D) and Tai Po (A) subzones
	Not exceed 5 mg/L at any time	Inland Waters in Shing Mun (A, C, D, E, H, I), Tai Po (B, C) subzones and other watercourses
Suspended solids (SS)	Not to cause the annual median level to exceed 20 mg/L.	Inland Waters in Shing Mun (A, B, C, F, G, H), Lam Tsuen (C, D) and Tai Po (A, B, C) subzones
	Not to cause the annual median level to exceed 25 mg/L.	Inland Waters in Shing Mun (D, E, I) subzones and other watercourses
Settleable Material	Bottom deposits or submerged objects should not adversely influence bottom-living communities, alter the basic Harbour geometry or shipping channels, present any hazard to shipping or diving activities, or affect any other beneficial use of the waters.	Whole zone
Ammonia Nitrogen (NH_3-N)	Not to exceed 0.5 mg/L at any time	Inland Waters
E. coli Bacteria	Not exceed 610 per 100mL, calculated as the geometric mean of all samples collected in one calendar year	Secondary Contact Recreation Subzone and Fish Culture Subzones
	Not exceed 1000 per 100mL, calculated as a running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days (or 14 and 42 days)	Inland Waters in Shing Mun (A, C, D, E, H, I) and Tai Po (B, C) subzones and other watercourses

Parameters	Objectives	Sub-Zone
	Not exceed 0 per 100mL, calculated as a running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days (or 14 and 42 days)	Inland Waters in Shing Mun (B, F, G), Lam Tsuen (C, D) and Tai Po (A) subzones
Chlorophyll-*a*	Not to cause the level of chlorophyll-*a* in waters of the subzone to exceed 20 mg/m^3, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Marine Waters in Harbour Subzone
	Not to cause the level of chlorophyll-*a* in waters of the subzone to exceed 10 mg/m^3, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Marine Waters in Buffer Subzone
	Not to cause the level of chlorophyll-*a* in waters of the subzone to exceed 6 mg/m^3, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Marine Waters in Channel Subzone
Toxic substances	Should not attain such a level as to produce significant toxic effects in humans, fish or any other aquatic organisms.	Whole zone

Source: Statement of Water Quality Objectives (Tolo Harbour and Channel Water Control Zone).
Note: The delineation of Shing Mun River, Lam Tsuen River and Tai Po River Subzones are defined in the following website: https://www.elegislation.gov.hk/hk/cap358F!en

Table 4.2 Water Quality Objectives for Victoria Harbour (Phases One, Two and Three) WCZs

Parameters	Objectives	Sub-Zone
Offensive odour, tints	Not to be present	Whole zone
Visible foam, oil scum, litter	Not to be present	Whole zone
Colour	Should not cause the colour of waters to exceed 50 Hazen units	Inland Waters
Dissolved oxygen (DO) within 2m of the seabed	Not less than 2 mg/L for 90% of the sampling occasions during the whole year	Marine Waters
Depth-averaged DO	Not less than 4 mg/L for 90% of the sampling occasions during the whole year	Marine Waters
	Not less than 4 mg/L	Inland Waters
pH	To be in the range of 6.5 - 8.5, human activity should not cause the natural pH range to be extended by more than 0.2	Marine Waters
	Not exceed the normal pH range of 6.0 – 9.0	Inland Waters
Salinity	Change due to human activity not to exceed 10% of ambient salinity level	Whole zone
Temperature	Change due to human activity not to exceed 2°C	Whole zone
Chemical oxygen demand (COD)	Not exceed 30 mg/L	Inland Waters
5-day biochemical oxygen demand (BOD_5)	Not exceed 5 mg/L	Inland Waters
Suspended solids (SS)	Not to raise the ambient level by more than 30% caused by human activity, nor give rise to accumulation of	Marine Waters

Parameters	Objectives	Sub-Zone
	suspended solids which may adversely affect aquatic communities	
	Not to cause the annual median level to exceed 25 mg/L.	Inland Waters
Unionized ammonia (UIA)	The un-ionized ammoniacal nitrogen level should not be more than 0.021 mg/L calculated as the annual average (arithmetic mean)	Whole zone
Nutrients	Shall not cause excessive or nuisance growth of algae or other aquatic plants	Marine Waters
Total inorganic nitrogen (TIN)	Annual mean depth-averaged inorganic nitrogen not to exceed 0.4 mg/L	Marine Waters
E. coli Bacteria	Not exceed 1000 per 100mL, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Inland Waters
Toxic substances	Should not attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other	Whole zone
	Human activity should not cause a risk to any beneficial use of the aquatic environment	Whole zone

Source: Statement of Water Quality Objectives (Victoria Harbour (Phases One, Two and Three) WCZ)

Hong Kong Planning Standards and Guidelines

4.2.4 The Hong Kong Planning Standards and Guidelines (HKPSG), Chapter 9 (Environment), provides additional guidelines against water pollution for sensitive uses such as aquaculture and fisheries zones, bathing waters and other contact recreational waters.

Water Supplies Department Water Quality Criteria

4.2.5 The Water Supplies Department (WSD) has specified a set of target seawater quality objectives for their flushing water intakes. The list is shown in **Table 4.3** below. These target objectives will be applied only at the points of seawater abstraction along the coastlines of inner Tolo Harbour and Victoria Harbour for flushing purpose.

Table 4.3 WSD's Target Seawater Quality Objectives at Flushing Water Intakes

Parameter (in mg/L unless otherwise stated)	WSD's Target Water Quality Limit at Flushing Water Intake
Colour (Hazen Unit)	< 20
Turbidity (NTU)	< 10
Threshold Odour Number (odour unit)	< 100
Ammonia Nitrogen (NH_3-N)	< 1
Suspended Solids (SS)	< 10
Dissolved Oxygen (DO)	> 2
5-Day Biochemical Oxygen Demand (BOD_5)	< 10
Synthetic Detergents	< 5
E. coli (no./100mL)	< 20,000

Remark: The above objectives are only applicable to flushing water intakes from seawater.

Cooling Water Intake Water Quality Criteria

4.2.6 The water quality criteria for cooling water intakes are different from that for the WSD's intakes as their beneficial uses are different (the former is used for cooling water system and the latter for flushing purpose).

Victoria Harbour

4.2.7 There are a number of cooling water intakes identified in Victoria Harbour. Cooling water intakes in vicinity of the Project discharge point include the existing and planned cooling water intakes for Kai Tak District Cooling System (DCS), cooling water intakes for Yau Tong Bay Ice Plant, North Point Government Office and Taikoo Place. Based on the information available from the past relevant EIAs e.g. EIA for Kai Tak Development (approved in 2009) and EIA for Sha Tin Cavern Sewage Treatment Works (CSTW) (approved in 2016), no specific water quality requirement is available for these cooling water intakes. Regarding the two planned cooling water intakes of Kai Tak DCS at Kai Tak River and Kai Tak Approach Channel respectively (which are closest to the Project discharge point) as well as the existing cooling water intake of Kai Tak DCS at Kowloon Bay, their operator, i.e. Electrical and Mechanical Services Department (EMSD), has been confirmed under this EIA that no specific water quality criteria are available for these three DCS intakes. Correspondence from EMSD is provided in **Appendix 4.1**.

Tolo Harbour

4.2.8 There is one proposed cooling water intake point in Tolo Harbour for the proposed District Cooling System (DCS) at Hong Kong Science Park (HKSP). Based on the consultation with the project proponent, namely Hong Kong Science and Technology Park Corporation (HKSTPC), at the time of preparing this EIA, the proposed DCS is still under design stage and therefore, the DCS design is not yet confirmed. For the purpose of this EIA, the proposed DCS intake location is tentatively set at the closest point of the HKSP boundary to Tai Po Industrial Estate (TPIE) as shown in **Figure 4.4**. No specific water quality criteria are assumed for this proposed DCS intake following the existing Kai Tak DCS design.

Seawater Intake for Mariculture

4.2.9 One existing seawater intake in Tolo Harbour is operated by the Marine Science Laboratory of the Chinese University of HK (CUHK) for experimental maricultural purpose. A summary of the target seawater quality objectives at this intake point (provided by the intake operator) is given in **Table 4.4** below. Supporting document from CUHK is attached in **Appendix 4.1**.

Table 4.4 Water Quality Objectives at Seawater Intake of Marine Science Laboratory of CUHK

Parameter	Target Water Quality Objectives
Salinity	No more than +/- 2 practical salinity unit (psu) from ambient level; < 2 psu change over 1 hour
Turbidity	< 5 NTU
pH	7 to 9
Unionized Ammonia (UIA)	< 0.05 mg/L
Suspended Solids (SS)	< 20 mg/L
Dissolved Oxygen (DO)	> 5 mg/L
Temperature	No more than +/- 2°C from ambient level; < 2°C change over 1 hour
Faecal coliforms	< 10,000 colony forming unit (cfu) per 100 mL
Ammonia Nitrogen (NH_3-N)	<0.2 mg/L
Nitrate Nitrogen (NO_3-N)	< 0.5 mg/L
Nitrite Nitrogen (NO_2-N)	< 0.05 mg/L
Hydrogen Sulphide	<0.001 mg/L

Source: Marine Science Laboratory of CHUK

Technical Memorandum on Effluent Discharge Standard

4.2.10 Besides setting the WQOs, the WPCO controls effluent discharging into the WCZs through a licensing system. Guidance on the permissible effluent discharges based on the type of receiving waters (foul sewers, stormwater drains, inland and coastal waters) is provided in the Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-DSS). The limits given in the TM cover the physical, chemical and microbial quality of effluents. Any effluent discharge during the construction and operational stages should comply with the relevant standards as stipulated in the TM-DSS.

Professional Persons Environmental Consultative Committee Practice Notes

4.2.11 The Professional Persons Environmental Consultative Committee Practice Note on Construction Site Drainage (ProPECC PN 1/94) provides good practice guidelines for dealing with various types of discharge from a construction site. Practices outlined in the ProPECC PN 1/94 should be followed as far as possible during construction to minimize the water quality impact due to construction site drainage. The Professional Persons Environmental Consultative Committee Practice Note on Drainage Plans subject to Comments by Environmental Protection Department (ProPECC PN 5/93) provides guidelines and practices for handling, treatment and disposal of various effluent discharges to stormwater drains and foul sewers. The design of site drainage and disposal of various site effluents generated within the development area should follow the relevant guidelines and practices as given in the ProPECC PN 5/93.

Sediment Deposition Criterion (Applicable to Ecological Subtidal Habitats Only)

4.2.12 Potential impacts on benthic organisms, including corals, may arise through excessive sediment deposition. The magnitude of the potential impacts will be assessed based on the predicted sedimentation rate.

4.2.13 There is no existing legislative standard on sedimentation rate available. According to Pastorok and Bilyard [1] and Hawker and Connell [2], a sedimentation rate higher than 100 g/m^2/day would introduce moderate to severe impact upon corals. This sedimentation rate of no more than 100 g/m^2/day will be adopted as the assessment criterion for protecting the sediment sensitive ecological resources, following the approach used in the approved EIAs for "CSTW", "Development of a Bathing Beach at Lung Mei, Tai Po", "TPSTW Stage V", "Wan Chai Development Phase II and Central-Wan Chai Bypass" and "Sha Tin to Central Link - Hung Hom to Admiralty Section" etc. This sedimentation rate criterion is considered to offer sufficient protection to marine ecological sensitive receivers and is anticipated to guard against unacceptable impacts. This protection has been confirmed by previous EM&A results which have indicated no adverse impacts to corals have occurred when this assessment criterion has been adopted.

4.2.14 This sedimentation criterion is used for protection of important subtidal habitats (e.g. corals) only and hence it is not applicable to other Water Sensitive Receivers (WSRs) such as bathing beach users and seawater intakes where the main concern would be on the surface / mid-depth water quality.

---

[1] Pastorok, R.A. and Billiard, G.R. (1985). "Effects of sewage pollution on coral-reef communities." Marine Ecology Progress Series 21: 175-189.

[2] Hawker, D. W. and Connell, D. W. (1992). "Standards and Criteria for Pollution Control in Coral Reef Areas" in Connell, D. W and Hawker, D. W. (eds.), Pollution in Tropical Aquatic Systems, CRC Press, Inc.

Water Quality Criteria for Fish Culture Zones

4.2.15 Several Fish Culture Zones (FCZs) are identified in the Tolo Harbour as shown in **Figure 4.4** below. The water quality criteria for FCZs will follow the Water Quality Objectives (WQOs) for Tolo Harbour and Channel WCZ stipulated under the Water Pollution Control Ordinance (WPCO). **Table 4.5** summarizes the water quality criteria at FCZs with reference to the statutory WQOs.

Table 4.5 Water Quality Criteria for Fish Culture Zones

Parameter (in mg/L unless otherwise stated)	Tolo Harbour and Channel WCZ		
	Harbour Subzone	Buffer Subzone	Channel Subzone
	Yim Tin Tsai FCZ	Yim Tin Tsai East FCZ	Yung Shue Au and Lo Fu Wat FCZs
DO Level within 2m from bottom	≥ 2	≥ 3	≥ 4
DO Level in remainder of water column	≥ 4	≥ 4	≥ 4
Annual Geometric Mean *E. coli* Level (no./100mL)	≤ 610	≤ 610	≤ 610
Running Arithmetic Mean of 5 daily Measurements of Chlorophyll-*a* Level	≤ 20	≤ 10	≤ 6

Remark: The above water quality criteria are in accordance with the statutory WQOs for Tolo Harbour and Channel WCZ. Full descriptions of the WQOs are provided in **Table 4.1**.

4.3 Water Sensitive Receivers

Introduction

4.3.1 Beneficial uses of the water system(s) and Water Sensitive Receivers (WSRs) in the assessment areas have been identified with reference to the relevant topographic maps, aerial photos, Outline Zoning Plans as well as other published plans and relevant studies as presented below.

Victoria Harbour Water Control Zone

4.3.2 The treated sewage effluent from daily operation of the TPSTW would be discharged into the marine water within the Victoria Harbour WCZ under the THEES. Major marine WSRs identified in Victoria Harbour are listed below and their indicative locations are given in **Figure 4.3**.

- WSD Flushing Water Intakes;
- Cooling Water Intakes;
- Typhoon Shelters; and
- Potential Water Sports Area at Kai Tak.

4.3.3 The feasibility of locating a potential water sports center within the Kai Tak Development (KTD) area is being investigated under the separate KTD project. The potential water sports area is included as a planned WSR. The existing intake of the first District Cooling System (DCS) plant at Kai Tak (currently in operation) is located at the ex-airport runway, which abstracts seawater from Kowloon Bay. A new Kai Tak DCS scheme with different intake locations is currently being planned under the separate KTD project. The proposed changes in the DCS intake locations have been considered in this EIA (see Sections 4.5.13 to 4.5.17). The planned Kai Tak DCS intake points are located in the lower reach of Kai Tak River and the mid-way of Kai Tak Approach Channel (KTAC).

4.3.4 Kai Tak River (KTR) is a man-made concrete nullah in highly developed urban land for drainage purpose. It is designed to receive treated sewage effluent from THEES, urban runoff from a large catchment area in Diamond Hill, Tsz Wan Shan, Wong Tai Sin, Kowloon City, San Po Kong and Kai Tak Development Area. The nullah has been continually modified and disturbed to suit the development needs in the vicinity. Based on the review of river water quality monitoring data collected by EPD in 2020, the *E.coli* levels at all the 6 monitoring stations in KTR significantly exceeded the WQO for inland waters. The BOD_5 levels measured at 3 upstream stations in KTR also exceeded the WQO for inland waters in 2020. The Kai Tak River Improvement project including reconstruction of the nullah such as deepening the nullah bed to increase its drainage capacity was completed in 2018. Although this improvement project also covered works to revitalize the nullah, the proposed works did not aim to improve the nullah water quality. There is currently no plan to change the historic and existing uses of this nullah to receive treated sewage effluent and urban runoff and to alleviate flooding problem in urbanized area.

4.3.5 Therefore, it is suitable to consider KTR as an urban drainage and a non-sensitive receiver for the treated effluent discharge. The same approach has been adopted in the past relevant EIAs such as the approved EIAs for "CSTW", "STSTW Stage III Extension" and "TPSTW Stage V".

4.3.6 Following the existing disposal arrangement, only treated effluent that meets the effluent discharge standards will be diverted to Victoria Harbour WCZ via the THEES. Based on the findings of the approved EIAs for "STSTW Stage III Extension", "TPSTW Stage V" and "CSTW", the water quality effect of the THEES effluent would mainly be confined within the water bodies at or near the Kai Tak Development Area as shown in **Figure 4.3**. The open channel of Victoria Harbour outside the breakwaters of Kwun Tong Typhoon Shelter (KTTS) has strong tidal flushing capacity and its water quality would not be adversely affected by the existing THEES discharge. The coverage of the study area in **Figure 4.3** is considered adequate for the purpose of this EIA.

Tolo Harbour and Channel Water Control Zone

4.3.7 Key marine WSRs in Tolo Harbour and Tolo Channel are listed below and their indicative locations are shown in **Figure 4.4**. The location of the existing emergency outfall of TPSTW in relation to the identified WSRs is also indicated in **Figure 4.4**.

- WSD Flushing Water Intakes;
- Cooling Water Intake for the proposed District Cooling System at Hong Kong Science Park;
- Seawater Intake of Marine Science Laboratory of CUHK;
- Gazetted Beach at Lung Mei;
- Shuen Wan Typhoon Shelter;
- Various Corals / Mangroves along the Coastlines of Tolo Harbour and Tolo Channel;
- Fish Culture Zones (FCZs);
- Hoi Ha Wan Marine Park /Site of Special Scientific Interest (SSSI);
- Ting Kok SSSI;
- Kei Ling Ha Mangal SSSI; and

- Important Nursery Area for Commercial Fisheries Resources [3].

4.3.8 The marine water in Tolo Harbour and Channel WCZ are designated under the WPCO as secondary contact recreation subzone, which can be used for water sports and water recreational activities (e.g. sailing, rowing). The *E. coli* bacteria would be the principle parameter for assessing the acceptability of using waters for water sports or secondary contact recreation activities with a WQO of not exceeding 610 no./100mL (calculated as the geometric mean of all samples collected in one calendar year).

4.3.9 Locations of the ecological resources including the corals, mangroves and SSSIs were identified from literature review and findings of marine ecological survey carried out in the intertidal and coastal waters around Tai Po Industrial Estate (TPIE) under this EIA. Descriptions of ecological and fisheries resources are separately presented in the ecological impact assessment and fisheries impact assessment of this EIA.

4.3.10 Inland waters within 500m from the site boundary of the Project includes two modified watercourses to the north of TPIE as shown in **Figure 4.5.** The lower reach of both watercourses is connected to underground man-made culverts in TPIE, which would eventually discharge to Tolo Harbour. As these inland watercourses are located at the upstream of the proposed Project works, they would not be affected by the Project and therefore are not considered as WSR of this Project.

4.4 Description of the Environment

Introduction

4.4.1 The assessment areas for this water quality impact assessment cover the Tolo Harbour and Channel WCZ and Victoria Harbour WCZ designated under the WPCO.

4.4.2 The baseline conditions of the two WCZs were established from the marine water quality monitoring data collected by EPD. Descriptions of the baseline conditions provided in the subsequent sections are extracted from the EPD's report "Marine Water Quality in Hong Kong in 2020".

Victoria Harbour Water Control Zone

4.4.3 The water quality monitoring results at stations in vicinity of the Project discharge, namely VT4, VT11, VM1, VM2 and VM4 are shown in **Table 4.6** below. The selected marine water quality monitoring stations are shown in **Figure 4.3**. Full compliances with the WQO for TIN, DO (depth average and bottom) and UIA were recorded at VT11, VM1, VM2, VM4 in 2020. The water quality recorded at VT4 in 2020 breached the WQO for TIN and DO (depth average) whilst achieved WQO compliance for DO (bottom layer) and UIA.

[3] AFCD 1998. Fisheries Resources and Fishing Operations in Hong Kong Waters.

Table 4.6 Baseline Water Quality Condition for Victoria Harbour WCZ in 2020

Parameter		Victoria Harbour (East)		Victoria Harbour (Central)	Kwun Tong Typhoon Shelter	To Kwa Wan Typhoon Shelter	WPCO WQO (in marine waters)
		VM1	VM2	VM4	VT4	VT11	
Temperature (°C)		24.0 (19.4 – 28.9)	24.3 (19.4 – 29.0)	24.5 (19.6 – 28.9)	24.7 (20.3 – 29.1)	25.3 (19.6-29.1)	Change due to human activity not to exceed 2°C
Salinity (part per thousand, ppt)		32.3 (31.0 - 33.6)	31.7 (28.9 - 33.2)	31.4 (28.7 - 33.1)	25.9 (20.0 - 29.8)	31.3 (29.6 – 32.3)	Change due to human activity not to exceed 10% of natural ambient level
Dissolved Oxygen (mg/L)	Depth Average	5.8 (4.2 – 7.6)	5.7 (4.3 – 6.9)	5.7 (4.4 - 6.9)	4.5 (2.4 – 6.1)	5.3 (4.6 - 6.4)	Not less than 4 mg/L for 90% of the sampling occasions during the whole year
	Bottom	5.8 (3.6 – 7.5)	5.5 (3.8 – 7.2)	5.6 (4.0 – 6.9)	4.0 (2.2 – 5.2)	4.8 (2.7 – 5.7)	Not less than 2 mg/L for 90% of the. sampling occasions during the whole year
Dissolved Oxygen (% Saturation)	Depth Average	83 (61 - 100)	81 (62 - 95)	81 (64 - 92)	62 (33 - 79)	77 (69 – 84)	Not available
	Bottom	82 (51 - 104)	77 (41 - 100)	78 (40 - 96)	56 (31 - 70)	69 (40 – 84)	Not available
pH		7.9 (7.7 - 8.2)	7.9 (7.7 - 8.1)	7.9 (7.5 - 8.1)	7.5 (6.6 - 8.0)	7.9 (7.6 - 8.2)	6.5 - 8.5 (± 0.2 from natural range)
Secchi Disc Depth (m)		2.5 (1.8 – 3.0)	2.4 (2.1 – 2.9)	2.4 (2.0 – 3.1)	2.0 (1.3 – 2.7)	1.9 (1.2 – 2.6)	Not available
Turbidity (NTU)		4.0 (1.5 – 5.8)	3.5 (1.5 – 5.7)	3.4 (1.2 – 6.4)	3.6 (1.1 - 4.8)	6.8 (2.7 – 15.5)	Not available
Suspended Solids (SS) (mg/L)		7.1 (2.4 – 12.0)	7.0 (2.6 – 13.7)	7.1 (1.6 – 14.3)	5.0 (1.2 – 10.5)	11.8 (2.6 – 22.8)	Not more than 30% increase
5-day Biochemical Oxygen Demand (BOD_5) (mg/L)		0.9 (0.4 – 3.2)	0.8 (0.3 – 1.9)	0.8 (0.3 – 1.6)	1.8 (1.3 – 2.4)	0.7 (0.5 – 1.0)	Not available
Ammonia Nitrogen (NH_3-N) (mg/L)		0.072 (0.032 - 0.095)	0.091 (0.027 - 0.153)	0.112 (0.033 - 0.207)	1.020 (0.417 – 1.340)	0.167 (0.066 – 0.277)	Not available
Unionized Ammonia (UIA) (mg/L)		0.003 (<0.001 - 0.006)	0.003 (<0.001 - 0.006)	0.004 (<0.001 - 0.007)	0.017 (0.007 - 0.038)	0.005 (0.003 – 0.007)	Not more than 0.021 mg/L for annual mean
Nitrite Nitrogen (NO_2-N) (mg/L)		0.022 (0.006 - 0.060)	0.026 (0.007 - 0.072)	0.028 (0.007 - 0.070)	0.320 (0.150 - 0.430)	0.026 (0.006 – 0.060)	Not available
Nitrate Nitrogen (NO_3-N) (mg/L)		0.096 (0.034 - 0.217)	0.133 (0.036 - 0.277)	0.149 (0.051 - 0.287)	0.995 (0.363 – 1.340)	0.106 (0.023 – 0.163)	Not available
Total Inorganic Nitrogen (TIN) (mg/L)		0.19 (0.12 - 0.34)	0.25 (0.12 - 0.43)	0.29 (0.15 - 0.45)	2.33 (0.93 –3.06)	0.30 (0.09 – 0.46)	Not more than 0.4 mg/L for annual mean
Total Kjeldahl Nitrogen (TKN) (mg/L)		0.56 (0. 20 – 1.23)	0.61 (0.36 – 1.20)	0.62 (0.35 - 1.07)	1.57 (0.85– 1.93)	0.63 (0.45 – 0.77)	Not available
Total Nitrogen (TN) (mg/L)		0.68 (0.41 – 1.32)	0.76 (0.47 – 1.30)	0.80 (0.55 – 1.19)	2.88 (1.37 – 3.67)	0.76 (0.48 – 0.92)	Not available
Orthophosphate Phosphorus (PO_4) (mg/L)		0.014 (0.005 - 0.022)	0.017 (0.005 - 0.035)	0.019 (0.011 - 0.032)	0.339 (0.090 - 0.503)	0.019 (0.010 – 0.034)	Not available
Total Phosphorus (TP) (mg/L)		0.05 (0.03 - 0.07)	0.05 (0.03 - 0.08)	0.06 (0.03 - 0.08)	0.42 (0.14 - 0.60)	0.07 (0.05 – 0.09)	Not available
Silica (as SiO_2) (mg/L)		0.83 (0.35 - 1.37)	0.90 (0.32 - 1.73)	1.01 (0.33 - 1.77)	3.65 (1.61– 6.83)	0.86 (0.55 – 1.30)	Not available
Chlorophyll-*a* (µg/L)		2.3 (0.2 – 9.7)	3.2 (<0.2 - 14.0)	3.1 (0.4 - 12.1)	5.4 (1.3 - 12.4)	1.2 (0.2 -2.6)	Not available

Parameter	Victoria Harbour (East)		Victoria Harbour (Central)	Kwun Tong Typhoon Shelter	To Kwa Wan Typhoon Shelter	WPCO WQO (in marine waters)
	VM1	VM2	VM4	VT4	VT11	
E. coli (no./100mL)	150 (51 - 1600)	240 (59 - 1600)	290 (27 - 1200)	15000 (600 - 73000)	800 (140 - 11000)	Not available
Faecal Coliforms (no./100mL)	300 (83 - 4100)	550 (86 - 3300)	740 (89 - 4100)	32000 (1100 - 280000)	1500 (200 – 19000)	Not available

Notes:
1. Data source: EPD Marine Water Quality in Hong Kong in 2020.
2. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
3. Data presented are annual arithmetic means of depth-averaged results except for *E. coli* and faecal coliforms that are annual geometric means.
4. Data in brackets indicate the ranges.

Trend of Water Quality in Victoria Harbour

4.4.4 The Victoria Harbour WCZ achieved an overall WQO compliance rate of 90% in 2020, with full compliance with the DO and UIA WQOs. Under the influence of regional background level in the Pearl River Estuary as well as local pollution sources, only 70% of the monitoring stations in the WCZ met the TIN WQO.

4.4.5 The *E. coli* level in the eastern side of Victoria Harbour has decreased markedly since the implementation of Harbour Area Treatment Scheme (HATS) Stage 1 in 2001. The annual Cross Harbour Swim, suspended since 1979 because of poor water quality, was resumed on the eastern side of the harbour in 2011 after implementation of the HATS Advance Disinfection Facilities (ADF). With full commissioning of the HATS Stage 2A, the *E.coli* level of the central harbour area has been further reduced. Since 2017, the race route of the event has returned to the traditional route in the central harbour area.

Tolo Harbour and Channel WCZ

4.4.6 The water quality monitoring results at stations closest to the existing emergency outfalls of sewage effluent discharges in Tolo Harbour, namely TM2, TM3 and TM4 in Harbour Subzone are shown in **Table 4.7** below. The selected marine water quality monitoring stations are shown in **Figure 4.4**. Full compliances with the WQO was recorded at all the three selected stations for DO, chlorophyll-*a* and *E. coli* in 2020.

Table 4.7 Baseline Water Quality Condition for Tolo Harbour and Channel WCZ in 2020

Parameter		Harbour Subzone			WPCO WQO (in marine waters)
		TM2	TM3	TM4	
Temperature (°C)		26.3 (20.6 - 29.8)	25.1 (20.2– 29.5)	25.6 (20.0 – 29.6)	▪ Change due to waste discharge not to exceed 1°C ▪ The rate of temperature change not to exceed 0.5 °C per hour, unless due to natural phenomena
Salinity (part per thousand, ppt)		29.9 (24.8- 32.8)	31.0 (24.9- 33.7)	30.8 (27.1- 33.1)	Change due to waste discharge not to be greater than ±3ppt
Dissolved Oxygen (mg/L)	Depth Average	6.1 (5.1 – 7.9)	6.4 (5.3– 7.2)	6.1 (5.1 – 6.5)	Not less than 4 mg/L in the water column (except for the bottom water later within 2 m from the seabed)
	Bottom	6.2 (4.5 – 8.3)	5.9 (3.8 – 7.2)	5.4 (2.9 – 6.5)	Not less than 2 mg/L within 2 m from the seabed

Parameter		Harbour Subzone			WPCO WQO (in marine waters)
		TM2	TM3	TM4	
Dissolved Oxygen (% Saturation)	Depth Average	89 (73 - 112)	92 (79 - 104)	88 (75 - 97)	Not available
	Bottom	90 (70 - 120)	86 (58 - 110)	78 (38 - 99)	Not available
pH		8.0 (7.7 - 8.3)	8.0 (7.6 - 8.3)	8.0 (7.8 - 8.2)	Change due to waste discharge not to be greater than ± 0.5 from natural range
Secchi Disc Depth (m)		2.4 (1.6 - 3.4)	2.3 (1.5 - 3.2)	2.7 (1.8 – 3.5)	Not available
Turbidity (NTU)		3.1 (1.5 – 5.5)	2.3 (0.7 – 4.9)	2.5 (1.2 - 4.1)	Not available
Suspended Solids (SS) (mg/L)		8.1 (1.4 – 17.0)	8.2 (1.4- 19.3)	8.5 (1.0 – 18.7)	Not available
5-day Biochemical Oxygen Demand (BOD_5) (mg/L)		1.7 (0.8 – 2.6)	1.8 (1.2 – 2.9)	1.4 (0.7 – 2.5)	Not available
Ammonia Nitrogen (NH_3-N) (mg/L)		0.045 (0.022 - 0.076)	0.046 (0.011 - 0.127)	0.036 (0.019 - 0.076)	Not available
Unionized Ammonia (UIA) (mg/L)		0.003 (<0.001 - 0.005)	0.002 (<0.001 - 0.006)	0.002 (<0.001 - 0.004)	Not available
Nitrite Nitrogen (NO_2-N) (mg/L)		0.004 (<0.002 - 0.010)	0.003 (<0.002 - 0.006)	0.003 (<0.002 - 0.006)	Not available
Nitrate Nitrogen (NO_3-N) (mg/L)		0.039 (<0.002 - 0.215)	0.013 (0.002 - 0.049)	0.009 (<0.002 - 0.027)	Not available
Total Inorganic Nitrogen (TIN) (mg/L)		0.09 (0.03 - 0.27)	0.06 (0.02 - 0.16)	0.05 (0.02 - 0.11)	Not available
Total Kjeldahl Nitrogen (TKN) (mg/L)		0.50 (0.22 - 0.81)	0.56 (0.25 - 0.86)	0.56 (0.30 - 0.85)	Not available
Total Nitrogen (TN) (mg/L)		0.54 (0.29 - 0.82)	0.57 (0.30 - 0.86)	0.57 (0.31- 0.85)	Not available
Orthophosphate Phosphorus (PO_4) (mg/L)		0.008 (0.002 - 0.026)	0.006 (0.003 - 0.014)	0.005 (<0.002 - 0.007)	Not available
Total Phosphorus (TP) (mg/L)		0.04 (<0.02 - 0.06)	0.04 (<0.02 - 0.06)	0.03 (<0.02 - 0.05)	Not available
Silica (as SiO_2) (mg/L)		1.48 (0.50 – 4.15)	0.84 (0.15 - 2.13)	0.82 (0.29 - 1.80)	Not available
Chlorophyll-*a* (µg/L)		5.8 (1.4 – 9.2)	5.8 (2.1 - 15.7)	5.2 (1.5 – 14.3)	Not to exceed 20 µg/L for a running arithmetic mean of 5 daily measurements
E. coli (no./100mL)		13 (<1 - 4500)	18 (<1 - 2700)	5 (<1 - 490)	Not to exceed 610 no./100mL for geometric mean
Faecal Coliforms (no./100mL)		76 (6 - 32000)	76 (1 - 13000)	23 (1 - 3100)	Not available

Notes:
1. Data source: EPD Marine Water Quality in Hong Kong in 2020.
2. Unless otherwise specified, data presented are depth-averaged (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M), Bottom (B).
3. Data presented are annual arithmetic means of depth-averaged results except for *E. coli* and faecal coliforms that are annual geometric means.
4. Data in brackets indicate the ranges.

Trend of Water Quality in Tolo Harbour and Channel

4.4.7 The overall marine WQO compliance rate for the Tolo Harbour and Channel WCZ in 2020 was 93% as compared to 79% in 2019. The compliance rate for the DO WQO maintained at 57%, same as 2018 and 2017. Furthermore, the Tolo Harbour and Channel WCZ consistently complied with the bacteriological WQO for the secondary contact recreation uses applicable to the entire marine water of the WCZ.

4.4.8 Tolo Harbour, however, was subject to a natural hydrological phenomenon of water stratification and associated lower bottom DO level due to restricted water exchange with open waters.

4.4.9 Upon the implementation of the Tolo Harbour Action Plan since the mid-1980s, there has been a marked improvement in the water quality in Tolo Harbour in the past three decades.

4.5 Consideration of Concurrent Projects

Project Programme

4.5.1 The construction works of this Project are tentatively scheduled to commence in 2025 for completion in 2036.

Proposed Sha Tin Cavern Sewage Treatment Works

4.5.2 The key components of the THEES and the existing TPSTW effluent disposal arrangement are described in Section 4.1.2. Currently, the treated effluent from TPSTW would occasionally exceed the capacity of the TPEPS due to the effect of storm and hence part of the treated effluent from TPSTW would be discharged to the Tolo Harbour via the existing emergency bypass outfall at TPSTW. Similarly, the combined flow from TPSTW and STSTW would also occasionally exceed the capacity of STEPS due to the storm effect and overflow of the combined effluent would be discharged into the Tolo Harbour via the existing emergency submarine outfall of STSTW.

4.5.3 Under the proposed concurrent project "Sha Tin Cavern Sewage Treatment Works (CSTW)", a separate gravity sewer bypassing the STEPS is proposed for connection of the treated effluent from the new CSTW directly to the Effluent Export Tunnel of the THEES. Overflow of treated effluent flow from the new CSTW into the Tolo Harbour would not arise during normal plant operation [4]. The CSTW project is currently under construction phase and is anticipated to commission before 2030. The land-based construction works of the proposed CSTW would be outside the assessment area of this Project.

Proposed THEES Upgrading

4.5.4 The effluent conveyance capacity of the existing TPEPS and submarine pipeline of THEES is 4,752 m^3 per hour. It is proposed under the "Agreement No. CE 13/2015 (DS) Review of Sewerage Infrastructure of THEES – Feasibility Study" to upgrade the capacity of TPEPS and submarine pipeline to 18,396 m^3 per hour, of which about 12,996 m^3 per hour will cater for the effluent from TPSTW. The remaining capacity of about 5,400 m^3 per hour is allowed for the potential treated effluent from other district(s). The design, arrangement and implementation programme of the potential treated effluent from the other district(s) are not available and will not be considered in this EIA. The effluent pumping system of TPSTW will also be modified to convey the TPSTW effluent directly to the inlet chamber of THEES tunnel portal. Intermediate pumping station at Sha Tin may not be necessary and the existing STEPS will be decommissioned.

4.5.5 The rate of TPSTW effluent discharge to the THEES tunnel would be limited by the pumping capacity of TPEPS. Any peak or surplus TPSTW flow exceeding the pumping capacity of TPEPS (e.g. due to storm events) would be overflowed to Tolo Harbour at the emergency outfall of TPSTW at Tai Po. The maximum capacity of the existing THEES tunnel is 946,080 m^3/day. It was assessed under the Agreement No. CE 13/2015 (DS) that the THEES tunnel and its downstream facilities are adequate to handle the effluent flow conveyed by the upgraded

[4] Approved EIA Report for Sha Tin Cavern STW (EIAO Register No.: AEIAR-202/2016).

TPEPS of 18,396 m^3 per hour with consideration of the future CSTW discharge. The upgraded TPEPS capacity is also smaller than the existing capacity of STEPS of 21,600 m^3 per hour. Therefore, in any case, no overflow of TPSTW effluent would occur at Sha Tin with or without the proposed THEES upgrading works.

4.5.6 The proposed THEES upgrading works involve construction of a new TPEPS, a new submarine pipeline and a new effluent rising mains. The THEES upgrading works are tentatively scheduled to commence in 2025 for completion in 2031, subject to the construction programme of this Project (upgrading of TPSTW) and the CSTW project.

4.5.7 The new submarine pipeline will be installed by the Horizontal Directional Drilling (HDD) method, which is a trenchless method with no disturbance to the seabed and marine habitat. The proposed driving pit and reception pit of the HDD works would be land-based and located at the helipad in TPIE (within the assessment area) and Pak Shek Kok (outside the assessment area) respectively. The new rising mains will be laid in the southern TPIE (within the assessment area) connecting between the new TPEPS and the new submarine pipeline.

4.5.8 At the time of preparing this EIA, "Agreement No. CE 13/2015 (DS) Review of Sewerage Infrastructure of THEES – Feasibility Study" is still on-going and therefore the design of the proposed THEES upgrading project is subject to further update. The design assumptions presented in this EIA represent the best available information for use in this water quality impact assessment.

Proposed Shuen Wan Golf Course

4.5.9 The proposed Shuen Wan Golf Course (SWGC) is located to the east of the Project site. It mainly involves the development of a new golf course within the existing Shuen Wan Restored Landfill (SWRL) site. According to the EIA Report for SWGC, the construction of the proposed SWGC would be completed by end 2023 prior to the construction of this Project.

Proposed Organic Waste Pre-treatment Centre

4.5.10 Development of Organic Waste Pre-treatment Centre (New Territories East) is proposed under "Agreement No. CE 5/2021 (EP)". The proposed Organic Waste Pre-treatment Centre (OWPC) involves the re-development of the existing Shuen Wan Landfill Leachate Pre-treatment Works and the existing pilot-scale Food Waste Pre-treatment Facilities into a full-scale organic waste (mostly food waste) pre-treatment plant to receive and pre-treat the source-separated food waste for transferring to the TPSTW and / or off-site anaerobic digesters in other Sewage Treatment Works (STWs) for co-digestion with sewage sludge. The proposed OWPC site is located to the north of the existing TPSTW site within the assessment area of this Project. It is tentatively scheduled to commence construction in 2025 for completion by 2029.

Proposed District Cooling System at Hong Kong Science Park

4.5.11 A new District Cooling System (DCS) is being proposed at the Hong Kong Science Park (HKSP). The intake of this proposed DCS is considered as a WSR of this Project (refers to Section 4.2.8). The HKSP including the proposed DCS is over 3.3 km away from the Project site. Cumulative water quality impact due to the construction of the DCS is not expected.

4.5.12 The key water quality concerns of the proposed DCS operation would be associated with the spent cooling water discharges including the spreading of thermal plume and release of anti-fouling agent or biocide (e.g. residual chlorine, C-Treat-6) into the marine environment. As this Project would not induce any thermal impact nor discharge of fouling agent/ biocide, there will not be any cumulative water quality impact due to the DCS operation.

Kai Tak Development – Interception and Pumping Scheme

4.5.13 Currently, the existing DCS South Plant is operated at Kai Tak, which extracts seawater from Kowloon Bay for cooling purpose and the spent cooling water is discharged back into Kowloon Bay. Both the intake and outfall of the existing DCS South Plant are located at a similar location along the ex-airport runway in the open water of Kowloon Bay.

4.5.14 Based on the latest information from Agreement No. CE 30/2008 (CE) [5] obtained from Civil Engineering and Development Department (CEDD), a new Interception and Pumping (IP) Scheme will be implemented under the Kai Tak Development (KTD). The proposed IP Scheme would involve one cooling water intake point at the lower reach of KTR and another intake point at the mid-way of KTAC. The water pumped from KTR and KTAC will be diverted to three Kai Tak DCS Plants (namely existing DCS South Plant, proposed Additional DCS North Plant and proposed 3rd DCS Plant) and all the spent water would be discharged into the Kowloon Bay as shown in **Figure 4.6**.

4.5.15 The proposed IP scheme would divert the water in the embayed areas at KTR and KTAC to the more open water in Kowloon Bay and would therefore improve the water circulation and water quality in KTAC.

4.5.16 The rates of water interception and pumping from KTR and KTAC would be the same as the design flow rates of the DCS plants. The relevant DCS design flow rates available from Agreement No. CE 30/2008 (CE) [6] are adopted in this EIA as the ultimate design flows of the IP scheme. The monthly varying average daily flows of the three DCS plants are adopted in this water quality modelling exercise.

4.5.17 As advised by CEDD, the design of the IP scheme is still on-going and the timing for finalization of the IP scheme design is not known. The descriptions of the proposed IP scheme as presented in this EIA represent the best available information. The 600m wide opening at the ex-airport runway proposed under the previous EIA for KTD had been superseded by the IP scheme. No opening at the ex-airport runway is assumed in this EIA.

4.6 Identification of Potential Impacts

Construction Phase

4.6.1 The existing TPSTW comprises two independent plants, namely West Plant and East Plant. The existing design capacity of the West Plant is 44,000 m^3/day. The existing design capacity of the East Plant is 76,000 m^3/day. The overall design capacity of the existing TPSTW is therefore 120,000 m^3/day. Owing to the space limitation within the existing TPSTW and in order to maintain the sewage treatment services of the existing TPSTW, a piece of government land to the south of the existing TPSTW (about 1.6 hectares) is identified as the proposed expansion site for the Project. Upgrading of TPSTW is designed to maintain normal operation of the existing TPSTW. A New West Plant will be built in the proposed expansion site that will provide adequate sewage treatment capacity to meet the projected sewage flow buildup prior to the decommissioning and demolition of the existing treatment works to the north of the proposed expansion site to make room for the remaining upgrading works. Commissioning of the New West Plant is tentatively scheduled in 2029. Under this construction approach, no temporary

[5] Agreement No. CE 30 /2008 (CE) Kai Tak Development – Infrastructure at Former runway and Remaining Areas of North Apron and Improvement of Adjacent Waterways – Design and Construction, Final Water Quality Report and EM&A Manual (Ref. 373-03), April 2021.

[6] Details of the DCS flow rates adopted in this EIA are presented in Section 6.6.4 and Appendix A of "Agreement No. CE 50/2019 (DS) Upgrading of Tai Po Sewage Treatment Works – Investigation, Working Paper on Water Quality Impact Assessment (Final), February 2021".

discharge of untreated or partially treated sewage effluent into the marine water will be allowed during the construction phase. The treated effluent from the New West Plant will be discharged via the THEES following the existing effluent disposal arrangement.

4.6.2 With reference to Sections 4.1.2 and 4.5.2, during normal operation, any effluent bypass from TPSTW to the Tolo Harbour will be discharged through the existing emergency outfall at the seawall (to the south of TPIE) as shown in **Figure 4.2**. This existing emergency outfall is in the form of underground sewage pipeline for diverting the effluent from TPEPS to the seawall. The existing sewage pipeline has been reviewed to have sufficient capacity to handle the maximum design flow of this Project. No outfall construction / modification will be required for this Project. This Project will not disturb the seawall and marine sediments and will not affect the sediment quality.

4.6.3 Only land-based construction will be carried out under the Project. The construction works will be undertaken at TPIE within Tolo Harbour and Channel WCZ only. No construction works will be undertaken in the Victoria Harbour WCZ. The proposed construction works will not alter any inland waters such as natural streams, watercourses and ponds as identified in Section 4.3.10. Decommissioning and demolition of existing facilities in the proposed expansion site is outside the scope of this Project and not considered in this assessment.

4.6.4 Potential sources of water quality impact associated with the Project during the construction phase are identified as follows:

- General land-based construction activities;
- Construction site run-off;
- Accidental chemical spillage;
- Sewage effluent from construction workforce;
- Contaminated site runoff; and
- Demolition works.

Operational Phase – Project Effluent Discharge

Design Flow and Effluent Standards

4.6.5 The 2019-based Territorial Population and Employment Data Matrix (TPEDM) provided by the Planning Department (PlanD) have been considered in the development of the design flow of this Project. The 2019-TPEDM covers all known development and redevelopment proposals within the territory.

4.6.6 With reference to the latest population and employment forecast available from the 2019-based TPEDM, the proposed design capacity of this Project of 160,000 m^3/day has been reviewed to be sufficient to cater for the sewage flow generated from the future developments within the catchment of TPSTW in Year 2041. The existing treatment process of TPSTW is secondary treatment works plus disinfection. The current treatment levels and the associated effluent standards of the existing TPSTW will be maintained for this Project as summarized in **Table 4.8**.

Table 4.8 Effluent Standards of Existing TPSTW and Proposed Project

Parameter	Unit	95th percentile	Maximum	Annual Average	Monthly Geometric Mean
5-day Biochemical Oxygen Demand (BOD_5)	mg/L	20	40	-	-
Total Suspended Solids (TSS)	mg/L	30	60	-	-
Total Nitrogen (TN)	mg/L	-	35	20	-
Ammonia Nitrogen (NH_3-N)	mg/L	-	10	5	-
E. coli	counts/100mL	15,000	-	-	1,000

Treated Sewage Effluent Reuse for Non-potable Use

4.6.7 Advance treatment facilities would be provided for further processing some of the Treated Sewage Effluent (TSE) from the upgraded TPSTW to produce reclaimed water that meets the required water quality standards for non-potable use (e.g. toilet flushing, landscape irrigation).

4.6.8 The spent reclaimed water would be eventually discharged back to the treatment works for treatment again and would not contribute to additional pollution load to the water environment. Thus, no additional impact on the water environment will be induced by the TSE reuse. The reclaimed water standards provided by Water Supplies Department (WSD) are shown in **Table 4.9**. Tertiary treatment will be provided in the reuse facility to treat the TSE. The treated TSE from the reuse facility will meet the WSD's standards.

Table 4.9 Reclaimed Water Requirements – WSD Water Quality Objectives

Parameter	Unit	Reclaimed Water Quality
E. coli	cfu/100mL	Non detectable
Total Residual Chlorine	mg/L	≥1 (existing treatment system)
Dissolved Oxygen (DO)	mg/L	≥2
TSS	mg/L	≤5
Colour	Hazen Unit (HU)	≤20
Turbidity	NTU	≤5
pH	-	6 to 9
Odour	Threshold odour no.	≤100
BOD_5	mg/L	≤10
NH_3-N	mg/L as N	≤1
Synthetic Detergents	mg/L	≤5

Note: Information provided and confirmed by Water Supplies Department

4.6.9 Some of the treated effluent from the Project will be directly reused in the sewage treatment process (e.g. for polymer preparation) within the Project site. Partially treated sewage, including but not limited to surplus activated sludge (SAS), supernatant from thickened SAS, primary effluent from the Project, may also be explored for directly reuse in the treatment process (e.g. for imported sludge dilution) within the Project site.

4.6.10 Some treated effluent of the Project will be transferred to the proposed OWPC directly for use in the food waste pre-treatment process or dilution of food waste.

4.6.11 All the treated effluent and/or partially treated sewage to be used in the treatment process of this Project and the proposed OWPC will be conveyed and handled within an automatic close-loop system without direct human contact. All treated effluent and/or partially treated sewage will be conveyed through enclosed pipelines. Water quality impact associated with the possible spillage during transportation of the treated/partially treated sewage effluent is not expected.

4.6.12 Any spent treated effluent and/or partially treated effluent will be transferred back to sewerage system or the treatment units of this Project by fully enclosed pipelines for further treatment. No adverse water quality impact and human health concern will arise.

Treated Effluent Overflow to Tolo Harbour under Normal Plant Operation

Baseline "Do-nothing" Scenario

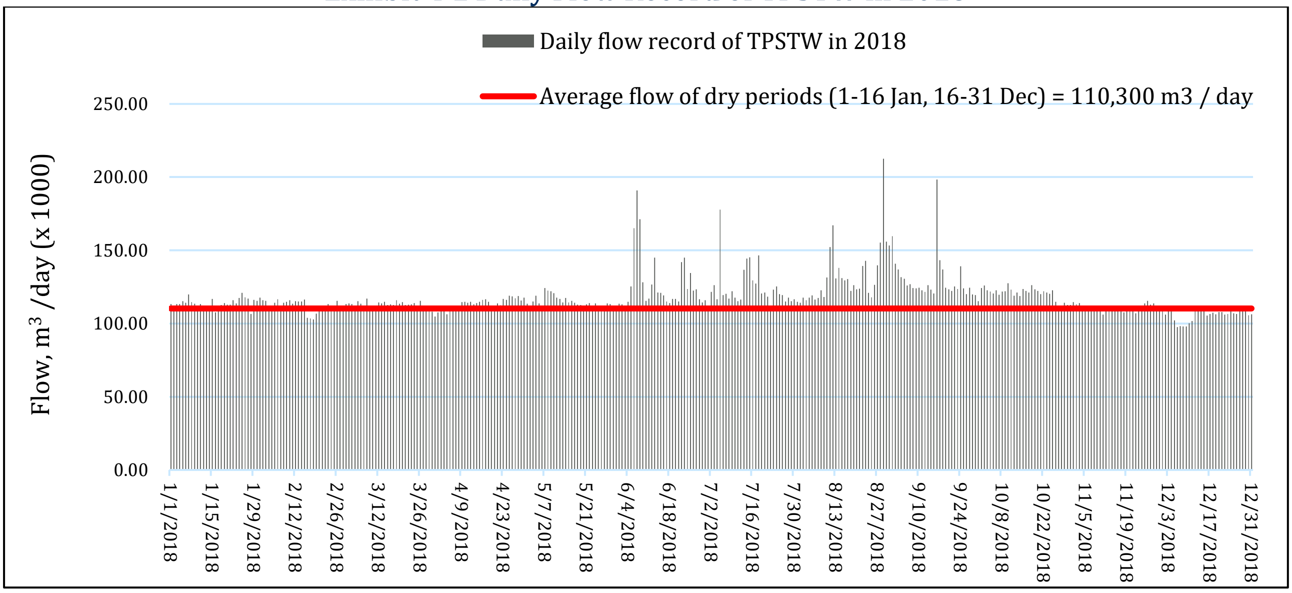
4.6.13 Under the baseline scenario, no upgrading of TPSTW and TPEPS would be carried out. The design capacity of TPSTW and TPEPS would remain to be 120,000 m^3/day and 4,752 m^3 per hour respectively. The CSTW project is currently under construction and will be included in the baseline scenario.

4.6.14 The treated effluent from TPSTW would occasionally exceed the existing capacity of the TPEPS due to the effect of storm and part of the secondarily treated and disinfected effluent from TPSTW would be discharged to Tolo Harbour via the emergency outfall of TPSTW. With the CSTW project, no overflow would occur at Sha Tin (see Section 4.5.3 to 4.5.5).

4.6.15 The quantities of overflow bypass would be subject to the effect of storm. Based on the review of past overflow records of TPSTW (from 2013 to 2018) conducted under Agreement No. CE 13/2015 (DS)[7], the low flow periods where storm events are rare occur in 1-16 January and 16-31 December.

4.6.16 The peaking factor analysis covering the period from 2013 to 2018 carried out under Agreement No. CE 13/2015 (DS) concluded that TPSTW has the highest peaking factor in 2018. The discharge record for 2018 as shown in **Exhibit 4.1** below are therefore used to estimate the overflow quantities of TPSTW. The recorded average dry weather flow (ADWF) of TPSTW in 2018 was about 110,300m³/day. This value is used as benchmark and any days with surplus flow above this ADWF value is assumed to be wet days with storm events.

Exhibit 4.1 Daily Flow Record of TPSTW in 2018



4.6.17 **Exhibit 4.2** below shows the surplus flow recorded in 2018. Similar analysis has been conducted under this EIA using the latest daily flow record of TPSTW in 2019 and 2020. The resulted surplus flow of TPSTW in 2019 and 2020 is shown in **Exhibit 4.3** and **Exhibit 4.4**.

[7] Agreement No. CE 13/2015 (DS) Review of Sewerage Infrastructure of THEES – Feasibility Study, Revised Working Paper on Task 4 (Additional Service) Final, October 2019.

Both the peak surplus flow value and the annual surplus flow volume in 2019 and 2020 are smaller than those recorded in 2018. Therefore, using the surplus flow of 2018 in estimation of the overflow quantities is conservative and appropriate. The average and maximum daily discharge of TPSTW from 2018 to 2020 are summarized in **Table 4.10**.

Table 4.10 TPSTW Discharge (2018 – 2020)

Year	Average Daily Effluent Flow (m^3)	Maximum Daily Effluent Flow (m^3)
2018	118,263	212,539
2019	118,833	199,888
2020	111,607	192,466

Exhibit 4.2 Surplus Flow of TPSTW in 2018

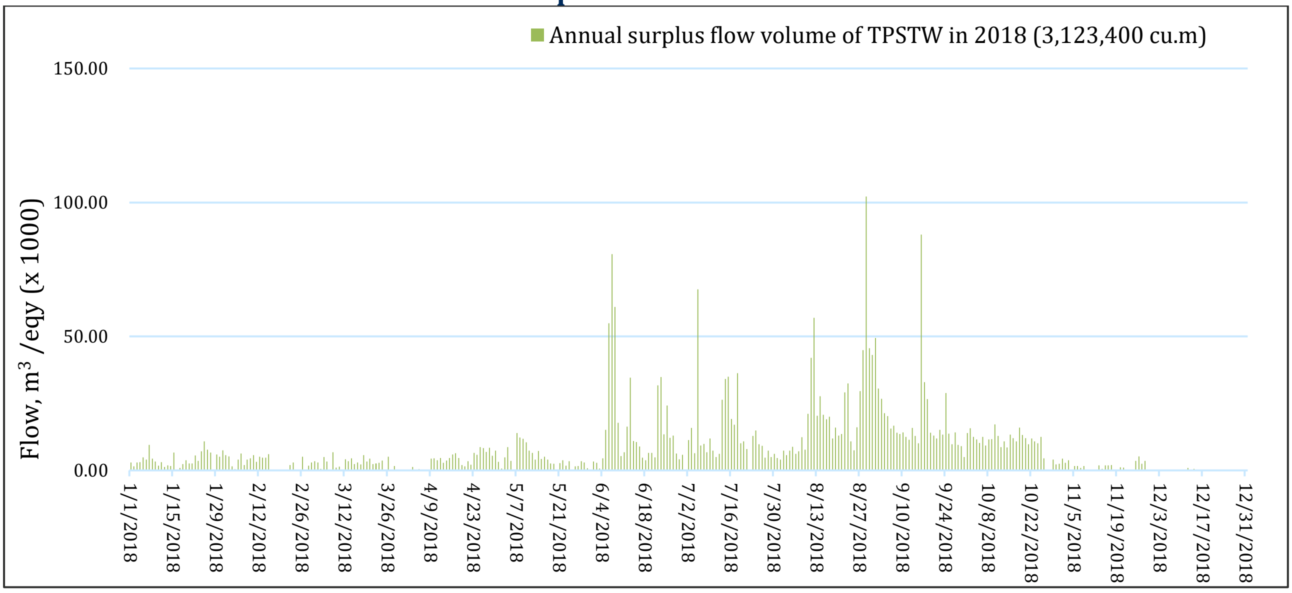


Exhibit 4.3 Surplus Flow of TPSTW in 2019

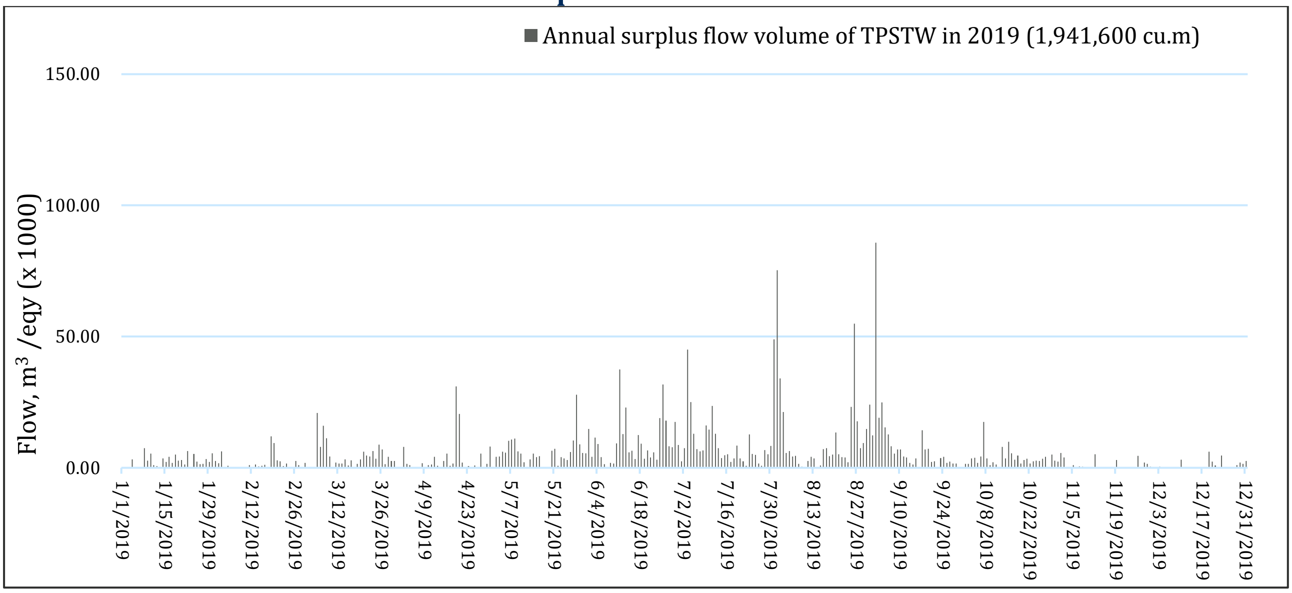
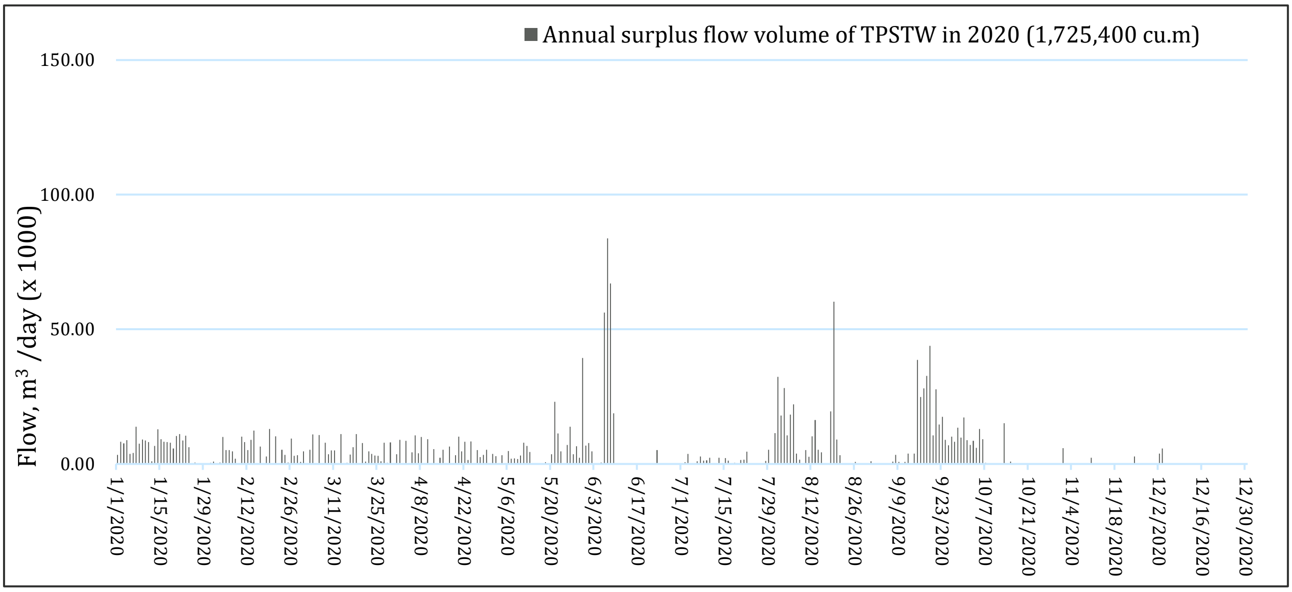
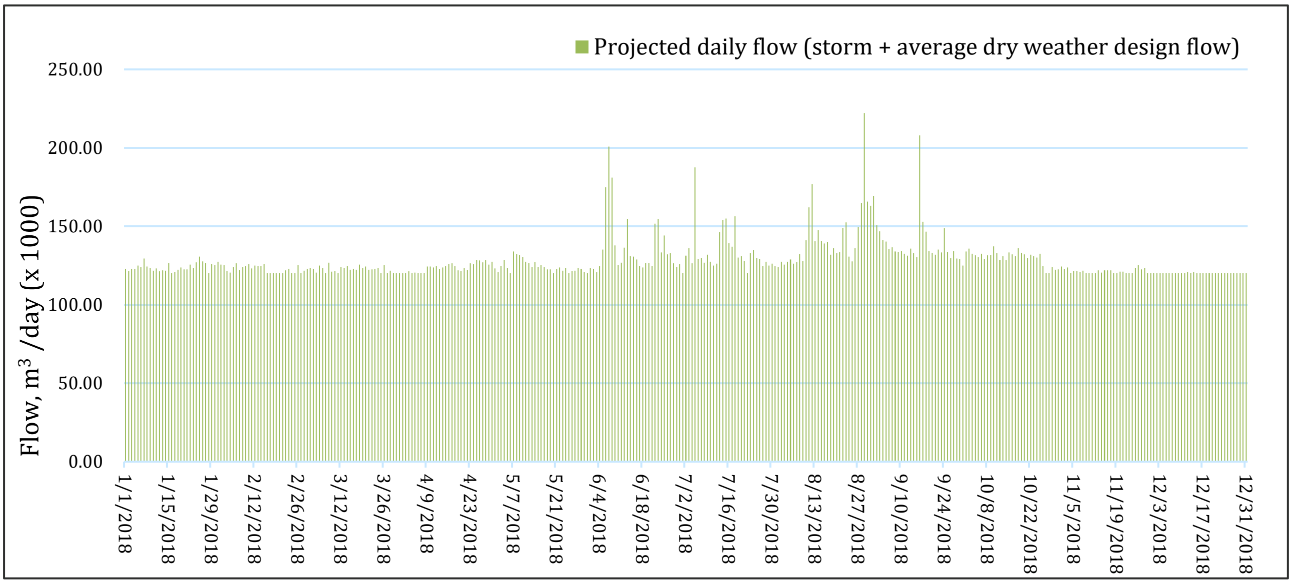


Exhibit 4.4 Surplus Flow of TPSTW in 2020



4.6.18 The surplus for each wet day is allocated to the existing design ADWF of TPSTW (i.e. 120,000 m^3/day) on the same day to take into account of the effect of storm events. The plot of the projected daily discharge rate of TPSTW under the baseline "without Project" scenario assuming a design daily flow of 120,000 m^3/day is shown in **Exhibit 4.5**.

Exhibit 4.5 Projected Daily Discharge Rate of TPSTW – Baseline "Do-nothing" Scenario



4.6.19 The typical dry weather diurnal flow pattern of TPSTW in 2018 is shown in **Table 4.11**. The percentages in the tables are applied to the existing design ADWF of TPSTW (i.e. 120,000 m^3/day) to derive the hourly dry weather diurnal flow of TPSTW. Latest dry weather diurnal flow record after 2018 is not available from DSD.

Table 4.11 Typical Dry Weather Diurnal Flow Pattern of TPSTW in 2018

Hour	% of Daily Flow	Hour	% of Daily Flow	Hour	% of Daily Flow	Hour	% of Daily Flow
0:00	4.72%	6:00	3.08%	12:00	4.34%	18:00	4.16%
1:00	4.13%	7:00	3.68%	13:00	4.47%	19:00	4.24%
2:00	3.58%	8:00	4.06%	14:00	4.83%	20:00	4.39%
3:00	3.44%	9:00	4.66%	15:00	4.57%	21:00	4.66%
4:00	3.32%	10:00	4.24%	16:00	4.16%	22:00	4.97%
5:00	3.13%	11:00	4.20%	17:00	4.01%	23:00	4.95%

Source: Agreement No. CE 13/2015 (DS)

4.6.20 The storm flow generated from each wet day is assumed to be contributed from a 4-hour storm event. The surplus flow for each wet day in **Exhibit 4.2** is allocated to the dry weather diurnal flow on the same day between 20:00 and 23:00. As the highest diurnal flow rates are observed between 20:00 and 23:00 in **Table 4.11**, allocating the surplus flow for each wet day to this period would represent a reasonable worst case. When the combined volume of surplus flow (if any) and dry weather diurnal flow of the TPSTW exceeds the existing capacity of TPEPS of 4752 m^3/hour, the effluent would overflow into Tolo Harbour. The hourly overflow rates at the ultimate design stage are estimated for a complete calendar year as shown in **Exhibit 4.6** below. Due to the capacity constraint of the existing TPEPS, overflow from TPSTW would occur in both dry and wet seasons. The annual overflow volume under the "do-nothing" scenario is estimated to be about 6,842,000 m^3. The annual overflow volume estimated under the approved EIA for "TPSTW Stage V" is larger because a larger design flow of 130,000 m^3/day was assumed in that EIA.

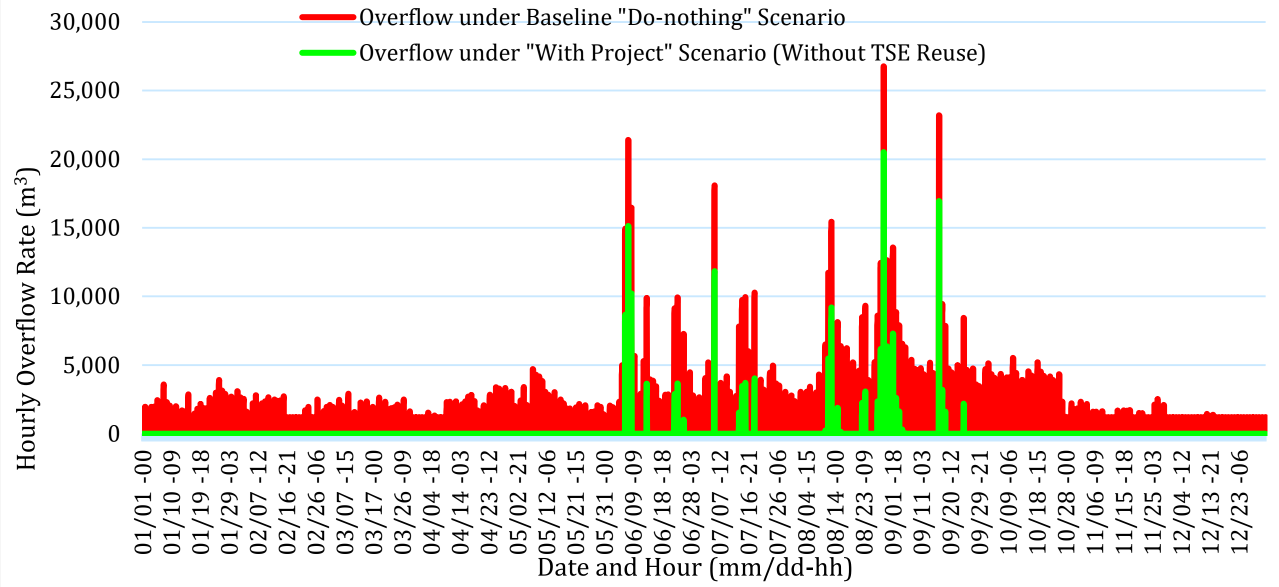
"With Project" Scenario

4.6.21 The "with Project" scenario assumes that the capacities of TPSTW and TPEPS will be upgraded.

4.6.22 The typical dry weather diurnal flow pattern of TPSTW in **Table 4.11** above is applied to the design flow of the Project (i.e. 160,000 m^3/day) to derive the hourly dry weather diurnal discharge. The surplus flow for each wet day estimated in **Exhibit 4.2** above is allocated to the projected dry weather diurnal flow of the Project on the same day between 20:00 and 23:00. When the combined volume of surplus flow (if any) and projected dry weather diurnal discharge from the Project exceeds the capacity of the new TPEPS allowed for TPSTW of 12,996 m^3 per hour (see Section 4.5.4), the effluent would overflow into Tolo Harbour.

4.6.23 The hourly overflow rates under the "with Project" scenario are estimated for a complete year as shown in **Exhibit 4.6** below.

Exhibit 4.6 Projected Hourly Overflow at Ultimate Design Stage



4.6.24 The hourly overflow estimated under the "do-nothing" scenario (as discussed in Sections 4.6.14 to 4.6.20 above) are included in **Exhibit 4.6** for comparison. Under the "do-nothing" scenario, overflow would occur every day over the entire year with an annual overflow volume of 6,842,000 m^3. Due to the THEES upgrading, the estimated annual overflow volume under the "with Project" scenario is much smaller and reduced to 632,000 m^3 (i.e. reduced by 91% as compared to the baseline "do-nothing" scenario). Under the "with Project" scenario, overflow would occur occasionally on 30 days of a year only, and the occurrences would be scattered within the period June to September (in wet season). The overflow volumes estimated for the "do-nothing" scenario and the "with Project" scenario are presented in **Table 4.12**.

Table 4.12 Estimated Overflow Quantities under Normal Operation

Scenario	TSE Discharge of TPSTW (m^3 per day)	Design Capacity of TPEPS Allowed for the Project (m^3 per hour)	Overflow Volume, June to September (Wet Season) (m^3)	Overflow Volume, Remaining Months (January to May and October to December) (m^3)	Annual Overflow Volume (m^3)
Baseline "Do-nothing" Scenario	120,000	4,752	3,481,000	3,361,000	6,842,000
"With Project" Scenario	160,000	12,996	632,000	0	632,000
Percentage Reduction of Overflow Volume:			82%	100%	91%

4.6.25 The overflow to Tolo Harbour in terms of the duration, annual volume and peak hourly rate would be greatly reduced in the future after commissioning of this Project and the THEES upgrading project (as compared to the baseline "do-nothing" scenario). Under the "with Project" Scenario, the total overflow volume within the period from June to September (wet season) would be significantly reduced by 82% as compared to the baseline "do-nothing" scenario. The overflow would be totally eliminated during the dry season. This Project would not cause any adverse water quality impact upon the Tolo Harbour under normal operation.

4.6.26 Overflow of treated effluent from the new CSTW would not arise under normal plant operation (see Section 4.5.3 to 4.5.5).

Treated Effluent Discharge to Victoria Harbour under Normal Plant Operation

4.6.27 The Treated Sewage Effluent (TSE) from this Project and the new CSTW will be discharged to the Victoria Harbour via the THEES. The THEES effluent will be discharged to the KTR and then eventually to the KTAC. The design flow of this Project (i.e. 160,000 m^3/day) is adopted for discharging to the Victoria Harbour WCZ, assuming that there would be no TSE reuse as a worst-case scenario.

THEES Maintenance Discharge to Tolo Harbour

4.6.28 Maintenance of the THEES tunnel may be required under the existing practice to ensure proper functioning and integrity of the tunnel. During the inspection or maintenance of the THEES tunnel, temporary suspension of the normal THEES operation with effluent bypass into the Tolo Harbour is unavoidable to provide a safe and dry zone within the THEES tunnel for the necessary inspection / maintenance works. The THEES maintenance discharge would only involve TSE.

4.6.29 During the THEES maintenance period, effluent bypass from the upgraded TPSTW would occur at the existing emergency outfall of TPSTW at Tai Po. Effluent bypass from the existing STSTW or the future CSTW would occur at the existing emergency submarine outfall in Sha Tin Hoi as shown in **Figure 4.4**. The effluent bypass from both the future upgraded TPSTW and the future CSTW during THEES maintenance period would be secondarily treated and disinfected. The key issues of concern would be the temporary increase in water pollution such as the increase of nutrients in Tolo Harbour.

4.6.30 Under the existing practice, regular inspection and maintenance of the THEES tunnel would be conducted when necessary, with duration of no more than 4 weeks each time based on past records. Thus, a 4-week THEES maintenance discharge period will be assumed in the water quality modelling. The frequency of the THEES maintenance would be no more than once every 5 years.

4.6.31 According to the latest information from Agriculture, Fisheries and Conservation Department (AFCD), the algae blooming season in Tolo Harbour would occur during the period from December to April/May. Hence, any future THEES maintenance, if required, would be scheduled outside the peak algae blooming season. (i.e. December to April/May). For water quality modelling purpose of this EIA, the 4-week THEES maintenance period will be assumed to occur in June and / or July outside the algae blooming season.

4.6.32 The design flow of this Project (i.e. 160,000 m^3/day) is adopted as the daily Project discharge rate during the THEES maintenance period.

Emergency Discharge of Partially Treated Sewage Effluent to Tolo Harbour

4.6.33 Water quality impact could arise from emergency discharge from this Project in case of power / plant failure. The key issues of concern would be the temporary increase in water pollution such as the depletion of oxygen and increase of nutrients and *E. coli* bacteria in Tolo Harbour.

4.6.34 Emergency discharge of sewage effluent from the future upgraded TPSTW, if any, would be discharged via the existing emergency outfall of TPSTW.

4.6.35 Based on the past discharge record of TPSTW, emergency sewage discharge had occurred only once since 1995 due to CLP power supply failure to TPSTW Stage IV inlet works. The duration of the emergency discharge from TPSTW was less than 3 hours with a total discharge volume of less than 9,000 m^3. For modelling purpose of this EIA, emergency discharge from this Project is assumed to continuously occur for 3 hours.

4.6.36 In accordance with the Environmental Permit (EP) of "TPSTW Stage V" obtained in 2004, dual power supply or ring main supply from CLP, standby equipment and treatment units have been provided for the existing TPSTW to prevent the occurrence of emergency discharge. Since then, emergency discharge to Tolo Harbour from the existing TPSTW had never happened again.

4.6.37 If dual power or ring main supply, standby equipment and treatment units are provided for this Project, the model assumption of total plant failure for a 3-hour period would be a very conservative scenario.

4.6.38 Mathematical modelling is conducted to simulate the impacts for emergency discharge centred at neap tide low water with the least water dispersion capacity. It is assumed that the sewage would be discharged in July during the wet season. Assuming a Project design flow of 160,000 m^3/day, the total discharge volume over the 3-hour period would be about 20,000 m^3. In case of power failure, the emergency discharge from the upgraded TPSTW would still be subject to settlement / sedimentation prior to the discharge and thus the quality of the emergency discharge is assumed to be similar to that of the primarily treated sewage effluent.

4.6.39 Concurrent emergency discharge from both TPSTW and STSTW had never occurred before. According to the EIA for "CSTW", backup power supply, standby equipment and standby treatment units will also be provided for the future CSTW. Hence, plant failure from both the upgraded TPSTW and CSTW together is not expected and will not be further considered in this assessment.

Summary of Potential Impacts from Treated Sewage Effluent

4.6.40 Sources of potential water quality impact associated with the Project effluent discharge during the operational phase are identified as follows:

- Discharge of TSE from the Project to the Victoria Harbour via THEES under normal plant operation;
- Discharge of TSE from the Project to Tolo Harbour under THEES maintenance event; and
- Discharge of partially treated sewage from the Project to Tolo Harbour under emergency situations.

Operational Phase – Other Water Pollution Sources

4.6.41 Other sources of potential water quality impacts associated with the Project also include the following:

- Possible spillage or rainwater wash off during transportation or handling of the pre-treated food waste;
- Wastewater generated from the sludge treatment / dewatering facility, pre-treated food waste reception facility and the facility for co-digestion of pre-treated food waste;
- Non-point source surface run-off from the Project site; and
- Possible spillage of chemicals (e.g. ferried chloride and polymer) during the handling, storage and transferring of the chemicals.

4.7 Assessment Methodology

Construction Phase

4.7.1 The WSRs that may be affected by the Project have been identified. Potential sources of water quality impact that may arise during the construction of the Project were described. All the identified sources of potential water quality impact were then evaluated and their impact significance determined. The need for mitigation measures to reduce any identified adverse impacts on water quality to acceptable levels was determined.

Operational Phase – Project Effluent Discharge

Modelling Tools

4.7.2 Computer modelling is used to assess the water quality impacts due to the partially treated/ treated or untreated sewage effluent discharge during the operational phase.

4.7.3 Delft3D suite of models, developed by Deltares, are used as the modelling platforms with the Deflt3D-FLOW module and the Delft3D-WAQ module used for hydrodynamic simulations and water quality simulations respectively. To simulate the potential impact from the Project on both Tolo Harbour and Victoria Harbour, two Delft3D models are adopted respectively:

- Tolo Harbour and Mirs Bay (THMB) Model; and
- Victoria Harbour (VH) Model.

4.7.4 Delft3D-FLOW is a 3-dimensional hydrodynamic simulation programme which calculates non-steady flow and transport phenomena that result from tidal and meteorological forcing on a curvilinear, boundary fitted grid.

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

THMB Model

4.7.6 The THMB Model was developed by EPD under Agreement No. WP01-27 [8]. The model was fully calibrated and verified by comparing computational results with field measurements. The THMB model was subsequently accepted by EPD for directly use under the approved EIAs for "CSTW" and "TPSTW Stage V" for hydrodynamic and water quality modelling in Tolo Harbour. No changes to the model set up of the THMB Model such as the grid layout, model parameters and process coefficients are proposed. The grid layout and coverage of the THMB Model are shown in **Appendix 4.2A**.

VH Model

4.7.7 The VH Model is based on the model setup developed under Agreement No. CE 30/2008 (CE) as presented in the Water Quality Modelling Report [9] obtained from CEDD in 2020. The model was fully calibrated and verified with field measurement data. The same model setup was

[8] WL | Delft Hydraulics (2002). Agreement No. WP01-27, Provision of Service for Enhancement of the Tolo Harbour & Mirs Bay Model, Final Report.

[9] Agreement No. CE 30 /2008 (CE) Kai Tak Development – Infrastructure at Former runway and Remaining Areas of North Apron and Improvement of Adjacent Waterways – Design and Construction, Water Quality Modelling Report (Ref. 039-04), August 2012.

applied in the latest modelling submissions of KTD [10] obtained from CEDD as well as in the approved EIA for "CSTW" for hydrodynamic and water quality modelling in KTAC. The grid layout and coverage of the VH Model are shown in **Appendix 4.2B**.

Modelling Scenarios

4.7.8 The time horizon for water quality modelling would be at ultimate design stage (UDS) when the Project flow reaches the design capacity. The modelling scenarios include:

Discharge to Victoria Harbour

4.7.9 **Scenario 1a - Baseline "Do-nothing" Scenario (Design Effluent Quality)**

- Normal operation of TPSTW with an ADWF of 120,000 m^3/day to Victoria Harbour.
- Design effluent standards are applied to the ADWF for deriving the THEES loading.

4.7.10 **Scenario 1b - "With Project" Scenario (Design Effluent Quality)**

- Normal operation of the Project with an ADWF of 160,000 m^3/day to Victoria Harbour.
- Design effluent standards are applied to the ADWF for deriving the THEES loading.

4.7.11 **Scenario 2a - Baseline "Do-nothing" Scenario (Measured Effluent Quality)**

- Same as Scenario 1a except that the 95th percentile effluent quality values from actual measurements were employed to derive the THEES loading.
- This is a more realistic worst-case scenario, see Note (6) under **Table 4.13**.

4.7.12 **Scenario 2b - "With Project" Scenario (Measured Effluent Quality)**

- Same as Scenario 1b except that the 95th percentile effluent quality values from actual measurements were employed to derive the THEES loading.
- This is a more realistic worst-case scenario, see Note (6) under **Table 4.13**.

Discharge to Tolo Harbour

4.7.13 **Scenario 3 – Normal Project Operation**

- Occasional overflow of TSE from the Project under normal operation as illustrated in **Exhibit 4.6** and discussed in Section 4.6.22.
- Normal Project operation will not induce any water quality impact in Tolo Harbour, see Section 4.6.25. This scenario serves only as a baseline for comparison with the THEES maintenance and emergency discharge scenarios.

4.7.14 **Scenario 4 - THEES Maintenance**

- Discharge of THEES effluent (only TSE involved) into Tolo Harbour for 4 weeks (outside the algae blooming season), see Section 4.6.31.
- Maintenance discharge from the Project is assumed to be 160,000 m^3/day (with no TSE reuse).
- Background Project discharge under Scenario 3 is adopted outside the THEES maintenance period.

4.7.15 **Scenario 5 - Emergency Discharge**

- Emergency discharge of primarily treated / settled effluent from the Project into Tolo Harbour under complete power / plant failure for 3 hours in wet season, see Section 4.6.38.
- The total emergency discharge would be about 20,000 m^3.

[10] Agreement No. CE 30 /2008 (CE) Kai Tak Development – Infrastructure at Former runway and Remaining Areas of North Apron and Improvement of Adjacent Waterways – Design and Construction, Final Water Quality Report and EM&A Manual (Ref. 373-02), June 2020.

- Background Project discharge under Scenario 3 is adopted outside the emergency discharge period.

4.7.16 Details of the modelling scenarios are presented in **Table 4.13**.

Table 4.13 Proposed Water Quality Modelling Scenarios

Scenario	Phase	Effluent Flow	Description	Effluent	BOD_5 (mg/L)	SS (mg/L)	TKN (mg/L)	TN (mg/L)	NH_3-N (mg/L)	*E. coli* (no./100mL)
Victoria Harbour										
1a (UDS)	Baseline "do-nothing" scenario (design effluent standards)	120,000 m^3/day (TPSTW) (1) + 340,000 m^3/day (CSTW)	• Interception and Pumping (IP) Scheme is adopted to divert some water from KTR and KTAC to Kowloon Bay, see Sections 4.5.13 to 4.5.17. • THEES loading based on design effluent standards of TPSTW and CSTW.	TPSTW	20 (2)	30 (2)	11.80 (3)	20 (4)	5 (4)	1,000 (4)
				CSTW	20 (5)	30 (5)	13.28 (5)	20 (5)	5 (5)	1,000 (5)
1b (UDS)	"With Project" Scenario (design effluent standards)	160,000 m^3/day (upgraded TPSTW) + 340,000 m^3/day (CSTW)	• IP Scheme is adopted to divert some water from KTR and KTAC to Kowloon Bay, see Sections 4.5.13 to 4.5.17. • THEES loading based on design effluent standards of this Project and CSTW.	This Project	20 (2)	30 (2)	11.80 (3)	20 (4)	5 (4)	1,000 (4)
				CSTW	20 (5)	30 (5)	13.28 (5)	20 (5)	5 (5)	1,000 (5)
2a (UDS)	Baseline "do-nothing" scenario (measured effluent quality)	120,000 m^3/day (TPSTW) (1) + 340,000 m^3/day (CSTW)	• IP Scheme is adopted to divert some water from KTR and KTAC to Kowloon Bay, see Sections 4.5.13 to 4.5.17. • THEES loading input based on actual performance of TPSTW and STSTW (with the same treatment level of this Project and CSTW)	TPSTW	6.60(6)	14.25 (6)	9.37 (6)	14.08 (6)	7.22 (6)	1,000 (4)
				CSTW	9.40 (5)	20.15 (5)	5.04 (5)	17 (5)	2.64 (5)	1,000 (5)
2b (UDS)	"with Project" Scenario (measured effluent quality)	160,000 m^3/day (upgraded TPSTW) + 340,000 m^3/day(CSTW)	• Use of IP Scheme to divert some water from KTR and KTAC to Kowloon Bay, see Sections 4.5.13 to 4.5.17. • THEES loading input based on actual performance of TPSTW and STSTW (with the same treatment level of this Project and CSTW)	This Project	6.60(6)	14.25 (6)	9.37 (6)	14.08 (6)	7.22 (6)	1,000 (4)
				CSTW	9.40 (5)	20.15 (5)	5.04 (5)	17 (5)	2.64 (5)	1,000 (5)
Tolo Harbour										
3 (UDS)	Baseline Scenario (with no THEES maintenance and no emergency discharge)	Reduced Project overflow (as shown in **Exhibit 4.6** above) was applied as the background discharge	• Serves as a baseline for comparison with Scenarios 4 and 5 to assist in identifying the water quality impact from THEES maintenance and emergency situations.	This Project	20 (2)	30 (2)	11.80 (3)	20 (4)	5 (4)	1,000 (4)
4 (UDS)	THEES maintenance	During THEES Maintenance: 160,000 m^3/day (from upgraded TPSTW) + 340,000 m^3/day (from CSTW) Outside THEES Maintenance Period: Reduced Project overflow (as shown in **Exhibit 4.6** above) was applied as the background discharge	Temporary bypass of secondarily treated and disinfected effluent from upgraded TPSTW and CSTW, see Section 4.6.31. (for 4 weeks outside algae blooming season)	This Project	20 (2)	30 (2)	11.80 (3)	20 (4)	5 (4)	1,000 (4)
				CSTW	20 (5)	30 (5)	13.28 (5)	20 (5)	5 (5)	1,000 (5)
5 (UDS)	Emergency discharge	Under Emergency Situation: 20,000 m^3 per discharge event (from upgraded TPSTW)	Emergency bypass of primarily treated / settled effluent from upgraded TPSTW, see Section 4.6.38. (for 3 hours in wet season)	This Project	177 (7)	174 (7)	57 (7)	58 (7)	38 (7)	2 x10^7 (8)

Scenario	Phase	Effluent Flow	Description	Effluent	BOD_5 (mg/L)	SS (mg/L)	TKN (mg/L)	TN (mg/L)	NH_3-N (mg/L)	*E. coli* (no./100mL)
		Outside Emergency Discharge Period: Reduced Project overflow (as shown in **Exhibit 4.6** above) was applied as the background discharge								

Notes:

(1) During EIA stage of the "TPSTW Stage V", the design capacity of TPSTW was proposed to be 130,000 m^3/day. The design capacity has been reviewed and changed to 120,000 m^3/day according to the latest operation information of TPSTW.

(2) At 95th percentile value of the effluent standard (refer to **Table 4.8**). Using the 95th percentile value as the effluent concentration for continuous discharge was considered conservative, given that the effluent concentrations would be lower than the 95th percentile value for most of the times.

(3) Based on the ratio of TKN : Total N adopted in the approved EIAs for CSTW and TPSTW Stage V.

(4) At mean value of the effluent standard (refer to **Table 4.8**). Unlike the WQO for DO which is a 10th percentile value, the WQOs for TIN and UIA is an annual mean objective. The WQO for chlorophyll-*a* is a 5-day running averaged value. The WQO for *E. coli* in Tolo Harbour is a geometric mean objective. Thus, using the mean effluent standard in model prediction is considered appropriate for comparison with the relevant WQOs. The same approach has been adopted in the EIA for CSTW and the latest modelling submissions of Agreement No. CE 30 /2008 (CE).

(5) Based on the same effluent values adopted in the approved EIA for CSTW.

(6) Based on maximum of all moving yearly 95th percentile values from latest measurements of effluents from TPSTW between January 2017 and July 2021. A yearly 95th percentile value is defined as the 95th percentile value over a one-year period (e.g. from 1 August 2020 to 31 July 2021). Use of the measured 95th percentile value for continuous input is conservative. This represents a reasonable worst case for impact assessment. The same approach is adopted in the EIA for CSTW as well as under the latest 2020 modelling submissions of Agreement CE 30/ 2008 (CE).

(7) Maximum value of monthly averaged data measured in primarily treated / settled effluent of TPSTW (between 2017 and 2021).

(8) Typical design concentrations adopted in the approved EIAs for CSTW and TPSTW Stage V.

Simulation Periods

4.7.17 For both THMB Model and VH Model, water quality simulations (using Delft3D-WAQ) for operational stages are conducted for 1 complete calendar year.

4.7.18 The simulations (using Delft3D-FLOW) are performed for both dry and wet seasons. For each season, the simulation period of the hydrodynamic model covers a 15-day full spring-neap cycle (excluding the spin-up period). The hydrodynamic results are used repeatedly to drive the water quality simulations for one complete calendar year (excluding the spin-up period).

Spin-up Periods

4.7.19 For THMB Model, a spin-up period of 1 complete calendar year is provided for each of the hydrodynamic simulation and water quality simulation.

4.7.20 For VH Model, a spin-up period of 23 days and 45 days is provided for hydrodynamic simulation and water quality simulation respectively.

4.7.21 These spin-up periods were tested to be adequate for producing acceptable model result.

Boundary Conditions

THMB Model

4.7.22 Tolo Harbour is a land-locked water body with a narrow exit to the open water. Also, the opening of the Tolo Channel is not facing directly to the incoming tides (from the South China Sea). Therefore, the influences on the hydrodynamics and water quality of Tolo Harbour due to changes in the environmental settings outside Tolo Harbour including major reclamation projects (e.g. the Third Runway project) and STW projects (e.g. Harbour Area Treatment Scheme) would be negligible.

4.7.23 The hydrodynamic boundary conditions of the THMB Model were developed under Agreement No. WP01-27 from the actual forcing of wind, rainfall and temperature. These boundary conditions were found to be reliable from other past relevant EIAs. Hence, the same set of hydrodynamic boundary conditions will be used in this EIA.

4.7.24 The water quality boundary condition of the THMB Model has been derived from the water quality monitoring results of the nearest EPD station to the open boundaries, namely MM16.

VH Model

4.7.25 The VH Model is linked to or nested within the regional Update Model developed by EPD under Agreement No. CE 42/97 [11]. The Update Model was fully calibrated and verified. It has been updated according to the latest changes of coastline configurations, bathymetry and pollution loading. Computations are firstly carried out using the Update Model and the results are used to provide open boundary conditions to drive the VH Model. The Update Model covers the outer regions of Pearl River Estuary, Macau, Ma Wan Channel, Cheung Chau, East Lamma Channel, Victoria Harbour, Tathong Channel, Nine Pin Islands, Po Toi Island, Tolo Harbour and Tolo channel. All major influences on hydrodynamics and water quality in the outer regions

[11] Agreement No. CE 42/97 Update on Cumulative Water Quality and Hydrological Effect of Coastal Development and. Upgrading of Assessment Tool.

including the Pearl River discharges would be incorporated into the VH Model.

Coastline Configurations

4.7.26 The construction works of this Project are tentatively scheduled to commence in 2025 for completion in 2036.

Victoria Harbour

4.7.27 Following the existing THEES arrangement, only TSE from the Project would be discharged to Victoria Harbour. The on-going or planned projects as listed in **Table 4.14** below would be completed before commissioning of this Project and therefore incorporated into the modelling exercise.

Table 4.14 Projects Affecting Coastline Configurations

Project	Status	Source of Information on Project Layout
Wan Chai Development Phase II (WDII) and Central-Wan Chai Bypass (CWB)	In operation	EIA Report for "WDII and CWB" (EIAO Register No.:AEIAR-125/2008)
Tseung Kwan O (TKO) – Lam Tin Tunnel (LTT) and Associated Works	Under construction	EIA Report for "TKO – Lam Tin Tunnel and Associated Works" (EIAO Register No.: AEIAR-173/2013)
Tuen Mun - Chek Lap Kok Link (TM-CLKL)	In operation	EIA Report for "TM-CLKL" (EIAO Register No.: AEIAR-146/2009)
Hong Kong - Zhuhai - Macao Bridge (HZMB) Hong Kong Boundary Crossing Facilities (BCF)	In operation	EIA Report for "HZMB Hong Kong BCF" (EIAO Register No.: AEIAR-145/2009)
HZMB - Hong Kong Link Road	In operation	EIA Report for "HZMB - Hong Kong Link Road" (EIAO Register No.: AEIAR-144/2009)
Tung Chung New Town Extension (TCNTE)	Under construction	EIA Report for "TCNTE" (EIAO Application No. EIA-233/2015)
Expansion of Hong Kong International Airport into a Three-Runway System (3RS)	Under construction	EIA Report for "3RS" (EIAO Register No.: AEIAR-185/2014)
Development of Integrated Waste Management Facilities (IWMF) Phase 1	Under construction	EIA Report for "Development of IWMF Phase 1" (EIAO Register No.: AEIAR-163/2012)

4.7.28 The implementation programme and layout for Container Terminal 10 Development at Southwest Tsing Yi and other Potential Reclamation Sites (PRS) in western waters (proposed under "Increasing Land Supply by Reclamation and Rock Cavern Development cum Public Engagement – Feasibility Study") are currently unconfirmed. These potential reclamations are excluded in this modelling exercise.

4.7.29 The treatment level of this Project would be secondary with disinfection. Based on the results of all past relevant studies e.g. EIA for "CSTW", the effect of secondarily treated and disinfected effluent would be highly localized and confined within the water bodies at or near Kai Tak Development Area. The effect of other potential reclamation sites (e.g. in western waters) would unlikely affect the overall conclusion of this assessment.

4.7.30 The coastal projects "Intermodal Transfer Terminal - Bonded Vehicular Bridge and Associated Roads" and "Cross Bay Link (CBL), Tseung Kwan O" are not considered in the modelling. Both projects would not involve reclamation but would include the construction of bridge piers only with limited effect on the tidal flushing (as predicted in their approved EIAs). It is considered that these bridge project would not affect the overall modelling results for the present EIA.

4.7.31 Based on the latest information, the wide (600m) opening at the former airport runway as proposed in the approved EIA for "KTD" will be superseded by the IP Scheme proposed under Agreement No. CE 30/2008 (CE) as discussed in Section 4.5. The 600m runway opening will not be considered in this EIA. Based on the past relevant model results, opening a wide (600m) gap at the former airport runway would result a greater water quality improvement and flushing at the KTAC as compared to the IP Scheme and therefore will be a less critical case for cumulative water quality impacts. Under the IP Scheme, there would be 3 DCS plants at Kai Tak with 2 intakes (in KTR and KTAC) and 3 outfalls (in Kowloon Bay) as shown in **Figure 4.6** above. The design flow rates of the 3 DCS plants available from Agreement No. CE 30/2008 (CE) are used in the modelling as both the seawater intake rates and the spent effluent discharge rates at the outfalls. The combined water intake rates (at KTR and KTAC) would be equal to the combined discharge rates in Kowloon Bay.

Tolo Harbour

4.7.32 No confirmed and planned reclamation is identified within the coverage of THMB Model. The layout and implementation programme of the PRS at Ma Liu Shiu are currently unconfirmed and will not be considered in the modelling. This PRS is located in the most inner zone of Tolo Harbour near Sha Tin Hoi. It is at the southernmost point of Tolo Harbour farthest from the Tolo Channel opening. It is also relative far away from the Project discharge point at Tai Po and will not block any tidal flow along the coast of Tai Po. This PRS would not affect the overall conclusion of this assessment.

<u>Model Bathymetry</u>

4.7.33 The model bathymetry schematization was checked against the depth data from the latest marine charts produced by the Hydrographic Office of Marine Department. In addition, major EIA projects that would affect the bathymetry are listed in **Table 4.15**. All these projects are either completed or under construction and therefore incorporated into the bathymetries of this modelling exercise.

Table 4.15 Projects Affecting Bathymetry

Project	Status	Source of Information on Project Layout
Central Kowloon Route (CKR)	Under construction	EIA Report for "CKR" (EIAO Register No.: AEIAR-171/2013)
Sha Tin to Central Link (SCL)	In operation	EIA Report for "SCL - Hung Hom to Admiralty Section" (EIAO Register No.: AEIAR-166/2012)
Kai Tak Cruise Terminal	In operation	EIA Report for "Dredging Works for Proposed Cruise Terminal at Kai Tak" (EIAO Register No.: AEIAR-115/2007)
Dredging Works for Sufficient Depth for Kwai Tsing Container Terminal and its Basin	Under construction	EIA Report for "Providing Sufficient Water Depth for Kwai Tsing Container Basin and its Approach Channel" (EIAO Register No.: AEIAR-156/2010)

<u>Background Pollution Loading</u>

Introduction

4.7.34 The approach in compiling the background pollution loading is summarized below. Details of the loading inventory are given in the Working Paper on Water Quality Impact Assessment [12].

Kai Tak Development Area

4.7.35 The inventory of background storm pollution loading to the KTAC and Kwun Tong Typhoon Shelter (KTTS) for the year of 2018 developed under Agreement No. CE 30/2008 (CE) [13] was obtained from the CEDD and is directly adopted in this EIA. This loading inventory was compiled using the results of storm pollution survey carried out in 2018 and also taking account of the rainfall related loading. Since the Government will continue to remove the pollution sources and rectify expedient connections, it is expected that the future storm pollution situations during operational phase of this Project would not be worse than the 2018 conditions. It is appropriate to adopt the 2018 storm loading inventory for the present EIA.

Tolo Harbour

4.7.36 The dry weather load in Tolo Harbour is compiled theoretically using the population forecast from the 2016-based TPEDM, which represents the latest forecast at the time of conducting the water quality modelling work. The relevant per capita load factors adopted in the EIA for CSTW were applied to the population number to give the total dry weather pollution load generated from the domestic, commercial and industrial activities. Review of the 2019-based TPEDM released after completion of the water quality modelling work revealed that there is no significant change in the overall population size in the assessment areas between the 2016-based TPEDM and the 2019-based TPEDM. Using the 2016-based TPEDM is considered representative for the purpose of estimation of the background pollution loading.

4.7.37 The population forecast from the 2016-based TPEDM is available for different design years up to 2041. The population used to estimate the background dry weather storm pollution in the UDS is based on a 10% extrapolation of the projected population for 2041. Adding a prudence allowance of 10% in the load estimation for these background discharges is a conservative approach to address the uncertainties on the population projection. It is assumed that 5% of the total pollution load would be lost to the storm water as a result of aged sewerage / drainage systems or unsewered properties and expedient connections (if any). Since the Government will continue to remove the pollution sources and rectify expedient connections, it is expected that the storm pollution situations in the future will be minimized. Thus, the percentage of pollution load lost to the storm system of 5% is considered reasonable. This percentage was also adopted in the approved EIAs for CSTW and TPSTW Stage V. The key steps for calculation of the background pollution load are summarized as follows:

- Total Population in the catchment area in UDS = Year 2041 Population Data x 1.1;
- Total Pollution Load (TPL) generated in the catchment area in UDS = Total Population in the catchment area in UDS x Per Head Load Factor; and
- Pollution Load discharged to marine water from the catchment area in UDS for model input = TPL generated in the catchment area in UDS x (5% sewage lost to the drainage system).

4.7.38 In addition, the rainfall related non-point source pollution is separately estimated in accordance with the methodology given in the EIA for CSTW. The rainfall related pollution

---

[12] Agreement No. CE 50/2019 (DS) Upgrading of Tai Po Sewage Treatment Works - investigation, Working Paper on Water Quality Impact Assessment (Final), February 2021.

[13] Agreement No. CE 30 /2008 (CE) Kai Tak Development – Infrastructure at Former runway and Remaining Areas of North Apron and Improvement of Adjacent Waterways – Design and Construction, Final Water Quality Report and EM&A Manual (Ref. 373-02), June 2020.

load is added on top of the dry weather storm pollution to give the overall pollution loading. The resulted storm pollution was distributed to five major river outlets of the Tolo Harbour.

Other Background Sources

4.7.39 The UDS is also used as the time horizon for other background loading outside the catchments of KTAC, KTTS and Tolo Harbour. The background discharges are compiled theoretically by applying the relevant per capita load factors to the projected population from 2016-based TPEDM or based on the design flow and load information of major STW from other EIA projects. The population used for the UDS is based on a 10% extrapolation of the projected population for 2041 to address the uncertainties of the population forecast. The inventory also incorporates the effect of storm events and other minor point source discharges in Hong Kong such as those from individual fish cultural zones.

Model Limitations

4.7.40 The Delft3D water quality modelling tools adopted for the assessment are not red tide modelling tools, which are not designed for the purpose of predicting the rise and fall of a red tide. Thus, the secondary water quality impact brought by the red tide occurrence, such as DO depletion, may not be truly reflected by the Delft3D module.

4.7.41 It should also be noted that the use of monthly averaged meteorological data (e.g. in terms of solar radiation and temperature) as well as the averaged pollution loading (calculated theoretically) for model input (under the existing EIA practice) may not be able to reflect the episodic events (e.g. stratification induced by extreme air temperature) as well as the day-to-day and year-to-year fluctuation of the pollution discharge into the sea. These are the model limitations that may cause a deviation between the model prediction and the actual situation, which need to be observed when reviewing the model results of this assessment.

Operational Phase – Other Water Pollution Sources

4.7.42 Other potential sources of water quality impacts that may arise during the operational phase are presented in Section 4.6.41. All the identified sources of potential water quality impact were qualitatively evaluated and their impact significance determined. The need for mitigation measures to reduce any identified adverse impacts on water quality to acceptable levels was determined.

4.8 Evaluation of Potential Impacts – Construction Phase

General Land-based Construction Activities

4.8.1 Various types of construction activities may generate wastewater. These include general cleaning and polishing, wheel washing, dust suppression sprays and utility installation. These types of wastewater would contain high concentrations of SS. Effluent discharged from various construction site facilities would be controlled to prevent direct discharge to the neighbouring inland waters and storm drains.

4.8.2 Construction works would also generate debris and rubbish such as packaging, construction materials and refuse. Uncontrolled discharge of site effluents, rubbish and refuse generated from the construction works could lead to deterioration in water quality. Debris and rubbish would be properly managed and controlled to avoid accidental release to the local storm system and inland waters.

4.8.3 Adoption of the guidelines and good site practices for handling and disposal of construction site discharges and refuse as specified in Section 4.11 would minimize the potential impacts.

Construction Site Runoff

4.8.4 Potential pollution sources of site runoff may include:

- Runoff and erosion of exposed bare soil and earth, drainage channel, earth working area and stockpiles;
- Release of any bentonite slurries, concrete washings and other grouting materials with construction run-off or storm water;
- Wash water from dust suppression sprays and wheel washing facilities; and
- Fuel, oil and lubricants from maintenance of construction vehicles and equipment.

4.8.5 During rainstorms, site runoff would wash away the soil particles on unpaved lands and areas with the topsoil exposed. The runoff is generally characterized by high concentrations of SS. Release of uncontrolled site run-off would increase the SS levels and turbidity in the nearby water environment. Site runoff may also wash away contaminated soil particles and therefore cause water pollution.

4.8.6 Windblown dust would be generated from exposed soil surfaces in the works areas. It is possible that windblown dust would fall directly onto the nearby water bodies when a strong wind occurs. Dispersion of dust within the works areas may increase the SS levels in surface run-off causing a potential impact to the nearby sensitive receivers.

4.8.7 It is important that proper site practice and good site management (as specified in the ProPECC PN 1/94 "Construction Site Drainage") be followed to prevent run-off 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, disturbance of water bodies would be avoided and deterioration in water quality would be minimal. Thus, unacceptable impacts on the water quality are not expected, provided that the relevant mitigation measures as specified in the ProPECC PN 1/94 "Construction Site Drainage" are properly implemented.

Accidental Chemical Spillage

4.8.8 The use, handling and storage of chemicals (e.g. engine oil, lubricants, spent acid / alkaline solutions / solvent etc.) would have the potential to create impacts on the water quality if spillage occurs. Chemical spillage may infiltrate into the surface soil layer, or run-off into local storm drains and eventually to the water environment. Thus, chemicals shall be handled, stored and disposed properly to avoid and contain spillage. The potential water quality impact associated with accidental chemical spillage could be mitigated by practical measures and good site practices as given Section 4.11.

Sewage Effluent from Construction Workforce

4.8.9 During the construction of the Project, the workforce on site will generate sewage effluents, which are characterized by high levels of BOD_5, ammonia and *E. coli* counts. However, this temporary sewage can be adequately treated by interim sewage treatment facilities, such as portable chemical toilets. Based on the Drainage Services Department (DSD) Sewerage Manual, the sewage production rate for construction workers is estimated at 0.35 m^3 per worker per day. For every 100 construction workers working simultaneously at the construction site, about 35 m^3 of sewage would be generated per day. Provided that sewage is not discharged directly into storm drains or inland waters adjacent to the construction site, and temporary sanitary facilities are serviced and properly maintained by a licensed waste collector, it is unlikely that sewage generated from the site would have a significant water quality impact.

Contaminated Site Runoff

4.8.10 With reference to the land contamination assessment carried out under this EIA, potential contaminated lands are identified at the existing TPSTW and the proposed expansion site. Any contaminated material disturbed, or material which comes into contact with the contaminated material, has the potential to be washed with site runoff into the nearby drainage system and eventually to the Tolo Harbour. As a result, the levels of Chemicals of Concern (CoC) such as petroleum hydrocarbons and metals in the marine water may be increased.

4.8.11 Mitigation measures will be required to avoid, control or properly treat any contaminated site runoff. With proper implementation of the recommended mitigation measures in Section 4.11, the potential water quality impacts arising from contaminated site run-off would be minimized.

Demolition Works

4.8.12 The Project would involve demolition works of some existing structures of TPSTW for construction of new treatment facilities. The sewage and chemical residues remaining or washed out from the decommissioned facilities would be a source of water pollution.

4.8.13 Surface runoff and site effluent may also be generated from the demolition works. Precipitation that falls on unpaved lands and areas with the topsoil exposed during the demolition would wash away soil particles. Such surface runoff and stormwater overflows with high levels of SS (if uncontrolled) which may lead to water quality impact.

4.8.14 Proper site practice and good site management as specified in the ProPECC PN 1/94 "Construction Site Drainage" and recommended in Section 4.11 should be implemented to control site runoff and site effluent from the demolition works, as well as to prevent wastewater or chemical residues, if any, in the decommissioned facilities from directly entering the Tolo Harbour. With proper implementation of the recommended mitigation measures, unacceptable water quality impacts would not arise.

4.9 Evaluation of Potential Impacts – Operational Phase (Project Effluent Discharge)

Normal Project / THEES Operation – Treated Effluent Discharge to Victoria Harbour

4.9.1 Four modelling scenarios (namely Scenarios 1a, 1b, 2a, and 2b) were simulated to assess the potential water quality impacts upon the Victoria Harbour during the normal Project /THEES operation.

4.9.2 The model results of the 4 scenarios are compared in **Appendix 4.3** as contour plots for DO, BOD_5, TIN, UIA, *E. coli*, SS, and sedimentation rate. All contour plots are presented as annual arithmetic averages except for the *E. coli* levels, which are annual geometric mean. Since the marine WQO in Victoria Harbour for depth-averaged (DA) DO and bottom DO is defined as not less than 4 and 2 mg/L respectively for 90% of times over a complete calendar year, the contour plots for DO are presented as 10th percentile (10%ile) DA and bottom values for comparison with the WQOs. Contour plot for annual mean DA DO values are also presented for reference.

<u>Bottom Dissolved Oxygen (DO)</u>

4.9.3 The predicted 10%ile bottom DO fully complied with the WQO of no less than 2 mg/L in all assessment areas including KTAC, KTTS, Kowloon Bay and the open channel of Victoria Harbour under all scenarios (1a, 1b, 2a and 2b), refer to Figure 03 of **Appendix 4.3**. Using the discharge license standards for compiling the THEES effluent loading under Scenarios 1a and 1b, the predicted 10%ile bottom DO levels ranged from ≥3 mg/L to <4 mg/L in part of the KTAC and at the corner of KTTS and corners of Kowloon Bay and ≥4 mg/L in the remaining assessment areas. The 10%ile bottom DO patterns are similar between Scenarios 1a and 1b. Under the more realistic worst-case scenarios by using the maximum 95%ile values of the measured effluent quality data for compiling the THEES effluent loading (Scenarios 2a and 2b), the predicted 10%ile bottom DO levels ranged from ≥3 mg/L to <4 mg/L at the corner of KTAC and corners of Kowloon Bay and ≥4 mg/L in the remaining assessment areas. The 10%ile bottom DO patterns are similar between Scenarios 2a and 2b. No adverse bottom DO impact is predicted.

Depth-averaged (DA) Dissolved Oxygen (DO)

4.9.4 Using the discharge license standards for compiling the THEES effluent loading under Scenarios 1a and 1b, the 10%ile DA DO levels would not comply with the WQO of no less than 4 mg/L in a small portion of the KTAC water (Figure 02 of **Appendix 4.3**). The size of non-compliance area in the KTAC water is slightly larger under Scenario 1b (with Project) as compared to the baseline condition (Scenario 1a). However, neither biological nor ecological sensitive receivers that are sensitive to DO depletion are located in KTAC. No unacceptable DO impact would be induced by this Project.

4.9.5 Under the more realistic worst-case scenarios by using the maximum 95%ile values of the measured effluent quality data for compiling the THEES effluent loading for continuous discharge (Scenarios 2a and 2b), full compliance with the WQO for DA DO would be achieved in KTAC (Figure 02 of **Appendix 4.3**). The predicted 10%ile DA DO patterns are similar between Scenarios 2a and 2b.

4.9.6 Under all the four scenarios, full compliance with the WQO for 10%ile DA DO is predicted in KTTS, Kowloon Bay and the open channel of Victoria Harbour outside the breakwaters of KTTS except for a small portion at the corners of Kowloon Bay where the 10% DA DO breached the WQO (Figure 02 of **Appendix 4.3**). This Project would not cause any adverse DA DO impact in Victoria Harbour WCZ.

5-Day Biochemical Oxygen Demand (BOD_5)

4.9.7 There is no marine WQO for BOD_5 in Victoria Harbour WCZ. Under Scenarios 1a and 1b, the predicted mean BOD_5 levels ranged from ≥1 mg/L to <5 mg/L in KTAC (except a small portion at the corner of KTAC with a level of >5 mg/L), from ≥0.5 mg/L to <1.5 mg/L in KTTS, from <0.5 mg/L to <5 mg/L in Kowloon Bay (except a small portion at the upper corner with a level of >5 mg/L) and <0.5 mg/L in the open channel of Victoria Harbour (except for some localized areas along the coastlines with higher BOD_5 levels). Under Scenarios 2a and 2b, the predicted mean BOD_5 levels ranged from ≥0.5 mg/L to <3 mg/L in KTAC, from ≥ 0.5 mg/L to <1.5 mg/l in KTTS, from <0.5 mg/L to <5 mg/L in Kowloon Bay (except a small portion at the upper corner with a level of >5 mg/L) and <0.5 mg/L in the open channel of Victoria Harbour (except for some localized areas along the coastlines with higher BOD_5 levels). As shown in the contour plot (Figure 04 of **Appendix 4.3**), no significant changes in the overall BOD_5 pattern in the KTAC, KTTS, Kowloon Bay and the open channel of Victoria Harbour would be induced by the Project (under Scenarios 1b and 2b) as compared to the baseline situation (under Scenarios 1a and 2a). No adverse BOD_5 impact would be resulted from this Project.

Suspended Solids (SS)

4.9.8 Under all the four assessment scenarios, the predicted mean SS levels ranged from ≥2 mg/L to <8 mg/L in KTAC (except a small portion at the corner of KTAC with levels of ≥8 mg/L to <10 mg/L), from ≥4 mg/L to <6 mg/L in KTTS, from ≥4 mg/L to <8 mg/L in Kowloon Bay (except a small portion at corners of Kowloon Bay with levels of ≥8 mg/L to <20 mg/L) and from ≥2 mg/L to <6 mg/L in open channel of Victoria Harbour (except for some localized areas along the coastlines with SS levels of ≥6 mg/L to <8 mg/L). The overall SS patterns are similar between the "with Project" scenario (Scenario 1b and 2b) and its baseline scenario (Scenario 1a and 2a). By comparing the baseline condition (Scenarios 1a and 2a) to the "with Project" condition (Scenarios 1b and 2b), the SS increase in all the assessment areas including the KTAC, KTTS, Kowloon Bay and the open channel of Victoria Harbour fully complied with the WQO for SS elevation of no more than 30% (Figure 08 of **Appendix 4.3**). No adverse SS impacts would be anticipated.

Unionized Ammonia (UIA)

4.9.9 Under Scenarios 1a and 1b using the discharge license standards for compiling the THEES effluent load for continuous discharge, the predicted UIA levels exceed the WQO of no more than 0.021 mg/L in KTAC, inner KTTS and inner Kowloon Bay. Under Scenarios 2a and 2b (using a more realistically worst THEES effluent loading), the predicted UIA in KTAC still exceed the WQO of no more than 0.021 mg/L, whereas the predicted UIA exceedance area is reduced in KTTS and inner Kowloon Bay compared to Scenario 1a and 1b (Figure 06 of **Appendix 4.3**).

4.9.10 The predicted UIA levels in in the open channel of Victoria Harbour and most areas of KTTS, and To Kwa Wan Typhoon Shelter comply with the WQO under all the four assessment scenarios (Figure 06 of **Appendix 4.3**).

4.9.11 Under the IP scheme, an annual average of over 680,000 m^3 per day of water is pumped from Kai Tak River and KTAC to Kowloon Bay (the average water pumping rate for wet season, May to September, is over 900,000 m^3/day). With consideration of the IP scheme, the size of UIA exceedance area in KTAC and inner Kowloon Bay are similar with and without this Project (Figure 06 of **Appendix 4.3**). The UIA exceedance area in inner KTTS however increases slightly under "with Project" scenario (Scenario 1b and 2b) as compared to its baseline scenario (Scenario 1a and 2a).

4.9.12 Although UIA exceedance is predicted, there are no WSRs such as sites of fisheries or ecological importance (that are susceptible to UIA increase) in KTAC, KTTS and Kowloon Bay. No unacceptable UIA impact in Victoria Harbour WCZ would be anticipated from this Project.

Total Inorganic Nitrogen (TIN)

4.9.13 Under all scenarios (with or without the Project), the predicted TIN levels exceed the WQO of ≤0.4 mg/L inside KTAC, KTTS and Kowloon Bay. The predicted TIN levels in the open channel of Victoria Harbour comply with the WQO (except for some localized areas along the coastlines with TIN levels of ≥0.4 mg/L to <0.8 mg/L) (Figure 05 of **Appendix 4.3**).

4.9.14 With consideration of the IP scheme, the size of TIN exceedance area are similar with and without this Project (Figure 05 of **Appendix 4.3**). This Project would not increase the degree of TIN exceedance as compared to the baseline (without Project) condition.

4.9.15 Implication of nutrient increase in marine water would be the possible enhancement of excessive phytoplankton growth (algal bloom / red tide). From the past red tide records from Hong Kong Red Tide Database of AFCD available since 1975, there has been only 1 red tide incident occurred near Kwun Tong Public Pier in KTTS and 1 red tide incident occurred near Hung Hom in Kowloon Bay. No historic red tide incident has been recorded in KTAC. Red tide occurrence would not be a key concern in KTAC, KTTS and Kowloon Bay. In addition, no sites of fisheries or ecological importance (which are sensitive to red tide) are located in KTAC, KTTS and Kowloon Bay.

4.9.16 This Project would not induce any unacceptable water quality impact in relation to TIN exceedance in KTAC, KTTS and Kowloon Bay.

<u>*E. coli*</u>

4.9.17 There is no WQO for *E. coli* available in Victoria Harbour WCZ under the existing situation. The predicted geometric mean *E. coli* levels under all scenarios are over 610 no./100mL along the coastlines of Victoria Harbour due to the storm pollution loading assumed in the modelling. The predicted geometric mean *E. coli* levels in areas away from the coastlines or away from the storm outfalls in the open channel of Victoria Harbour are below 610 no./100mL (Figure 07 of **Appendix 4.3**).

4.9.18 Under all the four assessment scenarios, the predicted geometric mean *E. coli* levels ranged from ≥180 no. /100mL to <2000 no. /100mL in KTAC and KTTS (except a small portion in KTAC and KTTS with a level of >2000 no. /100mL) and from <180 no. /100mL to <8000 no. /100mL in Kowloon Bay (except corners of Kowloon Bay with a level of >8000 no. /100mL). The overall *E. coli* patterns in all the assessment areas including KTAC, KTTS, Kowloon Bay and open channel of Victoria Harbour are similar under all the 4 modelling scenarios (Figure 07 of **Appendix 4.3**). This Project would not induce any additional *E. coli* impact in Victoria Harbour WCZ.

<u>Sedimentation</u>

4.9.19 There is no statutory WQO for sedimentation rate available in the marine water. Under all the 4 scenarios, the predicted mean sedimentation rate in the assessment area are less than 5 $g/m^2/day$ except for the upper corner of Kowloon Bay where the predicted values ranged from ≥5 $g/m^2/day$ to <10 $g/m^2/day$ (Figure 09 of **Appendix 4.3**). The overall sedimentation patterns in the assessment area are similar with and without this Project. This Project would not induce any adverse sedimentation impact.

<u>Impact on WSRs</u>

4.9.20 Following the same approach adopted under the approved EIAs for KTD and CSTW , the model results are presented for the WSRs that are within the potential influence zone of the THEES effluent, including the WSD flushing water intakes at Tai Wan (F6) and Cha Kwo Ling (F1), the intakes of the Kai Tak DCS (C1 to C3), the cooling water intake for Yau Tong Bay Ice Plant (C4), the To Kwa Wan Typhoon Shelter as well as the KTTS and possible water sports area (R1) in KTTS. Other WSRs were found not to be affected by the Project and are therefore not presented.

WSD Flushing Water Intakes

4.9.21 Based on the model results as summarized in **Table 4.16**, full compliance with the WSD target seawater quality objectives is predicted under all the 4 scenarios at the WSD flushing water intakes at Tai Wan (F6) and Cha Kwo Ling (F1) except for the maximum SS levels, which exceeded the WSD target of <10 mg/L. From **Table 4.6** above, the measured maximum SS levels in the main channel of Victoria Harbour (VM1, VM2 and VM4) are also over 10 mg/L in 2020. It is believed that the SS levels at the two flushing intakes (located in the Victoria Harbour channel) would also occasionally exceed the WSD target under the existing situation. As shown in **Table 4.16**, this Project would not cause any additional SS impact. The predicted SS values under "with Project" scenario (Scenario 1b and 2b) are the same or slightly lower than the SS values under its baseline scenario (Scenario 1a and 2a). No adverse SS impact upon the flushing water intakes at Tai Wan (F6) and Cha Kwo Ling (F1) would arise from the Project.

Table 4.16 Predicted Water Quality at Selected WSD Flushing Water Intakes

Parameter	Scenario (see Remarks)	WSD Flushing Water Intakes (see Figure 4.3)		
		Tai Wan (F6)	Cha Kwo Ling (F1)	Assessment Criteria #
Maximum Ammonia Nitrogen (mg/L)	1a	0.45	0.36	< 1
	1b	0.44	0.37	
	2a	0.41	0.32	
	2b	0.42	0.34	
Maximum Suspended Solids (mg/L)	1a	**17.3**	**15.6**	< 10
	1b	**17.3**	**15.5**	
	2a	**17.3**	**15.6**	
	2b	**17.3**	**15.5**	
Minimum Dissolved Oxygen (mg/L)	1a	4.8	4.9	> 2
	1b	4.9	4.9	
	2a	4.9	5.0	
	2b	4.9	5.0	
Maximum BOD_5 (mg/L)	1a	1.0	0.8	< 10
	1b	0.9	0.8	
	2a	0.9	0.7	
	2b	0.9	0.7	
Maximum *E. coli* (no./100mL)	1a	6014	1034	< 20,000
	1b	5878	1041	
	2a	6032	1030	
	2b	6034	1037	

Remarks: Data presented are in mid-depth water level. Bolded values indicate non-compliance of WQO.
\# WSD's Target Seawater Quality Objectives at Flushing Water Intakes
Scenario 1a: Baseline Scenario (THEES loading based on discharge license standards)
Scenario 1b: "With Project" Scenario (THEES based on discharge license standards)
Scenario 2a: Baseline Scenario (THEES based on actual measurement)
Scenario 2b: "With Project" Scenario (THEES based on actual measurements)

Cooling Water Intakes

4.9.22 There are no specific water quality criteria/requirements available for the Kai Tak DCS cooling water intakes and the cooling water intake for Yau Tong Bay Ice Plant. The model results at these cooling water intakes are tabulated in **Table 4.17**. The operation of the DCS and Yau Tong Bay Ice Plant is not sensitive to the water quality changes at their cooling intake points as confirmed by EMSD or reported in past relevant EIA Reports. No unacceptable water quality impact upon the cooling water intakes would be resulted from this Project.

Table 4.17 Predicted Water Quality at Cooling Water Intakes

Parameter	Scenario (see Remarks)	Kai Tak DCS Cooling Water Intakes			Yau Tong Bay Ice Plant Cooling Water Intake
		C1	C2	C3	C4
Maximum Ammonia Nitrogen (mg/L)	1a	4.08	2.68	1.23	0.36
	1b	4.67	2.82	1.14	0.37
	2a	3.37	2.08	0.92	0.32
	2b	4.03	2.30	0.92	0.34
Maximum Suspended Solids (mg/L)	1a	20.7	14.7	18.2	15.6
	1b	24.0	15.2	18.1	15.5
	2a	13.6	11.6	17.7	15.6

Parameter	Scenario (see Remarks)	Kai Tak DCS Cooling Water Intakes			Yau Tong Bay Ice Plant Cooling Water Intake
		C1	C2	C3	C4
	2b	14.8	11.7	17.6	15.5
Minimum Dissolved Oxygen (mg/L)	1a	2.2	2.9	4.7	4.9
	1b	2.0	3.3	4.8	4.9
	2a	2.9	4.4	4.8	5.0
	2b	2.7	4.2	4.8	5.0
Maximum BOD_5 (mg/L)	1a	16.0	6.9	2.2	0.8
	1b	17.8	7.4	2.1	0.8
	2a	7.8	3.3	1.4	0.7
	2b	8.4	3.4	1.3	0.7
Maximum *E. coli* (no./100mL)	1a	38445	4165	4014	1034
	1b	27228	4046	2767	1041
	2a	30844	3974	4422	1030
	2b	26892	3938	4506	1037

Remarks: Data presented are in mid-depth water level.
Scenario 1a: Baseline Scenario (THEES loading based on design effluent standards)
Scenario 1b: "With Project" Scenario (THEES based on design effluent standards)
Scenario 2a: Baseline Scenario (THEES based on actual measurement)
Scenario 2b: "With Project" Scenario (THEES based on actual measurements)

Kwun Tong Typhoon Shelter / Potential Water Sports Area at Kai Tak and To Kwa Wan Typhoon Shelter

4.9.23 The feasibility of locating a potential water sports area in KTTS is being investigated under the separate KTD project. The WQO laid down for secondary contact and recreational uses stipulates that the annual geometric mean *E. coli* level should not exceed 610 no./100mL. The model results showed that the annual geometric mean *E. coli* level predicted in most areas of KTTS (where the potential water sports area is proposed) would be around or below 610 no./100mL under all the modelling scenarios as shown in **Table 4.18** below. This Project would not induce any additional *E. coli* impact in KTTS.

4.9.24 It should be highlighted that this potential water sports centre is not a confirmed project and its feasibility is still subject to confirmation under separate studies. If this potential water sports centre is carried forward under the separate project, detailed justifications on the acceptability of using the KTTS for water sports activities will be provided under the separate KTD project.

4.9.25 TIN exceedance is predicted in KTTS and To Kwa Wan Typhoon Shelter (TKWTS) under all the assessment scenarios. Since no sites of fisheries or ecological importance are located in KTTS and TKWTS, the TIN exceedances in KTTS and TKWTS would not induce any unacceptable water quality impact as discussed in Sections 4.9.13 to 4.9.16. Full compliances with the WQOs are predicted for other parameters in KTTS and TKWTS.

Table 4.18 Predicted Water Quality at KTTS / Potential Water Sports Area and To Kwa Wan Typhoon Shelter

Parameter	Scenario (see Remarks)	KTTS / Potential Water Sports Area (R1)	To Kwa Wan Typhoon Shelter	WQO
10%ile Bottom Dissolved Oxygen (mg/L)	1a	4.3	4.8	≥2
	1b	4.2	4.9	
	2a	4.7	4.9	
	2b	4.7	4.9	

Parameter	Scenario (see Remarks)	KTTS / Potential Water Sports Area (R1)	To Kwa Wan Typhoon Shelter	WQO
10%ile Depth-Averaged Dissolved Oxygen (mg/L)	1a	4.8	5.0	≥4
	1b	4.8	5.0	
	2a	5.1	5.1	
	2b	5.1	5.1	
Unionized Ammonia (Annual Average) (mg/L)	1a	0.020	0.011	≤0.021
	1b	0.021	0.011	
	2a	0.016	0.009	
	2b	0.017	0.010	
Total Inorganic Nitrogen (Annual Average) (mg/L)	1a	**0.850**	**0.452**	≤0.4
	1b	**0.901**	**0.450**	
	2a	**0.926**	**0.463**	
	2b	**0.991**	**0.469**	
Geometric Mean *E. coli* (no./100mL)	1a	557	310	≤610 (applicable to R1 only)
	1b	553	287	
	2a	540	316	
	2b	537	318	
Suspended Solids (Annual Average) (mg/L)	1a	4.9	4.7	Not to raise the ambient level by more than 30% caused by human activity
	1b	5.0	4.7	
	2a	4.4	4.6	
	2b	4.5	4.6	

Remarks: Bolded values indicate non-compliance of WQO.
Scenario 1a: Baseline Scenario (THEES loading based on design effluent standards)
Scenario 1b: "With Project" Scenario (THEES based on design effluent standards)
Scenario 2a: Baseline Scenario (THEES based on actual measurement)
Scenario 2b: "With Project" Scenario (THEES based on actual measurements)

THEES Maintenance – Treated Effluent Discharge to Tolo Harbour

4.9.26 A continuous THEES maintenance discharge for a period of 4 weeks was simulated under Scenario 4. During the THEES maintenance period, disinfected secondary effluent would be discharged to Tolo Harbour from this Project and the concurrent CSTW project. The THEES maintenance will be scheduled outside the algae blooming season. The model results for Scenario 4 (with THEES maintenance discharge) are compared with the model results for Scenario 3 (baseline scenario without THEES maintenance) to identify the water quality changes due to the THEES maintenance discharge.

4.9.27 The water quality simulation results are presented as contour plots and are compared between Scenario 3 and Scenario 4 in **Appendix 4.4** for DO, BOD_5, TIN, UIA, *E. coli*, SS, chlorophyll-a and sedimentation rate. The water quality at individual WSRs predicted under Scenario 3 and Scenario 4 are tabulated in **Appendix 4.5**. Some model results in **Appendix 4.4** and **Appendix 4.5** are presented as annual mean over the 1-year simulation period to illustrate that 4-week THEES maintenance discharge would not significantly affect the average water quality condition over the year and thus the associated chronic effect on marine life would be minimal. The model simulation period covers at least 1 calendar year including the period from 1 January to 31 December. The THEES maintenance discharge is assumed to occur in June and / or July outside the algae blooming season (also see Section 4.6.31). The water quality conditions would return to the levels that are similar to the baseline range within about 2 to 4 weeks (mostly within 2 weeks and subject to the water quality parameters of concern) after termination of the discharge. Thus, the full effect of the THEES maintenance discharge has been incorporated into the annual mean results presented in **Appendix 4.4** and **Appendix 4.5**.

4.9.28 Although the maintenance discharge event would inevitably cause an increase in pollution levels in Tolo Harbour, the potential impact would be reversible according to the model simulation results. The time for water quality recovery at selected WSRs or indicator points are presented as time series plots in **Appendix 4.6**. These time series plots aim to illustrate the spatial changes of pollution elevations at locations both close to and further away from the THEES effluent discharge points.

4.9.29 Selected indicator points include WSD flushing water intake at Tai Po (F7), WSD flushing water intake at Sha Tin (F8), coral site near TPIE (CR1), coral site near SWGC (CR2), Yim Tin Tsai Fish Culture Zone (FCZ) (FC1), mangrove site at Tolo Pond (M1), EPD monitoring stations (TM3 and TM6), Yim Tin Tsai East FCZ (FC2), Lo Fu Wat FCZ (FC3) , Yung Shue Au FCZ (FC4) and Lung Mei Beach (B1). Locations of these WSRs or indicator points are shown in **Figure 4.4**. Detailed assessment of ecological and fisheries impacts is separately provided in Section 5 and Section 6 respectively.

Dissolved Oxygen (DO)

4.9.30 The contour plots (Figure 01 of **Appendix 4.4**) showed that the THEES maintenance (Scenario 4) would slightly increase the annual mean Depth Averaged (DA) DO as compared to the baseline condition (Scenario 3). The overall DA DO patterns are similar with and without THEES maintenance discharge. The contour plots (Figure 02 and Figure 03 of **Appendix 4.4**) showed that the THEES maintenance (Scenario 4) would not change the areas of non-compliance for minimum DA DO and minimum bottom DO as compared to the baseline condition (Scenario 3).

4.9.31 The DO levels predicted at all WSRs under Scenario 4 (with THEES maintenance discharge) fully complied with the WQO or assessment criteria except for the mangrove site at Tolo Pond (M1) where the minimum surface DO is 1.3 mg/L as compared to the WQO of ≥ 4 mg/L (**Appendix 4.5**). As the same minimum surface DO level of 1.3 mg/L is predicted under the baseline scenario with no THEES maintenance (Scenario 3), the low DO at M1 was not caused by the THEES maintenance discharge. The time series plot (Figure 19 of **Appendix 4.6**) showed that the predicted DO levels are not depleted at M1 during the 4-week THEES maintenance period. The THEES maintenance discharge may stimulate algal growth and cause a temporary increase in the DO level due to photosynthesis of green algae. The minimum surface DO of 1.3 mg/L is the minimum instantaneous value predicted over the entire 1-year simulation period. The time series plot showed that the surface DO at M1 would meet the WQO for most of the times. The THEES maintenance would not cause any additional DO depletion in Tolo Harbour. No unacceptable DO impact is predicted.

Nitrogen Related Parameters

4.9.32 There are no WQOs available for Unionized Ammonia (UIA) and Total Inorganic Nitrogen (TIN) in the marine water of Tolo Harbour. The THEES maintenance is predicted to cause no obvious and significant change to the annual mean UIA and TIN levels at all identified WSRs (Figures 05 and 06 of **Appendix 4.4** and **Appendix 4.5**).

4.9.33 As shown in the time series plots in Figures 10 to 12 of **Appendix 4.6**, the TIN levels at some selected WSRs would be elevated during the THEES maintenance period. Greater TIN increases are predicted at the WSD flushing water intake at Tai Po (F7), WSD flushing water intake at Sha Tin (F8), Yim Tin Tsai Fish Culture Zone (FC1), coral site near TPIE (CR1) and coral site near SWGC (CR2), which are close to the effluent discharge points. The TIN increases at the important nursery area for commercial fisheries resources can be reflected by the time series plots of TM6. Although some TIN elevations are still observed in TM6, the degree of elevations is significantly lower as compared to other closer WSRs (F7, F8, CR1 and CR2). FC3 and FC4 are also located within the important nursery area for commercial fisheries resources. The predicted TIN increases in FC3 and FC4 are negligible as reflected by the time series plot in Figure 11 of **Appendix 4.6**. The predicted TIN increases at the remaining fish culture zone (FC2) and Lung Mei Beach (B1) are also negligible.

4.9.34 The time series plots showed that the TIN increases would be localized (in inner Tolo Harbour). The TIN levels would return to the baseline levels within 2 weeks after termination of the discharge.

Suspended Solids (SS)

4.9.35 The THEES maintenance discharge (Scenario 4) would not cause any obvious change on the annual mean SS pattern in the Tolo Harbour as compared to the baseline condition (Scenario 3) (see Figure 08 of **Appendix 4.4**).

4.9.36 There is no WQO available for SS in the marine water of Tolo Harbour and Channel. As shown in the time series plots in Figures 13 to 15 of **Appendix 4.6**, the SS levels would be elevated during the THEES maintenance period. Greater SS elevations were observed at F7, F8, CR1, CR2 and TM3, which are closer to the THEES effluent discharge locations, whilst the SS increase at the remaining indicator points including the fish culture zones (FC1 to FC4), EPD monitoring station (TM6) and Lung Mei Beach (B1) is less significant / not obvious.

4.9.37 The time series plots showed that the SS impact at the closest WSRs (F7 and F8) would return to the levels that are approximately similar to baseline range within 2 weeks and substantially identical about 4 weeks after the end of the THEES maintenance period (Figure 13 of **Appendix 4.6**). The THEES maintenance frequency would be once in every 5 years (see Section 4.6.30). Mitigation measures recommended for the THEES maintenance are provided in Sections 4.12.3 and 4.12.4.

5-Day Biochemical Oxygen Demand (BOD_5)

4.9.38 There is no marine WQO for BOD_5 available in Tolo Harbour and Channel. The maintenance discharge under Scenario 4 would slightly change the pattern of mean BOD_5 levels in Tolo Harbour as compared to the baseline condition (Scenario 3) (see Figure 04 of **Appendix 4.4**). However, the range of mean BOD_5 levels in Tolo Harbour predicted under both scenarios would still be within the same range (from <2 mg/L to < 4 mg/L).

4.9.39 As shown in the time series plots in Figures 20 and 21 of **Appendix 4.6**, the BOD_5 levels at the closest WSRs (F7 and F8) would increase during and after the maintenance discharge, and can return to a condition similar to the baseline range within about 2 weeks after the end of the maintenance discharge. The predicted BOD_5 level at F7 and F8 would still comply with the target water quality objective of WSD even the levels would be elevated during and after the THEES maintenance discharge. The potential impact on F7 and F8 is further discussed in Sections 4.9.46 to 4.9.48.

E. coli

4.9.40 The annual geometric mean *E. coli* pattern simulated under the THEES maintenance discharge scenario (Scenario 4) is the same with that of the baseline condition (Scenario 3) (Figure 07 of **Appendix 4.4**). The geometric mean *E. coli* levels predicted in most of the assessment area including all the FCZs complied with the WQO of ≤610 no./100mL with or without the THEES maintenance. The geometric mean *E. coli* level predicted at Lung Mei Beach (B1) was less than 10 no./100mL under both scenarios, which complied well with the WQO of ≤180 no. /100 mL for bathing water (**Appendix 4.5**).

4.9.41 The annual geometric mean *E. coli* level predicted at the coral site in Sha Tin Hoi (CR5) marginally exceeded the WQO of 610 no./100mL under both the baseline condition (Scenario 3) and the THEES maintenance scenario (Scenario 4). The degree of exceedance is similar with and without the THEES maintenance discharge. Impact on marine ecology including the coral communities is separately assessed in Section 5.

4.9.42 The time series plots in Figures 16 to 18 of **Appendix 4.6** showed that the disinfected THEES effluent discharge would cause no obvious change to the baseline *E. coli* levels at all the selected WSRs and indicator points. No adverse *E. coli* impact is predicted from the THEES maintenance.

<u>Sedimentation</u>

4.9.43 The model predicted that the sedimentation in Tolo Harbour and Channel would not be adversely affected by the THEES maintenance discharge. The sedimentation patterns simulated under Scenarios 3 and 4 are very similar (Figure 09 of **Appendix 4.4**). The maximum sedimentation rates predicted in Tolo Harbour including all the coral sites are well below the assessment criterion of 100 $g/m^2/day$ (**Appendix 4.5**). No adverse sedimentation impact is predicted from the THEES maintenance.

<u>Chlorophyll-*a*</u>

4.9.44 The WQOs for chlorophyll-*a* is ≤20 μg/L, ≤10 μg/L and ≤6 μg/L in Harbour Subzone, Buffer Subzone and Channel Subzone of the Tolo Harbour and Channel WCZ respectively. The delineation of the three subzones are shown in Figure 10 of **Appendix 4.4**. Tolo Harbour is a shallow landlocked water body with poor flushing capacity, which is susceptible to algal formation and accumulation of algae. The predicted maximum 5-day running mean chlorophyll-*a* levels exceed the WQOs under both baseline situation (Scenario 3) and THEES maintenance (Scenario 4). The maximum values predicted at the WSRs range from 34 – 60 μg/L (in Harbour Subzone), 15 – 39 μg/L (in Buffer Subzone) and 8 – 18 μg/L (in Channel Subzone) under the THEES maintenance (Scenario 4) as compared to the baseline range of 18 – 40 μg/L (in Harbour Subzone), 13 – 20 μg/L (in Buffer Subzone) and 8 – 17 μg/L (in Channel Subzone) (under Scenario 3) (**Appendix 4.5**). The predicted mean chlorophyll-*a* levels are much lower. The average chlorophyll-*a* levels ranged from ≥6 to <15 μg/L in most areas of Harbour Subzone and from ≥3 to < 10 μg/L in most area of Buffer Subzone and Channel Subzone under Scenario 4 (Figure 10 of **Appendix 4.4**).

4.9.45 As shown in the time series plots in Figures 01 – 09 of **Appendix 4.6**, the chlorophyll-*a* elevations caused by the THEES maintenance discharge would be reversible. The model predicted that the chlorophyll-*a* levels can return to the condition similar to the baseline levels within about 2 weeks after termination of the THEES maintenance discharge.

<u>Potential Impact to WSRs</u>

WSD Flushing Water Intakes (F7 and F8)

4.9.46 The WSD has specified a target SS objective for the flushing water intakes. The maximum SS levels predicted at the two WSD intakes at Tai Po (F7) and Sha Tin (F8) are 11.2 and 12.3 mg/L (under Scenario 4 with THEES maintenance), which are above the WSD target of ≤10 mg/L (**Appendix 4.5**). Since the baseline SS levels at F7 and F8 under Scenario 3 (9.5 mg/L and 10.9 mg/L respectively) are already very close to or above the WSD target of ≤10 mg/L, the SS contribution from the THEES maintenance discharge would be small. The SS increases caused by the THEES maintenance discharge are predicted to be 1.7 mg/L and 1.4 mg/L at F7 and F8 as compared to the baseline levels. It should be noted that the SS levels mentioned above are the maximum instantaneous values over the entire 1-year simulation period. The average SS levels during the THESS maintenance would be lower.

4.9.47 As shown in the time series plots in Figure 13 of **Appendix 4.6**, the SS exceedance of < 3 mg/L is instantaneous and reversible. The SS levels would comply the WSD target for most of the times during and after the THEES maintenance discharge. No unacceptable health impacts to the end users of the intake water would be expected from this minor and instantaneous SS increase (in view that the average SS levels over the THEES maintenance period would be much lower than the WSD target). As a general measure to minimize any impact on the flushing water intakes due to planned maintenance discharge, close communication between DSD and WSD would be an effective means. Should it appear necessary, silt screen may be installed at the flushing water intakes to reduce the SS impacts arising from the planned maintenance discharge.

4.9.48 Full compliances with the WSD target objectives are predicted at F7 and F8 for all other parameters of concern. The THEES maintenance would not cause any unacceptable impact at the flushing water intakes.

Seawater Intake of Marine Science Laboratory (E1)

4.9.49 Full compliances with the reference criteria provided by the CUHK are predicted at E1 for UIA, *E.coli*, NH_3-H, NO_3-N, NO_2-N, SS and DO (**Appendix 4.5**) under the THEES maintenance scenario. Figure 22 of **Appendix 4.6** shows that the predicted baseline salinity levels at E1 would not be affected by the THEES maintenance discharge. Thus, full compliance with the target salinity objective of no more than +/- 2 psu from the ambient level and < 2 psu change over 1 hour would be achieved at E1. The THEES effluent is fully treated, which is not expected to have adverse odour impact on E1. Hydrogen sulphide impact upon E1 is not expected. No unacceptable water quality impact upon the CUHK intake is predicted.

Planned Cooling Water Intake of Science Park (C16)

4.9.50 The maximum pollution levels predicted at the cooling water intake (C16) under the THEES maintenance scenario are tabulated in **Appendix 4.5**. No specific water quality requirements are available for the cooling water intake. No unacceptable water quality impact upon the cooling water intake is predicted.

Ecological and Fisheries Resources

4.9.51 Based on the model prediction, the THEES maintenance discharge would cause a more significant increase in the TIN, SS and chlorophyll-*a* level in the inner Tolo Harbour (in Harbour Subzone). The predicted TIN, SS and chlorophyll-a levels in the Buffer and Channel Subzones are less sensitive to the THEES maintenance discharge. Other concerned parameters such as the predicted minimum DO, geometric mean *E.coli* and maximum sedimentation rates are also not sensitive to the THEES maintenance and not affected by the THEES effluent.

4.9.52 Nutrients such as TIN are not toxic to marine life but may stimulate algal growth. The presence of a certain amount of algae in water is also not harmful to marine life in general. Only their uncontrolled growth as algal bloom or red tide would adversely affect the environment. Chlorophyll-*a* is a green pigment in plant. The level of chlorophyll-a can provide an indication of algae or phytoplankton concentration in marine water.

4.9.53 The THEES is aimed to protect the water quality in Tolo Harbour by diverting the treated sewage effluent away for discharge into the Victoria Harbour. Regular inspection and maintenance of the THEES system are inevitable under the existing practice and during the Project operation. The short-term and once in a few years THEES maintenance would safeguard the normal function of the THEES and protection of marine life against water pollution in the long run.

4.9.54 The occurrence of the THEES maintenance would be remote with no more than once in every 5 years. The 4-week THEES maintenance assumed in the water quality modelling is a worse-case scenario. It represents the maximum possible extent of water quality impact in Tolo Harbour. The historic records showed that over the last 15 years, the closure of the THEES occurred only for 3 days in December 2010 and 26 hours only in November 2016.

4.9.55 The historic THEES closure event in December 2010 involved a more significant volume of effluent discharge to Tolo Harbour. **Appendix 4.7** compares the past red tide occurrences in Tolo Harbour before, during and after this THEES closure event. The comparison plot showed that there is no marked increase in the red tide occurrence during and after this historic THEES closure. No red tide was recorded within 2 months after the THEES maintenance.

4.9.56 Red tides are natural phenomena which occur seasonally in both polluted and unpolluted waters. The model contour plots in **Appendix 4.4** as well as the past water quality monitoring data in **Appendix 4.7** both showed a water quality gradient with an increasing pollution trend towards the inner Tolo Harbour, which is closer to the urbanized areas and pollution sources. However, a significant portion of the red tide incidents were recorded in the outer Tolo Channel (in Buffer and Channel Subzones) further away from the pollution sources (**Appendix 4.7**). No direct correlation between the increase in water pollution and red tide occurrence is identified. It is believed that the formation of red tide is a complicated process. It would depend on a combination of different factors such as the availability of sunlight, wind condition, flow regime, light penetration, salinity distribution, nutrient ratios and species competition, etc. From the past record, the short-term THEES effluent discharge is not a critical factor for triggering red tide in Tolo Harbour.

4.9.57 The TIN and chlorophyll-*a* elevations due to the THEES maintenance are predicted to be reversible. The baseline levels would be recovered within 2 weeks after the termination of the discharge. The SS levels would also return to the levels that are similar to the baseline range within 2 weeks after the end of the THEES maintenance period. The THEES maintenance event would be arranged outside the peak algae blooming seasons to minimize the chance of algal bloom.

4.9.58 Appropriate mitigation measures and Project-specific water quality monitoring programme as described in Sections 4.12 and 4.15 should be implemented to minimize the impact to the mariculture activities in the nearby fish culture zones. Detailed assessment of ecological and fisheries impacts is separately provided in Section 5 and Section 6 respectively. For information, any potential impacts from red tide or Harmful Algal Blooms (HABs) that may arise in the Tolo Harbour is currently managed and responded under the routine red tide monitoring and management protocol and response plan adopted by the Hong Kong government. AFCD is acting as the coordinator of the Red Tide Reporting Network, to receive reports of red tide, conduct investigation and provide warning of the risk associated and appropriate mitigation measures. The objectives of this red tide monitoring programme are to provide coordination of monitoring and response to red tides/HABs and fish kills and to compile and synthesize data necessary to effectively manage fisheries resources and the marine ecosystems. The existing red tide monitoring and management plan are described in the AFCD website. (https://www.afcd.gov.hk/english/fisheries/hkredtide/management/management.html).

Secondary Contact Recreational Subzone and Bathing Beach

4.9.59 The marine water in Tolo Harbour and Channel WCZ is designated under the WPCO as secondary contact recreation subzone for water sports and water recreational activities. Since the THEES effluents would be disinfected, the potential health impact upon the users of the recreational waters due to *E.coli* elevations would be minimized. As shown in **Appendix 4.5** and Figures 16 to 18 of **Appendix 4.6**, the maintenance discharge would cause no obvious elevation of *E. coli* levels as compared to the baseline condition at all WSRs including the bathing beach.

Emergency Discharge to Tolo Harbour

4.9.60 Emergency discharge due to emergency situations (e.g. power / treatment failure) may occur during the Project operation. Scenario 5 assumed that an emergency discharge from the Project would occur for a period of 3 hours in case of power or plant failure.

4.9.61 The water quality simulation results are presented as contour plots and are compared between Scenario 3 and Scenario 5 in **Appendix 4.4** for DO, BOD_5, TIN, UIA, *E. coli*, SS, chlorophyll-a and sedimentation rate. The water quality levels at different WSRs predicted under Scenario 5 are tabulated in **Appendix 4.5**. Some model results in **Appendix 4.4** and **Appendix 4.5** are presented as annual mean over the 1-year simulation period to illustrate that emergency discharge would not affect the average water quality condition over the year and thus the associated chronic effect on marine life would be minimal (also see Section 4.9.27).

4.9.62 The time required for water quality recovery from the emergency discharge at selected WSRs is illustrated in the time series plots of **Appendix 4.8**.

<u>Dissolved Oxygen (DO)</u>

4.9.63 Full WQO compliance for DO was predicted at all WSRs under the emergency situation (Scenario 5) except for the mangrove site at Tolo Pond (M1) where the minimum surface DO was 1.3 mg/L, as compared to the WQO of ≥4 mg/L (**Appendix 4.5**). However, under the baseline scenario (Scenario 3), the minimum surface DO level at M1 was also 1.3 mg/L. The low DO level was not caused by the emergency discharge.

4.9.64 The time series plots in Figure 19 of **Appendix 4.8** showed the THEES effluent would not change nor decrease the DO level at M1 as compared to the baseline condition. No adverse DO impact would be induced by the emergency discharge.

<u>Nitrogen Related Parameters</u>

4.9.65 No statutory WQO is available for UIA and TIN in the marine water of Tolo Harbour and Channel. The emergency discharge would not change the baseline mean UIA and TIN levels (**Appendix 4.5**). The time series plot (Figure 10 of **Appendix 4.8**) showed that immediate TIN elevation would occur at the two closest WSRs, namely WSD flushing water intake at Tai Po (F7) and coral site near TPIE (CR1), right after the emergency discharge. The TIN levels would be recovered to the baseline condition within about 2 days after termination of the emergency discharge. The predicted TIN elevations at the remaining selected WSRs and indicator points (F8, CR2, FC1, FC2, FC3, FC4, B1, TM3 and TM6) are negligible.

4.9.66 As shown in Figure 05 and Figure 06 of **Appendix 4.4**, the emergency discharge (Scenario 5) would not change the annual mean UIA and TIN patterns in Tolo Harbour as compared to the baseline condition (Scenario 3).

4.9.67 No adverse water quality impact associated with the nitrogen parameters would arise from the emergency discharge.

<u>Suspended Solids (SS)</u>

4.9.68 There is no WQO available for SS in the marine water of Tolo Harbour and Channel. As shown in the time series plots (Figures 13 to 15 of **Appendix 4.8**), the predicted SS elevations caused by the emergency discharge are minimal or negligible at all selected WSRs.

4.9.69 As shown in Figure 08 of **Appendix 4.4**, the emergency discharge (Scenario 5) would not change the annual mean SS pattern in Tolo Harbour as compared to the baseline condition (Scenario 3).

4.9.70 The emergency discharge would not cause any adverse SS impact in Tolo Harbour and Channel.

<u>5-Day Biochemical Oxygen Demand (BOD_5)</u>

4.9.71 There is no marine WQO for BOD_5 available in Tolo Harbour and Channel. The time series plots in Figure 20 and Figure 21 of **Appendix 4.8** showed that the emergency discharge would cause no obvious change to the BOD_5 level at the WSD flushing water intakes at Tai Po (F7) and Sha Tin (F8).

4.9.72 As shown in Figure 04 of **Appendix 4.4**, the emergency discharge (Scenario 5) would not change the annual mean BOD_5 pattern in Tolo Harbour as compared to the baseline condition (Scenario 3).

4.9.73 No adverse BOD_5 impact would arise from the emergency discharge.

<u>*E. coli*</u>

4.9.74 The short-term emergency discharge (Scenario 5) would not affect the annual geometric mean *E. coli* levels at all WSRs (**Appendix 4.5**). The short-term *E.coli* elevation is predicted at WSRs (F7, CR1) close to TPIE. The degree of *E.coli* elevation would be reduced in WSR (CR2) and indicator point (TM3) further away. The *E.coli* elevations in all remaining WSRs are negligible (Figures 16 to 18 of **Appendix 4.8**). The baseline levels at F7, CR1, CR2 and TM3 would be recovered within 2 days after termination of the emergency discharge. As shown in Figure 07 of **Appendix 4.4**, the annual geometric mean *E. coli* patterns are similar under Scenario 5 (with emergency discharge) and Scenario 3 (baseline condition).

<u>Sedimentation</u>

4.9.75 The short-term discharge under Scenario 5 would not adversely affect the maximum sedimentation rates in Tolo Harbour and Channel as shown in **Appendix 4.5**. The maximum sedimentation levels predicted in Tolo Harbour including all the coral sites fully complied with the criterion of ≤ 100 g/m^2/day under the emergency situation. As shown in Figure 09 of **Appendix 4.4**, the emergency discharge (Scenario 5) would not change the pattern of annual mean sedimentation rates in Tolo Harbour as compared to the baseline condition (Scenario 3). No adverse sedimentation impacts would be caused by the emergency discharge.

<u>Chlorophyll-*a*</u>

4.9.76 The short-term discharge under Scenario 5 would not change the maximum 5-day running mean chlorophyll-a levels in Tolo Harbour as shown in **Appendix 4.5**. The predicted maximum 5-day running mean chlorophyll-*a* levels under Scenario 5 at all selected WSRs are the same as that of the baseline condition (Scenario 3) as shown in **Appendix 4.5**.

4.9.77 As shown in the time series plots in Figures 01 to 09 of **Appendix 4.8**, the chlorophyll-a levels at all selected WSRs are not sensitive to the emergency discharge. The emergency discharge would induce no obvious elevation of chlorophyll-a at all selected WSRs or indicator points. No adverse chlorophyll-*a* impact is predicted.

Potential Impact to WSRs

WSD Flushing Water Intakes (F7 and F8)

4.9.78 The maximum *E.coli* level predicted at the WSD flushing water intake at Tai Po (F7) would inevitably increase and reach 36,500 no./100mL under the emergency situation, as compared to the WSD target objective of 20,000 no./100mL. The maximum *E.coli* value predicted at the WSD flushing water intake at Sha Tin (F8) far away was well below the target limit.

4.9.79 As shown in the time series plots (Figure 16 of **Appendix 4.8**), significant *E. coli* elevations are predicted at F7 right after the emergency discharge. The baseline *E. coli* levels would be recovered within about 2 days after termination of the emergency discharge.

4.9.80 The maximum SS level predicted at the WSD flushing water intake at Sha Tin (F8) would exceed the WSD target of 10 mg/L but the predicted maximum value (10.9 mg/L) under Scenario 5 is the same as that of the baseline condition (Scenario 3) as shown in **Appendix 4.5**. As a general measure to minimize any impact on the flushing water intakes due to emergency discharge, close communication between DSD and WSD would be an effective means. Should it appear necessary, silt screen may be installed at the flushing water intakes to reduce the SS impacts arising from the emergency discharge.

4.9.81 In case of emergency discharge, WSD would be notified and would take appropriate actions such as to increase the disinfection level for the seawater extracted from the flushing water intake at Tai Po as required. With proper implementation of the mitigation measures and contingency plan for emergency situation as recommended in Sections 4.12 and 4.15, no unacceptable health implications to the end users of the flushing water due to *E.coli* elevations would arise.

4.9.82 The emergency discharge would not change the water quality at F7 and F8 for other parameters of concern.

Seawater Intake of Marine Science Laboratory (E1)

4.9.83 Full compliances with the reference criteria provided by the CUHK are predicted at E1 for UIA, *E.coli*, NH_3-H, NO_3-N, NO_2-N, SS and DO (**Appendix 4.5**) under the emergency discharge scenario. Figure 22 of **Appendix 4.8** shows that the predicted baseline salinity levels at E1 would not be affected by the emergency discharge. Thus, full compliance with the target salinity objective of no more than +/- 2 psu from the ambient level and < 2 psu change over 1 hour would be achieved at E1. As indicated in **Appendix 4.5**, the emergency discharge would not change the baseline water quality levels for all selected water quality parameters. The short-term emergency discharge in Tai Po is not expected to affect this distant receiver of over 2 km away. Hydrogen sulphide impact upon E1 is not anticipated. No unacceptable water quality impact upon the CUHK intake is predicted.

Planned Cooling Water Intake of Science Park (C16)

4.9.84 The maximum pollution levels predicted at the cooling water intake (C16) under the emergency discharge scenario are tabulated in **Appendix 4.5**. No specific water quality requirements are available for the cooling water intake. The water quality levels for all assessment parameters predicted under Scenario 5 at C16 are the same as that predicted under the baseline condition (Scenario 3). No adverse water quality impact upon the cooling water intake is predicted.

Ecological and Fisheries Resources

4.9.85 Based on the model prediction in **Appendix 4.5**, the emergency discharge would cause no obvious water quality changes at the ecological and fisheries resources for all concerned parameters including the predicted minimum DO, geometric mean *E. coil*, maximum sedimentation rates and maximum 5-day running mean chlorophyll-*a*. Detailed assessment of ecological and fisheries impacts is separately provided in Section 5 and Section 6 respectively.

Secondary Contact Recreational Subzone and Bathing Beach

4.9.86 The marine water in Tolo Harbour and Channel WCZ is designated under the WPCO as secondary contact recreation subzone for water sports and water recreational activities. The emergency discharge would not change the geometric mean *E.coli* level at all identified WSRs as shown in **Appendix 4.5**. No health impact upon the users of the recreational waters due to *E.coli* elevations would be anticipated.

4.10 Evaluation of Potential Impacts – Operational Phase (Other Water Pollution Sources)

Handling and Transportation of Pre-treated Food Waste

4.10.1 The Project would receive pre-treated food waste from the proposed OWPC (see Section 4.5.10) for co-digestion with sludge generated from sewage treatment. Pre-treated food waste would contain high content of nutrients and organic matter, including BOD_5 and Chemical Oxygen Demand (COD). Any spillage or rainwater wash off during transportation or handling of the pre-treated food waste would potentially generate water pollution. However, provided that the incoming pre-treated food waste is transferred to the Project facilities through enclosed pipelines, no adverse water quality impact would be expected. Also, given that any pre-treated food waste loading and handling areas in the Project site would be enclosed within buildings to contain accidental spills, contamination of surface runoff would not arise.

Wastewater from Sludge / Pre-treated Food Waste

4.10.2 Sludge from daily operation of the Project in the future would require sludge dewatering before final disposal. Any wastewater generated from the sludge treatment facility, pre-treated food waste handling facility and the facility for co-digestion of pre-treated food waste would contain high BOD_5, COD and nutrient content. It may cause water pollution, if controlled. Containment and design measures will be adopted to collect the wastewater for feeding back into the sewage treatment process within the plant. There will be no discharge of wastewater.

4.10.3 The existing TPSTW is also receiving wastewater from sludge dewatering process as well as the leachate from Shuen Wan Landfill, which also have high COD, BOD_5 and nutrient content. The TSE of the existing TPSTW complied well with the effluent discharge standards. Hence, any wastewater generated from pre-treated food waste handling and co-digestion facilities can also be practically treated under the Project to meet the effluent discharge standards.

Non-point Source Surface Runoff

4.10.4 Potential water quality impact may arise from contaminated surface runoff during operational phase. Typical surface runoff in the existing TPSTW may contain small amount of grits and dirt. The proposed expansion site is currently occupied by waste recycling workshops including the operation of large machineries and open stockpiles of wastes (e.g. metals, plastics). The existing surface runoff in the proposed expansion site may be contaminated with metals, grease, dirt, grits and oil. This Project will not increase the paved surface areas and will not change the amount of surface runoff generated in the Project site.

4.10.5 According to the DSD "Stormwater Drainage Manual", annual rainfall in Hong Kong is around 2,400 mm. However, the EPD study namely "Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool (Update Study)" suggested that only rainfall events of sufficient intensity and volume would give rise to runoff and that runoff percentage is about 44% and 82% for dry and wet season, respectively. Therefore, only 1,512 mm of 2,400 mm annual rainfall would be considered as effective rainfall that would generate runoff (i.e. 1,512 mm = 2,400 mm × (82%+44%)/2).

4.10.6 The footprint of the Project site is about 14 hectares (140,000 m^2). Assuming 0.9 as the runoff coefficient (for concrete surfaces), the non-point source discharge or surface run-off is estimated to be 522 m^3/day (= 0.9 × 1,512 mm/year ×140,000 m^2). The nature or quality of the future surface runoff generated under this Project would be similar to that of the existing TPSTW. It is anticipated that with proper implementation of best management practices as recommended in Section 4.12, no adverse water quality impact from non-point source surface run-off is expected.

Chemical Spillage

4.10.7 A number of chemicals, such as ferric chloride and polymers, would be stored onsite and used for wastewater treatment process such as sludge conditioning / dewatering. Chemicals such as lubricants may also be used for plant operation. Potential water quality impact could arise from transferring and storage of these chemicals during operational phase, if uncontrolled. The potential water quality impact can however be practically minimized through the implementation of appropriate chemical storage and management measures as recommended in Section 4.12.

4.11 Mitigation Measures – Construction Phase

4.11.1 Mitigation measures as listed below are recommended to minimize the potential water quality impacts from the land-based construction works.

Construction Site Run-off and General Construction Activities

Boring and Drilling Water

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

Wheel Washing Water

4.11.3 All vehicles and plant should be cleaned before they leave a construction site to minimize the deposition of earth, mud, debris on roads. A wheel washing bay should be provided at every site exit if practicable and wash-water should have sand and silt settled out or removed before discharging into storm drains. The section of construction road between the wheel washing bay and the public road should be paved with backfall to reduce vehicle tracking of soil and to prevent site run-off from entering public road drains.

Rubbish and Litter

4.11.4 Good site practices should be adopted to remove rubbish and litter from construction sites so as to prevent the rubbish and litter from spreading from the site area. It is recommended to clean the construction sites on a regular basis.

Construction Site Run-off

4.11.5 The site practices outlined in ProPECC PN 1/94 "Construction Site Drainage" should be followed as far as practicable to minimize surface run-off and the chance of erosion. The following measures are recommended to protect water quality and sensitive uses of the coastal area, and when properly implemented should be sufficient to adequately control site discharges so as to avoid water quality impact.

4.11.6 Surface run-off from construction sites should be discharged into storm drains via adequately designed sand/silt removal facilities such as sand traps, silt traps and sedimentation basins. Channels or earth bunds or sandbag barriers should be provided on site to properly direct stormwater to such silt removal facilities. Perimeter channels at site boundaries should be provided on site boundaries where necessary to intercept storm run-off from outside the site so that it will not wash across the site. Catchpits and perimeter channels should be constructed in advance of site formation works and earthworks.

4.11.7 Silt removal facilities, channels and manholes should be maintained and the deposited silt and grit should be removed regularly, at the onset of and after each rainstorm to prevent local flooding. Before disposal at the public fill reception facilities, the deposited silt and grit should be solicited in such a way that it can be contained and delivered by dump truck instead of tanker truck. Any practical options for the diversion and re-alignment of drainage should comply with both engineering and environmental requirements in order to provide adequate hydraulic capacity of all drains. Minimum distance of 100m should be maintained between the discharge points of construction site run-off and the existing saltwater intakes.

4.11.8 Construction works should be programmed to minimize soil excavation works in rainy seasons (April to September). If excavation in soil cannot be avoided in these months or at any time of year when rainstorms are likely, for the purpose of preventing soil erosion, temporary exposed slope surfaces should be covered e.g. by tarpaulin, and temporary access roads should be protected by crushed stone or gravel, as excavation proceeds. Intercepting channels should be provided (e.g. along the crest / edge of excavation) to prevent storm runoff from washing across exposed soil surfaces. Arrangements should always be in place in such a way that adequate surface protection measures can be safely carried out well before the arrival of a rainstorm.

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

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

4.11.11 Construction materials (e.g. aggregates, sand and fill material) on sites should be covered with tarpaulin or similar fabric during rainstorms.

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

<u>Licensing of Construction Site Discharge</u>

4.11.13 There is a need to apply to EPD for a discharge license for discharge of effluent from the construction site under the WPCO. The discharge quality must meet the requirements specified in the discharge license. All the runoff and wastewater generated from the works areas should be treated so that it satisfies all the standards listed in the TM-DSS. The beneficial uses of the treated effluent for other on-site activities such as dust suppression, wheel washing and general cleaning etc., can minimize water consumption and reduce the effluent discharge volume. If monitoring of the treated effluent quality from the works areas is required during the construction phase of the Project, the monitoring should be carried out in accordance with the relevant WPCO license which is under the ambit of regional office (RO) of EPD.

Accidental Chemical Spillage

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

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

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

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

Sewage Effluent from Construction Workforce

4.11.17 The construction workforce on site will generate sewage. It is recommended to provide sufficient chemical toilets in the works areas. A licensed waste collector should be deployed to clean the chemical toilets on a regular basis.

4.11.18 Notices should be posted at conspicuous locations to remind the workers not to discharge any sewage or wastewater into the surrounding environment. Regular environmental audit of the construction site will provide an effective control of any malpractices and can encourage continual improvement of environmental performance on site. It is anticipated that sewage generation during the construction phase of the project would not cause water pollution problem after undertaking all required measures.

Contaminated Site Run-off

4.11.19 Any excavated contaminated material and exposed contaminated surface should be properly housed and covered to avoid generation of contaminated run-off. Open stockpiling of contaminated materials should not be allowed. Any contaminated run-off should be properly collected and treated to reduce the pollution level to an acceptable standard and remove any prohibited substances (such as total petroleum hydrocarbon) to an undetectable range. All treated effluent from the wastewater treatment units shall meet the conditions of the discharge license (see Section 4.11.13) and the requirements as stated in the TM-DSS.

Demolition Works

4.11.20 The decommissioned treatment facilities shall be cleaned prior to their demolition or removal. All wastewater residues, if any, in the decommissioned facilities shall be properly collected, contained and treated within the plant and shall not be discharged directly into the drainage system or the environment. Chemical residues, if any, in the decommissioned facilities shall be properly collected, handled and disposed in accordance with the Waste Disposal (Chemical Waste) (General) Regulations and the Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes published by EPD (as specified in Sections 4.11.14 to 4.11.16), and should be collected by a licensed chemical waste collector for proper disposal at the Chemical Waste Treatment Centre at Tsing Yi.

4.11.21 Proper site practice and good site management (as specified in the ProPECC PN 1/94 "Construction Site Drainage") and presented in Sections 4.11.2 to 4.11.13 above shall be followed to prevent polluted run-off and site effluent generated from the demolition works areas from directly entering the surrounding waters.

4.12 Mitigation Measures – Operational Phase

4.12.1 Mitigation measures as listed below are recommended to minimize the potential water quality impacts during the operational phase.

Normal Project / THEES Operation – Treated Effluent Discharge to Victoria Harbour

4.12.2 No adverse water quality impact upon the Victoria Harbour WCZ is predicted and no mitigation measures are therefore required.

THEES Maintenance – Treated Effluent Discharge to Tolo Harbour

4.12.3 The THEES should be regularly maintained to ensure that it is functioning properly. This will avoid any emergency repair of the THEES or unexpected discharge of treated sewage into the Tolo Harbour.

4.12.4 The regular THEES maintenance event should be carefully planned and scheduled outside the peak algae blooming season. (i.e. December to April/May) to minimize the risk of red tides. Relevant parties including the EPD, AFCD, WSD and the key stakeholders for mariculture and fisheries in Tolo Harbour should be informed of the THEES maintenance event prior to any discharge. The number of red tide incidents was found lowest from July to November according to the data from 1975 to 2020. It is recommended that shutdown of the THEES, if unavoidable, should be arranged within the period from July to November and should be shortened as far as possible. The scheduling of the maintenance discharge should also take into account any ongoing blooming event in the area, which may occur outside the blooming season. In planning of the maintenance work and before the maintenance discharge, AFCD should be consulted to seek advice on the potential for red tide occurrence in the receiving water. The maintenance discharge should be rescheduled or postponed based on AFCD's advice, as necessary.

Emergency Discharge to Tolo Harbour

4.12.5 Emergency discharges from the Project would be the consequence of pump failure, interruption of the electrical power supply or failure of treatment units. Dual power supply or ring main supply from CLP should be provided for the Project to prevent the occurrence of power failure. In addition, standby facilities for the main treatment units and standby equipment parts / accessories should also be provided in order to minimize the chance of emergency discharge. The occurrence of such emergency events would therefore be very remote.

4.12.6 To provide a mechanism to minimize the impact of emergency discharges and facilitate subsequent management of any emergency, an emergency contingency plan has been formulated by the DSD to clearly state the response procedure in case of pumping stations or sewage treatment works failure. The existing contingency plan developed by DSD is given in **Appendix 4.9**. The plant operators of the Project should carry out necessary follow-up actions according to the procedures of this existing contingency plan to minimize any water quality impact due to emergency discharge. The plant operators of the Project should also closely communicate with WSD in order to minimize any impact on WSD seawater intake due to emergency discharge. WSD may consider shutting down the Tai Po seawater pumping station or provision of a higher disinfection level for a short period of time in order to minimize any adverse impacts, should such be necessary.

Handling and Transportation of Pre-treated Food Waste

4.12.7 The incoming pre-treated food waste should be transferred to the Project facilities through enclosed pipelines. The pre-treated food waste loading and handling areas of this Project should be enclosed within buildings to contain any accidental spills.

Wastewater from Sludge / Pre-treated Food Waste

4.12.8 All wastewater generated from the sludge dewatering process and the pre-treated food waste related facilities should be fed back into the upgraded TPSTW for treatment before final disposal. No direct discharge of wastewater shall be allowed under this Project.

Non-point Source Surface Runoff

4.12.9 Best Management Practices (BMPs) for storm water discharge (as listed below) are recommended for the Project to minimize potential adverse water quality impacts.

<u>Design Measures</u>

- Exposed surface shall be avoided within the proposed Project site to minimize soil erosion. Development site shall be either hard paved or covered by landscaping area where appropriate to reduce soil erosion.
- The drainage system of the Project should be designed to avoid any case of flooding.

<u>Devices / Facilities to Control Pollution</u>

- Screening facilities such as standard gully grating and trash grille, with spacing which is capable of screening off large substances such as fallen leaves and rubbish should be provided at the inlet of drainage system.
- Road gullies with standard design and silt traps should be incorporated during the detailed design of any new access roads to remove particles present in storm water runoff.

<u>Administrative Measures</u>

- Good management measures such as regular cleaning and sweeping of road surface / open areas is proposed. The road surface / open area cleaning should also be carried out prior to occurrence of rainstorm.
- Manholes, as well as storm water gullies, ditches provided among the development areas should be regularly inspected and cleaned (e.g. monthly). Additional inspection and

cleansing should be carried out before forecast heavy rainfall.

Chemical Spillage

4.12.10 Chemical storage and handling areas should be bunded and enclosed within buildings. Separate drainage system should be provided as appropriate to avoid any spilled chemicals from entering into the storm drain in case of accidental spillage. Also, adequate tools for cleanup of spilled chemicals should be stored on site and appropriate training shall be provided to staff to reduce the chance of water pollution.

4.13 Evaluation of Cumulative Impacts

Construction Phase

4.13.1 With proper implementation of mitigation measures, the potential water quality impact, if any, generated from the Project would be localized. No unacceptable cumulative water quality with other concurrent projects (see Section 4.5) would arise.

Operational Phase

4.13.2 The background pollution loading into the marine water has been estimated and included in the modelling exercise for cumulative assessment. The model predicted that this Project would not contribute any unacceptable cumulative water quality impact with proper implementation of the recommended mitigation measures.

4.14 Residual Water Quality Impacts

4.14.1 With proper implementation of mitigation measures, no residual water quality impact is expected in construction and operational phases.

4.15 Environmental Monitoring and Audit (EM&A) Requirements

Land-based Construction Works

4.15.1 The potential water quality impact from the land-based construction works can be controlled by the recommended mitigation measures. Regular site inspections should be undertaken during the construction to ensure that the recommended mitigation measures are properly implemented. Discharge license(s) should be obtained under the WPCO if there are any construction site discharges. Monitoring of the construction site effluent shall be carried out in accordance with requirements stipulated in the WPCO discharge licenses.

Normal Project / THEES Operation – Treated Effluent Discharge to Victoria Harbour

Effluent Monitoring

4.15.2 The effluent of the existing TPSTW and STSTW are being routinely monitored by DSD. It is recommended that the existing effluent monitoring programme of DSD should be continued and implemented for the upgraded TPSTW and the future CSTW. Where necessary, the effluent monitoring data can be used for interpretation of the river and marine water quality monitoring results collected under this Project. Monitoring of the treated effluent from the Project should also be carried out in accordance with the requirements stipulated in the WPCO discharge license.

River and Marine Water Quality Monitoring in Victoria Harbour

4.15.3 Under normal operation of THEES, the effluent from the Project would be transported to the Victoria Harbour for discharge into the KTR and then to the KTAC and KTTS. A one-year impact water quality monitoring programme covering dry and wet seasons is proposed for KTR at a frequency of once per month after commissioning of the New West Plant (tentatively in 2029), see Section 4.6.1. The monitoring results should be compared with the routine river water quality monitoring data collected by EPD to verify whether there is any adverse water quality impact at KTR as compared to that before the implementation of this Project.

4.15.4 Marine water quality monitoring is also recommended in Victoria Harbour. A one-year baseline monitoring programme covering dry and wet seasons is proposed at a frequency of twice per month to establish the baseline water quality conditions at selected monitoring points in Victoria Harbour. The baseline monitoring programme should be carried out prior to the commissioning of the New West Plant (see Section 4.6.1). A one-year impact monitoring in Victoria Harbour covering dry and wet seasons should be conducted twice per month after commissioning of the New West Plant. The impact monitoring results shall be compared with the baseline monitoring results to verify whether there is any adverse marine water quality impact in Victoria Harbour as compared to that before the implementation of this Project.

4.15.5 In case adverse impact on KTR or Victoria Harbour is identified from the effluent and water quality monitoring results, the operating conditions of the upgraded TPSTW and THEES system should be investigated. After completion of the one-year impact monitoring programme for KTR and Victoria Harbour, a review shall be conducted by DSD to determine whether such monitoring shall be continued. The review results shall be submitted to EPD. Any amendment on the river and marine water quality monitoring programme shall be agreed by EPD. Details of the monitoring programme are provided in the standalone EM&A Manual.

THEES Maintenance Discharge to Tolo Harbour

4.15.6 Marine water quality monitoring is recommended in Tolo Harbour for the THEES maintenance event. A one-year baseline monitoring programme covering dry and wet seasons is proposed at a frequency of twice per month to establish the baseline water quality conditions at selected monitoring points. The baseline monitoring programme should be carried out prior to the construction of this Project. In case of THEES maintenance during the construction phase of the Project and after commissioning of the New West Plant tentatively scheduled in 2029 (see Section 4.6.1), marine water quality in Tolo Harbour should be monitored daily during and after the maintenance period. The monitoring should be carried out until the baseline water quality is restored for at least 2 consecutive days or at least 4 weeks after termination of the THEES maintenance discharge (whichever is longer). The flow and quality of the THEES maintenance discharge (from the existing / upgraded TPSTW and the existing STSTW / CSTW) should also be monitored daily during the THEES maintenance period.

4.15.7 The monitoring programme for THEES maintenance should continue throughout the construction phase of the Project as well as in the first 3 years after commissioning of the New West Plant. After the first 3 years of the New West Plant operation, a review shall be conducted by DSD to determine whether such monitoring shall be continued. The review results shall be submitted to EPD, AFCD, WSD and other relevant parties. Any amendment on the monitoring programme shall be agreed by EPD, AFCD and WSD. Details of the monitoring programme and an event and action plan for the THEES maintenance are provided in the standalone EM&A Manual.

Emergency Discharge to Tolo Harbour

4.15.8 Marine water quality monitoring in Tolo Harbour should be carried out for any emergency discharge event. A one-year baseline monitoring programme covering both dry and wet seasons is proposed at a frequency of twice per month to establish the baseline water quality conditions at selected monitoring points prior to the construction of this Project. The baseline monitoring periods for emergency discharge and THEES maintenance may be overlapped. In case of emergency discharge during the construction phase of this Project and after commissioning of the New West Plant, marine water quality in Tolo Harbour should be monitored daily throughout the emergency discharge period until the baseline water quality is restored for at least 2 consecutive days or at least 1 week after termination of the discharge (whichever is longer). The flow and quality of the emergency discharge should also be monitored daily during the emergency discharge period.

4.15.9 The monitoring programme for emergency discharge shall continue throughout the construction phase of the Project as well as in the first 3 years after commissioning of the New West Plant. After the first 3 years of the New West Plant operation, a review shall be conducted by DSD to determine whether such monitoring shall be continued. The review results shall be submitted to EPD, AFCD, WSD and other relevant parties. Any amendment on the monitoring programme shall be agreed by EPD, AFCD and WSD. Details of the monitoring programme and an event and action plan for the emergency discharge are provided in the standalone EM&A Manual.

4.16 Conclusions

Construction Phase

4.16.1 Only land-based construction will be carried out under the Project. Water quality impacts may result from the general construction activities, construction site run-off, sewage from construction workforce, accidental chemical spillage, polluted runoff and wastewater from contaminated materials and demolition works. The impacts could be mitigated and controlled by implementing the recommended mitigation measures. No unacceptable water quality impacts is expected. Regular site inspections should be undertaken routinely to inspect the construction activities and works area to ensure the recommended mitigation measures are proper implemented.

Operational Phase

Project Effluent Discharge

4.16.2 Potential water quality impacts due to the Project effluent discharge to marine water have been quantitatively assessed by mathematical modelling.

4.16.3 Following the existing practice, the treated effluent from the Project will be discharged to the Victoria Harbour through the THEES under normal operation. The treated effluent would be discharged into the KTAC and KTTS and eventually into the open channel of Victoria Harbour. The model results showed that there would be no unacceptable water quality impacts arising from the Project at all representative WSRs identified in the assessment area. No adverse water quality impact upon Victoria Harbour would arise from this Project.

4.16.4 Maintenance of the THEES is required to ensure proper functioning and integrity of the system. During the inspection or maintenance of the THEES tunnel, temporary suspension of the normal THEES operation with effluent bypass into the Tolo Harbour is unavoidable to provide a safe and dry zone within the tunnel. The model results indicated that the pollution level at certain WSRs in Tolo Harbour would be temporarily increased during the maintenance period, but the pollution elevation associated with the maintenance discharge would be reversible. The THEES maintenance discharge would be scheduled outside the algae blooming season to minimize the risk of red tide occurrence. The scheduling of the maintenance discharge would also take into account any ongoing blooming event in the area, which may occur outside the blooming season. Furthermore, an event and action plan and a marine water quality monitoring programme (as presented in the standalone EM&A Manual) are proposed for the THEES maintenance event to minimize the water quality impact.

4.16.5 Emergency discharges from the Project would be the consequence of pump failure, interruption of the electrical power supply or failure of treatment units. Mitigation measures, including dual power supply or ring main supply from CLP, standby pumps, treatment units and equipment, would be provided to avoid the occurrence of any emergency discharge. In case of emergency situation, the procedures and follow up actions stipulated in the existing contingency plan formulated by DSD shall be implemented to minimize the impact of emergency discharges and facilitate subsequent management of the emergency situation. An event and action plan and a marine water quality monitoring programme (as presented in the standalone EM&A Manual) are also proposed for the emergency discharge event to minimize the water quality impacts.

Others

4.16.6 Potential water quality impacts may also arise from the handling and transportation of pre-treated food waste, wastewater generated from the sludge / pre-treated food waste related processes, non-point source surface runoff from paved areas and accidental chemical spillage during the operational phase. The potential water quality impacts can be prevented by implementation of the recommended mitigation measures. No unacceptable water quality impacts is expected.