6 Water Quality

6.1 Legislation, Standards and Guidelines

6.1.1 General

6.1.1.1 The relevant legislation, standards and guidelines applicable to the present study for the assessment of water quality impacts include:

- Water Pollution Control Ordinance (WPCO) (Cap. 358);
- Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems Inland and Coastal Waters (TM-DSS);
- Environmental Impact Assessment Ordinance (EIAO) (Cap. 499), Technical Memorandum on Environmental Impact Assessment Process (TM-EIAO);
- Hong Kong Planning Standards and Guidelines (HKPSG);
- Practice Note for Professional Persons on Construction Site Drainage (ProPECC PN 1/94); and
- Proposed Assessment Criteria for Fungicides, Insecticides and Fertilizers.
- Pesticides Ordinance (Cap. 133)

<u>Water Pollution Control Ordinance (WPCO) (Cap. 358)</u>

6.1.1.2 WPCO (Cap. 358) provides the major statutory framework for the protection and control of water quality in Hong Kong. According to the Ordinance and its subsidiary legislation, the entire Hong Kong waters are divided into ten Water Control Zones (WCZs) and four supplementary WCZs. Each WCZ has a designated set of statutory Water Quality Objectives (WQOs) designed to protect the inland and/or marine environment and its users. The Project is located in the Tolo Harbour and Channel WCZ. The corresponding WQOs are summarised in the table below.

Table 6.1 WQOs of the Tolo Harbour and Channel Water Control Zones

Parameters	Objectives	Sub-Zone
Aesthetic appearance	(a) Waste discharges shall cause no noxious or offensive odour or offensive taint or colour in either waters or edible aquatic organisms in the subzone to be present in concentrations detectable by bioassay or organoleptic tests.	Harbour subzone, Buffer subzone and Channel subzone
	(b) Waste discharges shall cause no visible foam, oil, grease, scum, litter or other objectionable matter in waters of the subzone.	Harbour subzone, Buffer subzone and Channel subzone

Parameters	Objectives	Sub-Zone
Bacteria	The level of Escherichia coli should not exceed 610 per 100 mL, calculated as the geometric mean of all samples collected in one calendar year.	Secondary contact recreation subzone and Fish culture subzones
Chlorophyll-A	(a) Waste discharges shall not cause the level of chlorophyll-a in waters of the subzone to exceed 20 milligrams per cubic metre, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Harbour subzone
	(b) Waste discharges shall not cause the level of chlorophyll-a in waters of the subzone to exceed 10 milligrams per cubic metre, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Buffer subzone
	(c) Waste discharges shall not cause the level of chlorophyll-a in waters of the subzone to exceed 6 milligrams per cubic metre, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth.	Channel subzone
Dissolved oxygen	(a) Waste discharges shall not cause the level of dissolved oxygen in waters of the subzone to be less than 2 milligrams per litre within two metres of the bottom, or to be less than 4 milligrams per litre in the remainder of the water column.	Harbour subzone
	(b) Waste discharges shall not cause the level of dissolved oxygen in waters of the subzone to be less than 3 milligrams per litre within two metres of the bottom, or to be less than 4 milligrams per litre in the remainder of the water column.	Buffer subzone
	(c) Waste discharges shall not cause the level of dissolved oxygen in waters of the subzone to be less than 4 milligrams per litre at any point in the water column.	Channel subzone
Light penetration	(a) No changes in turbidity, suspended material, colour or other parameters arising from waste discharges shall reduce light transmission by more than 20 per cent of the normal level in the subzone at any location or any time.	Harbour subzone
	(b) No changes in turbidity, suspended material, colour or other parameters arising from waste discharges shall reduce light transmission by more than 15 per cent of the normal level	Buffer subzone

Parameters	Objectives	Sub-Zone
	in the subzone at any location or any time.	
	(c) No changes in turbidity, suspended material, colour or other parameters arising from waste discharges shall reduce light transmission by more than 10 per cent of the normal level in the subzone at any location or any time.	Channel subzone
pH	(a) Waste discharges shall not cause the normal pH range of any waters of the subzone to be extended by greater than +/- 0.5 pH units at any time.	Harbour subzone
	(b) Waste discharges shall not cause the normal pH range of any waters of the subzone to be extended by greater than +/- 0.3 pH units at any time.	Buffer subzone
	(c) Waste discharges shall not cause the normal pH range of any waters of the subzone to be extended by greater than +/- 0.1 pH units at any time.	Channel subzone
Salinity	Waste discharges shall not cause the normal salinity range of any waters of the subzone to be extended by greater than +/- 3 parts per thousand at any time.	Harbour subzone, Buffer subzone and Channel subzone
Settleable material	Waste discharges shall give rise to no bottom deposits or submerged objects which 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 of the subzone.	Harbour subzone, Buffer subzone and Channel subzone
Temperature	Waste discharges shall not cause the natural daily temperature range in waters of the subzone to be extended by greater than +/- 1.0℃ at any location or time. The rate of temperature change shall not exceed 0.5℃ per hour at any location, unless due to natural phenomena.	Harbour subzone, Buffer subzone and Channel subzone
Toxicants	Waste discharges shall not cause the toxicants in waters of the subzone to attain such a level as to produce significant toxic effects in humans, fish or any other aquatic organism, with due regard to biologically cumulative effects in food chains and to toxicant interactions with each other.	Harbour subzone, Buffer subzone and Channel subzone

Technical Memorandum on Standards for Effluents Discharge into Drainage and Sewerage Systems, Inland & Coastal Waters (TM-DSS)

6.1.1.3 Apart from the WQOs, Section 21 of the WPCO also specifies the limits to control the physical, chemical and microbial parameters for effluent discharges into foul sewers leading into the Government's sewage treatment plants and the coastal waters of Tolo and Port Shelter Water Control Zones as below tables. Subject to the flow rate of the effluents, corresponding standards for the effluent discharge into the Government's foul sewers should be followed.

Table 6.2 Standards for effluents discharged into foul sewers leading into the Government's sewage treatments plants

Parameter	Flow Rate (m^3/day)												
	≤ 10	> 10 & ≤100	> 100 & ≤ 200	> 200 & ≤ 400	> 400 & ≤ 600	> 600 & ≤ 800	> 800 & ≤ 1000	> 1000 & ≤1500	> 1500 & ≤2000	> 2000 & ≤3000	> 3000 & ≤4000	> 4000 & ≤5000	> 5000 & ≤6000
pH (pH units)	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10
Temperature (°C)	43	43	43	43	43	43	43	43	43	43	43	43	43
Suspended solids	1200	1000	900	800	800	800	800	800	800	800	800	800	800
Settleable solids	100	100	100	100	100	100	100	100	100	100	100	100	100
BOD	1200	1000	900	800	800	800	800	800	800	800	800	800	800
COD	3000	2500	2200	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Oil & Grease	100	100	50	50	50	40	30	20	20	20	20	20	20
Iron	30	25	25	25	15	12.5	10	7.5	5	3.5	2.5	2	1.5
Boron	8	7	6	5	4	3	2.4	1.6	1.2	0.8	0.6	0.5	0.4
Barium	8	7	6	5	4	3	2.4	1.6	1.2	0.8	0.6	0.5	0.4
Mercury	0.2	0.15	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.2	0.15	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Copper	4	4	4	3	1.5	1.5	1	1	1	1	1	1	1
Nickel	4	3	3	2	1.5	1.5	1	0.8	0.7	0.7	0.6	0.6	0.6
Chromium	2	2	2	2	1	0.7	0.6	0.4	0.3	0.2	0.1	0.1	0.1
Zinc	5	5	4	3	1.5	1.5	1	0.8	0.7	0.7	0.6	0.6	0.6
Silver	4	3	3	2	1.5	1.5	1	0.8	0.7	0.7	0.6	0.6	0.6
Other toxic metals individually	2.5	2.2	2	1.5	1	0.7	0.6	0.4	0.3	0.2	0.15	0.12	0.1

Parameter	**Flow Rate (m³/day)**												
	≤ 10	**> 10 & ≤100**	**> 100 & ≤ 200**	**> 200 & ≤ 400**	**> 400 & ≤ 600**	**> 600 & ≤ 800**	**> 800 & ≤ 1000**	**> 1000 & ≤1500**	**> 1500 & ≤2000**	**> 2000 & ≤3000**	**> 3000 & ≤4000**	**> 4000 & ≤5000**	**> 5000 & ≤6000**
Total toxic metals	10	10	8	7	3	2	2	1.6	1.4	1.2	1.2	1.2	1
Cyanide	2	2	2	1	0.7	0.5	0.4	0.27	0.2	0.13	0.1	0.08	0.06
Phenols	1	1	1	1	0.7	0.5	0.4	0.27	0.2	0.13	0.1	0.1	0.1
Sulphide	10	10	10	10	5	5	4	2	2	2	1	1	1
Sulphate	1000	1000	1000	1000	1000	1000	1000	900	800	600	600	600	600
Total nitrogen	200	200	200	200	200	200	200	100	100	100	100	100	100
Total phosphorus	50	50	50	50	50	50	50	25	25	25	25	25	25
Surfactants (total)	200	150	50	40	30	25	25	25	25	25	25	25	25

Note:

[1] All units in mg/L unless otherwise stated.

Table 6.3 Standards for effluents discharged into foul sewers leading into the Government's sewage treatments plants with microbial treatment

Parameter	**Flow Rate (m³/day)**												
	≤ 10	**> 10 & ≤100**	**> 100 & ≤ 200**	**> 200 & ≤ 400**	**> 400 & ≤ 600**	**> 600 & ≤ 800**	**> 800 & ≤ 1000**	**> 1000 & ≤1500**	**> 1500 & ≤2000**	**> 2000 & ≤3000**	**> 3000 & ≤4000**	**> 4000 & ≤5000**	**> 5000 & ≤6000**
Copper	1.5	1	1	1	0.8	0.6	0.5	0.4	0.3	0.2	0.15	0.1	0.05

Note:

[1] All units in mg/L unless otherwise stated.

Table 6.4 Standards for effluents discharged into the coastal waters of Tolo and Port Shelter Water Control Zones

Parameter	**Flow Rate (m^3/day)**											
	≤ 10	**> 10 & ≤200**	**> 200 & ≤400**	**> 400 & ≤600**	**> 600 & ≤800**	**> 800 & ≤1000**	**> 1000 & ≤1500**	**> 1500 & ≤2000**	**> 2000 & ≤3000**	**> 3000 & ≤4000**	**> 4000 & ≤5000**	**> 5000 & ≤6000**
pH (pH units)	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9
Temperature (℃)	45	45	45	45	45	45	45	45	45	45	45	45
Colour (lovibond units) (25mmcell length)	1	1	1	1	1	1	1	1	1	1	1	1
Suspended solids	30	30	30	30	30	30	15	15	15	15	15	15
BOD	20	20	20	20	20	20	10	10	10	10	10	10
COD	80	80	80	80	80	80	50	50	50	50	50	50
Oil & Grease	20	20	20	20	20	20	10	10	10	10	10	10
Iron	10	10	10	7	5	4	2.7	2	1.3	1	0.8	0.6
Boron	5	4	3	2.5	2	1.6	1.1	0.8	0.5	0.4	0.3	0.2
Barium	5	4	3	2.5	2	1.6	1.1	0.8	0.5	0.4	0.3	0.2
Mercury	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Other toxic metals individually	1	1	0.8	0.5	0.5	0.4	0.1	0.1	0.1	0.1	0.1	0.1
Total toxic metals	2	2	1.6	1	1	0.8	0.2	0.2	0.2	0.2	0.14	0.1
Cyanide	0.1	0.1	0.1	0.1	0.1	0.1	0.05	0.05	0.03	0.02	0.02	0.01
Phenols	0.5	0.5	0.5	0.25	0.25	0.25	0.1	0.1	0.1	0.1	0.1	0.1

Parameter	Flow Rate (m^3/day)											
	≤ 10	> 10 & ≤200	> 200 & ≤400	> 400 & ≤600	> 600 & ≤800	> 800 & ≤1000	> 1000 & ≤1500	> 1500 & ≤2000	> 2000 & ≤3000	> 3000 & ≤4000	> 4000 & ≤5000	> 5000 & ≤6000
Sulphide	5	5	5	5	5	5	2.5	2.5	1.5	1	1	0.5
Total residual chlorine	1	1	1	1	1	1	1	1	1	1	1	1
Total nitrogen	20	20	20	15	15	15	15	15	10	10	10	10
Total phosphorus	8	8	5	5	5	5	5	5	5	5	5	5
Surfactants (total)	15	15	15	15	15	15	10	10	10	10	10	10
E. coli (count/100ml)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Note:

[1] All units in mg/L unless otherwise stated.

Environmental Impact Assessment Ordinance (Cap. 499), Technical Memorandum on Environmental Impact Assessment Process (TM-EIAO)

6.1.1.4 The TM-EIAO specifies the assessment methods and criteria for impact assessment. This Study follows the TM-EIAO to assess the potential water quality impact that may arise during both the construction and operational phases of the Project. Sections in the TM-EIAO relevant to the water quality impact assessment are:

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

Hong Kong Planning Standards and Guidelines (HKPSG)

6.1.1.5 Chapter 9 of the HKPSG outlines environmental requirements that need to be considered in land use planning. The recommended guidelines, standards and guidance cover the selection of suitable locations for the developments and sensitive uses, provision of environmental facilities, and design, layout, phasing and operational controls to minimise adverse environmental impacts. It also lists out environmental factors that influence land use planning and recommends buffer distances for land uses.

Practice Note for Professional Persons on Construction Site Drainage (ProPECC PN 1/94) "Construction Site Drainage"

6.1.1.6 The ProPECC PN1/94 provides guidelines for the handling and disposal of construction discharges. It is applicable to this study for the control of site runoff and wastewater generated during the construction phase of the Project.

6.1.1.7 The types of discharges from construction sites outlined in the ProPECC Note PN1/94 that are relevant would include:

- Surface runoff;
- Groundwater;
- Wheel washing water;
- Water for testing and sterilization of water retaining structures and water pipes;
- Wastewater from building construction and site facilities; and
- Acid cleaning, etching and pickling wastewater.

Proposed Assessment Criteria for Fungicides, Insecticides and Fertilizers

6.1.1.8 According to the outline of Turfgrass Management Plan (TMP) in **Section 2.7**, agrochemicals including fertilizers, fungicides, herbicides and insecticides will be applied to the turf area during the operational phase. As the agrochemicals may lead to potential water quality impacts and there are no statutory criteria for assessing their concentration, their criteria have been established below for further assessment in subsequent sections.

(a) Fungicides and Insecticides

6.1.1.9 As there are neither numeric criteria under WQOs nor background measurement data for fungicides and insecticides, the criteria of residual fungicides and insecticides are determined with reference to the *Manual for the Assessment of Chemicals* published by the Organization for Economic Co-operation and Development (OECD) and the available ecotoxicity data in the corresponding Material Safety Data Sheet (MSDS) (as shown in **Appendix 6.1**).

6.1.1.10 According to the manual published by OECD [6-1], ecotoxicity test data (e.g. fish, *Daphnia* or algae) could be used to determine the corresponding Predicted No Effect Concentration (PNEC) which represents a concentration where no unacceptable adverse effects on the aquatic ecosystem (e.g. coral, fisheries, etc.) are expected. There are also examples of using PNEC as assessment criteria in local studies. PNEC was adopted as the assessment criteria for anti-scalant in the approved EIA study of Desalination Plant at Tseung Kwan O (AEIAR – 192/2015) where numeric criteria and background measurement data were not available. Also, the use of PNEC as assessment criteria are also common for some local projects such as district cooling systems. Therefore, it is proposed to adopt PNEC as the assessment criteria for this study.

6.1.1.11 According to the latest turf design, fungicides including Daconil and Bayleton would be used, and insecticides including Chlorpyrifos and Fipronil would be used. The typical MSDSs of these 4 agrochemicals have been extracted and reviewed. If there is any change in the use of agrochemicals in the future operation, MSDSs and monitoring parameters should be reviewed accordingly. According to the corresponding MSDSs, information such as lethal concentration to 50% test species (LC_{50}) or half maximal effective concentration (EC_{50}) and No Observable Effective Concentration (NOEC) is available.

6.1.1.12 Either acute (e.g. LC_{50} and EC_{50}) or chronic (e.g. NOEC) toxicity data are eligible to determine the criteria by applying an appropriate assessment factor to the lowest acute or chronic toxicity data. The assessment factor ranges from 100 – 1000 for acute data and 10 – 100 for chronic data which depends on the available toxicity test data from different trophic levels. If toxicity data is available from species representing three trophic levels (i.e. fish, *Daphnia* or algae), a lower assessment factor is applied. The criteria determined for fungicides and insecticides are summarised in **Table 6.5** and **Appendix 6.1** shows the details of the calculation.

Table 6.5 Criteria for fungicides and insecticides

Agrochemicals	Concentration Limit (mg/l)
Fungicides	
Daconil	4.7E-04
Bayleton	2.0E-02
Insecticides	
Chlorpyrifos	1.7E-05
Fipronil	6.8E-04

(b) *Herbicides*

6.1.1.13 There are also neither numeric criteria under WQOs nor background measurement data for the herbicides. While Mechanical methods (hand weeding) will be the primary means of control of turfgrass weeds, it is still occasionally required to apply herbicides. However, unlike fungicides and insecticides which would be applied across the entire turf area, the application of herbicides to the turf area is not on a regular basis and spot spraying will be adopted in applying herbicides to selected areas. Therefore, the amount of residual herbicides in the bypass of water storage tanks will be insignificant.

(c) *Fertilizers*

6.1.1.14 Fertilizers will be applied to the turf area in order to provide nutrients (e.g. nitrogen, phosphorus, etc.) to turfgrass for healthy growth and development. There are no numeric criteria for total inorganic nitrogen (TIN) and total phosphorus (TP) in WQOs for Tolo Harbour and Channel WCZ. For EPD's marine water quality monitoring stations, Station TM3 is the nearest marine monitoring station in the Tolo Harbour and Channel WCZ, which is at a distance of about 570m away. The marine water quality monitoring data for Station TM3 in 2013-2017 is shown in **Table 6.6**.

Table 6.6 Marine Water Quality Data at Station TM3 for Tolo Harbour and Channel WCZ in 2013-2017

Year	Annual Mean of TIN	Annual Mean of TP
2017	0.087	0.043
2016	0.116	0.047
2015	0.081	0.043
2014	0.068	0.025
2013	0.059	0.028

Note:

[1] Data above is extracted from the Annual Report of Marine Water Quality in Hong Kong in 2017.

6.1.1.15 According to the Annual Report of Marine Water Quality in Hong Kong in 2017, there were red tide incidents reported in the Tolo Harbour and Channel WCZ in the past 43 years (1975 – 2017). The number of red tide incidents has dropped significantly from the record high of 43 in 1988 to 3-10 in the past 5 years.

6.1.1.16 It could therefore be seen that the concentration of TIN and TP recorded in the marine water quality monitoring data in Tolo Harbour in 2013-2017 shows a low level of red tide incidents. Hence, the range of the marine water monitoring data in 2013-2017 for TIN and TP (as shown in **Table 6.6**) is adopted as the criteria for any bypass of the water storage tanks. In other words, if the concentrations of TIN and TP in the bypass of the water storage tanks do not exceed the monitoring results, adverse water quality impact is not anticipated from the stormwater bypass with residual fertilizers.

<u>Pesticides Ordinance (Cap. 133)</u>

6.1.1.17 The Pesticides Ordinance Cap. 133 was introduced to regulate the import, manufacture, repackage, storage, labeling and sale of all pesticides. Under the Pesticides Ordinance Cap. 133, only registered pesticides may be imported into and freely distributed for use in Hong Kong. Moreover, pesticides controlled under Stockholm Convention and Rotterdam Convention are set out in two schedules to the Ordinance (scheduled pesticides) - Schedule 1 lists pesticides under the Stockholm Convention and Part 1 of Schedule 2 for pesticides under the Rotterdam Convention. The import, export, manufacture, sale, supply, possession, use or transhipment (except air transhipment cargo) of all scheduled pesticides is prohibited except under a Pesticide Permit issued by he Director of Agriculture, Fisheries and Conservation (DAFC).

6.2 Baseline Conditions

6.2.1 General Description

6.2.1.1 The site boundary of the Project falls within the Tolo Harbour and Channel WCZ according to the WPCO. It is located at Ting Kok Road and adjoins the Tai Po Industrial Estate (TPIE). The WQO compliance rate of the Tolo Harbour and Channel WCZ was 79% in 2017 which is the same as 2016.

6.2.2 Baseline Water Quality Conditions

<u>Environmental Protection Department (EPD)'s Marine Monitoring Stations</u>

6.2.2.1 The existing marine water quality can be referred to EPD's marine water quality data obtained from routine monitoring carried out at Tolo Harbour and Channel WCZ (i.e. Stations TM2, TM3, TM4, TM5, TM6) and Shuen Wan Typhoon Shelter (i.e. Station TT1). The locations are shown in **Figure 6.1a**. Among these six stations, TM3 is the closest (about 570m) to the Project Site and hence is expected to have similar characteristics to the baseline conditions in the assessment area.

6.2.2.2 As discussed in **Section 6.2.1**, The latest water quality monitoring data in Year 2017 is adopted to determine the ambient water quality. Details of marine water quality monitoring data for Tolo Harbour and Channel WCZ are presented in **Table 6.7** respectively. According to EPD's publication "Marine Water Quality in Hong Kong 2017", the Tolo Harbour and Channel WCZ attained an overall WQO compliance rate of 79% in 2017 which is the same as 2016.

Table 6.7 Summary of EPD's Routine Marine Water Quality Data for Tolo Harbour and Channel WCZ in 2017

Parameters		Tolo Harbour and Channel WCZ [1][2][3][4]					Shuen Wan Typhoon Shelter
		TM2	TM3	TM4	TM5	TM6	TT1
Temperature (°C)		24.7 (18.7 - 30.7)	24.6 (18.4 - 30.8)	24.5 (18.4 - 30.4)	25 (18.4 - 31.3)	24.1 (18.1 - 30.0)	25.1 (18.7 - 30.9)
Salinity		29.7 (26.1 - 32.1)	30.6 (28.8 - 33.3)	30.7 (29.1 - 32.9)	30.4 (27.3 - 32.7)	31.3 (30.1 - 33.6)	30.2 (28.7 - 31.1)
Dissolved Oxygen (mg/L)	Depth Average	6.6 (4.7 - 7.7)	6.5 (4.8 - 7.9)	6.4 (5.0 - 8.0)	6.4 (5.0 - 7.6)	5.9 (3.2 - 7.1)	6.3 (4.5 - 8.4)
	Bottom	6.7 (4.7 - 8.6)	5.9 (3.6 - 7.6)	5.9 (2.7 - 8.0)	6.5 (5.0 - 8.1)	4.6 (<0.1 - 7.1)	6.0 (4.6 - 6.8)
Dissolved Oxygen (% Saturation)	Depth Average	94 (62 - 119)	93 (68 - 122)	92 (74 - 112)	92 (78 - 113)	83 (49 - 96)	92 (58 - 129)
	Bottom	97 (61 - 133)	83 (54 - 114)	83 (41 - 115)	93 (66 - 125)	64 (1 - 93)	87 (60 - 107)
pH		7.9 (7.6 - 8.3)	8.0 (7.7 - 8.3)	8.0 (7.7 - 8.2)	8.0 (7.7 - 8.3)	8.0 (7.7 - 8.2)	8.0 (7.7 - 8.2)
Secchi Disc Depth (m)		2.3 (1.6 - 3.0)	2.4 (2.0 - 3.0)	2.6 (1.8 - 3.5)	2.6 (1.5 - 3.8)	3.0 (2.0 - 4.5)	2.9 (1.8 - 4.0)
Turbidity (NTU)		2.0 (0.8 - 6.8)	2.1 (0.6 - 6.3)	1.9 (0.5 - 6.0)	2.3 (0.4 - 6.2)	1.8 (0.6 - 6.6)	2.3 (0.8 - 6.7)

Parameters	Tolo Harbour and Channel WCZ [1][2][3][4]					Shuen Wan Typhoon Shelter
	TM2	TM3	TM4	TM5	TM6	TT1
SS (mg/L)	4.5 (1.8 - 10.5)	4.4 (1.4 - 10.6)	4.6 (1.2 - 12.7)	4.6 (1.7 - 10.0)	3.8 (1.2 - 10.0)	3.3 (1.0 - 9.4)
5-day Biochemical Oxygen Demand (mg/L)	1.8 (0.9 - 3.6)	1.5 (0.7 - 2.0)	1.4 (0.8 - 2.3)	1.4 (0.7 - 3.5)	1.2 (0.6 - 2.2)	1.4 (0.6 - 2.4)
Ammonia Nitrogen (mg/L)	0.046 (0.010 - 0.115)	0.058 (0.022 - 0.133)	0.053 (<0.005 - 0.095)	0.032 (0.007 - 0.081)	0.045 (0.009 - 0.079)	0.059 (0.021 - 0.120)
Unionised Ammonia (mg/L)	0.001 (<0.001 - 0.003)	0.003 (<0.001 - 0.006)	0.002 (<0.001 - 0.006)	0.002 (<0.001 - 0.004)	0.002 (<0.001 - 0.004)	0.003 (<0.001 - 0.004)
Nitrite Nitrogen (mg/L)	0.004 (<0.002 - 0.018)	0.006 (<0.002 - 0.022)	0.006 (<0.002 - 0.022)	0.003 (<0.002 - 0.009)	0.007 (<0.002 - 0.022)	0.003 (<0.002 - 0.004)
Nitrate Nitrogen (mg/L)	0.028 (<0.002 - 0.139)	0.023 (<0.002 - 0.096)	0.019 (<0.002 - 0.067)	0.014 (<0.002 - 0.074)	0.015 (<0.002 - 0.051)	0.013 (<0.002 - 0.030)
Total Inorganic Nitrogen (mg/L)	0.08 (0.01 - 0.25)	0.09 (0.03 - 0.21)	0.08 (<0.01 - 0.15)	0.05 (0.01 - 0.14)	0.07 (0.01 - 0.13)	0.07 (0.02 - 0.15)
Total Kjeldahl Nitrogen (mg/L)	0.39 (0.22 - 0.68)	0.42 (0.24 - 0.92)	0.43 (0.25 - 0.76)	0.34 (0.18 - 0.55)	0.40 (0.24 - 0.80)	0.46 (0.23 - 1.06)
Total Nitrogen (mg/L)	0.42 (0.22 - 0.68)	0.45 (0.25 - 0.93)	0.46 (0.27 - 0.76)	0.36 (0.18 - 0.55)	0.43 (0.25 - 0.81)	0.47 (0.26 - 1.06)

Parameters	Tolo Harbour and Channel WCZ [1][2][3][4]					Shuen Wan Typhoon Shelter
	TM2	TM3	TM4	TM5	TM6	TT1
Orthophosphate Phosphorus (mg/L)	0.005 (0.002 - 0.012)	0.008 (<0.002 - 0.030)	0.008 (<0.002 - 0.037)	0.005 (<0.002 - 0.019)	0.007 (0.003 - 0.025)	0.004 (<0.002 - 0.006)
Total Phosphorus (mg/L)	0.05 (<0.02 - 0.15)	0.04 (<0.02 - 0.09)	0.05 (<0.02 - 0.10)	0.04 (<0.02 - 0.18)	0.04 (<0.02 - 0.08)	0.02 (<0.02 - 0.04)
Silica (as SiO_2) (mg/L)	1.26 (0.39 - 3.40)	1.31 (0.55 - 2.27)	1.27 (0.42 - 2.57)	1.06 (0.49 - 2.00)	1.13 (0.56 - 2.00)	0.99 (0.55 - 1.60)
Chlorophyll-a (µg/L)	5.1 (0.7 - 12.5)	4.9 (0.8 - 18.3)	4.8 (0.8 - 16.7)	3.4 (0.5 - 8.2)	3.6 (0.6 - 15.0)	4.1 (0.7 - 10.3)
E.coli (count/100mL)	5 (1 - 650)	9 (2 - 570)	2 (<1 - 210)	2 (<1 - 300)	2 (<1 - 230)	20 (12 - 47)
Faecal Coliforms (count/100mL)	29 (2 - 5900)	38 (5 - 4300)	7 (1 - 1600)	7 (<1 - 2800)	3 (<1 - 1600)	40 (18 - 160)

Notes:

[1] The table above is extracted from the Annual Report of Marine Water Quality in Hong Kong in 2017.

[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 the depth-averaged results except for E. coli and faecal coliforms which are annual geometric means.

[4] Data in brackets indicate the ranges.

6.2.2.3 According to the Annual Report of Marine Water Quality in Hong Kong in 2017, the Tolo Harbour is a shallow semi-enclosed water body with low water exchange rate with the Mirs Bay, and the harbour's essentially landlocked situation often leads to the natural stratification of the water column and lower bottom DO levels, particularly during the hot summer months, hence resulting in non-compliance with the DO objective.

6.3 Assessment Area and Water Sensitive Receivers

6.3.1 Assessment Area

6.3.1.1 The assessment area for the water quality impact assessment is stated in Clause 3.4.7.2 of EIA Study Brief (ESB-303/2017). It shall include the Tolo Harbour and Channel WCZ and the water sensitive receivers outside the 500 metres boundary but in the vicinity of the Project, if they are found also being affected by the Project and have a bearing on the environmental acceptability of the Project. The assessment area would be extended to include other areas such as fish culture zones, Site of Special Scientific Interest (SSSI), stream courses, existing and new drainage systems in the vicinity that may be impacted. **Figure 6.1a** and **Figure 6.1b** shows the water quality assessment area for this Project.

6.3.2 Water Sensitive Receivers

6.3.2.1 The key Water Sensitive Receivers (WSRs) within the 500m assessment area are identified and indicated in **Figure 6.1b**. They include inland watercourses, seawater intakes, coral colonies and seahorse within Tolo Harbour and Tolo Channel, as summarised in **Table 6.8**.

Table 6.8 WSRs within 500m assessment area

WSR ID	WSR Description	Approximate Distance from Project Boundary (m)
Seawater Intakes		
S1	Water Services Department (WSD) Seawater Intake in Tai Po	330
Corals		
C1	South of Project Site	<10
C2	Tai Po Industrial Estate	150
C3	Tai Po Industrial Estate	200
Seahorse		
H1	Tai Po Industrial Estate	370
Inland Watercourses		
W1	Ha Hang Watercourse near Ha Hang Village	290 (Separated by Ting Kok Road)
W2	Ha Hang Watercourse near Casa Marina II	90 (Separated by Ting Kok Road)

6.3.2.2 Other than the above WSRs within the 500m from the Project, Tolo Harbour also accommodates a number of other WSRs including fish culture zones, such as Yim Tin Tsai Fish Culture Zone, Yim Tin Tsai (East) Fish Culture Zone, Lo Fu Wat

Fish Culture Zone and Yung Shue Au Fish Culture Zone which are about 700m, 2km, 8km and 9km away from the Project respectively; Ting Kok SSSI which is about 2km away from the Project, corals and mangroves colonies within Tolo Harbour and Tolo Channel. All these are located much further away. Provided that the impacts on the key WSRs in **Table 6.8** can be controlled to an acceptable level, any impacts on those WSRs beyond 500m would also not be significant.

6.4 Construction Phase Assessment

6.4.1 Identification of Environmental Impacts

6.4.1.1 As discussed in **Section 2**, all the works of this Project would be land-based and no marine works would be required. Since there will be no modification of the existing seawall, sediment loss is not anticipated. Detailed construction phasing can also be found in **Section 2**. The major pollution sources during the construction phase would be construction site runoff and sewage from the workforce.

6.4.1.2 The pollution sources/impacts for the Project during the construction phase are summarized as follows.

- Site Run-off from general site operation;
- Accidental spillage of chemicals;
- Sewage from workforce; and
- Run-off during modification of open channel.

6.4.2 Prediction and Evaluation of Environmental Impacts

Site Run-off from General Site Operation

6.4.2.1 Construction site runoff would come from all over the works sites during the Project. The surface runoff might be polluted by:

- Wheel washing water;
- Wastewater from building construction, site facilities and road works;
- Acid cleaning, etching and pickling wastewater;
- Accidental spillage of chemicals; and,
- Soil erosion.

6.4.2.2 Construction runoff may cause physical, biological and chemical effects. The physical effects include potential blockage of drainage channels and an increase of SS levels near the shore of the Project Site. Runoff containing significant amounts of concrete and cement-derived material may cause primary chemical effects such as increasing turbidity and discoloration, elevation in pH, and accretion of solids. A number of secondary effects may also result in toxic effects to water biota due to elevated pH values, and reduced decay rates of faecal micro-organisms and photosynthetic rate due to the decreased light penetration.

6.4.2.3 The current engineering design has been proactively mindful to avoid and minimise the amount of surface run-off during site formation that may be released to Tolo Harbour. As discussed in **Section 2**, water storage tanks of total volume of 30,000m^3 will be constructed in phases underneath the access road. During the initial construction phase, temporary sedimentation tanks will be installed to intercept the surface runoff. Once one of these water storage tanks are constructed, they would be used to intercept any surface runoff for sedimentation.

6.4.2.4 As discussed in **Section 2**, when all the water storage tanks of total 30,000m^3 are completed, these water storage tanks can be able to cater for the surface runoff without the need to bypass to Tolo Harbour during most of the rainfall events. Only during heavy and/ or prolonged rainfall (i.e. daily accumulated rainfall to 145mm or smaller rainfall but last for days), the water storage tanks will become full. During that circumstance, any extra surface runoff would bypass the water storage tanks and enter the Tolo Harbour. If the water storage tanks are not available for sedimentation at the time of working due to site conditions, conventional sedimentation tank should be provided accordingly.

6.4.2.5 Since perimeter cut-off channels will be constructed to direct off-site water around the site and dikes or embankments will also be implemented for flood protection, thus, significant adverse impacts resulting from soil erosion is not anticipated.

6.4.2.6 Others appropriate precautionary measures as listed in **Section 6.4.3** shall be adopted to prevent site run-off to Tolo Harbour. With the proper implementation of mitigation measures stated in **Section 6.4.3**, no adverse water quality impact is anticipated.

<u>Accidental Spillage of Chemicals</u>

6.4.2.7 The chemicals used during construction, such as fuel, oil, solvents and lubricants from maintenance of construction machinery and equipment, may cause pollution and trigger physicochemical effects in the nearby water bodies if accidental spillage occurs. To avoid adverse impacts of chemical spillage, best practices of chemical storage practices such as storage under a covered area, provision of secondary containment and material safety data sheets are advised. Spill kits are also advised to handle spillage and the staff should be trained for handling spillage. With the implementation of mitigation measures stated in **Section 6.4.3**, adverse water quality impact is not anticipated.

<u>Sewage from Workforce</u>

6.4.2.8 According to Table T-2 of Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning, the unit flow is 0.23 m^3/day/employee. The number of workforce (clerical staff and workers) to be employed for the Project is around 200 during the construction period. It is estimated that the volume of sewage from workforce would be around 46 m^3/day. Because temporary sanitary facilities, e.g. portable chemical toilets, and sewage holding tanks will be provided, no adverse water quality impact is anticipated.

<u>Run-off during Modification of Open Channel</u>

6.4.2.9 As mentioned in **Section 2**, stormwater extraction from existing open channel is one of the options to provide stormwater for irrigation of the golf course. This option would involve having some local modifications to that existing open channel. The modification of open channel would involve the following construction works:

- Construction of downstream box culvert to the location of the proposed modification works for the existing open channel.
- Construction of temporary waterproof cofferdam at the location of the modifications works for the existing open channel during dry season to isolate the water flow from the construction works area.
- Connection of the downstream pipe with the existing open channel during dry season.
- Demolition of the temporary waterproof cofferdam.

6.4.2.10 The modification of open channel will not cause any adverse impact on the existing open channel, but construction of one additional extraction point at the existing open channel.

6.4.2.11 If not properly controlled, the excavated materials, wastewater, chemicals or other construction materials may enter the watercourses and give rise to water quality impact at the downstream area. To prevent adverse water quality impact, the open channel modification works should be scheduled in dry season as far as practicable when the flow is low. Sequencing of works should be duly planned to minimise water quality impacts. Dewatering of the construction works area shall be conducted prior to the construction works if necessary. Silt removal facilities should be adopted to treat the wastewater from dewatering operation prior to discharge. After completion of the construction works, the works area shall be cleaned up before receiving any water flow or connecting to any existing watercourses. Detailed mitigation measures are given in **Section 6.4.3**.

6.4.3 Mitigation Measures

Site Run-off from General Site Operation

6.4.3.1 To reduce the potential water quality impact due to construction site runoff, other than the timely implementation of the water storage tanks, the following good site practices in accordance to Practice Note for Professional Persons on Construction Site Drainage, Environmental Protection Department, 1994 (ProPECC PN 1/94) should be implemented to avoid potential adverse water quality impacts.

- Once one of the water storage tanks are completed, use the water storage tank for sedimentation.
- Construct perimeter cut-off drains to direct off-site water around the site and provide channels (both temporary and permanent drainage pipes and culverts), earth bunds or sand bag barriers on site to direct stormwater to silt removal facilities.
- Implementation of dikes or embankments for flood protection and provide temporary ditches to facilitate the runoff discharge into an appropriate watercourse, through a silt/sediment trap.
- Design efficient silt removal facilities based on the guidelines in Appendix A1 of ProPECC PN 1/94.
- Schedule construction works to minimize surface excavation works during the rainy seasons (April to September). Complete and vegetate all exposed earth areas as soon as possible after earthworks have been completed.

- Inspect and maintain all drainage facilities and erosion and sediment control structures regularly to ensure proper and efficient operation at all times and particularly following rainstorms.
- Implementation of measures to minimize the ingress of site drainage into excavations. If the excavation of trenches in wet periods is necessary, it should be dug and backfilled in short sections wherever practicable.
- Cover all construction materials at temporary storage area with tarpaulin or similar fabric during rainstorms and implementation of measures to prevent the washing away of construction materials, soil, silt or debris into any drainage system.
- Cover manholes (including newly constructed ones) adequately and seal temporarily to prevent silt, construction materials or debris being washed into the drainage system and storm runoff being directed into foul sewers.
- Take precautions at any time of year when rainstorms are likely. The actions to be taken based on the guidelines in Appendix A2 of ProPECC PN 1/94.
- Clean all vehicles and plant before leaving a construction site to ensure no earth, mud, debris and the like is deposited by them on roads and provide adequately designed and sited wheel washing facilities at every construction site exit where practicable. 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.
- Provide oil interceptors in the drainage system downstream of any oil/fuel pollution sources. Empty and clean the oil interceptors regularly to prevent the release of oil and grease into the storm water drainage system after accidental spillage.
- Collect, handle and dispose construction solid waste, debris and rubbish on site to avoid water quality impacts.
- Provide locks for all fuel tanks and storage areas and locate on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank to prevent spilled fuel oils from reaching water sensitive receivers nearby.

6.4.3.2 In addition, as a contingency measure, a 300mm bund wall is also recommended along the seawall during construction stage to prevent any potential overflow of stormwater into Tolo Harbour.

Accidental Spillage of Chemicals

6.4.3.3 To reduce the potential water quality impact due to accidental spillage of chemicals, the following mitigation measures should be implemented to avoid potential adverse water quality impacts.

- Properly sore and contain the chemicals used during construction, such as fuel, oil, solvents and lubricants in a designated area with secondary containment to prevent spillage and contamination of the nearby water environment.

- Locate any maintenance activities and workshops with chemicals use away from watercourses on hard standings within a bunded area and provide sumps and oil interceptors as appropriate.
- The Contractor shall register as a chemical waste producer and employ licensed collector for collection of chemical waste from the construction site. Any chemical waste generated shall be managed in accordance with the Waste Disposal (Chemical Waste) (General) Regulation.

Sewage from workforce

6.4.3.4 To mitigate the water quality impacts of sewage arising from the on-site construction workers, the following measures should be implemented:

- Provide temporary sanitary facilities, e.g. portable chemical toilets collect the sewage.
- Post notices at conspicuous locations to remind the workers not to discharge any sewage or wastewater into the surrounding environment during the construction phase of the Project.

Run-off during Modification of Open Channel

6.4.3.5 During modification of open channel, precaution measures shall be implemented to prevent adverse water quality impact to the surrounding environment. Good site practices as described in ProPECC PN 1/94 “Construction Site Drainage” should be adopted as far as applicable. The following key measures shall be implemented:

- Install cofferdams and impermeable sheet piles to isolate the water flow from the construction works area if necessary.
- Conduct dewatering within the cofferdam or flow diversion prior to the construction works to prevent water overflow to the surrounding area if necessary.
- Conduct temporary flow diversion in dry season when the water flow is low.
- Divert water drained from the watercourse to new/ temporary drainage for watercourse diversion if necessary. Collect and treat the water drained for water courses removal to meet the requirements of WPCO and TM-DSS before discharge.
- Temporary drainage for watercourse diversion will be carried out with reference to DSD Technical Circular No. 1/2017 – Temporary Flow Diversion and Temporary Works Affecting Capacity on Stormwater Drainage System.

6.4.4 Cumulative Impacts with Concurrent Projects

6.4.4.1 As discussed in **Section 2**, a number of concurrent projects in the vicinity of the Project has been identified. The construction phase of Shuen Wan Landfill Restoration Contract and Food Waste Pre-treatment Facilities for Food Waste / Sewage Sludge Anaerobic Co-Digestion Pilot Trial in Tai Po Sewage Treatment Works would be completed before the commencement of construction phase of the proposed Project. The Columbarium Development at Shuen Wan Landfill is still under planning stage and the programme is yet to be confirmed. The Development of a Bathing Beach at Lung Mei is located at 2.5km from the proposed development. Besides, the proposed construction works of the Project would be land-based and there would not be any marine works. Hence, with the implementation of the mitigation measures in **Section 6.4.3**, it is anticipated that the water quality impacts generated would be localized and there would be no adverse cumulative water quality impacts.

6.4.5 Residual Impacts

6.4.5.1 With the implementation of the aforementioned mitigation measures, no adverse residual environmental impacts are anticipated.

6.5 Operational Phase Assessment

6.5.1 Identification of Environmental Impacts

6.5.1.1 As discussed in **Section 2**, there will be no modification of the existing seawall, sediment loss is not anticipated. The key pollution sources / impacts during the operational phase include:

- Stormwater bypass;
- Sewage effluent;
- Wastewater from ancillary facilities; and
- Potential water seepage.

6.5.2 Prediction and Evaluation of Environmental Impacts

Stormwater Bypass – Runoff Management

6.5.2.1 To reduce the water quality impact by the surface runoff and soil erosion, special considerations have been formulated in designing the drainage system including:

- Collection system;
- Water storage tanks; and
- Outfall location.

6.5.2.2 The design rationale of the above-mentioned sub-systems is summarized in **Table 6.9**. Detailed arrangement of each sub-system will be given in the following sections.

Table 6.9 Design rationale of the drainage sub-systems

Sub-system	Design Rationale
Collections System	To minimize the chance of surface overflow (i.e. directly flow from the surface to Tolo Harbour) and thus soil erosion by diverting all the turf area runoff to the water storage tanks.
Water Storage Tanks	To retain as much runoff as practicable to minimise potential bypasses into Tolo Harbour.
Outfall Location	To be duly situated to allow an optimum distance from the adjacent WSRs.

(a) Collection System

6.5.2.3 For the collection system conveying the runoff to the water storage tanks, the whole collection network is designed to withstand rainstorm events of a 50-year return period. This means that, for a return period of less than 50-year, there will be no surface overflow from the Project Site to Tolo Harbour and all surface runoff will be conveyed under control to the water storage tanks. Thus, the surface overflow to Tolo Harbour can be minimised as much as practicable.

6.5.2.4 In addition, a collection system with a 50-year return period can effectively avoid surface overflow/flooding, thereby minimizing the potential of soil erosion.

(b) Water Storage Tanks

6.5.2.5 Water storage tanks with a total volume of 30,000m^3 which is equal to the volume of 12 Olympic-size swimming pools will be installed on-site. The main purpose of the water storage tanks is to store the runoff from the Project Site to reduce the bypass events during raining. In fact, this 30,000m^3 volume has been optimized given the site constraints on engineering issues. Since the Project Site was once a landfill site, the location of water storage tanks is limited to the area along the eastern side of the Project Site. Due to the ex-landfill waste bodies underneath, excavation is not allowed and thus the depth of the water storage tanks is also limited. Having considered the available space and site constraints, the volume of the proposed water storage tanks is optimized to 30,000m^3. A further discussion on the engineering constraints to retain all the stormwater from the proposed development is given in **Section 6.5.2.12**.

6.5.2.6 Apart from reducing the bypass events during raining, another purpose of the water storage tanks is to store water from different water sources in order to cope with the irrigation demand. In addition to the runoff generated from Project Site, water from WSD and an off-site channel will also be harvested and conveyed to the water storage tanks, if required. There will also be routine maintenance works for the water storage tanks to ensure proper functioning. Water from different water sources will have different level of pollution. A summary of the water sources and type of pollutants is given in **Table 6.10**.

Table 6.10 Potential pollutants of water sources

Water Source	Potential Pollutants
Runoff from Turf Area	Contains agrochemicals
Runoff from Access Road	Contains dust
Runoff from Landscape Area	Not anticipated
Water Supply from WSD	Not anticipated
Water Diverted from an Off-site Channel	Not anticipated

6.5.2.7 Based on the two purposes of the water storage tanks as mentioned above, an outline management plan for the water storage plan (as a part of the Turfgrass Management Plan) has been formulated. This outline can basically be divided into three stages which are normal operation, pre-prolonged rainfall, full capacity stages. A brief summary of the outline is provided in **Table 6.11**. More details will be elaborated in the following sections.

Table 6.11 Summary of Water Storage Plan

Stages	Details
Normal Operation	From December to the following March (4 months) with less rainfall • Remain 40% capacity of the water storage tanks full for irrigation • 60% capacity for runoff storage during rainfall which is sufficient to withstand a daily accumulated rainfall of 85mm • No single rainfall exceeding 85mm is recorded from December to the following March in the past 21 years From April to the following November (8 months) with more rainfall • Remain 15% capacity of the water storage tanks full for irrigation • 85% capacity for runoff storage during rainfall which is sufficient to withstand a daily accumulated rainfall of 125mm
Pre-prolonged rainfall	When prolonged rainfall is forecasted • Cease the application of agrochemicals in the golf course • Fully consume the water in the water storage tanks for the preparation to store 30,000m^3 rain water which can handle a daily accumulated rainfall of about 145mm.
Full capacity of water storage tanks	Full capacity of water storage tanks under rare prolonged or intense rainfall • Bypass any additional water through the outfall

Normal Operation

6.5.2.8 As discussed in **Section 2**, during December to the following March (4 months), the water storage tanks will mainly function as rainwater harvesting storage for on-site irrigation. The water storage tank would be approximately 40% full which would be sufficient for about a 7-day irrigation demand. The remaining 60% storage (approximately 18,000m^3) will be spared for rainwater retention to minimize bypass events into Tolo Harbour. The available retention storage is sufficient for a 85mm daily accumulated rainfall. Based on the historical data of average daily rainfall in the past 21 years, it is understood that no exceedance of 85mm daily accumulated rainfall was recorded during December to the following March. Therefore, the water quality impact arising from the surface runoff during December to the following March is considered insignificant.

6.5.2.9 Between April and the following November (8 months), it is anticipated the golf course operator will closely monitor the weather forecast by HKO. The water storage tank will be set to approximately 15% full with spare capacity of 85% (approximately 25,500m^3) to cope with the additional rain water. This storage is estimated to be capable of handling a daily accumulated rainfall of about 125mm.

Depending on the rainfall events to come, there may be bypass events into Tolo Harbour.

Pre-prolonged rainfall

6.5.2.10 When prolonged rainfall is forecasted in the coming days, the golf course operator will cease the application of agrochemicals in the golf course. And the stored water in the water storage tank will be fully consumed for the preparation to store 30,000m^3 rain water which can handle a daily accumulated rainfall of about 145mm.

Full capacity of water storage tanks

6.5.2.11 During prolonged and intense rainfall, there would be circumstances for bypass events to occur after the water storage tanks are of full capacity. It would be demonstrated in later sections that all these bypass events would not contain agrochemicals with levels without causing adverse water quality impact. Therefore, no adverse water quality impact is anticipated from these bypass events.

6.5.2.12 However, it is still desired to illustrate the benefit brought by the proposed water storage tanks. An analysis for consecutive days of rainfall has been conducted and shown in **Appendix 6.2**. It is concluded from the analysis that the number of days with bypass events have been significantly minimized and the bypass events would mainly occur during extreme weather events (tropical cyclones and/or red/black rainstorm events) or prolonged rainfall. A more comprehensive summary of the benefits of various proposed designs and practices is provided in **Section 6.5.2.34**.

6.5.2.13 Furthermore, a review of the feasibility to allocate a sufficient large water storage tanks to prevent the chances of full capacity is conducted. To construct a water storage tank that could retain all surface run-off, the size of water storage tanks could be more than 232,000 m^3 based on a sensitivity test, which is more than 7 times larger than the currently proposed tank. Details of the test can be found in **Appendix 6.2**. Some engineering constraints are listed below:

- As the subject site is largely comprised of waste mass that shall not be affected by any means, the only possible location to construct such large-scale water storage tank with sufficient loading capacity is along the eastern side of the site and the location of the proposed ancillary facilities, in which the available area for construction of the tank would be very limited as it would be bounded by the existing waste mass and seawall.
- With the limitation in area, to make a larger water storage tank than the currently proposed, the only way is to construct it with greater depths. However, in order not to affect the integrity of the waste mass and seawall, deep excavation is to be avoided as far as possible. Deep excavation would drawdown the existing groundwater table and hence cause ground settlement, which would in turn further affect the existing waste mass and seawall. Also, due to deep excavation, the temporary excavation and lateral support system would be extensive, which cause severe safety concerns during construction.

6.5.2.14 Due to the above-mentioned reasons, it is considered that the currently proposed capacity of water storage tank of 30,000m^3 is the best practical extent.

(c) Outfall Location

6.5.2.15 For the location of outfall, it is proposed to be located away from the adjacent WSRs and it is shown in **Figure 6.2** and is selected from one of the existing drainage outfalls so that no marine works are required. The location of outfall is proposed to be away from the WSD Seawater Intake in Tai Po (S1), seahorse (H1) and corals (C1, C2 and C3) which are located at the south of the Project Site.

<u>Stormwater Bypass – Turf Area Runoff</u>

6.5.2.16 According to the outline of TMP in **Section 2.7**, agrochemicals will be applied to the turf area during the operational phase. The proposed agrochemicals applied to the turf and the corresponding application area are summarised in **Table 6.12**.

Table 6.12 Proposed agrochemicals and corresponding application area

Agrochemicals [1]	Turf[3]			
	Green	Tee	Fairway	Rough
Fungicides [3]				
Daconil	✓	✓	✓	✓
Bayleton	✓	✓	✓	✓
Herbicides [3]				
Monosodium Methanearsonate (MSMA)	✓	✓	✓	✓
Roundup/ Glyphosate			[2]	[2]
Monument	✓	✓	✓	✓
Ronstar (Pre-emergence)	✓	✓	✓	✓
Insecticides				
Chlorpyrifos	✓	✓	✓	✓
Fipronil	✓	✓	✓	✓
Fertilizers				
Anderson 18-9-18	✓	✓		
Gypsum/ Dolomite	✓	✓	✓	✓
Ferrous Sulfate	✓	✓	✓	✓
Nitrophoska 12:12:17:2		✓	✓	✓

Notes:

[1] The selection of agrochemicals shall be further reviewed by the operator and documented in the future TMP and reviewed as necessary.

[2] As mentioned in the outline of TMP in **Section 2.7**, mechanical methods (hand weeding) of removing turfgrass weeds will be the primary means of control. Herbicides will only be applied spot by spot in the presence of persistent weeds. Hence the application area is not fixed.

[3] The use of salt water will also be explored as fungi control or weed control.

6.5.2.17 Since not all agrochemicals will be totally absorbed, consumed or decayed during the course of application, there will be residual agrochemicals on the application area which may later potentially be carried away by the turf area runoff.

6.5.2.18 The concentration of residual agrochemicals would generally be higher during the first flush but would be much diluted after raining for a period of time. Most of the residual agrochemicals will be carried away by the first flush which will be stored in the water storage tanks without bypassing to the sea. The remaining residual agrochemicals in turfgrass are generally in a trace amount and will be further diluted by the prolonged and heavy rainfall. These remaining residual agrochemicals if being bypassed to Tolo Harbour will be further diluted in seawater. Given that the retention time of Tolo Harbour is 14.4 days in wet season and 38 days in dry season, any of these trace agrochemicals will be eventually flushed out of Tolo Harbour. Besides, none of the currently proposed agrochemicals are Persistent Organic Pollutants set out in Schedule 1 of Pesticides Ordinance (Cap.133). Hence, there will not be significant accumulation. It should be noted that the import, export, manufacture, sale, supply, possession, use or transhipment (except air transhipment cargo) of all scheduled pesticides is prohibited except under a Pesticide Permit issued by DAFC under Cap. 133. As a conservative approach, the effluent concentration during the first flush stored in water storage tanks would be assessed against the criteria. It is considered that the first flush should contain the most concentrated chemicals whose concentrations in 1 in 20 year and 1 in 50 year storm are the same. Moreover, among the potential pollutants from different water sources in **Table 6.10**, the agrochemicals from the runoff are of the major concern in the water quality assessment. Since not all water sources will contain agrochemicals, the water from WSD and the off-site channel will have a dilution effect to the agrochemicals in the water storage tanks. As a conservative assumption, it is assumed that all water in the water storage tanks is only from the runoff generated from Project Site when evaluating the water quality impact arising from agrochemicals in the following assessment. The detailed assessment for each type of agrochemicals including fungicides, herbicides, insecticides and fertilizers is presented below.

(a) Percentage of Residual Agrochemical in the First Flush

6.5.2.19 To estimate the concentrations of the residual agrochemicals in the first flush stored in water storage tanks, it is essential to appreciate the environmental fate process undergone in the soil. In general, the environmental fate processes of agrochemicals consist of biodegradation, absorption by plants, dissolve in water, wash away by runoff or flow into seepage, etc.

6.5.2.20 To estimate the cumulative effect (i.e. the percentage of residual agrochemicals in the first flush) of the above-mentioned environmental fate process, it is recommended to calculate based on the site monitoring data from local, adjacent golf courses which are anticipated to have similar conditions as the Project and thus would be more representative. After reviewing the publicly available information in the relevant website, it is proposed to adopt the monitoring data in the Proposed Extension of Public Golf Course at Kau Sai Chau Island, Sai Kung EIA Study (hereinafter referred to as “the Kau Sai Chau case”) since it has published its long term (~10 years) monitoring data during the preparation of their EIA. Other existing golf courses such as Clearwater Bay Golf & Country Club, The Hong Kong Golf Club, Discovery Bay Golf Club, Shek O Country Club and The Hong Kong Golf Club (Deep Water Bay) have not published any of their monitoring data in the public domain and they are not within the same geographical zone as the proposed Project. The details are summarized in **Table 6.13**.

Table 6.13 Golf courses in Hong Kong

Golf courses	Data Available in Public Domain	Same Geographical Zone
Kau Sai Chau Golf Course	Yes	Yes
Clearwater Bay Golf & Country Club	No	No
The Hong Kong Golf Club	No	No
Discovery Bay Golf Club	No	No
Shek O Country Club	No	No

Golf courses	Data Available in Public Domain	Same Geographical Zone
The Hong Kong Golf Club (Deep Water Bay)	No	No
Sky City Nine Eagles Golf Course[1]	No	No

Notes:

[1] Sky City Nine Eagles Golf Course has been decommissioned in Year 2015.

6.5.2.21 The Kau Sai Chau case is an EIA Study for a third 18-hole public golf course on Kau Sai Chau in Hong Kong. In Kau Sai Chau case, a Turfgrass Management Plan was also established for the application of agrochemicals (i.e. fungicides, herbicides, insecticides and fertilizers) to the turf area, which was established based on the plan of the previous golf courses.

6.5.2.22 The amount, pattern and frequency of the application of agrochemicals would usually depend on the local conditions such as climate, seasons, meteorological conditions, local fauna and flora of insects, herbs and fungi. Since both Project Site and Kau Sai Chau case are located in the western rural areas of Hong Kong, they share the same geographical zone and thus have the similar local conditions. Therefore, the use of agrochemicals would be similar. In addition, the water quality monitoring of the Kau Sai Chai case was among others the most detailed data of the water quality conditions of a golf course in Hong Kong. The measurement data at water reservoirs used in the Kau Sai Chau case were over 10 years which thus covered various scenarios of the operation of a golf course. Thus, these monitoring data are considered representative and applicable to this study. These data has been used to calculate the percentage of residual agrochemicals at the proposed water storage tanks after the environmental fate process. With the calculated percentage of residual agrochemicals and the specifications of agrochemicals in the outline Turfgrass Management Plan as discussed in **Section 2.7**, the residual agrochemical concentrations in the water storage tanks can be estimated. The detailed discussion of the estimated residual agrochemical concentrations can be found from **Section 6.5.2.24** to **Section 6.5.2.33** and the detailed calculations can be found in **Appendix 6.3**.

6.5.2.23 **Table 6.14** summarises the percentage of residual agrochemicals in the bypass calculated based on the monitoring data from the Kau Sai Chau case.

Table 6.14 Parameters in the Kau Sai Chau case adopted

Agrochemicals	Percentage of Residual Agrochemicals
Fertilizer - TIN	1.6%[1]
Fertilizer - TP	0.6%[1]
Insecticide and Fungicide	0.00072% [2]

Notes:

[1] The residual percentage of fertilizer is obtained based on the nutrient adsorption rate from Appendix 6.2 –Table 10 of the approved Kau Sai Chau EIA (AEIAR-091/2005).

[2] The residual percentage of pesticides is calculated based on the residual mass in water reservoirs and the application loading using the data from Appendix 6.2 – Annex I of the approved Kau Sai Chau EIA (AEIAR-091/2005).

(b) <u>Residual Concentrations of Fungicides and Insecticides</u>

6.5.2.24 In the calculation, the runoff residual load is calculated based on the application rate and application area. The residual fungicide and insecticide concentrations in water storage tanks are calculated by adopting the runoff percentage in the Kau Sai

Chau case. **Table 6.15** summarises the results and the detailed calculation is presented in **Appendix 6.3**.

Table 6.15 Concentrations of fungicides and insecticides in water storage tanks

Agrochemicals	Residual Percentage[1]	Concentration in Water Storage Tanks (mg/L)	Criteria proposed (mg/L)	Compliance
Fungicides				
Daconil	0.00072%	4.2E-05	4.7E-04	Yes
Bayleton	0.00072%	1.5E-05	2.0E-02	Yes
Insecticides				
Chlorpyrifos	0.00072%	1.5E-05	1.7E-05	Yes
Fipronil	0.00072%	7.1E-08	6.8E-04	Yes

Note:

[1] With Reference to the EIA for Proposed Extension of Public Golf Course at Kau Sai Chau Island, Sai Kung.

6.5.2.25 According to the calculated results, the concentration of residual fungicides and insecticides in water storage tanks would comply with the proposed criteria. Adverse water quality impact from the residual fungicides and insecticides is therefore not anticipated.

6.5.2.26 During the bypass, since the water storage tanks would be full already, the surface runoff after such heavy and prolonged rainfall will bypass the water storage tanks, and will be subsequently delivered to Tolo Harbour directly. However, in view of the pre-compliance of the effluent with the proposed criteria in the water storage tanks before bypasses and further dilution of the effluent plume in sea after bypasses, no adverse water quality impact to the WSRs as well as other potential water sensitive receivers outside the assessment area (e.g. fisheries resources) would be anticipated.

(c) Residual Concentrations of Herbicides

6.5.2.27 As mentioned in **Section 6.1.1.13**, mechanical methods (hand weeding) of removing turfgrass weeds will be the primary means of control. The maintenance staff of the golf course will regularly inspect the turfgrass to identify any noticeable weeds as early as possible. Early identification can prevent expansive and persistent growth of herbs and therefore minimize the use of herbicide.

6.5.2.28 As such, with the practices as discussed above, the application of herbicides to the turf area is unlikely unless when expansive and persistent weeds happen to appear in the site. However, it should be noted that the application of herbicide is not a regular practice, and only spot spraying will be adopted in the application. Hence, it is anticipated that the amount of residual herbicides in runoff is not significant and that in the bypass is also insignificant.

(d) Residual Concentrations of Fertilizers

6.5.2.29 Fertilizers proposed for the golf course mainly contain nutrients including nitrogen, phosphorus, etc. and the residual fertilizers will be washed away by surface runoff, which will increase the nitrogen and phosphorus content in the water storage tank.

6.5.2.30 The residual TIN and TP concentration in water storage tanks are calculated by using the nutrient absorption rate in Kau Sai Chau case. **Table 6.16** summarises the results and the detailed calculation is presented in **Appendix 6.3**.

Table 6.16 Concentrations of TIN and TP in water storage tanks

Nutrients	Residual Percentage [1]	Concentration in Water Storage Tanks (mg/L)	Criteria proposed (mg/L) [2]	Compliance
TIN	1.6%	0.108	0.059-0.116	Yes
TP	0.6%	0.039	0.025-0.047	Yes

Note:

[1] With Reference to the EIA for Proposed Extension of Public Golf Course at Kau Sai Chau Island, Sai Kung.

[2] Among the range of the proposed criteria for TIN and TP, the highest values of annual average TIN (0.116 mg/L) and TP (0.047 mg/L) both occur in 2016 which is also year of highest rainfall of the past 21 years and adopted as a reference year for the analysis of consecutive rainfall.

6.5.2.31 It can be seen that the concentrations are within the ranges of the annual mean of TIN and TP in the monitoring data. Adverse water quality impact is therefore not anticipated from the residual fertilizers in the bypass.

6.5.2.32 Apart from that, **Table 6.17** also shows the comparison of the TIN and TP loadings between the stormwater of Tolo Harbour catchment and the stormwater bypass of the proposed development.

Table 6.17 Pollution loading of surface runoff

Parameters	Unit	Surface Runoff Loadings from Tolo Harbour Catchment [1]	Surface Runoff Loadings from the Proposed Development[2]	Proportion of Proposed Development
TIN	kg/d	116.4	0.063	<0.1%
TP	kg/d	38.8	0.023	<0.1%

Note:

[1] The loadings from Tolo Harbour catchment are calculated based on the whole catchment area of Tolo Harbour, rainfall information referenced from the Stormwater Drainage Manual and mean concentrations for stormwater runoff from the approved HATS EIA (AEIAR-121/2008). The detailed calculations of the stormwater loadings from Tolo Harbour catchment is shown in **Appendix 6.4.**

[2] Calculated based on the concentrations of TIN and TP in water storage tanks in, which is the concentration during first flush.

6.5.2.33 According to the results shown in the above table, the proportion of TIN and TP loading contributed from the proposed development during the bypass to the Tolo Harbour are less than 0.1% of the loadings from Tolo Harbour catchment, which are insignificant. Adverse water quality impact is not anticipated from the pollution loading from the proposed development.

(e) Summary of Overall Water Quality Impact of Agrochemicals

6.5.2.34 With a view to minimize the water quality impact arising from the use of agrochemicals, a number of measures and practices have been incorporated in the golf course design from the drainage system to the turfgrass management. A summary of all the water quality assessment viewpoints regarding the proposed measures and practices is shown below

- All the agrochemicals in the first flush from surface runoff will be retained in the water storage tanks and will be recycled for irrigation of turfgrass.
- Even if the agrochemicals in the first flush is anticipated to have higher concentrations, the estimated agrochemical concentration in the first flush stored at the water storage tanks are still in compliance with the relevant assessment criteria.
- With the large volume of the water storage tanks (i.e. equivalent to about 12 Olympic-sized swimming pool), the number of days with bypass events have been significantly minimized.
- The bypass events would mainly occur during extreme weather events (tropical cyclones or red/black rainstorm events) or prolonged rainfall. Most of the residual agrochemicals will have been carried away by the first flush which will be stored in the water storage tanks without bypassing to the sea. The remaining residual agrochemicals in turfgrass are generally in a trace amount and will be further diluted by the prolonged and heavy rainfall. These remaining residual agrochemicals if being bypassed to Tolo Harbour will be further diluted by dispersion in seawater. Therefore, the actual agrochemical concentrations at WSRs are anticipated to be much lower than the estimated agrochemical concentrations in the first flush stored in water storage tanks. Nevertheless, the higher-than-actual estimated agrochemical concentrations are still in compliance with the relevant criteria.
- Since bypass events would be minimized with the water storage tanks in place and the actual agrochemical concentrations are much lower, so the loading of agrochemicals to Tolo Harbour are intermittent and low.
- Given that the retention time of Tolo Harbour is 14.4 days in wet season and 38 days in dry season, any of these trace agrochemicals will be eventually flushed out of Tolo Harbour.
- None of the currently proposed agrochemicals are Persistent Organic Pollutants set out in Schedule 1 of Pesticides Ordinance (Cap.133). Moreover, all the agrochemicals will be subject to review during the detailed design of Turfgrass Management Plan and whether the agrochemical is environmental friendly (e.g. bioaccumulation, half-life, soil absorption rate, etc.) would be one of the important considerations. Hence, there will not be significant accumulation.

6.5.2.35 In short, the estimated agrochemical concentrations would comply with the relevant criteria at sources. If bypass events happen to occur, the actual agrochemicals concentration at WSRs would be much diluted and dispersed and would thus be much lower than the estimated. So no adverse water quality impact is anticipated. And the bypass events would seldom happen (only during extreme weather prolonged rainfall), have an insignificant amount of agrochemicals, flush out of Tolo Harbour and contain no Persistent Organic Pollutants. Therefore, no significant accumulation in Tolo Harbour is anticipated.

Stormwater Bypass – Access Road Runoff

6.5.2.36 There would be a proposed access road along the eastern side of the Project Site which is located next to the Tolo Harbour. The road runoff can be controlled by the best management practices such as properly designed silt traps with appropriate spacing, sufficient cleaning frequency for silt traps and road gullies, etc. will also be implemented. With the best management practices, it is anticipated that the road runoff would be controlled to an acceptable level.

Stormwater Bypass – Landscape Area Runoff

6.5.2.37 As mentioned in **Section 6.5.2.16**, the surface runoff from the landscape area will be collected by the surface channel and drained to the water storage tanks. Unlike turf area, there will not be agrochemicals applied to the landscape area. Thus, adverse water quality impact is not anticipated.

Sewage Effluent

6.5.2.38 As discussed in **Section 2**, in order to allow for more flexible uses and development of the Project to suit contemporary circumstances and operational requirements, the provision for staff quarters and overnight accommodations have been duly considered. For water quality assessment, the worst case development scenario will be presented. Please refer to **Appendix 6.2a** for the detailed assessment demonstrating sufficient capacity of sewerage system for the optional operation of staff quarter and overnight accommodation. After consideration of the planned upgrading works along Ting Kok Road under PWP No. 4403DS (upgrading construction works are anticipated to commence in March 2019 for completion by end 2023), hydraulic assessment indicates that the existing immediate downstream existing sewerage network of the proposed development has adequate capacity to serve both the existing and proposed development. Therefore, no adverse sewerage impacts on the existing/planned sewerage network are anticipated due to the proposed development and no upgrading or expansion of the existing sewerage networks, sewage treatment and disposal facilities for handling, treatment and disposal of wastewater/sewage arising from the Project are required. **Appendix 6.2a**, **Appendix 6.2b** and **Appendix 6.2c** show details of the hydraulic assessment including the projection of the sewage flow from the proposed development, projection of the sewage flow from the upstream other sewerage catchments, assessment of adequacy of the downstream sewerage system. For the sewage flow projection of the proposed development under **Appendix 6.2a,** employee density for various ancillary facilities of the Golf Development has been assumed with reference to other similar Golf Developments as well as Commercial and Industrial Floor Space Utilization Survey (CIFSUS) by Planning Department in 2005. It is also understood that DSD has been carrying out upgrading works along Ting Kok Road under PWP No. 4403DS. Upon completion of that upgrading works, large portion of the upstream Sewage Catchments which are originally discharging to the existing DN600 sewer along Ting Kok Road through the Ting Kok Road Sewage Pumping Station No. 6 to 8, and associated rising mains and gravity sewers, have been conveyed to the downstream Ting Kok Road Sewage Pumping Station No.5 directly through the upgraded Ting Kok Road Sewage Pumping Station No.7 and associated new rising mains and gravity sewers. Close liaison with DSD project team of on-going upgrading works along Ting Kok Road under PWP No. 4403DS will be continued in upcoming detailed design stages of the proposed Golf Development.

6.5.2.39 During the operational phase, there will be sewage generated from the guests and staffs using the proposed ancillary facilities within the golf course, such as the ancillary facilities and other associated facilities. A new sewerage system will be provided to collect and convey the sewage flows generated from the golf course development to the existing sewer manhole. It is proposed that the sewage generated from the Project would be conveyed to Tai Po Sewage Treatment Works (TPSTW). With the proper treatment in TPSTW, it is anticipated that the treated sewage would meet statutory requirements and thereby there would be no adverse water quality impacts.

Wastewater from Ancillary Facilities

6.5.2.40 The wastewater generated from the ancillary facilities of the golf course such as restaurants may have high concentrations of pollutants which may potentially exceed the influent standards of the government sewage treatment plant. For individual commercial/industrial tenants, discharge license under WPCO will be required and the discharge standards according to TM-DSS to government foul sewers will be applied. In order to comply with the discharge standards to public sewerage, pre-treatment may be considered subject to the effluent characteristics. All the sewage and wastewater generated will then be conveyed to the TPSTW for further treatment. No adverse water quality impact is anticipated.

Potential Water Seepage

6.5.2.41 As mentioned in **Section 6.5.2**, the residual agrochemicals may seep into the soil, thereby imposing potential water quality impact to ground water and leachate. The Project Site was once a landfill site and restoration works were implemented after the landfill ceased. A management system for landfill gas and leachate collection system has been operating effectively. To prevent the movement of leachate beyond the landfill site, an impermeable liner collection system has been in place. This impermeable liner also prevents the residual agrochemicals reaching the ground water. Therefore, the potential for ground water contamination is expected to be very low and no adverse effects to ground water is anticipated.

6.5.2.42 Prior to reaching the leachate collection system, the residual agrochemicals seeped into soil will be degraded through various environmental fate processes as mentioned in **Section 6.5.2.1**. As ballpark figures, the concentrations of the residual agrochemicals seeped into soil can be roughly estimated by the concentrations in water tanks, which are much lower compared with the pollutant concentration in leachate in general. Therefore, the residual agrochemicals seeped into soil would not cause significant change to the pollution characteristics of leachate. In addition, a proper drainage system, as mentioned in **Section 6.5.2.1**, will be set up to collect the surface runoff, thereby reducing the potential of residual agrochemicals seeped into soil. In short, the potential impact of the residual agrochemicals to leachate is not anticipated and no adverse effects to leachate is anticipated.

Sewage from Sewage Pumping Station (SPS)

6.5.2.43 There will be one proposed SPS located at the southern part of the Project Site collecting and conveying the sewage flows generated from the Project to the existing sewer through connecting to the existing manhole located in front of main entrance of Project on Ting Kok Road, which will be further conveyed to TPSTW through DSD's public sewerage network. The preliminary assessment indicates that the proposed SPS should be capable of conveying the sewage at the flow rate around 40 L/s, subject to detail design configuration during detailed design stage. In order to prevent the water quality impact arising from the emergency situation of the SPS, various measures to prevent the failure and leakage of the SPS are proposed as follows.

- To prevent the failure of SPS, contingency measures such as dual feed power supply and standby pump would need to be considered in the planning and design of the SPS. Scenarios like power failure, failure of the duty pump, fire or flooding, should be considered. With the above design provision as contingency measures, the risk of failure of SPS is considered to be negligible.
- In case of an extremely unlikely situation that the failure of SPS has occurred, suspension of sewage discharge towards SPS and provision of portable toilet and/or temporary sewage tankers would be considered to prevent sewage from leakage.

6.5.2.44 Given that a basket of measures has been proposed to prevent the failure and leakage of SPS, the water quality impact arising from the emergency situation of SPS is anticipated to be unlikely. Also, it should be noted that the preliminary assessment included the wastewater generated from the operation of staff quarter and overnight accommodation. The sewage amount is small when compared to the nearby sewage catchments. Details could be referred to **Appendix 6.2a**. A further review about the potential water quality impact arising from the SPS should be carried out during the detailed design stage.

6.5.3 Mitigation Measures

Stormwater Bypass

6.5.3.1 To reduce the water quality impact from the stormwater bypass to Tolo Harbour, the following mitigation measures are proposed:

- Design a drainage system to withstand rainstorms of a 50-year return period to reduce the chance of surface overflow.
- Design a water storage tank with a total volume of 30,000m^3 to avoid and limit uncontrolled surface runoff.
- Proper location of outfall (as shown in **Figure 6.2**) from water storage tank to minimize the water quality impact to the WSRs in the vicinity from surface runoff.
- Installation of standard silt traps in drainage system and implementation of best management practices to reduce the impacts of water pollution from access road runoff.

Wastewater from Ancillary Facilities

6.5.3.2 For the ancillary facilities, discharge licenses under WPCO will be required individually and the discharge standards according to TM-DSS to government foul sewers will be applied. In order to comply with the discharge standards to public sewerage, pre-treatment may be considered subject to the effluent characteristics. Compliance with WPCO for discharge of wastewater will thus be ensured.

Sewage from Sewage Pumping Station (SPS)

6.5.3.3 In order to avoid the occurrence of the failure of the SPS, the design of SPS will be cautiously reviewed to consider additional provisions including as follows:

- Dual feed power supply or backup power supply facilities such as diesel generator would be provided in case of power failure to sustain the function of pumping and treatment facilities.
- Standby pumps would be provided in case of unexpected breakdown of pumping facilities such that the standby pumps could take over and function to replace the broken pumps.
- Sewage tanker vehicles (each vehicle can remove $12m^3$ of sewage) could also be considered to remove sewage from the SPS to existing public sewer manhole located in front of main entrance of golf development on Ting Kok Road at during emergency case.

6.5.3.4 Moreover, as the proposed SPS is designed to only serve the Proposed Development, it would be possible to prevent the discharge to the SPS when malfunctions by temporarily suspending the use of some facilities of the Proposed Development if such unlikely catastrophic failure happens. This could prevent the leakage from the SPS. During that period, portable toilets and/or temporary sewage tankers could be considered for temporary service. Therefore, no adverse water quality arising from the SPS is anticipated.

6.5.4 Cumulative Impacts with Concurrent Projects

6.5.4.1 As discussed in **Section 2**, a number of concurrent projects in the vicinity of the Project has been identified. Surface runoff collected will only be bypassed from water storage tanks when there is prolonged rainfall when the daily accumulated rainfall depth exceeds 145mm. With the implementation of the mitigation measures, it is anticipated that the water quality impacts generated would be localized and there would be no adverse cumulative water quality impacts during the operational phase.

6.5.5 Residual Impacts

6.5.5.1 No residual adverse water quality impact is anticipated during the operational phase.

6.6 Conclusion

6.6.1 Construction Phase

6.6.1.1 Construction site runoff and sewage arising from the on-site construction workforce are the key identified environmental impacts. According to the current design, the construction works would be land-based and there would not be any marine works. Water storage tanks of total volume of $30,000m^3$ will be constructed in phases underneath the access road and temporary sedimentation tanks will be installed to intercept the surface runoff. Once one of these water storage tanks are available, they would be used to intercept any surface runoff for sedimentation. Good site practices in accordance with Practice Note for Professional Persons on Construction Site Drainage, Environmental Protection Department, 1994 (ProPECC PN 1/94) would be implemented and proper temporary sanitary facilities (e.g. portable chemical toilet) would be provided to properly collect the on-site sewage generated from the construction workers. With the proper implementation of those good practices and mitigation measures, it is anticipated that there would be no residual adverse water quality impact.

6.6.2 Operational Phase

6.6.2.1 During the operational phase, the stormwater from the surface runoff, sewage effluent and wastewater from ancillary facilities are the key identified environmental impacts. Drainage system and water storage tanks with a total volume of 30,000m^3 which is equivalent to 12 Olympic-sized swimming pools, together with a proper location of outfall sited away from the WSRs are designed to reduce the water quality impact by stormwater bypass. The sewage from the proposed development would be conveyed to TPSTW for treatment. Discharge license and discharge standards according to TM-DSS will be applied for the wastewater from ancillary facilities to comply with WPCO. With the mitigation measures mentioned in **Section 6.5.3** in place, residual adverse water quality impacts are not anticipated.

6.7 Reference

[6-1] The Organization for Economic Co-operation and Development (OECD). 2011. Manual for the Assessment of Chemicals – Chapter 4. Initial Assessment of Data.

[6-2] MSDS of Daconil Action, Syngenta, http://www.greencastonline.com/labels/daconil-action

[6-3] MSDS of Bayleton®50, Backed by Bayer, https://www.backedbybayer.com/golf-course-management/fungicides/bayleton-50/msds-bayleton-50

[6-4] MSDS of Chlorpyrifos 480EC, Arysta LifeScience, http://arystalifescience.co.za/solution/protection-and-nutrition/chlorpyrifos-480-ec/

[6-5] MSDS of Chipco® Choice, Backed by Bayer, https://www.backedbybayer.com/golf-course-management/insecticides/chipco-choice/msds-chipco-choice