# 5 WATER QUALITY IMPACT

## 5.1 Introduction

5.1.1 This section presents an assessment of the potential water quality impacts associated with the construction and operation of the Project. Recommendations for mitigation measures have been provided, where necessary, to minimize the identified water quality impacts to an acceptable level. The water quality impact assessment was conducted in accordance with the requirements in Annexes 6 and 14 of the EIAO-TM and the requirements in Section 3.4.6 and Appendix D of the EIA Study Brief (ESB-323/2019).

## 5.2 Environmental Legislation, Standards and Criteria

Environmental Impact Assessment Ordinance (EIAO)

5.2.1 The EIAO-TM was issued by EPD under Section 16 of the EIAO. The EIAO-TM specifies assessment methodologies and criteria that are to be followed in an EIA Study. Sections relevant to water quality impact assessment comprise:

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

Water Quality Objectives

5.2.2 The Water Pollution Control Ordinance (WPCO) provides the major statutory framework for the protection and control of water quality in Hong Kong. According to the Ordinance and its subsidiary legislation, Hong Kong waters are divided into ten Water Control Zones (WCZs) and four Supplementary Water Control Zones. 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 each WCZ based on their beneficial uses. According to Item 3.4.6.2 of the Study Brief, the assessment areas for this water quality impact assessment covers the Tolo Harbour and Channel WCZ as well as the Victoria Harbour (Phase Two) WCZ as designated under the WPCO. The selected WQOs for the Tolo Harbour and Channel WCZ, Tolo Harbour Supplementary WCZ and Victoria Harbour (Phase Two) WCZ are listed in **Table 5.1 to Table 5.3** respectively.

**Table 5.1 Summary of Key Water Quality Objectives for Tolo Harbour and Channel WCZ**

| Parameters | Objectives | Subzone |
|---|---|---|
| Offensive odour, tints | Not to be present | Whole zone |
| Visible foam, oil scum, litter | Not to be present | Whole zone |
| Dissolved Oxygen (DO) | Not less than 2 mg/L within two metres of the bottom, or not less than 4 mg/L in the remainder of the water column | Marine waters in Harbour Subzone |
| | Not less than 3 mg/L within two metres of the bottom, or not less than 4 mg/L in the remainder of the water column | Marine waters in Buffer Subzone |
| | Not less than 4 mg/L at any point in the water column | Marine waters in Channel Subzone |
| | Not less than 4 mg/L or 40% saturation (at 15℃) 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 |

| Parameters | Objectives | 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 to exceed the normal pH range of 6.5 - 8.5 at any time | Inland Waters in Shing Mun (A, B, C, F, G, H) subzones |
| | Not to 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 ℃ 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. | Marine waters |
| | Not to cause the natural daily temperature range to be extended by greater than ±2.0 ℃ at any location or time. | Inland waters |
| Chemical oxygen demand (COD) | Not to exceed 15 mg/L at any time | Inland Waters in Shing Mun (B, F, G) subzones |
| | Not to exceed 30 mg/L at any time | Inland Waters in Shing Mun (A, C, D, E, H, I) subzones and other watercourses |
| 5-day Biochemical Oxygen Demand ($BOD_5$) | Not to exceed 3 mg/L at any time | Inland Waters in Shing Mun (B, F, G) subzones |
| | Not to exceed 5 mg/L at any time | Inland Waters in Shing Mun (A, C, D, E, H, I) 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) 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 |

| Parameters | Objectives | Subzone |
|---|---|---|
| Colour | Human activity should not cause the colour of water to exceed 50 Hazen units. | Inland waters in SM(A), SM(C), SM(D), SM(E), SM(H), SM(I) and other inland watercourses |
| | Human activity should not cause the colour of water to exceed 30 Hazen units. | Inland waters in SM(B), SM(F) and SM(G) |
| 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 | Marine waters |
| Ammonia Nitrogen ($NH_3$-N) | Not to exceed 0.5 mg/L at any time | Inland waters |
| *E. coli* Bacteria | Not to 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 to exceed 1,000 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) subzones and other watercourses |
| | Not to 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) 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 | Toxic substances in the water 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: Tolo Harbour and Channel Water Control Zone Statement of Water Quality Objectives.
Note: The WQOs for inland waters are only reported for Shing Mun River catchment, which is within the Study Area of this Project. There are 9 subzones of inland waters in Shing Mun River catchment, namely SM(A) to SM(I) respectively, as delineated under Schedule 3 of Cap 358F Tolo Harbour and Channel Water Control Statement of Water Quality Objectives for Watercourses under the WPCO. Please refer to http://www.legislation.gov.hk/blis_pdf.nsf/CurAllEngDoc/D436F5EC4700FCAD482575EE007087E9/$FILE/CAP_358F_e_b5.pdf for the delineation of Shing Mun River Subzone

**Table 5.2 Summary of Key Water Quality Objectives for Tolo Harbour Supplementary WCZ**

| Parameters | Objectives | Subzone |
|---|---|---|
| Offensive odour, tints | Not to be present | Whole zone |
| Visible foam, oil scum, litter | Not to be present | Whole zone |
| *E. coli* Bacteria | Not to exceed 1 per 100mL, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days | Whole zone |
| Colour | Not to exceed 30 Hazen units at any time | Whole zone |
| Dissolved Oxygen (DO) | Not less than 4 mg/L at any time | Whole zone |
| pH | Not to exceed the normal pH range of 6.5 - 8.5 at any time | Whole zone |
| Temperature | Change due to human activity not to exceed 2℃ | Whole zone |
| Salinity | Change due to human activity not to exceed 10% of natural ambient salinity level. | Whole zone |
| Suspended Solids (SS) | Change due to human activity not to cause the annual median level to exceed 20 mg/L | Whole zone |
| 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 |
| 5-day Biochemical Oxygen Demand ($BOD_5$) | Not to exceed 3 mg/L at any time | Whole zone |
| Chemical Oxygen Demand (COD) | Not to exceed 15 mg/L at any time | Whole zone |
| Toxic Substances | Toxic substances in the water 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 (Tolo Harbour Supplementary Water Control Zone).

**Table 5.3 Summary of Key Water Quality Objectives for Victoria Harbour (Phase Two) WCZ**

| Parameters | Objectives | Subzone |
|---|---|---|
| Offensive odour, tints | Not to be present | Whole zone |
| Visible foam, oil scum, litter | Not to be present | Whole zone |
| *E. coli* Bacteria | Not to exceed 1,000 per 100mL, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days | Inland waters |
| Colour | Not to exceed 50 Hazen units at any time | Inland waters |

| Parameters | Objectives | Subzone |
|---|---|---|
| Dissolved Oxygen (DO) within 2 m 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 at any time | 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 units | Marine waters |
| | Not to exceed the normal pH range of 6.0 - 9.0 at any time | 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℃ | Whole zone |
| Suspended Solids (SS) | Not to raise the ambient level by more than 30% caused by human activity nor give rise to accumulation of SS which may adversely affect aquatic communities | Marine waters |
| | 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) | Not to exceed 0.4 mg/L, calculated as annual water column average | Marine waters |
| 5-day Biochemical Oxygen Demand ($BOD_5$) | Not to exceed 5 mg/L at any time | Inland waters |
| Chemical Oxygen Demand (COD) | Not to exceed 30 mg/L at any time | Inland waters |
| Toxic Substances | Toxic substances in the water 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 (Phase Two) Water Control Zone).

Hong Kong Planning Standards and Guidelines

5.2.3 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.

Technical Memorandum on Effluent Discharge Standard (TM-DSS)

5.2.4 Discharge of effluents is subject to control under the WPCO. The "Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters" (TM-DSS) gives guidance on the permissible effluent discharges based on

the type of receiving waters (foul sewers, storm water drains, inland and coastal waters). The standards control the physical, chemical and microbial quality of effluents. Any effluent discharge from the proposed construction and operation activities must comply with the relevant standards as stipulated in the TM-DSS.

5.2.5 The criteria for discharges to inland waters depend upon the beneficial uses of the waters. The majority of the inland water bodies potentially affected by the proposed developments are used for general amenity and secondary contact recreation, which are classified as Group D inland waters. The standards for effluents discharged into Group D inland waters are provided in **Table 5.4** below.

**Table 5.4 Standards for effluents discharged into Group D inland waters (All units in mg/L unless otherwise stated; all figures are upper limits unless otherwise indicated)**

| Flow rate ($m^3$/day)<br>Determinand | ≦200 | >200 and ≦400 | >400 and ≦600 | >600 and ≦800 | >800 and ≦1000 | >1000 and ≦1500 | >1500 and ≦2000 | >2000 and ≦3000 |
|---|---|---|---|---|---|---|---|---|
| pH (pH units) | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 | 6-10 |
| Temperature (℃) | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Colour (lovibond units)(25mm cell length) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Suspended solids | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| BOD | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| COD | 80 | 80 | 80 | 80 | 80 | 80 | 80 | 80 |
| Oil & Grease | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Iron | 10 | 8 | 7 | 5 | 4 | 2.7 | 2 | 1.3 |
| Boron | 5 | 4 | 3.5 | 2.5 | 2 | 1.5 | 1 | 0.7 |
| Barium | 5 | 4 | 3.5 | 2.5 | 2 | 1.5 | 1 | 0.7 |
| Mercury | 0.1 | 0.05 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Cadmium | 0.1 | 0.05 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Other toxic metal individually | 1 | 1 | 0.8 | 0.8 | 0.5 | 0.5 | 0.2 | 0.2 |
| Total Toxic metals | 2 | 2 | 1.6 | 1.6 | 1 | 1 | 0.5 | 0.4 |
| Cyanide | 0.4 | 0.4 | 0.3 | 0.3 | 0.2 | 0.1 | 0.1 | 0.05 |
| Phenols | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Sulphide | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Sulphate | 800 | 600 | 600 | 600 | 600 | 400 | 400 | 400 |
| Chloride | 1000 | 800 | 800 | 800 | 600 | 600 | 400 | 400 |
| Fluoride | 10 | 8 | 8 | 8 | 5 | 5 | 3 | 3 |
| Total phosphorus | 10 | 10 | 10 | 8 | 8 | 8 | 5 | 5 |
| Ammonia nitrogen | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 10 |
| Nitrate + nitrite nitrogen | 50 | 50 | 50 | 30 | 30 | 30 | 30 | 20 |
| Surfactants (total) | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |

| Flow rate ($m^3$/day) / Determinand | ≦200 | >200 and ≦400 | >400 and ≦600 | >600 and ≦800 | >800 and ≦1000 | >1000 and ≦1500 | >1500 and ≦2000 | >2000 and ≦3000 |
|---|---|---|---|---|---|---|---|---|
| *E. coli* (count/100ml) | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |

Source from Table 6 of TM-DSS, EPD

Professional Persons Environmental Consultative Committee Practice Notes (ProPECC PNs)

5.2.6 The Environmental Protection Department (EPD) has issued the Professional Persons Environmental Consultative Committee Practice Note on Construction Site Drainage (ProPECC PN 1/94) to provide guidelines for handling and disposal of construction site discharges. Practices outlined in ProPECC PN 1/94 shall be closely followed to control site runoff and wastewater generated during the construction phase of the proposed Project so as to minimize potential water quality impacts associated with construction site discharges.

5.2.7 The ProPECC PN 5/93 on Drainage Plans Subject to Comment by the EPD 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 new development area should follow the relevant guidelines and practices as given in the ProPECC PN 5/93.

ETWB Technical Circular (Works) No. 5/2005 Protection of Natural Streams/Rivers from Adverse Impacts Arising from Construction Works

5.2.8 ETWB Technical Circular (Works) No. 5/2005 provides an administrative framework to better protect all natural streams/rivers from the impacts of construction works. The procedures promulgated under this Circular aim to clarify and strengthen existing measures for protection of natural streams/rivers from government projects and private developments. The guidelines and precautionary mitigation measures given in the ETWB TC (Works) No. 5/2005 should be followed as far as possible to protect the inland watercourse at or near the Project area during the construction phase.

Guidelines for the Design of Small Sewage Treatment Plants

5.2.9 The "*Guidelines for the Design of Small Sewage Treatment Plants*" have been prepared with a view to providing Authorized Persons and designers with general advice on the design of small sewage treatment plants (STP). The guidelines highlight the importance of good plant design, which among other objectives, should aim to make future operation easy and reliable.

## 5.3 Description of Environment

Study Area

5.3.1 According to Section 3.4.6.2 of the Study Brief, the study area for this water quality impact assessment included areas within 500m from the boundary of the Project and covered the Tolo Harbour and Channel WCZ and Victoria Harbour (Phase Two) WCZ as designated under the WPCO.

5.3.2 The baseline conditions of the water bodies in the study area were established with reference to the routine river and marine water quality monitoring data collected by EPD, their corresponding monitoring locations are indicated in **60604728/R42b/Figure 5.1**. Descriptions of the baseline conditions provided in the subsequent sections are extracted from the EPD's reports "*River Water Quality in Hong Kong in 2020*" and "*Marine Water Quality in Hong Kong in 2020*".

Marine Water

*Water Quality in Victoria Harbour*

5.3.3 The marine water quality monitoring results at stations in vicinity of the Project, namely VM4 and VM5 are shown in **Table 5.5** below. Full compliances with the WQO was recorded at the two selected EPD stations for TIN, DO (depth average and bottom) and UIA in 2020.

**Table 5.5 Baseline Water Quality Condition for Victoria Harbour WCZ in 2020**

| Parameters | | Victoria Harbour (Central) | | WPCO WQO (in marine waters) |
|---|---|---|---|---|
| | | VM4 | VM5 | |
| Temperature (℃) | | 24.5 (19.6 - 28.9) | 24.2 (19.0 - 29.0) | Change due to waste discharge not to exceed 2 ℃ |
| Salinity | | 31.4 (28.7 - 33.1) | 30.9 (27.4 - 33.1) | Change due to waste discharge not to exceed 10% of natural ambient level |
| Dissolved Oxygen (DO) (mg/L) | Depth Average | 5.7 (4.4 - 6.9) | 5.6 (4.5 - 6.6) | Not less than 4 mg/L for 90% of the samples |
| | Bottom | 5.6 (4.0 - 6.9) | 5.4 (3.4 - 6.8) | Not less than 2 mg/L for 90% of the samples |
| Dissolved Oxygen (% Saturation) | Depth Average | 81 (64 - 92) | 79 (65 - 92) | Not available |
| | Bottom | 78 (40 - 96) | 74 (30 - 95) | Not available |
| pH | | 7.9 (7.5 - 8.1) | 7.9 (7.6 - 8.1) | 6.5 - 8.5 (± 0.2 from natural range) |
| Secchi Disc Depth (m) | | 2.4 (2.0 - 3.1) | 2.5 (1.8 - 3.0) | Not available |
| Turbidity (NTU) | | 3.4 (1.2 - 6.4) | 3.2 (1.7 - 4.8) | Not available |
| Suspended Solids (SS) (mg/L) | | 7.1 (1.6 - 14.3) | 7.7 (2.2 - 13.9) | Not more than 30% increase |
| 5-day Biochemical Oxygen Demand ($BOD_5$) (mg/L) | | 0.8 (0.3 - 1.6) | 0.8 (0.3 - 2.0) | Not available |
| Ammonia Nitrogen (mg/L) | | 0.112 (0.033 - 0.207) | 0.138 (0.050 - 0.203) | Not available |
| Unionized Ammonia (UIA) (mg/L) | | 0.004 (<0.001 - 0.007) | 0.005 (0.001 - 0.009) | Not more than 0.021 mg/L for annual mean |
| Nitrite Nitrogen (mg/L) | | 0.028 (0.007 - 0.070) | 0.027 (0.009 - 0.090) | Not available |
| Nitrate Nitrogen (mg/L) | | 0.149 (0.051 - 0.287) | 0.161 (0.059 - 0.377) | Not available |
| Total Inorganic Nitrogen (TIN) (mg/L) | | 0.29 (0.15 - 0.45) | 0.33 (0.18 - 0.61) | Not more than 0.4 mg/L for annual mean |

| Parameters | Victoria Harbour (Central) | | WPCO WQO (in marine waters) |
|---|---|---|---|
| | VM4 | VM5 | |
| Total Kjeldahl Nitrogen (mg/L) | 0.62 (0.35 - 1.07) | 0.63 (0.21 - 1.20) | Not available |
| Total Nitrogen (mg/L) | 0.80 (0.55 - 1.19) | 0.82 (0.49 - 1.34) | Not available |
| Orthophosphate Phosphorus ($PO_4$-P) (mg/L) | 0.019 (0.011 - 0.032) | 0.018 (0.006 - 0.033) | Not available |
| Total Phosphorus (mg/L) | 0.06 (0.03 - 0.08) | 0.05 (0.03 - 0.08) | Not available |
| Silica (as $SiO_2$) (mg/L) | 1.01 (0.33 - 1.77) | 0.99 (0.32 - 2.10) | Not available |
| Chlorophyll-*a* (µg/L) | 3.1 (0.4 - 12.1) | 3.0 (0.2 - 15.3) | Not available |
| *E. coli* (cfu/100mL) | 290 (27 - 1200) | 490 (79 - 5500) | Not available |
| Faecal Coliforms (cfu/100mL) | 740 (89 - 4100) | 1200 (190 - 8800) | Not available |

Note: 1. Data source: EPD Marine Water Quality in Hong Kong in 2020
2. Unless otherwise specified, data presented are depth-averaged values calculated by taking the means of three depths: Surface, Mid-depth, Bottom.
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.
5. cfu – colony forming unit.

*Trend of Water Quality in Victoria Harbour*

5.3.4 The overall WQO compliance rate of Victoria Harbour WCZ in 2020 was 90%. The WQO compliance rate for DO and UIA in 2020 were both 100%. 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.

5.3.5 The TIN compliance rate fluctuates year to year under the influence of regional TIN level in the entire Pearl River Estuary, local urban surface run-offs and Stonecutters Island Sewage Treatment Works (SCISTW) discharges. The regional influence was also observed in the monitoring data for North Western, Southern and Western Buffer WCZs. On the other hand, unionized ammonia nitrogen, *E. coli*, $PO_4$-P and $BOD_5$ levels showed decreasing trends over the past 30 years.

5.3.6 The *E. coli* level in the eastern side of Victoria Harbour has markedly decreased since the Harbour Area Treatment Scheme (HATS) Stage 1 commissioned in December 2001. With full commissioning of the HATS Stage 2A in December 2015, the *E. coli* level of the central harbour area has been further reduced.

*Water Quality in Tolo Harbour*

5.3.7 The marine water quality monitoring results at station in vicinity of the Project, namely TM2 is shown in **Table 5.6** below. Full compliances with the WQO was recorded at the selected EPD station TM2 for DO (depth average and bottom), chlorophyll-a and *E. coli* in 2020.

**Table 5.6 Baseline Water Quality Condition for Tolo Harbour and Channel WCZ in 2020**

| Parameters | | Harbour Subzone | WPCO WQO (in marine waters) |
|---|---|---|---|
| | | TM2 | |
| Temperature (℃) | | 26.3 (20.6 - 29.8) | Change due to waste discharge not to exceed ±1℃ and not to exceed 0.5 ℃ per hour at any location |
| Salinity | | 29.9 (24.8 - 32.8) | Change due to waste discharge not to be greater than ±3ppt at any time |
| Dissolved Oxygen (DO) (mg/L) | Depth Average | 6.1 (5.1 - 7.9) | Not less than 4 mg/L in the water column (except for the bottom water within 2 m from the seabed) |
| | Bottom | 6.2 (4.5 - 8.3) | Not less than 2 mg/L within 2 m from the seabed |
| Dissolved Oxygen (% Saturation) | Depth Average | 89 (73 - 112) | Not available |
| | Bottom | 90 (70 - 120) | Not available |
| pH | | 8.0 (7.7 - 8.3) | Change due to waste discharge not to be greater than ±0.5 pH units at any time. |
| Secchi Disc Depth (m) | | 2.4 (1.6 - 3.4) | Not available |
| Turbidity (NTU) | | 3.1 (1.5 - 5.5) | Not available |
| Suspended Solids (SS) (mg/L) | | 8.1 (1.4 - 17.0) | Not available |
| 5-day Biochemical Oxygen Demand ($BOD_5$) (mg/L) | | 1.7 (0.8 - 2.6) | Not available |
| Ammonia Nitrogen (mg/L) | | 0.045 (0.022 - 0.076) | Not available |
| Unionized Ammonia (UIA) (mg/L) | | 0.003 (<0.001 - 0.005) | Not available |
| Nitrite Nitrogen (mg/L) | | 0.004 (<0.002 - 0.010) | Not available |
| Nitrate Nitrogen (mg/L) | | 0.039 (<0.002 - 0.215) | Not available |
| Total Inorganic Nitrogen (TIN) (mg/L) | | 0.09 (0.03 - 0.27) | Not available |
| Total Kjeldahl Nitrogen (mg/L) | | 0.50 (0.22 - 0.81) | Not available |
| Total Nitrogen (mg/L) | | 0.54 (0.29 - 0.82) | Not available |
| Orthophosphate Phosphorus ($PO_4$-P) (mg/L) | | 0.008 (0.002 - 0.026) | Not available |

| Parameters | Harbour Subzone | WPCO WQO (in marine waters) |
|---|---|---|
| | TM2 | |
| Total Phosphorus (mg/L) | 0.04 (<0.02 - 0.06) | Not available |
| Silica (as $SiO_2$) (mg/L) | 1.48 (0.50 - 4.15) | Not available |
| Chlorophyll-*a* (µg/L) | 5.8 (1.4 - 9.2) | Harbour Subzone: Not to exceed 20 µg/L, calculated as a running arithmetic mean of 5 daily measurements for any single location and depth. |
| *E. coli* (cfu/100mL) | 13 (<1 - 4500) | Not to exceed 610 cfu/100mL for geometric mean of all samples collected in one calendar year |
| Faecal Coliforms (cfu/100mL) | 76 (6 - 32000) | Not available |

Note: 1. Data source: EPD Marine Water Quality in Hong Kong in 2020
2. Unless otherwise specified, data presented are depth-averaged values calculated by taking the means of three depths: Surface, Mid-depth, Bottom.
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.
5. cfu – colony forming unit.

*Trend of Water Quality in Tolo Harbour*

5.3.8 The monitoring results of key water quality parameters indicate that the overall WQO compliance rate of the Tolo Harbour and Channel WCZ in 2020 was 93%. Tolo Harbour consistently complied with the bacteriological WQO for secondary contact recreational uses applicable to the entire marine waters of the WCZ. Tolo Channel, however, was subject to a natural hydrological phenomenon of water column stratification and associated lower bottom DO level due to restricted water exchange with the open waters.

5.3.9 In the mid-1980s, with the implementation of the Tolo Harbour Action Plan, which includes the control of livestock waste, the provision and improvement of sewerage, the export of treated sewage effluent from Sha Tin and Tai Po Sewage Treatment Works outside Tolo Harbour for discharging into Victoria Harbour via Kai Tak River, as well as the extension of village sewerage in the catchment area, there has been a steady improvement in water quality in Tolo Harbour in the past three decades.

Inland Water

*Water Quality in Shing Mun River and its Tributaries*

5.3.10 Section of Shing Mun River, and its tributaries including Kwun Yam Shan Stream and Tin Sum Nullah are located within the study area, the corresponding water quality monitoring results at stations, namely TR19I, KY1 (closest to the Project Site) and TR20B, are shown in **Table 5.7** below.

**Table 5.7 Baseline Water Quality Condition for Shing Mun River and its Tributaries in 2020**

| Parameters | Shing Mun Main Channel | Kwun Yam Shan Stream | Tin Sum Nullah | WPCO WQO (in inland waters) |
|---|---|---|---|---|
| | TR19I | KY1 | TR20B | |
| Dissolved Oxygen (DO) (mg/L) | 6.7 (4.4 - 8.0) | 8.1 (7.9 - 9.2) | 7.9 (7.7 - 8.9) | ≥ 4 mg/L or 40% saturation (at 15℃) |
| pH | 8.1 (7.6 - 8.9) | 8.4 (8.2 - 8.8) | 7.7 (6.8 - 8.9) | within 6.0 - 9.0 for TR19I; within 6.5 - 8.5 for KY1 and TR20B |
| Suspended Solids (SS) (mg/L) | 3.5 (1.4 - 16.0) | 5.3 (2.4 - 9.3) | 0.5 (<0.5 - 1.1) | Annual median: ≤ 25 mg/L, for TR19I; ≤ 20 mg/L, for KY1 and TR20B |
| 5-day Biochemical Oxygen Demand ($BOD_5$) (mg/L) | 3.1 (1.7 - 8.5) | 0.5 (<0.1 - 1.1) | <0.1 (<0.1 - 0.4) | ≤ 5 mg/L, for TR19I and TR20B; ≤ 3 mg/L, for KY1 |
| Chemical Oxygen Demand (COD) (mg/L) | 13 (8 - 24) | 4 (<2 - 7) | 5 (<2 - 9) | ≤ 30 mg/L, for TR19I and TR20B; ≤ 15 mg/L, for KY1 |
| Oil & Grease (mg/L) | <0.5 (<0.5 - <0.5) | <0.5 (<0.5 - <0.5) | <0.5 (<0.5 - <0.5) | Not available |
| *E. coli* (cfu/100mL) | 140 (40 - 630) | 87 (30 - 330) | <1 (<1 - <1) | running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days (or 14 and 42 days): ≤ 1,000 cfu/100mL, for TR19I and TR20B; ≤ 0 cfu/100mL, for KY1 |
| Faecal Coliforms (cfu/100mL) | 2,500 (810 – 56,000) | 800 (160 – 3,800) | <1 (<1 - <1) | Not available |
| Ammonia Nitrogen (mg/L) | 0.130 (0.058 - 0.230) | 0.023 (0.015 - 0.032) | 0.034 (0.014 - 0.180) | ≤ 0.5 mg/L |
| Nitrate Nitrogen (mg/L) | 0.130 (0.014 - 0.510) | 0.305 (0.140 - 0.650) | 0.910 (0.470 - 1.800) | Not available |
| Total Kjeldahl Nitrogen (mg/L) | 0.58 (0.22 - 0.92) | 0.13 (<0.05 - 0.34) | 0.20 (<0.05 - 0.29) | Not available |
| Orthophosphate Phosphorus ($PO_4$-P) (mg/L) | 0.027 (0.014 - 0.047) | 0.054 (0.009 - 0.088) | 0.012 (0.007 - 0.130) | Not available |
| Total Phosphorus (mg/L) | 0.05 (0.04 - 0.40) | 0.10 (0.08 - 0.13) | 0.02 (<0.02 - 2.50) | Not available |

| Parameters | Shing Mun Main Channel | Kwun Yam Shan Stream | Tin Sum Nullah | WPCO WQO (in inland waters) |
|---|---|---|---|---|
| | TR19I | KY1 | TR20B | |
| Sulphide (mg/L) | <0.02 (<0.02 - <0.02) | <0.02 (<0.02 - <0.02) | <0.02 (<0.02 - <0.02) | Not available |
| Aluminium (Al) (µg/L) | <50 (<50 - <50) | 93 (<50 - 267) | 64 (<50 - 210) | Not available |
| Cadmium (Cd) (µg/L) | <0.1 (<0.1 - <0.1) | <0.1 (<0.1 - <0.1) | <0.1 (<0.1 - 0.7) | Not available |
| Chromium (Cr) (µg/L) | 2 (2 - 4) | <1 (<1 - <1) | <1 (<1 - <1) | Not available |
| Copper (Cu) (µg/L) | 5 (3 - 6) | <1 (<1 - 1) | 1 (<1 - 3) | Not available |
| Lead (Pb) (µg/L) | <1 (<1 - <1) | <1 (<1 - <1) | <1 (<1 - <1) | Not available |
| Zinc (Zn) (µg/L) | <10 (<10 - 16) | <10 (<10 - <10) | <10 (<10 - 13) | Not available |
| Flow ($m^3/s$) | NM | 0.008 (0.001 - 0.046) | 0.024 (0.015 - 0.098) | Not available |

Note: 1. Data source: EPD River Water Quality in Hong Kong in 2020
2. Data presented are in annual medians of monthly samples; except those for faecal coliforms and *E. coli* and which are in annual geometric means.
3. Figures in brackets are annual ranges.
4. "NM" indicates no measurement taken.
5. cfu – colony forming unit

*Trend of Water Quality in Shing Mun River and its Tributaries*

5.3.11 Shing Mun River, a major river which has three main tributaries and runs through the densely populated Sha Tin urban area, showed marked improvement during the past three decades. The WQO compliance rate of Shing Mun River was 90% in 2020.

5.3.12 Shing Mun River Main Channel (TR19I) is currently used for secondary contact recreation activities in Hong Kong, was rated "Excellent" in 2020, while it was rated "Good" in 2019.

*Water Quality in Kai Tak River*

5.3.13 Project Area at the Kowloon side of the Lion Rock Tunnel falls within the catchment area of Kai Tak River. The water quality monitoring results at station in vicinity of the Project, namely KN7 is shown in **Table 5.8** below. Kai Tak River had a WQO compliance rate of 85% in 2020, four monitoring stations in Kai Tak River maintained "Good" while two downstream stations were graded as "Fair" in 2020.

**Table 5.8 Baseline Water Quality Condition for Kai Tak River in 2020**

| Parameters | Kai Tak River | WPCO WQO (in inland waters) |
|---|---|---|
| | KN7 | |
| Dissolved Oxygen (DO) (mg/L) | 7.2 (6.9 - 7.9) | ≥ 4 mg/L |

| Parameters | Kai Tak River | WPCO WQO (in inland waters) |
|---|---|---|
| | KN7 | |
| pH | 7.2 (7.1 - 7.6) | within 6.0- 9.0 |
| Suspended Solids (SS) (mg/L) | 6.7 (4.1 - 11.0) | Annual median ≤ 25 mg/L |
| 5-day Biochemical Oxygen Demand ($BOD_5$) (mg/L) | 9.1 (2.7 - 11.0) | ≤ 5 mg/L |
| Chemical Oxygen Demand (COD) (mg/L) | 27 (10 - 32) | ≤ 30 mg/L |
| Oil & Grease (mg/L) | <0.5 (<0.5 - <0.5) | Not available |
| *E. coli* (cfu/100mL) | 3 300 (1 100 - 12 000) | The geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days: ≤ 1,000 cfu/100mL |
| Faecal Coliforms (cfu/100mL) | 6 400 (2 400 - 56 000) | Not available |
| Ammonia Nitrogen (mg/L) | 1.400 (0.360 - 3.900) | Not available |
| Nitrate Nitrogen (mg/L) | 3.700 (2.600 - 4.500) | Not available |
| Total Kjeldahl Nitrogen (mg/L) | 4.20 (0.96 - 5.30) | Not available |
| Orthophosphate Phosphorus ($PO_4$-P) (mg/L) | 0.700 (0.490 - 1.300) | Not available |
| Total Phosphorus (mg/L) | 1.30 (0.55 - 1.60) | Not available |
| Sulphide (mg/L) | <0.02 (<0.02 - <0.02) | Not available |
| Aluminium (Al) (µg/L) | <50 (<50 - 78) | Not available |
| Cadmium (Cd) (µg/L) | <0.1 (<0.1 - <0.1) | Not available |
| Chromium (Cr) (µg/L) | 1 (<1 - 2) | Not available |
| Copper (Cu) (µg/L) | 3 (2 - 4) | Not available |
| Lead (Pb) (µg/L) | <1 (<1 - <1) | Not available |
| Zinc (Zn) (µg/L) | 14 (11 - 21) | Not available |
| Flow ($m^3/s$) | 2.760 (1.166 - 4.572) | Not available |

*Trend of Water Quality in Kai Tak River*

5.3.14 The water quality of the Kai Tak River improved from mostly "Very Bad" in 1986 to "Good" and "Fair" in 2020. The *E. coli* level in rivers in the Kowloon district has been reduced by over 90% compared with 1999. It was expected that the water quality of Kai Tak River would further improve, upon completion of the sewerage repair and upgrading works in the river catchment area by the DSD and other improvement works in the Kai Tak Development Area by the CEDD.

## 5.4 Water Sensitive Receivers

5.4.1 According to Item 3.4.6.2 of the Study Brief, the assessment area for this water quality impact assessment includes areas within 500 metres from the boundary of the Project and covers the Tolo Harbour and Channel WCZ as well as the Victoria Harbour (Phase Two) WCZ as designated under the WPCO and the water sensitive receivers (WSRs) in the vicinity of the Project. WSRs within the study area were identified with reference to Annex 14 of the EIAO-TM.

5.4.2 Key WSRs within 500m from the boundary of the Project were identified at **Table 5.9** below and their respective locations are illustrated in **60604728/R42b/Figure 5.2**.

**Table 5.9 Water Sensitive Receivers**

| ID | Location | Nature | Description |
|---|---|---|---|
| S1 | Mau Tsai Shan | Natural watercourse | Moderate flow rate and comprised of natural sandy and rocky substratum.<br>Permanent flow from south to north, finally discharged to Shing Mun River. |
| S2 | Sha Tin Tau New Village | Semi-natural watercourse | Natural at the upper section. Section at Sha Tin Tau New Village has modified concrete bank but natural rocky substratum.<br>Permanent flow from south to north, finally discharged to Shing Mun River. |
| S3 | Kak Tin Village | Natural watercourse | Joins with S4 before discharging to a modified channel. Low to moderate flow and comprised of natural sandy and rocky substratum.<br>Permanent flow from south to north, finally discharged to Shing Mun River. |
| S4 | Hung Mui Kuk Village | Natural watercourse | Joins with S3 before discharging to a modified channel. Low to moderate flow and comprised of natural sandy and rocky substratum.<br>Permanent flow from south to north, finally discharged to Shing Mun River. |
| S5 | Hung Mui Kuk Picnic Site | Natural watercourse | Joins two tributaries to a channelised lower section near Lion Rock Tunnel Road.<br>Permanent flow from south to north, finally discharged to Shing Mun River. |
| S6 | Lion Rock towards Tei Lung Hau | Natural watercourse | Flow from Lion Rock and comprised of natural rocky substratum.<br>Permanent flow from south to north, finally discharged to Shing Mun River. |
| S7 | Beacon Hill towards Lion Rock Tunnel Shatin Portal | Natural watercourse | Moderate flow from Beacon Hill into a nullah. Comprised of natural sandy and rocky substratum. |

| ID | Location | Nature | Description |
|---|---|---|---|
| | | | Permanent flow from south to north, finally discharged to Shing Mun River. |
| S8 | Beacon Hill towards Tei Lung Hau | Semi-natural watercourse | Middle section at east of Shatin South Fresh Water Service Reservoir is channelised. Comprised of natural sandy and rocky substratum.<br>Permanent flow from south to north, finally discharged to Shing Mun River. |
| S9 | Beacon Hill towards Tin Sum Nullah | Semi-natural watercourse | Natural at the upper section. Joins Tin Sum Nullah near Shatin Water Treatment Works. One of the tributaries of Shing Mun River.<br>Permanent flow from south to north, finally discharged to Shing Mun River. |
| SW1 | Within Lion Rock Country Park | Natural watercourse | Natural seasonal watercourse which joins with S4 at Hung Mui Kuk, predominantly dry, no evident surface flow was observed during dry and wet seasons. |
| SW2 | Within Lion Rock Country Park | Natural watercourse | Natural seasonal watercourse, predominantly dry, no evident surface flow was observed during dry and wet seasons. |
| SW3 | Within Lion Rock Country Park | Natural watercourse | Natural seasonal watercourse, predominantly dry, no evident surface flow was observed during dry and wet seasons. |
| SW4 | Within Lion Rock Country Park | Natural watercourse | Natural seasonal watercourse which joins with WC8 near Lion Rock Tunnel Road, predominantly dry, no evident surface flow was observed during dry and wet seasons. |
| SW5 | Watercourse west of Lion Rock Park | Natural watercourse | Natural seasonal watercourse with flow running from north to south, finally discharged to Victoria Harbour. |
| SW6 | Watercourse west of Lion Rock Park | Natural watercourse | Natural seasonal watercourse with flow running from north to south, finally discharged to Victoria Harbour. |
| WC1 | Catchwater | Channelised watercourse | Catchwater which lead to Kowloon Reservoir. |
| WC2 | Watercourse southeast of Ha Keng Hau | Channelised watercourse | Concrete step-channel with very limited water flow.<br>Seasonal flow from south to north, finally discharged to Shing Mun River. |
| WC3 | Watercourse south of LRT Toll Plaza | Channelised watercourse | Concrete banks and discharges to an underground culvert. No water flow was observed.<br>Seasonal flow from south to north, finally discharged to Shing Mun River. |
| WC4 | Watercourse west of Lion Rock Park | Semi-natural watercourse | Natural at the upper section. Section near the service reservoir is channelised which discharges to an underground culvert. Received shallow water occasionally.<br>Seasonal flow from north to south, finally discharged to Kai Tak River. |
| WC5 | Watercourse west of Lion Rock Park | Semi-natural watercourse | Natural at the upper section. Section near the Kowloon Portal is channelised which discharges to an underground culvert. Received shallow water occasionally. |

| ID | Location | Nature | Description |
|---|---|---|---|
| | | | Seasonal flow from north to south, finally discharged to Kai Tak River. |
| WC6 | Watercourse west of Lion Rock Park | Channelised watercourse | Concrete banks and discharges to an underground culvert. Received shallow water occasionally.<br>Seasonal flow from north to south, finally discharged to Kai Tak River. |
| WC7 | Watercourse west of Lion Rock Park | Channelised watercourse | Concrete banks and discharges to an underground culvert. Received shallow water occasionally.<br>Seasonal flow from north to south, finally discharged to Kai Tak River. |
| WC8 | Within Lion Rock Country Park | Channelised watercourse | Modified watercourse which joins with SW4 near Lion Rock Tunnel Road, predominantly dry. |
| WC9 | Watercourse south of Tin Ma Court | Channelised watercourse | Concrete banks with limited water flow.<br>Seasonal flow from north to south, finally discharged to Kai Tak River. |
| WC10 | Watercourse north of Tin Ma Court | Channelised watercourse | Concrete banks with limited water flow.<br>Seasonal flow from north to south, finally discharged to Kai Tak River. |
| WC11 | Watercourse near Sha Tin Tau | Channelised watercourse | Concrete modified watercourse with very limited water flow.<br>Seasonal flow from south to north, finally discharged to Shing Mun River. |
| WC12 | Watercourse near Golden Lion Garden | Channelised watercourse | Concrete modified watercourse with very limited water flow.<br>Seasonal flow from south to north, finally discharged to Shing Mun River. |
| WC13 | Watercourse north of Lion Rock Park | Semi-natural watercourse | Natural at the upper section. Section near the service reservoir is channelised which discharges to an underground culvert. With limited water flow.<br>Seasonal flow from north to south, finally discharged to Kai Tak River. |
| WC14 | Watercourse west of Lion Rock Park | Semi-natural watercourse | Natural at the upper section. Section near the service reservoir is channelised.<br>Seasonal flow from north to south, finally discharged to Victoria Harbour. |
| WC15 | Watercourse near Jade Garden | Channelised watercourse | Concrete banks with limited water flow.<br>Seasonal flow from north to south, finally discharged to Victoria Harbour. |
| P1 | Ponds near Sha Tin Tau New Village | Concrete ponds | Small inactive ponds near the village housing at Sha Tin Tau New Village. |
| P2 | Ponds near Sha Tin Tau New Village | Concrete ponds | Small inactive ponds near the village housing at Sha Tin Tau New Village. |
| S10 | Within Lion Rock Country Park | Water Gathering Ground | Rainwater is collected via catchwaters and is then stored in Kowloon Reservoir. |

| ID | Location | Nature | Description |
|---|---|---|---|
| S11 | Beacon Hill | Site of Special Scientific Interest | Designated as a SSSI because of its rich floral diversity and the rare ferns and unusual orchids. |
| S12 | Lion Rock Country Park | Country Park | - |

5.4.3 Tin Sum Nullah (part of S9) is one of the tributaries of Shing Mun River. The main channel of Shing Mun River is currently used for secondary contact recreation activities, it runs through the densely populated Shatin urban areas and drains into Tolo Harbour. There are natural streams (S2 to S9) running across the Sha Tin Tau New Village and Lion Rock Country Park. A number of streams (S1 to S9) also runs down from the hills (Kwun Yam Shan, Tei Lung Hau, Beacon Hill, Lion Rock, Unicorn Ridge and Temple Hill). As shown in **60604728/R42b/Figure 5.2**, S7 and S8 are watercourses located in close proximity to the project site while S2 to S6 are watercourses running underneath the project site. The small section of S7 near an engineered slope crest above the Lion Rock Tunnel Shatin portals is located approximately 20 m from the Project footprint and would not be directly affected by construction works. Although some of the sections of S3 and S5 are located within works boundary, there is no construction works to be conducted at/within S3 and S5.

5.4.4 SW1, SW2, SW3 and SW4 are natural seasonal watercourses at Shatin side running underneath the project site. These seasonal watercourses are predominantly dry and no evident surface flow was observed during dry and wet seasons. Although some of the sections of SW1 are located within works boundary, there is no construction works to be conducted at/within SW1. SW5 and SW6 is a natural seasonal watercourse at Kowloon side which originate from the hillslope area of Beacon Hill and finally leading to Victoria Harbour.

5.4.5 WC1, WC2, WC3, WC8, WC11 and WC12 are all channelized watercourses at Shatin side. WC1 is a concretized rectangular catchwater located within Lion Rock Country Park in close proximity to the project site which convey catchwater to the Kowloon Reservoir. WC1 is located at a higher elevation than the aboveground works. WC2, located southeast of Ha Keng Hau, is a concrete step-channel with very limited water flow. WC3 is a small concrete nullah located at south of the Lion Rock Tunnel toll plaza within the project site. There is no construction works to be conducted at/within WC3. No water flow was observed at this modified watercourse. A modified watercourse WC8 linked to SW4 is a dry nullah which located within Lion Rock Country Park. WC11 and WC12 are channelized watercourses with flow finally leading to Shing Mun River.

5.4.6 WC4 to WC7, WC9, WC10 and WC13 to WC15 are semi-natural and/or channelized watercourses at Kowloon side. WC4, WC5, WC13 and WC14 are semi-natural watercourses (upper section is natural and modified to channel near service reservoir) in close proximity to the project site which discharge to an underground culvert. WC6 and WC7 are channelized watercourses in close proximity to the project site with concrete banks and discharge to an underground culvert. Although some of the sections of WC4 to WC7 are located within works boundary, there is no construction works to be conducted at/within WC4 to WC7. WC9, WC10 and WC15 are channelized watercourses near Jade Garden and Tin Ma Court. These watercourses (WC4 to WC7, WC9 and WC10) only contained limited water flow.

5.4.7 P1 and P2 are small inactive ponds which located near the village housing at Sha Tin Tau New Village. P2 is located in close proximity to the project site.

5.4.8 It should be noted that this Project would not involve any construction works at/within the above identified watercourses and ponds.

5.4.9 Although tunneling works will be located within the water gathering grounds (S10), no aboveground structure would be constructed within the area. The nearest aboveground structure would be located outside the boundary of the water gathering ground. The water gathering ground is located at a higher elevation than the aboveground works. That is, waters

are running from the water gathering grounds towards the Project. Thus, the water source of the existing water gathering ground is not expected to be affected during both construction and operational phases of the Project.

5.4.10 S11 is the Beacon Hill Site of Special Scientific Interest (SSSI) which designated in 1979 and it is situated in the upland region of Beacon Hill within Lion Rock Country Park. The area was designated as a SSSI because of its rich floral diversity and the rare ferns and unusual orchids it contains. The Beacon Hill SSSI is located at a higher elevation than the aboveground works and hence it is not expected to be affected during both construction and operational phases of the Project.

5.4.11 S12 is Lion Rock Country Park which designated in 1977, is one of the earliest country parks of Hong Kong. It covers a wide upland region set between North Kowloon and Shatin. The park borders on Kam Shan Country Park to the west by a boundary line on Tai Po Road, and commands a total area of 557 hectares.

## 5.5 Assessment Methodology

5.5.1 The assessment area includes inland waters within 500 metres from the boundary of the Project and other areas such as stream courses and the associated water systems in the vicinity that might be impacted by the Project. The methodology employed to assess potential water quality impacts associated with the construction and operation of the Project followed the detailed technical requirements given in Appendix D of the Study Brief. The WSRs that may be affected by the Project have been identified. Potential sources of water quality impact that may arise during the construction and operation stages of the Project were described, including point discharges and non-point sources to surface water runoff, sewage from workforce and polluted discharge generated from the Project. All the identified sources of potential water quality impact will be evaluated and their impact significance determined. Practical water pollution control measures will be recommended to mitigate identified water quality impacts.

## 5.6 Identification and Evaluation of Potential Impacts

Construction Phase

5.6.1 The major construction activities include demolition, site formation, excavation, foundation, superstructure and building construction, tunnel and roads widening as well as slope and E&M works. The potential sources of water quality impact associated with the construction works would include:

- Wastewater from general construction activities;
- Construction site run-off;
- Sewage from construction workforce;
- Accidental spillage of chemicals;
- Groundwater infiltration arising from tunnel boring;
- Water pollution from culvert modification works;
- Construction works in close proximity of inland watercourses; and
- Groundwater from contaminated areas and contaminated site runoff

*Wastewater from General Construction Activities*

5.6.2 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. Various construction works may 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 water quality deterioration. Adoption of the guidelines and good site practices for handling and disposal of construction discharges as part of the construction site management practices would minimize the potential impacts.

*Construction Site Run-off*

5.6.3 Potential pollution sources of site run-off may include:

- Run-off 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.

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

5.6.5 Wind blown dust would be generated from exposed soil surfaces in works areas. It is possible that wind blown 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.

5.6.6 It is important that proper site practice and good site management be followed to prevent run-off with high level of SS from entering the surrounding waters. Best Management Practices (BMPs) in controlling construction site discharges are recommended for this Project. With the implementation of BMPs 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.

*Sewage Effluent from Construction Workforce*

5.6.7 During the construction of the Project, the workforce on site will generate sewage effluents, which are characterized by high level of BOD, ammonia and *E. coli*. Based on the 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. Potential water quality impacts upon the local drainage and fresh water system may arise from these sewage effluent, if uncontrolled.

5.6.8 However, this temporary sewage can be adequately handled by temporary sanitary facilities, such as portable chemical toilets. According to the Reference Materials on Construction Site Welfare, Health and Safety Measures that issued by the Construction Industry Council (i.e. Section 5.6.10), the number of toilet facilities provided on site shall be at a ratio of not less than 1 for every 25 workers. The number of the chemical toilets required for the construction sites should be subject to later detailed design, the capacity of the chemical toilets, and

contractor's site practices. A licensed contractor should be employed to provide appropriate and adequate portable toilets and be responsible for appropriate disposal and maintenance.

5.6.9 Provided that sewage is not discharged directly into stormwater drains or inland waters adjacent to the construction site, and temporary sanitary facilities are used and properly maintained, it is unlikely that sewage generated from the site would have a significant water quality impact.

*Accidental Spillage of Chemicals*

5.6.10 The use of engine oil and lubricants and their storage as waste materials have the potential to create impacts on the water quality if spillage occurs. Waste oil may infiltrate into the surface soil layer, or runoff into adjacent waterbodies, increasing hydrocarbon levels. Groundwater pollution may also rise from the improper use and storage of chemical and petroleum products within the site area where groundwater infiltrates into the area. Infiltration of groundwater may occur at areas where there are faults and/or fissures in the rock mass. The potential impacts could however be mitigated by practical mitigation measures and good site practices.

*Groundwater Infiltration arising from Tunnel Boring*

5.6.11 Underground development may result in infiltration of groundwater. The major concern from underground construction activities would be the increase in site runoff and the associated potential drawdown of groundwater in any soil and aquifer layers. Groundwater infiltration would affect the construction works and infiltrated water would carry away silt and other contaminants from site into the site drainage. Consideration should be taken at the early design stage to minimize the infiltration of groundwater. Underground development may also drawdown groundwater in any soil and aquifer layers if uncontrolled. Practical groundwater control measures should be followed to minimize the potential groundwater infiltration.

*Water Pollution from Culvert Modification Works*

5.6.12 Only inlet of culvert near the administration building (culvert which would collect and convey rainwater to S6) will be extended (i.e. one culvert will be modified). The culvert modification works would involve excavation and construction works. If not properly controlled, the excavated materials, waste water, 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 culvert 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 minimize water quality impacts. A temporary drainage at most downstream should first be established to intercept and divert the upstream flow. Precautionary measures in Appendix D of ETWB TC No. 5/2005, such as temporary isolation to natural streams using sandbags and silt curtains, shall be applied to prevent pollutants running into the neighboring watercourse. Dewatering of the construction works area shall be conducted prior to the construction works. 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 watercourse. Detailed mitigation measures are given in **Section 5.7.**

*Construction Works in Close Proximity to Inland Water*

5.6.13 Construction activities in close vicinity to the inland watercourses (S2 to S8, SW1 to SW4, WC1 to WC8, WC14 and P2; ID refer to **Table 5.9** and **60604728/R42b/Figure 5.2**) may impact water quality due to the potential release of construction waste and wastewater. Construction waste and wastewater are generally characterized by high SS concentration and elevated pH. With the implementation of adequate construction site drainage and Best Management Practices as described in **Section 5.7.1 - 5.7.2** and provision of mitigation measures as specified in ETWB TC (Works) No. 5/2005 "Protection of natural streams/ rivers from adverse impacts arising from construction works" as detailed in **Section 5.7.26**, it is anticipated that water quality impacts would be minimal.

*Groundwater from Contaminated Areas and Contaminated Site Runoff*

5.6.14 It is identified that the tunnel portal areas have potential land contamination issues. Proper land contamination remediation and mitigation measures are proposed in **Section 7**. Any contaminated material disturbed, or material which comes into contact with the contaminated material, has the potential to be washed with site runoff into drainage system. Excavated contaminated materials would be properly stored, housed and covered to avoid generation of contaminated runoff. Open stockpiling of contaminated materials will not be allowed. Any contaminated site runoff will be properly treated and disposed in compliance with the requirements of the TM-DSS. Mitigation measures for contaminated site runoff are recommended under **Section 5.7.27**.

5.6.15 Groundwater pumped out or from dewatering process during excavation works in the contaminated areas might be potentially contaminated. Any contaminated groundwater will be either properly treated or properly recharged into the ground in compliance with the requirements of the TM-DSS. No direct discharge of contaminated groundwater will be adopted. Mitigation measures and monitoring requirements for contaminated groundwater discharge/recharge are recommended under **Section 5.7.28 - 5.7.29**. With proper implementation of the recommended mitigation measures, no unacceptable water quality would be expected from the groundwater generated from contaminated areas and contaminated site runoff.

Operation Phase

5.6.16 Potential water quality impacts associated with the Project operation would include:

- Surface run-off from road/bridge/viaduct;
- Sewage effluent from the new administration building and ventilation buildings;
- Wastewater generated from washing and maintenance operation; and
- Tunnel run-off and drainage

*Surface run-off from Road/Bridge/Viaduct*

5.6.17 Surface runoff to be generated from the Project is known as non-point source pollution. The paved and developed areas, especially the new road/bridge/viaduct will increase the quantity of surface runoff. The presence of oil, grease and grit on their surfaces could be washed into the nearby drainage system or even into the watercourses during rainfall event.

5.6.18 The Project was expected to have an additional 4.72ha paved area when in operation. According to the DSD *Stormwater Drainage Manual*, annual rainfall in Hong Kong is about 2400mm. The EPD study, *Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and upgrading of Assessment Tool*, 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, it was assumed that only 1512mm (i.e. 2400mm x (82%+44%)/2) of the 2400mm annual rainfall would be considered as effective rainfall that would generate surface runoff. With consideration of the paved area and a runoff coefficient of 0.9 for paved surface, the overall daily runoff generated from the Project was estimated to be about 176.0 $m^3$/day (i.e.1512/1000/365*47200*0.9).

5.6.19 Surface runoff generated from the paved or developed areas may contain debris, refuse and dust. Practices that cleaning agents used for road and building faced washing may also affect the water quality of the nearby receiving water. Minor non-point source pollution would be expected from the Project.

5.6.20 To minimise the impact from road runoff, all the road works planned under the Project should be designed with adequate drainage system and appropriate oil interceptors, as required.

The design of stormwater drains shall follow the relevant guidelines and practices as given in the ProPECC PN 5/93 "*Drainage Plans subject to Comment by the EPD*".

*Sewage effluent from New Administration Building and Ventilation Buildings*

5.6.21 Sewage generated from the new administration building and ventilation buildings under the operation phase is characterized by high level of BOD, ammonia and *E. coli*. It would not cause adverse water quality impacts if the sewage and wastewater generated from the proposed development would be properly treated and disposed. The estimation of sewage and other wastewater generated from operation of the proposed administration building, car parking area and ventilation buildings is summarized in **Table 5.10** below.

**Table 5.10 Estimation of Sewage and Other Wastewater from New Administration Building, Car Parking Area and Ventilation Buildings**

| Wastewater Generated from | Type of Wastewater Generated | Estimated Serving Population / Size | Estimated Quantity of Wastewater | Proposed Wastewater Treatment Method |
|---|---|---|---|---|
| *To On-site Sewage Treatment Plant (STP)* | | | | |
| New Administration Building | Sewage from Toilet | 150 staff<br>(Estimated Total No. of Tunnel Operating Staff) | 150 staff x 0.18 $m^3$/staff/day (1)<br>= 27 $m^3$/day | On-site STP adjacent to new Administration Building |
| | Effluent from food preparation and utensils washing | 6 staff<br>(Estimated Total No. of Canteen Staff) | 6 staff x 1.58 $m^3$/ staff/day (2)<br>= 9.48 $m^3$/day | Grease Trap before treated at on-site STP adjacent to new Administration Building |
| Car Parking Area | Washing and maintenance activities of tunnel work vehicles | 60 nos. of tunnel works vehicles | 60 vehicles<br>x 0.17 $m^3$/vehicle/7 day<br>= ~1.5 $m^3$/day<br>(each tunnel work vehicle is to be washed manually using wet towels once per week) | Petrol interceptor following by sedimentation tank before treated at on-site STP adjacent to new Administration Building |
| | | **Total:** | **~38 $m^3$/day** | |
| *To Septic Tank and Soakaway System (ST/SA system)* | | | | |
| Ventilation Building at Shatin Portal | Sewage from Toilet | Estimated no more than 5 staff | 5 staff x 0.18 $m^3$/staff/day (1)<br>= 0.9 $m^3$/day | ST/SA system adjacent to new Ventilation Building |
| | Washing and maintenance activities of ventilation systems | Not Applicable | 0.5 $m^3$/day<br>(general cleansing using water and vacuuming only) | Carbon filter before discharging to ST/SA system |
| Ventilation Building at Kowloon Portal | Sewage from Toilet | Estimated no more than 5 staff | 5 staff x 0.18 $m^3$/staff/day (1)<br>= 0.9 $m^3$/day | ST/SA system adjacent to new Ventilation Building |
| | Washing and maintenance activities of ventilation systems | Not Applicable | 0.5 $m^3$/day<br>(general cleansing using water and vacuuming only) | Carbon filter before discharging to ST/SA system |
| | | **Total:** | **~3 $m^3$/day (~1.5 $m^3$/day from each new Ventilation Building)** | |

Note: 1. Value refers to the commercial activity Type J3 of Table T-2 of the "*Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning*" issued by EPD.
2. Value refers to the commercial activity Type J10 of Table T-2 of the "*Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning*" issued by EPD.

5.6.22 There is no existing nearby public sewer serving the new administration building and car parking area while the nearest public sewer connection is located approximately 300m away from the new administration building and car parking area. It is also foreseeable that there is difficulty in the maintenance (i.e., replacement and repair works) of the public sewer connection to the new administration building and car parking area since portion of the sewer connection will be running across the trunk road at the toll plaza area. The on-site sewage treatment plant (STP) instead of public sewer connection for the new administration building and car parking area is therefore adopted. All sewage and wastewater generated from the new administration building and car parking area would be treated by the STP before discharging to the nearby road drainage system outside Lion Rock Country Park. The on-site sewage treatment facility will be designed generally with reference to EPD's "*Guidelines for the Design of Small Sewage Treatment Plant*".

5.6.23 Source of sewage generated from the operation of the new administration building include tunnel operating staff (i.e. estimated total 150 nos.) and staff canteen (with about 6 staff). The estimated average dry weather flow (ADWF) generated from the operation of the new administration building is about 36.5 $m^3$/day (i.e. 150 x 0.18 $m^3$/day/employee for Commercial type J3 + 6 x 1.58 $m^3$/day/employee for Commercial Type J10). Both sewage and wastewater from the new administration building and car parking area will be treated by the on-site STP. As presented in **Table 5.10**, the estimated ADWF for sewage and wastewater to be discharged to the on-site STP is about 38 $m^3$/day (27 $m^3$/day + 9.48 $m^3$/day + 1.5 $m^3$/day = ~38 $m^3$/day) and the estimated peak flow for sewage and wastewater to be discharged to the on-site STP is about 2.64 L/s (with peaking factor of 6 as stated in Section 3.3 of "*Guidelines for the Design of Small Sewage Treatment Plant*"). The on-site STP is designed with capacity to handle a peak flow of three times of ADWF (i.e. 38 $m^3$/day x 3 = 114 $m^3$/day) with provision of equalization tank to store three times of ADWF for 2 hours (i.e. minimum 9.5 $m^3$) for the surplus flow. The on-site STP in the type of Membrane Bio-reactor (MBR) with UV disinfection will be adopted and installed within the footprint area of the administration building. There is a need to apply to EPD for a discharge licence for effluent discharge from the on-site STP under the WPCO. The treated effluent of the MBR plant will be discharged to the adjacent road drainage system outside Lion Rock Country Park and subsequently discharge to Shing Mun River and shall meet the effluent standards of Group D inland water as specified in TM-DSS (see **Table 5.4**).

5.6.24 In addition, an emergency storage tank with 2 hours of ADWF capacity (i.e. ~3.2 $m^3$) will also be provided for temporary storage of sewage and the stored sewage will be tankered away if the operation of STP is anticipated could not be resumed before all the temporary storage capacity utilized, to avoid emergency discharge to drainage system. To further minimize the potential emergency discharge from the on-site STP, dual or standby power supply, standby sewage treatment units, flow sensors and alarm systems should be provided. Level sensors connected with alarm signalizing system will also be installed, to monitor the storage volume to avoid overflow of untreated wastewater/raw sewage. A warning signal will be generated automatically to alert the manager when the flow in the tank reached a pre-set level, allowing sufficient time for arranging tanker service to tanker away excessive untreated wastewater/raw sewage. Some spare parts such as electrical and mechanical components of the proposed STP will also be provided in case of facilities break down / emergency. Regular test, maintenances and replacement of membranes or equipment are necessary to maintain a good operation condition. Hence, no adverse water quality impact would therefore be anticipated.

5.6.25 The wastewater generated from canteen usually contains greasy waste. Grease trap will be installed for the wastewater generated from the canteen before being treated at the on-site STP. No adverse water quality would therefore be anticipated.

5.6.26 There is no existing public sewer serving the new ventilation buildings at Kowloon and Shatin portals while the nearest public sewer connections are also some distance away (i.e. >250m for the new ventilation building at Kowloon portal and >650m for the new ventilation building at Shatin portal). It is also anticipated that there is difficulty in the maintenance (i.e., replacement and repair works) of the public sewer connection/sewer connection to the new ventilation buildings since portion of the sewer connection will be running across approaching road at the Shatin portal and trunk road at the Lung Cheung Road Interchange. Besides, the new ventilation building at Shatin portal is also approximately 400m away from the proposed STP of which to be located near the new administration building. Therefore, the septic tank with soakaway system is adopted for both new ventilation buildings. The use of septic tank with soakaway system for the new ventilation buildings at both portals is considered adequate in view of minimal no. of tunnel operation staff required to be stationed at the new ventilation buildings. The design of septic tank with soakaway system shall follow the relevant guidelines and practices as given in the ProPECC PN 5/93 "*Drainage Plans subject to Comment by the EPD*". No adverse water quality impact would therefore be anticipated.

5.6.27 Regular maintenance shall be provided to all components of the wastewater treatment system in new administration building and ventilation buildings, including the on-site STP, septic tank with soakaway system, grease traps, etc. No adverse water quality impact would therefore be anticipated.

*Wastewater generated from washing and maintenance operation*

5.6.28 Wastewater will be generated from washing and maintenance activities of work vehicles at car parking area as well as the maintenance activities for ventilation system. Direct discharge of the generated wastewater to the nearby drainage system and water environment will create potential water quality impact.

5.6.29 The anticipated quantity of the wastewater from washing and maintenance activities of ventilation system is 0.5 $m^3$/day as it requires general cleansing (using water and vacuuming cleaning only). The wastewater generated from general cleansing of ventilation system is merely with dusts and undissolved oils. Wastewater discharging during washing and maintenance activities of ventilation system will be collected, treated with active carbon filter before discharge to the septic tank.

5.6.30 The anticipated quantity of the wastewater from washing and maintenance activities of work vehicles at car parking area is estimated about 1.5 $m^3$/day. Wastewater from washing and maintenance activities of work vehicles usually contains hydrocarbon pollutants such as petroleum and diesel. All wastewater generated from washing and maintenance activities of work vehicles at car parking area should be collected and treated by petrol interceptor following by sedimentation tank before discharge to the on-site STP. Regular maintenance shall be provided to all components of the wastewater treatment system, including the on-site STP, petrol interceptor, sedimentation tank, active carbon filter system, etc. A Licensed Chemical Contractor should be employed to collect and dispose of spent lubrication oil generated from vehicle maintenance activities in compliance with the Waste Disposal Ordinance. No adverse water quality impact would therefore be anticipated.

*Tunnel run-off and drainage*

5.6.31 During rainstorm, rainwater on the open and at-grade section may generate tunnel run-off. Seepage of groundwater into the tunnel may also generate tunnel run-off. Such run-off may contain limited amount of SS, oil and grease. Directly discharge of tunnel run-off may cause adverse water quality impact on nearby water environment.

5.6.32 The tunnel wall should be equipped with water-tight liner to avoid groundwater seepage. The amount of groundwater seepage into the tunnel would be insignificant. Any tunnel run-off could be contaminated with limited amount of lubricants, SS, iron, oil and grease from passing vehicles. Standard oil/grit interceptors/chambers should be provided to remove oil, lubricants, grease, silt and grit from the tunnel run-off before discharging into public drainage system. No adverse water quality impacts would be expected.

## 5.7 Mitigation of Adverse Environmental Impacts

Construction Phase

*General Construction Activities and Construction Site Run-off*

5.7.1 Control of potential pollution of nearby water bodies during the construction phase of the Project should be achieved by measures to:

- prevent or minimise the likelihood of pollutants (generated from construction activities) being in contact with rainfall or run-off; and
- abate pollutants in the stormwater surface run-off prior to the discharge of surface run-off to the nearby water bodies.

5.7.2 These principle objectives should be achieved by implementation of the Best Management Practices (BMPs) of mitigation measures in controlling water pollution. The guidelines for handling and disposal of construction site discharges as detailed in the ProPECC PN 1/94 "*Construction Site Drainage*" should be followed, where applicable. All effluent discharged from the construction site should comply with the standards stipulated in the TM-DSS. The following measures are recommended to protect water quality of the inland and coastal waters, and when properly implemented should be sufficient to adequately control site discharges so as to avoid water quality impacts.

*Construction Site Run-off*

5.7.3 Surface runoff 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 sand bag barriers should be provided on site during construction works to properly direct stormwater to such silt removal facilities. Perimeter channels should be provided on site boundaries where necessary to intercept storm runoff 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.

5.7.4 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. 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.

5.7.5 Construction works should be programmed to minimize soil excavation works in rainy seasons (April to September). If soil excavation 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.

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

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

5.7.8 Open stockpiles of construction materials (e.g. aggregates, sand and fill material) on sites should be covered with tarpaulin or similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.

5.7.9 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 runoff from getting into foul sewers. Discharge of surface runoff into foul sewers must always be prevented in order not to unduly overload the foul sewerage system.

5.7.10 If bentonite slurries are required for any construction works, they should be reconditioned and reused wherever practicable to minimise the disposal volume of used bentonite slurries. Temporary enclosed storage locations should be provided on-site for any unused bentonite that needs to be transported away after the related construction activities are completed. Requirements as stipulated in ProPECC Note PN 1/94 should be closely followed when handling and disposing bentonite slurries.

*Boring and Drilling Water*

5.7.11 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*

5.7.12 All vehicles and plants should be cleaned before they leave a construction site to minimise the deposition of earth, mud, debris on roads. A wheel washing bay should be provided at every site exit of practicable and washwater 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 runoff from entering public road drains.

*Rubbish and Litter*

5.7.13 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.

*Effluent Discharge*

5.7.14 There is a need to apply to EPD for a discharge licence for discharge of effluent from the construction site under the WPCO. The discharge quality must meet the requirements specified in the discharge licence. 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 minimise 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 licence.

*Acid Cleaning, Etching and Pickling Wastewater*

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

*Sewage Effluent from Construction Workforce*

5.7.16 No discharge of sewage to the stormwater drains and inland water will be allowed. Adequate and sufficient portable chemical toilets should be provided in the works areas to handle sewage from construction workforce. A licensed collector should be employed to clean and maintain the chemical toilets on a regular basis.

5.7.17 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 should be conducted to provide an effective control of any malpractices and achieve continual improvement of environmental performance on site.

*Accidental Spillage of Chemicals*

5.7.18 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. The Contractor is also recommended to develop management procedures for chemicals used and prepare an emergency spillage handling procedure to deal with chemical spillage in case of accident occurs.

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

5.7.20 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.
- Storage area should be selected at a safe location on site and adequate space should be allocated to the storage area.

*Groundwater Infiltration arising from Tunnel Boring*

5.7.21 Appropriate measures should be implemented to minimize the groundwater infiltration during the tunnel construction. The groundwater control strategies include:

- Probing Ahead: As normal practice, the Contractor will undertake rigorous probing of the ground ahead of excavation works to identify zones of significant water inflow. The probe drilling results will be evaluated to determine specific grouting requirements in line with the tunnel advance. In such zones of significant water inflow that could occur as a result of discrete, permeable features, the intent would be to reduce overall inflow by means of cut-off grouting executed ahead of the tunnel advance.
- Pre-grouting: Where water inflow quantities are excessive, pre-grouting will be required to reduce the water inflow into the tunnel. The pre-grouting will be achieved via a systematic and carefully specified protocol of grouting.
- In principle, the grout pre-treatment would be designed on the basis of probe hole drilling ahead of the tunnel face.

- The installation of waterproof lining would also be adopted after the formation of the tunnels.

5.7.22 In the event of excessive infiltration being observed as a result of the tunnelling or excavation works even after incorporation of the water control strategies, post-grouting should be applied as far as practicable as described below:

- Post-grouting: Groundwater drawdown will be most likely due to inflows of water into the tunnel that have not been sufficiently controlled by the pre-grouting measures. Where this occurs, post grouting will be undertaken before the lining is casted. Whilst unlikely to be required in significant measure, such a contingency should be allowed for reduction in permeability of the tunnel surround (by grouting) to limit inflow to acceptable levels.

5.7.23 The practical groundwater control measures stated above are proven technologies and have been extensively applied in other past projects. These measures or other similar methods, as approved by the Engineer to suit the works condition shall be applied to minimize the groundwater infiltration.

5.7.24 In case seepage of groundwater occurs, groundwater should be pumped out from works areas and discharged to the drainage system via silt trap. Groundwater from dewatering process should also be discharged to the storm system via silt removal facilities.

*Culvert Modification Works*

5.7.25 Precaution measures shall be implemented to prevent adverse water quality impact to the surrounding environment for culvert modification works. Good site practices are described in ETWB TC (Works) No. 5/2005 “Protection of natural streams/ rivers from adverse impacts arising from construction works” and ProPECC PN 1/94 “Construction Site Drainage” should be adopted where applicable. The following major measures shall be implemented:

- Cofferdams and impermeable sheet piles should be installed as appropriate to isolate the water flow from the construction works area.

- Dewatering of flow diversion shall be conducted prior to the construction works to prevent water overflow to the surrounding area.

- Flow diversion should be conducted in dry season as far as practicable when the water flow is low.

- Any excavated sediment from the culvert modification works shall be properly stored at bunded areas away from any watercourse and covered with tarpaulin before transporting out of the site. Detailed management of excavated sediment will be discussed in **Chapter 6**.

*Construction Works in Close Proximity to Inland Water*

5.7.26 The practices outlined in ETWB TC (Works) No. 5/2005 “Protection of natural streams/ rivers from adverse impacts arising from construction works” should also be adopted where applicable to minimize the water quality impacts on any natural streams or surface water systems. Relevant mitigation measures from the ETWB TC (Works) No. 5/2005 are listed below:

- The use of less or smaller construction plants may be specified in areas close to the watercourses to reduce the disturbance to the surface water.

- Temporary storage of materials (e.g. equipment, chemicals and fuel) and temporary stockpile of construction materials should be located well away from any watercourses when carrying out of the construction works.

- Stockpilling of construction materials and dusty materials should be covered and located away from any watercourses.

- Construction debris and spoil should be covered up and / or disposed of as soon as possible to avoid being washed into the nearby water receivers.

- Proper shoring may need to be erected in order to prevent soil or mud from slipping into the watercourses.

- Construction works close to the inland watercourses should be carried out in dry season as far as practicable where the flow in the surface channel or stream is low.

*Groundwater from Contaminated Areas and Contaminated Site Runoff*

5.7.27 Remediation of contaminated land should be properly conducted following the recommendations proposed under **Section 7**. Any excavated contaminated material and exposed contaminated surface should be properly housed and covered to avoid generation of contaminated runoff. Open stockpiling of contaminated materials should not be allowed. Any contaminated runoff generated under the construction process should be properly collected and diverted to wastewater treatment facilities (WTF) as necessary. The WTF shall deploy suitable treatment processes (e.g. oil interceptor/ activated carbon) 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 system shall meet the requirements as stated in TM-DSS and should be either discharged into the foul sewers or tankered away for proper disposal.

5.7.28 No direct discharge of groundwater from contaminated areas should be adopted. Prior to any excavation works within the potentially contaminated areas, the baseline groundwater quality in these areas should be reviewed based on the past relevant site investigation data and any additional groundwater quality measurements to be performed with reference to *Guidance Note for Contaminated Land Assessment and Remediation* and the review results should be submitted to EPD for examination. If the review results indicated that the groundwater to be generated from the excavation works would be contaminated, this contaminated groundwater should be either properly treated or properly recharged into the ground in compliance with the requirements of the TM-DSS. If wastewater treatment is to be deployed for treating the contaminated groundwater, the wastewater treatment unit shall deploy suitable treatment process (e.g. oil interceptor/ activated carbon) 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 plant shall meet the requirements as stated in the TM-DSS and should be either discharged into the foul sewers or tankered away for proper disposal.

5.7.29 If deployment of wastewater treatment is not feasible for handling the contaminated groundwater, groundwater recharging wells should be installed as appropriate for recharging the contaminated groundwater back into the ground. The recharging wells should be selected at places where the groundwater quality will not be affected by the recharge operation as indicated in Section 2.3 of TM-DSS. The baseline groundwater quality should be determined prior to the selection of the recharge wells, and submit a working plan to EPD for agreement. Pollution levels of groundwater to be recharged shall not be higher than pollutant levels of ambient groundwater at the recharge well. Groundwater monitoring wells should be installed near the recharge points to monitor the effectiveness of the recharge wells and to ensure that no likelihood of increase of groundwater level and transfer of pollutants beyond the site boundary. Prior to recharge, free products should be removed as necessary by installing the petrol interceptor. The Contractor should apply for a discharge licence under the WPCO through the Regional Office of EPD for groundwater recharge operation or discharge of treated groundwater.

Operation Phase

*Surface run-off from Road/Bridge/Viaduct*

5.7.30 Best Management Practices (BMPs) for stormwater discharge are recommended to reduce stormwater pollution arising from the Project.

*Design Measures*

5.7.31 Exposed surface shall be avoided within the Project Site to minimise soil erosion. The Project Site shall be either hard paved or covered by landscaping area and plantation where appropriate.

5.7.32 The drainage system within the Project Site should be designed to cater for the runoff from 50 year-return-period rainstorm.

*Devices / Facilities to Control Pollution*

5.7.33 Screening facilities such as standard gully grating and trash grille, with spacing which is capable of screening large substances such as fallen leaves and rubbish should be provided at the inlet of drainage system.

5.7.34 Road gullies with standard design and silt traps and oil interceptors should be incorporated during the detailed design to remove particles present in stormwater runoff.

*Administrative Measures*

5.7.35 Good management measures such as regular cleaning and sweeping of road surface / open areas is suggested. The road surface / open area cleaning should also be carried out prior to occurrence of rainstorm.

5.7.36 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.

*Sewage effluent from New Administration Building and Ventilation Buildings*

5.7.37 All sewage generated from the administration building would be treated by the on-site STP before discharging to the nearby road drainage system outside Lion Rock Country Park. The on-site sewage treatment facility will be designed generally with reference to EPD's "*Guidelines for the Design of Small Sewage Treatment Plant*". The on-site STP is designed with capacity to handle a peak flow of three times of ADWF (i.e. 114 $m^3$/day) with provision of equalization tank to store three times of ADWF for 2 hours (i.e. minimum 9.5 $m^3$) for the surplus flow. The on-site STP will adopt MBR with UV disinfection technology and installed within the footprint area of the administration building. There is a need to apply to EPD for a discharge licence for effluent discharge from the on-site STP under the WPCO. The treated effluent of the MBR plant will meet the effluent standards of Group D inland water as specified in TM-DSS (see **Table 5.4**).

5.7.38 In addition, an emergency storage tank with 2 hours of ADWF capacity (i.e. ~3.2 $m^3$) will also be provided for temporary storage of sewage and the stored sewage will be tankered away if the operation of STP is anticipated could not be resumed before all the temporary storage capacity utilized, to avoid emergency discharge to drainage system. To further minimize the potential emergency discharge from the on-site STP, dual or standby power supply, standby sewage treatment units, flow sensors and alarm systems should be provided. Level sensors connected with alarm signalizing system will also be installed, to monitor the storage volume to avoid overflow of untreated wastewater/raw sewage. A warning signal will be generated automatically to alert the manager when the flow in the tank reached a pre-set level, allowing sufficient time for arranging tanker service to tanker away excessive untreated

wastewater/raw sewage. Some spare parts such as electrical and mechanical components of the proposed STP will also be provided in case of facilities break down / emergency. Regular test, maintenances and replacement of membranes or equipment are necessary to maintain a good operation condition.

5.7.39 Wastewater generated from canteen within the new administration building will be collected and treated by grease trap before being treated at the on-site STP.

5.7.40 All sewage generated from the new ventilation buildings at Kowloon and Shatin portals would be treated by a septic tank with soakaway system each in view of minimal number of tunnel operation staff is required to be stationed at the new ventilation buildings. The design of septic tank with soakaway system shall follow the relevant guidelines and practices as given in the ProPECC PN 5/93 "*Drainage Plans subject to Comment by the EPD*". Regular maintenance shall be provided to all components of the wastewater treatment system, including the on-site STP, septic tank with soakaway system, grease traps, etc. No direct discharge of sewage effluent into the inland water will be allowed.

*Wastewater generated from washing and maintenance operation*

5.7.41 Wastewater from washing and maintenance activities of ventilation system will be collected and treated with active carbon filter before discharge to the septic tank. All wastewater generated from washing and maintenance activities of work vehicles at car parking area will be collected and treated by petrol interceptor following by sedimentation tank before discharge to the on-site STP. Regular maintenance shall be provided to all components of the wastewater treatment system, including the on-site STP, petrol interceptor, sedimentation tank, active carbon filter system, etc. A Licensed Chemical Contractor should be employed to collect and dispose of spent lubrication oil generated from vehicle maintenance activities in compliance with the Waste Disposal Ordinance. No direct discharge of these wastewaters into the inland water will be allowed.

*Tunnel run-off and drainage*

5.7.42 Mitigation measures are required to mitigate tunnel run-off during the operation phase as illustrated in follow:

- Road drainage channels discharge should pass through oil/grit interceptors/chambers to remove oil, grease and sediment before discharging into the public storm drainage system;
- The silt traps and oil interceptors should be cleaned and maintained regularly; and
- Oily contents of the oil interceptors should be transferred to an appropriate disposal facility, or to be collected for reuse, if possible.

## 5.8 Cumulative Impacts

5.8.1 According to **Section 2**, "Relocation of Diamond Hill Fresh Water and Salt Water Service Reservoirs to Cavern" and "Proposed Drainage Improvement Works at Chui Tin Street and Chui Tin Street Soccer Pitch" would be constructed concurrently with the Project and "Revised Trunk Road T4" and "In-situ Reprovisioning of Sha Tin Water Treatment Works – South Works" would also be operated in conjunction with the Project.

Construction Phase

5.8.2 The construction phase of "Relocation of Diamond Hill Fresh Water and Salt Water Service Reservoirs to Cavern" will overlap with that of the Project during 2025 to 2027. According to the Project Profile, potential water quality impact may arise due to construction site runoff and drainage from works areas, wastewater from general construction activities, sewage generated by construction workforce, accidental spillage of chemicals, construction works in

close proximity of inland watercourses and potential groundwater infiltration. With proper adoption of mitigation measures and good site practices, potential water quality impact would be minimized. No unacceptable water quality impact is expected.

5.8.3 The construction phase of the "Proposed Drainage Improvement Works at Chui Tin Street and Chui Tin Street Soccer Pitch" will also overlap with the Project during 2025 to 2031. The drainage improvement works would involve land-based construction only and the potential water quality impacts would include construction site runoff and drainage from works areas, wastewater from general construction activities, sewage generated by construction workforce and accidental spillage. With proper implementation of good site practices and mitigation measures such as guidelines as given in ProPECC PN 1/94, potential water quality impact would be minimized. No unacceptable water quality impact is expected.

5.8.4 As no significant water quality impact was expected from the Project, "Relocation of Diamond Hill Fresh Water and Salt Water Service Reservoirs to Cavern" and the "Proposed Drainage Improvement Works at Chui Tin Street and Chui Tin Street Soccer Pitch" during construction phase, adverse cumulative water quality impact is hence not anticipated.

Operation Phase

5.8.5 "In-situ Reprovisioning of Sha Tin Water Treatment Works – South Works" would operate in concurrent with the Project. According to the approved EIA report (AEIAR-187/2015), no washwater effluent from cleansing of the treatment works components would be discharged off-site. Standby treatment facilities and dual power supply will be provided to minimize the occurrence of overflow. No adverse water quality impact would be expected.

5.8.6 For the operation of "Revised Trunk Road T4", major sources of water quality impacts were expected to be paved area runoff and potential hydrodynamic and water quality impact on Shing Mun River due to the installation of permanent structures. Based on the EIA Report for "Revised Trunk Road T4", no unacceptable water quality impact is expected if the recommended mitigation measures are properly implemented.

5.8.7 As neither the Project nor the concurrent projects were anticipated to generate significant water quality impact during operation phase, adverse cumulative impacts were hence not anticipated.

## 5.9 Evaluation of Residual Impacts

5.9.1 With implementation of the recommended mitigation measures for the construction and operation phases of the Project, no adverse residual impacts on water quality are anticipated.

## 5.10 Environmental Monitoring and Audit

5.10.1 With proper implementation of the recommended mitigation measures, unacceptable water quality impacts at the identified WSRs are not expected. Nevertheless, a water quality monitoring programme is recommended to ensure compliance with the assessment criteria.

5.10.2 Detailed approach and methodology of the water quality monitoring programme are presented in the Environmental Monitoring and Audit Manual (EM&A Manual) under a separate cover and are briefly described below.

Construction Phase

5.10.3 Baseline monitoring should be undertaken for three times per week for a period of at least four weeks before commencement of the construction works to establish baseline water quality conditions of the area. Impact monitoring should be undertaken for three times per week during the construction period to obtain water quality data of the area throughout the construction period for comparison with the baseline water quality data and hence determine any water quality impacts from the construction activities. Post Project monitoring should also

be undertaken three times per week for four weeks after the completion of construction works. The interval between 2 sets of monitoring shall not be less than 36 hours.

5.10.4 The following parameters will be monitored under the water quality monitoring programme:

- pH (*in situ* measurement);
- Water temperature ($^0$C) (*in situ* measurement);
- Salinity (ppt) (*in situ* measurement);
- Dissolved Oxygen (DO) (% saturation and mg $L^{-1}$) (*in situ* measurement);
- Turbidity (NTU) (*in situ* measurement); and
- Suspended Solids (SS) (mg $L^{-1}$) (laboratory analysis).

5.10.5 Weekly site inspections and audits will be conducted to ensure that the recommended mitigation measures are properly implemented during the construction stage.

Operation Phase

5.10.6 Unacceptable water quality impacts are not expected during the operation of the Project. Therefore, environmental monitoring and audit for water quality is not recommended for the operation phase of the Project.

## 5.11 Conclusion

5.11.1 The potential water quality impacts from the construction works are associated with the general construction activities, construction site run-off, groundwater infiltration arising from tunnel boring, groundwater from contaminated areas and contaminated site runoff, construction in close proximity of inland watercourses, water pollution from culvert modification works, accidental spillage of chemicals and sewage effluent from construction workforce. Provided that proper site management practices and the mitigation measures including adequate construction site drainage, provision of sediment removal facilities, practical groundwater control measures and chemical toilets would be implemented, no adverse water quality impact during construction phase would be anticipated. Water quality monitoring and regular site inspection will be implemented for the construction works to ensure that the recommended mitigation measures are properly implemented.

5.11.2 The key potential sources of water quality impacts during operation phase would be related to non-point source stormwater runoff, sewage from administration building, wastewater from washing and maintenance operation, and tunnel run-off and drainage. Adequate drainage system with silt traps and oil interceptors should be provided to collect the stormwater runoff. All sewage and wastewater generated from the New Administration Building, Car Parking Area and Ventilation Buildings would be treated by on-site STP (nearby/adjoining new administration building) and septic tank with soakaway system (nearby/adjoining new ventilation buildings). With proper design of drainage and sewerage systems and implementation of the recommended mitigation measures, no adverse water quality impact during operation phase would be anticipated.