# 6 Sewerage and Sewage Treatment Implications

## 6.1 Overview

This section presents the assessment of potential sewerage and sewage treatment implementations, which may arise from the Project.

Under the existing condition, there is no public sewerage system in the vicinity of proposed development site. The proposed LMC Loop development will generate additional sewage flows and loads which cannot be handled by the existing Yuen Long Sewage Treatment Works (YLSTW) or Shek Wu Hui Sewage Treatment Works (SWHSTW). In order to meet the prevailing water quality policy for ensuring "no net increase in pollution load" to Deep Bay, construction of a new onsite STW and upgrading of SWHSTW are proposed.

The sewerage and sewage treatment implications have been conducted in accordance with the requirements of Annexes 14 of the TM-EIAO and EPD Report No. EPD/TP 1/05 Guidelines for Estimating Sewage Flows (GESF) for Sewerage Infrastructure Planning Version 1.0 as well as the requirements set out in Clause 3.4.5 and 3.4.7 of the EIA Study Brief.

## 6.2 Environmental Legislations, Standards and Guidelines

The relevant legislation, standards and guidelines related to sewerage and sewage treatment implications include:

- Water Pollution Control Ordinance (WPCO) CAP 358;
- Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems Inland and Coastal Waters (TM-DSS)
- Environmental Impact Assessment Ordinance (EIAO) (CAP. 499), Technical Memorandum on Environmental Impact Assessment Process (TM-EIAO);
- No Net Increase in Pollution Loads Requirement in Deep Bay;
- Hong Kong Planning Standards and Guidelines; and
- EPD Report No. EPD/TP 1/05 Guidelines for Estimating Sewage Flows (GESF) for Sewerage Infrastructure Planning Version 1.0

## 6.3 Description of the Environment

### 6.3.1 Existing Site Condition

As a result of the training of the SZ River, an area of about 87.7 ha which previously lied to the north of the river course became situated to the south of the re-aligned river course. The area, commonly known as the LMC Loop, was used as a disposal site for mud extracted from the river training work, some of which might be contaminated.

The Study Area comprises the area within the LMC Loop together with the adjoining area in Hong Kong and is shown on **Figure 1.1**. The LMC Loop is located near several major cross-boundary transport nodes including the LMC Boundary Control Point (BCP), the MTR LMC Station and the San Tin Interchange. To the north across the SZ River is the Huanggang Port of SZ. To the southwest is the Mai Po Nature Reserve and to the east is Hoo Hok Wai, comprising fish ponds of high ecological value.

Site characteristics of the LMC Loop and its surrounding land uses are:

- predominantly flat land with grasses and shrubs on it.
- surrounding area mainly rural in nature, comprising mostly wetland, natural landscape, hilly terrain, woodland, village settlements, agricultural land and fishponds.
- the Mai Po Nature Reserve, forming part of the Ramsar Site, is at about 5.4 km to the southwest of the LMC Loop.
- the LMC BCP and the LMC Spur Line BCP are located in close proximity to the southwest.
- across the SZ River to the north is the Futian Central Business District of SZ, where the Huanggang Station of SZ Metro Line can be connected to the LMC Station easily via the LMC Spur Line BCP.

## 6.3.2 Existing and Planned Sewerage Infrastructures

### 6.3.2.1 Existing Sewage Treatment Works

The proposed development site does not fall within sewerage catchment area (SCA) of Shek Wu Hui STW or Yuen Long STW. The information on existing and planned sewerage system within and in the vicinity of the Study Area has been obtained from relevant sources and is shown in **Figure 6.1**.

The following section provides a brief description of the STWs associated with the study.

**Shek Wu Hui STW (SWHSTW)**

SWHSTW is a secondary treatment works which collects and provides treatment to the waste water generated from Fanling/Sheung Shui and other areas before discharging into Deep Bay through Ng Tung River and SZ River. The capacity of the SWHSTW is being upgraded under the Project PWP Item 4229DS/A entitled "Expansion of Shek Wu Hui Sewage Treatment Works and Ting Kok Road Pumping Station No. 5" (the Project). The project is an interim expansion as recommended in Agreement No. CE28/99 entitled "Review of North District and Tolo Harbour Sewerage Master Plans". The construction works of the SWHSTW expansion commenced in September 2005 and has been completed in February 2009. The scope of the project includes increasing the treatment capacity of SWHSTW from 80,000m$^3$/day to 93,000m$^3$/day so as to cater for the base growth of population in Sheung Shui/Fanling areas up to year 2011 and extension of public sewerage to nearby villages. However, the above interim expansion does not take into consideration the additional sewage generated from the proposed development. Therefore, further expansion and upgrading of the SWHSTW would be required, if it is preferred to convey the sewage treatment to SWHSTW for treatment and disposal.

**Yuen Long STW (YLSTW)**

Alternatively, the sewage generated from proposed development site can be conveyed to Yuen Long STW. However, this option would require substantial upgrading of Ngau Tam Mei/San Tin Trunk Sewerage. Although, YLSTW does not reserve any capacity for the sewage flows from this project, it has some spare capacity based on design capacity of YLSTW as 70,000$m^3$/d and projected flow of 46,000$m^3$/day as per findings under Planning and Development Study in North West New Territories. However, due to recent proposal of effluent polishing at YLSTW, the capacity has been reduced to 46,000$m^3$/day.

#### 6.3.2.2 Existing and Planned Sewerage Systems

Under the present condition, there is no public sewerage system in the vicinity of proposed development site except for the Sewage Treatment Plant (STP) within LMC Terminus. The nearest sewerage system would be Ngau Tam Mei/San Tin Trunk Sewerage which is currently in design stage. However, the Ngau Tam Mei/San Tin Trunk Sewerage does not cater for additional flows from the proposed development.

**Figure 6.1** shows the existing and planned sewerage system in relation to the proposed development for further investigation during the course of the study. The current effluent discharge standards for SWHSTW and YLSTW are summarised in **Table 6.1** below.

**Table 6.1** Current effluent discharge standards for SWHSTW and YLSTW

| Parameter | SWHSTW | YLSTW |
|---|---|---|
| $BOD_5$ (mg/L) | 20 (95%-ile) / 40 (upper limit) | 20 (95%-ile) / 40 (upper limit) |
| TSS (mg/L) | 30 (95%-ile) / 60 (upper limit) | 30 (95%-ile) / 60 (upper limit) |
| $NH_3$-N (mg/L) | 2 (95%-ile) / 4 (upper limit) | Not specified |
| $NO_3$-N (mg/L) | 12 (95%-ile) / 24 (upper limit) | Not specified |
| *E. coli* (cfu/100mL) | 1,500 (95%-ile) / 100 (monthly geometric mean) | Not specified |

## 6.4 Assessment Methodology

The assessment of sewerage and sewage treatment implications is referred to Section 6.5 in Annex 14 of the TM-EIAO. Hydraulic assessment was conducted based on Part 1 of Sewerage Manual of DSD. Capacity consideration for the future population from LMC Loop and the design parameters were based on EPD's GESF.

### 6.4.1 Development Parameters

Based on the RODP, the proposed LMC Loop development site will have approximately 24,000 students and 29,370 staff. The breakdown of population/employment data are shown on **Table 6.2**. Approximately 12,000 students will be residing at Campus. Based on current planning proposals, approximately 1,200,000$m^2$ total GFA is proposed for the LMC Loop development and around 1.5% of the total GFA is assigned for Canteens. By assuming 25% of the GFA for Canteens for Kitchen purpose, the area of Kitchen is about 4,500$m^2$.

**Table 6.2** Population and employment data for the LMC Loop

| Land Use | Maximum Number of Students | Employment Opportunities |
|---|---|---|
| Higher Education | 24,000 (12,000 resident + 12,000 non-resident) | 6,000 |
| High-tech R&D / C&C Industries | N/A | 22,094 |
| Supporting Commercial | N/A | 1126 |
| Government Uses | N/A | 150 |
| **Total** | **24,000** | **29,370** |

### 6.4.2 Unit Flow Factors

A unit flow factor (UFF) of 0.04$m^3$/person/day comprising 0.025$m^3$/person/day for flushing and 0.015$m^3$/person/day for fresh water is used for sewage flows estimation for students according to Table T-2 of EPD's GESF. Similarly a unit flow factor (UFF) of 0.28$m^3$/person/day comprising 0.05$m^3$/person/day for flushing and 0.23$m^3$/person/day for fresh water is used for sewage flows estimation for staff and their associated activities. To estimate the sewage flows from students and staff residences, it is assumed that sewage flow will resemble Institutional and special class category in Table T-1 of EPD's GESF. A UFF of 0.19$m^3$/person/day is used for sewage flows estimation from residences. Whereas, a UFF as 0.5$m^3/m^2$ Kitchen Area/day is used to estimate the sewage flow generated from Kitchen areas.

### 6.4.3 Catchment Inflow Factors

The Catchment Inflow Factors ($P_{cif}$) cater for the net overall ingress of water or wastewater to the sewerage system. They are catchment-dependent and applicable to major sewerage facilities of a catchment. They are not applicable to new catchments which are deemed to be free from misconnections and pipe defects. Therefore, the $P_{cif}$ are not applicable in estimating the total flows from the new development areas.

### 6.4.4 Peaking Factors

Peaking factors cater for seasonal/diurnal fluctuation and normal amount of infiltration and inflow. The peaking factors shall be in accordance with EPD's GESF and are shown in **Table 6.3**.

Under normal condition, peaking factors (excluding stormwater allowance) are applicable to planning sewerage facilities receiving flow from new upstream sewerage systems which essentially have no misconnections and defects for infiltration. If the service conditions of the upstream sewerage systems for the planning horizons under consideration are unclear, peaking factors (including stormwater allowance) shall be used. For design purpose, the peaking factors (including stormwater allowance) will be adopted.

**Table 6.3** Peaking factors for various population ranges

| Population Range | Peaking Factor (including stormwater allowance) for facility with existing upstream sewerage | Peaking Factor (excluding stormwater allowance) for facility with new upstream sewerage |
|---|---|---|
| **Sewers** | | |
| < 1,000 | 8 | 6 |
| 1,000 – 5,000 | 6 | 5 |
| 5,000 – 10,000 | 5 | 4 |
| 10,000 – 50,000 | 4 | 3 |
| > 50,000 | Max ($7.3/N^{0.15}$, 2.4) | Max ($6/N^{0.175}$, 1.6) |
| **Sewage Treatment Works, Preliminary Treatment Works and Pumping Stations** | | |
| < 10,000 | 4 | 3 |
| 10,000 – 25,000 | 3.5 | 2.5 |
| 25,000 – 50,000 | 3 | 2 |
| > 50,000 | Max ($3.9/N^{0.065}$, 2.4) | Max ($2.6/N^{0.065}$, 1.6) |

Note:

N = Contributing population in thousands.

$$\text{Contributing population} = \frac{\text{Calculated total average flow}\,(m^3/day)}{0.27\,(m^3/day)}$$

## 6.4.5 Unit Load Factors

The global unit load factors used to estimate the sewage loading from the proposed developments are used as referred in Table 4 of the Sewerage Manual Part 1 (SM1) and are listed in **Table 6.4** below.

**Table 6.4** Summary of adopted unit load factors

| Trades | Unit | SS (kg/d) | BOD (kg/d) | COD (kg/d) | TKN (kg/d) | $NH_3$-N (kg/d) | *E. coli* (no./d) |
|---|---|---|---|---|---|---|---|
| Domestic (Residential) | Person | 0.04 | 0.042 | 0.09 | $8.5\times10^{-3}$ | $5 \times10^{-3}$ | $4.3\times10^{10}$ |
| Commercial[1] | Employee | 0.059 | 0.087 | 0.173 | $9.2\times10^{-3}$ | $4.8 \times10^{-3}$ | $3.5\times10^{10}$ |
| Schools[2] | Person | 0.034 | 0.034 | 0.07 | $6.7\times10^{-3}$ | $4 \times10^{-3}$ | $3.5\times10^{10}$ |

Notes:

[1] Unit Load Factors (Commercial) is the sum of Unit Load Factors for commercial activities and employed population.

[2] Unit Load Factors of Schools is the Unit Load Factor of employed population.

## 6.4.6 Hydraulic assessment

Pipe hydraulics is based on Colebrook-White Equation with ks = 1.5mm for concrete pipe and v = 0.000001 $m^2/s$ according to Table 5, DSD's SM1.

### 6.4.7 Interface Projects

#### 6.4.7.1 Land Use Planning for the Closed Area – Feasibility Study

According to the planning study for the Frontier Closed Area, with the opening of the Closed Area, it was proposed to expand the boundaries of the relevant recognized villages in order to cater for the 10-year Small House demand forecast for these recognized villages. An integrated approach needs to be adopted for the collection, treatment and disposal of sewage from these developments.

#### 6.4.7.2 North East New Territories New Development Areas Planning and Engineering Study – Investigation

The proposed North East New Territories New Development Areas (NDAs) Study is on-going. Based upon the planning proposals for NDAs development, SWHSTW cannot handle the additional sewage flows from NDAs and therefore expansion of SWHSTW is required. Furthermore, SWHSTW needs to be upgraded to cater for additional loading generated by other developments within its sewage catchment area.

One of the sewage treatment and disposal options for LMC Loop is to convey the sewage flows to SWHSTW for treatment and disposal. Therefore, allowance was made in the proposed expansion and upgrading of SWHSTW under NDAs Study.

## 6.5 Identification and Evaluation of Sewage and Sewerage Treatment Implications

### 6.5.1 Sewage Flow Estimation

Based upon the proposed development parameters for LMC Loop, a total Average Dry Weather Flow (ADWF) estimate from the LMC Loop would be approximately 14,689$m^3$/day with detailed calculation provided in **Appendix 6-1**.

Based on the above assumptions, the proposed sewage treatment works (STW) shall be designed with Average Dry Weather Flow (ADWF) of approximately 18,000$m^3$/day to suit the development parameters.

The projected flow would result in an equivalent population of approximately 55,560 and therefore STW shall be designed with a peaking factor of 2.40 with stormwater allowance.

### 6.5.2 Pollutant Load Estimation

The unit load factors used to estimate the pollutant loading are categorised by Domestic, Commercial and School (see **Table 6.4**)

For calculation of loading due to Domestic, the combined population of 13,145 has been assumed, made up of 12,000 residing students within the Loop campus and about 1,145 people residing at the nearby Lok Ma Chau village.

For calculation of loading due to School, the total number of students and staff in High Education has been assumed.

For loading due to Commercial, the C&C Industries, Hi-tech R&D, Supporting Commercial and Government Uses are grouped into this category.

For estimation of loading from Kitchen, SS and BOD loading of 300 g/m$^2$ kitchen area/day has been assumed in accordance with Appendix 3 of "Guidelines for the Design of Small Sewage Treatment Plant" from EPD.

Based on the above, the development parameters (see **Chapter 2**) and the load factors in **Table 6.4**, the pollutant loads are estimated and shown on **Table 6.5**.

**Table 6.5** Projected pollutant loads

| **Load** | **SS (kg/d)** | **BOD (kg/d)** | **COD (kg/d)** | **TKN (kg/d)** | **$NH_3$-N (kg/d)** | ***E. coli* (no./d)** |
|---|---|---|---|---|---|---|
| Residential | 525.8 | 552.1 | 1,183.1 | 111.7 | 65.7 | $5.65 \times 10^{14}$ |
| High Education | 612.0 | 612.0 | 1260.0 | 120.6 | 72.0 | $6.30 \times 10^{14}$ |
| Hi-tech R&D / C&C Industries | 1212.5 | 1787.9 | 3555.2 | 189.1 | 98.6 | $7.19 \times 10^{14}$ |
| Supporting Commercial | 157.5 | 232.3 | 461.9 | 24.6 | 12.8 | $9.35 \times 10^{13}$ |
| Kitchen (Area 4,500m2) | 1350.0 | 1350.0 | - | - | - | - |
| Government Uses | 8.9 | 13.1 | 26.0 | 1.4 | 0.7 | $5.25 \times 10^{12}$ |
| Total | 3866.7 | 4547.4 | 6486.2 | 447.4 | 249.8 | $2.01 \times 10^{15}$ |

With the total projected flow of 18,000m$^3$/day and the projected pollutant loads as shown in **Table 6.5**, the average sewage concentration is estimated and shown on **Table 6.6**.

**Table 6.6** Projected pollutant concentrations

| **SS (mg/L)** | **BOD (mg/L)** | **COD (mg/L)** | **TKN (mg/L)** | **$NH_3$-N (mg/L)** | ***E. coli* (no./100ml)** |
|---|---|---|---|---|---|
| 214.8 | 252.6 | 360.3 | 24.9 | 13.9 | $1.12 \times 10^7$ |

### 6.5.3 Treatment Implications

LMC Loop is located within the Deep Bay Water Control Zone (WCZ). Since the treated sewage effluent generated from the development site, if discharged directly or in-directly to the Deep Bay, is required to comply with 'No net increase in pollution load' Policy, compensation measures should be taken.

A new sewerage network will be required to convey sewage flow from various lots within the LMC Loop to the proposed on-site STW for its treatment and disposal. **Figure 6.2** shows the preliminary layout of the proposed sewerage system for the LMC Loop. The majority of alignment of the proposed trunk sewerage network is either along the proposed roads or through amenities area. The drainage reserve will be required to lay the sewer pipe outside the roads such as through amenities areas or open spaces. The hydraulic calculation of the sewerage system is presented in **Appendix 6-1**.

The development will be constructed in phases to support the first intake of population targeted in 2020 (see **Chapter 2**). In order to support the first population in-take, the construction of the new on-site sewage treatment works and the new trunk sewers will need to be completed prior to first population intake. The construction of sewerage system will be carried out as part of site formation works.

## 6.6 Mitigation Measures

### 6.6.1 On-site Sewage Treatment Works

#### 6.6.1.1 Compliance to "No Net Increase in Pollution Load"

In order to comply with 'No net increase in pollution loads' policy, the sewage from LMC Loop development shall be treated to a very high standard, together with the pollutant loads reduction measures in the northern districts including the planned NENT NDAs and SWHSTW.

As estimated, there will be 18,000$m^3$/day of sewage flow to be treated in the proposed onsite STW. With the proposed discharge standard of LMC Loop STW as shown in **Table 6.7**, the residual pollution loads of the STW effluent without compensation have been estimated and shown in **Table 6.8**.

**Table 6.7** Discharge standards for on-site STW

| Parameter | Unit | Value for design (proposed to be adopted as 95%-ile under licence conditions) | Proposed Upper Limit under licence conditions | Standards for effluents discharged into Group B inland waters (for reference) |
|---|---|---|---|---|
| Average flow | $m^3$/day | 18,000 | - | - |
| $BOD_5$ | mg/L | 5 | 10 | 20 |
| TN | mg/L | 8 | 16 | - |
| TP | mg/L | 1 | 2 | 5 |
| TSS | mg/L | 10 | 20 | 30 |
| $NH_3$-N | mg/L | 1.9 | 3.8 | 5 |
| *E.coli* | cfu/100mL | 1,500 | 100 (monthly geometric mean) | 100 |

Note: All the proposed discharge standards are set as 95$^{th}$-percentile except that for *E. Coli* as geometric mean. cfu = colony-forming unit. The maximum range of flow rate of 2,000-3,000$m^3$/day extracted from Table 4 of "Technical Memorandum - Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters" for reference purpose.

**Table 6.8** Pollutant loads discharge subject to "no net increase in pollution loads"

| Parameter | Unit | Average Flow = 18,000 $m^3$/day |
|---|---|---|
| $BOD_5$ | kg/day | 90 |
| TN | kg/day | 144 |
| TP | kg/day | 18 |

It should be noted that a pre-requisite for achieving "No net increase in pollution loads" for the LMC Loop development is to implement pollutant load reduction measures in the northern districts, such that the pollutant load given in **Table 6.8** above is covered. The compensation will be covered by upgrading of SWHSTW, which will be under the NENT NDAs study (see **Chapter 2**) and will be initiated by CEDD.

There will be additional buffer for pollutant load being discharged to Deep Bay when Treated Sewage Effluent (TSE) reuse is pursued. The minor relaxation of discharge standard could possibly be achieved or additional treatment capacity could be provided to other surrounding users. For design purpose, however, the proposed discharge standards and projected effluent flow given in **Table 6.7** shall be referenced as the basis.

As worst scenario consideration, TSE reuse is not included in calculations for compliance with "No net increase in pollution load" and the calculation are presented in **Appendix 6-2**.

In considering similar treatment method and domestic influent characteristics for both LMC on-site STW and SHWSTW, the effluent component in various parameters would be comparable. Given that the 3 parameters, $BOD_5$, TN and TP, have been shown to comply with the "No net increase in pollution load" policy, the same compliance can be expected of the other parameters such as SS and *E.coli*. In addition, SS and *E.coli* will not contribute algal bloom and will be reduced by settling and degrading. Adverse impact on the receiving water bodies (i.e. Shenzhen River) for SS and *E.coli* is not anticipated. Further review on the loading of $BOD_5$, TN (or ammonia), TP, SS and *E.coli* according to field data, assimilation capacity and water quality needs of the receiving water body is recommended during the detailed design stage of the proposed LMC Loop STW.

#### 6.6.1.2 Sewage Treatment Strategies

Under the current study stage, Membrane Bio-Reactor (MBR) system has been considered for the LMC Loop STW due to the very stringent discharge requirement. Compared to Conventional Activated Sludge Process with a Biological Effluent Filter for nitrogen removal, MBR system does not require large footprint as it can be operated under high mixed liquor suspended solids (MLSS) concentration, typically 8,000mg/L but could go up to as high as 15,000mg/L. In addition, membrane is used for the liquid-solid separation so no clarifier is required, which also saves plant footprint. MBR system is able to produce high quality effluent, which is suitable for non-potable reuse, such as toilet flushing, irrigation etc. Therefore, MBR system is proposed as the biological treatment process with the effluent re-use scheme adopted. **Table 6.9** presents the attributes of MBR system for on-site STW.

**Table 6.9** Attributes of MBR

| Attribute | MBR |
|---|---|
| Overall hydraulic retention time | 12-14 hrs |
| $BOD_5$ removal | 95-98% (norm of MBR performance) |
| Faecal coliform log removal | 6-7 |
| Area requirement | 0.08 ha per 1,000$m^3$/day capacity |

A sewerage network will be required to convey sewage flow from various lots within the LMC Loop. A draft sewerage master plan is given in **Appendix 6-3**.

### 6.6.2 Treated Sewage Effluent Reuse

Treated Sewage Effluent (TSE) reuse has the advantage of reducing wastewater discharge in the receiving waterbodies thereby reducing the pollution load to the environment. It also reduces demand on raw water, which is a scarce natural resource deserved for preservation to the maximum extent practicable.

TSE reuse is proposed for LMC Loop development as a result of a number of opportunities listed below:

*No net increase in pollution loads to Deep Bay*

- The additional pollutant loading within the sewage catchment will have to be compensated via a higher level of sewage treatment prior to discharge. More stringent TSE discharge requirement will be necessary. Under this setting, the quality of TSE for discharge is indeed equivalent to, if not far away from, TSE reuse for non-potable uses.

*Non-saline sewage/effluent*

- Unlike coastal areas, the northern district is not supplied with salt water for flushing due to the fact that extensive and long-distance pumping of salt water from Sha Tau Kok area to LMC Loop is not economical. In other words, the sewage or TSE will mainly be non-saline which may be suitable for higher grade non-potable reuse eg landscape irrigation, apart from low grade non-potable reuse eg toilet flushing.

*Cost-effectiveness*

- As mentioned above, since TSE discharge standard is very high for LMC Loop, further purification of TSE satisfying reuse standard would not be prohibitively high. In addition, the energy associated with distribution of TSE reuse within the 87 hectares of LMC Loop will minimise the pumping energy during the operation. Further, TSE reuse substitutes the alternative fresh water supply for non-potable purposes, making water reuse possible and enhancing water efficiency.

*Public anticipation*

- TSE reuse is not a new concept in Hong Kong as there have been several earlier pilot or demonstrated schemes. This could be regarded as one of the sustainable initiatives for new development, and is also in line with the Total Water Management (TWM) initiatives of the Hong Kong SAR Government.

#### 6.6.2.1 Applications and TSE Reuse Water Quality

The TSE is proposed to be reused for non-potable uses such as toilet flushing, landscape irrigation and make-up water for district cooling system (DCS). If there are reuses, the discharge effluent from the development to the Deep Bay (and thus the pollutant load) will be further reduced.

Since the total projected effluent reuse quantity is lower than the total treated effluent generated from the development area, there will always be discharges from the development area to the Deep Bay unless effluent exportation to outside the Deep Bay WCZ is implemented. However, sewage impacts to the Deep Bay from the development will be reduced proportionally if part of the treated effluent is to be reused. Therefore, the above implication assessment represents the worst case scenario without consideration of any reuse or exportation outside the Deep Bay WCZ.

Based on the current study stage, the amount of effluent to be reused within LMC Loop development is estimated and presented in **Table 6.10**. The proposed water quality standards of TSE reuse for various non-potable reuses are presented in **Table 6.11**, referencing the prevailing water supply guidelines, international guidelines (e.g. USEPA) or on-going TSE reuse projects (e.g. Ngong Ping STW) for the intended non-potable water uses, balancing with practicality and anticipated end-user satisfaction. One of the benefits of adopting a universal TSE reuse quality is to standardise such that additional distribution pipeline or conveyance system is not required.

**Table 6.10** Estimated quantities of TSE reuse

| Reuse of Effluent | Quantity ($m^3$/day) |
|---|---|
| Toilet Flushing | 3,510 |
| Irrigation (Including Ecological Area) | 1,950 |
| District Cooling System[Note] | 5,000 |
| **Total** | **10,460** |

Note: DCS is a closed circuit system. The water demand for DCS refers to the replenishment of water from cooling tower due to evaporation, drift and bleed-off. The 5000$m^3$/day water demand represents the average replenishment rate for DSC by TSE reuse.

**Table 6.11** Proposed water quality standards of TSE reuse

| Water Quality Parameter | Unit | Recommended Standard for Flushing, Landscape Irrigation and DCS Make-up |
|---|---|---|
| *E. Coli* | cfu/100mL | Not detectable |
| Total residual chlorine (TRC) | mg/L | >1 (out of treatment system)<br>>0.2 (at point-of-use) |
| Dissolved oxygen (DO) | mg/L | >2 |
| TSS | mg/L | <5 |
| Colour | HU | <20 |
| Turbidity | NTU | <5 |
| pH | - | 6 – 9 |
| Threshold odour number (TON) | TON | <100 |
| $BOD_5$ | mg/L | < 10 |
| Ammonia nitrogen | mg/L | <1 |
| Synthetic detergents | mg/L | <5 |

Note: Apart from TRC which has been specified, the water quality standards for all parameters shall be applied at the point-of-use of the system. HU = Hazen Unit. NTU = Nephelometric Turbidity Unit.

Chlorination with a minimum 30 minutes contact time will be provided to treat the colour and ammonia nitrogen. Minimum residual chlorine of 0.2 mg/L will be achieved at point-of-use.

Facilities for TSE reuse will involve the flushing water service reservoir. The area of water service reservoir will be about 2 ha. The major construction works will include earthwork, slopework (including soil nailing and retaining walls), concrete works for service reservoir structure and construction of maintenance road near the ECR.

#### 6.6.2.2 Public Health Implication

In general, the following precautionary measures should be adopted for TSE reuse:

- To avoid cross connection and hence contamination, all pipes and fittings used for the TSE water supply and distribution system should be purple in colour for distinguishing them from the pipes and fittings used for the fresh water supply and distribution systems.
- Regular checking/inspections of the TSE supply and distribution systems for possible cross connection to the fresh water supply and distribution system should be carried out. The use of non-toxic dye may be adopted in the checking/inspections.
- Warning signs should be permanently displayed where public access to TSE is possible (except for toilets) notifying the employees, visitors and the public at large that treated effluent is being used and is not suitable for drinking.
- Storage of sodium hypochlorite solution will be required and this is not a hazardous material. Thus, the storage is not considered as Potentially Hazardous Installation (PHI).

The usual practice to distinguish reclaimed water pipe work from potable pipework is by colour code. Under Demonstration Scheme on Reclaimed Water Uses in the Northern District, for example, purple/lavender coloured pipes were used between SWHSTW to respective user's premises for easy differentiation from existing pipework.

Apart from that, proper signage, promotion and education to the general public especially potential local users of reclaimed water for landscape irrigation shall be considered and implemented.

The main health concern with TSE reuse is the small but definite risk of diarrhoeal diseases associated with accidental ingestion of insufficiently treated TSE. With the implementation of precautionary measures set out in above, and the adoption of stringent health-based water quality standards for the TSE, significant increase in health risk is not expected.

## 6.7 Conclusions

Under the present condition, there is no public sewerage system in the vicinity of proposed development site. The proposed LMC Loop development will generate additional sewage flows and loads which cannot be handled by the existing YLSTW or SWHSTW. In order to meet the prevailing water quality policies of "No net increase in pollution load", treatment facility will be required for the generated sewage from LMC Loop development.

On-site STW and off-site load compensation at SWHSTW is recommended. In addition, MBR is recommended as the sewage treatment process to be adopted in the on-site STW, which requires smaller footprint and generates effluent quality readily for TSE reuse purpose. In order to meet "No net increase in pollution load" in Deep Bay upgrading of SWHSTW is recommended to compensate for the residual loads and the proposal is recommended to be taken into consideration in the ongoing Study for expansion/upgrading of SWHSTW.