5 Water Quality Impact

5.1 Overview

This section presents the assessment of potential water quality impacts, which may arise during the construction and operation of the LMC Loop. Control measures such as silt traps and oil interceptors will be implemented on site to control the potential surface runoff during construction / operational phase. Cofferdam/diaphragm wall will be employed to prevent disturbance to waterbodies during bridge pier and cut-and-cover underpass constructions.

During operational phase, the major water pollution source would be the sewerage and sewage implication from the proposed sewage treatment works for LMC Loop. A "no net increase in pollution loads requirement" in Deep Bay will be fulfilled by loading compensation in Deep Bay catchment by upgrading of Shek Wu Hui STW to advanced treatment level.

The water quality impact assessment has been conducted in accordance with the requirements of Annexes 6 and 14 of the TM-EIAO as well as the requirements set out under Clause 3.4.6 of the EIA Study Brief.

5.2 Environmental Legislations, Standards and Guidelines

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

- Water Pollution Control Ordinance (WPCO) CAP 358;
- Technical Memorandum 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
- ProPECC PN 1/94 "Construction Site Drainage"

5.2.1 Water Pollution Control Ordinance, CAP 358

The entire Hong Kong waters are divided into ten Water Control Zones (WCZs) and four supplementary WCZs under the Water Pollution Control Ordinance (WPCO) (CAP 358). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs) designed to protect the inland and/or marine environment and its users. The LMC Loop is located in the Deep Bay WCZ and the corresponding WQOs are summarised in **Table 5.1**.

Table 5.1 Water quality objectives for Deep Bay Water Control Zones

Parameters	Objectives	Sub-Zone
Offensive Odour, Tints	Not to be present	Whole zone
Visible foam, oil scum, litter	Not to be present	Whole zone
Dissolved Oxygen (DO) within 2 m of the seabed	Not less than 2.0mg/L for 90% of samples	Outer Marine Subzone excepting Mariculture Subzone
DO within 1 m below surface	Not less than 4.0mg/L for 90% of samples	Inner Marine Subzone excepting Mariculture Subzone
	Not less than 5.0mg/L for 90% of samples	Mariculture Subzone
Depth-averaged DO	Not less than 4.0mg/L for 90% of samples	Outer Marine Subzone excepting Mariculture Subzone
	Not less than 4.0mg/L	Yuen Long & Kam Tin (Upper and Lower) Subzones, Beas Subzone, Indus Subzone, Ganges Subzone, Water Gathering Ground Subzones and other inland waters of the Zone
5-Day Biochemical Oxygen Demand (BOD_5)	Not to exceed 3mg/L	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones
	Not to exceed 5mg/L	Yuen Long & Kam Tin (Lower) Subzone and other inland waters
Chemical Oxygen Demand (COD)	Not to exceed 15mg/L	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground
	Not to exceed 30mg/L	Yuen Long & Kam Tin (Lower) Subzone and other inland waters
pH	To be in the range of 6.5 – 8.5, change due to waste discharges not to exceed 0.2	Marine waters excepting Yung Long Bathing Beach Subzone
	To be in the range of 6.5 – 8.5	Yuen Long & Kam Tin (Upper and Lower) Subzones, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones
	To be in the range of 6.0 –9.0	Other inland waters
	To be in the range of 6.0 – 9.0 for 95% samples, change due to waste discharges not to exceed 0.5	Yung Long Bathing Beach Subzone
Salinity	Change due to waste discharges not to exceed 10% of ambient	Whole zone
Temperature	Change due to waste discharges not to exceed 2°C	Whole zone

Parameters	Objectives	Sub-Zone
Suspended solids (SS)	Not to raise the ambient level by 30% caused by waste discharges and shall not affect aquatic communities	Marine waters
	Not to cause the annual median to exceed 20mg/L	Yuen Long & Kam Tin (Upper and Lower) Subzones, Beas Subzone, Ganges Subzone, Indus Subzone, Water Gathering Ground Subzones and other inland waters
Unionized Ammonia (UIA)	Annual mean not to exceed 0.021mg/L as unionized form	Whole zone
Nutrients	Shall not cause excessive algal growth	Marine waters
Total Inorganic Nitrogen (TIN)	Annual mean depth-averaged inorganic nitrogen not to exceed 0.7mg/L	Inner Marine Subzone
	Annual mean depth-averaged inorganic nitrogen not to exceed 0.5mg/L	Outer Marine Subzone
Bacteria	Not exceed 610per 100ml, calculated as the geometric mean of all samples collected in one calendar year	Secondary Contact Recreation Subzones and Mariculture Subzones
	Should be zero per 100 ml, calculated as the running median of the most recent 5 consecutive samples taken between 7 and 21 days.	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones
	Not exceed 180per 100ml, calculated as the geometric mean of the collected from March to October inclusive in one calendar year. Samples should be taken at least 3 times in a calendar month at intervals of between 3 and 14days.	Yung Long Bathing Beach Subzone
	Not exceed 1000 per 100ml, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21days	Yuen Long & Kam Tin (Lower) Subzone and other inland waters
Colour	Not to exceed 30 Hazen units	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones
	Not to exceed 50 Hazen units	Yuen Long & KamTin (Lower) Subzone and other inland waters
Turbidity	Shall not reduce light transmission substantially from the normal level	Yuen Long Bathing Beach Subzone
Phenol	Quantities shall not sufficient to produce a specific odour or more than 0.05mg/L as C_6H_5OH	Yuen Long Bathing Beach Subzone

Parameters	Objectives	Sub-Zone
Toxins	Should not cause a risk to any beneficial uses of the aquatic environment	Whole Zone
	Should not attain such levels as to produce toxic carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms.	Whole Zone

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

Apart from the WQOs, Section 21 of the WPCO also specifies the limits to control the physical, chemical and microbial parameters for effluent discharges into drainage and sewage system at both inland and coastal waters under the Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-DSS). The discharge limits vary with the effluent flowrates. Sewerage from the LMC Loop should comply with the standards for effluent discharged into inland water. Group B and C inland water standards in TM-DSS are adopted and the effluent discharge standards are presented in **Tables 5.2a** and **5.2b**.

Table 5.2a Standards for effluents discharged into Group B Inland Waters

Parameter	Flowrate (m^3/day)							
	≤ 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)	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
Temperature (°C)	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	3	2	1
Boron	5	4	3	2.5	2	1.5	1	0.5
Barium	5	4	3	2.5	2	1.5	1	0.5
Mercury	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Selenium	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1

Parameter	Flowrate (m^3/day)							
	≤ 200	> 200 and ≤400	> 400 and ≤ 600	> 600 and ≤ 800	> 800 and ≤ 1000	> 1000 and ≤ 1500	> 1500 and ≤ 2000	> 2000 and ≤ 3000
Other toxic metals individually	0.5	0.5	0.2	0.2	0.2	0.1	0.1	0.1
Total Toxic metals	2	1.5	1	0.5	0.5	0.2	0.2	0.2
Cyanide	0.1	0.1	0.1	0.08	0.08	0.05	0.05	0.03
Phenols	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Sulphide	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Fluoride	10	10	8	8	8	5	5	3
Sulphate	800	800	600	600	600	400	400	400
Chloride	1000	1000	800	800	800	600	600	400
Total phosphorus	10	10	10	8	8	8	5	5
Ammonia nitrogen	5	5	5	5	5	5	5	5
Nitrate + nitrite nitrogen	30	30	30	20	20	20	10	10
Surfactants (total)	5	5	5	5	5	5	5	5
E. coli (cfu/100ml)	100	100	100	100	100	100	100	100

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

Table 5.2b Standards for effluents discharged into Group C Inland Waters

Parameter	Flowrate (m^3/day)			
	≤ 100	> 100 and ≤500	> 500 and ≤ 1000	> 1000 and ≤ 2000
pH (pH units)	6-9	6-9	6-9	6-9
Temperature (°C)	30	30	30	30
Colour (lovibond units) (25mm cell length)	1	1	1	1
Suspended solids	20	10	10	5
BOD	20	15	10	5
COD	80	60	40	20
Oil & Grease	1	1	1	1
Iron	0.5	0.4	0.3	0.2
Mercury	0.001	0.001	0.001	0.001

Parameter	Flowrate (m^3/day)			
	≤ 100	> 100 and ≤500	> 500 and ≤ 1000	> 1000 and ≤ 2000
Cadmium	0.001	0.001	0.001	0.001
Silver	0.1	0.1	0.1	0.1
Copper	0.1	0.1	0.05	0.05
Selenium	0.1	0.1	0.05	0.05
Lead	0.2	0.2	0.2	0.1
Nickel	0.2	0.2	0.2	0.1
Other toxic metals individually	0.5	0.4	0.3	0.2
Total Toxic metals	0.5	0.4	0.3	0.2
Cyanide	0.05	0.05	0.05	0.01
Phenols	0.1	0.1	0.1	0.1
Sulphide	0.2	0.2	0.2	0.2
Fluoride	10	7	5	4
Sulphate	800	600	400	200
Chloride	1000	1000	800	800
Total phosphorus	10	10	8	8
Ammonia nitrogen	2	2	2	1
Nitrate + nitrite nitrogen	30	30	20	20
Surfactants (total)	2	2	2	1
E. coli (cfu/100ml)	1000	1000	1000	1000

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

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

The general criteria and guidelines for evaluating and assessing water quality impacts are listed in Annexes 6 and 14 of the TM-EIAO.

5.2.4 No Net Increase in Pollution Loads Requirement in Deep Bay

In addition to the provisions of the TM, the 'No Net Increase in Pollution Loads Requirement' aims to provide protection to the inland and marine water quality of the Deep Bay WCZ. The pollutions entering into Deep Bay have exceeded the assimilative capacity of the water body. To increase pollution loads to the water body is environmentally undesirable. In accordance with Clause 3.4.6.5(xv) of the

EIA Study Brief and Town Planning Board Guideline No.12B, the pollution loads of concern should be offset by equivalent reduction of current loads for new discharge into Deep Bay. The policy ensures that developments within the Deep Bay catchment areas do not result in an increase in pollution loads to the inland and marine waters.

5.2.5 Hong Kong Planning Standards and Guidelines

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

5.2.6 ProPECC PN 1/94 "Construction Site Drainage"

The Practice Note for Professional Persons (ProPECC Note PN1/94) on Construction Site Drainage provides guidelines for the handling and disposal of construction discharges. It is applicable to this study for control of site runoff and wastewater generated during the construction phase. The types of discharges from construction sites outlined in the ProPECC Note PN1/94 include:

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

5.3 Description of the Environment

5.3.1 Existing Environment

The project boundary falls within the Deep Bay WCZ according to the WPCO. It is located on the south bank of mid-stream of Shenzhen River.

In terms of hydrological regime, LMC Loop is surrounded by a moat formed by the main line of Shenzhen River and the meander, which is a part of the Old Shenzhen River. The flowrate of the meander is nearly stagnant with minor baseflow to the Shenzhen River Main Line. Upstream of LMC Loop, tributaries draining into the Shenzhen River include Ng Tung River, Sheung Yue River, Ping Yuen River, Shawanhe, Bujihe and Futianhe. Downstream tributaries include San

Tin Eastern Main Drainage Channel, Huangguanghe and Xinzhouhe. A diagram of the river regime near the LMC Loop is shown in **Figure 5.1**.

The mainline of Shenzhen River also act as a major drainage channel to the stormwater catchments of Northern New Territories Drainage Master Plan. The catchment area covers North District, North Yuen Long, San Tin, Mai Po and South of Shenzhen City. A flood plain was formed by wetlands on Hong Kong side such as Mai Po, San Tin and Hoo Hok Wai.

There is no public sewage system in the vicinity of proposed development site except at the Sewage Treatment Works (STW) within MTR LMC Station, which is designed for LMC Station use only. Existing domestic wastewater generated by villages nearby is likely discharged directly to nearby streams or collected by individual soak away and septic tanks systems.

5.3.2 Existing Baseline Condition

5.3.2.1 River Water Quality

1) Ng Tung River and Sheung Yue River

The EPD has carried out routine water quality monitoring in Ng Tung River and Sheung Yue River, which is about 4.0 to 5.8km at upstream of the LMC Loop. According to the EPD's River Water Quality in Hong Kong in 2010, the compliance levels of WQO for Sheung Yue River were ranged from 78% to 90%. The river water quality was subjected to pollution from livestock farms, small industrial establishments and unsewered villages. For Ng Tung River, the compliance level on WQO could achieve up to 92% to 95% at midstream to upstream sections. However, it would drop to only 60% on WQO at downstream sections, as a result of the backflow from Shenzhen River. The environmental monitoring data are presented in **Table 5.3** and the locations of monitoring stations are presented in **Figure 5.1.**

Table 5.3 Water quality of Ng Tung River and Sheung Yue River between 2006 and 2010

Parameter	Monitoring Point	Concentration [1] [5-1]				
		2006	2007	2008	2009	2010
Ng Tung River						
Dissolved Oxygen (DO) (mg/L)	IN1	3.8	5.8	2.9	4.7	5.1
	IN2	7.7	6.9	8.1	6.8	6.6
	IN3	8.2	8.2	8.5	8.3	8.5
pH	IN1	7.2	7.2	7.1	7.3	7.4
	IN2	7.1	7.4	7.3	7.3	7.7
	IN3	7.4	7.4	7.1	7.5	7.6
Suspended Solid (SS) (mg/L)	IN1	25	16	35	24	20
	IN2	9	12	6	6	10
	IN3	4	3	3	4	8
BOD_5 (mg/L)	IN1	7	6	10	6	8
	IN2	2	3	3	3	3
	IN3	2	1	< 1	1	2
COD (mg/L)	IN1	26	20	25	15	18

Parameter	Monitoring Point	Concentration [1] [5-1]				
		2006	2007	2008	2009	2010
	IN2	10	11	9	8	8
	IN3	10	12	9	8	8
Sheung Yue River						
DO (mg/L)	RB1	8.4	8.1	8.3	9.0	9.7
	RB2	7.5	7.7	7.9	7.8	7.7
	RB3	8.2	6.5	6.7	7.8	8.1
pH	RB1	7.6	7.7	7.7	8.0	8.0
	RB2	7.3	7.5	7.4	7.5	7.5
	RB3	7.3	7.3	7.3	7.4	7.6
SS (mg/L)	RB1	7	10	13	7	8
	RB2	7	12	24	11	20
	RB3	16	17	17	16	9
BOD_5 (mg/L)	RB1	3	3	4	2	3
	RB2	4	5	4	3	4
	RB3	6	4	5	4	8
COD (mg/L)	RB1	11	12	11	10	8
	RB2	13	14	12	9	10
	RB3	27	19	17	12	14

Notes:
[1] Data presented are in annual medians of monthly samples

2) Shenzhen River

There is no existing EPD water quality monitoring station located in Shenzhen River. The baseline water quality near the LMC Loop can be referred to Shenzhen-Hong Kong Lok Ma Chau Loop Joint Development Project Environmental Impact Assessment Outline (Draft) 《深港落馬洲河套地區聯合開發項目環境影響評價大綱(送審稿)》[5-2], Shenzhen River Contaminated Sediment Remediation Strategy Joint Study《深圳河污染底泥治理策略合作研究》[5-3] and Shenzhen River and Deep Bay Water Quality and Ecological Baseline Survey Report《深圳河及深圳灣水環境與生態現狀調查與評介報告》studies conducted by SZMEPB [5-4].

According to Shenzhen-Hong Kong Lok Ma Chau Loop Joint Development Project Environmental Impact Assessment Outline (Draft) 《深港落馬洲河套地區聯會開發項目環境影響評價大綱(送審稿)》[5-2] prepared under the appointment of the SZMEPB, the water quality target for Shenzhen River is Category III surface water quality standard《地表水環境質量標準》 (GB3838-2002). In reality, the monitored water quality of Shenzhen River in 2006 exceeded the Category III standard and even worse than Category V (劣五類), which refers to the poorest water quality in the range.

Findings of the Proposed Working Plan for Implementing Contamination Survey in River Sediments《底泥污染調查建議工作計劃》[5-5] under the on-going study Shenzhen River Contaminated Sediment Remediation Strategy Joint Study《深圳河污染底泥治理策略合作研究》[5-3] suggested the pollution of Shenzhen River was resulted from untreated effluent discharge from urban areas such as Buji and Futian. The lack of proper sewage system has also exacerbated the poor water quality conditions.

In the SZ Baseline Survey Report, measurements were conducted at 4 monitoring stations along Shenzhen River during the periods of 2 – 4 August 2008, 11 – 13 October 2008 and 12 – 14 December 2008. Among all monitoring stations, Stations No. 2 (114°4'18"E, 22°31'4"N) and 3 (114°4'18"E, 22°31'4"N) were located in the main line of Shenzhen River alongside the LMC Loop (**Figure 5.1**). It is therefore considered representative of the water quality near the LMC Loop. Monitoring results at Stations No. 2 and 3 are summarized in **Tables 5.4a** and **5.4b** respectively.

Table 5.4a Water quality monitoring results at Station No. 2 near the LMC Loop in 2008

Parameter	Surface water quality standard (GB3838-2002)		Concentration		
	Cat III – 2nd class protection zone	Cat V - Amenity use	2 – 4 Aug 2008	11 – 13 Oct 2008	12 – 14 Dec 2008
Temperature (°C)	Man-made increase ≤1 and man-made reduction ≤ 2		30.3 (29.9 - 30.5)	28.2 (27.5 – 28.6)	20.6 (20.3 – 20.9)
Salinity (ppt)	-	-	< 2	< 2	< 2
pH	6 - 9	6 – 9	7.44 (7.21 – 7.56)	7.39 (7.21 – 7.58)	7.38 (7.21 – 7.53)
COD (mg/L)	20	40	16.8 (13.2 – 20.8)	9.23 (2.85 – 13)	1.76 (1.34 – 2.30)
BOD_5 (mg/L)	4	10	14.8 (12.1 – 18.4)	22.3 (12.6 – 30)	23.3 (20.2 – 27.4)
Ammonium Nitrogen (NH_4-N) (µg/L)	1.0	2.0	28.2 (15.0 – 41.3)	5.1 (4.0 – 6.4)	5.8 (3.3 – 7.1)
Total Phosphorus (mg/L)	0.2	0.4	0.923 (0.583 – 1.41)	1.29 (1.19 – 1.46)	2.39 (2.08 – 2.7)
Total Nitrogen (mg/L)	1.0	2.0	12.8 (11.4 – 13.8)	4.10 (1.21 – 9.52)	17.8 (16 – 20.4)
Mercury (Hg) (µg/L)	0.1	1	0.023 (0.018 – 0.037)	0.028 (0.024 – 0.031)	0.045 (0.040 – 0.053)
Arsenic (As) (µg/L)	50	100	3.2 (3.0 – 3.4)	2.7 (2.5 – 3.0)	2.3 (2.0 – 2.9)
Zinc (Zn) (µg/L)	1000	2000	11.1 (5.9 – 17.3)	9.5 (7.7 – 11.1)	15.8 (13.3 – 17.5)
Cadmium (Cd) (µg/L)	5	10	0.17 (Undetectable – 0.27)	Undetectable	0.26 (0.23 – 0.29)
Lead (Pb) (µg/L)	50	100	1.2 (0.7 – 1.6)	0.9 (0.7 – 1.0)	1.1 (0.9 – 1.2)
Copper (Cu) (µg/L)	1000	1000	1.7 (1.3 – 1.9)	2.3 (1.9 – 2.7)	2.5 (2.2 – 2.7)

Parameter	Surface water quality standard (GB3838-2002)		Concentration		
	Cat III – 2nd class protection zone	Cat V - Amenity use	2 – 4 Aug 2008	11 – 13 Oct 2008	12 – 14 Dec 2008
Chromium ions (Cr^{6+}) (μg/L)	50	100	3.7 (0.7 – 6.0)	9.5 (4.0 – 17)	8 (2.6 – 16.9)
Cyanide (mg/L)	200	200	≤ 0.003	≤ 0.005	< 0.002
Fluoride (mg/L)	-	-	0.57 (0.53 – 0.62)	0.84 (0.82 – 0.89)	0.81 (0.71 – 0.86)
Sulfide (μg/L)	200	1000	25.6 (1.2 – 71.8)	46.8 (17.6 – 89.9)	257 (138 – 520)
Volatile Phenol (mg/L)	5	100	≤ 0.002	≤ 0.002	< 0.002
Anionic surfactant (mg/L)	200	300	1.67 (1.02 – 2.13)	1.56 (1.07 – 2.16)	2.46 (2.27 – 2.82)
TPH (mg/L)	50	100	0.337 (0.268 – 0.563)	0.420 (0.275 – 0.541)	0.37 (0.341 – 0.404)
SS (mg/L)	-	-	36.8 (24.7 – 49.0)	34.3 (2.0 – 117)	47.8 (27.0 – 76.0)

Table 5.4b Water quality monitoring results at Station No. 3 near the LMC Loop in 2008

Parameter	Surface water quality standard (GB3838-2002)		Concentration		
	Cat III – 2nd class protection zone	Cat V - Amenity use	2 – 4 Aug 2008	11 – 13 Oct 2008	12 – 14 Dec 2008
Temperature (°C)	Man-made increase ≤1 and man-made reduction ≤ 2		30.3 (30.0 - 30.5)	28.2 (27.6 – 28.6)	20.2 (20.0 – 20.3)
Salinity (ppt)	-	-	< 2	< 2	< 2
pH	6 - 9	6 – 9	7.65 (7.40 – 7.79)	7.37 (7.13 – 7.63)	7.39 (7.35 – 7.46)
COD (mg/L)	20	40	15.3 (11.2 – 19.3)	10.8 (8.00 – 12.4)	1.35 (0.22 – 2.14)
BOD_5 (mg/L)	4	10	11.7 (8.7 – 18.0)	18.5 (8.71 – 25.1)	20.2 (9.68 – 28.0)
Ammonium Nitrogen (NH_4-N) (μg/L)	1.0	2.0	86.8 (47.6 – 137)	7.0 (3.8 – 16.7)	7.4 (6.1 – 8.9)

Parameter	Surface water quality standard (GB3838-2002)		Concentration		
	Cat III – 2nd class protection zone	Cat V - Amenity use	2 – 4 Aug 2008	11 – 13 Oct 2008	12 – 14 Dec 2008
Total Phosphorus (mg/L)	0.2	0.4	0.646 (0.416 – 0.934)	1.18 (1.09 – 1.25)	2.23 (1.99 – 2.74)
Total Nitrogen (mg/L)	1.0	2.0	10.3 (8.32 – 12.5)	2.14 (0.898 – 5.07)	16.7 (11.6 – 20.5)
Mercury (Hg) (μg/L)	0.1	1	0.024 (0.013 – 0.045)	0.027 (0.023 – 0.031)	0.043 (0.032 – 0.052)
Arsenic (As) (μg/L)	50	100	3.7 (3.3 – 4.2)	2.6 (2.3 – 2.7)	1.9 (1.8 – 2.1)
Zinc (Zn) (μg/L)	1000	2000	7.9 (3.9 – 16.1)	9.7 (7.7 – 11.1)	15.1 (11.4 – 19.4)
Cadmium (Cd) (μg/L)	5	10	0.15 (Undetectable – 0.25)	Undetectable	0.30 (0.2 – 0.62)
Lead (Pb) (μg/L)	50	100	1.9 (1.0 – 4.4)	0.9 (0.7 – 1.3)	1.1 (0.9 – 1.2)
Copper (Cu) (μg/L)	1000	1000	1.5 (1.3 – 1.9)	2.2 (1.7 – 2.5)	2.5 (2.3 – 2.7)
Chromium ions (Cr^{6+}) (μg/L)	50	100	2.4 (1.4 – 4.1)	8.3 (4.4 – 13.7)	6.1 (3 – 10.3)
Cyanide (mg/L)	200	200	≤ 0.002	≤ 0.003	≤ 0.002
Fluoride (mg/L)	-	-	0.55 (0.5 – 0.64)	0.82 (0.78 – 0.85)	0.80 (0.72 – 0.83)
Sulfide (μg/L)	200	1000	8.5 (0.6 – 42.6)	110.4 (32.4 – 247.7)	132 (1.9 – 395)
Volatile Phenol (mg/L)	5	100	≤ 0.002	≤ 0.003	≤ 0.002
Anionic surfactant (mg/L)	200	300	0.596 (0.118 – 1.16)	1.54 (1.05 – 2.28)	2.16 (1.81 – 2.54)
TPH (mg/L)	50	100	0.249 (0.194 – 0.306)	0.395 (0.297 – 0.479)	0.352 (0.25 – 0.531)
SS (mg/L)	-	-	28.9 (20 – 52.7)	17.7 (5.0 – 29.0)	65.1 (35.0 – 92.0)

The flow direction of Shenzhen River at the section alongside the LMC Loop is influenced by tidal effect. Thus, there is no major significant differentiation in water quality between Station 2 and 3. In Year 2008, the average SS and BOD_5 concentrations calculated from **Tables 5.4a** and **5.4b** at Station No. 2 and 3 were

38.4 mg/L and 18.5 mg/L respectively. The BOD_5, total phosphorus, total petroleum hydrocarbons (TPH), anionic surfactant and faecal coliform exceeded the GB3838-2002 Category III criteria and zero compliance rate was recorded.

The SZ Baseline Survey Report has concluded that current baseline water quality of Shenzhen River was worse than Category V (劣五類), which refers to the poorest water quality in the range. Exceedances were mainly due to BOD_5, ammonia nitrogen (NH_4-N), total phosphorus, anionic surfactant and faecal coliforms.

Comparing the pollutant concentrations between **Tables 5.3, 5.4a** and **5.4b**, the SS concentrations in Shenzhen River near the LMC Loop were generally higher than that of the upstream sections such as Ng Tung River and Sheung Yue River. Monitoring data in 2008 have shown that the average SS concentration was 37mg/L near the LMC Loop, whilst the upstream sections was about 14mg/L (3 to 35mg/L). The same for BOD_5 was 17mg/L and 4.5 mg/L (<1 to 10mg/L) respectively.

3) Ma Tso Lung Nullah/Stream

The Ma Tso Lung Nullah is close to the ECR. It was a natural stream before 2008 and was trained as a drainage nullah under the project 4156CD - Drainage improvement in Ki Lun Tsuen, Ma Tso Lung, Ying Pun, Shek Tsai Leng and Sha Ling in New Territories. Upstream of Ma Tso Lung Nullah is a natural stream near the proposed Kwu Tung North NDA.

Site visits were conducted in November 2012 and April 2013, which represents at both dry and wet season respectively. The base flowrates of Ma Tso Lung Nullah in wet season is generally higher than that of dry season. The majority of drainage catchment of Ma Tso Lung Nullah consists of local villages and natural hillsides. From site observations, the water condition is clear and there was no direct sewage discharge to the nullah and the existing water quality is anticipated to be good.

4) Meander

The Meander was a part of the Old Shenzhen River. After the Shenzhen River works in 1997, the Meander is formed as a moat of LMC Loop. Flap valves were installed in the connection to Shenzhen River in order to prevent tidal backflow upstream of Meander.

The EM&A programme for Shenzhen River Regulation Stage 2 Phase 2 had monitored the water quality along the Meander after ecological restoration in a period of 2 years. The latest monitoring results (Year 2002) are summarized in **Table 5.4c**.

Table 5.4c Water quality monitoring results at the Meander (2002)

Parameter	Concentration	
	Dry Season (Jan to Mar, Oct to Nov)	**Wet Season (Apr to Sep)**
Temperature (℃)	22.3 (15.1 to 32)	32.4 (27.5 to 36)

Parameter	Concentration	
	Dry Season (Jan to Mar, Oct to Nov)	Wet Season (Apr to Sep)
pH	7.9 (6.8 to 9.3)	7.2 (6.6 to 8.2)
DO (mg/L)	7.7 (5.3 to 12.9)	5.9 (2.9 to 8.2)
Ammonia Nitrogen (mg/L)	1.4 (0.1 to 3.2)	1.5 (0.3 to 4.9)
Conductivity (micro-S/cm)	2838 (994 to 5180)	3065 (481 to 5920)
Salinity (g/L)	1.5 (0.5 to 2.8)	1.6 (0.2 to 3.2)

Additional in-situ water quality monitoring was also conducted on 31 July 2009 and 3 February 2010. The monitoring results were summerized in **Table 5.4d**.

Table 5.4d Water quality monitoring results at the Meander (2009 to 2010)

Parameter	Concentration	
	31 July 2009	3 February 2010
Temperature (℃)	31.6 (26.9 to 33.5)	22.3 (22.1 to 22.6)
pH	7.3 (6.6 to 8.1)	7.6 (6.9 to 8.1)
DO (mg/L)	2.7 (2.1 to 3.8)	7.8 (1.6 to 10.2)
Turbidity (NTU)	19.3 (8 to 35)	23.3 (16 to 36)

After Shenzhen River Regulation, the Meander is formed as a moat with flap valves, which likes a “long-shaped pond”. The ammonia nitrogen levels (**Table 5.4d**) are rather low without the influence from Shenzhen River. However, while there is less water circulation, the reaeration rate is low. In addition, non-point source pollutant from surface runoff during wet season would contribute a low DO levels.

5) Ping Hang Stream / Channel at South of Lung Hau Road

The Ping Hang Stream and Channel at South of Lung Hau Road are closed to ECR and Direct Link to MTR LMC Station respectively. Site visits were conducted in November 2012 and April 2013. From site observations, there was no direct sewage discharge to the nullah and river water is observed as clear. The existing water quality is anticipated to be good.

6) San Tin Eastern Drainage Channel

The San Tin Eastern Drainage Channel is an engineered nullah with low ecological value. According to the Approved EIA for LMC Spur Line (EIA-071/2001), water quality monitoring was conducted in San Tin Eastern Drainage

Channel. The monitoring location (Station W1 and WM3) is presented in **Figure 5.1** and the monitoring results are presented in **Table 5.4e**.

Table 5.4e Water quality monitoring results at Station W1 and WM3 at San Tin Eastern Drainage Channel in 2000

Parameter	Concentration	
	Station W1 (Upstream)	Station WM3 (Downstream)
pH	7.5	6.8
Temperature (℃)	25	22.3
DO (mg/L)	1.5	5.1
Turbidity (NTU)	103	85
COD (mg/L)	380	28
BOD (mg/L)	200	10
SS (mg/L)	190	118
NH_3-N (mg/L)	83	8
NO_2-N and NO_3-N (mg/L)	0.1	0.2
TIN (mg/L)	83	8
Total phosphorus (mg/L)	15	0.4
Orthophosphate (mg/L)	12	<0.1
E. coli (cfu/100mL)	1,036,667	16,333
Salinity (ppt)	0.7	0.5

Site visits were conducted in November 2012 and April 2013. From site observations, there is no major discharge along San Tin Eastern Drainage Channel and the water condition is slightly turbid. However, wastewater might be discharged from upstream villiages. According to the water quality monitoring results above, higher levels of BOD was recorded in upstream locations and the water quality improves in downstream, although SS and *E. coli*. levels are still high.

5.3.2.2 Marine Water Quality

The existing water quality downstream of the LMC Loop can be referred to EPD's routine marine monitoring data at Inner Deep Bay area (Stations DM1 to DM3 according to EPD's data), which is about 7.1 to 13.8km away from the LMC Loop. According to the Marine Water Quality in Hong Kong 2008, Deep Bay has the poorest water quality in the territory with high concentrations of organic and inorganic pollutants and low levels of DO.

According to the Marine Water Quality in Hong Kong 2010, the compliance level of WQOs at Deep Bay was 40%, same as Year 2009. The total inorganic nitrogen exceeded the WQOs (i.e. 0.7mg/L) at three Stations DM1, DM2 and DM3 by 0.76, 2.27 and 3.11 mg/L, respectively. Details of EPD's marine water quality monitoring at Inner Deep Bay are presented in **Table 5.5** and the locations of monitoring stations are presented in **Figure 5.1.**

Table 5.5 Marine water quality of Inner Deep Bay between 2006 and 2010

Parameter	Monitoring Point	Concentration [5-6]				
		2006	2007	2008	2009	2010
Dissolved Oxygen (mg/L)	DM1 [1]	3.8	3.8	5.2	4.1	4.2
	DM2 [2]	5	5.3	6.7	5.0	4.9

Parameter	Monitoring Point	Concentration [5-6]				
		2006	2007	2008	2009	2010
	DM3 [3]	5.8	6.4	7.2	6.2	6.2
Ammonia Nitrogen (mg/L)	DM1 [1]	3.07	5.62	2.88	4.04	2.830
	DM2 [2]	2.52	3.74	2.47	2.63	1.930
	DM3 [3]	0.69	0.84	0.55	0.57	0.436
Unionised Ammonia, mg/L (Annual mean)	DM1 [1]	0.041	0.057	0.045	0.050	0.025
	DM2 [2]	0.055	0.058	0.082	0.046	0.025
	DM3 [3]	0.013	0.017	0.014	0.015	0.009
Nitrite Nitrogen, mg/L	DM1 [1]	0.269	0.256	0.284	0.254	0.348
	DM2 [2]	0.27	0.305	0.291	0.280	0.348
	DM3 [3]	0.188	0.21	0.178	0.202	0.218
Nitrate Nitrogen (mg/L)	DM1 [1]	0.52	0.259	0.528	0.470	0.628
	DM2 [2]	0.48	0.308	0.52	0.505	0.687
	DM3 [3]	0.63	0.539	0.673	0.678	0.803
Total Inorganic Nitrogen, mg/L (Annual mean)	DM1 [1]	3.86	6.13	3.7	4.77	3.81
	DM2 [2]	3.27	4.36	3.28	3.42	2.97
	DM3 [3]	1.51	1.59	1.4	1.45	1.46
Total Kjeldahl Nitrogen (mg/L)	DM1 [1]	3.73	7.1	3.76	4.86	3.24
	DM2 [2]	3.1	4.89	3.34	3.09	2.33
	DM3 [3]	0.95	1.28	0.92	0.81	0.65
Total Nitrogen, mg/L	DM1 [1]	4.51	7.61	4.57	5.58	4.22
	DM2 [2]	3.85	5.51	4.15	3.87	3.36
	DM3 [3]	1.77	2.03	1.77	1.69	1.68
Orthophosphate Phosphorus (mg/L)	DM1 [1]	0.35	0.549	0.278	0.372	0.301
	DM2 [2]	0.29	0.405	0.24	0.283	0.236
	DM3 [3]	0.11	0.14	0.081	0.109	0.079
Total Phosphorous (mg/L)	DM1 [1]	0.51	0.73	0.41	0.55	0.38
	DM2 [2]	0.41	0.55	0.36	0.38	0.30
	DM3 [3]	0.16	0.2	0.13	0.16	0.11
E.coli (cfu/100L) (Annual geometric mean)	DM1 [1]	2000	5000	1400	1500	1300
	DM2 [2]	1300	1200	680	470	480
	DM3 [3]	120	38	85	32	26
pH	DM1 [1]	7.3	7.1	7.4	7.4	7.3
	DM2 [2]	7.4	7.3	7.6	7.5	7.5
	DM3 [3]	7.6	7.5	7.8	7.7	7.7
Suspended Solids (mg/L)	DM1 [1]	58.8	20.7	41.5	58.8	34.3
	DM2 [2]	29	19.7	22.9	38.4	23.8
	DM3 [3]	16.9	13.4	11.2	23.2	10.0
Salinity (psu)	DM1 [1]	16.1	17.1	17	17.5	17.2
	DM2 [2]	18.9	19.1	18.1	19.5	19.0
	DM3 [3]	22.2	22.9	21.2	22.9	21.4

Notes:

[1] Station DM1 is located at about 2.4 km downstream of Shenzhen River Estuary (about 7.1 km downstream of the LMC Loop)

[2] Station DM2 is located at about 3.1 km downstream of Shenzhen River Estuary (about 7.8 km downstream of the LMC Loop)

[3] Station DM3 is located at about 9.1 km downstream of Shenzhen River Estuary (about 13.8 km downstream of the LMC Loop)

At downstream sections near Deep Bay, the average SS concentration was 25 mg/L (11.2 to 41.5 mg/L). It was slightly reduced from mid-stream near LMC Loop (37 mg/L). The reason of such concentration reduction may likely due to natural dilution and sedimentation near the estuary area.

5.4 Water Sensitive Receivers

A desktop study on relevant RODP and Revised PLP of the Project, Approved San Tin Outline Zoning Plan (No. S/YL-ST/8) and Approved Ma Tso Lung and Hoo Hok Wai Development Permission Area Plan (No. DPA/NE-MTL/2) and site visits were conducted to identify the water quality sensitive receivers (WSRs) for the LMC Loop. These include Shenzhen River, LMC meander, San Tin wetlands, Hoo Hok Wai and Ma Tso Lung Nullah. These WSRs (**Figure 5.2**) and their respective approximate distance are given in **Table 5.6**. Other potential WSR such as inner Deep Bay and Ma Po Ramsar Site (Mangrove) are located at further downstream of Shenzhen River. However, these areas are considered far away from site (>2km compared to the 500m assessment area) and water quality impact is not anticipated.

Table 5.6 Water quality sensitive receivers

ID	WSRs	Status	Location with respect to the LMC Loop	Approximate Distance from Site
WSR1	Shenzhen River	Channelized with low ecological value	Surrounding the LMC Loop	-
WSR2	LMC Meander	Natural river with high ecological value	Surrounding the LMC Loop	-
WSR3	San Tin Wetlands (Fish Ponds)	Abundant or active fishponds with high ecological value	Downstream of the LMC Loop	>360m
WSR4	Hoo Hok Wai	Abundant or active fishponds with high ecological value	Upstream of the LMC Loop	>200m
WSR5	Ma Tso Lung Nullah/Stream	Downstream is drainage channel with low ecological value; Upstream is a natural stream and act as an ecological linkage to Hoo Hok Wai	Close to ECR	-
WSR6	Ping Hang Stream	Natural stream with high ecological value	Close to ECR	-
WSR7	Channel at south of Lung Hau Road	Drainage channel	Close to Direct Link to MTR LMC Station	-
WSR8	Fishponds	Abundant or active	Between ECR and	-

ID	WSRs	Status	Location with respect to the LMC Loop	Approximate Distance from Site
	adjacent to the Meander	fishponds	WCR	

5.5 Assessment Methodology

In accordance with Clause 3.4.6.2 of the EIA Study Brief, the area for water quality impact assessment included all areas within a distance of 500m from the Project site boundary, including Shenzhen River (WSR1) and Meander (WSR2), Lok Ma Chau (WSR1 and WSR2), wetland at Hoo Hok Wai (WSR4) and San Tin (WSR3), other small watercourses (WSR5 to WSR7) and the Fishponds adjacent to the Meander (WSR8). The assessment would be extended to include other areas such as stream courses and associated water systems, fish ponds in the vicinity being impacted by the Project if found justifiable. Apart from the identified major WSR in **Table 5.6**, other ponds or streams (e.g. those small natural watercourses in Ping Hang, Tai Law Hau and Ma Tso Lung) were considered as minor. Nevertheless, the assessment was still applicable to these minor ponds or streams.

The major area of concern during construction and operation of the LMC Loop development are the works associated with sewage treatment and sewerage infrastructures; ingress of water pollutants to Shenzhen River, Inner Deep Bay, Hoo Hok Wai and San Tin wetlands, and important habitats such as mangroves from storm water drainage system and surface runoff; and the potential for increasing risks of flooding as a result of hydrological changes. The provision and adequacy of the existing, committed and planned future facilities to reduce pollution arising from the storm water drainage system and surface water runoff during construction and operation of the Project was analyzed and proposed.

There will be no requirement for reclamation. Minor excavation works will be conducted during bridge pier construction and cut-and-cover underpass, the excavation works would be within cofferdam or diaphragm walls with no contact with waterbodies. No dredging work is required and thus quantification of impacts arsing from dredging works under Clause 3.4.6.5(xiii) is not required. The assessment approach is referred to Annex 6 – Criteria for Evaluating Water Pollution and Annex 14 – Guidelines for Assessment of Water Pollution under the TM-EIAO.

5.6 Identification and Evaluation of Environmental Impacts

The water quality impact assessment has covered the Project including the following DPs:-

- LMC Loop:
  - Ecological Area (DP1)
  - Drainage System under Internal Transport Networks (DP4)
  - Sewage Treatment Works (DP5)
  - Other non-DP components (refer to **Section 2**)

- Associated Infrastructures outside LMC Loop:
  - Western Connection Road (DP2);
  - Direct Linkage to LMC Station (DP3);
  - Eastern Connection Road (DP6); and
  - Flushing Water Service Reservoir (DP7).

5.6.1 Construction Phase

5.6.1.1 Construction Site Runoff

Construction site runoff would come from all over the works site (~0.329 km^2 including 30% active area) during de-contamination and site formation period of 4.5 years. According to DSD Stormwater Drainage Manual, the total peak runoff is about 2094 m^3/hr under 10-year-return-period rainstorm. The surface runoff might be polluted by:

- Runoff and erosion from site surfaces, drainage channels such as Ma Tso Lung Nullah, earth working areas and stockpiles;
- Wash water from dust suppression sprays and wheel washing facilities; and
- Fuel, oil, solvents and lubricants from maintenance of construction machinery and equipment.

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

5.6.1.2 Groundwater from Contaminated Area

Environmental site investigation works were carried out between 25 November 2009 and 1 February 2010 in LMC Loop (around 87 ha). Soil and groundwater samples were collected. Elevated level of metal "arsenic" was detected from soil samples at 5 borehole locations, whereas no contamination was detected in ground water samples. Details are given in **Section 8** - Land Contamination.

For the purpose of excavations works, groundwater would be pumped out and discharged. Given that no contaminated groundwater sample was detected, no adverse water quality impact due to groundwater discharge is anticipated.

However, due to site access constraints in existing occupied lots outside LMC Loop, no environmental site investigations works were carried out during the course of this study (see **Section 8 - Land Contamination**), groundwater contamination assessment would be recommended when the areas are accessible for site investigation.

5.6.1.3 Sewage from Workforce

Sewage effluents will arise from the sanitary facilities provided for the on-site construction workforce. According to Table T-2 of Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning, the unit flow is 0.15 m^3/day/employed populations and the entire construction period is from 2014 to 2027. The characteristics of sewage would include high levels of BOD_5, Ammonia and *E. coli* counts. Since portable chemical toilets and sewage holding tank will be provided, no adverse water quality impact is anticipated.

5.6.1.4 Riverbanks Formation for Ecological Area

During site and riverbanks formation for southern edge of Ecological Area, the temporary channeling works will be required in the meander with the extent of about 30m in length for construction of ECR underpass and depressed road only. There will be no underwater works in the other sections of natural riverbank at southern edge for EA. The ecological impact due to slopework above-water is assessed in **Section 12**.

Sand/silt may enter the meander through erosion or surface runoff during the temporary channeling. In addition, bottom sediment of the meander would be re-suspended after disturbance. There will also be increase in flooding risk due to flow contraction from scaffolding or cofferdam works.

5.6.1.5 Construction of Bridge Crossing under WCR / Direct Link to LMC Station / ECR

Bridges would be constructed crossing the meander and San Tin Eastern Drainage Channel for WCR and Direct Link to LMC Station. The river widths and depths are 30 to 60m and 1 to 4m respectively. Subject to detailed structural design, the pier areas crossing these rivers is about 2m x 3m, which consist of less than 10% in cross sections. The pile caps will be located below river beds and the piers arrays will mainly align with the existing bridges such as Border Road and MTR Spur Line Viaduct to minimize the hydrodynamic impact and the associated scouring effect during operation. In addition, there are existing hydraulic structures such as weirs and flap valves in the meander and San Tin Eastern Drainage. Additional bridge piers to these channels will not impose significant hydrological impact and thus, the water quality regime will not be disturbed. Thus, the adverse water quality impact is not anticipated.

For ECR crossing minor watercourses/streams at Ping Hang or Ma Tso Lung, low level viaducts will be provided. Given the limited sizes of these streams, the cross sections of low level viaduct will be larger than or same as that of the original streams such that the hydrodynamic and water quality regime will not be disturbed. Precast structures will be used for viaducts sections at those small streams in Ma Tso Lung, Ping Hang and channel near Lung Hau Road such that there will be no construction works in the water streams.

If unmitigated, bottom sediment may be disturbed and resuspended during bridge piers constructions in the water environment. Some fish ponds might be filled or partially filled for road widening purpose. Dewatering process during fish pond filling may potentially release turbid water into the environment. The SS levels in the fish ponds may be increased and secondary water quality impacts such as DO depletion and nutrient pollution level increase will occur in the fish ponds. Mitigation measures will be required and details are discussed in **Section 5.7.1.5**.

5.6.1.6 Construction of Underpass / Depressed Road under ECR

Due to the ecological concerns, underpass/depressed road will be constructed across the Meander and fishponds for ECR. Bottom sediment may be disturbed during cut-and-cover activities in the water environment during construction of underpass.

Excavations will be required within the cofferdams or diaphragm walls, such that the works are will be separated from river waters. Temporary river contraction by cofferdams or diaphragm walls will be required in the Meander. The sequence of flow contraction will be divided into two batches (half year per each batch) and all the works will be conducted in dry season (October to March) in order to avoid and minimize the impact to flow regimes. 50% (around 30m) of the width of the Meander (total width around 60m) will be occupied by the erected cofferdams or diaphragm walls. Given all the works will be conducted during in dry season and the hydrological changes will be minimal, the water quality regime will not be affected.

The potential water quality impact associated with the drainage diversion will be from the run-off and erosion from site surfaces and earth working areas. Small amount of wastewater may be released during the disconnection of various drainage systems. Regular inspection and maintenance should be provided in order to prevent the occurrence of disconnection.

The underpass/depressed road will be constructed by cut-&-cover method and fully enclosed by cofferdams or diaphragm walls. Construction methodology using cofferdams or diaphragm walls can minimise the intrusion of groundwater during excavation. Diaphragm walls involve excavation of a narrow trench that is kept full of slurry, which exerts hydraulic pressure against the trench walls and acts as a shoring to prevent collapse. Slurry trench excavations can be performed in all types of soil, even below the groundwater table. In order to provide an effective cut-off to groundwater flow, the walls will need to be toe grouted. Once the excavation of a panel is completed, a steel reinforcement cage will be placed in the centre of the panel. Concrete is then poured in one continuous operation. Once the primary panels are set, secondary panels will be constructed between the primary panels and the process then repeats to create a continuous wall. It should be noted that this slurry trench method will reduce the gap between the panels to the practicable minimum. After this, soil excavation will be commenced. The intrusion of groundwater through cofferdams or diaphragm walls during soil excavation is therefore considered insignificant. **Appendix 5-4** indicates the tentative working sequences on ECR underpass construction.

5.6.1.7 Bio-remediation of Shenzhen River

In-situ bio-remediation of Shenzhen River may be required. The time period taken will be subject to odour monitoring results and further investigation. The extension of bio-remediation section will be about 500m from LMC Loop. Sediment treatment by nitrate injection will cover Shenzhen River alongside LMC Loop. Compared to offsite treatment, which will require dredging activities, in-situ bioremediation is likely to cause much less water quality impact due to minimal seabed disturbance. In addition, in-situ bioremediation will improve sediment quality, thus induce a beneficial improvement to Shenzhen River water quality and promote recolonization of aquatic life/waterbirds.

The major water quality impact concerns associated with in-situ bioremediation are the potential release of nitrate-nitrogen, ammonia and heavy metals from the sediments into the surrounding water bodies during the bioremediation activities.

An in-situ bioremediation field test using calcium nitrate was conducted by Shenzhen River Contaminated Sediment Remediation Strategy Joint Study《深圳河污染底泥治理策略合作研究》[5-3] in 2011. According to Bioremediation Field Test Draft Final Report《生化處理技術實地試驗總報告書(送審終稿)》[5-7], pore water and elutriate test results for heavy metals is monitored and the results are extracted in **Table 5.7a** and **b** below.

Table 5.7a Pore Water Test Results for Bio-remediation by Injecting Calcium Nitrate.

Scenario	Heavy Metal (µg/L)								
	As	Cu	Pb	Cd	Ni	Zn	Hg	Cr	Ag
Baseline	N.D.	N.D.	N.D.	N.D.	61-123	167-423	N.D.	702-729	N.D.
After Injection	N.D.	N.D. – 47	N.D.	N.D.	N.D.-90	179-264	N.D.	233-639	N.D.
Water Quality Target GB 3838-2002 (Cat III)	50	1000	50	5	N/A	1000	0.1	50	N/A

Note: N.D. = Not detectable

Table 5.7b Elutriate Test Results for Bio-remediation by Injecting Calcium Nitrate.

Scenario	Heavy Metal (µg/L)								
	As	Cu	Pb	Cd	Ni	Zn	Hg	Cr	Ag
Baseline	N.D.	N.D.	N.D.	N.D.	N.D.-0.064	N.D.-671	N.D.	N.D.-829	N.D.
After Injection	N.D.	N.D.	N.D.	N.D.	N.D.-0.068	N.D.-311	N.D.	145-428	N.D.
Water Quality Target GB 3838-2002 (Cat III)	50	1000	50	5	N/A	1000	0.1	50	N/A

Note: N.D. = Not detectable

According to the report, pore water and elutriate test results after bioremediation were generally below Category III of GB3838-2002.

There is no nutrient monitoring for elutriate or pore water under the test. Instead, nitrate nitrogen monitoring on surface water at Shenzhen River were conducted before and after the in-situ bioremediation field test. The test results were summarised in **Table 5.7c** below.

Table 5.7c Nitrate Nitrogen levels at Shenzhen River before and after the in-situ bioremediation field test

	Nitrate Nitrogen (mg/L)	
	Control Stations (500m surrounding the works area)	**Impact Stations (50 to 100m surrounding the works area)**
Before injection	2.28 (not detectable to 5.02)	2.8 (not detectable to 4.91)
Just after 1st injection	5.36 (4.27 to 7.33)	3.79 (1.60 to 4.90)
Just after 2nd injection	6.80 (6.08 to 8.74)	5.82 (5.27 to 6.10)
7 days after 2nd injection	5.50 (4.44 to 7.58)	5.12 (4.63 to 5.58)
14 days after 2nd injection	4.65 (3.70 to 5.11)	4.34 (3.15 to 6.26)
30 days after 2nd injection	3.98 (3.18 to 6.02)	3.60 (3.32 to 3.90)

Note: To eliminate the tidal influence, the impact stations were located 50 to 100m surrounding the works area and the control stations were located far away from (>500m) and surrounding the works area.

According to the analysis in the Bioremediation Field Test Draft Final Report 《生化處理技術實地試驗總報告書(送審終稿)》[5-7], the concentration of nitrate nitrogen were gradually reduced in time and the highest level of nitrate nitrogen will still within the environmental requirement for the study. In addition, the report mentioned that the increase of nitrate nitrogen were mainly due to natural variations of Shenzhen River since the results in control stations were rather high.

Alongside the Shenzhen River, there were several discharge points such as Futian River, Buji River and other sewerage outfalls. Thus the river water quality is dominated by these pollution sources. Therefore, with the poor baseline water quality in Shenzhen River, the field test results in both control stations and impact stations were highly varied by the baseline conditions when the impact is insignificant.

There is no criterion for nitrate nitrogen according to GB3838-2002. According to Australian Water Quality Guidelines for Fresh and Marine Waters[5-10], a 95% level of species protection could be achieved when nitrate nitrogen is less than 7 mg/L. The highest nitrate nitrogen levels will be occurred after 2nd injection and the concentration is 5.27 to 6.10 mg/L at the impact stations, which is below the Australian guideline. Compared to the baseline levels of up to 4.91 mg/L and control stations of up to 8.74 mg/L, the increase is not significant and highly disturbed by background variations. Thus, adverse transient impact is not anticipated.

According to the Biochemical Processing Technology Field Test and Final Test Report, increase of nitrate nitrogen is not significant compare with the control stations in either immediate injection or 30 days after injections. Thus, long term residue impact due to bio-remediation are not anticipated.

The bio-remediation works will only involve chemical injections and no dredging work is required. Thus, it is anticipated that the bio-remediation works will involve minor disturbance only and could be mitigated by good site practices.

According to the Environmental Review Report (Draft Final, Jan 2013) 《環境複查報告書(預終稿 2013 年 1 月)》, water quality monitoring during bio-remediation is recommended. The report also recommended the following site practices (extracted) in order to minimize the environmental impact:

- Chemical injections: suitable injector should be used in order to minimize the disturbance to bottom sediment and water bodies. Chemicals should be injected gradually in the required sediment layer.
- Injection area: Less than 10,000m^2 per day
- Specific environment: Increase the frequency of water quality monitoring during low flow and summer time, immediate actions when exceedance observed.
- Injection vessels: Strictly control the injection vessels and number of concurrent vessels during injection, especially to avoid multi-marine works concurrently. It is recommended to inject the chemicals in batches. Not more than one working vessel should be allowed in a certain area and fully allow the assimilative capacity of Shenzhen River and Deep Bay.

Monitoring of heavy metals and nutrient will be conducted during bio-remediation and the details are included in the EM&A Manual.

5.6.1.8 Construction of Direct Link to LMC Station

During construction of viaduct for Direct Link to LMC Station, the existing reedbeds for effluent polishing in LMC Station under Clause 2.14 of FEP-080/2007 may be disturbed. While bridge or tunnel options are not advised, viaduct option is recommended (See **Section 2.4.1**). The piers of viaduct were optimized to avoid permanent encroachment to the reedbeds. However, temporary reedbed loss of around 320m^2 will be unavoidable due to land requirement during construction phase.

According to the EIA for MTR LMC Spurline (EIA-071/2001), the BOD loading to the reedbeds (effluent polishing efficiency is 50% thus 12.3 kg/day BOD removal by reedbeds) is 24.6 kg/day. An additional flow from San Tin Eastern Drainage Channel was then added to the reedbeds such that the total BOD removal was 24.6 kg/day so as to meet the requirement of "no net increase in pollution loads requirement in Deep Bay". During construction phase, a temporary loss of 320 m^2 of reedbed which is equivalent to slight reduction of 0.7% of total reedbed size of 4.65 ha is considered acceptable, and indeed the loss of 320 m^2 will be reinstated upon completion of the construction. In addition, the LMC Spur Line terminal is not under ultimate use during the construction period of Direct Link. Therefore, adverse water quality impact is not anticipated. However, in precautionary consideration, compensation on the loss of reedbed area is required as shown in **Section 5.7.1.8**.

5.6.2 Operational Phase

5.6.2.1 Sewage and Sewerage System

During operational phase, sewage discharge from approximate 53,000 population of the proposed development at the LMC Loop will be the major water pollution source. A conformal design standard to satisfy the WQO and the "No net increase in pollution loads requirement in Deep Bay" will apply.

Subject to engineering findings during detailed design stage, reuse of treated sewage effluent (TSE) from the on-site STW may supply the water for flushing, District Cooling System (DCS) operation and landscape area irrigation. Its potential health impact to the end users is assessed in **Chapter 6**.

Emergency discharge might be required if the on-site STW had failed. This will have adverse water quality impact to surrounding waterbodies if not properly controlled. The impact due to emergency discharge would be subject to the quantity and quality of sewage discharge and the assimilation capacity of receiving bodies, i.e. Shenzhen River. The flow is about 14,689 m^3/day. Precautionary measures are required to prevent and minimise the impact.

Effluent will be discharged to the Shenzhen River. If TSE reuse required, part of the effluent, will go via a further treatment such as chlorination. The chlorination process and all related pump sets will be located within the on-site STW. Treated effluent from on-site STW will then be pumped and diverted to the Flushing Water Service Reservoir. The pump sets will be man-controlled. While malfunction occurred in flushwater distribution system, effluent treatment such as chlorination and the related pumps will be shut down and effluent will be discharge to Shenzhen River via the STW. Thus Emergency overflow and bypass to Flushing Water Service Reservoir is not required. During regular cleaning of Flushing Water Service Reservoir, wastewater will be generated and mitigation measures such as good site practices are required.

5.6.2.2 Discharge from District Cooling System (subject to engineering findings during detailed design stage)

Water circulation for the operation of district cooling system (DCS) will be in closed circuit and will be completed after two phases of construction (western and eastern). Water demand in DCS refers to the replenishment/blown down of water from cooling tower in the heat rejection system due to evaporation, drift and bleed-off and the estimated amount is about 5000m^3/day. During emergency or maintenance condition, wastewater will be discharged to the proposed STW. Adverse water quality impact is not anticipated.

5.6.2.3 Surface Runoff

Potential water quality impacts may arise from the LMC Loop and road runoff discharge, which is known as non-point source pollutions, during operational phase. Substances such as dust and lubricant oil deposited and accumulated on the road surfaces will be washed into the drainage system, fish ponds or streams during rainfall. The total length of external connections is about 4.8 km. According to DSD Stormwater Drainage Manual, the total peak runoff is about 3238 m^3/hour and 4119 m^3/hour under 10-year and 50 year-return-period rainstorm. The hydrological impact within LMC Loop is presented in **Section 5.6.2.4** and the required mitigation measures is presented in **Section 5.7.2.4** respectively. Mitigation measures to road runoff will be required in the design of drainage systems.

Under existing scenario, the area was mainly rural area. Additional loading would be due to addition runoff from reducing of infiltration rate from the development. Worst scenario will be due to first flush under heavy rainstorm events. Typical runoff concentrations were measured under the study of Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool – Pollution Loading Inventory Report[5-9]. Under normal condition, runoff will not be generated in low rainfall intensity [5-9]. In addition, the additional loading could minimize by proper design and site management. Given the stochastic nature of non-point source pollution, a semi empirical but conservative estimate is presented in **Appendix 5-3**. The estimate takes into account the proposed land use, previous local and oversea studies and prevailing road and open space management practice with enhancement where beneficial.

5.6.2.4 Drainage System

Bridge crossing with no encroachment to river waters will be provided when the external road connections crossing ecological important streams. There will be no permanent alternation of water courses and natural streams with high ecological value. Box culverts will be installed in other small streams. In addition, the proposed development will be within in LMC Loop only, compared with the whole stormwater catchment for Shenzhen River.

The only change in hydrology regime due to the project involves the additional paved area, which will affect the infiltration rate in the catchment. Increasing flood risk as a result of extra stormwater runoff may occur. According to the hydraulic modelling results in Drainage Impact Assessment report under this study, the performance of the permanent drainage system will comply with the relevant regulations and the potential change in water levels at Shenzhen River (near LMC Loop at Ch 11155 to 13155) is less than 0.02m under 1 in 50 year return period rainfall. In the permanent drainage system design, the Ecological Area will have a side function for flood retention in order to minimize the impacts. Thus, potential flood risk is considered as minimal. Provided the minimal hydrological changes due to the project, the water quality regime will not be affected.

5.7 Mitigation Measures

5.7.1 Construction Phase

5.7.1.1 Construction Site Runoff

In accordance with the Practice Note for Professional Persons on Construction Site Drainage, Environmental Protection Department, 1994 (ProPECC PN 1/94), construction phase mitigation measures should be provided as far as practicable and the Storm Water Pollution Control Plan is given below.

Storm Water Pollution Control Plan

- At the start of site establishment, perimeter cut-off drains to direct off-site water around the site should be constructed with internal drainage works and erosion and sedimentation control facilities implemented. Channels (both temporary and permanent drainage pipes and culverts), earth bunds or sand bag barriers should be provided on site to direct stormwater to silt removal facilities. According to DSD's Stormwater Drainage Manual, to handle a 10 year-return-period storm, the sizes of drains for LMC Loop, WCR, Direct Link and ECR should be no less than 986mm, 409mm, 321mm and 444mm in diameter, respectively. Details of the reference calculation and a storm water pollution control plan are presented in **Appendix 5-1**. The design of the temporary on-site drainage system will be undertaken by the contractor prior to the commencement of construction. The size of the drains shall be determined to suit the actual site arrangement according to the DSD's Stormawater Drainage Manual
- Diversion of natural stormwater should be provided as far as possible. The design of temporary on-site drainage should prevent runoff going through site surface, construction machinery and equipment in order to avoid or minimize polluted runoff. Sedimentation tanks with sufficient capacity, constructed from pre-formed individual cells of approximately 6 to 8 m^3 capacities, are recommended as a general mitigation measure which can be used for settling surface runoff prior to disposal. The system capacity shall be flexible and able to handle multiple inputs from a variety of sources and suited to applications where the influent is pumped.
- The dikes or embankments for flood protection should be implemented around the boundaries of earthwork areas. Temporary ditches should be provided to facilitate the runoff discharge into an appropriate watercourse, through a silt/sediment trap. The silt/sediment traps should be incorporated in the permanent drainage channels to enhance deposition rates.
- The design of efficient silt removal facilities should be based on the guidelines in Appendix A1 of ProPECC PN 1/94. The detailed design of the sand/silt traps should be undertaken by the contractor prior to the commencement of construction.
- Construction works should be programmed to minimize surface excavation works during the rainy seasons (April to September). All exposed earth areas should be completed and vegetated as soon as possible after earthworks have been completed. If excavation of soil cannot be avoided during the rainy season, or at any time of year when rainstorms are likely, exposed slope surfaces should be covered by tarpaulin or other means.
- All drainage facilities and erosion and sediment control structures should be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rainstorms. Deposited silt and grit should be removed regularly and disposed of by spreading evenly over stable, vegetated areas.
- Measures should be taken to minimise the ingress of site drainage into excavations. If the excavation of trenches in wet periods is necessary, it

should be dug and backfilled in short sections wherever practicable. Water pumped out from trenches or foundation excavations should be discharged into storm drains via silt removal facilities.

- All open stockpiles of construction materials (for example, aggregates, sand and fill material) of should be covered with tarpaulin or similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.
- Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris being washed into the drainage system and storm runoff being directed into foul sewers.
- Precautions to be taken at any time of year when rainstorms are likely, actions to be taken when a rainstorm is imminent or forecasted, and actions to be taken during or after rainstorms are summarized in Appendix A2 of ProPECC PN 1/94. Particular attention should be paid to the control of silty surface runoff during storm events.
- All vehicles and plant should be cleaned before leaving a construction site to ensure no earth, mud, debris and the like is deposited by them on roads. An adequately designed and sited wheel washing facilities should be provided at every construction site exit where practicable. Wash-water should have sand and silt settled out and removed at least on a weekly basis to ensure the continued efficiency of the process. The section of access road leading to, and exiting from, the wheel-wash bay to the public road should be paved with sufficient backfall toward the wheel-wash bay to prevent vehicle tracking of soil and silty water to public roads and drains.
- Oil interceptors should be provided in the drainage system downstream of any oil/fuel pollution sources. The oil interceptors should be emptied and cleaned regularly to prevent the release of oil and grease into the storm water drainage system after accidental spillage. A bypass should be provided for the oil interceptors to prevent flushing during heavy rain.
- Construction solid waste, debris and rubbish on site should be collected, handled and disposed of properly to avoid water quality impacts.
- All fuel tanks and storage areas should be provided with locks and sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank to prevent spilled fuel oils from reaching water sensitive receivers nearby.
- Regular environmental audit on the construction site should be carried out in order to prevent any malpractices. Notices should be posted at conspicuous locations to remind the workers not to discharge any sewage or wastewater into the meander, wetlands and fish ponds.
- During the construction of ECR, proper site drainage system with adequate silt removal facilities should be deployed in order to prevent polluted runoff discharged to the Ma Tso Lung Nullah and the meander. A discharge license should be obtained from EPD prior to any site runoff discharge.
- The construction works of underpass should be conducted during dry season (October to March) to prevent excess stormwater runoff to the meander. Cofferdams or diaphragm walls should be deployed to fully separate the works area and the river waters.

By adopting the above plan with best management practices, it is anticipated that the impacts of construction site runoff from the construction site will be reduced to satisfactory levels before discharges. Subject to detailed design and contractor's site arrangement, the Storm Water Pollution Control Plan should be reviewed and updated. The requirement of Storm Water Pollution Plan will be incorporated in the project contract documents.

5.7.1.2 Groundwater from Contaminated Area

Given that no contamination was detected in groundwater sample in LMC Loop, no adverse water quality impact due to groundwater discharge is anticipated. No mitigation measure is therefore required for groundwater treatment.

Outside the LMC Loop, as no site investigation has been carried out due to site access denial, additional investigation may be required to identify if contaminated groundwater is found (refer to **Section 8**).

If the investigation results indicated that the groundwater to be generated from construction works would be contaminated, the contaminated groundwater should be either discharged into recharged wells, or properly treated in compliance with the requirements of Technical Memorandum on Standards for Effluents Discharged into Drainage on Sewerage Systems, Inland and Coastal Waters.

If recharged well method were used, the groundwater quality in the recharged well should not be affected by recharging operation, i.e. the pollution levels of the recharged groundwater should not be higher than that in the recharging wells.

If treatment and discharge method were used, the design of wastewater treatment facilities, such as active carbon and petrol interceptor, should be submitted to the EPD and a discharge license should be obtained under the WPCO through the Regional Offices of EPD.

5.7.1.3 Sewage from Workforce

Portable chemical toilets and sewage holding tanks should be provided for handling the construction sewage generated by the workforce. A licensed contractor should be employed to provide appropriate and adequate portable toilets to cater 0.15m^3/day/employed populations and be responsible for appropriate disposal and maintenance.

Notices should be posted at conspicuous locations to remind the workers not to discharge any sewage or wastewater into the nearby environment during the construction phase of the Project. Regular environmental audit on the construction site should be conducted in order to provide an effective control of any malpractices and achieve continual improvement of environmental performance on site. It is anticipated that sewage generation during the construction phase of the Project would not cause water quality impact after undertaking all required measures.

5.7.1.4 Riverbanks Formation for Ecological Area

In order to prevent sediment transport during riverbank works, deployment of silt curtain should be implemented, especially when construction works encroach or occur in close distance to water body. It is recommended to carry out all the riverbank works within a cofferdam or diaphragm wall.

Water quality of the Shenzhen River and the meander would be monitored to ensure effectiveness of the implemented mitigation measures.

5.7.1.5 Construction of Bridge Crossing under WCR / Direct Link to LMC Station / ECR

Good site management as stipulated in ProPECC PN1/94 should be fully implemented to avoid polluted liquid or solid wastes from falling into the WSRs.

If bridge/structures erected on pond, the pond water will be drained and refilled after completion of works at all affected ponds. Thus, the water quality of the pond will not be affected by the construction works.

Cofferdam or diaphragm walls should be deployed for protecting fish ponds or nearby watercourses/streams during bridge pier/box culvert construction and/or road widening work at fishponds.

For the low level viaducts crossing the small streams at Ma Tso Lung, Ping Hang and channel near Lung Hau Road, precast structures will be used such that there will be no construction work in the water streams, and thus, to avoid direct water quality impacts.

5.7.1.6 Construction of Underpass / Depressed Road under ECR

Good site management as stipulated in ProPECC PN1/94 should be fully implemented to avoid polluted liquid or solid wastes from falling into the WSRs.

Cofferdam or diaphragm walls should be deployed for protecting fish ponds or the meander during excavation activities such that the construction works will be separated from the meander and nearby fishpond waters. As a precaution measures, silt curtain/screen could be deployed to cover the cofferdam/diaphragm walls.

For ECR underpass, subject to further engineering review, the sequence of flow contraction will be divided into two batches (half year per each batch) and all the works will be conducted in dry season (October to March) in order to avoid and minimize the impact to flow regimes. 50% (around 30m) of the width of the Meander (total width around 60m) will be occupied by the erected cofferdams or diaphragm walls. **Appendix 5-4** indicates the tentative working sequences on ECR underpass construction.

5.7.1.7 Bio-remediation in Shenzhen River

Major water quality impact due to bio-remediation is not anticipated. According to Biochemical Processing Technology Field Test and Final Test Report《生化處理技術實地試驗總報告書》[5-7], the pore water and elutriate test results after bioremediation were well below Category V of GB3838-2002, which refers to the poorest water quality in the range.

Not more than one working vessel is allowed to work concurrently and the maximum injection area should be less than 10,000m^2 per day.

Water quality monitoring and audit is recommended to ensure that the proposed bio-remediation operation would not result in adverse water quality impact. Details of the water quality monitoring programme are presented in the EM&A Manual. If unacceptable water quality impact in the receiving water is recorded, additional measures such as slowing down, or rescheduling of works should be implemented as necessary.

5.7.1.8 Construction of Direct Link to LMC Station

The effluent polishing efficiency of the reedbed at LMC Station will not be deteriorated in theory. However, as a precautionary consideration, the following options are proposed to compensate for the small loss of reedbed area:

1. Reprovision of similar or larger size reedbed near the affected reedbed to compensate for the loss. The area reprovisioned reedbed should not be less than 320m^2 in total area. **Figure 5.4** shows the possible locations for reprovisioned reedbed.

2. Reprovision of a package sewage treatment plant (e.g. MBR) to provide the same sewage treatment efficiency of the affected reedbed. The package sewage treatment plant should at least have a BOD removal of 0.395 kg/day (49.2 kg/day/2ha x 0.032 ha x 50%); or

3. Increasing the Hydraulic Retention Time (HRT) of the entire system by 1.6%. There will be negligible increase in water depth (about 10mm) in the reedbed, which will not deteriorate the function of existing system. **Appendix 5-2** gives the justifications for the required HRT.

It should be noted that the above calculation assumes an ultimate loading from MTR Lok Ma Chau Station. However, it is currently not under a full capacity and unlikely to achieve full capacity during the construction of Direct Link, which is tentative from 2015 to 2020. In order to prevent over-design of mitigation measures, the Project Proponent shall further liaise with MTRC on the actual loading during construction of Direct Link and review the required mitigation measures, if required.

The affected reedbed will be reinstated after construction of Direct Link. There will only be temporary minor reedbed loss due to viaduct piers during construction and the function reedbed will not be affected permanently. Since the reedbed within MTR LMC Station is under the conditions of FEP-06/129/2002/F. A process of Variations of Environmental Permit might be required. During detail design stage, these options will be further evaluated in terms of land resumptions, responsibilities, etc. The selection of abovementioned options are subject to future discussion with MTRC.

5.7.2 Operational Phase

5.7.2.1 Sewage and Sewerage System

All the sewage generated from the LMC Loop will be collected and treated in the proposed new STW to achieve compliance with the "No Net Increase in Pollution Loads Requirement in Deep Bay".

Membrane bio-reactor wastewater treatment technology will be adopted for the STW. The effluent discharge from the proposed STW will comply with the no net increase in pollution loads requirement by compensating the river quality in Deep Bay catchment. Onsite treatment and offsite compensation is proposed to achieve the no net increase in pollution load requirement. A STW with ultimate capacity of 18,000 m^3/day is proposed in LMC Loop and the effluent will be discharged to the Shenzhen River. Compensation of pollution loading will be achieved by upgrading the existing Shek Wu Hui such that a higher effluent quality level and capacity would be reached.

The ultimate load from the proposed STW is summarised in **Table 5.8** below. Detail of these options for compensation is given in **Section 6.6.1**.

Table 5.8 Pollutant emission inventory subject to "no net increase in pollution loads requirement in Deep Bay"

	Parameter	Unit	Average Flow = 18,000 m^3/day	Base Case
On-site STW in LMC Loop	BOD_5	kg/day	90	-
	TN	kg/day	144	-
	TP	kg/day	18	-
Cumulative with NENT NDA	BOD_5	kg/day	1990	2260
	TN	kg/day	1664	1695
	TP	kg/day	208	565

Emergency discharge, with maximum flowrate of about 14,689 m^3/day, will be diverted to Shenzhen River when the on-site STW had failed, the following precautions measures shall be included in the STW design in order minimize the occurrences:

- Standby unit should be provided to facilitate repair and maintenance of equipment;
- Dual power supply, or back-up power, should be provided, perfectly in the format of ring main or automatic-operated emergency generator with sufficient capacity to cope with the demand loading of the essential plant equipment;
- Telemetry system should be provided to the closest manned plant for unmanned facilities, such that swift actions could be taken in case of malfunction of unmanned facilities; and
- Manual cleaning should be provided at all screens and overflow bypass to prevent the discharge of floating solids.

The occurrence of emergency discharge is remote accorrding to local experience. According to the EIA report of Tai Po STW (EIA-097/2004), emergency discharge of untreated effluent was occurred once due to power failure at Year

1995. The duration of the emergency discharge was less than 3 hours with a total discharge volume of less than 9,000 m^3, compared to their design flow of 88,000 m^3/day at that time. With the implementation of dual power and the abovementioned precaution measures, the occurrence of emergency discharge for LMC Loop on-site STW is unlikely.

As discussed in **Section 5.6.2.1**, emergency discharge for Flushing Water Service Reservoir is not required. However, during regular cleaning, waste water will be generated. These wastewater should be delivered to STWs or diverted back to influent pipes of on-site STW.

5.7.2.2 Discharge from District Cooling System (subject to engineering findings during detailed design stage)

As discussed in **Section 5.6.2.2**, effluent discharge from district cooling system would only occur during emergency or maintenance condition. All the effluent will be discharged to the proposed STW for treatment and adverse water quality impact is not anticipated. No mitigation measure is therefore required.

5.7.2.3 Surface Runoff

During operational phase, vehicle dust, tyre scraps and oils might be washed away from the paved surface to the nearby water courses by surface runoff or road surface cleaning. Usually only silt traps will be provided for rural roads. However, in considering the ecological importance in the vicinity, oil interceptors will be installed in proposed road in advance. The design of road gullies with silt traps and oil interceptors should be incorporated in later detailed design. Frequent manually cleaning should be provided.

In the ecological sensitive areas, runoff will be controlled by management practices. Runoff will be intercepted by silt traps with management practices before diverting to Ping Hang Stream, Ma Tso Lung Stream and the Meander remove the pollutants at source. At the outfalls to these rivers, the Project Proponent or the delegated operation parties should manage the road/open area cleaning prior to the occurrence of a storm. The operator should undertake the cleaning at an interval of twice a week and the frequency should be increased to suit actual site conditions. Moreover, it is recommended each of the cleaning events should not be separated by more than four days and should be carried out during low traffic flow period, preferably using either manually or vacuum air sweeper/truck equipped with side broom, which is to sweep road sludge and debris into the suction nozzle to increase the removal efficiency of pollutants. The collected pollutants would be tankered away for off-site disposal at landfill sites. After removal of the pollutants, the pollution levels from stormwater would be much reduced.

Given the stochastic nature of non-point source pollution and adopting flexible management to suit site conditions, the impact to the receiving water body is insignificant. **Appendix 5-3** shows the calculation of non-point source loading rates.

Storm Water Pollution Control Plan

Subject to detailed design and requirement of relevant government departments, the capacities of road drainage system shall cater the runoff from 50 year-return-period rainstorm. Proper drainage systems with silt traps and oil interceptors should be installed. According to DSD's Stormwater Drainage Manual, the drainage pipe size of WCR, Direct Link and ECR should be no less than 1050mm, 778mm and 1130mm, respectively. Details of calculation and a storm water pollution control plan are presented in **Appendix 5-1**. However, the actual size of the storm drains will be subject to detailed design. The Storm Water Pollution Control Plan should be updated and submitted to EPD for approval prior to construction.

During the EM&A programme, the project proponent should verify the efficiency of silt traps and cleaning frequencies by water quality monitoring during typical rainstorm events.

5.7.2.4 Drainage System

Compared to the whole stormwater catchment for Shenzhen River, the overall hydrology regime will not be significantly changed with the implementation of proper drainage system.

According to the model results of Drainage Impact Assessment (DIA), the largest variation of water level at Shenzhen River with and without LMC Loop Development is less than 0.02 m under 50-year-return-period rainstorm. The storm water pollution control plan is presented in **Appendix 5-1**.

5.8 Cumulative Impact

5.8.1 Construction Phase

Although the construction of SZ River Regulation Phase IV is concurrent with that of LMC Loop, the separation distance from site is about 7km, which is outside the 500m of assessment area. In addition, according to the approved EIA report (AEIAR-160/2011) for Regulation of Shenzhen River Stage IV, the water quality impacts of the river training project would be mitigated within acceptable levels and thus no significant cumulative water quality impact is anticipated with the Loop project.

5.8.2 Operational Phase

In addition to the sewage generated from the LMC Loop operation, implication of sewage flows would occur from other catchments such as from nearby villages. In order to tackle the cumulative sewage flows, designed capacity of the proposed STW will be marked up. The details of sewerage impact assessment will be discussed in **Section 6** of this report.

5.9 Residual Environmental Impacts

No adverse residual impact is anticipated during the construction and operation of the Project with the implementation of mitigation measures.

5.10 Level of Uncertainties

The estimated total sewage flow from the development is 14,689 m^3/day which is based on the estimation from proposed population and future land use. The calculations of no net increase in pollution loading did not consider the TSE reuse which is in a conservative side to cater the uncertainties. In spite the daily sewage flow is 14,689 m^3/day, the treatment capacity of on-site STW has been designed to 18,000 m^3/day in order to cater any uncertainties.

5.11 Conclusion

With full implementation of the mitigation measures, no adverse impact is anticipated. No adverse residual impact and cumulative impact is anticipated during both the construction and operational phase of the Project. In order to ensure effectiveness of the implemented mitigation, regular water quality monitoring in the meander are recommended during the construction phase.

5.12 Reference

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