Sewerage Impact Assessment for Proposed Residential Care Home for the Elderly (RCHE) Development at Tung Tsz, Tai Po

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1. Background

The applicant, R Lee Architect, intends to develop one 10-storey building block situated at Tung Tsz, Tai Po, New Territories for the Proposed Residential Care Home for the Elderly (RCHE) Development.

The purpose of this report is to conduct a Sewerage Impact Assessment (SIA) to assess the potential sewerage impact arising from the proposed development.

2. Objective

These SIA objectives are to assess the potential sewerage impact arising from the proposed development and recommend mitigation measures, if necessary, to alleviate the impacts.
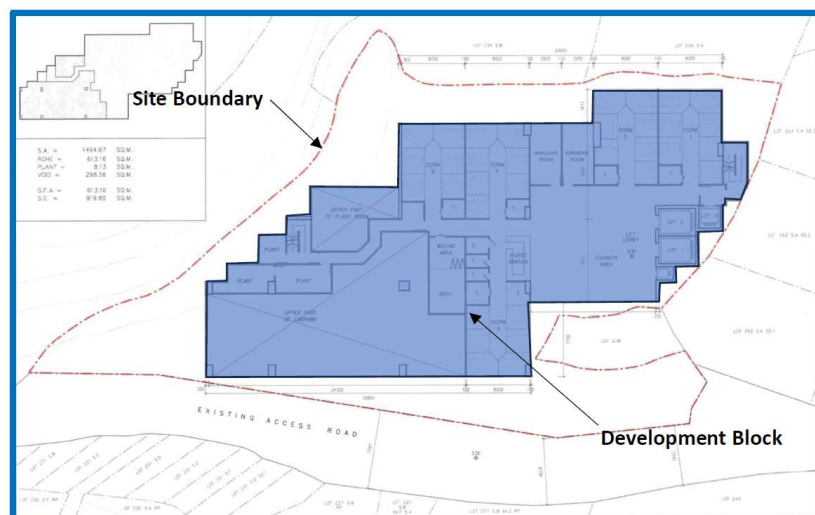
3. Site Information

The Premise: D.D.23, Lot 232RP, 232 S.A. RP, 232 S.A.ss. 1 to 14, 232 S.B. RP, 232 S.B. ss 1 to 2, 232 S.C. to 232 S.E., 233 RP, 233 S.A to 233 S.M., 237 S.R. 238, 239 RP, 239 SG.

Address: Tung Tsz, Tai Po

Location Plan:

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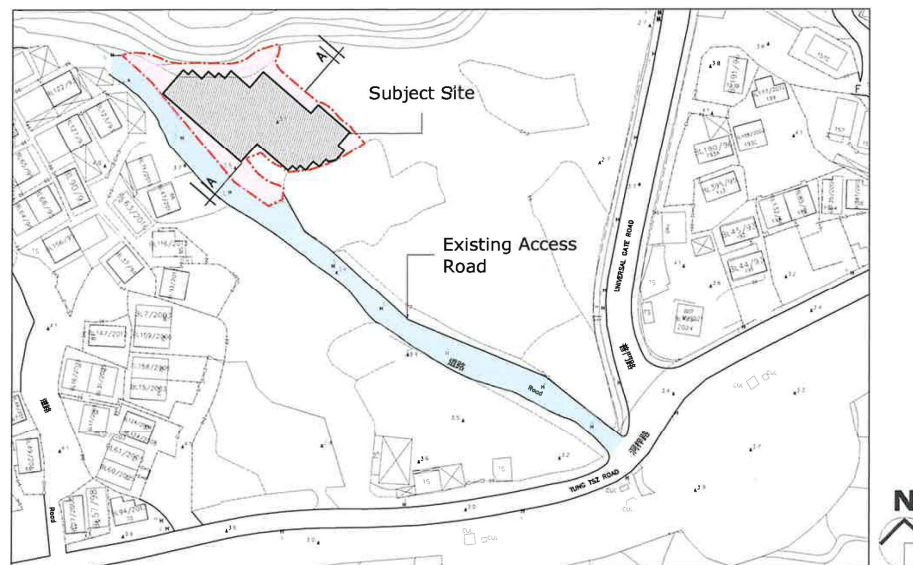
Development Plan:

Development Schedule:

Proposed Residential Care Home for the Elderly (RCHE) Development

Site Area:	1,494.67m^2
Class of Site:	A
Proposed Plot Ratio for Non-domestic:	5.2 < 9.5
Proposed Site Coverage above for Non-domestic (Above 15m):	62.42% < 80%
Proposed Building Height:	34.50mPD
Absolute Height:	31.0m
Proposed No. of storey:	10 storeys

No. of beds						
Floor	No. of storey	Dorm		Isolation room		Staff
		Each floor	Sub-total	Each floor	Sub-total	
1/F-5/F	5	41	205	2	10	0
6/F	1	18	18	0	0	0
7/F	1	11	11	0	0	0
8F	1	0	0	0	0	12
Total			234		10	12

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4. Sewage Impact Assessment

4.1. Design Parameter and Assumptions

The sewage flow estimation, assessment and evaluation of impacts are based on the following established principals and guidelines of Hong Kong:

- EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning No.: EPD/TP 1/05 (GESF)
- Hong Kong Planning Standards and Guidelines (HKPSG)
- Drainage Services Department Sewerage Manual, Third Edition, May 2013

The estimate of sewage demands for the proposed development is based on the latest development parameter provided by the Architect.

4.2. Unit Flow Factors

To derive the unit flow factor for visitors, it is assumed that visitors will stay maximum 8 hrs per day within the development site. The sewage flow will be from two sources, one from flushing and the other from use of wash basin. The unit flow factors from flushing use, has assumed flushing water consumption of $0.1m^3$/person/day for 16 hours of typical domestic residents, employees and visitors usage. The unit flow factor from the wash basin use has assumed a consumption of $0.03m^3$/person/day on 8 hours daily basis. This results in UFF of 0.08m3/person/day.

According to the GESF, the unit flow factor (UFF) of the proposed RCHE development and the existing development is shown in **Table 1** below.

Table 1 – Unit Flow Factor (UFF) of the Proposed RCHE Development and the Existing Development

Type	UFF, Planning for Future (m^3/person/day)
Domestic	
Modern Village	0.27
Institutional and special class	0.19
Commercial	
J11 Community, Social & Personal Services	0.28
Visitor	0.08

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4.3. Peaking Factors

The peaking factors to cater for seasonal/diurnal flow variations, and infiltration and inflow due to storm events are made reference to EPD's GESF and shown in **Table 2**.

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 the design purpose, the peaking factors (including stormwater allowance) shall be used.

Table 2 – 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
(a) For 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	$\mathrm{Max}\left(\dfrac{7.3}{N^{0.15}}, 2.4\right)$	$\mathrm{Max}\left(\dfrac{6}{N^{0.175}}, 1.6\right)$
(b) 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	$\mathrm{Max}\left(\dfrac{3.9}{N^{0.065}}, 2.4\right)$	$\mathrm{Max}\left(\dfrac{2.6}{N^{0.065}}, 1.6\right)$

Notes of Table T-5:

(1) N is the contributing population in thousands.

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4.4.   Estimated Sewage Flow from the Proposed Development

With reference to the GESF, sewage flow estimation for the proposed development is provided in **Table 3**.

No. of Residents/Employees
a) No. of Residents = 256 beds (Adopted from latest engineering information)
b) No. of Employees = 60+20 Nos. (60 staff will be deployed according to the latest engineering information, a total of 80 staff is adopted as conservative approach considering handover during shift)
c) No. of Visitors = 152 Nos. per day (Adopted from latest engineering information)

Table 3 – Estimation Sewage Generated by the Proposed Development

Site	Use	Global Unit Flow Factor (m³/person/day)	No. of Residents/Employees	ADWF (m³/day)
Tung Tsz, Tai Po	RCHE (Institutional and special class)	0.19	256 residents	48.64
	RCHE (J11, Community, Social & Personal Services)	0.28	60+20 staff	22.4
	Visitor	0.08	152 per day	12.16
Total			488	83.20

Sewer Pipe Design:
For sewer pipe, one quarter (1/4) full bore is used to allow space for a core of air in centre of the stack and the air keeps fluctuations to a minimum.

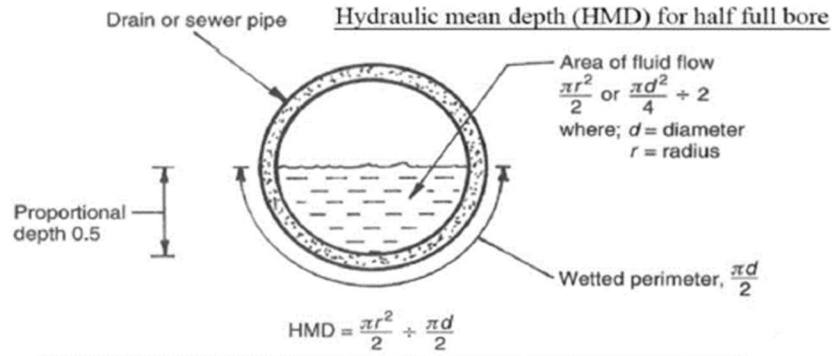Minimum velocity of 0.7m/s (smaller than 300mm diameter) is used for maintaining self-cleansing purpose.

To facilitate inspection and cleaning, pipe should not be less than 200mm diameter.

Peak Flow = (ADWF) (P) = (83.2)(8) = 665.6 m³/day or 0.0077 m³/s

1/4 full bore, velocity of 0.7m/s and 300mm pipe is used.

The capacity of the pipe:
$Q = V \times A = (0.7)(\pi)[(0.300)^2/4] \times 0.25 = 0.01237$ m³/s > 0.0077 m³/s, **OK**

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Drain or sewer pipe

Hydraulic mean depth (HMD) for half full bore

Area of fluid flow

$\frac{\pi r^2}{2}$ or $\frac{\pi d^2}{4} \div 2$

where; d = diameter
r = radius

Proportional depth 0.5

Wetted perimeter, $\frac{\pi d}{2}$

$HMD = \frac{\pi r^2}{2} \div \frac{\pi d}{2}$

Depth of flow	HMD
0.25	Pipe dia. (m) / 6.67
0.33	Pipe dia. (m) / 5.26
0.50	Pipe dia. (m) / 4.00
0.66	Pipe dia. (m) / 3.45
0.75	Pipe dia. (m) / 3.33
Full	Pipe dia. (m) / 4.00

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Chezy's formula:

$V = C\sqrt{(m \times i)}$

where

V = velocity of flow = 0.7m/s

m = hydraulic mean depth (HMD) → HMD = 0.300 / 6.67 = 0.0450

C = Chezy coefficient = $(0.0450)^{1/6}/(0.015(\text{concrete pipe}))$ = 39.76
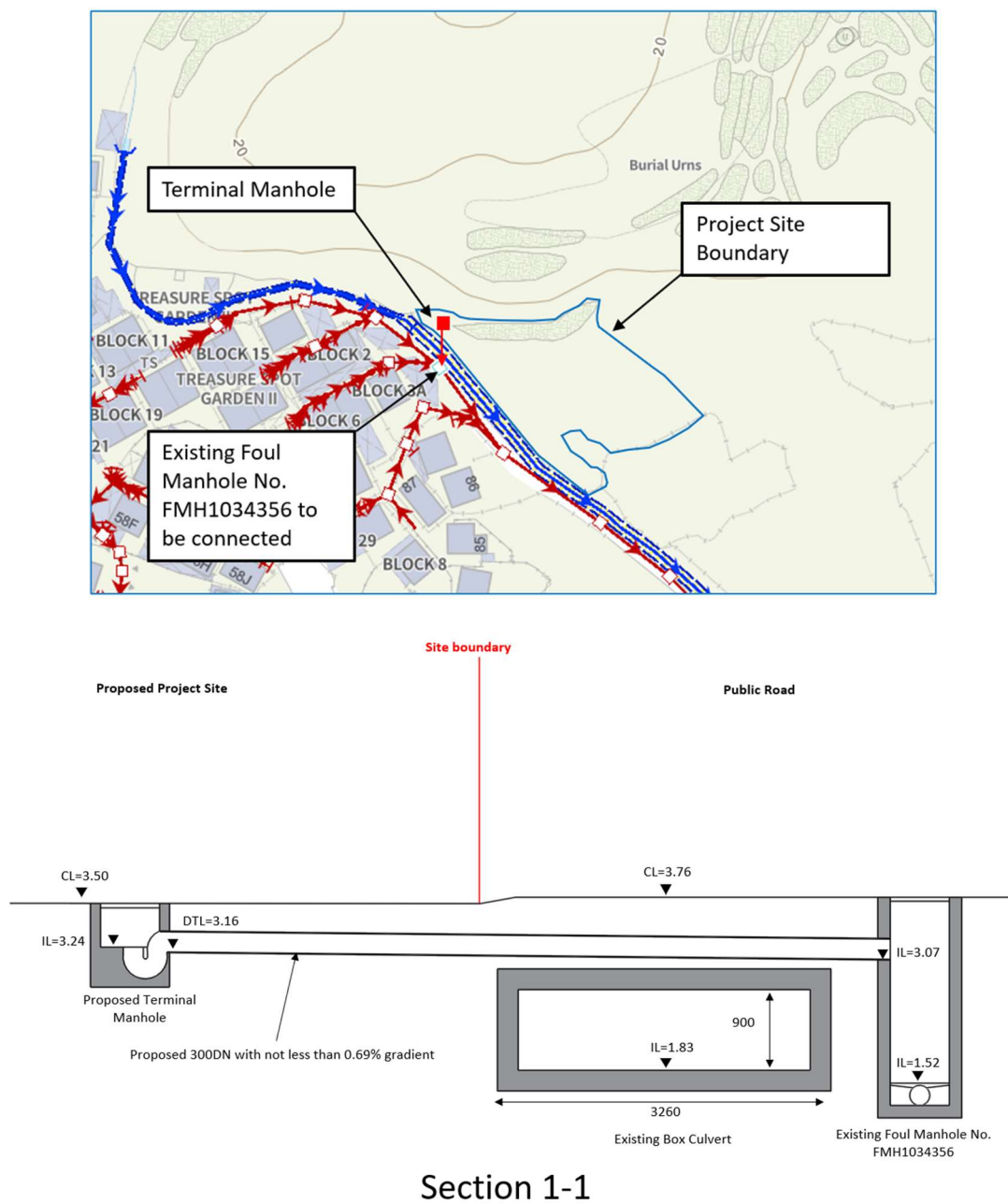
$0.7 = 39.76 \times (0.0450 \times i)^{0.5}$

$(0.7/39.76)^2 = 0.0450 \times i$

Thus i = 0.0069 or 0.69% (i = inclination)

Sewerage Impact Assessment for Proposed Residential Care Home for the Elderly (RCHE) Development at Tung Tsz, Tai Po

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4.5. Total Combined Sewage Flow

The foul water from the developing site will be discharged into the nearby existing Foul Manhole No. FMH1034356 (as shown below). The downstream invert level of the proposed DN300 sewer will be around 3.07mPD. Given that there is a site constraint of the existing box culvert located between the site and the public sewerage system as shown in Section 1-1, sufficient soil cover cannot be provided. As such, the proposed pipe under the footpath and carriageway will be surrounded by concrete to protect the integrity of the pipe. The foul water will be transferred to the nearby TKRSPS No. 7 with an ADWF of about 7,800 m³/day. The Project proponent shall be responsible for the construction and maintenance of the proposed sewerage drainage system.

Section 1-1

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The tentative occupation year of the proposed development is 2030. However, the projection of the tertiary planning units is up to 2027 only from the Common Spatial Data Infrastructure (CSDI). Given that the trend of projected population at Tai Po area is steady, adopting 2027 projection figure is considered appropriate for estimating the sewage impact of the proposed project. Additional flow contributed by the proposed RCHE development has been incorporated into the existing sewerage system to investigate the cumulative impact. Detailed calculations of the estimated sewage flow contribution to TKRSPSNo.7 are given in **Appendix A**.

Sewage demands arising from existing demands and the proposed development have been estimated and are summarized in **Table 4** below. Detailed breakdown of population and sewage flow are presented in **Appendix A**.

Table 4 – Contribution of Existing and Planned Sewage Flow to TKRSPS No. 7 in 2027

	TPU Zone (Subunit)	Location	Projections of Population Distribution Year 2027	ADWF	
				Increment (m³/day)	Cumulative (m³/day)
Existing Sewerage Catchment	728 (35)	Jade Forest Villa & Tung Tsz	856	231.07	4519.02
	728 (8)	Treasure Spot Garden II	498	134.58	
	728 (38)	San Tau Kok	1083	292.42	
	728 (37)	Po Sam Pai	1440	388.90	
	728 (25)	Ting Kok Village	2709	731.30	
	728 (27)	Soka Gakkai Recreational Centre	610	170.87	
	728 (28)	Lo Tsz Tin	1451	391.87	
	728 (30)	Lung Mei, Wong Chuk Tsuen & Tai Mei Tuk	2725	735.75	
	728(7)	Treasure Spot Garden	1261	340.41	
	728(13)	Shuen Wan Chan Uk	1866	503.70	
	721 (20)	Tung Tsz Scout Centre	811	227.08	
	722(36)	HKPF Tung Tsz Holiday Home	500	140.00	
	722(37)	Tung Tsz Shan Road Garden	856	231.07	
Planned Sewerage Catchment	728 (8)	Proposed RCHE	488	83.2	83.2
Total					4602.22
ADWF of TKRSPS No. 7 (m³/day)					7800.00

**Sewerage Impact Assessment for Proposed Residential Care
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4.6.   Potential Impact to Sewerage Facilities

Detailed hydraulic assessment on the existing sewerage pipeline systems are presented in **Appendix A**.

The total ADWF from the proposed development is estimated to be 83.2 m^3/day. The combined sewage flow contribution to TKRSPS No. 7 is estimated to be 4602.22 m^3/day. Given that the ADWF of TKRSPS No. 7 is 7800 m^3/day according to the Project Profile PP-560/2017 available from EPD website, the capacity of TKRSPS No. 7 is adequate to meet the demands within its service area at year 2030. According to the hydraulic calculations on the cumulative impact to the downstream sewerage system in **Appendix A**, the existing sewerage system is adequate to handle the additional sewage flow generated from the proposed development. As such, the increased sewage flow from the proposed development will have no adverse impact to the existing sewerage system.

5.   **Conclusion**

The design capacity of the TKRSPS No.7 is adequate to meet demands within its service area and able to cater for the additional sewage flow from the proposed development. The estimated cumulative flows from the existing and proposed development are well below the sewerage system design capacity.

As such, the increase sewage flow from the proposed development will have no adverse impact on Tolo Harbour Water Control Zone.

Appendix A
Hydraulic Calculations

Appendix A1 - Projections of Population Distribution of the Assessment Area (Year 2023-2031)

TPU Zone [2]	Population [1]						
	2021	2022	2023	2024 [3]	2025	2026	2027
711, 712, 721 & 728	18300	17700	18200	19600	19400	18900	18700

Population Estimation of Specific Location in the TPU Zone

TPU Zone (Subunit) [2]	No.	Location	OZP Zone	Approx. Site Area (m2)	2027 Population		Notes
728 (35)	1	Jade Forest Villa & Tung Tsz	V	46700	856		-
728 (8)	2	Treasure Spot Garden II	V	27200	498		-
728 (38)	3	San Tau Kok	V	59100	1083		-
728 (37)	4	Po Sam Pai	V	78600	1440		-
728 (25)	5	Ting Kok Village	V	147800	2709		-
728 (27)	6	Soka Gakkai Recreational Centre	G/IC	33300	610		-
728 (28)	7	Lo Tsz Tin	V	79200	1451	18700	-
728 (30)	8	Lung Mei, Wong Chuk Tsuen & Tai Mei Tuk	V	148700	2725		-
728(7)	9	Treasure Spot Garden	V	68800	1261		-
728(13)	10	Shuen Wan Chan Uk	V	101800	1866		-
728(14)	11	The Beverly Hills	n.a.	106500	1952		-
728(16)	12	Sam Mun Tsai Village	R(D)	50600	927		-
711 (3)	13	Wu Kau Tang	V	27880	511		-
721 (20)	14	Tung Tsz Scout Centre	n.a.	-	811		[4]
722(36)	15	HKPF Tung Tsz Holiday Home	GB	-	500		[5]
722(37)	16	Tung Tsz Shan Road Garden	V	-	856	1356	[6]
		Total		976180	20056		-

Notes:

[1] Population data for No.1-13 are extracted from CSDI Projections of Population Distribution 2023-2031_TPU

[2] TPU Zone No. is extracted from CSDI TPUSU_2021_Layer

[3] Population is up to 2027 only from CSDI. Year 2027 is considered appropriate for estimating the sewage impact of the proposed development as the trend of projected population at Tai Po area is steady.

[4] The population of Tung Tsz Scout Centre is adopted from the official website: https://www.lcsd.gov.hk/en/camp/sngocc/p_ng_tungtsz.html

[5] A population of 500 is adopted for HKPF Tung Tsz Holiday Home as conservative approach given that the population is limited according to the official website https://www.police.gov.hk/offbeat/806/chi/b03.htm

[6] Consider that the scale and characteristic of Tung Tsz Shan Road Garden is similar to Jade Forest Villa & Tung Tsz, population figure of Jade Forest Villa & Tung Tsz is adopted for estimating the population of Tung Tsz Shan Road Garden as conservative approach.

Sewerage system of The Beverly Hills, Sam Mun Tsai Village and Wu kau Tang is not connected to TKRSPS No.7

Partial Population Estimation of San Tau Kok

ID	Proportion	Approx. Site Area (m2)	Population
A1	4%	2364	43
A2	2%	1182	22
A3	11%	6501	119
A4	10%	5910	108
A5	24%	14184	260
A6	18%	10638	195
A7	25%	14775	271
A8	6%	3546	65
Sum	100%	59100	1083

Partial Estimation for San Tau Kok
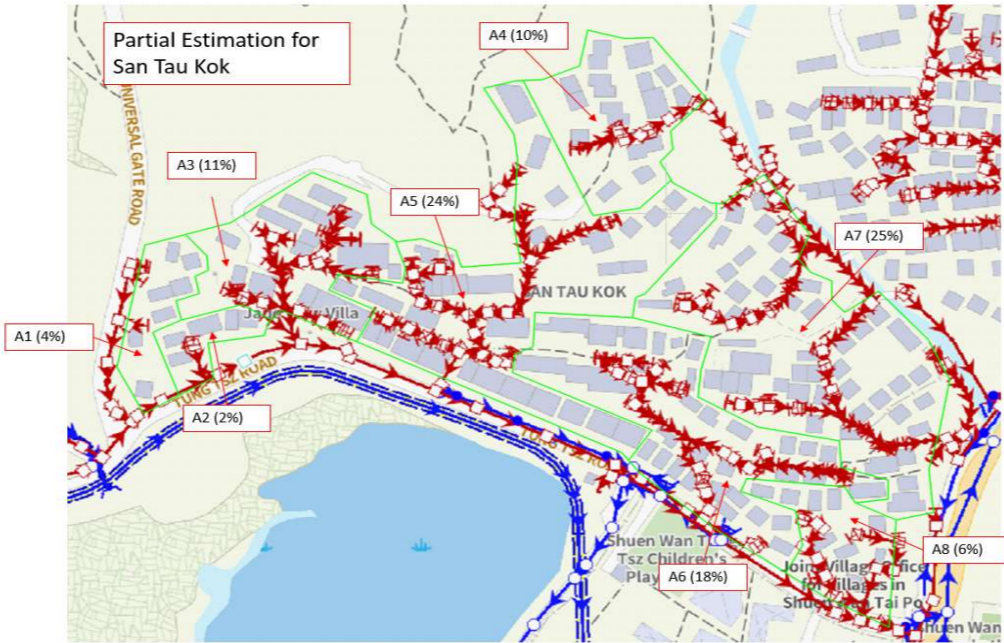
Appendix A2 - Unit Flow Factor of Different Types of Flow

Type	Planning For Future (m3/person/day) [1]
Domestic	
Modern Village [1]	0.27
Institutional and special class [1]	0.19
Commercial	
J11 Community, Social & Personal Services [1]	0.28
Visitor [2]	0.08

Notes:
[1] Unit Flow Factors are extracted from EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05
[2] Unit Flow Factors are calculated based on assumption. Please refer to Section 4.2 for detailed assumption.

Appendix A3 - Existing and Planned Sewage Flow Contributing to TKRSPS No. 7 (Year 2027)

	TPU Zone (Subunit) [1]	No. [2]	Location	OZP Zone	Type of Flow	Projections of Population Distribution Year (Year 2027)	ADWF Increment (m3/day)	ADWF Cumulative (m3/day)	Notes
Existing Sewerage Catchment	728 (35)	1	Jade Forest Villa & Tung Tsz	V	Modern Village	856	231.07		-
	728 (8)	2	Treasure Spot Garden II	V	Modern Village	498	134.58		-
	728 (38)	3	San Tau Kok	V	Modern Village	1083	292.42		-
	728 (37)	4	Po Sam Pai	V	Modern Village	1440	388.90		-
	728 (25)	5	Ting Kok Village	V	Modern Village	2709	731.30		-
	728 (27)	6	Soka Gakkai Recreational Centre	G/IC	J11 Community, Social & Personal Services	610	170.87		-
	728 (28)	7	Lo Tsz Tin	V	Modern Village	1451	391.87		-
	728 (30)	8	Lung Mei, Wong Chuk Tsuen & Tai Mei Tuk	V	Modern Village	2725	735.75	4519.02	-
	728(7)	9	Treasure Spot Garden	V	Modern Village	1261	340.41		-
	728(13)	10	Shuen Wan Chan Uk	V	Modern Village	1866	503.70		-
	721 (20)	14	Tung Tsz Scout Centre	n.a.	J11 Community, Social & Personal Services	811	227.08		[3]
	722(36)	15	HKPF Tung Tsz Holiday Home	GB	J11 Community, Social & Personal Services	500	140.00		[4]
	722(37)	16	Tung Tsz Shan Road Garden	V	Modern Village	856	231.07		[5]
Planned Sewerage Catchment	728 (8)	-	Proposed RCHE	G/IC	Institutional and special class	256	48.64	83.2	-
					J11 Community, Social & Personal Services	80	22.4		-
					Visitor	152	12.16		[6]
Total						17154	4602.22		-
ADWF of TKRSPS No. 7 (m3/day) [7]							7800.00		[7]

Notes:
[1] TPU Zone No. Refer to CSDI TPUSU_2021_Layer.
[2] Population of areas with numbering are estimated from CSDI Projections of Population Distribution 2023-2031_TPU.
[3] The population of Tung Tsz Scout Centre is adopted from the official website: https://www.lcsd.gov.hk/en/camp/sngocc/p_ng_tungtsz.html
[4] A population of 500 is adopted for HKPF Tung Tsz Holiday Home as conservative approach given that the population is limited according to the official website https://www.police.gov.hk/offbeat/806/chi/b03.htm
[5] Consider that the scale and characteristic of Tung Tsz Shan Road Garden is similar to Jade Forest Villa & Tung Tsz, population figure of Jade Forest Villa & Tung Tsz is adopted for estimating the population of Tung Tsz Shan Road Garden as conservative approach.
[6] No of visitors of the proposed RCHE is adopted from latest engineering information
[7] ADWF of TKRSPS No. 7 is captured from Project Profile PP-560/2017 available from EPD website.
Sewerage system of Treasure Spot Garden and Shuen Wan Chan Uk is not affected by the proposed development as no interchange in between before entering TKRSPS. No.7

Partial Population Estimation of San Tau Kok

ID	Proportion	ADWF
A1	4%	11.70
A2	2%	5.85
A3	11%	32.17
A4	10%	29.24
A5	24%	70.18
A6	18%	52.64
A7	25%	73.11
A8	6%	17.55
Sum	**100%**	**292.42**

Partial Estimation for San Tau Kok

Appendix A4 - Capacity Performance of Existing and Proposed Sewers (Year 2027)

$$V = -2\sqrt{2gdS}\, \log\!\left(\frac{k}{3.7d} + \frac{2.51v}{d\sqrt{2gdS}} \right)$$

Where k is equivalent roughness with value equals 1.5mm for existing sewers
v is kinematic viscosity of fluid =1.14x10^-6 m2/s and g is the gravity=9.81 m/s2,
V is velocity, d is the diameter of the sewer and S is the gradient of the sewer

Table A4-1 Impact Assessment of the Proposed Sewers to the Existing Sewers along Access Road near Treasure Spot Garden II

| Manhole [1] | | ADWF (m3/d) | Accumulated ADWF (m3/d) | Contributing Population | Peaking Factor [3] | Peak Flow (m3/d) | Peak Flow (L/s) | Pipe Parameter [1] | | | | | | Velocity (m/s) [2] | Capacity (L/s) | Peak Flow/Capacity (%) | Adequate Capacity |
Upstream Manhole No.	Downstream Manhole No.							Diameter (mm)	Length (m)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Gradient (S), m/m					
FMH1034356	FMH1034357	217.78	217.78	986	8	1742.26	20.17	225.00	25.29	1.495	1.280	0.0085	1.06	42.04	48%	YES
FMH1034357	FMH1034358	0.00	217.78	986	8	1742.26	20.17	225.00	28.42	1.271	1.043	0.0080	1.03	40.83	49%	YES
FMH1034358	FMH1034359	0.00	217.78	986	8	1742.26	20.17	225.00	20.83	1.030	0.858	0.0083	1.04	41.43	49%	YES
FMH1034359	FMH1034360	0.00	217.78	986	8	1742.26	20.17	225.00	14.54	0.848	0.729	0.0082	1.04	41.24	49%	YES
FMH1034360	FMH1034361	0.00	217.78	986	8	1742.26	20.17	225.00	15.53	0.724	0.586	0.0089	1.08	42.98	47%	YES
FMH1034361	FMH1034362	0.00	217.78	986	8	1742.26	20.17	225.00	36.56	0.575	0.279	0.0081	1.03	41.02	49%	YES
FMH1034362	FMH1034364	0.00	217.78	986	8	1742.26	20.17	225.00	16.19	0.270	0.159	0.0069	0.95	37.73	53%	YES
FMH1034364	FMH1034301	0.00	217.78	986	8	1742.26	20.17	225.00	10.69	0.149	0.104	0.0042	0.74	29.51	68%	YES

Notes:
[1] Manhole No. and pipe information are extracted from geoinfo map and CSDI
[2] Velocity is calculated by Colebrook-White Equation given in Appendix A4
[3] Peaking Factor can refer to Table T-5 of EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05
[3] Although the assessed sewerage system only serves less than a half buildings of Treasure Spot Garden II, the total ADWF and population is adopted for conservative approach.
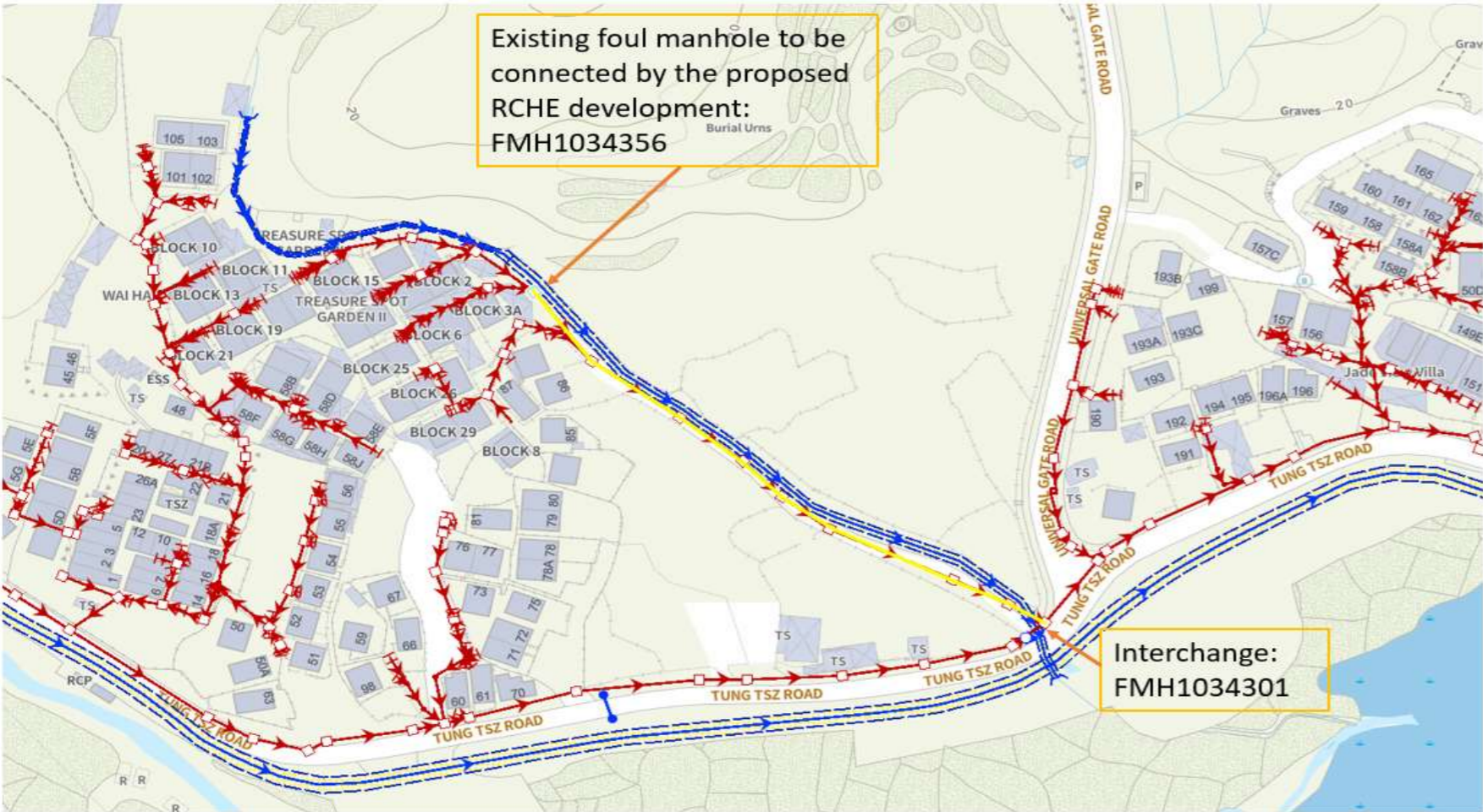
Table A4-2 Cumulative Impact Assessment of the Proposed Sewers to the Existing Sewers along Tung Tsz Road (Before Rising Main)

| Manhole [1] | | ADWF (m3/d) | Accumulated ADWF (m3/d) | Contributing Population | Peaking Factor [3] | Peak Flow (m3/d) | Peak Flow (L/s) | Pipe Parameter [1] | | | | | Velocity (m/s) [2] | Capacity (L/s) | Peak Flow/Capacity (%) | Adequate Capacity |
Upstream Manhole No.	Downstream Manhole No.							Diameter (mm)	Length (m)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Gradient (S), m/m				
FMH1034301	FMH1041146	829.21	1047.00	4009	5.00	5234.98	60.59	375.00	23.20	0.094	0.008	0.0037	0.97	107.54	56%	YES
FMH1041146	FMH1034302	11.70	1058.69	4052	5.00	5293.46	61.27	375.00	3.04	0.030	0.008	0.0072	1.36	150.52	41%	YES
FMH1034302	FMH1034303	0.00	1058.69	4052	5.00	5293.46	61.27	375.00	13.70	-0.007	-0.048	0.0030	0.87	96.56	63%	YES
FMH1034303	FMH1034304	0.00	1058.69	4052	5.00	5293.46	61.27	375.00	29.20	-0.079	-0.257	0.0061	1.25	138.09	44%	YES
FMH1034304	FMH1034305	5.85	1064.54	4074	5.00	5322.70	61.61	375.00	13.40	-0.320	-0.390	0.0052	1.16	127.79	48%	YES
FMH1034305	FMH1034306	0.00	1064.54	4074	5.00	5322.70	61.61	375.00	28.20	-0.405	-0.457	0.0018	0.69	75.66	81%	YES
FMH1034306	FMH1034307	32.17	1096.71	4193	5.00	5483.53	63.47	400.00	19.60	-0.474	-0.520	0.0023	0.81	101.38	63%	YES
FMH1034307	FMH1034308	0.00	1096.71	4193	5.00	5483.53	63.47	400.00	3.20	-0.520	-0.523	0.0009	0.51	63.81	99%	YES
FMH1034308	FMH1034309	0.00	1096.71	4193	5.00	5483.53	63.47	375.00	44.00	-0.528	-0.740	0.0048	1.11	122.70	52%	YES
FMH1034309	FMH1034310	70.18	1166.89	4453	5.00	5834.44	67.53	375.00	20.86	-0.748	-0.893	0.0070	1.34	147.51	46%	YES
FMH1034310	FMH1034311	0.00	1166.89	4453	5.00	5834.44	67.53	375.00	35.36	-0.913	-1.141	0.0064	1.29	142.04	48%	YES
FMH1034311	FMH1034312	0.00	1166.89	4453	5.00	5834.44	67.53	375.00	35.01	-1.141	-1.415	0.0078	1.42	156.56	43%	YES

Notes:

[1] Manhole No. and pipe information are extracted from geoinfo map and CSDI

[2] Velocity is calculated by Colebrook-White Equation given in Appendix A4

[3] Peaking Factor can refer to Table T-5 of EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05
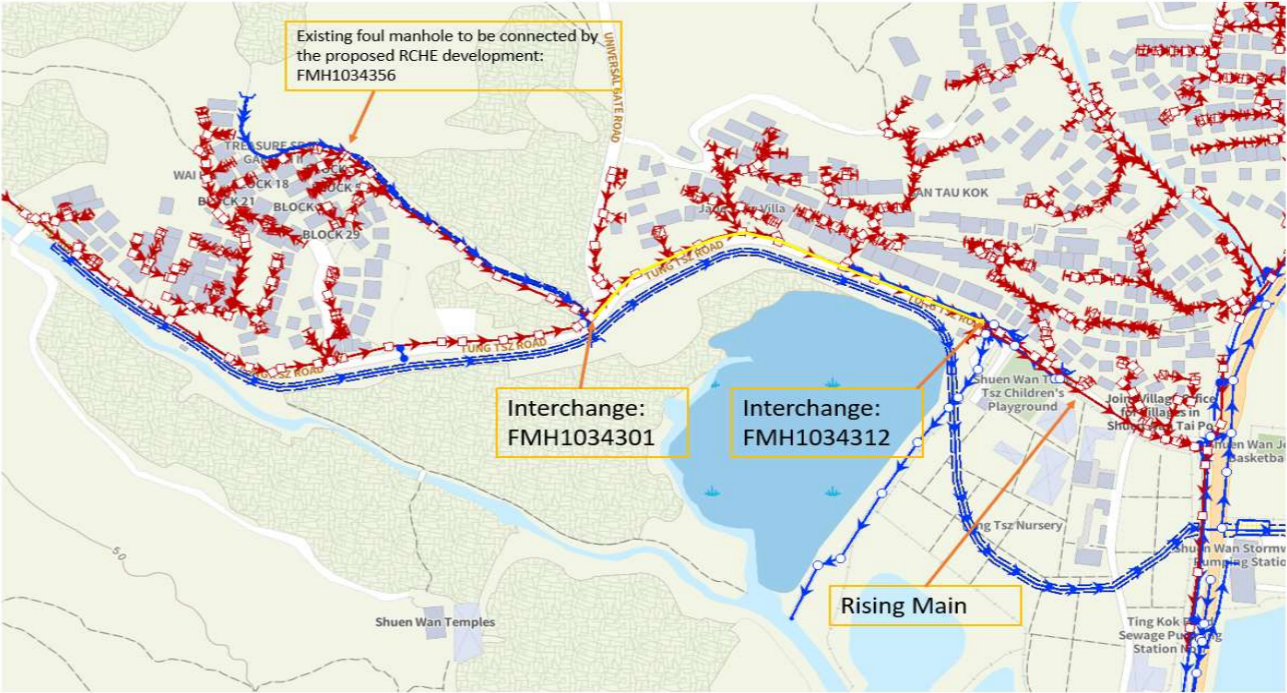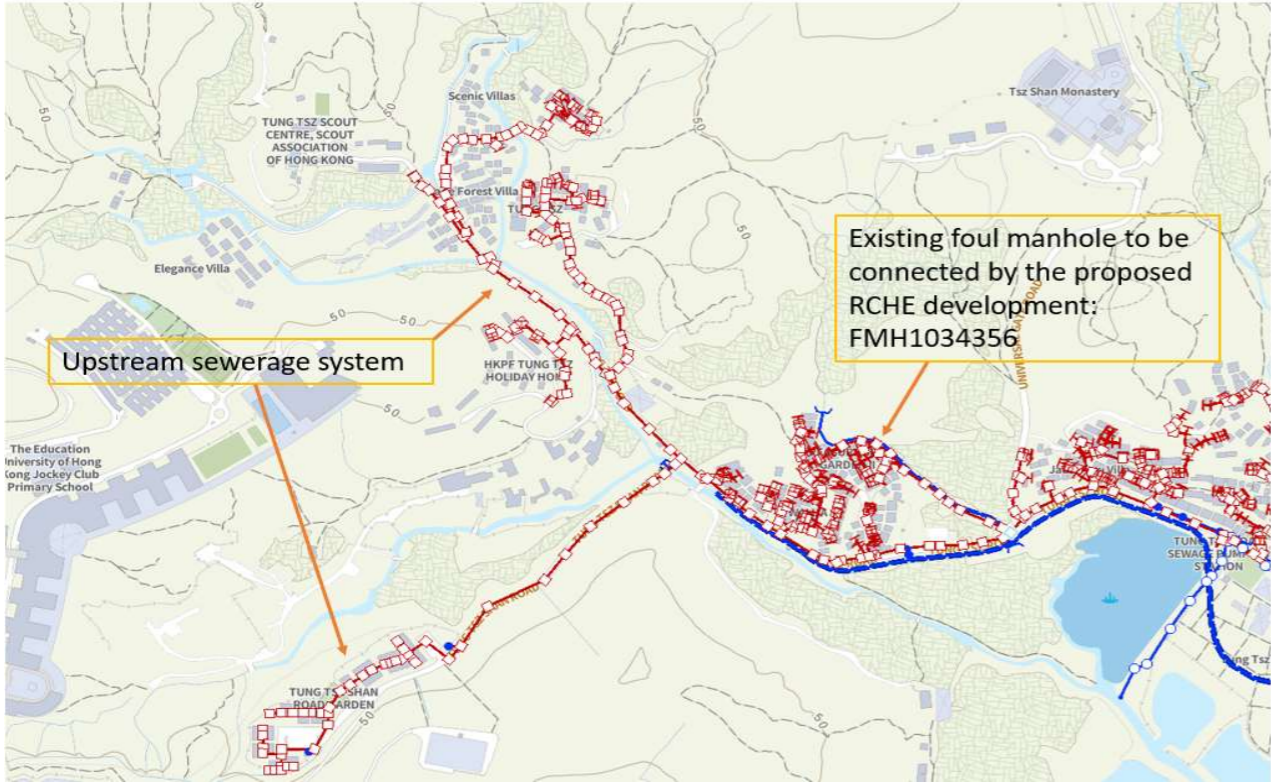
Table A4-3 Cumulative Impact Assessment of the Proposed Sewers to the Existing Sewers along Tung Tsz Road (Rising Main)

| Manhole [1] | | ADWF (m3/d) | Accumulated ADWF (m3/d) | Contributing Population | Peaking Factor [3] | Peak Flow (m3/d) | Peak Flow (L/s) | Pipe Parameter [1] | | | | | Velocity (m/s) [2] | Capacity (L/s) | Peak Flow/Capacity (%) | Adequate Capacity |
Upstream Manhole No.	Downstream Manhole No.							Diameter (mm)	Length (m)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Gradient (S), m/m				
Tung Tsz Road Sewage Pumping Station	FMH1034368	52.64	1219.52	4648	5	6097.62	70.57	200.00	137.30	1.31	2.68	-0.0100	3.00	94.25	75%	YES

Notes:

[1] Manhole No. and pipe information are extracted from geoinfo map and CSDI

[2] With reference to Sewerage Manual - Pumping Stations and Rising Mains published by DSD, the desirable range of velocity of rising mains would be 1 to 2 m/s with a maximum velocity of 3 m/s.

[3] Peaking Factor can refer to Table T-5 of EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05

7. RISING MAINS DESIGN

7.1 HYDRAULIC DESIGN

7.1.1 Steady State Hydraulics

The hydraulic design of rising mains involves the sizing of the mains and its number to meet the pump operational and the velocity requirements. As for the pump operational requirements, please refer to the system head capacity curve in Chapter 3.

The selection of a suitable size for the rising mains should be based on economic analysis of capital cost and recurrent cost of the pumping system including the power cost. Trial and error approach should be adopted in order to arrive at optimal solution while maintaining the velocity within acceptable limits. The maximum velocity should not exceed 3 m/s which are usually governed by the concerns for the power cost. The desirable range of velocity should be 1 m/s to 2 m/s with due consideration given to the various combinations of number of duty pumps in operation.

Table A4-4 Cumulative Impact Assessment of the Proposed Sewers to the Existing Sewers along Tung Tsz Road (After Rising Main)

| Manhole [1] | | ADWF (m3/d) | Accumulated ADWF (m3/d) | Contributing Population | Peaking Factor [3] | Peak Flow (m3/d) | Peak Flow (L/s) | Pipe Parameter [1] | | | | | Velocity (m/s) [2] | Capacity (L/s) | Peak Flow/Capacity (%) | Adequate Capacity |
Upstream Manhole No.	Downstream Manhole No.							Diameter (mm)	Length (m)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Gradient (S), m/m				
FMH1034368	FMH1034369	0.00	1219.52	4648	5.00	6097.62	70.57	300.00	11.11	2.51	2.39	0.0106	1.43	100.99	70%	YES
FMH1034369	FMH1034370	119.89	1339.42	5092	4.00	5357.66	62.01	300.00	5.83	2.36	2.32	0.0077	1.22	86.03	72%	YES
FMH1034370	FMH1023886	0.00	1339.42	5092	4.00	5357.66	62.01	300.00	10.97	2.31	2.21	0.0091	1.32	93.53	66%	YES
FMH1023886	FMH1023880	0.00	1339.42	5092	4.00	5357.66	62.01	300.00	6.37	1.90	1.73	0.0267	2.27	160.34	39%	YES

Notes:

[1] Manhole No. and pipe information are extracted from geoinfo map and CSDI

[2] Velocity is calculated by Colebrook-White Equation given in Appendix A4

[3] Peaking Factor can refer to Table T-5 of EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05

Table A4-5 Cumulative Impact Assessment of the Proposed Sewers to the Existing Sewers along Ting Kok Road

| Manhole [1] | | ADWF (m3/d) | Accumulated ADWF (m3/d) | Contributing Population | Peaking Factor [3] | Peak Flow (m3/d) | Peak Flow (L/s) | Pipe Parameter [1] | | | | | Velocity (m/s) [2] | Capacity (L/s) | Peak Flow/Capacity (%) | Adequate Capacity |
Upstream Manhole No.	Downstream Manhole No.							Diameter (mm)	Length (m)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Gradient (S), m/m				
FMH1023880	FMH1023881	2418.69	3758.11	14028	3.00	11274.33	130.49	600.00	8.91	1.73	1.70	0.0034	1.26	355.21	37%	YES
FMH1023881	FMH1023884	0.00	3758.11	14028	3.00	11274.33	130.49	600.00	34.88	1.70	1.60	0.0029	1.16	327.65	40%	YES
FMH1023884	FMH1023921	0.00	3758.11	14028	3.00	11274.33	130.49	600.00	38.58	1.60	1.50	0.0026	1.10	311.46	42%	YES
FMH1023921	FMH1024036	0.00	3758.11	14028	3.00	11274.33	130.49	600.00	38.55	1.50	1.39	0.0029	1.16	326.87	40%	YES
FMH1024036	FMH1067559	0.00	3758.11	14028	3.00	11274.33	130.49	600.00	15.11	1.39	1.29	0.0066	1.76	498.68	26%	YES

Notes:

[1] Manhole No. and pipe information are extracted from geoinfo map and CSDI

[2] Velocity is calculated by Colebrook-White Equation given in Appendix A4

[3] Peaking Factor can refer to Table T-5 of EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Report No.: EPD/TP 1/05