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Appendix 9 of Planning Statement - Sewerage Impact Assessment

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D02 Sewerage Impact Assessment

S12A Rezoning Application – Request for Amendment to the Lung Yeuk Tau and Kwan Tei South OZP from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A)2" Zone at Various Lots in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau, N.T.

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This report is confidential and is provided solely for the purposes of supporting S12A Rezoning Application – Request for Amendment to the Lung Yeuk Tau and Kwan Tei South OZP from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A)2" Zone at Various Lots in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau, N.T.. This report is provided pursuant to a Consultancy Agreement between SMEC Asia Limited ("SMEC") and Carlton Woodcraft Manufacturing Ltd, under which SMEC undertook to perform specific and limited tasks for Carlton Woodcraft Manufacturing Ltd. This report is strictly limited to the matters stated in it and subject to the various assumptions, qualifications and limitations in it and does not apply by implication to other matters. SMEC makes no representation that the scope, assumptions, qualifications and exclusions set out in this report will be suitable or sufficient for other purposes nor that the content of the report covers all matters which you may regard as material for your purposes.

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1 INTRODUCTION

1.1 Project Background

1.1.1 With reference to the latest policy address in developing the Northern Metropolis, it is aimed to optimise the use of land resources, adopt a higher development intensity and increase high-quality housing supply. In order to address the aforementioned needs, it is planned to redevelop a land with an area of approximately 22,445m^2 comprising various lots in D.D. 83, and the adjoining government land with an area of about 1,358m^2, Lung Yeuk Tau, New Territories, into proposed flat, shop and services and eating place ("the Site" or "the Proposed Development").

1.1.2 The Site is currently zoned "Residential (Group C)" ("R(C)") and "Agriculture" ("AGR") under the Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan ("OZP"). It is planned to develop a commercial complex for shop and services and eating place, and Residential Development comprising five blocks for domestic use. For the Proposed Development, it is proposed to amend the Site to "Residential (Group A)2" ("R(A)2") by submitting an application under Section 12A of the *Town Planning Ordinance* ("TPO").

1.1.3 In order to support the rezoning application, SMEC Asia Ltd ("SMEC") has been commissioned to prepare this Sewerage Impact Assessment ("SIA") Report to evaluate and assess impacts from the Proposed Development on the downstream public sewerage system. Effective mitigation measures to reduce any adverse sewerage issues identified will be recommended.

1.2 Site Description

1.2.1 The Site is located in a developed area in Lung Yeuk Tau, New Territories, which is a flat land used for workshop, storage and warehouses. Its northern part is currently occupied by a permanent domestic structure, temporary structures for open storage yards, storage of construction materials and workshops, open carparks and vacant land. The southern part is currently occupied for warehouse storage.

1.2.2 As shown on ***Figure 1-1***, Sha Tau Kok Road (Lung Yeuk Tau) Section is located to the immediate north of the Site that runs along the northeast-southwest direction. Across the opposite site of Sha Tau Kok Road (Lung Yeuk Tau) Section, there are San Wai Barracks, a recycling centre and some warehouses. The Site is mainly surrounded by Tung Chun Soy Sauce factory place and some vegetated land to the east, Queen's Hill Estate to the south, village houses and warehouses to the west, intermixed with temporary structures, scattered vegetated and abandoned land.

1.3 Project Description

1.3.1 The Proposed Development will tentatively comprise a commercial complex and a Residential Development with the following components:

- Five Residential Blocks
- One Clubhouse
- One Swimming Pool
- One Commercial Complex

1.4 Objective of the Report

1.4.1 The objectives of this SIA are to:

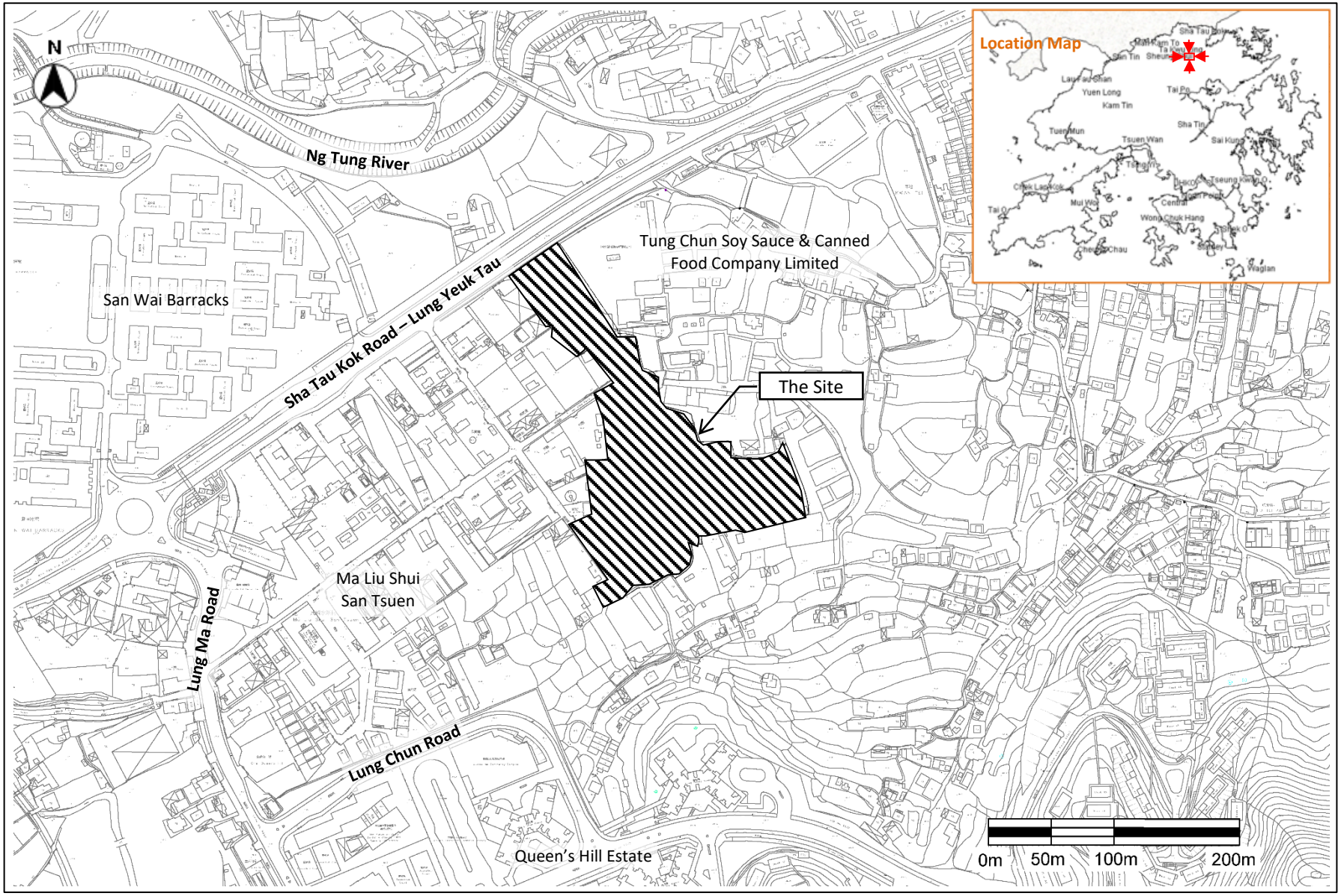
- Assess the potential sewerage impacts arising from the Proposed Development.
- Recommend the necessary mitigation measures to alleviate the impacts.

1.5 Reference Materials

1.5.1 In evaluating the sewerage impact arising from the Project, the following documents have been referred to:

- Drainage Services Department ("DSD") publication *Sewerage Manual (with Eurocodes incorporated) (Part 1) Key Planning Issues and Gravity Collection System, 3rd Edition, May 2013*
- Environmental Protection Department ("EPD") publication *Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Version 1.0, March 2005* ("GESF")
- GeoInfo Map (https://www.map.gov.hk/gm/) reviewed on 7 February 2023

Figure 1-1 Site Location and its Environs



2 EXISTING ENVIRONMENT AND BASELINE CONDITIONS

2.1 Existing Baseline Conditions

2.1.1 Based on the sewerage data of GeoInfo Map checked on 7 February 2023 and the sewerage layout plan shown on ***Figure 2-1***, there is existing municipal sewerage system running along Sha Tau Kok Road (Lung Yeuk Tau) Section from the north of the Site and then to the northwest of it.

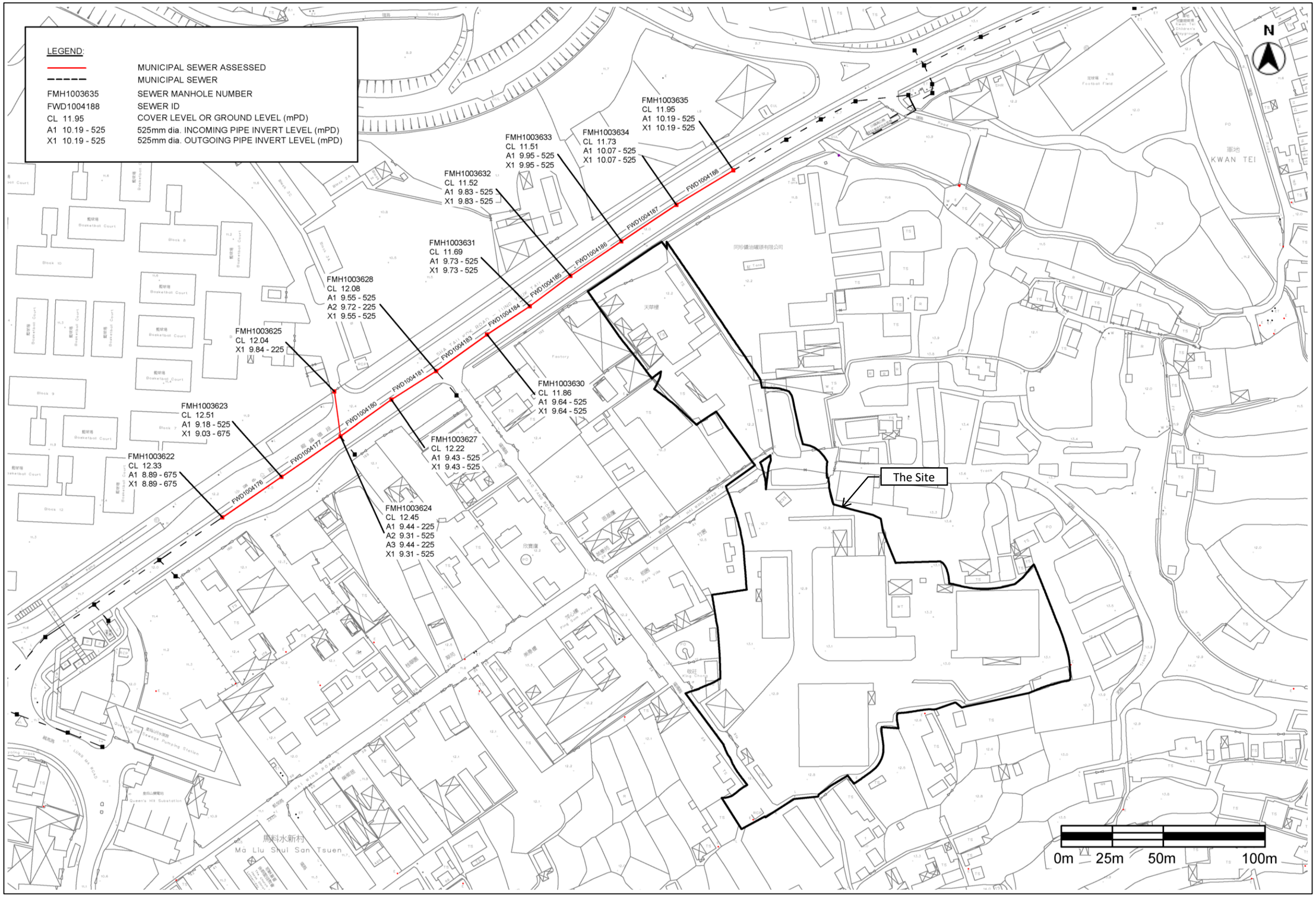
2.1.2 It is proposed to connect the Site to the aforementioned municipal sewers along Sha Tau Kok Road (Lung Yeuk Tau) Section at Manhole FMH1003632, about 11m from the northern boundary of the Site, for the discharge of sewage generated from the Proposed Development. The manhole is connected to the next manhole by a 525mm diameter sewer toward the southwest direction.

2.2 Sewerage Impact During Operation Phase

2.2.1 During the operation of the Proposed Development, the major sources of sewage will be the sewage generated by the staff and visitors of the commercial complex, the sewage generated by the residents and staff of the Residential Development, as well as the wastewater generated from the swimming pool of the club house.

2.2.2 Sewage arising from the Proposed Development is proposed to be discharged to the Manhole FMH1003632 to the north of the Site and flow through the existing sewer of 525mm to reach Manhole FMH1003631 beneath Sha Tau Kok Road (Lung Yeuk Tau) Section. The proposed sewerage connection to existing municipal sewer is shown on ***Figure 2-1***.

Figure 2-1 Existing Sewerage Layout Plan



3 SEWERAGE ANALYSIS

3.1 Assumptions and Methodology

3.1.1 In order to assess the acceptability of the sewerage impact arising from the Proposed Development, the anticipated sewage generation has been estimated based on Environmental Protection Department ("EPD")'s *Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning* ("GESF") shown in ***Table 3-1.***

Table 3-1: Parameters for Estimating Wastewater Generation from the Proposed Development

PARAMETER	VALUE	REMARK
Generation from Residents of Residential Development		
No. of Residents	9,915	As advised by the Applicant.
Unit Flow Factor of Residents	0.190m^3/day/person	The unit flow factor for "Private R1" given in Table T-1 of GESF [Note 1].
Generation from Staff of Residential Development		
Total Area	3,595m^2	Non-domestic GFA as advised by the Applicant.
No. of Staff	119	Worker density by All Type for "Community, Social & Personal Services" is 3.3 staff in 100m^2 as stated in Table 8 of Commercial and Industrial Floor Space Utilization Survey.
Unit Flow Factor of Staff	0.280m^3/day/staff	The unit flow factor for employees of "J11 Community, Social & Personal Services" + that for commercial employee given in Table T-2 of GESF. For J11, the "per-employee" unit flow factor takes into account the flows of customers and/or tenants.
Generation from Retail Staff of Commercial Complex		
Total Area	3,220m^2	As advised by the Applicant.
No. of Staff	113	Worker density by All Type for "Retail Trade" is 3.5 staff in 100m^2 as stated in Table 8 of Commercial and Industrial Floor Space Utilization Survey.
Unit Flow Factor of Staff	0.280m^3/day/staff	The unit flow factor for employees of "J4 Wholesale & Retail" given in Table T-2 of GESF + that for commercial employee.
Generation from Restaurant Staff of Commercial Complex		
Total Area	2,350m^2	As advised by the Applicant.
No. of Staff	120	Worker density by All Type for "Restaurants" is 5.1 staff in 100m^2 as stated in Table 8 of Commercial and Industrial Floor Space Utilization Survey.
Unit Flow Factor of Staff	1.580m^3/day/staff	The unit flow factor for employees of "J10 Restaurants & Hotels" + that for commercial employee given in Table T-2 of GESF. For J10, the "per-employee" unit flow factor takes into account the flows of customers and/or tenants.

PARAMETER	VALUE	REMARK
Generation from Swimming Pool of Clubhouse		
Total Area	525m^2	The tentative design of the swimming pool is provided by the Applicant.
Water Depth of Swimming Pool	1.25 m	As advised by the Applicant.
Time for Completely Changing Water	6 hours	CAP 132CA Swimming Pools Regulation.
Filtration Rate	40 m^3/m^2-hour	The average high rate filtration for domestic pool [Note 2]
Backwash Rate	0.81 m^3/m^2-min	The maximum typical backwash rate for combined air-water backwash [Note 3]
Others		
Catchment Inflow Factor	1.0	Catchment inflow factor for North District is adopted as stated in Table T-4 of GESF.
Peaking Factor	8 for contributing population <1,000 6 for contributing population from 1,000 to 5,000 5 for contributing population from 5,000 to 10,000	Peaking factor (including stormwater allowance) for sewers is adopted as stated in Table T-5 of GESF.

3.1.2 Note:

1. Residential Density Zone R1 is with a maximum domestic plot ratio of 6 to 8 in most of the new towns except Tsuen Wan while R2 is with a maximum domestic plot ratio of 6 in accordance with Table 2 of Chapter 2 of the *Hong Kong Planning Standards and Guidelines* ("HKPSG"). Because the domestic plot ratio of the Proposed Development is 6.50 as mentioned in Table 3 of the Planning Statement, the Unit Flow Factor of 0.190m^3/person/day for Private R1 in Table T-1 of GESF should be adopted.
2. The average high-rate filtration for domestic pool in Plumbing Engineering Services Design Guide - Domestic Swimming Pool
3. Wastewater Engineering - Treatment, Disposal, Reuse, 4th ed., Metcalf and Eddy

3.2 Results and Discussion

3.2.1 Sewage generation from operation of the Proposed Development and also the upstream and downstream catchments has been calculated. A layout plan showing the catchment areas is detailed in ***Appendix A*** and sewage generation calculations are provided in ***Appendix B***. The capacity of the existing municipal sewerage system between adjacent upstream and downstream manholes has been evaluated in ***Appendix C***.

3.2.2 As shown in ***Appendix B***, the total estimated Average Dry Weather Flow ("ADWF") from the Proposed Development is calculated to be 2,153.9m^3/day during operation, which will be discharged to Manhole FMH1003632 and flow through the existing sewer of 525mm diameter beneath Sha Tau Kok Road (Lung Yeuk Tau).

3.2.3 Sewage from other properties/uses upstream and downstream discharged to the sewerage system between Manhole FMH1003635 to FMH1003622 have been taken into account in the evaluation. As shown in ***Appendix C***, the utilisation of public submain sewers from Manholes

FMH1003632 to FMH1003623 are insufficient for the Proposed Development and upstream catchments. Mitigation measure shall be implemented to alleviate the potential impact on the existing municipal sewerage system resulting from the Proposed Development. The public submain sewers to be under surcharged are summarised in ***Table 3-2***.

Table 3-2: Utilisations between Manholes FMH1003632 and FMH1003623

MANHOLE		LEVEL (OUT), mPD	LEVEL (IN), mPD	LENGTH, m	PIPE DIAMETER, mm	% OF CAPACITY USED
FROM	TO					
FMH1003632	FMH1003631	9.83	9.73	23	0.525	106.3%
FMH1003631	FMH1003630	9.73	9.64	23.2	0.525	112.7%
FMH1003630	FMH1003628	9.64	9.55	28.8	0.525	125.5%
FMH1003628	FMH1003627	9.55	9.43	24.1	0.525	100.3%
FMH1003627	FMH1003624	9.43	9.31	28.8	0.525	109.8%
FMH1003624	FMH1003623	9.31	9.18	33.2	0.525	133.6%

Proposed Mitigation Measure – Upgrading Sewer Size

3.2.4 In order to mitigate the adverse sewerage impact, the sewer sections with insufficient capacity shall be upgraded as far as practicable, subject to liaison with relevant Authorities in the detailed design stage. Indicatively, the concerned sewers would be upgraded from the current 525mm Ø pipe to 600mm Ø or 625mm Ø pipe. The proposed upgrading works are shown in ***Table 3-3***.

Table 3-3: Utilisations between Manholes FMH1003632 and FMH1003623 with Proposed Sewerage System Upgrading Works

MANHOLE		LEVEL (OUT), mPD	LEVEL (IN), mPD	LENGTH, m	PIPE DIAMETER, mm	% OF CAPACITY USED
FROM	TO					
FMH1003632	FMH1003631	9.83	9.73	23	0.600	74.4%
FMH1003631	FMH1003630	9.73	9.64	23.2	0.600	78.8%
FMH1003630	FMH1003628	9.64	9.55	28.8	0.600	87.8%
FMH1003628	FMH1003627	9.55	9.43	24.1	0.600	70.2%
FMH1003627	FMH1003624	9.43	9.31	28.8	0.600	76.8%
FMH1003624	FMH1003623	9.31	9.18	33.2	0.625	83.9%

3.2.5 After the implementation of the mitigation measure, upgrading sewer size, the utilisations of public submain sewers from Manholes FMH1003632 to FMH1003623 are sufficient for the Proposed Development, upstream and downstream catchments. There is a range of 48% to 87.8% of the design capacity when taking into consideration the sewage contributed by the Proposed Development as well as from the upstream catchments. This shows that less than 100% of the available capacity will be used and so there will be no unacceptable impact on the existing municipal sewerage system resulting from the Proposed Development.

3.2.6 The design and construction of the sewers/manholes to be upgraded will be provided to the satisfaction of relevant government department(s) in detail design stage. The upgraded sewers/manholes will be handed over to DSD for maintenance.

3.2.7 Therefore, the sewerage analysis indicates there will be no unacceptable impact on the existing municipal sewerage system under the worst-case scenario of existing flows and the peak sewage discharge from the Proposed Development.

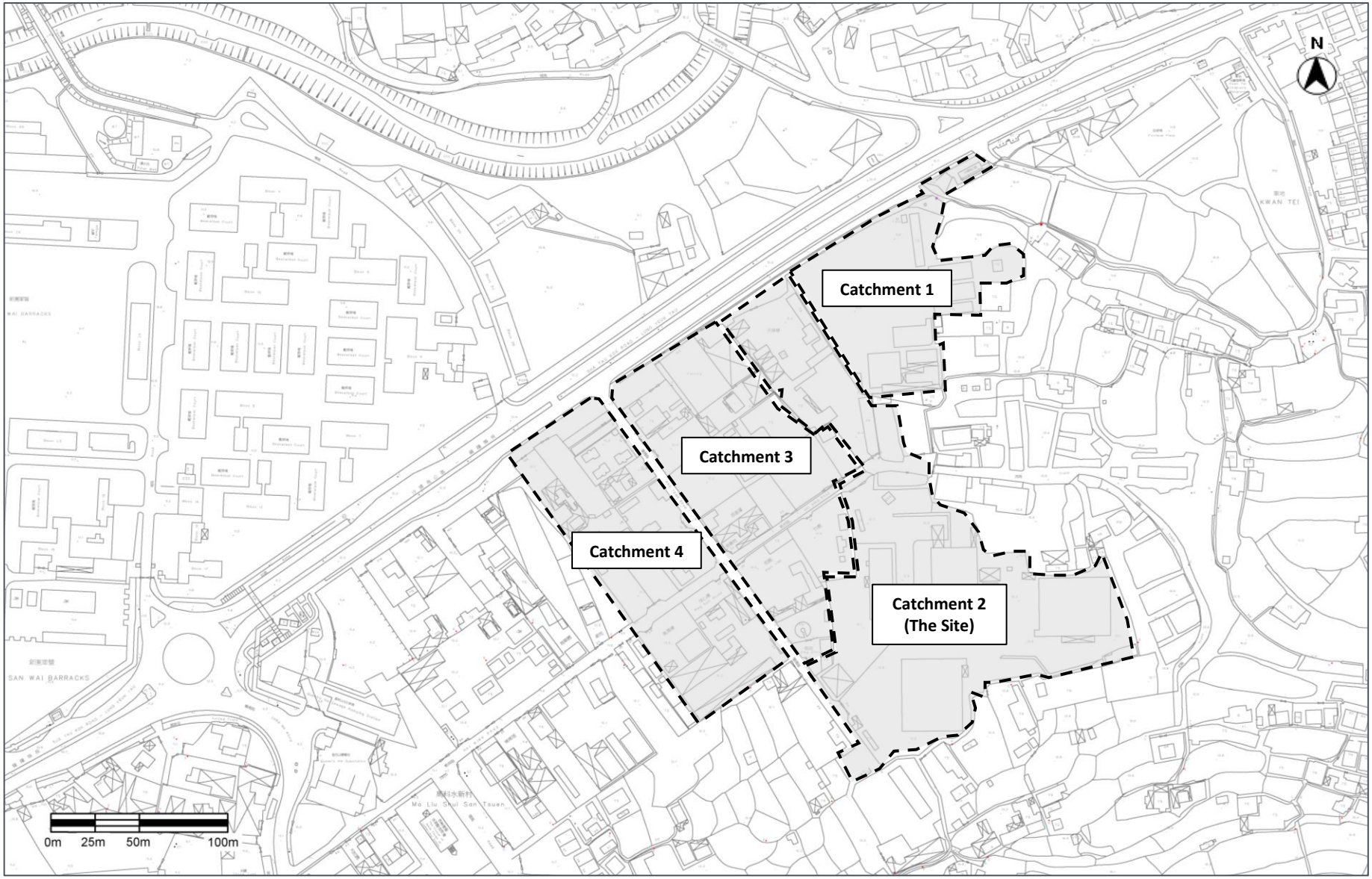
4 CONCLUSION

4.1.1 Potential sewerage impacts arising from the Proposed Development have been assessed. Sewage generated from the Proposed Development will be collected and conveyed to the public sewerage system at Manhole FMH1003632 underneath Sha Tau Kok Raod (Lung Yeuk Tau).

4.1.2 The total estimated Average Daily Dry Weather (ADWF) flow from the Proposed Development is about (i.e. 2,153.9m^3/day). The utilisations between Manholes FMH1003632 to FMH1003623 ranged between 48% and 133.6% of the available sewerage capacity, when taking into consideration the sewage contributed by the Proposed Development and also the upstream and downstream catchments. This shows that there may be insufficient capacity from Manhole FMH1003632 to FMH1003623. Mitigation measure shall be provided to alleviate impact on the existing municipal sewerage system resulting from the Proposed Development.

4.1.3 To mitigate the adverse sewerage impact, the sewer sections with insufficient capacity should be upgraded as far as practicable, subject to liaison with relevant Authorities in the detailed design stage. Indicatively, the concerned sewer would be upgraded from the current 525mm Ø pipes to 600mm Ø or 625mm Ø pipes. The sewerage analysis indicates there will be no unacceptable impact on the existing downstream sewerage system for existing flows and the peak sewage discharge from the Proposed Development at the Site after upgrade of the sewerage system.

Appendix A LOCATION PLAN OF CATCHMENT AREA


N
Catchment 1
Catchment 3
Catchment 4
Catchment 2
(The Site)
0m 25m 50m 100m

Appendix B CALCULATION OF SEWAGE GENERATION DURING OPERATION OF THE PROPOSED DEVLOPMENT

Calculation of Sewage Generation from the Proposed Development, Upstream and Downstream Catchments				Remarks/ Justification
Catchment 1				
1a) Sha Tau Kok Road Ma Liu Shui San Tsuen Pumping Station				
Average daily flow of the pumping station	=	2064	m^3/day	As advised by DSD.
1b) Tung Chun Soy Sauce & Canned Food Company Limited				
Usable floor area	=	1475	m^2	Based on estimation from survey map.
Staff occupancy density	=	40	m^2/staff	Worker Density Industry Group (Flatted Factories) for "Manufacturing" is 2.5 staff in 100m^2 as stated in Table 8 of ref. 1.
No. of staff	=	37	staff	
Unit Flow Factor (UFF) per staff	=	0.63	m^3/day/staff	Unit flow factor for "Industrial Employee + J1 Manufacturing (North District)" in Table T-3 of ref. 2.
Estimated total average daily dry weather flow rate	=	23.3	m^3/day	
Total average daily dry weather flow rate of Catchment 1	**=**	**2087.3**	**m^3/day**	
Catchment 2 - Proposed Development				
2a) Sewage generated by the Residential Development				
i. Sewage generated by Residents of the Residential Development				
No. of Flats	=	3305	flats	As advised by the Applicant.
Total population in Proposed Residential Development	=	9915	persons	As advised by the Applicant.
Unit Flow Factor (UFF) per resident	=	0.19	m^3/day/person	Unit flow factor for Private R1 type in Table T-1 of Ref. 2.
Total Sewage Generation by the Residents of the Residential Development	=	1883.9	m^3/day	
ii. Sewage generated by Staff of the Residential Development				
Total Gross Floor Area (GFA) of non-domestic portion of Residential Development	=	3595	m^2	As advised by the Applicant.
Staff occupancy density	=	30.3	m^2/staff	Worker density Industry Group (All Type) for "Community, Social & Personal Services" is 3.3 staff in 100m^2 as stated in Table 8 of ref. 1.
No. of Onsite Staff (e.g. security, management office, clubhouse etc.)	=	119	staff	
Unit Flow Factor (UFF) per staff	=	0.28	m^3/day/staff	Refer to "Commercial Employee" + J11 "Commerical, Social & Personal Services" of Table T-2 of Ref 2.
Total Sewage Generation by the Staff of the Residential Development	=	33.32	m^3/day	
Total Sewage Generation by Residents and Staff for the Proposed Residential Development	**=**	**1917.2**	**m^3/day**	
2b) Sewage generated by the Commercial Complex				
i. Sewage generated by Staff of Retail Shops of the Commercical Complex				
Total Gross Floor Area (GFA) of Retail Shops of the Commercial Complex	=	3220	m^2	As advised by the Applicant.
Staff occupancy density	=	28.6	m^2/staff	Worker density Industry Group (All Type) for "Retail Trade" is 3.5 staff in 100m^2 as stated in Table 8 of ref. 1.
No. of Staff of Retail Shops	=	113	staff	
Unit Flow Factor (UFF) per staff	=	0.28	m^3/day/staff	Unit flow factor for "Commercial Employee + J4 Wholesale & Retail" in Table T-2 of ref. 2.
Total Sewage Generation by the Staff of Retail Shops of the Commercial Complex	=	31.6	m^3/day	
ii. Sewage generated by Staff of Restaurants of the Commercical Complex				
Total Gross Floor Area (GFA) of Restaurants of the Commercial Complex	=	2350	m^2	As advised by the Applicant.
Staff occupancy density	=	19.6	m^2/staff	Worker density Industry Group (All Type) for "Restaurants" is 5.1 staff in 100m^2 as stated in Table 8 of ref. 1.
No. of Staff of Retail Shops	=	120	staff	
Unit Flow Factor (UFF) per staff	=	1.58	m^3/day/staff	Unit flow factor for "Commercial Employee + J10 Restaurants & Hotels" in Table T-2 of ref. 2.
Total Sewage Generation by the Staff of Restaurants of the Commercial Complex	=	189.6	m^3/day	
Total Sewage Generation by Staff of the Commercial Complex	**=**	**221.2**	**m^3/day**	
2c) Wastewater generated from Swimming Pool in the Clubhouse				
Approximate Area of Swimming Pool	=	525.4	m^2	Based on estimation from survey map.
Average Water Depth of Swimming Pool	=	1.25	m	As advised by the Applicant.
Approximate Size of Swimming Pool	=	656.7	m^3	
Time for Completely Changing Water	=	6	hours	The minimum turnover time in ref. 3.
Turnover Rate	=	109.5	m^3/hour	
Filtration Rate	=	40	m^3/m^2-hour	The average high rate filtration for domestic pool in ref. 4.
Filter Area	=	2.7	m^2	
Backwash Rate	=	0.81	m^3/m^2-min	The maximum typical backwash rate for combined air-water backwash in Table 11-12 of ref. 5.
Estimated flow from the Swimming Pool	**=**	**15.5**	**m^3/day**	7 minutes for cleaning the filter by backwashing water excluding the air scouring time is recommended in B8.5.5 of ref. 6.
Total sewage generated from Catchment 2 (Proposed Development)	**=**	**2153.9**	**m^3/day**	

Catchment 3				
3a) Low-rise residential buildings/ Village houses				
No. of Residential Buildings	=	5	buildings	Park Villa, King Chong, 4 Dao Yang Road, 26 and 31 Hai Wing Road, and temporay structures.
No. of Flats	=	15	flats	Assumed 3 units per building.
No. of Residents	=	41	persons	Average domestic household size of 2.7 for Queen's Hill District from 2021 population by-census.
Unit Flow Factor (UFF) per resident	=	0.37	m^3/day/person	Unit flow factor for Private R3 type in Table T-1 of Ref. 2.
Estimated total average daily dry weather flow rate	=	15.17	m^3/day	
3b) Shun Cheong Electrical Products Factory Limited				
Usable floor area	=	1834	m^2	Based on estimation from survey map.
Staff occupancy density	=	40	m^2/staff	Worker Density Industry Group (Flatted Factories) for "Manufacturing" is 2.5 staff in 100m^2 as stated in Table 8 of ref. 1.
No. of staff	=	46	staff	
Unit Flow Factor (UFF) per staff	=	0.63	m^3/day/staff	Unit flow factor for "Industrial Employee + J1 Manufacturing (North District)" in Table T-3 of ref. 2.
Estimated total average daily dry weather flow rate	=	29.0	m^3/day	
Total average daily dry weather flow rate of Catchment 3	**=**	**44.2**	**m^3/day**	
Catchment 4				
4a) Low-rise residential buildings/ Village houses				
No. of Residential Buildings	=	7	buildings	Ping Sum House, 19 - 21 Dao Yang Road, 34 Hai Wing Road
No. of Flats	=	21	flats	Assumed 3 units per building.
No. of Residents	=	57	persons	Average domestic household size of 2.7 for Queen's Hill District from 2021 population by-census.
Unit Flow Factor (UFF) per resident	=	0.37	m^3/day/person	Unit flow factor for Private R3 type in Table T-1 of Ref. 2.
Estimated total average daily dry weather flow rate	=	21.1	m^3/day	
Total average daily dry weather flow rate of Catchment 4	**=**	**21.1**	**m^3/day**	

Note:

1 Commercial and Industrial Floor Space Utilization Survey, Planning Department, 2005
2 Environmental Protection Department (EPD) publication Guidelines for Estimating Sewage Flows (GESF) for Sewage Infrastructure Planning Version 1.0, March 2005.
3 CAP 132CA Swimming Pools Regulation
4 Plumbing Engineering Services Design Guide - Domestic Swimming Pool
5 Wastewater Engineering - Treatment, Disposal, Reuse, 4th ed., Metcalf and Eddy
6 General Specification for Swimming Pool Water Treatment Installation in Government Buildings of HKSAR, 2012 ed., Architectural Services Department

Appendix C CALCULATION OF FLOW CAPACITY

Pipe Segment between Manholes		Sewer ID	Length	Level (Out)	Level (In)	d	r	A_w	P_w	R	s	k_s	V	Q_C	ADWF	P_c	P	Q_p	Catchment	Is $Q_c > Q_p$?	% of capacity
			m	mPD	mPD	m	m	m^2	m	m	-	mm	m/s	m^3/s	m^3/day			m^3/s		Y/N	%
FMH1003635	FMH1003634	FWD1004188	30.8	10.19	10.07	0.525	0.263	0.216	1.649	0.131	0.004	3	1.125	0.219	2087.31	7731	5	0.121		Y	55.3%
FMH1003634	FMH1003633	FWD1004187	30.4	10.07	9.95	0.525	0.263	0.216	1.649	0.131	0.004	3	1.130	0.220	2087.31	7731	5	0.121	Catchment 1	Y	55.0%
FMH1003633	FMH1003632	FWD1004186	23.2	9.95	9.83	0.525	0.263	0.216	1.649	0.131	0.005	3	1.294	0.252	2087.31	7731	5	0.121		Y	48.0%
FMH1003632	FMH1003631	FWD1004185	23.0	9.83	9.73	0.525	0.263	0.216	1.649	0.131	0.004	3	1.187	0.231	4241.24	15708	5	0.245		N	106.3%
FMH1003631	FMH1003630	FWD1004184	23.2	9.73	9.64	0.525	0.263	0.216	1.649	0.131	0.004	3	1.120	0.218	4241.24	15708	5	0.245	Catchment 1 to Catchment 2	N	112.7%
FMH1003630	FMH1003628	FWD1004183	28.8	9.64	9.55	0.525	0.263	0.216	1.649	0.131	0.003	3	1.006	0.196	4241.24	15708	5	0.245		N	125.5%
FMH1003628	FMH1003627	FWD1004181	24.1	9.55	9.43	0.525	0.263	0.216	1.649	0.131	0.005	3	1.271	0.247	4285.39	15872	5	0.248		N	100.3%
FMH1003627	FMH1003624	FWD1004180	28.8	9.43	9.31	0.525	0.263	0.216	1.649	0.131	0.004	3	1.162	0.226	4285.39	15872	5	0.248	Catchment 1 to Catchment 3	N	109.8%
FMH1003625	FMH1003624	FWD1004178	20.2	9.84	9.44	0.225	0.113	0.040	0.707	0.057	0.020	3	1.442	0.052	747.53	2769	5	0.052	Full bore	Y	100.0%
FMH1003624	FMH1003623	FWD1004177	33.2	9.31	9.18	0.525	0.263	0.216	1.649	0.131	0.004	3	1.126	0.219	5054.01	18719	5	0.292		N	133.6%
FMH1003623	FMH1003622	FWD1004176	33.2	9.03	8.89	0.675	0.338	0.358	2.121	0.169	0.004	3	1.377	0.444	5054.01	18719	5	0.292	Catchment 1 to Catchment 4	Y	65.9%

Legend

d = pipe diameter, m

r = pipe radius (m) = 0.5d

A_w = wetted area (m^2) = πr^2

P_w = wetted perimeter (m) = $2\pi r$

s = Slope of the total energy line

R = Hydraulic radius (m) = A_w/P_w

s = Slope of the total energy line

k_s = hydraulic pipeline roughness, mm

V = Velocity of flow calculated based on Colebrook-White Equation, m/s

Q_c = Flow Capacity (10% sedimentation incorporated), m^3/s

Q_p = Estimated total peak flow from the Site during peak season, m^3/s

P_c = Contributing Population = ADWF/0.27

P = Peaking Factor (including stormwater allowance) for facility with existing upstream sewerage

ADWF = Total average dry weather flow, m^3/day

Note

1. Whilst sewage generation from the Site is estimated based on the *"Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Version 1.0"* (published by the Environmental Protection Department (EPD), 2005) using the best available information, the flow capacities of pipe segments are calculated based on Colebrook-White Equation.
2. The roughness value is referred to Table 5 of the *"Sewerage Manual, Key Planning Issues and Gravity Collection System"* published by the Drainage Services Department (DSD). It is assumed that the materials adotped for the sewer pipe is concrete with velocity when flowing half full approximately of 1.2 m/s in poor condition, therefore the roughness values Ks = 3 mm.
3. The invert and outlet level is ndicative only, it would subject to Drainage Proposal in the detailed design stage.

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