Appendix F

Sewerage Impact Assessment

Prepared for

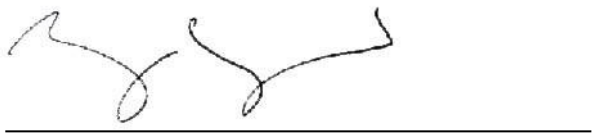
Wing Mau Tea House Limited

Prepared by

Ramboll Hong Kong Limited

PROPOSED REZONING FROM "RESIDENTIAL (GROUP B)1" ZONE TO "RESIDENTIAL (GROUP B)4" ZONE FOR MEDIUM-DENSITY HOUSING DEVELOPMENT TO INCLUDE A FOOTPATH FOR PUBLIC USE AT VARIOUS LOTS AND ADJACENT GOVERNMENT LAND IN DD130, LAM TEI, TUEN MUN

SEWERAGE IMPACT ASSESSMENT

Date	**11 January 2024**
Prepared by	**Ken Li** **Environmental Consultant**
Signed	
Approved by	**Katie Yu** **Senior Manager**
Signed	
Project Reference	**FECLTS12EI00**
Document No.	**R9117_v2.1.docx**

Ramboll Hong Kong Limited

21/F, BEA Harbour View Centre
56 Gloucester Road, Wan Chai, Hong Kong

Tel: (852) 3465 2888
Fax: (852) 3465 2899
Email: hkinfo@ramboll.com

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CHAPTERS

TABLES

FIGURES

APPENDICES

1. INTRODUCTION

1.1 Background and Objectives

1.1.1 The Application Site is located at various lots and adjoining government land in D.D.130, Lam Tei, Tuen Mun.

1.1.2 In order to confirm the environmental feasibility of the Proposed Development, Ramboll Hong Kong Limited is commissioned to conduct the Sewerage Impact Assessment based on the information of the Proposed Development.

1.2 Application Site and its Environ

1.2.1 With a development area of 8,896m^2 and zoned as Residential (Group B) 1" (R(B)1) zone, the Application Site is currently a vacant site situated at D.D. 130, Lam Tei bounded by the Castel Peak Road - Lam Tei to the east separated by the Tuen Ma Line viaduct and LRT tracks. Existing residential development, Lingrade Garden, is located to the north of the Application Site. Some temporary carpark, open storage and village houses are located to the west of the site separated by a nullah.

1.2.2 **Figure 1.1** shows the location of the Application Site and its environ.

1.3 Proposed Development

1.3.1 The Proposed Development consists of 5 residential towers ranging from 14 storeys to 27 storeys. A clubhouse is situated below Tower 1 and Tower 3. The number of storeys and building height information of the residential towers are as follow:

- Tower 1: 27 storeys (+107.8 mPD)
- Tower 2: 27 storeys (+107.8 mPD)
- Tower 3: 16 storeys (+66.8 mPD)
- Tower 4: 14 storeys (+59.8 mPD)
- Tower 5: 24 storeys (+94.8 mPD)

1.3.2 The total numbers of units are 1,385 units with a proposed domestic GFA of 44,480m^2 (PR5.0). Detailed plans of the Proposed Development are presented in **Appendix 1.1**.

2. SEWERAGE IMPACT ASSESSMENT

2.1 Scope of Work

2.1.1 The Application site is currently vacant and there is no public sewer network serving the Application Site and the surrounding environment due to the isolation by a nullah.

2.1.2 The aim of this study is to evaluate the sewage flow generated from the Proposed Development and assess whether there is adverse sewerage impacts to the surrounding environment.

2.2 Assessment Criteria and Methodology

2.2.1 The Commercial and Industrial Floor Space Utilization Survey (CIFSUS) conducted by the Planning Department has been used to determine the worker density for various economic activities and planned usage types.

2.2.2 Environmental Protection Department's (EPD's) Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning, Version 1 (GESF) is referred to estimate the quantity of the sewage generated from the Proposed Development and the existing development. Sewage flow parameters and global peaking factors in this document are adopted.

2.2.3 According to the Table T-1 of the said EPD Guideline, the unit flow factor (UFF) of resident (Private R2) is 0.27 m^3/day, while the UFF for employees for the clubhouse is 0.28m^3/day.

2.3 Existing Condition

2.3.1 Currently, there are no public sewerage facilities in the vicinity of the Application Site and the extension of the public sewerage system to Application Site is unlikely as the Application Site is separated from the nearest sewerage manhole by a nullah. It will therefore be necessary to provide on-site treatment facilities before discharging the treated effluent into the nearby nullah.

2.4 Future Estimated Flow

2.4.1 Under the current scheme, the Proposed Development will consist of 1,385 residential units, a clubhouse with a size of 2,002 m^2 and two swimming pools with an area of 48m^2 and 108m^2 respectively. Based on such design parameters, the Average Dry Weather Flow (ADWF) excluding the backwash of the swimming pools is estimated to be 1,028.2 m^3/day, as tabulated in **Table 2.1** below and **Appendix 2.1**.

Table 2.1 Estimated Sewage Flow from the Proposed Development

			Remarks
Residential Use			
Total number of residential units	=	1,385	
Total number of residents	=	3,740	people (average household size of 2.7 is assumed)
Design flow	=	270	litre/person/day -- (Private R2 in Table T-1 of GESF)
Sewage Generation Rate	=	1,009.7	m^3/day
Clubhouse			

			Remarks
Total GFA	=	2,002	m^2
Assumed floor area per employee	=	30.3	m^2 per employee -- (refer to Table 8 of CIFSUS - Community, Social & Personal Services)
Total number of employees		66	employees
Design flow	=	280	litre/employee/day -- (refer to Table T-2 of GESF - J11 Community, Social & Personal Services)
Sewage Generation Rate	=	18.5	m^3/day
Proposed Adult Swimming Pool			
Assumed area of swimming pool	=	108	m^2
Average depth of water		1.2	m
Volume of swimming pool	=	129.6	m^3
Turnover rate	=	6	hr
Surface loading rate of filter	=	50	$m^3/m^2/hr$
Filter areas required		0.4	m^2 (Volume of Swimming Pool/Turnover Rate/ Surface Loading Rate of Filter)
Backwash duration	=	30	min/d
Backwash flow rate	=	30	$m^3/m^2/hr$
Design flow for swimming pool backwashing	=	6.5	m^3/day (Backwash flow rate x Filter areas required x Backwash duration)
Design flow for swimming pool backwashing	=	0.08	litre/sec
Proposed Children Swimming Pool			
Assumed area of swimming pool	=	48	m^2
Average depth of water		1.2	m
Volume of swimming pool	=	57.6	m^3
Turnover rate	=	6	hr
Surface loading rate of filter	=	50	$m^3/m^2/hr$
Filter areas required		0.2	m^2

			Remarks
			(Volume of Swimming Pool/Turnover Rate/ Surface Loading Rate of Filter)
Backwash duration	=	30	min/d
Backwash flow rate	=	30	$m^3/m^2/hr$
Design flow for swimming pool backwashing	=	2.9	m^3/day (Backwash flow rate x Filter areas required x Backwash duration)
Design flow for swimming pool backwashing	=	0.03	litre/sec
Total Flow from the Proposed Development			
Flow Rate	=	1,028.2	m^3/day
Flow Rate with P_{CIF} (Tuen Mun – 1.1)	=	1131.0	m^3/day (refer to Table T-4 of GESF - Tuen Mun - 1.1)
Contributing Population	=	4189	people
Peaking factor	=	4.0	(refer to Table T-5 of GESF for a population of <10,000 incl. stormwater allowance)
Peak flow (excluding backwash of all pools)	=	52.4	litre/sec
Peak flow (including backwash of all pools)	=	52.5	litre/sec

2.5 Proposed Sewage Treatment Facility

2.5.1 As the Application Site is not served by public sewerage system currently, it is proposed to provide on-site sewage treatment to ensure sewage can be discharged in a proper manner. Once public sewerage system is connected to the Application Site, the sewage flow from the proposed development may be discharged to the public sewerage system in the future.

2.5.2 The use of Sewage Treatment Plant (STP) is recommended for the Proposed Development. The "Guidelines for the Design of Small Sewage Treatment Plants" published by the EPD for the design, construction, operation and maintenance of STP should be followed. The effluent should be treated to acceptable standards as stated in "Technical Memorandum Standards for Effluents Discharged into Drainage and Sewerage systems, Inland and Coastal waters". As the proposed development have a population of more than 2,000, the Applicant will approach EPD to discuss the design of the STP during detailed design stage.

2.5.3 Suitable treatment for the sewage generated by the proposed development could practically be provided by a package treatment unit, i.e. treatment facilities which are supplied and installed as complete units, including all treatment stages. For example, one appropriate technology would be Membrane Bioreactor (MBR) units, followed by disinfection to achieve the required effluent standards. The treated effluent can then be discharged of into the drainage system. A sample of the MBR unit is enclosed in **Appendix 2.2**.

2.5.4 The design and operation of the STP will be in accordance with the "Guidelines for Design of Small Sewage Treatment Plants" published by the EPD, with adequate capacity to handle three times of ADWF. The area of the STP will be approximately 1,254m^2 occupying two basement floors. The treated effluent would then be discharged into a new drainage pipe connecting to the existing nullah to the west of the Application Site. **Figure 2.1** shows the indicative location of the on-site treatment plant and the capacity checking of the pipe discharging into the nullah is also presented in **Appendix 2.1**. The exact discharge location and pipe design will be subject to further study and agreed with EPD during detailed design stage.

2.5.5 The effluent generated from the Proposed Development will go through the process of disinfection to achieve the necessary discharge standards as set out in EPD's Technical Memorandum – Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (Table 10b – Standards for Effluents Discharged into the marine waters of Southern, Mirs Bay, Junk Bay, North Western, Eastern Buffer and Western Buffer Water Control Zone).

2.5.6 As a good practice for sewage treatment facilities, measures will be incorporated into the design to minimise the risk of emergency overflow from the treatment plant. These measures include standby pumps, secure power supplies, appropriate alarms, as well as comprehensive Operation and Maintenance procedures in order to keep the facilities in good working order.

2.5.7 The proposed on-site MBR will be fully enclosed with deodorising system, so that the noise and odour emitted from the plant will not have adverse impact upon the surrounding residents.

2.5.8 The project proponent will be responsible for the implementation and maintenance of the proposed STP and arrangement of the sludge from the proposed STP.

2.5.9 The detailed design and size of the MBR unit will be provided in later stage for EPD's approval.

3. CONCLUSION

3.1.1 A residential development is proposed for the Application Site at D.D.130 Lam Tei, Tuen Mun. The potential sewerage impact has been quantitatively addressed.

3.1.2 Since there is no public sewerage system available for the Proposed Development, on-site treatment will be required. Connection to the public sewer will be a long-term option after availability of trunk sewer connecting to the Application Site.

3.1.3 An on-site treatment with Membrane Bioreactor (MBR) will be used to treat effluent from the Proposed Development, discharge the treated effluent to the nearby nullah. Relevant statutory guidelines and regulations will be followed and detail design of the MBR unit will be provided in later stage.

3.1.4 With the sewage treatment plant and proper maintenance in place, it is concluded that the Proposed Development will not have any unacceptable adverse sewerage impact to the surrounding.

Figures

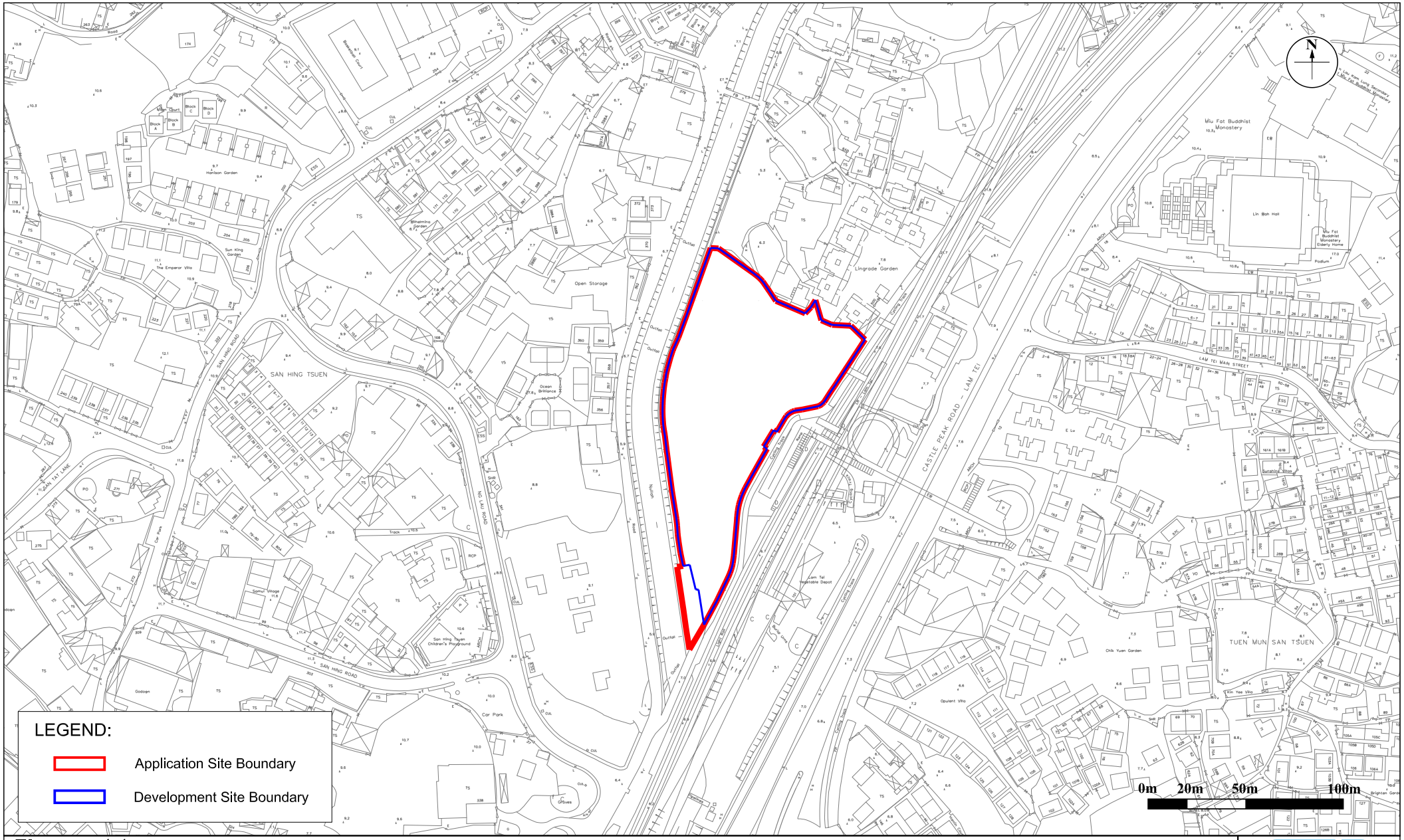


Figure: 1.1

Title: Location of Application Site and its Environ

Project: Proposed Rezoning from "Residential (Group B)1" Zone to "Residential (Group B)4" Zone for Medium-Density Housing Development to Include a Footpath for Public use at Various Lots and Adjacent Government Land in DD130, Lam Tei, Tuen Mun

RAMBOLL

Drawn by: KL

Checked by: KY

Rev.: 2.1

Date: Jan 2024

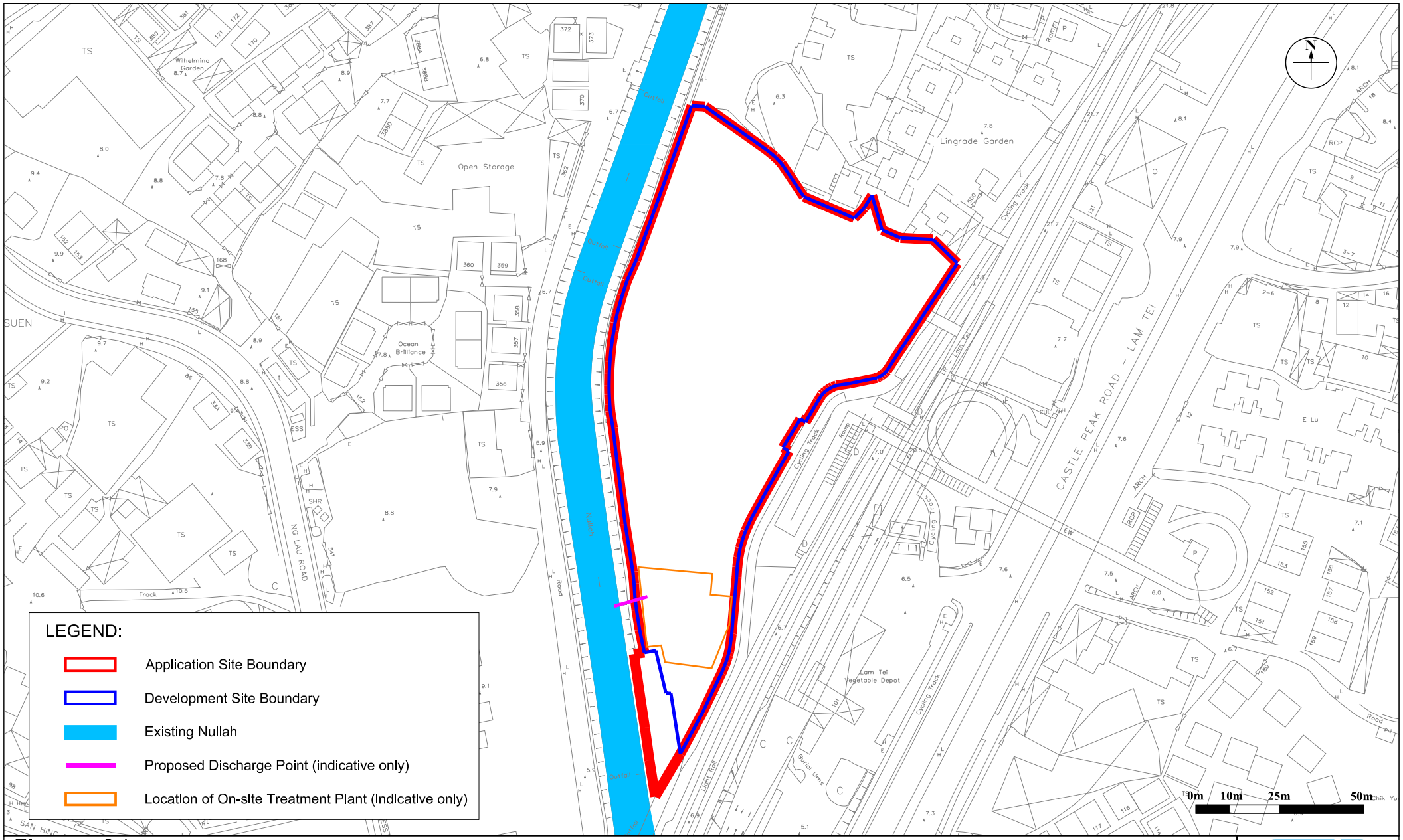


Figure: 2.1

Title: Proposed Discharge Location of Treated Sewage

Project: Proposed Rezoning from "Residential (Group B)1" Zone to "Residential (Group B)4" Zone for Medium-Density Housing Development to Include a Footpath for Public use at Various Lots and Adjacent Government Land in DD130, Lam Tei, Tuen Mun

RAMBOLL

Drawn by: KL

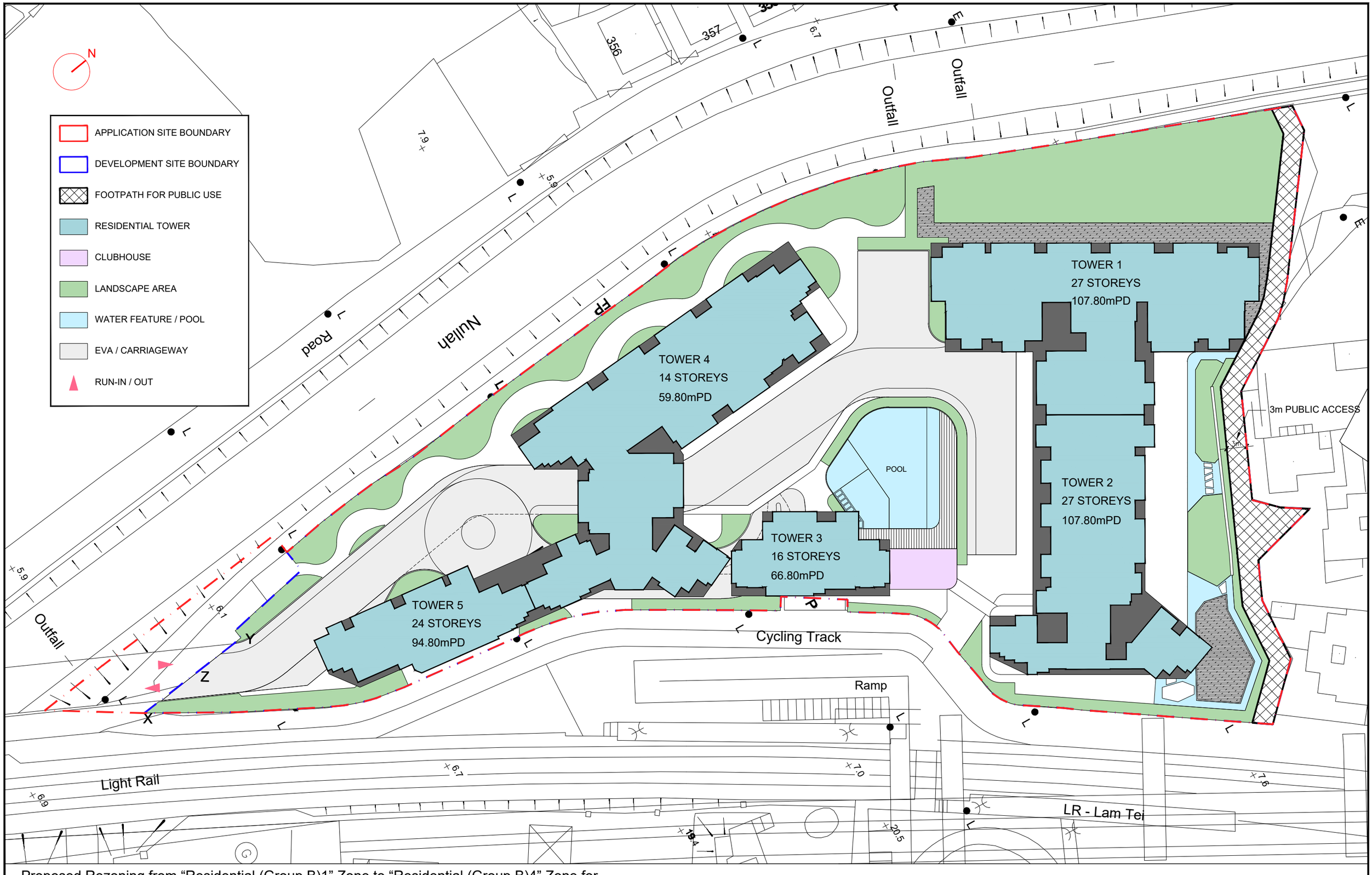
Checked by: KY

Rev.: 2.1

Date: Jan 2024

Appendix 1.1

Detailed Layout Plans of the Proposed Development



Proposed Rezoning from “Residential (Group B)1” Zone to “Residential (Group B)4” Zone for
Medium-Density Housing Development to Include a Footpath for Public Use at Various Lots and Adjacent Government Land in DD130, Lam Tei, Tuen Mun

MLP

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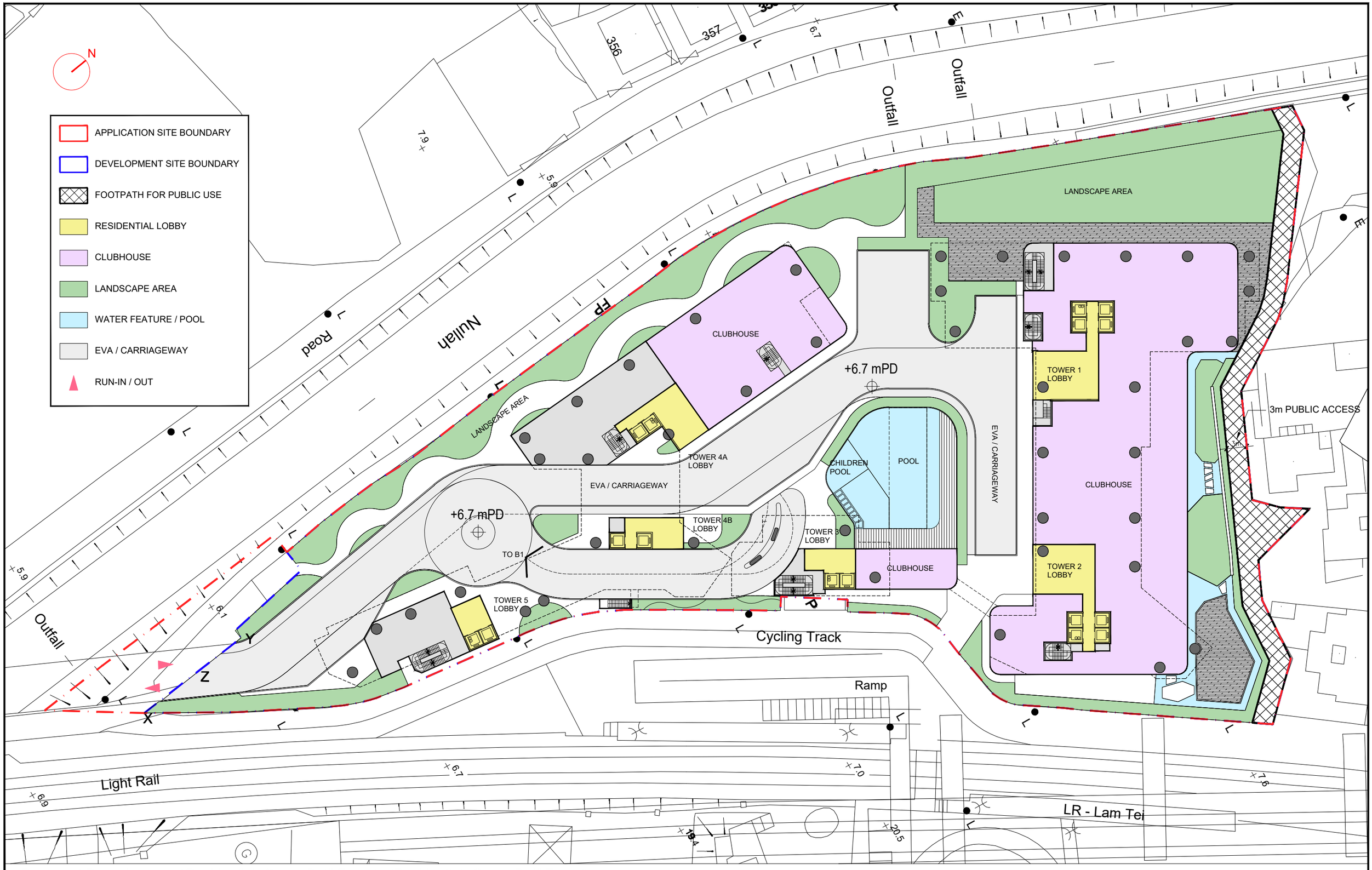
LWK +PARTNERS



Proposed Rezoning from “Residential (Group B)1” Zone to “Residential (Group B)4” Zone for
Medium-Density Housing Development to Include a Footpath for Public Use at Various Lots and Adjacent Government Land in DD130, Lam Tei, Tuen Mun

GROUND FLOOR

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LWK +PARTNERS

N

APPLICATION SITE BOUNDARY

DEVELOPMENT SITE BOUNDARY

FOOTPATH FOR PUBLIC USE

RESIDENTIAL LOBBY

LANDSCAPE AREA

WATER FEATURE / POOL

EVA / CARRIAGEWAY

RUN-IN / OUT

Nullah

Road

Outfall

Outfall

Outfall

TRANSFER PLATE

TRANSFER PLATE

TRANSFER PLATE

Cycling Track

Ramp

Light Rail

LR - Lam Tei

3m PUBLIC ACCESS

SKY GARDEN
CUM REFUGE
+11.7 mPD

Proposed Rezoning from “Residential (Group B)1” Zone to “Residential (Group B)4” Zone for
Medium-Density Housing Development to Include a Footpath for Public Use at Various Lots and Adjacent Government Land in DD130, Lam Tei, Tuen Mun

FIRST FLOOR

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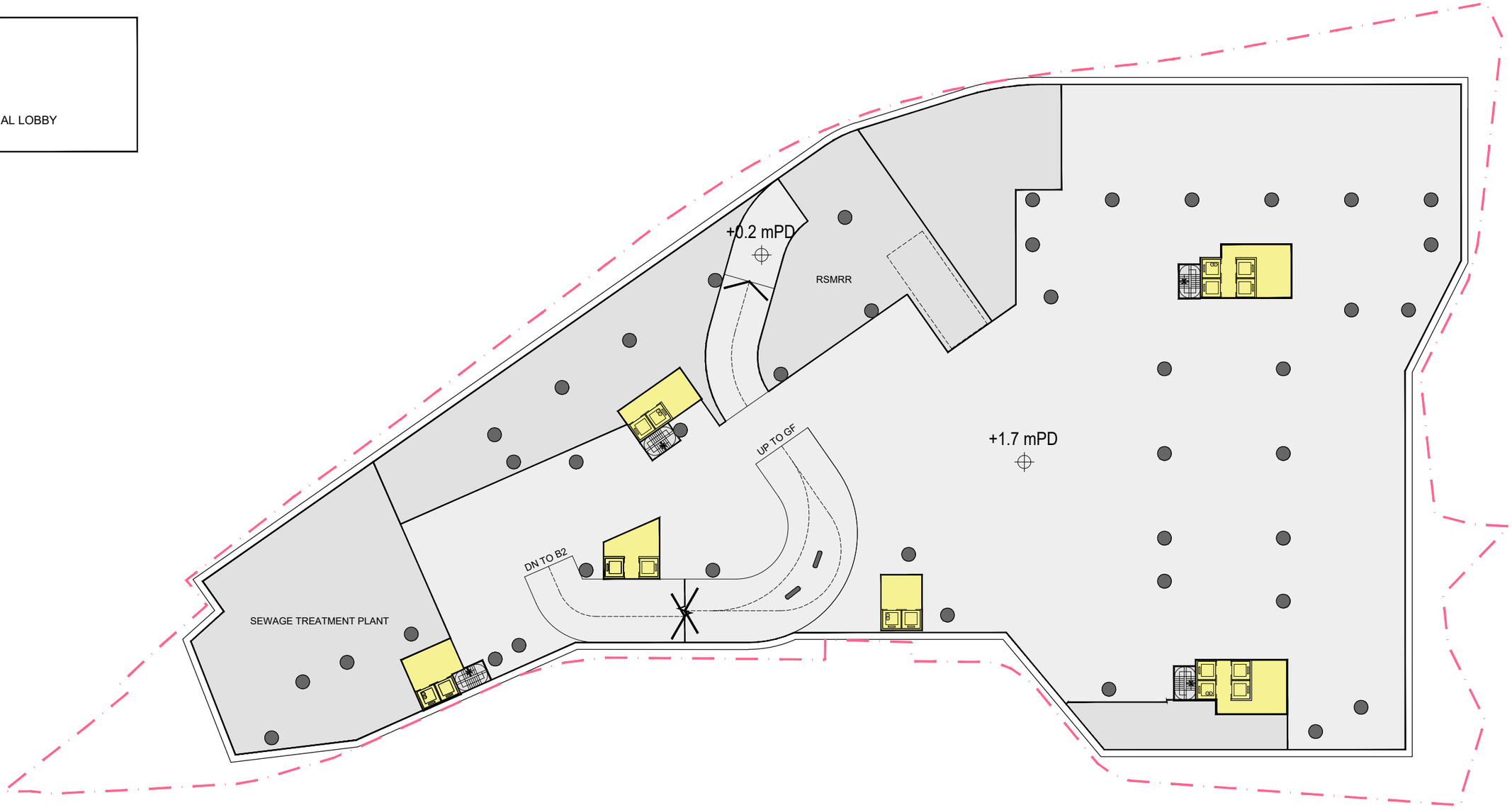
LWK
+PARTNERS

N

CARPARK

E & M

RESIDENTIAL LOBBY



Number of car parking spaces at B1: 119
Total number of car parking spaces: 247

Proposed Rezoning from “Residential (Group B)1” Zone to “Residential (Group B)4” Zone for
Medium-Density Housing Development to Include a Footpath for Public Use at Various Lots and Adjacent Government Land in DD130, Lam Tei, Tuen Mun

B1

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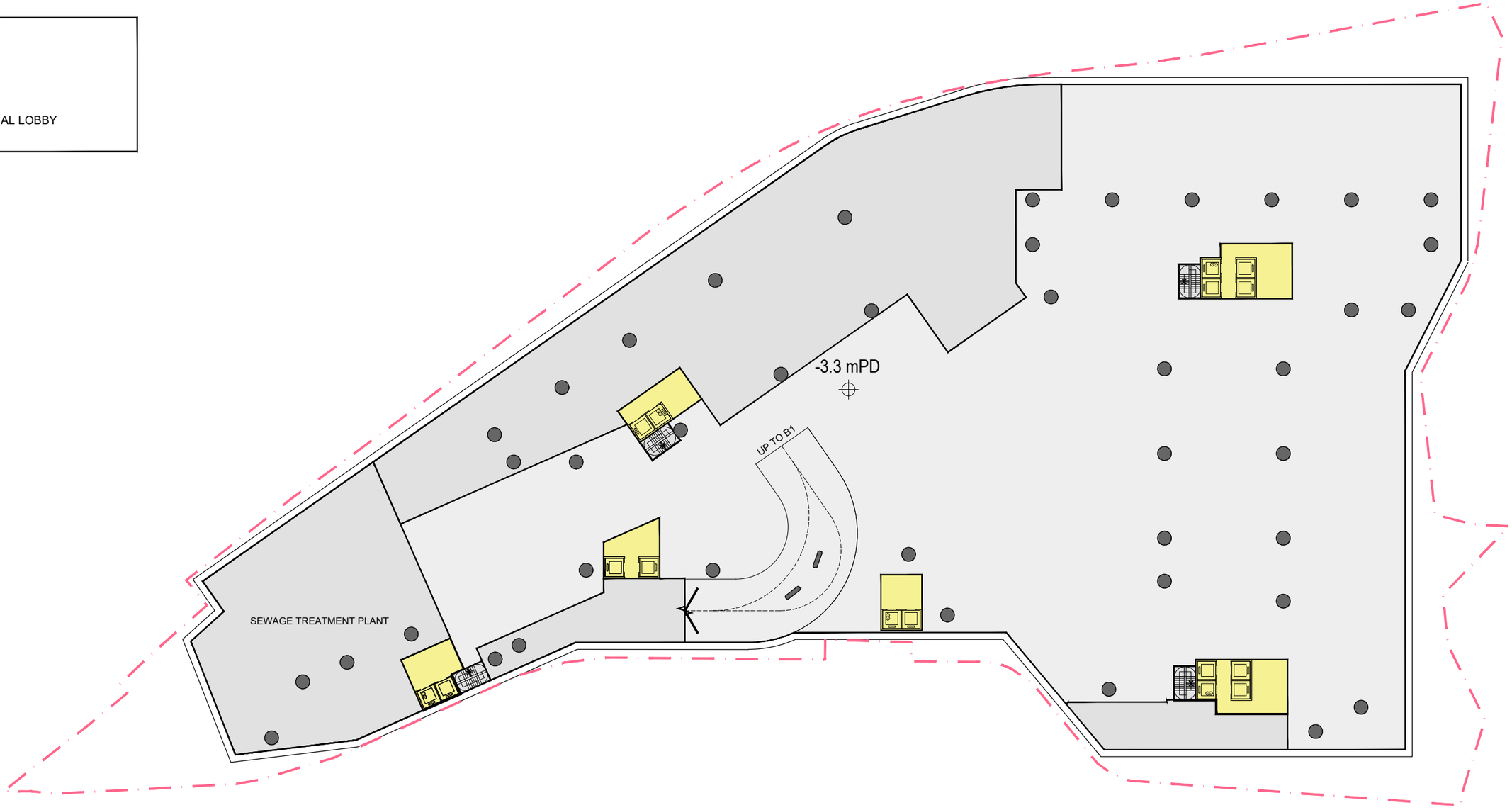
LWK + PARTNERS

N

CARPARK

E & M

RESIDENTIAL LOBBY



Number of car parking spaces at B1: 128
Total number of car parking spaces: 247

Proposed Rezoning from “Residential (Group B)1” Zone to “Residential (Group B)4” Zone for
Medium-Density Housing Development to Include a Footpath for Public Use at Various Lots and Adjacent Government Land in DD130, Lam Tei, Tuen Mun

B2

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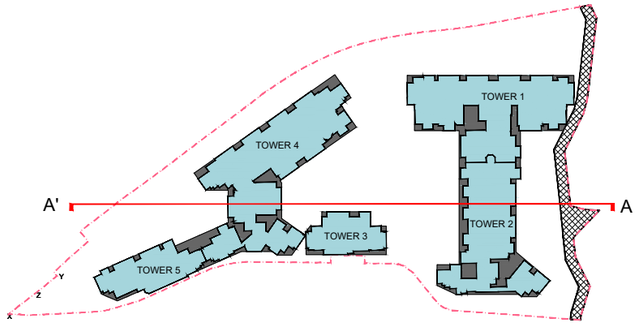
LWK + PARTNERS



Proposed Rezoning from “Residential (Group B)1” Zone to “Residential (Group B)4” Zone for
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SCHEMATIC SECTION - SECTION A-A'

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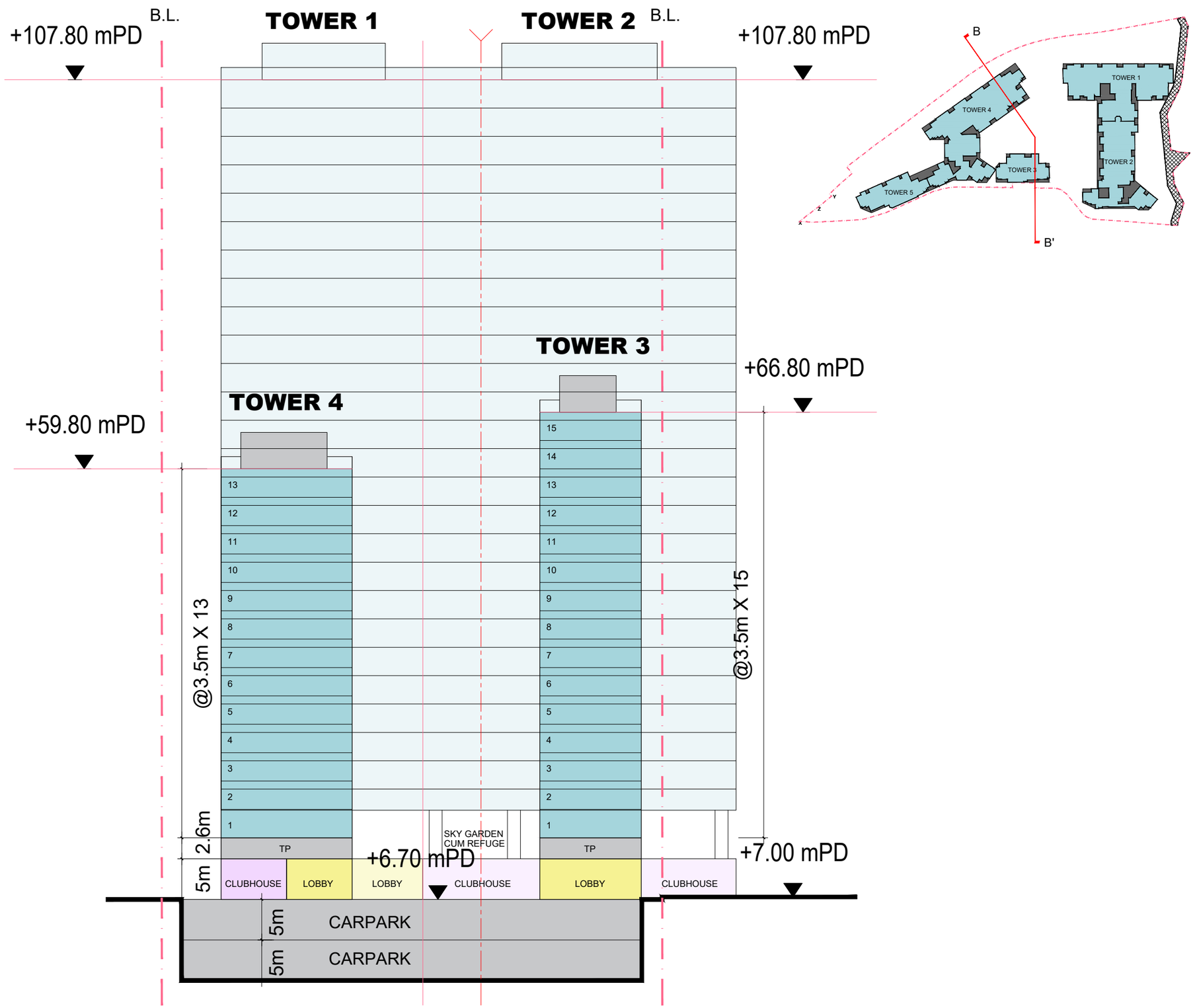
LWK + PARTNERS



Proposed Rezoning from “Residential (Group B)1” Zone to “Residential (Group B)4” Zone for
Medium-Density Housing Development to Include a Footpath for Public Use at Various Lots and Adjacent Government Land in DD130, Lam Tei, Tuen Mun

SCHEMATIC SECTION - SECTION B-B'

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LWK + PARTNERS

Appendix 2.1

Detailed Sewerage Impact Assessment Calculations

Table 1 Calculation for Sewage Generation Rate of the Proposed Development at the Application Site

Residential Units			
Total number of residential units	=	1,385	units
Total number of residents	=	3739.5	residents (2.7 people per flat is assumed)
Design flow	=	270	litre/person/day -- (Private R2 in Table T-1 of GESF)
Sewage generation rate	=	1,009.7	m^3/day
Clubhouse			
Total GFA	=	2,002	m^2
Assumed floor area per employee	=	30.3	m^2 per employee -- (refer to Table 8 of CIFSUS - Community, Social & Personal Services)
Total number of employees	=	66	employees
Design flow for employees	=	280	litre/employee/day -- (refer to Table T-2 of GESF - J11 Community, Social & Personal Services)
Sewage generation rate	=	18.5	m^3/day
Proposed Adult Swimming Pool			
Assumed area of swimming pool	=	108	m^2
Average depth of water	=	1.2	m
Volume of swimming pool	=	129.6	m^3
Turnover rate	=	6	hr
Surface loading rate of filter	=	50	$m^3/m^2/hr$
Filter areas required	=	0.4	m^2
Backwash duration	=	30	min/d
Backwash flow rate	=	30	$m^3/m^2/hr$
Design flow for swimming pool backwashing	=	6.5	m^3/day
Design flow for swimming pool backwashing	=	0.08	litre/sec
Proposed Children Swimming Pool			
Assumed area of swimming pool	=	48	m^2
Average depth of water	=	1.2	m
Volume of swimming pool	=	57.6	m^3
Turnover rate	=	6	hr
Surface loading rate of filter	=	50	$m^3/m^2/hr$
Filter areas required	=	0.2	m^2
Backwash duration	=	30	min/d
Backwash flow rate	=	30	$m^3/m^2/hr$
Design flow for swimming pool backwashing	=	2.9	m^3/day
Design flow for swimming pool backwashing	=	0.03	litre/sec
Total Flow from the Proposed Development			
Flow rate (excluding backwash of all pools)	=	1,028.2	m^3/day
Flow rate with P_{CIF} (Tuen Mun - 1.1)	=	1131.0	m^3/day (refer to Table T-4 of GESF - Tuen Mun - 1.1)
Contributing population	=	4189	people
Peaking factor	=	4.0	(refer to Table T-5 of GESF for a population of <10,000 incl. stormwater allowance)
Peak flow (excluding backwash of all pools)	=	52.4	litre/sec
Peak flow (including backwash of all pools)	=	52.5	litre/sec

Remarks:
(1) For job type J11, the “per-employee” unit flow factor takes into account the flows of customers and tenants.

Table 2 Hydraulic Capacity of Proposed Drainage Pipe for Onsite Sewage Treatment Plant

Segment	Manhole Reference	Manhole Reference	Material	Pipe Dia.	Pipe Length	g	k_s	s	v	V	Area	Q	Estimated Capacity
				mm	m	m/s^2	m		m^2/s	m/s	m^2	m^3/s	L/s
-	STP	Nullah	Clayware	350	10.30	9.81	0.0030	0.003	0.000001	0.74	0.10	0.07	71

Remarks: (1) g=gravitational acceleration; k_s=equivalent sand roughness; s=gradient; v=kinematic viscosity of water; V=mean velocity

(2) According to Section 5.1.2 of SDM, gradient of at least 1: DN (i.e. Nominal diameter of the sewer in mm) is adopted.

(3) The values of ks = 3.0mm is used for the calculation of slimed clayware sewer, poor condition @mean velocity = approximately 0.75m/s (based on Table 5: Recommended Roughness Values in Sewerage Manual)

(4) The value of velocity (V) is referred to the Tables for the hydraulic design of pipes, sewers and channels (8th edition)

(5) Equation used: $$V=-\sqrt{(8gDs)}\log\left(\frac{k_s}{3.7D}+\frac{2.51v}{D\sqrt{(2gDs)}}\right)$$

Table 3 Capacity Checking for the Proposed Drainage Pipe of the Onsite Sewage Treatment Plant

Segment	Manhole Reference	Manhole Reference	Pipe Dia. (mm)	Pipe Length (m)	Gradient	Estimated Capacity (L/s)	Peak Flow from the Proposed Development only (L/s)	Contribution from the Proposed Development only (%)	Status
-	STP	Nullah	350	10.3	0.003	71	52.4	74.0%	OK

Appendix 2.2

Sample of Membrane Bioreactor

In conventional activated sludge processes, separation of treated water from the sludge is mainly achieved by sedimentation in secondary clarification tank. This requires a considerable amount of space and capital cost, and separation efficiency is low.

Using membrane to replace the secondary clarification tank, suspended solids can be completely removed from treated water, resulting in a high effluent quality. It not only concentrates slow-growing bacteria, but also retains large molecular organic compounds in reactor, thereby increasing contact time with the sludge. Thus, removal rate of COD, BOD, nitrogen and phosphorus will be greatly increased.

Raw wastewater (left) and treated water (right)

Advantanges of MBR

1 **High effluent quality**
- Permeate - free of suspended solids

2 **Small footprint, elimination of secondary clarification tank**
- Only half of the area of conventional activated sludge process is required, and capital cost is reduced
- Solve the problem of poor sedimentation in conventional activated sludge process; especially for winter

3 **Long solid retention time, easy management**
- Sludge wasting volume is greatly reduced

4 **High biomass concentration and treatment efficiency**
- Operate at biomass concentration of 10,000 - 20,000 mg/L, COD removal and denitrification occur simultaneously

5 **Easy to install in the existing aeration tank to become a MBR system**

6 **Easy for operation & maintenance**

7 **Greatly reduce the volume of aeration tank**

8 **Reduce fouling and increase water flux**

Case Studies

Wastewater Source	Parameters	Influent	Effluent	Removal Rate (%)
Food Processing	BOD (mg/L)	1590	1	99.9
	COD_{Cr} (mg/L)	2600	7	99.0
	SS/ (mg/L)	380	<1	100
Sauce Production	BOD (mg/L)	3630	5	99.9
	SS/ (mg/L)	380	<1	100
Landfill Leachate	COD_{Cr} (mg/L)	~10,000	60	99.4
	SS/ (mg/L)	<500	<1	100
Grey Water Recycling	BOD (mg/L)	<=200	<=10	95.0
	SS/ (mg/L)	<=200	< 1	100

Uses of MBR

1 **Domestic wastewater treatment / Grey water recycling**
High treatment efficiency, high effluent quality

2 **Industrial wastewater treatment**
Suitable for landfill leachate, high BOD food processing wastewater, livestock wastewater, chemical wastewater and pulp and paper wastewater

3 **Water reuse or recycling**
Direct reuse or purified with reverse osmosis

20151014/1

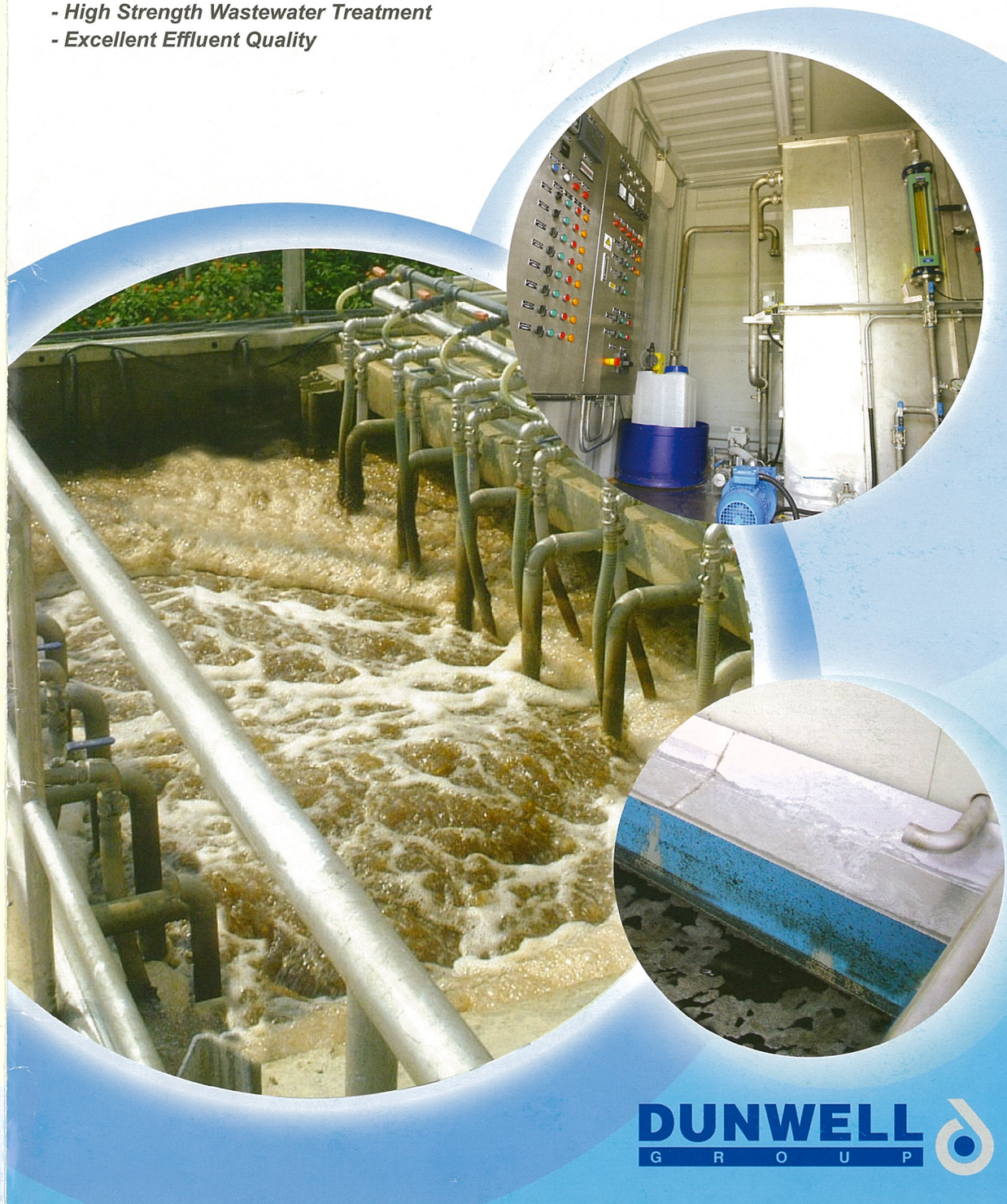
Dunwell Engineering Company Limited
8 Wang Lee Street, Yuen Long Industrial Estate, Yuen Long, N.T., Hong Kong
Tel：(852) 2443 8168
Fax：(852) 2789 3346
Email：decl@dunwellgroup.com
Website：www.dunwellgroup.com

DUNWELL GROUP

MBR

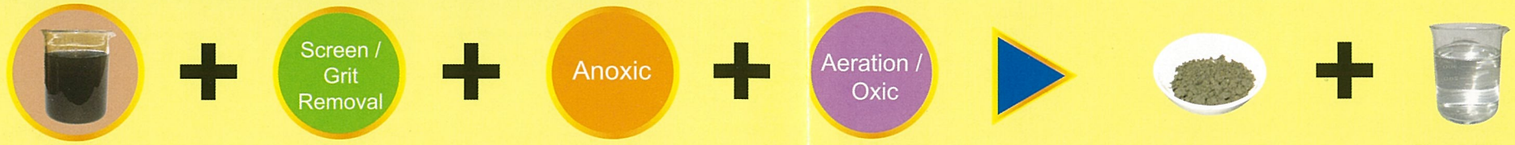
Membrane Bio-Reactor

- Wastewater Reuse
- High Strength Wastewater Treatment
- Excellent Effluent Quality



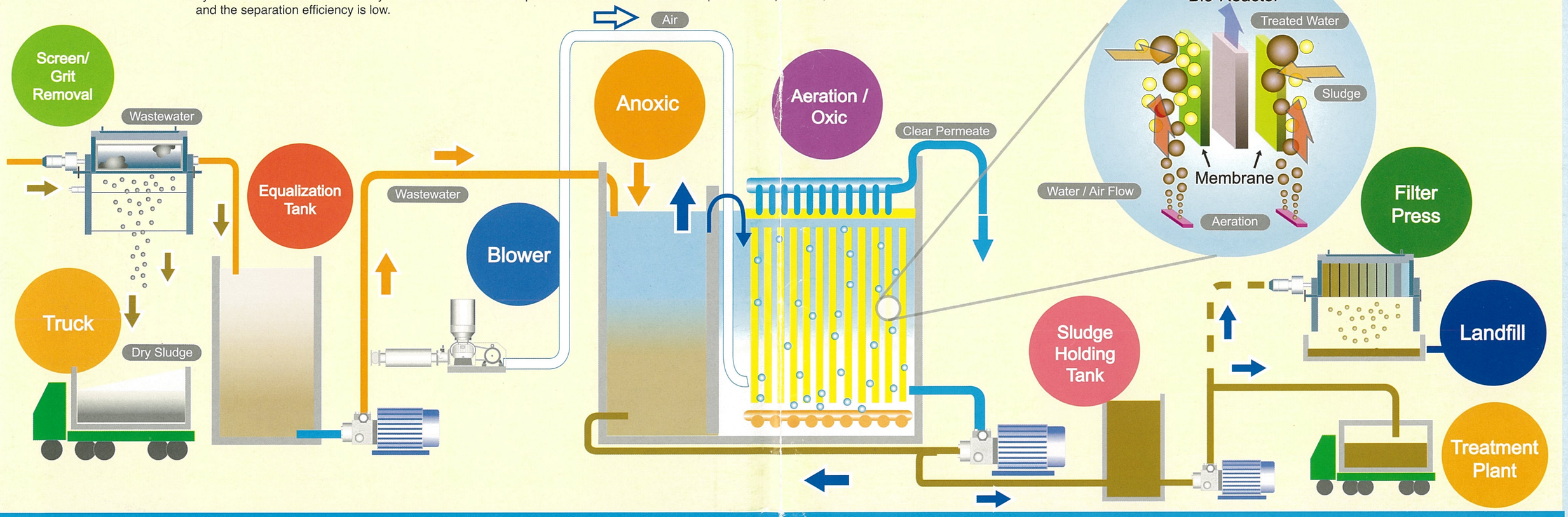
DUNWELL GROUP

MBR Membrane Bio-Reactor

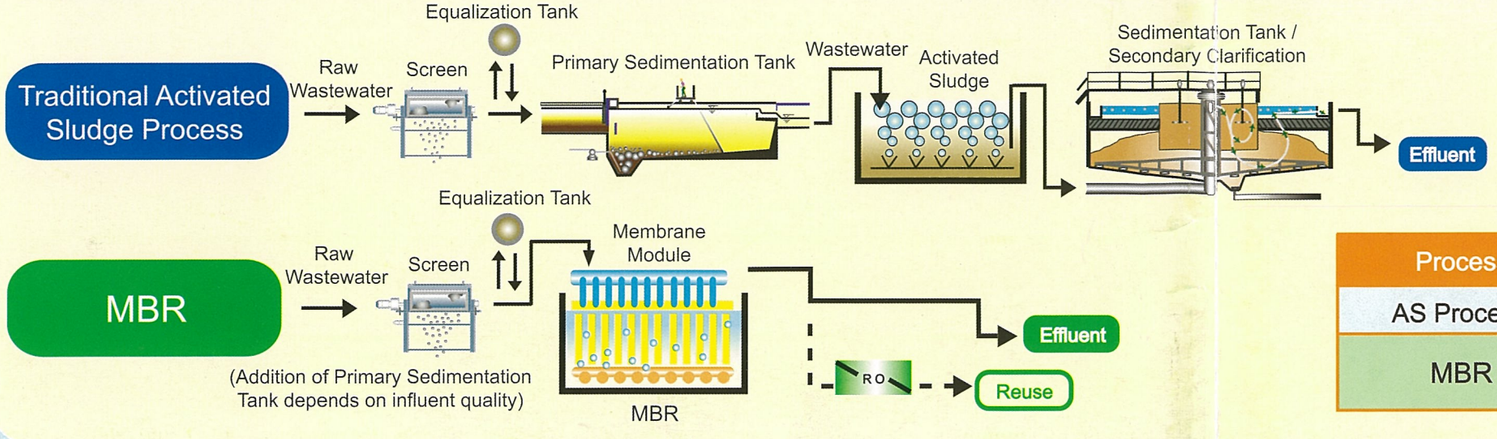


MBR is a new wastewater treatment technology, which combines biological treatment with membrane separation.

In conventional activated sludge processes, the separation of the treated water from the sludge in mainly achieved by sedimentation in the secondary clarification tank. This requires a considerable amount of space and capital cost, and the separation efficiency is low.



MBR and Traditional Activated Sludge Process Comparison



Comparison between MBR & Traditional AS Process

Process	Performance	Maintenance	Sludge Conc.	Space Saving	Direct Reuse
AS Process	Fair	Fair	Low	Fair	No
MBR	Excellent	Easy	High	Yes	Yes