

Attachment E

Revised Drainage Impact Assessment

Application for Amendment of Plan under Section 12A of the Town Planning Ordinance (Cap. 131), to Rezone the Application Site from “Open Space” to “Residential (Group A)11”, for Proposed Residential Development with Social Welfare Facilities, Religious Institution, and Shop and Services at Sha Tin Town Lot 310 in D.D. 184, Sha Tin, New Territories
(Planning Application No. Y/ST/63)

Application for Amendment of Plan under Section 12A of the Town Planning Ordinance (Cap. 131), to Rezone the Application Site from “Open Space” to “Residential (Group A) 11” at Sha Tin Town Lot 310 in D.D. 184, Sha Tin

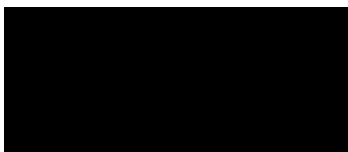
Drainage Impact Assessment

Reference

Issue 2 | September 2026

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number



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1. Introduction

1.1 Project Background

- 1.1.1 This Drainage Impact Assessment (“DIA”), appended to the Supporting Planning Statement, is prepared in support of the Planning Application under Section 12A of the Town Planning Ordinance (Cap. 131) for the Proposed Residential Development with ‘Social Welfare Facility’, ‘Religious Institution’ and ‘Shop and Services’ (“Proposed Amendment”) at Sha Tin Town Lot (STTL) 310 in D.D. 184, Sha Tin, New Territories (“the Application Site”).

1.2 Proposed Development

- 1.2.1 The Application Site has a site area of about 5,225 m² and it is proposed with residential development with clubhouse, reprovision of Hong Kong Bible Research and Education Centre, Residential Care Home for the Elderly, and Shop and Services. Key development parameters of the Application Site are shown in **Table 1.1 below**.

Table 1.1 Development Parameters

Description	Site Information
Site Location	Sha Tin Town Lot (STTL) 310 in D.D. 184, Sha Tin
Application Site Area	About 5,225 m ²
GFA	Domestic: 26,125 m ² Clubhouse: 1,050 m ² Reprovision of Hong Kong Bible Research and Education Centre: 2,900 m ² Residential Care Home for the Elderly RCHE (including 100-beds): 2,980 m ² Parents/Relative Resource Centre (PRC): 238 m ² Shop and Services: 562 m ²
No. of Units (About)	450
Anticipated Population (About)	Domestic: 1,125 Clubhouse ⁽¹⁾ : 35 Reprovision of Hong Kong Bible Research and Education Centre ⁽¹⁾ : 96 RCHE ⁽¹⁾ : 199 PRC ⁽¹⁾ : 8

Application for Amendment of Plan under Section 12A of the Town Planning Ordinance (Cap. 131), to Rezone the Application Site from “Open Space” to “Residential (Group A) 11” at Sha Tin Town Lot 310 in D.D. 184, Sha Tin

	Shop and Services ⁽²⁾ :	29
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- (1) Community, Social & Personal Services = 3.3 employee per 100m² of GFA based on PlanD's Commercial and Industrial Floor Space Utilization Survey "CIFSUS" Table 8.
- (2) Retail Trade Services = 3.5 employee per 100m² of GFA based on PlanD's Commercial and Industrial Floor Space Utilization Survey "CIFSUS" Table 8.

1.3 Purpose of the Report

- 1.3.1 This **Drainage Impact Assessment ("DIA")**, appended to the Supporting Planning Statement, is prepared in support of the Application for the proposed residential development.
- 1.3.2 The DIA Report includes relevant information to assess current flooding conditions, and flood risks after the proposed works including:
- Outline the current flooding susceptibility and proposed drainage;
 - Outline the changes to the drainage characteristics and potential drainage impacts with might arise from the proposed project;
 - Details of any proposed drainage impact mitigation measure and any further drainage impact implications; and
 - Details of any proposed monitoring requirements.
- 1.3.3 The DIA Report outlines the existing drainage network in the vicinity of the Site; studies the proposed development; defines the potential impacts that may arise; and proposed mitigation measures where necessary.
- 1.3.4 The Report is structured as follows:
- **Section 1** introduces the project background, objectives and scope of the Project;
 - **Section 2** presents the methodology and design criteria;
 - **Section 3** describes the existing drainage system and its performance;
 - **Section 4** describes the proposed drainage system and its performance, and the potential drainage impacts;
 - **Section 5** summarises the conclusion.

2. Assessment Methodology

2.1 Overview

- 2.1.1 This chapter describes the methodology assessing the drainage network performance under both existing and proposed conditions.

2.2 Design Standards and Guidelines

- 2.2.1 The DIA has been prepared in accordance with the following design manuals and information have been adopted:

- DSD’s Advice Note No. 1 – Application of the Drainage Impact Assessment Process to Private Sector Projects;
- Stormwater Drainage Manual (SDM) Fifth Edition, January 2018;
- Stormwater Drainage Manual – Corrigendum No. 1/2022;
- Stormwater Drainage Manual – Corrigendum No. 1/2024;
- Stormwater Drainage Manual – Corrigendum No. 2/2024 (SDM 2024);
- CEDD GEO – Technical Guidance Note No. 39 (TGN 39) “*Guidelines for Estimation of surface Runoff from Natural Terrain Catchments for Drainage Design Purposes*”.
- Drainage Record Plans obtained from the GeoInfo¹ Map services of the Lands Department.

2.3 Design Criteria

- 2.3.1 The SDM 2024 recommends a range of different flood protection standards for various land uses, as shown in **Table 2.1** below.

Table 2.1 Design Flood Protection Standards

Land Use and Drainage Type	Return Period
Intensively used Agricultural Land	2-5 years
Village Drainage including Internal Drainage System under a Polder Scheme	10 years ¹
Main Rural Catchment Drainage Channels	50 years ²
Urban Drainage Trunk Systems	200 years
Urban Drainage Branch Systems	50 years

¹ <https://www.map.gov.hk/gm/>

Notes:

1. The impact of a 50 year event should be assessed in each village to check whether a higher standard than 10 years can be justified.
2. Embanked channels must be capable of passing a 200 year flood within banks

2.3.2 For low lying area or those in congested urban locations, the recommended standards may not be suitable or achievable. In such cases, consistent with SDM 2024, a pragmatic approach should be considered.

2.3.3 Where catchments are tidally influenced, the SDM 2024 recommends that for a T-year flood, peak flood levels are taken as the higher of the flood levels resulting from the following two cases:

Case A : a T-year sea level in conjunction with a X-year rainfall; and

Case B : a X-year sea level in conjunction with a T-year rainfall.

In the above rule,

X = 10 when T = 50, 100 or 200; and

X = 2 when T = 2, 5 or 10.

2.4 Method of Analysis

Drainage Network Performance

2.4.1 The performance the stormwater drainage network has been assessed as per SDM 2024 Section 8.3 and Table 12. Underground stormwater network has been assessed through Colebrook-White formula, river and channels have been assessed though Manning's formula.

Catchment Runoff

2.4.2 The catchment runoff has been assessed through the adoption of the Rational Method as specified in section 7.5.2 of SDM.

2.4.3 The inlet time, or time of concentration of a natural catchment has been assessed with Brandsby William's Equation as per SDM section 7.5.2. The inlet time for urbanised catchments has been set to 5 minutes.

2.5 Design Parameters

Design Roughness

2.5.1 The adopted roughness coefficients are consistent with SDM Table 13 and Table 14; and are summarised in **Table 2.2**.

Table 2.2 Adopted Roughness Coefficients

Drainage Network Element	Colebrook Roughness [mm]
Existing Drainage Pipes	0.6
Proposed Drainage Pipes	0.6
Drainage Network Element	Manning's Roughness [-]
Natural Stream, winding with pools and ineffective slopes (fair)	0.050

Design Siltation Allowance

2.5.2 To cater for capacity reduction due to materials deposited within stormwater network, siltation allowance has been adopted in accordance with SDM Section 9.3 and summarised below:

- (a) 5% reduction in flow area if the gradient is greater than 1 in 25.
- (b) 10% reduction in flow area in other cases.

Design Runoff Coefficients

2.5.3 The adopted runoff coefficients are summarised in **Table 2.3** and are consistent with SDM section 7.5 and GEO TGN 39.

Table 2.3 Adopted Runoff Coefficients

Surface	Runoff Coefficients
Paved Area	0.9
Unpaved Area	0.3

Design Rainfall

2.5.4 The synthetic rainfall designed in SDM section 4.3 has been adopted in this assessment. A uniformly distributed rainfall with an intensity determined by the Intensity-Duration-Frequency (IDF) relationship has been used.

2.5.5 The assessed catchments fall within SDM defined rainfall zone “HKO Headquarters”; the adopted rainfall parameters are obtained from SDM Table 3a and summarised in **Table 2.4**.

Table 2.4 Adopted Rainfall IDF Parameters

Parameter	Return Period: 50 years
a	505.5
b	3.29

c	0.355
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- 2.5.6 The assessed catchment areas are less than 25km², hence no aerial reduction factor has been applied.

Design Sea Level

- 2.5.7 The synthetic design sea levels defined in SDM section 5.3 has been adopted in this assessment. The Site is located in Sha Tin, the nearest design sea level gauging station of “*Tai Po Kau*” has been adopted.

Design Climate Change Scenario

- 2.5.8 With a conservative approach the Climate Change conditions defined in SDM section 6.8 for End of 21st Century have been adopted.
- 2.5.9 The adopted rainfall increase and design allowance as stipulated in SDM are summarised in **Table 2.5**.

Table 2.5 Adopted Rainfall Increase

Scenario	Rainfall Increase	Design Allowance	Adopted Total Increase
End 21 st Century	16.0%	12.1%	28.1%

- 2.5.10 The adopted sea levels together with their increase and design allowance stipulated in SDM are summarised in **Table 2.6**.

Table 2.6 Adopted Sea Levels

Return Period	Tai Po Kau [mPD]	Scenario	Mean Sea Level Rise [m]	Stom Surge [m]	Design Allowance [m]	Adopted Total Sea Levels [mPD]
10	3.54	End 21 st Century	0.47	0.17	0.25	4.43
50	4.41			0.25	0.29	5.42

3. Existing Conditions

3.1 Overview

- 3.1.1 This chapter describes the existing drainage network and the existing catchments. The design runoff flows are defined and the performance of the existing drainage network in such conditions is assessed.

3.2 Existing Drainage Network

- 3.2.1 The Application Site is located in Sha Tin by Shing Mun River, which is at the northeast of Lion Rock Tunnel Road and the northwest of Tao Chung South Road.
- 3.2.2 The runoff from the Application Site is collected by a 375mm stormwater pipe at terminal manhole SMH4003968 at west of the site, which connects to a 450mm stormwater pipe and discharges to Shing Mun River immediately downstream.
- 3.2.3 Within the vicinity of the Application Site, a trapezoidal channel is located to the north, while an existing drainage network of 350mm to 450mm diameter pipes is located to the west to collect runoff from the site verge. A schematic plan of the existing drainage network is shown in **Figure 3.1**.

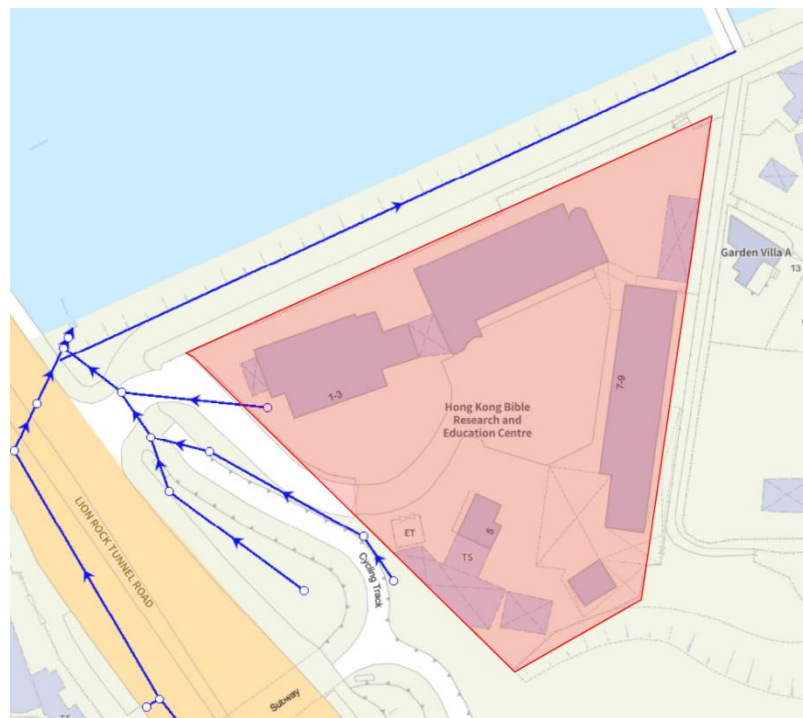


Figure 3.1 Existing Drainage Network Schematic

Existing Flooding Records

- 3.2.4 Available flooding records have been reviewed; the Application Site is not classified as Flooding Blackspots according to DSD website².

Ecological Sensitive Streams

- 3.2.5 The presence of Ecologically Important Streams/Rivers (EIS) as per ETWB TCW No. 5/2005 and associated website³ has been scrutinised. There are no EIS that will be affected by proposed works.

3.3 Existing Catchments and Runoffs

- 3.3.1 The Application Site is currently zoned as “*Open Space*” under the draft Sha Tin OZP No. S/ST/39. The existing Hong Kong Bible Research and Education Centre consists of a few scattered buildings on paved land with tress and small pieces of grassland. The Application Site has been considered as partially paved. The existing land uses near the Application Site are shown in **Figure 3.2**.



Figure 3.2 Existing Land Use near Application Site

- 3.3.2 The existing catchments discharge locations and the assessed existing runoff for the design storm event for Application Site are summarised in **Table 3.1** and further detailed in **Appendix C**.

² Flooding blackspot DSD website, inspected on 16/04/2024
https://www.dsd.gov.hk/EN/Flood_Prevention/Our_Flooding_Situation/Flooding_Blackspots/index.html

³ Ecologically Important Streams AFCD website, inspected on 16/04/2024
https://www.afcd.gov.hk/english/conservation/con_wet/streams_rivers_hk/Con_NSR/Ecologically_Important_Streams.html

Table 3.1 Existing Catchments and Runoff for 50-year End 21st Century rainfall event

Catchment	Discharges to	Area [ha]	Paved % (according to existing use)	Existing runoff [m ³ /s]
1 (Application Site)	SMH4003968	0.52	86%	0.36
2	SMH4003964	0.28	78%	0.18

3.4 Performance of Existing Network

3.4.1 The existing flow capacities of downstream of terminal manhole assessed below as shown in **Table 3.2**, while detailed calculations are provided in **Appendix C**.

Table 3.2 Existing Network Performance

Design return period	Network element	Pipe Size [mm]	Capacity [m ³ /s]	Existing flow [m ³ /s]	Utilisation %
50 years - End 21 st Century	SWD4004017	375	0.13	0.36	270.7%
50 years - End 21 st Century	SWD4004013	450	0.24	0.54	227.8%

3.4.2 The assessment shows that the stormwater pipe sections downstream of the terminal manhole are operating at over 100% utilisation, indicating that these sections have insufficient capacity to accommodate existing runoff.

4. Proposed Drainage Impact and Mitigation Measures

4.1 Overview

- 4.1.1 This chapter describes the proposed development and assesses the changes in land use, runoff characteristics, and flood storage. The proposed network is then described, and its performance assessed.

4.2 Changes in Land Use and Runoff

- 4.2.1 The catchment of subject site has not been changed according to the redevelopment plan. The existing development covers an area of approximately 5,225m² which is assessed as partly paved. Green area will be included in the proposed development.

4.3 Changes in Flood Storage

- 4.3.1 There is no flood storage within the Application Site, and no flood volume is accumulated during severe storm events. The proposed development will be fully drained by the existing drainage network and does not include flood storage infrastructure. No change in flood storage has been identified.

4.4 Changes in Paved Area

- 4.4.1 The existing development has a paved area of 4,494 m², which is about 86% of the Application Site. Following the redevelopment, the paved area will be reduced to 3,553 m², which is about 68% of the Application Site. This represents a decrease of 941 m², indicating a reduction in impervious area and surface runoff.

Table 4.1 Change in Paved Area

Site	Existing Site		Proposed Development	
	Paved Area (m ²)	Unpaved Area (m ²)	Paved Area (m ²)	Unpaved Area (m ²)
Application Site	4,494	731 (86%)	3,553	1,672 (68%)

4.5 Proposed Drainage Network

- 4.5.1 Although the proposed development results in a reduction of paved area and runoff, the assessment indicated that the existing network remains insufficient to accommodate the design runoff. Upgrading works to the existing network are therefore proposed.

- 4.5.2 The runoff from the Application Site with the proposed development will be collected by the existing terminal manhole (ref. SMH 4003968) or newly constructed terminal manhole adjacent to this manhole to cater for the development (subject to later design). From there, the existing 375mm dia. stormwater pipe (ref. SWD4004017) is proposed to be upgraded to 600mm dia., and the downstream 450mm pipe (ref. SWD4004013) will be upgraded to 675mm dia.. The upgraded system will then discharge to the Shing Mun River. A layout plan is provided in **Appendix B**.
- 4.5.3 External catchment areas located to the east, south and west of the Application Site has been identified and is shown in **Appendix B**. Since the site may obstruct the existing flow path, 225mm U-channel are proposed as peripheral drains along the eastern, southern and western boundary to intercept and divert the runoff to the existing terminal manhole (ref. SMH 4003968).

4.6 Performance and Impacts of the Proposed Drainage Network

- 4.6.1 The performance of the proposed drainage network has been assessed under the 1 in 50 years End 21st Century Scenario.
- 4.6.2 The proposed upgrades have sufficient capacity to convey the design flows as summarised in **Table 4.2** and further detailed in **Appendix C**.

Table 4.2 Performance of the Upgraded Network with Proposed Development

Design return period	Network element	Pipe Size [mm]	Capacity [m ³ /s]	Design flow [m ³ /s]	Utilisation %
50 years - End 21 st Century	Proposed 225mm U-channel	225	0.03	0.01	35.8%
50 years - End 21 st Century	Proposed 225mm U-channel	225	0.03	0.02	74.5%
50 years - End 21 st Century	Proposed 225mm U-channel	225	0.03	0.02	70.8%
50 years - End 21 st Century	SWD4004017	600	0.46	0.32	70.9%
50 years - End 21 st Century	SWD4004013	675	0.69	0.51	73.4%

- 4.6.3 With the proposed upgrading works implemented, the system will provide adequate capacity under design storm conditions, and no adverse impact is anticipated.

4.7 Maintenance Responsibility

- 4.7.1 The management and maintenance responsibilities for the drainage network inside the Application Site will be constructed and maintained by the developer or the management of the development after completion. The proposed drainage system outside the

Application Site including terminal manhole will be constructed by the developer and handed over to DSD upon completion of the construction works.

5. Conclusion

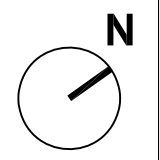
- 5.1.1 The Application Site is proposed with Residential Development with ‘Social Welfare Facility’, ‘Religious Institution’ and ‘Shop and Services’ (“Proposed Amendment”) at Sha Tin Town Lot (STTL) 310 in D.D. 184, Sha Tin, New Territories. The Application Site within “*Open Space*” zone is currently occupied by Hong Kong Bible Research and Education Centre.
- 5.1.2 This DIA has assessed the impacts of the proposed development in the Application Site accordance with DSD’s Advice Note No. 1 “*Application of the Drainage Impact Assessment Process to Private Sector Projects*” and DSD SDM.
- 5.1.3 The assessment indicates that although the overall paved area will decrease from 86% to 68% and corresponding surface runoff will decrease after redevelopment, the existing drainage network within the Application Site does not have sufficient capacity to accommodate the design runoff flows.
- 5.1.4 Upgrading works are therefore proposed. Runoff from the Application Site under the proposed development will be collected by the existing manhole ref. SMH 4003968 or a newly constructed terminal manhole adjacent to this manhole. In addition, peripheral drains are proposed along the **eastern**, southern and **western boundaries** to intercept and divert the runoff to the existing manhole.
- 5.1.5 From the terminal manhole, the existing 375mm dia. stormwater pipe (ref. SWD4004017) will be upgraded to 600mm dia., and the downstream 450mm dia. pipe (ref. SWD4004013) will be upgraded to 675mm dia.. The upgraded system will then discharge to the Shing Mun River.
- 5.1.6 With the implementation of the proposed upgrading works, the development will not cause adverse drainage impact to the existing public drainage infrastructure in the vicinity of the Application Site.

Appendix A

Master Layout Plan of Indicative Scheme in Application Site



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-	FIRST SUBMISSION	FH	09/25
Rev	Description	By	Date
Consultant			
ARUP			
Contract No. and Title			
SHATIN TOWN LOT 310			
Drawing Title			
MASTER LAYOUT PLAN			
Drawing no.			Rev.
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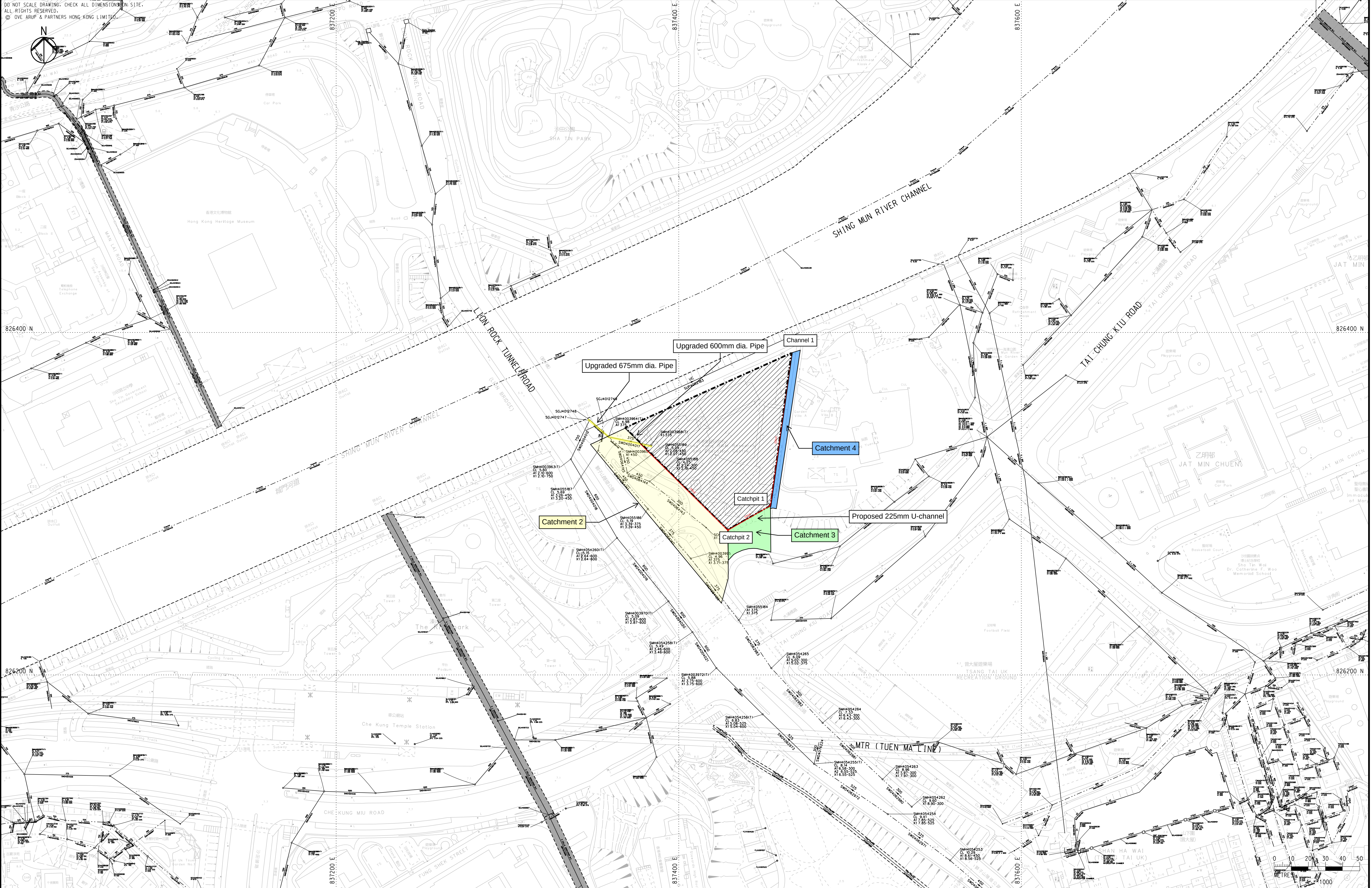
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-	FIRST SUBMISSION	FH	09/25
Rev	Description	By	Date
Consultant			
ARUP			
Contract No. and Title			
SHATIN TOWN LOT 310			
Drawing Title			
GROUND FLOOR PLAN			
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Appendix B

Drawings

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LEGEND

- PROPOSED DEVELOPMENT
- EXISTING DRAINAGE AND MANHOLE

Job Title

Application for Amendment of Plan under Section 12A of the Town Planning Ordinance (Cap. 131), to Rezone the Application Site from "Open Space" to "Residential (Group A) 11" at Sha Tin Town Lot 310 in D.D. 184, Sha Tin

Drawing Title

EXISTING DRAINAGE NETWORK

Drawing Status

SUBMISSION

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Job No.

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Drawing No.

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Appendix C

Runoff Assessment

Table A - Hydraulic Checking of the existing drainage system after completion of the Proposed Development

A) Design Parameters :

Runoff

Runoff Coeff., C = 0.90 (Paved)
= 0.30 (Unpaved)

Return Period = 50 years Main Rural Catchment Drainage Channels

sc Inlet Time, T_o = minutes 5.00 Urban Drainage
Time of Flow is conservatively assumed = 0 min

sc Rainfall Intensity, I = a / (Tc + b)^c 50-year (Gumbel solution)
where : a = 505.5 (Table 3a, Stormwater Drainage Manual Corridendum 1/24)
b = 3.29
c = 0.355

Peak Runoff, Q_p = 0.278 C I A

Rainfall Increase = 28.1% (End 21st Century, Table 28 &31 Corrigendum 1/22)
due to Climate Change

B) Existing Catchment Runoff:

Catchment		Characteristics			Time			Catchment								Rainfall	Runoff Flows	
Name	Type	Total catchment area		Catchment slope	Inlet, t _o	Flow, t _f	Concentration, t _c	Paved Area	Unpaved Area	Catchment area (hard pavement)	Catchment area (grassland)	Paved effective Area	Unpaved effective Area	Effective area (Sum of C x A)		Intensity	Peak Runoff	Towards
	Rural / Urban	[ha]	[m ²]	[m / 100m]	[min]	[min]	[min]	[ha]	[ha]	[%]	[%]	[ha]	[ha]	[ha]	[km ²]	[mm/h]	[m ³ /s]	
1 (Application Site)	Urban	0.52	5225	1	5.0	0.0	5.0	0.45	0.07	86%	14%	0.41	0.02	0.43	0.0042765	305.6	0.36	SMH4003968
2	Urban	0.28	2770	1	5.0	0.0	5.0	0.22	0.06	78%	22%	0.19	0.02	0.21	0.0021288	305.6	0.18	SMH4003964

C) Proposed Catchment Runoff:

Catchment		Characteristics			Time			Catchment								Rainfall	Runoff Flows	
Name	Type	Total catchment area		Catchment slope	Inlet, t _o	Flow, t _f	Concentration, t _c	Paved Area	Unpaved Area	Catchment area (hard pavement)	Catchment area (grassland)	Paved effective Area	Unpaved effective Area	Effective area (Sum of C x A)		Intensity	Peak Runoff	Towards
	Rural / Urban	[ha]	[m ²]	[m / 100m]	[min]	[min]	[min]	[ha]	[ha]	[%]	[%]	[ha]	[ha]	[ha]	[km ²]	[mm/h]	[m ³ /s]	
1 (Application Site)	Urban	0.52	5225	1	5.0	0.0	5.0	0.36	0.165	68%	32%	0.32	0.05	0.37125	0.0037125	305.6	0.32	SMH4003968
2	Urban	0.28	2770	1	5.0	0.0	5.0	0.22	0.06	78%	22%	0.19	0.02	0.21	0.0021288	305.6	0.18	SMH4003964
3	Urban	0.05	489	1	5.0	0.0	5.0	0.00	0.05	0%	100%	0.00	0.01	0.01	0.0001467	305.6	0.01	SMH4003968
4	Urban	0.04	380	1	5.0	0.0	5.0	0.00	0.04	0%	100%	0.00	0.01	0.01	0.000114	305.6	0.01	SMH4003968

Note: Total catchment area under proposed conditions is conservatively assumed as existing catchment.

Table - Capacity Performance of Drain

Notes:
Calculated by Colebrook-White Equation $\bar{V} = -\sqrt{32gRS_f} \log \left[\frac{k_s}{14.8R} + \frac{1.255\nu}{R\sqrt{32gRS_f}} \right]$
 ν is kinematic viscosity of fluid = 1.14 x 10⁻⁶ m²/s and g is the gravity = 9.81 m/s².
 V is the velocity, D is the diameter of the sewer and S is the gradient of the sewer.

Pipe Material	Roughness
	ks (mm)
PC	0.6

Siltation
S < 1 in 25 10%
S > 1 in 25 5%

Assumed data

Existing Network

Manhole			Existing Pipe Parameter																						
UP_MAN No.	DN_MAN No.	Catchment inflow	Runoff flows (m ³ /s)	Upstream flows (m ³ /s)	Design Flow (m ³ /s)	DIA (D) (mm)	DIA (D) (m)	Area (m ²)	Perimeter (m)	Hydr Radius (m)	LEN (m)	UP_GL (mPD)	DN_GL (mPD)	UP_INV (mPD)	DN_INV (mPD)	Gradient (S)	Pipe Material	Roughness Use ks (mm)	Pipe Material ks (mm)	VEL (m/s)	CAP full bore (m ³ /s)	Siltation (%)	CAP w. Silt. (m ³ /s)	F/C (%)	Adequate Capacity?
SMH4003968	SMH4003964		0.36	0.00	0.36	375	0.375	0.110	1.178	0.094	25.9	4.13	4.98	2.48	2.33	179	PC	0.60	PC, ks=0.6 mm	1.35	0.15	10%	0.13	270.7%	NO
SMH4003964	SMH4086443		0.18	0.36	0.54	450	0.45	0.159	1.413	0.113	11.8	4.98	5.50	2.33	2.25	148	PC	0.60	PC, ks=0.6 mm	1.67	0.27	10%	0.24	227.8%	NO

Existing Network With Proposed Development

Manhole			Existing Pipe Parameter																						
UP_MAN No.	DN_MAN No.	Catchment inflow	Runoff flows (m ³ /s)	Upstream flows (m ³ /s)	Design Flow (m ³ /s)	DIA (D) (mm)	DIA (D) (m)	Area (m ²)	Perimeter (m)	Hydr Radius (m)	LEN (m)	UP_GL (mPD)	DN_GL (mPD)	UP_INV (mPD)	DN_INV (mPD)	Gradient (S)	Pipe Material	Roughness Use ks (mm)	Pipe Material ks (mm)	VEL (m/s)	CAP full bore (m ³ /s)	Siltation (%)	CAP w. Silt. (m ³ /s)	F/C (%)	Adequate Capacity?
SMH4003968	SMH4003964		0.32	0.02	0.34	375	0.375	0.110	1.178	0.094	25.9	4.13	4.98	2.48	2.33	179	PC	0.60	PC, ks=0.6 mm	1.35	0.15	10%	0.13	251.5%	NO
SMH4003964	SMH4086443		0.18	0.34	0.52	450	0.45	0.159	1.413	0.113	11.8	4.98	5.50	2.33	2.25	148	PC	0.60	PC, ks=0.6 mm	1.67	0.27	10%	0.24	216.6%	NO

Proposed Upgrades

Manhole			Proposed Pipe Parameter																						
UP_MAN No.	DN_MAN No.	Catchment inflow	Runoff flows (m ³ /s)	Upstream flows (m ³ /s)	Design Flow (m ³ /s)	DIA (D) (mm)	DIA (D) (m)	Area (m ²)	Perimeter (m)	Hydr Radius (m)	LEN (m)	UP_GL (mPD)	DN_GL (mPD)	UP_INV (mPD)	DN_INV (mPD)	Gradient (S)	Pipe Material	Roughness Use ks (mm)	Pipe Material ks (mm)	VEL (m/s)	CAP full bore (m ³ /s)	Siltation (%)	CAP w. Silt. (m ³ /s)	F/C (%)	Adequate Capacity?
SMH4003968	SMH4003964		0.32	0.02	0.34	600	0.6	0.283	1.884	0.150	25.9	4.13	4.98	2.48	2.33	179	PC	0.60	PC, ks=0.6 mm	1.82	0.51	10%	0.46	73.0%	YES
SMH4003964	SMH4086443		0.18	0.34	0.52	675	0.675	0.358	2.120	0.169	11.8	4.98	5.50	2.33	2.25	148	PC	0.60	PC, ks=0.6 mm	2.15	0.77	10%	0.69	74.8%	YES

Abbreviation:

DN_MAN
DIA
LEN
UP_GL
DN_GL
UP_INV
DN_INV
VEL
CAP
F/C
PC
MC
GRP
PE

1 Upstream Manhole
Downstream Manhole
Diameter
Length
Upstream Ground Level
Downstream Ground Level
Upstream Invert Level
Downstream Invert Level
Peak Pipe Velocity
Peak Pipe Capacity
Peak Flow/Capacity
Precast Concrete Pipe
Monolithic Concrete
Factory manufactured GRP
Polyethylene, uPVC

Table - Capacity Performance of Proposed Channel

Notes:
Calculated by Manning Equation

$$\bar{V} = \frac{R^{1/6}}{n} \sqrt{RS_f}$$

V is the velocity, R is the hydraulic radius of the channel and S_f is the slope of the channel.

Siltation	
S < 1 in 25	10%
S > 1 in 25	5%

Proposed Channel

Proposed Grates		Grate Data																				
US	DS	Channel Shape	Length (m)	US GL (mPD)	DS GL (mPD)	US D/L (mPD)	DS D/L (mPD)	Bottom Width (m)	Area (m ²)	Wetted Perimeter (m)	Hydraulic Radius Gradient (m ³ /s)	Slope	Manning coefficient	Flow Velocity (m/s)	CAP full bore (m ³ /s)	Siltation (%)	CAP w. S. (m ³ /s)	Upstream Flow (m ³ /s)	Additional Flow (m ³ /s)	Total Flow (m ³ /s)	Capacity (%)	
Channel 1	CP1	U	27	4.6	5	4.375	4.375	0.225	0.045	0.58	0.08	270	0.0037	0.013	0.86	0.04	10.03	0.01	0.00	0.01	0.00	35.84
	CP2	U	5	4.275	4.025	4.025	4.025	0.225	0.045	0.58	0.08	320	0.0037	0.013	0.86	0.01	0.01	0.01	0.01	0.01	74.59	
	CP2	U	65	5	4.13	4.025	3.825	0.225	0.045	0.58	0.08	375	0.0037	0.013	0.78	0.03	0.02	0.00	0.02	0.00	70.80	