EnviroSolutions & Consulting Ltd
16/F & 17/F, 700 Nathan Road, Mong Kok, Kowloon Hong Kong
Tel: No. +852 3960 7000 | Fax: +852 3960 7111
www.envirosc.com | www.simplyehs.com

Proposed Religious Institution (the Supreme Kwan Ti Temple) and Improvement to the Existing Access Road, Tai Tong, Yuen Long

Drainage Impact Assessment (Project Profile)

Prepared for:
Kwan Ti Culture Service Limited

31 October 2024

EnviroSolutions & Consulting Ltd
16/F & 17/F, 700 Nathan Road, Mong Kok, Kowloon Hong Kong
Tel: No. +852 3960 7000 | Fax: +852 3960 7111
www.envirosc.com | www.simplyehs.com

Proposed Religious Institution (the Supreme Kwan Ti Temple) and Improvement to the Existing Access Road, Tai Tong, Yuen Long
Drainage Impact Assessment (Project Profile)

Prepared for
Kwan Ti Culture Service Limited

For and on behalf of
EnviroSolutions & Consulting

Alexi BHANJA
Group COO

ESC Project No.	EPA23.1060-J.01
Deliverable No.	D02
Revision No.	1

File Location

https://envirosc.sharepoint.com/teams/hkprojects/shared documents/epa23.1060-j.01 kwan ti - temple_tai tong/07 deliverables/dia rev1.docx

Rev.	Description	Prepared	Reviewed	Approved	Date
0	Drainage Impact Assessment (Project Profile)	MJW	CL	AW	17/07/2024
1	Drainage Impact Assessment (Project Profile	MJW	CL	AW	31/10/2024

Distribution ☐ Internal ☒ Confidential ☐ Public

CONTENTS

APPENDICES

FIGURES

TABLES

1 PROJECT BACKGROUND

1.1 Introduction

1.1.1 It is planned to develop a temple for Kwan Ti ("the Proposed Development") at DD 117 Tai Tong Shan Road Lots Nos. 1622, 1624 and 1629, and the adjoining government land, Yuen Long, N.T., Hong Kong ("the Site"). The site area is approx. 17,393m^2.

1.1.2 The Site is zoned "Recreation" ("REC") and Green Belt ("GB") under the Approved Tai Tong Outline Zoning Plan ("OZP") No. S/YL-TT/20.Referring to the Schedule of Uses under Approved OZP Mo. S/YL-TT/20, "Religious Institution" Use is under Column 2 of both REC and GB zonings. Therefore, a planning application under Section 16 of the *Town Planning Ordinance* ("TPO") is required for the Proposed Development.

1.1.3 EnviroSolutions & Consulting Ltd ("ESC") has been appointed to prepare this Drainage Impact Assessment (Project Profile) ("DIA (PP)") to support the S16 planning application for the Proposed Development.

1.2 Site Description

1.2.1 The site location and its environs are summarized below and shown in **Figure 1-1**:

- To the North: Tai Tong Kwan Ti Square, Tai Tong Organic EcoPark
- To the East: access road, slopes
- To the South: Tai Tong Lychee Valley
- To the West: natural stream, Tai Tong Riding Club

1.2.2 The development schedule of the Proposed Development is shown below:

Development Site Area	About 17,393m^2
Maximum Building Height	35.999m
Greenery Coverage	20%

1.3 Objectives of this Report

1.3.1 The objectives of this DIA (PP) Report are to:

- Review the existing drainage conditions of the Site and surroundings.
- Assess the potential drainage impacts arising from the Proposed Development.
- Recommend the necessary mitigation measures to alleviate drainage impact, if any.

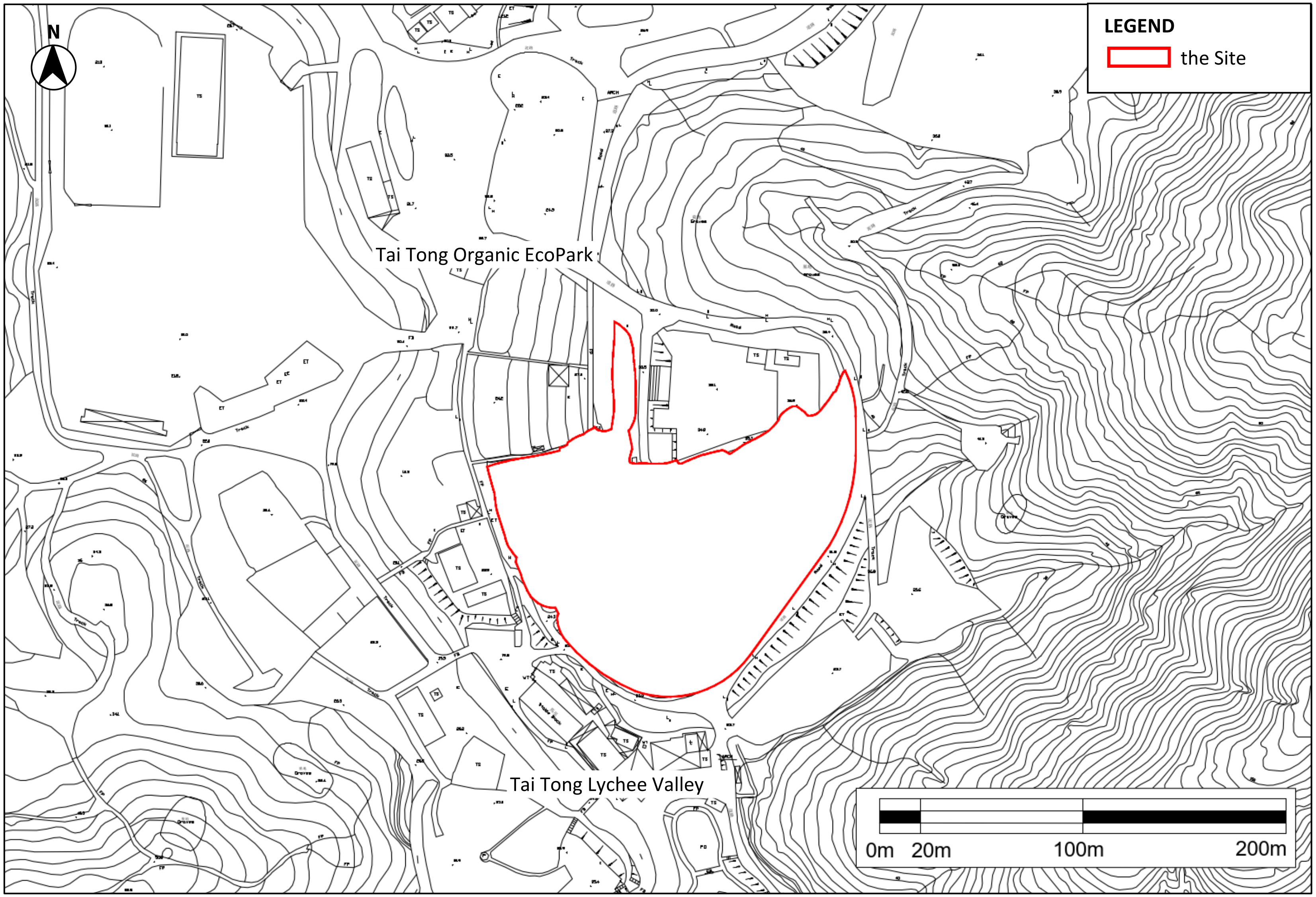
1.4 Reference Materials

1.4.1 In evaluating the drainage impact arising from the Proposed Development, the following materials have been referred to:

- Stormwater Drainage Manual (with Eurocodes incorporated) – Planning, Design and Management (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
- DSD Advice Note No. 1 – Application of the Drainage Impact Assessment Process to Private Sector Projects
- Technical Note to prepare a Drainage Submission

Figure 1-1 Site Location and its Environs



2 DESCRIPTION OF EXISTING ENVIRONMENT AND DRAINAGE CONDITIONS

2.1 Site Location and Topography

2.1.1 As illustrated in **Figure 1-1**, the Site is surrounded by various recreational areas including Kwan Ti Square, Tai Tong Organic EcoPark to the north, and Tai Tong Lychee Valley to the south.

2.1.2 The Site is situated at DD 117 Tai Tong Shan Road Lots Nos. 1622, 1624 and 1629 and the adjoining government land. According to the topographic survey, the site area is about 17,393m^2 with elevation ranging from+23.8mPD to +39.1mPD.

2.2 Existing Baseline Conditions

2.2.1 According to the drainage record provided in Geoinfo Map, no public drainage system was observed in the vicinity of the Site. A site inspection was conducted on 5 January 2024 to review the existing site condition and identify the drainage connection of the surrounding catchments. The site survey photos showing the site condition and drainage connection are provided in **Figure 2-1**. It shows that majority of the Site is currently covered by vegetation, with 30% of the Site was paved with concrete. The detailed discussion about surrounding catchments is provided in the following sections.

2.3 Proposed Discharge Point

2.3.1 It is proposed to discharge the stormwater runoff from the Site to the existing stream to the west of the Site. The indicative discharge point is shown in **Figure 2-1**.

Figure 2-1 Existing Site Condition and Proposed Discharge Point

3 DRAINAGE ANALYSIS

3.1 Assumptions and Methodology

3.1.1 Peak instantaneous run off before and after the Proposed Development was calculated based on the Rational Method. The recommended physical parameters, including runoff coefficient (C) and storm constants for different return periods, are as per the *Stormwater Drainage Manual*.

3.1.2 The Rational Method has been adopted for hydraulic analysis and the peak runoff is given by the following expression:

$$Q_p = 0.278\,C\,i\,A$$ ***--- Equation 1***

where Q_p = peak runoff in m^3/s
C = runoff coefficient
i = rainfall intensity in mm/hr
A = catchment area in km^2

3.1.3 Rainfall intensity is calculated using the following expression:

$$i = \frac{a}{(t_d + b)^c}$$ ***--- Equation 2***

where i = rainfall intensity in mm/hr
t_d = duration in minutes ($t_d \leq 240$)
a,b,c = storm constants given in table 3 of SDM

3.1.4 For a single catchment, duration (t_d) can be assumed equal to the time of concentration (t_c) which is calculated as follows:

$$t_c = t_0 + t_f$$ ***--- Equation 3***

where t_c = time of correction
t_0 = inlet time (time taken for flow from the remotest point to reach the most upstream point of the urban drainage system)
t_f = flow time

3.1.5 Generally, t_0 is much larger than t_f. As shown in Equation 2, t_d is the divisor. Therefore, larger t_d will result in smaller rainfall intensity (i) as well as smaller Q_p. For the worst-case scenario, t_f is assumed to be negligible and so:

$$t_c = t_0 = t_f$$

$$t_0 = \frac{0.14465\,L}{H^{0.2}A^{0.1}}$$ ***--- Equation 4***

where A = catchment area (m^2)
H = average slope (m per 100m), measured along the line of natural flow, from the summit of the catchment to the point under consideration
L = distance (on plan) measured on the line of natural flow between the summit and the point under consideration (m)

3.1.6 The Colebrook-White Equation was adopted for calculation of drainage capacity of pipes. Full bore flow with no surcharge is assumed, and 10% sedimentation was incorporated in the calculation of drainage capacity in accordance with the *Stormwater Drainage Manual*.

$$V = -\sqrt{8gDsg} * \log(\frac{ks}{3.7D} + \frac{2.51v}{D\sqrt{2gDs}})$$ ***--- Equation 5***

where V = mean velocity (m/s)
g = gravitational acceleration (m/s^2)
D = internal pipe diameter (m)
ks = hydraulic pipeline roughness (m)
v = kinematic viscosity of fluid (m^2/s)
s = hydraulic gradient (energy loss per unit length due to friction)

3.1.7 On the other hand, the capacity of open channel has been calculated using the Manning's Equation:

$$V = \frac{R^{1/6}}{n} \times \sqrt{Rs}$$ ***--- Equation 6***

where V = mean velocity (m/s)
R = hydraulic radius (m)
n = Meaning coefficient ($s/m^{1/3}$)
s = hydraulic gradient (energy loss per unit length due to friction)

3.2 Assessment Assumptions

Identification of Catchments

3.2.1 Based on the site visit and the topographic maps obtained from the Lands Department in January 2024, six (6) catchments named Catchments A to F were identified, as shown in **Figure 3-1**.

Internal Catchment (the Site)

3.2.2 The Site includes Catchment A. Majority of the site area is currently covered by vegetation, trees and bare soil, with some concrete-paved roads and temporary structure. Therefore, Catchment A are currently 70% soft landscape and 30% paved area.

3.2.3 After the Proposed Development, the Site will be occupied by several building blocks with some soft landscape. As advised by the project landscape architect, the greenery coverage of the Proposed Development will be not less than 20%. Therefore, the pavement condition of catchment A will be 20% soft landscape and 80% paved area after Proposed Development. It is assumed that the runoff will be finally discharged to the stream to the west of the Site The details will be further discussed in the following sections.

3.2.4 With reference to the *Stormwater Drainage Manual*, the runoff coefficients vary from different surface characteristics, as summarized in **Table 3-1** below.

Table 3-1 Runoff Coefficients of Different Surface Characteristics

SURFACE CHARACTERISTICS	RUNOFF COEFFICIENT
Concrete	0.80 - 0.95
Flat Grassland (heavy soil)	0.13 - 0.25
Steep Grassland (heavy soil)	0.25 - 0.35

3.2.5 As the Site is relatively flat, the runoff coefficients adopted were 0.95 and 0.25 for paved area and soft landscape, respectively. Thus, the average runoff coefficients for the Site before and after the Proposed Development were 0.46 and 0.81 respectively. The surface characteristics and runoff coefficients of Catchment A is summarised in **Table 3-2** below.

Table 3-2 Surface Characteristics and Runoff Coefficients of the Site

SCENARIO	AREA	SURFACE CHARACTERISTICS	RUNOFF COEFFICIENT
Before Development	A: 17,393m^2	30% paved + 70% unpaved	0.46
After Development		80% paved + 20% unpaved	0.81

Surrounding Catchments

3.2.6 **Catchment B** – Catchment B is a religious plaza with some paved access roads and grass fields. It is assumed that it is comprised of 80% soft landscape and 20% paved area. According to the site visit and topographic survey maps obtained from Lands Department, no drainage reception system was observed within Catchment B. Therefore, it is assumed that stormwater runoff from Catchment B would overflow to Catchment A as conservative approach. Runoff from Catchment B will be taken into account in the proposed drainage system of Catchment A.

3.2.7 **Catchment C** – Catchment C is located southwest of the Site. According to the topographic map, the catchment is located at the downstream of the Site. The runoff from this Catchment will not have any drainage impact on the Site. Hence, the runoff from this catchment will not be further assessed.

3.2.8 **Catchment D** – Catchment D is the slope located to the southeast of the Site. As the elevation of the middle of the road is greater than the slope toe to the east of the Site, the stormwater runoff from this catchment will be drained away at the slope toe and will not overflow into the Site. There is no obvious drainage connection between Catchment D and the Site. Hence, the runoff from this catchment will not have any drainage impact on the Site and will not be further assessed.

3.2.9 **Catchment E** – Similar to Catchment D, Catchment E is the slope located to the northeast of the Site. Similarly, the stormwater runoff from this catchment will be drained away via the roadside drains at the slope toe and will not overflow into the Site. There is no obvious drainage connection between Catchment D and the Site. Hence, the runoff from this catchment will not have any drainage impact on the Site and will not be further assessed.

3.2.10 **Catchment F** – Catchment F is located to the north of the Site. According to the topographic map, the catchment is located at the downstream of the Site. The runoff from this Catchment will not have any drainage impact on the Site and the access road. Hence, the runoff from this catchment will not be further assessed.

3.2.11 The runoff of Catchments A and B are estimated using the Rational Method. The surface characteristics and runoff coefficients of the surrounding catchments are summarised in **Table 3-3** below.

Table 3-3 Surface Characteristics and Runoff Coefficients of Surrounding Catchment

CATCHMENT	AREA	SURFACE CHARACTERISTICS	RUNOFF COEFFICIENT
B	5,552m^2	30% paved (flat) + 70% unpaved (flat)	0.46

Estimated Runoff

Peak Runoff from the Site

3.2.12 Based on the assumptions as described in **Section 3.2**, the runoff from the Site before and after development was estimated based on the return periods of 2, 10 and 50 years. The rainfall increase due to climate change effect of 16% for end of 21st Century has been also considered in the runoff estimation. As summarised in **Table 3-4**, there will be around 75% of increment in the estimated peak runoff after the proposed development under all assessed return periods. The detailed calculation is provided in **Appendix A**.

Table 3-4 Estimated Peak Runoff of the Site

RETURN PERIOD	ESTIMATED PEAK RUNOFF (m^3/s)		
	BEFORE DEVELOPMENT	AFTER DEVELOPMENT	INCREMENT
2 Years	0.409	0.717	75%
10 Years	0.521	0.915	75%
50 Years	0.592	1.039	76%

Cumulative Peak Runoff

3.2.13 As mentioned in **Paragraph 3.2.6**, it is assumed that the runoff from Catchment B may overflow to Catchment A in the worst-case scenario. Therefore, runoff from Catchment B will be regarded as the cumulative runoff. The estimated cumulative runoff is summarised in **Table 3-5.** below and detailed in **Appendix A**.

Table 3-5 Estimated Cumulative Runoff of the Site and Catchment B

RETURN PERIOD	ESTIMATED PEAK RUNOFF (m^3/s)		
	CATCHMENT A	CATCHMENT B	CUMULATIVE
2 Years	0.717	0.142	0.859
10 Years	0.915	0.179	1.094
50 Years	1.039	0.201	1.241

3.3 Capacity of Proposed Stormwater Pipe

3.3.1 A series of perimeter surface drains with sand trap/catch pit will be proposed to collect the cumulative runoff of the Site, which will finally connect to proposed discharge point at the stream to the west of the Site via a Ø900mm stormwater drainage pipe. The indicative location of terminal manhole provided with sand trap and proposed Ø900mm stormwater drainage pipe is shown in **Figure 3-2**.

3.3.2 The calculation on the capacity of the proposed Ø900mm stormwater pipe are summarised in **Table 3-6** below and detailed in **Appendix B**.

Table 3-6 Summary of Indicative Stormwater Pipe

SIZE (mm)	RELATED CATCHMENT	RUNOFF (m^3/s)	CAPACITY (m^3/s)	% OF CAPACITY	SUFFICIENT CAPACITY?
Ø900mm	Catchment A and B	1.241	1.552	80%	Yes

3.3.3 The calculation shows that the proposed Ø900mm stormwater pipe will have sufficient capacity for the cumulative runoff. Therefore, no adverse drainage impact due to the Proposed Development is anticipated.

Figure 3-1 Identification of Catchments

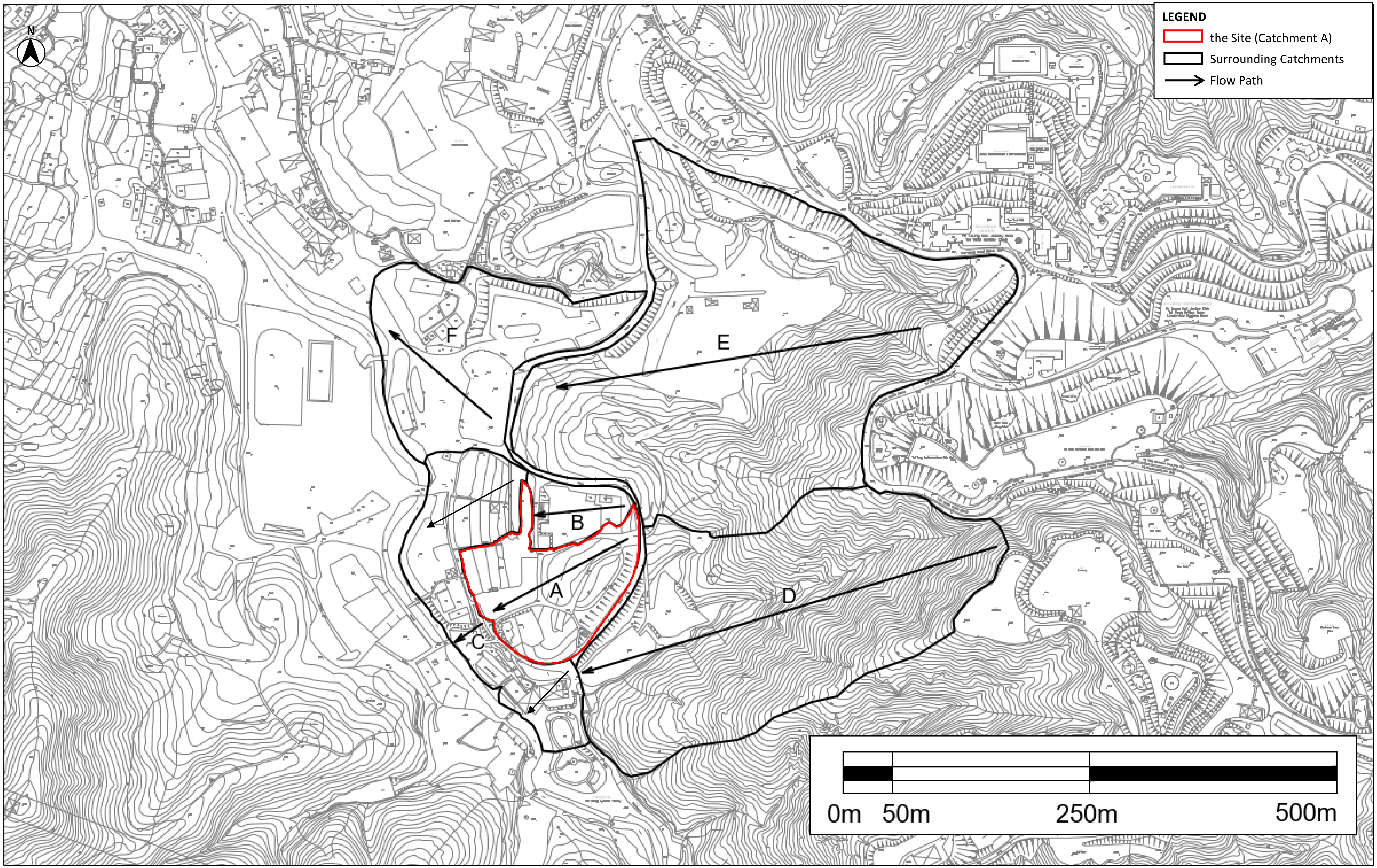
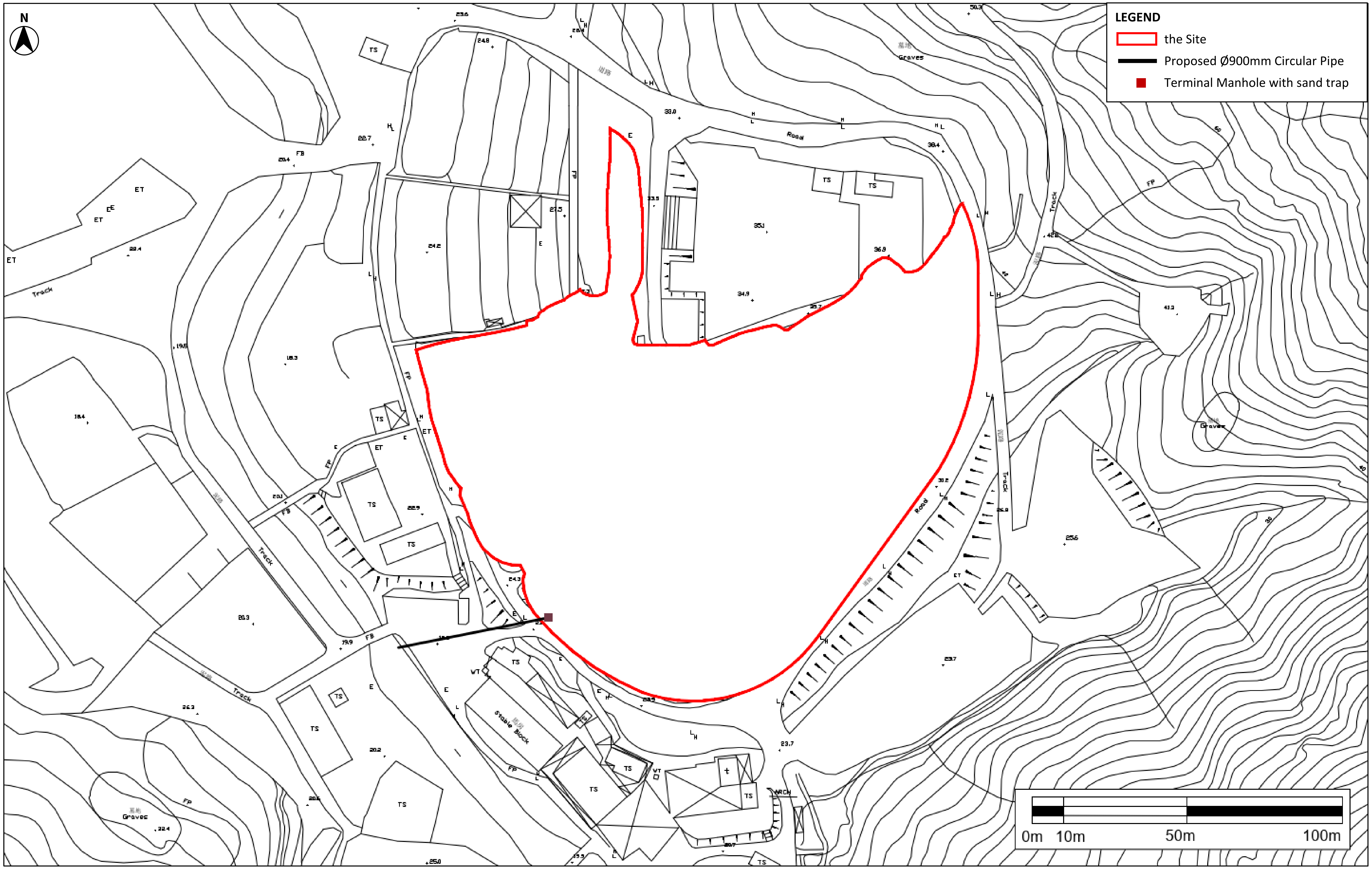


Figure 3-2 Indicative Location of Proposed Terminal Manhole and Stormwater Pipe



4 CONCLUSION

4.1.1 Potential drainage impacts that may arise from the Site after the Proposed Development have been assessed.

4.1.2 The peak runoff before and after development of the Site has been estimated using the Rational Method and based on the catchment surface characteristics for the existing environment and the Proposed Development. The estimated peak runoff generated from the Site is 1.188m^3/s under a 50-year return period.

4.1.3 The indicative location of proposed terminal manhole and Ø900 stormwater pipe shown on **Figure 3-2** will properly divert the runoff arising from the Site including cumulative runoff from Catchment B, which may overflow into the Site. The runoff would finally be discharged to the existing stream to the west of the Site.

4.1.4 The capacity of proposed Ø900 stormwater pipe has been checked. The calculation shows that it can handle the cumulative runoff from the Site and surrounding catchments. As such, no adverse drainage impact is anticipated.

4.1.5 This DIA(PP) Report indicates the initial findings regarding drainage impact and proposed stormwater drainage connection. A qualified engineer should be engaged by the Architect/Contractor of the Proposed Development to review and provide detailed designs for the internal Site drainage layout.

4.1.6 Adequate opening for any walls or hoarding to be erected along the Site boundary shall be provided to allow any overland flow passing through the Site walls/hoarding so that such runoff can be properly intercepted and diverted by the proposed drainage system within the Site. Such requirements shall be included in the design of the Site boundary fencing during the detailed design stage.

Appendix A Runoff Calculations

Calculation of Runoff for Return Period of 2 Years

Catchment ID	Catchment Area (A), km^2	Average slope (H), m/100m	Flow path length (L), m	Inlet time (t_0), min	Duration (t_d), min	Storm Constants [Note 2]			Runoff intensity (i), mm/hr	Runoff coefficient (C)	C x A	Peak runoff (Q_p), m^3/s	Peak runoff with Climate Change (Q'_p), m^3/s [Note 3]
						a	b	c					
Before the Proposed Development													
Site Area (Catchment A)	0.0174	9.05	170.0	5.96	5.96	446.1	3.38	0.463	158.53	0.46	0.0080	0.353	0.409
Catchment B	0.0056	5.37	102.0	4.45	4.45	446.1	3.38	0.463	172.03	0.46	0.0026	0.122	0.142
											Total	**0.475**	**0.551**
After the Proposed Development													
Site Area (Catchment A)	0.0174	8.47	170.0	6.04	6.04	446.1	3.38	0.463	157.91	0.81	0.0141	0.618	0.717
Catchment B	0.0056	5.37	102.0	4.45	4.45	446.1	3.38	0.463	172.03	0.46	0.0026	0.122	0.142
											Total	**0.741**	**0.859**

Calculation of Runoff for Return Period of 10 Years

Catchment ID	Catchment Area (A), km^2	Average slope (H), m/100m	Flow path length (L), m	Inlet time (t_0), min	Duration (t_d), min	Storm Constants [Note 2]			Runoff intensity (i) mm/hr	Runoff coefficient (C)	C x A	Peak runoff (Q_p), m^3/s	Peak runoff with Climate Change (Q'_p), m^3/s [Note 3]
						a	b	c					
Before the Proposed Development													
Site Area (Catchment A)	0.0174	9.05	170.0	5.96	5.96	485	3.11	0.397	202.09	0.46	0.0080	0.449	0.521
Catchment B	0.0056	5.37	102.0	4.45	4.45	485	3.11	0.397	217.25	0.46	0.0026	0.154	0.179
											Total	**0.604**	**0.700**
After the Proposed Development													
Site Area (Catchment A)	0.0174	8.47	170.0	6.04	6.04	485	3.11	0.397	201.39	0.81	0.0141	0.789	0.915
Catchment B	0.0056	5.37	102.0	4.45	4.45	485	3.11	0.397	217.25	0.46	0.0026	0.154	0.179
											Total	**0.943**	**1.094**

Calculation of Runoff for Return Period of 50 Years

Catchment ID	Catchment Area (A), km^2	Average slope (H), m/100m	Flow path length (L), m	Inlet time (t_0), min	Duration (t_d), min	Storm Constants [Note 2]			Runoff intensity (i) mm/hr	Runoff coefficient (C)	C x A	Peak runoff (Q_p), m^3/s	Peak runoff with Climate Change (Q'_p), m^3/s [Note 3]
						a	b	c					
Before the Proposed Development													
Site Area (Catchment A)	0.0174	9.05	170.0	5.96	5.96	505.5	3.29	0.355	229.46	0.46	0.0080	0.510	0.592
Catchment B	0.0056	5.37	102.0	4.45	4.45	505.5	3.29	0.355	244.46	0.46	0.0026	0.174	0.201
											Total	**0.684**	**0.793**
After the Proposed Development													
Site Area (Catchment A)	0.0174	8.47	170.0	6.04	6.04	505.5	3.29	0.355	228.76	0.81	0.0141	0.896	1.039
Catchment B	0.0056	5.37	102.0	4.45	4.45	505.5	3.29	0.355	244.46	0.46	0.0026	0.174	0.201
											Total	**1.070**	**1.241**

Note:

1. Runoff is calculated in accordance with DSD's "*Stormwater Drainage Manual (with Eurocodes incorporated) - Planning, Design and Management*" (SDM), fifth edition, January 2018.
2. Storm Constants were adopted from Table 3a Storm Constants for Different Return Periods of HKO Headquarters of DSD's *Corrigendum No. 1/2024.*
3. Table 28 Rainfall Increase due to Climate Change of DSD's *Corrigendum No. 1/2022* of 16% for end of-21st Century is adopted.

Appendix B Calculation of Drainage Capacity

Calculation of Drainage Capacity for Return Period of 50 Years

Drainage Capacity of Proposed Stormwater Drainage Pipe

Description	Shape	Catchment Description	d	r	Aw	Pw	R	s	ks	V	Qc	Qp'	Is Qc > Qp' ?	% of capacity
Proposed Stormwater Pipe Connecting to Proposed Discharge Point	Circular Pipe	Catchment A, Catchment B	0.900	0.450	0.636	2.827	0.225	0.005	0.06	2.711	1.552	1.241	Y	80%

Where

d = pipe diameter, m
r = pipe radius (m) = 0.5d
A_w = wetted area (m^2) = (r^2/2) (b + sinq)
P_w = wetted perimeter (m) = br
R = Hydraulic radius (m) = A_w/P_w
k_s = hydraulic pipeline roughness, mm
V = Velocity of flow calculated based on Colebrook-White Equation, m/s
Q_c = Flow Capacity including 10% for siltation, m^3/s
Q_o = Estimated total peak flow from the Site during peak season, m^3/s

Note
1. Flow capacity of pipe segment is calculated based on Colebrook-White Equation.
2. The diameter and gradient of the proposed stormwater pipe is indicative only. Its details will be subject to change during the detailed design stage.
3. The ks value of 0.06 in good condition for precast concrete pipes with 'O' ring joints recommended in Table 14 of the SDM for design purpose is adopted.
4. 10% reduction in flow area has been adopted to consider sedimentation reduction in accordance with Section 9.3 of SDM