Appendix III

Drainage Proposal

EnviroSolutions & Consulting Ltd

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Temporary Storage for MiC Components and Construction Materials with Ancillary Workshops, Office, Staff Car Park and Machinery at Various Lots in DD 107, Sha Po

Drainage Proposal

Prepared for:
Sanfield (Management) Ltd

4 December 2024

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Drainage Proposal

Prepared for
Sanfield (Management) Ltd

For and on behalf of
EnviroSolutions & Consulting

Alexi BHANJA
Group COO

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Rev.	Description	Prepared	Reviewed	Approved	Date
1	Drainage Proposal	MW	JC	AW	14/12/2023
2.2	Drainage Proposal	MW	JC	AW	26/03/2024
3	Drainage Proposal	MW	JC	AW	26/04/2024
4	Drainage Proposal	MW	JC	AW	04/06/2024
5.1	Drainage Proposal	MW	JC	AW	24/07/2024
6	Drainage Proposal	MW	JC	AW	20/09/2024
7	Drainage Proposal	MW	JC	AW	30/10/2024
8	Drainage Proposal	MW	JC	AW	04/12/2024

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CONTENTS

APPENDICES

FIGURES

TABLES

1 PROJECT BACKGROUND

1.1 Introduction

1.1.1 Aligning with Government directives to enhance the quantity, speed, efficiency, and quality of housing, the construction industry is spearheading the development of highly productive construction methods, including the widespread adoption of Modular Integrated Construction ("MiC"). MiC, an innovative construction method, involves assembling building components off-site in a controlled environment before transporting and seamlessly integrating them into the construction site.

1.1.2 In order to support in adopting MiC, a temporary storage for MiC Components and Construction Materials with Ancillary Workshops, Office, Staff Car Park and Machinery for a period of three years ("the Proposed Development" or "Proposed Use") at various lots in DD 107, Sha Po, Yuen Long, New Territories ("the Site") is proposed.

1.1.3 The Site is zoned Comprehensive Development Area (1) ("CDA(1)") under the Approved Kam Tin North Outline Zoning Plan ("OZP") No. S/YL-KTN/10. In accordance with Note (11) of the OZP, temporary use of development of any land or building exceeding a period of three years will require permission from the Town Planning Board ("TPB"). Therefore, a planning application pursuant to Section 16 of the *Town Planning Ordinance* ("TPO") is required.

1.1.4 In order to support the planning application for the Proposed Development, EnviroSolutions & Consulting Ltd ("ESC") has been appointed to prepare this Drainage Proposal.

1.2 Site Description

1.2.1 The Site locations and its environs are shown in **Figure 1-1** which the uses surrounding the Site include:

- To the North: Park Yoho
- To the East: temporary structures
- To the South: nullah and open storage
- To the West: Park Yoho

1.3 Project Description

1.3.1 The Site area will be approx. 9,705m^2. The indicative layout of the Proposed Development can be referred to the Planning Statement.

1.3.2 The Proposed Use aims to serve as a transshipment depot for MiC components, with the objective of meeting the growing demand for MiC applications while ensuring efficient logistics and seamless implementation of MiC in housing projects. MiC components intended for temporary storage will weigh about 10 to 20 tonnes, with maximum length and width of approx. 8m and 2.5m respectively. The proposed use also serves as a hub for modular construction materials being used for housing project sites in order to promote more Green Construction Methodology. The Proposed Development comprises an open storage area, providing a secure location for the temporary storage of MiC components

and modular construction materials, along with ancillary facilities, including three workshops, an office, a staff car park, a guardhouse and machinery (i.e. tower crane and hoisting crane etc.) to support its operation needs. The proposed ancillary office is a two-storey structure designed to accommodate about 50 staff members. The office is intended to provide administrative/supporting services to facilitate the seamless transshipment of MiC components. The proposed ancillary single-storey workshops, equipped with lifting machinery, will be enclosed, primarily serving for internal quality control and quality assurance checks of MiC components, as well as any necessary final touching-up works before their delivery to construction sites. Additionally, solar panels will be installed on the workshop and office roofs for self-sufficiency purpose, contributing to environmental protection through renewable energy generation.

1.3.3 The operating hours of the Proposed Use will be from 8:00 a.m. to 7:00 p.m. from Monday to Saturday and without operation on Sunday and public holidays.

1.4 Objectives of this Report

1.4.1 The objectives of this Drainage Proposal are to:

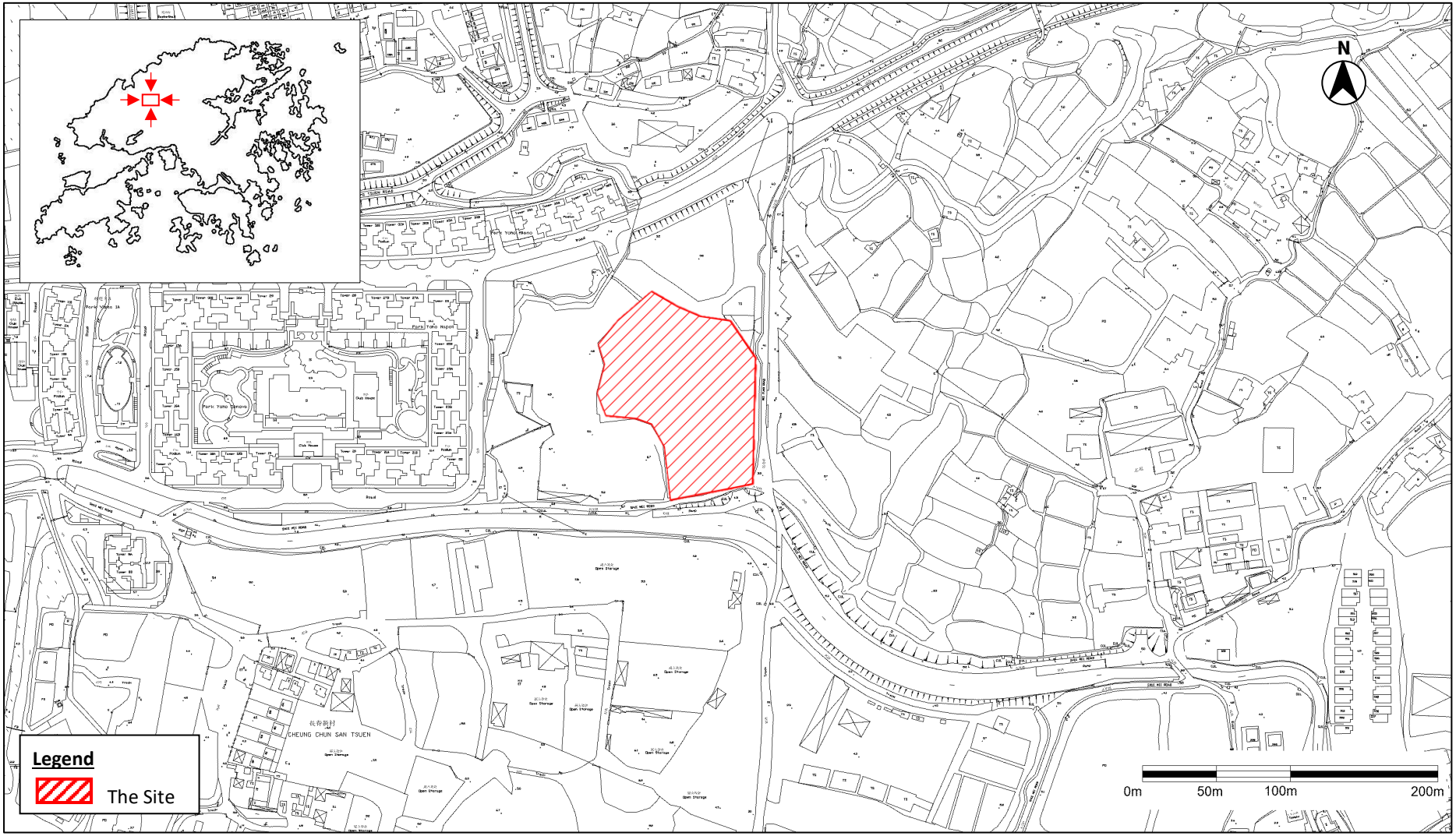
- Assess the potential drainage impacts arising from the Proposed Development.
- Recommend the necessary mitigation measures to alleviate any impacts.

1.5 Reference Materials

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

- Drainage Services Department ("DSD") publication *Stormwater Drainage Manual (with Eurocodes incorporated) – Planning, Design and Management (2018 Edition)*
- DSD Advice Note No. 1 – Application of the Drainage Impact Assessment Process to Private Sector Projects
- Drainage Services Department publication Technical Note to prepare a "Drainage Submission".
- Drainage data of GeoInfo Map reviewed on 23 November 2023.

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 located to the south of a nullah and the north of the other nullah.

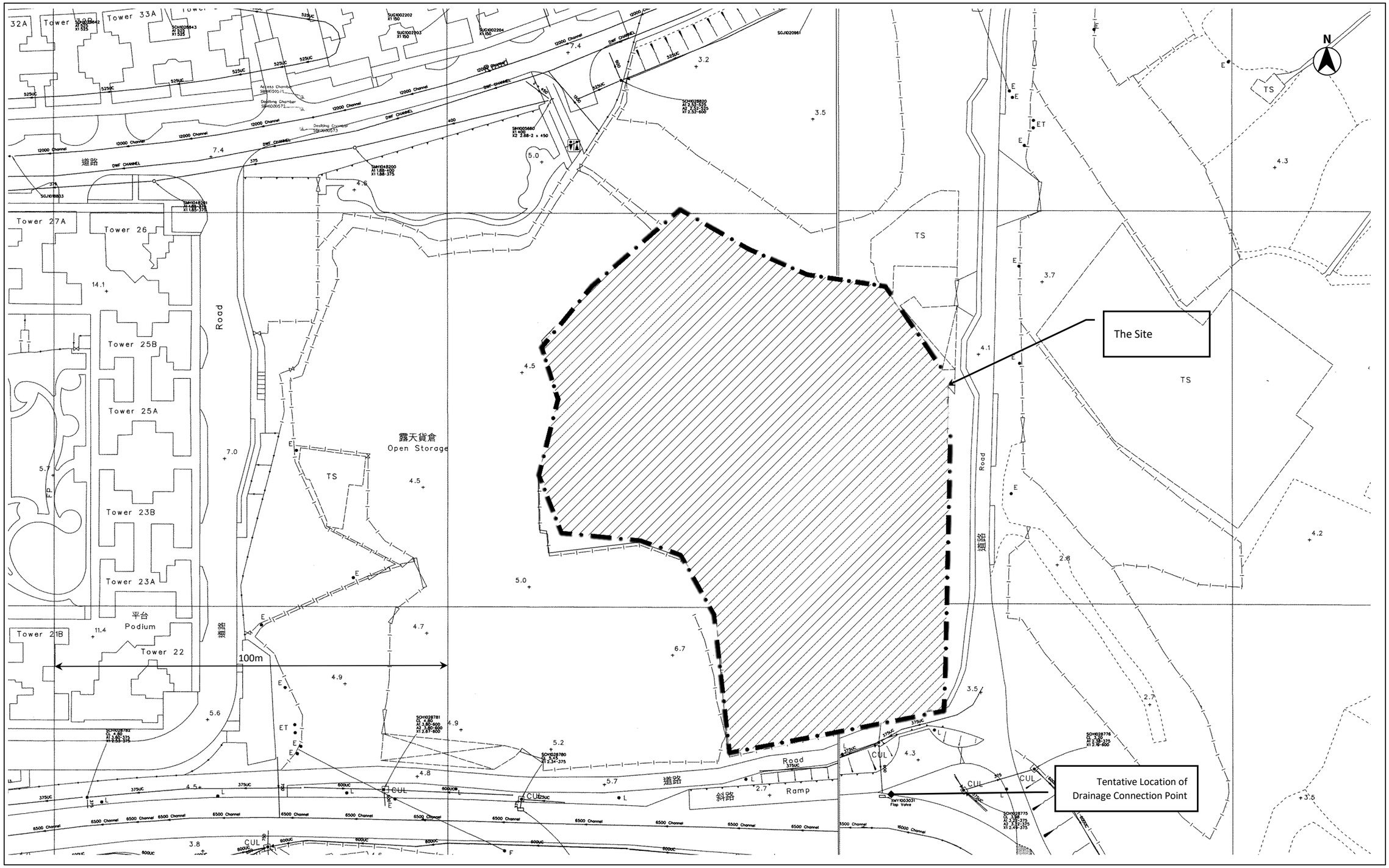
2.1.2 With reference to the layout plans appended to the Planning Statement, the Site elevations range between +3.31mPD and +4.20mPD.

2.2 Existing Baseline Conditions

2.2.1 Majority of the Site area is currently paved.

2.2.2 With reference to the drainage layout plans obtained from the DSD as shown in **Figure 2-1**, it is proposed to divert the Site runoff to the existing stormwater pipe SWD1065697 via the proposed underground pipe.

Figure 2-1 Drainage Layout Plan



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:

$$Q_p = 0.278\, C\, i\, A \qquad \textbf{--- Equation 1}$$

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:

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

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:

$$t_c = t_0 + t_f \qquad \textbf{--- Equation 3}$$

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:

$$t_c = t_0 = t_f$$

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

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*.

$$V = -\sqrt{8gDsg} * \log\left(\frac{ks}{3.7D} + \frac{2.51v}{D\sqrt{2gDs}}\right)$$ ***--- 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 With reference to the layout plans and the elevations as mentioned in **paragraph 2.1.2** and some elevations shown on **Figure 2-1**:

1. The elevation the area to the north of the Site should be +3.5mPD which is lower than that of ~3.56mPD of the northern portion of the Site. Therefore, it is not likely for runoff overflowing from the areas to the north of the Site to the Proposed Development.
2. Mei Fung Road and Shui Mei Road are located to the east and south of the Site respectively. Based on the Site observations which can be verified by reviewing Street Views of Google Map, Mei Fung Road and Shui Mei Road are provided with road drains, and runoff from these roads will likely not overflow into the Site. However, these road drains also connect to the existing stormwater pipe SWD1065697 which is proposed to discharge the runoff from the Site. Therefore, the runoff from these two roads have been assessed and will be taken into account for the calculation of the drainage capacity of the existing stormwater pipe SWD1065697.
3. For the areas to the east and the south of the Site, they are separated by Mei Fung Road and Shui Mei Road respectively. Based on site observations and the topographic map downloaded from Lands Department, the area to the south of the Site is downstream from the Site and Shui Mei Road. Therefore, runoff from the area to the South of the Site will not overflow into the Site. Meanwhile, part of the area to the east of the Site may overflow into Mei Fung Road and has been included in Catchment E, and the rest of the area to the east of the Site will flow into either the nullah to the north or south of the Site, and will not overflow into the Site or Mei Fung Road.

4. For the area to the immediate west of the Site, there is an existing open storage. This open storage to the west of the Site should be filled ponds for plant nursery which was approved with conditions by the TPB on 10 September 1999 (TPB's ref.: A/YL-KTN/95). One of its approval conditions was "*The provision of drainage facilities to the satisfaction of the Director of Drainage Services or of the Town Planning Board*". Although the existing use of the aforementioned open storage could not be observed during the site visit on 9 April 2020 because the open storage was fenced off, according to the satellite photograph dated 16 March 2020 that open storage is still used for plant nursery. Therefore, drainage facilities should be provided for the aforementioned open storage. Moreover, with reference to the topographic basemap from Lands Department (**Figure 2-1** refers), the catchment flow of the open storage to the west of the Site should be from East to West, which is away from the Site. Hence, there should be no runoff overflowing to the Site.

3.2.2 As mentioned in **paragraph 2.2.2** and indicated on **Figure 2-1**, it is recommended to divert the runoff from the Site to the existing stormwater pipe SWD1065697 via the proposed underground pipe. Therefore, four sub-catchments of the Site, Catchments A1, A2, B and C, Shui Mei Road (Catchment D) and Mei Fung Road (Catchment E) have been assessed. Catchments A to E have been indicated and shown on **Figure 3-1**.

3.3 Estimated Runoff

Peak Runoff from the Site

3.3.1 Based on the assumptions as described in **Section 3.2**, the runoff from the Site was estimated based on the return periods of 2, 10 and 50 years summarised in **Table 3-1** and detailed in **Appendix A**.

Table 3-1 Estimated Peak Runoff of the Site

RETURN PERIOD	ESTIMATED PEAK RUNOFF (m^3/s)
2 Years	0.476
10 Years	0.604
50 Years	0.682

3.4 Proposed Indicative Drainage Layout

3.4.1 A proposed drainage layout showing U-channels, proposed underground pipes, existing stormwater pipe SWD1065697 and invert levels has been indicated based on the calculations in **Appendix B**. The U-channels, proposed underground pipe and existing stormwater pipe SWD1065697 of the indicative drainage layout and their invert levels are summarised in **Table 3-2** and shown on **Figure 3-2**. Note that calculation of drainage capacity below is indicative only and will be finalised in the Updated Drainage Proposal prepared by the qualified engineer. A method statement and agreement should be sought from DSD before commencement of any drainage works connecting to the existing channel.

Table 3-2 Summary of Indicative Drainage Facilities

DESCRIPTION	SIZE (mm)	RELATED CATCHMENT	RUNOFF (m^3/s)	CAPACITY (m^3/s)	% OF CAPACITY USED	SUFFICIENT CAPACITY?
U-Channel 1 with gradient of 1:200	Not less than Ø480mm	Catchment A1 of the Site	0.206	0.248	83	Yes
Boundary-Channel 2 with gradient 1:200	Not less than Ø550mm	Catchment B & C of the Site	0.296	0.356	83	Yes
U-Channel 3 with gradient 1:200	Not less than Ø660mm	Catchment A2, B and C	0.476	0.579	82	Yes
Proposed Underground Pipe with gradient 1:200	Not less than Ø725mm	Catchment A1, A2, B & C of the Site	0.682	0.883	77	Yes
Existing Pipe SWD1065697	Not less than Ø600mm	Catchment A to E	1.528	0.610	250	No

3.4.2 As the existing pipe SWD1065697 does not have sufficient capacity to handle the cumulative runoff from the Site, Shui Mei Road and Mei Fung Road, this pipe shall be upgraded to handle the cumulative runoff from these catchments. For upgrading of this pipe, it shall be replaced with a size of at least Ø925mm provided with flap valve at the downstream discharge point.

3.4.3 To protect the upgraded pipe and its upstream catchpits, a flap valve shall be provided at the downstream discharge point.

3.4.4 The calculation of the capacity of the proposed upgraded pipe is summarised in Table and detailed in **Appendix B**.

Table 3-3 Summary of Proposed Upgraded Pipe

DESCRIPTION	SIZE (mm)	RELATED CATCHMENT	RUNOFF (m^3/s)	CAPACITY (m^3/s)	% OF CAPACITY USED	SUFFICIENT CAPACITY?
Proposed Upgraded Pipe	Not less than Ø925mm	Catchment A to E	1.528	1.730	88	Yes

3.4.5 The indicative outfall to be provided with a sand trap is tentatively connected to the existing catchpit SCH1028778, which is currently connected to the existing stormwater pipe SWD1065697, via the proposed underground pipe as shown on **Figure 3-2**. The typical design of catchpit and sand trap can be referred to **Figure 3-3** and **Figure 3-4**. With the provision, implementation and maintenance of the indicative drainage layout and the proposed upgrading works to existing pipe SWD1065697, no adverse drainage impact due to the Proposed Development is anticipated. Due to the insufficient information of the existing underground pipe and topographic data in the surrounding area of the Site, an Updated Drainage Proposal will be conducted in detail design stage to review the calculation and incorporate proposed upgrading works, if necessary.

3.4.6 Indicative cross-section drawings can be referred to **Appendix C**.

Figure 3-1 Identification of Catchments

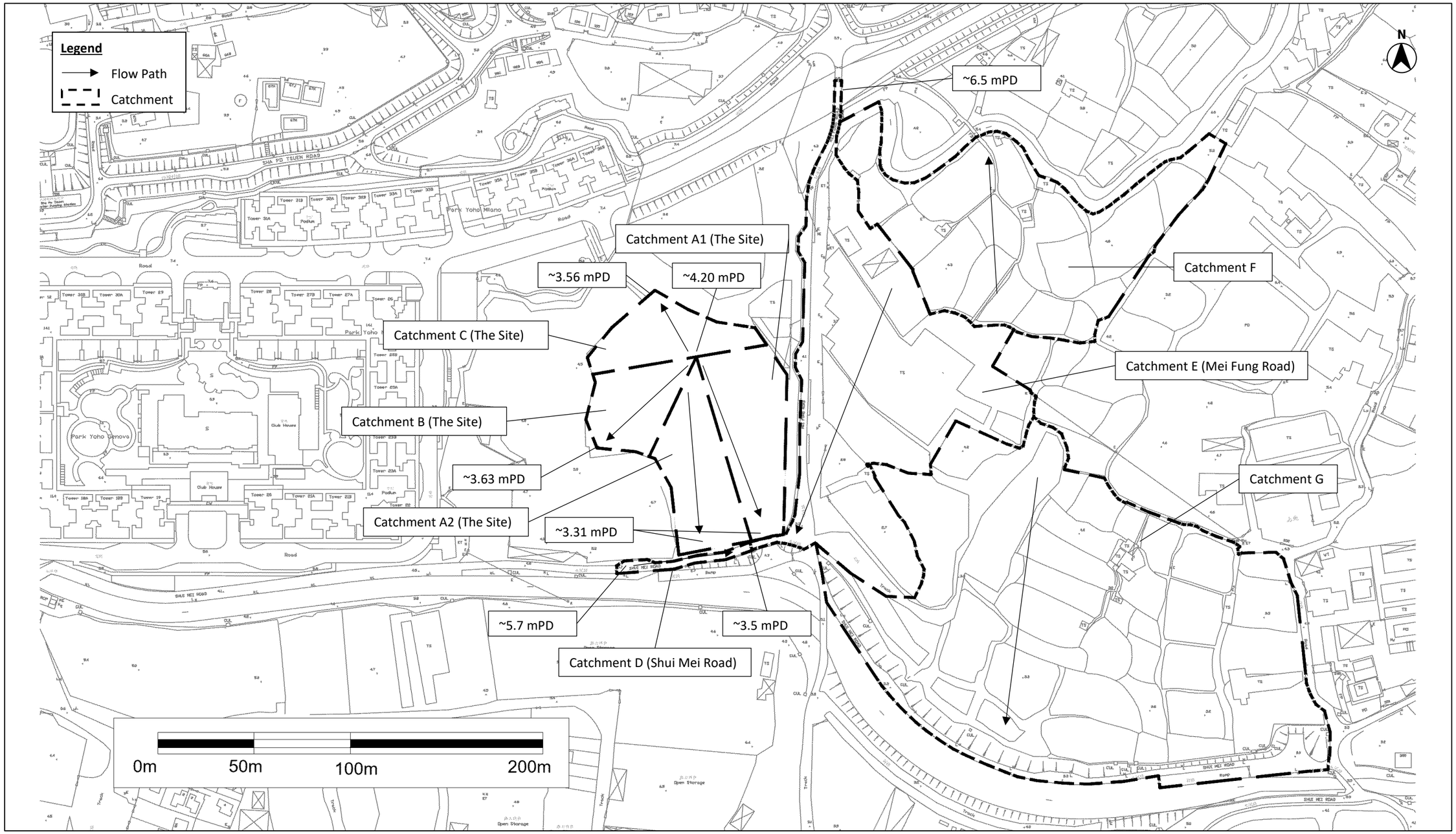


Figure 3-2 Indicative Proposed Drainage Diversion Layout

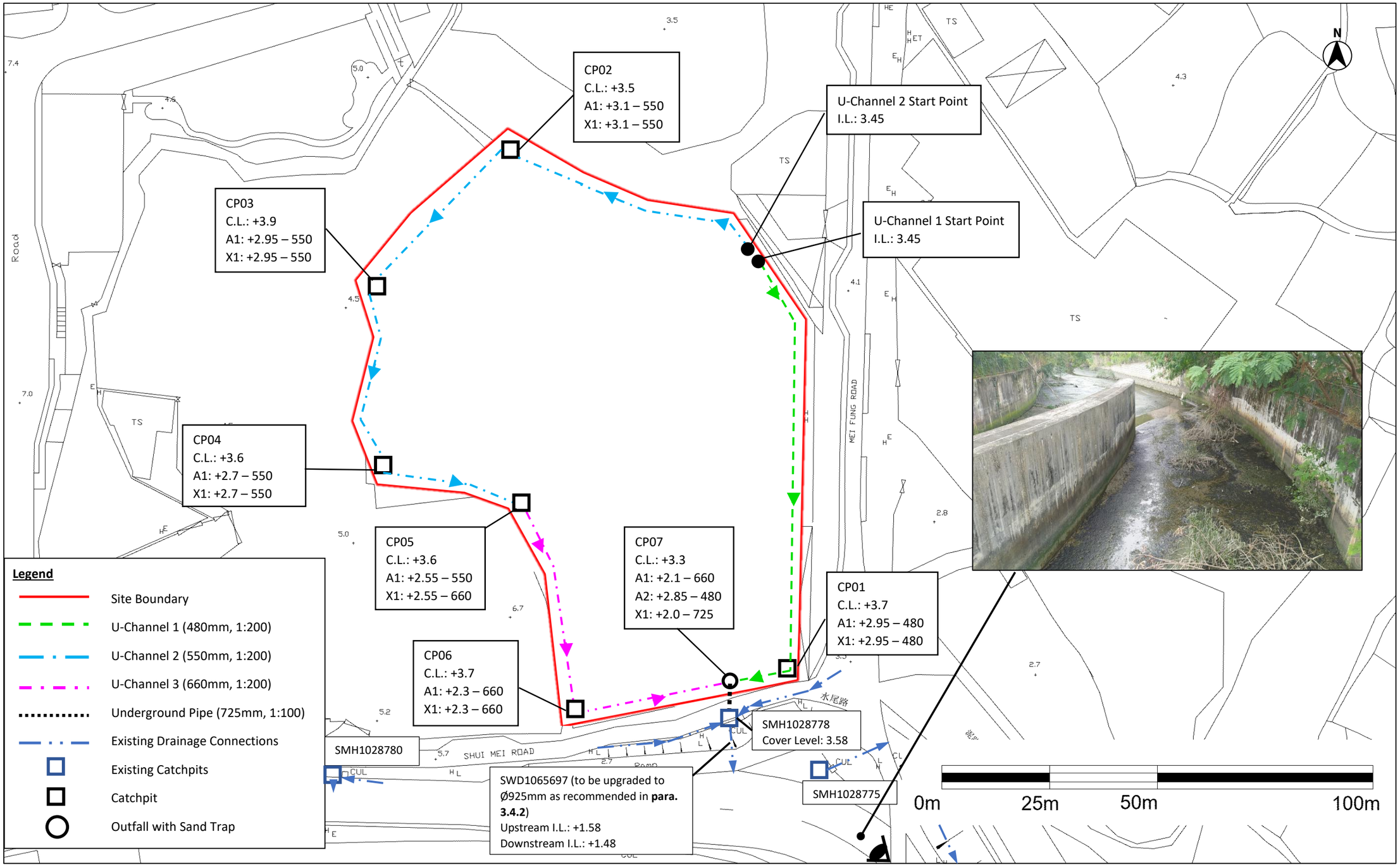


Figure 3-3 Typical Details of Catchpit and Sand Trap

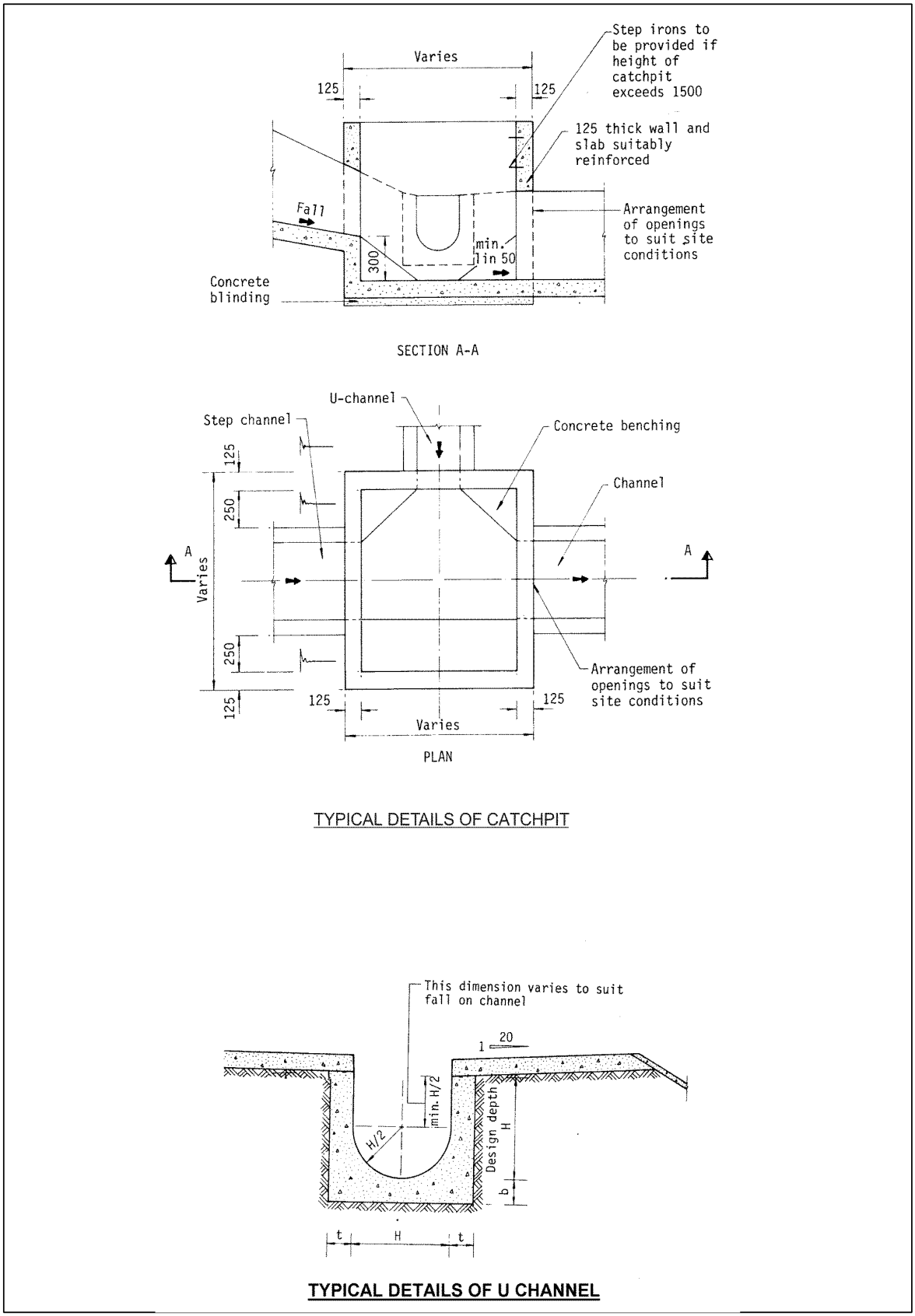
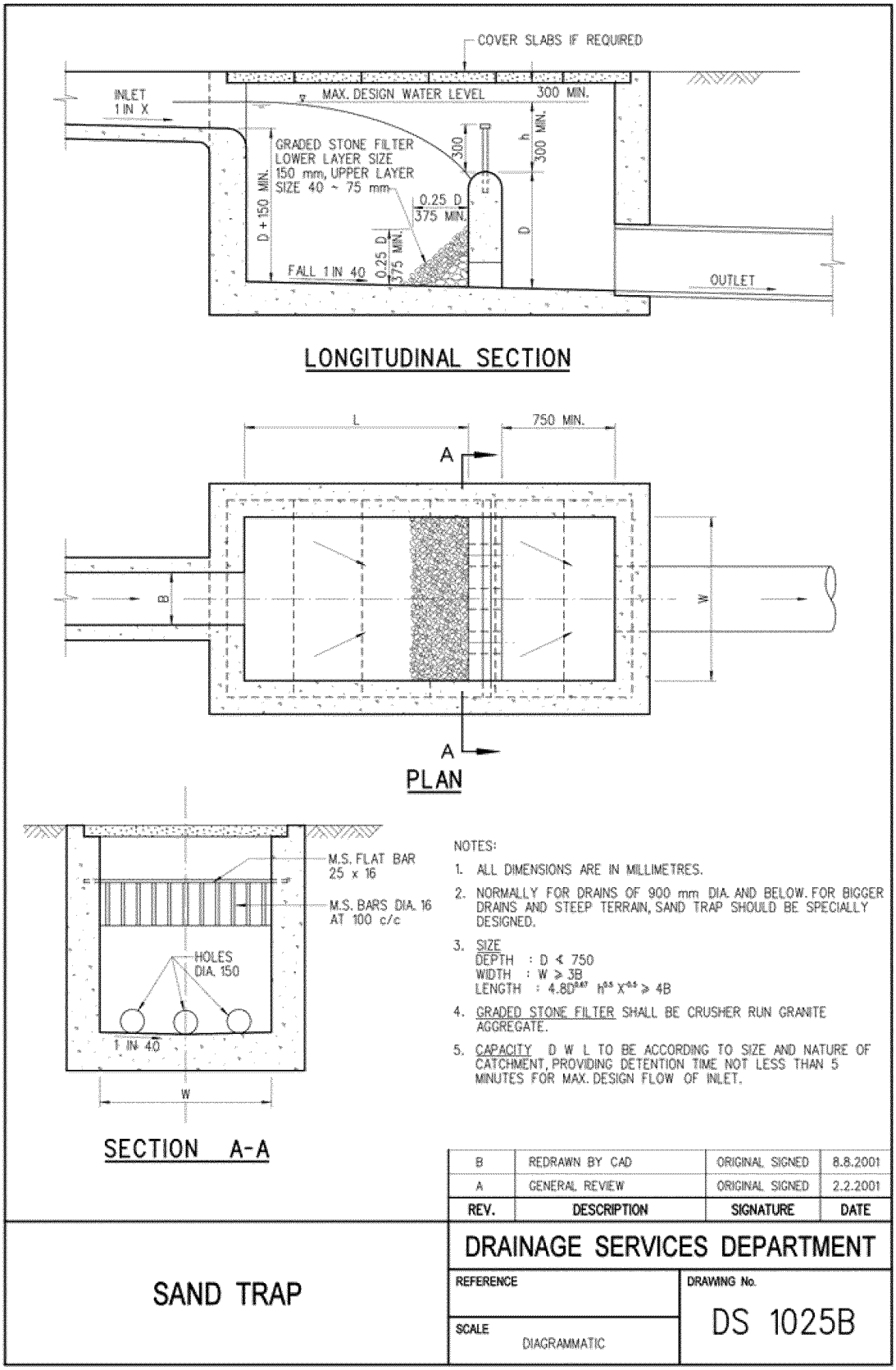


Figure 3-4 Typical Details of Sand Trap



4 CONCLUSION

4.1.1 Potential drainage impacts that may arise from the Site after construction of 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 0.682m^3/s under a 50 years return period.

4.1.3 The indicative drainage layout shown on **Figure 3-2** will properly divert the runoff arising from the Site which there should currently be no runoff from any upper catchments overflowing the Site. The runoff should be diverted to the existing stormwater pipe SWD1065697 according to the drainage plan shown on **Figure 2-1** and **Figure 3-2**. As such, with provision of the proposed upgrading works to stormwater pipe SWD1065697, i.e., with a minimum pipe diameter of 925mm provided with flap valve as recommended in **paragraph 3.4.2**, the pipe capacity is less than 100% and thus, no adverse drainage impact is anticipated.

4.1.4 Since this Drainage Proposal has been prepared based on the limited information available at this planning stage, the drainage layout shown on **Figure 3-2** is indicative only. The Applicant has committed to do the following if this planning application is approved:

1. Appoint a qualified surveyor to carry out topographical survey to identify, AS A MINIMUM, the existing elevations of the Site and within 200m from the Site boundaries. The topographical survey results mentioned shall be summarised in a Topographical Survey Report to be certified by the qualified surveyor.
2. Appoint a qualified engineer to prepare an Updated Drainage Proposal including updated cross-section drawings indicated in **Appendix C** in accordance with relevant DSD guidelines, including *Technical Note to prepare a "Drainage Submission" and Stormwater Drainage Manual – Planning, Design and Management*, the latest DSD drainage records/SMO survey maps and the Topographical Survey Report mentioned above. The Updated Drainage Proposal shall include, AS A MINIMUM, the following information:
    a. Identification of upper and lower catchments, if any, with reference to the Topographical Survey Report.
    b. Review the extents of the cumulative catchments, if any, upon completion of topography survey and subsequently review the sizes of the proposed drainage facilities indicated on **Figure 3-2**.
    c. Proposed drainage layout showing AS A MINIMIUM the cover levels and invert levels of the U-channels, catchpits and sand traps.
    d. Cross section plans showing the existing and proposed ground levels of the Site with respect to adjacent areas, the existing open channel, and any other information required by DSD.
    e. Provision of sand trap or similar before the collected runoff is discharged to public drainage facilities.
    f. Provision of standard details to indicate the sectional details including the discharging pipe connection of the proposed drainage layout plan.
    g. All other information and calculations required in relevant DSD guidelines.

h. Recommendation for providing adequate opening which should be at least 100mm for any walls or hoarding to be erected along the Site boundary 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.

i. Interpretation that no overland flow shall be obstructed and there will be no adverse impact on the existing natural streams, village drains, ditches and the adjacent areas, etc. due to the Proposed Development.

j. Prior to commencing the proposed drainage work, obtain Consent from the District Lands Office/Yuen Long and/or any other government departments for public lots; and/or owners of private lot to the drainage connection into the municipal drainage system.

3. The Updated Drainage Proposal shall be certified by the qualified engineer and annexed with the Topographical Survey Report certified by the qualified surveyor, and shall be submitted to TPB/DSD for approval.

4. Provide, implement and maintain all the mitigation measures to be recommended in the approved Updated Drainage Proposal to ensure that no additional drainage impact due to the Proposed Development will result in flooding/ponding to other off-site areas.

5. A method statement and agreement should be sought from DSD before commencement of any drainage works connecting to the existing channel.

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			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					
Catchment A1 (The Site)	0.0031	0.90	99.0	6.54	6.54	446.1	3.38	0.463	154.17	0.95	0.0030	0.127	0.141
Catchment A2 (The Site)	0.0027	0.90	99.0	6.63	6.63	446.1	3.38	0.463	153.55	0.95	0.0026	0.111	0.123
Catchment B (The Site)	0.0019	0.84	68.0	4.79	4.79	446.1	3.38	0.463	168.69	0.95	0.0018	0.085	0.094
Catchment C (The Site)	0.0020	1.77	40.7	2.45	2.45	446.1	3.38	0.463	197.17	0.95	0.0019	0.106	0.117
Catchment D (Road)	0.0003	3.14	70.0	4.53	4.53	446.1	3.38	0.463	171.24	0.95	0.0003	0.014	0.016
Catchment E (Road)	0.0148	1.26	239.0	12.64	12.64	446.1	3.38	0.463	123.49	0.95	0.0141	0.484	0.538
											Total	**0.927**	**1.030**

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			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					
Catchment A1 (The Site)	0.0031	0.90	99.0	6.54	6.54	485	3.11	0.397	197.18	0.95	0.0030	0.163	0.181
Catchment A2 (The Site)	0.0027	0.90	99.0	6.63	6.63	485	3.11	0.397	196.48	0.95	0.0026	0.142	0.158
Catchment B (The Site)	0.0019	0.84	68.0	4.79	4.79	485	3.11	0.397	213.50	0.95	0.0018	0.107	0.119
Catchment C (The Site)	0.0020	1.77	40.7	2.45	2.45	485	3.11	0.397	245.39	0.95	0.0019	0.131	0.146
Catchment D (Road)	0.0003	3.14	70.0	4.53	4.53	485	3.11	0.397	216.36	0.95	0.0003	0.018	0.020
Catchment E (Road)	0.0148	1.26	239.0	12.64	12.64	485	3.11	0.397	162.33	0.95	0.0141	0.636	0.707
											Total	**1.198**	**1.331**

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			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					
Catchment A1 (The Site)	0.0031	0.90	99.0	6.54	6.54	505.5	3.29	0.355	224.56	0.95	0.0030	0.185	0.206
Catchment A2 (The Site)	0.0027	0.90	99.0	6.63	6.63	505.5	3.29	0.355	223.86	0.95	0.0026	0.162	0.180
Catchment B (The Site)	0.0019	0.84	68.0	4.79	4.79	505.5	3.29	0.355	240.77	0.95	0.0018	0.121	0.134
Catchment C (The Site)	0.0020	1.77	40.7	2.45	2.45	505.5	3.29	0.355	271.79	0.95	0.0019	0.146	0.162
Catchment D (Road)	0.0003	3.14	70.0	4.53	4.53	505.5	3.29	0.355	243.59	0.95	0.0003	0.020	0.023
Catchment E (Road)	0.0148	1.26	239.0	12.64	12.64	505.5	3.29	0.355	189.19	0.95	0.0141	0.741	0.824
											Total	**1.376**	**1.528**

Note:
1) Runoff is calculated in accordance with DSD's "*Stormwater Drainage Manual (with Eurocodes incorporated) - Planning, Design and Managemen* t" (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 *Corrogendum No. 1/2022* of 11.1% for mid 21st Century is adopted.

Appendix B Calculation of Drainage Capacity

Calculation of Drainage Capacity for Return Period of 50 Years

Indicative Drainage capacity of the Internal Drainage System

Channel	Catchments	Shape	D, m	Depth, m	Slope (s)	A_w, m^2	P_w, m	R, m	n	v, m/s	Q_c, m^3/s	Q_p, m^3/s	Capacity	Remark
U-Channel 1	Catchment A1	U-Shape	0.480	0.240	0.005	0.206	1.234	0.167	0.016	1.338	0.248	0.206	83%	OK
U-Channel 2	Catchment B & C	U-Shape	0.550	0.275	0.005	0.270	1.414	0.191	0.016	1.466	0.356	0.296	83%	OK
U-Channel 3	Catchments A2, B & C	U-Shape	0.660	0.330	0.005	0.389	1.697	0.229	0.016	1.655	0.579	0.476	82%	OK

Legend

D = diameter, m

A_w = Cross Section Area of Flow, m^2

P_w = Wetted Perimeter, m

R = Hydraulic Radius = A_w/P_w, m

s = Hydraulic Gradient

n = Manning's roughness coefficient

V = Mean Velocity, m/s

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

Q_p = Estimated Peak Flow, m^3/s

Note
1. Flow capacity of pipe segment is calculated based on Manning's 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. 10% reduction in flow area has been adopted to consider sedimentation reduction in accordance with Section 9.3 of SDM

Calculation of Pipe Capacity for Existing Discharge Segment

Drainage capacity of Proposed Underground Pipe

Segment	Upstream Manhole	Downstream Manhole	D, m	r, m	Slope (s)	A_w, m^2	P_w, m	R, m	k_s, mm	v, m/s	Q_c, m^3/s	Q_p, m^3/s	Capacity	Remark
Proposed Underground Pipe	Outfall with Sand Trap	SMH1028778	0.725	0.363	0.005	0.413	2.278	0.181	0.06	2.375	0.883	0.682	77%	OK

Legend

d = pipe diameter, m
r = pipe radius (m) = 0.5d
A_w = wetted area (m^2) = πr^2
P_w = wetted perimeter (m) = $2\pi r$
R = Hydraulic radius (m) = A_w/P_w
s = Slope of the total energy line
k_s = equivalent sand 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

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

Drainage capacity of Existing Pipe SWD1065697

Segment	Upstream Manhole	Downstream Manhole	D, m	r, m	Slope (s)	A_w, m^2	P_w, m	R, m	k_s, mm	v, m/s	Q_c, m^3/s	Q_p, m^3/s	Capacity	Remark
SWD1065697	SCH1028778	Nullah	0.600	0.300	0.010	0.283	1.885	0.150	0.6	2.397	0.610	1.528	250%	"NOTOK

Legend

d = pipe diameter, m
r = pipe radius (m) = 0.5d
A_w = wetted area (m^2) = πr^2
P_w = wetted perimeter (m) = $2\pi r$
R = Hydraulic radius (m) = A_w/P_w
s = Slope of the total energy line
k_s = equivalent sand 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

Note

1. Flow capacity of pipe segment is calculated based on Colebrook-White Equation.
2. For a conservative estimation, the ks value of 0.6 in poor condition for precast concrete pipes with 'O' ring joints recommended in Table 14 of the SDM for design purpose is adopted
3. 10% reduction in flow area has been adopted to consider sedimentation reduction in accordance with Section 9.3 of SDM

Drainage capacity of the Proposed Upgraded Pipe

Segment	Upstream Manhole	Downstream Manhole	D, m	r, m	Slope (s)	A_w, m^2	P_w, m	R, m	k_s, mm	v, m/s	Q_c, m^3/s	Q_p, m^3/s	Capacity	Remark
Upgraded Pipe	SCH1028778	Nullah	0.925	0.463	0.008	0.672	2.906	0.231	0.60	2.861	1.730	1.528	88%	OK

v, m^2/s	g, m/s^2
1E-06	9.81

Legend

d = pipe diameter, m
r = pipe radius (m) = 0.5d
A_w = wetted area (m^2) = πr^2
P_w = wetted perimeter (m) = $2\pi r$
R = Hydraulic radius (m) = A_w/P_w
s = Slope of the total energy line
k_s = equivalent sand 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

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. For a conservative estimation, the ks value of 0.6 in poor 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

Appendix C Cross Section of the Site and the Surrounding Area After the Proposed Development

Figure C-1 Cross Section of the Site

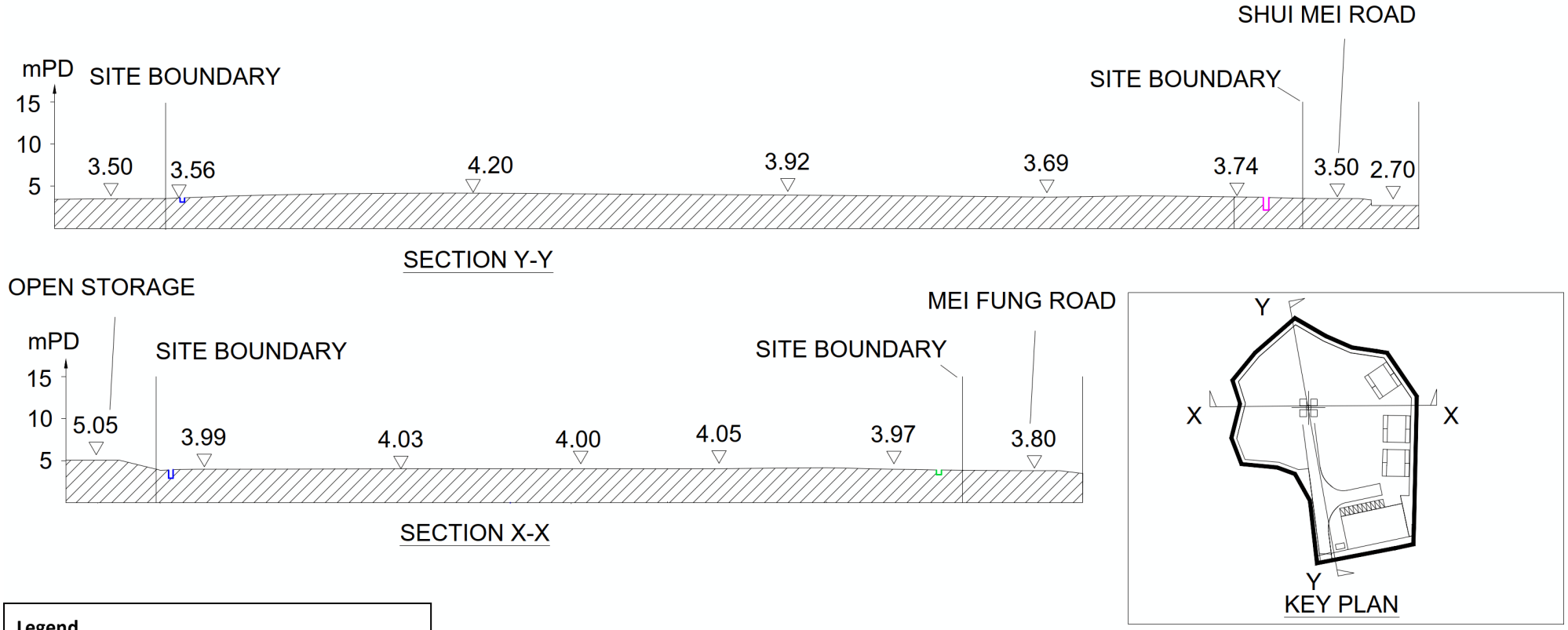
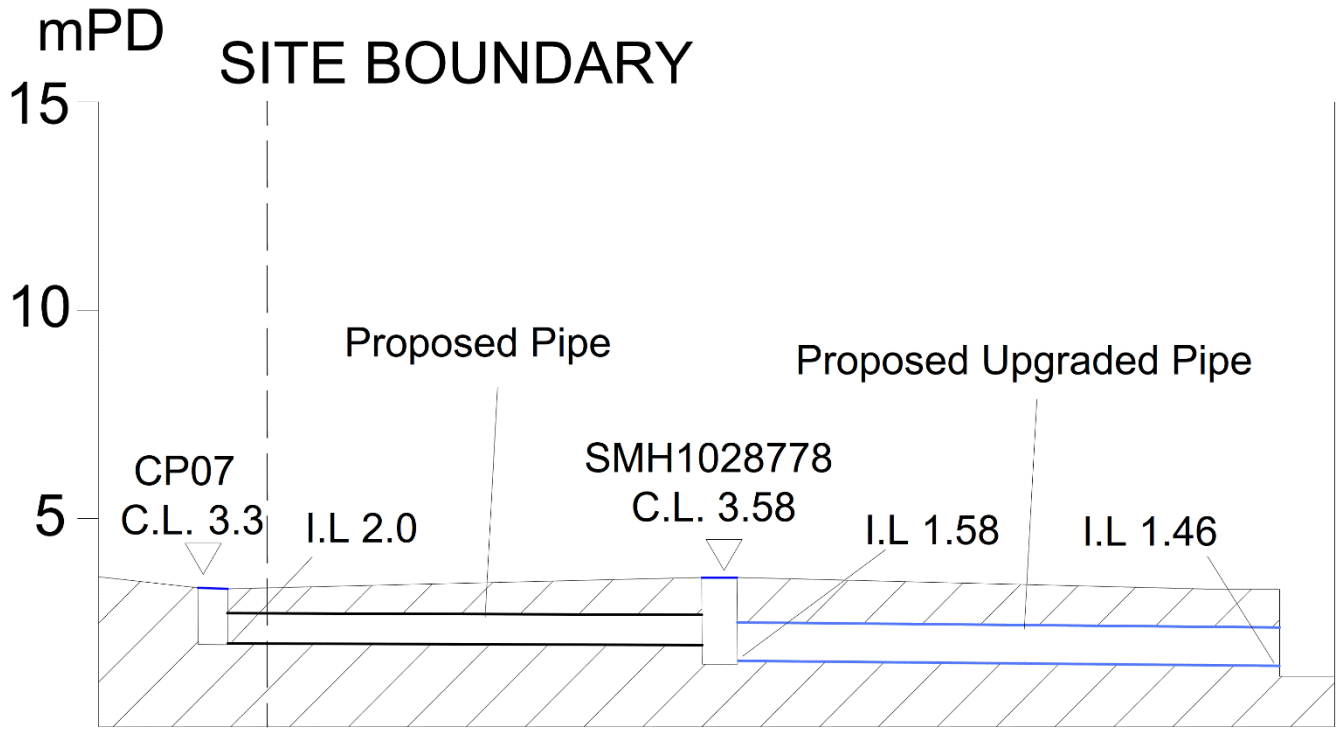


Figure C-2 Cross Section of CP07 to the Discharge Point



Legend

Proposed Underground Pipe (725mm, 1:200)

Proposed Upgraded Pipe (925mm, 1:100)

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Accountability

We understand the importance of being accountable to each other and our clients.

Passion

We are completely passionate about providing practical solutions and outcomes that deliver for our clients.

Insight

We work in an environment that encourages and values insight as a critical quality which informs our decisions and our clients and supports practical solutions and project delivery.

Integrity

We behave with respect and honesty toward each other, our clients and our stakeholders.