Appendix G

Drainage Impact Assessment

AECOM

Section 16 Planning Application for Proposed Commercial Use at Phase IIa Development of an Approved Master Layout Plan (MLP) with Minor Relaxation of Plot Ratio Restriction (Proposed Amendments to the Approved MLP for Comprehensive Residential, Commercial, Social Welfare Facility and Public Vehicle Park Development; with Minor Relaxation of Plot Ratio Restriction Approved at Phase III)

Drainage Impact Assessment

May 2026

Delivering a better world

Prepared by:

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1. Introduction

1.1 Background

1.1.1 AECOM Asia Company Limited (AECOM) was commissioned by the project proponent to act as the engineering consultant to conduct a Drainage Impact Assessment (DIA) to support the Proposed Commercial Development to the south of Castle Peak Road – Yuen Long, New Territories.

1.1.2 This planning application is submitted for proposed commercial development in Phase IIa of a Comprehensive Commercial/Residential Development at the "Comprehensive Development Area" ("CDA") to the immediate south of Castle Peak Road in Area 12, Yuen Long. The location plan is shown in **DIA/Figure 1**.

1.1.3 The Application Site is zoned "CDA" under the Draft Yuen Long Outline Zoning Plan (OZP) No. S/YL/28 and is the subject of various previously approved planning applications for comprehensive commercial/residential development between 1995 and 2023. Due to multiple ownership involved, a phased development approach has all along been adopted for the various development proposals approved therein.

1.1.4 According to the latest planning application No. A/YL/298 for proposed subsidized sale flats (SSF) and social welfare facility (SWF) development approved on 31.3.2023 (hereafter referred to as the "Approved CDA Development") for the subject "CDA" site, the Approved CDA Development is divided into three phases, including Phase I (i.e. the completed commercial/residential development known as the completed YOHO Midtown at the northern and eastern portions), Phases IIa & IIb (i.e. the approved hotel and flats development at the northwestern portion), and Phase III (i.e. the proposed SSF and SWF under the approved application at the southwestern portion).

1.1.5 It should be emphasized that the subject matter of the current planning application is the proposed change in Phase IIa to commercial development only. No change is proposed for Phases I, IIb and III developments within the same "CDA" zone. Under the Approved CDA Development, Phase IIa was proposed for hotel development. However, in order to contribute to achieving home-job balance and creating a mixed-use neighbourhood in Yuen Long District, Phase IIa is now proposed to be a commercial/office development with supporting commercial/retail facilities.

1.1.6 This DIA report serves as a supporting document for the S16 Planning Application for amendments to an approved master layout plan under application No. A/YL/298.

1.2 Objective of this Submission

1.2.1 This report outlines the assessment results of the potential drainage impacts caused by the proposed development at Phase IIa of the Application Site. The main objectives of this assessment include the following:

(i) Review the existing stormwater drainage conditions;

(ii) Outline the methodology adopted in this assessment;

(iii) Outline changes to the drainage characteristics and potential drainage impacts which may arise from the proposed development in Phase IIa;

(iv) Propose drainage mitigation measures where appropriate to mitigate the potential drainage impacts.

1.3 Nomenclature

1.3.1 The following abbreviations and shortened expressions in **Table 1** are adopted in this report.

AECOM	AECOM Asia Company Limited
DSD	Drainage Services Department
DIA	Drainage Impact Assessment
GFA	Gross Floor Area
MLP	Master Layout Plan
mPD	Metres above Principal Datum
SDM	Stormwater Drainage Manual (5^{th} Edition, DSD)

Table 1 - Nomenclature

2. Development Proposal

2.1 The Proposed Development

2.1.1 The Phase IIa development site area is approximately 1,230m^2 with a proposed non-domestic Gross Floor Area (GFA) of not more than 12,207m^2, comprising a commercial/office space of about 11,607m^2 and commercial/retail area of about 600m^2. The tentative intake year for the Phase IIa development is 2030.

2.1.2 The Master Layout Plan (MLP) of the Proposed Development is shown in **DIA/Figure 2**. The proposed development schedule is summarised in **Table 2** below.

Development Parameters (1)	**Phase IIa**
Development Site Area	About 1,230m^2
Total Non-domestic GFA for Proposed Commercial Development (2) - Commercial/Office - Commercial/Retail	Not more than 12,207m^2 About 11,607m^2 About 600m^2
Total Non-domestic Plot Ratio	About 9.93
Maximum Site Coverage	Not exceeding 24m: Not more than 92% Above 24m: Not more than 65%
Maximum Building Height (to the main roof)	Not more than 145mPD
Total No. of Storeys (3)	29 storeys
No. of Blocks	1

Table 2 - Development Schedule

Remarks:

(1) Development parameters shown on this indicative development schedule are for Phase IIa development only (i.e. subject matter of the current planning application).

(2) Including ‘Office’, ‘Eating Place’, ‘Place of Entertainment’, ‘Place of Recreation, Sports or Culture’, ‘School’ (kindergarten, nursery, language, computer, commercial and tutorial schools, art school, ballet and other types of schools providing interest / hobby related courses) and ‘Shop and Services’.

(3) Including 23 commercial / office storeys + 2 commercial / retail storeys (including M/F) + 4 storeys for E&M, carpark and entrance lobby; excluding 1 refuge floor and transfer plate.

3. Assessment Methodology

3.1 Overview of Methodology

3.1.1 This DIA is carried out in accordance with the requirements of the Stormwater Drainage Manual (5th Edition) (SDM), SDM Corrigendum Nos. 1/2022, 1/2024 and 2/2024 promulgated by DSD.

3.1.2 Potential stormwater impacts due to the proposed development are assessed quantitatively. Catchment based runoff will be estimated using Rational Method while the hydraulic performance of the drains shall adopt Colebrook-White with appropriate roughness factors corresponding to the materials and deteriorating conditions. The adopted design parameters for hydraulic calculations are summarised in **Table 3** below.

Design Storm Return Period	50 years
Colebrook-White Roughness Value, k_s	0.6 (Concrete pipe under poor condition)
Viscosity of Water, ν	1×10^{-6} m^2/s
Runoff Coefficients, C	0.95 (Paved Area)
	0.35 (Unpaved Area)
Rainfall increase due to Climate Change (end century)	16%
Rainfall increase due to Climate Change (mid century)	11.1%
Design Allowance (end century)	12.1%
Design Allowance (mid century)	0%

Table 3 - Design Hydraulic Parameters

3.2 Climate Change

3.2.1 According to DSD's SDM, rainfall allowance due to the effect of climate change should be considered in drainage impact assessments. With reference to the SDM Corrigendum No. 1/2022, a 16% increase in rainfall intensity by the end of the 21st century and a 12.1% design allowance has been considered for this assessment.

3.3 Design Flood Levels

3.3.1 According to DSD's SDM Clause 6.4 and Table 11, two flood cases for the combined rain and tide events are considered for a 50-year return period, which is summarised in **Table 4**.

Flood Level Return Period	Case I (50A)	Case II (50B)
50 years	50-year rain + 10-year sea level	10-year rain + 50-year sea level

Table 4 - Design Flood Levels

3.3.2 Sufficient freeboard will be provided in accordance with DSD's SDM Clause 6.5.

4. Drainage Impact Assessment

4.1 Site Description

4.1.1 Phase IIa of the Application Site is bound by Castle Peak Road – Yuen Long to the North and Yau Tin East Road to the South.

4.1.2 The site area of Phase IIa is currently partially covered with vegetation (about 8%), while the remaining portion is occupied by various sheds (about 92%). Aerial view of the existing site refers to **Appendix 1**, and the existing catchment area plan is shown in **DIA/Figure 3**.

4.2 Existing Drainage System

4.2.1 Phase IIa is located adjacent to an existing nullah SCP1009740 along Yau Tin East Road receiving stormwater runoff. Layout of the existing drainage system refers to **DIA/Figure 4**. The boundary conditions including the discharge and water level of the existing nullah provided by DSD are enclosed in **Appendix 2**.

4.2.2 It is noted that the downstream of the existing nullah is under upgrading under DSD's contract No. DC/2022/03, Yuen Long Barrage Scheme. Once the project is completed by mid-2030, water level of the nullah at Yau Tin East Road is expected to be lowered resulting in an increased flooding resilience. As the boundary conditions provided by DSD are in accordance with the 2018 edition of the SDM, appropriate adjustments are made to incorporate the changes from SDM Corrigendum Nos. 1/2022 and 1/2024. The resulting boundary conditions are summarized in **Table 5**. Detailed calculations can be referred to **Appendix 3**.

Flood Case	Boundary Conditions	Prior to Yuen Long Barrage Scheme		After completion of Yuen Long Barrage Scheme	
		Mid-century conditions provided by DSD	Projected mid-century conditions adopted in this DIA (1)	Mid-century conditions provided by DSD	Projected end-century conditions adopted in this DIA
50A	Water Level (mPD)	4.57	4.85	3.89	4.41
	Discharge (m^3/s)	28.34	29.85	33.27	40.42
50B	Water Level (mPD)	4.76	5.02	3.72	4.16
	Discharge (m^3/s)	24.51	25.36	31.85	38.00

(1) Mid century climate change is adopted for the boundary conditions prior to completion of the Yuen Long Barrage Scheme as the project is anticipated to be completed by mid-2030.

Table 5 - Boundary Conditions of Existing Nullah

4.3 Runoff Estimation

4.3.1 Rational Method has been adopted for the estimation of runoff from the pre-development and post-development scenarios.

4.3.2 The surface runoff from Phase IIa before development is about 0.094m^3/s, and the post-development runoff is slightly increased to 0.099m^3/s due to having a slight increase in paved area. The summary of surface runoff is shown in **Table 6** below. Detail calculations of runoff estimation for both pre-development and post-development refer to **Appendix 4**.

	Paved Area (m^2)	Unpaved Area (m^2)	Time of Concentration (min)	Rainfall Intensity (1) (mm/hr)	Surface runoff (m^3/s)
Pre-Development	1,130 (2)	100 (2)	5	305.6	0.094
Post-Development (Prior to Yuen Long Barrage Scheme)	1,230 (3)	0	5	265.1(4)	0.086
Post-Development (after completion of Yuen Long Barrage Scheme)	1,230 (3)	0	5	305.6	0.099

(1) Rainfall intensity include 16% rainfall increase due to climate change and 12.1% design allowance.

(2) Existing Phase IIa site is about 92% paved and 8% unpaved as shown in **DIA/Figure 3**, with reference to aerial photo under **Appendix 1**.

(3) Post-development Phase IIa is assumed to be 100% paved as a conservative approach.

(4) Since the upgrading works by DSD (Yuen Long Barrage scheme) is in progress and is expected to be completed by mid-2030, mid-century 50-year rainfall is adopted for the interim stage prior to completion of the upgrading works.

Table 6 - Runoff Estimation

5. Potential Drainage Impacts and Mitigation Measures

5.1 Proposed Drainage System

5.1.1 Terminal manhole TMH1 is proposed to collect surface runoff within Phase IIa. The runoff will be collected by a newly constructed drainage system to be discharged to the existing nullah SCP1009740 at Yau Tin East Road via. a new outlet with flap valve. The proposed drainage layout plan is shown in **DIA/Figure 5**.

5.1.2 The proposed stormwater pipes are designed to cater for effect of climate change. Minimum 300mm freeboard is achieved at the interim stage prior to completion of Yuen Long Barrage Scheme. Once the Yuen Long Barrage Scheme is completed, minimum freeboard is expected to increase to over 500mm, complying with DSD SDM Clause 6.5. Hydraulic calculation refers to **Appendix 5.**

5.1.3 The drainage system including internal drainage will be further developed and submitted for vetting in the detailed design stage. Perimeter drains would be provided where necessary to intercept surface runoff from the site.

5.2 Potential Drainage Impacts

5.2.1 The increase in runoff of the existing nullah SCP1009740 due to Phase IIa development at the ultimate stage is summarized in **Table 7**. The increase in runoff is considered to be insignificant.

Existing Drains	Existing Runoff (50-year) (m^3/s)	Runoff (50-year) of Phase IIa (m^3/s)	Percentage Increase
Existing Nullah SCP1009740	40.42	0.099	0.25%

Table 7 - Summary of Drainage Impacts

5.3 Construction Stage Drainage Mitigation Measures

5.3.1 No major drainage issues during the construction stage are anticipated. The temporary drainage arrangement during the construction stage shall be designed by the contractor and submitted to DSD for approval.

6. Maintenance Responsibility

6.1.1 The development is responsible for the construction and maintenance of all drainage facilities within the Phase IIa Site Boundary, including the internal drainage system and stormwater terminal manhole.

6.1.2 The development is also responsible for the construction of the drainage pipes and manholes proposed in the DIA report outside the Application Site boundary, and once completed will be handed over to DSD for future maintenance.

7. Conclusion

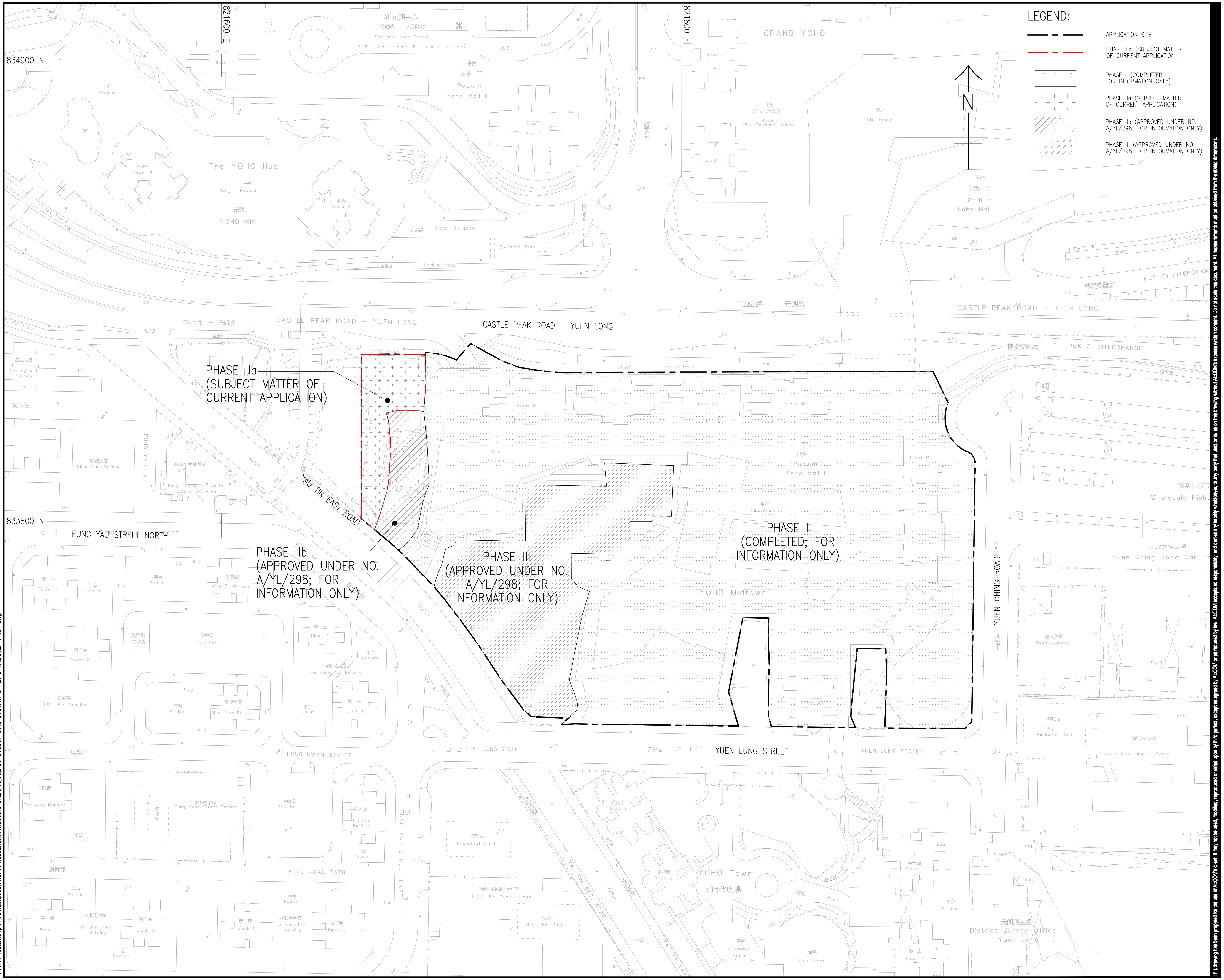
7.1.1 The DIA for the Application Site was previously approved under planning application No. A/YL/298. Under this planning application, the MLP for Phase IIa is amended, and the drainage impacts arising from Phase IIa development is assessed under this DIA.

7.1.2 The surface runoff of Phase IIa will be discharged to a proposed drainage system to be ultimately discharged to the existing nullah SCP1009740 to the south of Phase IIa.

7.1.3 Based on the hydraulic calculation, no impact to the existing drainage system is envisaged.

End of Report

Figures



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PROJECT 項目

SECTION 16 PLANNING APPLICATION FOR PROPOSED COMMERCIAL USE AT PHASE IIA DEVELOPMENT OF AN APPROVED MASTER LAYOUT PLAN (MLP) WITH MINOR RELAXATION OF PLOT RATIO RESTRICTION (PROPOSED AMENDMENTS TO THE APPROVED MLP FOR COMPREHENSIVE RESIDENTIAL, COMMERCIAL, SOCIAL WELFARE FACILITY AND PUBLIC VEHICLE PARK DEVELOPMENT; WITH MINOR RELAXATION OF PLOT RATIO RESTRICTION APPROVED AT PHASE III)

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I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 審核

STATUS 階段

SCALE 比例: A3 1 : 1500

DIMENSION UNIT 尺寸單位: METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號: YOHO

AGREEMENT NO. 協議編號

SHEET TITLE 圖紙名稱: SITE LOCATION PLAN

SHEET NUMBER 圖紙編號: YOHO/DIA/FIGURE 1

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Approved:
Checked:
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Project Management Initials:
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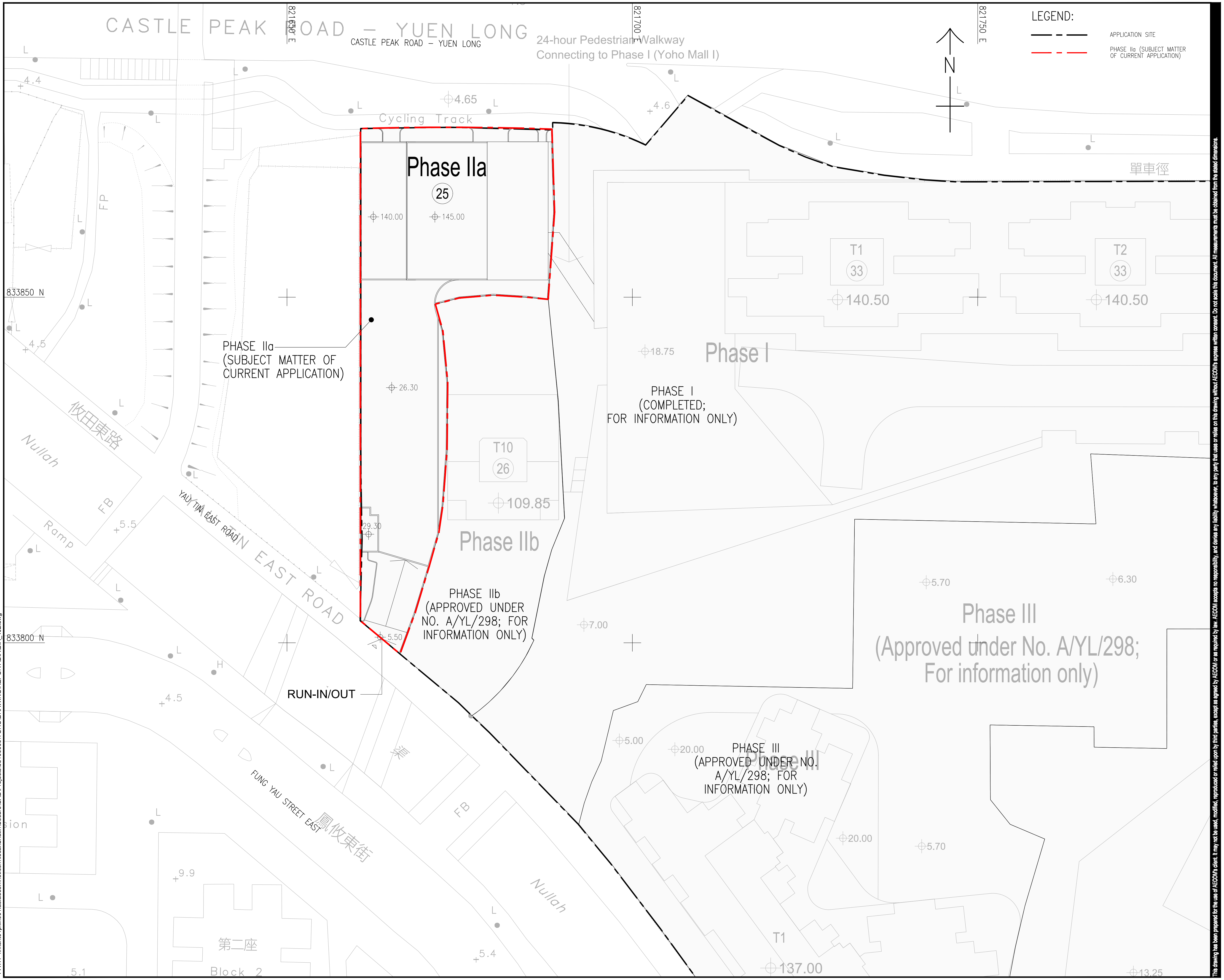

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PROJECT

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KEY PLAN

PROJECT NO. YOHO

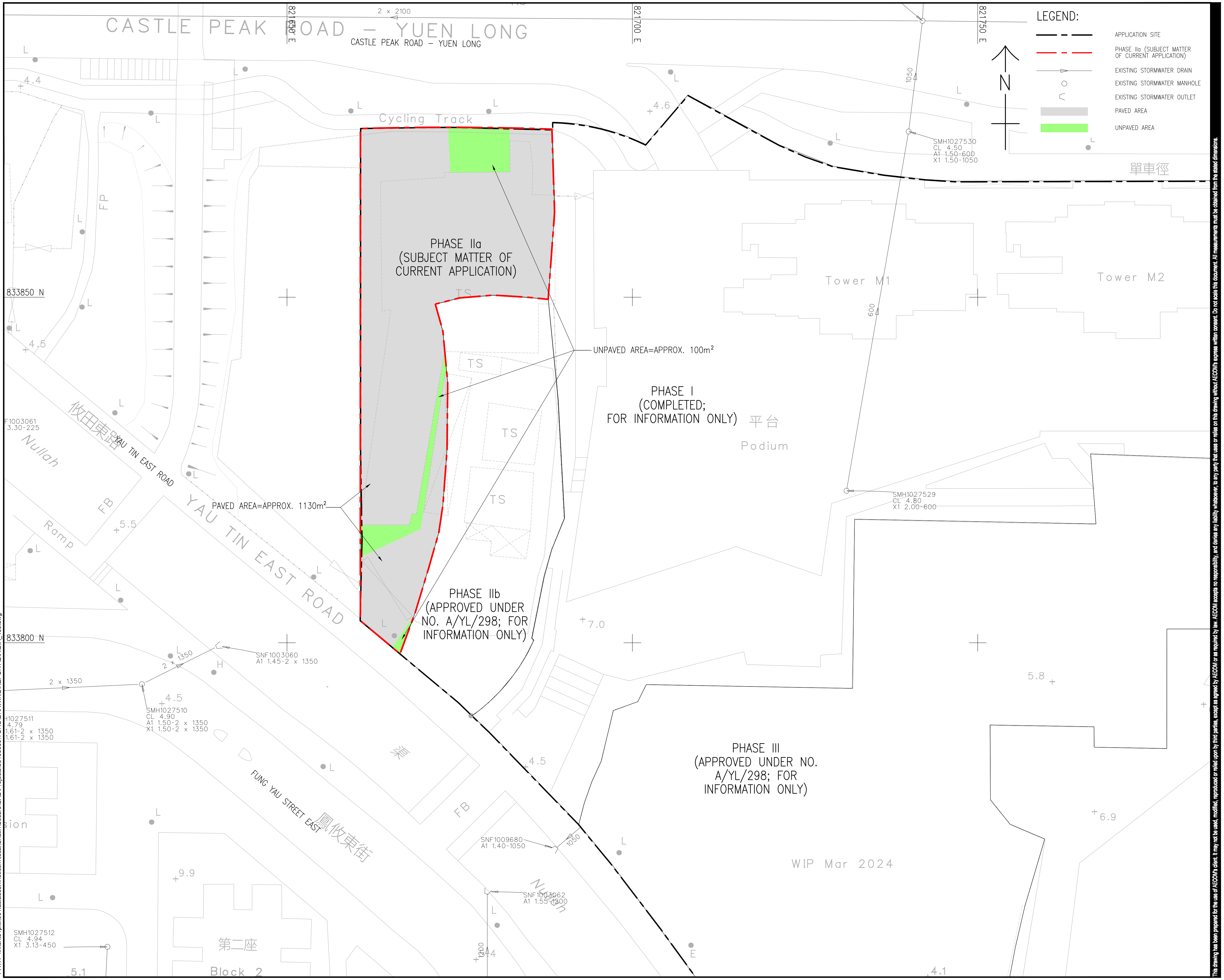
AGREEMENT NO.

SHEET TITLE

MASTER LAYOUT PLAN

SHEET NUMBER

YOHO/DIA/FIGURE 2



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KEY PLAN

PROJECT NO.: YOHO

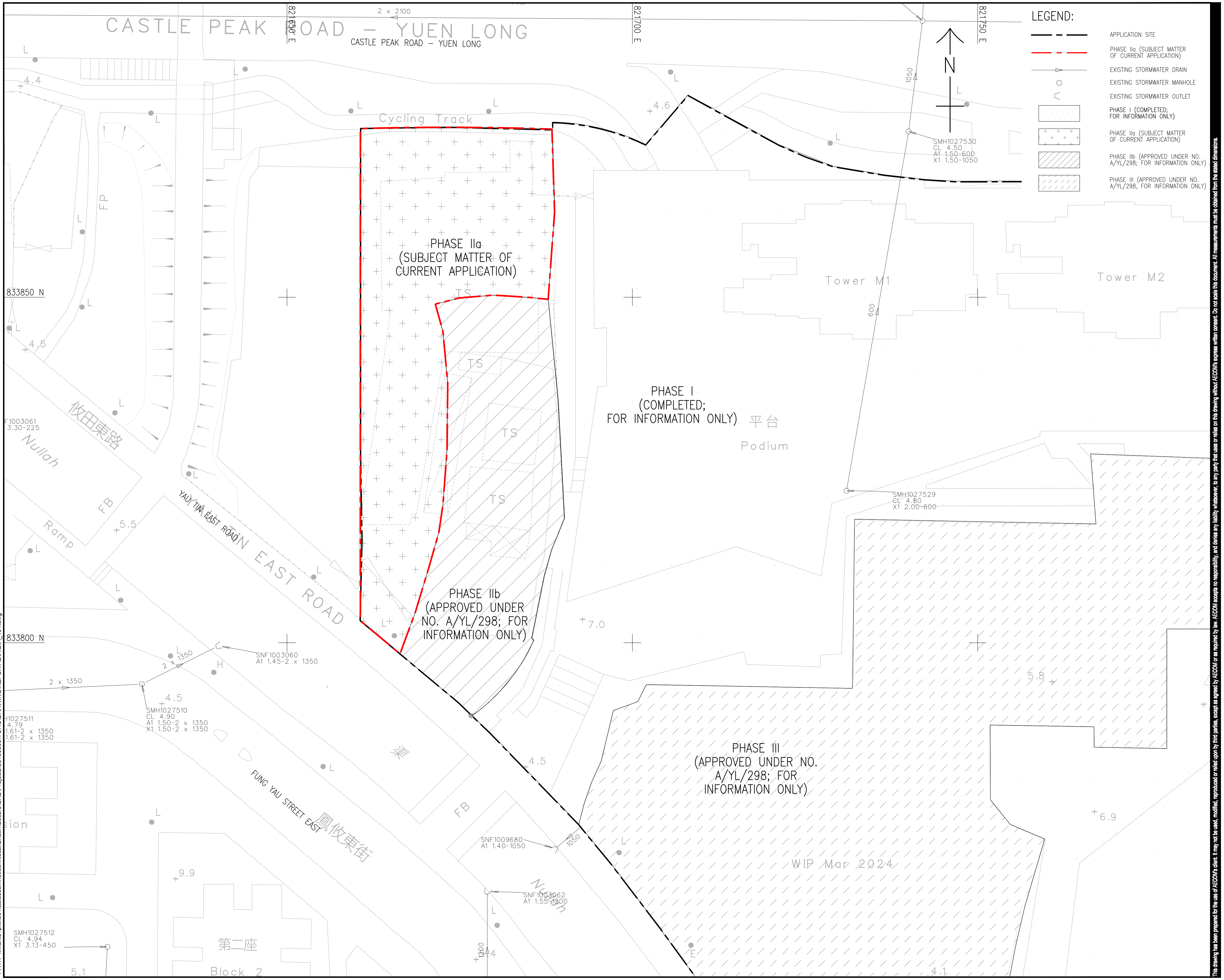
AGREEMENT NO.

SHEET TITLE

EXISTING CATCHMENT AREA PLAN FOR PHASE IIa

SHEET NUMBER

YOHO/DIA/FIGURE 3



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A3 1 : 500 | METRES

KEY PLAN

PROJECT NO. | **AGREEMENT NO.**

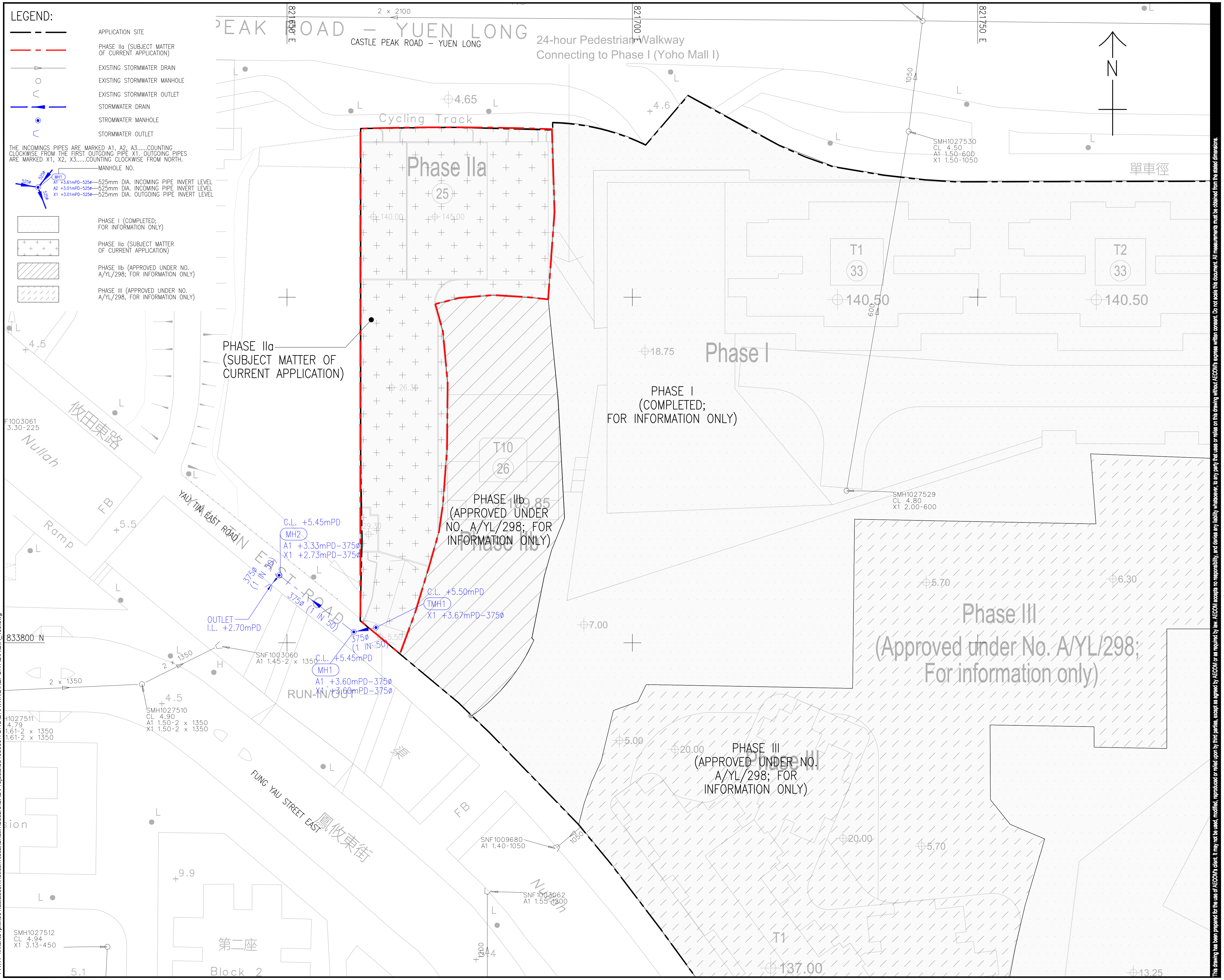
YOHO

SHEET TITLE

EXISITNG DRAINAGE LAYOUT PLAN

SHEET NUMBER

YOHO/DIA/FIGURE 4



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PROJECT

SECTION 16 PLANNING APPLICATION FOR PROPOSED COMMERCIAL USE AT PHASE IIA DEVELOPMENT OF AN APPROVED MASTER LAYOUT PLAN (MLP) WITH MINOR RELAXATION OF PLOT RATIO RESTRICTION (PROPOSED AMENDMENTS TO THE APPROVED MLP FOR COMPREHENSIVE RESIDENTIAL, COMMERCIAL, SOCIAL WELFARE FACILITY AND PUBLIC VEHICLE PARK DEVELOPMENT; WITH MINOR RELAXATION OF PLOT RATIO RESTRICTION APPROVED AT PHASE III)

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SHEET TITLE

PROPOSED DRAINAGE LAYOUT PLAN

SHEET NUMBER

YOHO/DIA/FIGURE 5

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Appendix 1

Aerial View of the Existing Site

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Survey & Mapping Office, Lands Department
The Government of Hong Kong Special Administrative Region

E188289C 6900' 24 Feb 2023 UltraCam Eagle 210mm
YUEN LONG 元朗

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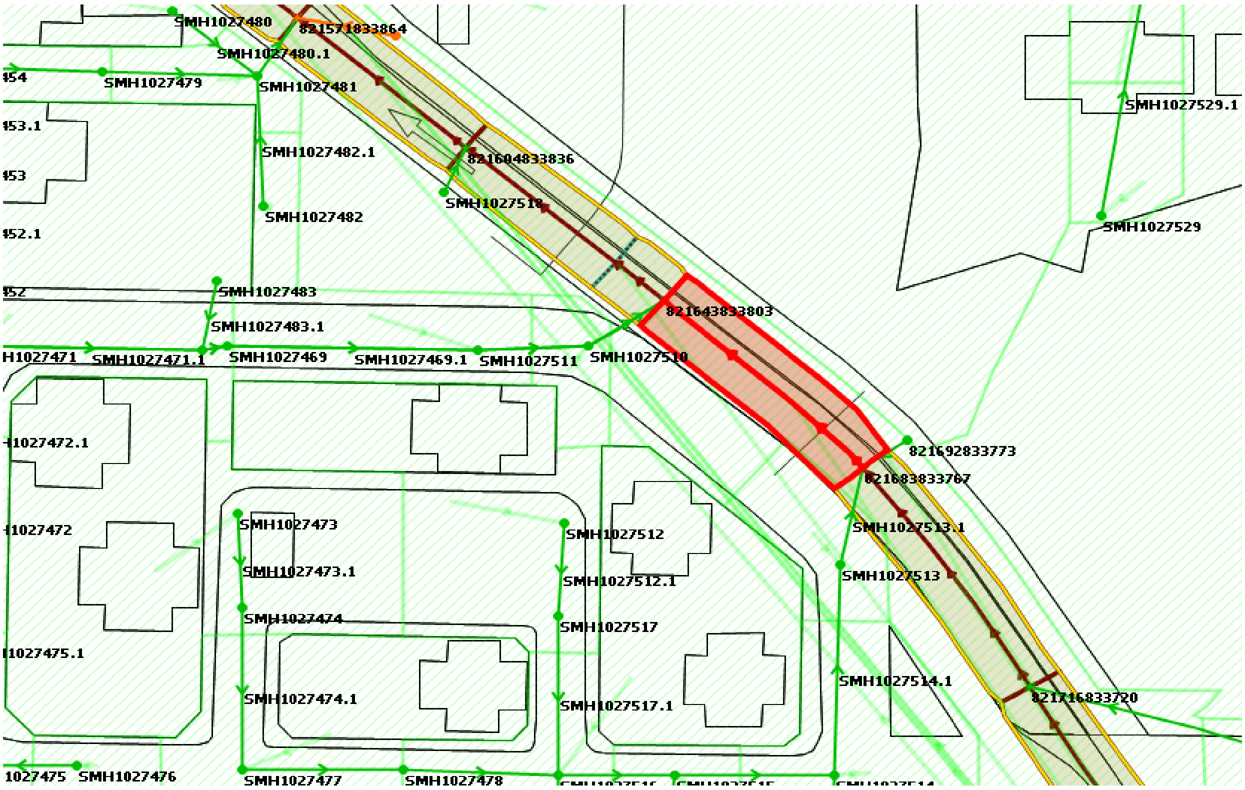
Appendix 2

Boundary Conditions by DSD

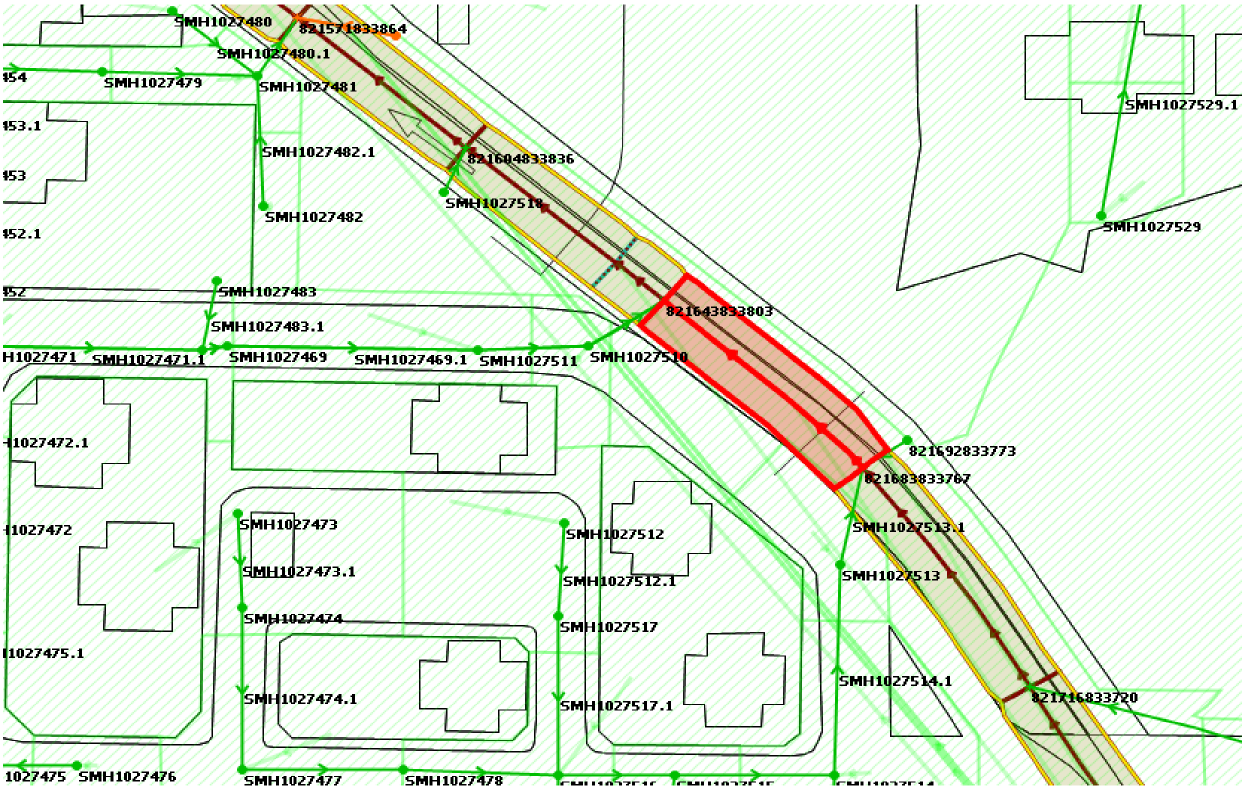
PP Scenario with Mid-Century Climate Change

Object / Node ID	Properties / Cases	50A	50B
821643833803	Point A (mAD)	3.890	3.722
821683833767	Point B (mAD)	3.886	3.718
821683833767.1	DS Discharge (m^3/s)	33.173	31.855
	US Discharge (m^3/s)	33.274	31.855



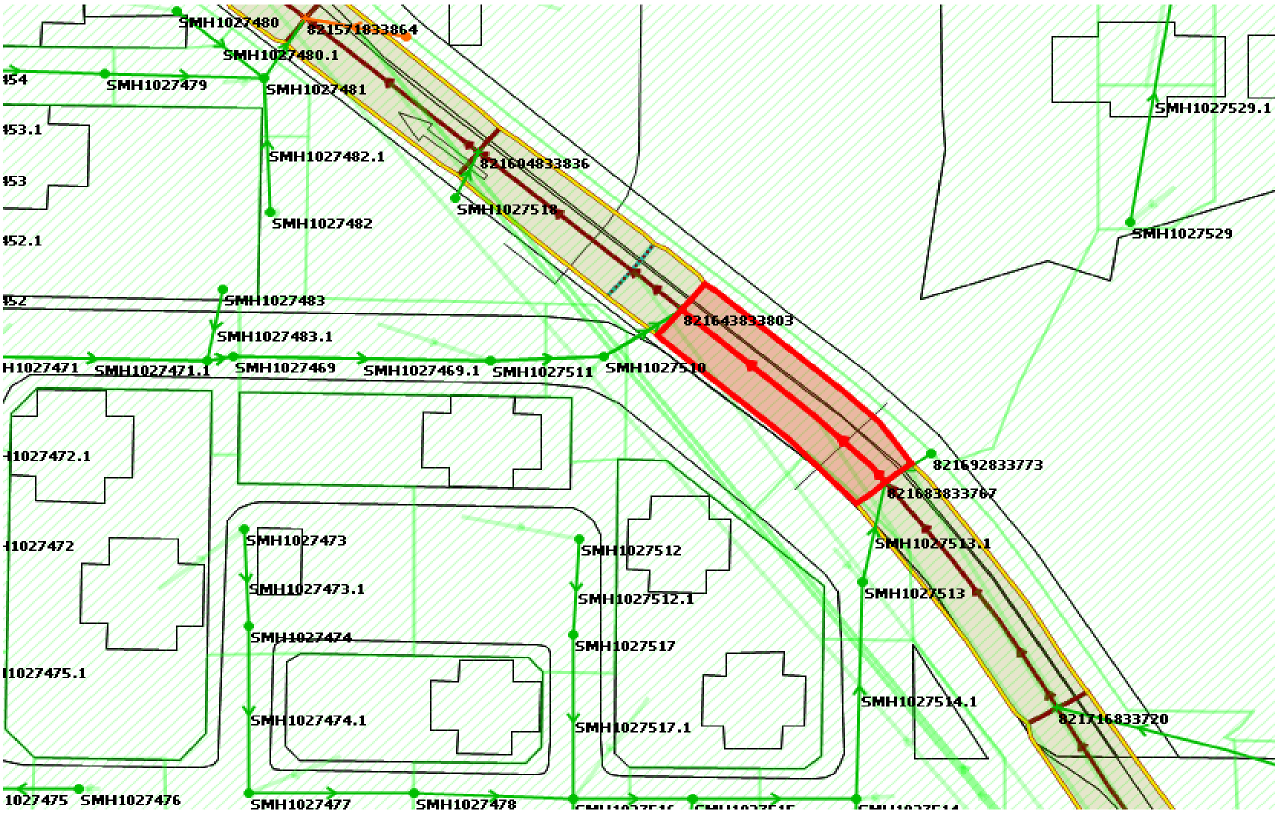
PP Scenario without Mid-Century Climate Change

Object / Node ID	Properties \ Cases	50A	50B
821643833803	Point A (mAD)	3.777	3.581
821683833767	Point B (mAD)	3.774	3.579
821683833767.1	DS Discharge (m^3/s)	32.269	29.850
	US Discharge (m^3/s)	32.294	29.879



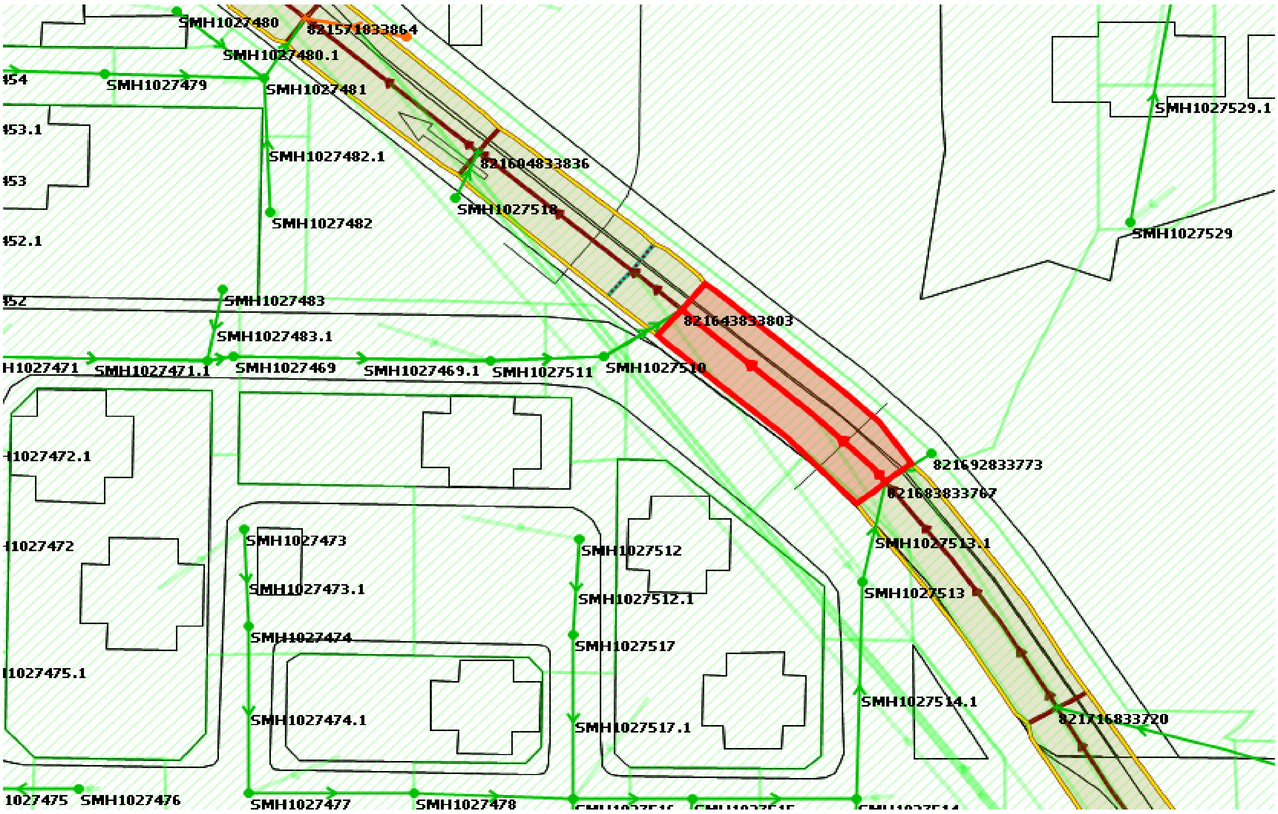
EE Scenario with Mid-Century Climate Change

Object / Node ID	Properties \ Cases	50A	50B
821643833803	Point A (mAD)	4.565	4.762284
821683833767	Point B (mAD)	4.564	4.763165
821683833767.1	DS Discharge (m^3/s)	28.3795	24.37818
	US Discharge (m^3/s)	28.3413	24.51451



EE Scenario without Mid-Century Climate Change

Object / Node ID	Properties \ Cases	50A	50B
821643833803	Point A (mAD)	4.294	4.477
821683833767	Point B (mAD)	4.292	4.478
821683833767.1	DS Discharge (m^3/s)	27.587	24.404
	US Discharge (m^3/s)	27.569	24.259



Appendix 3

Projection of Boundary Conditions of Existing Nullah

Comparison of rainfall increase due to climate change (Corrigendum No. 1/2022)

Mid Century		
Rainfall increase at mid-century using SDM2018	=	10.4%
Rainfall increase at mid-century with latest corrigendum	=	11.1%
Percentage increase in latest corrigendum	=	0.6%
End Century		
Rainfall increase at end-century using SDM2018	=	13.8%
Rainfall increase at end-century with latest corrigendum	=	28.1%
Percentage increase in latest corrigendum	=	12.6%

Reference from SDM2018:

Table 28 – Rainfall Increase and Sea Level Rise due to Climate Change

	Rainfall Increase	Sea Level Rise (m)
Mid 21st Century (2041 – 2060)	10.4%	0.23
End of 21st Century (2081 – 2100)	13.8%	0.49

Reference from Corrigendum No. 1/2022:

(k) Table 28 Rainfall Increase due to Climate Change

Replace the table with the following:

Table 28 – Rainfall Increase due to Climate Change

	Rainfall Increase
Mid 21st Century	11.1%
End of 21st Century	16.0%

Notes:
1. The rainfall increase is relative to the average of 1995-2014.
2. Mean projection values are adopted in the table.
3. Mid 21st century refers to years 2041 – 2060; end of 21st century refers to years 2081 – 2100.

Appendix 2 – Design Allowance in Mid 21st Century

Rainfall Increase	**Extreme Sea Level Rise (Sum of Mean Sea Level Rise and Storm Surge Increase)**				
	Return Period (Years)	**North Point/ Quarry Bay (m)**	**Tai Po Kau (m)**	**Tsim Bei Tsui (m)**	**Tai O (m)**
0 %	2	0.04	0.05	0.05	0.04
	5	0.04	0.06	0.05	0.04
	10	0.04	0.07	0.06	0.05
	20	0.04	0.07	0.06	0.05
	50	0.05	0.08	0.06	0.05
	100	0.05	0.09	0.07	0.06
	200	0.05	0.10	0.07	0.06

Notes:
1. Mid 21st century refers to period around 2050.
2. Design allowance for rainfall increase has been included in Table 28.

Table 31 Design Allowance in End of 21st Century

Rainfall Increase	**Extreme Sea Level Rise (Sum of Mean Sea Level Rise and Storm Surge Increase)**				
	Return Period (Years)	**North Point/ Quarry Bay (m)**	**Tai Po Kau (m)**	**Tsim Bei Tsui (m)**	**Tai O (m)**
12.1%	2	0.20	0.22	0.20	0.19
	5	0.21	0.24	0.22	0.20
	10	0.22	0.25	0.23	0.21
	20	0.22	0.27	0.23	0.22
	50	0.24	0.29	0.25	0.22
	100	0.24	0.31	0.26	0.23
	200	0.25	0.34	0.27	0.24

Note:
1. End of 21st century refers to period around 2090.
2. Design allowance was derived from the projection difference (median values) between very high greenhouse gas emissions scenario [SSP5-8.5] and intermediate greenhouse gas emissions scenario [SSP2-4.5]. For design allowance in mid 21st century, designers can make reference to the table as shown in Appendix 2.

Assessment of Impact of Corrigendum No. 1/2024

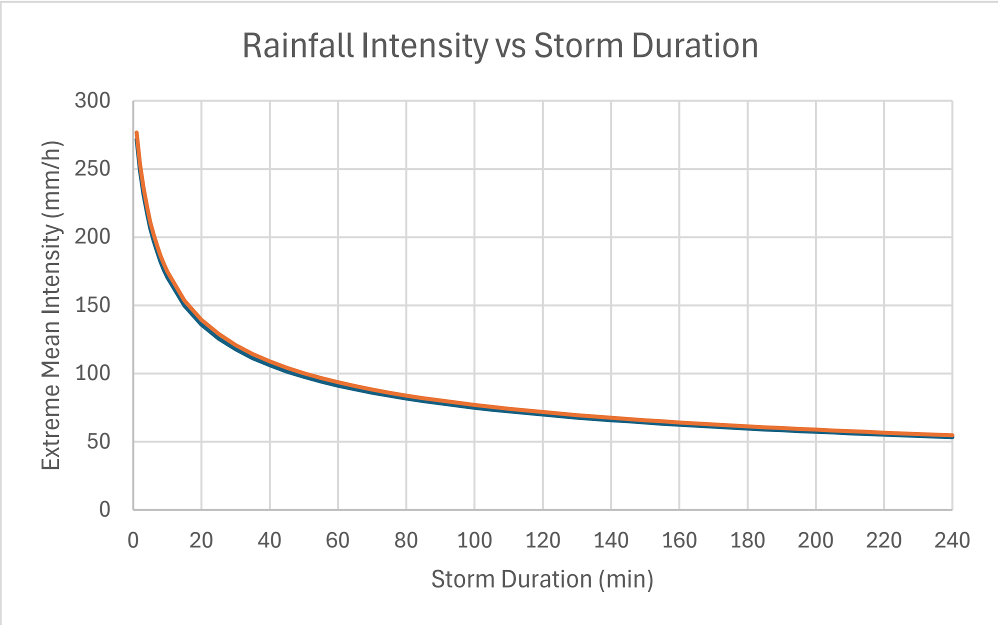
For 10-year return period

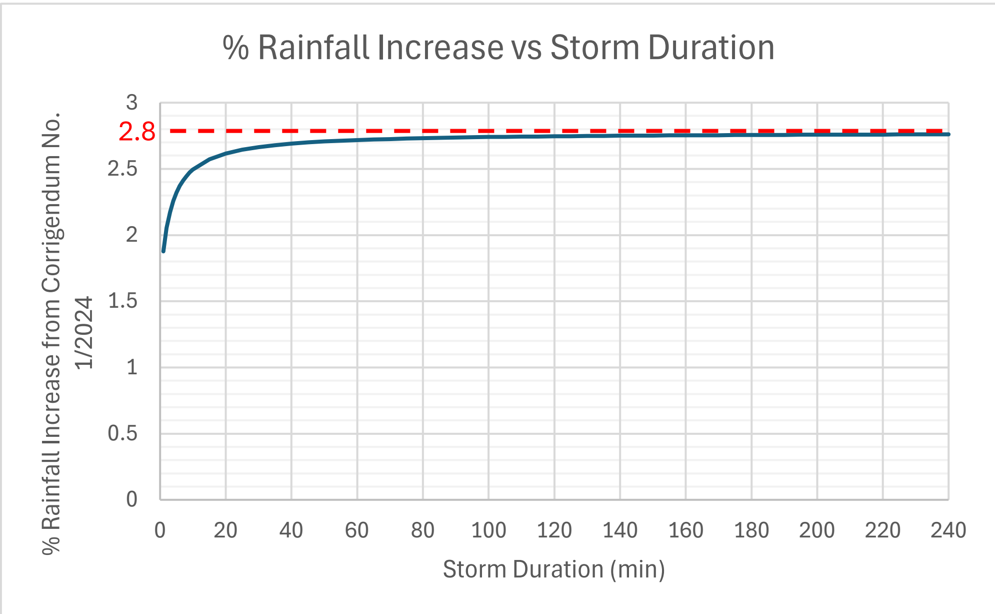
Storm Constant Pre- Corrigendum No. 1/2024

a	471.9
b	3.02
c	0.397

Storm Constant Post- Corrigendum No. 1/2024

a	485
b	3.11
c	0.397





Maximum increase in rainfall due to Corrigendum No. 1/2024 = 2.8%

Assessment of Impact of Corrigendum No. 1/2024

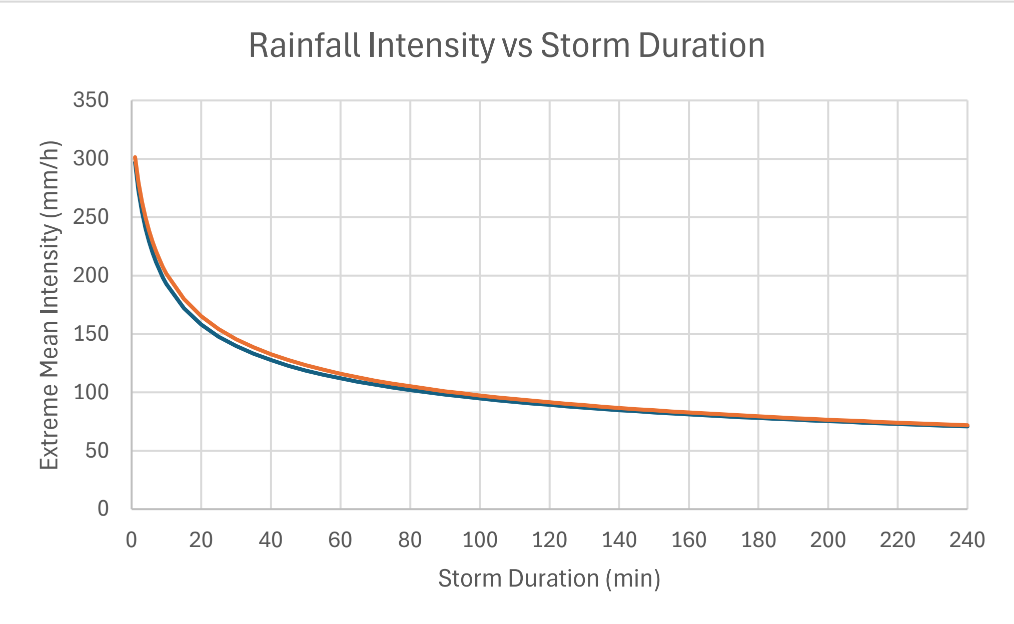
For 50-year return period

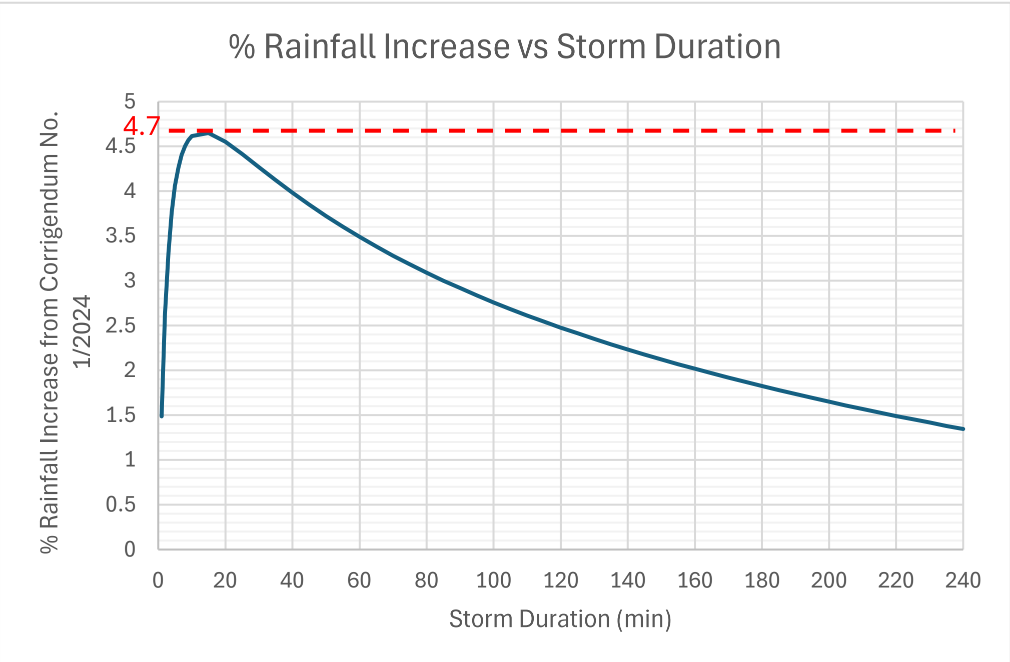
Storm Constant Pre- Corrigendum No. 1/2024

a	451.3
b	2.46
c	0.337

Storm Constant Post- Corrigendum No. 1/2024

a	505.5
b	3.29
c	0.355





Maximum increase in rainfall due to Corrigendum No. 1/2024 = 4.7%

Comparison of sea level increase due to climate change at Tsim Bei Tsui (Corrigendum No. 1/2022)

Mid century

	2018 ver.	2022 ver.	Difference
10-year	3.74 mPD	3.86 mPD	0.12 m
50-year	4.32 mPD	4.46 mPD	0.14 m

End century

	2018 ver.	2022 ver.	Difference
10-year	4.00 mPD	4.37 mPD	0.37 m
50-year	4.58 mPD	5.01 mPD	0.43 m

Reference from SDM 2018:

Table 8 – Design Extreme Sea Levels (in mPD)

Return Period (Years)	North Point/ Quarry Bay (1954-2017)	Tai Po Kau (1962-2017)	Tsim Bei Tsui (1974-2017)	Tai O (1985-2017)
2	2.73	2.91	3.07	2.87
5	2.94	3.20	3.31	3.16
10	3.09	3.45	3.51	3.36
20	3.24	3.73	3.74	3.57
50	3.45	4.19	4.09	3.84
100	3.63	4.60	4.40	4.06
200	3.81	5.10	4.77	4.28

Table 28 – Rainfall Increase and Sea Level Rise due to Climate Change

	Rainfall Increase	Sea Level Rise (m)
Mid 21st Century (2041 – 2060)	10.4%	0.23
End of 21st Century (2081 – 2100)	13.8%	0.49

Reference from Corrigendum No. 1/2022:

Table 8 – Design Extreme Sea Levels (in mPD)

Return Period (Years)	North Point/ Quarry Bay (1954-2019)	Tai Po Kau (1962-2019)	Tsim Bei Tsui (1954-2019)	Tai O (1954-2019)
2	2.82	2.97	3.07	2.87
5	3.03	3.27	3.31	3.16
10	3.20	3.54	3.52	3.36
20	3.38	3.86	3.74	3.57
50	3.66	4.41	4.09	3.84
100	3.91	4.93	4.41	4.06
200	4.19	5.59	4.78	4.28

Note:

1. The extreme sea levels at Tsim Bei Tsui and Tai O were based on the frequency analysis of instrumental data and correlated data from North Point/ Quarry Bay for an extended data set of 66 years (from 1954 to 2019).
2. For facilities which are vulnerable and sensitive to sea water level, e.g. E&M installations, where more stringent design is desirable, designers can make reference to the extreme sea levels as shown in Appendix 1. These extreme sea levels were derived with inclusion of significant storm surge events in Hong Kong before 1954.

Table 30a Storm Surge Increase in Mid 21st Century

Return Period (Years)	North Point/ Quarry Bay (m)	Tai Po Kau (m)	Tsim Bei Tsui (m)	Tai O (m)
2	0.04	0.05	0.05	0.03
5	0.05	0.07	0.06	0.05
10	0.06	0.08	0.08	0.05
20	0.07	0.10	0.09	0.06
50	0.08	0.13	0.11	0.08
100	0.09	0.15	0.12	0.09
200	0.10	0.17	0.13	0.10

Notes: Mid 21st century refers to period around 2050.

Table 29 – Mean Sea Level Rise due to Climate Change

	Mean Sea Level Rise
Mid 21st Century	0.20 m
End of 21st Century	0.47 m

Notes:

1. The mean sea level rise is relative to the average of 1995-2014.
2. Median projection values are adopted in the table.
3. Mid 21st century refers to period around 2050; end of 21st century refers to period around 2090.

Table 30b Storm Surge Increase in End of 21st Century

Return Period (Years)	North Point/ Quarry Bay (m)	Tai Po Kau (m)	Tsim Bei Tsui (m)	Tai O (m)
2	0.06	0.09	0.09	0.06
5	0.09	0.14	0.12	0.09
10	0.10	0.17	0.15	0.10
20	0.12	0.20	0.17	0.12
50	0.14	0.25	0.20	0.14
100	0.16	0.29	0.23	0.16
200	0.18	0.34	0.26	0.18

Notes: End of 21st century refers to period around 2090.

Table 31 Design Allowance in End of 21st Century

Rainfall Increase	Extreme Sea Level Rise (Sum of Mean Sea Level Rise and Storm Surge Increase)				
	Return Period (Years)	North Point/ Quarry Bay (m)	Tai Po Kau (m)	Tsim Bei Tsui (m)	Tai O (m)
12.1%	2	0.20	0.22	0.20	0.19
	5	0.21	0.24	0.22	0.20
	10	0.22	0.25	0.23	0.21
	20	0.22	0.27	0.23	0.22
	50	0.24	0.29	0.25	0.22
	100	0.24	0.31	0.26	0.23
	200	0.25	0.34	0.27	0.24

Note:

1. End of 21st century refers to period around 2090.
2. Design allowance was derived from the projection difference (median values) between very high greenhouse gas emissions scenario [SSP5-8.5] and intermediate greenhouse gas emissions scenario [SSP2-4.5]. For design allowance in mid 21st century, designers can make reference to the table as shown in Appendix 2.

Appendix 2 – Design Allowance in Mid 21st Century

Rainfall Increase	Extreme Sea Level Rise (Sum of Mean Sea Level Rise and Storm Surge Increase)				
	Return Period (Years)	North Point/ Quarry Bay (m)	Tai Po Kau (m)	Tsim Bei Tsui (m)	Tai O (m)
0 %	2	0.04	0.05	0.05	0.04
	5	0.04	0.06	0.05	0.04
	10	0.04	0.07	0.06	0.05
	20	0.04	0.07	0.06	0.05
	50	0.05	0.08	0.06	0.05
	100	0.05	0.09	0.07	0.06
	200	0.05	0.10	0.07	0.06

Notes:

1. Mid 21st century refers to period around 2050.
2. Design allowance for rainfall increase has been included in Table 28.

50A - Mid Century (prior to Yuen Long Barrage Scheme)

Water Level from DSD	=	4.57 mPD
Flow Depth	=	4.57 - 1.45
	=	3.12 m
Allowance in flow depth due to Corrigendum rainfall increase	=	4.7% + 0.6%
	=	5.3%
Water level increase due to Corrigendum rainfall increase	=	0.053 x 3.12
	=	0.17 m
Increase in sea level due to Corrigendum	=	0.12 m
Projected water level incorporating latest Corrigendum	=	4.57 + 0.17 + 0.12
	=	**4.85** mPD
Discharge from DSD	=	28.34 m^3/s
Rainfall increase due to Corrigendum	=	4.7% + 0.6%
	=	5.3%
Projected discharge incorporating latest Corrigendum	=	**29.85** m^3/s

50B - Mid Century (prior to Yuen Long Barrage Scheme)

Water Level from DSD	=	4.76 mPD
Flow Depth	=	4.76 - 1.45
	=	3.31 m
Allowance in flow depth due to Corrigendum rainfall increase	=	2.8% + 0.6%
	=	3.4%
Water level increase due to Corrigendum rainfall increase	=	0.034 x 3.31
	=	0.11 m
Increase in sea level due to Corrigendum	=	0.14 m
Projected water level incorporating latest Corrigendum	=	4.76 + 0.11 + 0.14
	=	**5.02** mPD
Discharge from DSD	=	24.51 m^3/s
Rainfall increase due to Corrigendum	=	2.8% + 0.6%
	=	3.4%
Projected discharge incorporating latest Corrigendum	=	**25.36** m^3/s

50A - End Century (with Yuen Long Barrage Scheme Implemented)

Water Level from DSD	=	3.89 mPD
Flow Depth	=	3.89 - 1.45
	=	2.44 m
Allowance in flow depth due to Corrigendum rainfall increase	=	1.16 x 1.047 - 1
	=	21.5%
Water level increase due to Corrigendum rainfall increase	=	0.215 x 2.44
	=	0.52 m

With Yuen Long Barrage Scheme, backwater effect from increase in sea level is assumed to be negligible.

Projected water level incorporating latest Corrigendum	=	3.89 + 0.52
	=	**4.41** mPD
Discharge from DSD	=	33.27 m^3/s
Rainfall increase due to Corrigendum	=	1.16 x 1.047 - 1
	=	21.5%
Projected discharge incorporating latest Corrigendum	=	**40.42** m^3/s

50B - End Century (with Yuen Long Barrage Scheme Implemented)

Water Level from DSD	=	3.72 mPD
Flow Depth	=	3.72 - 1.45
	=	2.27 m
Allowance in flow depth due to Corrigendum rainfall increase	=	1.16 x 1.028 - 1
	=	19.3%
Water level increase due to Corrigendum rainfall increase	=	0.193 x 2.27
	=	0.44 m

With Yuen Long Barrage Scheme, backwater effect from increase in sea level is assumed to be negligible.

Projected water level incorporating latest Corrigendum	=	3.72 + 0.44
	=	**4.16** mPD
Discharge from DSD	=	31.85 m^3/s
Rainfall increase due to Corrigendum	=	1.16 x 1.028 - 1
	=	19.3%
Projected discharge incorporating latest Corrigendum	=	**38.00** m^3/s

Appendix 4

Runoff Estimation

Appendix 4 - Estimate of Surface Runoff under Existing and After Development Scenarios

Existing Scenario

Rainfall Return Period : 1 in 50 (Mid Century)

Phase	IIa		Total Runoff (m^3/s)
Catchment	Paved	Unpaved	
Catchment area, A (m^2)	1130	100	
Runoff coefficient (c)	0.95	0.35	
Rainfall intensity (i)	265.1	265.1	
Runoff (Q)	0.079	0.003	0.082

Rainfall Return Period : 1 in 50 (End Century)

Phase	IIa		Total Runoff (m^3/s)
Catchment	Paved	Unpaved	
Catchment area, A (m^2)	1130	100	
Runoff coefficient (c)	0.95	0.35	
Rainfall intensity (i)	305.6	305.6	
Runoff (Q)	0.091	0.003	0.094

After Proposed Development

Rainfall Return Period : 1 in 10 (Mid Century)

Phase	IIa		Total Runoff (m^3/s)
Catchment	Paved	Unpaved	
Catchment area, A (m^2)	1230	0	
Runoff coefficient (c)	0.95	0.35	
Rainfall intensity (i)	234.7	234.7	
Runoff (Q)	0.076	0.000	0.076

Rainfall Return Period : 1 in 10 (End Century)

Phase	IIa		Total Runoff (m^3/s)
Catchment	Paved	Unpaved	
Catchment area, A (m^2)	1230	0	
Runoff coefficient (c)	0.95	0.35	
Rainfall intensity (i)	270.7	270.7	
Runoff (Q)	0.088	0.000	0.088

Rainfall Return Period : 1 in 50 (Mid Century)

Phase	IIa		Total Runoff (m^3/s)
Catchment	Paved	Unpaved	
Catchment area, A (m^2)	1230	0	
Runoff coefficient (c)	0.95	0.35	
Rainfall intensity (i)	265.1	265.1	
Runoff (Q)	0.086	0.000	0.086

Rainfall Return Period : 1 in 50 (End Century)

Phase	IIa		Total Runoff (m^3/s)
Catchment	Paved	Unpaved	
Catchment area, A (m^2)	1230	0	
Runoff coefficient (c)	0.95	0.35	
Rainfall intensity (i)	305.6	305.6	
Runoff (Q)	0.099	0.000	0.099

Appendix 5

Hydraulic Calculations

<u>Appendix 5 - Hydraulic Calculations for Proposed Drainage System (After Proposed Development and before Yuen Long Barrage Scheme)</u>

Checking of Velocity, Capacity and Hydraulic Head

Assume the proposed box culvert is operated under uniform flow at all time Using Colebrook-White Equation given in Table 12 of DSD Stormwater Drainage Manual as recommended by Section 8.3.1 of DSD Stormwater Drainage Manual

Colebrook-White Equation

$$\bar{v} = -\sqrt{32gRS}\,\log\left(\frac{k_s}{14.8R} + \frac{1.255\,v}{R\sqrt{32gRS}}\right)$$

where	$\bar{v}$ =	mean velocity (m/s)			
	g =	acceleration due to gravity (m/s^2)	=	9.81	m^2/s
	R =	hydraulic radius (m)			
	S =	frictional gradient (dimensionless)			
	k_s =	surface roughness (m)			
	v =	kinematic viscoity (m^2/s)	=	0.000001	m^2/s

Calculation for 50A (1 in 10 years tide with 1 in 50 rainfall)

Colebrook-White Capacity

Accumulated Flow	MH#		IL		Conduit Length (m)	Gradient X (1 in X)	Type	Dimension (mm)		Flowable Area (m^2)	K_s (mm)	Wetted Perimeter (m)	Hydraulic Radius (m)	Velocity (m/s)	Capacity* (m^3/s)	Utilisation	Capacity Check	Remark
	From	To	US	DS				Height	Width									
0.086	TMH1	MH1	3.67	3.60	3.3	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	33.8%	√	Runoff from Phase IIa (0.086)
0.086	MH1	MH2	3.60	3.33	13.6	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	33.8%	√	Runoff from Phase IIa (0.086)
0.086	MH2	Outlet	2.73	2.70	1.8	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	33.8%	√	Runoff from Phase IIa (0.086)

*10% allowance for siltation is included

Freeboard Checking

MH#		Length (m)	Shape	Pipe Size (mm)		Area (m^2)	Design Flow (m^3/s)	Velocity (Required) m/s	Frictical Gradient (Required)	Velocity (Calculated) m/s	Frictional Slope	Surcharge Depth (m)	Minor loss coefficient K	Minor Loss (m)	US invert (mPD)	Tide Level (mPD)	Water Level in Manhole (mPD)	Ground Level (mPD)	Available Freeboard (m)	Sufficient Freeboard (OK if >0.3)	Remark
From	To																				
TMH1	MH1	3.3	Pipe	375	375	0.11	0.09	0.87	430.0	0.87	0.0023	0.01	0.9	0.03	3.67	4.85	5.06	5.50	0.44	OK	1 no. of sudden contraction + 45 degree elbow
MH1	MH2	13.6	Pipe	375	375	0.11	0.09	0.87	430.0	0.87	0.0023	0.03	0.9	0.03	3.60	4.85	5.02	5.45	0.43	OK	1 no. of sudden contraction + 45 degree elbow
MH2	Outlet	1.8	Pipe	375	375	0.11	0.09	0.87	430.0	0.87	0.0023	0.00	2.5	0.10	2.73	4.85	4.95	5.45	0.50	OK	1 no. of sudden contraction, 1 no. of outlet loss, 90 degree elbow

Calculation for 50B (1 in 50 years tide with 1 in 10 rainfall)

Colebrook-White Capacity

Accumulated Flow	MH#		IL		Conduit Length (m)	Gradient X (1 in X)	Type	Dimension (mm)		Flowable Area (m^2)	K_s (mm)	Wetted Perimeter (m)	Hydraulic Radius (m)	Velocity (m/s)	Capacity* (m^3/s)	Utilisation	Capacity Check	Remark
	From	To	US	DS				Height	Width									
0.076	TMH1	MH1	3.67	3.60	3.3	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	29.9%	√	Runoff from Phase IIa (0.076)
0.076	MH1	MH2	3.60	3.33	13.6	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	29.9%	√	Runoff from Phase IIa (0.076)
0.076	MH2	Outlet	2.73	2.70	1.8	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	29.9%	√	Runoff from Phase IIa (0.076)

*10% allowance for siltation is included

Freeboard Checking

MH#		Length (m)	Shape	Pipe Size (mm)		Area (m^2)	Design Flow (m^3/s)	Velocity (Required) m/s	Frictical Gradient (Required)	Velocity (Calculated) m/s	Frictional Slope	Surcharge Depth (m)	Minor loss coefficient K	Minor Loss (m)	US invert (mPD)	Tide Level (mPD)	Water Level in Manhole (mPD)	Ground Level (mPD)	Available Freeboard (m)	Sufficient Freeboard (OK if >0.3)	Remark
From	To																				
TMH1	MH1	3.3	Pipe	375	375	0.11	0.08	0.77	550.0	0.77	0.0018	0.01	0.9	0.03	3.67	5.02	5.18	5.50	0.32	OK	1 no. of sudden contraction + 45 degree elbow
MH1	MH2	13.6	Pipe	375	375	0.11	0.08	0.77	550.0	0.77	0.0018	0.02	0.9	0.03	3.60	5.02	5.15	5.45	0.30	OK	1 no. of sudden contraction + 45 degree elbow
MH2	Outlet	1.8	Pipe	375	375	0.11	0.08	0.77	550.0	0.77	0.0018	0.00	2.5	0.08	2.73	5.02	5.10	5.45	0.35	OK	1 no. of sudden contraction, 1 no. of outlet loss, 90 degree elbow

<u>Capacity checking of Existing Nullah</u>

50-year runoff of existing nullah	=	29.85 m^3/s
Increase in runoff from Phase IIa development	=	0.086 / 29.85
	=	<u>0.29%</u>

Appendix 5 - Hydraulic Calculations for Proposed Drainage System (After Proposed Development and after Yuen Long Barrage Scheme)

Checking of Velocity, Capacity and Hydraulic Head

Assume the proposed box culvert is operated under uniform flow at all time Using Colebrook-White Equation given in Table 12 of DSD Stormwater Drainage Manual as recommended by Section 8.3.1 of DSD Stormwater Drainage Manual

Colebrook-White Equation

$$\bar{v} = -\sqrt{32gRS}\,\log\left(\frac{k_s}{14.8R} + \frac{1.255\,\nu}{R\sqrt{32gRS}}\right)$$

where					
	$\bar{v}$ =	mean velocity (m/s)			
	g =	acceleration due to gravity (m/s^2)	=	9.81	m^2/s
	R =	hydraulic radius (m)			
	S =	frictional gradient (dimensionless)			
	k_s =	surface roughness (m)			
	ν =	kinematic viscoity (m^2/s)	=	0.000001	m^2/s

Calculation for 50A (1 in 10 years tide with 1 in 50 rainfall)

Colebrook-White Capacity

Accumulated Flow	MH# From	MH# To	IL US	IL DS	Conduit Length (m)	Gradient X (1 in X)	Type	Dimension (mm) Height	Dimension (mm) Width	Flowable Area (m^2)	K_s (mm)	Wetted Perimeter (m)	Hydraulic Radius (m)	Velocity (m/s)	Capacity* (m^3/s)	Utilisation	Capacity Check	Remark
0.099	TMH1	MH1	3.67	3.60	3.3	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	38.9%	√	Runoff from Phase IIa (0.099)
0.099	MH1	MH2	3.60	3.33	13.6	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	38.9%	√	Runoff from Phase IIa (0.099)
0.099	MH2	Outlet	2.73	2.70	1.8	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	38.9%	√	Runoff from Phase IIa (0.099)

*10% allowance for siltation is included

Freeboard Checking

MH# From	MH# To	Length (m)	Shape	Pipe Size (mm)		Area (m^2)	Design Flow (m^3/s)	Velocity (Required) m/s	Frictical Gradient (Required)	Velocity (Calculated) m/s	Frictional Slope	Surcharge Depth (m)	Minor loss coefficient K	Minor Loss (m)	US invert (mPD)	Tide Level (mPD)	Water Level in Manhole (mPD)	Ground Level (mPD)	Available Freeboard (m)	Sufficient Freeboard (OK if >0.3)	Remark
TMH1	MH1	3.3	Pipe	375	375	0.11	0.10	1.00	320.0	1.01	0.0031	0.01	0.9	0.05	3.67	4.41	4.69	5.50	0.81	OK	1 no. of sudden contraction + 45 degree elbow
MH1	MH2	13.6	Pipe	375	375	0.11	0.10	1.00	320.0	1.01	0.0031	0.04	0.9	0.05	3.60	4.41	4.63	5.45	0.82	OK	1 no. of sudden contraction + 45 degree elbow
MH2	Outlet	1.8	Pipe	375	375	0.11	0.10	1.00	320.0	1.01	0.0031	0.01	2.5	0.13	2.73	4.41	4.54	5.45	0.91	OK	1 no. of sudden contraction, 1 no. of outlet loss, 90 degree elbow

Calculation for 50B (1 in 50 years tide with 1 in 10 rainfall)

Colebrook-White Capacity

Accumulated Flow	MH# From	MH# To	IL US	IL DS	Conduit Length (m)	Gradient X (1 in X)	Type	Dimension (mm) Height	Dimension (mm) Width	Flowable Area (m^2)	K_s (mm)	Wetted Perimeter (m)	Hydraulic Radius (m)	Velocity (m/s)	Capacity* (m^3/s)	Utilisation	Capacity Check	Remark
0.088	TMH1	MH1	3.67	3.60	3.3	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	34.5%	√	Runoff from Phase IIa (0.088)
0.088	MH1	MH2	3.60	3.33	13.6	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	34.5%	√	Runoff from Phase IIa (0.088)
0.088	MH2	Outlet	2.73	2.70	1.8	50	Pipe	375	375	0.11	0.6	1.2	0.094	2.57	0.255	34.5%	√	Runoff from Phase IIa (0.088)

*10% allowance for siltation is included

Freeboard Checking

MH# From	MH# To	Length (m)	Shape	Pipe Size (mm)		Area (m^2)	Design Flow (m^3/s)	Velocity (Required) m/s	Frictical Gradient (Required)	Velocity (Calculated) m/s	Frictional Slope	Surcharge Depth (m)	Minor loss coefficient K	Minor Loss (m)	US invert (mPD)	Tide Level (mPD)	Water Level in Manhole (mPD)	Ground Level (mPD)	Available Freeboard (m)	Sufficient Freeboard (OK if >0.3)	Remark
TMH1	MH1	3.3	Pipe	375	375	0.11	0.09	0.88	420.0	0.88	0.0024	0.01	0.9	0.04	3.67	4.16	4.38	5.50	1.12	OK	1 no. of sudden contraction + 45 degree elbow
MH1	MH2	13.6	Pipe	375	375	0.11	0.09	0.88	420.0	0.88	0.0024	0.03	0.9	0.04	3.60	4.16	4.33	5.45	1.12	OK	1 no. of sudden contraction + 45 degree elbow
MH2	Outlet	1.8	Pipe	375	375	0.11	0.09	0.88	420.0	0.88	0.0024	0.00	2.5	0.10	2.73	4.16	4.26	5.45	1.19	OK	1 no. of sudden contraction, 1 no. of outlet loss, 90 degree elbow

Capacity checking of Existing Nullah

50-year runoff of existing nullah	=	40.42 m^3/s
Increase in runoff from Phase IIa development	=	0.099 / 40.42
	=	0.25%

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