Appendix G

Drainage Impact Assessment

Section 16 Planning Application for Proposed Residential Development with Minor Relaxation of Plot Ratio Restriction at Lots 1027, 1029, 1030, 1034A, 1034B, 1039 (Part), 1040, 1042 RP, 1043 RP, 1044 RP (Part), 1045, 1047, 2233 (Part), 2251 S.A RP, 2256 RP, 2315 (Part) and 2316 RP (Part) in D.D. 92 and Adjoining Government Land (New Lot to be known as Lot 2644 in D.D. 92), Kwu Tung South, Sheung Shui, New Territories

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Drainage Impact Assessment

Binnies Hong Kong Limited
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Kwun Tong, Kowloon

September 2025

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1. INTRODUCTION

1.1 Binnies Hong Kong Limited (Binnies) has been commissioned to carry out drainage impact assessment in support of a planning application for proposed residential development with minor relaxation of plot ratio restriction on the draft Kwu Tung South Outline Zoning Plan (OZP) No. S/NE-KTS/21 at various lots in D.D. 92 and Adjoining Government Land (New Lot to be known as Lot 2644 in D.D. 92), (hereafter referred to as the "Application Site") under Section 16 (S16) of the Town Planning Ordinance (the Ordinance) (CAP. 131). The Application Site is now zoned "Comprehensive Development Area (3)" ("CDA(3)").

1.2 The Application Site is bounded by Kwu Tung Road to the north, Hang Tau Road to the east, and Sheung Yue River as well as existing meander and some existing planting area to the west. Access to the Application Site is via Hang Tau Road (***KT3/DIA/001***). The Application Site covers an area of approximately 2 ha.

1.3 The Applicant had previously obtained rezoning agreement from the Board (under application No. Y/NE-KTS/15) for proposed residential development on 28 October 2022 (the Approved Scheme). To realise residential development at the subject "CDA(3)" zone, the Applicant now submits a refined scheme for the Board's consideration under S16 of the Ordinance.

1.4 The Proposed Development consists of 1,062 units, club house and car parking facilities with a maximum plot ratio of 2.012. A summary of key information of the Proposed Development is shown below in ***Table 1.1***.

Table 1.1 Development Information

	Proposed Development
Site Area	About 19,591 m^2
Plot Ratio	Not more than 2.012
Total Domestic Gross Floor Area (GFA)	Not more than 39,400 m^2
No. of Residential Units	1,062

1.5 This report presents the findings of a drainage impact assessment to support the Proposed Development at the Application Site. The objectives of this sewerage impact assessment are to:

- examine the existing and planned drainage facilities in the region;
- identify and quantify the potential drainage impacts arising from the Proposed Development; and
- formulate and evaluate options for drainage scheme for the Proposed Development.

2. EXISTING DRAINAGE AND FLOOD CONDITON

2.1 The Application Site is largely vacant and covered with wild grass in the southern portion and occupied by a few temporary structures. The Application Site adjoins Hang Tau Road to the east and is undeveloped. The existing River Beas planting area and meander to the immediate west of the Application Site was constructed by the government under the River Beas Rehabilitation Scheme completed by Drainage Services Department (DSD) in 2001.

2.2 The land use of the Application Site will be changed after the Proposed Development and is assumed to be paved. The existing drainage layout and sub-catchments for and in vicinity of the Application Site are shown on ***KT3/DIA/002***.

Existing Catchment Drainage

2.3 The Application Site lies in the middle reach of River Beas to the immediate south of Fanling Highway. The River Beas runs from the south to the north and discharges into River Indus, which further discharges into Shenzhen River to the north. The Shenzhen River flows to the west and eventually discharges into Deep Bay.

2.4 River Beas locates within the Indus Basin forming one of the tributaries of River Indus and serves the southwest part of the Indus Basin. River training to the downstream section of River Beas north of Fanling Highway was completed in 2002 by the then Territory Development Department under PWP Item No. 53CD Stage 1 — Main Drainage Channels for Fanling, Sheung Shui and Hinterland.

2.5 The improvement works to the River Beas south (upstream) of Fanling Highway was completed by DSD under River Beas Rehabilitation Scheme in 2001. The river rehabilitation works in the upstream section of River Beas south of Fanling Highway were designed for a 2 year flood protection standard.

2.6 Information received from DSD indicates that the estimated water levels in River Beas just near the southern part of the Application Site under the planned development scenario are 8.90 mPD and 9.41 mPD respectively for a 50-year and 200-year return period combined events.

2.7 Existing drainage networks and existing catchment plan are shown on ***KT3/DIA/003***.

Site Topography

2.8 The Application Site is a narrow strip of land on the eastern side of River Beas and adjoins Hang Tau Road. The Application Site slopes downward from south to north in general, and dipped gently towards River Beas along the western boundary. The carriageway at Hang Tau Road falls from about +14 mPD at the southern end of the Application Site to about +8 mPD at near the northern Site entrance. The carriageway then rises to about +10.5 mPD to connect with Kam Hang Road.

2.9 The existing ground level within the Application Site falls gently from 10 mPD to 8 mPD (south to north). The ground levels along the eastern boundary generally match with Hang Tau Road. The ground levels along the western boundary are at about 8 mPD in general.

2.10 With reference of the drainage records, there is an existing 300 U-channel running within the eastern side of the Application Site. This 300 U-channel serves to convey the overland flows from within the Application Site and discharge to drainage pipes running along Hang Tau Road. Other runoff within the Application Site discharge towards River Beas by overland flow.

2.11 Based on the topography, runoff from catchment areas to the east of Hang Tau Road are bounded by road curb of Hang Tau Road and collected by the drainage systems running along Hang Tau Road, which includes drainage pipes and U-channels. The runoff is subsequently discharged into the existing drainage channel along the southern toe of Kwu Tung Road embankment which subsequently discharges into River Beas.

2.12 The project includes minor modification works to Hang Tau Road by the Project Proponent. The works are indicated on KT3/DIA/004.

3. ASSESSMENT APPROACH

3.1 The assessment criteria for the Application Site is based on the standards as set out in DSD's 5th edition of Stormwater Drainage Manual (SDM) published in January 2018 and the updates pursuant to Corrigendum No. 1/2022 and No. 1/2024 promulgated.

3.2 Table 10 of the SDM provides the recommended design return periods based on flood levels for the various drainage systems depending on the land use. According to the SDM, 50-year design return period is recommended for the design of drainage system.

3.3 The Rational Method is adopted for evaluating the runoff for the drainage design.

According to the rainfall zone as shown in Figure 3 of the SDM by DSD published in January 2018, the Site is located in an area that adopts rainfall statistics of North District area. Hence, the design storm constants are adopted in accordance with Table 3d of the SDM. The storm constants are shown in ***Table 3.1*** below.

Table 3.1 Storm Constants with 50-year Return Period

Parameter	Value
a	474.6
b	2.90
c	0.371

The runoff coefficient (C) values for the Rational Method were adopted in accordance with Clause 7.5.2 of the SDM. A table of runoff coefficient is shown in ***Table 3.2*** below.

Table 2.2 Runoff Coefficient

Land Use	Runoff Coefficient (C) Value
Unpaved (e.g. existing tree groups)	0.35
Paved (e.g. concrete)	0.95

3.4 The effects of climate change are considered in accordance with Clause 6.8 and Table 28 of the SDM. A summary of increased rainfall due to climate change is shown in ***Table 3.3*** below.

Table 3.3 Rainfall Increase due to Climate Change

Classification	Rainfall Increase	Design Allowance
End of 21st Century (2081-2100)	16.0%	12.1%

3.5 The roughness values of pipes were adopted in accordance with Table 13 and 14 of the SDM. As a conservation approach, 10% (of flow area) sedimentation is adopted for the proposed drainage system in design checking. A summary of roughness coefficients is shown in **Table 3.4** below.

Table 3.4 Roughness Coefficient

Classification	Roughness Coefficient	Remarks
Poor Precast Concrete Pipes	Colebrook-White k_s = 0.6mm	Concrete Pipe
U-Channel	Mannings'n = 0.016	Peripheral drains

4. POTENTIAL DRAINAGE IMPACT BY THE PROPOSED DEVELOPMENT

4.1 The Application Site will be developed into a residential development. The master layout plan of the Proposed Development is shown in ***Annex A***.

Changes to Drainage Characteristics

4.2 The Proposed Development will induce changes in land use of the Application Site. The percentage of paved area comprising building blocks, concrete structures, roads and other paved facilities will be increased. As a result, there will be an increase in surface runoff generated from the Proposed Development.

4.3 Information received from DSD indicates that the estimated water levels in River Beas just at the upstream of Fanling Highway under the planned development scenario are 8.90 mPD and 9.41 mPD respectively for a 50-year and 200-year return period combined events. Provided that the Application Site is formed to a minimum level for flood protection and there is effective gravity drainage, the Proposed Development would not be subject to flood in 50-year events. The required minimum site formation levels are discussed in Section 5 below.

Volume of Runoff and Peak Runoff Rate

4.4 The Application Site will be developed into a residential development with plot ratio (PR) not more than 2.012 under the proposed scheme. About 80 % of the Application Site will be paved and the rest will be landscaped. Since the Application Site is located next to the main trunk, a 200-year return period storm event will be used to calculate the estimated peak runoff rate. The increase in peak runoff rates due to the Proposed Development at the Application Site against 200 year return periods storm event for the respective sub-catchment under a 24-hour design rainfall as given in DSD's SDM are shown in ***Table 4.1*** below. The effect of climate change in the drainage design has been included in the calculation with reference of Table 28 of the SDM.

Table 4.1 Estimated Peak Runoff Rate

Return Period	Peak Runoff Rate (m^3/s)		
	Before Development (1)	**After Development (2)**	**Increase in Runoff (2) — (1)**
200 years	236.68	236.89	0.21

4.5 The analyses indicate that the change of paved area will result in a slight increase in runoff rates after the development. Improvement to local drainage system is required to discharge the flow to the improved River Beas.

4.6 To assess the impact of the increase in peak runoff rate in River Beas, the full flow discharge rate in River Beas is estimated. The increased peak runoff rate from a 200 year return period storm event when compared to the full flow capacity of River Beas is approximately 0.19%. It is considered that the increased flood risk of River Beas would be negligible. Capacity calculation is shown in ***Annex C.***

5. PROPOSED DRAINAGE STRATEGY FOR THE PROPOSED DEVELOPMENT

5.1 According to the information received from DSD in January 2020, the predicted 50-year return period water level in this area is approximately 8.90 mPD. The existing ground levels within the Application Site vary from 10 mPD (south) to 8 mPD (north). To facilitate drainage via gravity flow from the Proposed Development to the River Beas, it is proposed that a minimum formation level of about 9.50 mPD be kept for the Application Site.

5.2 The runoff from the areas within the Application Site will be collected by the future internal drainage system and discharged to the existing drainage channel along the southern toe of Kwu Tung Road embankment which subsequently discharges into River Beas. Referring to **Section 4.7** above, River Beas is expected to have adequate capacity to cater for the additional runoff from the Proposed Development at the Application Site.

5.3 Based on the topography, the surface runoff from the catchment areas to the west and to the south of the Application Site are flowing towards River Beas. Hence, no surface channels are required along the southern and western boundaries.

5.4 As described above, Hang Tau Road and the existing drainage system along Hang Tau Road intercept and discharge runoff from the village areas east of Hang Tau Road. Thus, there should not be overland flow from that area and peripheral drainages along the eastern boundary would not be required. Similarly, the topography to the west of the Application Site generally falls towards the existing meander in that area and further considering the land status of that area, peripheral drainage along the western boundary is also not required. The short northern and southern boundaries of the Application Site are already bounded by existing surface drainage that are outside the Application Site and would not be modified by this project, hence, peripheral drainage along these boundaries is not required.

5.5 The internal drainage system within the Application Site will be designed, constructed and maintained by the project proponent in the later stages of the project.

5.6 The series of existing surface channels within the Application Site would not be required after development and would be demolished as the internal drainage system of the Application Site will convey the overland flows within the Application Site to the downstream existing drainage system.

5.7 With reference to the drainage records of DSD, there are drainage pipes that encroach onto the northeastern part of the Application Site. As those drainage pipes serve to convey overland flows collected along Hang Tau Road, it is proposed the existing drainage pipes which encroach onto the Application Site be diverted outside the site to run along Hang Tau Road. Specifically, the existing drainage pipes between existing manholes SMH1041850, SMH1041854 and SCH1023269 is proposed to be diverted. The proposed diversion scheme is shown in ***KT3/DIA/003***.

5.8 The sub-catchment used as input to the hydraulic calculation is shown on ***KT3/DIA/002*** and the associated runoff calculations are shown in ***Annex B***. The proposed drainage infrastructure for the Proposed Development is shown in ***KT3/DIA/004***. The hydraulic calculations of proposed drainages are shown in ***Annex D.***

5.9 The drainage system including the outlet and the internal drainage system will be constructed by the Applicant and will be maintained by the Applicant or the management agent of the development after completion.

5.10 As the proposed drainage infrastructures are gravity systems, no specific maintenance operation is envisaged but it is considered desirable that they should be inspected at least annually before the commencement of wet season to ensure their proper functioning.

6. CONSTRUCTION CONSIDERATIONS

6.1 The contractor for the Proposed Development will be responsible for the maintenance of the existing drainage facilities in the vicinity of the Proposed Development during the construction stage. The contract documents will specify that the contractor must put in place appropriate temporary drainage measures to ensure that the flooding conditions during the construction period must not be worse than those under existing conditions. The contractor's attention shall be drawn to the diversion of the existing U-channel along the boundary of the Application Site. Such measures must be submitted to the Authorized Person or his representative for approval before construction activities commence.

6.2 A settling basin will be installed to intercept runoff from the construction site before discharge into the public drains.

7. MONITORING REQUIREMENTS

7.1 Periodic inspection should be carried out by the Authorized Person or his representative to ensure that the measures specified above and the drainage measures proposed by the contractor to maintain the existing flooding conditions around the Application Site are carried out properly by the contractor, especially during the wet season.

8. CONCLUSION

8.1 The Proposed Development will increase the runoff generated from the Application Site. The Application Site does not fall within flood plains of 50-year and 200-year events due to high site formation level.

8.2 The section of River Beas downstream of Fanling Highway has been trained. The estimated water levels in River Beas just at the upstream of Fanling Highway under the planned development scenario are 8.90 mPD and 9.41 mPD respectively for a 50-year and 200-year return period combined events. Provided that the Application Site is formed to a minimum level for flood protection and there is effective gravity drainage, the Proposed Development would not be subject to flood in 50-year events.

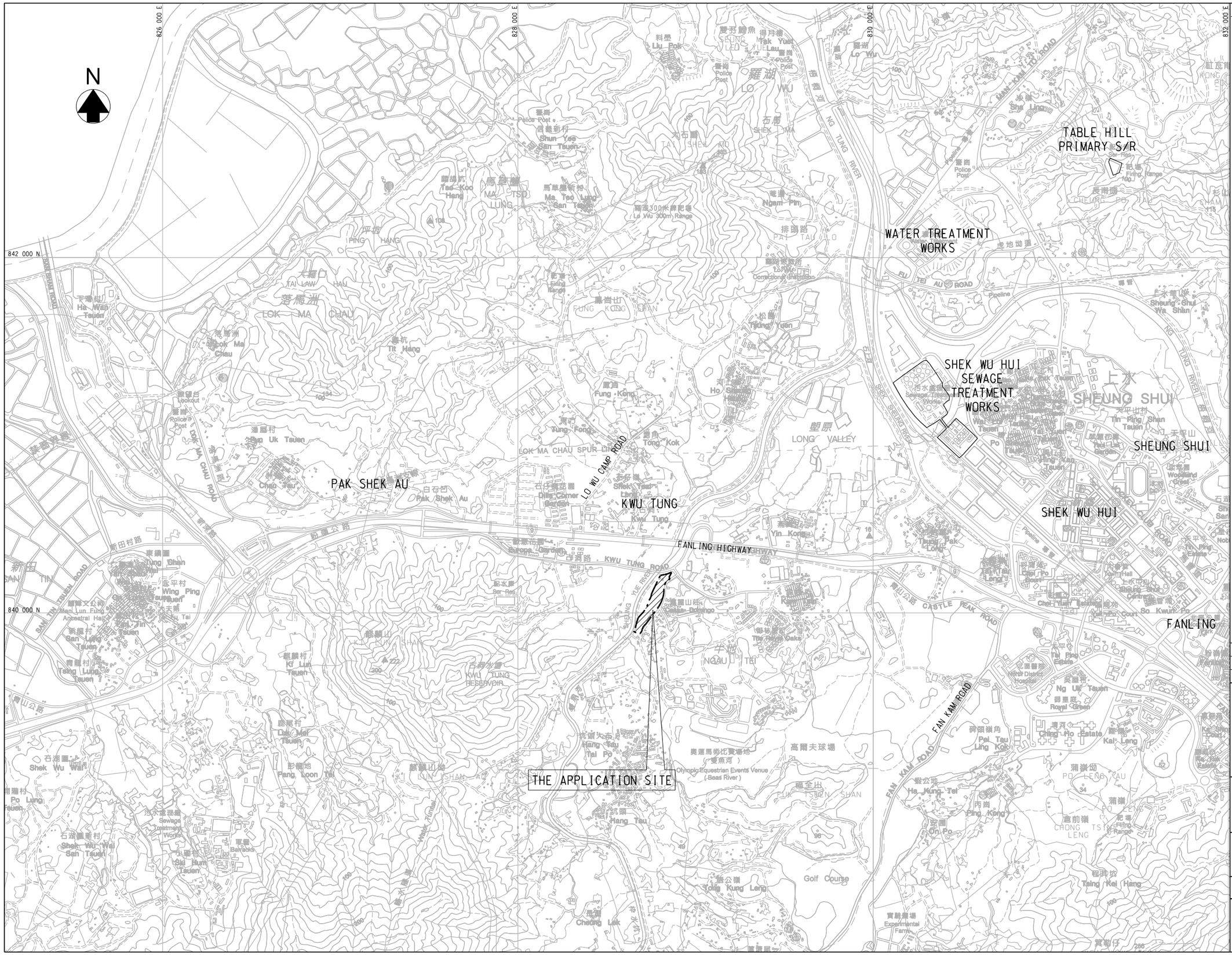
8.3 The existing ground level within the Application Site falls gently from 13 mPD to 8 mPD (south to north). The ground levels along the eastern boundary generally match with Hang Tau Road. The ground levels along the western boundary are at about 8 mPD in general. To facilitate drainage via gravity flow from the Proposed Development to the River Beas, a minimum formation level of about 9.50 mPD is proposed for the Application Site. Runoff within the Application Site would be collected by future internal drainage and will be discharged into the existing drainage channel along the southern toe of Kwu Tung Road embankment to River Beas.

8.4 Temporary drainage measures shall be implemented to ensure that the flooding conditions must not be worsened during construction. Periodic inspection by the Authorized Person or his representative will be carried out during construction.

8.5 With the implementation of the above proposed drainage measures and temporary drainage works, the proposed residential development will be acceptable from drainage perspective.

END OF TEXT

FIGURES



LEGEND:

THE APPLICATION SITE

	Designed	Checked
Initial	ZL	NS
Date	02/14	02/14

Project title

Section 16 Planning Application for Proposed Residential Development with Minor Relaxation of Plot Ratio Restriction at Lots 1027, 1029, 1030, 1034A, 1034B,1039 (Part), 1040, 1042 RP, 1043 RP, 1044 RP (Part), 1045, 1047, 2233 (Part), 2251 S.A RP,2256 RP, 2315 (Part) and 2316 RP (Part) in D.D. 92 and Adjoining Government Land (New Lot to be known as Lot 2644 in D.D. 92), Kwu Tung South, Sheung Shui, New Territories

Drawing title

LOCATION PLAN

Figure no.	Revision
KTS/DIA/001	-

Scale

A3 1 : 20000

BINNIES HONG KONG LIMITED
賓尼斯工程顧問有限公司

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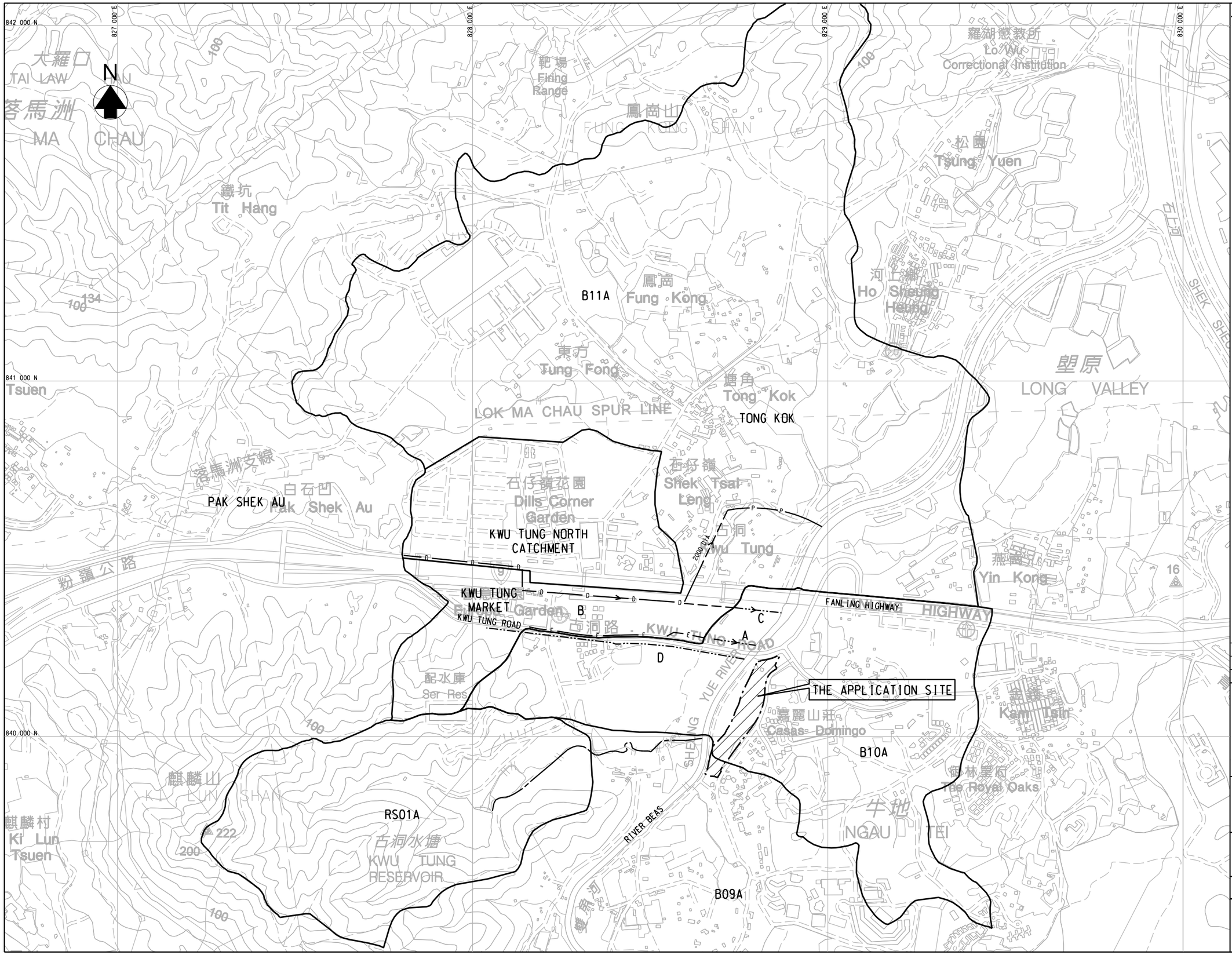

LEGEND:

- THE APPLICATION SITE
- DRAINAGE SUB-CATCHMENT OF RIVER BEAS
- RES TRIBUTARY
- P — PROPOSED RIVER CHANNEL UNDER PWP ITEM 53CD STAGE 1
- LOCAL DRAINS AT KWU TUNG
- A — EXISITNG CHANNEL A
- E — EXISTING DRAINAGE SYSTEM ALONG KWU TUNG ROAD
- D — DRAINAGE LAYOUT FROM KWU TUNG NORTH

	Designed	Checked
Initial	ZL	NS
Date	02/14	02/14

Project title

Section 16 Planning Application for Proposed Residential Development with Minor Relaxation of Plot Ratio Restriction at Lots 1027, 1029, 1030, 1034A, 1034B,1039 (Part), 1040, 1042 RP, 1043 RP, 1044 RP (Part), 1045, 1047, 2233 (Part), 2251 S.A RP,2256 RP, 2315 (Part) and 2316 RP (Part) in D.D. 92 and Adjoining Government Land (New Lot to be known as Lot 2644 in D.D. 92), Kwu Tung South, Sheung Shui, New Territories

Drawing title

Existing Drainage Layout and Sub-catchments

Figure no.	Revision
KTS/DIA/002	-

Scale: A3 1 : 10000

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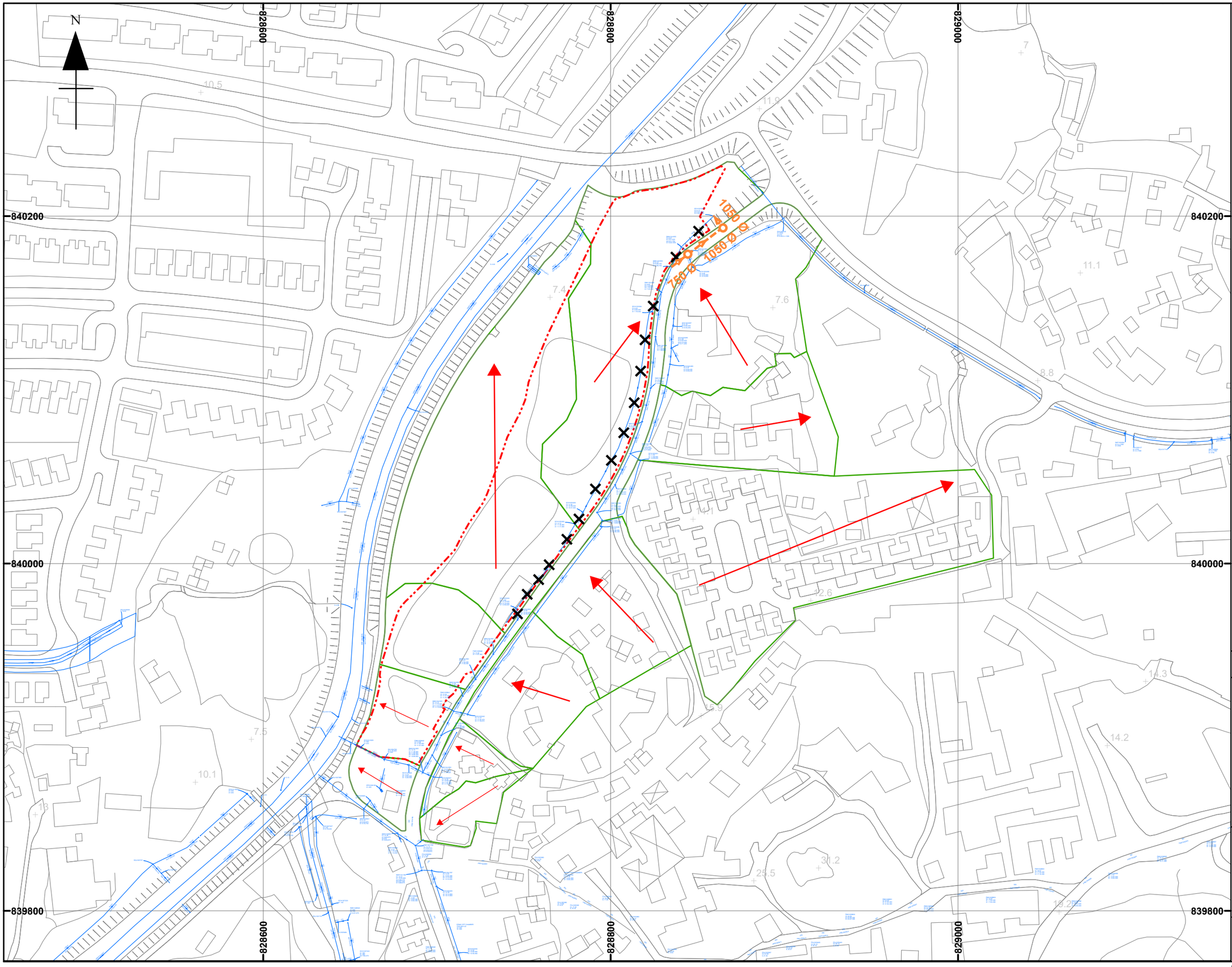

Legend

- The Application Site
- Existing Catchment
- Existing drainage Pipe
- Direction of Flow
- Existing Drainage Pipe to be demolished
- Proposed Drainage Diversion Pipe

Initial Data	Checked Data
KW	LCH

Project

Section 16 Planning Application for Proposed Residential Development with Minor Relaxation of Plot Ratio Restriction at Lots 1027, 1029, 1030, 1034A, 1034B, 1039 (Part), 1040, 1042 RP, 1043 RP, 1044 RP(Part), 1045, 1047, 2233 (Part), 2251 S.A RP,2256 RP, 2315 (Part) and 2316 RP (Part) in D.D. 92 and Adjoining Government Land (New Lot to be known as Lot 2644 in D.D. 92), Kwu Tung South, Sheung Shui, New Territories

Title

Existing Catchment Plan

Figure No.	Scale
KT3/DIA/003	1:2,000 @ A3

binnies

Plot date: 2020-01-30

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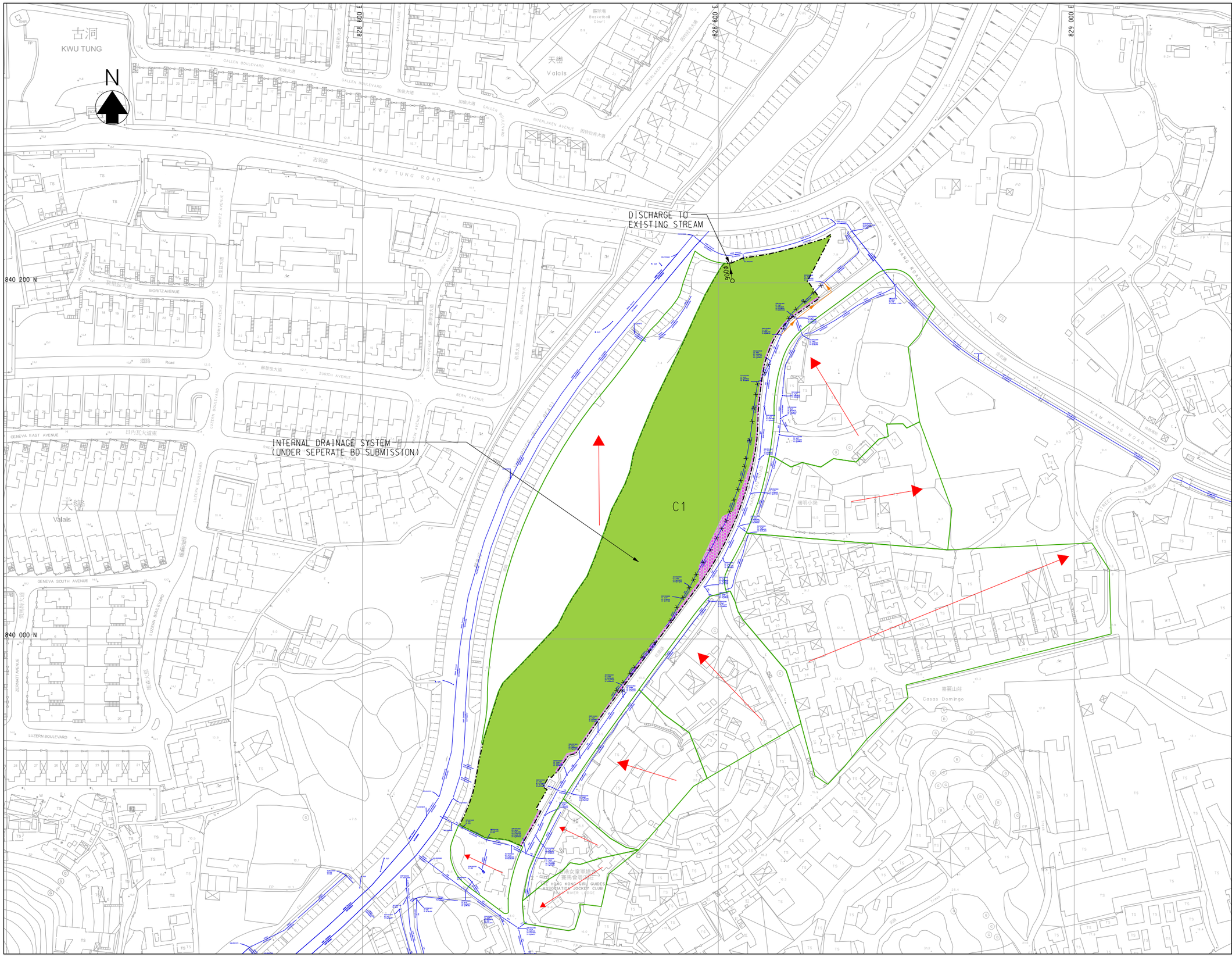

LEGEND:

- THE APPLICATION SITE
- PROPOSED OUTFALL STRUCTURE
- PROPOSED DRAINAGE DIVERSION PIPE
- EXISTING CATCHMENT
- DIRECTION OF FLOW
- EXISTING DRAINAGE PIPE/U-CHANNEL TO BE DEMOLISHED
- PLANNED ROAD WIDENING WORKS BY DEVELOPER

	Designed	Checked
Initial	ZL	NS
Date	02/14	02/14

Project title

SECTION 16 PLANNING APPLICATION FOR PROPOSED HOUSES AT LOTS 1027, 1029, 1030, 1034 S.A, 1034 S.B, 1039 (PART), 1040, 1042 RP, 1043 RP, 1044 RP (PART), 1045, 1047, 2233 (PART), 2251 S.A RP, 2256 RP, 2315 (PART) AND 2316 RP (PART) IN D.D. 92 AND ADJOINING GOVERNMENT LAND (NEW LOT TO BE KNOWN AS LOT 2644 IN D.D. 92), KWU TUNG SOUTH, SHEUNG SHUI, THE NEW TERRITORIES

Drawing title

PROPOSED DRAINAGE SYSTEM AND CATCHMENT PLAN

Figure no.	Revision
KT3/DIA/004	-

Scale: A1 1 : 1000

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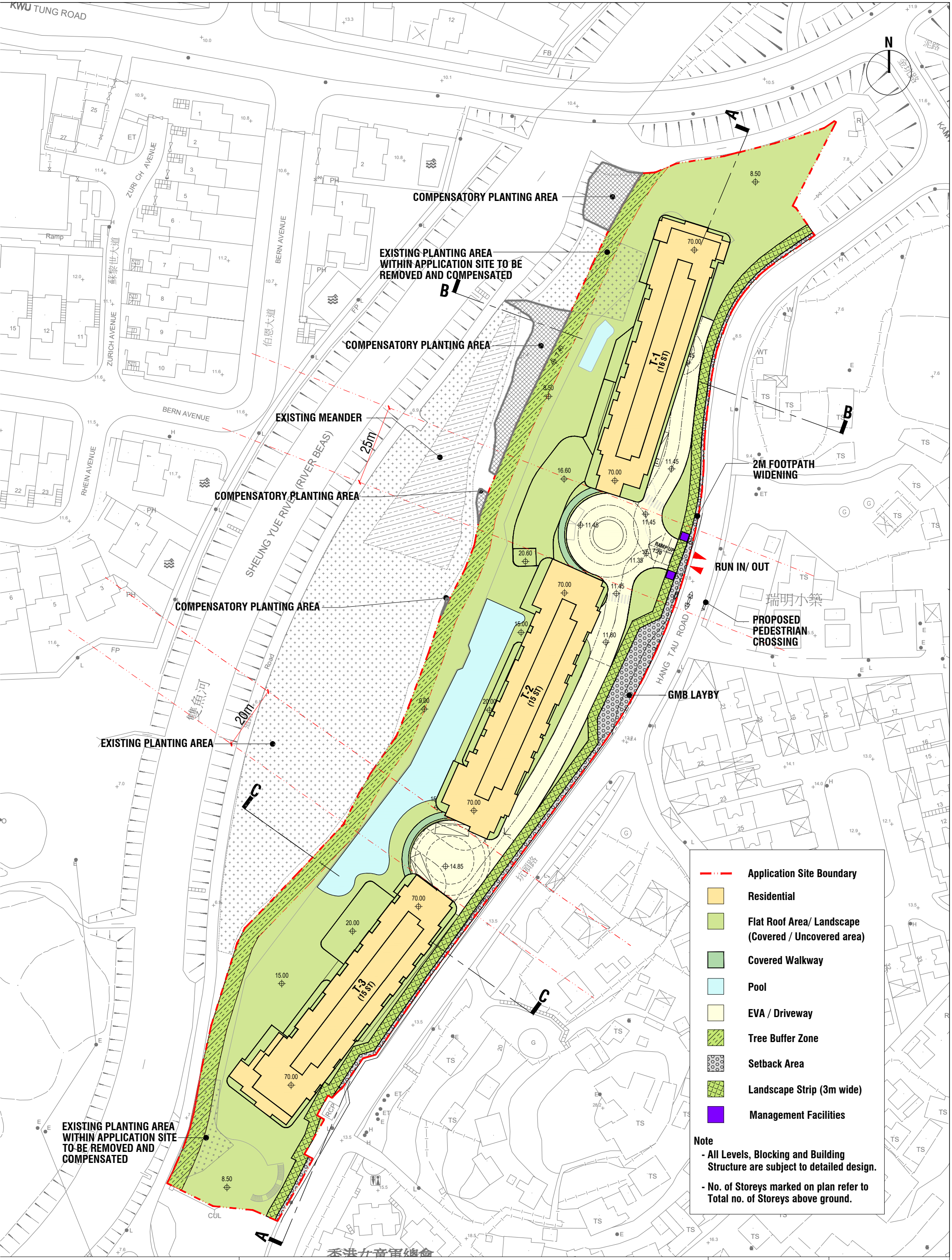
Annex A
Master Layout Plan



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Title

Indicative Master Layout Plan

Rev.	Date
	28 AUG 2025
Scale	Figure
1:1000 [A3]	

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Title

Indicative Basement Layout Plan

Rev.	Date
	27 AUG 2025
Scale	Figure
1:1000 [A3]	

COMPENSATORY PLANTING AREA

EXISTING PLANTING AREA WITHIN APPLICATION SITE TO BE REMOVED AND COMPENSATED

COMPENSATORY PLANTING AREA

EXISTING MEANDER

COMPENSATORY PLANTING AREA

COMPENSATORY PLANTING AREA

EXISTING PLANTING AREA

EXISTING PLANTING AREA WITHIN APPLICATION SITE TO BE REMOVED AND COMPENSATED

2M FOOTPATH WIDENING

CARPARK ENTRANCE

RUN IN/ OUT

PROPOSED PEDESTRIAN CROSSING

CARPARK ENTRANCE

GMB LAYBY

EVA/DRIVEWAY

25m

20m

T1A
T1
T1B
T2A
T2
T2B
T3
T3A
T3B

A
B
C

N

KWU TUNG ROAD
ZURI CH AVENUE
ZURICH AVENUE
BERN AVENUE
RHEIN AVENUE
SHEUNG YUE RIVER (RIVER BEAS)
HANG TAU ROAD
蘇黎世大道
伯恩大道
雙魚河
坑頭路
瑞明小築

Application Site Boundary
Residential
Landscape (Covered / Uncovered area)
Clubhouse
Covered Walkway above
Pool
M&E
EVA / Driveway
Tree Buffer Zone
Setback Area
Landscape Strip (3m wide)
Management Facilities

Note
- All Levels, Blocking and Building Structure are subject to detailed design.
- No. of Storeys marked on plan refer to Total no. of Storeys above ground.

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Title

Indicative Ground Floor Layout Plan

Rev.	Date
	28 AUG 2025
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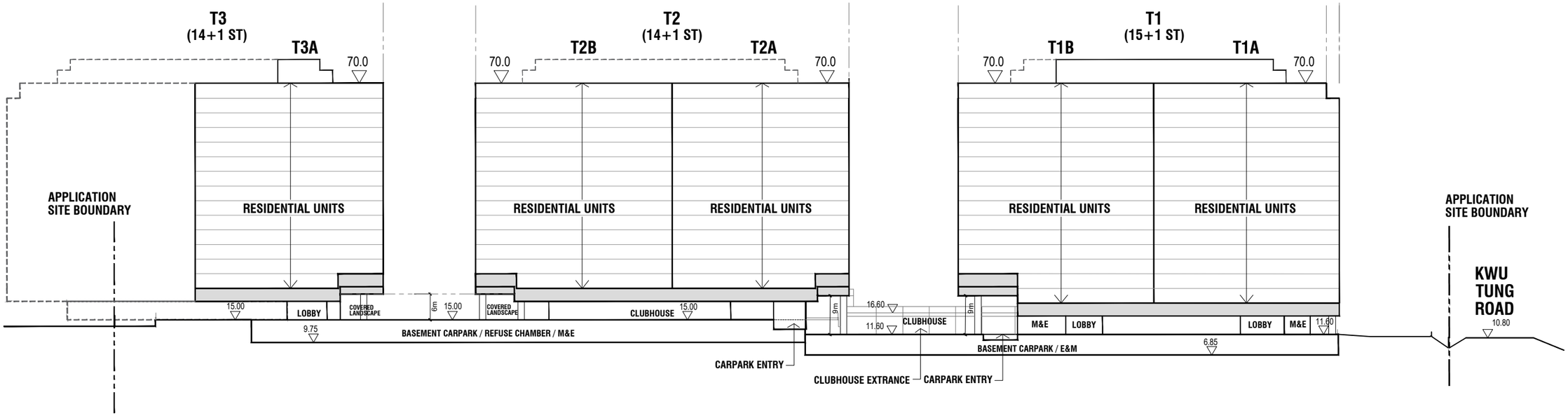
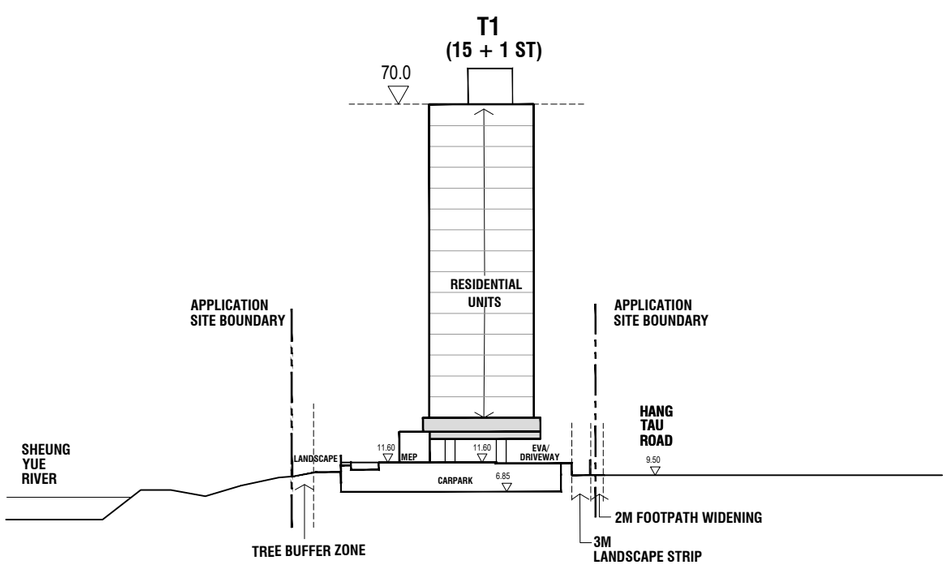
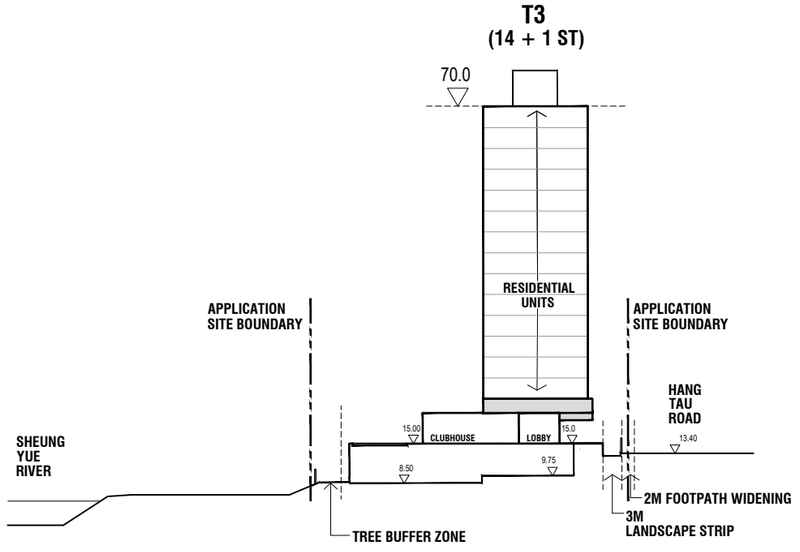


SECTION A-A



SECTION B-B



SECTION C-C

Note

- **All Levels, Blocking and Building Structure are subject to detailed design.**
- **No. of Storeys marked on plan refer to Total no. of Storeys above ground.**

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Title

Indicative Sections

Rev.	Date
	28 JULY 2025
Scale	Figure
1:1000 [A3]	A-4

Annex B
Runoff Calculations

Runoff calculation before development

1 Objective

Estimate Catchment Runoffs (Diverted)

2 Assumption

SDM 14.6.2

Design Return Period of Rainfall Profile: 200 years

$$F(t) = \begin{cases} \dfrac{a[b+2(1-c)t]}{(2t+b)^{c+1}} & , \quad 0 \le t \le \dfrac{t_d}{2} \\ F(-t) & , \quad -\dfrac{t_d}{2} \le t \le 0 \end{cases}$$

a = 501
b = 2.5
c = 0.35

The initial soil Antecedent Moisture Condition:

3 Planned Condition

3.1 Curve Number for Development Site

Curve Number: **61.444** (Weighted CN Number for the Catchment)

3.2 SCS Method

i) Time of Concentration
ii) Design Rainstorm Profile
iii) Unit Hydrograph
iv) Excess Rainfall Hyetograph
v) Discharge Hydrograph
vi) Volume of Storage Pond

3.3 Time of concentration

SDM 7.5.2(d)

$$t_0 = \frac{0.14465\ L}{H^{0.2}\ A^{0.1}}$$

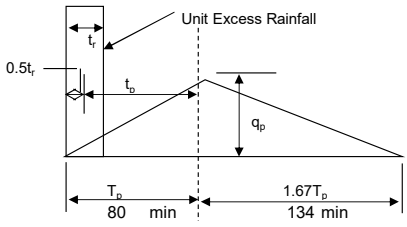
where, t_0 = time of concentration of a natural catchment (min)
A = catchment area (m^2)
H = average slope (m per 100m)
L = distance of flow path (m)

A = **14656379** m^2
t_0 = **133.1** min

3.4 Unit Hydrograph (by using triangular unit hydrograph)

Duration, tr = 1 min = 0.017 hr
Lag Time, tp = 0.6 t_0 = 79.836 min = 1.33 hr
Rise Time, Tp = tr/2 + tp = 1.339 hr (80.3 min)
Peak Discharge q_p = CxQxA / Tp = 2.280 m^3/s (Shape factor C = 0.75 , Q=1 for unit hydrograph)

Figure 1. Configuration of Unit Hydrograph



2.67Tp = 214 min

3.5 Excess Rainfall (by SCS Method)

Potential Maximum Retention (S) = (1000 / 61.44378 - 10) x 25.4

= 159.386 mm

Initial Loss (Ia) = 0.2 x S = 31.877 mm

Continuous Loss (Fa) = S (P - Ia) / (P - Ia + S) (P is Cummulative Rainfall)

Cumulative Excess Rainfall (Pe) = $(P - 0.2S)^2/(P+0.8S)$

Runoff calculation after development

1 Objective

Estimate Catchment Runoffs (Diverted)

2 Assumption

SDM 14.6.2

Design Return Period of Rainfall Profile: 200 years

$$F(t) = \begin{cases} \frac{a[b+2(1-c)t]}{(2t+b)^{c+1}} & , \quad 0 \le t \le \frac{t_d}{2} \\ F(-t) & , \quad -\frac{t_d}{2} \le t \le 0 \end{cases}$$

a = 501
b = 2.45
c = 0.35

The initial soil Antecedent Moisture Condition:

3 Planned Condition

3.1 Curve Number for Development Site

Curve Number: **61.480** (Weighted CN Number for the Catchment)

3.2 SCS Method

i) Time of Concentration
ii) Design Rainstorm Profile
iii) Unit Hydrograph
iv) Excess Rainfall Hyetograph
v) Discharge Hydrograph
vi) Volume of Storage Pond

3.3 Time of concentration

SDM 7.5.2(d)

$$t_0 = \frac{0.14465\ L}{H^{0.2}\ A^{0.1}}$$

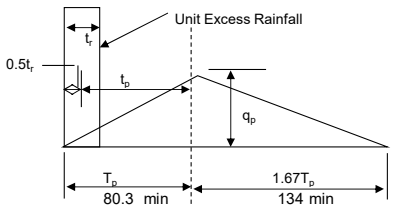
where, t_0 = time of concentration of a natural catchment (min)
A = catchment area (m^2)
H = average slope (m per 100m)
L = distance of flow path (m)

A = **14656379** m^2
t_0 = **133.0** min

3.4 Unit Hydrograph (by using triangular unit hydrograph)

Duration, tr = 1 min = 0.017 hr
Lag Time, tp = 0.6 t_0 = 79.806 min = 1.33 hr
Rise Time, Tp = tr/2 + tp = 1.338 hr (80.3 min)
Peak Discharge q_p = CxQxA / Tp = 2.281 m^3/s (Shape factor C = 0.75 , Q=1 for unit hydrograph)

Figure 1. Configuration of Unit Hydrograph



2.67Tp = 214 min

3.5 Excess Rainfall (by SCS Method)

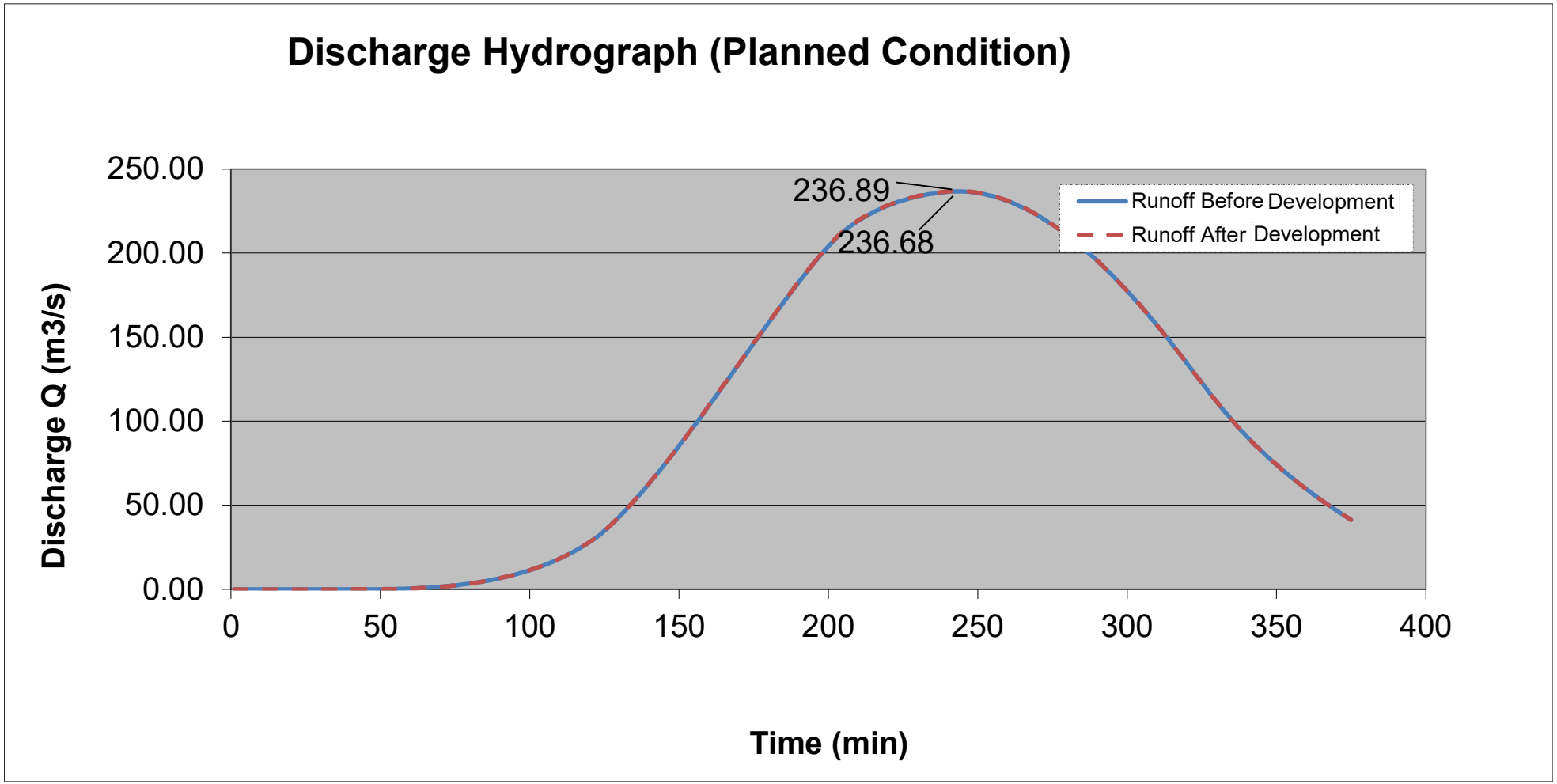
Potential Maximum Retention (S) = (1000 / 61.480159 - 10) x 25.4

= 159.141 mm

Initial Loss (Ia) = 0.2 x S = 31.828 mm

Continuous Loss (Fa) = S (P - Ia) / (P - Ia + S) (P is Cummulative Rainfall)

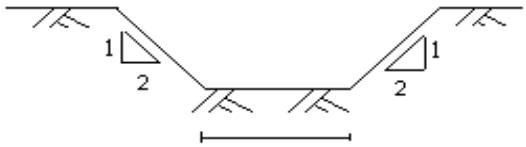
Cumulative Excess Rainfall (Pe) = $(P - 0.2S)^2/(P+0.8S)$


Discharge Hydrograph (Planned Condition)
Discharge Q (m3/s)
250.00
200.00
150.00
100.00
50.00
0.00
0
50
100
150
200
250
300
350
400
236.89
236.68
Runoff Before Development
Runoff After Development
Time (min)

Annex C
Capacity Calculation for River Beas

Annex C Hydraulic calculation at River Beas

$$Q = \frac{A}{n} S^{1/2} R^{2/3}$$



15.621m

Area of flow	A =	52.468	m^2	(estimated)
Wetted Perimeter	P =	26.211	m	
Hydraulic radius	R =	2.002		
Hydraulic gradient	S =	0.002		
Mannings Coefficient	n =	0.035		Table 13 of SDM

Discharge in the Channel Q = $\frac{A}{n}$ x s^(1/2) x R^(2/3)

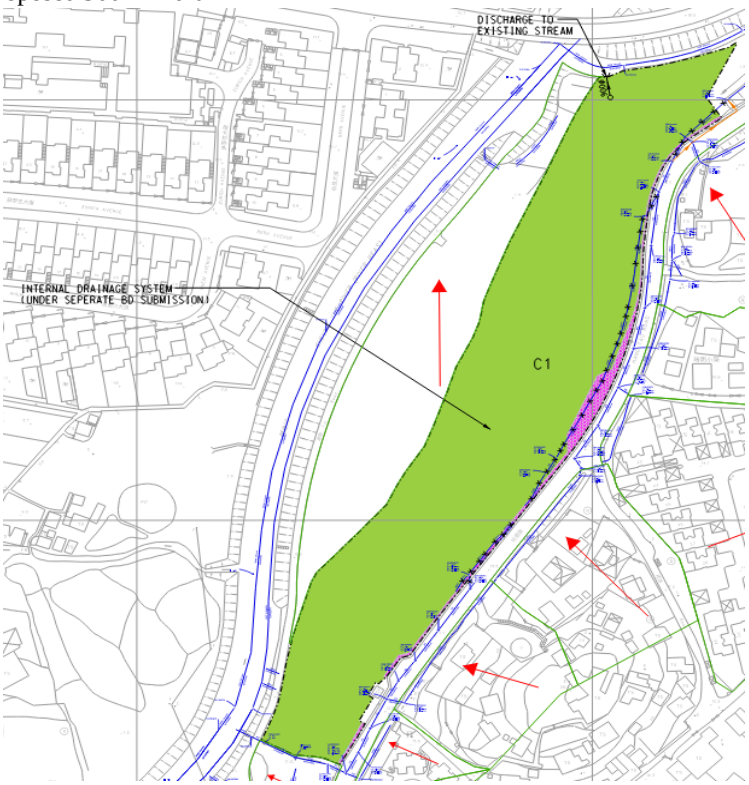
= 111.523 m^3/s (Refer to Annex B)

Increase rate of discharge Q' = 0.21 m^3/s

Percentage with respect to
Full flow of River Beas = 0.19%

Annex D
Hydraulic Calculation for Internal Drainages

Capacity Check: Proposed 900 mm drain



Design Parameters					
Design storm			50	year return period	
Storm constants		a	474.6		
		b	2.9		
		c	0.371		
Average Slope		H	1.00	m/100m	
Length of flow		L	345.00	m	
Inlet time	$t_0=0.14465L/H^{0.2}A^{0.1}$	t_0	18.58	min	
Length of drain		Lj	0.00	m	
Flow velocity of drain		Vj	2.21	m/s	
Unpaved area		A_U	249	m^2	
Runoff coef.		C_U	0.35		
Paved area		A_P	19591	m^2	
Runoff coef.		C_P	0.95		
Catchment area		A_{Total}	19,591	m^2	
Runoff coef.		$C_{average}$	0.95		
Surface roughness		k_s	0.6	mm	*For Poor Precast Concrete Pipes*
kinematic viscosity		v	1.14	mm^2/s	
Frictional gradient		S_f 1 in	200		

Capacity Check: Proposed 900 mm drain

Peak Runoff

Flow time	t_f	=	Lj / Vj			
		=	0.00	min		
Time of concentration	t_c	=	$t_0 + t_f$			
		=	18.58	min		
Inetnsity	i	=	$a / (t_c + b)^c$	x	1.281	*Climate Change factor (SDM Table 28)*
		=	194.86	mm/hr		
Peak runoff	Q_p	=	0.278 C i A			
		=	**1.01**	m^3/s		

Capacity of 900Ø Drain

Trial pipe size	D	=	**900**	mm
Hydraulic radius	R = D/4	=	0.225	m
Mean velocity (Colebrook-White)	$\bar{V}$	=	$-\sqrt{32gRS_f}\log\left[\frac{k_s}{14.8R}+\frac{1.255\nu}{R\sqrt{(32gRS_f)}}\right]$	
		=		
		=	2.21	m/s
Capacity provided	Q	=	*V* x Cross Section Area of Drain	
		=	**1.41**	m^3/s
Allow 10% Area for Siltation	$Q_{90\%}$	=	**1.27**	m^3/s
		>	Peak runoff Q_p	**OK**