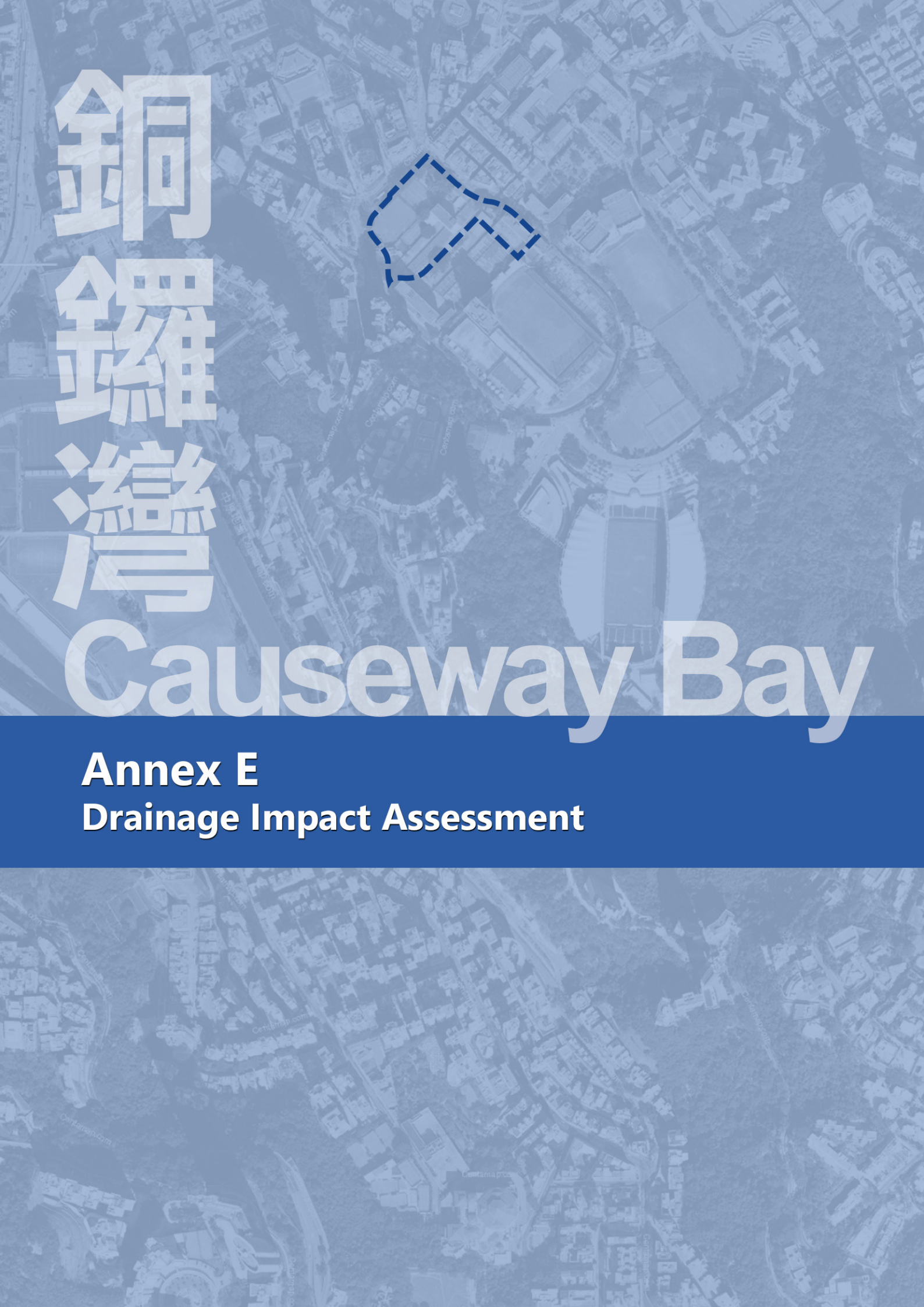




銅鑼灣

Causeway Bay

Annex E

Drainage Impact Assessment

Proposed Redevelopment at Caroline Hill Road, Causeway Bay

Drainage Impact Assessment (DIA)

Report Ref

05 | 10 October 2025

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 247866

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ARUP

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Appendix E

Pipe capacity check for Proposed Drainage discharge points

1 Introduction

1.1 General

This revised DIA had been submitted to support the Fresh S16 Planning Application with the revised layout plan submission. The recommendation established in the previously approved DIA remains unchanged.

2 The Development

The subject site is located at Causeway Bay at the junction of Caroline Hill Road and Leighton Road. The subject site area covers approx. 14,800m². It was occupied by the ex-Electrical and Mechanical Services Department (EMSD) Headquarters, the ex-Civil Aid Service Headquarters, the ex-Post Office Recreation Club and the PCCW Recreation Club.

Below is an aerial photograph of the subject site.

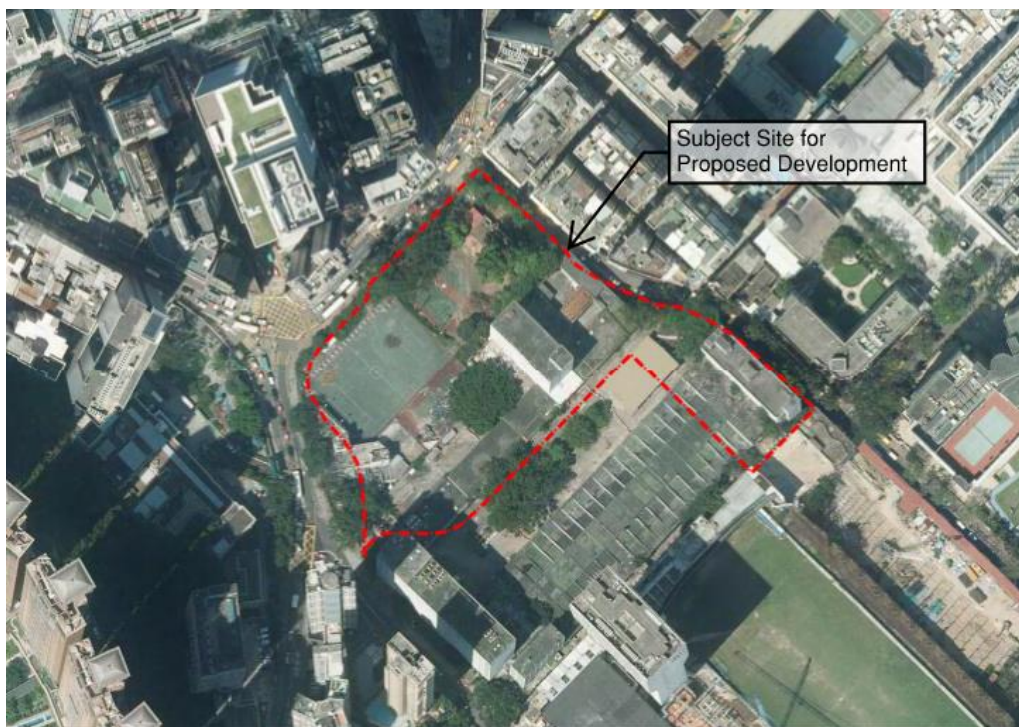


Figure 1 - Location of Subject Site

For the general arrangement in subject site, two office towers are separated by the future public road as shown in below proposed ground floor plan. Two existing Old and Valuable Trees (OVT) are observed in the subject site. One OVT (OVT No. HKP WCH/1) is located at the North of the subject site and next to Leighton Road. Another OVT (OVT No. EMSD WCH/1) is located at the South of the subject site and next to the Future Public Road.

Below is the proposed development plan which is presented in **Appendix A**.

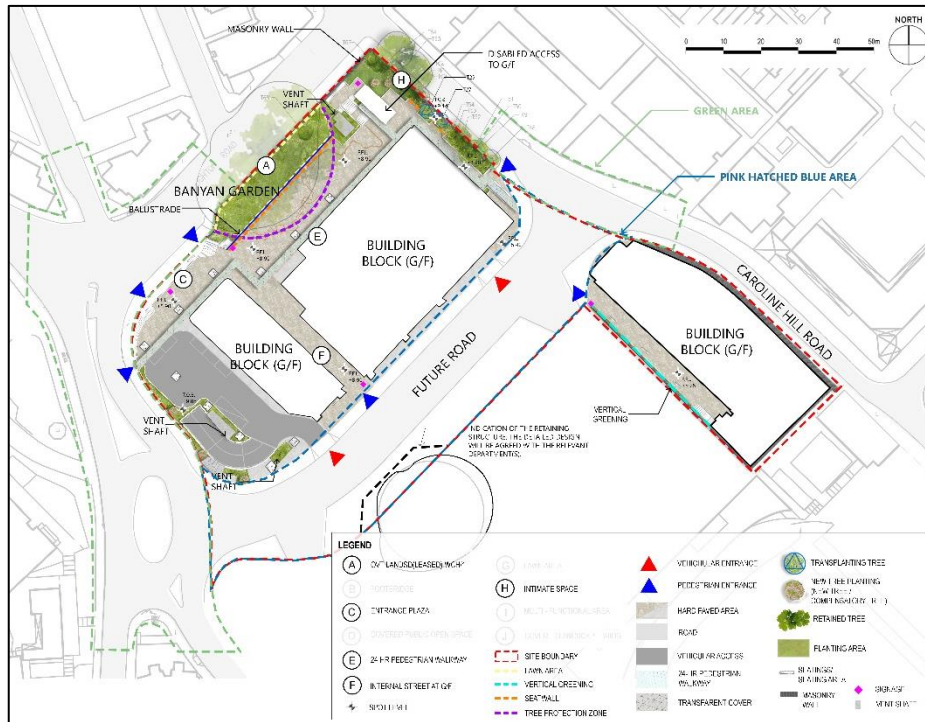


Figure 2 - Proposed Development Plan

Below is the layout plan for two old and valuable trees which is presented in **Appendix B**.



Figure 3 - OVT layout Plan

3 Methodology and Technical Approach

3.1 Assessment Approach

The DIA is following the standards set out in the Stormwater Drainage Manual (Fifth Edition) issued by *Drainage Services Department in January 2018 (DSD SDM)* and the Corrigendum No. 1/2022, 1/2024 and 2/2024.

3.1.1 Runoff Estimation

Flood Protection Level

The design standard for a drainage system shall be able to accommodate a flood event with a predefined return period, which the return period depends on the area and type of drainage system.

The design flood protection level is determined in accordance with *Table 10 of the DSD SDM*, which is reproduced in **Table 3.1**.

Table 3.1 – Recommended Design Return Periods based on Flood Levels

Category	Return Period
Intensively Used Agricultural Land	2-5 years
Village Drainage including Internal Drainage System under a Polder Scheme	10 years ^{1,3}
Main Rural Catchment Drainage Channels	50 years ^{2,3}
Urban Drainage trunk systems	200 years ⁴
Urban drainage branch systems	50 years ⁴
Notes: 1. The impact of a 50-year event should be assessed in each village to check whether a higher standard than 10 years can be justified. 2. Embanked channels must be capable of passing a 200-year flood within banks. 3. ‘Village Drainage’ refers to the local stormwater drainage system within a village. A stormwater drain conveying stormwater runoff from an upstream catchment but happens to pass through a village may need to be considered as either a ‘Main Rural Catchment Drainage Channel’ or ‘Village Drainage’, depending on the nature and size of the upstream catchment (refer to Section 6.6.1 of the DSD SDM.) 4. An ‘Urban Drainage Branch System’ is defined as a group or network of connecting drains collecting runoff from the urban area and conveying stormwater to a trunk drain, river or sea (refer to <i>Section 6.6.2 of the DSD SDM</i>). 5. An ‘Urban Drainage Trunk System’ collects stormwater from branch drains and/or river inlets, and conveys the flow to outfalls in river or sea (refer to <i>Section 6.6.2 of the DSD SDM</i>).	

To assess the hydraulic performance of the proposed drainage system, a flood protection level with a return period of 50 years for “Urban Drainage Branch Systems” is used in this DIA.

Peak Runoff

The peak runoff is estimated using the Rational Method in accordance with *Section 7.5.2 of the DSD SDM* with the following equation:

$$Q = 0.278CiA$$

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

Runoff coefficient

The runoff coefficients, C , for different surface characteristic to be adopted in this DIA for the peak runoff estimation are referenced to *Section 7.5.2 (b) of the DSD SDM* and listed in **Table 3.2**.

Table 3.2 – Runoff Coefficient

Surface Characteristics	Runoff Coefficient, C^1
Asphalt	0.70 – 0.95
Concrete	0.80 – 0.95
Brick	0.70 – 0.85
Grassland (heavy soil ²)	
- Flat	0.13 – 0.25
- Steep	0.25 – 0.35
Grassland (sandy soil)	
- Flat	0.05 – 0.15
- Steep	0.15 – 0.20
Notes:	
1. For steep natural slopes or areas where a shallow soil surface is underlain by an impervious rock layer, a higher C value of 0.4 – 0.9 may be applicable.	
2. Heavy soil refers to fine grain soil composed largely of silt and clay.	

Referring to the equation for peak runoff estimation, a greater value of C implies a greater peak runoff. Considering that the effect of soaking in unpaved area may not be as high as grassland, to be conservative, the runoff coefficient for the unpaved area is assumed to be 0.35; and the runoff coefficient for the paved area is assumed to be 0.9.

Rainfall Intensity

The rainfall intensity is determined by the following equation with reference to *Section 4.3.3 of the DSD SDM*:

$$i = \frac{a}{(t_d + b)^c}$$

where,
 i = rainfall intensity in mm/hr
 t_d = duration in minutes
 a, b, c = storm constants

The storm constants, i.e. a , b , and c , under *Table 3a “Storm Constants for Different Return Period of HKO Headquarters”* of the *DSD SDM*, which are recommended for general application, are adopted in this DIA.

According to *Section 6.8 of the DSD SDM*, the rainfall in Hong Kong is projected to increase under climate change. Considering the effect of climate change, 16.0% rainfall increase and design allowance of 12.1% rainfall increase for end-21st century as given in *Table 28 and 31 of the DSD SDM* has been included in calculating the rainfall intensity. Therefore, the equation becomes:

$$i = \frac{a}{(t_d + b)^c} \times (1 + 16.0\% + 12.1\%)$$

where,
 i = rainfall intensity in mm/hr
 t_d = duration in minutes
 a, b, c = storm constants

Time of Concentration

The duration of minutes, t_d , is referred to the time for a drop of water to flow from the remotest point in the catchment to its outlet, i.e. the time of concentration, t_c .

3.1.2 System Capacity

The capacity of the existing drainage system is checked by using the continuity equation, assuming full-bore flow condition:

$$Q = VA$$

where,
 Q = peak runoff in m³/s
 V = cross-sectional mean velocity in m/s
 A = cross-sectional area of the pipe/channel in m²

The cross-section mean velocity, V , is estimated using the Colebrook White equation:

$$\bar{V} = -\sqrt{32gRS_f} \log \left[\frac{k_s}{14.8R} + \frac{1.255\nu}{R\sqrt{32gRS_f}} \right]$$

where,
 $\bar{V}$ = cross-sectional mean velocity (m/s)
 S_f = friction gradient (dimensionless)
 g = acceleration due to gravity (m/s²)
 R = hydraulic radius (m)
 k_s = surface roughness (m)
 ν = kinematic viscosity (m²/s)

Referring to the equation for cross-section mean velocity estimation, a greater value of k_s implies a smaller velocity of the drainage system. To be conservative, the surface roughness is assumed to be 0.6 mm for precast concrete pipe and 0.03mm for PE pipes with reference to *Table 14 - Recommended Roughness Values k_s of the DSD SDM*, considering the reduced hydraulic performance in future due to degradation of material. The design calculation should also take into consideration of pipe siltation as per *DSD SDM Section 9.3*.

3.1.3 Sub-Catchment area

The catchment plan for existing case, the Approval Scheme and the Proposed Scheme are attached in **Appendix D**. The changes in the planting area around the OVT are summarized in below table for easy reference.

Formerly EMSD development (the Existing Case)	
Paved	15,490.5m ²
Unpaved	133.5m ²
Approval Scheme	
Paved	14,050m ²
Unpaved	750m ²
Proposed Scheme	
Paved	14,133.5m ²
Unpaved	666.5m ²

Compared with the existing site, both the Approval Scheme and Proposed Scheme will have the landscape area increase from the existing case of 133.5m² by enlarging the area of OVT zone to 750m² for the Approval Scheme and 666.5m² for the Proposed Scheme.

3.2 Existing Drainage System

Based on the latest underground utility survey record, there are totally 10 existing drainage connection points inside the site boundary as shown in below figure, including three 150Ø, seven 225Ø and one 375Ø drainage pipes.

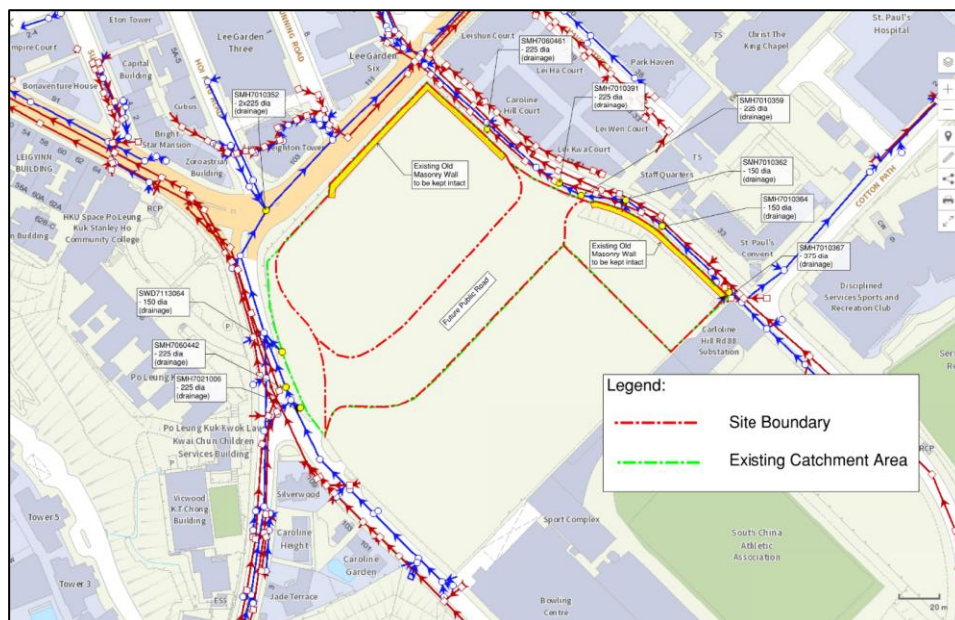


Figure 5 - Location of existing connection points inside the site boundary

Thus, total catchment area of 15,624m² in subject site is assumed to discharge to the nearest existing drainage system, which is located on the running southwest to northeast across the Tong Lo Wan Road. 15,490.5m² and 133.5m² are considered as paved and unpaved area respectively. The catchment area plan is presented in **Appendix D**.

The surface runoff is discharged to an existing 2250mm (w) x 2150mm (h) box culvert (SBP7001145), which is running along Tung Lo Wan Road. And then, the stormwater is discharge to Victoria Harbour, combining the surface runoff with road gullies and catchment from the upstream of Causeway Bay.

3.3 Proposed Drainage System

Proposed drainage discharge points are developed by keeping the similar catchment distribution as existing. The layout plan of existing and proposed drainage discharge points is presented in **Appendix C**.



Figure 5 - Location of proposed connection points of subject site

Thus, for proposed development, total catchment area of 14,800m² within the subject site is assumed to discharge to the nearest existing drainage system, which is located on the running southwest to northeast across the Tong Lo Wan Road. 14,133.5m² and 666.5m² are considered as paved area and unpaved area. The catchment area plan is presented in **Appendix D**.

3.4 Potential Drainage Impacts

Currently, the surface runoff of subject site is discharged by the existing drainage discharge points, diverting to the existing 900Ø drainage pipe along Leighton Road which is further diverted to the existing box culvert at Tung Lo Wan Road.

For the characteristic of the existing catchment, the paved and unpaved area are 15,490.5m² and 133.5m² respectively. For the characteristic of the catchment for proposed development, the unpaved area would be increased to 666.5m² by enlarging the area of OVT zone. Therefore, the total surface runoff from the site

would be reduced. The surface runoff from the subject site would be then discharged to the proposed drainage discharge points. The peak runoff to the existing branch of drainage pipe along Leighton Road should be reduced. Thus, there is no drainage impact to the existing drainage system as a result of the proposed redevelopment.

The summary table for the catchment of drainage connections is shown below.

Existing Case						Approved Scheme				
	Downstream Manhole	Pipe dia. (mm)	Sub-Catchment ref.	Paved catchment (m ²)	Unpaved catchment (m ²)	Downstream Manhole	Pipe dia. (mm)	Sub-Catchment ref.	Paved catchment (m ²)	Unpaved catchment (m ²)
South of subject site	SMH7021006	225	A4, A5, 50%A7	751.6	0					
	SMH7060442	225	A2, A6	1352	0					
	SWD7113064	150	50%A7	349	0					
Total area of the South			A2, A4-A7	2,452.6	0					
North of subject site	SMH7010352	825	A2-A8, A10	5,610.3	133.5	SMH7010352	825	B2, B3, B4	4,500	750
Total area of the North			A2-A8, A10	5,610.3	133.5			B2, B3, B4	4,500	750
East of subject site	SMH7060461	225	A9, A11, A12	2,122	0	SMH7010330	400	B5, B6	3,400	0
	SMH7010391	225	A1, A13	4,937.7	0	SMH7010358	375	B1, B7	3,550	0
	SMH7010362	150	50%A14, 50%A15	1,410.3	0	SMH7010391	300	B8	2,600	0
	SMH7010364	150	50%A14, 50%A15	1,410.3	0					
Total area of the East			A1, A9, A11, A12, A13, A14, A15	9,880.2	0			B1, B5-B8	9,550	0
Total area of the site			A1-A15	15,490.5	133.5			B1-B8	14,050	750
						Proposed Scheme				
	Downstream Manhole	Pipe dia. (mm)	Sub-Catchment ref.	Paved catchment (m ²)	Unpaved catchment (m ²)					
South of subject site										
Total area of the South										
North of subject site	SMH7010352	825	B2, B3, B4	4,824.0	426.0					
Total area of the North			B2, B3, B4	4,824.0	426.0					
East of subject site	SMH7010330	400	B5, B6	3,159.5	240.5					
	SMH7010358	375	B1, B7	3,550	0					
	SMH7010391	300	B8	2,600	0					
Total area of the East			B1, B5-B8	9,309.5	240.5					

Total area of the site			B1-B8	14,133.5	666.5
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The summary table for the peak runoff of drainage connections is shown below.

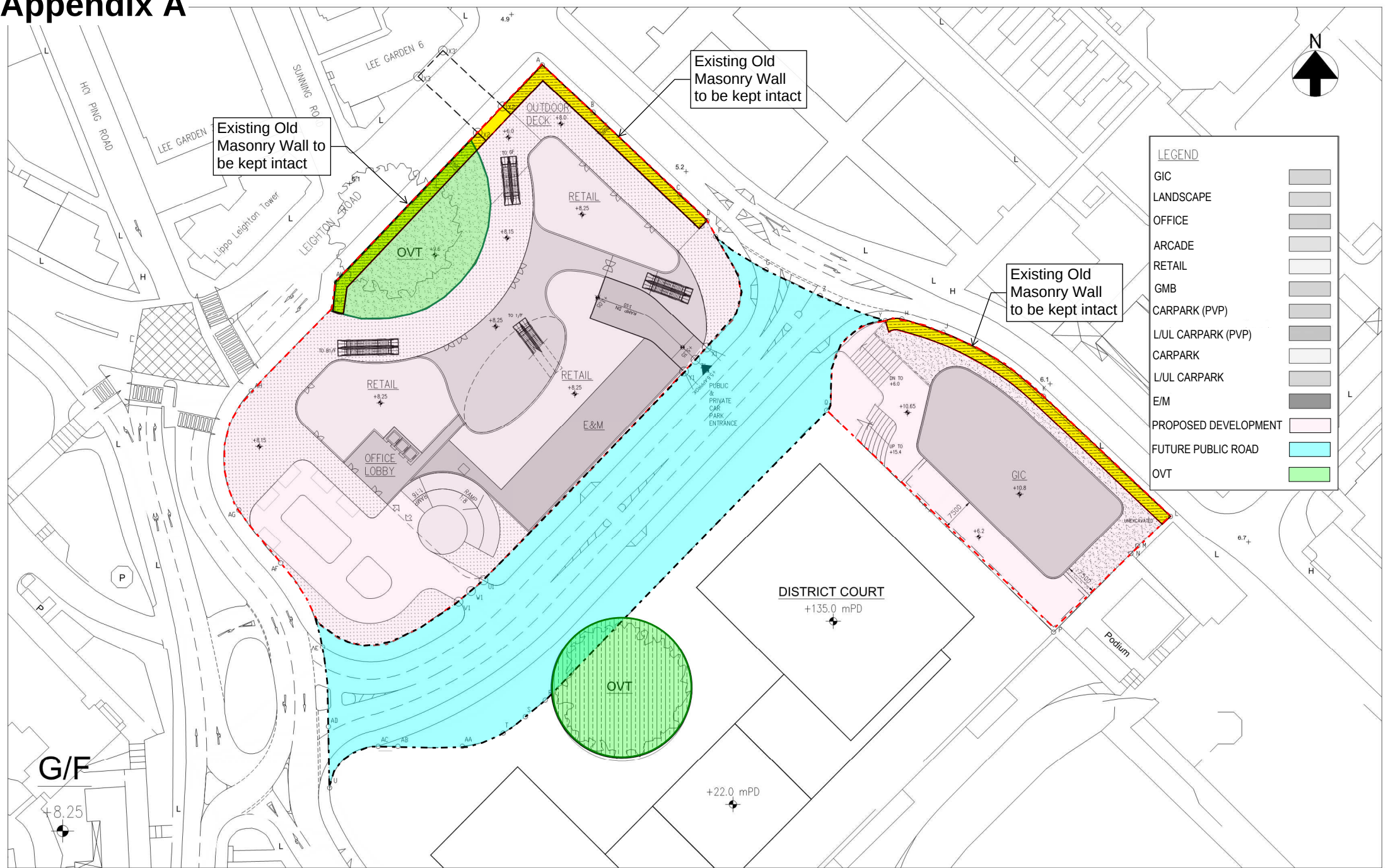
Existing Case						Approved Scheme				
	Sub-Catchment ref.	Paved catchment (m ²)	Unpaved catchment (m ²)	Peak Runoff (m ³ /s)	Remark	Sub-Catchment ref.	Paved catchment (m ²)	Unpaved catchment (m ²)	Peak Runoff (m ³ /s)	% change
South of subject site	A2, A4-A7	2452.6	0	0.169	-	-	-	-	-	-
North of subject site	A2-A8, A10,	5610.3	133.5	0.387	-	B2, B3, B4	4,500	750	0.317	-18.06%
East of subject site	A1, A9, A11, A12, A13, A14, A15	9880.2	0	0.679	-	B1, B5-B8	9,550	0	0.657	-3.34%
Total Peak Runoff	A1-A15	15,490.5	133.5	1.066	-	B1-B8	14,050	750	0.974	-8.68%
						Proposed Scheme				
	Sub-Catchment ref.	Paved catchment (m ²)	Unpaved catchment (m ²)	Peak Runoff (m ³ /s)	% change					
South of subject site	-	-	-	-	-					
North of subject site	B2, B3, B4	4,824.0	426.0	0.336	-13.17%					
East of subject site	B1, B5-B8	9,309.5	240.5	0.643	-5.41%					
Total Peak Runoff	B1-B8	14,133.5	655.5	0.979	-8.22%					

4 Conclusion

Since the total surface runoff for the proposed scheme will be reduced with enlarged landscape area when compared with the existing case, the peak runoff to the existing branch of drainage pipe along Leighton Road should also be reduced and should be beneficial to the existing drainage system. Therefore, it is concluded that there would be no impact to the existing drainage system as a result of the proposed scheme.

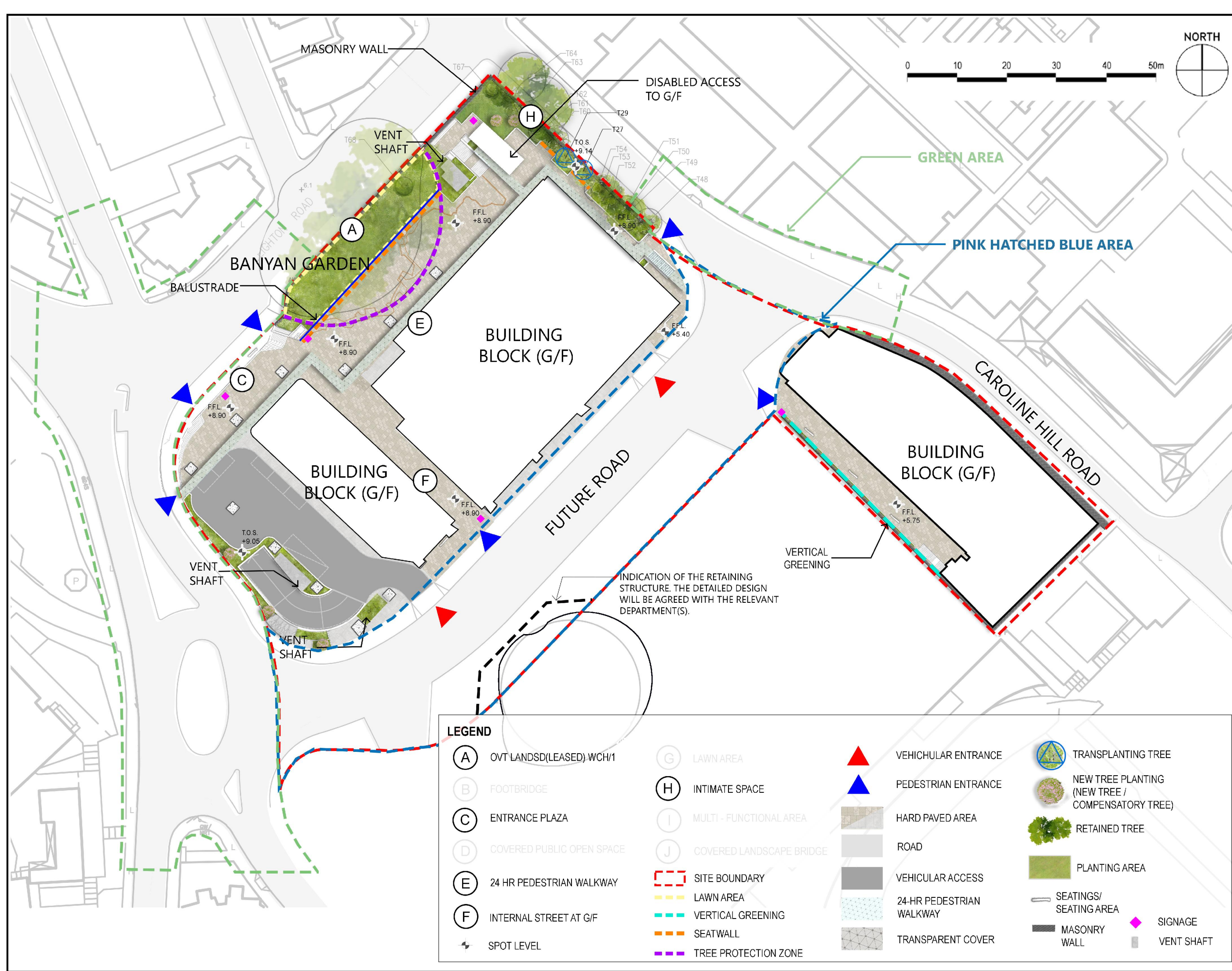
Appendix A

Layout Plan of Caroline Hill Road Development



Layout Plan of Caroline Hill Road Development

(Approved Layout Plan)



REV	DATE	DESCRIPTION
otherland UNIT 2307-08, 23/F, NEW TECH PLAZA, 34 TAI YAU STREET SAN PO KONG KOWLOON, HONG KONG, Tel: (852) 2893 0370 Fax: (852) 2893 3139 WWW.OTHERLAND.COM.HK		
CLIENT: PATCHWAY HOLDINGS (HK) LIMITED		
PROJECT: CAROLINE HILL ROAD		
TITLE: APPENDIX C2 - LANDSCAPE MASTER PLAN (G/F)		
SCALE:	1:750@A3	
DRAWN BY:	OY	
CHECKED BY:	PC	
APPROVED BY:	PC	
DRAWING DATE:	AUG 2025	
PROJECT No:	HYSAN02	
SHEET No:	HYSAN02-LMP-C2-2	REV: -
THIS DRAWING AND DESIGN ARE COPYRIGHTED AND NO PORTION MAY BE REPRODUCED WITHOUT THE PRIOR PERMISSION TO THE LANDSCAPE ARCHITECT.		

Appendix B

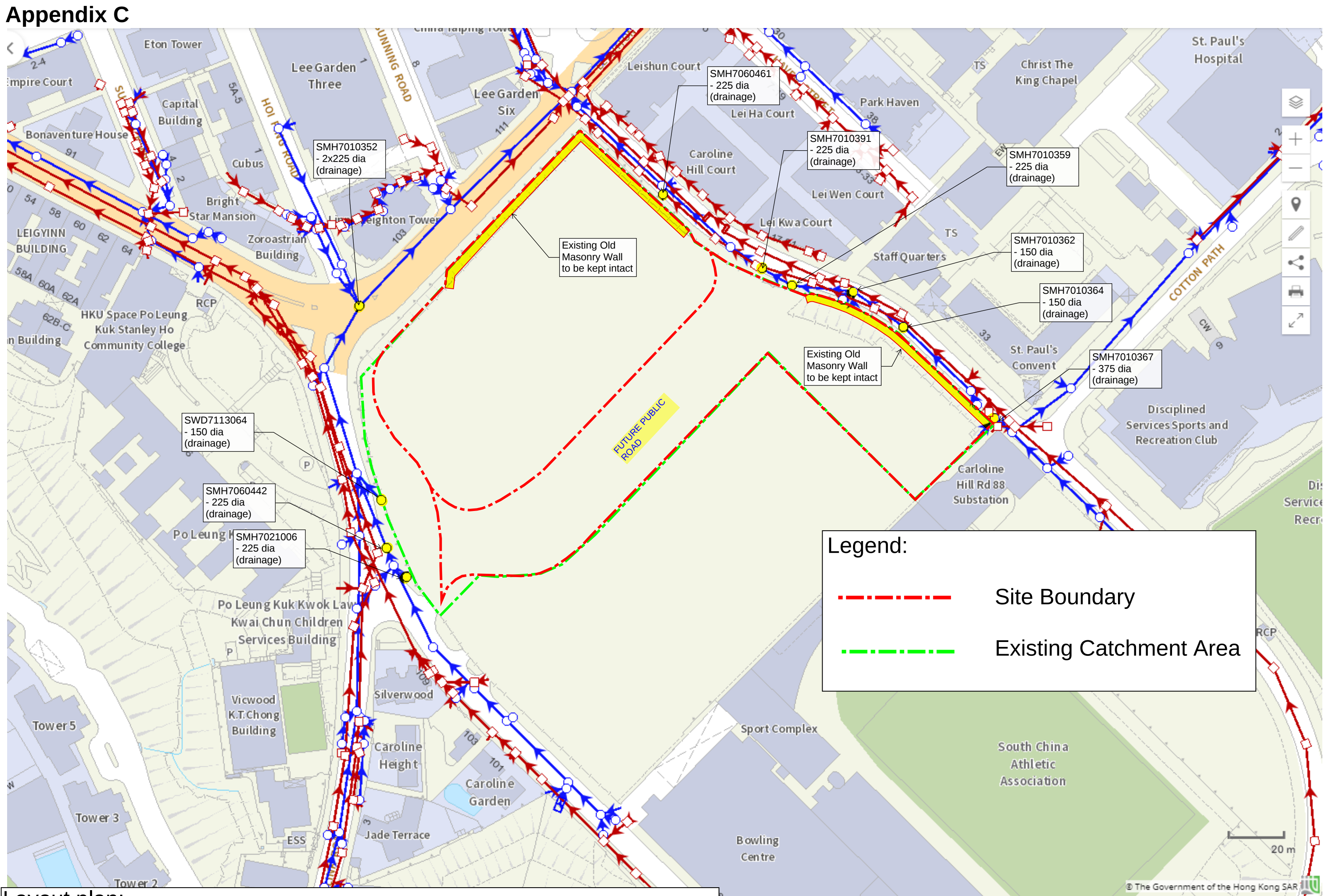
Layout Plan of OVT

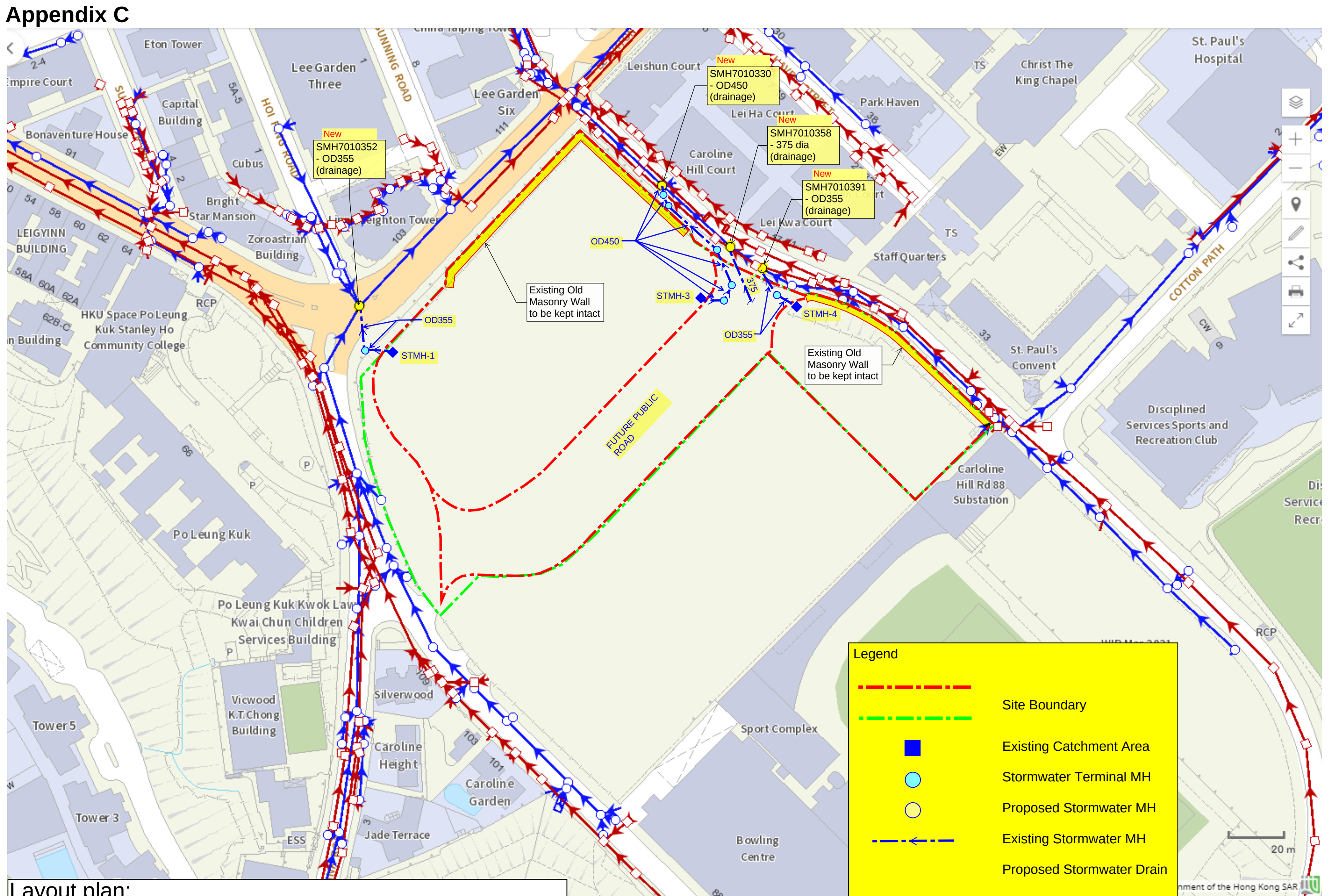
Appendix B



Appendix C

Drainage Layout plan for Caroline Hill Road Development

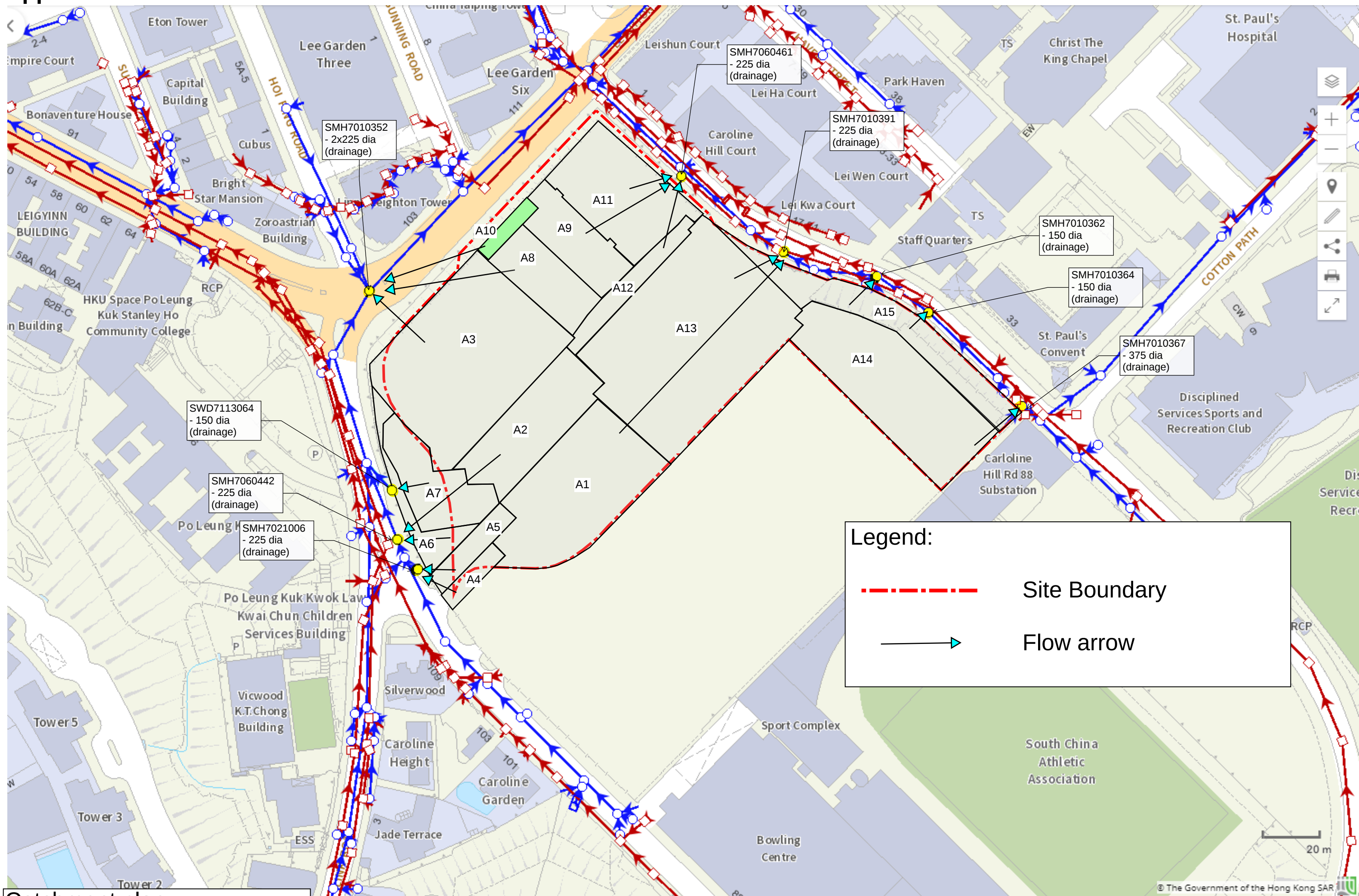


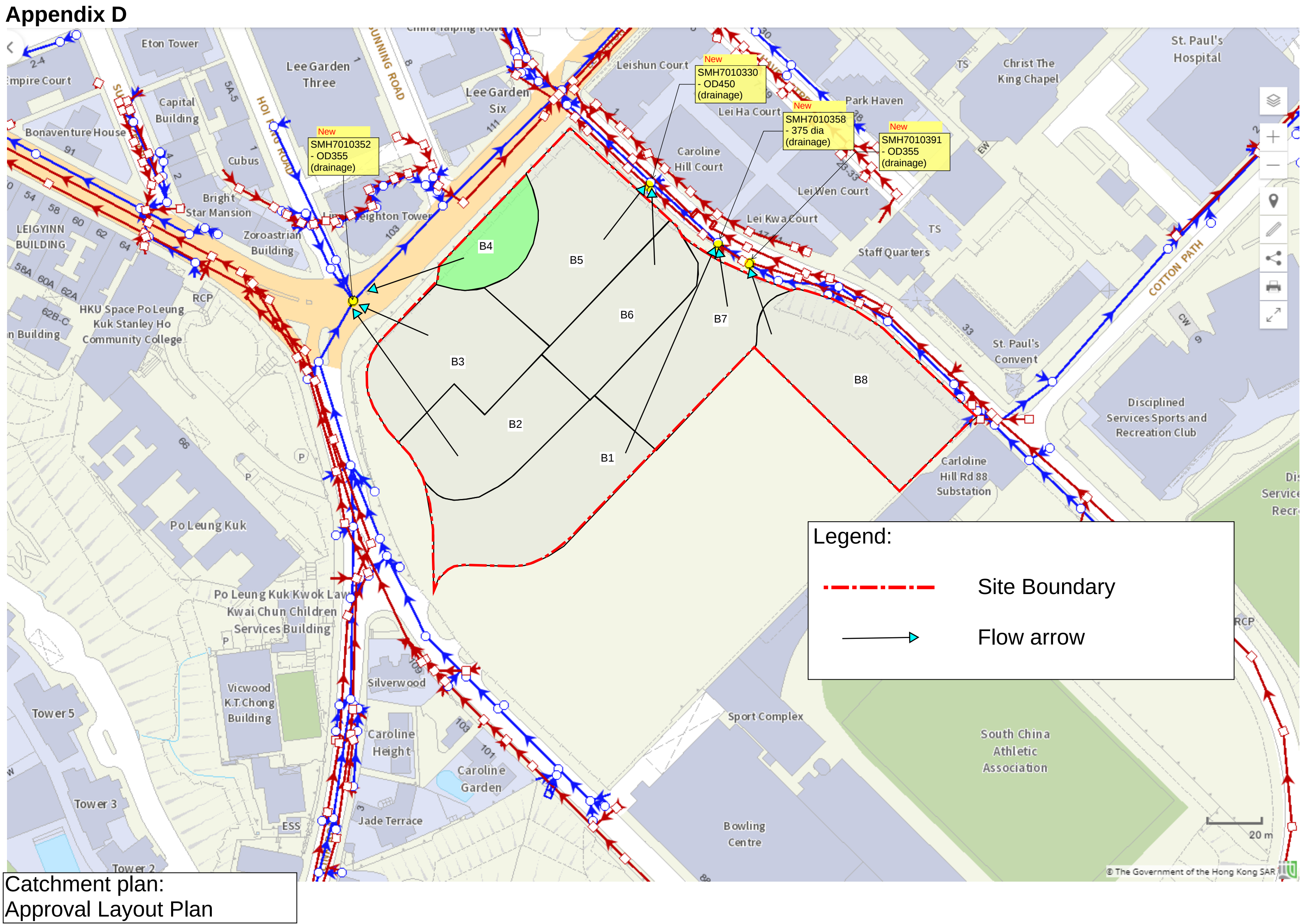


Appendix D

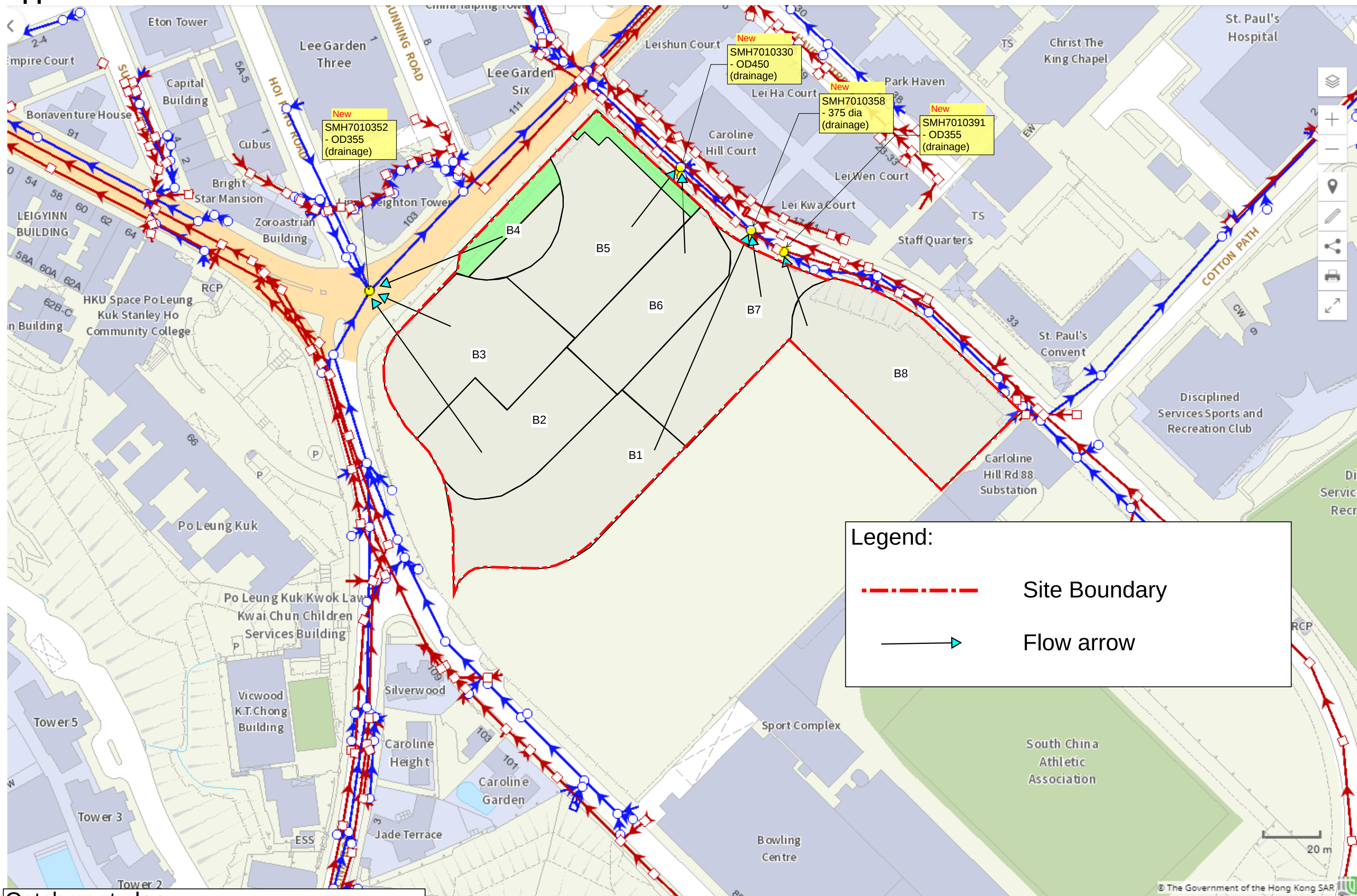
Catchment plan for Caroline Hill Road Development

Appendix D





Appendix D



Catchment plan:
Proposed Layout Plan

Appendix E

Pipe capacity check for Proposed Drainage discharge points

ARUP	Job No.		Sheet No.		Rev.						
	285077				C						
	Member/Location										
Job Title	Caroline Hill Road, Causeway Bay					Drg. Ref.					
Calculation	Pipe Capacity Checking					Made by	JP	Date	10 Oct 2025	Chd.	CC

Notes

1

Runoff Coeff., C =

0.90
0.35
0.35

(Paved)
(Steep natural slope)
(unpaved)

Return Period =

50 years

(Main Rural Catchment Drainage Channels)

(Table 10, Stormwater Drainage Manual)

Rainfall Intensity, I = a / (T_c + b)^c

where :

a =

505.5

b =

3.29

c =

0.355

(Gumbel solution)

Return Period = 50 years

(Table 3a, Stormwater Drainage Manual)
(Corrigendum No.1 2024 SDM)

2

Calculate by Colebrook-White Equation

$$\bar{V} = -\sqrt{32gRS_f} \log \left[\frac{k_s}{14.8R} + \frac{1.255\nu}{R\sqrt{32gRS_f}} \right]$$

v is kinematic viscosity of fluid = 1.14 x 10-6 m²/s and g is the gravity = 9.81m/s²

V is the velocity, R is the hydraulic radius and S is the gradient of the stormwater drain.

3

A 10% reduction in flow area is adopted to take into account the effects on flow capacity due to deposition of sediment in pipes.

4

Climate Change Factor (%) =16.0% + 12.1% = 28.1%

(Table 28 and 31, Stormwater Drainage Manual, for rainfall increase at End 21st)

Catchment Area Distribution			
Catchment Area	Area (m2)		
	paved	natural slope	unpaved
B1	2235	0	0
B2	2200	0	0
B3	2300	0	0
B4	361	0	389
B5	1492	0	241
B6	1068	0	0
B7	1915	0	0
B8	2600	0	0
Total	14170.5	0	629.5

Runoff Calculation
Return period = 50 years

Location		Sub-	Catchment Area of the development						Drainage Character				Hydraulic parameter		Time of the development			(i) Extreme	Peak	Full bore	%	Full bore		
US	DS	Catchment Reference	Paved		Steep Natural Slope		Unpaved		Drainage Shape	Drainage size			Slope	cross area	Hydraulic Diameter, D	t _a	t _f	t _c	mean intensity (1 in 50) with climate change	Runoff	Capacity			Velocity
			Sub-Catchment	Accumulative Area	Sub-Catchment	Accumulative Area	Sub-Catchment	Accumulative Area		width/dia (mm)	height (mm)	length (m)												
STMH-1	SMH7010352	B2, B3, B4	4,861.0	4,375	0	0	389.0	136	Circular PE Pipe	311.6	-	-	0.100	0.07	0.29	5.00	0.00	5.00	305.6	0.338	0.45	75		6.58
STMH-3	SMH7010330	B5, B6	3,159.5	2,844	0	0	240.5	84	Circular PE Pipe	395.2	-	-	0.010	0.11	0.37	5.00	0.00	5.00	305.6	0.220	0.25	87	2.29	PE100-RC, SDR 17, PN10, OD450, ID395.2
Future Public Road Drainage	SMH7010358	B1, B7	3,550.0	3,195	0	0	0.0	0	Circular Concrete Pipe	375	-	-	0.026	0.10	0.35	5.00	0.00	5.00	305.6	0.244	0.28	89	2.77	
STMH-4	SMH7010391	B8	2,600.0	2,340	0	0	0.0	0	Circular PE Pipe	311.6	-	-	0.020	0.07	0.29	5.00	0.00	5.00	305.6	0.179	0.20	92	2.84	PE100-RC, SDR 17, PN10, OD355, ID311.6

ARUP	Job No.		Sheet No.		Rev.						
	285077				C						
	Member/Location										
Job Title	Caroline Hill Road, Causeway Bay					Drg. Ref.					
Calculation	Pipe Capacity Checking					Made by	IP	Date	10 Oct 2025	Chd.	CC

Notes

1

Runoff Coeff., C =0.90 (Paved)
0.35 (Steep natural slope)
0.35 (unpaved)

Return Period =50 years (Main Rural Catchment Drainage Channels)

(Table 10, Stormwater Drainage Manual)

2

Calculate by Colebrook-White Equation

$$\bar{V} = -\sqrt{32gRS_f} \log \left[\frac{k_s}{14.8R} + \frac{1.255\nu}{R\sqrt{32gRS_f}} \right]$$

ν is kinematic viscosity of fluid = 1.14 x 10-6 m²/s and g is the gravity = 9.81m/s²
 V is the velocity, R is the hydraulic radius and S is the gradient of the stormwater drain.

3

A 10% reduction in flow area is adopted to take into account the effects on flow capacity due to deposition of sediment in pipes.

4

Climate Change Factor (%) =16.0% + 12.1% =28.1%

(Table 28 and 31, Stormwater Drainage Manual, for rainfall increase at End 21st)

Rainfall Intensity, I = a / (T_c + b)^c
where :

a =	505.5
b =	3.29
c =	0.355

(Gumbel solution)
Return Period = 50 years

(Table 3a, Stormwater Drainage Manual)
(Corrigendum No.1 2024 SDM)

Catchment Area Distribution			
Catchment Area	Area (m2)		
	paved	natural slope	unpaved
B1	2235	0	0
B2	2200	0	0
B3	2300	0	0
B4	361	0	389
B5	1492	0	241
B6	1068	0	0
B7	1915	0	0
B8	2600	0	0
Total	14170.5	0	629.5

Comparison between Total Peak Runoff
Return period = 50 years

Proposed Development		Sub-Catchment Reference	Catchment Area of the development						Drainage Character				Hydraulic parameter		Time of the development			(i) Extreme	Peak	Full bore	%	Full bore	
Location	DS		Paved		Steep Natural Slope		Unpaved		Drainage Shape	Drainage size			Slope (S _f)	cross area (A) (m ²)	Hydraulic Diameter, D (m)	t _a	t _f	t _c	mean intensity (1 in 50) with climate change (mm/h)	Runoff (m ³ /s)	Capacity (m ³ /s)		Velocity (m/s)
US			Sub-Catchment (m ²)	Accumulative Area (m ²)	Sub-Catchment (m ²)	Accumulative Area (m ²)	Sub-Catchment (m ²)	Accumulative Area (m ²)		width/dia (mm)	height (mm)	length (m)											
	South of subject site	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(min)	(min)	(min)	-	(m ³ /s)	(m ³ /s)	-	-
-	North of subject site	B2, B3, B4	4,824.0	4,342	0	0	426.0	149	Circular Concrete Pipe	-	-	-	-	-	-	5.00	0.00	5.00	305.6	0.336	-	-	-
-	East of subject site	B1, B5-B8	9,309.5	8,379	0	0	240.5	84	Circular Concrete Pipe	-	-	-	-	-	-	5.00	0.00	5.00	305.6	0.643	-	-	-
-	Total	B1-B8	14,133.5	12,720	0	0	666.5	233	Circular Concrete Pipe	-	-	-	-	-	-	5.00	0.00	5.00	305.6	0.979	-	-	-

Existing Development																								
Location		Sub-Catchment Reference	Catchment Area of the development						Drainage Character						Hydraulic parameter		Time of the development			(i) Extreme mean intensity (1 in 50) with climate change	Peak Runoff	Full bore Capacity	%	Full bore Velocity
US	DS		Paved		Steep Natural Slope		Unpaved		Drainage Shape	Drainage size			Slope (S _r)	cross area (A) (m ²)	Hydraulic Diameter, D (m)	t _e (min)	t _r (min)	t _c (min)						
			Sub-Catchment (m ²)	Accumulative Area (m ²)	Sub-Catchment (m ²)	Accumulative Area (m ²)	Sub-Catchment (m ²)	Accumulative Area (m ²)		width/dia (mm)	height (mm)	length (m)												
	South of subject site	A2, A4-A7	2452.6	2,207	0	0	0	0	Circular Concrete Pipe	-	-	-	-	-	-	5.00	0.00	5.00	305.6	0.169	-	-	-	
-	North of subject site	A2-A8, A10	5610.3	5,049	0	0	133.5	47	Circular Concrete Pipe	-	-	-	-	-	-	5.00	0.00	5.00	305.6	0.387	-	-	-	
-	East of subject site	A1, A9, A11, A12, A13, A14, A15	9880.2	8,892	0	0	0	0	Circular Concrete Pipe	-	-	-	-	-	-	5.00	0.00	5.00	305.6	0.679	-	-	-	
-	Total	A1-A15	15490.5	13,941	0	0	133.5	47	Circular Concrete Pipe	-	-	-	-	-	-	5.00	0.00	5.00	305.6	1.066	-	-	-	