Appendix E

Drainage Impact Assessment

Section 16 Planning Application for Submission of Layout Plan for Permitted 'Flat' and 'Social Welfare Facility' Uses at TWIL 5 and Lot No. 429 in D.D. 399, Ting Kau, Tsuen Wan

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Report on
Drainage Impact Assessment

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Kwun Tong, Kowloon

January 2024

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1. INTRODUCTION

1.1 Binnies Hong Kong Limited (Binnies) has been commissioned to carry out drainage impact assessment to support a Section 16 Planning Application for Submission of Layout Plan for Permitted 'Flat' and 'Social Welfare Facility' Uses on the Approved Tsuen Wan West Outline Zoning Plan No. S/TWW/21 to facilitate a private residential development at TWIL 5 and Lot No. 429 in D.D. 399, Ting Kau, Tsuen Wan (the Application Site).

1.2 The Application Site covers an area of approximately 0.64 ha and currently fall within a "Residential (Group B) 2" ("R(B)2") zone under approved Tsuen Wan West Outline Zoning Plan (OZP) No. S/TWW/21.

1.3 The Application Site is proposed to be redeveloped from the existing hotel into a private residential development with social welfare facility. The previous S12A application no. Y/TWW/7 was approved by the Town Planning Board (TPB) on 2nd June 2022, which consists of a residential block with 661 nos. of units and a 760 m^2 60-place Day Care Centre for the Elderly.

1.4 The Application Site is bounded by Castle Peak Road – Ting Kau to the north, Tsing Long Highway to the west, and Aztec Lodge to the east and south. Location of the Application Site is shown in **Figure TIK/GEN/001.**

Existing Development

1.5 The Application Site is currently occupied by a hotel development, namely Royal View Hotel, which has been present since 2007.

Proposed Redevelopment

1.6 The Proposed Redevelopment will redevelop the existing hotel into 2 nos. of residential block with 674 nos. of residential units and the 60-place Day Care Centre for the Elderly. A summary of key information of the Proposed Redevelopment is shown below in **Table 1.1**.

Table 1.1 Indicative Redevelopment Schedule

Development Parameters	Proposed Redevelopment
Application Site Area[1]	About 6,431 m^2
Development Site Area[2]	About 6,066 m^2
Gross Floor Area (GFA)[3] - Domestic portion - Non-Domestic portion[3 4 5]	 Not more than 29,400 m^2 Not less than 760 m^2
No. of Blocks	2
No. of Storeys[6]	15 storeys (Tower 1) 14 storeys (Tower 2)
Maximum Building Height	Not more than 77mPD
No. of Units	Not more than 674
Anticipated Population[7]	About 1,820

Notes:

[1] Application Site formulated based on the lot boundary of TWIL 5 and Lot No. 429 in D.D. 399 which are currently occupied by an existing hotel development.
[2] The development site area of about 6,066m^2 excludes the portion of an access road within TWIL 5 of about 365 m^2.
[3] GFA of not less than 760 m^2 for the social welfare facility shall be provided in accordance with the OZP restriction.
[4] Detailed NOFA to be agreed with Social Welfare Department.
[5] The residents' clubhouse GFA is based on the maximum GFA concession for clubhouse according to Buildings Department's Practice Note APP-104.
[6] Excluding basement levels.
[7] The anticipated population is derived by assuming 2.7 persons per flat as per the average household size of Tsuen Wan District Council District in 2022 under General Household Survey by Census and Statistics Department.

1.7 This report presents the findings of a drainage impact assessment to support the Proposed Redevelopment at the Application Site. The objectives of this drainage 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 Redevelopment; and
- formulate and evaluate options for drainage scheme for the Proposed Redevelopment.

2. EXISTING DRAINAGE AND FLOOD CONDITION

2.1 The Application Site is currently occupied by Royal View Hotel. According to the as-built drawings of the drainage layout, it is identified that the surface runoff is collected by internal drainage system and conveyed to the terminal stormwater manhole, then subsequently discharged to the existing catch pit no. SCH4009903 near the northern part of the Application Site.

2.2 The existing connection point is shown in **Figure TIK/DIA/001**.

Existing Catchment Drainage

2.3 The Application Site lies near the southern part of Ma Wan Channel. A series of drainage pipes ranging from 675 mm to 1050 mm diameter are located near the roundabout of Caste Peak Road – Ting Kau. This series of drainage pipe connect to an existing 3-cell 3400 mm x 2000mm stormwater box culvert, which is located along the western side of Ting Kau Sitting-out Area.

2.4 In addition, there is a 15m wide drainage reserve for the existing 3-cell box culvert at the Ting Kau Sitting-out Area.

2.5 The existing drainage networks are shown on **Figure TIK/DIA/001**.

Current Flooding Susceptibility

2.6 According to the DSD's location map for flooding blackspots in March 2020, no flooding blackspot is identified within the concerned drainage catchment.

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. 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.

3.2 According to the SDM, 50-year design return period is recommended for the design of drainage system. The 10-year return period sea level has also been considered. However, in accordance with Clause 5.3.2 Table 8 and Clause 6.8 Table 29 to Table 31 of SDM and the Corrigendum, the 50-year return period sea level with rise due to climate change in the end of 21st Century (+4.51 mPD) is well below the site and drainage pipes with invert levels (above +20 mPD), no influence from sea level is anticipated. A summary of the design extreme sea level and sea level rise due to climate change is shown in the following **Table 3.1 and Table 3.2** respectively.

Table 3.1 Design Extreme Sea Level

50-year Return Period
3.66 mPD

Table 3.2 Sea Level and Storm Surge Increase due to Climate Change

Classification	Sea Level Rise	Storm Surge Increase	Design Allowance
End of 21st Century (2081-2100)	0.47 m	0.14 m	0.24 m

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

According to the rainfall zone as shown in Figure 3 of SDM, the Application Site is located in an area that adopts rainfall statistics of Hong Kong Observatory Headquarters. Hence, the design storm constants are adopted in accordance with Table 3a of the SDM. The storm constants are shown in **Table 3.3** below.

Table 3.3 Storm Constants with 50-year Return Period

Parameter	Value
a	505.5
b	3.29
c	0.355

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 **Table3.4** below.

Table 3.4 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 Table 28 and Table 31 in SDM Corrigendum. A summary of increased rainfall due to climate change is shown in **Table 3.5** below.

Table 3.5 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 3.6** below.

Table 3.6 Roughness Coefficient

Classification	Roughness Coefficient	Remarks
Poor Precast Concrete Pipes	Colebrook-White k_s = 0.6mm	Concrete Pipe
Box Culvert	Mannings'n = 0.015	Peripheral drains

4. POTENTIAL DRAINAGE IMPACT BY THE PROPOSED REDEVELOPMENT

4.1 The Application Site will be redeveloped into a residential development from the existing Royal View Hotel. The Indicative Layout Plan of the Proposed Redevelopment is shown on **Annex A**.

Changes to Drainage Characteristics

4.2 The percentage of paved area, comprising building blocks, concrete structures, of the Application Site before and after the Proposed Redevelopment are similar.

4.3 A summary of the land use is shown in **Table 4.1** below. The surface characteristics of the Application Site before and after the Redevelopment are shown in **Figures TIK/DIA/002** and **TIK/DIA/003** respectively.

Table 4.1 Summary of Paved Conditions of the Application Site

	Site Area			
	6445 m^2			
	Paved Area		**Unpaved Area**	
Before Redevelopment	5285 m^2	82.0%	1160 m^2	18.0%
After Redevelopment	5799 m^2	90.0%	646 m^2	10.0%

Volume of Runoff

4.4 It would be basically the same in peak runoff rates at the Application Site of 50 years return periods under a 24-hours design rainfall as given in SDM are shown in **Table 4.2** below. The effect of climate change in the drainage design has been included in the calculation with reference to Table 28 of the SDM. Detailed calculation is shown in **Annex B**.

Table 4.2 Summary of Surface Runoff

Before Development	**After Development**
Runoff (m^3/s)	**Runoff (m^3/s)**
0.2963	0.3131

4.5 To assess the impact of the peak runoff rate in the existing drainage pipes, estimation of the utilization is prepared in **Annex B**. The paving condition of catchment before and after the Redevelopment are shown in **Figures TIK/DIA/004** and **TIK/DIA/005** respectively. The runoff from catchment is assumed to be discharged to Storm Water Manhole SMH4068335.

4.6 According to Guidelines to Property Managers for Formulation of their House-rules to Protect the Environment published by Environmental Protection Department, the direct effluent from annual cleaning of swimming pool should be discharged to stormwater drain. As the annual cleaning of swimming pool should not be carried out under severe weather (i.e. typhoon and rainstorms), the discharge of the annual pool cleaning is a case checked separately from the case with maximum storm runoff from the proposed development. Detailed analysis is shown in **Annex B**.

4.7 As shown in **Annex B**, the drainage pipes and the 3-cell box culvert have adequate capacity to cater the runoff generated by the Proposed Redevelopment. Also, the capacity utilization of subsequent drainage pipes will be increased by equal to or less than 2.8% after the Proposed Redevelopment. Thus, it is considered the change in runoff is negligible and the existing drainage pipes would be capable to cater runoff generated by the Proposed Redevelopment.

4.8 Improvement to the existing local and public drainage systems are not required as the existing drainage system have sufficient capacity to cater the flow. Therefore, no adverse drainage impacts on the public drainage system are anticipated.

5. PROPOSED DRAINAGE STRATEGY FOR THE PROPOSED REDEVELOPMENT

Proposed Drainage Disposal Scheme

5.1 As the Application Site is currently occupied by the existing Royal View Hotel, it is proposed that the surface runoff arise from the Proposed Redevelopment would be collected by the existing internal drainage system and subsequently discharge to the public drainage system.

5.2 The runoff from the Application Site will be discharged into the existing drainage catch pit no. SCH4009903 near the roundabout of the Castle Peak Road – Ting Kau which subsequently discharges into the existing box culverts near Ting Kau Sitting-out Area.

5.3 The proposed connection point is shown on **Figure TIK/DIA/001**.

5.4 The detailed arrangement of the proposed internal drainage system will be further studied at the later design stage of the project.

5.5 Blue-green drainage infrastructure will be considered in the later design stage of the project as appropriate.

5.6 According to the calculation in **Annex B**, one segment of existing stormwater drain (SWD4080513) that would operate close to its capacity under condition for annual cleansing of swimming pool in the Proposed Redevelopment. Stormwater drain upgrading works by the applicant is proposed for the abovementioned segment.

5.7 The segment requires upgrading works is shown on **Figure TIK/DIA/003**.

6. CONSTRUCTION CONSIDERATIONS

6.1 The contractor for the Proposed Redevelopment will be responsible for the maintenance of the existing drainage conditions in the vicinity of the Proposed Redevelopment 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.

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 paving conditions within the Application Site under the Proposed Redevelopment are similar to the existing development. The runoff generated from the Proposed Redevelopment on the Application Site is also similar.

8.2 Based on the proposed drainage disposal scheme, the surface runoff generated by the Proposed Redevelopment would be collected by the internal drainage system and subsequently conveyed to the existing drainage catch pit no. SCH4009903. The catch pit is then connected to the drainage system and eventually discharged at the existing box culvert near Ting Kau Sitting-out Area.

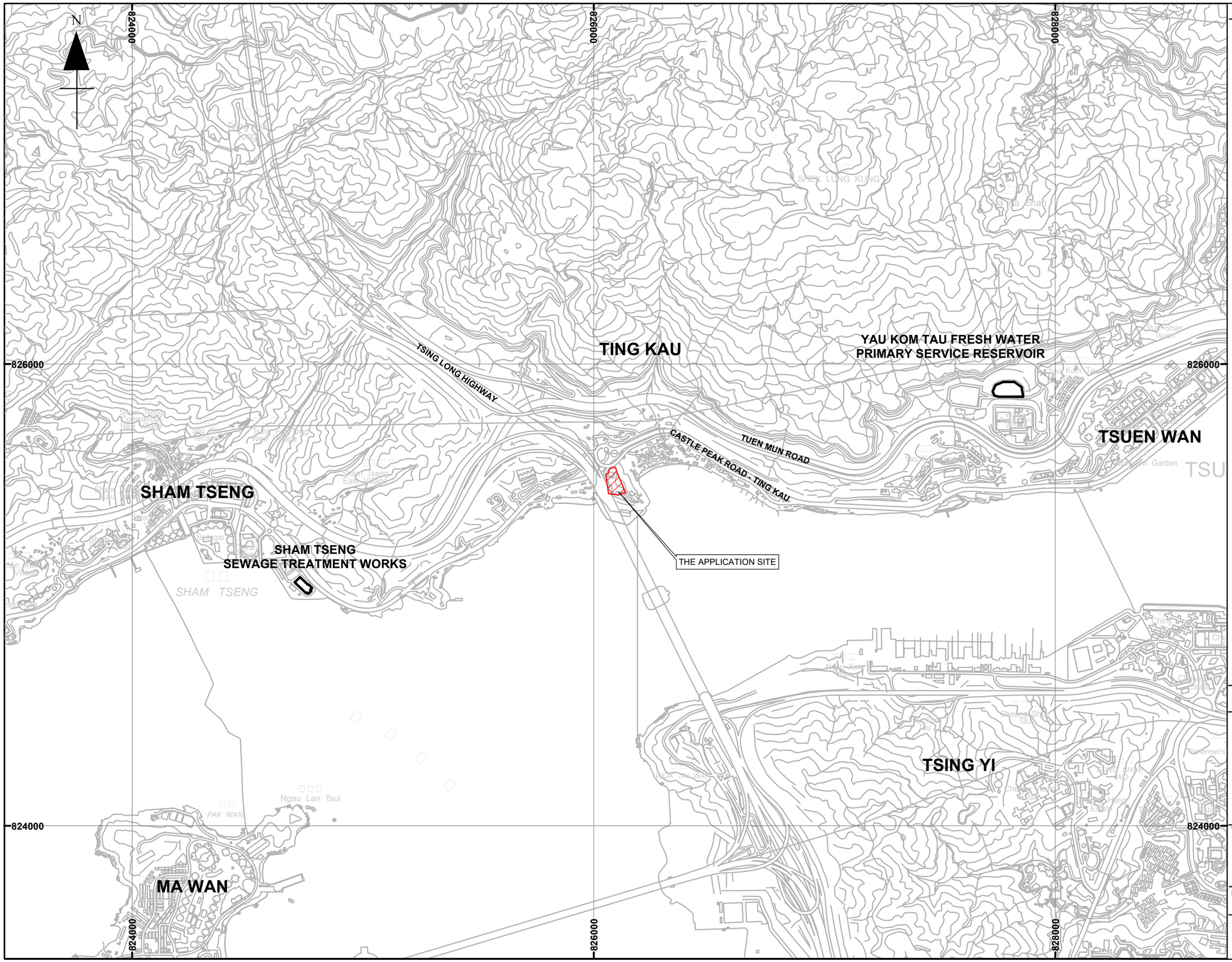
8.3 Assessment on existing public drainage system has been conducted, a segment of stormwater drain would operate close to its capacity and upgrading works by the applicant is proposed. With the proposed works, it is considered that the existing public drainage has adequate capacity to cater the runoff generated by the Proposed Redevelopment.

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 and the Registered General Building Contractor 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 Redevelopment at the Application Site will be acceptable from drainage perspective.

END OF TEXT

FIGURES



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Legend

The Application Site

Initial	Date	Checked	Date
Kathy		KKL	

Project

Section 16 Planning Application for Submission of Layout Plan for Permitted 'Flat' and 'Social Welfare Facility' Uses at TWIL 5 and Lot No. 429 in D.D. 399, Ting Kau, Tsuen Wan

Title

Site Location Plan

Figure No.	Scale
TIK/GEN/001	1:15,000 @ A3

Plot date: 2021-10-25

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N

825800 826000 826200 826400

825600

825400

CASTLE PEAK ROAD - TING KAU

TING KAU

Ting Kau

EXISTING AND PROPOSED CONNECTION TO EXISTING CATCH PIT SCH4009903

EXISTING 3-CELLS STROMWATER BOX CULVERT

TING KAU BRIDGE

Legend

- The Application Site
- Existing Drainage Pipe

Initial	Date	Checked	Date
Kathy		KKL	

Project

Section 16 Planning Application for Submission of Layout Plan for Permitted 'Flat' and 'Social Welfare Facility' Uses at TWIL 5 and Lot No. 429 in D.D. 399, Ting Kau, Tsuen Wan

Title

Existing Drainage System

Figure No.	Scale
TIK/DIA/001	1:2,000 @ A3

Plot date: 2021-10-25

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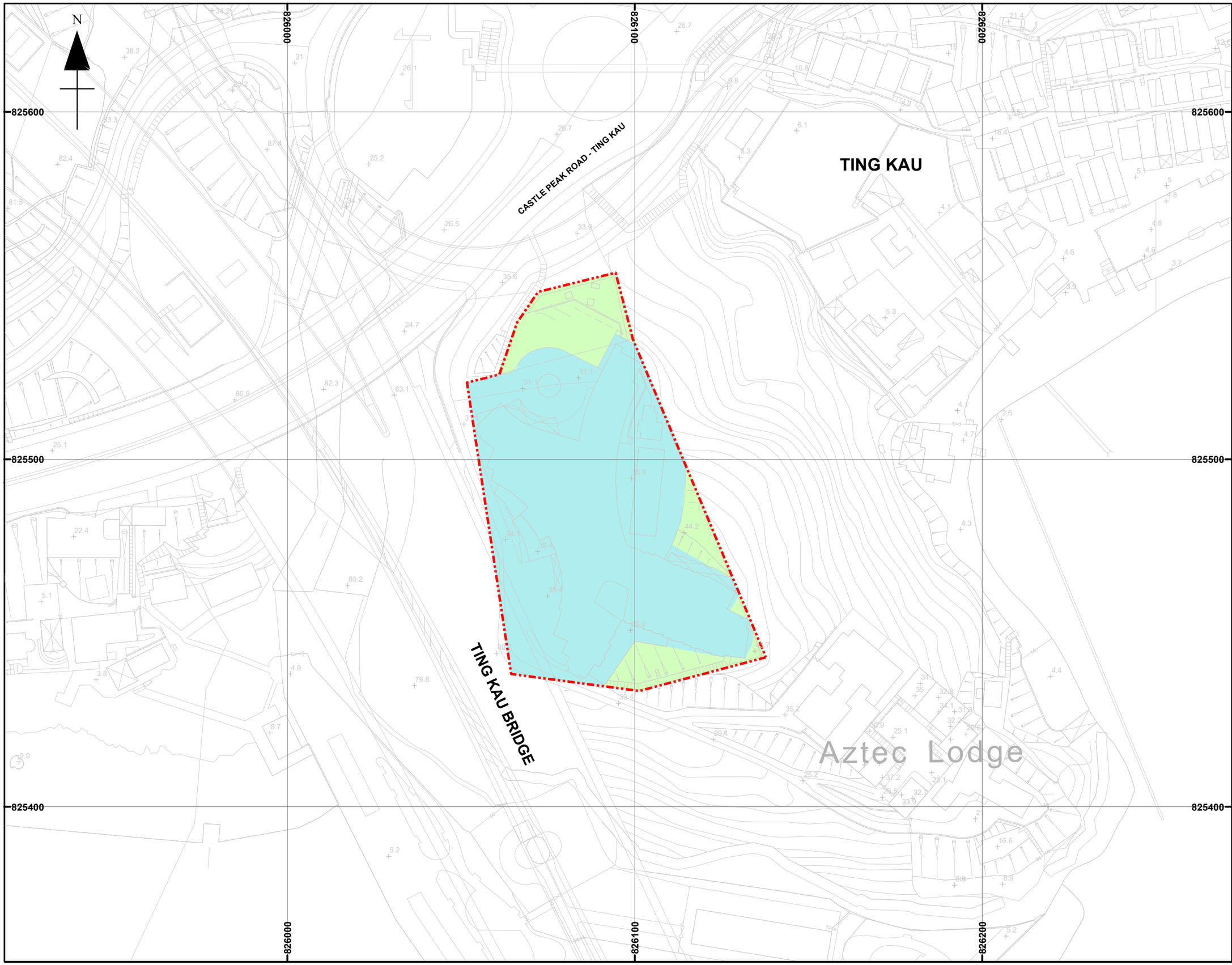

Legend

The Application Site

Paved Condition

Unpaved

Paved

Initial	Date	Checked	Date
Kathy		KKL	

Project

Section 16 Planning Application for Submission of Layout Plan for Permitted 'Flat' and 'Social Welfare Facility' Uses at TWIL 5 and Lot No. 429 in D.D. 399, Ting Kau, Tsuen Wan

Title

Existing Paved Condition

Figure No.	Scale
TIK/DIA/002	1:1,000 @ A3

binnies

Plot date: 2021-10-25

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Legend

- Proposed Site
- Existing Drainage Pipe
- Proposed Drainage Pipe Upgrading
- The Application Site

Paved Condition

- Unpaved
- Paved

Initial	Date	Checked	Date
Kathy		KKL	

Project

Section 16 Planning Application for Submission of Layout Plan for Permitted 'Flat' and 'Social Welfare Facility' Uses at TWIL 5 and Lot No. 429 in D.D. 399, Ting Kau, Tsuen Wan

Title

Proposed Drainage Works and Paved Condition

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

Plot date: 2021-10-25

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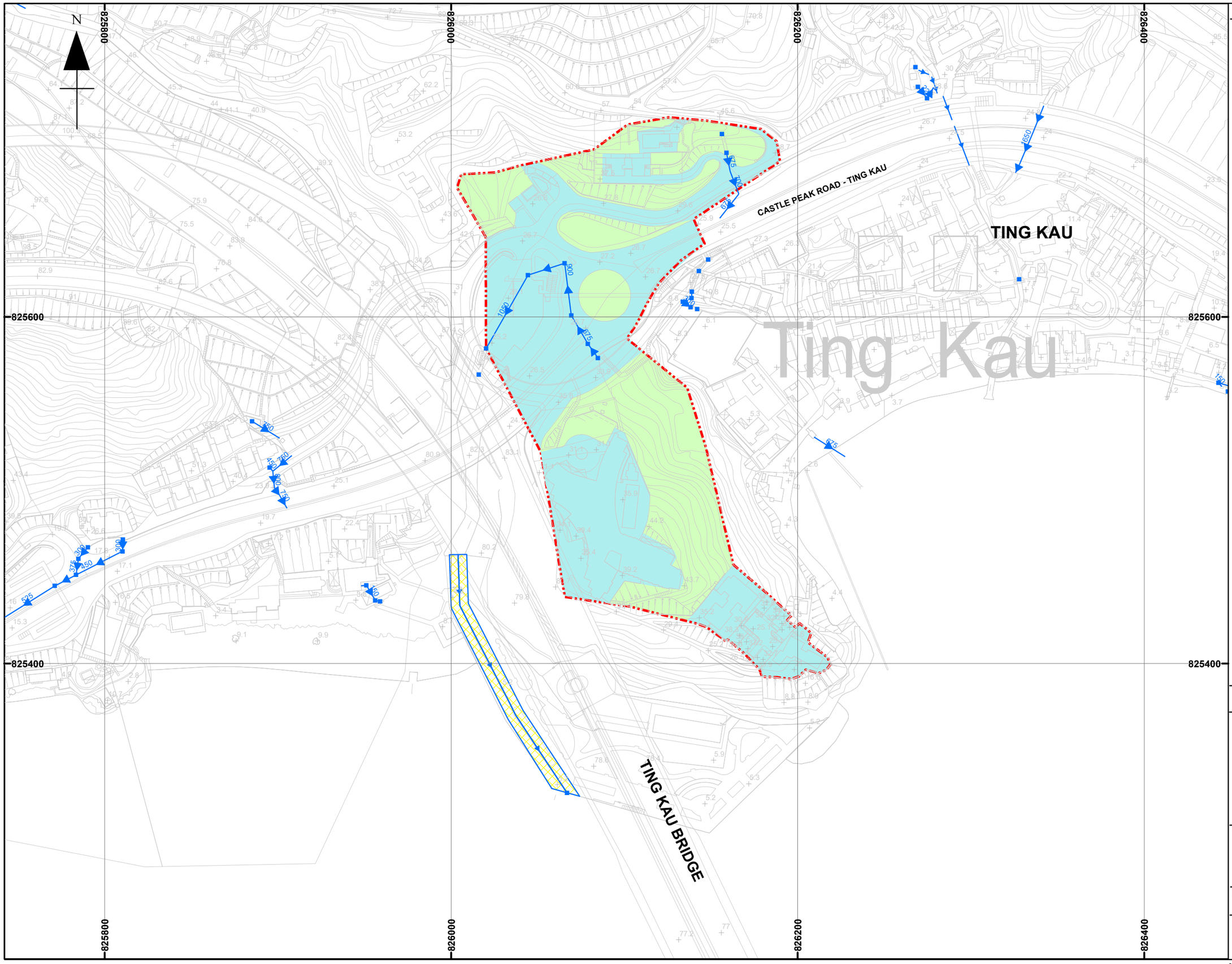

Legend

- Existing Drainage Pipe
- Catchment

Paved Condition

- Unpaved
- Paved

Initial	Date	Checked	Date
Kathy		KKL	

Project

Section 16 Planning Application for Submission of Layout Plan for Permitted 'Flat' and 'Social Welfare Facility' Uses at TWIL 5 and Lot No. 429 in D.D. 399, Ting Kau, Tsuen Wan

Title

Existing Paved Condition of Catchment

Figure No.	Scale
TIK/DIA/004	1:2,000 @ A3

binnies

Plot date: 2021-10-11

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N

825800 826000 826200 826400

825600

825400

CASTLE PEAK ROAD - TING KAU

TING KAU

TING KAU BRIDGE

Ting Kau

Legend

- Proposed Site
- Existing Drainage Pipe
- Proposed Drainage Pipe Upgrading
- Catchment

Paved Condition

- Unpaved
- Paved

Initial	Date	Checked	Date
Kathy		KKL	

Project

Section 16 Planning Application for Submission of Layout Plan for Permitted 'Flat' and 'Social Welfare Facility' Uses at TWIL 5 and Lot No. 429 in D.D. 399, Ting Kau, Tsuen Wan

Title

Proposed Paved Condition of Catchment

Figure No.	Scale
TIK/DIA/005	1:2,000 @ A3

Plot date: 2021-10-11

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Annex A

Layout Plan

LEGEND

- APPLICATION SITE BOUNDARY
- DEVELOPMENT SITE BOUNDARY
- FOOTPATH / COVERED AREA
- CARPARK / DRIVEWAY
- RESIDENTIAL USE
- LANDSCAPE AREA
- PRIVATE FLAT ROOF / PRIVATE GARDEN

ABBREVIATION:

DE = DAY CARE CENTRE FOR THE ELDERLY

LMR = LIFT MACHINE ROOM

N

INDICATIVE MASTER LAYOUT PLAN

PROPOSED REDEVELOPMENT AT ROYAL VIEW HOTEL AT TING KAU, N.T.

DATE : 03/07/2024

1 : 400 (A3)

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Annex B

Runoff Estimation and Capacity Checking

Capacity Check: Existing Development

Design Parameters					
Design storm			50	year return period	
Storm constants		a	505.5		
		b	3.29		
		c	0.355		
Average Slope		H	2.00	m/100m	
Length of flow		L	43.00	m	
Inlet time	$t_0=0.14465L/H^{0.2}A^{0.1}$	t_0	2.25	min	
Length of drain		Lj	43.00	m	
Flow velocity of drain		Vj	1.85	m/s	
Unpaved area		A_U	1160	m^2	
Runoff coef.		C_U	0.35		
Paved area		A_P	5285	m^2	
Runoff coef.		C_P	0.95		
Catchment area		A_{Total}	6,445	m^2	
Runoff coef.		$C_{average}$	0.84		
Surface roughness		k_s	0.60	mm	*For Poor Precast Concrete Pipes*
kinematic viscosity		v	1.14	mm^2/s	
Frictional gradient		S_f 1 in	200		

Capacity Check: Existing Development

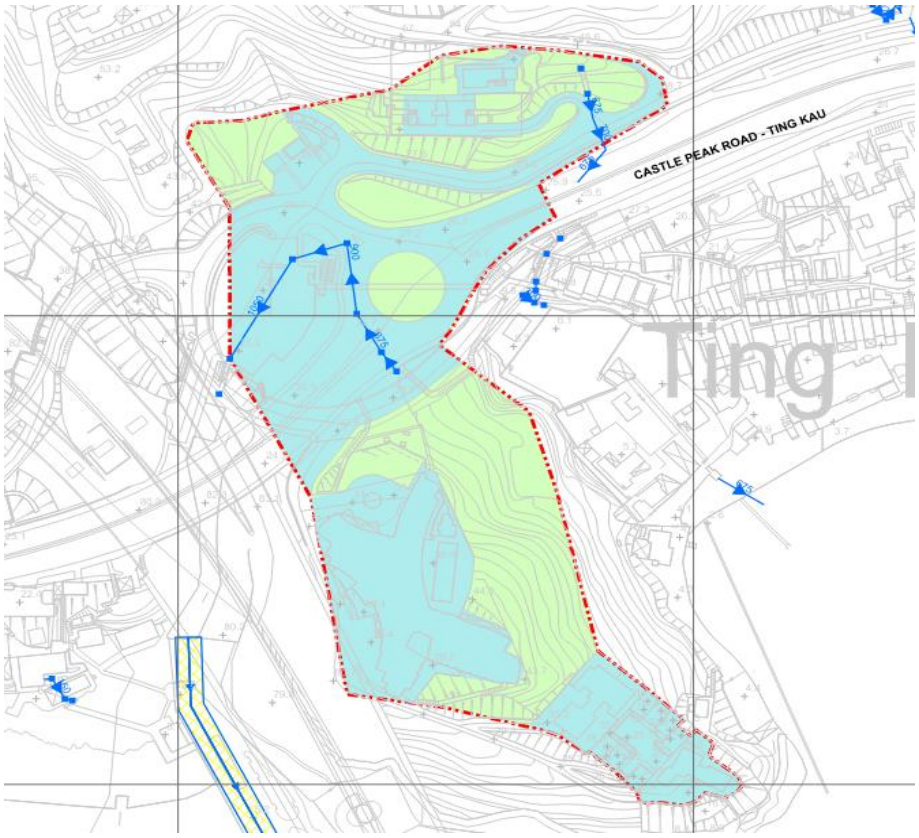
Peak Runoff

Flow time	t_f	=	Lj / Vj			
		=	23.27	min		
Time of concentration	t_c	=	$t_0 + t_f$			
		=	25.52	min		
Inetnsity	i	=	$a / (t_c + b)^c$	x	1.281	*Climate Change factor (SDM Table 28)*
		=	196.39	mm/hr		
Peak runoff	Q_p	=	0.278 C i A			
		=	**0.2963**	m^3/s		

Capacity of Existing 675Ø Drain

Trial pipe size	D	=	**675**	mm
Hydraulic radius	R = D/4	=	0.16875	m
Mean velocity (Colebrook-White)	$\bar{V}$	=	$-\sqrt{32gRS_f}\log\left[\frac{k_s}{14.8R}+\frac{1.255\nu}{R\sqrt{(32gRS_f)}}\right]$	
		=		
		=	1.85	m/s
Capacity provided	Q	=	*V* x Cross Section Area of Drain	
		=	**0.66**	m^3/s
Allow 10% Area for Siltation	$Q_{90\%}$	=	**0.60**	m^3/s
		>	Peak runoff Q_p	**OK**

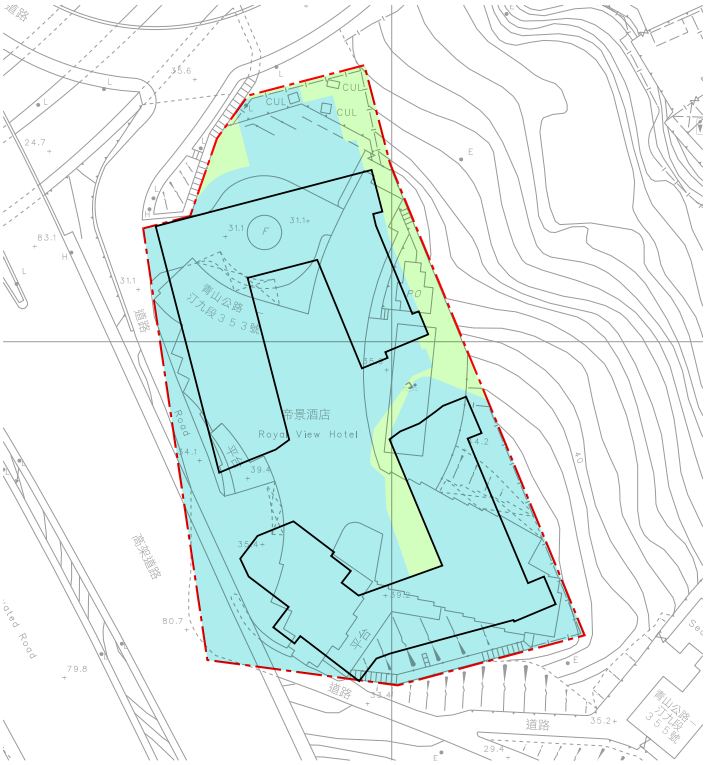
Estimation of Peak Runoff: Drainage Catchment (with existing hotel in development site)



Design Parameters					
Design storm			50	year return period	
Storm constants		a	505.5		
		b	3.29		
		c	0.355		
Average Slope		H	10.00	m/100m	
Length of flow		L	135.00	m	
Inlet time	$t_0=0.14465L/H^{0.2}A^{0.1}$	t_0	4.37	min	
Length of drain		Lj	135.00	m	
Flow velocity of drain		Vj	1.85	m/s	
Unpaved area		A_U	12519	m^2	
Runoff coef.		C_U	0.35		
Paved area		A_P	19211	m^2	
Runoff coef.		C_P	0.95		
Catchment area		A_{Total}	31,730	m^2	
Runoff coef.		$C_{average}$	0.71		
Surface roughness		k_s	0.60	mm	*For Poor Precast Concrete Pipes*
kinematic viscosity		ν	1.14	mm^2/s	
Frictional gradient		S_f 1 in	200		

Estimation of Peak Runoff:	Drainage Catchment (with existing hotel in development site)					
Peak Runoff						
Flow time	t_f	=	Lj / Vj			
		=	73.06	min		
Time of concentration	t_c	=	$t_0 + t_f$			
		=	77.43	min		
Inetnsity	i	=	$a / (t_c + b)^c$	x	1.281	*Climate Change factor (SDM Table 28)*
		=	136.24	mm/hr		
Peak runoff	Q_p	=	0.278 C i A			
		=	**0.8572**	m^3/s		

Capacity Check: Proposed Development



Design Parameters					
Design storm			50	year return period	
Storm constants		a	505.5		
		b	3.29		
		c	0.355		
Average Slope		H	2.00	m/100m	
Length of flow		L	43.00	m	
Inlet time	$t_0=0.14465L/H^{0.2}A^{0.1}$	t_0	2.25	min	
Length of drain		Lj	43.00	m	
Flow velocity of drain		Vj	1.85	m/s	
Unpaved area		A_U	646	m^2	
Runoff coef.		C_U	0.35		
Paved area		A_P	5799	m^2	
Runoff coef.		C_P	0.95		
Catchment area		A_{Total}	6,445	m^2	
Runoff coef.		$C_{average}$	0.89		
Surface roughness		k_s	0.60	mm	*For Poor Precast Concrete Pipes*
kinematic viscosity		v	1.14	mm^2/s	
Frictional gradient		S_f 1 in	200		

Capacity Check: Proposed Development

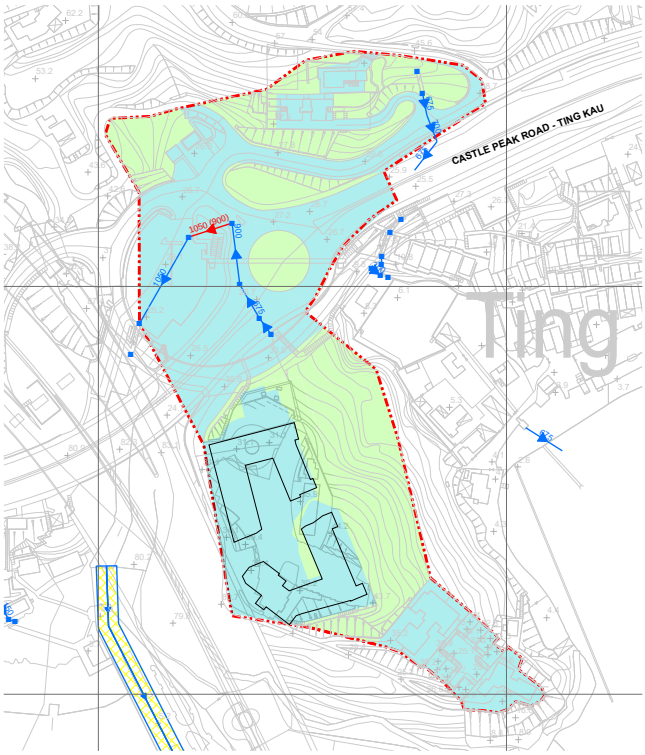
Peak Runoff

Flow time	t_f	=	Lj / Vj			
		=	23.27	min		
Time of concentration	t_c	=	$t_0 + t_f$			
		=	25.52	min		
Inetnsity	i	=	$a / (t_c + b)^c$	x	1.281	*Climate Change factor (SDM Table 28)*
		=	196.39	mm/hr		
Peak runoff	Q_p	=	0.278 C i A			
		=	**0.3131**	m^3/s		
		>	Peak runoff before the Development			

Capacity of 675Ø Drain

Trial pipe size	D	=	**675**	mm	
Hydraulic radius	R = D/4	=	0.16875	m	
Mean velocity (Colebrook-White)	$\bar{V}$	=	$-\sqrt{32gRS_f}\log\left[\frac{k_s}{14.8R}+\frac{1.255\nu}{R\sqrt{(32gRS_f)}}\right]$		
		=			
		=	1.85	m/s	
Capacity provided	Q	=	*V* x Cross Section Area of Drain		
		=	**0.66**	m^3/s	
Allow 10% Area for Siltation	$Q_{90\%}$	=	**0.60**	m^3/s	
		>	Peak runoff Q_p		**OK**

Estimation of Peak Runoff: Drainage Catchment (with Proposed Development)



Design Parameters					
Design storm			50	year return period	
Storm constants		a	505.5		
		b	3.29		
		c	0.355		
Average Slope		H	10.00	m/100m	
Length of flow		L	135.00	m	
Inlet time	$t_0=0.14465L/H^{0.2}A^{0.1}$	t_0	4.37	min	
Length of drain		Lj	135.00	m	
Flow velocity of drain		Vj	1.85	m/s	
Unpaved area		A_U	12190	m^2	
Runoff coef.		C_U	0.35		
Paved area		A_P	19540	m^2	
Runoff coef.		C_P	0.95		
Catchment area		A_{Total}	31,730	m^2	
Runoff coef.		$C_{average}$	0.72		
Surface roughness		k_s	0.60	mm	*For Poor Precast Concrete Pipes*
kinematic viscosity		ν	1.14	mm^2/s	
Frictional gradient		S_f 1 in	200		

Estimation of Peak Runoff:	Drainage Catchment (with Proposed Development)					
Peak Runoff						
Flow time	t_f	=	Lj / Vj			
		=	73.06	min		
Time of concentration	t_c	=	$t_0 + t_f$			
		=	77.43	min		
Inetnsity	i	=	$a / (t_c + b)^c$	x	1.281	*Climate Change factor (SDM Table 28)*
		=	136.24	mm/hr		
Peak runoff	Q_p	=	0.278 C i A			
		=	**0.8647**	m^3/s		

Annex B Capacity Checking of Existing Drainage System (Peak Flow Condition)

Note:
1) In estimating the full flow velocity/discharge, Colebrook-White's equation is adopted for circular drains and Manning's Manning is adopted for box culverts.

With Existing Hotel in Development Site

Pipe	Feature Number	Type	Shape	Diameter (mm)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Cross-setion Area (m2)	Wetted Perimeter (m)	Hydraulic radius (m)	Pipe Length (m)	Frictional Gradient (1 in)	Kinematic Viscosity (mm2/s)	Surface roughness (mm)	Mean velocity (m/s)	No. of pipe/cell	Capacity provided (m3/s)	Allow 10% Area for Siltation	Peak Runoff (m3/s)	Utilization (%)
SCH4009903 to SMH4068333	SWD4080477	Pipe	Circular	675	23.56	23.38	--	--	0.169	10.3	200	1.14	0.6	1.84790	1	0.66126	0.59514	0.2963	49.8%
SMH4068333 to SMH4068334	SWD4080474	Pipe	Circular	675	22.87	22.67	--	--	0.169	18	200	1.14	0.6	1.84790	1	0.66126	0.59514	0.2963	49.8%
SMH4068334 to SMH4068335	SWD4080475	Pipe	Circular	900	22.67	22.16	--	--	0.225	28	200	1.14	0.6	2.21024	1	1.40610	1.26549	0.2963	23.4%
SMH4068335 to SMH4068346	SWD4080513	Pipe	Circular	900	22.16	--	--	--	0.225	30.4	300	1.14	0.6	1.80202	1	1.14639	1.03175	0.8572	83.1%
SMH4068346 to SCH4010820	SWD4080530	Pipe	Circular	1050	--	--	--	--	0.2625	22.3	300	1.14	0.6	1.98264	1	1.71677	1.54509	0.8572	55.5%
--	SBP4002761	Box Culvert	Rectangular	--	--	--	6.8	10.8	0.62962963	43	300	--	0.015	848.25444	3	17304.39051	15573.95146	0.8572	0.006%
--	SBP4014204	Box Culvert	Rectangular	--	--	--	6.8	10.8	0.62962963	51	300	--	0.015	848.25444	3	17304.39051	15573.95146	0.8572	0.006%
--	SBP4014203	Box Culvert	Rectangular	--	--	--	6.8	10.8	0.62962963	61	300	--	0.015	848.25444	3	17304.39051	15573.95146	0.8572	0.006%

With Proposed Development (S16)

Pipe	Feature Number	Type	Shape	Diameter (mm)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Cross-setion Area (m2)	Wetted Perimeter (m)	Hydraulic radius (m)	Pipe Length (m)	Frictional Gradient (1 in)	Kinematic Viscosity (mm2/s)	Surface roughness (mm)	Mean velocity (m/s)	No. of pipe/cell	Capacity provided (m3/s)	Allow 10% Area for Siltation	Peak Runoff (m3/s)	Utilization (%)	Change in Utilization, Existing (%)
SCH4009903 to SMH4068333	SWD4080477	Pipe	Circular	675	23.56	23.38	--	--	0.169	10.3	200	1.14	0.6	1.84790	1	0.66126	0.59514	0.3131	52.6%	2.8%
SMH4068333 to SMH4068334	SWD4080474	Pipe	Circular	675	22.87	22.67	--	--	0.169	18	200	1.14	0.6	1.84790	1	0.66126	0.59514	0.3131	52.6%	2.8%
SMH4068334 to SMH4068335	SWD4080475	Pipe	Circular	900	22.67	22.16	--	--	0.225	28	200	1.14	0.6	2.21024	1	1.40610	1.26549	0.3131	24.7%	1.3%
SMH4068335 to SMH4068346	SWD4080513	Pipe	Circular	900	22.16	--	--	--	0.225	30.4	300	1.14	0.6	1.80202	1	1.14639	1.03175	0.8647	83.8%	0.7%
SMH4068346 to SCH4010820	SWD4080530	Pipe	Circular	1050	--	--	--	--	0.2625	22.3	300	1.14	0.6	1.98264	1	1.71677	1.54509	0.8647	56.0%	0.5%
--	SBP4002761	Box Culvert	Rectangular	--	--	--	6.8	10.8	0.62962963	43	300	--	0.015	848.25444	3	17304.39051	15573.95146	0.8647	0.006%	0.0%
--	SBP4014204	Box Culvert	Rectangular	--	--	--	6.8	10.8	0.62962963	51	300	--	0.015	848.25444	3	17304.39051	15573.95146	0.8647	0.006%	0.0%
--	SBP4014203	Box Culvert	Rectangular	--	--	--	6.8	10.8	0.62962963	61	300	--	0.015	848.25444	3	17304.39051	15573.95146	0.8647	0.006%	0.0%

Annex B Capacity Checking of Existing Drainage System (Annual Cleansing from Swimming Pool)

Note:
1) In estimating the full flow velocity/discharge, Colebrook-White's equation is adopted for circular drains and Manning's Manning is adopted for box culverts.
2) Cleansing of the swimming pool will be carried out annually.
3) Annual cleansing of the swimming pool will not be carried out under peak flow condition (i.e. typhoon, etc.).
4) Assume full capacity from 600 dia. outlet pipe discharges to the publiuc drainage system.

Capacity of 600Ø Outlet Drain

Type	Shape	Diameter (mm)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Hydraulic radius (m)	Frictional Gradient (1 in)	Kinematic Viscosity (mm2/s)	Surface roughness (mm)	Mean velocity (m/s)	No. of pipe/cell	Capacity provided (m3/s)
Pipe	Circular	600	27.5	23.38	0.150	200	1.14	0.6	1.71657	1	0.48535

Capacity Checking of Existing Drainage System

Pipe	Feature Number	Type	Shape	Diameter (mm)	Upstream Invert Level (mPD)	Downstream Invert Level (mPD)	Cross-setion Area (m2)	Wetted Perimeter (m)	Hydraulic radius (m)	Pipe Length (m)	Frictional Gradient (1 in)	Kinematic Viscosity (mm2/s)	Surface roughness (mm)	Mean velocity (m/s)	No. of pipe/cell	Capacity provided (m3/s)	Allow 10% Area for Siltation	Peak Runoff (m3/s)	Utilization (%)
SCH4009903 to SMH4068333	SWD4080477	Pipe	Circular	675	23.56	23.38	--	--	0.169	10.3	200	1.14	0.6	1.84790	1	0.66126	0.59514	0.4853	81.6%
SMH4068333 to SMH4068334	SWD4080474	Pipe	Circular	675	22.87	22.67	--	--	0.169	18	200	1.14	0.6	1.84790	1	0.66126	0.59514	0.4853	81.6%
SMH4068334 to SMH4068335	SWD4080475	Pipe	Circular	900	22.67	22.16	--	--	0.225	28	200	1.14	0.6	2.21024	1	1.40610	1.26549	0.4853	38.4%
SMH4068335 to SMH4068346	SWD4080513	Pipe	Circular	1050 (900)	22.16	--	--	--	0.2625	30.4	300	1.14	0.6	1.98264	1	1.71677	1.54509	1.0369	67.1%
SMH4068346 to SCH4010820	SWD4080530	Pipe	Circular	1050	--	--	--	--	0.2625	22.3	300	1.14	0.6	1.98264	1	1.71677	1.54509	1.0369	67.1%
--	SBP4002761	Box Culvert	Rectangular	--	--	--	6.8	10.8	0.62962963	43	300	--	0.015	848.25444	3	17304.39051	15573.95146	1.0369	0.007%
--	SBP4014204	Box Culvert	Rectangular	--	--	--	6.8	10.8	0.62962963	51	300	--	0.015	848.25444	3	17304.39051	15573.95146	1.0369	0.007%
--	SBP4014203	Box Culvert	Rectangular	--	--	--	6.8	10.8	0.62962963	61	300	--	0.015	848.25444	3	17304.39051	15573.95146	1.0369	0.007%