Appendix 8

Drainage Impact Assessment

MOTT MACDONALD

Proposed ‘Social Welfare Facility’ (Residential Care Home for Persons with Disabilities) (“RCHD”) and Proposed Excavation of Land associated with the Proposed RCHD in “Village Type Development” Zone, at portion of Former Wa Fung School (華封學校) and adjoining Government Land, Lam Hau Tsuen, Yuen Long, New Territories

Drainage Impact Assessment Report (Rev. A)

August 2025

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Proposed 'Social Welfare Facility' (Residential Care Home for Persons with Disabilities) ("RCHD") and Proposed Excavation of Land associated with the Proposed RCHD in "Village Type Development" Zone, at portion of Former Wa Fung School (華封學校) and adjoining Government Land, Lam Hau Tsuen, Yuen Long, New Territories

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Mott MacDonald Hong Kong Limited
registered in Hong Kong no. 236497

Contents

Appendices

1 INTRODUCTION

1.1 Background

1.1.1 The Applicant intends to convert the former Wa Fung School (part) in Lam Hau Tsuen (the Site) and adjoining Government land into a **'Social Welfare Facility' (Residential Care Homes for Persons with Disabilities) (RCHD)** under the Town Planning Ordinance.

1.2 Site Description and Major Scope of Works

1.2.1 The Application Site covers a total land area of about 2,945 m^2, is located in Lam Hau Tsuen surrounded by some existing village houses, open storage and vehicle repair workshops in its vicinity. It is bounded by Yuen Long Highway to its north and Shan Ha Road to its south and the Site is currently with an area zoned "Village Type Development" on the Approved Tong Yan San Tsuen Outline Zoning Plan (OZP) No. S/YL-TYST/14. The location of the Site is shown in **Appendix A**. This report is prepared to support the present planning application.

1.3 Scope and Structure of this Report

1.3.1 This Drainage Impact Assessment (DIA) is prepared to support the aforesaid planning application under Section 16 of the Town Planning Ordinance. This report forms part of the application document and will demonstrate that the implementation of the proposed **RCHD** development is feasible in terms of its impact on the drainage system.

The DIA focuses on the potential drainage impacts due to the implementation of the proposed RCHD. The objective of the DIA is to identify, assess and mitigate potential adverse drainage impacts which may arise from the Site.

1.3.2 This DIA Report contains the following sections in addition to this introduction (Section 1): -

- **Section 2:** Methodology and Design Parameters for Drainage Impact Assessment
- **Section 3:** Existing and Planned Drainage System
- **Section 4:** Drainage Impact Assessment and Proposed Drainage System
- **Section 5:** Conclusion

2 METHODOLOGY AND DESIGN PARAMETERS FOR DRAINAGE IMPACT ASSESSMENT

2.1 Methodology

Assessment Approach

2.1.1 The following approach and methodology have been adopted in this drainage impact assessment: -

- Carry out desktop study to collect the relevant information for the assessment, relevant information for the assessment to be collected included drainage record plans from DSD and assessment reports as mentioned in Section 2.1.2;
- Based on desktop information, identify the existing and proposed drainage systems in the vicinity (location of the Development refers to **Appendix A**);
- Estimate the additional drainage runoff arising from the proposed RCHD development; and
- Assess the drainage impacts arising from the proposed RCHD development and provide mitigation measure.

Design Standards, Guidelines and Reference

2.1.2 The drainage runoff to be generated from the proposed RCHD development is based on the following standards, guidelines and reference for the drainage design: -

- Drainage Manual published by Drainage Services Department (DSD);
- Technical Guidance Note No. 39 (TGN 39) Guidelines for Estimation of Surface Runoff from Natural Terrain Catchments for Drainage Design Purposes by Geotechnical Engineering Office (GEO); and

2.2 Assessment Criteria, Design Parameters and Assumptions

<u>Assessment Criteria</u>

2.2.1 The assessment criteria are based on the recommendations set out in the Stormwater Drainage Manual (SDM) – 5th Edition issued by the Drainage Services Department (DSD).

2.2.2 The assessment criteria is based on the recommendations set out in the Stormwater Drainage Manual (SDM) – 5th Edition issued by the Drainage Services Department (DSD). According to "Approved Tong Yan San Tsuen Outline Zoning Plan No. S/YL-TYST/14", the site area is located within "Village Type Development" and proposed drainage system serving the proposed site is categorised as "Urban Drainage Branch System", the drainage system in the vicinity of the Study Area shall be assessed for 10-year and 50-year storm event as recommended in SDM.

Design Parameters and Assumptions

Design Rainfall

2.2.3 A rainfall profile will be determined based on the equation as mentioned in Clause 4.3.5 of SDM where storm constants (a, b & c) are given in Table 3a in SDM and presented in Table 2 under the DIA.

Equation 1 – Intensity-Duration-Frequency (IDF) Relationship

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

where

F(t) = rate of rainfall or instantaneous intensity in mm/hr at time t (in minutes)

td = rainstorm duration (in minutes) (td <= 240)

a, b, c= storm constants given in Table 3a of SDM and repeated in the following table.

Table 1 - Storm Constants for Different Return Periods

Return Period T (years)	10	50
a	485.0	505.5
b	3.11	3.29
c	0.397	0.355

2.2.4 Rainfall duration of 240 minutes has been adopted for the assessment.

Design Modification due to Climate Change

2.2.5 The project of rainfall increase percentage and sea level rise were added to the design rainfall intensities and design water level boundary to cope with the potential impact of climate change.

2.2.6 A climate change effect up to end of 21st Century will be considered in the subject hydraulic assessment in accordance with Section 6.8 of SDM and corrigendum No. 1/2022 of SDM. Design allowance of 12.1% for rainfall increase is incorporated to design calculation according to Table 31 of SDM Corrigendum No.1/2022.-

Table 2: Percentage of Rainfall Increase and Sea Level Rise due to Climate Change

	Rainfall Increase	Sea Level Rise (m)
End of 21st Century (2081 – 2100)	16.0 %	0.47

Runoff Coefficients

2.2.7 Rational method with fixed runoff coefficient would be adopted to calculate the surface runoff of the affected drainage catchments.

2.2.8 The surface runoff would be calculated based on the land use and the extent of the drainage catchment. The runoff coefficients for this DIA are based on standards as set out in Section 7.5.2 (b) of SDM. The runoff coefficients of concrete and steep grassland (heavy soil) have been adopted respectively and are listed in **Table 3**.

Table 3 – Run-off Coefficient

	Concrete Paved Area	Grassland
Runoff Coefficient	0.9	0.25

Roughness

2.2.9 Conduit roughness value of k_s = 3mm in respect to poor condition of precast concrete pipe from SDM, has been adopted in the hydraulic assessment.

Sediment

2.2.10 Siltation for the urban pipeline system follows the recommendation given in SDM, which suggests allowing for 5% reduction in flow area if the gradient is greater than 1 in 25 or 10% reduction in flow area in other areas.

3 EXISTING AND PLANNED DRAINAGE SYSTEMS

3.1 Existing Drainage Systems

3.1.1 The proposed RCHD development covers a total land area of about 2,945 m^2 and is located in Lam Hau Tsuen. In accordance with "Approved Tong Yan San Tsuen Outline Zoning Plan No. S/YL-TYST/14", the site falls within an area zoned "Village Type Development".

3.1.2 A series of 900mm dia. drains is laid along Shan Ha Road that connect to existing trapezoidal channel between Shan Ha Road and Long Hon Road. In addition, there is an existing channel in the vicinity of Lam Hau Tsuen that connects to existing channel between Lam Tai East Road and Lam Tai West Road.

3.1.3 As observed from the topographic data, the runoff from the existing school development in village zone mainly discharges to two directions, the west portion of site area drains to the existing trapezoidal channel between Shan Ha Road and Long Hon Road via local drains while the east portion of the site area drains to existing channel running across Yuen Long Highway via local drainage channel along the perimeter of Lam Hau Tsuen. The sub-catchment plan for the drainage system in the vicinity of the subject site and the location of aforementioned drainage system are shown in **Appendix C** and **Appendix E** respectively.

3.1.4 The summary of the existing catchment area estimation is supplemented in **Appendix D**, while the existing stormwater drainage system and the corresponding calculation of hydraulic capacity assessment of existing pipelines is provided in **Appendix H**.

3.2 Existing Land Use Surface Characteristics of other catchments

3.2.1 The existing surface characteristic of the catchments serviced by the existing 900mm diameter pipes laid along Shan Ha Road and its discharge points have been determined and summarised in **Table 4**.

Table 4 – Catchment Properties of the Existing 900mm dia. drains

Catchment ID	Total Area (m^2)	Paved Area (m^2)	Discharge Point
A1	7277	7277	SMH1012284
A2	366	366	SMH1012285
A3	209	209	SMH1012286
A4	211	211	SMH1012288

4 DRAINAGE CONDITION AFTER THE DEVELOPMENT

4.1 Design Drainage Flow

4.1.1 The proposed RCHD development at former Wa Fung School covers an area of 2,945 m^2 which is mainly paved area with some landscaping area. The layout plan of the proposed RCHD development is shown in **Appendix B**.

4.1.2 Proposed drainage system within the proposed development will be designed in detailed design stage.

4.1.3 The weighted average C value of the Site after the implementation of the proposed RCHD development is shown and summarised in the following table: -

Table 5 – Proposed Catchment Properties

Catchment ID	Land use	Weighted Runoff Coefficient C	Area (m^2)
RCHD1	Paved Area (86.07%), Unpaved Area (13.93%)	0.81***	2,945
A0	Paved Area (10%), Unpaved Area (90%)	0.32	1,135
*** Assuming 86.07% of the development area to be paved area (C=0.9), 13.93% of the development area to be unpaved area (C=0.25)			

4.1.4 It is proposed that the collected runoff from the proposed RCHD would be discharged to proposed 525mm and 600mm dia. drains and would then be conveyed the existing 900mm dia. drains along Sha Ha Road. The runoff from the proposed RCHD would ultimately be conveyed to the existing trapezoidal channel between Shan Ha Road and Long Hon Road. The proposed catchment plan and proposed drainage system are indicated in **Appendix F.** The summary of the proposed catchment area estimation is supplemented in **Appendix G**,

4.2 Drainage Impact Assessment

4.2.1 As discussed in above sections, the drainage impact to the existing drainage system due to the proposed development at the site has been assessed. The assessed pipelines including existing 900mm diameter pipeline along Shan Ha Road. The result of the hydraulic assessment under 1 in 10 years rainstorm and 1 in 50 years rainstorm are summarised in below tables, the detailed calculation is shown in **Appendix I**.

Table 6 – Utilization Comparison of the Existing 900mm dia. Drains between Existing and Proposed Drainage Condition (1 in 10 years rainstorm)

		Existing Condition		Proposed Condition	
Upstream Manhole	Downstream Manhole	Runoff(L/s)	Utilization	Runoff(L/s)	Utilization
SMH1012284	SMH1012285	483.79	65%	483.79	65%
SMH1012285	SMH1012286	503.70	56%	635.40	71%
SMH1012286	SMH1012287	510.08	62%	640.65	77%

SMH1012287	SMH1012288	507.32	37%	637.95	47%
SMH1012288	SNF1002275	518.28	23%	647.69	29%

Table 7 – Utilization Comparison of the Existing 900mm dia. Drains between Existing and Proposed Drainage Condition (1 in 50 years rainstorm)

		Existing Condition		Proposed Condition	
Upstream Manhole	Downstream Manhole	Runoff(L/s)	Utilization	Runoff(L/s)	Utilization
SMH1012284	SMH1012285	547.56	74%	547.56	74%
SMH1012285	SMH1012286	570.71	64%	729.03	81%
SMH1012286	SMH1012287	578.97	70%	736.03	89%
SMH1012287	SMH1012288	576.22	42%	733.30	54%
SMH1012288	SNF1002275	589.04	26%	744.86	33%

4.2.2 Due to catchment redistribution of the proposed site, there will be additional runoffs of approximately 130L/s and 160L/s for 1 in 10 years and 1 in 50 years storm respectively under the proposed condition. The utilization of the existing drainage system would undergo an increase of 15% at most under the proposed condition of a 1 in 10 years rainstorm. Under 1 in 50 years rainstorm, the utilization of existing drainage system would undergo an increase of not more than 19% under the proposed condition. As the existing drains are identified to withstand the additional runoff brought by the proposed drainage condition, there will be no adverse drainage impact caused to the existing drainage system.

4.2.3 To convey the runoff from the proposed site, a series of 525mm and 600mm dia. drains has been proposed which will be connected to the existing 900mm dia. drains at Shan Ha Tsuen as shown in **Appendix F.** The utilizations of the proposed drains have been assessed and the results are summarized in below tables. Based on the results, the proposed drains will have utilizations of less than 73% under the proposed drainage condition of 1 in 10 years rainstorm event and less than 84% under proposed condition of 1 in 50 years rainstorm event. Detailed calculations can be referred from **Appendix I**.

Table 8 – Hydraulic Calculation for the Proposed drains (1 in 10 years rainstorm)

Upstream Manhole	Downstream Manhole	Pipe Size (mm)	Utilization
SMH00	SMH01	525	36%
SMH01	SMH02	525	57%
SMH02	STM01 (Terminal manhole)	600	60%
STM01 (Terminal manhole)	SMH04	600	73%
SMH04	SMH1012285	600	73%

Table 9 – Hydraulic Calculation for the Proposed dia. drains (1 in 50 years rainstorm)

Upstream Manhole	Downstream Manhole	Pipe Size (mm)	Utilization
SMH00	SMH01	525	41%
SMH01	SMH02	525	65%
SMH02	STM01 (Terminal manhole)	600	68%
STM01 (Terminal manhole)	SMH04	600	83%
SMH04	SMH1012285	600	83%

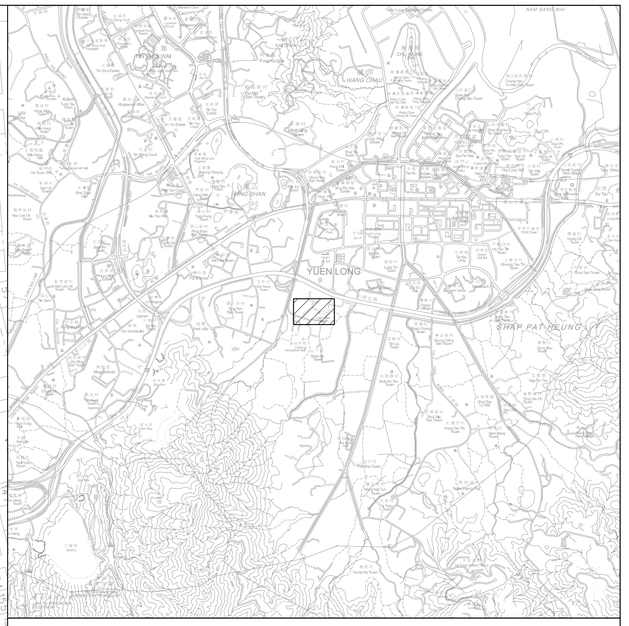
5 CONCLUSION

5.1.1 As discussed in previous sections, the runoff from the proposed RCHD will be redistributed to the existing 900mm diameter pipeline along Shan Ha Road via proposed 525mm and 600 mm diameter pipes. The proposed site is zoned as "Village Type Development" according to the OZP. The proposed RCHD development will have about 86.07% of paved area with about 13.93% unpaved area in order to provide more area for the users.

5.1.2 Hydraulic calculation has been carried out for the existing 900mm pipeline. It is found that the pipeline is capable to convey the additional runoff from the proposed site. In conclusion, there will be no adverse drainage impact to the existing drainage system under the proposed development.

Appendices

A. Location Plan of the Development Site



KEYPLAN (1:30000)

櫃口村
LAM HAU TSUEN

SHAN HA ROAD

LEGENDS:

SITE BOUNDARY

0 10 20 30 40 50
METRES
1 : 500 @ A1

Job Title
PROPOSED SOCIAL WELFARE FACILITY (RESIDENTIAL CARE HOME FOR DISABLED) AT FORMER WA FUNG SCHOOL

APPENDIX A

Date	Scale	Drawing Title
MAR 2025	1 : 500 @ A1	LOCATION PLAN OF THE DEVELOPMENT SITE
Drawn	Job No.	
WTL	601100775	

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B. Layout Plan of the Development Site

PROPOSED AREA FOR SEPTIC TANK & SOAKAWAY PIT SYSTEM (UNDERGROUND)

SITE ENTRANCE +10.46

UNEXCAVATED

F.S. WATER TANKS

PUMP ROOM

TRANSFORMER ROOM

SWITCH ROOM

PLANTER

3.6m

12.9m

LGV

+14.00

RAMP UP 1:12

RAMP UP 1:20.1

LINE OF ROOF ABOVE

OFFICE

SITTING & DINING AREA

KITCHEN

D. W.C.

STAFF W.C.

EVA

CP1

CP2

BR 1

BR 2

BR 3

BR 4

BR 5

BR 6

BR 7

BR 8

BR 9

BR 10

BR 11

W.C.

COVERED WALKWAY/CORRIDOR

ISOLATION RM 1

ISOLATION RM 2

STORE

LAUNDRY

STAFF QUARTER

PAVILION

EXISTING SCHOOL BUILDING

+16.40

16.7

17.3

8.7

9.2

KEYPLAN (1:10000)

0 5 10 15 20 25

METRES

1 : 250 @ A1

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Job Title: PROPOSED SOCIAL WELFARE FACILITY (RESIDENTIAL CARE HOME FOR DISABLED) AT FORMER WA FUNG SCHOOL			Drawing no.: APPENDIX B
Date: MAR 2025	Scale: 1 : 250 @ A1	Drawing Title: MASTER LAYOUT PLAN OF PROPOSED RESIDENTIAL CARE HOME FOR DISABLED	
Drawn: WTL	Job No.: 601100775		MOTT MACDONALD

C. Existing Catchment Plan

Existing Trapezoidal Channel

Catchment A4
Area: 211m^2

Catchment A3
Area: 209m^2

Catchment A2
Area: 366m^2

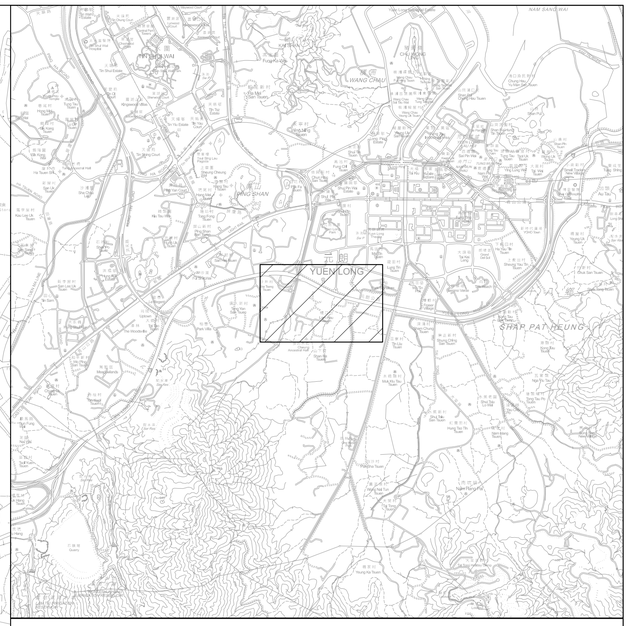
Existing
900mm drains

Catchment A1
Area: 7277m^2

YUEN LONG HIGHWAY

LAM TAI WEST ROAD

LAM TAI EAST ROAD



KEYPLAN (1:30000)

LEGENDS:

- SITE BOUNDARY
- EXISTING DRAINAGE NETWORK
- EXISTING CATCHMENT WHERE PROPOSED DEVELOPMENT LOCATED
- EXISTING CATCHMENT A1 TO EXISTING 900mm DRAINS
- EXISTING CATCHMENT A1 TO EXISTING 900mm DRAINS
- EXISTING CATCHMENT A3 TO EXISTING 900mm DRAINS
- EXISTING CATCHMENT A4 TO EXISTING 900mm DRAINS
- EXISTING CHANNEL
- CATCHMENT SURFACE RUNOFF FLOW DIRECTION

0 30 60 90 120 150
METRES
1 : 1500 @ A1

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Job Title
PROPOSED SOCIAL WELFARE FACILITY (RESIDENTIAL CARE HOME FOR DISABLED) AT FORMER WA FUNG SCHOOL

APPENDIX C

Date	Scale	Drawing Title
MAR 2025	1 : 1500 @ A1	EXISTING CATCHMENT PLAN
Drawn	Job No.	
WTL	601100775	

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D. Summary of Existing Catchments

Appendix D - Summary of Existing Catchments

Catchment ID	Discharge Manhole No.	Surface Type % (Conc. Paved)	Surface Type % (Grassland)	Surface Type % (Rock Slope)	Catchment Area, A (m^2)	Catchment Area, A (m^2) (Conc. Paved)	Catchment Area, A (m^2) (Grassland)	Catchment Area, A (m^2) (Rock Slope)
A1	SMH1012284	100	0	0	7277.00	7277.00	0.00	0.00
A2	SMH1012285	100	0	0	366.00	366.00	0.00	0.00
A3	SMH1012286	100	0	0	209.00	209.00	0.00	0.00
A4	SMH1012288	100	0	0	211.00	211.00	0.00	0.00

E. Existing Stormwater Drainage System

EXISTING TRAPEZOIDAL CHANNEL

SMH1012288
C.L. +8.83
A1 +6.70 - 900
X1 +6.66 - 900

SMH1012287
C.L. +8.96
A1 +6.86 - 900
X1 +6.84 - 900

SMH1012286
C.L. +8.98
A1 +6.98 - 900
X1 +6.94 - 900

SMH1012285
C.L. +9.05
A1 +7.15 - 900
X1 +7.04 - 900

SMH1012284
C.L. +9.14
A1 +7.24 - 900
X1 +7.22 - 900

900

櫸口村
LAM HAU TSUEN

SHAN HA ROAD

KEYPLAN (1:30000)

LEGENDS:

- SITE BOUNDARY
- EXISTING STORMWATER DRAINS
- EXISTING CATCHMENT A1 TO EXISTING 900mm DRAINS
- EXISTING CATCHMENT A1 TO EXISTING 900mm DRAINS
- EXISTING CATCHMENT A3 TO EXISTING 900mm DRAINS
- EXISTING CATCHMENT A4 TO EXISTING 900mm DRAINS
- EXISTING CHANNEL

0 10 20 30 40 50
METRES
1 : 500 @ A1

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Job Title
PROPOSED SOCIAL WELFARE FACILITY (RESIDENTIAL CARE HOME FOR DISABLED) AT FORMER WA FUNG SCHOOL

APPENDIX E

Date	Scale	Drawing Title
MAR 2025	1 : 500 @ A1	EXISTING DRAINAGE SYSTEM
Drawn	Job No.	
WTL	601100775	

MOTT MACDONALD

F. Proposed Catchment Plan and Proposed Stormwater Drainage System

EXISTING TRAPEZOIDAL CHANNEL

SMH1012288
C.L. +8.83
A1 +6.70 - 900
X1 +6.66 - 900

SMH1012287
C.L. +8.96
A1 +6.86 - 900
X1 +6.84 - 900

SMH1012286
C.L. +8.98
A1 +6.98 - 900
X1 +6.94 - 900

SMH1012285
C.L. +9.05
A1 +7.04 - 600
A2 +7.15 - 900
X1 +7.04 - 900

SMH1012284
C.L. +9.14
A1 +7.24 - 900
X1 +7.22 - 900

SMH01
C.L. +9.60
A1 +7.93 - 525
X1 +7.93 - 525

SMH00
C.L. +10.50
A1 +8.05 - 525
X1 +8.05 - 525

SMH02
C.L. +8.30
A1 +7.50 - 525
X1 +7.50 - 600

STM01
C.L. +9.31
A1 +7.30 - 600
X1 +7.30 - 600

SMH04
C.L. +9.28
A1 +7.19 - 600
X1 +7.19 - 600

900 900 900 900 600 600 600 525 525

櫸口村
LAM HAU TSUEN

SHAN HA ROAD

KEYPLAN (1:30000)

LEGENDS:

- SITE BOUNDARY
- EXISTING STORMWATER DRAINS
- EXISTING CHANNEL
- PROPOSED STORMWATER DRAINS (TO BE MAINTAINED BY APPLICANT)
- PROPOSED STORMWATER DRAINS (TO BE MAINTAINED BY DSD)
- PROPOSED CATCHMENT RCHD1 TO EXISTING 900mm DRAINS
- PROPOSED CATCHMENT A0 TO BE INTERCEPTED BY PROPOSED RCHD1
- EXISTING CATCHMENT A1 TO EXISTING 900mm DRAINS
- EXISTING CATCHMENT A1 TO EXISTING 900mm DRAINS
- EXISTING CATCHMENT A3 TO EXISTING 900mm DRAINS
- EXISTING CATCHMENT A4 TO EXISTING 900mm DRAINS

0 10 20 30 40 50
METRES
1 : 500 @ A1

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Job Title
PROPOSED SOCIAL WELFARE FACILITY (RESIDENTIAL CARE HOME FOR DISABLED) AT FORMER WA FUNG SCHOOL

APPENDIX F

Date	Scale	Drawing Title
MAR 2025	1 : 500 @ A1	PROPOSED CATCHMENT PLAN AND PROPOSED STORMWATER DRAINAGE SYSTEM
Drawn	Job No.	
WTL	601100775	

MOTT MACDONALD

G. Summary of Proposed Catchments

Appendix G - Summary of Proposed Catchments

Catchment ID	Discharge Manhole No.	Surface Type % (Conc. Paved)	Surface Type % (Grassland)	Surface Type % (Rock Slope)	Catchment Area, A (m^2)	Catchment Area, A (m^2) (Conc. Paved)	Catchment Area, A (m^2) (Grassland)	Catchment Area, A (m^2) (Rock Slope)
RCHD1	STM01	86.07	13.93	0	2945.00	2534.76	410.24	0.00
A0	STM01	10	90	0	1135.00	113.50	1021.50	0.00
A1	SMH1012284	100	0	0	7277.00	7277.00	0.00	0.00
A2	SMH1012285	100	0	0	366.00	366.00	0.00	0.00
A3	SMH1012286	100	0	0	209.00	209.00	0.00	0.00
A4	SMH1012288	100	0	0	211.00	211.00	0.00	0.00

H. Drain Capacity Calculation Before Developement

Appendix H - Drain Capacity Calculation Before Development

Design assumptions and parameters

1 The hydraulic design for gravity pipes is based on Colebrook-White equation and Wallingford charts.

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

2 Pipe roughness = 3 mm Concrete Pipe under poor condition

3 Transitional flow and water at 15 degree celcius, i.e. kinematic viscosity, v = 1.14 x 10-6 m^2/s

(i) Full bore flow velocity >= 1m/s

4 Reduction in flow area = 5% if the gradient is greater than 1 in 25
10% in other cases

5 Design return period = 1 in 10 year 1 in 50 year (Stormwater Drainage Manual, Fifth Edition, DSD)

a =	485	a =	505.5
b =	3.11	b =	3.29
c =	0.397	c =	0.355

Rainfall intensity $i = \frac{a}{(b + t_d)^c}$ where t_d = duration in rainfall and is equal to the time of concentration, minutes

6 Runoff is calculated by Rational Method (Q_{peak} = CiA)

7 Time of flow in the pipe = L/pipe partial flow velocity/60

8 Rainfall Increase (End of 21st Century): 28.10% (with 12.1% Design Allowance)

9 Runoff Coefficient C 0.25 for steep grassland
0.9 for Concrete Paved Area (Conc. Paved)

10 Design Return Period 1 in 50 yr for urban drainage branch system
1 in 200 yr for urban drainage trunk system

1 in 10 Years Storm Event

Pipe Information								Time of Concentration								Design Runoff									Capacity Check			
US MH	DS MH	Pipe Dia (mm)	Approx. Pipe Length m	Pipe material	US IL mPD	DS IL mPD	Pipe Gradient (1 in x)	Catchment ID	Catchment Area m2	H1 (m)	H2 (m)	Flow Path (m)	Time of Entry min.	Time of Flow min.	Time of Conc. min.	Surface Type % (Conc. Paved)	Surface Type % (Grassland)	Surface Type % (Rock Slope)	Runoff Coefficient	C*Catchment Area m2	Rainfall Intensity mm/hr	Cumulative C*Catchment Area m2	Design Discharge l/s	Cumulative Design Discharge l/s	Pipe Capacity l/s	Pipe Full Flow Velocity m/s	% utilization	Remarks
SMH1012284	SMH1012285	900	27.00	CONC.	7.22	7.15	386	A1	7277.00	-	-	-	5.00	0.38	5.38	100	0	0	0.90	6549.30	265.72	6549.30	483.79	483.79	744	1.17	65	1 in 10 yr.
SMH1012285	SMH1012286	900	16.00	CONC.	7.04	6.98	267	A2	366.00	-	-	-	5.00	0.19	5.57	100	0	0	0.90	329.40	263.40	6878.70	503.70	503.70	896	1.41	56	1 in 10 yr.
SMH1012286	SMH1012287	900	25.00	CONC.	6.94	6.86	313	A3	209.00	-	-	-	5.00	0.32	5.89	100	0	0	0.90	188.10	259.64	7066.80	510.08	510.08	827	1.30	62	1 in 10 yr.
SMH1012287	SMH1012288	900	16.00	CONC.	6.84	6.70	114	-	-	-	-	-	5.00	0.12	6.02	-	-	-	-	-	258.23	7066.80	507.32	507.32	1369	2.15	37	1 in 10 yr.
SMH1012288	SNF1002275	900	25.00	CONC.	6.66	6.08	43	A4	211.00	-	-	-	5.00	0.12	6.14	100	0	0	0.90	189.90	256.91	7256.70	518.28	518.28	2230	3.51	23	1 in 10 yr.

1 in 50 Years Storm Event

Pipe Information								Time of Concentration								Design Runoff									Capacity Check			
US MH	DS MH	Pipe Dia (mm)	Approx. Pipe Length m	Pipe material	US IL mPD	DS IL mPD	Pipe Gradient (1 in x)	Catchment ID	Catchment Area m2	H1 (m)	H2 (m)	Flow Path (m)	Time of Entry min.	Time of Flow min.	Time of Conc. min.	Surface Type % (Conc. Paved)	Surface Type % (Grassland)	Surface Type % (Rock Slope)	Runoff Coefficient	C*Catchment Area m2	Rainfall Intensity mm/hr	Cumulative C*Catchment Area m2	Design Discharge l/s	Cumulative Design Discharge l/s	Pipe Capacity l/s	Pipe Full Flow Velocity m/s	% utilization	Remarks
SMH1012284	SMH1012285	900	27.00	CONC.	7.22	7.15	386	A1	7277.00	-	-	-	5.00	0.38	5.38	100	0	0	0.90	6549.30	300.74	6549.30	547.56	547.56	744	1.17	74	1 in 50 yr.
SMH1012285	SMH1012286	900	16.00	CONC.	7.04	6.98	267	A2	366.00	-	-	-	5.00	0.19	5.57	100	0	0	0.90	329.40	298.44	6878.70	570.71	570.71	896	1.41	64	1 in 50 yr.
SMH1012286	SMH1012287	900	25.00	CONC.	6.94	6.86	313	A3	209.00	-	-	-	5.00	0.32	5.89	100	0	0	0.90	188.10	294.70	7066.80	578.97	578.97	827	1.30	70	1 in 50 yr.
SMH1012287	SMH1012288	900	16.00	CONC.	6.84	6.70	114	-	-	-	-	-	5.00	0.12	6.02	-	-	-	-	-	293.31	7066.80	576.22	576.22	1369	2.15	42	1 in 50 yr.
SMH1012288	SNF1002275	900	25.00	CONC.	6.66	6.08	43	A4	211.00	-	-	-	5.00	0.12	6.14	100	0	0	0.90	189.90	291.99	7256.70	589.04	589.04	2230	3.51	26	1 in 50 yr.

I. Drain Capacity Calculation After Development

Appendix I - Drain Capacity Calculation After Development

Design assumptions and parameters

1 The hydraulic design for gravity pipes is based on Colebrook-White equation and Wallingford charts.

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

2 Pipe roughness = 3 mm Concrete Pipe under poor condition

3 Transitional flow and water at 15 degree celcius, i.e. kinematic viscosity, v = 1.14 x 10-6 m^2/s

(i) Full bore flow velocity >= 1m/s

4 Reduction in flow area = 5% if the gradient is greater than 1 in 25
10% in other cases

5 Design return period = 1 in 10 year 1 in 50 year (Stormwater Drainage Manual, Fifth Edition, DSD)

a =	485	505.5
b =	3.11	3.29
c =	0.397	0.355

Rainfall intensity $i = \frac{a}{(b + t_d)^c}$ where t_d = duration in rainfall and is equal to the time of concentration, minutes

6 Runoff is calculated by Rational Method (Q_{peak} = CiA)

7 Time of flow in the pipe = L/pipe partial flow velocity/60

8 Rainfall Increase (End of 21st Century): 28.10% (with 12.1% Design Allowance)

9 Runoff Coefficient C 0.25 for steep grassland
0.9 for Concrete Paved Area (Conc. Paved)

10 Design Return Period 1 in 50 yr for urban drainage branch system
1 in 200 yr for urban drainage trunk system

1 in 10 Years Storm Event

Pipe Information								Time of Concentration					Design Runoff									Capacity Check			Remarks
US MH	DS MH	Pipe Dia (mm)	Approx. Pipe Length m	Pipe material	US IL mPD	DS IL mPD	Pipe Gradient (1 in x)	Catchment ID	Catchment Area m2	Time of Entry min.	Time of Flow min.	Time of Conc. min.	Surface Type % (Conc. Paved)	Surface Type % (Grassland)	Surface Type % (Rock Slope)	Runoff Coefficient	C*Catchment Area m2	Rainfall Intensity mm/hr	Cumulative C*Catchment Area m2	Design Discharge l/s	Cumulative Design Discharge l/s	Pipe Capacity l/s	Pipe Full Flow Velocity m/s	% utilization	
SMH00	SMH01	525	4.57	CONC.	8.05	7.93	38	RCHD1 + A0	4080.00	5.00	0.03	5.03	65	35	0	0.67	2741.37	270.27	2741.37	205.97	205.97	569	2.63	36	1 in 10 yr.
SMH01	SMH02	525	42.74	CONC.	7.93	7.50	99	-	-	5.00	0.44	5.47	-	-	-	-	-	264.70	2741.37	201.73	201.73	352	1.63	57	1 in 10 yr.
SMH02	STM01 (Terminal manhole)	600	46.28	CONC.	7.50	7.30	231	-	-	5.00	0.66	6.13	-	-	-	-	-	256.98	2741.37	195.85	195.85	329	1.16	60	1 in 10 yr.
STM01 (Terminal manhole)	SMH04	600	40.00	CONC.	7.30	7.19	364	-	-	5.00	0.72	6.85	-	-	-	-	-	249.45	2741.37	190.10	190.10	262	0.93	73	1 in 10 yr.
SMH04	SMH1012285	600	59.24	CONC.	7.19	7.04	395	-	-	5.00	1.11	7.96	-	-	-	-	-	239.19	2741.37	182.29	182.29	251	0.89	73	1 in 10 yr.
SMH1012284	SMH1012285	900	27.00	CONC.	7.22	7.15	386	A1	7277.00	5.00	0.38	5.38	100	0	0	0.90	6549.30	265.72	6549.30	483.79	483.79	744	1.17	65	1 in 10 yr.
SMH1012285	SMH1012286	900	16.00	CONC.	7.04	6.98	267	A2	366.00	5.00	0.19	8.15	100	0	0	0.90	329.40	237.59	9620.07	635.40	635.40	896	1.41	71	1 in 10 yr.
SMH1012286	SMH1012287	900	25.00	CONC.	6.94	6.86	313	A3	209.00	5.00	0.32	8.47	100	0	0	0.90	188.10	234.96	9808.17	640.65	640.65	827	1.30	77	1 in 10 yr.
SMH1012287	SMH1012288	900	16.00	CONC.	6.84	6.70	114	-	-	5.00	0.12	8.59	-	-	-	-	-	233.97	9808.17	637.95	637.95	1369	2.15	47	1 in 10 yr.
SMH1012288	SNF1002275	900	25.00	CONC.	6.66	6.08	43	A4	211.00	5.00	0.12	8.71	100	0	0	0.90	189.90	233.03	9998.07	647.69	647.69	2230	3.51	29	1 in 10 yr.

1 in 50 Years Storm Event

Pipe Information								Time of Concentration					Design Runoff									Capacity Check			Remarks
US MH	DS MH	Pipe Dia (mm)	Approx. Pipe Length m	Pipe material	US IL mPD	DS IL mPD	Pipe Gradient (1 in x)	Catchment ID	Catchment Area m2	Time of Entry min.	Time of Flow min.	Time of Conc. min.	Surface Type % (Conc. Paved)	Surface Type % (Grassland)	Surface Type % (Rock Slope)	Runoff Coefficient	C*Catchment Area m2	Rainfall Intensity mm/hr	Cumulative C*Catchment Area m2	Design Discharge l/s	Cumulative Design Discharge l/s	Pipe Capacity l/s	Pipe Full Flow Velocity m/s	% utilization	
SMH00	SMH01	525	4.57	CONC.	8.05	7.93	38	RCHD1 + A0	4080.00	5.00	0.03	5.03	65	35	0	0.67	2741.37	305.24	2741.37	232.63	232.63	569	2.63	41	1 in 50 yr.
SMH01	SMH02	525	42.74	CONC.	7.93	7.50	99	-	-	5.00	0.44	5.47	-	-	-	-	-	299.73	2741.37	228.43	228.43	352	1.63	65	1 in 50 yr.
SMH02	STM01 (Terminal manhole)	600	46.28	CONC.	7.50	7.30	231	-	-	5.00	0.66	6.13	-	-	-	-	-	292.06	2741.37	222.58	222.58	329	1.16	68	1 in 50 yr.
STM01 (Terminal manhole)	SMH04	600	40.00	CONC.	7.30	7.19	364	-	-	5.00	0.72	6.85	-	-	-	-	-	284.53	2741.37	216.84	216.84	262	0.93	83	1 in 50 yr.
SMH04	SMH1012285	600	59.24	CONC.	7.19	7.04	395	-	-	5.00	1.11	7.96	-	-	-	-	-	274.22	2741.37	208.98	208.98	251	0.89	83	1 in 50 yr.
SMH1012284	SMH1012285	900	27.00	CONC.	7.22	7.15	386	A1	7277.00	5.00	0.38	5.38	100	0	0	0.90	6549.30	300.74	6549.30	547.56	547.56	744	1.17	74	1 in 50 yr.
SMH1012285	SMH1012286	900	16.00	CONC.	7.04	6.98	267	A2	366.00	5.00	0.19	8.15	100	0	0	0.90	329.40	272.60	9620.07	729.03	729.03	896	1.41	81	1 in 50 yr.
SMH1012286	SMH1012287	900	25.00	CONC.	6.94	6.86	313	A3	209.00	5.00	0.32	8.47	100	0	0	0.90	188.10	269.94	9808.17	736.03	736.03	827	1.30	89	1 in 50 yr.
SMH1012287	SMH1012288	900	16.00	CONC.	6.84	6.70	114	-	-	5.00	0.12	8.59	-	-	-	-	-	268.94	9808.17	733.30	733.30	1369	2.15	54	1 in 50 yr.
SMH1012288	SNF1002275	900	25.00	CONC.	6.66	6.08	43	A4	211.00	5.00	0.12	8.71	100	0	0	0.90	189.90	267.99	9998.07	744.86	744.86	2230	3.51	33	1 in 50 yr.