Appendix 8

Sewerage Impact Assessment (SIA)

SECTION 16 PLANNING APPLICATION FOR PROPOSED SOCIAL WELFARE FACILITY (RESIDENTIAL CARE HOME FOR THE ELDERLY (RCHE)) IN LOT 669 S.A SS.2 RP (PART) AND LOT 669 S.B RP (PART) IN D.D.117, YUEN LONG

SEWERAGE IMPACT ASSESSMENT

February 2024

Report No: RT23044-SIA-01_v0

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Project:	SECTION 16 PLANNING APPLICATION FOR PROPOSED SOCIAL WELFARE FACILITY (RESIDENTIAL CARE HOME FOR THE ELDERLY (RCHE)) IN LOT 669 S.A SS.2 RP (PART) AND LOT 669 S.B RP (PART) IN D.D.117, YUEN LONG SEWERAGE IMPACT ASSESSMENT
Report No.:	Ref: RT23044-SIA-01_v0

Revision	Issue Date	Description	Author	Checker	Approver
0	16/02/2024	Issued for Comment	KCC	ZC	HM

Prepared By:

KC Chan

Senior Consultant

Checked by

Zoe Chan

Technical Manager

Approved by:

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Director

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- We disclaim any responsibility to the client and others in respect of any matters outside the project scope.
- This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies upon the report at their own risk.

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1 INTRODUCTION

1.1 PROJECT BACKGROUND

1.1.1. The Turbo Regal Limited (the Project Proponent) is proposed to develop the Social Welfare Facility (Residential Care Home for The Elderly) at Lot 669 S.A ss.2 RP (Part) and Lot 669 S.B RP (Part) in D.D.117, Yuen Long (hereafter refer to the Proposed Development).

1.1.2. BeeXergy Consulting Limited was appointed by DeSPACE (International) Limited (the Town Planner) to conduct a Sewerage Impact Assessment (SIA) for the Proposed Development to support the application under Section 16 of the Town Planning Ordinance. The latest architectural drawings and technical information on the Project Site were largely provided by the Project Architect.

1.2 PROJECT LOCATION

1.2.1. The Project Site is located at Wong Nai Tun Tsuen, Tai Tong, Yuen Long, bounded by a nullah to the East, farmland to the West, and low-rise residential buildings to the North and South. **Figure 1** shows the location of the Project Site and its surrounding area.

1.3 DESCRIPTION OF THE SUBJECT SITE AND PROPOSED DEVELOPMENT

1.3.1. The Project Site area is approximately 2,244m^2. The Proposed Development is an 8-storey building consisting of car parks, kitchen, rehabilitation areas, dormitories, multi-purpose rooms, and utility rooms. The master layout plan provided by the Project Architect is enclosed in **Appendix A**.

2 SEWERAGE IMPACT ASSESSMENT

2.1 SCOPE OF WORKS

2.1.1. The objective of this SIA is to assess whether the capacity of the sewerage networking is sufficient to cope with the peak sewage flow arising from the Proposed Development during its operation stage or not and to recommend appropriate mitigation measures to alleviate unacceptable sewerage impact, if any.

2.2 EXISTING SEWERAGE FACILITIES

2.1.2. The existing sewerage record from the Lands Department (LandsD) and Drainage Service Department (DSD) are obtained for this SIA and attached in **Figure 2**. There are no existing manholes located within the Project Site. The closest manhole is FHM1035122 which is located approximately 27m away from the boundary of the Project Site.

2.1.3. A site survey to identify the existing site condition and surrounding environment was conducted on 11 December 2023. The existing footbridge to the East of the Project Site (+15.3mPD, based on topographic data from the LandsD) is approximately 3.6m above the existing nullah while an unknown pipe with concrete footings was observed at approximately 2.4m above the nullah. Given the above observation and reference to DSD's sewerage connection at Shan Ha Road (FWD1012009), a 2.4m headroom (above the nullah) will be reserved for the sewerage connection across the existing nullah to avoid impact on the nullah's drainage capacity. The site survey record is enclosed in **Appendix B**. Reference case showing the sewerage connection at Sha Ha Road is shown in **Appendix C**.

2.1.4. A new terminal manhole (namely S1) will be built to collect the sewage generated from the Proposed Development and connect to the existing manhole FMH1035122 via a 225mm diameter sewer pipe. A 2.4m headroom (above the nullah) will be reserved for the sewerage connection across the existing nullah. The capacity check of the sewer will start from the proposed terminal manhole S1.

2.1.5. The location of the proposed termination manhole and connection are shown in **Figure 3**.

2.3 ASSESSMENT CRITERIA, METHODOLOGY, AND ASSUMPTIONS

2.3.1. The Unit Flow Factors and Global Peaking Factor are adopted from the figures in the Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning (Version

1.0)[1] (GESF) issued by the Environmental Protection Department (EPD) in March 2005 to estimate the sewage flows generated from the Project Site.

2.3.2. The Unit Flow Factors and Catchment Inflow Factors as shown in **Table 2.1** below are adopted in the assessment and the surrounding catchments are shown in **Figure 4**.

Table 2.1 Unit Flow Factors and Catchment Inflow Factors Extracted from GESF

Parameter	Value	Justification
Population		
Residents in Proposed Development	360 people	A maximum of 360 bed spaces can be provided according to proposed development scheme.
Visitors in Proposed Development	720 people	Assume 2 visitors will visit the resident once per month.
Employees in Proposed Development	108 people	Estimated staff at 30% of the residential population.
Kitchen Operation in Proposed Development	18 people	Estimated staff at 5% of the residential population.
Total Residents in Catchment A	2749 people	2.9 number of persons in average domestic household size for "Yuen Long – Shap Pat Heung West" based on 2021 Population Census's Main Table D304.
Total Residents in Catchment B	296 people	2.9 number of persons in average domestic household size for "Yuen Long – Shap Pat Heung West" based on 2021 Population Census's Main Table D304.
Total Residents in Catchment C	122 people	2.9 number of persons in average domestic household size for "Yuen Long – Shap Pat Heung West" based on 2021 Population Census's Main Table D304.
Total Residents in Catchment D	270 people	2.9 number of persons in average domestic household size for "Yuen Long – Shap Pat Heung West" based on 2021 Population Census's Main Table D304.
Total Residents in Catchment E	113 people	2.9 number of persons in average domestic household size for "Yuen Long – Shap Pat

[1] http://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentinhk/water/guide_ref/files/gesf.pdf

		Heung West" based on 2021 Population Census's Main Table D304.
Total Residents in Catchment F	35 people	2.9 number of persons in average domestic household size for "Yuen Long – Shap Pat Heung West" based on 2021 Population Census's Main Table D304.
Total Workers in Catchment G	385 people	0.4 workers per GFA (in $100m^2$) based on Table 8 "Storage (All Types)" in the Commercial and Industrial Floor Space Utilization Survey (CIFSUS) published by the Planning Department in 2005.
Total Residents in Catchment H	9 people	2.9 number of persons in average domestic household size for "Yuen Long – Shap Pat Heung West" based on 2021 Population Census's Main Table D304.
Unit Flow Factors		
Residents and Visitors in Proposed Development	$0.19m^3$/day	"Institutional and special class" based on EPD's GESF Table T-1.
Employees in Proposed Development	$0.28m^3$/day	J11 "Community, Social & Personal Services" based on EPD's GESF Table T-2.
Kitchen Operation in Proposed Development	$1.58m^3$/day	"Commercial employee" and "J10 Restaurants & Hotels" based on EPD's GESF Table T-2.
Residents in Catchments A, B, C, D, E, F, and H	$0.27m^3$/day	"Modern Village" based on EPD's GESF Table T-1.
Workers in Catchment G	$0.18m^3$/day	"Commercial employee" and Commercial activities of "J3 Transport, Storage & Communication" based on EPD's GESF Table T-2
Catchment Inflow Factor (P_{CIF})		
Discharge from the Project Site and all Catchments	1.0	Yuen Long Catchment based on EPD's GESF Table T-4.

Note:

The characteristics of Catchments are determined based on the dominant landuse within the Catchments (Catchments A to F: Residential; Catchment G: Open Storage).

2.3.3. With reference to Table T-5 of GESF, a global peaking factor of 8 and 6 (including stormwater allowance) are adopted according to the contributing population.

2.3.4. With reference to Table 5 in the Sewerage Manual (Part 1)[2] issued by the DSD in May 2013, slimed sewer of k_s of 0.6mm under "Poor" condition is assumed for both the sewers from the Subject Site and existing sewerage system in the worst-case scenario. The Colebrook-White Equation will be used to analyse the flow conditions. Equation (ii) for circular pipes flowing partially full is adopted to estimate the sewage flow for the Subject Site and following sewers.

2.4 RESULTS AND DISCUSSION

2.4.1. The estimated average flow rate and total peak flow of the Proposed Development are approximately 263.880m^3/day and 24.43L/s.

2.4.2. Sewage generated from the Proposed Development and surrounding catchment areas will be connected at the downstream of sewage network. The cumulative flow is generally no more than 65.5% of sewer capacity and no adverse sewerage impacts to the existing sewerage system are identified. Therefore, no upgrading or improvement works of the sewerage system are required. Details of the sewage calculation are included in **Appendix D**.

[2] http://www.dsd.gov.hk/EN/Files/Technical_Manual/technical_manuals/Sewerage_Manual_1_Eurocodes.pdf

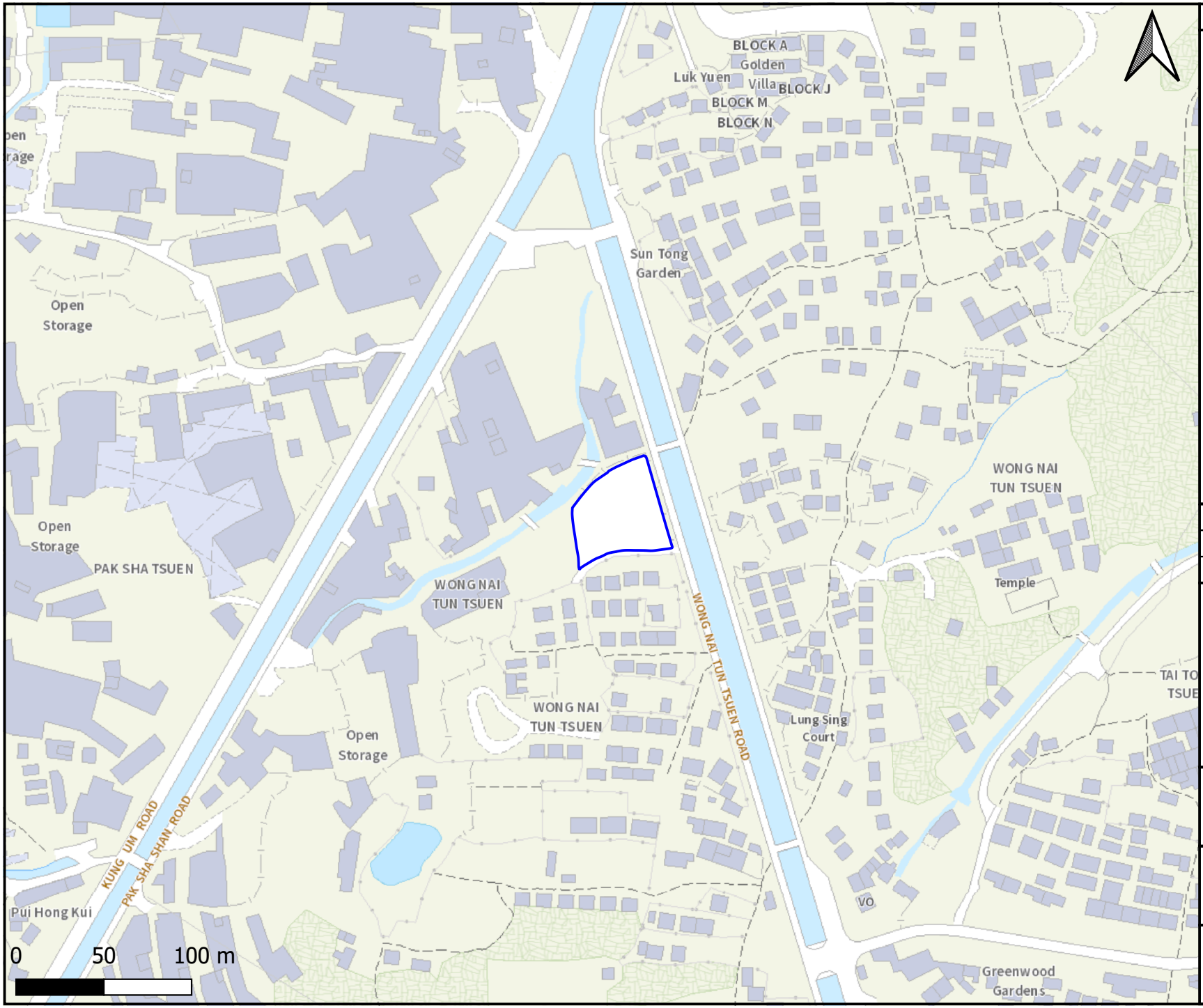
3 CONCLUSION

3.1.1. A Social Welfare Facility (Residential Care Home for the Elderly) is proposed to develop at Lot 669 S.A ss.2 RP (Part) and Lot 669 S.B RP (Part) in D.D.117, Yuen Long. This is the SIA to support the application under Section 16 of the Town Planning Ordinance.

3.1.2. Based on the SIA results, it is found that the existing sewerage system serving the area has sufficient capacity to cater for the sewage generation from the proposed development and the surrounding catchment areas. Adverse sewerage impacts are not anticipated, and thus no upgrading or improvement works are required.

FIGURE 1

LOCATION OF THE PROJECT SITE AND ITS SURROUNDING AREA



Legend

Project Site

	Prepared	Checked	Approved
Initial	KCC	ZC	HM
Date	231220	231220	231220

Project Title

Section 16 Planning Application for Proposed Social Welfare Facility (Residential Care Home for the Elderly (RCHE)) in Lot 669 S.A ss.2 RP (Part) and Lot 669 S.B RP (Part) in D.D.117, Yuen Long

Figure Title

Location of Project Site and its surrounding area

Figure No.	**Rev.**
Figure 1	0

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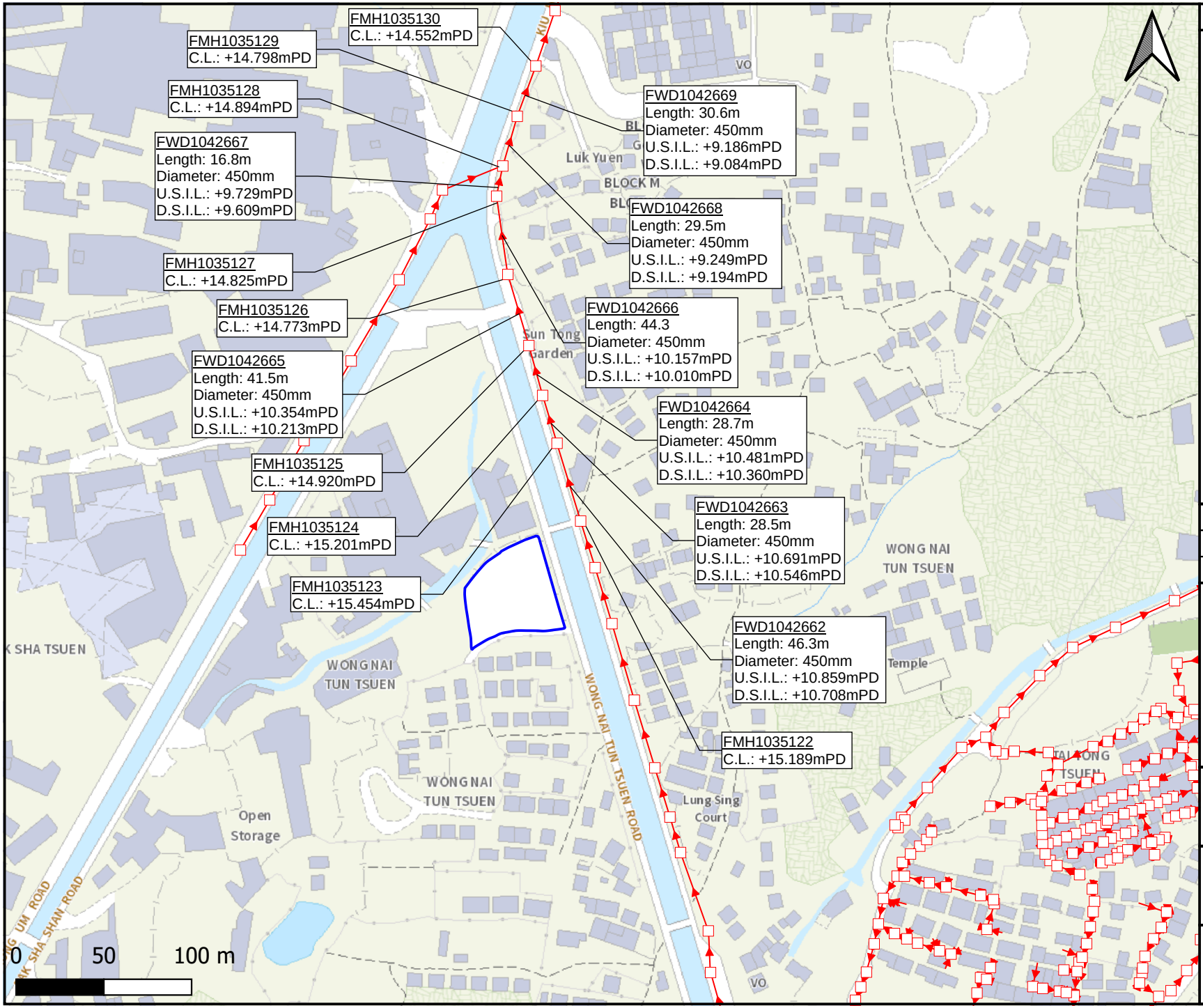
FIGURE 2

EXISTING SEWERAGE SYSTEM



Legend

- Project Site
- Existing Pipe (Sewer)
- Existing Manhole (Sewer)

	Prepared	Checked	Approved
Initial	KCC	ZC	HM
Date	240109	240109	240109

Project Title

Section 16 Planning Application for Proposed Social Welfare Facility (Residential Care Home for the Elderly (RCHE)) in Lot 669 S.A ss.2 RP (Part) and Lot 669 S.B RP (Part) in D.D.117, Yuen Long

Figure Title

Existing Sewerage System

Figure No.	**Rev.**
Figure 2	0

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FIGURE 3

PROPOSED TERMINAL MANHOLE AND CONNECTION

Legend

- Project Site
- Existing Pipe (Sewer)
- Existing Manhole (Sewer)
- Terminal Manhole (S1)
- Proposed Connection

	Prepared	Checked	Approved
Initial	KCC	ZC	HM
Date	240109	240109	240109

Project Title

Section 16 Planning Application for Proposed Social Welfare Facility (Residential Care Home for the Elderly (RCHE)) in Lot 669 S.A ss.2 RP (Part) and Lot 669 S.B RP (Part) in D.D.117, Yuen Long

Figure Title

Proposed Sewerage Arrangement

Figure No.	**Rev.**
Figure 3	0

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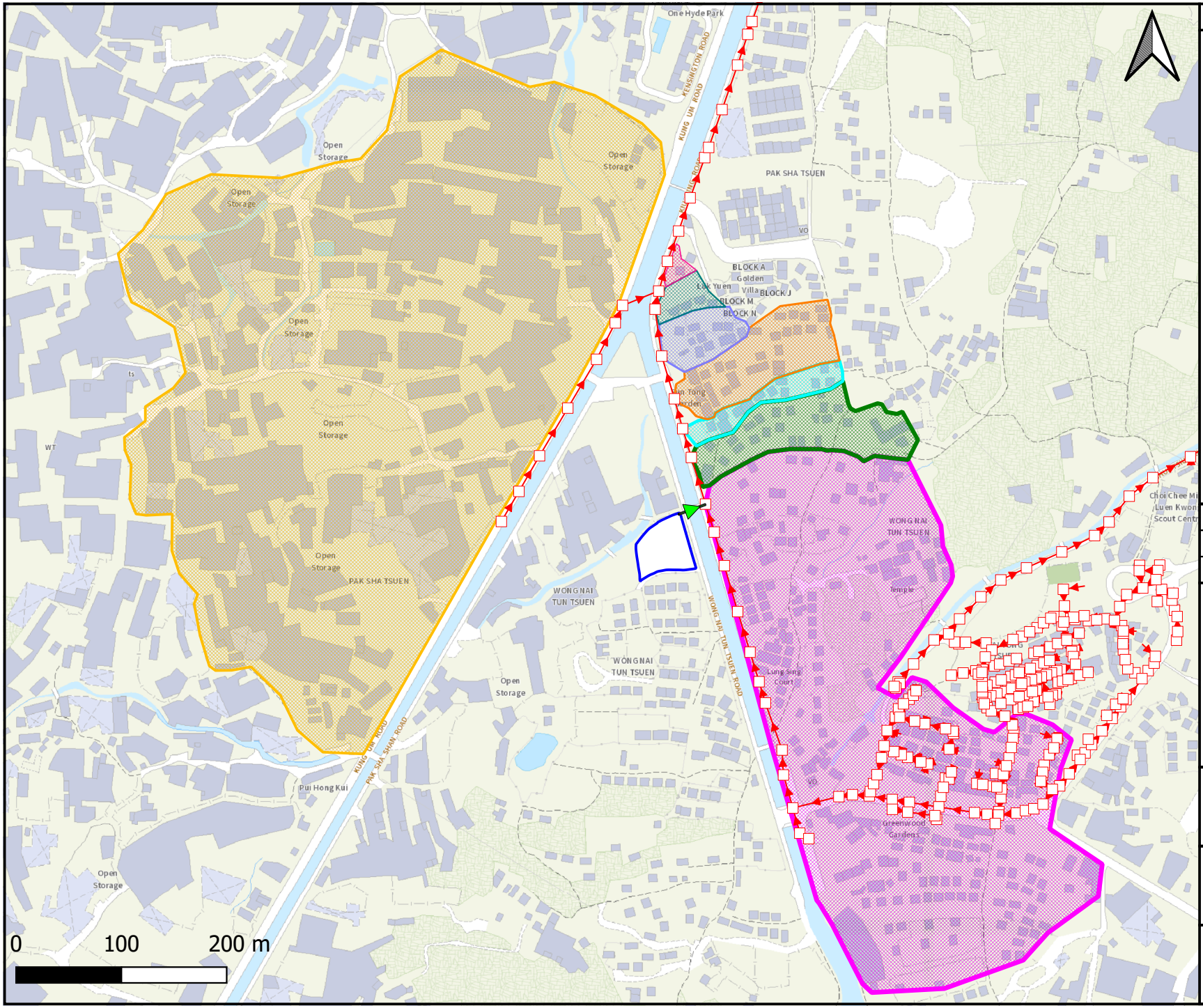
FIGURE 4
SURROUNDING CATCHMENTS



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Legend

- Project Site
- Existing Pipe (Sewer)
- Existing Manhole (Sewer)
- Proposed Terminal Manhole
- Proposed Connection
- Catchment A
- Catchment B
- Catchment C
- Catchment D
- Catchment E
- Catchment F
- Catchment G
- Catchment H

	Prepared	Checked	Approved
Initial	KCC	ZC	HM
Date	240109	240109	240109

Project Title

Section 16 Planning Application for Proposed Social Welfare Facility (Residential Care Home for the Elderly (RCHE)) in Lot 669 S.A ss.2 RP (Part) and Lot 669 S.B RP (Part) in D.D.117, Yuen Long

Figure Title

Surrounding Catchments

Figure No.	**Rev.**
Figure 4	0

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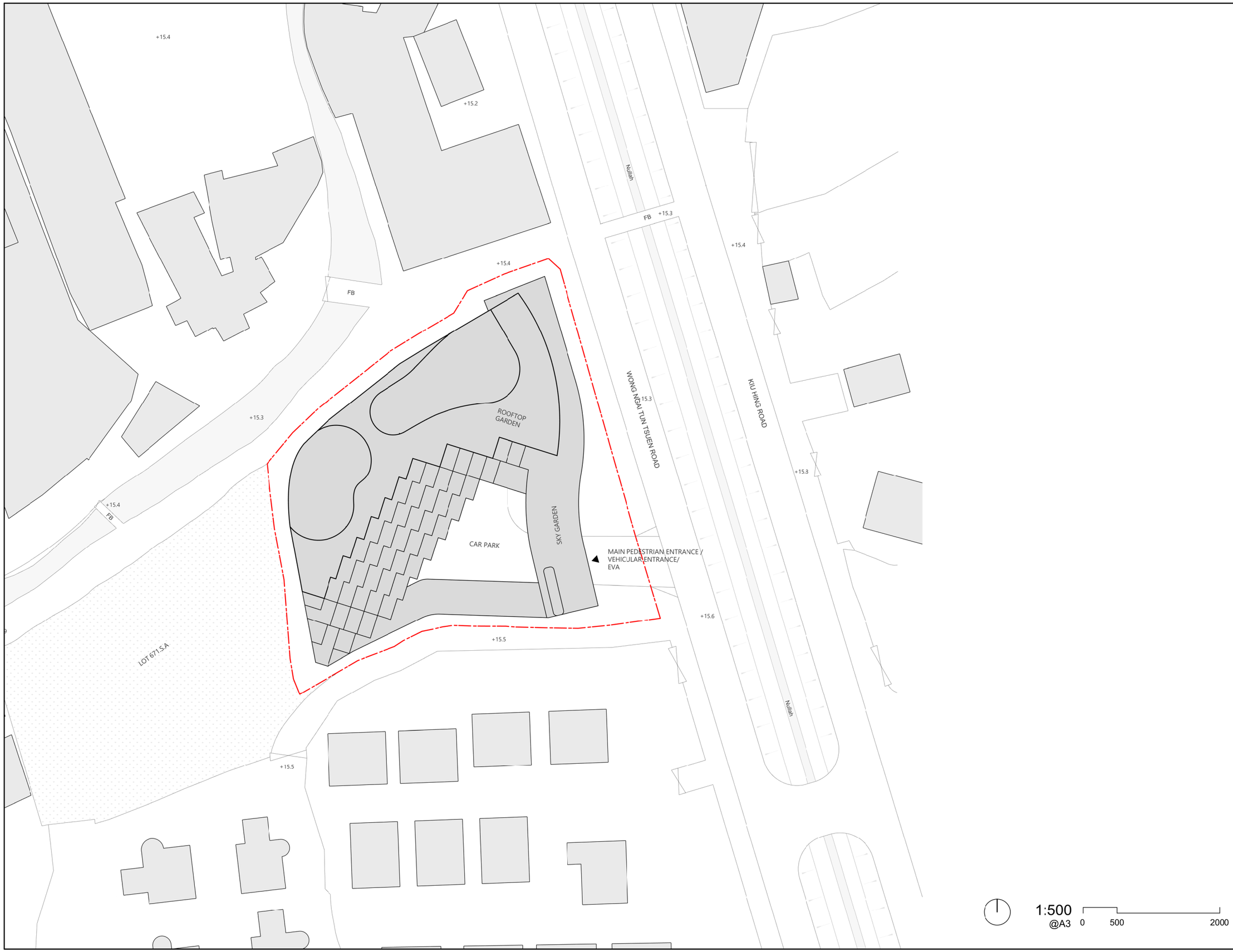
APPENDIX A
MASTER LAYOUT PLAN



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Issue	Description	Date

Project no: 21019

Project: Tai Tong RCHE Site

Client: Christian Zheng Sheng Association Limited

Address: Lot 669 S.A ss2 and 669 S.B RP in DD117, Yuen Long, Hong Kong

Drawn: EK Scale: 1:500 @A3

Rev: -

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FOR INFORMATION

Issue	Description	Date
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Project no: 22010

Project: Tai Tong Residential Care Home for the Elderly

Client:

Address:

Drawn: Scale: 1:250@A3

Title: G/F Layout Plan

Sheet: Rev:-

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Project no: 22010

Project: Tai Tong Residential Care Home for the Elderly

Client:

Address:

Drawn: Scale: 1:250@A3

Title: 1/F Layout Plan

Sheet: Rev:-

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Project: Tai Tong Residential Care Home for the Elderly

Client:

Address:

Drawn: Scale: 1:250@A3

Title: 2/F Layout Plan

Sheet: Rev:-

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Project: Tai Tong Residential Care Home for the Elderly

Client:

Address:

Drawn: Scale: 1:250@A3

Title: 3/F Layout Plan

Sheet: Rev:-

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Project no: 22010

Project: Tai Tong Residential Care Home for the Elderly

Client:

Address:

Drawn: Scale: 1:250@A3

Title: 4/F Layout Plan

Sheet: Rev:-

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Address:

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Title: 6/F Layout Plan

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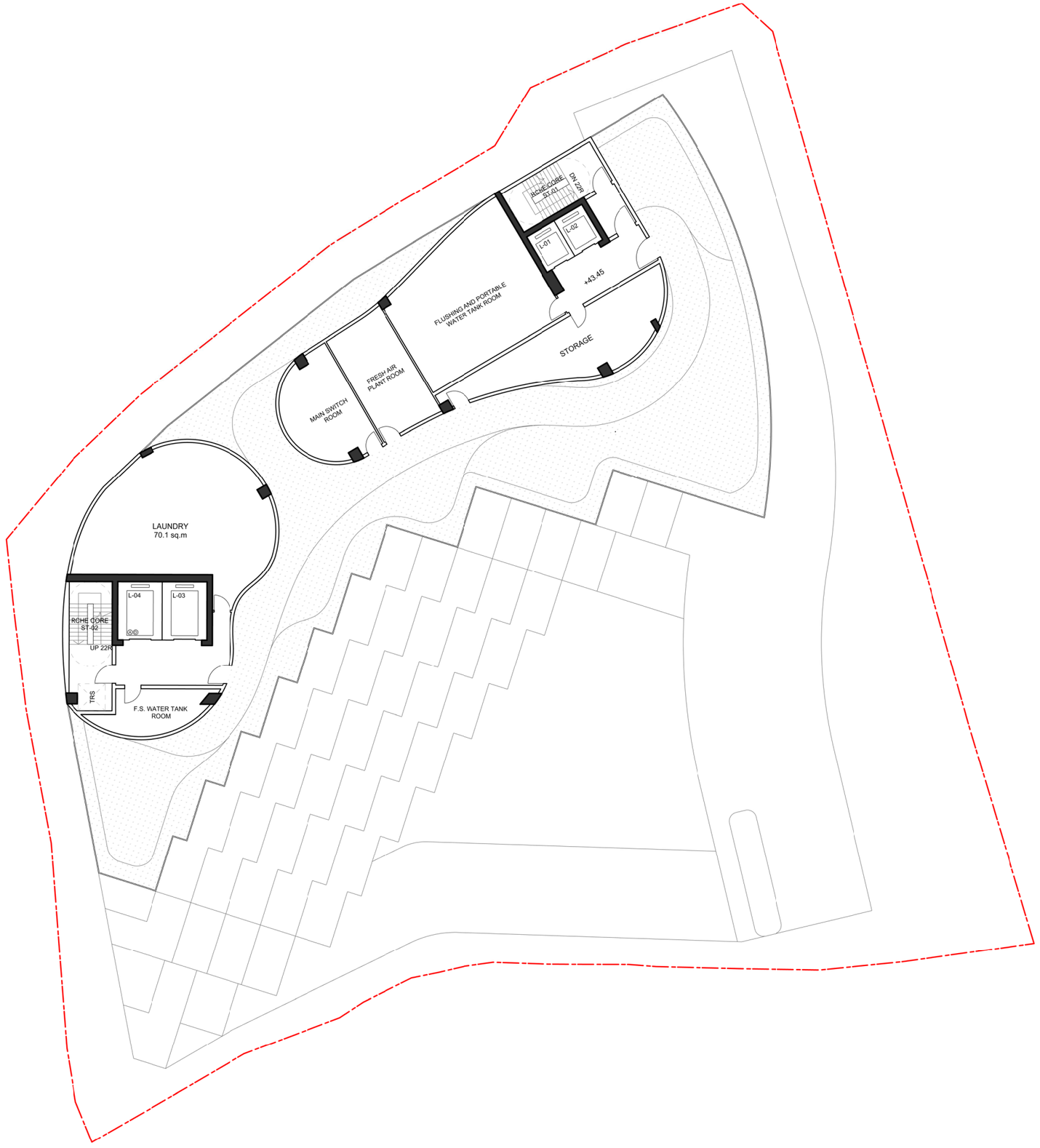

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Client:

Address:

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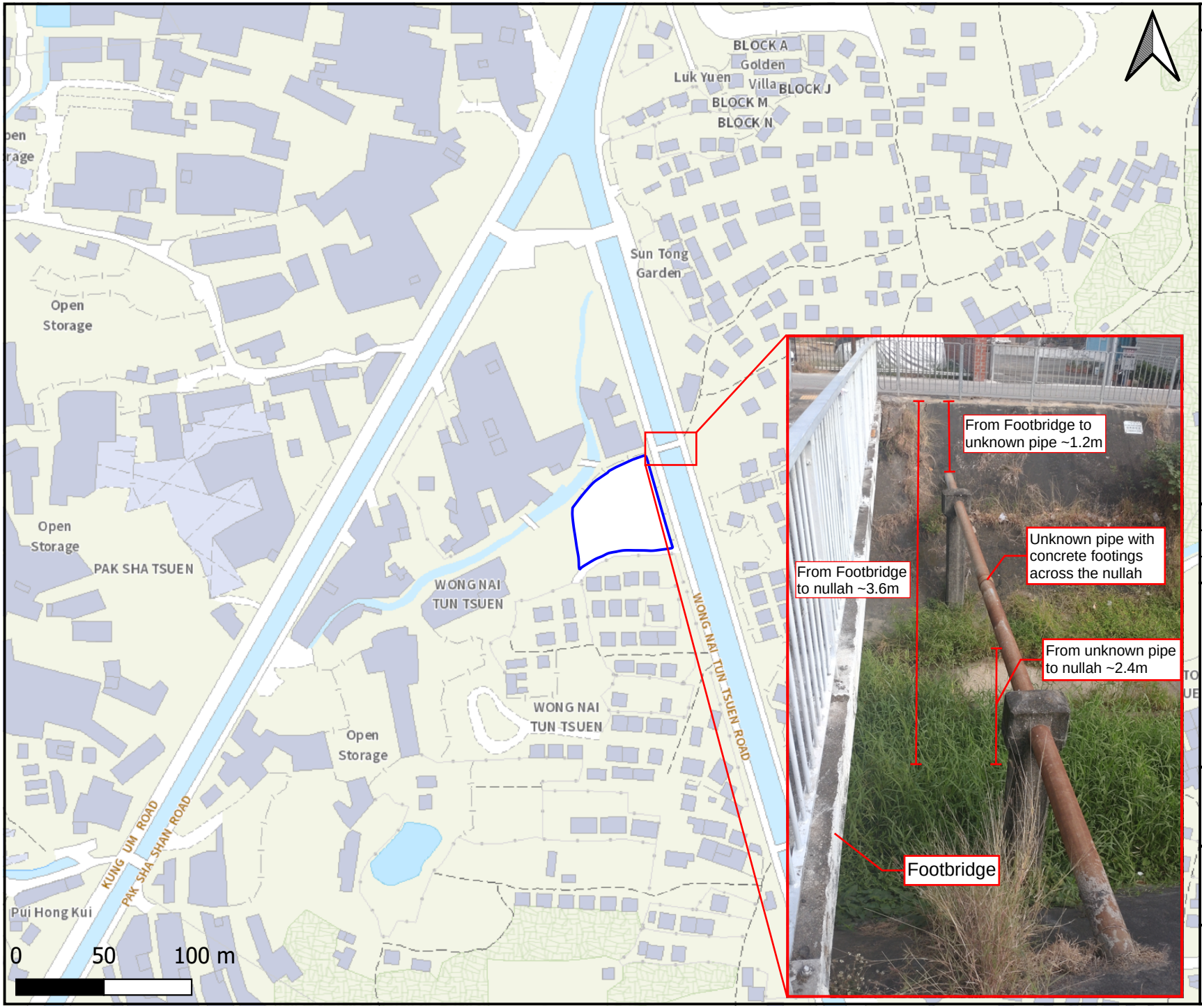
Title: 7/F Layout Plan

Sheet: Rev:-

APPENDIX B
SITE SURVEY RECORD



Legend

Project Site

	Prepared	Checked	Approved
Initial	KCC	ZC	HM
Date	231220	231220	231220

Project Title

Section 16 Planning Application for Proposed Social Welfare Facility (Residential Care Home for the Elderly (RCHE)) in Lot 669 S.A ss.2 RP (Part) and Lot 669 S.B RP (Part) in D.D.117, Yuen Long

Appendix Title

Site Survey Record

Appendix No.	**Rev.**
Appendix B	0

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APPENDIX C
REFERENCE CASE AT SHA HA ROAD

Legend

- Existing Manhole (Sewer)
- Existing Pipe (Sewer)

	Prepared	Checked	Approved
Initial	KCC	ZC	HM
Date	240110	240110	240110

Project Title

Section 16 Planning Application for Proposed Social Welfare Facility (Residential Care Home for the Elderly (RCHE)) in Lot 669 S.A ss.2 RP (Part) and Lot 669 S.B RP (Part) in D.D.117, Yuen Long

Appendix Title

Reference Case of sewerage connection at Sha Ha Road

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Appendix C	0

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APPENDIX D

SEWAGE CALCULATION AND HYDRAULIC CAPACITY CHECK

APPENDIX C - CALCULATION OF SEWAGE FLOW

Development	GFA (m^2)	No. of Flat	Occupancy Density [(a), (b)] (Number of Persons) (Workers per GFA in $100m^2$)	Estimated Population	Unit Flow Factor (m^3/day)	Estimated Average Dry Weather Flow (m^3/day)	Catchment Inflow Factor	Estimated Average Dry Weather Flow X Catchment Inflow Factor (m^3/day)	Remarks
1) Proposed Development									
Proposed Development Resident	10000	-	-	360	0.19	68.400	1.0	68.400	Estimated Population: The proposed development scheme will provide a maximum of 360 bed spaces. Unit Flow Factor: 0.190m^3/day for 'Institutional and special class' based on EPD's GESF Table T-1
Proposed Development Community, Social & Personal Services Visitor		-	-	720	0.19	136.800		136.800	Estimated Population: Assume 2 visitors will visit the resident per visit. Unit Flow Factor: 0.190m^3/day for 'Institutional and special class' based on EPD's GESF Table T-1
Proposed Development Community, Social & Personal Services Employee		-	-	108	0.28	30.240		30.240	Estimated Population: Estimated staff at 30% of the residential population. Unit Flow Factor: 0.280m^3/day for "Commercial employee" and 'Commercial activities of "J11 Community, Social & Personal Services" based on EPD's GESF Table T-2.
Proposed Development Kitchen Operation		-	-	18	1.58	28.440		28.440	Estimated Population: Estimated staff at 5% of the residential population. Unit Flow Factor: 1.58m^3/day for "Commercial employee" and "Commercial activities" of "J10 Restaurants & Hotels" based on EPD's GESF Table T-2.
Total Avaerage Daily Dry Weather Flow of Proposed Development (m^3/day)								**263.880**	
2) Catchment A									
Residential Area to the along Kiu Hing Road	-	948	2.9	2749	0.27	742.284	1.0	742.284	No. of Flat is estimated by the equation: No. of Building x No. of Storey Occupancy Density: 2.9 Number of persons in average domestic household size for "Yuen Long - Shap Pat Heung West" based on 2021 Population Census's Main Table D304. Unit Flow Factor: 0.270m^3/day for 'Modern village' based on EPD's GESF Table T-1.
Total Avaerage Daily Dry Weather Flow of Catchment A (m^3/day)								**742.284**	
3) Catchment B									
Residential Area to the along Kiu Hing Road	-	102	2.9	296	0.27	79.866	1.0	79.866	No. of Flat is estimated by the equation: No. of Building x No. of Storey Occupancy Density: 2.9 Number of persons in average domestic household size for "Yuen Long - Shap Pat Heung West" based on 2021 Population Census's Main Table D304. Unit Flow Factor: 0.270m^3/day for 'Modern village' based on EPD's GESF Table T-1.
Total Avaerage Daily Dry Weather Flow of Catchment B (m^3/day)								**79.866**	
3) Catchment C									
Residential Area to the along Kiu Hing Road	-	42	2.9	122	0.27	32.886	1.0	32.886	No. of Flat is estimated by the equation: No. of Building x No. of Storey Occupancy Density: 2.9 Number of persons in average domestic household size for "Yuen Long - Shap Pat Heung West" based on 2021 Population Census's Main Table D304. Unit Flow Factor: 0.270m^3/day for 'Modern village' based on EPD's GESF Table T-1.
Total Avaerage Daily Dry Weather Flow of Catchment C (m^3/day)								**32.886**	
4) Catchment D									
Residential Area to the along Kiu Hing Road	-	93	2.9	270	0.27	72.819	1.0	72.819	No. of Flat is estimated by the equation: No. of Building x No. of Storey Occupancy Density: 2.9 Number of persons in average domestic household size for "Yuen Long - Shap Pat Heung West" based on 2021 Population Census's Main Table D304. Unit Flow Factor: 0.270m^3/day for 'Modern village' based on EPD's GESF Table T-1.
Total Avaerage Daily Dry Weather Flow of Catchment D (m^3/day)								**72.819**	
5) Catchment E									
Residential Area to the along Kiu Hing Road	-	39	2.9	113	0.27	30.537	1.0	30.537	No. of Flat is estimated by the equation: No. of Building x No. of Storey Occupancy Density: 2.9 Number of persons in average domestic household size for "Yuen Long - Shap Pat Heung West" based on 2021 Population Census's Main Table D304. Unit Flow Factor: 0.270m^3/day for 'Modern village' based on EPD's GESF Table T-1.
Total Avaerage Daily Dry Weather Flow of Catchment E (m^3/day)								**30.537**	
6) Catchment F									
Residential Area to the along Kiu Hing Road	-	12	2.9	35	0.27	9.396	1.0	9.396	No. of Flat is estimated by the equation: No. of Building x No. of Storey Occupancy Density: 2.9 Number of persons in average domestic household size for "Yuen Long - Shap Pat Heung West" based on 2021 Population Census's Main Table D304. Unit Flow Factor: 0.270m^3/day for 'Modern village' based on EPD's GESF Table T-1.
Total Avaerage Daily Dry Weather Flow of Catchment F (m3/day)								**9.396**	
7) Catchment G									
Open Storage and Workshop along Kung Um Road	96250	-	0.4	385	0.18	69.300	1.0	69.300	GFA is estimated based on the desktop study. Occupancy Density: 0.4 workers per GFA (in $100m^2$) based on Table 8 "Storage (All Types)" in the Commercial and Industrial Floor Space Utilization Survey (CIFSUS) published by the Planning Department in 2005. Unit Flow Factor: 0.180m^3/day for "Commercial employee" and Commercial activities of "J3 Transport, Storage & Communication" based on EPD's GESF Table T-2
Total Avaerage Daily Dry Weather Flow of Catchment G (m^3/day)								**69.300**	
8) Catchment H									
Residential Area to the along Kiu Hing Road	-	3	2.9	9	0.27	2.349	1.0	2.349	No. of Flat is estimated by the equation: No. of Building x No. of Storey Occupancy Density: 2.9 Number of persons in average domestic household size for "Yuen Long - Shap Pat Heung West" based on 2021 Population Census's Main Table D304. Unit Flow Factor: 0.270m^3/day for 'Modern village' based on EPD's GESF Table T-1.
Total Avaerage Daily Dry Weather Flow of Catchment H (m^3/day)								**2.349**	

Note:

(a) "Number of Persons" was adopted in the estimation of population for Catchment A to F and G

(b) "Workers per GFA in $100m^{2}$" was adopted in the estimation of population for Catchment H.

Appendix C - Hydraulic Capacity of the Proposed and Downstream Sewers

Manhole Reference	Cover Level	Manhole Reference	Cover Level	Sewer Reference	Pipe Dia.	Pipe Length	Upstream Invert Level	Downstream Invert Level	g (1)	k_s (1), (3)	s (1)	v (1)	V (1), (2)	A	Q (4)	Estimated Capacity	ADWF	Contributing Population	Peaking Factor	Peak Flow	Capacity	Compliance	Remarks
	mPD		mPD		mm	m	mPD	mPD	m/s^2	m		m^2/s	m/s	m^2	m^3/s	L/s	m^3/day			L/s	%		
S1	+15.400	FMH1035122	+15.189	-	225	26.7	+14.400	+14.000	9.81	0.0006	0.0150	1.31E-06	1.5990	0.0398	0.0636	63.58	263.88	1206	8	24.43	38.4%	Yes	Project Site
FMH1035122	+15.189	FMH1035123	+15.454	FWD1042662	450	46.3	+10.859	+10.708	9.81	0.0006	0.0033	1.31E-06	1.1518	0.1590	0.1832	183.19	1006.16	3955	6	69.87	38.1%	Yes	Project Site + Catchment A
FMH1035123	+15.454	FMH1035124	+15.201	FWD1042663	450	28.5	+10.691	+10.546	9.81	0.0006	0.0051	1.31E-06	1.4426	0.1590	0.2294	229.43	1086.03	4251	6	75.42	32.9%	Yes	Project Site + Catchment A + B
FMH1035124	+15.201	FMH1035125	+14.920	FWD1042664	450	28.7	+10.481	+10.360	9.81	0.0006	0.0042	1.31E-06	1.3117	0.1590	0.2086	208.62	1118.92	4373	6	77.70	37.2%	Yes	Project Site + Catchment A + B + C
FMH1035125	+14.920	FMH1035126	+14.773	FWD1042665	450	41.5	+10.354	+10.213	9.81	0.0006	0.0034	1.31E-06	1.1759	0.1590	0.1870	187.03	1191.74	4643	6	82.76	44.3%	Yes	Project Site + Catchment A + B + C + D
FMH1035126	+14.773	FMH1035127	+14.825	FWD1042666	450	44.3	+10.157	+10.010	9.81	0.0006	0.0033	1.31E-06	1.1619	0.1590	0.1848	184.80	1222.27	4756	6	84.88	45.9%	Yes	Project Site + Catchment A + B + C + D + E
FMH1035127	+14.825	FMH1035128	+14.894	FWD1042667	450	16.8	+9.729	+9.609	9.81	0.0006	0.0071	1.31E-06	1.7122	0.1590	0.2723	272.32	1231.67	4756	6	85.53	31.4%	Yes	Project Site + Catchment A + B + C + D + E + F
FMH1035128	+14.894	FMH1035129	+14.798	FWD1042668	450	29.5	+9.249	+9.194	9.81	0.0006	0.0019	1.31E-06	0.8671	0.1590	0.1379	137.91	1300.97	4756	6	90.35	65.5%	Yes	Project Site + Catchment A + B + C + D + E + F + G
FMH1035129	+14.798	FMH1035130	+14.552	FWD1042669	450	30.6	+9.186	+9.084	9.81	0.0006	0.0033	1.31E-06	1.1646	0.1590	0.1852	185.22	1303.32	4756	6	90.51	48.9%	Yes	Project Site + Catchment A + B + C + D + E + F + G + H

Note:

(1) g=gravitational acceleration; k_s=equivalent sand roughness; s=gradient; v=kinematic viscosity of water; V=mean velocity

(2) The mean velocity (V) is claculated by the Colebrook-White Equation for circular pipes:

$$V = -\sqrt{(8gDs)}\log\left(\frac{k_s}{3.7D} + \frac{2.51v}{D\sqrt{(2gDs)}}\right)$$

where V = mean velocity (m/s)

g = gravitational acceration (m/s^2)

D = internal pipe diameter (m)

s = slope

ks = roughness coefficient(m)

v = kinematic viscosity of fluid (m^2/s)

(3) The value of k_s = 0.6mm is used for the calculation of existing pipe for conservative approach and 0.6mm for proposed new clayware pipe in poor condition based on DSD's "Sewerage Manual" Table 5: Recommended roughness values

(4) Peak flow (Q) is calculated by Q = V x A