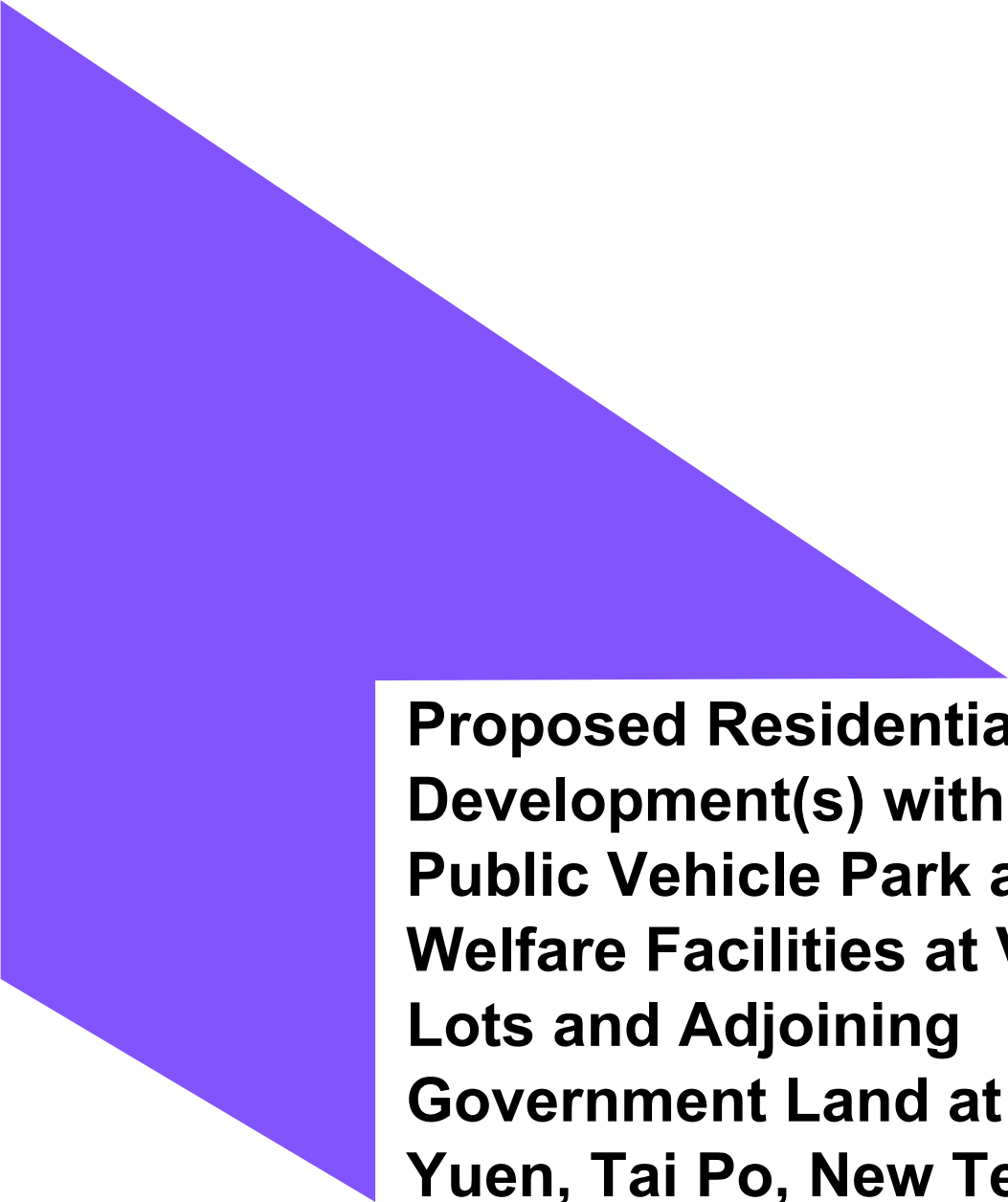


Appendix 12

Water Supply Impact Assessment



Proposed Residential Development(s) with Retail, Public Vehicle Park and Social Welfare Facilities at Various Lots and Adjoining Government Land at Fung Yuen, Tai Po, New Territories

Water Supply Impact Assessment (Revision A1)

Sep 2025

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Proposed Residential Development(s) with Retail, Public Vehicle Park and Social Welfare Facilities at Various Lots and Adjoining Government Land at Fung Yuen, Tai Po, New Territories

Water Supply Impact Assessment (Revision A1)

Sep 2025

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Contents

1	Introduction	1
1.1	Background	1
1.2	Key Development Parameters	1
1.3	Objectives of Report	2
1.4	Structure of Report	2
2	Methodology and Design Parameters for Water Supply Impact Assessment	3
2.1	General Approach	3
2.2	Methodology	3
2.3	Design Parameters	4
2.4	Planned Population and Employee Data of the Development	5
2.5	Existing Water Supply System	5
3	Estimation of Water Demand of the Development	6
3.1	Estimated Water Demand from the Development	6
4	Proposed Water Supply Arrangement	8
4.1	Water Demand and Water Supply System	8
4.2	Water Impact Assessment	8
5	Conclusion	11
6	Appendices	12

1 Introduction

1.1 Background

- 1.1.1 Mott MacDonald Hong Kong Limited (hereinafter as “MMHK”) was commissioned by the Applicant to prepare a Water Supply Impact Assessment (WSIA) for supporting the proposed development at Fung Yuen, Tai Po (the Development). The location of the proposed Development is shown in **Appendix A**.
- 1.1.2 This S.12A application is to seek the Town Planning Board’s approval for the proposed amendments to the Draft Tai Po Outline Zoning Plan No. S/TP/31 (“the OZP”) for the proposed development at various lots and adjoining Government land at Fung Yuen, Tai Po, New Territories (“the Development Site”).
- 1.1.3 The proposed development will include residential development(s) with supporting retail and public vehicle park facilities in Area (A); and a social welfare complex comprising a Residential Care Home for the Elderly (“RCHE”) and a Day Care Unit (“DCU”) for the Elderly in Area (B).
- 1.1.4 The Applicant submitted an s.12A Planning Application (No. Y/TP/38) to TPB in 2022 to rezone the current western portion of the “CDA(1)” zone to “R(B)13” zone to enable a proposed residential development with retail facilities and public vehicle park, and amending the maximum building height restriction of the “G/IC” zone from 2 storeys to 8 storeys to the south of the “CDA(1)” zone for a proposed 8-storey Social Welfare Complex. While tremendous effort has been put to address and resolve the comments from Planning Department and relevant Government departments during circulation of the application, it is noted that majority of the Government departments have no further adverse comment on the technical assessments attached to Application No. Y/TP/38 since almost 3 years efforts being put by the Applicant & consultancy team.
- 1.1.5 Taking into account comments received from relevant Government departments and in order to achieve a wholistic planning scheme for the entire “CDA(1)” zone, the Applicant has put forward to include the CDA(1) Future Phase proposed in Application No. Y/TP/38 into the Development Site of this Application. The Proposed Development Proposal in this Application is largely the same as that under Application No. Y/TP/38. The Development Site of this Application is solely formed by the previous development sites, i.e. Area (A), Area(B) and the “CDA(1)” Future Phase. The total GFA, PR, building height, no. of units and estimated population of the Development Proposal is almost exactly the same as that under Application No. Y/TP/38.
- 1.1.6 This report forms part of the application document and will demonstrate that the proposed Development is feasible in terms of its impact on the water supply system.

1.2 Key Development Parameters

- 1.2.1 The Development will include the residential development with supporting retail and public vehicle park facilities in Area (A) Phase I; residential development in Area (A) Phase II; and a Social Welfare Complex (SWC) with 150-place Residential Care Home

for the Elderly (“RCHE”) and a 30-place Day Care Unit (“DCU”) for the Elderly in Area (B).

- 1.2.2 The layout of the Development is provided in **Appendix B** and the development data is given in **Table 1.1** below:-

Table 1.1: Data of the Development

Items	Details
Development Site Area	
- Area (A) Phase I	About 26,567 m ²
- Area (A) Phase II	About 5,287 m ²
- Area (B)	About 3,347 m ²
Development Theme	Residential development with Retail, Public Vehicle Park and Social Welfare Complex
No. of Residential Unit	1,988 units
Total GFA for Area (A)	110,377 m ²
Total Plot Ratio for Area (A)	About 3.47
Social Welfare Complex	150-p residential care cum 30-p day care unit for the elderly
GFA for Social Welfare Complex	4,782 m ²

1.3 Objectives of Report

- 1.3.1 This WSIA Report aims to identify the existing and planned water supply systems within and near the Development and to investigate the physical constraints to the Development due to the existing and planned water supply networks. This includes both fresh water and salt water systems where are available.

1.4 Structure of Report

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

Section 2 – Methodology and Design Parameters for Water Supply Impact Assessment

Covering the approach of the WSIA and the parameters for water consumption prediction. The estimation of future demand due to the Development will be illustrated based on the parameters.

Section 3 –Estimation of Water Demand of the Development

Identifying and estimating the water demand arising from the Development in respect to published guidelines.

Section 4 – Proposed Water Supply Arrangement

Discussing the potential water supply system for the Development and assessing the impact on the existing water supply system.

Section 5 – Conclusion

Summarising the findings and concluding the water supply impact arising from the Development.

2 Methodology and Design Parameters for Water Supply Impact Assessment

2.1 General Approach

- 2.1.1 The WSIA is carried out to identify and assess if there are any potential adverse impacts on water supply system arising from the Development.

2.2 Methodology

Assessment Approach

- 2.2.1 The following approach and methodology have been adopted in this water supply impact assessment:-
- Estimating the water demand of the Development;
 - Identifying the existing and planned water supply systems within the Study Area;
 - Examining the impact on the water supply systems arising from the Development; and
 - Identifying improvement and upgrading works if necessary.
- 2.2.2 The unit demands used in estimating the fresh water and flushing water consumption for the Development are presented in **Table 2.1**. The unit demands for residential development and service trade are based on unit water demand in Water Supplies Department Departmental Instruction (WSD DI) 1309. The unit demands for residents of the proposed Social Welfare Complex, staffs for retail (J4) and Social Welfare Complex (J11) are based on EPD Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning (GESF).

Table 2.1: Unit demand for the Development

Development Type	Unit	Fresh Water Demand	Flushing Water Demand
Residential Use (R2) ⁽ⁱ⁾	m ³ /h/d	0.30	0.07
Residential Use for Social Welfare Complex ^{(iii) & (iv)}	m ³ /h/d	0.24	0.07
Service Trade (Residential)	m ³ /h/d	0.05	-
Staff for the Commerce (Retail) (Type J4) ^{(ii) & (iv)}	m ³ /h/d	0.35	0.07
Staff for Social Welfare Complex (Type J11) ^{(ii) & (iv)}	m ³ /h/d	0.35	0.07

Remarks:-

- The proposed residential development is type R2 residential development. The unit water demand has been making reference to the domestic unit flow factor for Residential R2 – All areas under Table 1 of WSD's DI 1309.
- The water demand for Staffs of Social Welfare Complex (Type J11 – Community, Social & Personal Services) and Staff of the Commerce in the residential development (Type J4 Wholesale & Retail) are estimated based on the assumptions below:-
 - The unit water demand has been making reference to the Table T-2 of EPD's Technical Paper (Report No, EPD/TP1/05) - Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning (GESF); and
 - According to Sewerage Manual – Key Planning Issues and Gravity Collection System, the sewage flow values for commercial categories are based on 80% of

Development Type	Unit	Fresh Water Demand	Flushing Water Demand
the mean daily water demand from WSD which is equivalent to a factor of 1.25. Therefore, the fresh water demand adopted for service trade refer to the data from EPD's Technical Paper should be factored by 1.25.			
iii.	The water demand for residents of Social Welfare Complex is estimated based on the assumptions below:-		
	a. The unit water demand has been making reference to the domestic unit flow factor for Institutional and Special Class under Table T-1 of EPD's Technical Paper (Report No. EPD/TP1/05) - Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning (GESF); and		
	b. According to Sewerage Manual – Key Planning Issues and Gravity Collection System (1995), the sewage flow values for commercial categories are based on 80% of the mean daily water demand from WSD which is equivalent to a factor of 1.25. Therefore, the fresh water demand adopted for residential of Social Welfare Complex refer to the data from EPD's Technical Paper should be factored by 1.25.		
iv.	Assume the flushing water demand for staff (Type J4 & J11) and residents of Social Welfare Complex is similar to that of the residential development, 70 l/h/d.		

2.3 Design Parameters

Peaking Factor

2.3.1 In accordance with the WSD DI 1309, the minimum capacity of the distribution system should be sufficient for the following peak demands.

- Fresh Water Supply – 3 times mean daily demand
- Salt Water (Flushing Water) Supply – 2 times mean daily demand

Peaking Flow Velocity

2.3.2 According to Section 1.2.1 of WSD's Manual of Main laying Practice (2012 Edition), the maximum flow velocity under peak flow for both pumping mains and distribution mains should be less than 3m/s.

2.3.3 Minimum velocity of 1m/s under peak flow is also desirable to avoid water stagnant.

2.3.4 Design flow velocity is preferably to be ranged between 1m/s to 3m/s under peak flow.

Residual Head

2.3.5 According to WSD DI 1309 and Handbook on Plumbing Installation for Buildings, the following minimum residual heads shall be maintained.

1. Fresh (Portable Water) Supply – 20 m
2. Salt Water (Flushing Water) Supply – 15 m

2.4 Planned Population and Employee Data of the Development

- 2.4.1 The design population of the Development is shown in **Table 2.2** below. The layout plan of the residential development (i.e. Area (A) Phases I and Area (A) Phase II) and the Social Welfare Complex (i.e. Area (B)) could be referred to **Appendix B**.

Table 2.2: Population data of the Development

Type	Unit	Household Size	Population (nos.)
Area (A) Phase I			
Residential Use (R2)	1,718	2.6	4,467 ⁽ⁱ⁾
Residential (Service Trade)	-	-	4,467
Staff for Commerce (Retail) (Type J4)	-	-	28 ⁽ⁱⁱⁱ⁾
Sub-Total =			4,495
Area (A) Phase II			
Residential Use (R2)	270	2.6	702 ⁽ⁱ⁾
Residential (Service Trade)	-	-	702
Sub-Total =			702
Area B			
Residential Use (R2)	-	-	150
Staff for Social Welfare Complex (Type J11)	-	-	110 ⁽ⁱⁱⁱ⁾
Sub-Total =			260
Total =			5,457
Remark:-			
i.	According to latest statistics from Census and Statistics Department, the territorial-wide average domestic household size is 2.6 in 2024. Thus, the population for the residential development in Area (A) Phase I and Area (A) Phase II are $1,718 \times 2.6 = 4,467$ and $270 \times 2.6 = 702$ respectively.		
ii.	According to Commercial and Industrial Floor Space Utilization Survey (CIFSUS) published by PlanD, the worker density of Retail Trade business is 3.5 worker/ 100 m ² . Thus, the no. of staff in commercial area for the proposed development is $800 \times 3.5 / 100 = 28$.		
iii.	According to Commercial and Industrial Floor Space Utilization Survey (CIFSUS) published by PlanD, the worker density of Community, Social & Personal Services business is 2.3 worker/ 100 m ² . Thus, the no. of staff in commercial area for the proposed development is $4,782 \times 2.3 / 100 = 110$.		

2.5 Existing Water Supply System

- 2.5.1 Portal water and flushing water of the Development as well as the surrounding area are served by nearby Ha Hang Fresh Water Service Reservoir which has a capacity of 18,746 m³ and Ha Hang Salt Water Service Reservoir which has a capacity of 3,200 m³.
- 2.5.2 Series of distribution mains ranging from DN600 to DN 200 and DN 450 to DN150 convey the fresh and salt water supply to the area respectively.
- 2.5.3 Along Fung Yuen Road near the site area of the Development, fresh water main of 300 mm diameter and salt water main of 150 mm diameter are laid at the eastern part of the site. Existing water supply system is shown in **Appendix C**.

3 Estimation of Water Demand of the Development

3.1 Estimated Water Demand from the Development

3.1.1 Based on the unit water demand listed in **Table 2.1** and the estimated population presented in **Table 2.2**, the mean daily fresh water and flushing water demands for the residential development in Area (A) are approximately 1,638 m³/day and 315 m³/day for Area (A) Phase I, and 259 m³/day and 50 m³/day for Area (A) Phase II respectively. For the Social Welfare Complex, the mean daily fresh water and flushing water demands are estimated to be about 75 m³/day and 19 m³/day. The details of the water demand estimation are shown in **Table 3.1** and **Table 3.2**.

Table 3.1: Water demand estimation for the residential development

Development Type	Population (nos.)	Unit	Fresh Water Demand	Flushing Water Demand	Total Mean Fresh Water Demand (m ³ /d)	Total Mean Flushing Water Demand (m ³ /d)
Area (A) Phase I						
Residential Use (R2)	4,467	m ³ /h/d	0.30	0.07	1,340.10	312.69
Service Trade (Residential)	4,467	m ³ /h/d	0.05	-	223.35	-
Staff for Commerce (Service Trade – Type J4)	28	m ³ /h/d	0.35	0.07	9.80	1.96
Landscaping	-	-	-	-	63.76	-
Sub-Total =					1,637.01 (say 1,638)	314.65 (say 315)
Area (A) Phase II						
Residential Use (R2)	702	m ³ /h/d	0.30	0.07	210.60	49.14
Service Trade (Residential)	702	m ³ /h/d	0.05	-	35.10	-
Landscaping	-	-	-	-	12.69	-
Sub-Total =					258.39 (say 259)	49.14 (say 50)
Total =					1895.4	363.79
Remark:-						
i. Water demand for irrigation normally ranges from 6 to 10L/m ² /day, as such an average irrigation water demand of 8L/m ² /day is adopted. The landscape area of the Development in Area (A) Phases I and Area (A) II is assumed to be 30% of the site area, i.e 26,567 m ² x 30% = 7,970.1 m ² and 5,287 m ² x 30% = 1,586m ² respectively.						

Table 3.2: Water demand estimation for the Social Welfare Complex

Development Type	Population (nos.)	Unit	Fresh Water Demand	Flushing Water Demand	Total Mean Fresh Water Demand (m³/d)	Total Mean Flushing Water Demand (m³/d)
Area (B)						
Residential Use (R2)	150	m³/h/d	0.24	0.07	36.00	10.50
Staff for Residential Development (Service Trade – Type J11)	110	m³/h/d	0.35	0.07	38.50	7.70
Total =					74.50 (say 75)	18.20 (say 19)

4 Proposed Water Supply Arrangement

4.1 Water Demand and Water Supply System

- 4.1.1 As discussed in **Section 3**, the estimated fresh water and flushing water demands for the residential development in Area (A) are approximately 1,638 m³/day and 315 m³/day for Phase I, and 259 m³/day and 50 m³/day for Phase II. For supplying fresh water to the residential development under this planning application, it is proposed to branch off a DN200 fresh water main for Area (A) Phase I and a DN100 fresh water main for Area (A) Phase II from the existing DN300 fresh water main at Fung Yuen Road. For the flushing water, a DN100 flushing water main for Area (A) Phase I and a DN80 flushing water main for Area (A) Phase II are proposed to branch off from the existing DN150 salt water main respectively at Fung Yuen Road.
- 4.1.2 For the Social Welfare Complex in Area (B), the estimated fresh water and flushing water demands are about 75 m³/day and 19 m³/day respectively. It is proposed to branch off a DN80 fresh water main and a DN80 flushing water main from the existing DN300 fresh water main and DN150 salt water main at Fung Yuen Road.
- 4.1.3 The proposed connection points for Area (A) Phase I, Area (A) Phase II and Area (B) from the existing watermain are enclosed in **Appendix D**.

4.2 Water Impact Assessment

Checking of Residual Pressures for Existing Fresh Water Supply Main

- 4.2.1 The top level and invert level of Ha Hang Fresh Water Reservoir is 82.075 mPD and 76.200 mPD respectively. It is assumed in the design that the water level at the service reservoir is at 50% of the full depth. Thus, the water level of Ha Hang Fresh Water Reservoir is assumed as 79.138 mPD.
- 4.2.2 For assessing the impact to the existing DN600-DN200 fresh watermain, a few control points (namely Control Points A to F as shown in **Appendix D**), have been established for comparing the residual pressures of the fresh watermain with and without the proposed Development. Based on the hydraulic calculation results shown in **Table 4.1**, the residual head under existing condition at the Control Points range from 65.20 m to 34.26 m. With the additional demand from the Development, the residual head remain well within the requirement of 20 m according to Handbook on Plumbing Installation for Buildings as the residual head under Proposed Condition range from 63.11 m to 28.52 m. The residual head at the connection point of the residential developments in Area (A) Phase I, Area (A) Phase II and the Social Welfare Complex in Area (B) are 56.25, 52.32 m and 59.45 m respectively. Thus, it is considered that there is no insurmountable impact arising from the Development to the existing fresh water supply system.
- 4.2.3 The hydraulic calculation of residual head for the existing fresh watermain from Ha Hang Fresh Water Reservoir along the assessed water supply system at Fung Yuen Road can be referred to **Appendix E**.

Table 4.1: Summary of residual head of fresh water along the existing distribution main under existing and proposed Conditions

Control Point	Approx. Existing Ground Level (mPD)	Residual Head of the Existing Water Distribution Main under Existing Condition (m)	Residual Head of the Existing Water Distribution Main under Proposed Condition (m)
Control Point A	4.76	65.20	63.11
Control Point B	4.57	64.18	61.49
Control Point C #	4.49	63.49	59.45
Control Point C1 *	5.43	61.71	56.25
Control Point C2 ^	7.57	58.06	52.32
Control Point D	14.38	46.70	40.96
Control Point E	16.65	42.11	36.37
Control Point F	20.67	34.26	28.52
Remark: (i) # The control point for the proposed fresh water supply connection point to the Social Welfare Complex (ii) * The control point for the proposed fresh water supply connection point to the residential development of Area (A) Phase I (iii) ^ The control point for the proposed fresh water supply connection point to the residential development of Area (A) Phase II			

Checking of Residual Pressures for Existing Salt Water for Flushing Water Supply System

- 4.2.4 The top level and invert level of Ha Hang Salt Water Reservoir is 85.000 mPD and 80.300 mPD respectively. It is assumed in the design that the water level at the service reservoir is at 50% of the full depth. Thus, the water level of Ha Hang Salt Water Reservoir is assumed as 82.650 mPD.
- 4.2.5 Similar to fresh water supply system, for assessing the impact to the existing DN450-DN150 salt watermain, a few control points (namely Control Point 1 to 4 as shown in **Appendix D**) have been established for comparing the residual pressures of the fresh watermain with and without the Development. Based on the hydraulic calculation results summarised in **Table 4.2**, the residual head under existing condition at the Control Points range from 72.81 m to 36.22 m. With the additional demand from the Development, the residual head remain well within the requirement of 15 m according to Handbook on Plumbing Installation for Buildings as the residual head under Proposed Condition range from 72.26 m to 31.20 m. The residual head at the connection point of the residential development in Area (A) Phase I, Area (A) Phase II and the Social Welfare Complex are 56.18, 48.57 m and 61.80 m respectively. Thus, it is considered that there is no insurmountable impact arising from the Development to the existing salt water supply system.
- 4.2.6 The hydraulic calculation of residual head for the existing fresh watermain from Ha Hang Salt Water Reservoir along the assessed water supply system at Fung Yuen Road can be referred to **Appendix E**.

Table 4.2: Summary of residual head of salt water along the existing distribution main under existing and proposed conditions

Control Point	Approx. Existing Ground Level (mPD)	Residual Head of the Existing Water Distribution Main under Existing Condition (m)	Residual Head of the Existing Water Distribution Main under Proposed Condition (m)
Control Point 1	4.35	72.81	72.26
Control Point 2	4.58	66.12	65.41
Control Point 2.1 #	4.59	64.16	61.80
Control Point 3 *	5.39	60.69	56.18
Control Point 3.1 ^	7.22	53.59	48.57
Control Point 4	13.41	36.22	31.20
Remark: (i) # The control point for the proposed water supply connection point to the Social Welfare Complex (ii) * The control point for the proposed water supply connection point to the residential development of Area (A) Phase I (iii) ^ The control point for the proposed water supply connection point to the residential development of Area (A) Phase II			

5 Conclusion

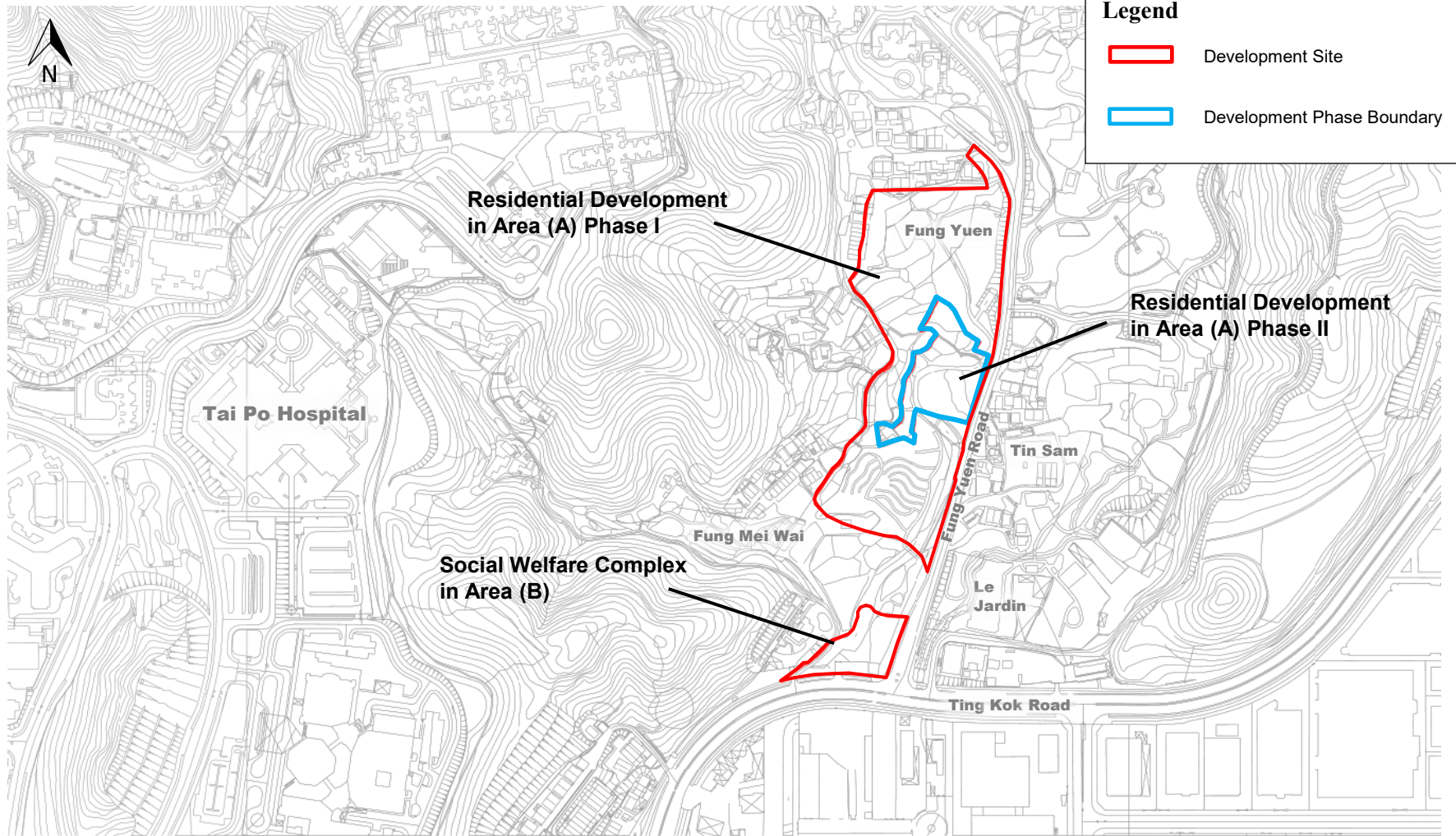
- 5.1.1 Based on the unit water demand and the estimated population, the mean daily fresh water and flushing water demand for the residential development in Area (A) are approximately 1,638 m³/day and 315 m³/day for Phase I, and 259 m³/day and 50 m³/day for Phase II. For supplying fresh water to the residential development under this planning application, it is proposed to branch off a DN200 fresh water main for Area (A) Phase I and a DN100 fresh water main for Area (A) Phase II from the existing DN300 fresh water main at Fung Yuen Road. For the flushing water, a DN100 flushing water main for Area (A) Phase I and a DN80 flushing water main for Area (A) Phase II are proposed to branch off from the existing DN150 salt water main respectively at Fung Yuen Road.
- 5.1.2 For the proposed Social Welfare Complex, the mean daily fresh water and flushing water demand is estimated to be about 75 m³/day and 19 m³/day respectively. It is proposed to branch off a DN80 fresh water main and a DN80 flushing water main from the existing DN300 fresh water main and DN150 salt water main at Fung Yuen Road.
- 5.1.3 Based on the hydraulic calculation, residual heads of proposed condition at the connection point of the Development are estimated. For the residential development of Area (A) Phases I and Area (A) Phases II, the residual heads are 56.25 m and 52.32 m for fresh water supply respectively and 56.18 m and 48.57 for salt water supply respectively. For the Social Welfare Complex, the residual heads are 59.45 m for fresh water supply and 61.80 m for flushing water supply respectively. In addition, the furthest fresh water Control Point F and salt water Control Point 4 are 28.52 m and 31.20 m which are well within residual head requirement of 20 m and 15 m for water supply system.
- 5.1.4 Based on the assessment findings, it is considered that there is no insurmountable impact from the additional water demand from the Development on the existing water supply system.

6 Appendices

Appendix A	Location Plan
Appendix B	Layout Plan
Appendix C	Existing Water Supply System with the Water Mains to be Assessed
Appendix D	Layout Plan for Hydraulic Calculation of Residual Head
Appendix E	Residual Head Calculation for Fresh and Flushing Water Mains

Appendix A

Location Plan



Project Proposed Residential Development(s) with Retail, Public Vehicle Park and Social Welfare Facilities at Various Lots and Adjoining Government Land at Fung Yuen, Tai Po, New Territories

Title Location Plan

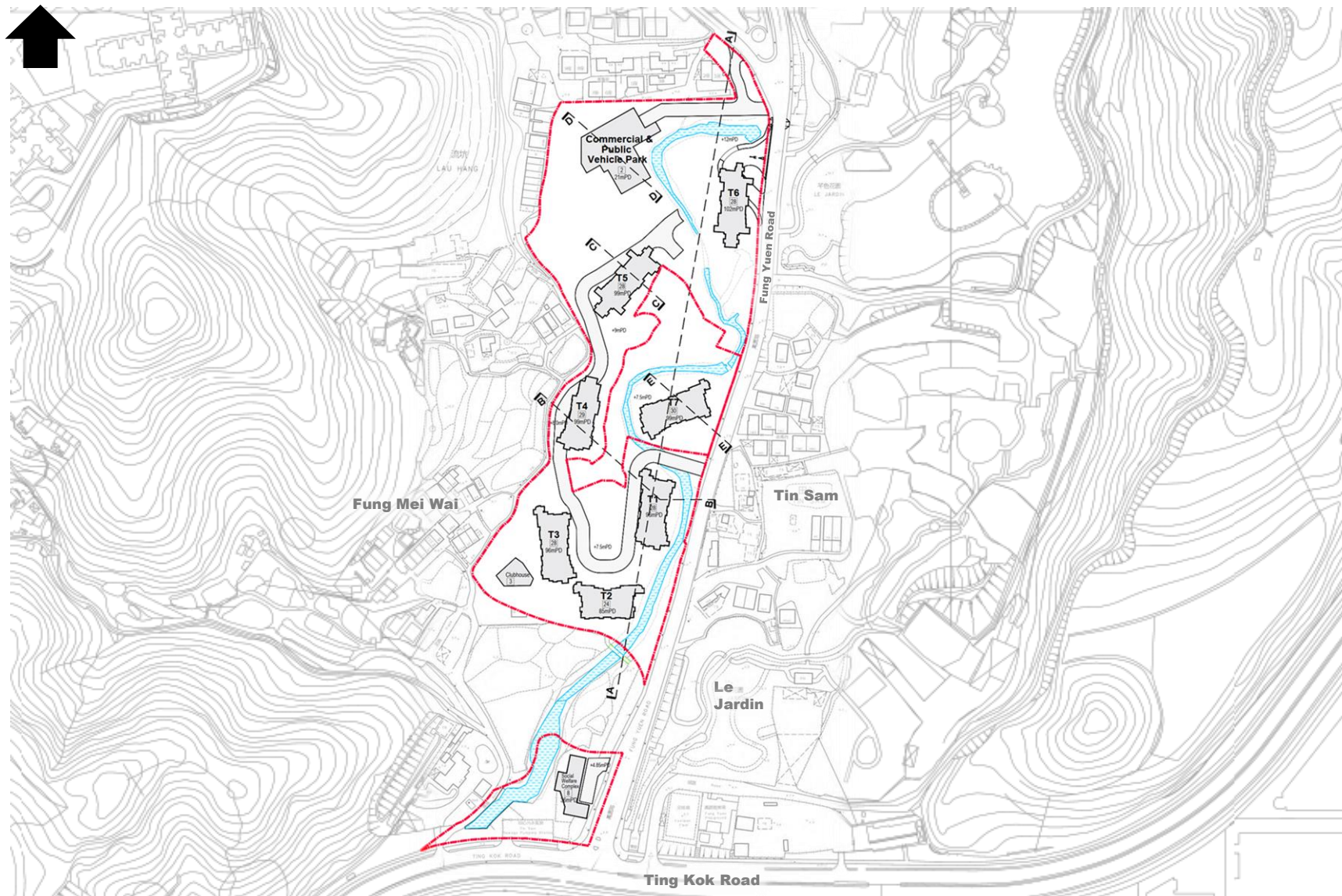
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Appendix A

Appendix B

Layout Plan



Project Proposed Residential Development(s) with Retail, Public Vehicle Park and Social Welfare Facilities at Various Lots and Adjoining Government Land at Fung Yuen, Tai Po, New Territories

Title Layout Plan

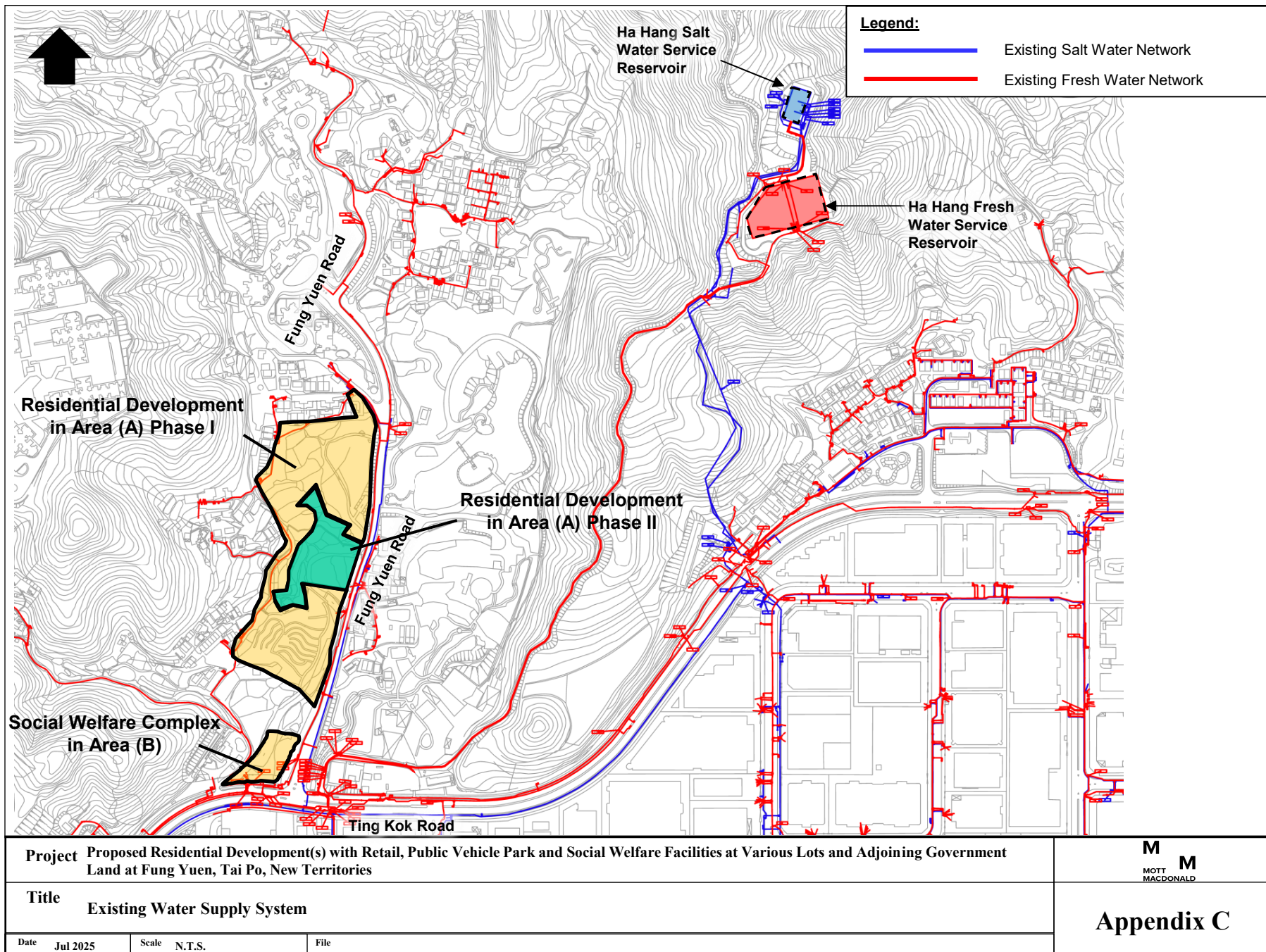
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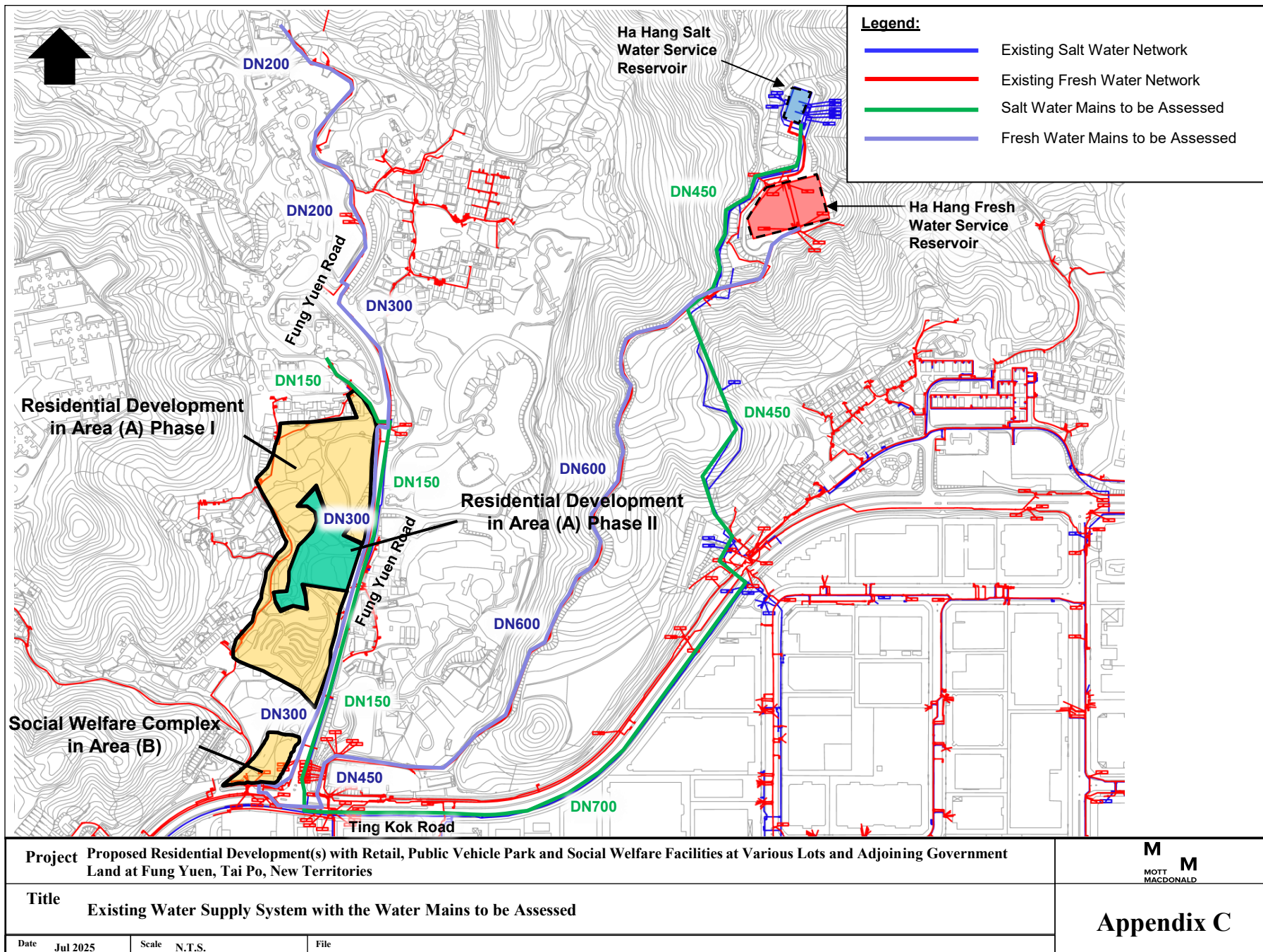
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Appendix B

Appendix C

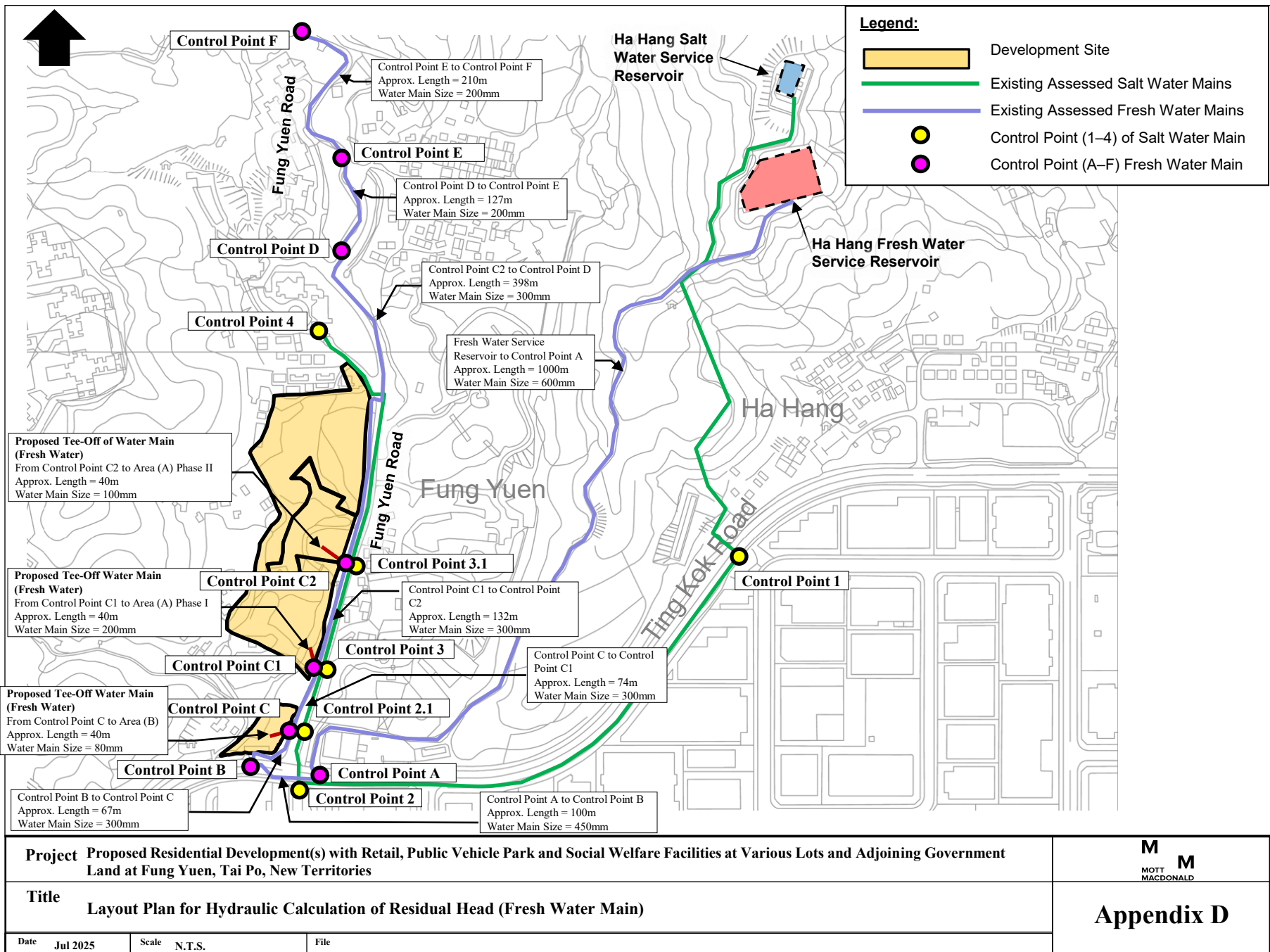
Existing Water Supply System with the Water Mains to be Assessed

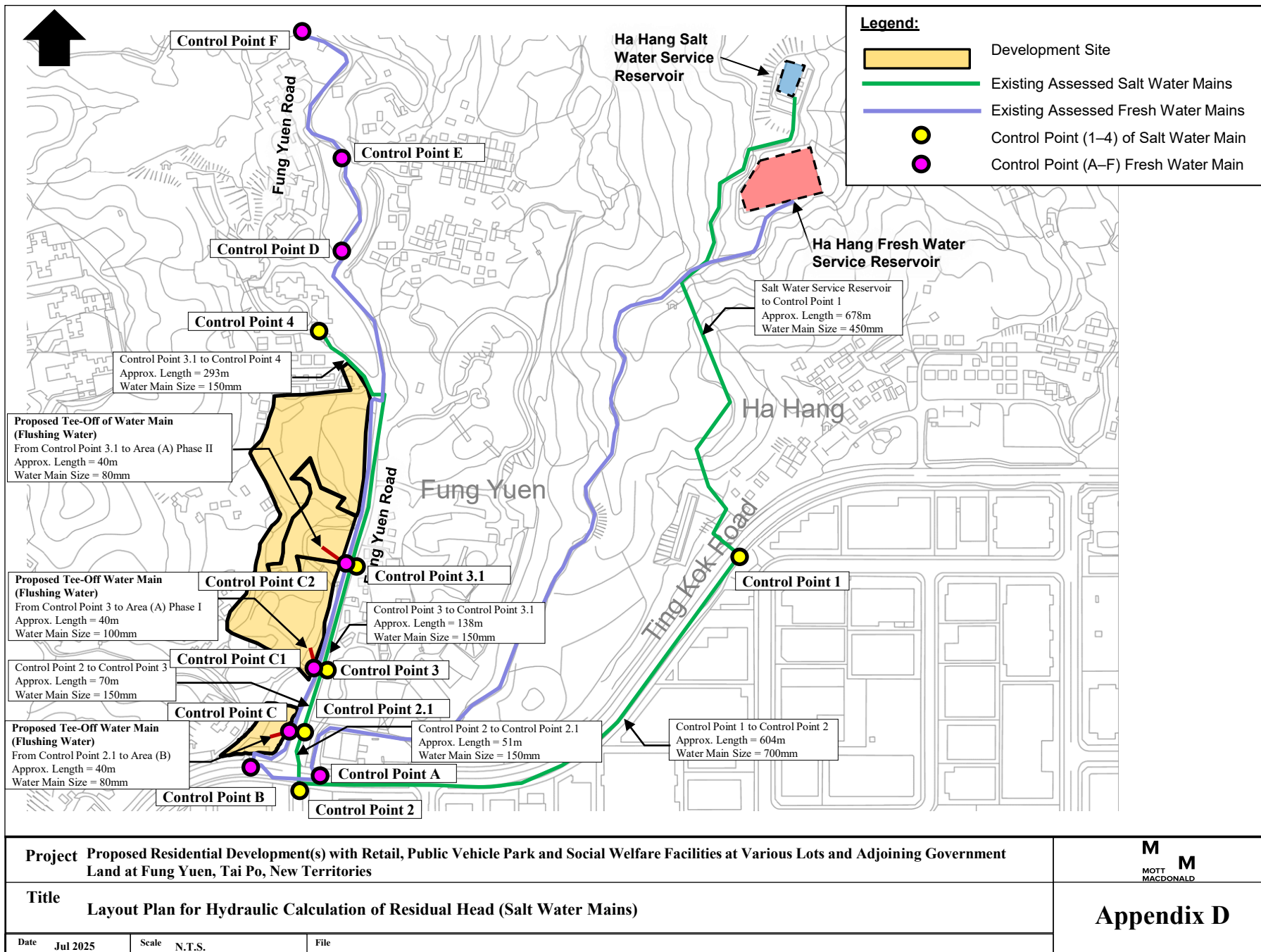




Appendix D

Layout Plan for Hydraulic Calculation of Residual Head





Project Proposed Residential Development(s) with Retail, Public Vehicle Park and Social Welfare Facilities at Various Lots and Adjoining Government Land at Fung Yuen, Tai Po, New Territories

Title Layout Plan for Hydraulic Calculation of Residual Head (Salt Water Mains)

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Appendix D

Appendix E

Residual Head Calculation for Fresh and Flushing Water Mains

Summary table of the residual head at control points

Residual Head (m)					
Fresh Water			Flushing Water		
Control Point	Existing Condition	Proposed Condition	Control Point	Existing Condition	Proposed Condition
Control Point A	65.20	63.11	Control Point 1	72.81	72.26
Control Point B	64.18	61.49	Control Point 2	66.12	65.41
Control Point C #	63.49	59.45	Control Point 2.1 #	64.16	61.80
Control Point C 1 *	61.71	56.25	Control Point 3 *	60.69	56.18
Control Point C 2 ^	58.06	52.32	Control Point 3.1 ^	53.59	48.57
Control Point D	46.70	40.96	Control Point 4	36.22	31.20
Control Point E	42.11	36.37			
Control Point F	34.26	28.52			
Remark: # The control point for the proposed water supply connection point to the Social Welfare Complex in Area (B) * The control point for the proposed water supply connection point to the residential development of Area (A) Phase I ^ The control point for the proposed water supply connection point to the residential development of Area (A) Phase II					

Part 1 - Hydraulic Calculation for Fresh Water Supply System

Design Criteria and Assumption for Fresh Water Supply System

1. Basic Information

Existing Control Point along the Existing Fresh Water Mains from Ha Hang FWSR to DN200 FW Main

Control Point ID	Control Point A	Control Point B	Control Point C	Control Point C1	Control Point C2	Control Point D	Control Point E	Control Point F
Approx. Ground Level (mPD)	4.76	4.57	4.49	5.43	7.57	14.38	16.65	20.67

Note:

- The locations of Control Point refer to **Appendix D**.

Existing Pipe Segment along the Existing Fresh Water Mains from Ha Hang FWSR to DN200 FW Main

Segment Location	from Reservoir to Control Point A	from Control Point A to Control Point B	from Control Point B to Control Point C	from Control Point C to Control Point C1	from Control Point C1 to Control Point C2	from Control Point C2 to Control Point D	from Control Point D to Control Point E	from Control Point E to Control Point F
Approx. Segment Length (m)	1000	100	67	74	132	398	127	210
Size (mm)	600	450	300	300	300	300	200	200
Internal Pipe Diameter (mm)	586	424	282	282	282	282	189	189
Cross Section Area (m2)	0.2697	0.1412	0.0625	0.0625	0.0625	0.0625	0.0281	0.0281

Note:

- The locations of pipe segment refer to **Appendix D**.
- The internal pipe diameter is from Table 1 of WSD's Guidelines for Hydraulic Modeling

2. Water Main Velocity Assumption

- With reference to WSD's Guidelines for Hydraulic Modeling, the existing peak velocity along the existing water main is assumed as below;

Segment Location	from Reservoir to Control Point A	from Control Point A to Control Point B	from Control Point B to Control Point C	from Control Point C to Control Point C1	from Control Point C1 to Control Point C2	from Control Point C2 to Control Point D	from Control Point D to Control Point E	from Control Point E to Control Point F
Existing Peak Velocity (m/s)	2.5	2.0	1.5	1.5	1.5	1.5	1.5	1.5

3. Headloss Assumption

- Hazen-Williams equation is adopted in the hydraulic calculation;
- Hazen-Williams Coefficient, C, is adopted as 110 for water main size < 600mm and 120 for water main size >= 600mm according to WSD's Guidelines for Hydraulic Modeling;
- Minor headloss is assumed to be equal to 10% of friction headloss.

4. Water Main Network Assumption

- 1.5 m cover from the ground level is assumed for the water mains.

Approx. Soffit Level for Control Points

Control Point ID	Control Point A	Control Point B	Control Point C	Control Point C1	Control Point C2	Control Point D	Control Point E	Control Point F
Approx. Ground Level (mPD)	4.76	4.57	4.49	5.43	7.57	14.38	16.65	20.67
Approx. Soffit Level (mPD)	3.26	3.07	2.99	3.93	6.07	12.88	15.15	19.17

- According to WSD comments, the invert level and top Water Head Level of Ha Hang Fresh water Service Reservoir are 76.200mPD and 82.075mPD. Hence, it is assumed that in the design the water level at the service reservoir is at half full which will be $(76.200 \text{ mPD} + 82.075 \text{ mPD}) / 2 = 79.138 \text{ mPD}$

Part 1. Calculation of Residual Head of Fresh Water Main under Existing Condition

(by using Hazen-Williams Equation)

1. Head Loss Equation (Hazen William Equation)

$$V = 0.3564 \times C \times D^{0.63} \times i^{0.54}$$

where

V = Velocity along the pipeline in m/s

C = Hazen-Williams Constant, 110 for D < 600mm, 120 for D ≥ 600mm

D = Diameter of the pipeline in meter

i = Hydraulic Gradient

2. Hydraulic Gradient Equation

$$\text{Hydraulic Gradient} = \frac{\text{Headloss}}{\text{Pipe Length}}$$

3. Headloss and Residual Head Calculation

From Ha Hang Fresh Water Service Reservoir to Control Point A

Parameter	Unit	
Nonimal Pipe Diameter	mm	600
Internal Pipe Diameter, D	mm	586
Assumed Velocity under Peak Flow Condition, v	m/s	2.5
Hazen-William Constant	-	120
Hydraulic Gradient, i		0.00971
Travel Distance	m	1000
Estimated Major Headloss	m	9.71
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.97
Top Water Level at Water Service Reservoir	mPD	79.14
Water Head Level at Control Point A	mPD	68.46
Approx. Ground Level at Control Point A	mPD	4.76
Approx. Soffit Level at Control Point A	mPD	3.26
Residual Head at Control Point A	m	65.20

From Control Point A to Control Point B

Parameter	Unit	
Nonimal Pipe Diameter	mm	450
Internal Pipe Diameter, D	mm	424
Assumed Velocity under Peak Flow Condition, v	m/s	2.0
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01101
Travel Distance	m	100
Estimated Major Headloss	m	1.10
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.11
Water Head Level at Control Point A	mPD	68.46
Water Head Level at Control Point B	mPD	67.25
Approx. Ground Level at Control Point B	mPD	4.57
Approx. Soffit Level at Control Point B	mPD	3.07
Residual Head at Control Point B	m	64.18

From Control Point B to Control Point C

Parameter	Unit	
Nonimal Pipe Diameter	mm	300
Internal Pipe Diameter, D	mm	282
Assumed Velocity under Peak Flow Condition, v	m/s	1.5
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01040
Travel Distance	m	67
Estimated Major Headloss	m	0.70
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.07
Water Head Level at Control Point B	mPD	67.25
Water Head Level at Control Point C	mPD	66.48
Approx. Ground Level at Control Point C	mPD	4.49
Approx. Soffit Level at Control Point C	mPD	2.99
Residual Head at Control Point C	m	63.49

From Control Point C to Control Point C1

Parameter	Unit	
Nonimal Pipe Diameter	mm	300
Internal Pipe Diameter, D	mm	282
Assumed Velocity under Peak Flow Condition, v	m/s	1.50
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01040
Travel Distance	m	74
Estimated Major Headloss	m	0.77
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.08
Water Head Level at Control Point C	mPD	66.48
Water Head Level at Control Point C1	mPD	65.64
Approx. Ground Level at Control Point C1	mPD	5.43
Approx. Soffit Level at Control Point C1	mPD	3.93
Residual Head at Control Point C1	m	61.71

From Control Point C1 to Control Point C2

Parameter	Unit	
Nonimal Pipe Diameter	mm	300
Internal Pipe Diameter, D	mm	282
Assumed Velocity under Peak Flow Condition, v	m/s	1.50
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01040
Travel Distance	m	132
Estimated Major Headloss	m	1.37
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.14
Water Head Level at Control Point C1	mPD	65.64
Water Head Level at Control Point C2	mPD	64.13
Approx. Ground Level at Control Point C2	mPD	7.57
Approx. Soffit Level at Control Point C2	mPD	6.07
Residual Head at Control Point C2	m	58.06

From Control Point C2 to Control Point D

Parameter	Unit	
Nonimal Pipe Diameter	mm	300
Internal Pipe Diameter, D	mm	282
Assumed Velocity under Peak Flow Condition, v	m/s	1.50
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01040
Travel Distance	m	398
Estimated Major Headloss	m	4.14
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.41
Water Head Level at Control Point C2	mPD	64.13
Water Head Level at Control Point D	mPD	59.58
Approx. Ground Level at Control Point D	mPD	14.38
Approx. Soffit Level at Control Point D	mPD	12.88
Residual Head at Control Point D	m	46.70

From Control Point D to Control Point E

Parameter	Unit	
Nonimal Pipe Diameter	mm	200
Internal Pipe Diameter, D	mm	189
Assumed Velocity under Peak Flow Condition, v	m/s	1.50
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01658
Travel Distance	m	127
Estimated Major Headloss	m	2.11
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.21
Water Head Level at Control Point D	mPD	59.58
Water Head Level at Control Point E	mPD	57.26
Approx. Ground Level at Control Point E	mPD	16.65
Approx. Soffit Level at Control Point E	mPD	15.15
Residual Head at Control Point E	m	42.11

From Control Point E to Control Point F

Parameter	Unit	
Nonimal Pipe Diameter	mm	200
Internal Pipe Diameter, D	mm	189
Assumed Velocity under Peak Flow Condition, v	m/s	1.50
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01658
Travel Distance	m	210
Estimated Major Headloss	m	3.48
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.35
Water Head Level at Control Point E	mPD	57.26
Water Head Level at Control Point F	mPD	53.43
Approx. Ground Level at Control Point F	mPD	20.67
Approx. Soffit Level at Control Point F	mPD	19.17
Residual Head at Control Point F	m	34.26

Part 1. Residual Head of Fresh Water Main Under Proposed Condition (with Proposed Development)

(by using Hazen-Williams Equation)

1. Head Loss Equation (Hazen William Equation)

$$V = 0.3564 \times C \times D^{0.63} \times i^{0.54}$$

where

V = Velocity along the pipeline in m/s

C = Hazen-Williams Constant, 110 for D < 600mm, 120 for D ≥ 600mm

D = Internal diameter of the pipeline in meter

i = Hydraulic Gradient

2. Hydraulic Gradient Equation

$$\text{Hydraulic Gradient} = \frac{\text{Headloss}}{\text{Pipe Length}}$$

3. Headloss and Residual Head Calculation

From Ha Hang Fresh Water Service Reservoir to Control Point A

Parameter	Unit	
Nonimal Pipe Diameter	mm	600
Internal Pipe Diameter, D	mm	586
Assumed Velocity under Peak Flow Condition, v	m/s	2.75
Hazen-William Constant	-	120
Hydraulic Gradient, i		0.01161
Travel Distance	m	1000
Estimated Major Headloss	m	11.61
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	1.16
Top Water Level at Water Service Reservoir	mPD	79.14
Water Head Level at Control Point A	mPD	66.37
Approx. Ground Level at Control Point A	mPD	4.76
Approx. Soffit Level at Control Point A	mPD	3.26
Residual Head at Control Point A	m	63.11

From Control Point A to Control Point B

Parameter	Unit	
Nonimal Pipe Diameter	mm	450
Internal Pipe Diameter, D	mm	424
Assumed Velocity under Peak Flow Condition, v	m/s	2.48
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01644
Travel Distance	m	100
Estimated Major Headloss	m	1.64
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.16
Water Head Level at Control Point A	mPD	66.37
Water Head Level at Control Point B	mPD	64.56
Approx. Ground Level at Control Point B	mPD	4.57
Approx. Soffit Level at Control Point B	mPD	3.07
Residual Head at Control Point B	m	61.49

From Control Point B to Control Point C

Parameter	Unit	
Nonimal Pipe Diameter	mm	300
Internal Pipe Diameter, D	mm	282
Assumed Velocity under Peak Flow Condition, v	m/s	2.60
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.02869
Travel Distance	m	67
Estimated Major Headloss	m	1.92
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.19
Water Head Level at Control Point B	mPD	64.56
Water Head Level at Control Point C	mPD	62.44
Approx. Ground Level at Control Point C	mPD	4.49
Approx. Soffit Level at Control Point C	mPD	2.99
Residual Head at Control Point C	m	59.45

From Control Point C to Control Point C1

Parameter	Unit	
Nonimal Pipe Diameter	mm	300
Internal Pipe Diameter, D	mm	282
Assumed Velocity under Peak Flow Condition, v	m/s	2.55
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.02785
Travel Distance	m	74
Estimated Major Headloss	m	2.06
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.21
Water Head Level at Control Point C	mPD	62.44
Water Head Level at Control Point C1	mPD	60.18
Approx. Ground Level at Control Point C1	mPD	5.43
Approx. Soffit Level at Control Point C1	mPD	3.93
Residual Head at Control Point C1	m	56.25

From Control Point C1 to Control Point C2

Parameter	Unit	
Nonimal Pipe Diameter	mm	300
Internal Pipe Diameter, D	mm	282
Assumed Velocity under Peak Flow Condition, v	m/s	1.64
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01231
Travel Distance	m	132
Estimated Major Headloss	m	1.63
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.16
Water Head Level at Control Point C1	mPD	60.18
Water Head Level at Control Point C2	mPD	58.39
Approx. Ground Level at Control Point C2	mPD	7.57
Approx. Soffit Level at Control Point C2	mPD	6.07
Residual Head at Control Point C2	m	52.32

From Control Point C2 to Control Point D

Parameter	Unit	
Nonimal Pipe Diameter	mm	300
Internal Pipe Diameter, D	mm	282
Assumed Velocity under Peak Flow Condition, v	m/s	1.50
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01040
Travel Distance	m	398
Estimated Major Headloss	m	4.14
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.41
Water Head Level at Control Point C2	mPD	58.39
Water Head Level at Control Point D	mPD	53.84
Approx. Ground Level at Control Point D	mPD	14.38
Approx. Soffit Level at Control Point D	mPD	12.88
Residual Head at Control Point D	m	40.96

From Control Point D to Control Point E

Parameter	Unit	
Nonimal Pipe Diameter	mm	200
Internal Pipe Diameter, D	mm	189
Assumed Velocity under Peak Flow Condition, v	m/s	1.50
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01658
Travel Distance	m	127
Estimated Major Headloss	m	2.11
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.21
Water Head Level at Control Point D	mPD	53.84
Water Head Level at Control Point E	mPD	51.52
Approx. Ground Level at Control Point E	mPD	16.65
Approx. Soffit Level at Control Point E	mPD	15.15
Residual Head at Control Point E	m	36.37

From Control Point E to Control Point F

Parameter	Unit	
Nonimal Pipe Diameter	mm	200
Internal Pipe Diameter, D	mm	189
Assumed Velocity under Peak Flow Condition, v	m/s	1.50
Hazen-William Constant	-	110
Hydraulic Gradient, i		0.01658
Travel Distance	m	210
Estimated Major Headloss	m	3.48
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.35
Water Head Level at Control Point E	mPD	51.52
Water Head Level at Control Point F	mPD	47.69
Approx. Ground Level at Control Point F	mPD	20.67
Approx. Soffit Level at Control Point F	mPD	19.17
Residual Head at Control Point F	m	28.52

Part 2 - Hydraulic Calculation for Salt Water Supply System (Flushing Water)

Design Criteria and Assumption for Salt Water Supply System

1. Basic Information

Existing Control Point along the Existing Salt Water Mains from Ha Hang SWSR to DN150 SW Main

Control Point ID	Control Point 1	Control Point 2	Control Point 2.1	Control Point 3	Control Point 3.1	Control Point 4
Approx. Ground Level (mPD)	4.35	4.58	4.59	5.39	7.22	13.41

Note:

- The locations of Control Point refer to **Appendix D**

Existing Pipe Segment along the Existing Salt Water Mains from Ha Hang SWSR to DN150 SW Main

Segment Location	from Reservoir to Control Point 1	from Control Point 1 to Control Point 2	from Control Point 2 to Control Point 2.1	from Control Point 2.1 to Control Point 3	from Control Point 3 to Control Point 3.1	from Control Point 3.1 to Control Point 4
Approx. Segment Length (m)	678	604	51	70	138	293
Size (mm)	450	700	150	150	150	150
Internal Pipe Diameter	424	648	138	138	138	138
Cross Section Area (m ²)	0.1412	0.3298	0.0150	0.0150	0.0150	0.0150

Note:

- The locations of pipe segment refer to **Appendix D**.
- The internal pipe diameter is from Table 1 of WSD's Guidelines for Hydraulic Modeling

2. Water Main Velocity Assumption

- The existing peak velocity along the existing water main is assumed as below;

Segment Location	from Reservoir to Control Point 1	from Control Point 1 to Control Point 2	from Control Point 2 to Control Point 2.1	from Control Point 2.1 to Control Point 3	from Control Point 3 to Control Point 3.1	from Control Point 3.1 to Control Point 4
Existing Peak Velocity (m/s)	1.5	2.0	1.5	1.5	1.5	1.5

3. Headloss Assumption

- Hazen-Williams equation is adopted in the hydraulic calculation;
- Hazen-Williams Coefficient, C, is adopted as 90 for salt water main according to WSD's Guidelines for Hydraulic Modeling;
- Minor headloss is assumed to be equal to 10% of friction headloss.

4. Water Main Network Assumption

- 1.5 m cover from the ground level is assumed for the water mains.

Approx. Soffit Level for Control Points

Control Point ID	Control Point 1	Control Point 2	Control Point 2.1	Control Point 3	Control Point 3.1	Control Point 4
Approx. Ground Level (mPD)	4.35	4.58	4.59	5.39	7.22	13.41
Approx. Soffit Level (mPD)	2.85	3.08	3.09	3.89	5.72	11.91

- According to WSD comments, the invert level and top Water Head Level of Ha Hang Salt Water Service Reservoir are 80.3mPD and 85mPD. Hence, it is assumed that in the design the water level at the service reservoir is at half full which will be $(80.30 \text{ mPD} + 85.00 \text{ mPD}) / 2 = 82.65 \text{ mPD}$

Part 2. Residual Head of Flushing Water Main under Existing Condition

(by using Hazen-Williams Equation)

1. Head Loss Equation (Hazen William Equation)

$$V = 0.3564 \times C \times D^{0.63} \times i^{0.54}$$

where

V = Velocity along the pipeline in m/s

C = Hazen-Williams Constant, 90

D = Internal diameter of the pipeline in meter

i = Hydraulic Gradient

2. Hydraulic Gradient Equation

$$\text{Hydraulic Gradient} = \frac{\text{Headloss}}{\text{Pipe Length}}$$

3. Headloss and Residual Head Calculation

From Ha Hang Salt Water Service Reservoir to Control Point 1

Parameter	Unit	
Nonimal Pipe Diameter	mm	450
Internal Pipe Diameter, D	mm	424
Assumed Velocity under Peak Flow Condition, v	m/s	1.5
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.00937
Travel Distance	m	678
Estimated Major Headloss	m	6.35
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.64
Top Water Level at Water Service Reservoir	mPD	82.65
Water Head Level at Control Point 1	mPD	75.66
Approx. Ground Level at Control Point 1	mPD	4.35
Approx. Soffit Level at Control Point 1	mPD	2.85
Residual Head at Control Point 1	m	72.81

From Control Point 1 to Control Point 2

Parameter	Unit	
Nonimal Pipe Diameter	mm	700
Internal Pipe Diameter, D	mm	648
Assumed Velocity under Peak Flow Condition, v	m/s	2.0
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.00973
Travel Distance	m	604
Estimated Major Headloss	m	5.88
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.59
Water Head Level at Control Point 1	mPD	75.66
Water Head Level at Control Point 2	mPD	69.20
Approx. Ground Level at Control Point 2	mPD	4.58
Approx. Soffit Level at Control Point 2	mPD	3.08
Residual Head at Control Point 2	m	66.12

From Control Point 2 to Control Point 2.1

Parameter	Unit	
Nonimal Pipe Diameter	mm	150
Internal Pipe Diameter, D	mm	138
Assumed Velocity under Peak Flow Condition, v	m/s	1.5
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.03470
Travel Distance	m	51
Estimated Major Headloss	m	1.77
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.18
Water Head Level at Control Point 2	mPD	69.20
Water Head Level at Control Point 2.1	mPD	67.25
Approx. Ground Level at Control Point 2.1	mPD	4.59
Approx. Soffit Level at Control Point 2.1	mPD	3.09
Residual Head at Control Point 2.1	m	64.16

From Control Point 2.1 to Control Point 3

Parameter	Unit	
Nonimal Pipe Diameter	mm	150
Internal Pipe Diameter, D	mm	138
Assumed Velocity under Peak Flow Condition, v	m/s	1.5
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.03470
Travel Distance	m	70
Estimated Major Headloss	m	2.43
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.24
Water Head Level at Control Point 2.1	mPD	67.25
Water Head Level at Control Point 3	mPD	64.58
Approx. Ground Level at Control Point 3	mPD	5.39
Approx. Soffit Level at Control Point 3	mPD	3.89
Residual Head at Control Point 3	m	60.69

From Control Point 3 to Control Point 3.1

Parameter	Unit	
Nonimal Pipe Diameter	mm	150
Internal Pipe Diameter, D	mm	138
Assumed Velocity under Peak Flow Condition, v	m/s	1.5
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.03470
Travel Distance	m	138
Estimated Major Headloss	m	4.79
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.48
Water Head Level at Control Point 3	mPD	64.58
Water Head Level at Control Point 3.1	mPD	59.31
Approx. Ground Level at Control Point 3.1	mPD	7.22
Approx. Soffit Level at Control Point 3.1	mPD	5.72
Residual Head at Control Point 3.1	m	53.59

From Control Point 3.1 to Control Point 4

Parameter	Unit	
Nonimal Pipe Diameter	mm	150
Internal Pipe Diameter, D	mm	138
Assumed Velocity under Peak Flow Condition, v	m/s	1.5
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.03470
Travel Distance	m	293
Estimated Major Headloss	m	10.17
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	1.02
Water Head Level at Control Point 3.1	mPD	59.31
Water Head Level at Control Point 4	mPD	48.13
Approx. Ground Level at Control Point 4	mPD	13.41
Approx. Soffit Level at Control Point 4	mPD	11.91
Residual Head at Control Point 4	m	36.22

Part 2. Residual Head of Flushing Water Main under Proposed Condition (with Proposed Development)

(by using Hazen-Williams Equation)

1. Head Loss Equation (Hazen William Equation)

$$V = 0.3564 \times C \times D^{0.63} \times i^{0.54}$$

where

V = Velocity along the pipeline in m/s

C = Hazen-Williams Constant, 90

D = Internal diameter of the pipeline in meter

i = Hydraulic Gradient

2. Hydraulic Gradient Equation

$$\text{Hydraulic Gradient} = \frac{\text{Headloss}}{\text{Pipe Length}}$$

3. Headloss and Residual Head Calculation

From Ha Hang Salt Water Service Reservoir to Control Point 1

Parameter	Unit	
Nonimal Pipe Diameter	mm	450
Internal Pipe Diameter, D	mm	424
Assumed Velocity under Peak Flow Condition, v	m/s	1.56
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.01010
Travel Distance	m	678
Estimated Major Headloss	m	6.85
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.69
Top Water Level at Water Service Reservoir	mPD	82.65
Water Head Level at Control Point 1	mPD	75.11
Approx. Ground Level at Control Point 1	mPD	4.35
Approx. Soffit Level at Control Point 1	mPD	2.85
Residual Head at Control Point 1	m	72.26

From Control Point 1 to Control Point 2

Parameter	Unit	
Nonimal Pipe Diameter	mm	700
Internal Pipe Diameter, D	mm	648
Assumed Velocity under Peak Flow Condition, v	m/s	2.03
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.00997
Travel Distance	m	604
Estimated Major Headloss	m	6.02
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.60
Water Head Level at Control Point 1	mPD	75.11
Water Head Level at Control Point 2	mPD	68.49
Approx. Ground Level at Control Point 2	mPD	4.58
Approx. Soffit Level at Control Point 2	mPD	3.08
Residual Head at Control Point 2	m	65.41

From Control Point 2 to Control Point 2.1

Parameter	Unit	
Nonimal Pipe Diameter	mm	150
Internal Pipe Diameter, D	mm	138
Assumed Velocity under Peak Flow Condition, v	m/s	2.09
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.06421
Travel Distance	m	51
Estimated Major Headloss	m	3.27
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.33
Water Head Level at Control Point 2	mPD	68.49
Water Head Level at Control Point 3	mPD	64.89
Approx. Ground Level at Control Point 3	mPD	4.59
Approx. Soffit Level at Control Point 3	mPD	3.09
Residual Head at Control Point 2.1	m	61.80

From Control Point 2.1 to Control Point 3

Parameter	Unit	
Nonimal Pipe Diameter	mm	150
Internal Pipe Diameter, D	mm	138
Assumed Velocity under Peak Flow Condition, v	m/s	2.06
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.06261
Travel Distance	m	70
Estimated Major Headloss	m	4.38
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.44
Water Head Level at Control Point 2.1	mPD	64.89
Water Head Level at Control Point 3	mPD	60.07
Approx. Ground Level at Control Point 3	mPD	5.39
Approx. Soffit Level at Control Point 3	mPD	3.89
Residual Head at Control Point 3	m	56.18

From Control Point 3 to Control Point 3.1

Parameter	Unit	
Nonimal Pipe Diameter	mm	150
Internal Pipe Diameter, D	mm	138
Assumed Velocity under Peak Flow Condition, v	m/s	1.58
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.03803
Travel Distance	m	138
Estimated Major Headloss	m	5.25
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	0.52
Water Head Level at Control Point 3	mPD	60.07
Water Head Level at Control Point 3.1	mPD	54.29
Approx. Ground Level at Control Point 3.1	mPD	7.22
Approx. Soffit Level at Control Point 3.1	mPD	5.72
Residual Head at Control Point 3.1	m	48.57

From Control Point 3.1 to Control Point 4

Parameter	Unit	
Nonimal Pipe Diameter	mm	150
Internal Pipe Diameter, D	mm	138
Assumed Velocity under Peak Flow Condition, v	m/s	1.50
Hazen-William Constant	-	90
Hydraulic Gradient, i		0.03470
Travel Distance	m	293
Estimated Major Headloss	m	10.17
Minor Headloss (Extra 10% of Estimated Major Headloss)	m	1.02
Water Head Level at Control Point 3.1	mPD	54.29
Water Head Level at Control Point 4	mPD	43.11
Approx. Ground Level at Control Point 4	mPD	13.41
Approx. Soffit Level at Control Point 4	mPD	11.91
Residual Head at Control Point 4	m	31.20

