MTR Corporation Limited

Consultancy Agreement No. NEX/2102 Express Rail Link Preliminary Design for XRL Tunnels & Associated Structures

Working Paper No. 40

Sewerage Impact Assessment for Environmental Impact Assessment Study
Southern Package

January 2009

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DRAWINGS AND FIGURES

APPENDICES

List of Abbreviations

AAJV	Arup-Atkins Joint Venture
ACL	Atkins China Ltd
AEL	Airport Express Line
ARUP	Ove Arup & Partners HK Ltd
BD	Buildings Department
CEDD	Civil Engineering and Development Department
CLP	China Light and Power
DSD	Drainage Services Department
DSM	MTRCL Design Standard Manual
EAP	Emergency Access Point
EEP	Emergency Evacuation Point
EIA	Environmental Impact Assessment
ERS	Emergency Rescue Station
EVA	Emergency Vehicular Access
GEO	Geotechnical Engineering Office
GIU	Geotechnical Information Unit
HGV	Huang Gang Park Ventilation Building (VB0)
HKSAR	Hong Kong Special Administrative Region
HTW	Hoi Ting Road Works Area
HyD	Highways Department
KCV	Kwai Chung Ventilation Building (VB6)
KSL	Kowloon Southern Link
KTW	Kam Tin Road Works Area
LKM	Lam Kam Road Magazine
MD	Marine Department
MKV	Mong Kok West Ventilation Building (VB8)
MLW	Mei Lai Road Works Area
MPV	Mai Po Ventilation Building (VB1)
MTRCL	MTR Corporation Limited
NAC	Nam Cheong Station
NB	North Bound Track
NCB	Nam Cheong Barge Point
NCV	Nam Cheong Ventilation Building (VB7)
NPW	Nam Cheong Park Works Area

NTV	Ngau Tam Mei Ventilation Building (VB2)
PHV	Pat Heung Ventilation Building (VB4)
PLA	Peoples Liberation Army
RCB	Rambler Channel Barge Point
RDO	Railway Development Office
SB	South Bound Track
SKM	So Kwun Wat Magazine
SSS	Shek Kong Stabling Sidings
SLB	Siu Lam Barge Point
SMV	Shing Mun Ventilation Building (VB5)
SYW	Shek Yam Works Area
TCL	Tung Chung Line
TMB	Tuen Mun Barge Point
TPV	Tai Kong Po Ventilation Building (VB3)
TUW	Tse Uk Tsuen Works Area
TWL	Tsuen Wan Line
URA	Urban Redevelopment Authority
VB	Ventilation Building
WKT	West Kowloon Terminus
WR	West Rail Line
WSD	Water Supplies Department
X310	Huang Gang Park to Mai Po Tunnels
X311	Mai Po to Ngau Tam Mei Tunnels
X312	Ngau Tam Mei to Tai Kong Po Tunnels
X313	Tai Kong Po to ERS Tunnels
X314	ERS to Tse Uk Tsuen Tunnels
X315	Tse Uk Tsuen to Shek Yam Tunnels
X316	Shek Yam to Mei Lai Road Tunnels
X317	Mei Lai Road to Nam Cheong Tunnels
X318	Nam Cheong to Mongkok West Tunnels
XRL	Express Rail Link

1 Introduction

1.1 Proponent's Requirement

A request has been made by the Mass Transit Railway Corporation Limited (MTRCL) to prepare Sewerage Impact Assessment (SIA) Report(s) which would form part of the Environmental Impact Assessment for approval by the EPD, as required, in connection with both planning approvals and engineering requirements.

1.2 Background

The project comprises approximately 27km of tunnel from the Huang Gang Ventilation Shaft (HGV) north of the boundary between the Shenzhen Special Economic Zone (Shenzhen SEZ) and the Hong Kong Special Administrative Region (Hong Kong SAR) to a new terminus station in West Kowloon. The project includes eight ventilation buildings, two ventilation adits and six ventilation shafts, an Emergency Rescue Station, the Shek Kong Stabling Sidings with an integrated first line maintenance facility and other associated buildings and facilities. The system will carry long-haul services to numerous destinations in the Mainland as well as shuttle services to various locations in the Pearl River Delta.

The Preliminary Design alignment runs from approximately 150m north of the Shenzhen River, the boundary between the Shenzhen SEZ and the Hong Kong SAR, to the new terminus station in West Kowloon.

This SIA Study is for the railway alignment's southern section from the southern slopes of Tai Mo Shan (Chainage 131+500) to the northern end of the West Kowloon Terminus (WKT) (Chainage 140+500) as shown in Drawing No. NEX2102/P/000/AAV/C14/702.

1.3 Scope of SIA Study

This SIA Study assesses the impact that the southern section of the proposed railway alignment, from the southern slopes of Tai Mo Shan (Chainage 131+500) to the northern end of the West Kowloon Terminus (WKT) (Chainage 140+500), will have on the existing and committed sewerage system of the area. This working paper has been organized as follows:

- Section 2 presents the overall description of the existing catchment area and introduces the extend of the study area;
- Section 3 presents the design assumption and criteria made in estimating the sewage flow;
- Section 4 presents the sewage flow figures generated by the proposed railway works, the planning year studied and provides the corresponding projected population and sewage flow figures for the existing sewerage network;
- Section 5 describes the existing and committed sewerage infrastructure studied under this project;
- Section 6 indentifies any adverse impacts on the existing sewerage infrastructure due to the railway works, and investigates the necessity sewerage improvement works; and
- Section 7 summaries the assessment findings and conclusions.

2 Sewerage Catchment Area

2.1 Overall Description

The southern section of the proposed XRL railway alignment falls into the Tsuen Wan Catchment and West Kowloon Catchment. Figure extract from the "Review of West Kowloon and Tsuen Wan Sewerage Mater Plan" showing these catchments is attached in Appendix A for reference. The relevant sewerage basins for Tsuen Wan Catchment are Tsuen Wan Basin and Kwai Chung Basin. While the relevant sewerage basins for West Kowloon Catchment includes Lai Chi Kok Basin, Sham Shui Po Basin and Yau Ma Tei Basin. Sewage generated within these catchments is conveyed to the Stonecutters Island Sewage Treatment Works for the treatment.

2.2 Study Area

Sewage generated from the southern section of the proposed railway alignment will be discharged to the public sewers at four discharge points which are the four ventilation buildings. The foul sewage would eventually go to Stonecutters Island Sewage Treatment Works via different sewerage facilities such as pumping station, screening plant, preliminary treatment work etc.

After reviewing the sewerage systems based on the sewerage record plans collected from DSD, the sewers and sewerage facilities which may be potentially impacted by the XRL works are listed in Table 2.1.

Table 2.1 Sewerage System and facilities which may be potentially impacted by the XRL permanent works for the southern section of the proposed railway alignment

Ventilation Building	Affected Sewers	Relevant Sewerage Facilities
VB5	Cheung Shan Estate Road West	Tsuen Wan Sewage Pumping Station, Kwai Chung Preliminary Treatment Works
VB6	Wing Yip Street	Kwai Chung Industrial Wastewater Pumping Station, Kwai Chung Preliminary Treatment Works
VB7	Sham Mong Road	Cheung Sha Wan Sewage Screening Plant & Sewage Pumping Station
VB8	Hoi Ting Road	Anchor Street Sewage Pumping Station, Sham Shui Po No. 2 Sewerage Screening Plant, Cheung Sha Wan Sewage Screening Plant & Sewage Pumping Station

3 Design Assumption and Criteria

There are two major sources of sewage generated from the southern section of the proposed railway alignment. They are the toilet sanitary wastewater and floor drainage generated at the ventilation buildings and the foul water from the tunnel and adit foul water drainage system.

3.1 Design Assumptions and Criteria

This SIA has been carried out based on the guideline set out in the DSM, Sewerage Manual (SM) Part 1 (DSD, 1995) and Plumbing Engineering Services Design Guide. A copy of Plumbing Engineering Services Design Guide is attached in Appendix B as reference.

3.1.1 Ventilation Buildings

The toilet sanitary waste and floor drainage generated at the ventilation buildings are classified as foul water under the DSM. The ventilation buildings will be provided with a foul water drainage system that will collect foul water flows generated at the ventilation buildings for conveyance and discharge to the public sewerage system.

As the DSM does not cover the foul water discharge estimation for this kind of development, Plumbing Engineering Services Design Guide is adopted for this study. The discharge rate for each appliance within the ventilation building is extracted from the Plumbing Engineering Services Design Guide and is listed in Table 3.1 below.

Table 3.1 Foul Water Discharge Rate for Appliance of the Ventilation Building

Appliance	Discharge Unit (l/s)
Wash Basin	0.3
WC	1.8
Floor Drain	0.3 (assumed)

3.1.2 Railway Tunnel and Ventilation Adit

Under the DSM, the foul water is defined as the groundwater seepages through the tunnel structures, fire protection water discharges and track washdown flows. The discharge rate of such foul water is shown in Table 3.2.

Table 3.2 Foul Water Discharge Rate for Tunnel Foul Water

Type of Foul Water	Foul Water Discharge Rate	DSM Clause
Fire Protection Water	15 l/s	7.8.2.2.3(b)
Groundwater Seepages	1.5 l/m/day	4.9.3.9
Track Washdown Flow	7 l/s	4.9.3.11

The foul water drainage system comprises a drainage trackform surface drainage system that will convey foul water discharges to a foul water carrier drainage system. The foul water discharges will be conveyed to foul water line sumps at the lowest point of the tunnel alignment and be further conveyed via pressurised mains through the ventilation adits for discharge to the public sewerage system. VB5 and VB8 are the outlets for these pressurised mains for the southern section of the proposed railway alignment. Oil interceptors will be required at VB5 and VB8 to remove any oil contaminants from the railway tunnel and ventilation adit foul water discharges that are pumped to ground level at these ventilation buildings.

4 DEVELOPMENT AND FLOW PROJECTIONS

4.1 Flow Data for the Study Area

As described in Section 2.1, the southern section of the proposed XRL railway alignment falls into the Tsuen Wan and Northwest Kowloon Catchment. The Sewerage Master Plan (SMP) for these two catchments: Tsuen Wan, Kwai Chung and Tsing Yi Sewerage Master Plan (1998) and North West Kowloon Sewerage Master Plan (1992) were developed over ten years ago. Most of the information stated in the SMP is outdated. Population and land uses are changed over the past 10 years, and some recent developments have not been covered by the SMP. As such, EPD launched a Review of West Kowloon and Tsuen Wan Sewerage Mater Plan in 2006. The study is currently still in progress and expected to be completed in September 2009.

Due to lack of flow data in SMP, Sewage Treatment Division 2 (ST2) of DSD was approached for the latest flow data, such as the existing flow data of the affected sewerage facilities as listed in Table 4.1, to facilitate the sewerage impact assessment.

Table 4.1 Existing Flow Rate of Each Affected Sewerage Facility

Sewerage Facilities	Existing Flow Rate (m^3/s)
Tsuen Wan Sewage Pumping Station,	1.04
Kwai Chung Industrial Wastewater Pumping Station	0.35
Kwai Chung Preliminary Treatment Works	2.31
Cheung Sha Wan Sewage Screening Plant & Sewage Pumping Station	3.59
Anchor Street Sewage Pumping Station	0.97
Sham Shui Po No. 2 Sewerage Screening Plant	3.13
Stonecutters Island Sewage Treatment Works	16.20

4.2 Flow Generated by the XRL Works

4.2.1 Ventilation Buildings

The major foul water generated at the ventilation buildings is toilet sanitary wastewater and floor drainage. As there is a basement for the ventilation building VB5, VB7 and VB8, a pump sump would be provided at the basement to collect the foul water from floor drain. The foul water would then be pumped to the ground level for discharge. Foul water generated at these three ventilation buildings is listed in Table 4.2, with detailed calculations given in Appendix C.

Table 4.2 Foul Water Discharge Rate for the Foul Water Drainage System for VB5, VB7 & VB8

Ventilation Building	toilet sanitary wastewater (l/s)	Floor Drainage (l/s)	Total from Ventilation Building (l/s)
VB5	1.5	3	4.5
VB7	1.5	3	4.5

VB8	1.5	3	4.5

The toilet sanitary wastewater for all ventilation buildings and the floor drains foul water for VB6 will be discharged to the public sewerage system by gravity. Assumed all the appliances will not be in use simultaneously the total foul water generated is 1.8l/s and the calculation is given in Appendix C.

4.2.2 Railway Tunnel and Ventilation Adit

As discussed in Section 3.1.2, the foul water from the railway tunnel and ventilation adit mainly consists of groundwater seepages through the tunnel structures, fire protection water discharges and track washdown flow. The fire protection water, at a flow rate of 15 litres/second, is the largest of these discharges and is the design flow adopted for the tunnel foul water drainage system.

A design pump rate of 17 litres/second is employed for the foul water line sumps. It implies that foul water from the railway tunnel and ventilation adit will be discharged at a flow rate of 17 litres/second to the public sewerage system via outlets at VB5 and VB8.

4.2.3 Estimated Flow from the Southern Section of the Proposed Railway Alignment

Estimated foul water generated from the southern section of the proposed railway alignment and to be discharged to the public sewerage system are listed in Table 4.3.

Table 4.3 Foul Water Discharge Rate from the Southern Section of the Proposed XRL Railway Alignment

Ventilation Building	Discharge From the Ventilation Building (l/s)	Discharge From the Tunnel Foul Drainage System (l/s)	Total Discharge Rate to the Public Sewerage System (l/s)
VB5	4.5	17	21.5
VB6	1.8	N/A	1.8
VB7	4.5	N/A	4.5
VB8	4.5	17	21.5

5 Existing And Committed Sewerage Infrastructure

5.1 Sewerage System

Drawing No.NEX2102/P/000/AAV/D06/775 to 778 show the proposed foul water drainage system at the corresponding ventilation building for the southern section of the proposed railway alignment and the proposed connections with the public sewerage system, to be made via a sewage terminal manhole at the ventilation building boundary. Oil interceptors will be required at VB5 and VB8 to remove any oil contaminants from the railway tunnel and ventilation adit foul water discharges that are pumped to ground level at these ventilation buildings. Table 5.1 below provides details of the proposed connection between the ventilation building foul water system and the existing public sewerage.

Table 5.1 Ventilation Building Foul Water Connections with the Existing Sewerage System

Ventilation Building	Location of Public Drainage Connection Point	Manhole / Access Point Reference	Downstream pipe diameter (mm)
VB5	Cheung Shan Estate Road West, Shing Mun	FMH4020455	225
VB6	Wing Yip Street, Kwai Chung	FMH4021617	225
VB7	Sham Mong Road,	FMH4018395	300
VB8	Lai Cheung Road, Mong Kok	FMH4011937	225

5.2 Sewerage Treatment Facilities

As described in Section 2.2, sewage from the permanent works of the southern section of the proposed XRL railway alignment will be conveyed by the existing sewerage systems via sewerage facilities to the Stonecutters Island Sewage Treatment Works for treatment.

The relevant sewerage facilities and their corresponding capacities are listed in Table 5.2.

Table 5.2 Capacity of Each Existing Sewerage Facility

Sewerage Facility	Design Capacity of Each Facility (m^3/s)
Tsuen Wan Sewage Pumping Station,	4.80
Kwai Chung Industrial Wastewater Pumping Station	10.00
Kwai Chung Preliminary Treatment Works	5.23
Cheung Sha Wan Sewage Screening Plant & Sewage Pumping Station	3.15
Anchor Street Sewage Pumping Station	9.00
Sham Shui Po No. 2 Sewerage Screening Plant	14.72
Stonecutters Island Sewage Treatment Works	19.97

The data of the sewerage facilities capacity is provided by ST2 of DSD as the “Review of West Kowloon and Tsuen Wan Sewerage Mater Plans" is still in progress.

6 Sewerage Impact Assessment

6.1 Performance Assessment for Sewerage System

Hydraulic analysis has been carried out on the basis of sewerage record plans collected from DSD. As tabled in Table 4.3, additional flows from the southern section of the XRL railway alignment will be discharged into DSD manholes reference FMH4020455, FMH4021617, FMH4018395 and FMH4011937 respectively. The capacity check for the existing sewer is listed in table 6.1 below and the detail calculation is given in Appendix D.

Table 6.1 Foul Water Discharges to Public Sewerage

Water Discharge Location	Railway Tunnel Foul Water Discharges (l/s)	Details of Downstream Sewer			Percentage of Capacity of Existing Sewer used to Receive Tunnel Foul Water Discharges
		Size	Gradient	Pipe-Full Capacity (m^3/s)	
VB5	21.5	225	1 in 24	0.08	25.7%
VB6	1.8	225	1 in 26	0.08	2.3%
VB7	4.5	300	1 in 184	0.06	7%
VB8	21.5	225	1 in 56	0.05	40%

As shown in Table 6.1 above, for VB6, the discharge of the tunnel foul water drainage system to the existing public sewerage occupies only around 2% of the available capacity of the existing sewer. Therefore it is rational to assume that the impact to its associated existing sewerage system is very limited, and the existing sewer can have adequate spare capacity to accommodate these additional flows generated at VB6.

For VB5, VB7 and VB8, further performance assessment was carried out. As the hydraulic models for Tsuen Wan Catchment and North West Kowloon Catchment are still under development, baseline condition of the affected sewerage system is assessed based on the sewerage record plans collected from DSD and the unit flow factors stated in Table 4 of SM.

The sub-catchment of the immediate downstream public sewer, to receive discharges from VB5, covers Sau Shan House and Tsuen Wan Lutheran School. Sau Shan House is one of the three buildings in Cheung Shan Estate which is public rental housing constructed nearly 30 years ago by Housing Authority. Since there is no reconstruction plan for the site at the moment, the change upon population associated with the estate is estimated to be limited. As a result, the current population stated by Housing Authority is used for the assessment. While Tsuen Wan Lutheran School is a primary school currently with approximately 800 students and staffs. Appendix D gives the estimation of the existing flow rate for this sub-catchment in details.

The sub-catchment of the immediate downstream public sewer, to receive discharges from VB7, covers Ying Wa College and Ying Wa Primary School. The schools currently contain approximately 2500 students and staffs. Appendix D provides the estimation of the existing flow rate for this sub-catchment in details.

The sub-catchment of the immediate downstream public sewer, to receive discharges from VB8, is Tai Kok Tsui Ventilation Station which is one of the ventilation stations for Tung

Chung Line. The foul water discharge rate is assumed to be the same as the maximum discharge from the ventilation buildings under XRL.

The performance assessment results for VB5, VB7 and VB8 are listed in Table 6.2 below.

Peak flows are used in the assessment of hydraulic adequacy of the sewerage system within the catchment. The global peaking factors including stormwater allowance (Table 3 in SM) and roughness coefficient, ks of 3mm (Table 5 in SM) are used for this assessment study.

Table 6.2 Assessment of Additional Foul Water Discharges to Public Sewerage System against the Baseline Condition

Water Discharge Location	Railway Tunnel Foul Water Discharges (l/s)	Existing Flow Rate (l/s)	Details of Downstream Sewer		Spare Capacity of Downstream Sewer
			Size	Pipe-Full Capacity (l/s)	
VB5	21.5	46	225	80	16%
VB7	4.5	4	300	60	86%
VB8	21.5	21.5	225	50	14%

It shows that the existing sewerage system can cope with additional sewerage flows introduced by the construction of the XRL.

6.2 Performance Assessment for Sewerage Facilities

The existing and design capacity of the relevant sewerage facilities is listed in Table 5.2 according to the data provided by ST2 of DSD. With the proposed railway works, the flow increased at each sewerage facilities is listed in Table 6.3.

Table 6.3 Assessment of Additional Foul Water Discharges to the Relevant Sewerage Facilities

Sewerage Facilities	Relevant VB	Additional Flow (m^3/s)	Percentage of Capacity of Existing Sewerage Facilities used to Receive Tunnel Foul Water Discharges
Tsuen Wan Sewage Pumping Station,	VB5	0.022	0.46
Kwai Chung Industrial Wastewater Pumping Station	VB6	0.002	0.03
Kwai Chung Preliminary Treatment Works	VB5 & VB6	0.023	0.46
Cheung Sha Wan Sewage Screening Plant & Sewage Pumping Station	VB7 & VB8	0.026	0.83
Anchor Street Sewage Pumping Station	VB8	0.022	0.02
Sham Shui Po No. 2 Sewerage Screening Plant	VB8	0.022	0.15

Stonecutters Island Sewage Treatment Works	VB5 to VB8	0.050	0.25

As shown in Table 6.3 above, discharges of the tunnel foul water drainage systems to the existing public sewerage systems occupy less than 1% of the available capacity of all the existing sewerage facilities (the detail calculation is given in Appendix D). It is concluded that all the existing and committed sewerage facilities have an adequate capacity to cater for the additional sewerage flows generated by the southern section of the XRL together with those from the Tsuen Wan Catchment and North West Kowloon Sewerage Catchment.

7 Conclusions

7.1 Conclusions

There are two major sources of sewage generated from the southern section of the proposed railway alignment. They are the toilet sanitary wastewater and floor drainage generated at the ventilation buildings and the foul water from the tunnel and adit foul water drainage system. The foul water generated would be discharged to the public sewage system. As a result, the impact on the existing sewer and sewerage facilities is assessed under this report to be in line with DSD and EPD's requirements for the proposed XRL works.

The EPD's Sewerage Master Plan (SMP) was obtained and reviewed. It is identified that the southern section of the proposed XRL works falls into two catchments named Tsuen Wan Catchment and North West Kowloon Catchment. The sewer and sewerage facilities potentially impacted by the railway works are identified based on the record plans provided by DSD.

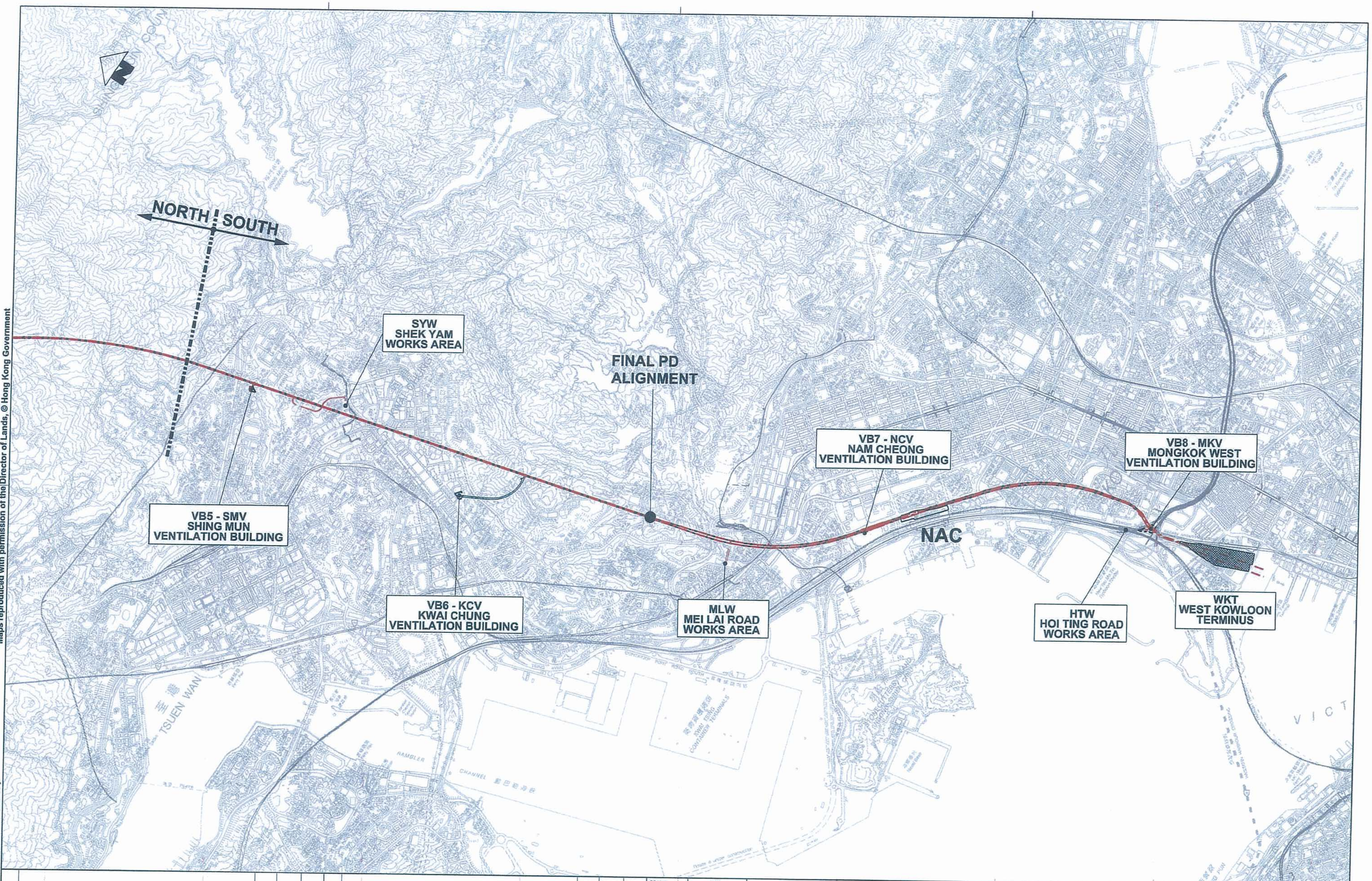
The foul water flows generated by the proposed railway works were estimated based on the guideline set out in the DSM, Sewerage Manual (SM) Part 1 (DSD, 1995) and Plumbing Engineering Services Design Guide.

The existing flows for the sewer and sewerage facilities are required for the sewerage impact assessment. As the SMP obtained was carried out 10 years ago and the study of "Review of West Kowloon and Tsuen Wan Sewerage Master Plan" is still in progress, the existing sewer flows are estimated based on the current situation of upstream sub-catchments and the existing flow data for the sewerage facilities obtained from the ST2 of DSD.

The downstream sewers of the four discharge locations and the relevant sewerage facilities for the southern section of the proposed railway alignment were then assessed. The result indicates that the existing capacities of the sewerage systems would be adequate to convey the flows generated by the XRL permanent works together with the existing flows.

It is concluded that no adverse impact would be caused on the existing sewerage systems by the proposed southern section of XRL works, and no any improvement or mitigation works are required in general.

Drawings



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TITLE

NEX-2102
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SOUTHERN SECTION RAILWAY ALIGNMENT
PROPOSED RAILWAY WORKS
SHEET 2 OF 2

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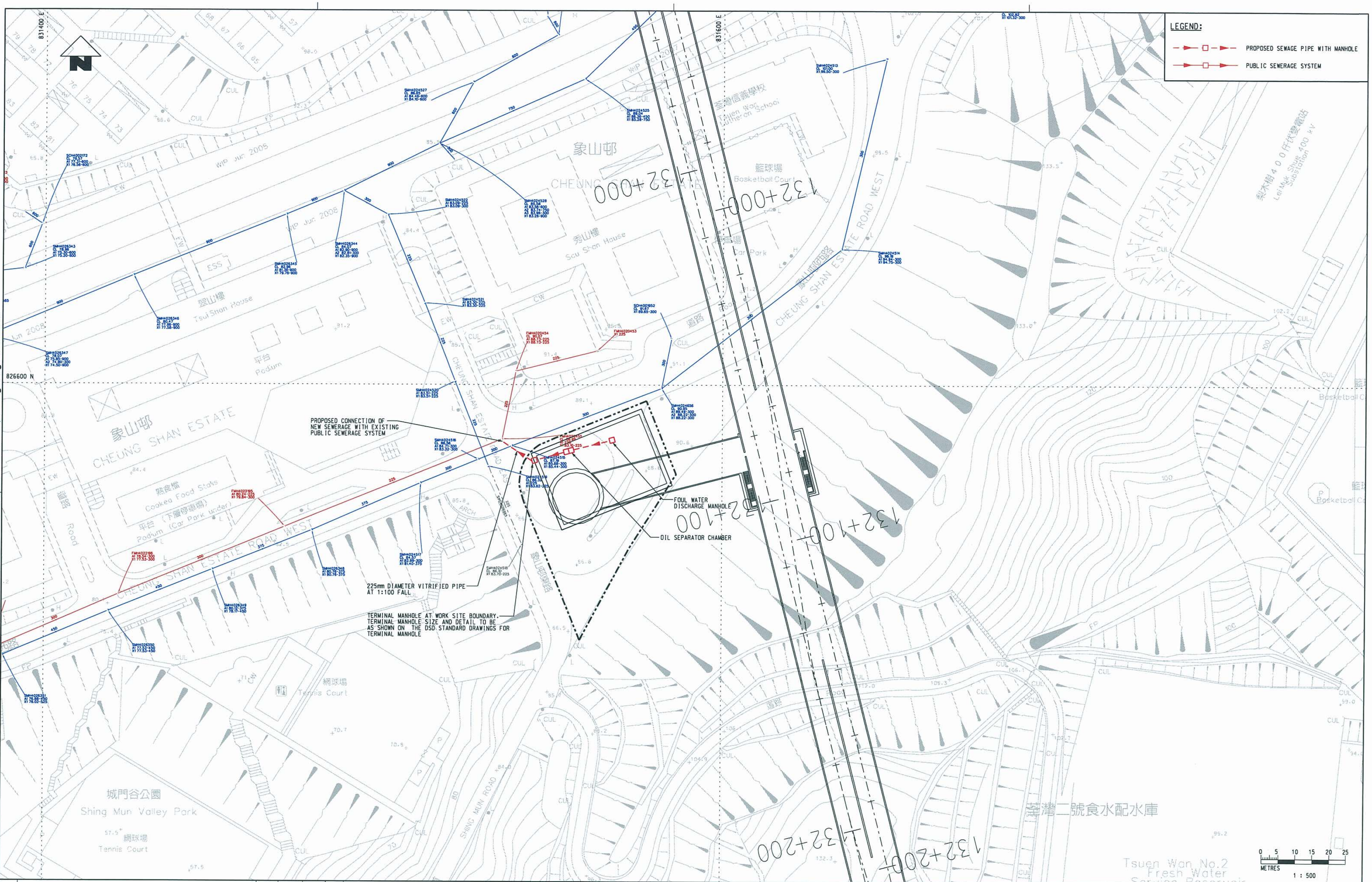

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TITLE

NEX-2102
PRELIMINARY DESIGN
VB5 - SMV
SHING MUN VENTILATION BUILDING-
PROPOSED FOUL WATER DRAINAGE

SCALE 1 : 500 (A1)

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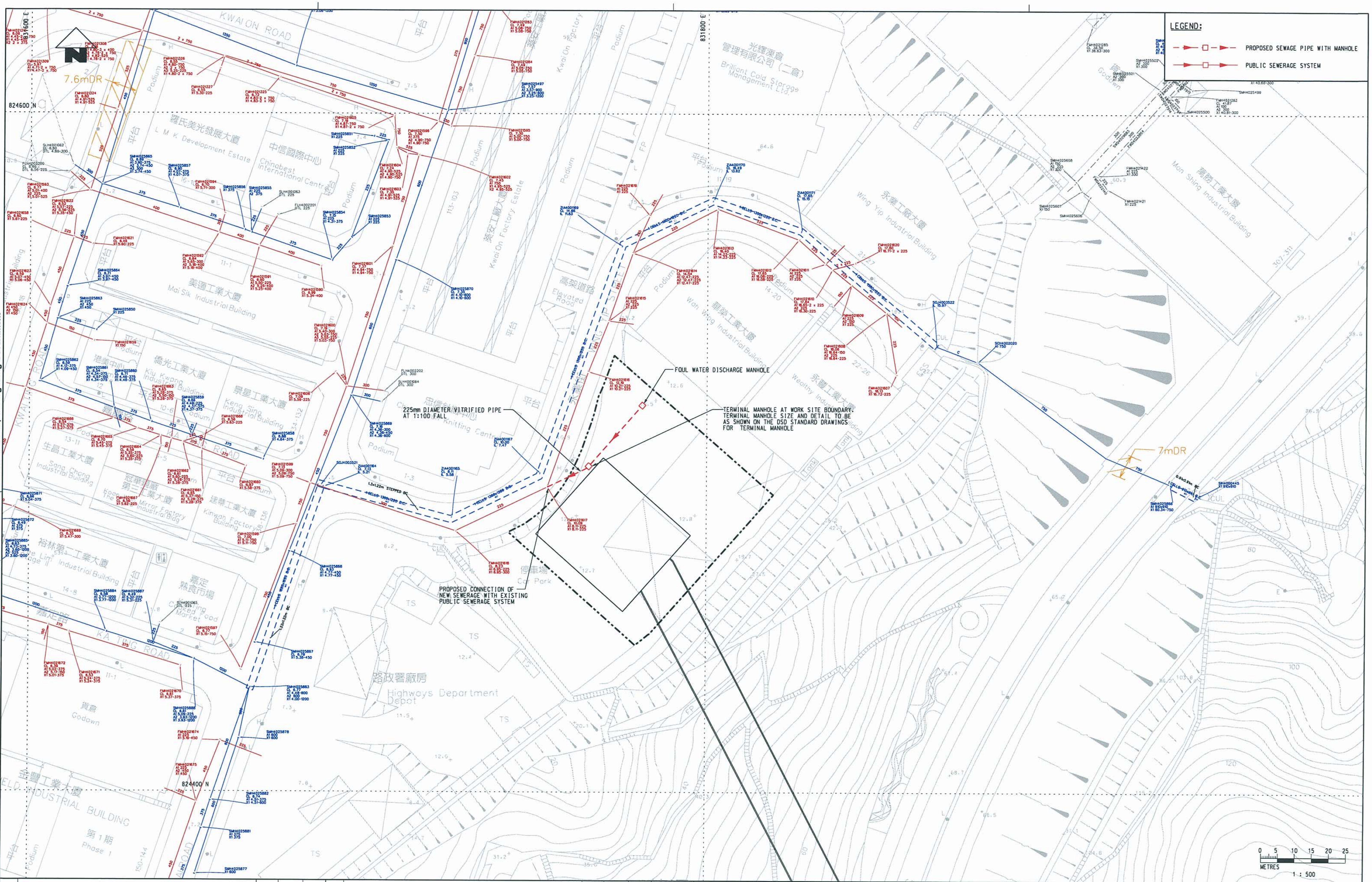

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TITLE

NEX-2102
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VB6 - KCV
KWAI CHUNG VENTILATION BUILDING-
PROPOSED FOUL WATER DRAINAGE

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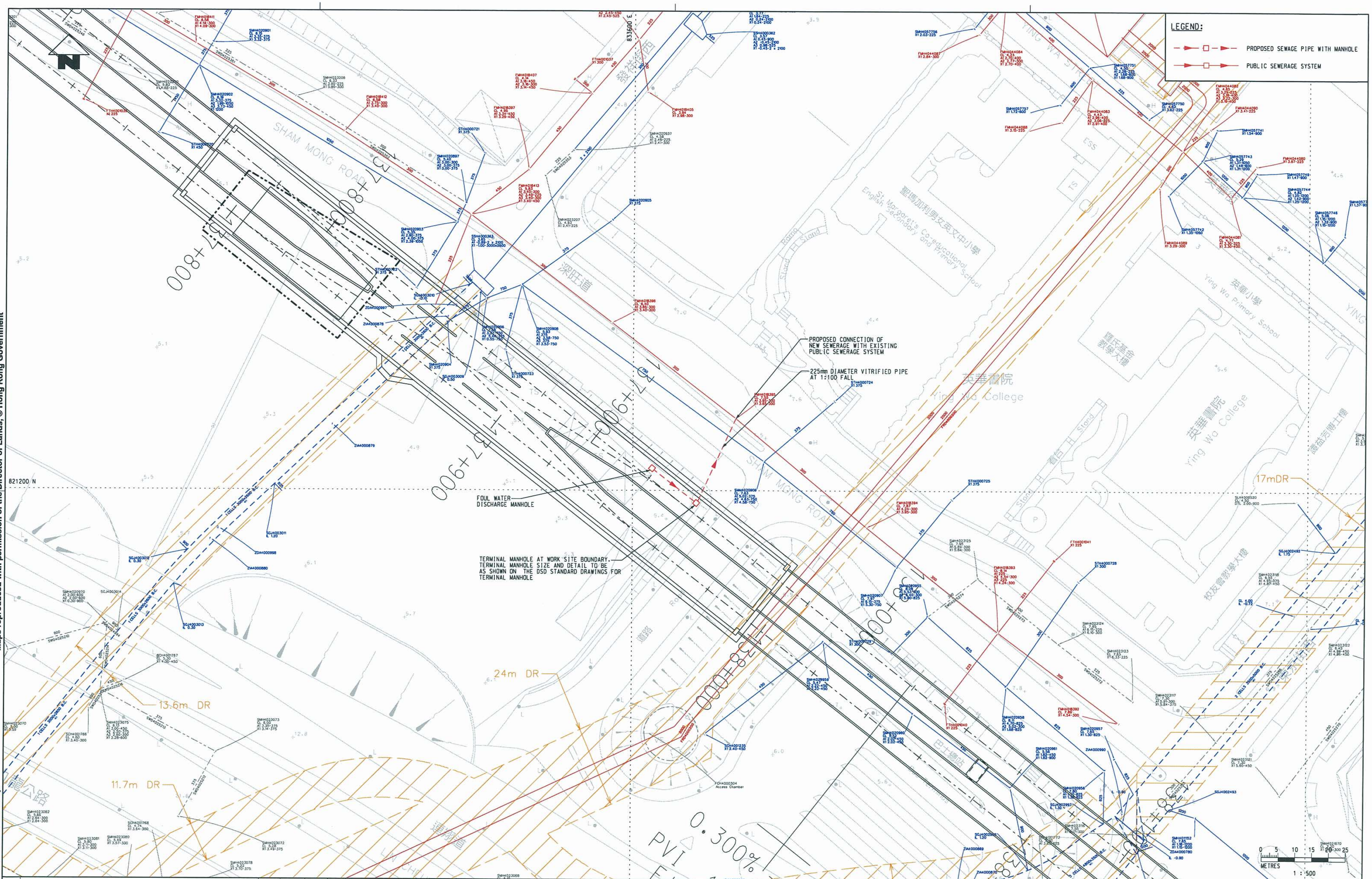

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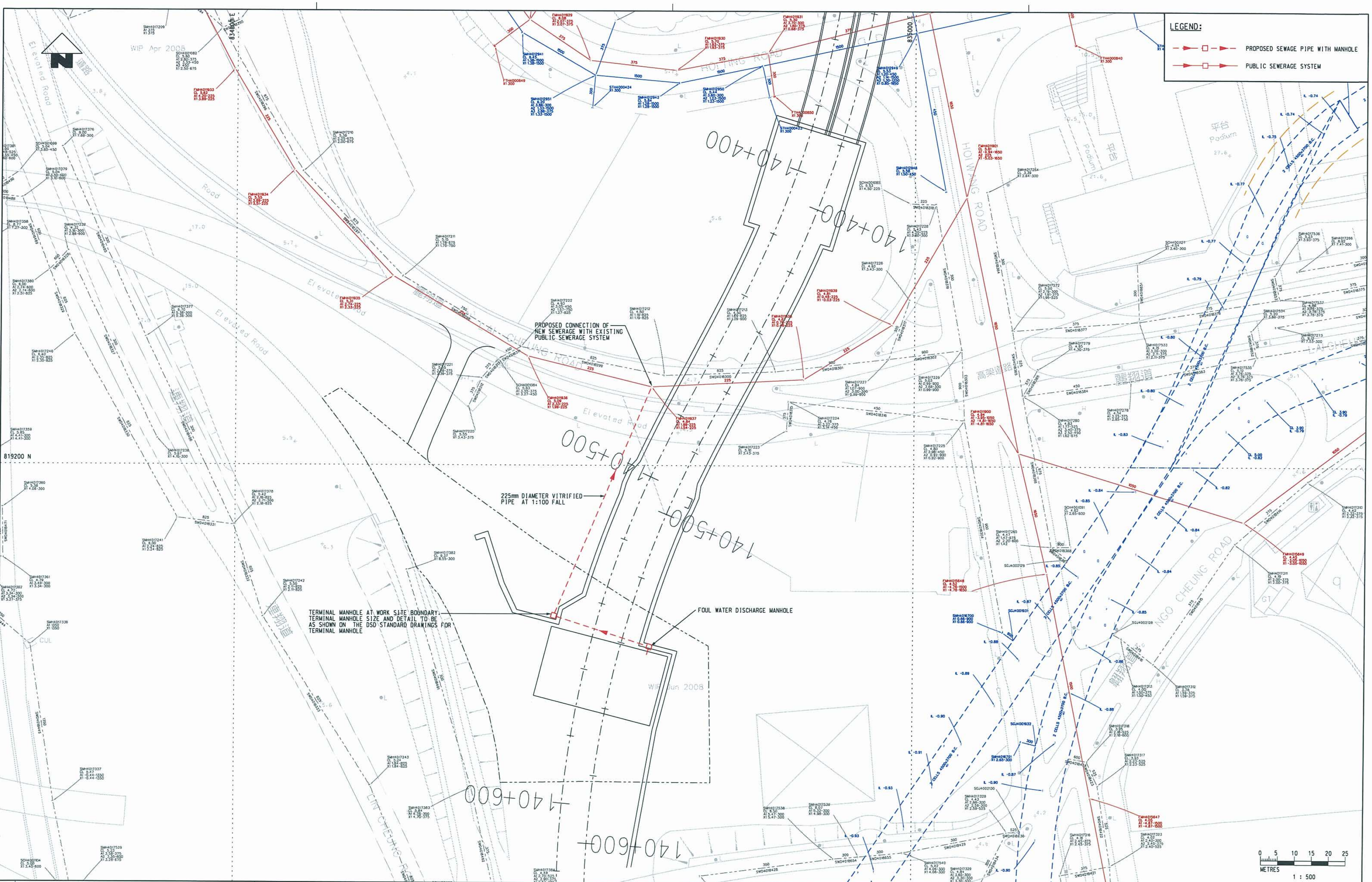
TITLE

NEX-2102
PRELIMINARY DESIGN
VB7 - NCV
NAM CHEONG VENTILATION BUILDING-
PROPOSED FOUL WATER DRAINAGE

SCALE 1 : 500 (A1)

DRAWING NO. NEX2102/P/000/AAV/C14/777

REV. A



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DESIGNED	PL
CHECKED	AL
APPROVED	JM
DATE	24/NOV/2008

REV	DESCRIPTION	BY	DATE	APPROVED
A	PRELIMINARY DESIGN STAGE (FINAL)	LW	24NOV08	JM

MTR

EXPRESS RAIL LINK

ORIGINATOR

Arup Atkins JV

Supported by TFP Farrells, DLS, SIYUAN, Knight Frank, Team 73

CADD REF. NEX2102_P_000_AAV_C14_778A.dgn

TITLE

NEX-2102
PRELIMINARY DESIGN
VB8 - MWV
MONGKOK WEST VENTILATION BUILDING-
PROPOSED FOUL WATER DRAINAGE

SCALE 1 : 500 (A1)

DRAWING NO. NEX2102/P/000/AAV/C14/778

REV. A

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Appendix A

Tsuen Wan and West Kowloon Sewerage Catchment

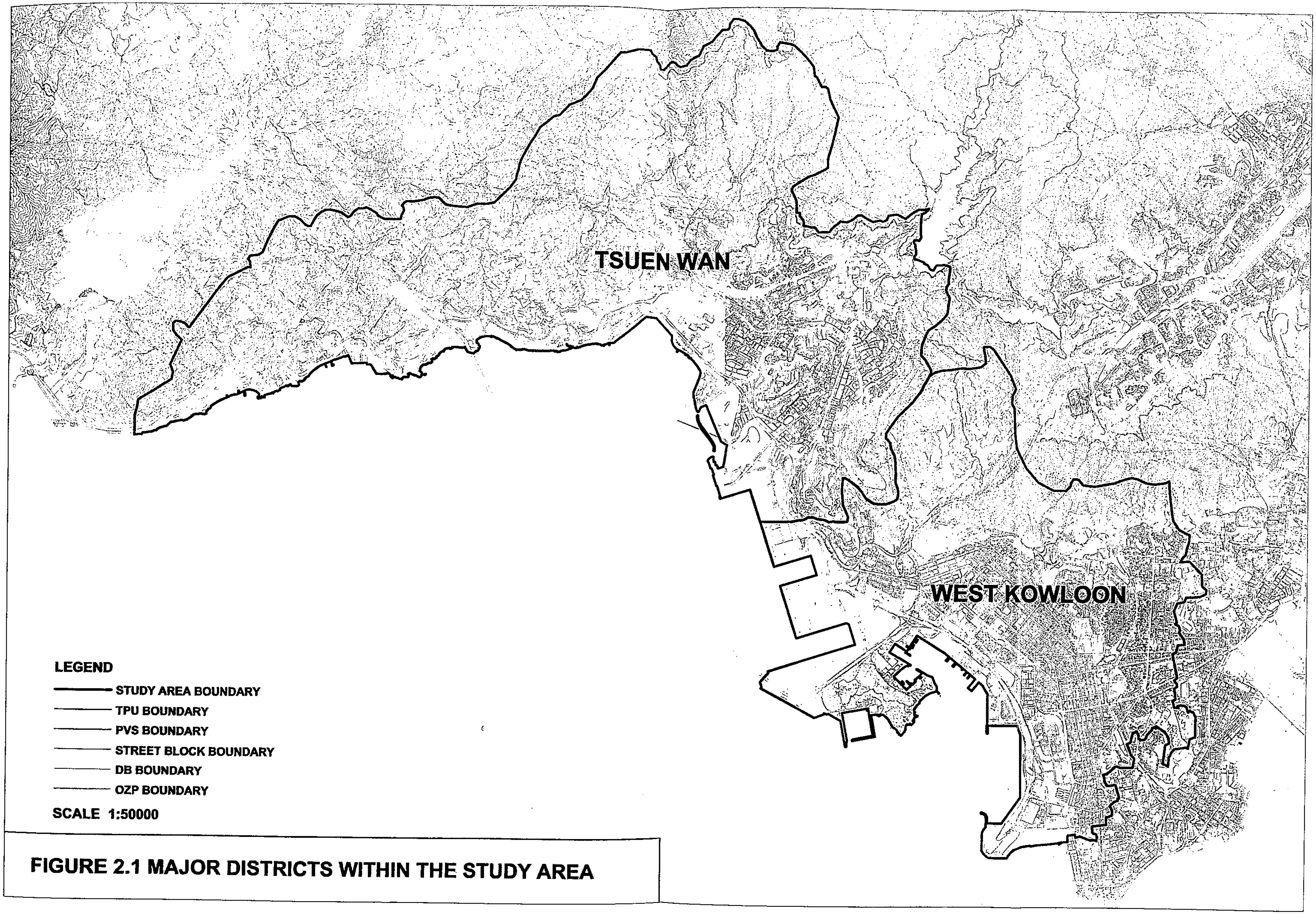

FIGURE 2.1 MAJOR DISTRICTS WITHIN THE STUDY AREA

Appendix B

Plumbing Engineering Services Design Guide

Not all sanitary appliances will be in simultaneous use. The peak design flow can be assessed by applying a frequency of use K factor (see Table 6) to the total sum of the discharge units, and by using the following equation:

$$Qww = K\sqrt{\sum DU}$$

Where:

Q_{ww} = Wastewater flow rate (l/s)

K = Frequency of use

$\sum DU$ = Sum of discharge units

Before the stack selection can be made, any other continuous or fixed flow must be added to the Qww value. The following equation explains further:

$$Q_{tot} = Q_{ww} + Q_c + Q_p$$

Where:

Q_{tot} = Total flowrate (l/s)

Q_{ww} = Wastewater flowrate (l/s)

Q_c = Continuous flowrate (l/s)

Q_p = Pumped flowrate (l/s)

Once the Q_{tot} value has been obtained, a decision about the stack size, and ventilation principle can be made by referring to Table 7 and 8. The pipe sizes relate to the pipe bores which have traditionally been used in the UK. The theoretical minimum bore for 50, 75, 100 and 150 sizes is 44, 75, 96, and 146mm respectively. Both Table 4 and 5 are based on 'swept entry' equal branches, which are required in the UK.

Table 5

Appliance	DU (L/s)
Wash basin or bidet	0.3
Shower without plug	0.4
Shower with plug	1.3
Single urinal with cistern	0.4
Slab urinal (per person)	0.2
Bath	1.3
Kitchen sink	1.3
Dishwasher (household)	0.2
Washing machine (6kg)	0.6
Washing machine (12kg)	1.2
WC with 6 l cistern	1.2 – 1.7
WC with 7.5 l cistern	1.4 – 1.8
WC with 9 l cistern	1.6 – 2.0

The Water Regulations & Byelaws in the UK do not allow the use of 7.5 or 9 litre WC flushing cisterns on new installations, the information is provided for use in connection with existing systems.

Table 6

Usage of appliances	K
Intermittent use, e.g. dwelling, guesthouse, office	0.5
Frequent use, e.g. hotel, restaurant, school, hospital	0.7
Congested use, e.g. toilets and/or showers open to the public	1.0
Special use, e.g. laboratory	1.2

Table 7 Maximum capacity of PRIMARY ventilated discharge stacks

Min. stack & vent I.D.	Litres/sec
75mm*	2.6
100mm	5.2
150mm	12.4

** No WC's allowed on 75mm stacks*

Table 8 Maximum capacity of SECONDARY ventilated discharge stacks

Min. stack & vent I.D.		Litres/sec
Stack & vent	Vent	
75mm*	50mm	3.4
100mm	50mm	7.3
150mm	50mm	18.3

** No WC's allowed on 75mm stacks*

Example 1

Determine total design flowrate and stack requirements for an 11-storey block of apartments. The each stack will serve one apartment per floor, comprising of bathroom, en-suite shower room and fully fitted kitchen.

DU per flat:

2 WC's x 1.7 =	3.4
2 wash basins x 0.3 =	0.6
1 bath =	1.3
1 shower =	0.4
1 kitchen sink =	1.3
1 washing machine =	0.6
1 dishwasher =	0.2
	7.8

Assume a primary ventilated stack is adequate; therefore the bottom storey must connect separately to drain (see Figure 5).

For 10 storeys, $\sum DU$: 7.8 x 10 = 78

K = 0.5, so $Q_{ww} = 0.5\sqrt{78} = 4.42$l/s

Q_c & Q_p = zero, so $Q_{tot} = 4.42$l/s

From Table 7, a 100mm primary ventilated stack has a limit of 5.2l/s, so this size is adequate. Secondary ventilation is not required.

Example 2

Determine total design flowrate and stack requirements for an 11-storey hotel. The stack will serve two en-suite bathrooms on each floor; there will be air conditioning units on the roof with a peak discharge of 0.2L/s, and laundry equipment on the 5th floor with a peak discharge of 0.5l/s.

DU per typical floor:

2 WC's x 1.7 =	3.4
2 wash basins x 0.3 =	0.6
2 baths x 1.3 =	2.6
	6.6

Assume a primary ventilated stack is adequate; therefore the bottom storey must connect separately to drain (see Figure 5).

For 10 storeys, $\sum DU$: 6.6 x 10 = 66

K = 0.7, so $Q_{ww} = 0.7\sqrt{66} = 5.7$l/s

Q_{tot}: 5.7 + 0.2 + 0.5 = 6.4l/s

There are two options; a 150mm primary ventilated stack, or a 100mm secondary ventilated stack and 50mm secondary vent. Practical considerations would dictate the best choice, for example a proprietary fitting such as the collar boss (see Figure 19) is only available in the 100mm size.

Self-sealing waste valves

The recent introduction to the plumbing market of waste valves to replace the water seal trap offers the installer an opportunity to reconsider his system design, often reducing the amount of pipework required, whilst still meeting the mandatory requirement of Building Regulation ADH.1. These valves and their function are described in Figures 22 to 26.

As the name suggests, these valves open to allow the flow of water from the appliance, or to allow air to enter the pipework system in the case of negative pressure, then closes automatically when the flow stops or the pipework system pressure reaches eqilibrium with atmosphere.

This means that a system fitted with valves in place of water seal traps would be self-ventilating.

The valves are designed to open between 3 and 6mb and will remain sealed against 400+mb back pressure.

These valves are particularly useful for situations where water seals would be lost by evaporation – for example, holiday homes, condensate drains from chillers and air conditioning units. (See manufacturers' detailed instructions.)

The valves are available in 32mm (1¼") and 40mm (1½") body size, together with 87½° knuckle elbow and running adaptor. Universal compression outlets are used for making connections to either push fit BS 5254 or solvent weld BS 5255 waste systems.

Appendix C

Calculation for Foul Water Flow Generated by the XRL Works

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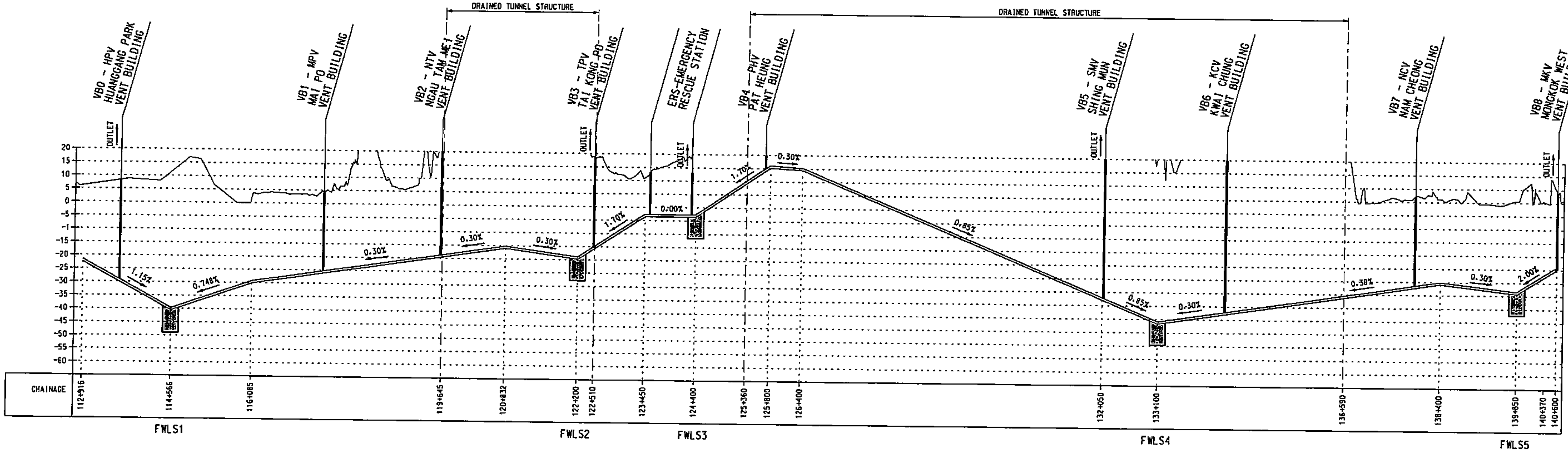

LEGEND:

FOUL WATER LINE SUMP

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					A	PRELIMINARY DESIGN STAGE (FINAL)	LW	24NOV08	JM

DRAWN	LW
DESIGNED	PL
CHECKED	RS
APPROVED	JM
DATE	24/NOV/2008

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EXPRESS RAIL LINK

ORIGINATOR

Arup Atkins JV

Supported by TFP Farrells, DLS, SIYUAN, Knight Frank, Team 73

CADD REF. NEX2102_P_000_AAV_C14_744A.dgn

TITLE
NEX-2102
PRELIMINARY DESIGN

SCHEMATIC OF RAILWAY TUNNEL FOUL WATER DRAINAGE

SCALE N/A

DRAWING NO. NEX2102/P/000/AAV/C14/744

REV. A

ARUP

Job No.	Sheet No.	Rev.
		FPD

Member/Location

Drg. Ref.

Made by RC Date 2008-12-01 Chd.

Job Title NEX-2102 Express Rail Link

Calculation Calculation for Foul Water Discharge at Each Ventilation Building

Operation Hour	19
Storage capacity (Hour)	24

Frequency of use *	Usage per hour	Loading unit (LU)
Low	3	1
Medium	6	2
High	12	4

* According to Plumbing Engineering Services Design Guide

Tunnel Foul Water Drainage System

Designation No.	Sump Location	Outlet Location	Floor Drain *		Total Discharge (L/s)	@Inflow rate (L/s)	Design Pump rate (L/s)
			No. of FD	Discharge Unit (L/s)			
Tunnel Foul Water Drainage	TUNNEL AT 133 + 100	VB 5	N/A	N/A	15	7.5	8.5
Tunnel Foul Water Drainage	TUNNEL AT 139 + 850	VB 8	N/A	N/A	15	7.5	8.5

Ventilation Building (Southern Section of XRL)

Designation No.	Location	Foul Water Generated from Ventilation Builsing			Total Discharge (L/s)
		WC (L/s)	Washbasin (L/s)	**Floor Drain	
Ventilation Building Gravity Foul Water Syste	VB5	1.8	0.3	N/A	1.5
Ventilation Building Gravity Foul Water Syste	VB6	1.8	0.3	1.2	1.8
Ventilation Building Gravity Foul Water Syste	VB7	1.8	0.3	N/A	1.5
Ventilation Building Gravity Foul Water Syste	VB8	1.8	0.3	N/A	1.5

Designation No.	Sump Location	Outlet Location	Floor Drain *		Total Discharge (L/s)	@Inflow rate (L/s)	Design Pump rate (L/s)
			No. of FD	Discharge Unit (L/s)			
Ventilation Building Floor Drainage	VB 5	VB 5	13	0.3	3.9	1.0	3
Ventilation Building Floor Drainage	VB 7	VB 7	9	0.3	2.7	0.8	3
Ventilation Building Floor Drainage	VB 8	VB 8	11	0.3	3.3	0.9	3

Total Discharge at Ventilation Building

Discharge Location	Tunnel Foul Water Drainage System	Ventilation Building Gravity Foul Water	Ventilation Building Floor Drainage	Total Discharge (L/s)
VB5	17	1.5	3	21.5
VB6	N/A	1.8	N/A	1.8
VB7	N/A	1.5	3	4.5
VB8	17	1.5	3	21.5

\# Required Tank Capacity = No. of Fitments x Loading Unit * Operation Hour

** Floor Drain to gravity system and Total Discharge = $\sqrt{}$WC + Wahbasin + Fllor Drain

* No. of Fitment is count as if it connects to Sump tank

@ Inflow rate for ventilation building = 0.5 x $\sqrt{}$Total Discharge; 2 duty pump will be provided for tunnel foul water sump pits so Inflow rate is half of the total discharge

Appendix D

Performance Assessment for Sewerage System

Appendix D
Assessment of Railway Works Foulwater Discharges to the Public Sewerage Systems

Kinematic Viscosity, n = 0.000001141 m^2/sec @ 20°C

V = $-2(2gDS)^{1/2} \log [K_s/3.7D + 2.51n/D(2gDS)^{1/2}]$ (Colebrook-White)

Description of Flow Discharge	Railway Structure Design Discharge Flows	Proposed Connection Point on Public Drainage / Sewerage System	Hydraulic Capacity Assessment of Existing Public Stormwater Drain and Sewer Proposed for Connection to Receive Railway Structures Groundwater and Foulwater Discharges											Design Flow Discharge / Connecting Drain Capacity
			Connecting Conduit Size	Connecting Drain Description	Hydraulic Roughness Coefficient	Upstream Invert Level	Downstream Invert Level	Conduit Length	Conduit Gradient		Cross-sectional Area of Flow	Velocity of Flow	Drain Capacity, Qo	
	(m^3/sec)		(mm)			(mPD)	(mPD)	(m)	(m/m)	(1-in)	(m^2)	(m/sec)	(m^3/sec)	(%)
All wastewater from VB5 to Public Sewerage	0.0215	FMH4020455	225	VC	3	83.10	80.24	68	0.042	24	0.04	2.10	0.08	25.72
All wastewater from VB6 to Public Sewerage	0.0018	FMH4021617	225	VC	3	8.11	6.95	30	0.039	26	0.04	2.02	0.08	2.25
All wastewater from VB7 to Public Sewerage	0.0045	FMH4018395	300	VC	3	3.65	3.40	46	0.005	184	0.07	0.92	0.06	6.95
All wastewater from VB8 to Public Sewerage	0.0215	FMH4011937	225	VC	3	1.54	0.76	44	0.018	56	0.04	1.36	0.05	39.65

Appendix D
Assessment of Railway Works Foulwater Discharges to the Public Sewerage Systems

Sewage Flow Rate for Upstream Catchment

Description of Flow Discharge	Landuse Type	Population	Global Unit Flow Factor (DSD SM Table 2)	Global Unit Flow Factor	Total Flow Rate			Remarks
			(m^3/day/person)	DSD SM Table 3	(m^3/day)	(m^3/s)	(l/s)	
Upstream Catchment for VB5	Public Housing	2500	0.3	5	3750	0.0434	43.40	Total population is 5500 for Cheung Shan Housing Estate which included three buildings with similar populations.
	School	800	0.025	8	160	0.0019	1.85	
						Total:	45.25	
Upstream Catchment for VB7	School	2500	0.025	6	375	0.0043	4.34	
Upstream Catchment for VB8	Ventilation Building	-	-	-	-	0.0215	21.50	Assume the discharge is same as the maximum foul water discharge rate for XRL

Spare Capacity of Downstream Sewer

Water Discharge Location	Railway Tunnel Foul Water Discharges	Existing Flow Rate (l/s)	Details of Downstream Sewer		Spare Capacity of Downstream Sewer
	(l/s)		Size	Pipe-Full Capacity (l/s)	
VB5	21.5	46	225	80	16%
VB7	4.5	4	300	60	86%
VB8	21.5	21.5	225	50	14%

Appendix D
Assessment of Railway Works Foulwater Discharges to the Public Sewerage Systems

Capacity Check for Relevant Sewerage Facilities

Sewerage Facilities	Existing Flow Rate		Design Capacity		Additional Flow from VBs	Percentage of Capacity of Existing Sewerage Facilities used to Receive Tunnel Foul Water Discharges	Percentage of Spare Capacity for Existing Sewerage Facilities
	(m^3/day)	(m^3/s)	(m^3/day)	(m^3/s)	(m^3/s)	%	%
Tsuen Wan Sewage Pumping Station,	30,000	0.35	414,720	4.80	0.022	0.46	92.31
Kwai Chung Industrial Wastewater Pumping Station	200,000	2.31	864,000	10.00	0.003	0.03	76.82
Kwai Chung Preliminary Treatment Works	90,000	1.04	451,872	5.23	0.024	0.46	79.62
Cheung Sha Wan Sewage Screening Plant & Sewage Pumping Station	84,194	0.97	272,160	3.15	0.026	0.83	68.24
Anchor Street Sewage Pumping Station	270,144	3.13	7,877,600	91.18	0.022	0.02	96.55
Sham Shui Po No. 2 Sewerage Screening Plant	310,509	3.59	1,271,808	14.72	0.022	0.15	75.44
Stonecutters Island Sewage Treatment Works	1,400,000	16.20	1,725,000	19.97	0.050	0.25	18.59

Hong Kong Housing Authority

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Property Location and Profile

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Cheung Shan Estate, Tsuen Wan, New Territories & Islands

Type of Estate:	Public Rental Housing
Year of Intake:	1978
Type(s) of Block(s):	Old Slab, Twin Tower
No. of Blocks:	3
Name of Block(s):	Lok Shan House Sau Shan House Tsui Shan House
No. of Rental Flats:	1 600
Flat Size (m^2):	33.1 - 54.9
No. of Households:	1 600 as at end December 200
Authorized Population:	5 500 as at end December 200
Estate Management Advisory Committee (EMAC)	Formed
District Tenancy Management Office/ Estate Office:	Tsuen Wan District Tenancy Management Office Podium, Wing C, Kwai Shue House, Lei Muk Shue (2) Estate, Kwai Chung. Telephone: 2423 7680 Fax: 2423 6854
Property Management:	Good Yield Property Managem Ltd Cheung Shan Estate Office G/F, Sau Shan House, Cheung Shan Estate, Tsuen Wan Telephone: 2493 5227 Fax: 2415 3770
Carpark Management:	Wilson Parking (Hong Kong) Limited Room 2901, Metroplaza, Towe Hing Fong Road, Kwai Chung, N.T. Tel: 2487 6138 Fax: 2428 6026 Hot Line:2402 3052 Web site: www.wilsonparking.com.hk E-mail: wcho@wilsonparking.com.hk
Estate Website:	-
Further Information:	-