

Drainage Impact Assessment for Proposed Residential Care Home for the Elderly (RCHE) Development at Tung Tsz, Tai Po

C241003W-02-D

PREPARED FOR

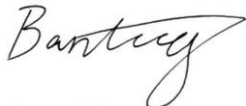
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A handwritten signature in black ink, appearing to read 'Banting'.

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18 November 2025

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1. Background

The applicant, R Lee Architect, intends to develop one 10-storey building block situated at Tung Tsz, Tai Po, New Territories for the Proposed Residential Care Home for the Elderly (RCHE) Development.

The purpose of this report is to conduct a Drainage Impact Assessment (DIA) to assess the potential drainage impact arising from the proposed development.

2. Objective

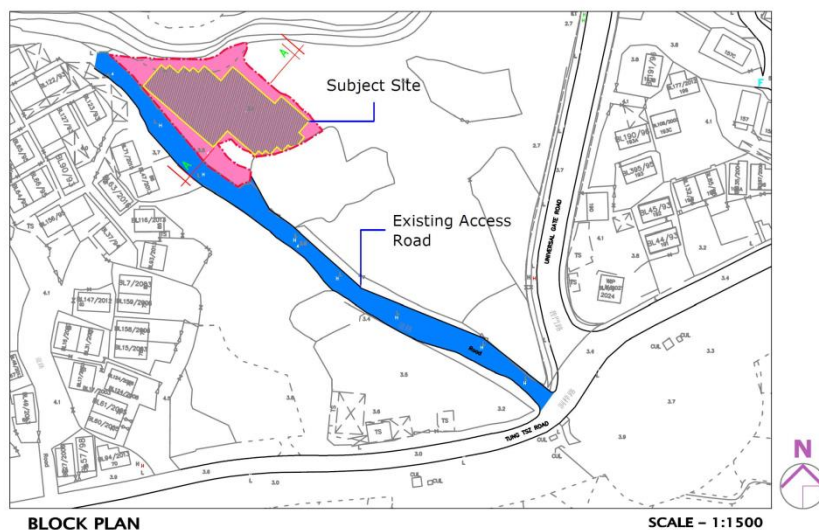
These DIA objectives are to assess the potential drainage impact arising from the proposed development and recommend mitigation measures, if necessary, to alleviate the impacts.

3. Site Information

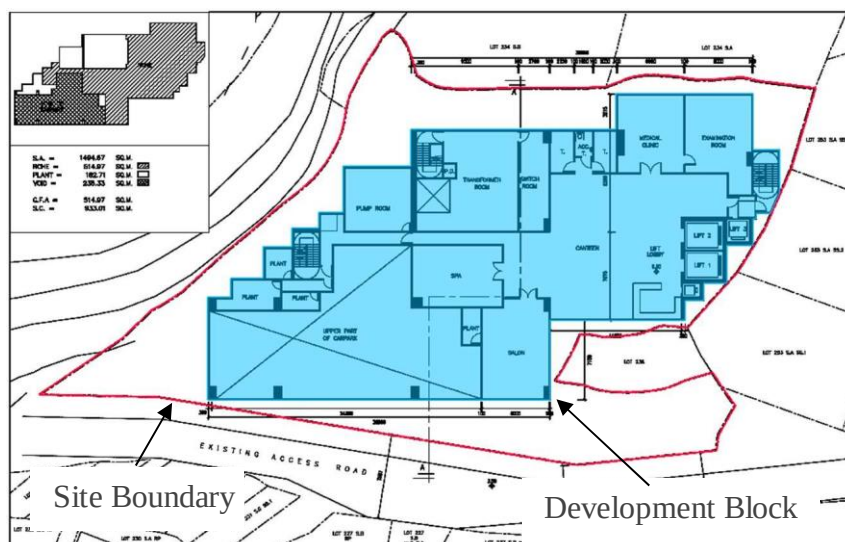
The D.D.23, Lot 232RP, 232 S.A. RP, 232 S.A.ss. 1 to 14, 232 S.B. RP, 232
Premise: S.B. ss 1 to 2, 232 S.C. to 232 S.E., 233 RP, 233 S.A to 233 S.M., 237
S.R. 238, 239 RP, 239 SG.

Address: Tung Tsz, Tai Po

**Location
Plan:**



Development Plan:



Development Schedule:

Site Area: 1,476.48m²

Class of Site: A

Proposed Plot Ratio for Non-domestic: 4.11 < 7.4

Proposed Site Coverage above for Non-domestic (Above 15m): 63.19% < 92%

Proposed Building Height: 27.50mPD

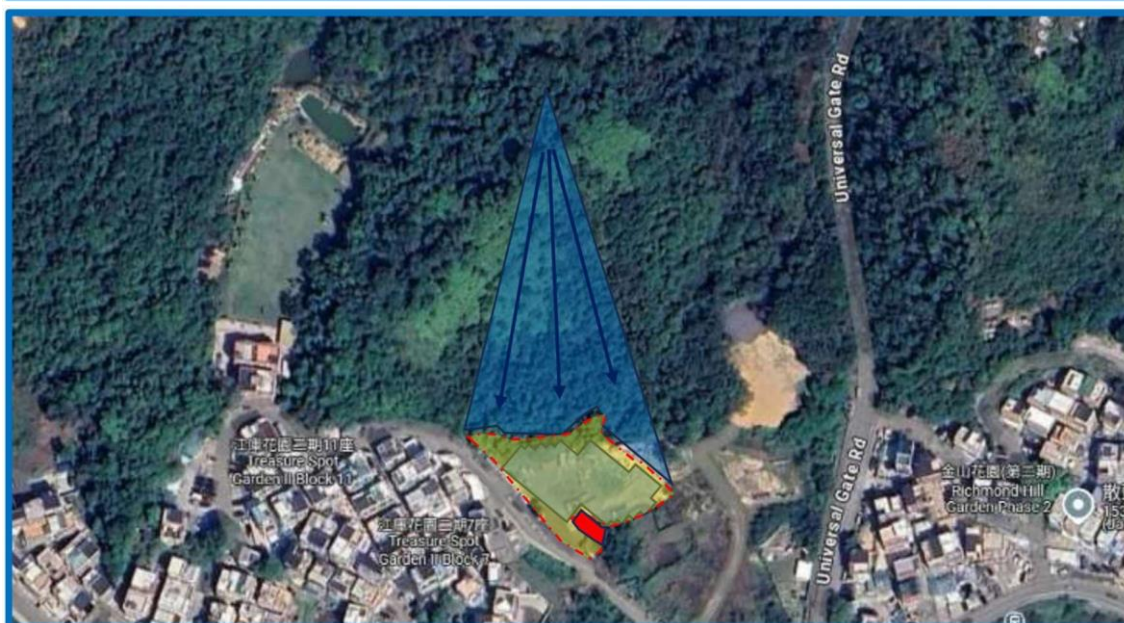
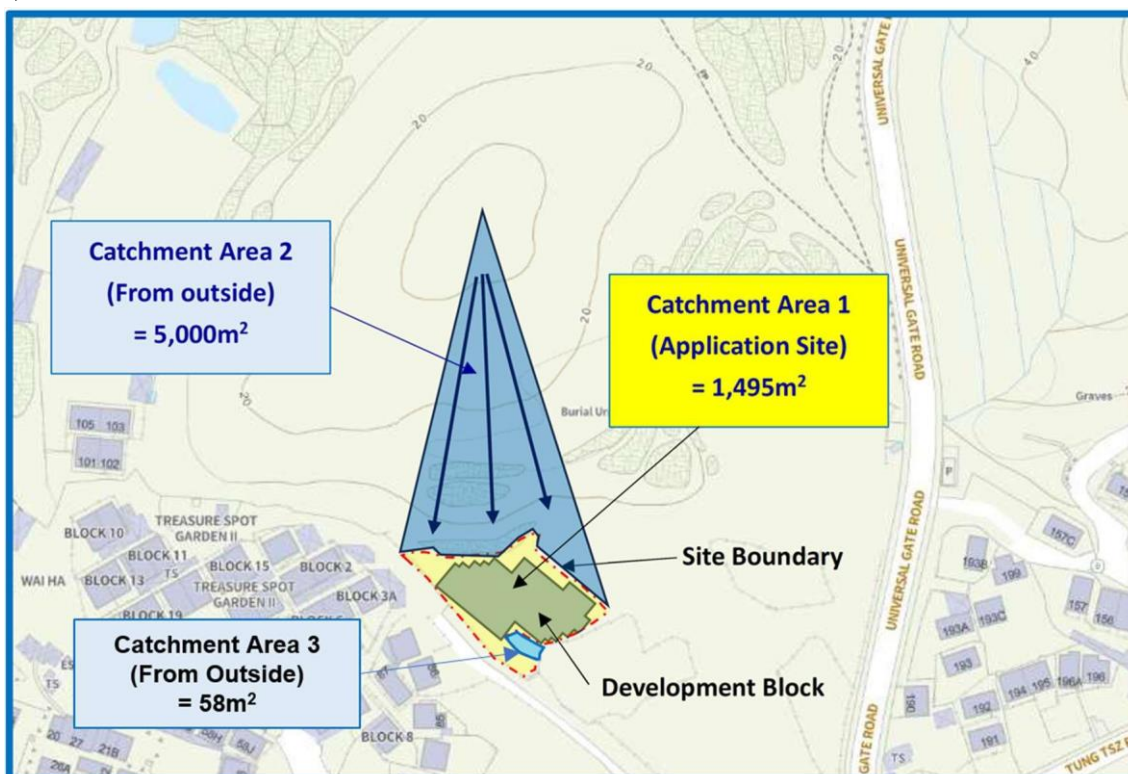
Absolute Height: 24.0m

Proposed No. of storey: 8 storeys

No. of beds						
Floor	No of Storey	Dorm		Isolation room		Staff
		Each floor	Sub-total	Each floor	Sub-total	
1/F-3/F	3	41	123	2	6	0
4/F	1	18	18	0	0	0
5/F	1	11	11	0	0	0
6/F	1	0	0	0	0	0
Total		152		6		0

4. Drainage Impact Assessment

i) Catchment Areas



Catchment Area 1 (Application Site, existing, concrete paved) = 1,495m²

Catchment Area 1 (Application Site, proposed to be paved with asphalt) = 1,495m²

Catchment Area 2 (From the adjacent hillside, grass land) = 5,000m²

Catchment Area 3 (Lot No.238, DD 23) = 58m²

ii) Design Manual

In evaluating the drainage impact arising from the proposed development, the following sources of information have been specifically referred to:

- Stormwater Drainage Manual (SDM) Fifth Edition, January 2018
- Storm Drainage Manual (SDM) – Corrigendum No. 1/2022
- DSD's Advice Note No.1 – Application of the Drainage Impact Assessment Process to Private Sector Projects; and
- Drainage Record Plan obtained from the GeoInfo map Services of the Lands Department (<https://www.map.gov.hk/gm/?lg=en>)

iii) Design Method

a) Rational Method (DSD STORMWATER DRAINAGE MANUAL 7.5.2)

$$Q_p = 0.278CiA$$

Where

Q_p = peak runoff in m³/s

C = runoff coefficient (dimensionless)

i = rainfall intensity in mm/hr

A = catchment area in km²

b) Runoff Coefficient

In Hong Kong, a value of $C = 1.0$ is commonly used in developed urban areas. In less developed areas, appropriate C values in order to ensure that the design would be fully cost-effective.

Surface Characteristics	Runoff coefficient, C^*
Asphalt	0.70-0.95
Concrete	0.80-0.95
Brick	0.70-0.85
Grassland(heavy soil**)	
Flat	0.13-0.25
Steep	0.25-0.35
Grassland(sandy soil)	
Flat	0.05-0.15
Steep	0.15-0.20

The existing site has been concreted while majority of vegetations have been cleared, C_1 of the existing site is taken as 0.8 conservatively.

The surface of the site will be covered by Asphalt, C1 of the proposed developed site should be 0.95 and the surface of the adjacent hill side is Grassland (sandy soil, steep), the C2 should be 0.2. The Lot No.238, DD 23 is mainly Grassland (sandy soil, flat), the C3 should be 0.15.

c) The existing box culvert with an equivalent diameter larger than 1.8 m is considered as trunk drains. 200-year design return period should be adopted.

d) Rainfall Intensity

Table 2a – Intensity-Duration-Frequency (IDF) Relationship of HKO Headquarters for durations not exceeding 240 minutes

Duration (min)	Extreme Intensity (mm/h) for various Return Periods T (year)								
	2	5	10	20	50	100	200	500	1000
240**	31.5	41.6	48.5	55.1	63.9	70.6	77.3	86.3	93.2
120++	50.4	66.0	75.7	84.7	95.9	104	112	121	128
60++	72.5	93.5	107	119	134	145	155	168	178
30++	93.3	115	128	139	153	162	170	180	187
15++	116	138	151	163	176	185	194	204	211
10*	131	155	169	181	195	204	212	222	229
5*	157	185	200	212	226	235	242	251	257
2*	191	223	239	252	265	273	280	287	291
1*	217	251	268	280	293	300	306	312	315
0.50*	242	279	296	309	320	327	332	337	339
0.25+++	268	307	324	336	347	353	357	361	363

- Notes:**
1. non-stationary GEV distribution analysis by assuming the location and scale parameters changing linearly over time and shape parameter remaining unchanged has been incorporated in the frequency analysis.
 2. ++ based on continuous rainfall recorded at HKO Headquarters (1947 – 2023).
 3. +++ based on Jardine rate-of-rainfall records at King's Park (1952 – 2015), and the 1-min OTT data at King's Park (2016 – 2023) scaled into the rate-of-rainfall.
 4. * distribution parameters are interpolated.
 5. ** based on hourly rainfall records at HKO Headquarters (1884 – 1939; 1947 – 2023).

i (rainfall intensity) = 242mm/hr (Duration of 5 min is adopted as conservative approach)

e) Climate Change

Climate change is taken into account in drainage system capacity check calculation.

- 16.0% Rainfall intensity increase for the end of the 21st century (2081–2100) is included referring to SDM, Table 28.
- 12.1% Rainfall Design Allowance for end of 21st century is included referring to Corrigendum No. 1/2022 of the SDM.
- The tide level adopted in this assessment is referred to Table 9 in the SDM which is given below:

Table 9 Mean Higher High Water (MHHW) Levels (in mPD)

Replace the table with the following:

Table 9 – Mean Higher High Water (MHHW) Levels (in mPD)

North Point/ Quarry Bay (1954-2019)	Tai Po Kau (1963-2019)	Tsim Bei Tsui (1974-2019)	Tai O (1985-2019)
2.01	2.02	2.32	2.13

Notes: Data period for analysis at Tai O tide station does not cover 1998-2010 inclusive.

The MHHW level of Tai Po Kau is 2.02 mPD. In addition, the projected extreme sea level due to climate change by the end of the 21st century are 5.42 mPD and 6.74 mPD under the 50-year and 200-year return periods respectively. The potential impact of these extreme water levels has been considered in Section 7 of this report. Appropriate flood protection, backflow prevention and emergency measures will be implemented to reduce the risk of flooding to the proposed development and the surrounding drainage system.

f) Calculations of Water Flow

Existing Situation

$$Q_p = 0.278 C_i A$$

$$C_1 = 0.8 \text{ (Concrete) (Existing Site)}$$

$$C_2 = 0.2 \text{ (Grass Land, Sandy Soil, Steep) (Adjacent Area)}$$

$$C_3 = 0.15 \text{ (Grass Land, Sandy Soil, Flat) (Adjacent Area)}$$

$$i = 242 \text{ mm/hr}$$

$$A_1 = 1,495 \text{ m}^2 \text{ (0.001495 km}^2\text{) (Existing Site)}$$

$$A_2 = 5,000 \text{ m}^2 \text{ (0.005000 km}^2\text{) (Adjacent Hill Side)}$$

$$A_3 = 58 \text{ m}^2 \text{ (0.000058 km}^2\text{) (Lot No. 238, DD 23)}$$

$$Q_p = 0.278 \times 242 \times ((0.8 \times 0.001495) + (0.2 \times 0.005000) + (0.15 \times 0.000058))$$

$$Q_p = 0.1484 \text{ m}^3/\text{s or } 8,904 \text{ l/min}$$

Proposed Development Situation

$$Q_p = 0.278 C_i A$$

$$C_1 = 0.95 \text{ (Asphalt) (Application Site)}$$

$$C_2 = 0.2 \text{ (Grass Land, Sandy Soil) (Adjacent Area)}$$

$$C_3 = 0.15 \text{ (Grass Land, Sandy Soil, Flat) (Adjacent Area)}$$

$$i = 242 \text{ mm/hr}$$

$$A_1 = 1,495 \text{ m}^2 \text{ (0.001495 km}^2\text{) (Existing Site)}$$

$$A_2 = 5,000 \text{ m}^2 \text{ (0.005000 km}^2\text{) (Adjacent Hill Side)}$$

$$A_3 = 58 \text{ m}^2 \text{ (0.000058 km}^2\text{) (Lot No. 238, DD 23)}$$

$$Q_p = 0.278 \times 242 \times ((0.95 \times 0.001495) + (0.2 \times 0.005000) + (0.15 \times 0.000058))$$

$$Q_p = 0.1635 \text{ m}^3/\text{s or } 9,810 \text{ l/min}$$

By considering Future Site Runoff with climate change increase to end of 21st Century and deposition of sediment, 28.1% and 10% of discharge is added respectively.

$$Q_{p(\text{existing})} = Q_p \times 128.1\% \times 110\% = 0.2092 \text{ m}^3/\text{s or } 12,552 \text{ l/min}$$

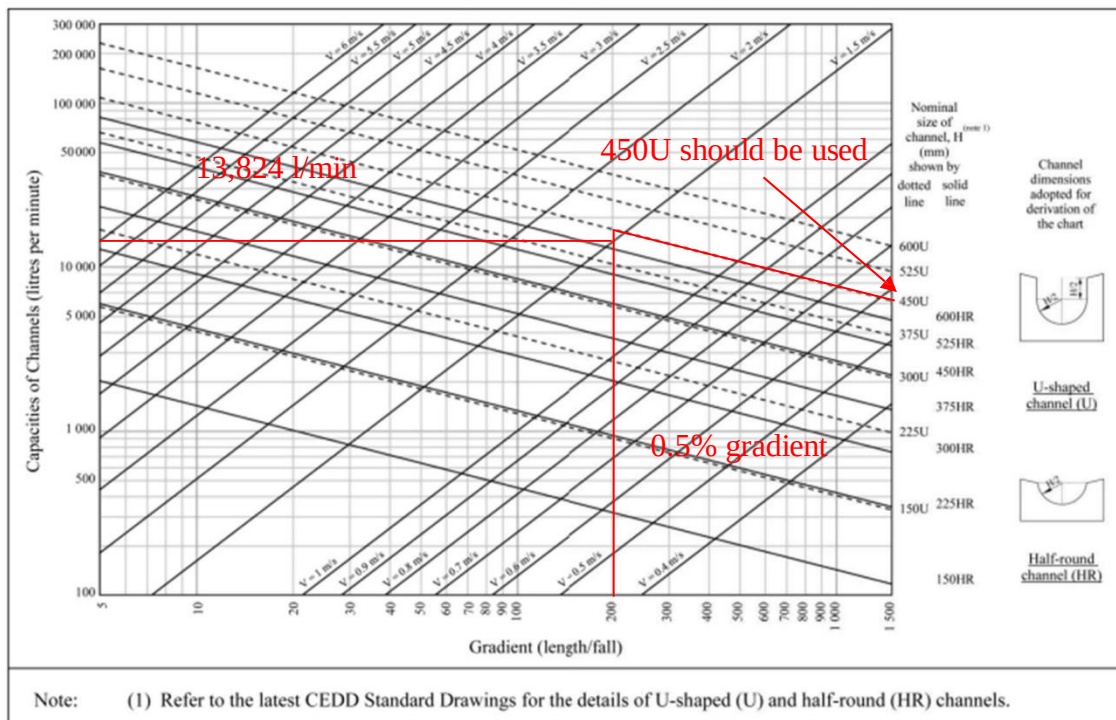
$$Q_{p(\text{Design})} = Q_p \times 128.1\% \times 110\% = 0.2304 \text{ m}^3/\text{s or } 13,824 \text{ l/min}$$

For conservative calculations, all catchment areas are combined for all U-Channels.

g) Design of U-channel

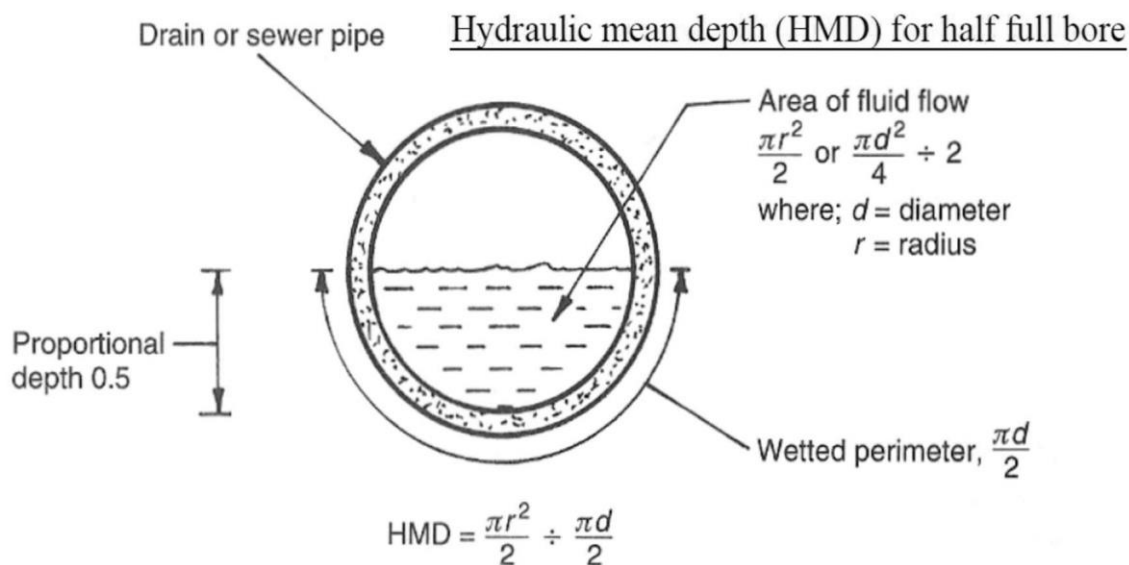
GEO Technical Guidance Note No. 43 (TGN43) Guidelines on Hydraulic

Figure 1 - Chart for the rapid design of U-shaped and half-round channels up to 600 mm



For 13,824 l/min, 450 U-channel will be used

h) Design of Pipe



Depth of flow	HMD
0.25	Pipe dia. (m) / 6.67
0.33	Pipe dia. (m) / 5.26
0.50	Pipe dia. (m) / 4.00
0.66	Pipe dia. (m) / 3.45
0.75	Pipe dia. (m) / 3.33
Full	Pipe dia. (m) / 4.00

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The 0.5 full bore, a self-cleansing velocity of 1.8m/s and 675mm pipe is used.

The capacity of the pipe:

$$Q = V \times A = (1.8) \times \pi \times (0.675/2)^2 \times 0.5 = 0.3220 \text{ m}^3/\text{s} > 0.2304 \text{ m}^3/\text{s}, \text{ OK}$$

Chezy's formula:

$$V = C\sqrt{(m \times i)}$$

where

$$V = \text{velocity of flow} = 1.8\text{m/s} < 3\text{m/s}$$

$$m = \text{hydraulic mean depth (HMD)} \rightarrow \text{HMD} = 0.600 / 4.00 = 0.15$$

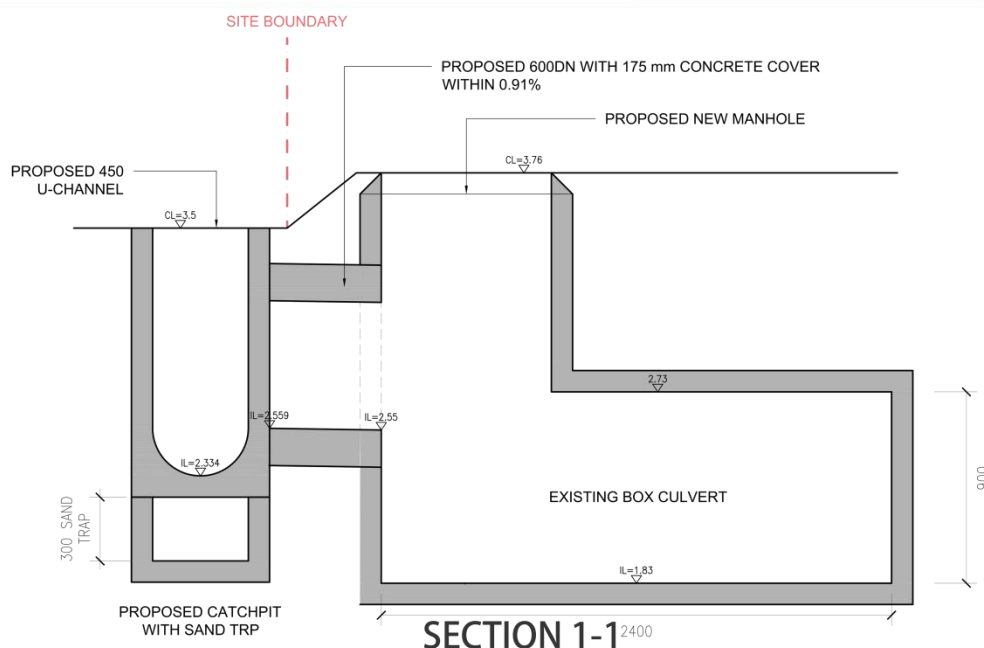
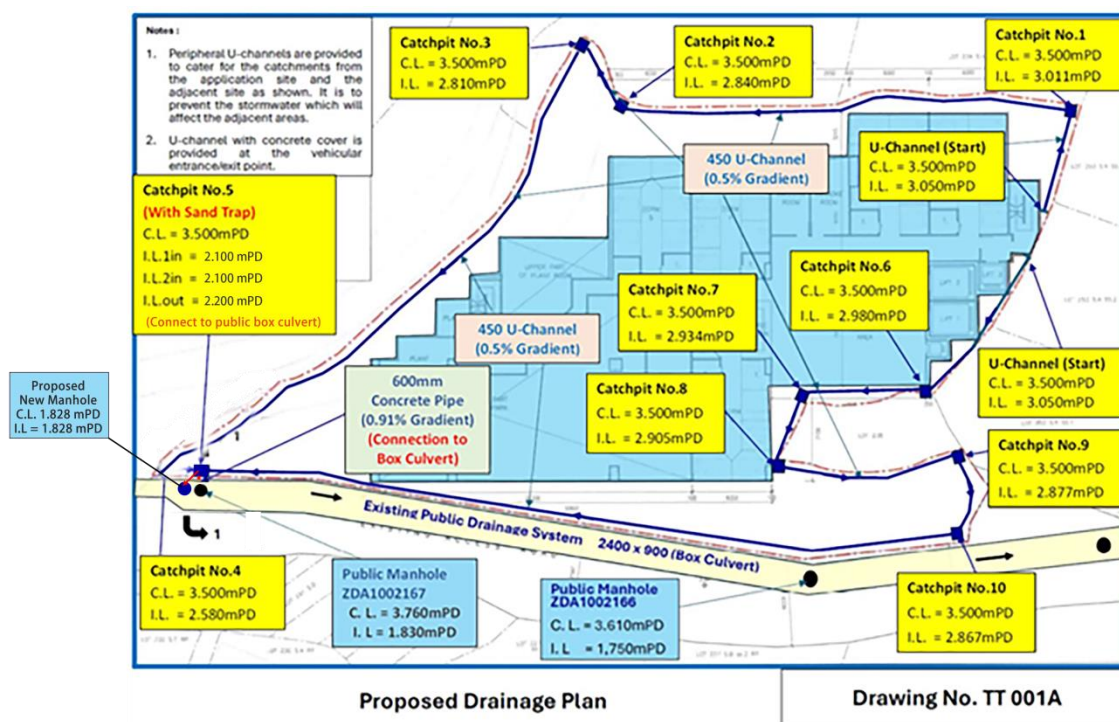
$$C = \text{Chezy coefficient} = (0.15)^{1/6} / (0.015(\text{concrete pipe})) = 48.59$$

$$1.8 = 48.59 \times (0.16875 \times i)^{0.5}$$

$$(1.8/48.59)^2 = 0.16875 \times i$$

$$\text{Thus } i = 0.008132 \text{ or } 0.81\% (i = \text{inclination or gradient as } 1/X)$$

i) Drainage Plan



Details and method statement for connection of proposed DN675 pipe to the existing box culvert should be submitted for DSD's approval before the connection works. CCTV inspection should be conducted before and after the connection works. DSD

should be informed before commencement of the works and the connection works should be conducted in dry season.

The proposed DN675 stormwater connection pipe does not have sufficient cover at certain locations. To protect the pipe against imposed traffic, construction and other external loads, the proposed DN675 pipe will be fully surrounded by 175 mm thick reinforced concrete. The reinforced concrete surround will extend continuously around the pipe along the section with insufficient cover.

The reinforced concrete surround, including its concrete grade, reinforcement arrangement, pipe bedding, extent and termination details, shall be designed by a suitably qualified engineer with due consideration of the actual cover, pipe outside diameter, imposed loading and the proximity of the existing box culvert. The detailed design and construction method statement shall be submitted to DSD for approval prior to commencement of the works.

The proposed stormwater drainage system will discharge to the existing box culvert at the southwest of the Application Site through a proposed manhole and a side-entry connection pipe. The proposed connection works will involve the formation of an opening at the side wall of the existing box culvert.

Prior to commencement of the connection works, the existing box culvert at the proposed connection location shall be investigated to verify its dimensions, wall thickness, reinforcement arrangement and structural condition. The investigation shall include review of available as-built records, CCTV inspection, trial pits and/or non-destructive testing, as appropriate.

The detailed design of the proposed manhole, side-entry connection, opening size and location, strengthening arrangement, watertight connection detail, excavation and lateral support (ELS) works, and construction method statement shall be prepared by a Registered Structural Engineer (RSE) for submission to DSD for approval prior to commencement of the works. The detailed structural assessment shall demonstrate that the proposed opening, new manhole, excavation works and construction loads will not adversely affect the structural integrity of the existing box culvert.

The formation of the opening shall be carried out by controlled low-vibration cutting or core drilling. Percussive breaking methods shall not be used unless otherwise agreed by DSD. The proposed connection shall be properly sealed and made watertight by suitable concrete surround, non-shrink grout and/or waterstop details as specified in the approved detailed design.

Construction materials, plants and heavy vehicles shall be kept away from the existing box culvert as far as practicable. No stockpiling or heavy loading shall be permitted

within the vicinity of the existing box culvert unless justified in the approved temporary works design. Where necessary, steel road plates shall be provided to protect the existing box culvert from vehicle loading.

Monitoring of settlement and movement of the existing box culvert shall be carried out before, during and after the connection works. The monitoring locations, frequency, trigger levels, action levels and contingency measures shall be agreed with DSD prior to commencement of the works. CCTV inspections of the existing box culvert shall be conducted before and after the connection works.

DSD shall be informed before commencement of the works. The connection works shall be carried out during the dry season, with suitable temporary drainage and flow control measures in place. No adverse impact on the structural integrity and hydraulic performance of the existing box culvert is anticipated, subject to implementation of the approved detailed structural design, construction method statement and mitigation measures.

5. Calculation of Capacity of existing Box Culvert

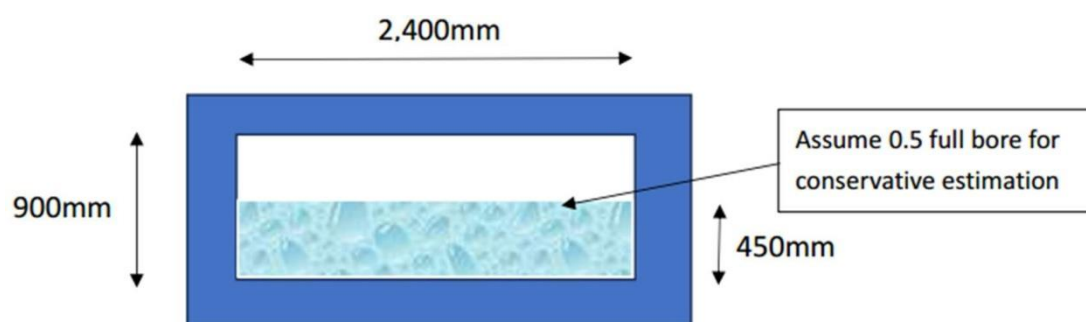
Size of existing box culvert = 2,400mm x 900mm

Invert Level ZDA1002167 = 1.83mPD

Invert Level ZDA1002166 = 1.75mPD

Distance between two manholes = 60m

Gradient = $(1.83 - 1.75) / 60 = 0.00133$ or 0.133%



**Typical Cross Section
Of the Existing Box Culvert**

Mannings's formula:

$$C = m^{1/6} / n$$

Where C = Chezy coefficient

n = coefficient of roughness (0.015 for concrete)

m = hydraulic mean depth (HMD) = area of flow / wetted perimeter

$$\text{Area of flow} = 2.4 \times 0.45 = 1.08$$

$$\text{Wetted perimeter} = 0.45 \times 2 + 2.4 = 3.3$$

$$m = 1.08 / 3.3 = 0.327$$

$$C = 0.327^{1/6} / 0.015 = 55.34$$

Chezy's formula:

$$V = C\sqrt{(m \times i)}$$

$$V = 55.34 \sqrt{(0.327 \times 0.00133)} = 1.154 \text{ m/s}$$

Capacity of the Existing Box Culvert

$$Q = 1.154 \times 1.08 = 1.246 \text{ m}^3/\text{s}$$

Total flow from the proposed development

$$= 0.2304 \text{ m}^3/\text{s} < 1.246 \text{ m}^3/\text{s} \text{ (Adequate Capacity)}$$

Utilization of the existing box culvert without the proposed development

$$= \frac{0.2092 \text{ m}^3/\text{s}}{1.246 \text{ m}^3/\text{s}}$$

$$= 16.790\%$$

Utilization of the existing box culvert with the proposed development

$$= \frac{0.2304 \text{ m}^3/\text{s}}{1.246 \text{ m}^3/\text{s}}$$

$$= 18.491\%$$

6. Temporary Drainage Arrangements during Construction Stage

Proper measures shall be taken to maintain the existing drainage characteristics of the catchment areas and to minimize drainage impacts associated with the construction works. The principal drainage impacts which are associated with construction of the works have been identified as follows:

- (a) Erosion of ground materials;
- (b) Sediment transportation to existing downstream drainage system; and
- (c) Obstruction to drainage systems.

All proposed works should not obstruct any overland flow, and all existing flow paths, along with runoff directed towards the existing watercourse/drainage system, are to be intercepted and directed to the proposed drainage system. A temporary drainage system designed with sufficient capacity shall be provided to prevent flood risk within the Application Site before commencement of construction works, including site formation works. For example, perimeter channels should be provided at the site boundary to intercept surface runoff from outside the Application Site so that overland flow across the Application Site can be avoided. Moreover, permanent U-channels shall be constructed prior to commencement of other construction works, which can form part of the temporary drainage system during the construction stage.

To ensure proper operation of the site drainage channels and desilting facilities, inspection of the temporary drainage system shall be carried out on a weekly basis, and the desilting facilities shall be cleaned on a daily basis.

If excavated materials cannot be transported away within the same day, the materials should be covered by tarpaulin/impervious sheets. Stockpiles of construction materials of more than 50 m³ in open areas shall also be covered with tarpaulin or similar fabric during rainstorms.

All runoff discharged into the existing drainage system will be settled in silt traps to ensure no sediment is discharged into the existing system. Silt traps will normally be provided along the site drainage immediately upstream of the proposed discharge point to the existing system. The silt traps shall be inspected daily and immediately after each rainstorm.

Liaison shall be carried out with relevant parties regarding temporary drainage arrangements to ensure that the drainage system is functioning adequately.

Further guidelines and site practices outlined in EPD's Practice Note ProPECC PN 1/94, DSD Technical Circular No. 1/2017 – Temporary Flow Diversions and Temporary Works Affecting Capacity in Stormwater Drainage System, and DSD Practice Note No. 1/2004 – Design Rainfall Depth for Temporary Works within the Dry Season shall be

followed as far as practicable to minimize the adverse drainage impact caused by the construction works.

A contingency plan shall be implemented in the event that rainfall exceeds, or is forecast to exceed, the adopted design rainfall depth and profile. The Contractor shall monitor the latest weather forecast, rainstorm warning and rainfall information issued by the Hong Kong Observatory throughout the construction period.

A competent site representative shall be designated to inspect and ensure the proper functioning of the temporary drainage system, including perimeter channels, catchpits, silt traps, temporary drains and discharge points, before, during and after heavy rainfall events.

Prior to the onset of heavy rainfall, the Contractor shall clear debris, sediment and obstructions from the temporary drainage system and silt traps; secure or cover stockpiles and loose materials; provide temporary bunds, sandbags and/or waterproof sheets at vulnerable locations; and ensure that sufficient portable pumps, standby power supply and discharge hoses are available on site.

In the event that the water level within the temporary drainage system rises abnormally, or ponding is observed within the Application Site, the Contractor shall immediately deploy portable pumps and temporary diversion measures, stop works in the affected area where necessary, and take appropriate actions to prevent flooding within and outside the Application Site.

The Contractor shall maintain an emergency contact list and ensure that adequate manpower, equipment and materials are available for timely implementation of the contingency measures. The drainage system shall be inspected immediately after each heavy rainfall event and any damage, blockage or sediment accumulation shall be rectified without delay.

Trigger / condition	Immediate actions
Heavy rainstorm forecast or rainstorm warning issued	Inspect and clear all temporary drains, catchpits and silt traps; secure loose materials and stockpiles; place pumps, hoses, sandbags and temporary bunds at designated locations.
Amber / Red / Black Rainstorm Warning in force	Suspend vulnerable excavation and connection works where necessary; deploy designated site personnel; inspect drainage facilities regularly; maintain pumps and emergency materials in standby condition.
Abnormal water level, surcharge, blockage or ponding observed	Stop affected works; remove blockage; deploy pumps and temporary diversion; install sandbags/ bunds as necessary; prevent runoff from leaving the Application Site or entering excavation.
After heavy rainfall	Inspect, remove deposited silt/ debris, repair damage, record the event and restore the temporary drainage system.

7. Measures to tackle the extreme sea level

The extreme sea level due to climate change by the end of the 21st century under a 50-year return period is 5.42mPD and under a 200-year return period is 6.74mPD. These levels have been taken into consideration. The following measure would be applied to tackle the extreme sea level.

Flood Protection Measure

Permanent raised thresholds/upstands will be provided at the low-lying entrances and vulnerable openings of the proposed development to reduce the risk of surface runoff entering the building.

Demountable flood boards or temporary flood barriers will be provided at the main entrance, vehicle entrance and other vulnerable low-level openings where necessary. The flood boards will be stored at an accessible location and deployed by the building management/maintenance personnel before or during extreme rainfall or high downstream water-level conditions.

The flood protection measures will be inspected and maintained regularly. Any damaged or defective flood board, barrier or upstand will be repaired or replaced promptly. Emergency sandbags and portable flood barriers will be kept available as supplementary measures.

Back flow prevention

Non-return valves or flap valves are installed at terminal manhole.

Site drainage

The ground fall should be ensuring away from the building to prevent run off from flowing toward the building.

Emergency measure

Sandbags, portable flood gates and pumping equipment should be standby on site.

8. Conclusion

U-channels with catchpits are proposed to convey runoff from the proposed Project Site for collection. The collected runoff will be discharged to the existing box culvert by drainage pipe.

The Project Proponent will be responsible for the construction and on-going maintenance of the drainage facilities.

No change in total catchment area, and the increase in stormwater flow is small (from 0.2092 m³/s to 0.2304 m³/s), there will be no unacceptable drainage impacts as a result of the proposed development.

The assessment reviews that the U-channel and drainage pipe have sufficient capacity to cater for the drainage flow from the proposed Project Site.

Temporary drainage impact mitigation measures and monitoring and audit are proposed to ensure that the existing drainage system will not be affected during the construction stage.