

Appendix F

Waterworks Impact Assessment Report

Agreement No. CE 79/2023 (GE)
Underground Quarrying at Tsing Yi North –
Investigation, Design and Construction
Waterworks Impact Assessment Report
(Final) (Ref. B22a-04)

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1 Introduction

1.1 Project Background

- 1.1.1 Rock, principally as aggregates in concrete, is the most predominately used construction material for buildings and infrastructure developments in Hong Kong. Local quarries, where rock is sourced for such uses, are strategically important to the construction industry in Hong Kong. Apart from extraction of virgin rock, surplus rock generated from local construction projects can be processed and recycled at quarries for beneficial reuse. In addition, the quarries are suitable sites for housing manufacturing plants of rock-derived construction materials such as ready-mixed concrete and asphalt. Historically, rock has been quarried in Hong Kong by way of surface quarrying – open/pit extraction at the ground surface. By doing this, the quarries have been operating as self-financing business entities rather than government-funded facilities.
- 1.1.2 Currently, Lam Tei Quarry (LTQ) at Tuen Mun is the only active local quarry, for which the current quarry contract is scheduled for completion in 2025. Recognising the importance of local quarries in minimizing the risk of irregularities in the supply of imported rock, the Government has been searching for suitable sites to set up new surface quarries in order to maintain local rock supply, with a view to have at least one new quarry to dovetail with the closure of Lam Tei Quarry.
- 1.1.3 Apart from rock materials, Hong Kong is also desperately in need of developable land to meet socio-economic needs. Creating spaces in underground rock caverns is one of the solutions in boosting land supply in the medium to long terms. To create land in this manner, the cavern formation will not only generate a large amount of good quality rock, but this process is also a source of rock materials which could be an integral part of the local rock supply in future. This is the underlying concept of the initiative of underground quarry-cum-cavern development, which is unprecedented in Hong Kong. There are, nevertheless, successful examples of this approach in other countries, e.g. Switzerland, Norway and the United States of America, where the entire operation combining quarrying and subsequent uses of the cavern spaces created (e.g. cold storage, data centres, warehousing and recreational complexes) is confirmed to be commercially viable.
- 1.1.4 Preliminary reviews under the Strategic Cavern Study identified the prospect of this concept and thereby proposed it as one of the initiatives under the long-term strategy for cavern developments in Hong Kong. Accordingly, in November 2018, when formulating the local quarry strategy for maintaining the local rock supply, the Government also recognized this initiative as a potential long-term solution that is complementary to new surface quarries. In other words, underground quarrying in Hong Kong is being pursued as a dual-benefit policy initiative contributing to enhanced land supply and sustainable use of local rock resources.
- 1.1.5 In 2017, CEDD commissioned the Underground Quarry Study to evaluate the feasibility of this initiative, covering various aspects including technical acceptability, statutory and regulatory requirements, business model analyses and implementation mechanisms. Based on the results of a systematic territory-wide site search, the hillside at Tsing Yi North, which is one of the 48 Strategic Cavern Areas (SCVAs) as delineated in the Cavern Master Plan (CMP) jointly promulgated by CEDD and PlanD in 2017, was recommended to take forward.
- 1.1.6 In 2019, the CEDD and PlanD jointly commissioned the Pilot Planning and Engineering Study on Development of Selected Strategic Cavern Areas – Feasibility Study (“Pilot Study”) to enable the Government to earmark sites for cavern development and to facilitate the implementation of cavern development. The study findings concluded that it is worthwhile launching a scheme of underground quarrying at Tsing Yi North. It is envisioned as an integral part of the long-term local quarry strategy. Shortage of rock import from the mainland China due to lockdown arising from COVID-19 outbreak in early 2020 caused substantial impacts across the construction industry in Hong Kong, heightening the importance of local quarries in the supply chain. To enhance crisis preparedness, it is timely to proceed with the scheme, along with other quarry related initiatives to maintain local rock supply.

- 1.1.7 Following the commencement of the IDC assignment for developing and designing the pilot underground quarry at Lam Tei, Tuen Mun in 2021, CEDD launched an IDC assignment for developing a new underground quarry at Tsing Yi North in 2023.
- 1.1.8 To implement the proposed underground quarry-cum-cavern development at Tsing Yi North, it is necessary to conduct a site-specific investigation and design for the scheme, building on the work completed under the Underground Quarry Study and the pilot study.
- 1.1.9 This Assignment aims to complete all the tasks necessary and sufficient to undertake the assignments including statutory procedures, public consultation, detailed technical assessments, broad design for potential facilities, formulation of implementation arrangement etc. at the investigation, design and early construction stages, in order to enable commencement of the underground quarrying tentatively targeted at 2027. These include various impact assessments, reference design of caverns and the underground quarrying-related activities (e.g. the materials processing/manufacturing plants and their operations) coordinated or implemented by the Government, business case analyses, implementation strategy and procurement arrangements. Consultation within the Government and with public and relevant stakeholders/industry players will also be carried out.
- 1.1.10 This Assignment will also look into any works potentially required by the quarry operators during the operation stage of the proposed underground quarrying. Given its pilot nature, the underground quarrying operation will be subject to the prevailing and/or new implementation mechanisms such as contract form, site supervision and any independent audits required. These will be examined and tailor-designed under this Assignment. Depending on the findings, it may call for works or tasks for which the Government may procure consultancy services separately during the operation stage.
- 1.1.11 AECOM Asia Co. Ltd. has been commissioned by the Civil Engineering and Development Department (CEDD) on 13 June 2024 to undertake Agreement No. CE 79/2023 (GE) – Underground Quarrying at Tsing Yi North – Investigation, Design and Construction. It is targeted to commence the construction works in Year 2027.
- 1.1.12 The location plan with the proposed TYNUQ is shown in **Figure 1.1**.

1.2 Scope of this Report

- 1.2.1 According to Clause 6.17 of the Brief, The Consultants shall liaise and obtain consent of the Water Supplies Department (WSD) to the operation of underground quarry which are within the water gathering grounds, waterworks reserves and WSD tunnel reserves or will affect the existing and planned waterworks installations. The Consultants shall also liaise with various utilities owners to ensure the underground quarry will not adversely affect the utilities nearby and propose diversion / relocation or mitigation / protection measures to the utilities.
- 1.2.2 The objectives of the report are as follows:
- (a) to assess the water demands for the proposed underground quarry development;
 - (b) to take cognisance of the existing and proposed Projects which may have a bearing on the WIA;
 - (c) to identify needs for provision of any new waterworks, reserves, utilities and other improvement works to cope with the proposed underground quarry development;
 - (d) to assess the short-term and long-term impacts on the existing and planned water supply systems / utilities arising from the proposed underground quarry development;
 - (e) to identify need of any mitigation and protective measures such as diversion, reprovisioning and modification of waterworks installations and utilities to cope with the proposed quarry development;
 - (f) to protect waterworks installations and utilities and keep minimum disturbance to their normal operation during construction and in operation stage of the proposed quarry development;

- (g) to enable an agreement in principle to be reached between WSD in respect of waterworks improvement works, mitigation and protection schemes, diversion schemes, re-provisioning works and/or modifications of waterworks installations, connection point for incorporation in design and during operation stages of the proposed underground quarry development;
- (h) to preliminary assess and identify the needs for provision of any new waterworks, reserves, utilities and other improvement works for the future formed cavern space, in which such provision during the operation of underground quarrying stage would be beneficial to the future formed cavern.

1.3 Nomenclature and Abbreviations

- 1.3.1 The following table lists the abbreviated titles of government bureaux, departments, offices, statutory bodies and public organisations mentioned in this Report.

Table 1.1 Abbreviations for Government Bodies

Abbreviations for Bureaux/Departments/ relevant organisations	Full title
CEDD	Civil Engineering and Development Department
EMSD	Electrical and Mechanical Services Department
GEO	Geotechnical Engineering Office
HyD	Highways Department
PlanD	Planning Department
WSD	Water Supplies Department

- 1.3.2 The following table lists the meanings of abbreviations for expressions adopted in this Report.

Table 1.2 Abbreviations Adopted in this Report

Abbreviations	Full Meaning
FWSR	Fresh Water Service Reservoir
GESF	EPD's Guidelines for Estimating Sewage Flows
LtQ	Lam Tei Quarry
MDD	Mean Daily Demand
MIC	Maximum Instantaneous Chargetweight
PPV	Peak Particle Velocity
PWD	Peak Water Demand
SCVA	Strategic Cavern Area
TMF	Temporary Mains-water for Flushing
TSE	Treated Sewage Effluent
TYNUQ	Tsing Yi North Underground Quarry
UFF	Unit Flow Factor
UIA	Utilities Impact Assessment
WIA	Waterworks Impact Assessment

2 Project Profile

2.1 Site Location

- 2.1.1 The proposed site is located in the northwestern area of Tsing Yi Island between the North West Tsing Yi Interchange to the west and Yau Kom Tau to the east. The proposed underground quarry will be undertaken in the Strategic Cavern Area (SCVA) No. 10, beneath the mountain of Shek Wan. The location plan of the Project is shown in **Figure 1.1**.

2.2 Proposed Development

- 2.2.1 For the purpose of underground quarrying, the project site is classified as a construction site throughout the construction and operation phases. All the proposed waterworks, except the section of realigned 40GIL (DN40) water main at Tam Kon Shan Road, are temporary works under the project. These temporary works will be removed from the site upon completion of the contract. The waterworks assessment for the future land use and the corresponding permanent works shall be carried out by others under separate study.

Portals and Access Tunnels Leading to Underground Quarry

- 2.2.2 The formation of portals at Ngau Kok Wan and Tam Kon Shan Road will require soil and rock slope cutting works. It is envisaged that excavation in soil and rock is involved at the section of access tunnel near portal. After excavation of the Main Access Tunnels near portals, the remaining excavation is anticipated to be conducted in rock using drill and blast method.

Underground Quarry

- 2.2.3 Connection Tunnels will be built around the perimeter of the underground quarry. Subject to the need of the quarry operator, the underground quarry is allowed for housing rock processing facilities, stockpiling the excavated rocks / aggregates and storage of construction materials. To the southeast of the proposed cavern extent, an area of potential cavern expansion is identified.

Expansion of Surface Land at Ngau Kok Wan

- 2.2.4 To facilitate a more flexible site setup, it is proposed to carry out surface land expansion at the western side of the existing surface land of Ngau Kok Wan by means of site formation in order to enlarge the surface land area. The site formation will require soil and rock excavation by mechanical means with piling works to form a retaining structure.

Provision of Loading / Unloading Area with Conveyor Belt near Wok Tai Wan

- 2.2.5 To develop a connection by means of conveyor belt to Wok Tai Wan to enable a more flexible site setup by the future operator and enhance synergy between Wok Tai Wan and Ngau Kok Wan, it is proposed to create a loading / unloading point near the access road for transporting rock to/from Wok Tai Wan through a conveyor belt system along the hillside. To facilitate the rock storage needs of the project, Wok Tai Wan is identified as the stockpiling area.

2.3 Ancillary Facilities Area

- 2.3.1 Initially before any underground space is created, for the operation of the underground quarry, surface works area shall be provided to set up the following:

- Site office for staff
- Workshop for machinery
- Installation of blasting mitigation measures at portals
- Stockpiling area
- Tunnel ventilation facilities
- Set up of ancillary activities

- 2.3.2 The Contractor will be responsible to develop their own arrangement of the site setup to suite their operational needs. With reference to the existing site set up of Lam Tei Quarry and Lam Tei Underground Quarry, the major activities for supporting the ancillary operations would include the followings:

- Rock processing

- Raw material storage
- Stockpiling area for preliminary crushed rock and C&D material
- Concrete production
- Asphalt production

2.4 Construction Phase

- 2.4.1 After quarrying contract award and before any production is made, the quarry operator will need to carry out site set up works. During this construction phase, machineries and plants will be transported to surface land for installation. In parallel, initial site establishment and construction works including construction of portals and short portions of the main access tunnels will be conducted by mechanical means. No blasting, crushing, concrete or asphalt production will be carried out during the construction phase.
- 2.4.2 The construction phase will take approximately one to two years, including the period required for procurement, delivery, installation and license application.

2.5 Operation Phase

- 2.5.1 Once the initial set up is ready, drill and blast method will be adopted for excavation of rock. Drill and blast operation involves drilling of rock, charging of explosives, blasting and removal of as-blasted rock. The as-blasted rock fragments are crushed on site down to suitable sizes for use as aggregates. Aggregates will go through further process for concrete and asphalt production within the rock processing area of the quarry site before being delivered off site as products to construction sites.
- 2.5.2 The operational phase will commence after the construction phase and will continue until the rock reserves are depleted.

3 WATERWORKS IMPACT ASSESSMENT

3.1 Objectives

- 3.1.1 The purpose of this Waterworks Impact Assessment (WIA) is to identify and assess any adverse impacts on the existing and committed fresh and saltwater supply systems, if any, arising from the proposed TYNUQ. Mitigation measures will then be proposed to mitigate any identified adverse impact.

3.2 Assessment Methodology

- 3.2.1 The proposed quarry development will require certain demands of fresh water.
- 3.2.2 The following approaches are involved in carrying out the Waterworks Impact Assessment:
- Identify the existing waterworks facilities.
 - Assess the water demands and capacities for development.
 - Investigate the impact on existing facilities.
 - Recommend suitable mitigation measures and diversion scheme to protect existing waterworks.
- 3.2.3 The water mains record plan information depicted in this Report is an extract of available information provided by WSD as shown in **Appendix A**. The locations and alignments of water mains as shown on drawings are indicative only.

3.3 Existing Waterworks Facilities

Fresh Water Supply System

- 3.3.1 TYNUQ is located at Tsing Yi's Ngau Kok Wan. DN40 (40GIL) water mains are found in the vicinity of the proposed TYNUQ for direct connection. The DN40 water mains connect Ngau Kok Wan to the DN400 water mains located to the east of TYNUQ on Tam Kon Shan Road. Fresh water supply in the vicinity of TYNUQ is currently provided by Tsing Yi North High Level Fresh Water Service Reservoir (T.W.L. +125 mPD, Capacity 9,306 m³) (hereinafter, TYNHLFWSR) and Tsing Yi North Low Level Fresh Water Service Reservoir (T.W.L. +75.04 mPD, Capacity 17,072 m³) (hereinafter, TYNLLFWSR).
- 3.3.2 It is noted that the TYNUQ is located at the most downstream waterworks network of Tsing Yi fresh water supply zone. The DN400 water mains located to the east of TYNUQ on Tam Kon Shan Road are supplied by the TYNLLFWSR, while the DN250 water mains located to the south of TYNUQ along Cheung Tsing Highway are supplied by TYNHLFWSR. The existing fresh water layout is as shown in **Figure 2.1**.

Flushing Water Supply System

- 3.3.3 Reuse of Treated Sewage Effluent (TSE) is proposed as the source of water supply for toilet flushing. Since the quarry operation and its ancillary activities form part of a temporary works of a construction site with limited number of staff, TSE is considered sufficient to fulfil the anticipated flushing water demand. Details related to TSE are elaborated in **Section 3.7**. In case the flushing water demand exceeded that of the TSE supply, Contractor may apply for salt water flushing through further liaison with WSD or consider adopting alternative sources of flushing water (such as seawater from waterfront etc.) to meet the actual need.

3.4 Water Demand Estimation

Water Use in Quarry Site

- 3.4.1 The maximum number of staff working regularly in the Quarry Site is anticipated to be about 100. Potable water and flushing water will be the main water consumption by these staff.
- 3.4.2 During quarry operation, as a dust suppression control measure, water will be sprayed over exposed ground or concerned areas, mainly at Ngau Kok Wan and Wok Tai Wan, and at operation such as rock crushing. Water will also be used for drilling activity for underground quarry excavation works.
- 3.4.3 Concrete and asphalt production will be carried out within the surface land area at Ngau Kok Wan. A significant amount of water will be used for concrete production. Asphalt production will consume insignificant water occasionally for cleaning purpose. No water is required in asphalt production.

Unit Demands for Workers

- 3.4.4 As quarry activity is not classified in any of the categories specified in WSD's DI No. 1309, EPD's GESF for Sewage Infrastructure Planning is adopted when estimating the water demands. Fresh water demand is assumed to be equal to sewage flow produced from the quarry activity. According to GESF Table T-2, UFF under the catalogue of "J8 Mining and Quarrying" is zero. The total unit flow generated from an employee in proposed quarry development is the sum of the unit flow factor of employee (0.08 m³/day per employee) and the unit flow factor of commercial activities (0 m³/day per employee). For fresh water and flushing water demand, 0.03 m³/day per employee and 0.05 m³/day per employee are adopted respectively as established in GESF Appendix III Sections (4)(d) and (3)(a). **Table 3.1** provides the WSD's consumer classifications, fresh water and flushing water unit demands assumed for the estimation of water demands by the proposed quarry development.

Table 3.1 Proposed Unit Demands for Fresh and Flushing Water Supply

Unit Demand (m ³ /head/day)	
Fresh Water	Flushing Water
0.03	0.05

Notes:

(1) Adopt UFF under catalogue J8 (0.08 m³/day per employee) in GESF Table T-2

(2) UFF is split into value of 0.03 m³/head/day and 0.05 m³/head/day for fresh water and flushing water respectively as established in GESF Appendix III (3)(a) and (4)(d)

Fresh Water Demand for Concrete Production

- 3.4.5 For water demand in concrete production, the peak daily demand (PWD) is 1116 m³/day, which has include the water used for concrete production related operation, for example, dust suppression sprinkler, washing of mixer, washing of concrete trucks and testing equipment.

Fresh Water Demand for Asphalt Production

- 3.4.6 No water is required during the asphalt production process. Nevertheless, with reference to asphalt production activity in the industry, they consume about 19.2 m³/day water for cleaning purposes during production.

Water Demand for Dust Suppression in Quarry Site

- 3.4.7 Preliminary Environmental Review revealed that dust suppression measure is needed to mitigate air quality impact. Watering with an intensity of 1.37 L/m² once per hour on active open works areas (heavy construction and blasting activities), rock crushing and its stockpile areas is anticipated to reduce dust emissions effectively.
- 3.4.8 The haul road area requires dust suppression is approx. 0.5 ha. The water demand for dust suppression is estimated as 82.2 m³/day. The remaining areas that requires dust suppression by water would be served by recycled water of the site.

Water Demand for Carrying Out Underground Quarry Excavation Works

- 3.4.9 As Drill-and-Blast method is adopted for the majority of excavation works to be carried out during the operation of the underground quarry, water is used during the drilling activity relevant to the excavation and support installation works. The maximum water consumption and peak daily demand (PWD) for the excavation works is approximately 108 m³/day, derived from the maximum water demand of typical drilling machinery.

Water Demand for Fire Fighting

- 3.4.10 Similar to the existing quarry site, TYNQU site is considered as a temporary construction site. FSD Circular Letter No. 2/2008 - Fire Protection measures in Construction Sites would be followed. The facilities shall be capable of relaying water with a minimum flow of 900 L/min.

Fresh Water Demand for Future Concrete Batching Plant at Tam Kon Shan Road (by others)

- 3.4.11 It is noted that a new concrete plant will be established at the area of Tam Kon Shan Road. From the planning application available on Town Planning Board for application A/TY/150, a daily concrete production of 4200m³ is anticipated. The water demand could therefore be estimated as 776 m³/day PWD for concrete production.
- 3.4.12 For the planned expansion development for a nearby concrete batching plant at Tam Kon Shan Road. There is no information regarding the scale of expansion available from the public domain and government department. Due to limited space available for expansion as observed at the existing site, it is assumed that such expansion will involve 1 more production line with 100m³/hr design production capacity for our assessment purpose. As such, the water demand from this expansion is estimated to be 222m³/day PWD for concrete production.
- 3.4.13 Therefore, the total additional water demand from the future concrete batching plant development by others at the area of Tam Kon Shan Road is assumed to be 998m³/day PWD.

Peak Factors for Estimation

- 3.4.14 In line with the guidelines specified in WSD's DI 1309, the following peak demand factors are adopted for estimation. The peak flow rates in distribution mains are listed as follows:
- a) Peak flow rates in fresh water distribution mains = 3 x MDD.
 - b) Peak flow rates in salt water distribution mains = 2 x MDD.
- 3.4.15 As discussed in Section 3.3.3, all water consumption will be supplied by fresh water distribution mains. So, a peak factor of 3 is adopted for fresh water for workers while 2 is adopted for flushing.
- 3.4.16 However, since the water demand for concrete production, asphalt production and tunnel/cavern works were considered based on the maximum production capacity or maximum usage, no peak factor is adopted for these water usages.

Residual Heads for Water Supply

- 3.4.17 The fresh water and flushing water supply systems for the proposed quarry development will be designed to provide minimum residual heads at the extremity of the system according to WSD Circular Letter No. 1/2007. The details are as follows:
- a) Fresh water: 20m

Estimation of Total Water Demand

- 3.4.18 To estimate water demand, the following equation is used:

$$\text{Estimated Water Demand} = \text{Number of Employees} \times \text{Unit Water Demand}$$

- 3.4.19 The water demands, including fresh water and flushing water, for the proposed quarry development are summarized in **Table 3.2**.

Table 3.2 Summary of Estimated Fresh and Flushing Water Demand for Regular Operation

Water Usage	No. of Employees	Unit Water Demand (m ³ /head/day)	MDD (m ³ /day)	Peak Factor	PWD (m ³ /day)
Workers' Use	100	0.03	3	3	9
Flushing	100	0.05	5	2	10
Concrete Production	-	-	1116	-	1116
Asphalt Production	-	-	19.2	-	19.2
Dust Suppression	-	-	82.2	-	82.2
Underground Quarry Excavation	-	-	108	-	108
Total:			1334	-	1345

3.4.20 According to **Table 3.3**, the proposed quarry development will require a total fresh demand of 1334 m³/day and 1345 m³/day under the condition of MDD and PWD respectively in the normal scenario.

3.4.21 For the assessment of the potential impact on freshwater supply network, both the water demand from the proposed quarry development and future nearby concrete batching plant development by others are considered. As such, the total water demand would be 2332 m³/day and 2343 m³/day under the condition of MDD and PWD respectively.

Table 3.3 Total Water Demands

Total Demand	MDD (m ³ /day)	PWD (m ³ /day)
Normal Scenario	1334	1345
Future nearby Concrete Batching Plant development (by others)	998	998
Total	2332	2343

3.5 Potential Impact on Fresh Waterworks Installations

Fresh Water Main

- 3.5.1 The DN40 (40GIL) fresh water mains near the TYNUQ site at Ngau Kok Wan do not have sufficient capacity to meet the water demand during both the construction and operation of TYNUQ. New connection to the fresh water supply system is considered necessary.
- 3.5.2 Two networks are available for connection. TYNUQ is located downstream to two fresh water supply system, i.e. DN400 fresh water mains on Tam Kon Shan Road to the east of TYNUQ from TYNLLFWSR, and DN250 fresh water mains on Cheung Tsing Highway located to the south of TYNUQ supplied by TYNHLFWSR.
- 3.5.3 The terrain between Tam Kon Shan Road and Ngau Kok Wan may present difficulties for laying water mains during the early stages of the project. Although the connection from the existing DN250 fresh water mains on Cheung Tsing Highway involves comparatively less construction works as compared to connection to the DN400 fresh water mains on Tam Kon Shan Road, the existing DN250 fresh water mains on Cheung Tsing Highway are maintained by Tsing Ma Control Area. Therefore, connection to the existing DN400 fresh water mains on Tam Kon Shan Road is more preferable.
- 3.5.4 It is proposed that the temporary waterworks connecting to the proposed TYNUQ site from the existing network will be undertaken by the quarry operator as part of the temporary works under the contract. The waterworks include temporary water main connecting directly to the site office, concrete production and other ancillary activities at Ngau Kok Wan. These temporary waterworks will be constructed and maintained by the Contractor throughout the contract period and will be removed from the site upon completion of the contract.
- 3.5.5 It is also identified that there is an existing 40GIL water main located within the proposed Tam Kon Shan portal site formation area. It connects water from Tam Kon Shan Road to Ngau Kok Wan. As presented in **Figure 2.2** and **2.3**, it is proposed to realign this section of 40GIL within the portal site formation footprint along the proposed portal slope and connect with the remaining section of the existing 40GIL to suit the proposed site formation works at the portal. The proposed realignment work will be constructed and maintained by the Contractor throughout the contract period. This section of the realigned 40GIL will be handed over to WSD upon completion of contract.

3.6 Potential Impact on Fresh Water Supply Network

- 3.6.1 The fresh water MDD of TYNUQ, i.e. 1345 m³/day, accounts for 7.9% TYNLLFWSR's capacity. It is recommended to connect to the DN400 freshwater mains as shown in **Figure 2.2** and **2.3** with 2 proposed schemes. It should be noted that these two proposed schemes are served as reference design to facilitate WIA purpose. The contractor is not required to follow these schemes and they could propose alternative schemes subject to the approval of relevant authorities as part of the contractor's temporary works design.
- 3.6.2 There are 2 proposed schemes for the connection route:
- Scheme 1 – Underground connection route
- 3.6.3 Following the breakthrough of the connection tunnel between Ngau Kok Wan and Tam Kon Shan, the contractor may install temporary water pipe within the tunnel to supply water from Tam Kon Shan to Ngau Kok Wan for ancillary activities. However, as water is essential for ancillary activities such as concrete production, the ancillary activities can only commence after the tunnel breakthrough with water pipe installed, which may occur several years after contract commencement.
- Scheme 2 – Aboveground connection route
- 3.6.4 After discussion with LandsD and HyD, an aboveground connection route is developed at the slope area under the Tsing Yi North Coastal Road viaduct. Temporary water pipe could be installed by the contractor along the existing maintenance access of slope for water supply from Tam Kon Shan to Ngau Kok Wan so as to facilitate early commencement of ancillary activities without the need to wait for tunnel breakthrough.

- 3.6.5 As shown in **Table 3.4**, the proposed quarry development will occupy 7.8% and 7.9% of the nominal capacity of TYNLLFWSR under the condition of MDD and PWD respectively. When the additional water demand of the future nearby concrete batching plant is also incorporated, the combined increase in demand would account for approximately 13.7% of the reservoir's nominal capacity.

Table 3.4 Estimated Total Fresh Water Demands to Existing Waterworks Installations

Waterworks Installations	Capacity (m³/day)	% of Water Demands over Capacity				Emergency Supply for Fire Fighting
		Normal Scenario		Future nearby Concrete Batching Plant development (by others)		
		MDD	PWD	MDD	PWD	
TYNLLFWSR	17,072	7.8%	7.9%	13.7%	13.7%	7.6%

- 3.6.6 With reference to the daily flow record of TYNLLFWSR from the period from January 2024 to August 2025 provided by WSD/NTW(SD), the average daily flow is 14,040 m³. Therefore, the estimated total water demand including the future nearby concrete batching plant would be 16,383m³, accounting for 96.0% of the TYNLLFWSR (17,072m³) which is sufficient.
- 3.6.7 In terms of hydraulic impact on the existing system, the impact on the head loss of a pipe main with larger diameter is less than that on a pipe main with smaller diameter. Assuming a maximum flow velocity 2 m/s for DN400 (0.251m³/s), the PWD of 1345 m³/day (0.016m³/s) accounts for approximate 6.4% capacity of the DN400. Since the T.W.L. and I.L. of TYNLLFWSR is at +75.04 mPD and +69.04 mPD respectively (75% water depth at +73.54 mPD), and the proposed site formation level of the TYNUQ site at Ngau Kok Wan is +5 mPD, the minimum residual head of 20 m is allowed at the system extremity. Under the fire-fighting scenario, the resultant residual water pressure at the system extremity is assessed to be not less than 17 m head, which complies with the fire-fighting requirement stipulated in WSD DI No. 1309.
- 3.6.8 For Scheme 1, one DN200 pipe arrangements are proposed. The hydraulic analysis of Scheme 1 estimating the head loss and residual head is enclosed in **Appendix C1**.
- 3.6.9 For Scheme 2, the proposed waterworks route runs along the site formation and slope of Tam Kon Shan Portal, reaching a maximum elevation of +52 mPD. The pressure head available from the existing freshwater system is insufficient to overcome this elevation difference. Therefore, a temporary pump well will be installed on-site to boost the supply and provide a minimum pressure head of +52 mPD. One DN200 pipe from the existing DN400 to the pump well and three DN100 pipes from the pump well to the site are proposed under Scheme 2. The calculated head losses and residual pressure heads for the proposed Scheme 2 route under both normal and fire-fighting conditions are provided in **Appendix C2**.

Requirements and Standards

- 3.6.10 Guidance and standards set out for the protection of WSD facilities under “Conditions of Working in the Vicinity of Waterworks Installations” is referred.
- 3.6.11 The allowable PPVs and vibration amplitudes for WSD facilities are provided in **Table 3.5**. An allowable PPV limit of 25mm/s is assigned to the associated pipeline.

Table 3.5 Typical Allowable PPV Values for WSD Utilities and Structures

Utility	Installation	Maximum Allowable Peak Particle Velocity (mm/s)	Maximum Allowable Vibrational Amplitude (mm)
Water Supplies Department	Water Mains	25	0.2

- 3.6.12 A section of existing 40GIL pipe is identified near the proposed excavation works for tunnel and site formation. As shown in **Table 3.6**, an allowable differential settlement limit of 1 in 200 is assigned to the associated pipeline.

Table 3.6 Maximum Acceptable Differential Settlement of WSD Existing Pipe

Pipe material	GI
Maximum acceptable differential settlement	1 in 200

Potential Impact from Blasting Works and Protection / Mitigation Schemes

- 3.6.13 The blasting works in the proposed quarry development will induce ground vibration and disturb the utility facilities with an anticipated Maximum Instantaneous Charge (MIC) of 10kg per delay. The quarry operator shall control the PPV induced from the underground quarry development below the allowable limit. The vibration impact to the existing waterworks shall be within acceptable level.
- 3.6.14 To protect the utilities from the impact of blasting, the quarry operator shall identify all utilities within the blasting influence zone and liaise with corresponding utility undertakers for consulting the latest vibration limit. The design of blasting shall be timely reviewed to ensure the blasting induced vibration to the utilities is within the limit. The quarry operator shall provide all necessary protection for the utilities within blasting influence zone as per advice from the utility owners.
- 3.6.15 Allowable chargeweight of blasting works adopted in Underground Quarry Site should be restricted in order to reduce the PPV induced to existing waterworks to an acceptable level. After lowering down the allowable chargeweight adopted in particular portion of Underground Quarry Site, the vibration impact induced from the proposed blasting works would be controlled to within manageable level.
- 3.6.16 Vibration monitoring at the utilities would be carried out during the blasting operation if they are within the influence zone of that particular blast. The purpose of vibration monitoring is to reveal the adverse construction impact to the waterworks. Quarry operator shall take immediate action to strengthen the protection of waterworks when monitoring result exceed the Alert, Alarm and Action (AAA) Level. A proposed waterworks monitoring layout plan is shown in **Figure 3.1**, the monitoring plans shall be prepared by the quarry operator in construction / operation phase and agreed with Mines Division and WSD. Structure settlement markers would also be installed at the waterworks to provide settlement monitoring data for taking necessary protection strengthening measures when AAA Level exceedance is observed.

Proposed AAA Levels

- 3.6.17 The proposed AAA levels for ground vibration are shown in **Table 3.7**.

Table 3.7 Alert, Alarm and Action (AAA) Levels for Ground Vibration

Control Level	Triggering level
Alert (90% of 25mm/s)	22.5mm/s
Alarm (95% of 25mm/s)	23.7mm/s
Action (100% of 25mm/s)	25mm/s

3.6.18 The proposed AAA levels for differential settlement of WSD existing are shown in **Table 3.8**.

Table 3.8 Alert, Action and Alarm (AAA) levels for Differential Settlement of WSD Existing Pipe

Control Level	Triggering level
Alert	1:400
Alarm	1:300
Action	1:200

3.7 Conservation of Portable water

Reuse of Treated Sewage Effluent (TSE)

3.7.1 Due to the precious water resources in Hong Kong, it is worthwhile to consider the reuse of Treated Sewage Effluent (TSE) as it has the advantage of reducing wastewater discharge in receiving waterbodies thereby reducing the pollution load to the environment. Wastewater generated from the concrete batching and surface run-off in the site will be collected, treated and recycled by sedimentation tank. The treated water will be stored on site as a supplementing water supply source to support non-production and non-portable use. TSE would be mainly applied on flushing and dust control within the Site. On the other hand, TSE would also be used for washing and cleaning process and irrigation purposed to reduce the water demand. However, with an unstable generation rate of wastewater, the treated water can only be supplementing the fresh water supply and not regarded as an independent supply source. The application of treated effluent can be referred to **Appendix B**.

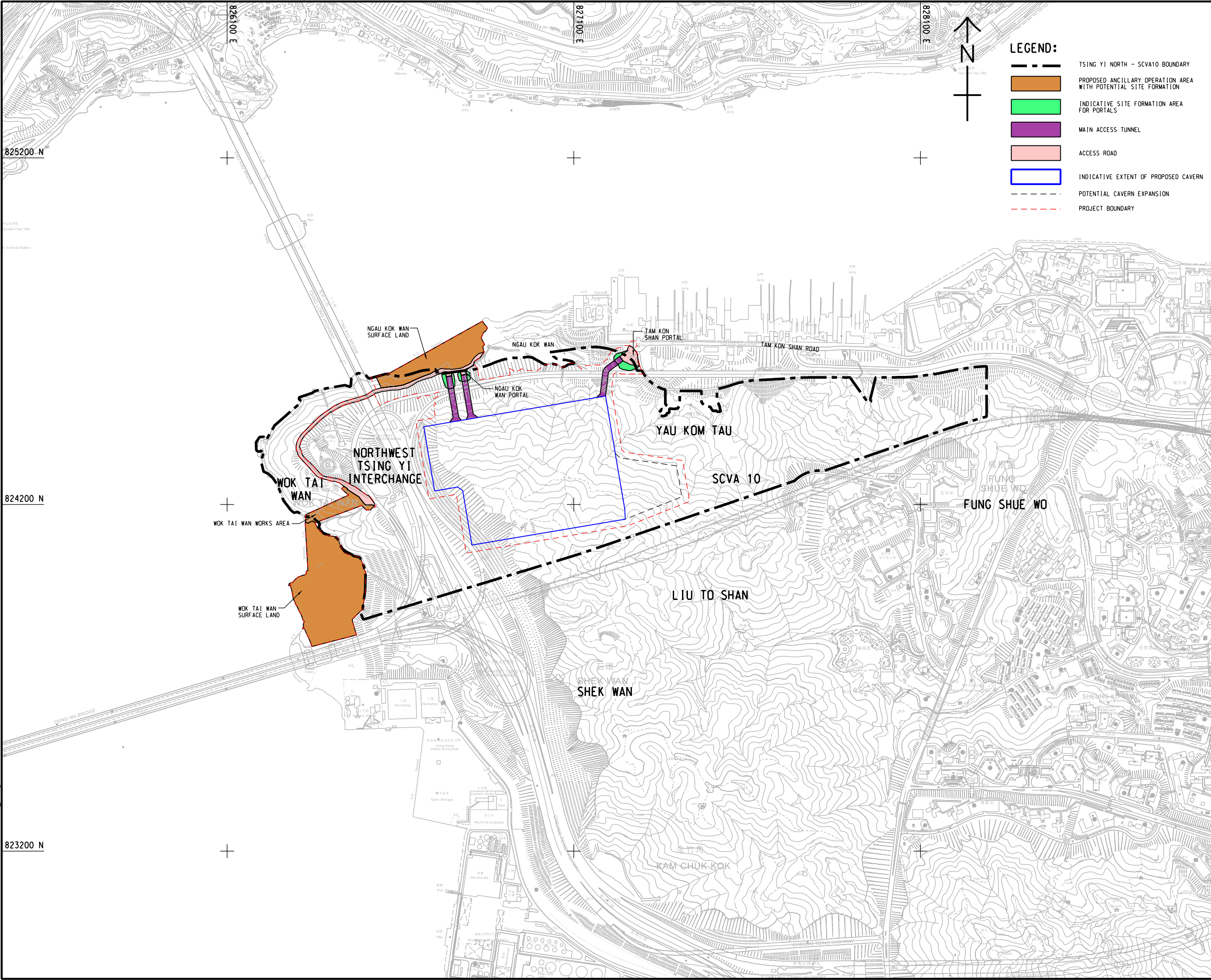
3.8 Conclusion of Waterworks Impact Assessment

- 3.8.1 The proposed TYNUQ is located near Ngau Kok Wan at the most downstream water mains network of Tsing Yi water supply zone. Two fresh water service reservoirs, namely TYNLLFWSR and TYNHLFWSR, are available for the fresh water supply to the proposed TYNUQ. After considering the system supply capacity and the convenience of connection to the two water supply systems, connection to the water mains to the east of the TYNUQ supplied by TYNLLFWSR is proposed.
- 3.8.2 Since the quarry operation and its ancillary activities form part of a temporary works of a construction site, similar to other existing quarry and planned underground quarry site, Temporary Mains-water for Flushing (TMF) is proposed to be adopted as source of water supply for toilet flushing.
- 3.8.3 It is proposed that the temporary waterworks connecting to the proposed TYNUQ site from the existing network will be undertaken by the quarry operator as part of the contract. The details of the new connection and its alignment are subject to further discussion with WSD by the Contractor (quarry operator), so that the actual water demand and the alignment of the new water main could fulfil the Contractor's operation requirements. These temporary waterworks will be constructed and maintained by the Contractor throughout the contract period and will be removed from the site upon completion of the contract.
- 3.8.4 It is also proposed to realign a section of 40GIL within the Tam Kon Shan portal site formation footprint along the proposed portal slope and connect with the remaining section of the existing 40GIL to suit the proposed site formation works. The details of the connection and its alignment are subject to further discussion with WSD by the Contractor (quarry operator), so that the alignment could fulfil the Contractor's site formation design. The proposed realignment work will be constructed and maintained by the Contractor throughout the contract period. This section of the realigned 40GIL will be handed over to WSD upon completion of contract.
- 3.8.5 Based on the assessment results, the proposed TYNUQ would require an additional water demand which is approximately 7.9% of and does not exceed the capacity of the TYNLLFWSR. It is envisaged that the water supply impact arising from the proposed development on the existing water supply system is acceptable, subject to further comments from relevant authorities.

Figures

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PROJECT
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QUARRYING AT
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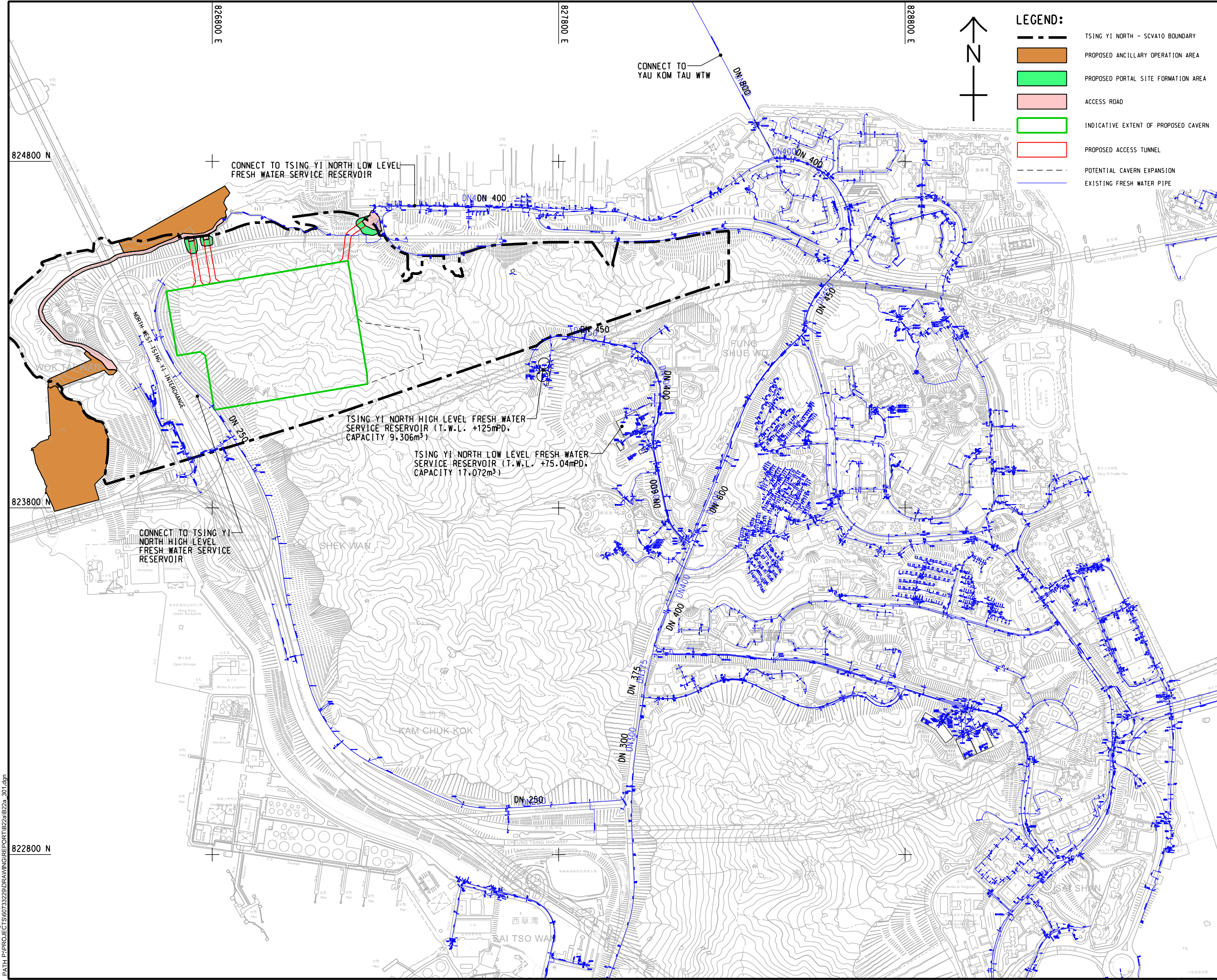
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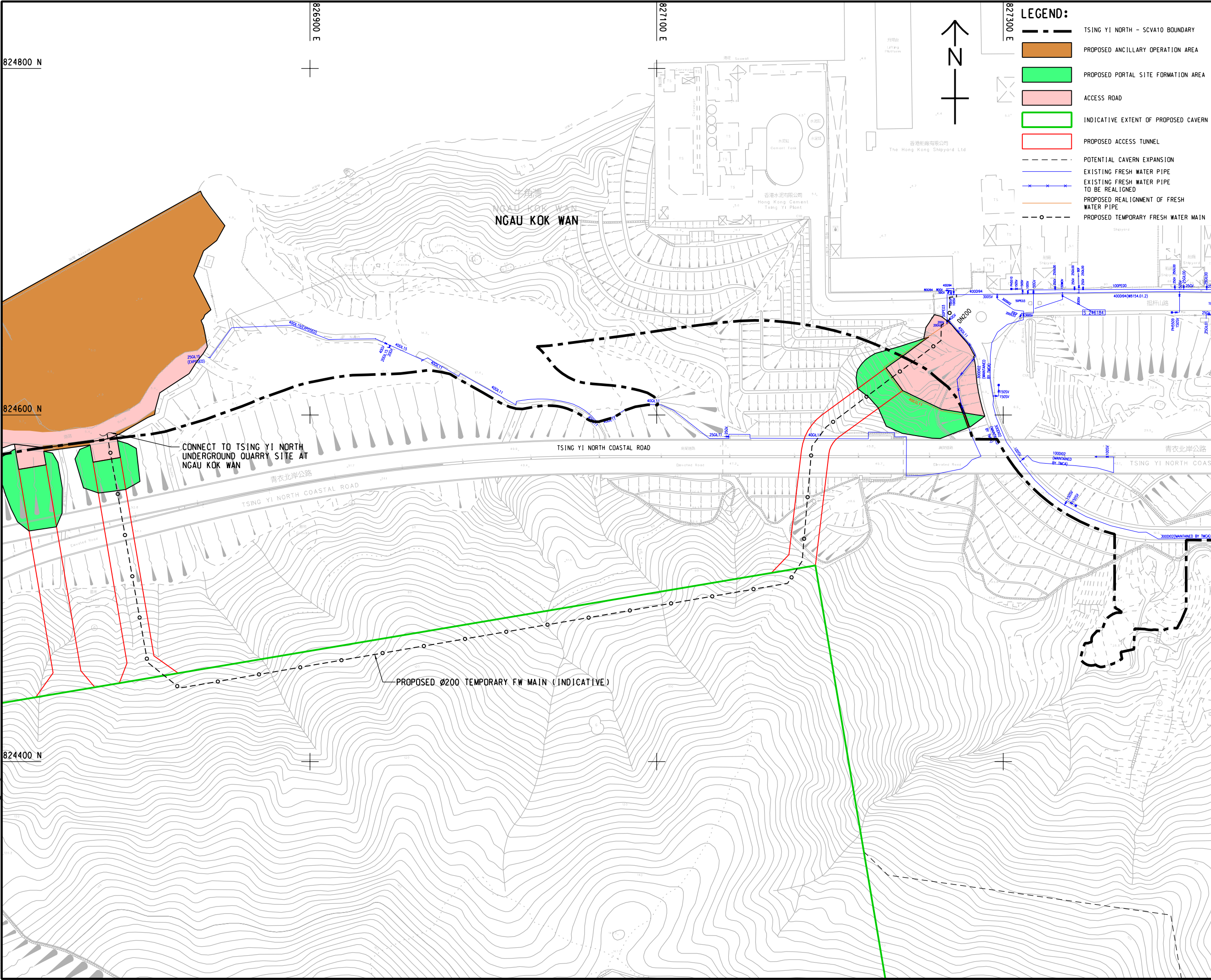
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60733229	CE 79/2023 (GE)
SHEET TITLE 圖紙名稱	
EXISTING FRESH WATER LAYOUT PLAN	
SHEET NUMBER 圖紙編號	
60733229/B22a/FIGURE 2.1	

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圖紙名稱
PROPOSED FRESH WATERWORKS LAYOUT PLAN (SCHEME 1)

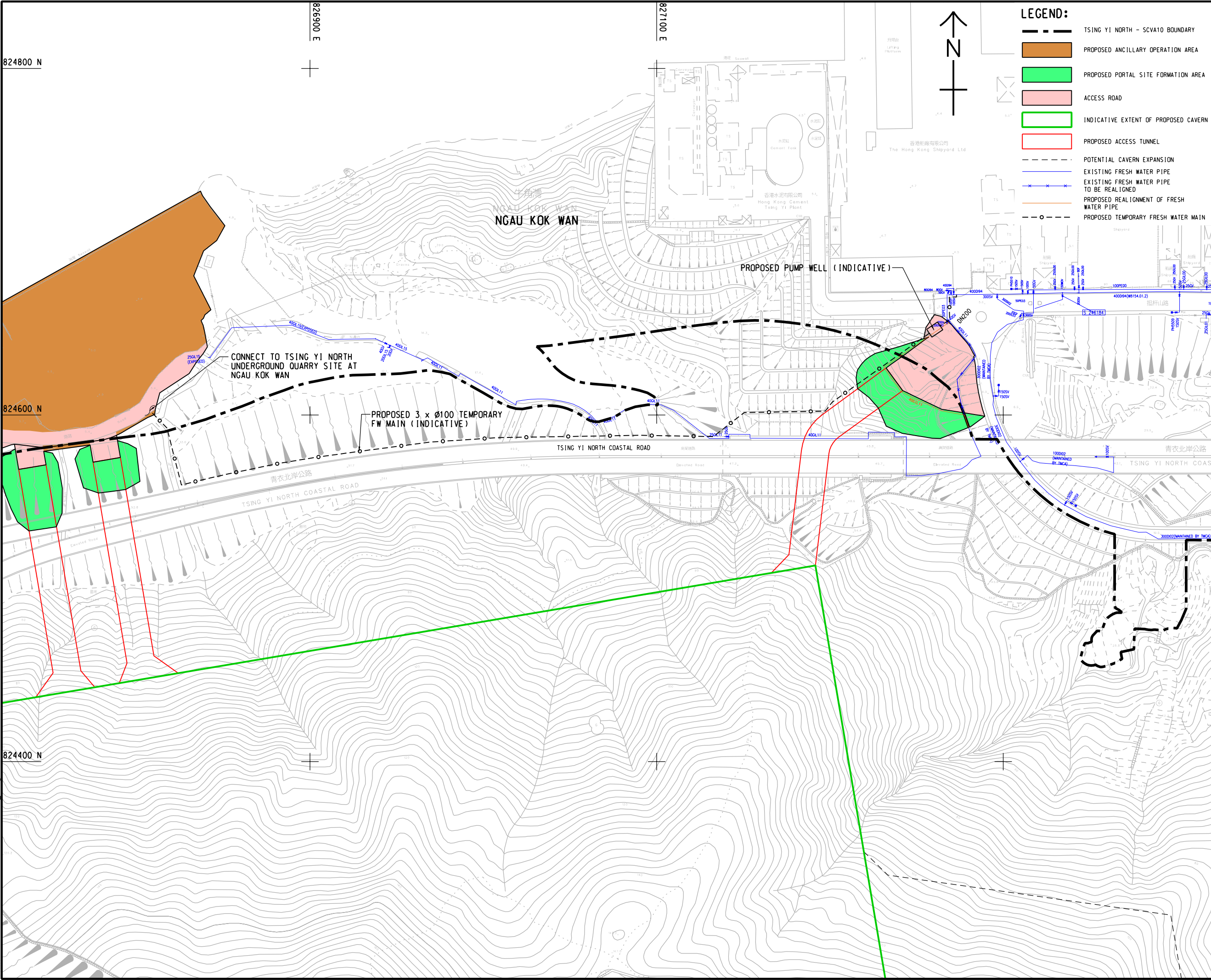
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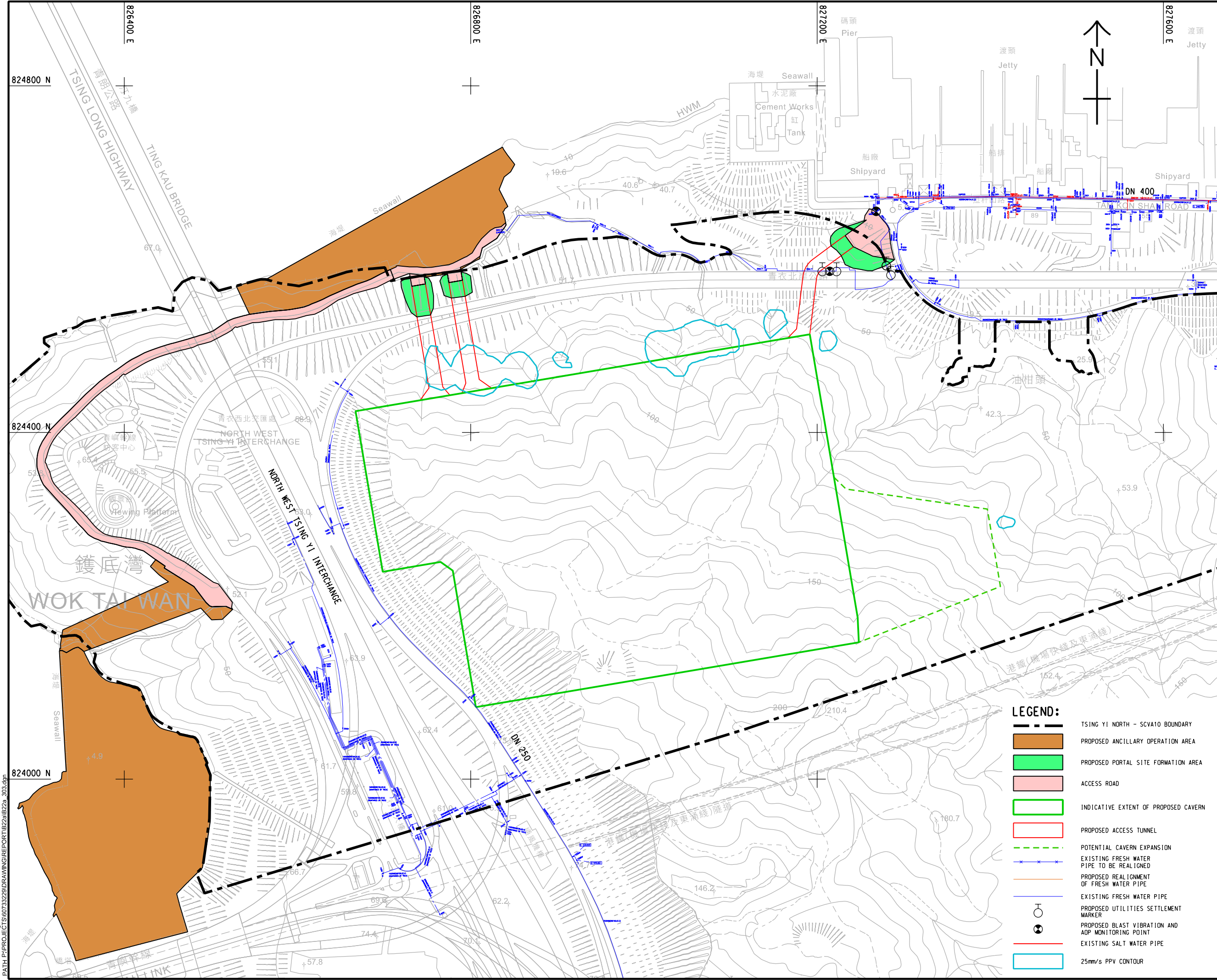
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PROPOSED FRESH WATERWORKS LAYOUT PLAN (SCHEME 2)

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- LEGEND:**
- TSING YI NORTH - SCVA10 BOUNDARY
 - PROPOSED ANCILLARY OPERATION AREA
 - PROPOSED PORTAL SITE FORMATION AREA
 - ACCESS ROAD
 - INDICATIVE EXTENT OF PROPOSED CAVERN
 - PROPOSED ACCESS TUNNEL
 - POTENTIAL CAVERN EXPANSION
 - EXISTING FRESH WATER PIPE TO BE REALIGNED
 - PROPOSED REALIGNMENT OF FRESH WATER PIPE
 - EXISTING FRESH WATER PIPE
 - PROPOSED UTILITIES SETTLEMENT MARKER
 - PROPOSED BLAST VIBRATION AND AOP MONITORING POINT
 - EXISTING SALT WATER PIPE
 - 25mm/s PPV CONTOUR

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WATERWORKS MONITORING LAYOUT PLAN

SHEET NUMBER
60733229/B22a/FIGURE 3.1

Appendix A

Existing Utilities Record

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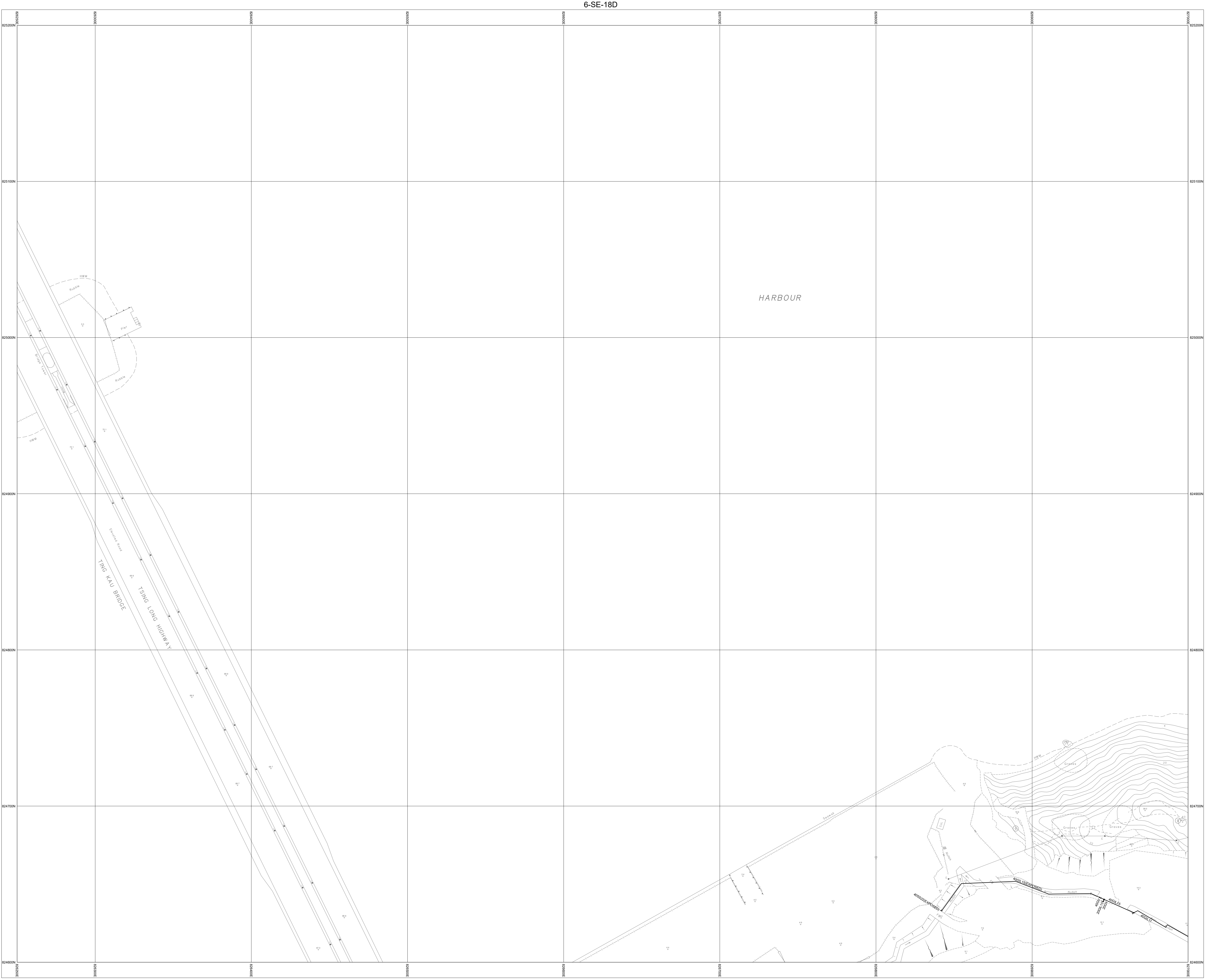
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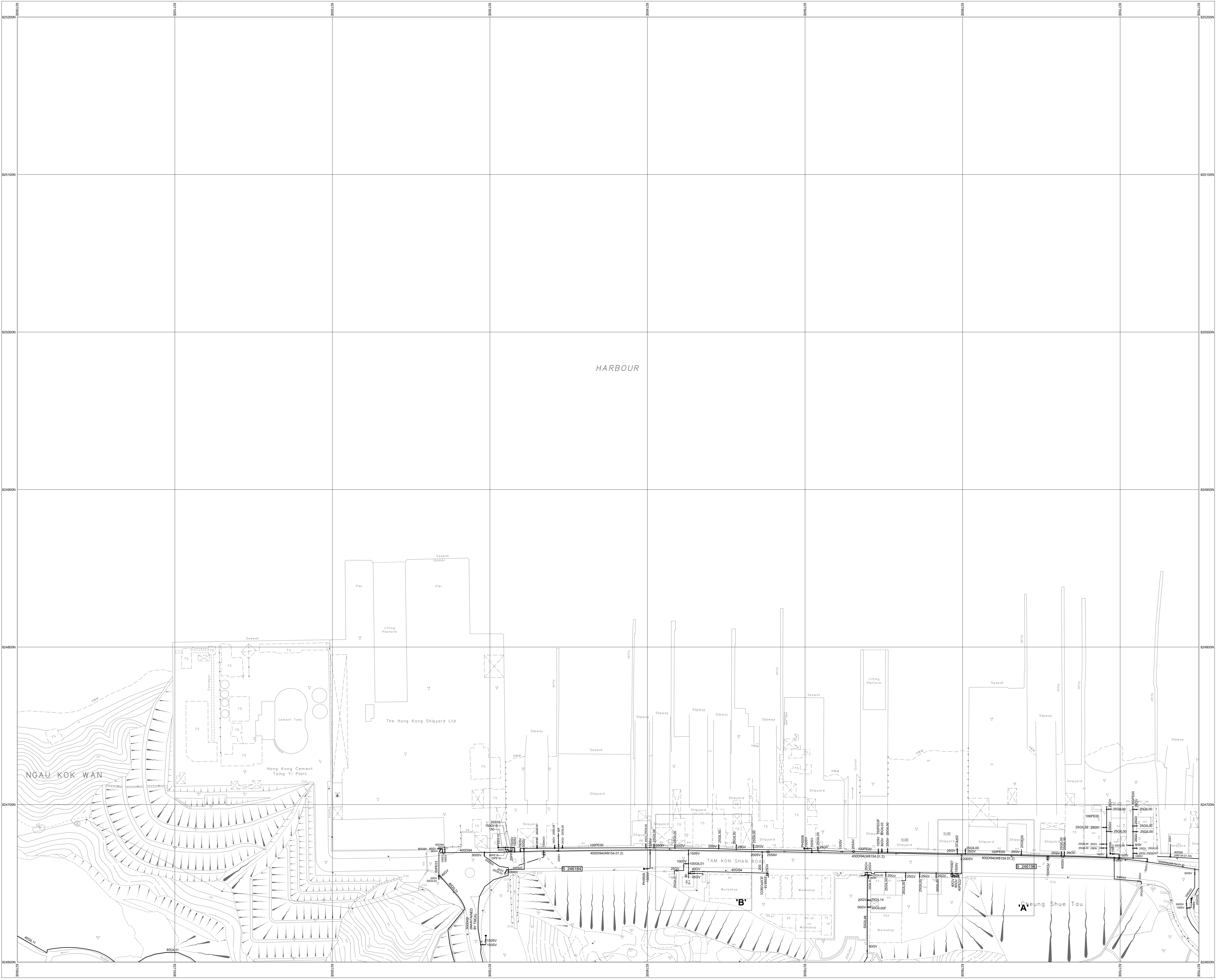
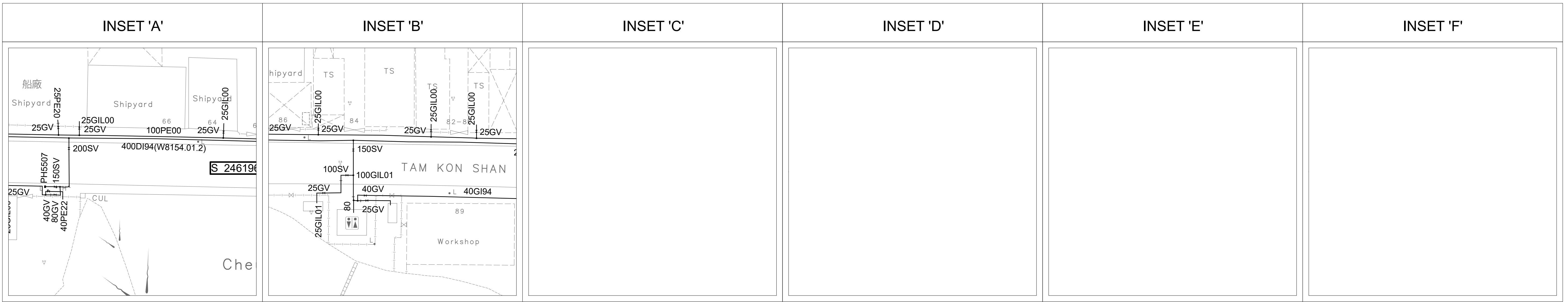
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TAM KON SHAN ROAD, TSING YI

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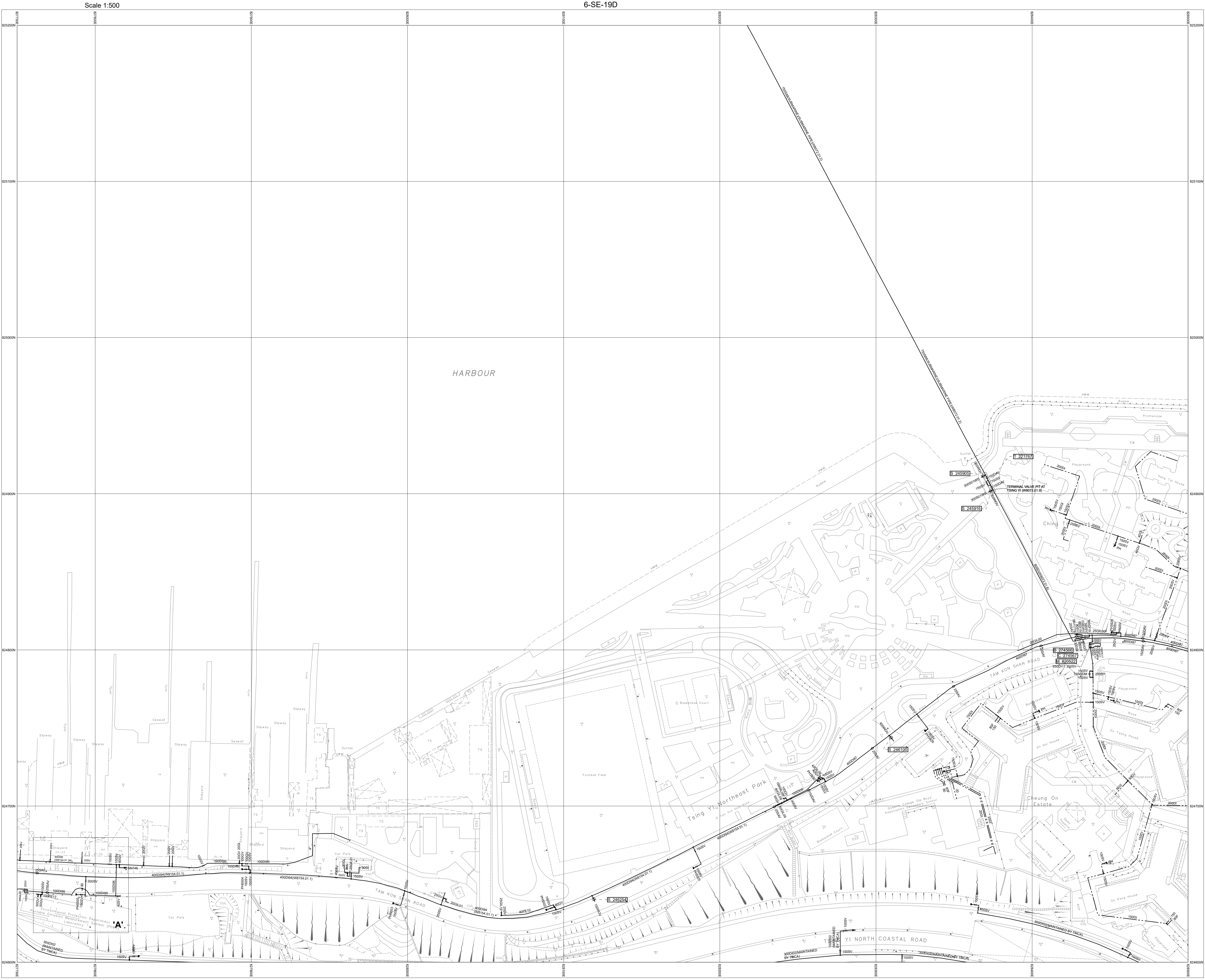
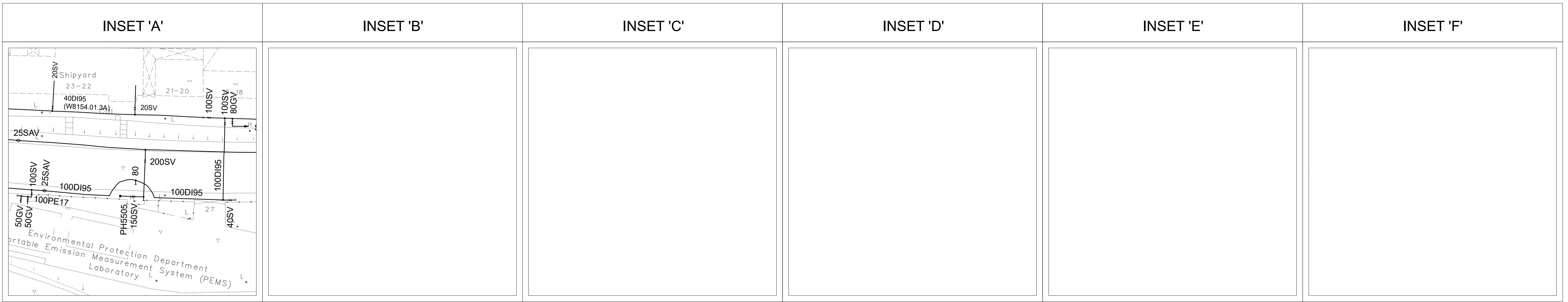
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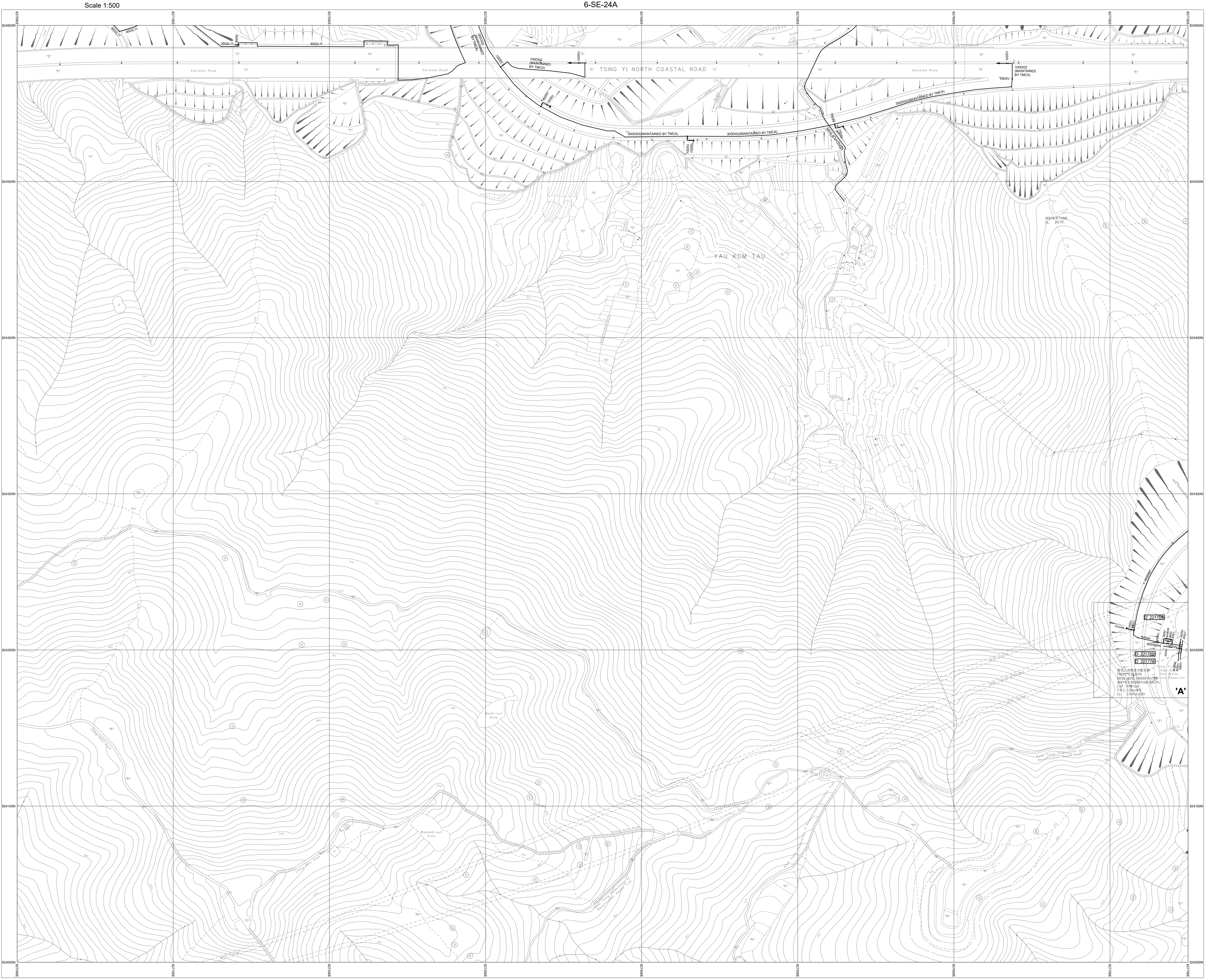
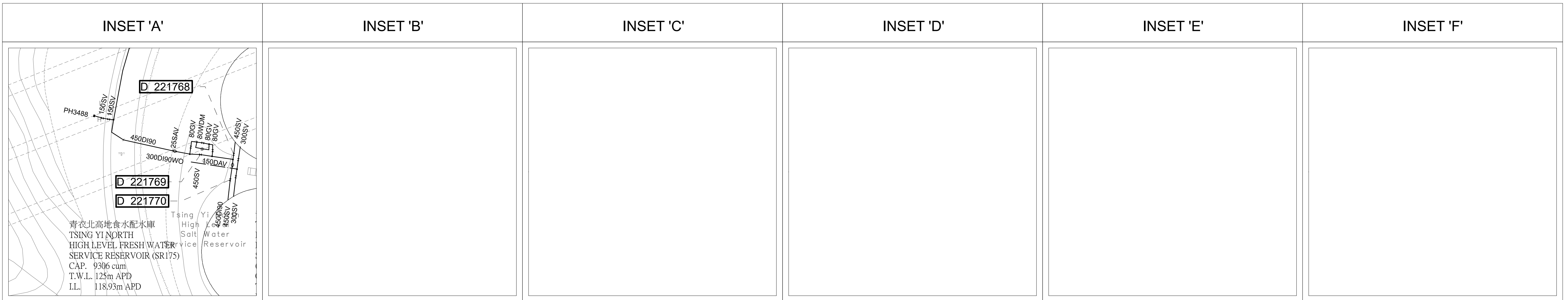
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CHEUNG ON ESTATE, TSING YI

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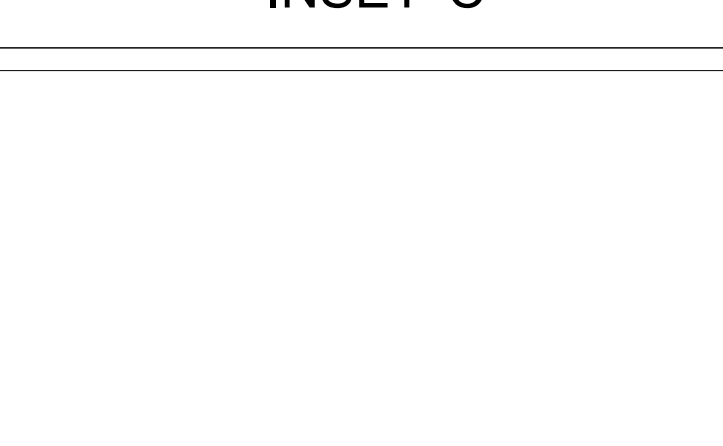
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INSET 'A'	

INSET 'B'



INSET 'C'



INSET 'D'

Figure 1 is a large, empty rectangular box with a thin black border, occupying the majority of the page below the title. It is labeled 'INSET 'E'' in the top right corner.

INSET 'F'

The map is a detailed topographic representation of the Fung Shue Wo area. It features contour lines indicating elevation, with labels such as 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, 950, 1000, 1050, 1100, 1150, 1200, 1250, 1300, 1350, 1400, 1450, 1500, 1550, 1600, 1650, 1700, 1750, 1800, 1850, 1900, 1950, 2000, 2050, 2100, 2150, 2200, 2250, 2300, 2350, 2400, 2450, 2500, 2550, 2600, 2650, 2700, 2750, 2800, 2850, 2900, 2950, 3000, 3050, 3100, 3150, 3200, 3250, 3300, 3350, 3400, 3450, 3500, 3550, 3600, 3650, 3700, 3750, 3800, 3850, 3900, 3950, 4000, 4050, 4100, 4150, 4200, 4250, 4300, 4350, 4400, 4450, 4500, 4550, 4600, 4650, 4700, 4750, 4800, 4850, 4900, 4950, 5000, 5050, 5100, 5150, 5200, 5250, 5300, 5350, 5400, 5450, 5500, 5550, 5600, 5650, 5700, 5750, 5800, 5850, 5900, 5950, 6000, 6050, 6100, 6150, 6200, 6250, 6300, 6350, 6400, 6450, 6500, 6550, 6600, 6650, 6700, 6750, 6800, 6850, 6900, 6950, 7000, 7050, 7100, 7150, 7200, 7250, 7300, 7350, 7400, 7450, 7500, 7550, 7600, 7650, 7700, 7750, 7800, 7850, 7900, 7950, 8000, 8050, 8100, 8150, 8200, 8250, 8300, 8350, 8400, 8450, 8500, 8550, 8600, 8650, 8700, 8750, 8800, 8850, 8900, 8950, 9000, 9050, 9100, 9150, 9200, 9250, 9300, 9350, 9400, 9450, 9500, 9550, 9600, 9650, 9700, 9750, 9800, 9850, 9900, 9950, 10000. The map also shows various roads, including 'TSING YI COASTAL ROAD', 'FUNG SHUE WO', and 'WANG ESTATE'. It includes numerous labels for buildings, such as 'S.K.H. Ho Chuk Wan Primary School', 'Cheung Hang Estate', and 'Wang Estate'. The map is overlaid with a grid and includes numerous numerical annotations and labels for specific locations and features.

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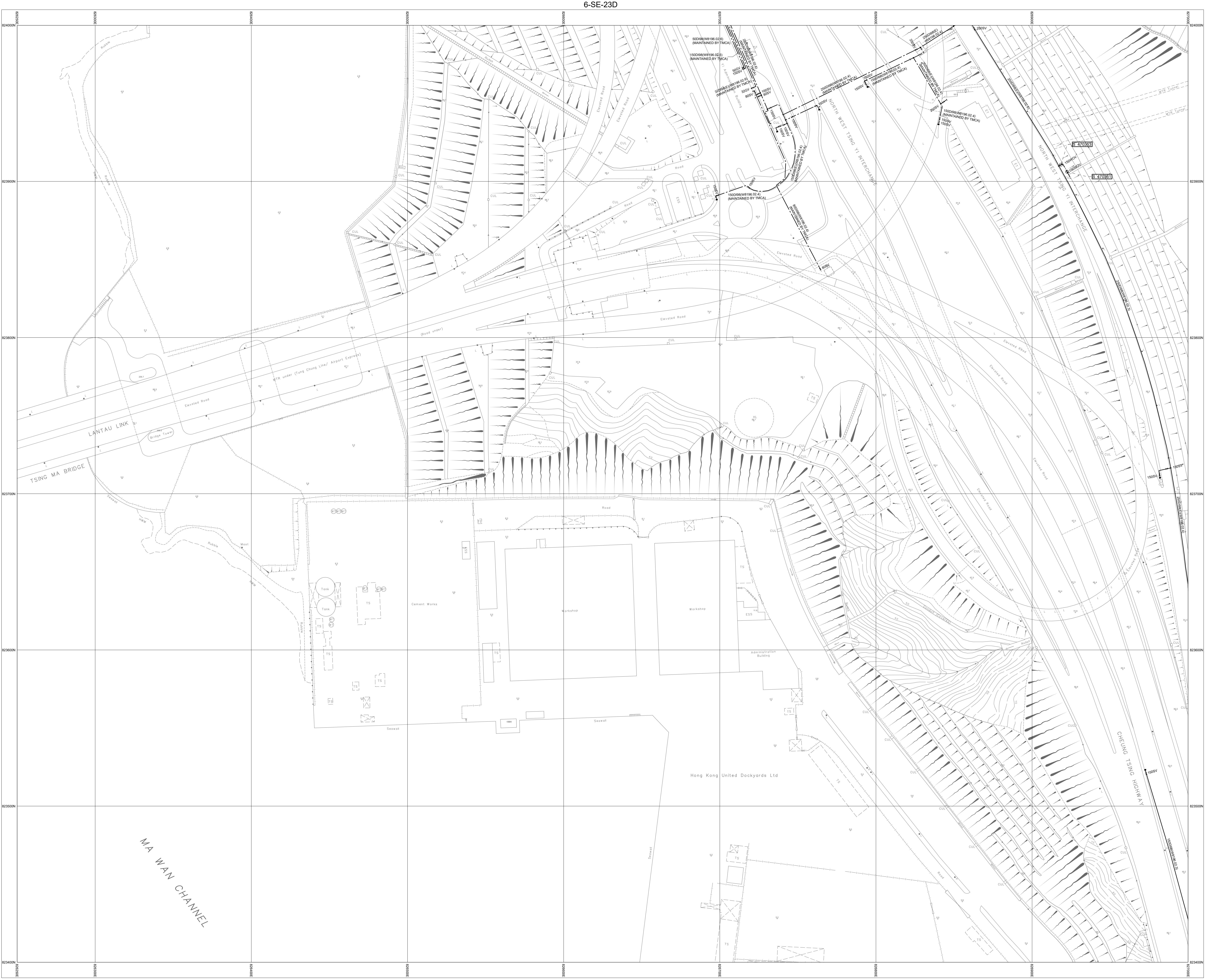
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FRESH WATER MAINS RECORD PLAN

NORTH WEST TSING YI

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DATE REVISED : 20/04/2022

SIGNED

K.T. CHU
CE/MSW

DATE: 07/10/1999

DRAWING NO.

W67880/ 10-NE-3B

 Water Supplies Department
HONG KONG

Reference Date Updated On: 2024/03/19

SCALE

1:1 000

METRES 20 10 0 20 40 60 80 100 METRES

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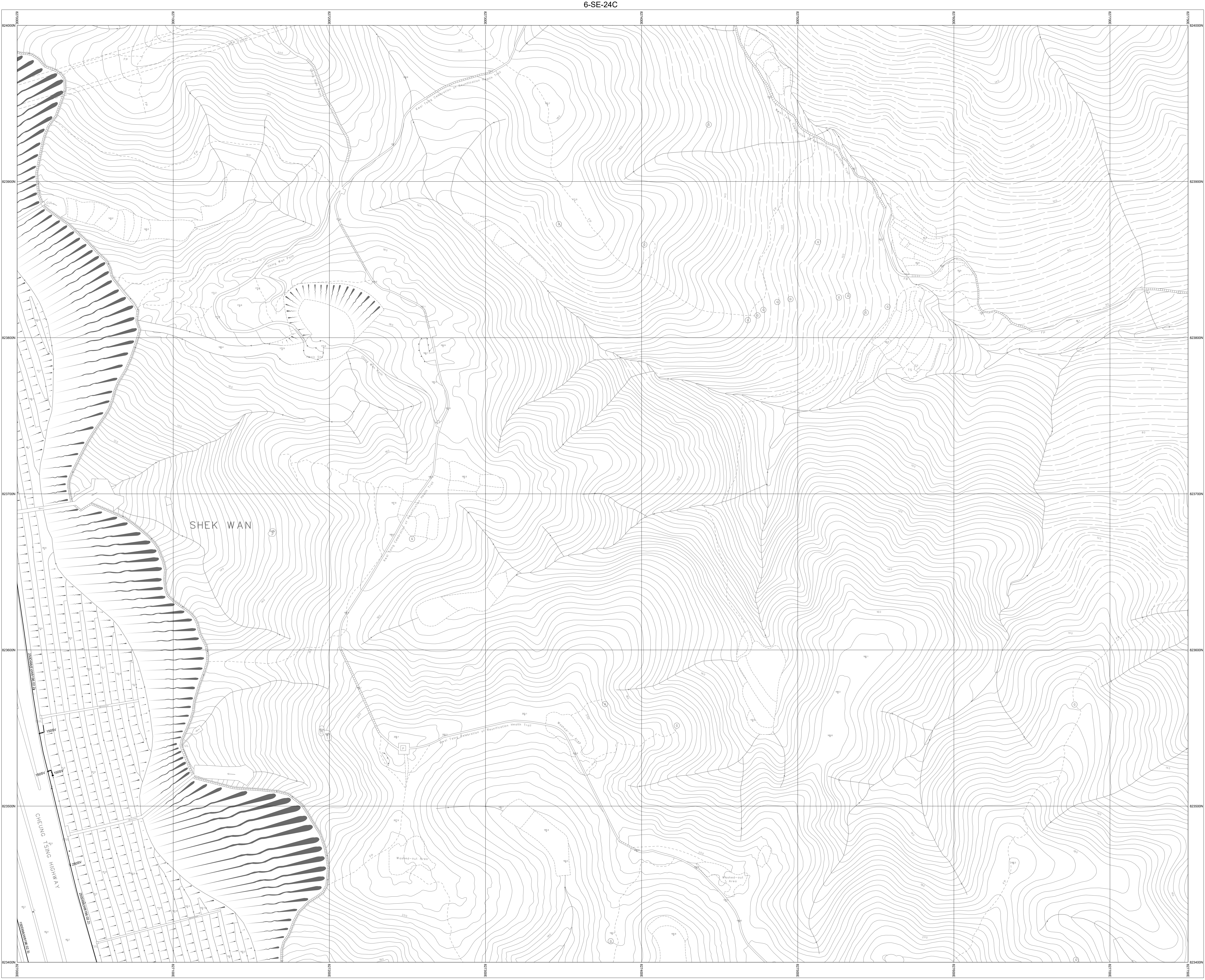
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INSET 'F'



NOTES:

1. FOR MAINS RECORDS SIGN CONVENTIONS AND DESIGNATIONS SEE SKETCH NO.3988.
2. DIMENSIONS OF MAINS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
3. ALL LEVELS ARE IN METRES ABOVE PRINCIPAL DATUM.

SCALE 1:1 000

METRES 20 10 0 20 40 60 80 100 METRES

FRESH WATER MAINS RECORD PLAN

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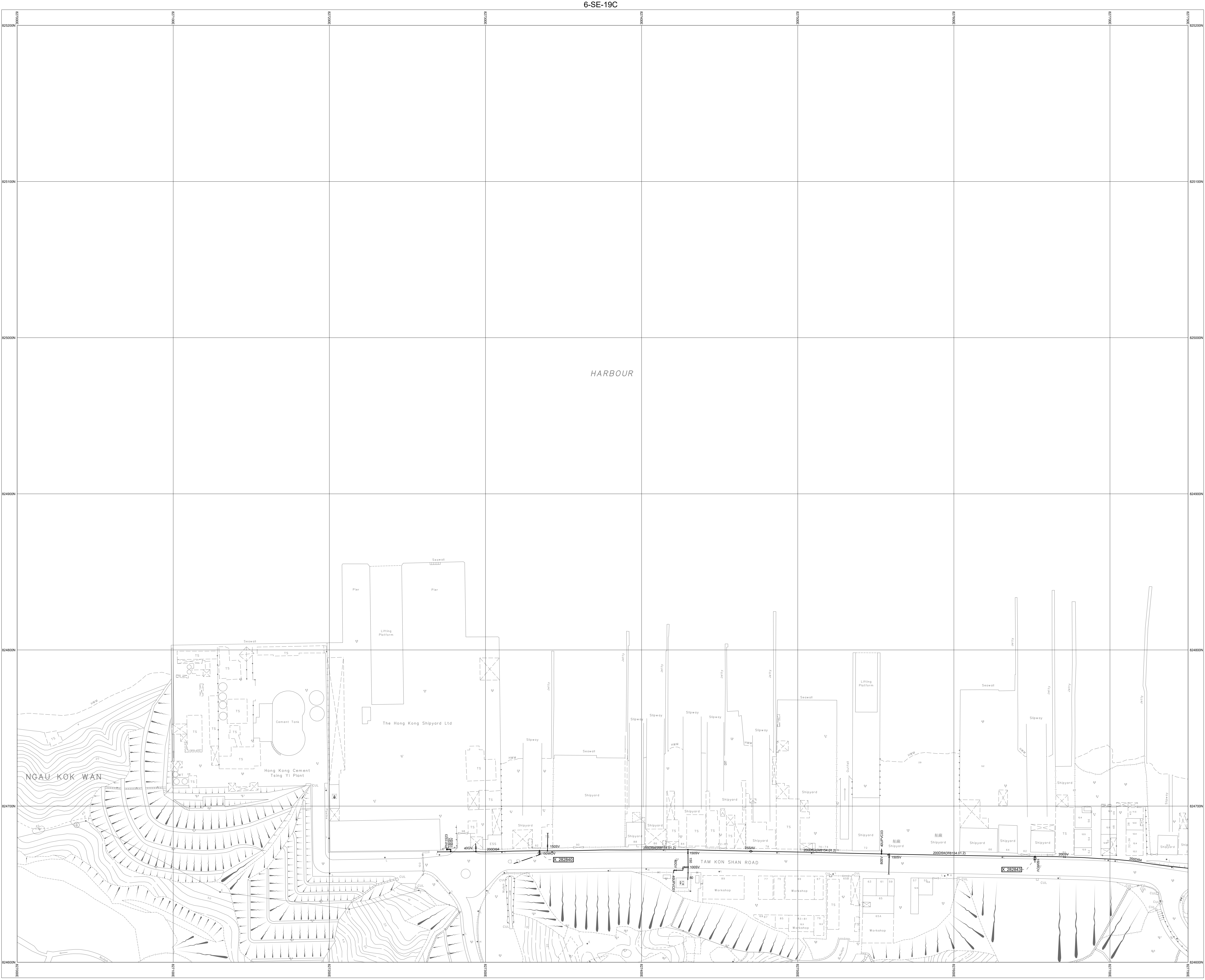
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6-SE-24C

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Water Supplies Department
HONG KONG

TAM KON SHAN ROAD, TSING YI

SCALE 1:1 000

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INSET 'A'

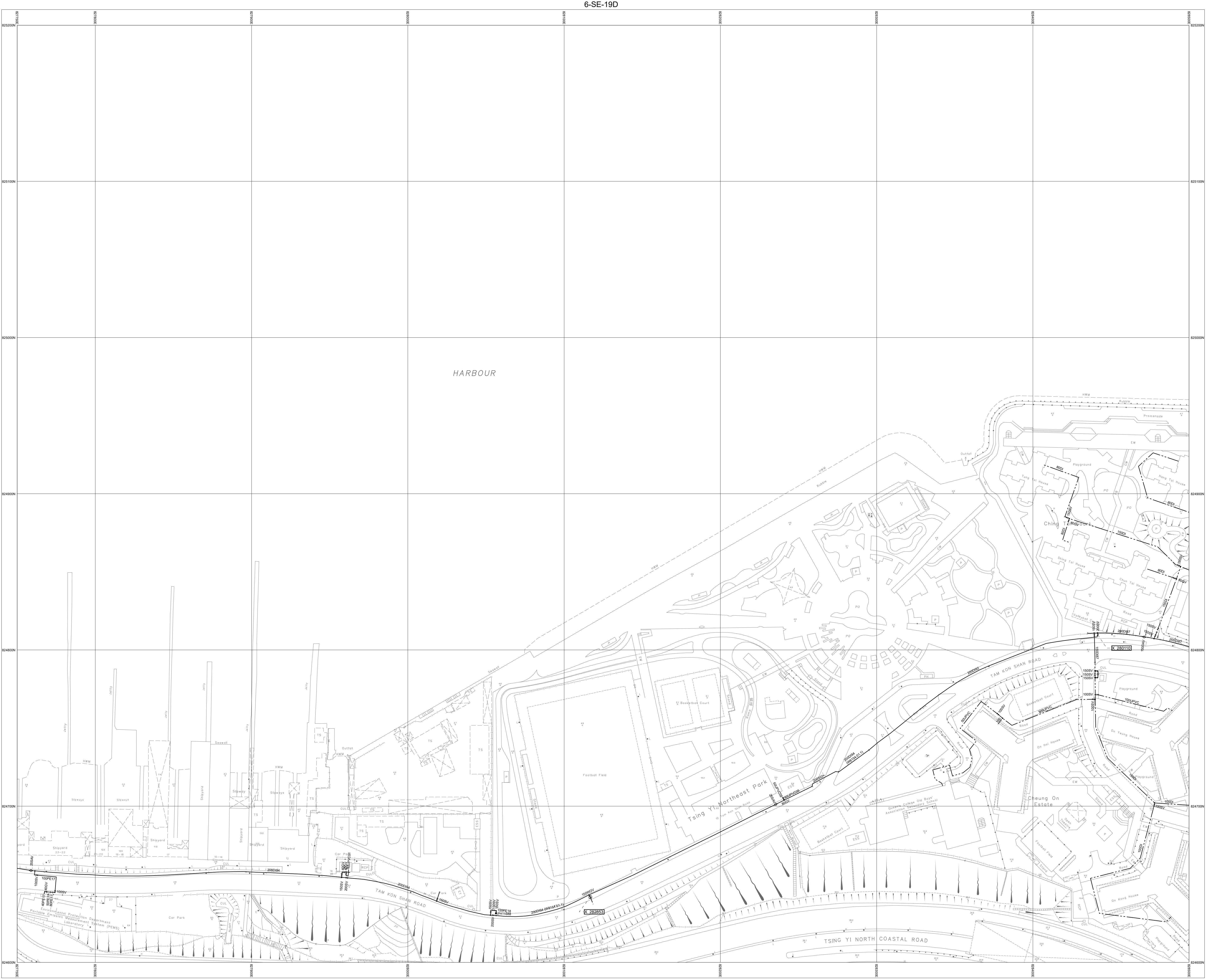
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NOTES:
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6-SE-24D

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SALT WATER MAINS RECORD PLAN

CHEUNG ON ESTATE, TSING YI

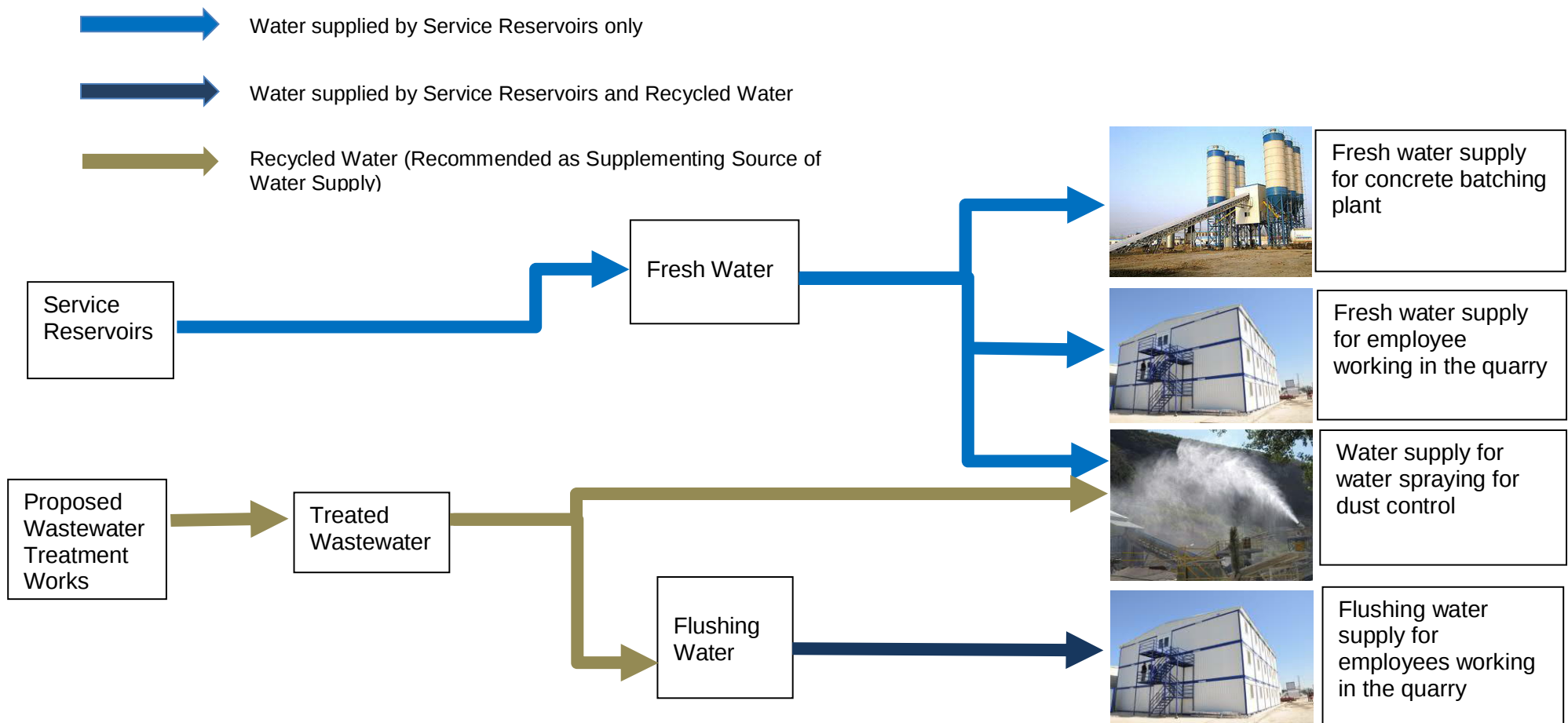
SCALE 1:1 000

METRES 20 10 0 20 40 60 80 100 METRES

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Appendix B

Schematic Flow Diagram of Proposed Water Supply Arrangement



Schematic Flow of Proposed Water Supply Arrangement

Appendix C

Hydraulic Analysis of Head Loss and Residual Head

Appendix C1

Estimation of Hydraulic Gradient and Headloss by using Hazen-Williams Equation

$$V = 0.85 C_{hw} R^{0.63} S_f^{0.54}$$

Location : Tsing Yi Underground Quarry
Water Type : Fresh Water
Scheme 1 (Normal Scenario)

From TYNLLFWSR to Tsing Yi Underground Quarry

Parameters	Unit	Watermain Section			
		DN600	DN450	DN400	DN200
Nominal Pipe Diameter, DN	mm	600	450	400	200
Assumed Velocity Under Peak Flow Condition, V	m/s	2.5	2.0	2.0	1.0 *
Hydraulic Radius, R	m	0.15	0.1125	0.1	0.05
Hazen-Williams Coef, C_{hw}		120	110	110	110
Hydraulic Gradient, S_f or 1 in		0.0095 105	0.0103 97	0.0119 84	0.0073 138
Travel Distance	m	1,130	240	1,600	830
Estimated Headloss	m	10.8	2.5	19.0	6.0

* Peak Velocity for 1345 m³/12 hr flow

Frictional Loss	m	38.3
Minor Loss*	m	7.7
Total Head loss	m	45.9

* Assumed as 20% of Length Factor and Frictional Loss

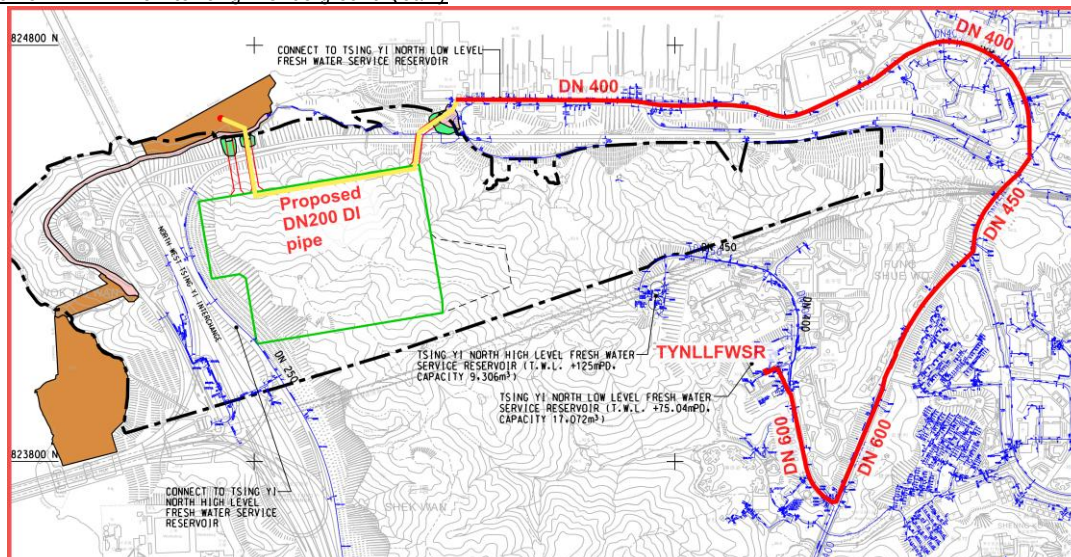
Top Water Level of Service Reservoir	mPD	75.0
Invert Level of Service Reservoir	mPD	69.0
Delivery Head at Service Reservoir (75% of the full depth)	mPD	73.5
Water Head at Tee-off Location	mPD	27.6
Residual Head	m	22.6

Note:

For conservative, assume the maximum flow velocity of DI 1309 for hydraulic assessment.

Pipe Diameter (mm)	Flow Velocity (m/s)
> DN700	3.0
DN700 - DN525	2.5
DN450 - DN375	2.0
<= DN300	1.5

Route from TYNLLFWSR to Tsing Yi Underground Quarry



Estimation of Hydraulic Gradient and Headloss by using Hazen-Williams Equation

$$V = 0.85 C_{hw} R^{0.63} S_f^{0.54}$$

Location : Tsing Yi Underground Quarry
Water Type : Fresh Water
Scheme 1 (Firefighting Scenario)

From TYNLLFWSR to Tsing Yi Underground Quarry

Parameters	Unit	Watermain Section			
		DN600	DN450	DN400	DN200
Nominal Pipe Diameter, DN	mm	600	450	400	200
Assumed Velocity Under Peak Flow Condition, V	m/s	2.5	2.0	2.0	0.5 *
Hydraulic Radius, R	m	0.15	0.1125	0.1	0.05
Hazen-Williams Coef, C_{hw}		120	110	110	110
Hydraulic Gradient, S_f or 1 in		0.0095 105	0.0103 97	0.0119 84	0.0019 533
Travel Distance	m	1,130	240	1,600	830
Estimated Headloss	m	10.8	2.5	19.0	1.6

* Peak Velocity for 900 L/min flow, assume the whole site would be suspended during a fire that firefighting water demand is the only water demand

no restriction on flow velocity under fire flow condition provided that the required firefighting pressure at fire hydrants can be maintained.

Frictional Loss	m	33.8
Minor Loss*	m	6.8
Total Head loss	m	40.5

* Assumed as 20% of Length Factor and Frictional Loss

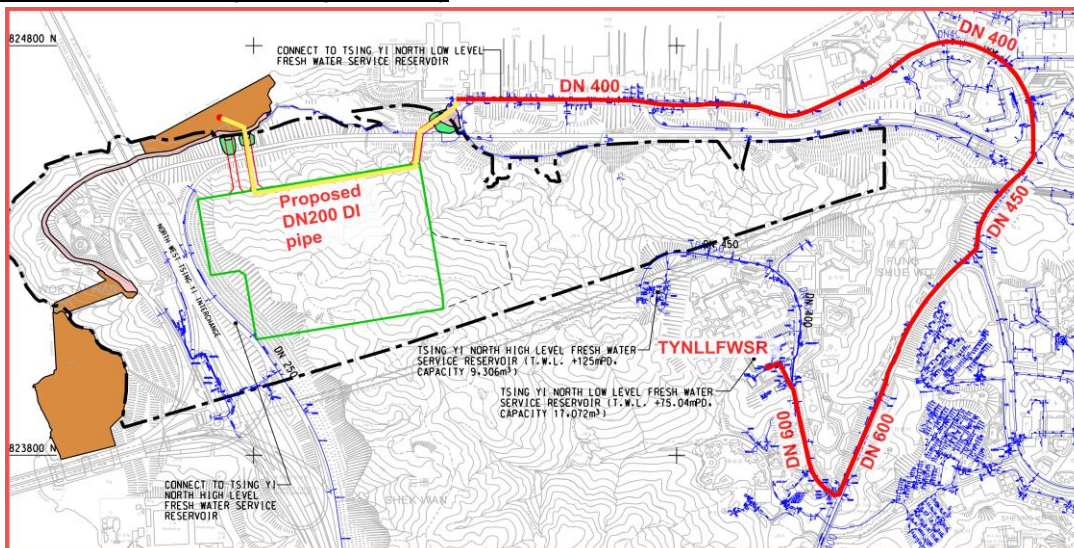
Top Water Level of Service Reservoir	mPD	75.0
Invert Level of Service Reservoir	mPD	69.0
Delivery Head at Service Reservoir (75% of the full depth)	mPD	73.5
Water Head at Tee-off Location	mPD	33.0
Residual Head	m	28.0

Note:

For conservative, assume the maximum flow velocity of DI 1309 for hydraulic assessment.

Pipe Diameter (mm)	Flow Velocity (m/s)
> DN700	3.0
DN700 - DN525	2.5
DN450 - DN375	2.0
<= DN300	1.5

Route from TYNLLFWSR to Tsing Yi Underground Quarry



Appendix C2

Estimation of Hydraulic Gradient and Headloss by using Hazen-Williams Equation

$$V = 0.85 C_{hw} R^{0.63} S_f^{0.54}$$

Location : Tsing Yi Underground Quarry
 Water Type : Fresh Water
 Scheme 2 (Normal Scenario)

From TYNLLFWSR to Tsing Yi Underground Quarry

Parameters	Unit	Watermain Section				After Pump
		DN600	DN450	DN400	DN200	DN100*3
Nominal Pipe Diameter, DN	mm	600	450	400	200	100
Assumed Velocity Under Peak Flow Condition, V	m/s	2.5	2.0	2.0	1.0 *	1.3 *
Hydraulic Radius, R	m	0.15	0.1125	0.1	0.05	0.025
Hazen-Williams Coef, C_{hw}		120	110	110	110	135
Hydraulic Gradient, S_f or 1 in		0.0095 105	0.0103 97	0.0119 84	0.0073 138	0.0190 53
Travel Distance	m	1,130	240	1,600	30	520
Estimated Headloss	m	10.8	2.5	19.0	0.2	9.9

* Peak Velocity for 1345 m³/12 hr flow

Frictional Loss	m	32.4
Minor Loss*	m	6.5
Total Head loss	m	38.9

* Assumed as 20% of Length Factor and Frictional Loss

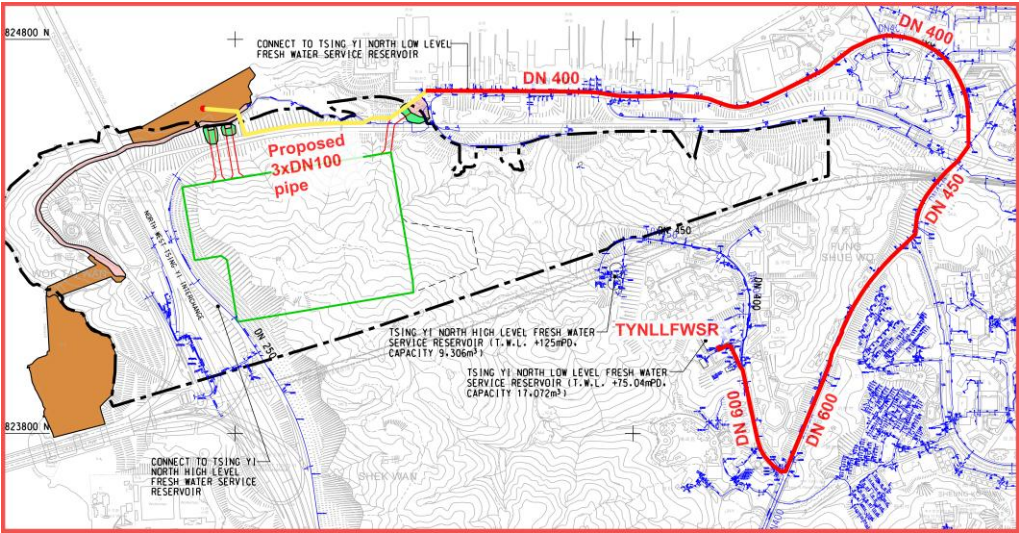
Top Water Level of Service Reservoir	mPD	75.0
Invert Level of Service Reservoir	mPD	69.0
Delivery Head at Service Reservoir (75% of the full depth)	mPD	73.5
Water Head at Tee-off Location	mPD	34.6
Residual Head before Pump	m	29.6
Pump pressure	mPD	52.0
Water Head at Tee-off Location	mPD	42.1
Residual Head at site	m	37.1

Note:

For conservative , assume the maximum flow velocity of DI 1309 for hydraulic assessment.

Pipe Diameter (mm)	Flow Velocity (m/s)
> DN700	3.0
DN700 - DN525	2.5
DN450 - DN375	2.0
<= DN300	1.5

Route from TYNLLFWSR to Tsing Ti Underground Quarry



Estimation of Hydraulic Gradient and Headloss by using Hazen-Williams Equation

$$V = 0.85 C_{hw} R^{0.63} S_f^{0.54}$$

Location : Tsing Yi Underground Quarry
Water Type : Fresh Water
Scheme 2 (Firefighting Scenario)

From TYNLLFWSR to Tsing Yi Underground Quarry

Parameters	Unit	Watermain Section				After Pump
		DN600	DN450	DN400	DN200	DN100*3
Nominal Pipe Diameter, DN	mm	600	450	400	200	100
Assumed Velocity Under Peak Flow Condition, V	m/s	2.5	2.0	2.0	0.5 *	0.6 *
Hydraulic Radius, R	m	0.15	0.1125	0.1	0.05	0.025
Hazen-Williams Coef, C_{hw}		120	110	110	110	135
Hydraulic Gradient, S_f or 1 in		0.0095 105	0.0103 97	0.0119 84	0.0019 533	0.0049 203
Travel Distance	m	1,130	240	1,600	30	520
Estimated Headloss	m	10.8	2.5	19.0	0.1	2.6

* Peak Velocity for 900 L/min flow, / Assume the whole site would be suspended during a fire that firefighting water demand is the only water demand, no restriction on flow velocity under fire flow condition provided that the required firefighting pressure at fire hydrants can be maintained.

Frictional Loss	m	32.3
Minor Loss*	m	6.5
Total Head loss	m	38.7

* Assumed as 20% of Length Factor and Frictional Loss

Top Water Level of Service Reservoir	mPD	75.0
Invert Level of Service Reservoir	mPD	69.0
Delivery Head at Service Reservoir (75% of the full depth)	mPD	73.5
Water Head at Tee-off Location	mPD	34.8
Residual Head before Pump	m	29.8
Pump pressure	mPD	52.0
Water Head at Tee-off Location	mPD	49.4
Residual Head at site	m	44.4

Note:
For conservative, assume the maximum flow velocity of DI 1309 for hydraulic assessment.

Pipe Diameter (mm)	Flow Velocity (m/s)
> DN700	3.0
DN700 - DN525	2.5
DN450 - DN375	2.0
<= DN300	1.5

Route from TYNLLFWSR to Tsing Ti Underground Quarry

