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☐ Urgent ☐ Return Receipt Requested ☐ Sign ☐ Encrypt ☐ Mark Subject Restricted ☐ Expand personal&publi

就規劃申請 申請編號為 A/ST/1025 提出意見
18/01/2024 00:32

From:
To: tpbpd@pland.gov.hk
Sent by: tpbpd@pland.gov.hk
File Ref:

Sha Tin is not a high-risk area for flooding. During the black rainstorm in 2023, there were only sporadic reports of minor flooding in Sha Tin. The Shing Mun River has a natural function of channeling water, which helps mitigate flooding.

While there may be instances of flooding in the tunnels along the river, the water naturally recedes within a few days after heavy rain, causing minimal disruption and posing no significant danger.

If we were to hypothetically experience an extremely rare event such as a 500-year storm combined with astronomical tides, causing the water level in the Shing Mun River to rise significantly, the capacity of the underground reservoir would be able to withstand the risk of flooding in Sha Tin?

Compared to areas like Chai Wan or Wong Tai Sin, which are more susceptible to flooding, Sha Tin already has sufficient and surplus drainage and flood prevention facilities. There is no need for additional engineering projects. It is only necessary to ensure timely channel clearance before heavy summer rains to maintain unobstructed water flow. The risk of flooding in Sha Tin is already low.

Even if localized water accumulation were to occur, as stated by the Director of Drainage Services, it would not pose a significant problem.

Given the annual fiscal deficit of the Hong Kong government, it is important to prioritize fiscal responsibility and reduce unnecessary public spending. Therefore, I hope the authorities will reconsider the necessity of constructing the underground reservoir in Sha Tin. It is highly disruptive and detrimental to the landscape of Sha Tin Park, hindering visitors' enjoyment of the facilities and green spaces.

With Regards,

沙田並非水浸黑點，在2023年黑色暴雨期間，沙田只有零星水浸報告，城門河已有自然疏通水浸嘅功用。
河道兩旁嘅隧道確實有水浸嘅現象，但大雨過後，過幾天就自然水退，擾民嘅時間很短，亦沒有什麼危險性。
假設再有這種500年一遇嘅暴雨，加上天文大潮，城門河水水位很高，請問這個地下蓄水池的容量是否可以抵擋到沙田水浸嘅風險呢
相對於柴灣或黃大仙，這些地區更加是水浸黑點，更加需要這裏防洪設施。
我覺得沙田現有嘅排水防洪設施已經足夠有餘，並不需要這種額外工程，只需在夏季

暴雨前及早疏通渠道，保證渠道暢通，沙田暴雨水浸嘅風險已經很低。
就算有，只是局部積水，正如渠務署處長所言。
香港政府年年財政赤字，應以量入為出為原則，減少不必要嘅公共開支，所以希望當局重新考慮是否再需要在沙田起這個地下蓄水池，因為我覺得非常之擾民，而且亦破壞沙田公園嘅景觀，阻礙遊人在相關設施或草地上消遣作樂。
此致

Appendix III of
<u>RNTPC Paper No. A/ST/1025</u>

Previous Application at Government Land at Sha Tin Park near Yi Ching Lane, Sha Tin, New Territories

Applications rejected by the RNTPC

No.	Application No.	Application Site	Applied Use	Site Area (m^2) (About)	Date of Consideration	Decision
1	A/ST/323	Part of Sha Tin Park	Heritage Museum	10,400	17.6.1994	Rejected

Reason for rejection

(a) The design of the proposed museum is bulky and massive and does not match the openness of Sha Tin Central Park;

(b) There is insufficient landscaping proposals in the submission to demostrate how the proposed museum will integrate with Sha Tin Central Park;

(c) No proposal on the diversion of the existing trunk storm water drain running across the application site has been included in the submission;

(d) The coach parking spaces for the proposed museum are insufficient.

Recommended Advisory Clauses

(a) to note the comments of the District Lands Officer/Sha Tin, Lands Department (DLO/ST, LandsD) that:

(i) should the application be approved by the Town Planning Board (the Board), Leisure and Cultural Services Department (LCSD) and Drainage Services Department (DSD) should liaise with his office for any necessary amendments/arrangements of the Government Land Allocation (GLA) (including the boundary) for Sha Tin Park; and

(ii) the proposed works boundary of the associated drainage pipes outside the Application Site as shown on the drawings nos. 60674881/R13/431 and 60617767/PER/FIGURE 2.5 both of Appendix H at Preliminary Environmental Review Report are not consistent. The drainage pipes as shown on the drawing no. 60617767/PER/FIGURE 2.5 of Appendix H together with another drawing no. 60617767/TIA_ST/FIGURE 1.9.1 of Appendix I in Traffic Impact Assessment Report should not fall within the areas responsible by the owners of relevant private developments under lease including (i) the Green Area of STTL 268 (Scenery Court), (ii) the Pink Area and near the Pink Hatched Green Area of STTL 161 (Hilton Plaza) and the Amenity Area of STTL 361 (New Town Plaza Phase III) to tally with the drawing no. 60674881/R13/431 because the relevant lease conditions have no provision to allow laying of government drains within the coloured areas as aforesaid;

(b) to note the comments of the Director of Leisure and Cultural Services (DLCS) to comply with the Technical Circular (Works) No. 4/2020 administered by the Development Bureau;

(c) to note the comments of the Chief Town Planner/Urban Design and Landscape, Planning Department (CTP/UD&L, PlanD) that approval of the application does not imply approval of tree works such as pruning, transplanting and felling under lease. The applicant is reminded to seek approval for any proposed tree works from relevant departments prior to commencement of the works;

(d) to note the comments of the Chief Architect/Advisory and Statutory Compliance Division, Architectural Services Department (CA/ASC, ArchSD) that the treatment/articulation of the building facades of the two buildings should be further considered in the design stage, particularly along the 41m long elevation of the pump house building to reduce the massive scale, and for the back elevations of the transformer room building, including its fence wall;

(e) to note the comments of the Director of Fire Services (D of FS) that:

(i) detailed fire services requirement will be formulated upon receipt of formal submission of general building plans and

(ii) the Emergency Vehicular Access (EVA) provision shall comply with the standard as stipulated in Section 6, Part D of the Code of Practice for Fire Safety in Buildings 2011, which is administered by the Buildings Department; and

(f) to note the comments of the Director of Food and Environmental Hygiene (DFEH):

(i) in case that Food and Environmental Hygiene Department (FEHD) is requested to take up management responsibility of new refuse collection points and other facilities, FEHD should be separately consulted. Prior consent from FEHD must be obtained and sufficient amount of recurrent cost must be provided to FEHD;

(ii) if provision of cleansing service for new public roads, streets, cycle tracks, footpaths, paved areas, public carpark, footbridge, subway, etc, is required, FEHD should be separately consulted. Prior consent from FEHD must be obtained and sufficient amount of recurrent cost must be provided to FEHD;

(iii) the associated works and operations shall not cause any environmental nuisance, pest infestation and obstruction to the surroundings. For any waste generated from the operations and works, the project proponent should arrange its proper disposal at their own expenses; and

(iv) no FEHD's facilities should be affected.

2023年 12月 2 0日
此文件在＿＿＿＿＿＿＿＿收到。城市規劃委員會只會在收到所有必要的資料及文件後才正式確認收到申請的日期。

20 DEC 2023
This document is received on ＿＿＿＿＿＿＿＿. The Town Planning Board will formally acknowledge the date of receipt of the application only upon receipt of all the required information and documents.

Form No. S16-I
表格第 S16-I 號

APPLICATION FOR PERMISSION UNDER SECTION 16 OF THE TOWN PLANNING ORDINANCE (CAP. 131)

根據《城市規劃條例》(第131章) 第16條遞交的許可申請

Applicable to proposals not involving or not only involving:
適用於建議不涉及或不祇涉及:

(i) Construction of "New Territories Exempted House(s)";
興建「新界豁免管制屋宇」;

(ii) Temporary use/development of land and/or building not exceeding 3 years in rural areas or Regulated Areas; and
位於鄉郊地區或受規管地區土地上及/或建築物內進行為期不超過三年的臨時用途/發展;及

(iii) Renewal of permission for temporary use or development in rural areas or Regulated Areas
位於鄉郊地區或受規管地區的臨時用途或發展的許可續期

Applicant who would like to publish the notice of application in local newspapers to meet one of the Town Planning Board's requirements of taking reasonable steps to obtain consent of or give notification to the current land owner, please refer to the following link regarding publishing the notice in the designated newspapers: https://www.tpb.gov.hk/en/plan_application/apply.html

申請人如欲在本地報章刊登申請通知，以採取城市規劃委員會就取得現行土地擁有人的同意或通知現行土地擁有人所指定的其中一項合理步驟，請瀏覽以下網址有關在指定的報章刊登通知：https://www.tpb.gov.hk/tc/plan_application/apply.html

General Note and Annotation for the Form
填寫表格的一般指引及註解

\# "Current land owner" means any person whose name is registered in the Land Registry as that of an owner of the land to which the application relates, as at 6 weeks before the application is made
「現行土地擁有人」指在提出申請前六星期，其姓名或名稱已在土地註冊處註冊為該申請所關乎的土地的擁有人的人

& Please attach documentary proof 請夾附證明文件

^ Please insert number where appropriate 請在適當地方註明編號

Please fill "NA" for inapplicable item 請在不適用的項目填寫「不適用」

Please use separate sheets if the space provided is insufficient 如所提供的空間不足，請另頁說明

Please insert a「✔」at the appropriate box 請在適當的方格內上加上「✔」號

2303191 8/12 by hand

For Official Use Only 請勿填寫此欄	Application No. 申請編號	A/ST/1025
	Date Received 收到日期	20 DEC 2023

1. The completed form and supporting documents (if any) should be sent to the Secretary, Town Planning Board (the Board), 15/F, North Point Government Offices, 333 Java Road, North Point, Hong Kong.
申請人須把填妥的申請表格及其他支持申請的文件（倘有），送交香港北角渣華道 333 號北角政府合署 15 樓城市規劃委員會(下稱「委員會」)秘書收。

2. Please read the "Guidance Notes" carefully before you fill in this form. The document can be downloaded from the Board's website at http://www.tpb.gov.hk/. It can also be obtained from the Secretariat of the Board at 15/F, North Point Government Offices, 333 Java Road, North Point, Hong Kong (Tel: 2231 4810 or 2231 4835), and the Planning Enquiry Counters of the Planning Department (Hotline: 2231 5000) (17/F, North Point Government Offices, 333 Java Road, North Point, Hong Kong and 14/F, Sha Tin Government Offices, 1 Sheung Wo Che Road, Sha Tin, New Territories).
請先細閱《申請須知》的資料單張，然後填寫此表格。該份文件可從委員會的網頁下載（網址：http://www.tpb.gov.hk/），亦可向委員會秘書處（香港北角渣華道 333 號北角政府合署 15 樓 – 電話：2231 4810 或 2231 4835)及規劃署的規劃資料查詢處(熱線：2231 5000) (香港北角渣華道 333 號北角政府合署 17 樓及新界沙田上禾輋路 1 號沙田政府合署 14 樓)索取。

3. This form can be downloaded from the Board's website, and obtained from the Secretariat of the Board and the Planning Enquiry Counters of the Planning Department. The form should be typed or completed in block letters. The processing of the application may be refused if the required information or the required copies are incomplete.
此表格可從委員會的網頁下載，亦可向委員會秘書處及規劃署的規劃資料查詢處索取。申請人須以打印方式或以正楷填寫表格。如果申請人所提交的資料或文件副本不齊全，委員會可拒絕處理有關申請。

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1. Name of Applicant 申請人姓名/名稱

(☐Mr. 先生 / ☐Mrs. 夫人 / ☐Miss 小姐 / ☐Ms. 女士 / ☐Company 公司 / ☑Organisation 機構)

Drainage Projects Division of Drainage Services Department
The Government of the Hong Kong Special Administration Region
香港特別行政區政府渠務署排水工程部

2. Name of Authorised Agent (if applicable) 獲授權代理人姓名/名稱（如適用）

(☐Mr. 先生 / ☐Mrs. 夫人 / ☐Miss 小姐 / ☐Ms. 女士 / ☑Company 公司 / ☐Organisation 機構)

AECOM Asia Company Limited

3. Application Site 申請地點

(a)	Full address / location / demarcation district and lot number (if applicable) 詳細地址／地點／丈量約份及地段號碼（如適用）	Government Land at Sha Tin Park near Yi Ching Lane, Sha Tin, New Territories (GLA-ST RSD) (Part)
(b)	Site area and/or gross floor area involved 涉及的地盤面積及／或總樓面面積	☑Site area 地盤面積 4530 sq.m 平方米☑About 約 ☑Gross floor area 總樓面面積 1350 sq.m 平方米☑About 約
(c)	Area of Government land included (if any) 所包括的政府土地面積（倘有）	4530 sq.m 平方米 ☑About 約

(d)	Name and number of the related statutory plan(s) 有關法定圖則的名稱及編號	Approved Sha Tin Outline Zone Planning Plan No. S/ST/37
(e)	Land use zone(s) involved 涉及的土地用途地帶	Open Space (O)
(f)	Current use(s) 現時用途	Sha Tin Park managed by Leuisure and Cultural Services Department (If there are any Government, institution or community facilities, please illustrate on plan and specify the use and gross floor area) (如有任何政府、機構或社區設施，請在圖則上顯示，並註明用途及總樓面面積)

4. "Current Land Owner" of Application Site 申請地點的「現行土地擁有人」

The applicant 申請人 –

☐ is the sole "current land owner"#& (please proceed to Part 6 and attach documentary proof of ownership).
是唯一的「現行土地擁有人」#& (請繼續填寫第 6 部分，並夾附業權證明文件)。

☐ is one of the "current land owners"# & (please attach documentary proof of ownership).
是其中一名「現行土地擁有人」#& (請夾附業權證明文件)。

☐ is not a "current land owner"#.
並不是「現行土地擁有人」#。

☑ The application site is entirely on Government land (please proceed to Part 6).
申請地點完全位於政府土地上（請繼續填寫第 6 部分）。

5. Statement on Owner's Consent/Notification
就土地擁有人的同意/通知土地擁有人的陳述

(a) According to the record(s) of the Land Registry as at .... (DD/MM/YYYY), this application involves a total of .... "current land owner(s)"#.
根據土地註冊處截至 .... 年 .... 月 .... 日的記錄，這宗申請共牽涉 .... 名「現行土地擁有人」#。

(b) The applicant 申請人 –

☐ has obtained consent(s) of .... "current land owner(s)"#.
已取得 .... 名「現行土地擁有人」#的同意。

Details of consent of "current land owner(s)" # obtained 取得「現行土地擁有人」#同意的詳情

No. of 'Current Land Owner(s)' 「現行土地擁有人」數目	Lot number/address of premises as shown in the record of the Land Registry where consent(s) has/have been obtained 根據土地註冊處記錄已獲得同意的地段號碼／處所地址	Date of consent obtained (DD/MM/YYYY) 取得同意的日期 (日/月/年)

(Please use separate sheets if the space of any box above is insufficient. 如上列任何方格的空間不足，請另頁說明)

☐ has notified .... "current land owner(s)"#
已通知 .... 名「現行土地擁有人」#。

Details of the "current land owner(s)" # notified 已獲通知「現行土地擁有人」#的詳細資料		
No. of 'Current Land Owner(s)' 「現行土地擁有人」數目	Lot number/address of premises as shown in the record of the Land Registry where notification(s) has/have been given 根據土地註冊處記錄已發出通知的地段號碼／處所地址	Date of notification given (DD/MM/YYYY) 通知日期(日/月/年)

(Please use separate sheets if the space of any box above is insufficient. 如上列任何方格的空間不足，請另頁說明)

☐ has taken reasonable steps to obtain consent of or give notification to owner(s):
已採取合理步驟以取得土地擁有人的同意或向該人發給通知。詳情如下：

Reasonable Steps to Obtain Consent of Owner(s) 取得土地擁有人的同意所採取的合理步驟

☐ sent request for consent to the "current land owner(s)" on ________________ (DD/MM/YYYY)#&
於________________(日/月/年)向每一名「現行土地擁有人」#郵遞要求同意書&

Reasonable Steps to Give Notification to Owner(s) 向土地擁有人發出通知所採取的合理步驟

☐ published notices in local newspapers on ________________ (DD/MM/YYYY)&
於________________(日/月/年)在指定報章就申請刊登一次通知&

☐ posted notice in a prominent position on or near application site/premises on
________________ (DD/MM/YYYY)&
於________________(日/月/年)在申請地點／申請處所或附近的顯明位置貼出關於該申請的通知&

☐ sent notice to relevant owners' corporation(s)/owners' committee(s)/mutual aid committee(s)/management office(s) or rural committee on ________________ (DD/MM/YYYY)&
於________________(日/月/年)把通知寄往相關的業主立案法團/業主委員會/互助委員會或管理處，或有關的鄉事委員會&

Others 其他

☐ others (please specify)
其他（請指明）

____

____

____

____

Note: May insert more than one「✔」.
Information should be provided on the basis of each and every lot (if applicable) and premises (if any) in respect of the application.
註: 可在多於一個方格內加上「✔」號
申請人須就申請涉及的每一地段（倘適用）及處所（倘有）分別提供資料

6. Type(s) of Application 申請類別

- ☐ Type (i) 第(i)類 — Change of use within existing building or part thereof 更改現有建築物或其部分內的用途
- ☐ Type (ii) 第(ii)類 — Diversion of stream / excavation of land / filling of land / filling of pond as required under Notes of Statutory Plan(s) 根據法定圖則《註釋》內所要求的河道改道／挖土／填土／填塘工程
- ☑ Type (iii) 第(iii)類 — Public utility installation / Utility installation for private project 公用事業設施裝置/私人發展計劃的公用設施裝置
- ☐ Type (iv) 第(iv)類 — Minor relaxation of stated development restriction(s) as provided under Notes of Statutory Plan(s) 略為放寬於法定圖則《註釋》內列明的發展限制
- ☐ Type (v) 第(v)類 — Use / development other than (i) to (iii) above 上述的(i)至(iii)項以外的用途／發展

Note 1: May insert more than one「✓」.
註 1： 可在多於一個方格內加上「✓」號
Note 2: For Development involving columbarium use, please complete the table in the Appendix.
註 2： 如發展涉及靈灰安置所用途，請填妥於附件的表格。

(i) *For Type (i) application 供第(i)類申請*

(a) Total floor area involved 涉及的總樓面面積	sq.m 平方米		
(b) Proposed use(s)/development 擬議用途/發展	(If there are any Government, institution or community facilities, please illustrate on plan and specify the use and gross floor area) (如有任何政府、機構或社區設施，請在圖則上顯示，並註明用途及總樓面面積)		
(c) Number of storeys involved 涉及層數		Number of units involved 涉及單位數目	

(d) Proposed floor area 擬議樓面面積	Domestic part 住用部分 …………………… sq.m 平方米 ☐About 約
	Non-domestic part 非住用部分……………… sq.m 平方米 ☐About 約
	Total 總計 ……………………… sq.m 平方米 ☐About 約

(e) Proposed uses of different floors (if applicable) 不同樓層的擬議用途(如適用) (Please use separate sheets if the space provided is insufficient) (如所提供的空間不足，請另頁說明)	Floor(s) 樓層	Current use(s) 現時用途	Proposed use(s) 擬議用途

(ii) For Type (ii) application 供第(ii)類申請

<table>
<tr><td>(a) Operation involved
涉及工程</td><td>☐ Diversion of stream 河道改道

☐ Filling of pond 填塘
Area of filling 填塘面積 .... sq.m 平方米 ☐About 約
Depth of filling 填塘深度 .... m 米 ☐About 約

☐ Filling of land 填土
Area of filling 填土面積 .... sq.m 平方米 ☐About 約
Depth of filling 填土厚度 .... m 米 ☐About 約

☐ Excavation of land 挖土
Area of excavation 挖土面積 .... sq.m 平方米 ☐About 約
Depth of excavation 挖土深度 .... m 米 ☐About 約

(Please indicate on site plan the boundary of concerned land/pond(s), and particulars of stream diversion, the extent of filling of land/pond(s) and/or excavation of land)
(請用圖則顯示有關土地／池塘界線，以及河道改道、填塘、填土及／或挖土的細節及/或範圍))</td></tr>
<tr><td>(b) Intended use/development
有意進行的用途／發展</td><td></td></tr>
</table>

(iii) For Type (iii) application 供第(iii)類申請

(a) Nature and scale 性質及規模

☑ Public utility installation 公用事業設施裝置

☐ Utility installation for private project 私人發展計劃的公用設施裝置

Please specify the type and number of utility to be provided as well as the dimensions of each building/structure, where appropriate
請註明有關裝置的性質及數量，包括每座建築物/構築物(倘有)的長度、高度和闊度

Name/type of installation 裝置名稱／種類	Number of provision 數量	Dimension of each installation /building/structure (m) (LxWxH) 每個裝置／建築物／構築物的尺寸 (米) (長 x 闊 x 高)
Underground stormwater storage tank	1	43m(L)x50m(W)x11m (H)
Pump house	1	43m(L)x27.4m(W)x13m(H)
Transformer and Switch Room	1	13m(L)x13m(W)x6.8m(H)

(Please illustrate on plan the layout of the installation 請用圖則顯示裝置的布局)

(iv) For Type (iv) application 供第(iv)類申請

(a) Please specify the proposed minor relaxation of stated development restriction(s) and **also fill in the proposed use/development and development particulars in part (v) below** –
請列明擬議略為放寬的發展限制**並填妥於第(v)部分的擬議用途/發展及發展細節** –

☐	Plot ratio restriction 地積比率限制	From 由 ………………… to 至 …………………
☐	Gross floor area restriction 總樓面面積限制	From 由 ………..sq. m 平方米 to 至 ………..sq. m 平方米
☐	Site coverage restriction 上蓋面積限制	From 由 ……………..% to 至 ………………… %
☐	Building height restriction 建築物高度限制	From 由 ……………..m 米 to 至 ………………… m 米 From 由 …………….. mPD 米 (主水平基準上) to 至 ……………..mPD 米 (主水平基準上) From 由 …………….. storeys 層 to 至 …………….. storeys 層
☐	Non-building area restriction 非建築用地限制	From 由 ……………..m to 至 ………………… m
☐	Others (please specify) 其他（請註明）	…………………………………………………… ……………………………………………………

(v) For Type (v) application 供第(v)類申請

(a) Proposed use(s)/development 擬議用途/發展	(Please illustrate the details of the proposal on a layout plan 請用平面圖說明建議詳情)

(b) Development Schedule 發展細節表

Proposed gross floor area (GFA) 擬議總樓面面積	…………………… sq.m 平方米	☐About 約
Proposed plot ratio 擬議地積比率	……………………	☐About 約
Proposed site coverage 擬議上蓋面積	…………………… %	☐About 約
Proposed no. of blocks 擬議座數	………………………	
Proposed no. of storeys of each block 每座建築物的擬議層數	……………………… storeys 層 ☐ include 包括……storeys of basements 層地庫 ☐ exclude 不包括……storeys of basements 層地庫	
Proposed building height of each block 每座建築物的擬議高度	…………… mPD 米(主水平基準上) ……………………… m 米	☐About 約 ☐About 約

☐ Domestic part 住用部分

GFA 總樓面面積	………………… sq. m 平方米	☐About 約
number of Units 單位數目	………………………	
average unit size 單位平均面積	…………………sq. m 平方米	☐About 約
estimated number of residents 估計住客數目	………………………	

☐ Non-domestic part 非住用部分

	GFA 總樓面面積	
☐ eating place 食肆	………………… sq. m 平方米	☐About 約
☐ hotel 酒店	………………… sq. m 平方米 (please specify the number of rooms 請註明房間數目) ………………………	☐About 約
☐ office 辦公室	………………… sq. m 平方米	☐About 約
☐ shop and services 商店及服務行業	………………… sq. m 平方米	☐About 約

☐ Government, institution or community facilities 政府、機構或社區設施

(please specify the use(s) and concerned land area(s)/GFA(s) 請註明用途及有關的地面面積／總樓面面積)

…………………………………………………
…………………………………………………
…………………………………………………

☐ other(s) 其他

(please specify the use(s) and concerned land area(s)/GFA(s) 請註明用途及有關的地面面積／總樓面面積)

…………………………………………………
…………………………………………………
…………………………………………………

☐ Open space 休憩用地

(please specify land area(s) 請註明地面面積)

☐ private open space 私人休憩用地	…………… sq. m 平方米	☐ Not less than 不少於
☐ public open space 公眾休憩用地	…………… sq. m 平方米	☐ Not less than 不少於

(c) Use(s) of different floors (if applicable) 各樓層的用途 (如適用)

[Block number] [座數]	[Floor(s)] [層數]	[Proposed use(s)] [擬議用途]
………………	………………	…………………………………………………
………………	………………	…………………………………………………
………………	………………	…………………………………………………
………………	………………	…………………………………………………
………………	………………	…………………………………………………

(d) Proposed use(s) of uncovered area (if any) 露天地方（倘有）的擬議用途

…………………………………………………
…………………………………………………
…………………………………………………
…………………………………………………
…………………………………………………

7. Anticipated Completion Time of the Development Proposal
擬議發展計劃的預計完成時間

Anticipated completion time (in month and year) of the development proposal (by phase (if any)) (e.g. June 2023)
擬議發展計劃預期完成的年份及月份 (分期 (倘有)) (例：2023 年 6 月)
(Separate anticipated completion times (in month and year) should be provided for the proposed public open space and Government, institution or community facilities (if any))
(申請人須就擬議的公眾休憩用地及政府、機構或社區設施 (倘有) 提供個別擬議完成的年份及月份)

Tentatively Q4 2028

8. Vehicular Access Arrangement of the Development Proposal
擬議發展計劃的行車通道安排

Any vehicular access to the site/subject building? 是否有車路通往地盤／有關建築物？	Yes 是	☐ There is an existing access. (please indicate the street name, where appropriate) 有一條現有車路。(請註明車路名稱(如適用)) …… ☑ There is a proposed access. (please illustrate on plan and specify the width) 有一條擬議車路。（請在圖則顯示，並註明車路的闊度）
	No 否	☐
Any provision of parking space for the proposed use(s)? 是否有為擬議用途提供停車位？	Yes 是	☐ (Please specify type(s) and number(s) and illustrate on plan) 請註明種類及數目並於圖則上顯示) Private Car Parking Spaces 私家車車位 ____ Motorcycle Parking Spaces 電單車車位 ____ Light Goods Vehicle Parking Spaces 輕型貨車泊車位 ____ Medium Goods Vehicle Parking Spaces 中型貨車泊車位 ____ Heavy Goods Vehicle Parking Spaces 重型貨車泊車位 ____ Others (Please Specify) 其他 (請列明) ____
	No 否	☑
Any provision of loading/unloading space for the proposed use(s)? 是否有為擬議用途提供上落客貨車位？	Yes 是	☐ (Please specify type(s) and number(s) and illustrate on plan) 請註明種類及數目並於圖則上顯示) Taxi Spaces 的士車位 ____ Coach Spaces 旅遊巴車位 ____ Light Goods Vehicle Spaces 輕型貨車車位 ____ Medium Goods Vehicle Spaces 中型貨車車位 ____ Heavy Goods Vehicle Spaces 重型貨車車位 ____ Others (Please Specify) 其他 (請列明) ____
	No 否	☑

9. Impacts of Development Proposal 擬議發展計劃的影響

If necessary, please use separate sheets to indicate the proposed measures to minimise possible adverse impacts or give justifications/reasons for not providing such measures.
如需要的話，請另頁註明可盡量減少可能出現不良影響的措施，否則請提供理據/理由。

Does the development proposal involve alteration of existing building? 擬議發展計劃是否包括現有建築物的改動?	Yes 是	☐ Please provide details 請提供詳情 ………………
	No 否	☑
Does the development proposal involve the operation on the right? 擬議發展是否涉及右列的工程? (Note: where Type (ii) application is the subject of application, please skip this section. 註：如申請涉及第(ii)類申請，請跳至下一條問題。)	Yes 是	☑ (Please indicate on site plan the boundary of concerned land/pond(s), and particulars of stream diversion, the extent of filling of land/pond(s) and/or excavation of land) (請用地盤平面圖顯示有關土地／池塘界線，以及河道改道、填塘、填土及／或挖土的細節及/或範圍) ☐ Diversion of stream 河道改道 ☐ Filling of pond 填塘 Area of filling 填塘面積 ……………… sq.m 平方米 ☐About 約 Depth of filling 填塘深度 ……………… m 米 ☐About 約 ☐ Filling of land 填土 Area of filling 填土面積 ……………… sq.m 平方米 ☐About 約 Depth of filling 填土厚度 ……………… m 米 ☐About 約 ☑ Excavation of land 挖土 Area of excavation 挖土面積 4530 sq.m 平方米 ☑About 約 Depth of excavation 挖土深度 12 m 米 ☑About 約
	No 否	☐

Would the development proposal cause any adverse impacts? 擬議發展計劃會否造成不良影響？			
	On environment 對環境	Yes 會 ☐	No 不會 ☑
	On traffic 對交通	Yes 會 ☐	No 不會 ☑
	On water supply 對供水	Yes 會 ☐	No 不會 ☑
	On drainage 對排水	Yes 會 ☐	No 不會 ☑
	On slopes 對斜坡	Yes 會 ☐	No 不會 ☑
	Affected by slopes 受斜坡影響	Yes 會 ☐	No 不會 ☑
	Landscape Impact 構成景觀影響	Yes 會 ☐	No 不會 ☑
	Tree Felling 砍伐樹木	Yes 會 ☑	No 不會 ☐
	Visual Impact 構成視覺影響	Yes 會 ☐	No 不會 ☑
	Others (Please Specify) 其他 (請列明) ____	Yes 會 ☐	No 不會 ☐

Please state measure(s) to minimise the impact(s). For tree felling, please state the number, diameter at breast height and species of the affected trees (if possible)
請註明盡量減少影響的措施。如涉及砍伐樹木，請說明受影響樹木的數目、及胸高度的樹幹直徑及品種(倘可)

Details refer to the attached Planning Application Report Appendix E

10. Justifications 理由

The applicant is invited to provide justifications in support of the application. Use separate sheets if necessary.
現請申請人提供申請理由及支持其申請的資料。如有需要，請另頁說明。

Please refer to the attached Planning Application Report Section 4 for details.

11. Declaration 聲明

I hereby declare that the particulars given in this application are correct and true to the best of my knowledge and belief.
本人謹此聲明，本人就這宗申請提交的資料，據本人所知及所信，均屬真實無誤。

I hereby grant a permission to the Board to copy all the materials submitted in this application and/or to upload such materials to the Board's website for browsing and downloading by the public free-of-charge at the Board's discretion. 本人現准許委員會酌情將本人就此申請所提交的所有資料複製及/或上載至委員會網站，供公眾免費瀏覽或下載。

Signature 簽署 .... ☐ Applicant 申請人 / ☑ Authorised Agent 獲授權代理人

WU YAT FEI, ALEX — Name in Block Letters 姓名（請以正楷填寫）

Executive Director — Position (if applicable) 職位 （如適用）

Professional Qualification(s) 專業資格 ☑ Member 會員 / ☐ Fellow of 資深會員
☐ HKIP 香港規劃師學會 / ☐ HKIA 香港建築師學會 /
☐ HKIS 香港測量師學會 / ☐ HKIE 香港工程師學會 /
☐ HKILA 香港園境師學會/ ☐ HKIUD 香港城市設計學會
☐ RPP 註冊專業規劃師
Others 其他 Institution of Civil Engineers

on behalf of 代表 AECOM ASIA COMPANY LIMITED

AECOM ASIA COMPANY LIMITED AECOM WAT

☑ Company 公司 / ☐ Organisation Name and Chop (if applicable) 機構名稱及蓋章（如適用）

Date 日期 08/12/2023 (DD/MM/YYYY 日/月/年)

Remark 備註

The materials submitted in this application and the Board's decision on the application would be disclosed to the public. Such materials would also be uploaded to the Board's website for browsing and free downloading by the public where the Board considers appropriate.
委員會會向公眾披露申請人所遞交的申請資料和委員會對申請所作的決定。在委員會認為合適的情況下，有關申請資料亦會上載至委員會網頁供公眾免費瀏覽及下載。

Warning 警告

Any person who knowingly or wilfully makes any statement or furnish any information in connection with this application, which is false in any material particular, shall be liable to an offence under the Crimes Ordinance.
任何人在明知或故意的情況下，就這宗申請提出在任何要項上是虛假的陳述或資料，即屬違反《刑事罪行條例》。

Statement on Personal Data 個人資料的聲明

1. The personal data submitted to the Board in this application will be used by the Secretary of the Board and Government departments for the following purposes:
委員會就這宗申請所收到的個人資料會交給委員會秘書及政府部門，以根據《城市規劃條例》及相關的城市規劃委員會規劃指引的規定作以下用途：
   (a) the processing of this application which includes making available the name of the applicant for public inspection when making available this application for public inspection; and
   處理這宗申請，包括公布這宗申請供公眾查閱，同時公布申請人的姓名供公眾查閱；以及
   (b) facilitating communication between the applicant and the Secretary of the Board/Government departments.
   方便申請人與委員會秘書及政府部門之間進行聯絡。

2. The personal data provided by the applicant in this application may also be disclosed to other persons for the purposes mentioned in paragraph 1 above.
申請人就這宗申請提供的個人資料，或亦會向其他人士披露，以作上述第 1 段提及的用途。

3. An applicant has a right of access and correction with respect to his/her personal data as provided under the Personal Data (Privacy) Ordinance (Cap. 486). Request for personal data access and correction should be addressed to the Secretary of the Board at 15/F, North Point Government Offices, 333 Java Road, North Point, Hong Kong.
根據《個人資料(私隱)條例》(第 486 章)的規定，申請人有權查閱及更正其個人資料。如欲查閱及更正個人資料，應向委員會秘書提出有關要求，其地址為香港北角渣華道 333 號北角政府合署 15 樓。

For Developments involving Columbarium Use, please also complete the following:
如發展涉及靈灰安置所用途，請另外填妥以下資料:

Ash interment capacity 骨灰安放容量@

Maximum number of sets of ashes that may be interred in the niches
在龕位內最多可安放骨灰的數量 ____________________
Maximum number of sets of ashes that may be interred other than in niches
在非龕位的範圍內最多可安放骨灰的數量 ____________________

Total number of niches 龕位總數 ____________________

Total number of single niches
單人龕位總數 ____________________

Number of single niches (sold and occupied)
單人龕位數目 (已售並佔用) ____________________
Number of single niches (sold but unoccupied)
單人龕位數目 (已售但未佔用) ____________________
Number of single niches (residual for sale)
單人龕位數目 (待售) ____________________

Total number of double niches
雙人龕位總數 ____________________

Number of double niches (sold and fully occupied)
雙人龕位數目 (已售並全部佔用) ____________________
Number of double niches (sold and partially occupied)
雙人龕位數目 (已售並部分佔用) ____________________
Number of double niches (sold but unoccupied)
雙人龕位數目 (已售但未佔用) ____________________
Number of double niches (residual for sale)
雙人龕位數目 (待售) ____________________

Total no. of niches other than single or double niches (please specify type)
除單人及雙人龕位外的其他龕位總數 (請列明類別)

____

Number. of niches (sold and fully occupied)
龕位數目 (已售並全部佔用) ____________________
Number of niches (sold and partially occupied)
龕位數目 (已售並部分佔用) ____________________
Number of niches (sold but unoccupied)
龕位數目 (已售但未佔用) ____________________
Number of niches (residual for sale)
龕位數目 (待售) ____________________

Proposed operating hours 擬議營運時間 ____________________

____

@ Ash interment capacity in relation to a columbarium means –
就靈灰安置所而言，骨灰安放容量指：
- the maximum number of containers of ashes that may be interred in each niche in the columbarium;
  每個龕位內可安放的骨灰容器的最高數目；
- the maximum number of sets of ashes that may be interred other than in niches in any area in the columbarium; and
  在該靈灰安置所並非龕位的範圍內，總共最多可安放多少份骨灰；以及
- the total number of sets of ashes that may be interred in the columbarium.
  在該骨灰安置所內，總共最多可安放多少份骨灰。

Gist of Application 申請摘要

(Please provide details in both English and Chinese as far as possible. This part will be circulated to relevant consultees, uploaded to the Town Planning Board's Website for browsing and free downloading by the public and available at the Planning Enquiry Counters of the Planning Department for general information.)
(請盡量以英文及中文填寫。此部分將會發送予相關諮詢人士、上載至城市規劃委員會網頁供公眾免費瀏覽及下載及於規劃署規劃資料查詢處供一般參閱。)

<table>
<tr><td>Application No.
申請編號</td><td colspan="4">(For Official Use Only) (請勿填寫此欄)</td></tr>
<tr><td>Location/address
位置／地址</td><td colspan="4">Government Land at Sha Tin Park near Yi Ching Lane,
Sha Tin, New Territories
(GLA-ST RSD) (Part)</td></tr>
<tr><td>Site area
地盤面積</td><td colspan="4">4530 sq. m 平方米 ☑About 約
(includes Government land of 包括政府土地 4530 sq. m 平方米 ☑About 約)</td></tr>
<tr><td>Plan
圖則</td><td colspan="4">Approved Sha Tin Outline Zone Planning Plan No. S/ST/37
沙田分區計劃大綱圖編號 S/ST/37</td></tr>
<tr><td>Zoning
地帶</td><td colspan="4">休憩用地 (Open Space)</td></tr>
<tr><td>Applied use/ development
申請用途/發展</td><td colspan="4">Public utility installation (stormwater storage facility)
公用事務設施裝置(雨水蓄洪設施) (渠務署)</td></tr>
<tr><td rowspan="3">(i) Gross floor area and/or plot ratio
總樓面面積及／或地積比率</td><td></td><td>sq.m 平方米</td><td colspan="2">Plot Ratio 地積比率</td></tr>
<tr><td>Domestic
住用</td><td>☐ About 約
☐ Not more than 不多於</td><td colspan="2">☐About 約
☐Not more than 不多於</td></tr>
<tr><td>Non-domestic
非住用</td><td>1350 ☑ About 約
☐ Not more than 不多於</td><td colspan="2">0.3 ☑About 約
☐Not more than 不多於</td></tr>
<tr><td rowspan="3">(ii) No. of blocks
幢數</td><td>Domestic
住用</td><td colspan="3"></td></tr>
<tr><td>Non-domestic
非住用</td><td colspan="3">1 block of DSD's pump house
1 block of DSD's Transformer & Switch Room</td></tr>
<tr><td>Composite
綜合用途</td><td colspan="3"></td></tr>
</table>

(iii)	Building height/No. of storeys 建築物高度／層數	Domestic 住用	m 米 ☐ (Not more than 不多於)
			mPD 米(主水平基準上) ☐ (Not more than 不多於)
			Storeys(s) 層 ☐ (Not more than 不多於) *(☐Include 包括/☐ Exclude 不包括* *☐ Carport 停車間* *☐ Basement 地庫* *☐ Refuge Floor 防火層* *☐ Podium 平台)*
		Non-domestic 非住用	m 米 ☐ (Not more than 不多於)
			+18.7 mPD 米(主水平基準上) ☑ (Not more than 不多於)
			1 Storeys(s) 層 ☑ (Not more than 不多於) *(☐Include 包括/☑ Exclude 不包括* *☑ Carport 停車間* *☑ Basement 地庫* *☑ Refuge Floor 防火層* *☑ Podium 平台)*
		Composite 綜合用途	m 米 ☐ (Not more than 不多於)
			mPD 米(主水平基準上) ☐ (Not more than 不多於)
			Storeys(s) 層 ☐ (Not more than 不多於) *(☐Include 包括/☐ Exclude 不包括* *☐ Carport 停車間* *☐ Basement 地庫* *☐ Refuge Floor 防火層* *☐ Podium 平台)*
(iv)	Site coverage 上蓋面積		30 % ☑ About 約
(v)	No. of units 單位數目		
(vi)	Open space 休憩用地	Private 私人	sq.m 平方米 ☐ Not less than 不少於
		Public 公眾	2500 sq.m 平方米 ☑ Not less than 不少於

(vii) No. of parking spaces and loading / unloading spaces 停車位及上落客貨車位數目	Total no. of vehicle parking spaces 停車位總數 Private Car Parking Spaces 私家車車位 Motorcycle Parking Spaces 電單車車位 Light Goods Vehicle Parking Spaces 輕型貨車泊車位 Medium Goods Vehicle Parking Spaces 中型貨車泊車位 Heavy Goods Vehicle Parking Spaces 重型貨車泊車位 Others (Please Specify) 其他 (請列明) ____________ ____________	
	Total no. of vehicle loading/unloading bays/lay-bys 上落客貨車位／停車處總數 Taxi Spaces 的士車位 Coach Spaces 旅遊巴車位 Light Goods Vehicle Spaces 輕型貨車車位 Medium Goods Vehicle Spaces 中型貨車車位 Heavy Goods Vehicle Spaces 重型貨車車位 Others (Please Specify) 其他 (請列明) ____________ ____________	

Submitted Plans, Drawings and Documents 提交的圖則、繪圖及文件

	Chinese 中文	English 英文
Plans and Drawings 圖則及繪圖		
Master layout plan(s)/Layout plan(s) 總綱發展藍圖／布局設計圖	☐	☑
Block plan(s) 樓宇位置圖	☐	☑
Floor plan(s) 樓宇平面圖	☐	☑
Sectional plan(s) 截視圖	☐	☑
Elevation(s) 立視圖	☐	☑
Photomontage(s) showing the proposed development 顯示擬議發展的合成照片	☐	☑
Master landscape plan(s)/Landscape plan(s) 園境設計總圖／園境設計圖	☐	☐
Others (please specify) 其他（請註明）	☐	☐
____________		
____________		
Reports 報告書		
Planning Statement/Justifications 規劃綱領/理據	☐	☑
Environmental assessment (noise, air and/or water pollutions) 環境評估（噪音、空氣及／或水的污染）	☐	☑
Traffic impact assessment (on vehicles) 就車輛的交通影響評估	☐	☑
Traffic impact assessment (on pedestrians) 就行人的交通影響評估	☐	☐
Visual impact assessment 視覺影響評估	☐	☐
Landscape impact assessment 景觀影響評估	☐	☐
Tree Survey 樹木調查	☐	☑
Geotechnical impact assessment 土力影響評估	☐	☑
Drainage impact assessment 排水影響評估	☐	☑
Sewerage impact assessment 排污影響評估	☐	☑
Risk Assessment 風險評估	☐	☐
Others (please specify) 其他（請註明）	☐	☐
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Note: May insert more than one「✔」. 註：可在多於一個方格內加上「✔」號

Note: The information in the Gist of Application above is provided by the applicant for easy reference of the general public. Under no circumstances will the Town Planning Board accept any liabilities for the use of the information nor any inaccuracies or discrepancies of the information provided. In case of doubt, reference should always be made to the submission of the applicant.

註： 上述申請摘要的資料是由申請人提供以方便市民大眾參考。對於所載資料在使用上的問題及文義上的歧異，城市規劃委員會概不負責。若有任何疑問，應查閱申請人提交的文件。

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渠務署
Drainage Services Department

Agreement No. CE 44/2021(DS)

Drainage Improvement Works in Sha Tin and Sai Kung – Design & Construction

Planning Submission

(Sha Tin Town Centre Stormwater Storage and Pumping Facility)

Report No. 60667488/27/F

November 2023

AECOM Delivering a better world

TABLE OF CONTENTS

APPENDICES

*Appendix D-L will show the context relevant to the Application Site (Sha Tin Town Centre) only.

REMARKS:
This planning application submission is about the stormwater storage and pumping facility exclusively. The proposed pipes which are not located in the subject application site which are shown in this submission are for reference only and would not be discussed in detail. According to Approved Sha Tin Outline Zoning Plan No. S/ST/37 Notes (7)(a) and (b), provision, maintenance or repair of public utility pipeline as well as drainage works **co-ordinated or implemented by Government** are always permitted on land falling within the boundaries of the Plan except where the uses or developments are specified in Column 2 of the Notes of individual zones.

EXECUTIVE SUMMARY

Broad Development Parameters

a)	Application Site	Open Space at Sha Tin Park near Yi Ching Lane
b)	Site Area	Approx. 4530 m^2
c)	Total Floor Area	Underground Storage tank for drainage: 2150 m^2 Above-ground 1-storey DSD's Pump House: 1180m^2 (Building Height: 13m; +18.7mPD) Above-ground 1-storey DSD's Transformer & Switch Room: 170m^2 (Building Height: 6.8m; +12.5mPD)
d)	Statutory Plan	Approved Sha Tin Outline Zoning Plan (OZP) No. S/ST/37
e)	Zoning	"O" Open Space
f)	Applied Use/ Development	Stormwater Storage and Pumping Facility

Justification

The Review of Drainage Master Plan in Sha Tin and Sai Kung – Feasibility Study (DMP Review) identified that Sha Tin Town Centre would be subject to high flood risk having taken into account the tidal impacts at Shing Mun River, dilapidated drainage networks, updated hydrological statistics and the anticipated effects of climate change. The existing drainage system cannot achieve the required flood standard. It is found that there is high risk of flooding due to insufficient capacity of existing drainage system, high water level at Shing Mun River causing backflow to upstream drainage and the relatively low-lying areas in Sha Tin Town Centre, e.g. Sha Tin Centre Street and Pak Hok Tin Street. Flooding impacts on traffic and residential area in the flood prone areas will also result in losses and inconvenience to the general public. To effectively relieve the flood risk in Sha Tin Town Centre, the proposed Sha Tin Town Centre Stormwater Pumping Scheme has been proposed. Upon completion of the works, the standards of flood protection at Sha Tin Town Centre will be largely enhanced to that specified in the standards of the Stormwater Drainage Manual (SDM) and the flood risks thereon can be significantly reduced.

The proposed site is zoned “Open Space” (“O”) on the Sha Tin Outline Zoning Plan (OZP) No. S/ST/37. As stipulated in Schedule of Use of the OZP for “O”, the proposed stormwater storage and pumping facility, regarded as “Public Utility Installation”, is a column 2 use for the “O” zone. Therefore, planning permission from the Town Planning Board (TPB) is required.

The proposed development comprises 2 no. of new 1 storey building structure (including 1-storey pump house and 1-storey Transformer and Switch Room), a re-provided green open space (i.e. lawn), park amenities, all of which are above an underground stormwater storage tank. The proposed pump house provides ancillary equipment and control systems for the operation of the underground storage tank and pumping facility. Fence wall is proposed to build surround the above-ground Drainage Services Department (DSD) pump house and Transformer & Switch Room. Area within the fence walls will be maintained by DSD and do not allow public access for security of the pumping equipment and public safety. DSD will carry out periodic inspection, routine cleansing, maintenance of the underground storage tank and pumping facility annually, with access openings located at within the pump house, fenced area and inconspicuous locations at the green open space that will not interrupt the operation and usage of nearby leisure facilities. The proposed green open space (i.e lawn), park amenities above storage tank will be re-provided for public enjoyment and maintained and managed by the Leisure and Cultural Services Department (LCSD). The size of the storage tank and pump house had been carefully designed to meet flood protection standard as required to reduce flood risk and minimize the area occupied in the existing open space as far as practicable. In addition, re-provision of the open space above the underground storage tank would minimize disturbance to the public.

The justifications of this application are: having considered other potential sites in the neighbourhood, the Application Site is the most suitable site for the proposed development due to its location; strategic integrated design by utilizing underground space for essential infrastructure and allowing public amenities to be reprovided above ground, thus allowing both uses of land on one site to make good use of the scarce land resources in the urban neighbourhood; the necessity and urgency of the drainage works to increase flood resilience of its catchment; minimal impact on the public enjoyment of open space during operation; and no adverse environmental, traffic, water supply, geotechnical and drainage impacts.

The proposed development is an essential facility for Sha Tin Town Centre to meet the required flood protection standard and flood prevention. It reduces the risk of flooding and its consequent nuisance to the public in Sha Tin Town Centre, promotes local flood resilience and thus minimizes damage costs. The Applicant therefore requests that the Board approves this application.

行政摘要

概括發展規範

甲）	申請地址	沙田公園近宜正里之休憩用地
乙）	地盤面積	約 4530 平方米
丙）	總樓面面積	(地下建築物面積：2150 平方米) 地面建築物面積： 渠務署抽水泵房(一層): 1180 平方米 (建築物高度: 13 米, 主水平基準以上 18.7 米) 渠務署變壓房及電掣房(一層): 170 平方米(建築物高度: 6.8 米, 主水平基準以上 12.5 米)
戊）	法定圖則名稱及編號	沙田分區計劃大綱圖編號 S/ST/37
己）	涉及的土地用途地帶	“O” 休憩用地
庚）	申請用途	雨水蓄洪及抽水設施

理由

鑑於沙田及西貢雨水排放整體計劃檢討 –可行性研究識別出沙田市中心因排水管綫老化、水文數據更新以及氣候變化將會帶來的極端降雨量及潮汐水位，和受著城門河高潮水位，該區的水浸風險為高。因現有排水系統排水能力不足和因城門河高潮水位而造成倒流及現有沙田市中心較低地勢(如沙田正街，白鶴汀街), 現有排水系統未達所需的防洪標準。 另外，在低窪的地區的交通及住宅用地會較易受水浸影響，而會對公眾造成損失及不便。為有效降低沙田市中心該區的水浸風險，擬議在沙田市中心興建雨水蓄洪及抽水計劃。工程完成後，沙田市中心的的排洪能力會提升，能達到所需的防洪標準並減低該區的水浸風險。

建議的選址劃為沙田分區計劃大綱圖(OZP)編號 S/ST/37 的「休憩用地」類別。根據 OZP 的「休憩用地」附表第二欄，擬建雨水蓄洪及抽水設施屬於「公共事業設施裝置」，須先向城市規劃委員會申請規劃許可。

非住宅用途的擬建發展包括兩幢單層建築物 (包括一幢抽水泵房，一幢變壓房及電掣房) ，而休憩用地(草坪)、公園休憩設施，這設施將會重置於地下蓄洪池的地面上。單層建築的抽水泵房提供控制系統及附屬設施以應付蓄洪池及水泵的運作。擬建新圍牆會圍繞抽水泵房和變壓房及電掣房的渠務署用地範圍而建。圍牆用地範圍會由渠務署保養及管理，而且因抽水設施保安及公眾安全問題，圍牆用地範圍不會開放給公眾使用，。渠務署每年會替蓄洪池及水泵設備作例行檢查，清潔及保養維修，維修出入口設於抽水泵房內或渠務署用地範圍內或休憩用地不顯眼的位置，期間將不會影響鄰近休閒設施的使用及運作。地下蓄洪池上的草坪及公園休憩設施將由康樂文化事務署(康

文署) 保養及管理並開放供公眾享用。地下蓄洪池和抽水泵房的擬議大小已小心考慮防洪標準及有效降低水浸風險所需的佔地要求，而休憩用地和設施重置於地下蓄洪池的地面上能減少對公眾的影響。

這宗規劃申請的理由為：經過考慮附近其他潛在地點後，申請地點的位置最為適合興建地下蓄洪池；策略地使用一地兩用的綜合設計，運用地下空間作重要基建並在地面上提供公共休憩設施，充分善用城市中稀缺的土地資源；排水工程的必要性和迫切性，以提高該集水區的防洪能力；蓄洪池運作期間將不會影響公眾享用休憩用地，並且不會對附近造成不良的環境、交通、供水、岩土和排水影響。

擬議的雨水蓄洪及抽水設施是一項重要的防洪基礎設施，目的是減低當區的水浸風險，從而減輕水浸對公眾造成的滋擾，以提高沙田市中心的承洪韌性並減低洪水造成的財物損傷。因此申請人希望城規會批准是項申請。

1 INTRODUCTION

1.1 Background

1.1.1 The Review of Drainage Master Plan in Sha Tin and Sai Kung – Feasibility Study (DMP Review) identified that Sha Tin Town Centre in Sha Tin would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics.

1.1.2 To relieve the flood risk in the above areas, the Study has proposed implementing drainage improvement measures, mainly in form of stormwater pumping scheme and drainage upgrading works. Upon completion of the Project, the standards of flood protection at areas concerned will be largely enhanced to that specified in the standards of the Stormwater Drainage Manual (SDM) and the flood risks thereon can be significantly reduced.

1.1.3 Without the proposed project, about 16 hectares of the areas in Sha Tin Town Centre will be subject to high flood risk. Flooding impacts on traffic and residential area in the flood prone areas will also result in losses and inconvenience to the general public.

1.1.4 In May 2018, Development Bureau (DEVB) signed out a Project Definition Statement (PDS) to justify and define the scope of the “Drainage Improvement Works in Sha Tin and Sai Kung”. The Drainage Services Department (DSD) then completed a Technical Feasibility Statement (TFS) confirming its technical feasibility. The TFS was subsequently approved by DEVB in August 2018. The project was included into Cat B under PWP Item No. 4182CD in September 2018.

1.1.5 In October 2019, AECOM Asia Company Limited (AECOM) was appointed by the Drainage Services Department (DSD) to undertake the investigation study of the “Drainage Improvement Works in Sha Tin and Sai Kung” (the Investigation Study). The Investigation Study recommended the drainage improvement works in Sha Tin and Sai Kung as briefly described in the following:

(a) Stormwater pumping scheme at Sha Tin Town Centre (STTCSPS), including an underground storage tank, a pump house and associated pipeworks and electrical and mechanical (E&M) works, as well as drainage upgrading works around Sha Tin Town Centre such as Pak Hok Tin Street, Sha Tin Centre Street and ancillary works including reinstatement of playgrounds and associated facilities;

1.1.6 This planning application covers Sha Tin Town Centre stormwater pumping scheme at (STTCSPS) in Sha Tin Park. The proposed new pipes associated with the stormwater pumping scheme which are not located at the application site would not be discussed in this town planning submission.

1.2 Description of the Project

1.2.1 The STTCSPS comprises the following works and a location plan is given in **Drawing No. 60674881/SK4053** in **Appendix A**.

(a) A stormwater pumping scheme at Sha Tin Park including an underground storage tank, a pump house, E&M works and associated pipeworks;

(b) Ancillary works including but not limited to re-provision of the green space area and associated park facilities.

1.3 Purpose of Submission

1.3.1 The Applicant, DSD, proposed a stormwater pumping scheme at Sha Tin Park. The area is zoned “Open Space” on the Sha Tin Outline Zoning Plan (OZP) No. S/ST/37. The proposed stormwater storage tank and associated pump house are “Public Utility Installation” falling under Column 2 use within “O” zone according to the notes of the OZP, which requires planning permission from the Town Planning Board (the “Board”).

1.3.2 This planning application is submitted to the Board under Section 16 of the Town Planning Ordinance for the proposed STTCSPS only.

1.3.3 AECOM is commissioned by the Applicant to prepare and submit this planning application to the Board for consideration and approval.

2 DESCRIPTION OF PROPOSED STORMWATER STORAGE AND PUMPING FACILITY

2.1 Description of the Site

2.1.1 The application site is located at the Sha Tin Park in Sha Tin Town Centre. It covers an area of about 4530m^2 with an existing park including Family Games Area (a lawn), Fitness Corner, Azalea Garden, pavilion, associated LCSD’s leisure facilities as shown in **Appendix D**. Reprovision of LCSD’s facilities will be arranged during construction of the STTCSPS.

2.1.2 The site is visible to the public nearby and to the users of the park. The current condition with surrounding environment is shown in **Appendix B**.

2.2 Proposed Stormwater Pumping Scheme

2.2.1 Since the potential flood risk around Sha Tin Town Centre is caused by the backflow from Shing Mun River to the upstream drainage system, and the relatively low ground level at the area susceptible to flooding. Besides, a flooding incident has been reported on 15 August 2015 at New Town Plaza Bus Station, Therefore, hydraulic performance of Sha Tin Town Centre cannot achieve the required flood protection standard.

2.2.2 The proposed pumping station consists of a pump with maximum pump rate of $4m^3/s$ and an underground stormwater tank with a capacity of $8000m^3$. The runoff will be discharged into the pumping station via the new drainage network and then discharge into Shing Mun River by pump. The excessive water will be stored in the underground tank. After provision of these proposed improvement works, the flood protection level of Sha Tin Town Centre around Sha Tin Centre Street and Pak Hok Ting Street will be increased to the required flood protection standard.

2.2.3 The footprint of the underground storage tank is approximately 2150 m^2 with a height of the tank is approximately 11m. The existing LCSD facilities (eg. Family Games Area, Fitness Corner, Azalea Garden, pavilion, etc. as shown in **Appendix D**) of 4530 m^2 will be demolished. On completion, the above-ground structure consisting of the associated DSD pump house (approx. 1180 m^2) and switch room and transformer room (approx. 170 m^2). The LCSD leisure facilities will be re-provided at the space above the storage tank.

2.2.4 Details of the proposed drainage improvement works, sections of the stormwater storage tank and layout/sections of the aboveground structure are presented in **Appendix A**. The layout of above-ground structure is preliminary and would be further finetuned during detailed design stage.

2.3 Tentative Project Programme

2.3.1 The tentative project programme is illustrated as below:

1. DC consultation	July 2021 and Q1 2024
2. Submission of s.16 application	Nov 2023
3. LegCo consultation	Q3 2024
4. Commencement of construction	Q1 2025
5. Completion	Q4 2028

3 ARCHITECTURAL AND LANDSCAPE DESIGN

3.1 Architectural Design

3.1.1 The proposed STTCSPS comprises of underground storage tank and above-ground DSD pump house, transformer Room and switch room. The above ground pumping station consists of DSD facilities serving the operational needs for the underground storage tank and stormwater pumps. Timber-pattern fibre glass panel is proposed for external wall to provide texture and variation to the blank surface and lessen the massiveness of the pumping house. The roof top would be placed with PV panels to enhance the sustainability of the site. The architectural plan of the proposed STTCPS are presented in **Appendix C**. The detailed architectural design of pump house and transformer Room and switch room would be designed to be in harmony with the surrounding throughout the life of development and would be vetted by DSD during detailed design stage. Layout of trees are indicative and would be further finetuned to follow the tree preservation and removal proposal approved in design stage. Layout of landscapes would be further finetuned during detailed design.

3.2 Landscape Design

3.2.1 A tree survey had been carried out. Due to low survival rate of transplanting, some existing trees will be inevitably felled to suit the construction works. Compensatory planting will be implemented with ratio of not less than 1:1 with respect to the number of felled trees. Sufficient space will be provided for the compensatory trees, taking into account of the space required to cater for the establishment and healthy growth of the trees up to maturity. No Old and Valuable Tree (OVT) is identified within the Project Boundary. Details of the tree compensatory planting plan are presented in **Appendix E**. The tree proposal would be submitted for approval in design stage. Soil depth and volume would follow LCSD's "General Standards and Maintenance Requirements for Landscape Works to be Handed over to LCSD for Horticultural Maintenance" and Development Bureau's "Guidelines on Soil Volume for Urban Trees".

4 JUSTIFICATIONS

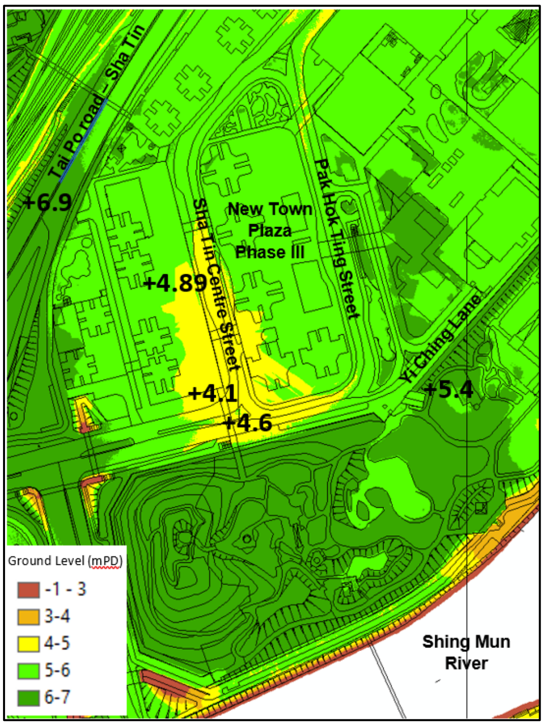
4.1.1 Sha Tin Town Centre with surrounding building complexes is the densest area in Sha Tin. The bus terminal, Tai Po Road and MTR station form a large transportation hub and generates a heavy traffic in Sha Tin Centre Street and Pak Hok Ting Street.

4.1.2 The surface runoff in this basin is captured by the existing drainage networks in Tai Po Road (Sha Tin), Sha Tin Centre Street and Pak Hok Ting Street and discharged in Shing Mun River through a 1800mm diameter pipe in Sha Tin Park. Existing drainage pipes with size varies from 225mm to 1800mm diameter connecting to the Shing Mun River. However, existing drainage system is under tidal impacts of Shing Mun River.

4.1.3 Drainage system at Sha Tin Town Centre is required to meet the required protection levels to cater climate change and extreme weather conditions. The Review of Drainage Master Plan in Sha Tin and Sai Kung – Feasibility Study (DMP Review) was completed in December 2019. The hydraulic modelling results from DMP Review identified that the branch drainage system in Sha Tin Town Centre has insufficient capacity for flood protection. In a large rainfall event under a high tide condition, the drainage networks will be surcharged and cannot be drained away due to high water level at Shing Mun River. Therefore, the flood water will be trapped inside the basin and cause flooding in the town centre because of the backflow from Shing Mun River.

4.1.4 The road level of Sha Tin Centre Street outside New Town Plaza Phase 3 is +4.89mPD. The road level falls towards to Sha Tin Park to +4.1mPD at the junction of Sha Tin Centre Street and Pak Hok Ting Street. The ground level of Sha Tin Park is above +5.4mPD as shown in **Figure 4.1**. This arrangement forms a local basin in Sha Tin Town Centre and a sag point at the junction of Sha Tin Centre Street and Pak Hok Tin Street. i.e. low-lying areas are identified in Sha Tin Town Centre. Therefore the low-lying areas in Sha Tin Town Centre would be subject to high flood risks because of the high water levels at Shing Mun River during rainstorm and insufficient capacity of existing drainage system.

Figure 4.1 – Ground Levels at Sha Tin Town Centre



4.1.5 High water levels at Shing Mun River were repeatedly observed. High water levels at Shing Mun River could be caused by astronomical high tide, typhoon passage, storm surge, heavy rainfall and sea level rise due to climate change. Rainwater would be trapped inland if heavy rainfall take place.

4.1.6 High water levels at Shing Mun River, which were caused by astronomical high tide and winter monsoon, were identified near Sha Tin Town Centre on 20 February 2023, 31 January 2022 (**Photo 4-1**)., 15 December 2020

Photo 4-1 High Water Levels at Shing Mun River Observed in January 2022

4.1.7 The flooding incident reported in Sha Tin Town Centre Street on 15 August 2015 is example to substantiate the above findings. Flooding impacts on traffic and residential area in the flood prone areas will also result in losses and inconvenience to the general public.

4.1.8 To effectively relieve the flood risk in the low-lying areas of Sha Tin Town Centre, the DMP Review has proposed the drainage improvement works mainly in the form of stormwater pumping scheme and drainage system upgrading works. Upon completion of the Project, the flood risk at areas concerned will be largely enhanced to that specified in the standard of the Stormwater Drainage Manual (SDM) and the flood risks thereon can be significantly reduced.

4.1.9 The application site is the only available open space in this drainage catchment with sufficient large pace to accommodate the required stormwater retention volume, structure of the storage tank and its ancillary facilities. The size of the stormwater tank is designed to cater stormwater storage for the required flood protection standard under latest stormwater design standard and anticipated climate change scenario and is also designed to provide necessary spacing to cater the pump equipment and ancillary facilities.

4.1.10 No private land resumption is required for the application site.

4.1.11 The location of the application site is situated at the most downstream of the drainage network in Sha Tin Town Centre between upstream branched drainage system and outlet to Shing Mun River. The stormwater storage and pumping facilities proposed at this application site is the most effective solution to isolate the influence of the water level in Shing Mun River from the concerned low-lying areas in Sha Tin Town Centre. During high tide and rainstorm event, the stormwater within Sha Tin Town Centre drainage catchment can be intercepted and stored in the storage tank and further discharged to Shing Mun River effectively with pumps under the development. Therefore, this is the most appropriate location for this proposed stormwater storage and pumping facility.

4.1.12 The site location was selected considering the arrangement of existing drainage system. The location of the application site is the nearest government land for connecting existing drainage system to connect to, thus fewer pipe laying and construction works. Due to minimum modification made on the existing drainage network and creating the least nuisance to the public, the proposed development at the application is more cost-effective. The site is also selected because of its low-impact development which could avoid the large-scale upstream and downstream drainage improvement works.

4.1.13 The construction of the proposed stormwater proposed stormwater storage and pumping facility at the application site would avoid private land resumption and substantial road opening at some high-volume carriageways. The disturbance to the public, traffic and environmental impacts would be lessened.

4.1.14 The application site is currently for recreation and leisure use only. The application site would serve for underground stormwater storage tank and part of the above-ground space in the application site would be re-provided for the park upon completion of the development. With the adoption of co-use concept in the application site, the land resources could be utilized more efficiently.

4.1.15 Besides, most of the attractions and special features in Sha Tin Park, e.g. wedding garden, children playground, main plaza, amphitheatre, plaza pool and fountain are not affected by the development.

4.1.16 The proposed pump house is served for non-domestic purpose and will provide lifting equipment, equipment for screening and control systems for the operation of the underground storage tank and pumping facility. The above-ground transformer and switch room is also served for non-domestic purpose and will provide transformer and electric switchboard for the operation of the pumping facility.

4.1.17 Based on the above justifications, the proposed location at Sha Tin Park is recommended for the construction of the proposed works.

4.1.18 Public consultation to Sha Tin District Council was carried out on 6 July 2021. Sha Tin District had no comments on the proposed development.

5 POTENTIAL IMPACT AFTER THE WORKS

5.1 Environmental Impact

5.1.1 Air Quality

5.1.1.1 Construction works of the Project will create fugitive dust, especially during excavation of the proposed underground storage tank. Due to the limited scale and construction nature of the Project, the expected impact to air quality would be minor and localised during construction phase. Through implementation of dust mitigation measures required under the Air Pollution Control (Construction Dust) Regulation, construction fugitive dust would be controlled at source to acceptable levels.

5.1.1.2 In view of the nature of the proposed drainage improvement works, the Project itself would not be an air pollutant emission source and thus air quality impact would not be expected during operational phase.

5.1.2 Noise Impact

<u>Construction Phase</u>

5.1.2.1 The proposed stormwater storage tank will have potential noise impacts during the construction phase. The use of powered mechanical equipment during construction phase for various works activities including site clearance, excavation works and construction of above-ground structures is expected to create noise to the nearby sensitive receivers. Assessment indicated that the construction nose impact can be significantly reduced by use of quiet powered mechanical equipment (QPME), noise barriers and enclosures, and good site practices. With the implementation of the recommended mitigation measures, no exceedance of construction noise criteria is expected.

Operational Phase

5.1.3 It is assumed that the fixed plants at the proposed stormwater pumping station would be in operation / standby for 24 hours. Hence, evening and night-time operation of the fixed noise sources have also been assumed. The maximum allowable sound power levels of the fixed noise sources of the Project for daytime/ evening time and night-time are 87 dB(A) and 81 dB(A) as detailed in Appendix 4.4 of **Appendix H**. Given that the proposed fixed plants are properly designed to meet the maximum allowable sound power levels, no adverse fixed plant noise impact would be anticipated.

5.1.4 Water Quality

5.1.4.1 Construction of stormwater pumping station and underground storage tank at Application Site would only involve land-based construction works. No marine works would be required. Potential water quality impacts arising from the construction phase include:

- General construction activities;
- Construction site runoff;
- Accidental spillage of chemicals and potential contamination of surface water and groundwater; and
- Sewage effluent from construction workforce.

Construction Phase

5.1.4.2 All site practices outlined in the Water Quality Objectives (WQOs) and *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems*, *Inland and Coastal Waters* (TM-DSS) stipulated under the *Water Pollution Control Ordinance* (Cap. 358) (*WPCO*) should be complied with. Mitigation measures for water quality in Construction Phase are stipulated in Section 5.7 of **Appendix H**.

5.1.4.3 The site practices outlined in *ProPECC PN 1/94 "Construction Site Drainage"* should be followed as far as practicable during the drainage improvement works in order to minimise surface runoff and to control erosion, and also to retain and reduce any suspended solids prior to discharge.

5.1.4.4 Contractor must register as a chemical waste producer if chemical wastes would be produced from the construction activities. The *Waste Disposal Ordinance (Cap 354)* (WDO) and its subsidiary regulations in particular the *Waste Disposal (Chemical Waste) (General) Regulation* shall be observed and complied with for control of chemical wastes.

5.1.4.5 Examples of mitigation measures on water quality in construction phase are shown as the following:-

- Debris and refuse generated on-site should be collected, handled and disposed of properly to avoid entering any nearby water bodies and public drainage system. Stockpiles of cement and other construction materials should be kept covered when not being used.

- A wheel washing bay shall be provided at every site exit if practicable and wash-water shall have sand and silt settled out or removed before discharging into storm drains.

- Suitable containers shall be used to hold the chemical wastes to avoid leakage or spillage during storage, handling and transport.

- Regular environmental audit of the construction site will provide an effective control of any malpractices and can encourage continual improvement of environmental performance on site.

5.1.4.6 Maintenance desilting of the storm drains and stormwater pumping station should be carried during dry season months when the drains are in dry condition to avoid any potential water quality impacts.

<u>Operational Phase</u>

5.1.4.7 The proposed stormwater pumping scheme for the application site aims to mitigate the existing flooding risk in Sha Tin Town Centre and the proposed works has not expanded any of the existing drainage catchment. The operation of the proposed drainage improvement works does not constitute any elements that would be water pollution sources and would not generate any new pollution load to the catchment. Maintenance works such as desilting of the proposed stormwater drains and stormwater pumping station would tentatively be carried out on an annual basis during dry season months when the drains are in dry condition to avoid any potential water quality impacts. No adverse water quality impact would be expected during operational phase.

<u>Evaluation of Residual Impacts</u>

5.1.4.8 With the proper implementation of the proposed mitigation measures, no adverse water quality impacts would be anticipated from the construction or operation of the construction of the pump house and underground storage tank.

5.1.4.9 The preliminary environmental review report is attached in **Appendix H**.

5.2 Drainage Impact

5.2.1 Since the objective of the project is to improve the drainage capabilities of the Sha Tin Town Centre area and alleviate flood risks, no adverse drainage impact will be anticipated. A preliminary drainage impact assessment is attached in **Appendix J**.

5.3 Traffic Impact

5.3.1 During construction phase, trenchless method will be adopted as far as practicable for the proposed pipe laying works along Sha Tin Centre Street and Pak Hok Ting Street to minimize the traffic impact. With the implementation of temporary traffic arrangement at along Sha Tin Centre Street and Pak Hok Ting Street, the traffic impact during construction is considered temporary and minimal.

5.3.2 During operation phase, it is expected that only a few and infrequent maintenance vehicles will enter the proposed stormwater storage tank, therefore operational traffic impact is minimal.

5.3.3 The preliminary traffic impact assessment is attached in **Appendix I**.

5.4 Geotechnical Impact

5.4.1 Results of ground investigation works, field tests and laboratory tests carried out for this Project were used to update the geotechnical parameters and recommendations made. With the recommendations made on the feasible schemes of the foundation for the Project, it is anticipated that the proposed construction works would not impose any adverse effect on the adjacent ground and structures. A preliminary geotechnical assessment report is attached in **Appendix L**.

5.5 Landscape Impact

5.5.1 A tree survey has been conducted and compensatory tree planting will be provided in accordance with the relevant technical circulars. With the implementation of the recommended mitigation measures, including transplanting and compensatory planting, residual landscape impact is not anticipated during construction and operation stages.

5.5.2 Mitigation measures are proposed to minimize potential landscape impact during construction. The storage tank would be placed underground and the proposed above-ground structures will have architectural and landscape design. Architectural design is shown in **Appendix C** and landscape layout is shown in **Appendix F**. The building mass is encased with a timber textured ‘screen’ to reduce its bulkiness, forming a dissolved barrier at the park edge. In addition, the ‘screen’ constructed with vertical timber-textured planks and green mesh forms a natural backdrop, which blend in with the adjacent vast greening, and continue the greening of the existing site edge facing Yi Ching Lane. Besides, the landscaped areas are expanded with a central lawn above the underground tanks, which are open and well connected to the existing park and pathways. With the mitigation measures including aesthetic design of above-ground structures and landscape treatments such as vertical greening are proposed to enhance the visual amenity of the proposed development, no significant adverse visual impact in operational phase would be anticipated.

5.6 Water Supply Impact

5.6.1 No adverse waterworks impact is identified from the Project. It is anticipated that no major watermain diversion would be required. Trial pit will be conducted before the construction of the proposed works to identify the exact location of the watermain. The Contractor shall monitor for excessive ground settlement to detect possible damages to the integrity of adjacent watermains during the construction phase.

5.7 Sewerage Impact

5.7.1 No proposed sewerage works is required and thus no adverse sewerage impact form the project. It is anticipated that no major sewerage diversion would be required. A preliminary sewerage impact assessment report is attached in **Appendix K**.

5.8 Affected LCSD Facilities due to the Proposed Development

5.8.1 The existing LCSD facilities in the application site are shown in **Appendix D**. These facilities would be demolished for the proposed development. The existing LCSD facilities included:-

- Climbing Plant Archway (Landscape Tunnel);
- Fitness Corner;
- Pavilion;
- Family Games Area (Lawn);
- Azalea Garden

5.8.2 As agreed with LCSD in the co-ordination meeting, the following facilities should be re-provided at the application site upon completion of the proposed development. New facilities would be provided above the underground storage tank:-

- Fitness Corner;
- Seating Shelter(1);
- Family Games Area (Lawn);

Remark (1): Seating shelter would replace pavilion.

5.8.3 Climbing plant archway (landscape tunnel) and azalea garden would be affected permanently by the proposed development.

5.9 Potential Impact to Existing Sha Tin Park Users during Construction Phase

5.9.1 Area of Sha Tin Park is approx. 8 hectares, only 5% of the existing park would be affected during construction.

5.9.2 Fitness corner, seating shelter, family games area (lawn) in the application site would be suspended temporarily, about 46 months, during construction i.e. Q1 2025 - Q4 2028. These facilities would be reprovided upon completion of the development.

5.9.3 For the suspended fitness corner during construction, another fitness facilities are also provided next to Shing Mun River promenade outside South Garden Children's Playground, which is less than 100m from the application site (**Photo 5-1**), the affected user could use the fitness facilities within Sha Tin Park near the application site during construction, hence the impact is considered minimal.

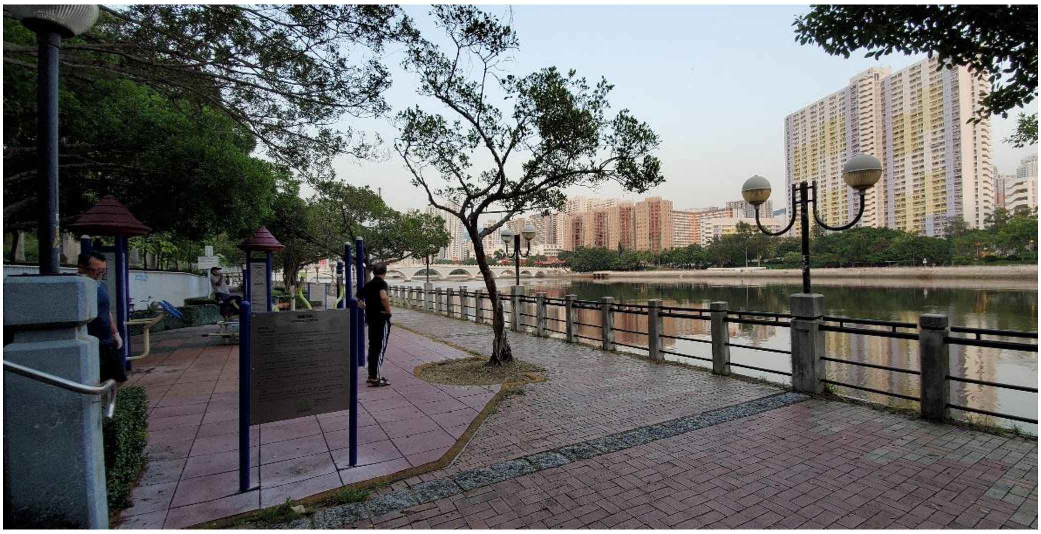


Photo 5-1 – Existing Fitness Facilities near Application Site

5.9.4 For the suspended pavilion during construction, another pavilion and sheltered sitting-out area could be identified at the existing Veranda, which is less than 50m away from the application site (**Photo 5-2**), the affected user could use the pavilion within Sha Tin Park near the application site during construction, hence the impact is considered minimal.

Photo 5-2 – Existing Pavilion near Application Site

5.9.5 For the suspended Family Games Area (Lawn) during construction, another lawn could be identified next to North Garden Children's Playground, which is less than 400m away from the application site (**Photo 3**), the affected user could use the lawn within Sha Tin Park near the application site during construction, hence the impact is considered minimal.

Photo 5-3 – Existing Family Game Area (Lawn) near the Application Site

5.9.6 Since alternative facilities which serve the same purposes of the affected facilities could be found within 400m of the application site, the impact to the park users is considered minimal during construction.

5.9.7 During construction, hoardings would be erected around the application site to mitigate air, dust, noise, visual impacts to the existing Sha Tin Park users.

5.9.8 Air, noise, water quality impacts to the park users and mitigation measures were discussed in **Section 5.1**.

5.9.9 Plan showing the locations of the alternative facilities with reference to the application plan is shown in **Appendix D**.

5.10 Potential Impact to Existing Sha Tin Park Users during Operational Phase

5.10.1 During operation phase, the fitness corner, seating shelter and family games area (lawn) which are reprovided aboveground of the underground storage tank would not be affected by the operation of proposed stormwater pumping and storage facility.

5.10.2 Since the pumps are enclosed underground, noise generated during operation would be minimal.

5.10.3 Maintenance of the proposed stormwater pumping and storage facility would be carried out at the DSD's pump house.

5.10.4 For safety of Sha Tin Park users, boundary fence and walls would be erected to clearly delineated between DSD's pump house and Sha Tin Park, in order to keep the park users away from the stormwater pumping and storage facility. Security locks would be installed at the entrance/exit gates of stormwater pumping and storage facility.

5.10.5 Similar co-use concept of recreation facilities and flood prevention facilities had been adopted at LCSD's Happy Valley recreation ground with DSD's Happy Valley Stormwater Storage Scheme, which has been operated since 2017.

6 CONCLUSION

6.1.1 As stipulated in the Schedule of Use of the OZP for "Open Space", the proposed stormwater storage and pumping facility which is considered as "Public Utility Installation" requires planning permission from the TPB.

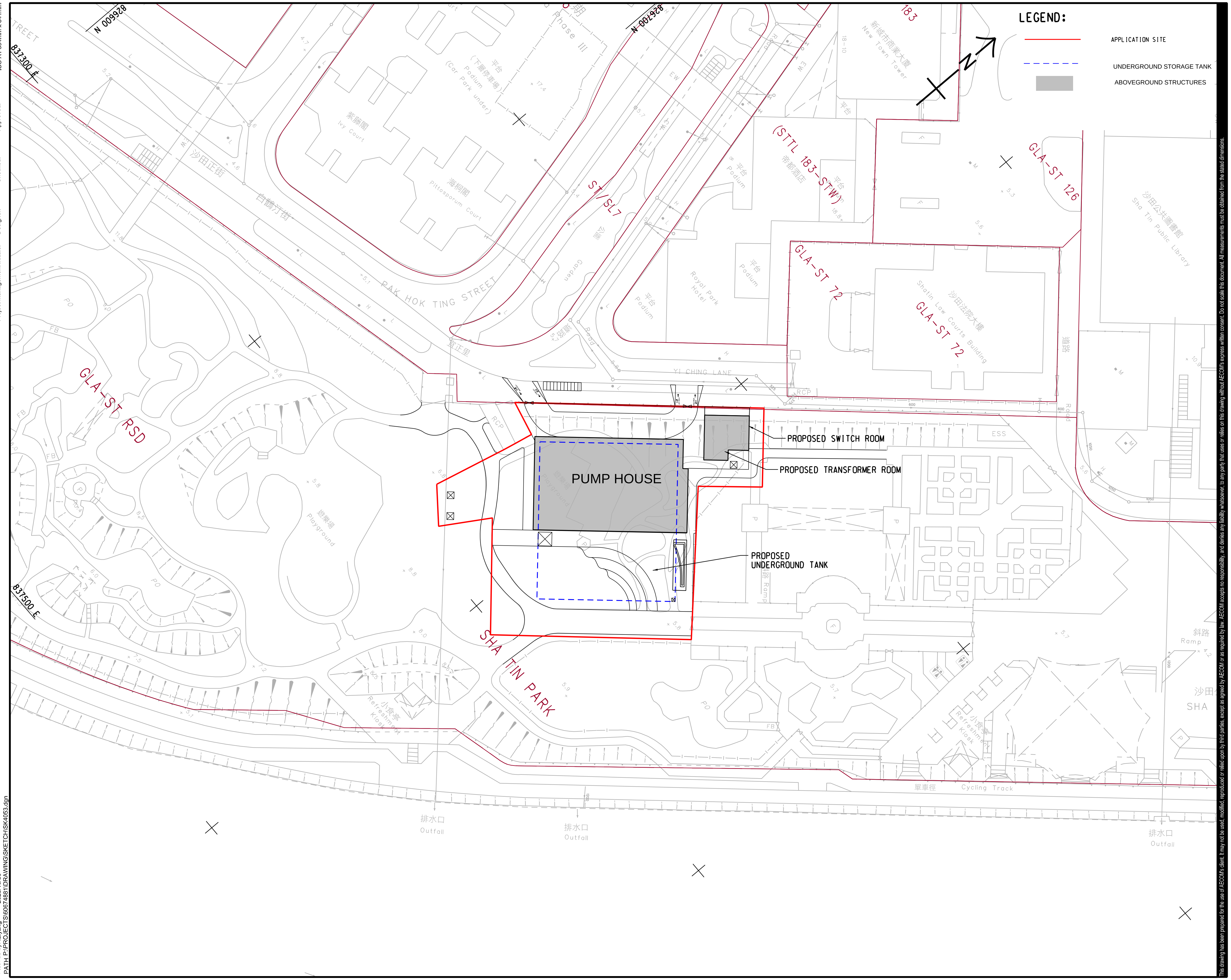
6.1.2 The application site is considered as the most suitable location for the proposed stormwater storage and pumping facility in the consideration of hydraulic performance, construction cost, traffic impact, social impact and environmental impact.

6.1.3 With the provision of the stormwater storage and pumping facility, the flooding problem in Sha Tin Town Centre will be alleviated.

6.1.4 The potential impacts due to construction of the proposed stormwater storage and pumping facility have been reviewed. With the implementation of recommended mitigation measures, it is concluded that no adverse impacts will be brought by the project.

- END -

Appendix A – Proposed Works



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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

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DIMENSION UNIT 尺寸單位

METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號

60674881

CONTRACT NO. 合約編號

CE 44/2021 (DS)

SHEET TITLE 圖紙名稱

PRELIMINARY LAYOUT PLAN AND SECTIONS OF SHA TIN TOWN CENTRE STORMWATER PUMPING STATION (STTCSPS)

SHEET NUMBER 圖紙編號

60674881/SK4053

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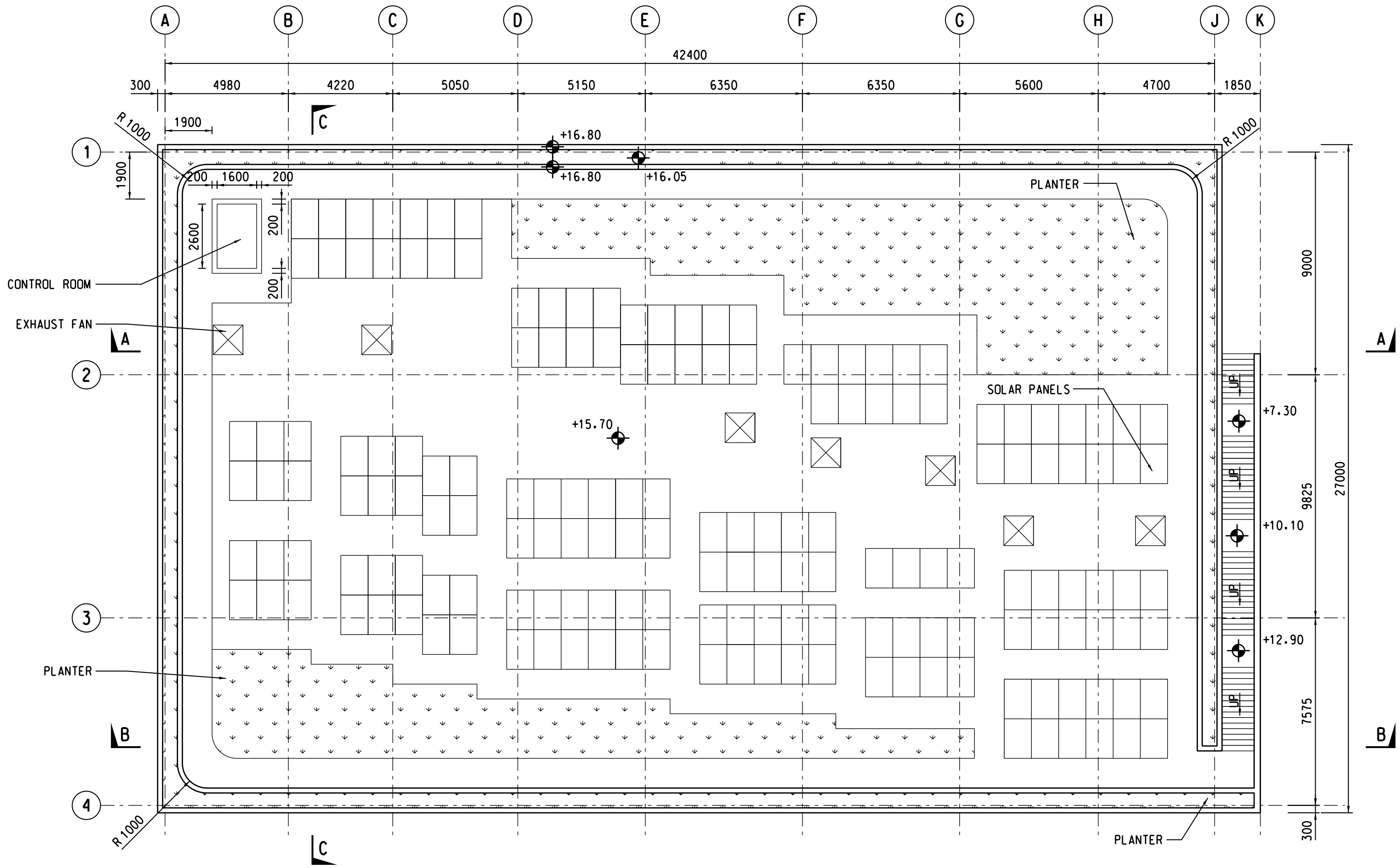
Project Management Initials:



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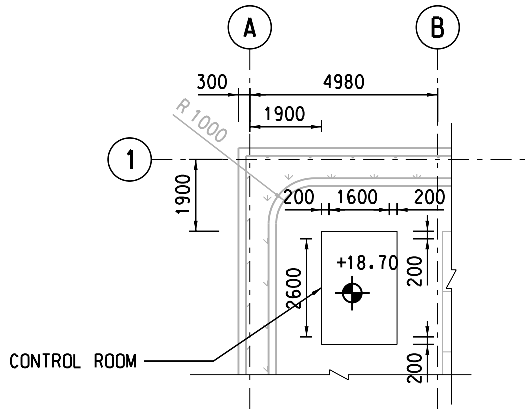

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KEY PLAN

PROJECT NO.

60674881

CONTRACT NO.

CE 44/2021 (DS)

SHEET TITLE

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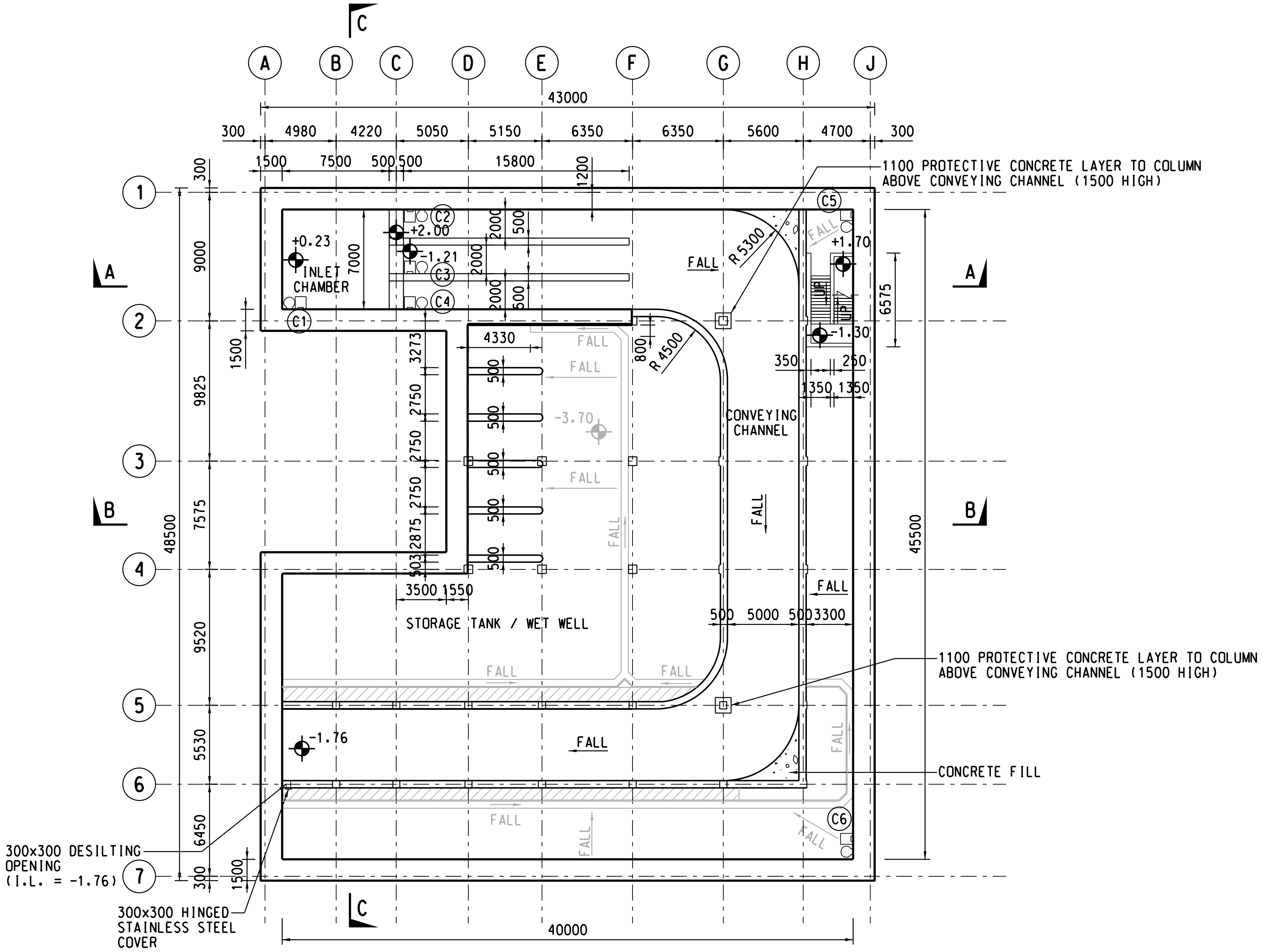
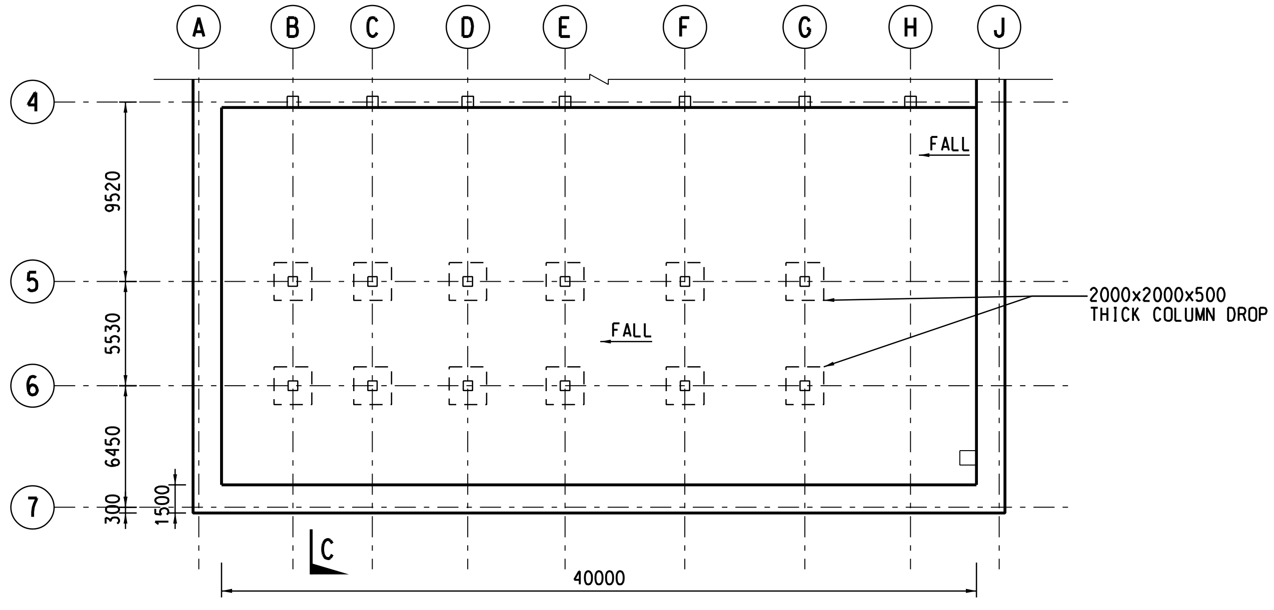


UNDERGROUND STORMWATER STORAGE TANK LAYOUT PLAN AT +0.23/-1.76mPD



PART PLAN AT +3.70mPD

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PROJECT NO.: 60674881

CONTRACT NO.: CE 44/2021 (DS)

SHEET TITLE

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SHEET NUMBER

60674881/SK4103

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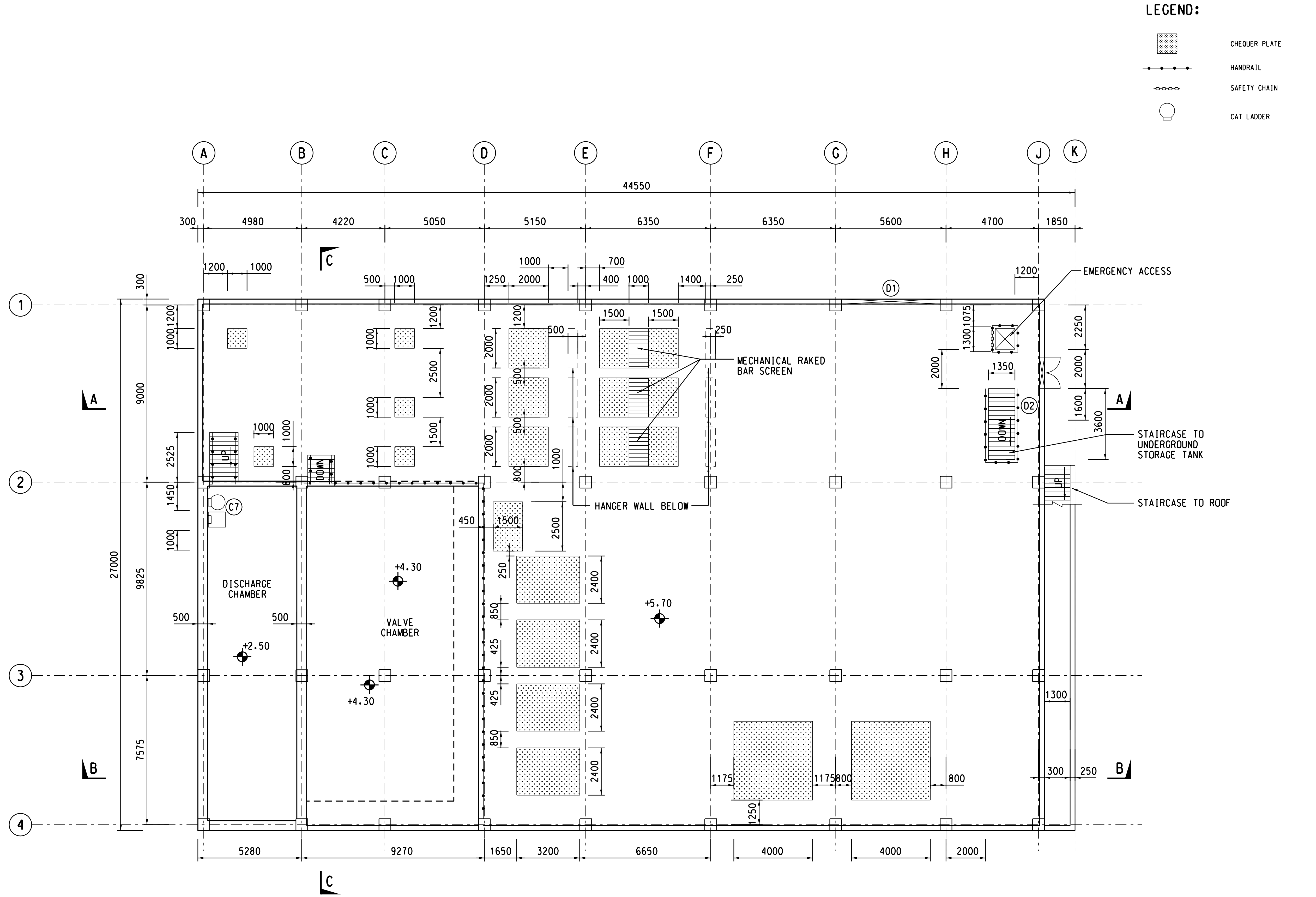

PUMPING HOUSE GROUND FLOOR PLAN AT +5.70mPD

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CONTRACT NO. 合約編號: CE 44/2021 (DS)

SHEET TITLE 圖紙名稱

STTCSPS PUMP HOUSE - LAYOUT AT G/F +5.70mPD

SHEET NUMBER 圖紙編號

60674881/SK4101

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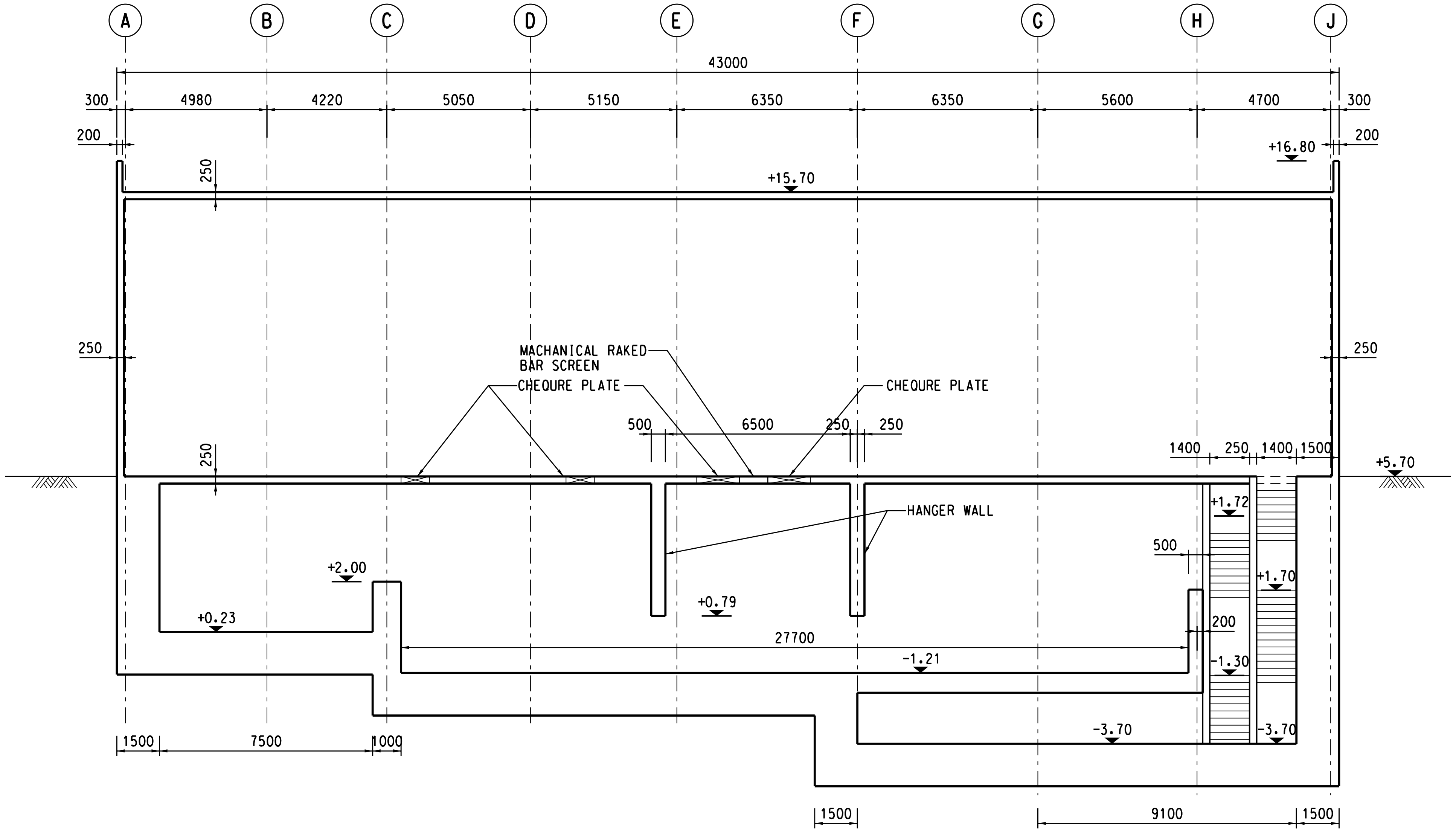

SECTION A - A

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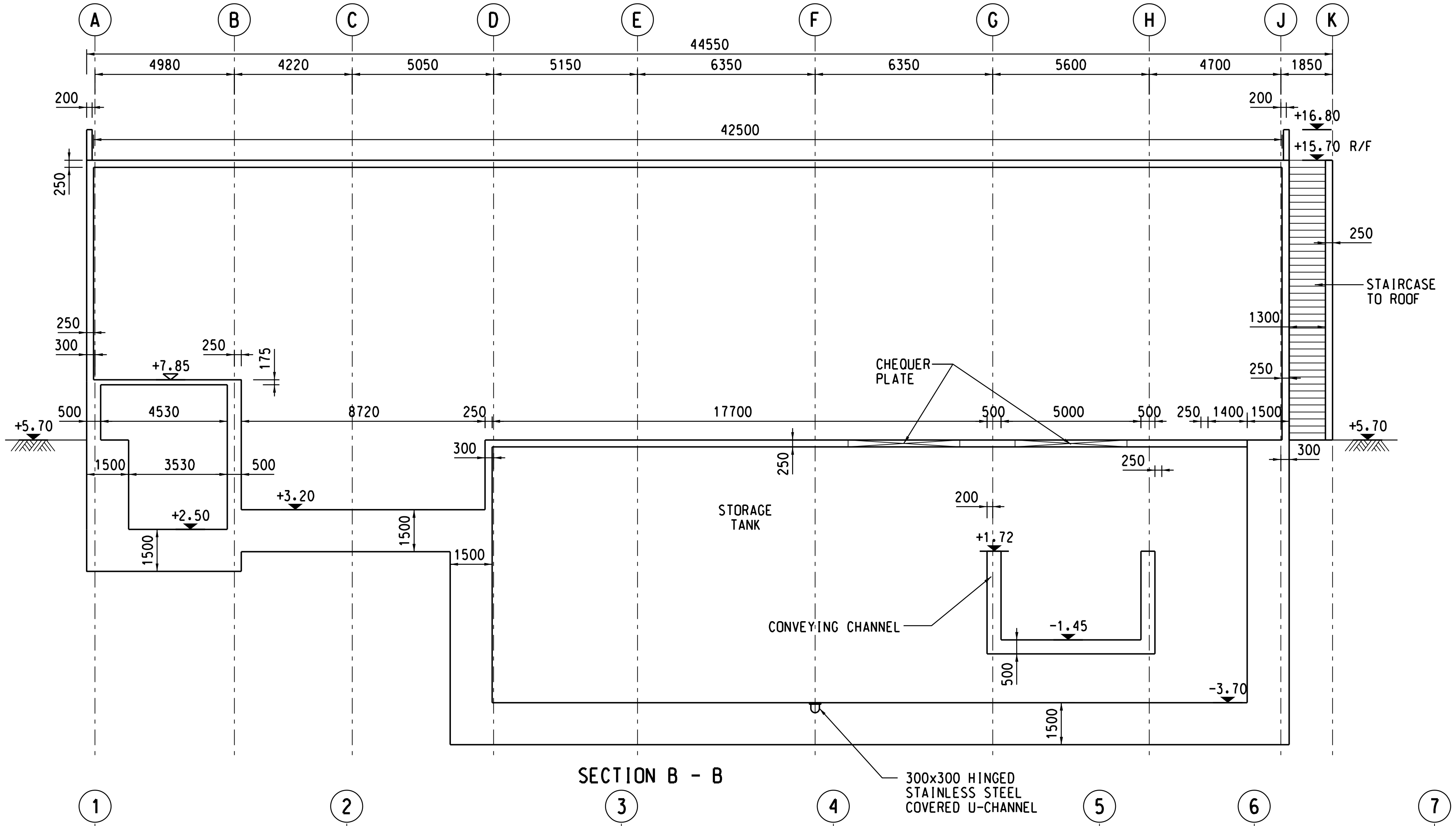

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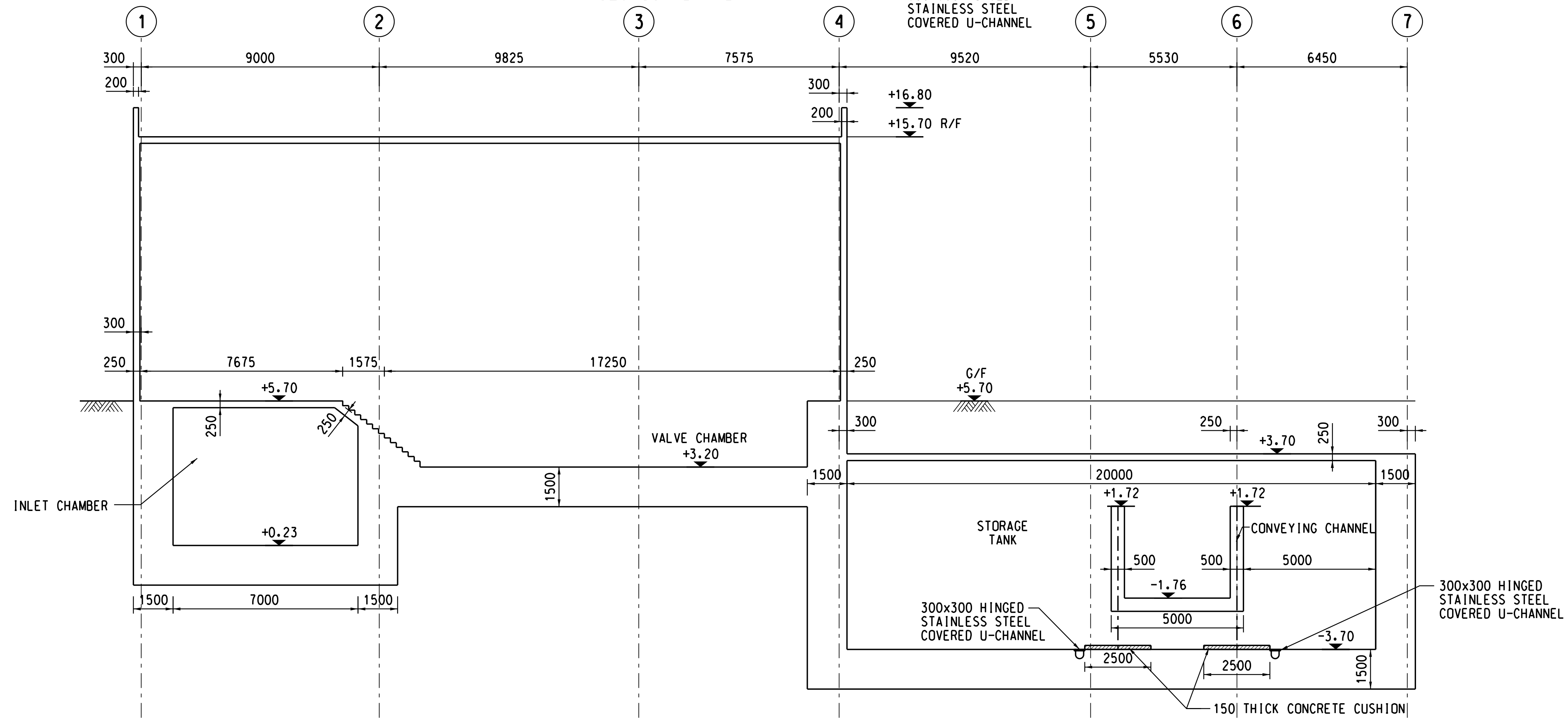

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CONTRACT NO. 合約編號 — CE 44/2021 (DS)

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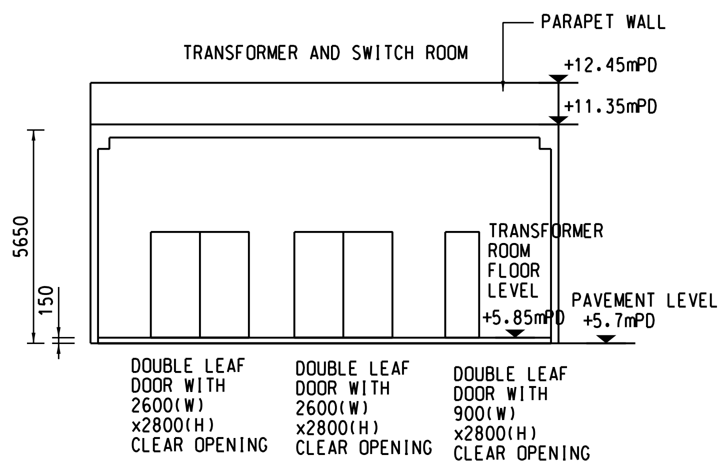

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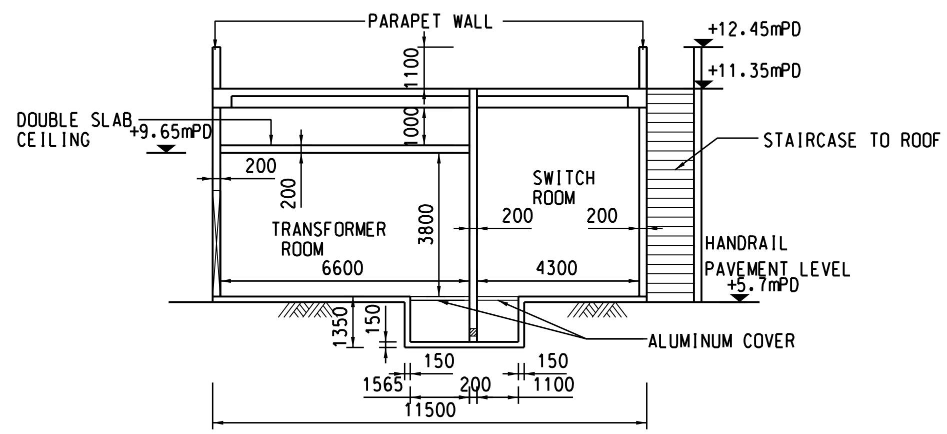

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60674881

CONTRACT NO.
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CE 44/2021 (DS)

SHEET TITLE
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STTCSPS TRANSFORMER AND SWITCH ROOM - SECTION

SHEET NUMBER
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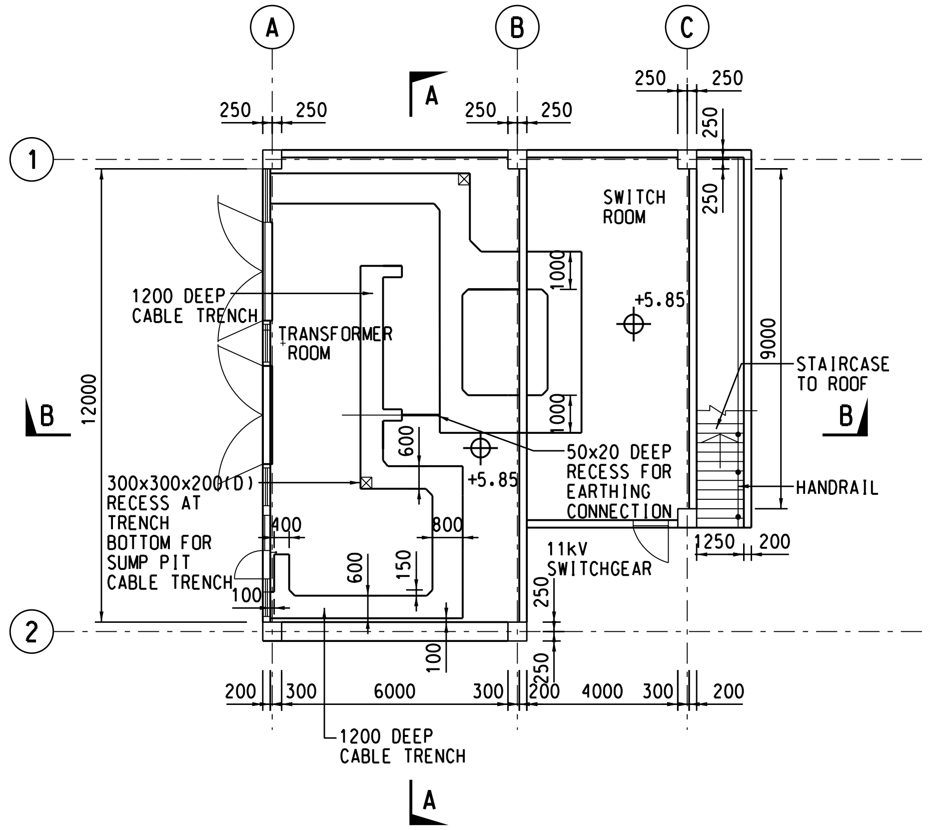
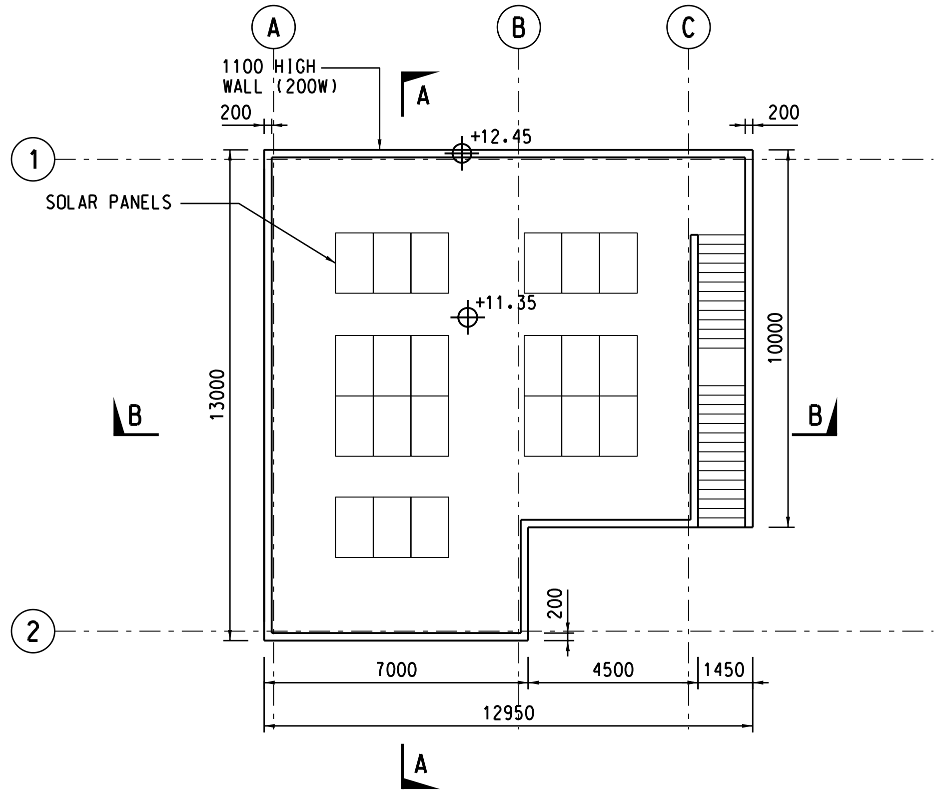


TRANSFORMER AND SWITCH ROOM GROUND FLOOE PLAN AT +5.85mPD



TRANSFORMER AND SWITCH ROOM ROOF FLOOE PLAN AT +11.35mPD

ISO A1 594mm x 841mm

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Project Management Initials:

Plot File by: Yuxuan.He 10/19/2023

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STTCSPS TRANSFORMER AND WITCH ROOM - LAYOUT AT +5.85 AND +11.35mPD

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Appendix B – Current Condition with Surrounding Environment

Appendix C – Architectural Design

Figure 1a – Overview of Architectural Design

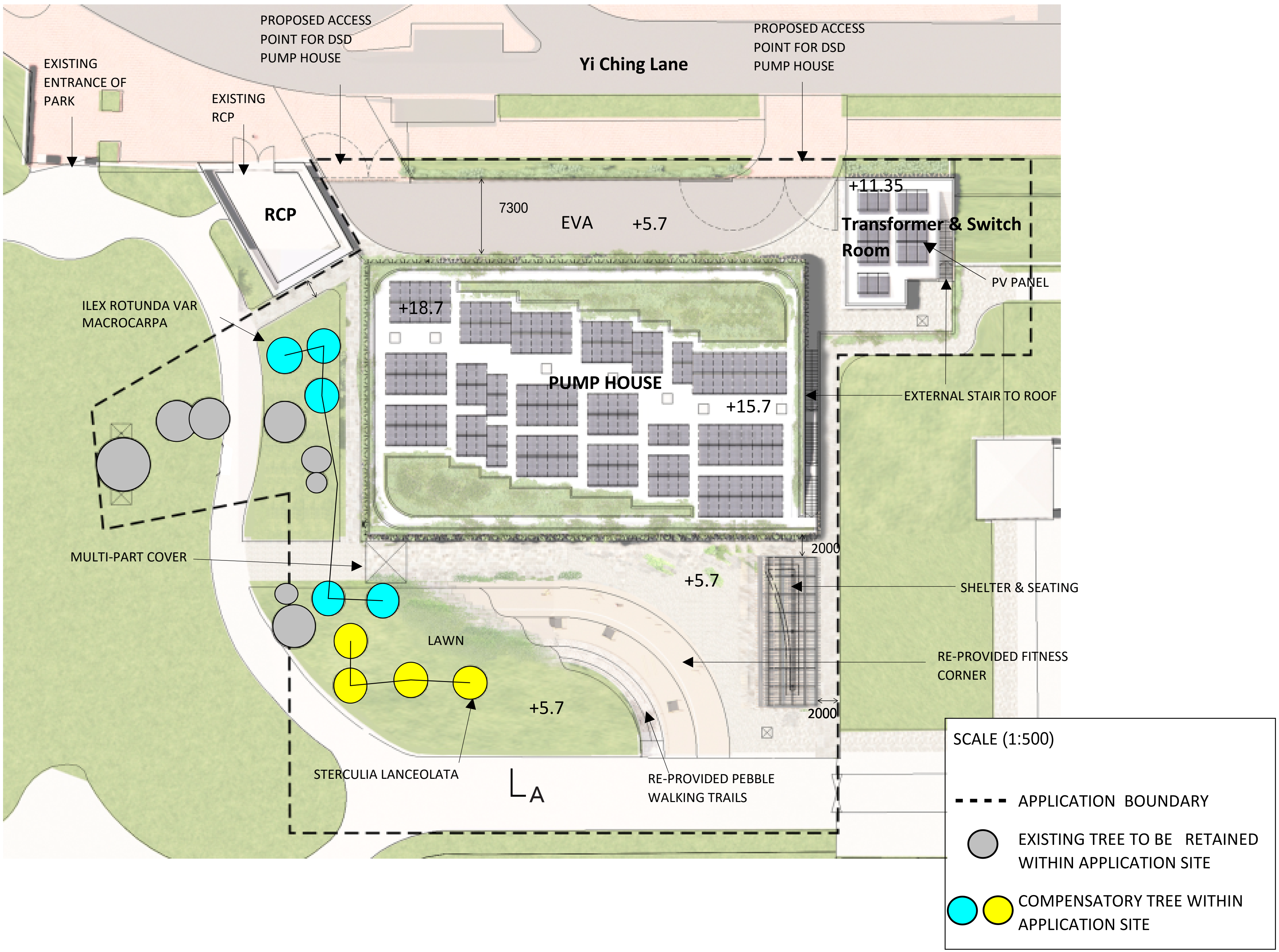


Figure 1b – Overview of Architectural Design

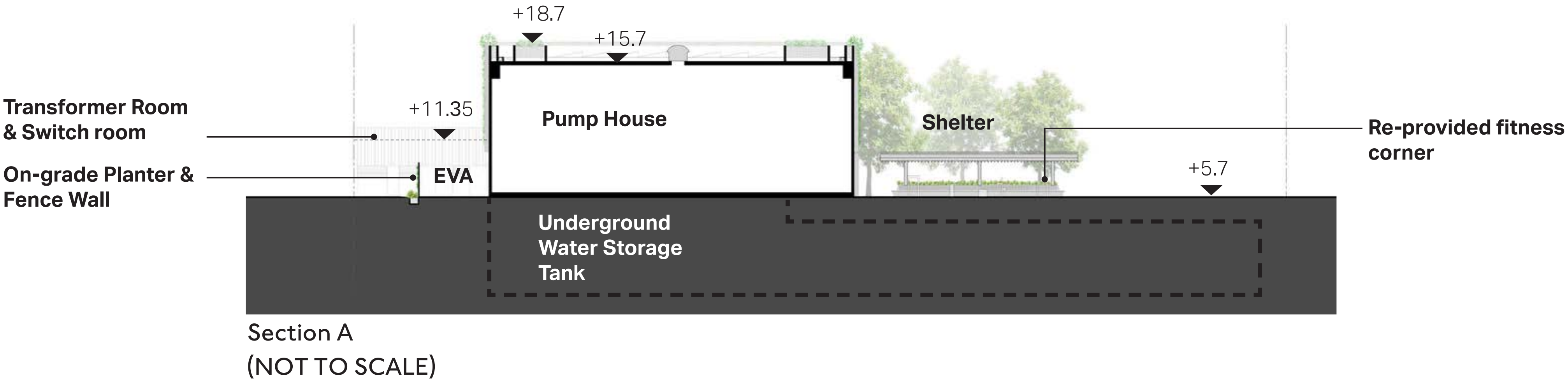


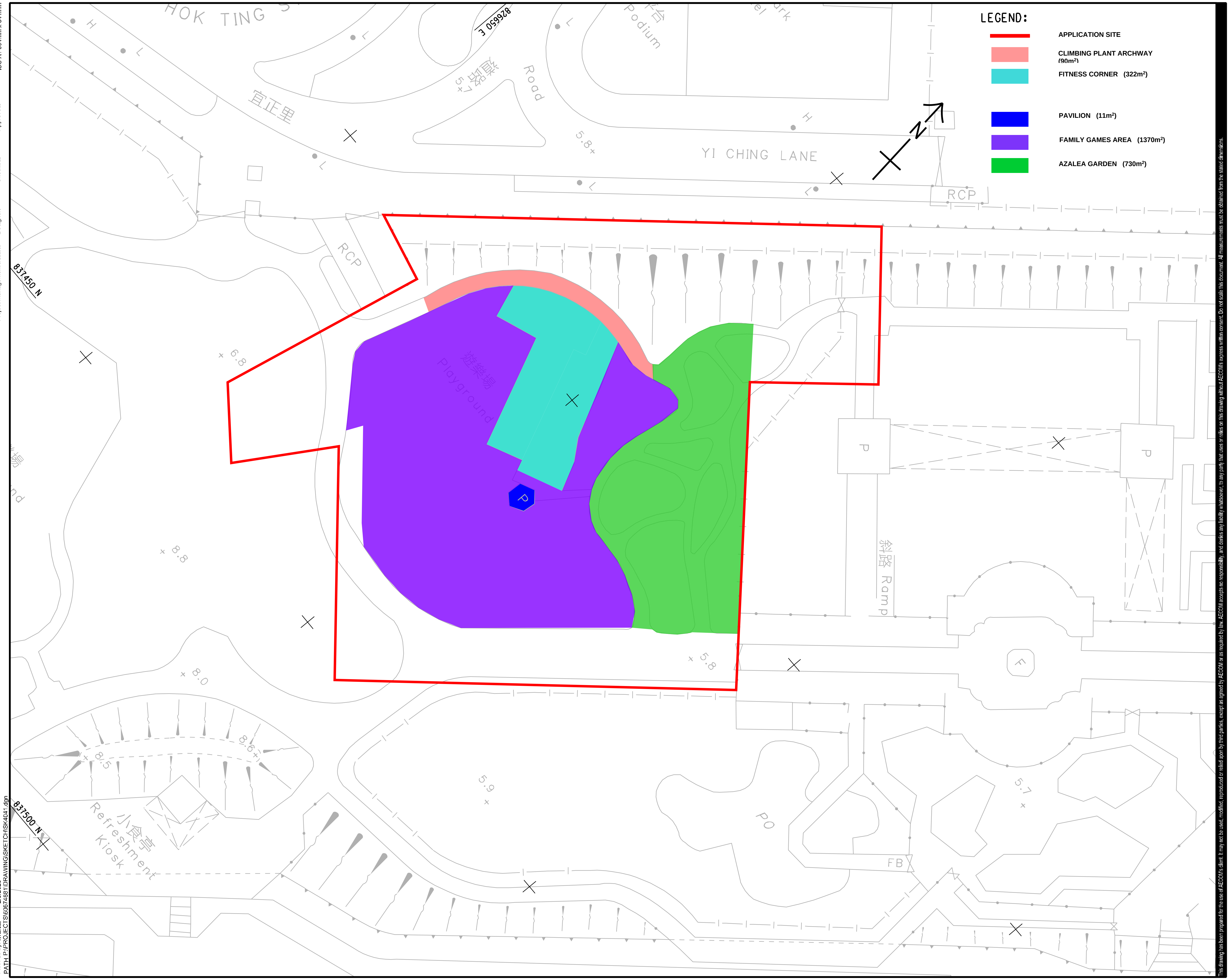
Figure 2 - View from Yi Ching Lane

Figure 3 - View from Park (1)

Figure 4 - View from Park (2)

Figure 5 **- View from Park (3)**

Appendix D – Plan for Existing LCSD Facilities and Plan for Affected Alternative Facilities



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KEY PLAN

PROJECT NO.

60674881

CONTRACT NO.

CE 44/2021 (DS)

SHEET TITLE

SHA TIN PARK FACILITIES PLAN

SHEET NUMBER

60674881/SK4041

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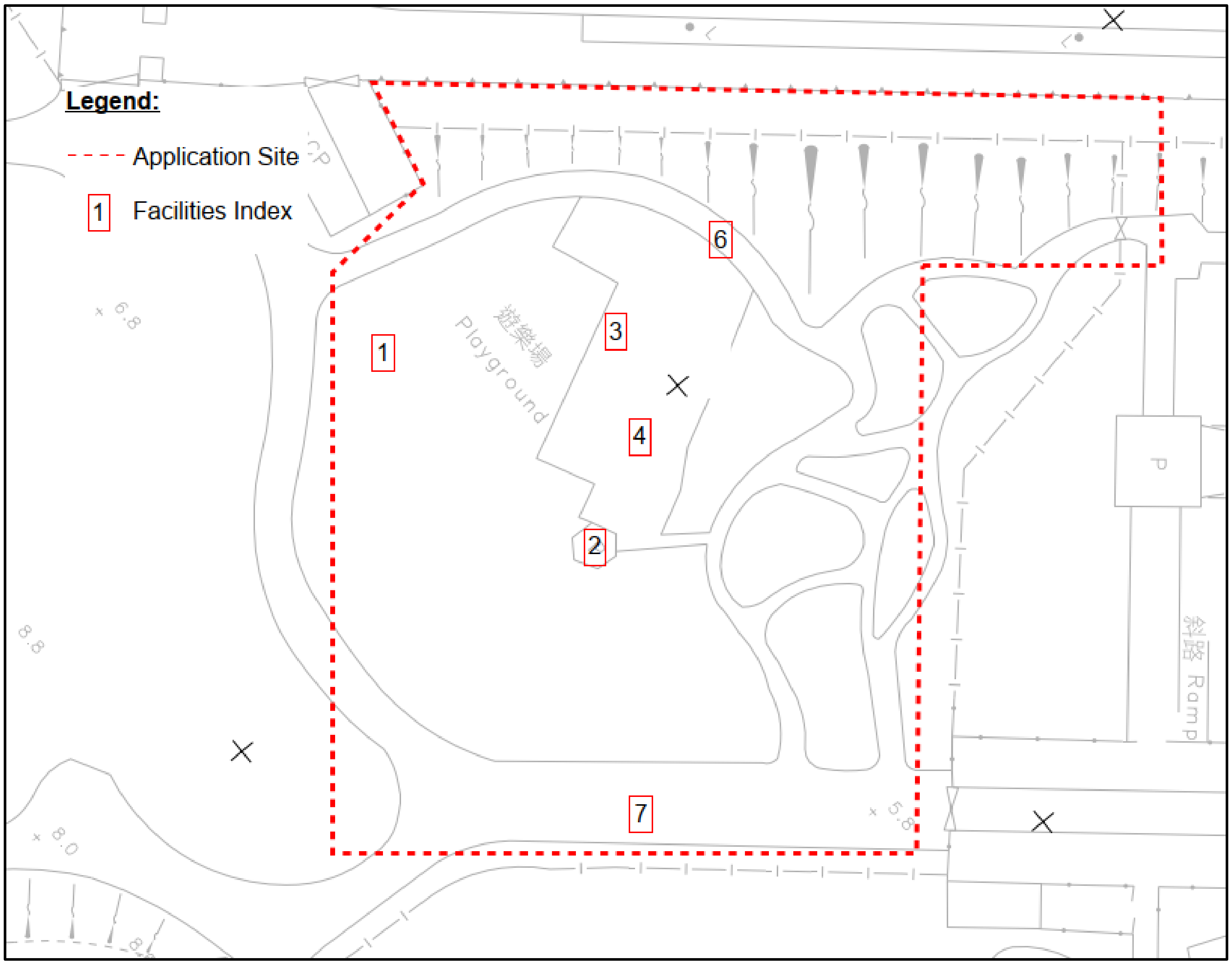
Sha Tin Park Facilities Plan



Facility 1: Benches (w/ or w/o Shelter)

Facility 2: Pavilion

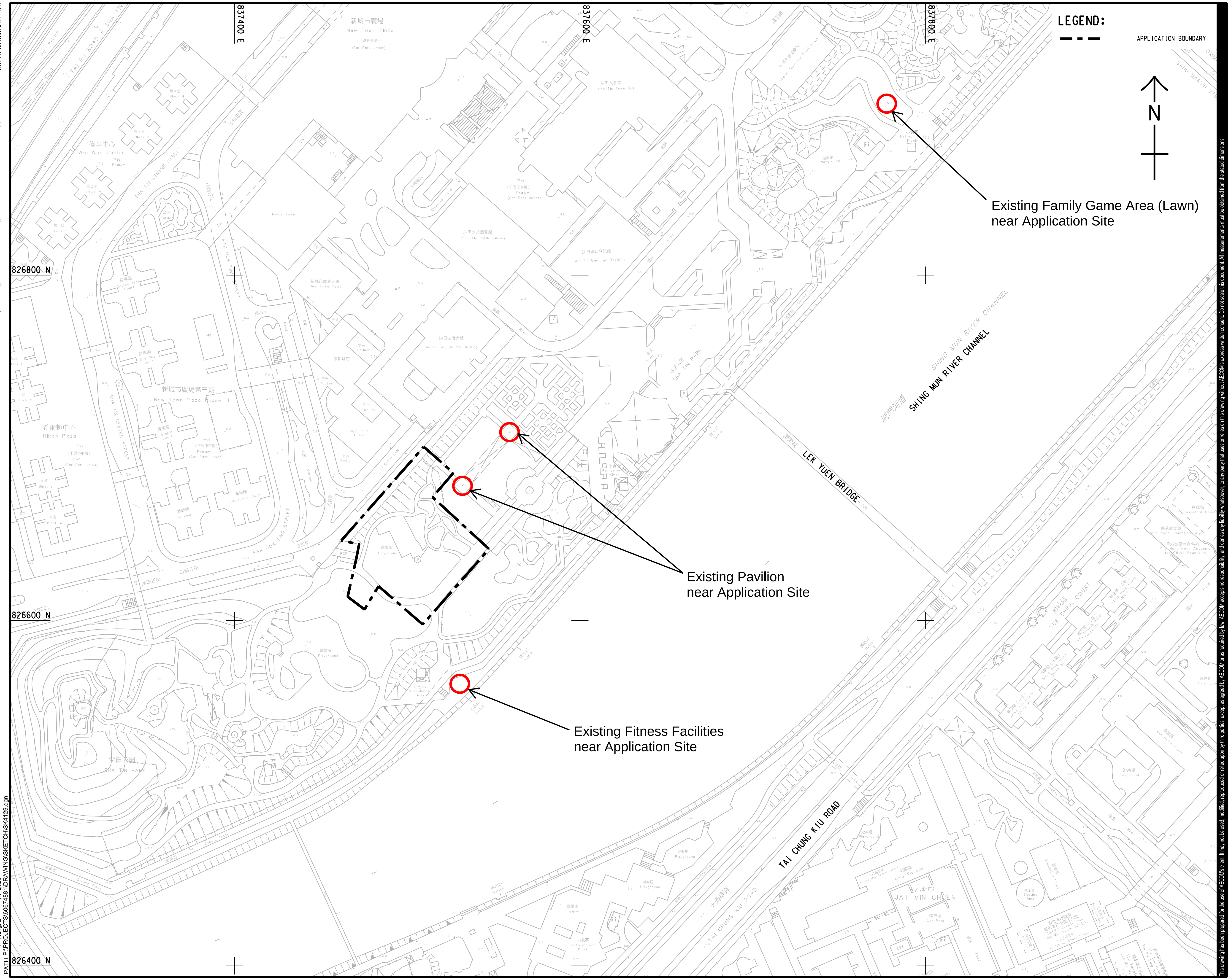
3.1

Facility 3: Fitness Corner

<u>Facility 4: Benches (w/ or w/o Shelter)</u>

Facility 6: Climbing Plant Archway

Facility 7: Benches



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PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT 業主

渠務署
Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
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SUB-CONSULTANTS 分判工程顧問公司

ISSUE/REVISION 修訂

I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 校核

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CONTRACT NO. 合約編號: CE 44/2021 (DS)

SHEET TITLE 圖紙名稱

LOCATION PLAN OF ALTERNATIVE FACILITIES

SHEET NUMBER 圖紙編號

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Appendix E – Tree Survey Report and Tree Felling / Transplanting Application

Agreement No. CE 44/2021
Drainage Improvement Works in Sha Tin and Sai Kung – Design and Construction

Tree Survey Report and Tree Preservation and Removal Proposal
(Sha Tin Park)

Table of Contents

Page

1 INTRODUCTION

1.1 Project Background

1.1.1 The Review of Drainage Master Plan in Sha Tin and Sai Kung – Feasibility Study (DMP Review) identified that the following areas in Sha Tin would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics:

(a) Sha Tin Town Centre;

1.1.2 The flooding incidents reported in Sha Tin Centre Street on 15 August 2015 are examples to substantiate the above findings.

1.1.3 To relieve the flood risk in the above areas, the DMP Review Study has proposed implementing drainage improvement measures, mainly in form of stormwater pumping scheme and drainage upgrading works. Upon completion of the proposed improvement measures, the standards of flood protection at areas concerned will be largely enhanced to that specified in the standards of the Stormwater Drainage Manual (SDM) and the flood risks thereon can be significantly reduced.

1.1.4 In May 2018, Development Bureau (DEVB) signed out a Project Definition Statement (PDS) to justify and define the scope of the “Drainage Improvement Works in Sha Tin and Sai Kung” (the Project). The Drainage Services Department (DSD) then completed a Technical Feasibility Statement (TFS) confirming its technical feasibility. The TFS was subsequently approved by DEVB in August 2018. The Project was included into Cat B under PWP Item No. 4182CD in September 2018.

1.1.5 In October 2019, DSD commissioned Agreement No. CE 6/2018(DS) “Drainage Improvement Works in Sha Tin and Sai Kung – Investigation” (referred to hereinafter as the “Investigation Study”) to carry out various reviews, survey, investigation, impact assessments and preliminary design for the Project. The Project comprises the drainage improvement works recommended under the DMP Review Study as described below:

(a) Stormwater pumping scheme at Sha Tin Town Centre, including an underground storage tank, a pump house and associated pipeworks and electrical and mechanical (E&M) works, as well as drainage upgrading works around Sha Tin Town Centre such as Pak Hok Ting Street, Sha Tin Centre Street, Man Lai Road and ancillary works including reinstatement of playgrounds and associated facilities;

1.1.6 AECOM Asia Company Limited was appointed by DSD on 20 December 2021 to undertake Agreement No. 44/2021(DS) “Drainage Improvement Works in Sha Tin and Sai Kung – Design and Construction” (referred to hereinafter as “the Project”) of, of which the starting date of the Project is 29 December 2021.

1.1.7 The scope of the Project mainly comprises adoptive review, investigations, surveys, investigations, impact assessments, public consultation, detailed design, tendering, construction to the commissioning of the works.

1.2 Scope of this Report

1.2.1 The Consultant would carry out a comprehensive survey of all existing trees within the project area and identify with reference to DEVB TCW No. 6/2015, No. 4/2020 and 5/2020 and DSD TC No. 4/2015. Drawings showing the location and size of the trees together with a tree schedule showing the species, height, circumference of trunk, tree spread, general condition and photographs would be prepared. The number of trees to be retained, transplanted or felled due to the proposed works would be presented in the report and indicated in the drawings. The report would be submitted to the Tree Works Vetting Panel (TWVP) as required in accordance with the aforementioned technical circulars.

1.2.2 Following this introductory section, the remainder of the Report is arranged as follows:

- Section 1 outlines the proposed works for the project;
- Section 2 describes environmental legislations, standards and guidelines related to tree survey and tree preservation and removal proposal;
- Section 3 illustrates the tree survey methodology;
- Section 4 presents the tree retention, transplanting and felling proposals;
- Section 5 presents the compensatory tree planting proposals;
- Section 6 presents the transplant tree planting proposals; and
- Section 7 summarises the findings of the report.

1.3 Abbreviation

1.3.1 The following table lists out the abbreviated titles of Government bureaux, departments, offices, statutory bodies and public organizations mentioned in this Report.

Abbreviation	Full Title
AFCD	Agriculture, Fisheries and Conservation Department (AFCD);
ASD	Architectural Services Department;
CEDD	Civil Engineering and Development Department;
DEVB	Development Bureau
DSD	Drainage Services Department;
EPD	Environmental Protection Department
GEO	Geotechnical Engineering Office of Civil Engineering and Development Department
HyD	Highways Department
HD	Housing Department (HD)
LandsD	Lands Department (LandsD)
LCSD	Leisure and Cultural Services Department.

2 LEGISLATIONS, STANDARDS AND GUIDLEINES

2.1 Government Publications, Guidelines and Reports

2.1.1 Government Publications, Guidelines and Reports related to Tree Survey, Preservation and Removal Proposals include:

- Agriculture, Fisheries and Conservation Department – AFCD Nature Conservation Practice Note No. 1 – Clearing Mikania
- Agriculture, Fisheries and Conservation Department – AFCD Nature Conservation Practice Note No. 2 – Measurement of Diameter at Breast Height (DBH)
- Agriculture, Fisheries and Conservation Department – AFCD Nature Conservation Practice Note No. 3 – The Use of Plant Names
- Civil Engineering and Development (2006) – General Specifications for Civil Engineering Works, Sections 3 and 26
- Civil Engineering and Development (2008) – Project Administration Handbook, Chapters 1 and 4
- Development Bureau – Latest Guidelines for Tree Risk Management and Assessment Arrangement on an Area Basis and on a Tree Basis
- GEO Publication (2000) – Highway Slope Manual, Chapters 6 and 8
- GEO Publication No. 1/2011 – Technical Guidelines on Landscape Treatment for Slopes
- GEO Report No. 56 (1999) – Application of Prescriptive Measures to Slopes and Retaining Walls, 2nd Edition
- GEO Report No. 116 (2001) – Review of Effective Methods of Integrating Man made Slopes and Retaining Walls (Particularly for Roadside Slopes) into Their Surroundings
- GEO Report No. 136 (2003) – Guidelines on Safe Access for Slope Maintenance
- GEO Report No. 183 (2006) – Performance Assessment of Greening Techniques on Slopes
- GEO Special Project Report No. SPR 7/2004 (2004) – Identification of Suitable Vegetation Species for Use on Man-made Slopes
- Input Guideline - HyD Slope Vegetation (SVI) Records
- HyD TC No. 10/2001 – Visibility of Directional Signs
- HyD HQ/GN/13 – Interim Guidelines for Tree Transplanting Works under Highways Department's Vegetation Maintenance Ambit
- HyD HQ/GN/15 – Guidelines for Greening Works along Highways
- HyD RD/GN/44 – Guidance Notes on Design and Construction of Pavements with Paving Units
- HyD Requirements for Handover of Vegetation to Highways Department
- Latest General Requirement of Roadside Landscape Areas to be Handed over to LCSD
- "Guidelines on Tree Preservation during Development", GLTMS of DEVB
- "Guidelines on Tree Transplanting", GLTMS of DEVB
- Proper Planting Practices and other relevant guidelines issued by GLTMS of DevB

2.2 Technical Circulars

2.2.1 Technical Circulars related to Landscape Design include:

- ETWB TCW No. 13/2003A – Guidelines and Procedures for Environmental Impact Assessment of Government Projects and Proposals Planning for Provision of Noise Barriers
- DEVB TC(W) No. 2/2012 - Allocation of Space for Quality Greening on Roads.
- DEVB TC(W) No. 3/2012 - Site Coverage of Greenery for Government Building Projects.
- DEVB TC(W) No. 6/2015 – Maintenance of Vegetation and Hard Landscape Features
- DEVB TC(W) No. 5/2017 – Community Involvement in Greening Works
- DEVB TC(W) No. 1/2018 – Soft Landscape Provisions for Highway Structures
- DEVB TC(W) No. 4/2020 – Tree Preservation
- DEVB TC(W) No. 5/2020 – Registration of Old and Valuable Trees, and Guidelines for their Preservation
- CEDD TC No. 6/2014 – Vetting Committee on Slope Appearance
- CEDD TC No. 6/2020 – Reporting of Incidents on CEDD Works Sites
- Design Technical Guideline No. 17 of CEDD, Tree Preservation for Slope Works
- GEO Publication No. 1/2011- Technical Guidelines on Landscape Treatment for Slopes

2.3 Ordinances and Regulations

2.3.1 Ordinances and Regulations related to Landscape Design include:

- Forests and Countryside Ordinance (Cap. 96) and its subsidiary legislations
- Plant Varieties Protection Ordinance (Cap. 490)

- Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586)
- Cap. 499, "Environmental Impact Assessment Ordinance"

3 TREE SURVEY METHODOLOGY

3.1 Individual Tree Survey

3.1.1 In accordance with DEVB TC(W) No. 4/2020, upon topographic and detail tree survey, all existing individual trees with a trunk diameter larger than or equal to 95mm measured 1300mm above ground level are surveyed and identified with the following information recorded:

(a) Drawing. : Drawing where the individual tree can be found.

(b) Tree No. : Individual trees as being number labelled on site and marked on site and denoted correspondingly on the plan.

(c) Photo No. : The photograph reference number of the tree being identified.

(d) Species: Scientific and Chinese names of the trees surveyed.

(e) Tree size:

(i) Overall Height: Height measured from ground level to the top branch;

(ii) Trunk Diameter: Diameter of the main trunk measured at 1.3m high above ground level;

(iii) Average Crown Spread: Average diameter of the foliage canopy.

(f) Amenity Value of a tree should be assessed by its functional values for shade, shelter, screening, reduction of pollution and noise and also its fung shui significance, and classified into the following categories:

(i) High – important trees which should be retained by adjusting the design layout accordingly;

(ii) Medium – trees that are desirable to be retained in order to create a pleasant environment, which includes healthy specimens of lesser importance than "Good" trees;

(iii) Low – trees that are dead, dying or potentially hazardous and should be removed.

(g) Form:

(i) Good - Well-balanced crown and straight strong trunk(s);

(ii) Average - Slightly unbalanced crown and non-straight trunk(s);

(iii) Poor - Misshapen or awkwardly-forked trunk and / or unbalanced crown.

(h) Health:

(i) Good - Sound and healthy trees;

(ii) Average - Trees which are with few or no visible defects or health problem;

(iii) Poor - Rot and / or cavities in the main trunk and / or crown die back, severely infected with disease.

(i) Structural Condition:

(i) Good - Trees with no or little sign of structural defect and would have low risk level of potential failure;

(ii) Average - Trees with moderate sign of structural defect and would have medium risk level of potential failure;

(iii) Poor - Trees with significant and obvious sign of structural defect and would have high risk level of potential failure.

(j) Suitability for Transplanting: Assess the suitability of affected trees be transplanted taken into account of the following factors: -

- conditions of the tree to be transplanted (including form, health and structure which will affect success of the proposed transplanting);
- size, species, and conservation status of the tree to be transplanted;
- availability and suitability of a permanent receptor site, both within and outside the project site;
- adequate time for preparation of transplanting operation;
- identification of a long-term maintenance party for the transplanted tree(s);
- access to the existing location and transportation to the receptor site (including availability of access to accommodate the tree, topography of the proposed route, engineering limitations, etc.); and
- cost-effectiveness.

Trees with the following features should not be considered suitable for transplanting under normal circumstances:

- low amenity value;
- irrecoverable form after transplanting (e.g. if substantial crown and root pruning are necessary to facilitate the transplanting);
- low survival rate after transplanting;
- very large size (unless the feasibility to transplant has been considered financially reasonable and technically feasible during the feasibility stage);
- with evidence of over-maturity and onset of senescence;
- with poor health, structure or form (e.g. imbalanced form, leaning, with major cavity/cracks/splits); or
- undesirable species (e.g. *Leucaena leucocephala* which is an invasive exotic tree).
- on steep slope
- trees grown under poor conditions which have limited the formation of proper root ball necessary for transplanting

Having considered the above factors and features of the trees, trees are assessed as follows: -

(i) High - Trees are highly suitable for transplanting.

(ii) Medium - Trees are moderately suitable for transplanting.

(iii) Low – Trees are not suitable for transplanting.

(k) Conservation Status: State the rarity and protection status of the species under relevant ordinances in Hong Kong. References such as Rare and Precious Plants of Hong Kong, the IUCN Red List of Threatened Species and the Forests and Countryside Ordinance (Cap. 96) are used.

(l) Recommendation: Proposed action for individual species which fall into three categories:

(i) Retain

(ii) Transplant

(iii) Remove

(m) Maintenance Department to Provide comment on TPRP (before and after) AFCD (Agriculture, Fisheries and Conservation Department) / HyD (Highways Department) / LCSD (Leisure and Cultural Services Department) / Respective Government Department

(n) Justification: Proposed works which justify the recommendation.

(o) Additional Remarks: Supplementary note towards the assessment.

4 TREE SURVEY FINDINGS AND RECOMMENDATIONS

4.1 Tree Survey Plans

4.1.1 In order to determine whether or not the existing trees will be affected by the proposed works, reference has been made to the latest developed engineering designs. For ease of reference, the engineering design for the works has been overlaid on the Tree Survey Plans in **Appendix I**.

4.2 Justification for trees to be affected

4.2.1 The engineering layout has been designed to minimize the impact on existing trees. Any trees surveyed which are in conflict with the proposed works will be proposed to be transplanted or felled. Justification will be provided for any trees to be affected.

4.3 Responsible Panel

4.3.1 According to Clause 13 of DEVB TC(W) No.4/2020, Drainage Service Department (DSD) is the responsible tree works vetting and approving panel.

4.4 Tree Preservation, Transplanting and Felling Proposals

4.4.1 Tree Assessment Schedule is shown in **Appendix II**. Photos of tree surveyed are shown in **Appendix III**. No OVT is identified within the Application Boundary.

4.4.2 Findings and recommended treatments to existing trees found within in various site areas under maintenance department is summarized in **Table 4.1**.

Table 4.1 Summary of Tree Survey and Treatment Recommendations

Maintenance Department to provide expert advice	Trees to be Retained	Trees to be Transplanted	Trees to be removed	Undesirable Trees to be removed	Total Trees Surveyed individually within the Application Boundary
LCSD	9	16	58	0	83
Total	**9**	**16**	**58**	**0**	**83**

4.4.3 Findings and recommended treatments to existing trees found within in various site areas is summarized in **Table 4.2**.

Table 4.2 Summary of Tree Survey and Treatment Recommendations in different locations

Location	Trees to be Retained	Trees to be Transplanted	Trees to be removed	Total Trees Surveyed within the Application Boundary
Shatin Park	9	16	58	83
Total	**9**	**16**	**58**	**83**

4.4.5 Trees will be retained and preserved in-situ on site, if there is no direct conflict between the existing trees and the proposed works such that tree felling is not required. During construction period, Retained Tree will be protected from construction activity as per General Specification for Civil Engineering Works (2006 Edition), Section 26 Preservation and Protection of Trees. In general, Retained Trees should be protected by fences installed at the driplines as appropriate.

4.4.6 Among the trees affected by proposed works, trees are selected as far as possible for transplanting to reduce the impact on trees from the Project. Transplanting should be considered as far as possible unless the trees affected are of low conservation and amenity value, or have a low chance of surviving or recovering to its normal form after transplanting. If the trees to be transplanted to other permanent locations within site are not possible, transplant the trees to a permanent location off site. Location of recipient site should preferably be within the same area for retention of amenity value in the vicinity. To strike a balance between cost and benefit, only trees with high conservation value or high amenity value including rare and precious species and "transplantable" trees (i.e. trees that have a very good chance of recovering to its normal form) should be considered for transplanting.

5 COMPENSATORY TREE PLANTING PROPOSALS

5.1 Guidelines for Compensation

5.1.1 A number of existing trees within the site will be inevitably be affected by the Project. Compensatory planting in a ratio not less than 1:1 in terms of number (i.e. the number of compensatory tree within the site and off-site shall not be lower than that the number of trees felled, including dead trees) shall be provided in accordance with DEVB TC(W)No. 4/2020 – Tree Preservation.

5.1.2 According to the principles of "right tree for the right place" and the recommended tree list for Sha Tin District GMP based on "Street Tree Selection Guide", proposed trees are selected to match the site, environmental conditions, surrounding landscape character and design intent.

5.1.3 Compensatory tree planting will generally be of heavy standard size with trunk diameter at breast height (DBH) of a minimum 75mm.

5.1.4 For slope works, the ratio of 1:1 by number and the heavy standard requirement will not be applied due to the site constraints, instead planting in the form of tree whips and shrub mix planting is proposed subject to the gradient of the proposed new slopes.

5.1.5 Sufficient space shall be provided for the planting of compensatory trees to allow adequate space required to cater for the establishment and healthy growth of the trees up to maturity.

5.2 Compensatory Planting Proposals

5.2.1 Compensatory planting to mitigate the loss of existing trees due to the project is proposed and be illustrated in **Appendix IVa** & **Appendix IVb** and described below: -

- Heavy Standard and standard Trees with shrubs/ground covers are provided for the proposed roadside areas within the application boundary;

5.2.2 There is not sufficient space within application boundary for compensatory tree planting, trees proposed for compensation will be planted within the application boundary of the originally trees planting areas as far as possible after engineering works and planting soil backfilling completed. **Table 5.1** shows the proposed tree species to be compensated and its number within the Application site.

Table 5.1 List of Tree Species to be compensated within application boundary

Species		Spacing (mm)	Size	Quantity
Tree Planting within site				
Ilex rotunda var macrocarpa (ILE. ROT)*	小果鐵冬青	5000	Heavy Standard	4
Sterculia lanceolata (STE.LAN)*	假蘋婆	5000	Heavy Standard	5

* Native species

5.2.3 Compensatory planting comprises planting heavy standard and standard trees in suitable areas in the Application Site, summary of removed and compensatory tree quantity is listed in **Table 5.2**

Table 5.2. Tree Compensation Summary

	Description	No. of tree
	Tree Felling Summary	
(1)	Sha Tin Park	58
	Total	**58**
	Tree Compensation Summary	
(1)	Sha Tin Park (within application boundary)	9
(2)	Sha Tin Park (outside application boundary) [1]	**49**

Remarks [1]: Trees to be compensated outside application boundary in Table 5.2 is for information only.

5.2.4 Due to a shortage of available space for tree compensation in the application site, the remaining 49 no. of trees would be compensated outside the application boundary, and is omitted from this report for clarity.

6 TRANSPLANT PLANTING PROPOSAL

6.1.1 16 no. of trees will be transplanted from the application site to the proposed receptor locations as shown in **Appendix V**.

6.1.2 Due to a shortage of available space for tree transplant, the receptor location are situated outside application boundary.

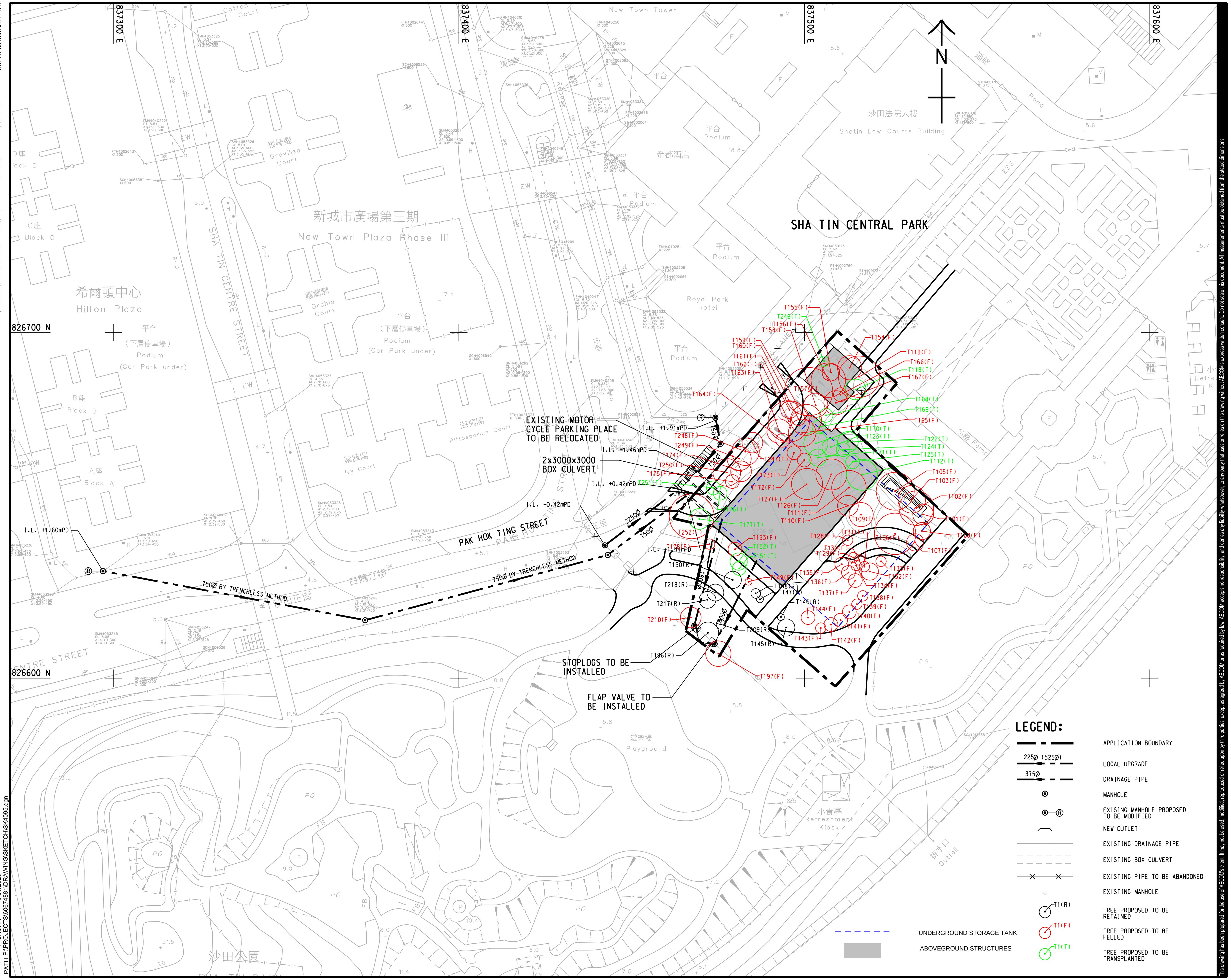
7 CONCLUSION

7.1.1 Due to the proposed works, approximately **83** trees within the Sha Tin Park application boundaries have been surveyed and of which **9** no trees is proposed to be retained; **16** trees are proposed to be transplanted outside the application boundary, **58** trees are proposed to be felled.

7.1.2 To compensate the loss of existing trees, approximately **9** nos. heavy standard trees are proposed to be planted within the application boundary.

Appendix I

Tree Survey Plan (with Engineering Design overlaid)



AECOM

PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT 業主

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KEY PLAN 索引圖

PROJECT NO. 項目編號: 60674881

CONTRACT NO. 合約編號: CE 44/2021 (DS)

SHEET TITLE 圖紙名稱

TREE TREATMENT PLAN FOR DRAINAGE IMPROVEMENT WORKS AT SHA TIN TOWN CENTRE (STN1)

SHEET NUMBER 圖紙編號

60674881/SK4095

ISO A1 594mm x 841mm Approved: Checked: Designer: Project Management Initials:

Plot File by: CAOPA 10/30/2023
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Appendix II

Tree Assessment Schedule

Tree Assessment Schedule
Contract No. **DP 08/2020**
Topographical and Tree Surveys for Drainage Improvement Works in Sha Tin and Sai Kung
Sha Tin Park

Surveyed by :
Date of Tree Survey : July 2020, July 2022

Drawing No.	Tree ID Number	Tree Photo No.	Tree Species		Measurements			Amenity Value	Top of Soil Level above Root Zone (mPD)	Form	Health	Structural Condition	Suitability for transplanting **		Conservation Status ***	Recommendation	Maintenance department to provide comments on TPRP		Vetting and approving panel of TPRP	Additional Remarks
			*Scientific name	Chinese name	Height (m)	DBH (mm)	Spread (m)	(high(H) /medium (M) /low(L)		(good (G)/average(A)/poor(P)			(high(H)/ medium (M)/low(L)	Remarks*		(retain/transplant /remove)	Before	After		
60674881/SK4095	T101	T101	*Delonix regia*	鳳凰木	12.0	160	6.0	M	5.7	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T102	T102	*Delonix regia*	鳳凰木	11.0	280	10.0	M	5.9	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T103	T103	*Delonix regia*	鳳凰木	10.0	190	8.0	M	5.9	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T105	T105	*Celtis sinensis*	朴樹	10.0	300	11.0	M	6.0	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T106	T106	*Peltophorum pterocarpum*	雙翼豆	21.0	500	12.0	M	6.1	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T107	T107	*Spathodea campanulata*	火焰樹	13.0	380	5.0	M	5.9	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T108	T108	*Spathodea campanulata*	火焰樹	11.0	300	5.0	M	5.9	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T109	T109	*Sapium sebiferum*	烏桕	9.0	320	7.0	M	6.3	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T110	T110	*Sapium sebiferum*	烏桕	9.0	200	6.0	M	5.6	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T111	T111	*Delonix regia*	鳳凰木	10.0	250	10.0	M	5.7	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T112	T112	*Delonix regia*	鳳凰木	7.0	250	9.0	M	5.7	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T118	T118	*Delonix regia*	鳳凰木	7.0	160	6.0	M	5.8	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T119	T119	*Delonix regia*	鳳凰木	7.0	270	12.0	M	5.5	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T122	T122	*Delonix regia*	鳳凰木	9.0	220	6.0	M	6.1	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T123	T123	*Delonix regia*	鳳凰木	6.0	130	5.0	M	6.4	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T124	T124	*Delonix regia*	鳳凰木	6.0	150	4.0	M	6.4	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T125	T125	*Delonix regia*	鳳凰木	7.0	160	4.0	M	5.8	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T126	T126	*Peltophorum pterocarpum*	雙翼豆	13.0	470	9.0	M	6.4	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T127	T127	*Peltophorum pterocarpum*	雙翼豆	13.0	550	9.0	M	6.2	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T128	T128	*Grevillea robusta*	銀樺	9.0	320	3.0	M	6.2	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T129	T129	*Podocarpus macrophyllus*	羅漢松	5.0	190	3.0	M	6.5	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T130	T130	*Podocarpus macrophyllus*	羅漢松	6.0	160	3.0	M	6.7	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T131	T131	*Podocarpus macrophyllus*	羅漢松	6.0	100	3.0	M	6.6	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T132	T132	*Araucaria heterophylla*	異葉南洋杉	21.0	380	5.0	M	6.5	P	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T133	T133	*Thuja orientalis*	扁柏	4.0	140	3.0	M	6.7	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T134	T134	*Podocarpus macrophyllus*	羅漢松	6.0	120	3.0	M	6.4	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T135	T135	*Lagerstroemia speciosa*	大花紫薇	6.0	130	4.0	M	6.1	A	A	A	L	-	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T136	T136	*Lagerstroemia speciosa*	大花紫薇	7.0	130	4.0	M	6.1	A	A	A	L	-	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T137	T137	*Lagerstroemia speciosa*	大花紫薇	7.0	140	4.0	M	6.1	A	A	A	L	-	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T138	T138	*Lagerstroemia speciosa*	大花紫薇	5.0	100	3.0	M	6.3	A	A	A	L	-	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T139	T139	*Lagerstroemia speciosa*	大花紫薇	5.0	120	3.0	M	6.4	A	A	A	L	-	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T140	T140	*Lagerstroemia speciosa*	大花紫薇	5.0	120	4.0	M	6.6	A	A	A	L	-	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T141	T141	*Lagerstroemia speciosa*	大花紫薇	5.0	130	4.0	M	6.8	A	A	A	L	-	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T142	T142	*Lagerstroemia speciosa*	大花紫薇	6.0	130	4.0	M	6.9	A	A	A	L	-	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T143	T143	*Lagerstroemia speciosa*	大花紫薇	5.0	110	3.0	M	7.1	A	A	A	L	-	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T144	T144	*Lagerstroemia speciosa*	大花紫薇	5.0	120	4.0	M	7.1	A	A	A	L	-	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T145	T145	*Nageia nagi*	竹柏	6.0	160	5.0	M	7.6	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T146	T146	*Nageia nagi*	竹柏	4.0	100	3.0	M	7.4	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T147	T147	*Nageia nagi*	竹柏	5.0	120	2.0	M	7.1	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T148	T148	*Nageia nagi*	竹柏	5.0	100	3.0	M	6.9	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T149	T149	*Nageia nagi*	竹柏	5.0	110	2.0	M	6.7	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T150	T150	*Nageia nagi*	竹柏	7.0	150	5.0	M	6.8	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T151	T151	*Nageia nagi*	竹柏	8.0	140	4.0	M	6.7	A	A	A	L	c	No	transplant	LCSD	LCSD	DSD	wounded bark
60674881/SK4095	T152	T152	*Nageia nagi*	竹柏	10.0	270	5.0	M	6.7	A	A	A	L	c, d	No	transplant	LCSD	LCSD	DSD	wounded bark
60674881/SK4095	T153	T153	*Nageia nagi*	竹柏	7.0	160	4.0	M	6.6	P	A	A	L	c, f	No	remove	LCSD	LCSD	DSD	codominant trunks
60674881/SK4095	T154	T154	*Delonix regia*	鳳凰木	10.0	200	7.0	M	6.0	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T155	T155	*Schefflera heptaphylla*	鴨腳木	6.0	200	5.0	M	8.0	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T156	T156	*Ficus microcarpa*	細葉榕	7.0	300	10.0	M	7.9	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T157	T157	*Celtis sinensis*	朴樹	15.0	550	14.0	M	8.6	A	A	A	L	b, d, h, i	No	remove	LCSD	LCSD	DSD	on slope
60674881/SK4095	T158	T158	*Peltophorum pterocarpum*	雙翼豆	18.0	200	7.0	M	8.3	A	A	A	L	d	No	remove	LCSD	LCSD	DSD	asymmetric crown
60674881/SK4095	T159	T159	*Ficus microcarpa*	細葉榕	9.0	260	9.0	M	8.5	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T160	T160	*Schefflera heptaphylla*	鴨腳木	6.0	100	4.0	L	9.1	A	A	A	L	a	No	remove	LCSD	LCSD	DSD	on slope
60674881/SK4095	T161	T161	*Schefflera heptaphylla*	鴨腳木	6.0	180	5.0	L	8.3	A	A	A	L	a	No	remove	LCSD	LCSD	DSD	on slope
60674881/SK4095	T162	T162	*Cinnamomum camphora*	樟樹	15.0	350	12.0	M	9.2	A	A	A	L	c, h	No	remove	LCSD	LCSD	DSD	on slope
60674881/SK4095	T163	T163	*Albizia lebbeck*	大葉合歡	10.0	230	7.0	L	8.7	P	A	A	L	a, f	No	remove	LCSD	LCSD	DSD	asymmetric crown

Drawing No.	Tree ID Number	Tree Photo No.	Tree Species		Measurements			Amenity Value	Top of Soil Level above Root Zone (mPD)	Form	Health	Structural Condition	Suitability for transplanting **		Conservation Status ***	Recommendation	Maintenance department to provide comments on TPRP		Vetting and approving panel of TPRP	Additional Remarks
			*Scientific name	Chinese name	Height (m)	DBH (mm)	Spread (m)	(high(H) /medium (M) /low(L)		(good (G)/average(A)/poor(P)			(high(H)/ medium (M)/low(L)	Remarks*		(retain/transplant /remove)	Before	After		
60674881/SK4095	T164	T164	*Sterculia lanceolata*	假蘋婆	5.0	170	4.0	M	8.3	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	on slope
60674881/SK4095	T165	T165	*Ficus microcarpa*	細葉榕	6.0	180	8.0	M	8.2	P	A	A	L	f, h	No	remove	LCSD	LCSD	DSD	heavy limb, asymmetric crown
60674881/SK4095	T166	T166	*Delonix regia*	鳳凰木	9.0	120	4.0	M	6.4	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T167	T167	*Delonix regia*	鳳凰木	10.0	200	7.0	M	6.6	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T168	T168	*Delonix regia*	鳳凰木	9.0	150	4.0	M	6.8	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T169	T169	*Delonix regia*	鳳凰木	8.0	140	4.0	M	6.7	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T170	T170	*Delonix regia*	鳳凰木	9.0	180	7.0	M	6.6	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T171	T171	*Delonix regia*	鳳凰木	10.0	130	5.0	M	6.3	A	A	A	L	b, c	No	transplant	LCSD	LCSD	DSD	contorted trunk
60674881/SK4095	T172	T172	*Delonix regia*	鳳凰木	9.0	110	4.0	L	6.5	P	A	A	L	a, f	No	remove	LCSD	LCSD	DSD	sparse crown
60674881/SK4095	T173	T173	*Callistemon viminalis*	串錢柳	6.0	120	4.0	M	7.0	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	leaning, sparse foliage
60674881/SK4095	T174	T174	*Celtis sinensis*	朴樹	9.0	290	6.0	M	6.8	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	crooked trunk
60674881/SK4095	T175	T175	*Schefflera heptaphylla*	鴨腳木	5.0	110	4.0	L	6.9	A	A	A	L	a, f	No	remove	LCSD	LCSD	DSD	forked trunk
60674881/SK4095	T176	T176	*Viburnum odoratissimum*	珊瑚樹	5.0	110	4.0	M	7.1	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	slight crooked trunk
60674881/SK4095	T177	T177	*Schefflera heptaphylla*	鴨腳木	5.0	160	6.0	M	6.9	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	slightly leaning, asymmetric crown
60674881/SK4095	T178	T178	*Viburnum odoratissimum*	珊瑚樹	5.0	200	3.0	L	6.6	P	A	A	L	a	No	remove	LCSD	LCSD	DSD	pruned trunk,
60674881/SK4095	T196	T196	*Eucalyptus exserta*	窿緣桉	20.0	210	6.0	M	7.2	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T197	T197	*Eucalyptus exserta*	窿緣桉	22.0	260	7.0	M	7.6	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T209	T209	*Eucalyptus exserta*	窿緣桉	9.0	160	3.0	M	7.5	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T210	T210	*Eucalyptus torelliana*	毛葉桉	11.0	130	6.0	M	6.8	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T217	T217	*Eucalyptus robusta*	大葉桉	16.0	370	5.0	M	7.2	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T218	T218	*Melaleuca cajuputi subsp. Cumingiana*	白千層	11.0	450	5.0	M	6.8	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T246	T246	*Sterculia lanceolata*	假蘋婆	5.0	200	3.0	M	7.0	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T247	T247	*Sterculia lanceolata*	假蘋婆	6.0	180	6.0	M	7.3	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	on slope, root system exposed
60674881/SK4095	T248	T248	*Bridelia tomentosa*	土蜜樹	6.0	220	8.0	L	7.2	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	exposed roots
60674881/SK4095	T249	T249	*Schefflera heptaphylla*	鴨腳木	5.0	160	7.0	M	7.1	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	leaning
60674881/SK4095	T250	T250	*Syzygium jambos*	蒲桃	10.0	330	8.0	M	7.2	P	A	A	L	-	No	remove	LCSD	LCSD	DSD	pruned trunk, asymmetric crown
60674881/SK4095	T251	T251	*Schefflera heptaphylla*	鴨腳木	5.0	130	4.0	M	7.1	A	A	P	L	-	No	transplant	LCSD	LCSD	DSD	leaning
60674881/SK4095	T252	T252	*Albizia lebbeck*	大葉合歡	16.0	390	13.0	M	6.9	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	leaning, on slope

Remarks for Suitability for Transplanting

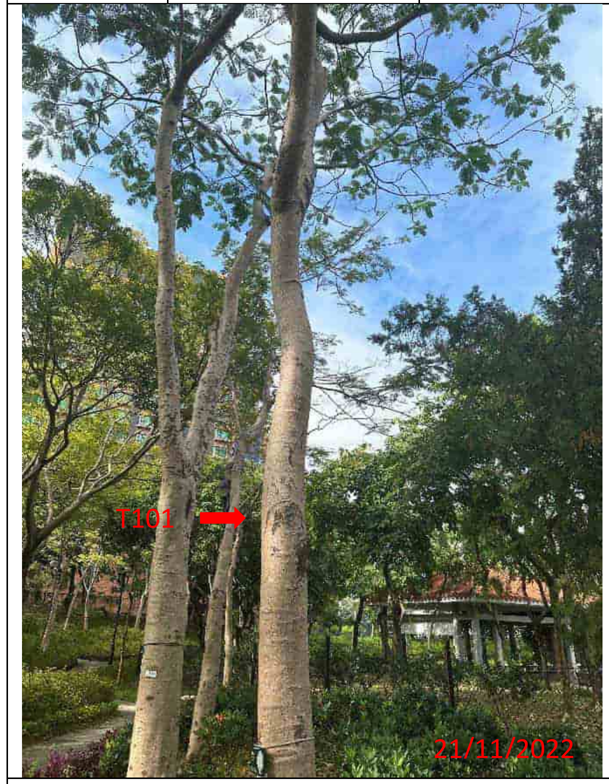
(a) Low amenity value;
(b) Irrecoverable form after transplanting (e.g. transplanting requires substantial crown and root pruning);
(c) Low chance of survival upon transplanting;
(d) Very large size (unless the feasibility to transplant has been considered financially reasonable and technically feasible during the feasibility stage);
(e) With evidence of over-maturity and onset of senescence;
(f) With poor health, structure or form (e.g. imbalanced form, leaning , with major cavity/cracks/splits); or cavity/cracks/splits); or
(g) Undesirable species (e.g. *Leucaena leucocephala* which is an invasive exotic and self-seeding tree);
(h) On steep slope.
(i) trees grown under poor conditions which have limited the formation of proper root ball necessary for transplanting

Conservation status
Rare tree species listed in "Rare and Precious of Hong Kong"
(http://herbarium.gov.hk/PublicationsPreface.aspx?BookNameId=1) published by Agriculture, Fisheries and Conservation Department
Endangered plant species protected under the Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586)
Tree species listed in the Forestry Regulations (Cap. 96A) under the Forests and Countryside Ordinance (Cap. 96)

Appendix III

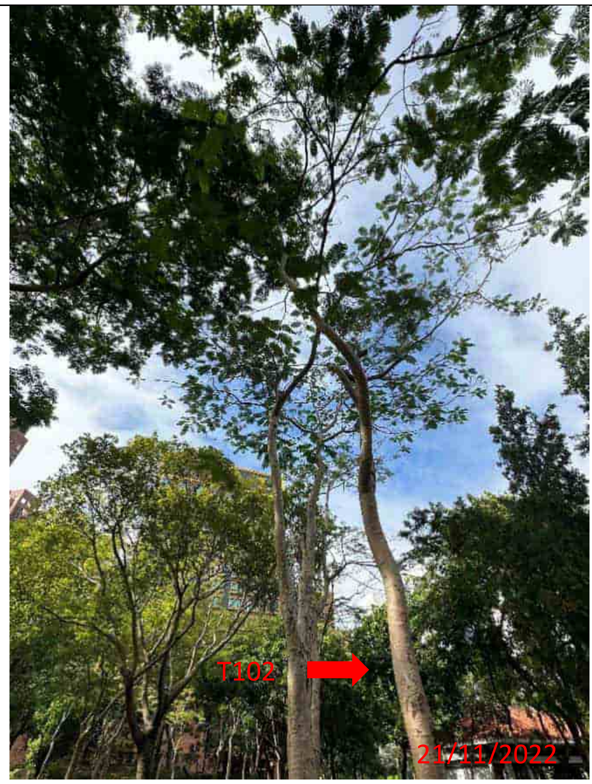
Tree Photographs

T101	Delonix regia		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
12	6	160	



Tree Trunk Photo

Tree Root Collar Photo

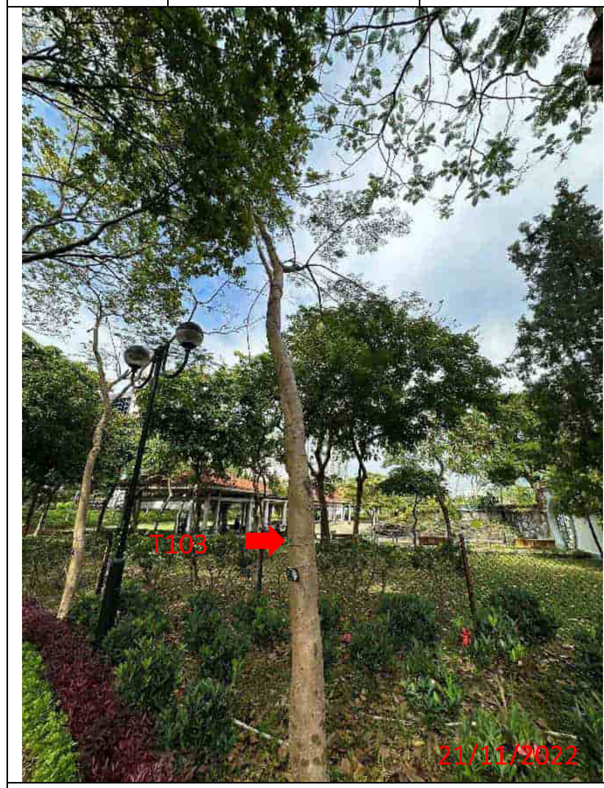


T102	Delonix regia		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
11	10	280	

Tree Trunk Photo

Tree Root Collar Photo

T103	Delonix regia		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
10	8	190	



Tree Trunk Photo

Tree Root Collar Photo

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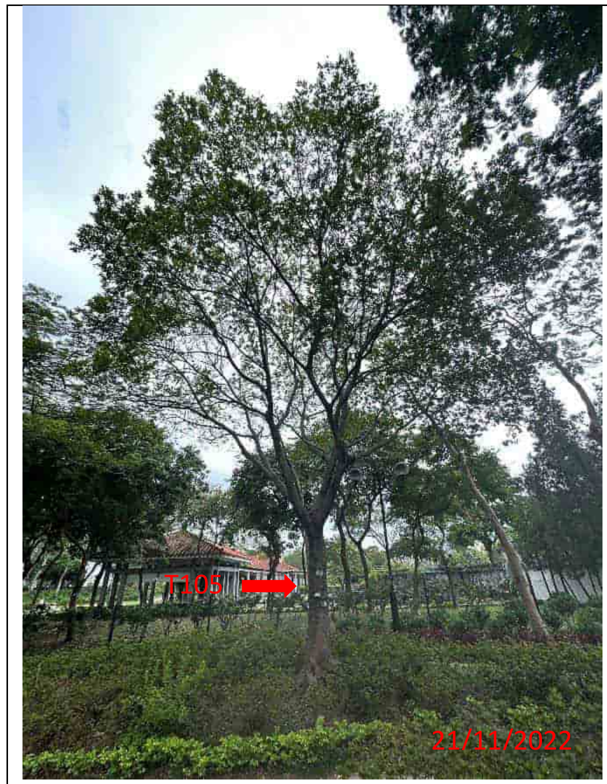
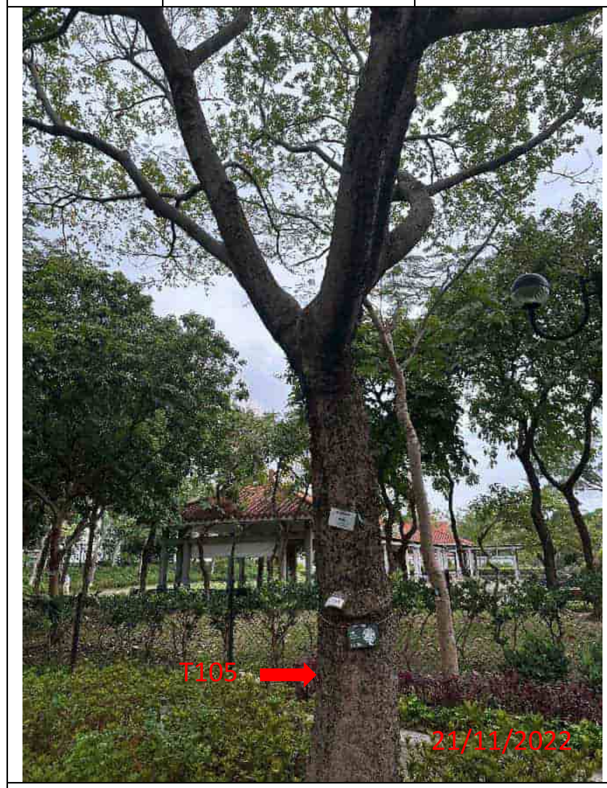
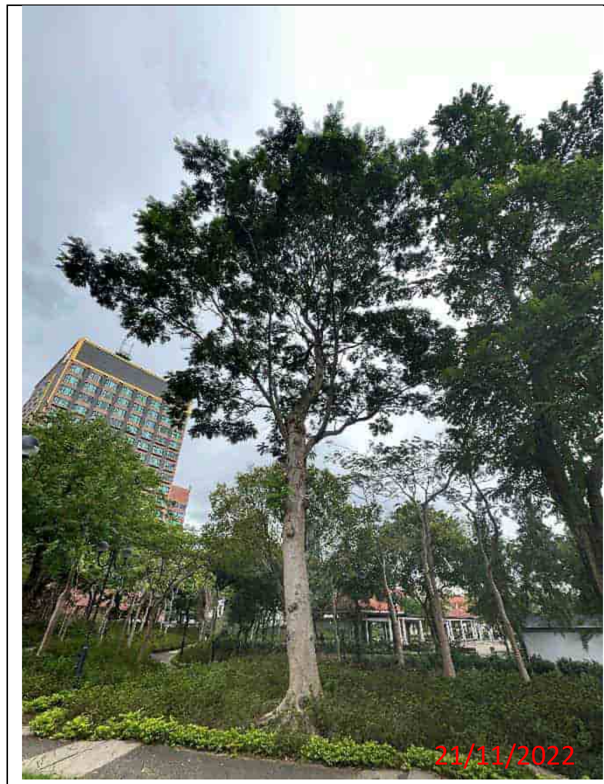


T105	Celtis sinensis		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
10	11	300	

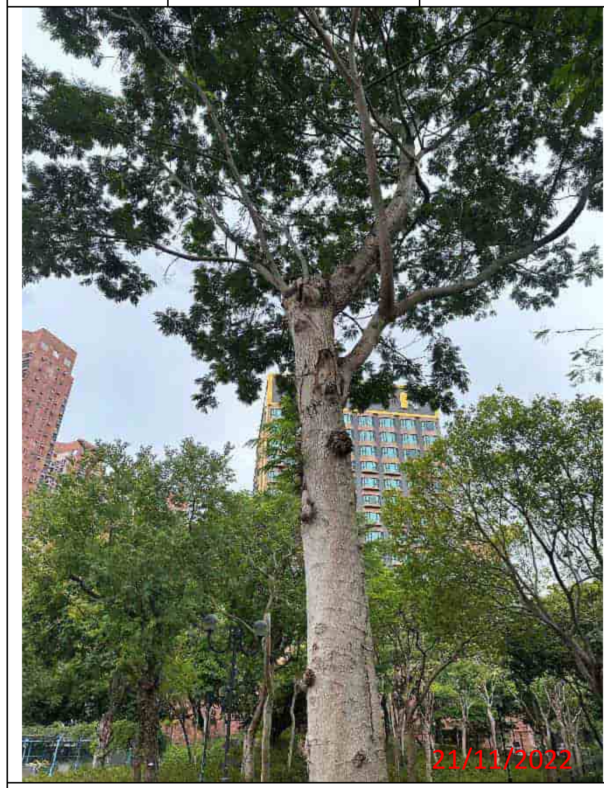


Tree Trunk Photo

Tree Root Collar Photo



T106	Peltophorum pterocarpum		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
21	12	500	



Tree Trunk Photo

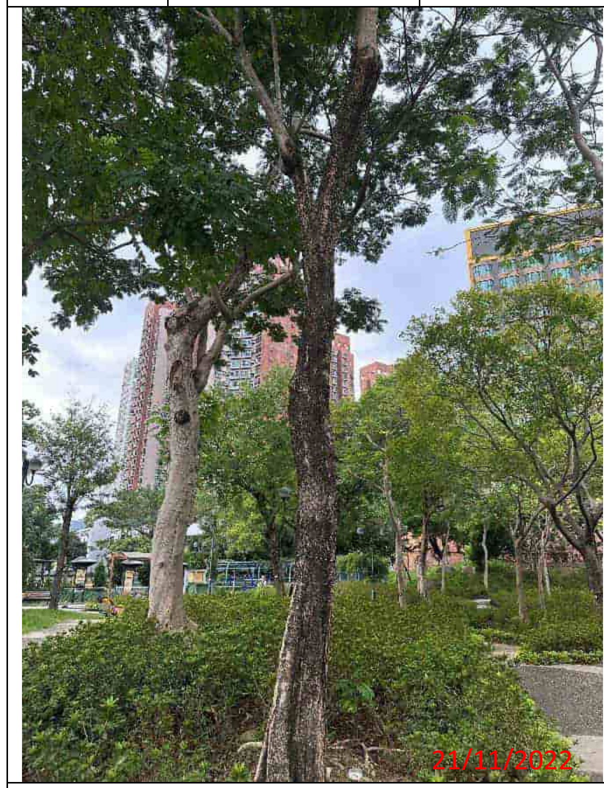
Tree Root Collar Photo

T107	Spathodea campanulata		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
13	5	380	

Tree Trunk Photo

Tree Root Collar Photo

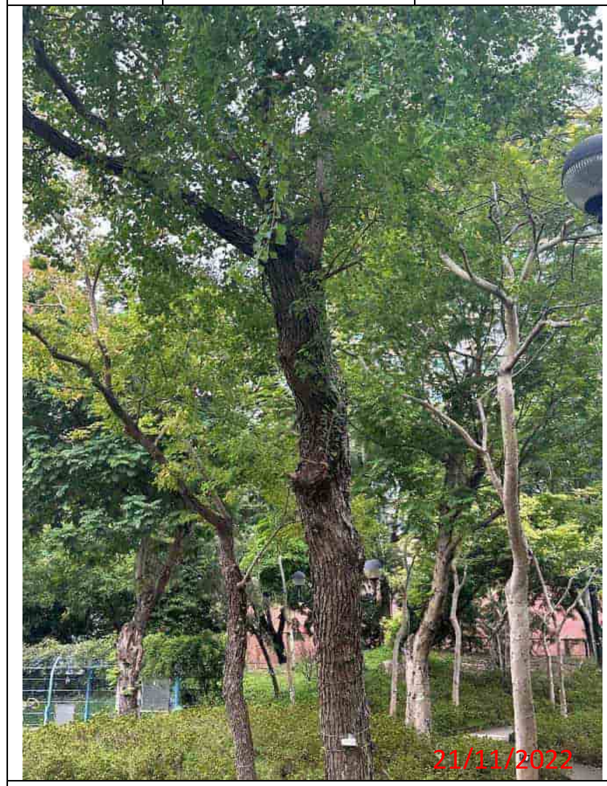
T108	Spathodea campanulata		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
11	5	300	



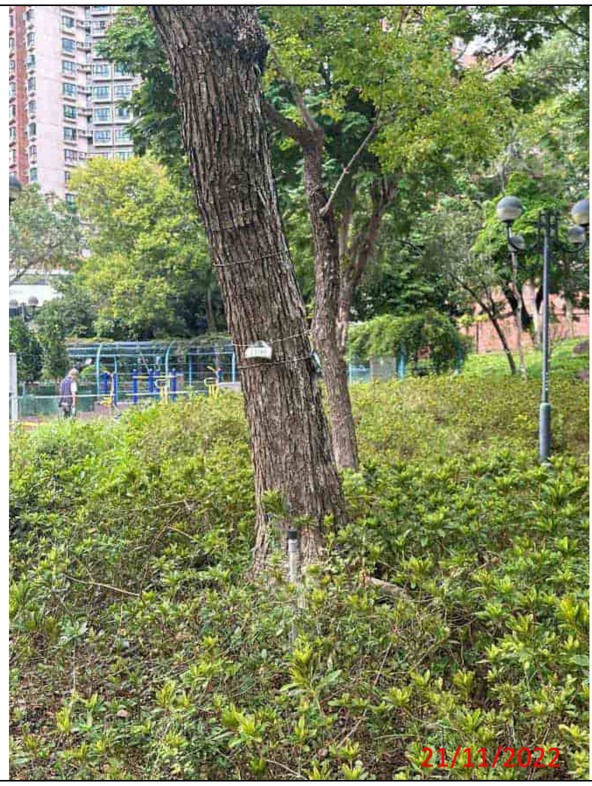
Tree Trunk Photo

Tree Root Collar Photo

T109	Sapium sebiferum		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
9	7	320	



Tree Trunk Photo

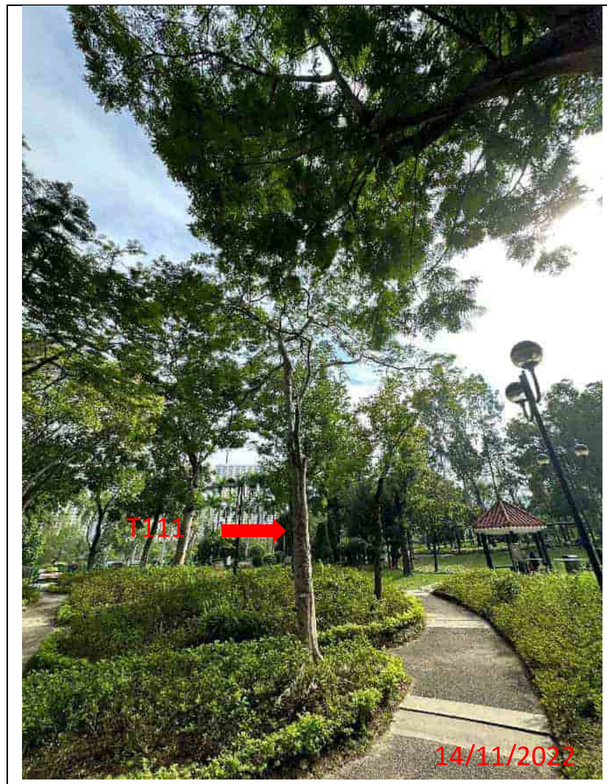


Tree Root Collar Photo

T110	Sapium sebiferum		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
9	6	200	

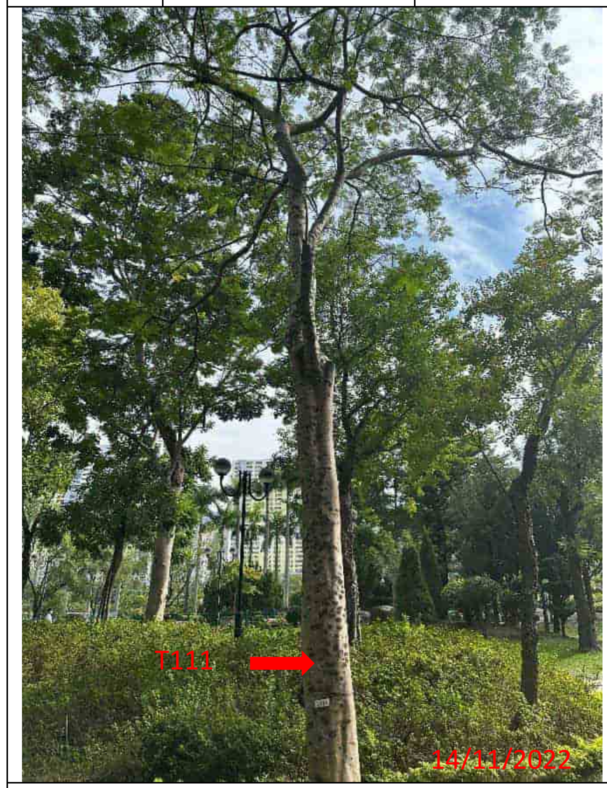
Tree Trunk Photo

Tree Root Collar Photo



Tree Crown Photo

T111	Delonix regia	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
10	10	250



Tree Trunk Photo

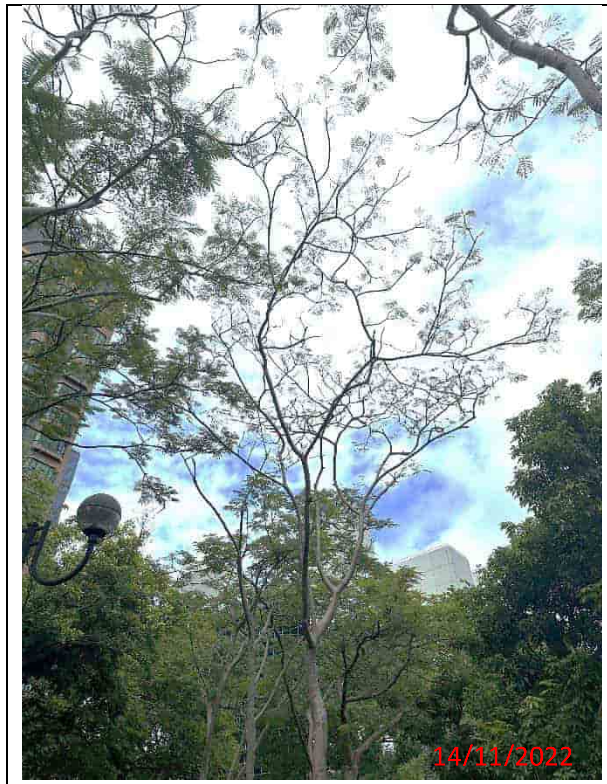
Tree Root Collar Photo

Tree Crown Photo

T112	Delonix regia	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
7	9	250

Tree Trunk Photo

Tree Root Collar Photo



Tree Crown Photo

T117	Delonix regia	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
7	6	160

Tree Trunk Photo

Tree Root Collar Photo

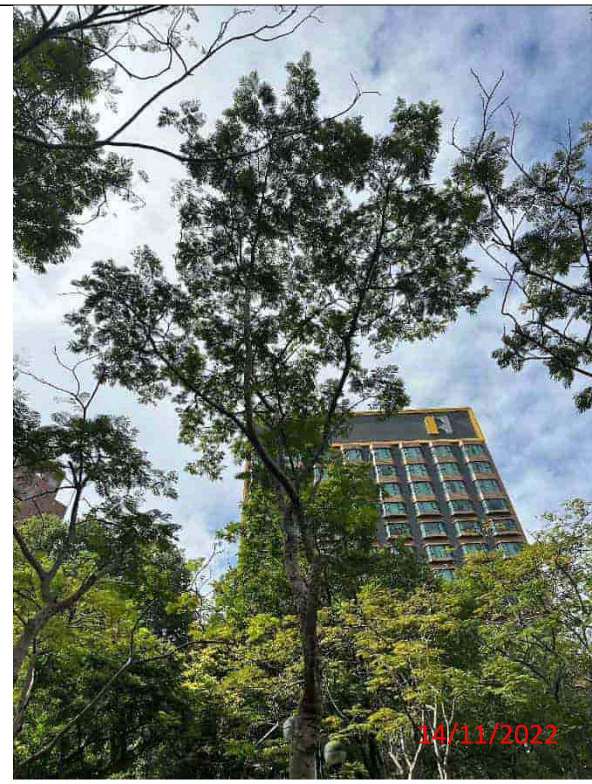
Tree Crown Photo

T118	Delonix regia	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
7	6	160

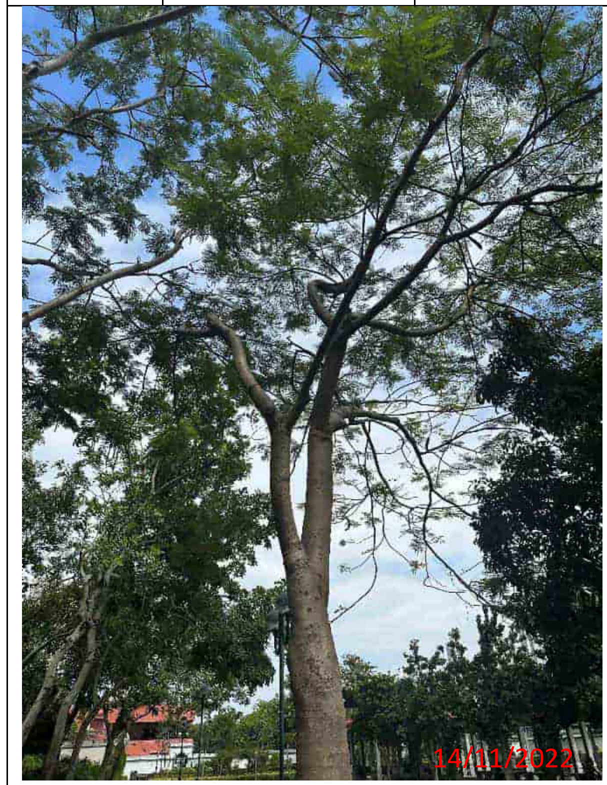
Tree Trunk Photo

Tree Root Collar Photo

T119	Delonix regia		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
7	12	270	



T122	Delonix regia		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
7	6	160	



Tree Trunk Photo

Tree Root Collar Photo

Tree Trunk Photo

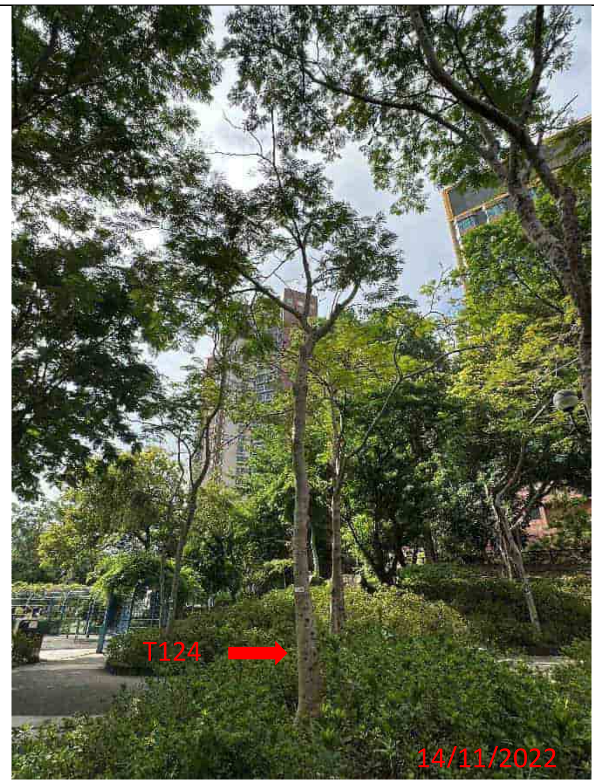
Tree Root Collar Photo

Tree Crown Photo

T123	Delonix regia	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
6	5	130

Tree Trunk Photo

Tree Root Collar Photo



Tree Crown Photo

T124	Delonix regia	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
6	4	150

Tree Trunk Photo

Tree Root Collar Photo

T125	Delonix regia		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
7	4	160	

Tree Trunk Photo

Tree Root Collar Photo

T126	Peltophorum pterocarpum		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
13	9	470	

Tree Trunk Photo

Tree Root Collar Photo

T127	Peltophorum pterocarpum		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
13	9	550	

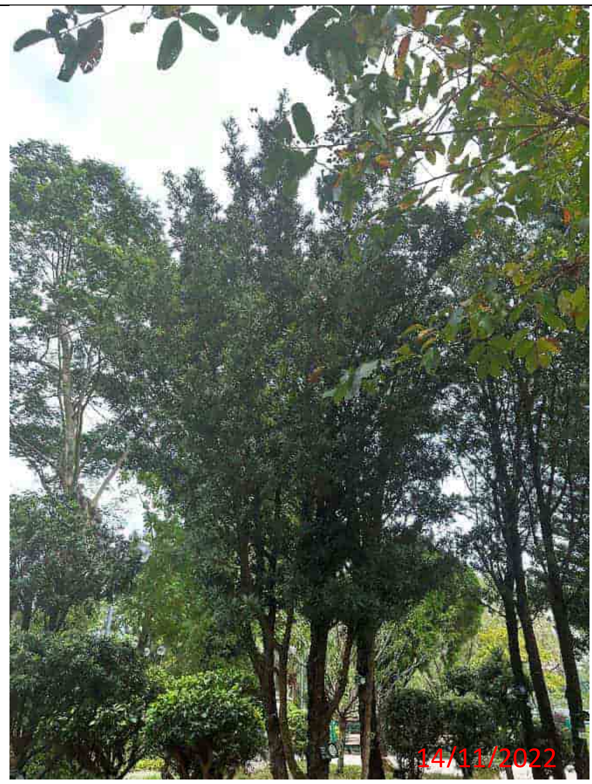
Tree Trunk Photo

Tree Root Collar Photo

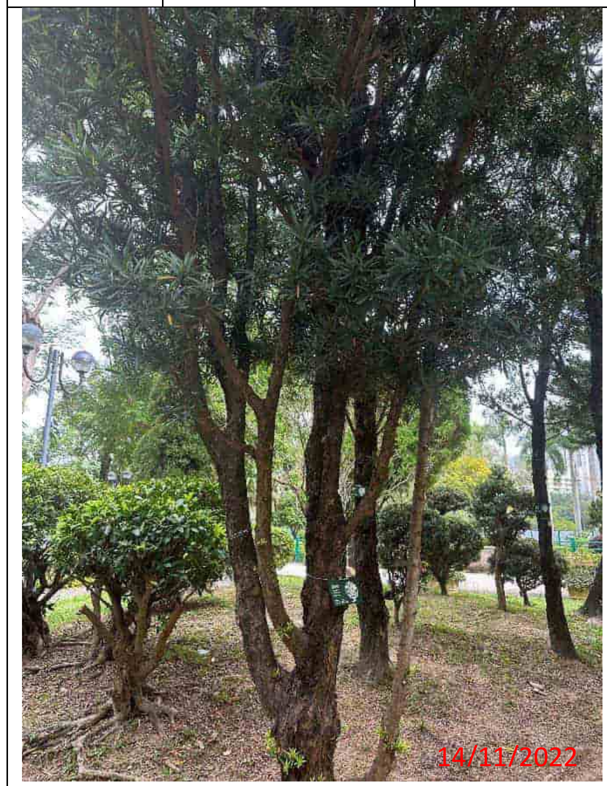
T128	Grevillea robusta		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	3	320	

Tree Trunk Photo

Tree Root Collar Photo



T129	Podocarpus macrophyllus		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	3	190	



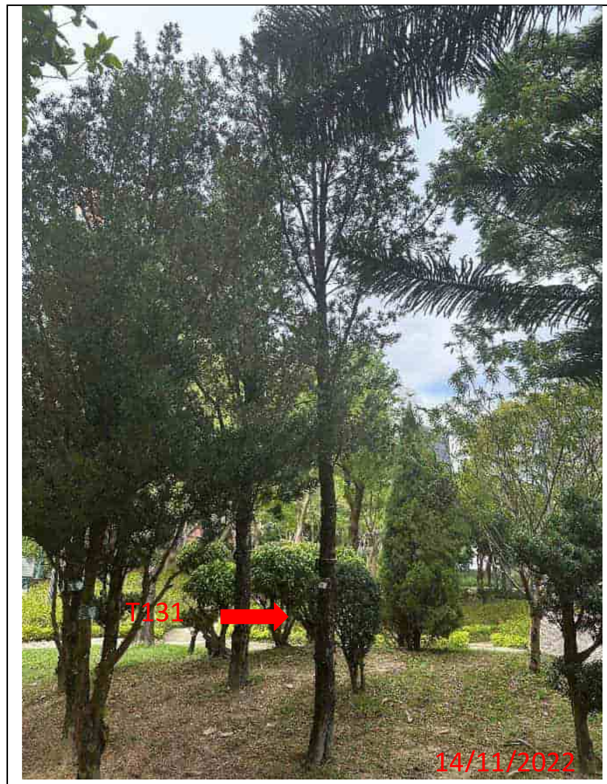
Tree Trunk Photo

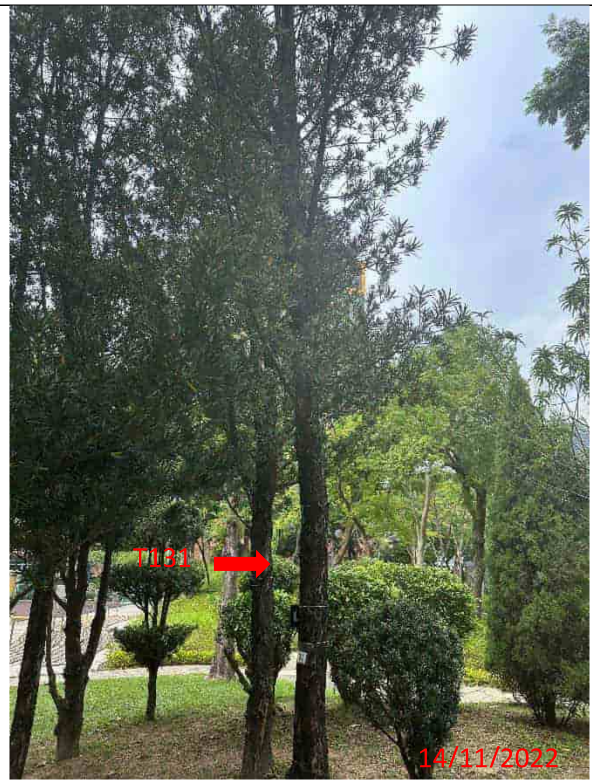
Tree Root Collar Photo

T130	Podocarpus macrophyllus		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
6	3	160	

Tree Trunk Photo

Tree Root Collar Photo





Tree Crown Photo

T131	Podocarpus macrophyllus		
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
6	3	100	

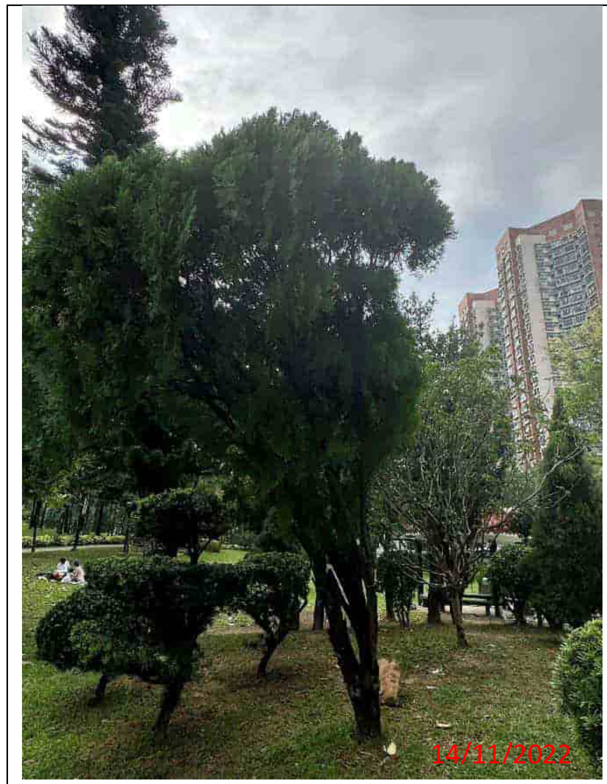
Tree Trunk and Root Collar Photo

Tree Crown Photo

T132	Araucaria heterophylla		
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
21	5	380	

Tree Trunk Photo

Tree Root Collar Photo



Tree Crown Photo

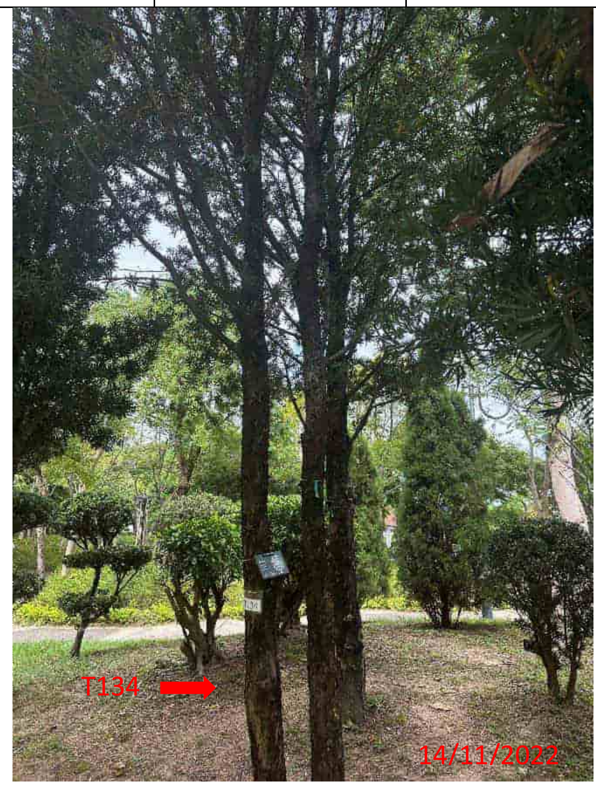
T133	Thuja orientalis	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
4	3	140

Tree Crown Photo

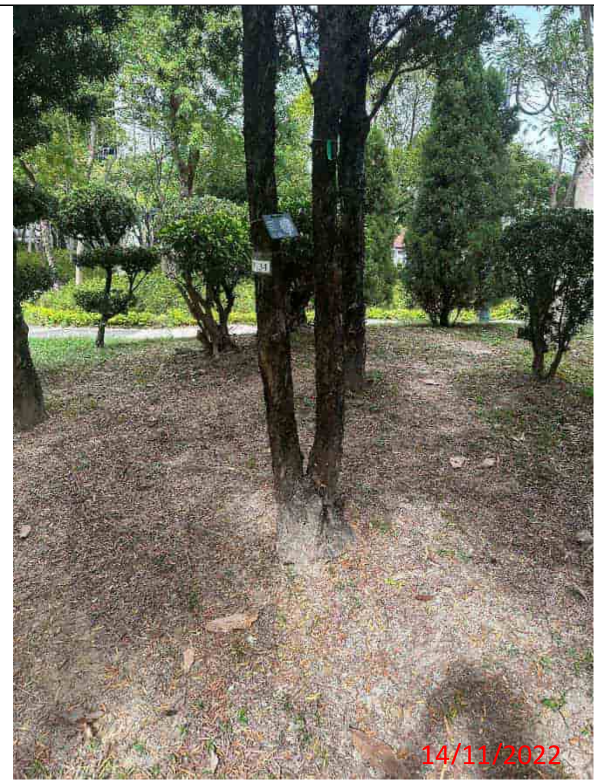
T134	Podocarpus macrophyllus	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
6	3	120

Tree Trunk Photo

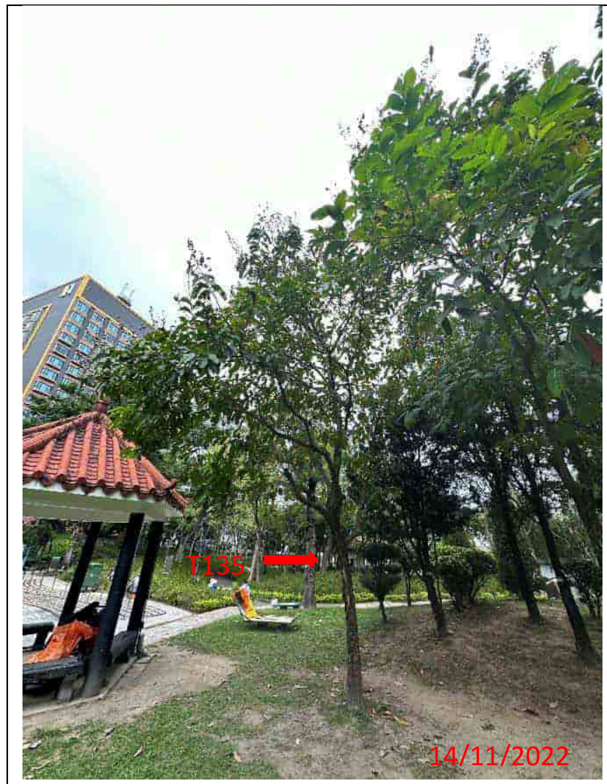
Tree Root Collar Photo



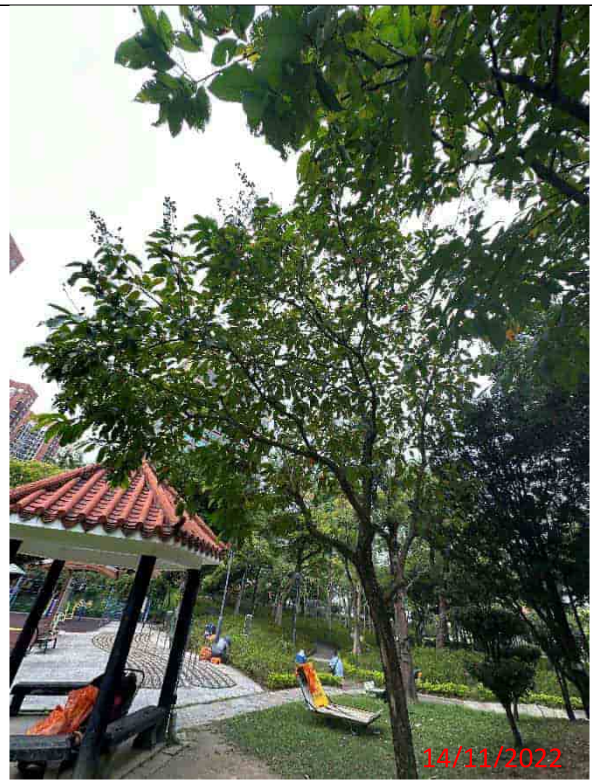
Tree Trunk Photo



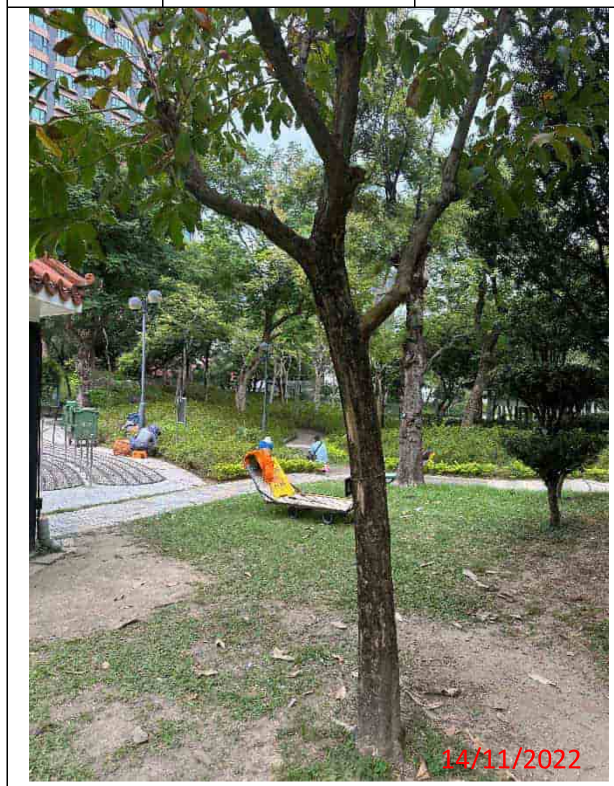
Tree Root Collar Photo



T135	Lagerstroemia speciosa	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
6	4	130



Tree Crown Photo



Tree Trunk Photo

Tree Root Collar Photo

T136	Lagerstroemia speciosa	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
7	4	130

Tree Crown Photo

Tree Trunk Photo

Tree Root Collar Photo

Tree Crown Photo

T137	Lagerstroemia speciosa	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
7	4	140

Tree Trunk Photo

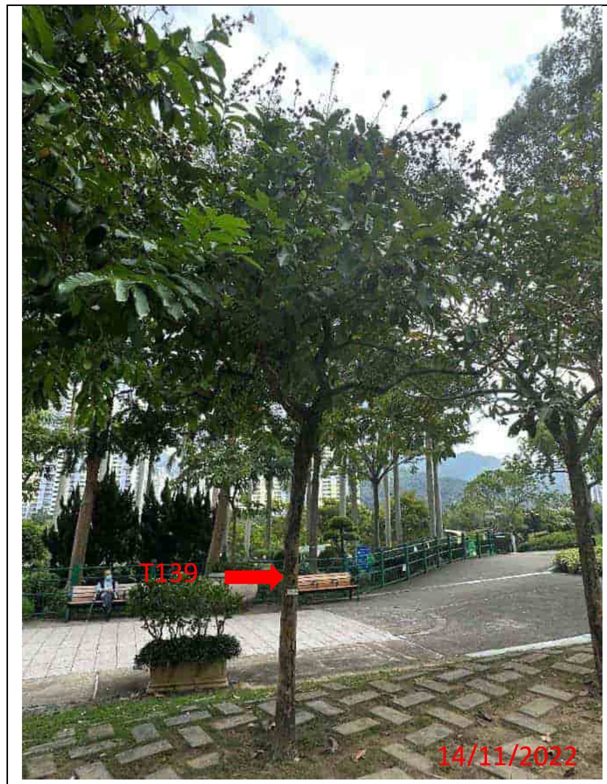
Tree Root Collar Photo

Tree Crown Photo

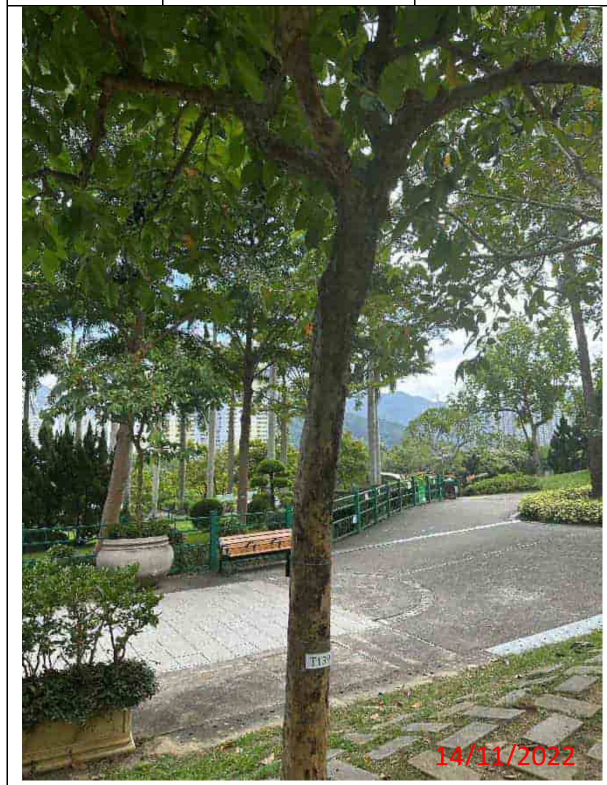
T138	Lagerstroemia speciosa	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
5	3	100

Tree Trunk Photo

Tree Root Collar Photo

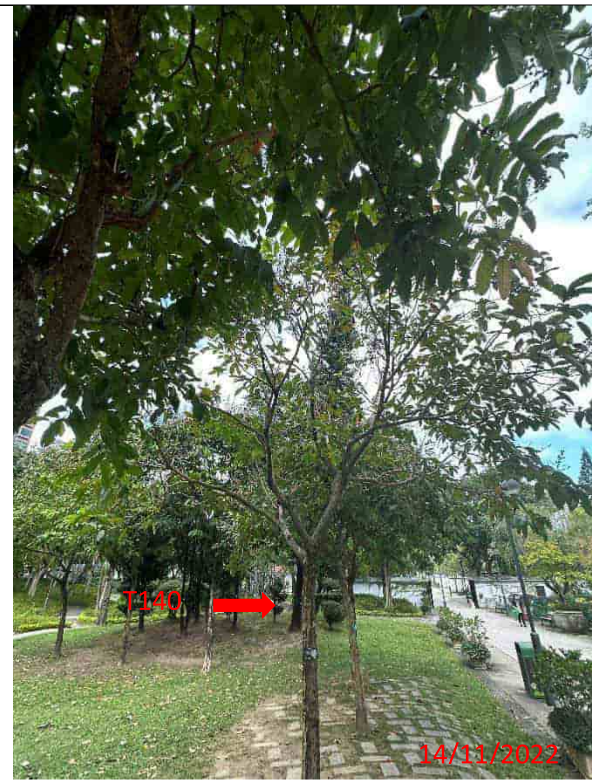


T139	Lagerstroemia speciosa		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	3	120	



Tree Trunk Photo

Tree Root Collar Photo



T140	Lagerstroemia speciosa		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	4	120	

Tree Trunk Photo

Tree Root Collar Photo

T141	Lagerstroemia speciosa		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	4	130	

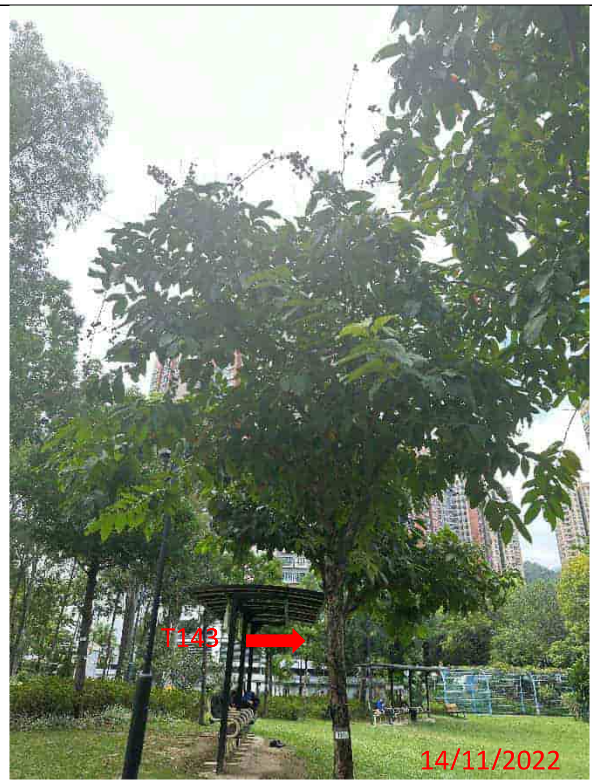
Tree Trunk Photo

Tree Root Collar Photo

T142	Lagerstroemia speciosa		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
6	4	130	

Tree Trunk Photo

Tree Root Collar Photo

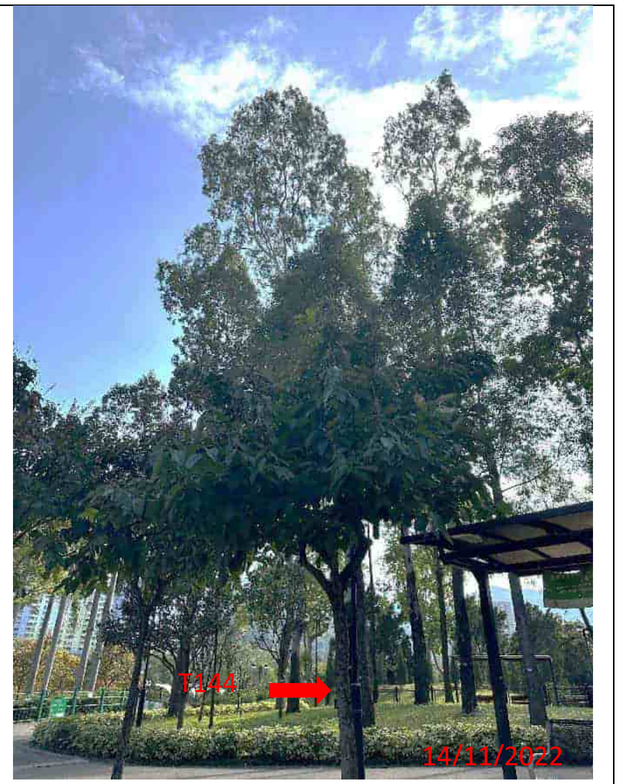


Tree Crown Photo

T143	Lagerstroemia speciosa	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
5	3	110

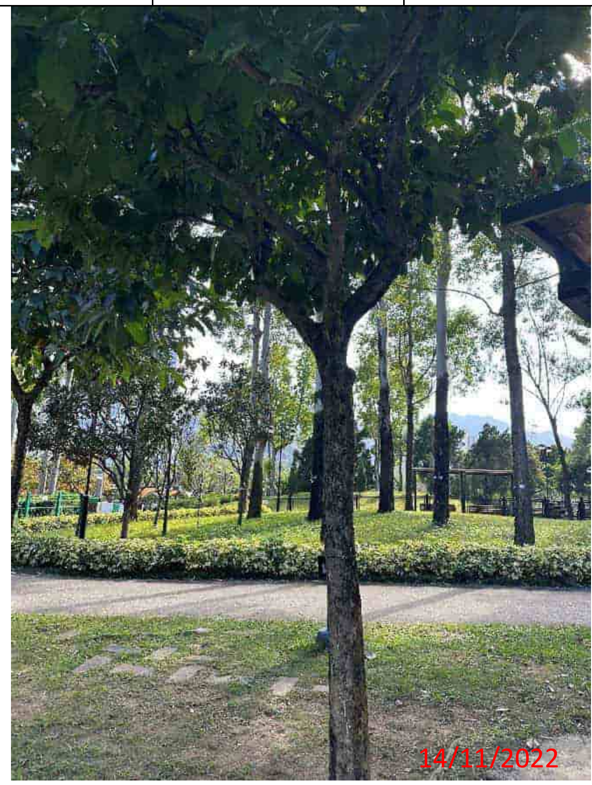
Tree Trunk Photo

Tree Root Collar Photo



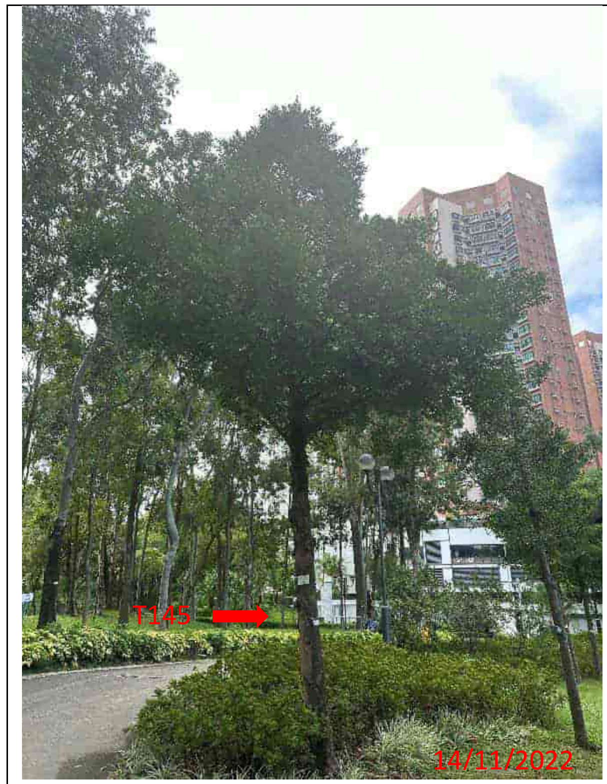
Tree Crown Photo

T144	Lagerstroemia speciosa	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
5	4	120



Tree Trunk Photo

Tree Root Collar Photo



T145	Nageia nagi		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
6	5	160	

Tree Trunk Photo

Tree Root Collar Photo

T146	Nageia nagi		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
4	3	100	

Tree Trunk Photo

Tree Root Collar Photo

Tree Crown Photo

T147	Nageia nagi	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
5	2	120

Tree Trunk photo

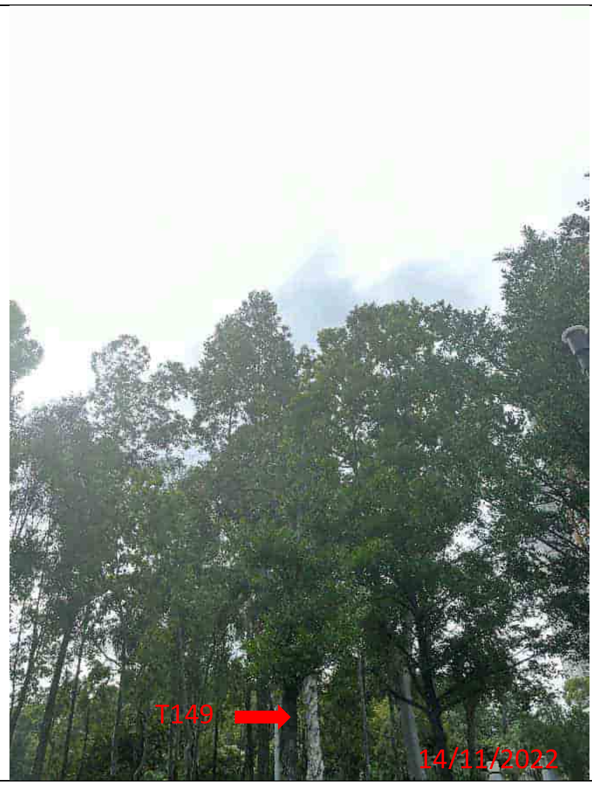
Tree Root Collar Photo

Tree Crown Photo

T148	Nageia nagi	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
5	3	100

Tree Trunk Photo

Tree Root Collar Photo



T149	Nageia nagi		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	2	110	

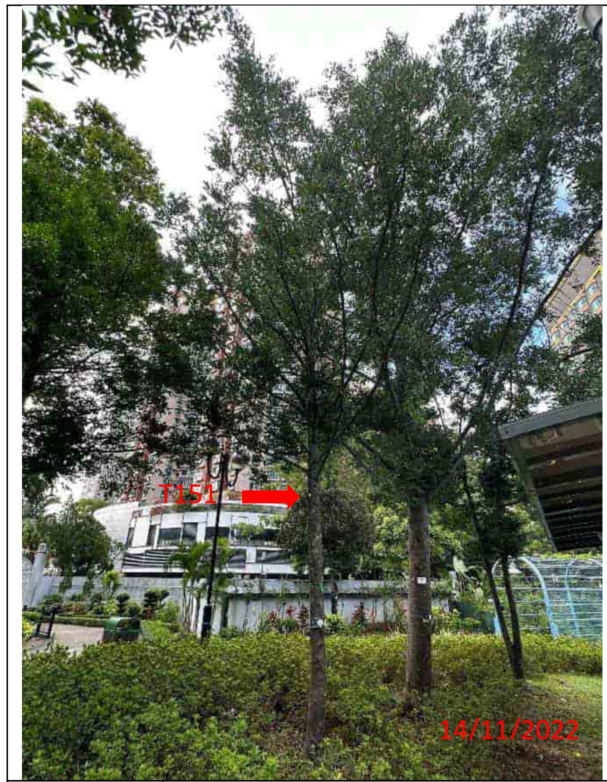
Tree Trunk Photo

Tree Root Collar Photo

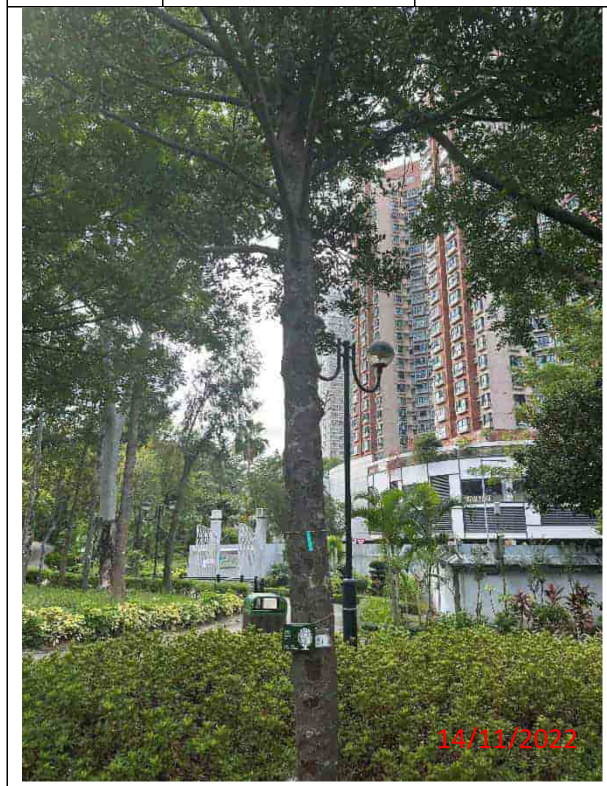
T150	Nageia nagi		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
7	5	150	

Tree Trunk Photo

Tree Root Collar Photo



T151	Nageia nagi		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
8	4	140	



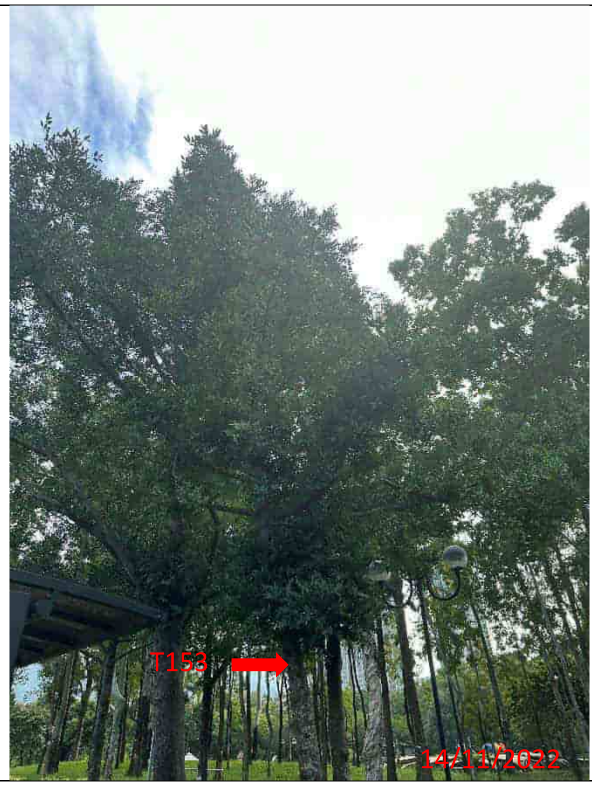
Tree Trunk Photo

Tree Root Collar Photo

T152	Nageia nagi		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
10	5	270	

Tree Trunk Photo

Tree Root Collar Photo

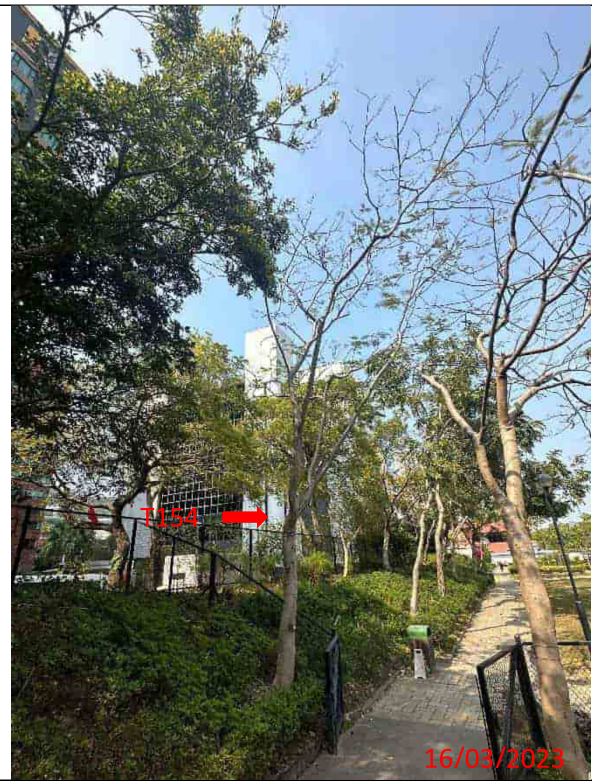


Tree Crown Photo

T153	Nageia nagi	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
7	4	160

Tree Trunk Photo

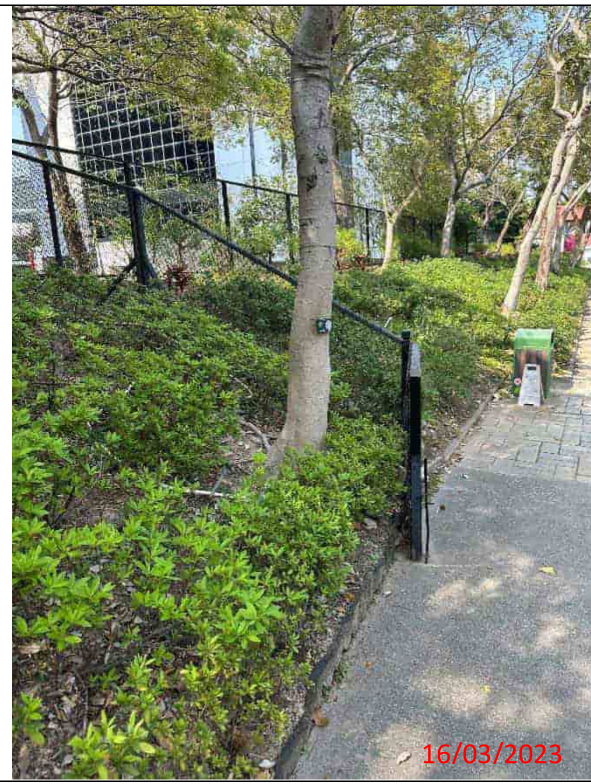
Tree Root Collar Photo



Tree Crown Photo

T154	Delonix regia	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
10	7	200

Tree Trunk Photo



Tree Root Collar Photo

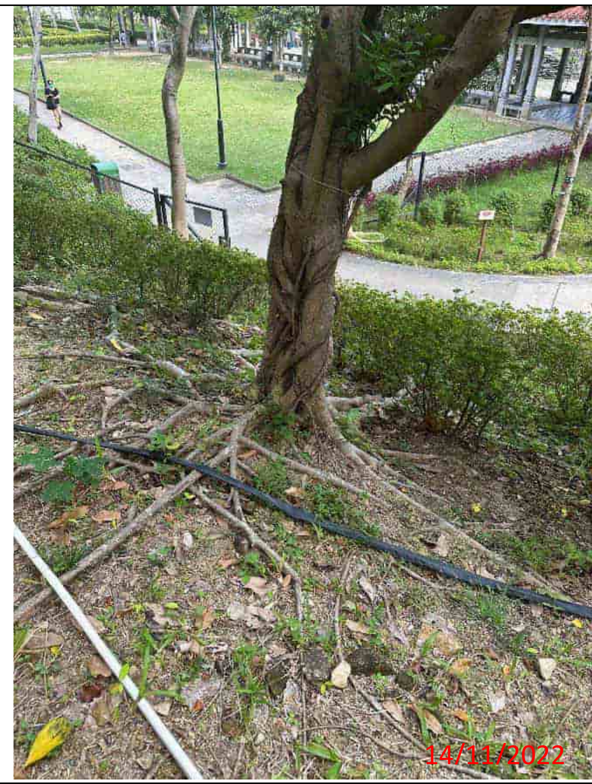
T155	Schefflera heptaphylla		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
6	5	200	

Tree Trunk Photo

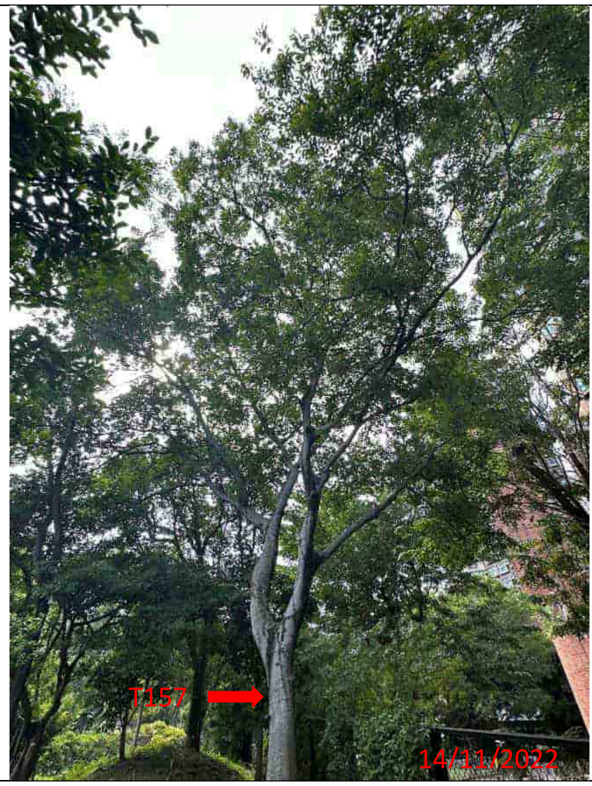
Tree Root Collar Photo

T156	Ficus microcarpa		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
7	10	300	

Tree Trunk Photo

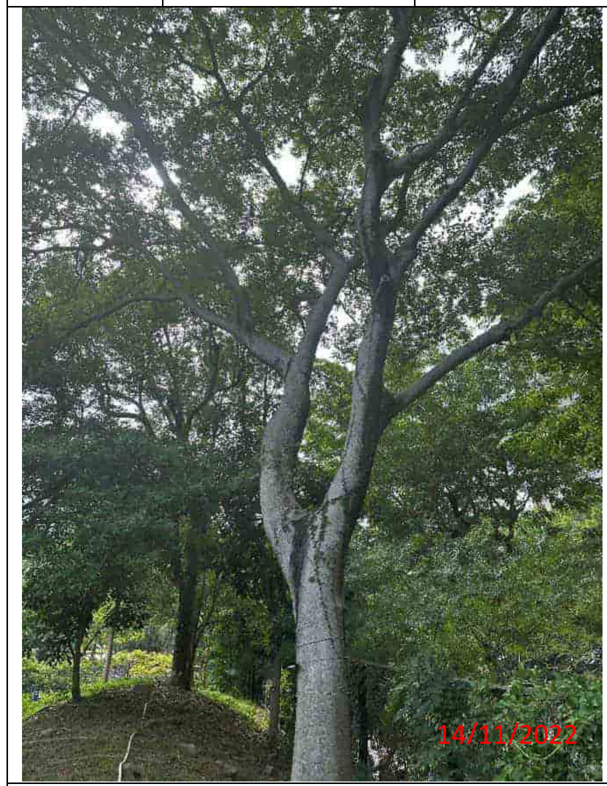


Tree Root Collar Photo



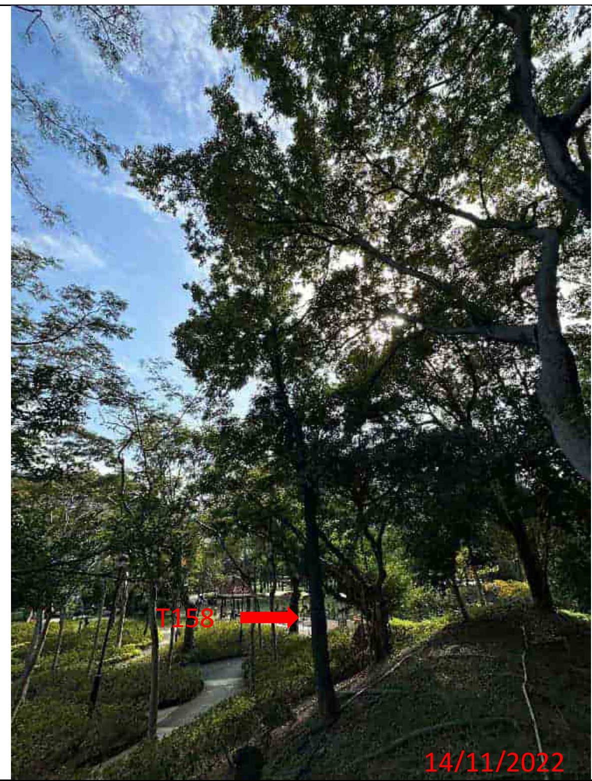
Tree Crown Photo

T157	Celtis sinensis	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
15	14	550



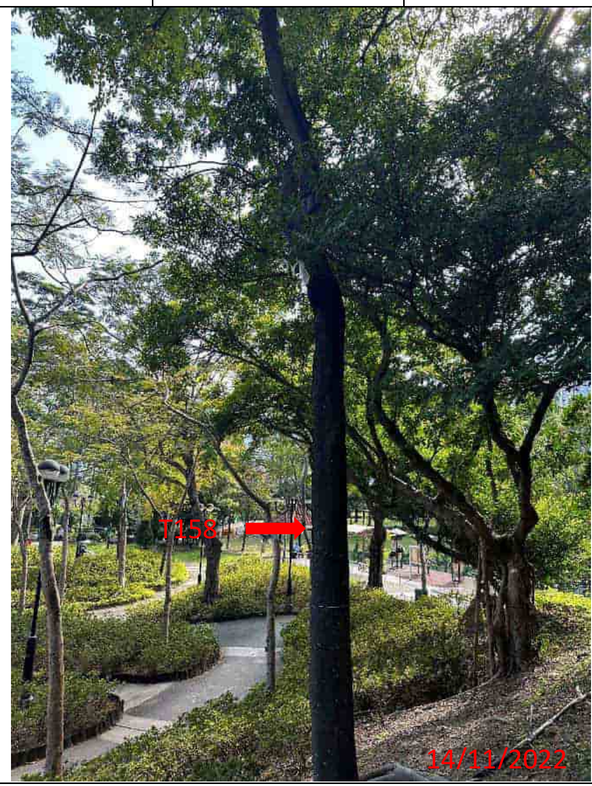
Tree Trunk Photo

Tree Root Collar Photo

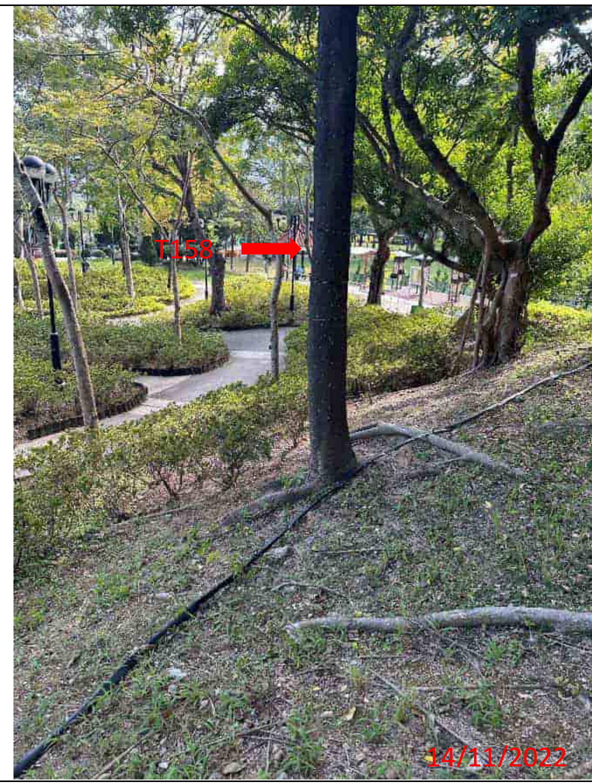


Tree Crown Photo

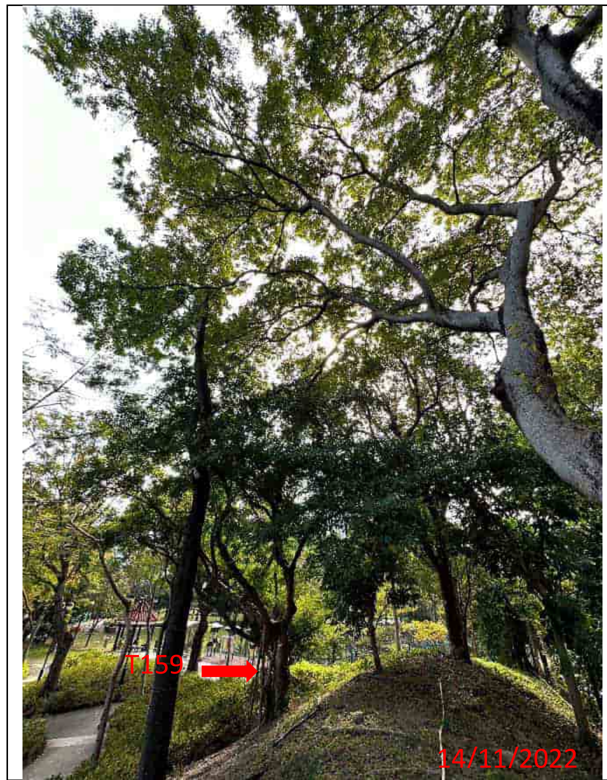
T158	Peltophorum pterocarpum	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
18	7	200



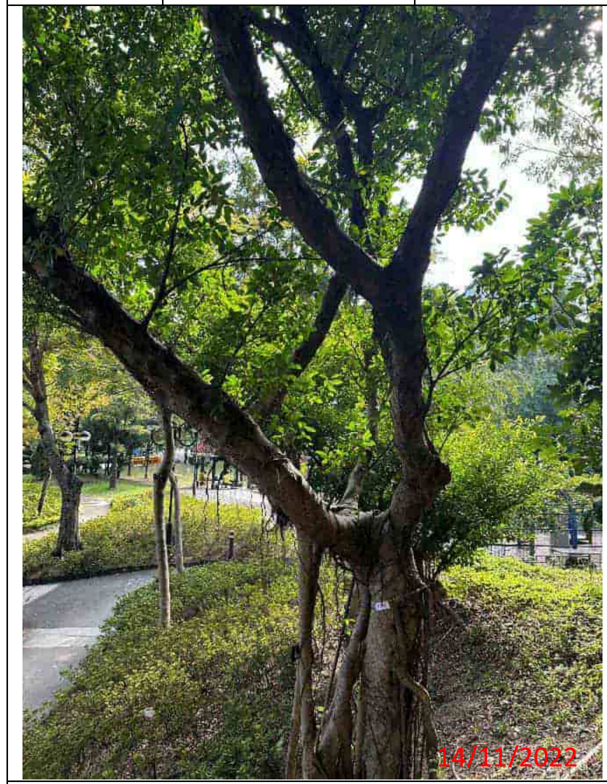
Tree Trunk and Root Collar Photo



Tree Root Collar Photo

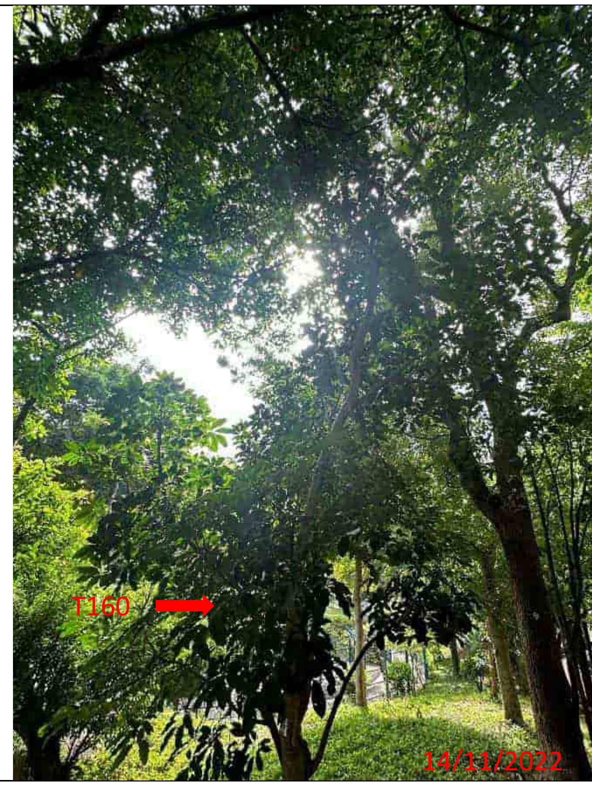


T159	Ficus microcarpa		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
9	9	260	



Tree Trunk Photo

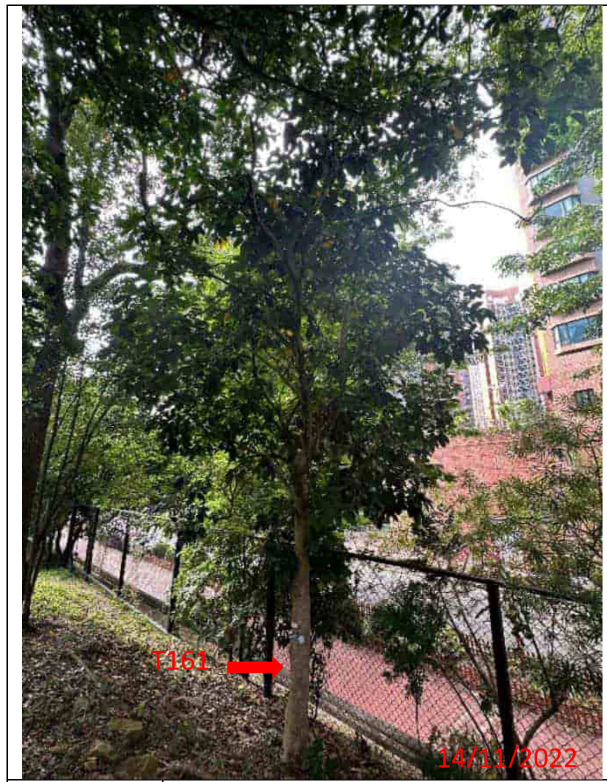
Tree Root Collar Photo



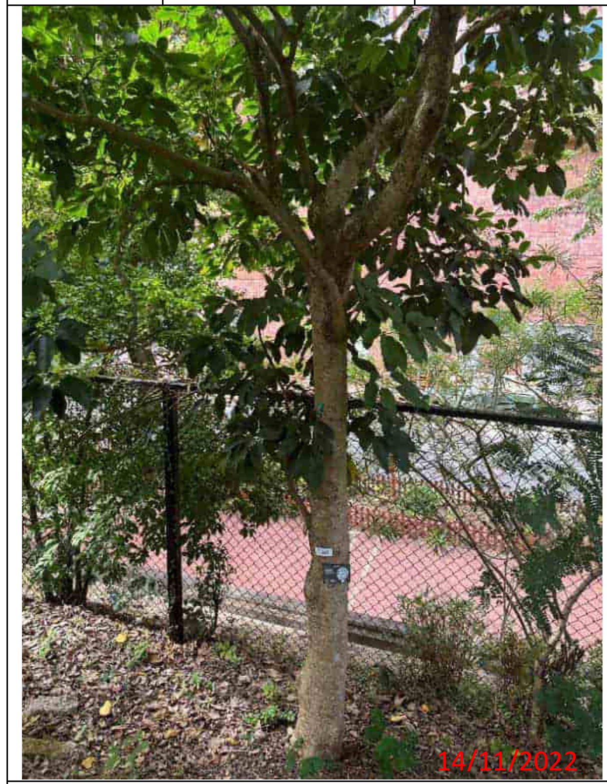
T160	Schefflera heptaphylla		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
6	4	100	

Tree Trunk Photo

Tree Root Collar Photo



T161	Schefflera heptaphylla		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
6	5	180	



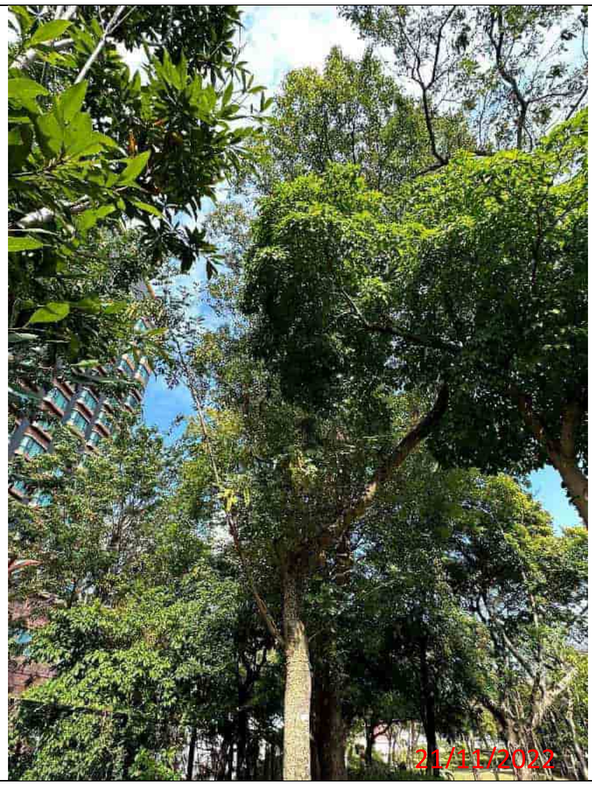
Tree Trunk Photo

Tree Root Collar Photo

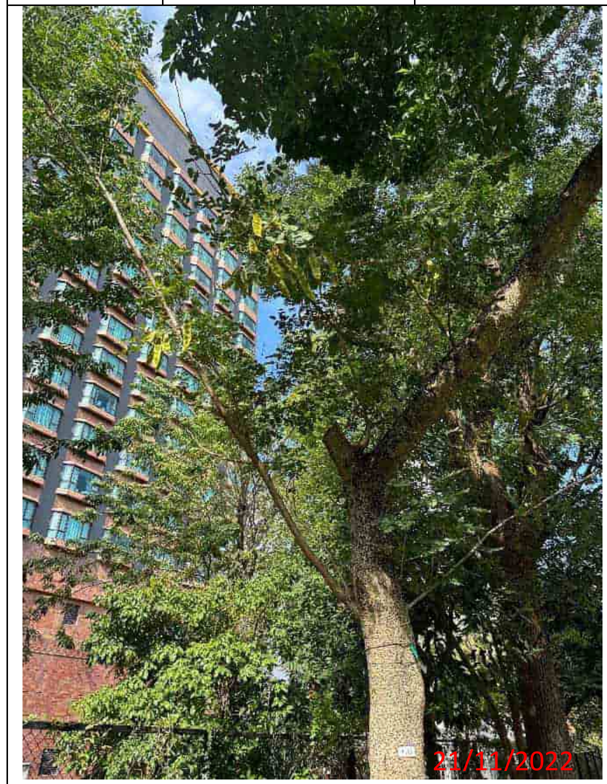
T162	Cinnamomum camphora		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
15	12	350	

Tree Trunk Photo

Tree Root Collar Photo

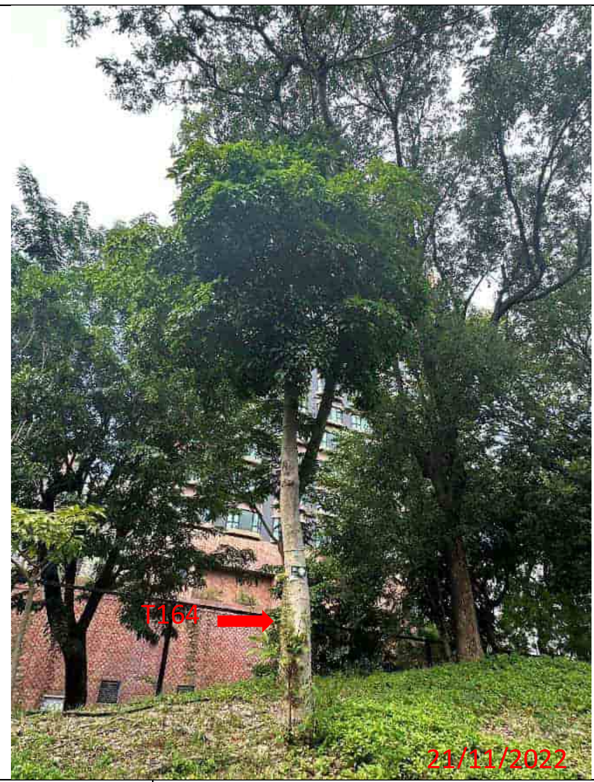


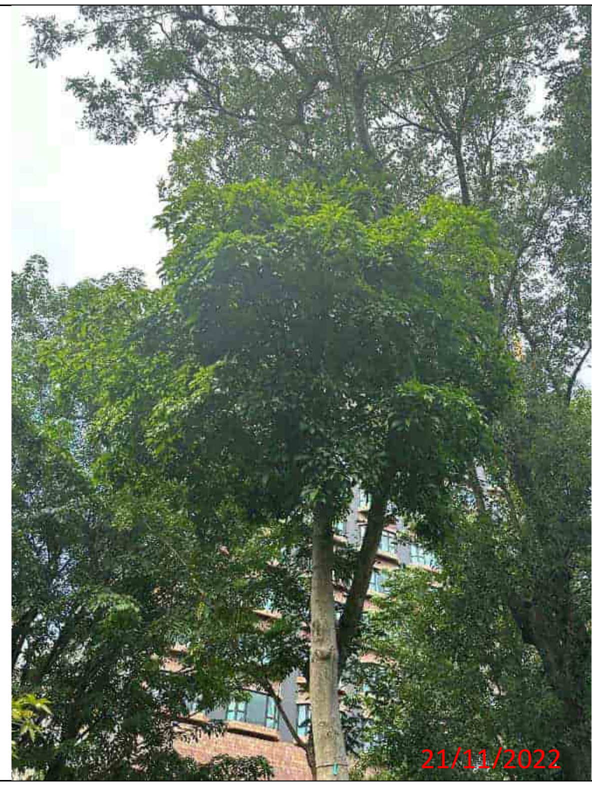
T163	Albizia lebbeck		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
10	7	230	



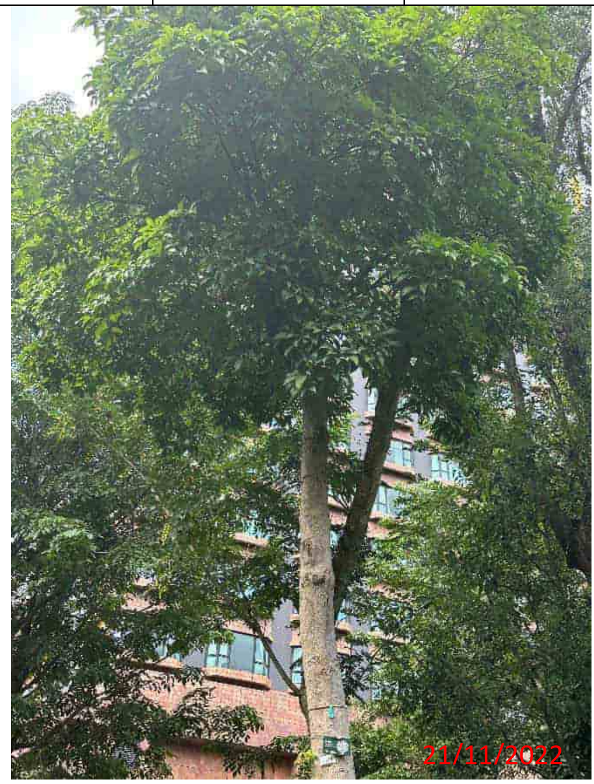
Tree Trunk Photo

Tree Root Collar Photo



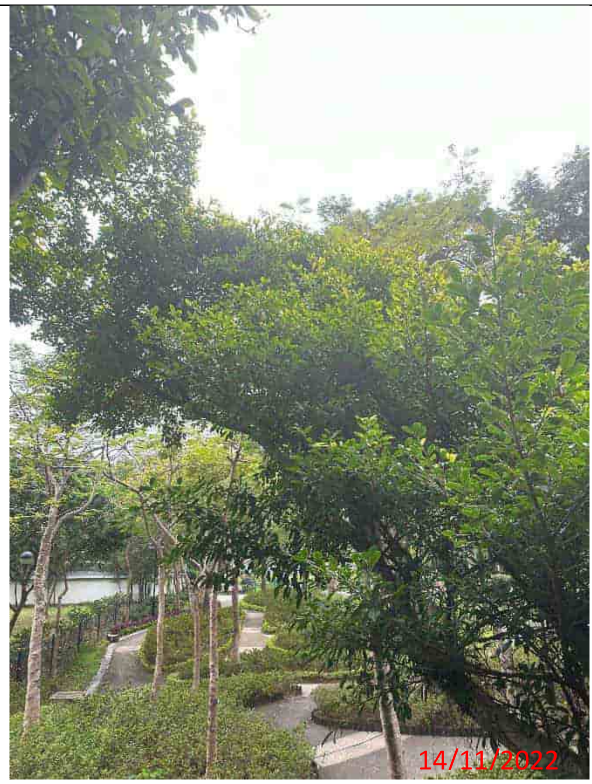


T164	Sterculia lanceolata		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	4	170	

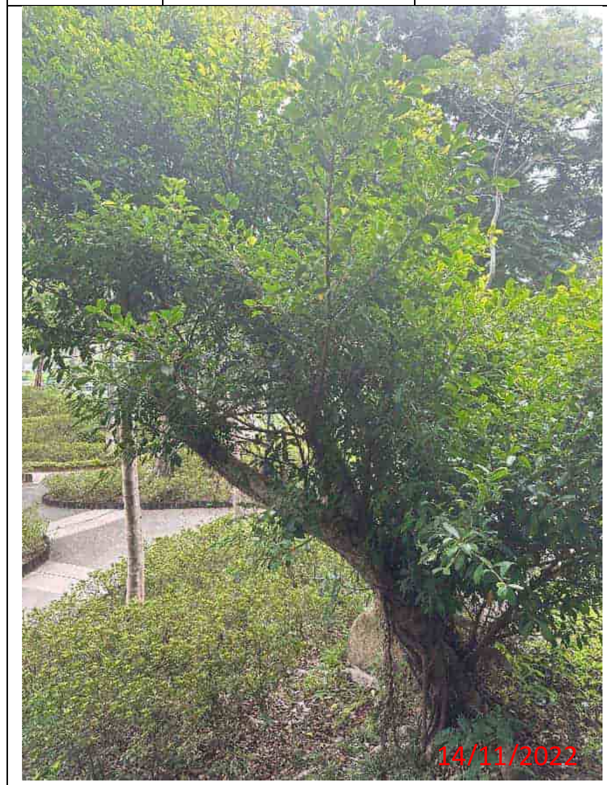


Tree Trunk Photo

Tree Root Collar Photo



T165	Ficus microcarpa		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
6	8	180	



Tree Trunk Photo

Tree Root Collar Photo

T166	Delonix regia		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
9	4	120	

Tree Trunk Photo

Tree Root Collar Photo

T167	Delonix regia		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
10	7	200	

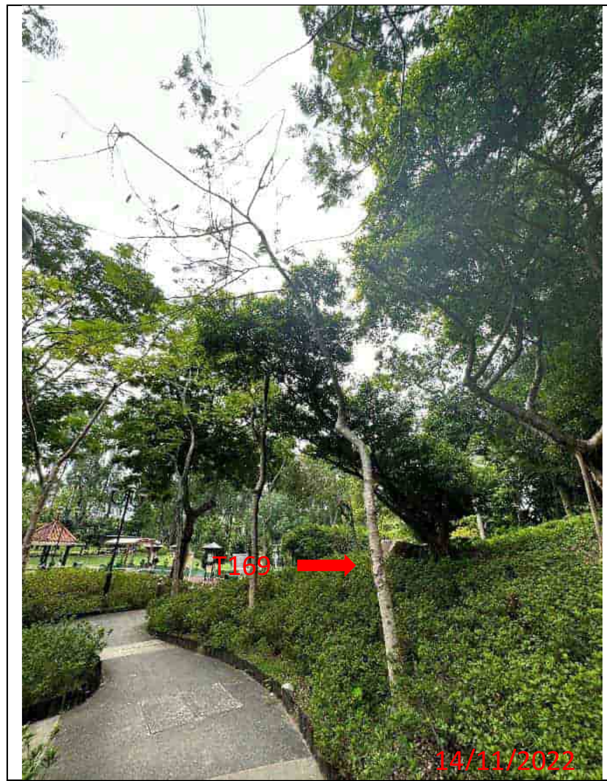
Tree Trunk Photo

Tree Root Collar Photo

T168	Delonix regia		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
9	4	150	

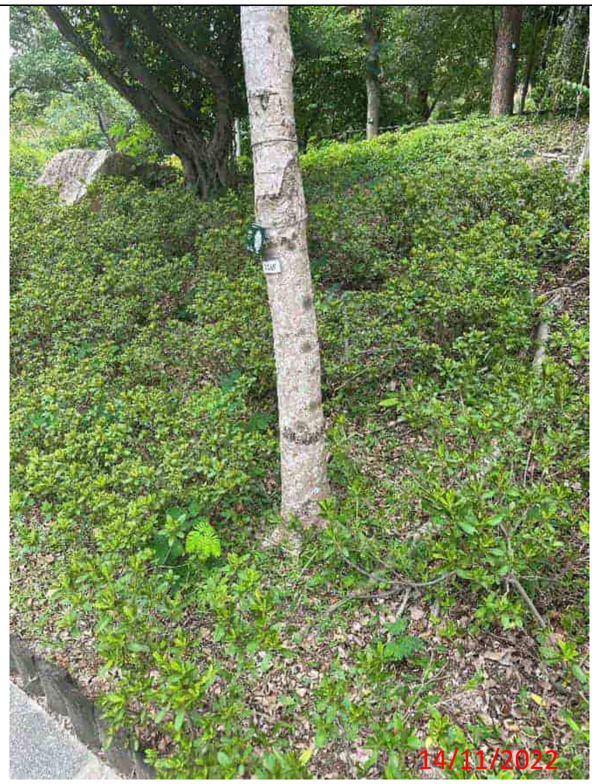
Tree Trunk Photo

Tree Root Collar Photo



T169	Delonix regia		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
8	4	140	

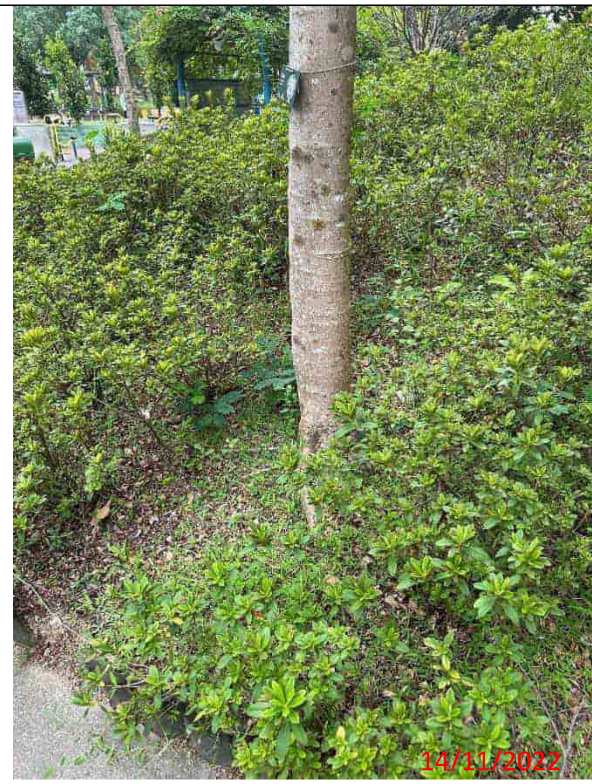
Tree Trunk Photo



Tree Root Collar Photo

T170	Delonix regia		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
9	7	180	

Tree Trunk Photo



Tree Root Collar Photo

Tree Crown Photo

T171	Delonix regia	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
10	5	130

Tree Trunk Photo

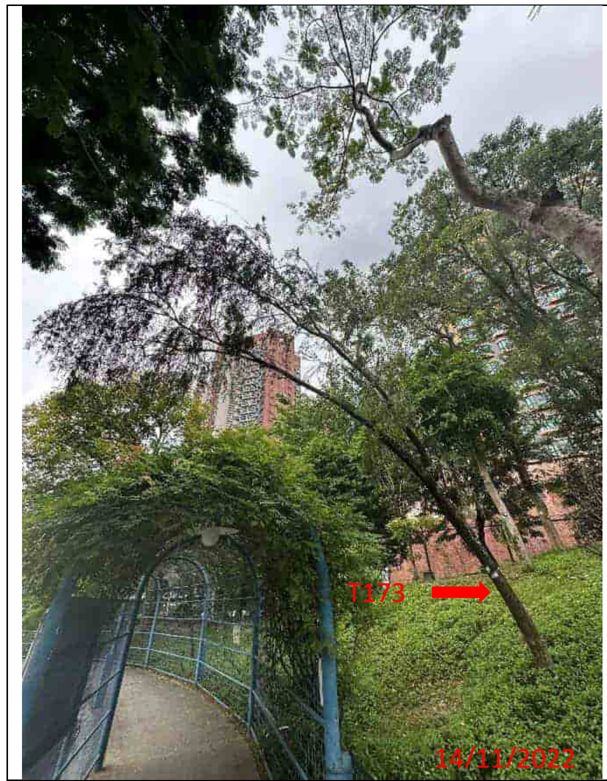
Tree Root Collar Photo

Tree Crown Photo

T172	Delonix regia	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
9	4	110

Tree Trunk Photo

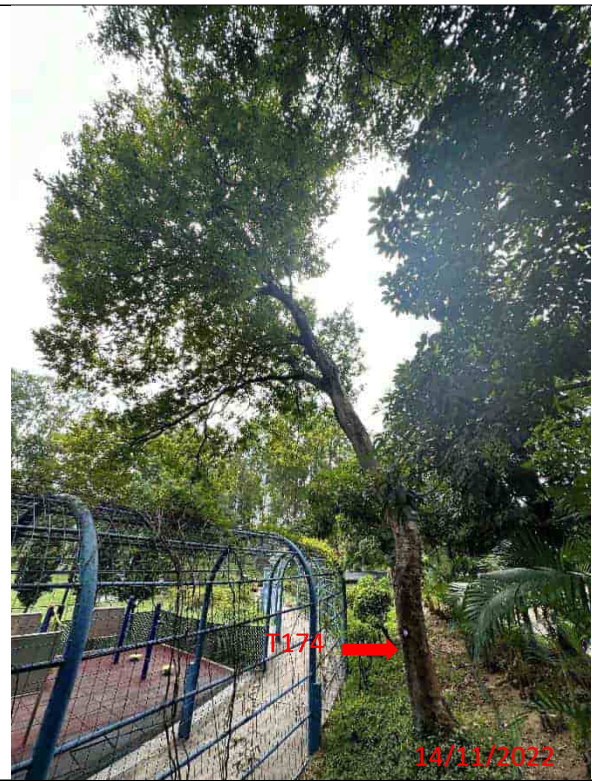
Tree Root Collar Photo



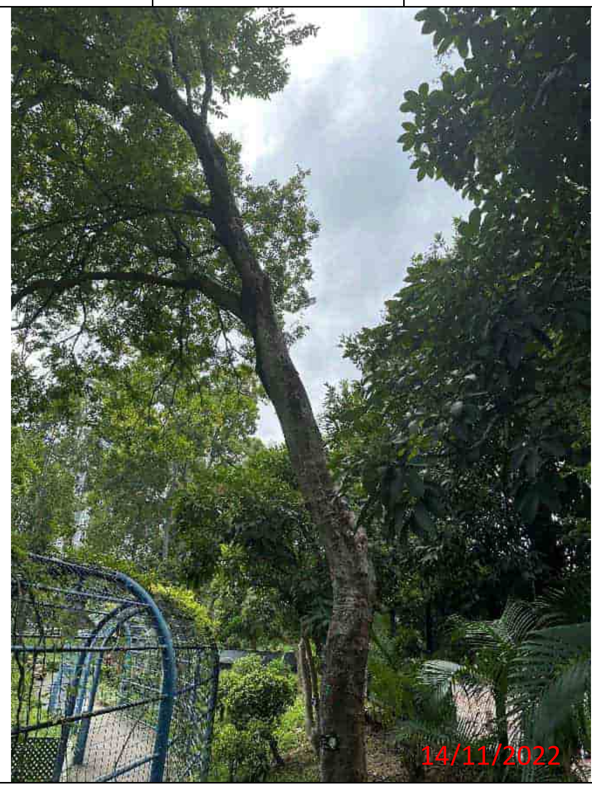
T173	Callistemon viminalis		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
6	4	120	

Tree Trunk Photo

Tree Root Collar Photo

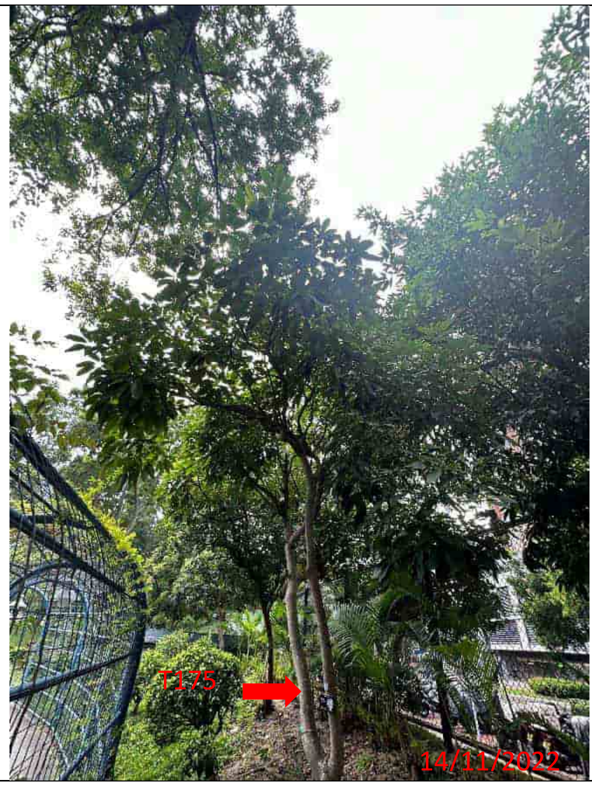


T174	Celtis sinensis		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
9	6	290	



Tree Trunk Photo

Tree Root Collar Photo



T175	Schefflera heptaphylla		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	4	110	

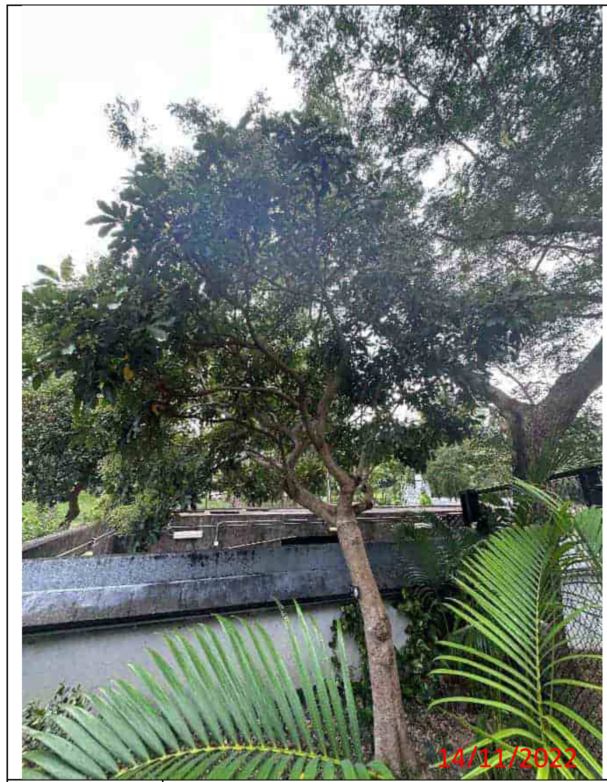
Tree Trunk Photo

Tree Root Collar Photo

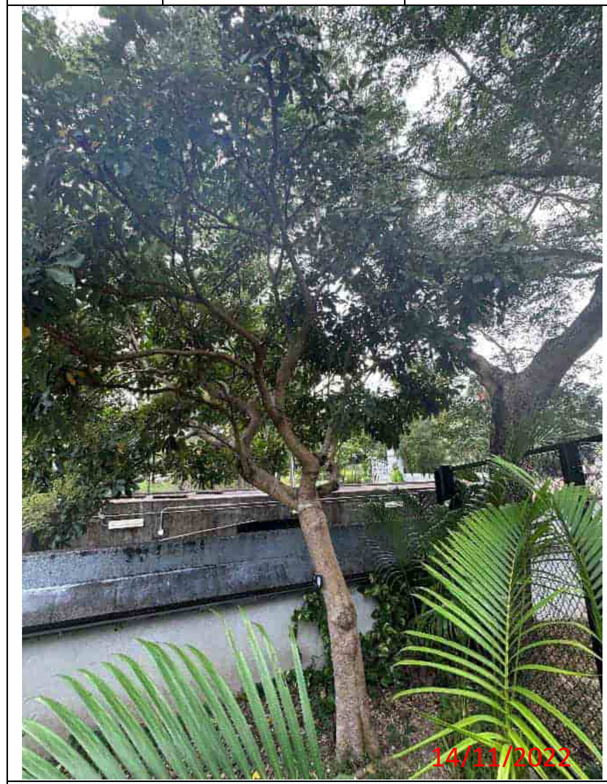
T176	Viburnum odoratissimum		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	4	110	

Tree Trunk Photo

Tree Root Collar Photo



T177	Schefflera heptaphylla		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	6	160	

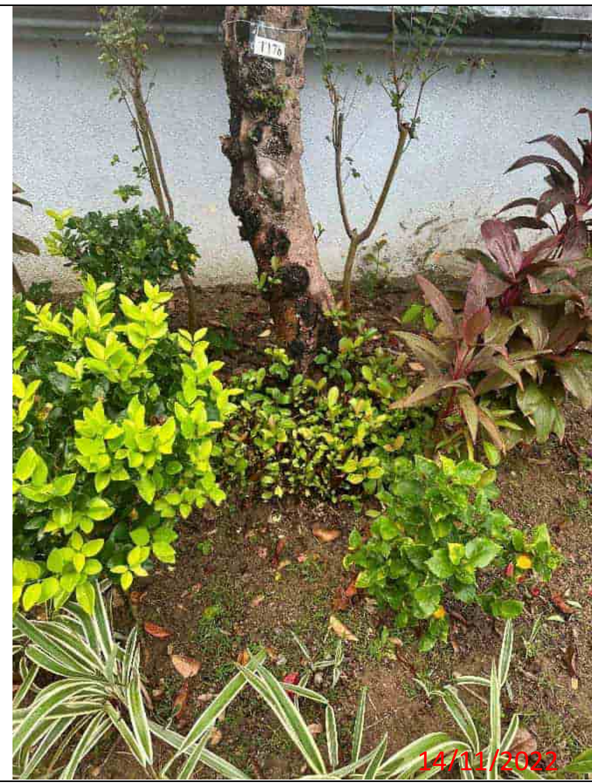


Tree Trunk Photo

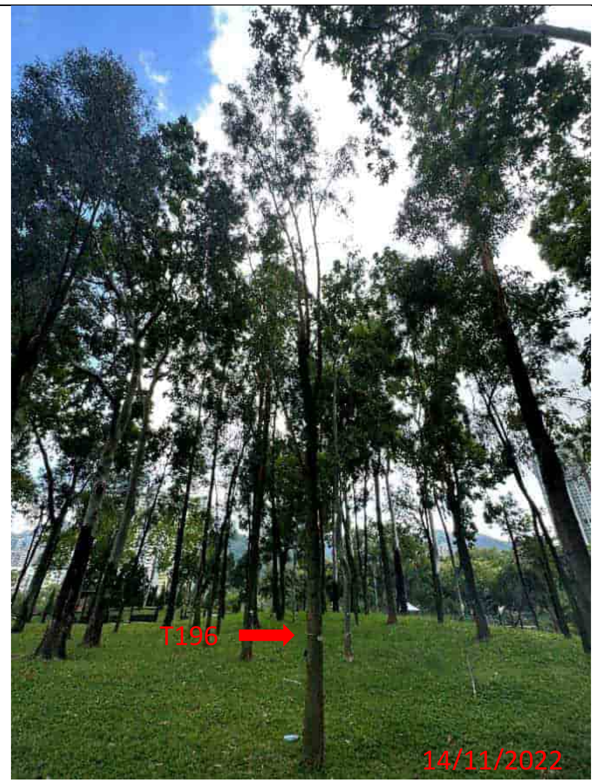
Tree Root Collar Photo

T178	Viburnum odoratissimum		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	3	200	

Tree Trunk Photo

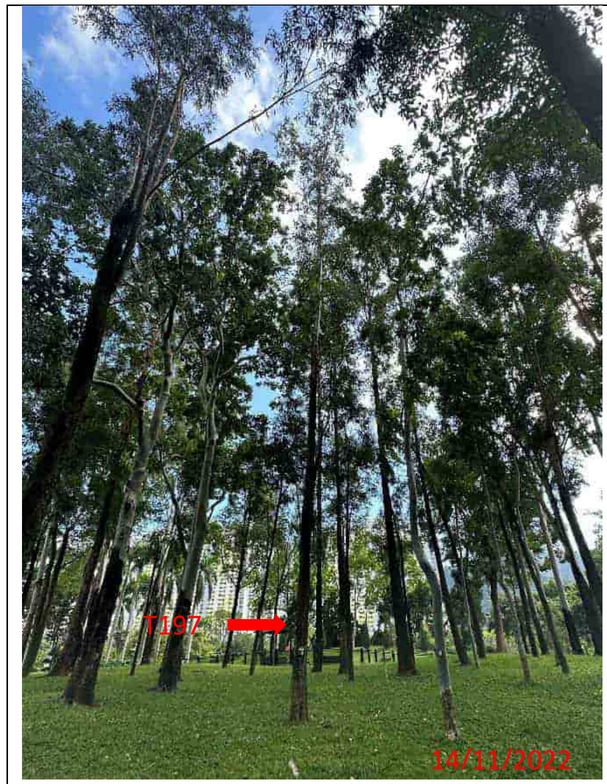


Tree Root Collar Photo

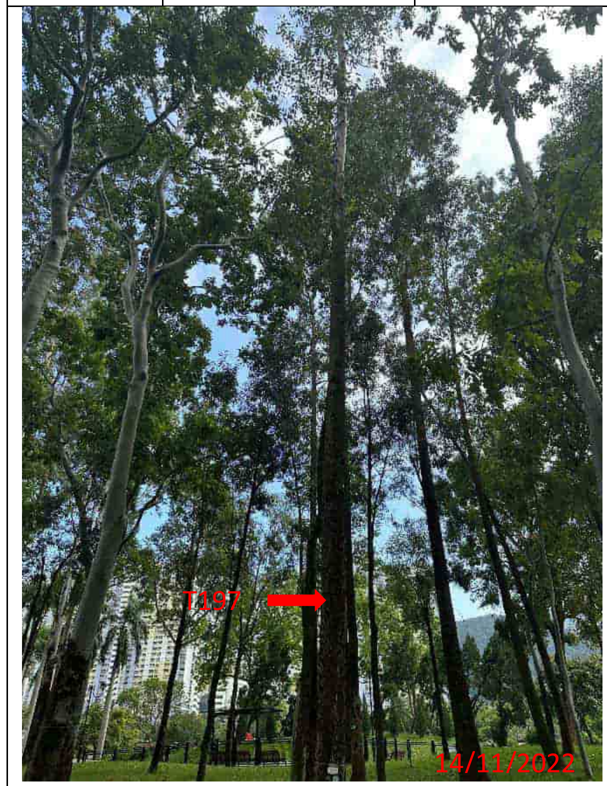


T196	Eucalyptus exserta		Tree Crown and Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
20	6	210	

Tree Trunk Photo	Tree Root Collar Photo



T197	Eucalyptus exserta		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
22	7	260	

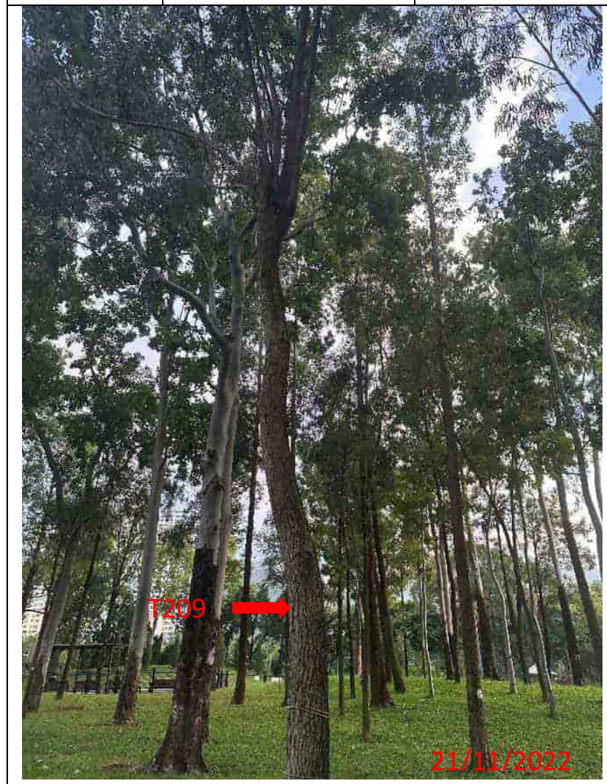


Tree Trunk Photo

Tree Root Collar Photo

T209	Eucalyptus exserta	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
9	3	160

Tree Crown Photo



Tree Trunk Photo

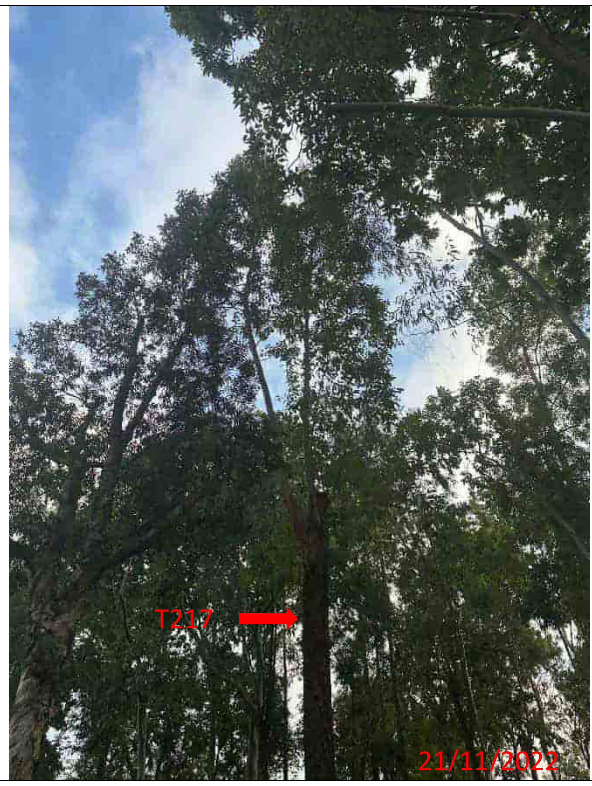
Tree Root Collar Photo

T210	Eucalyptus torelliana	
Height (m)	Crown Spread (m)	Aggregated DBH (mm)
11	6	130

Tree Crown Photo

Tree Trunk Photo

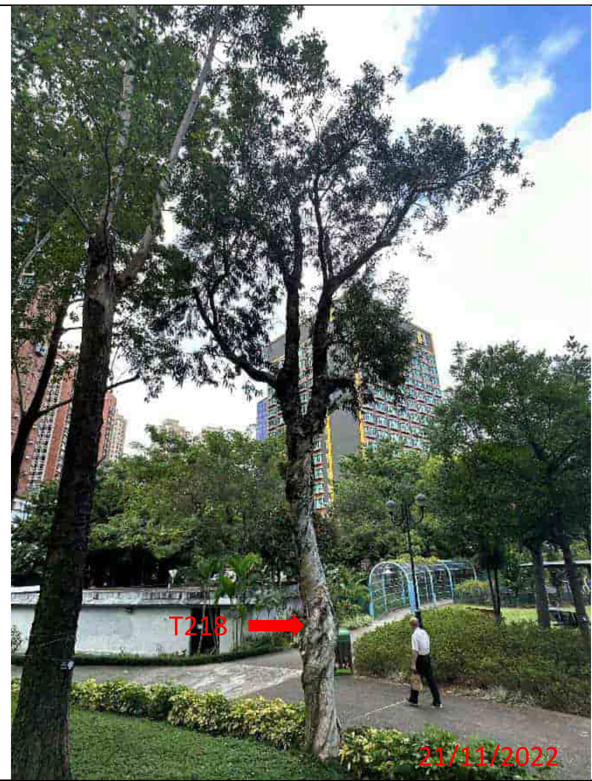
Tree Root Collar Photo



T217	Eucalyptus robusta		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
16	5	370	

Tree Trunk Photo

Tree Root Collar Photo

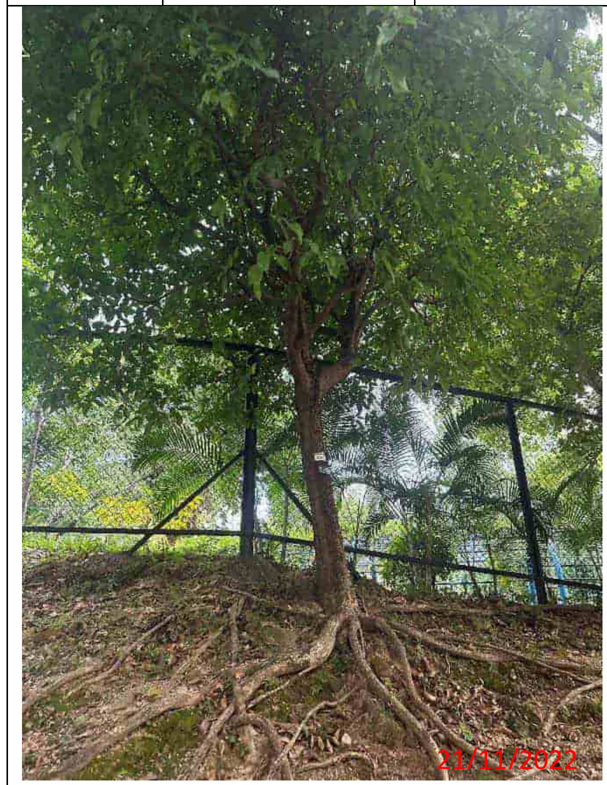


T218	Melaleuca cajuputi subsp. Cumingiana		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
11	5	450	

Tree Trunk Photo

Tree Root Collar Photo

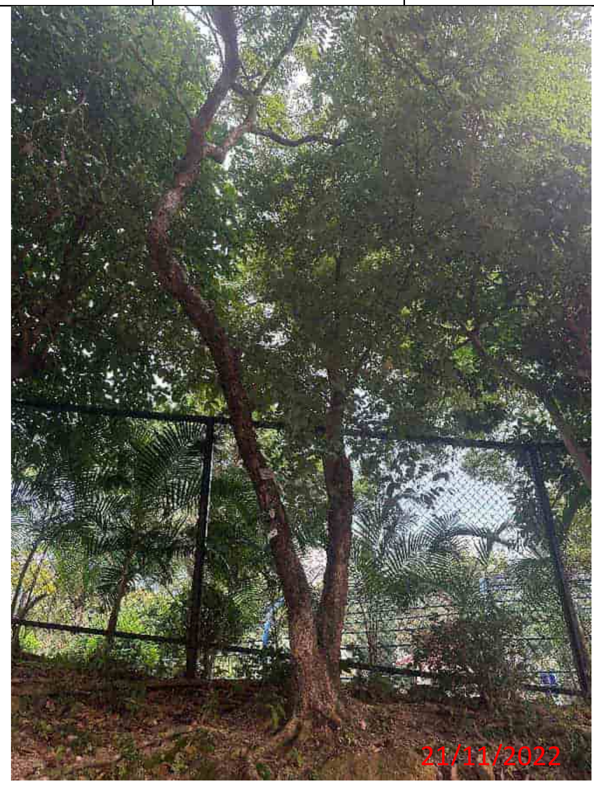
T247	Sterculia lanceolata		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
6	6	180	



Tree Trunk Photo

Tree Root Collar Photo

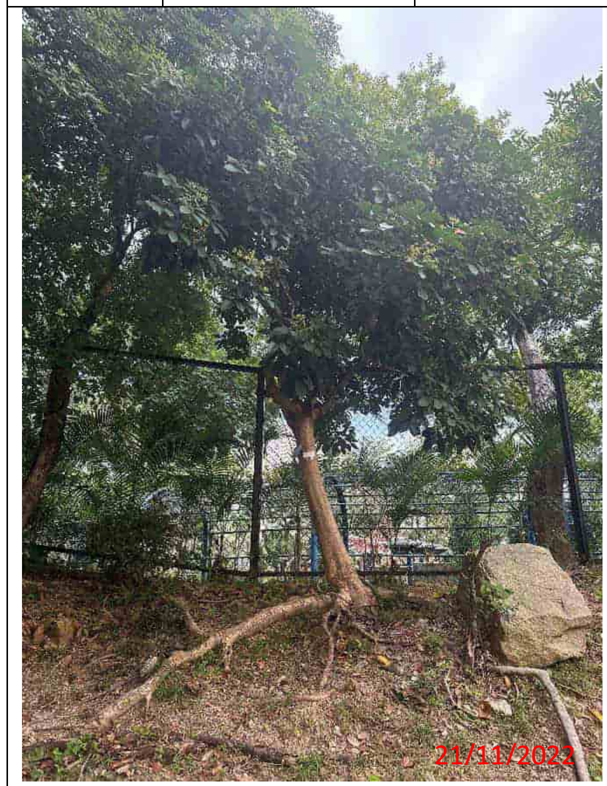
T248	Bridelia tomentosa		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
6	8	220	



Tree Trunk Photo

Tree Root Collar Photo

T249	Schefflera heptaphylla		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	7	160	



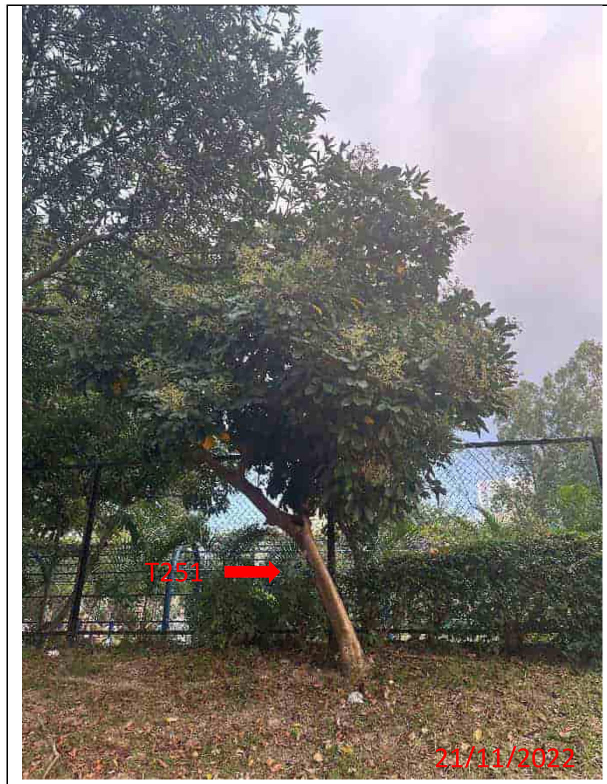
Tree Trunk Photo

Tree Root Collar Photo

T250	Syzygium jambos		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
10	8	330	

Tree Trunk Photo

Tree Root Collar Photo



T251	Schefflera heptaphylla		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
5	4	130	

Tree Trunk Photo

Tree Root Collar Photo

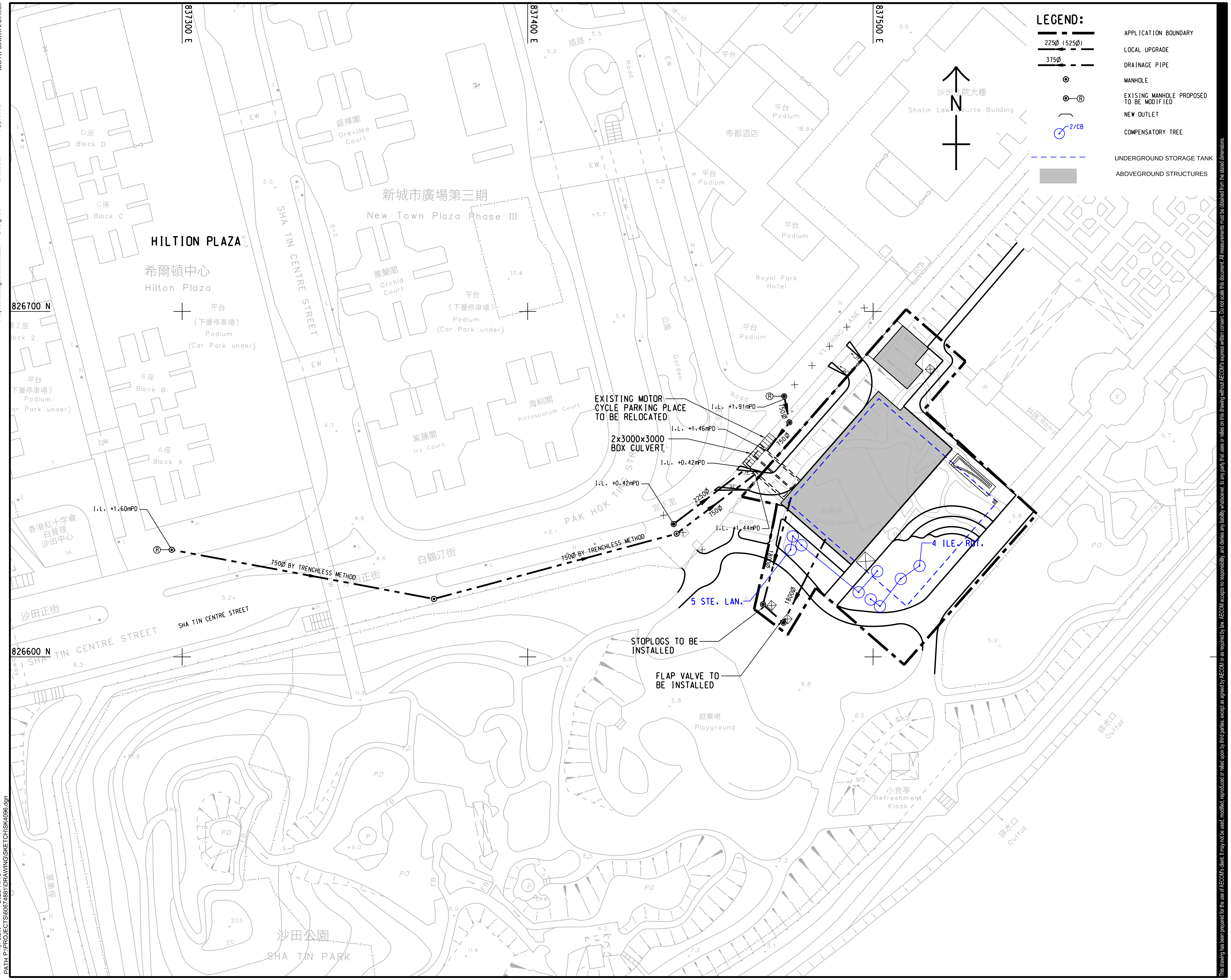
T252	Albizia lebbeck		Tree Crown Photo
Height (m)	Crown Spread (m)	Aggregated DBH (mm)	
16	13	390	

Tree Trunk Photo

Tree Root Collar Photo

Appendix IVa

Compensatory Planting Plan (within Application Boundary)



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PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT 業主

渠務署
Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
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I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

SCALE 比例 — A1 1 : 500

DIMENSION UNIT 尺寸單位 — METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號 — 60674881

CONTRACT NO. 合約編號 — CE 44/2021 (DS)

SHEET TITLE 圖紙名稱

TREE COMPENSATION PLAN (INSIDE APPLICATION BOUNDARY)

SHEET NUMBER 圖紙編號

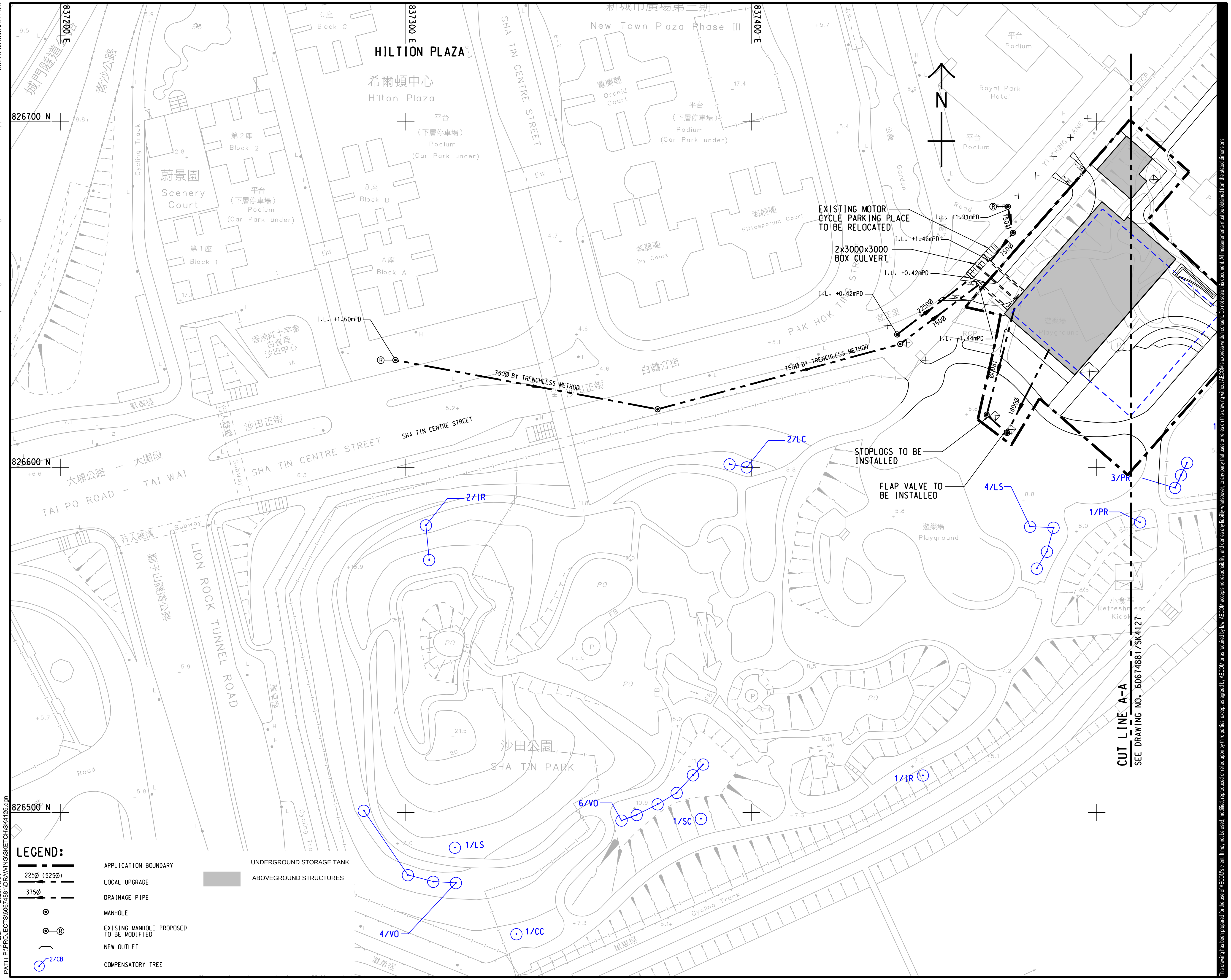
60674881/SK4096

Plot File by: JiaW 2023/11/15
PATH P:\PROJECTS\60674881\DRAWING\SKETCH\SK4096.dgn
Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm

Appendix IVb

Compensatory Planting Plan (Outside Application Boundary) [FOR INFORMATION ONLY]

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:



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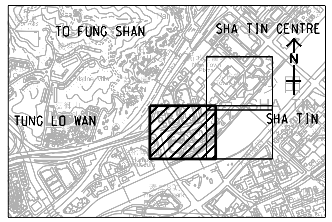
STATUS 階段

SCALE 比例: A1 1 : 500

DIMENSION UNIT 尺寸單位: METRES

KEY PLAN 索引圖: A1 1 : 20000



PROJECT NO. 項目編號: 60674881

CONTRACT NO. 合約編號: CE 44/2021 (DS)

SHEET TITLE 圖紙名稱

TREE COMPENSATORY PLAN (OUTSIDE APPLICATION BOUNDARY)

SHEET 1 OF 3

SHEET NUMBER 圖紙編號

60674881/SK4126

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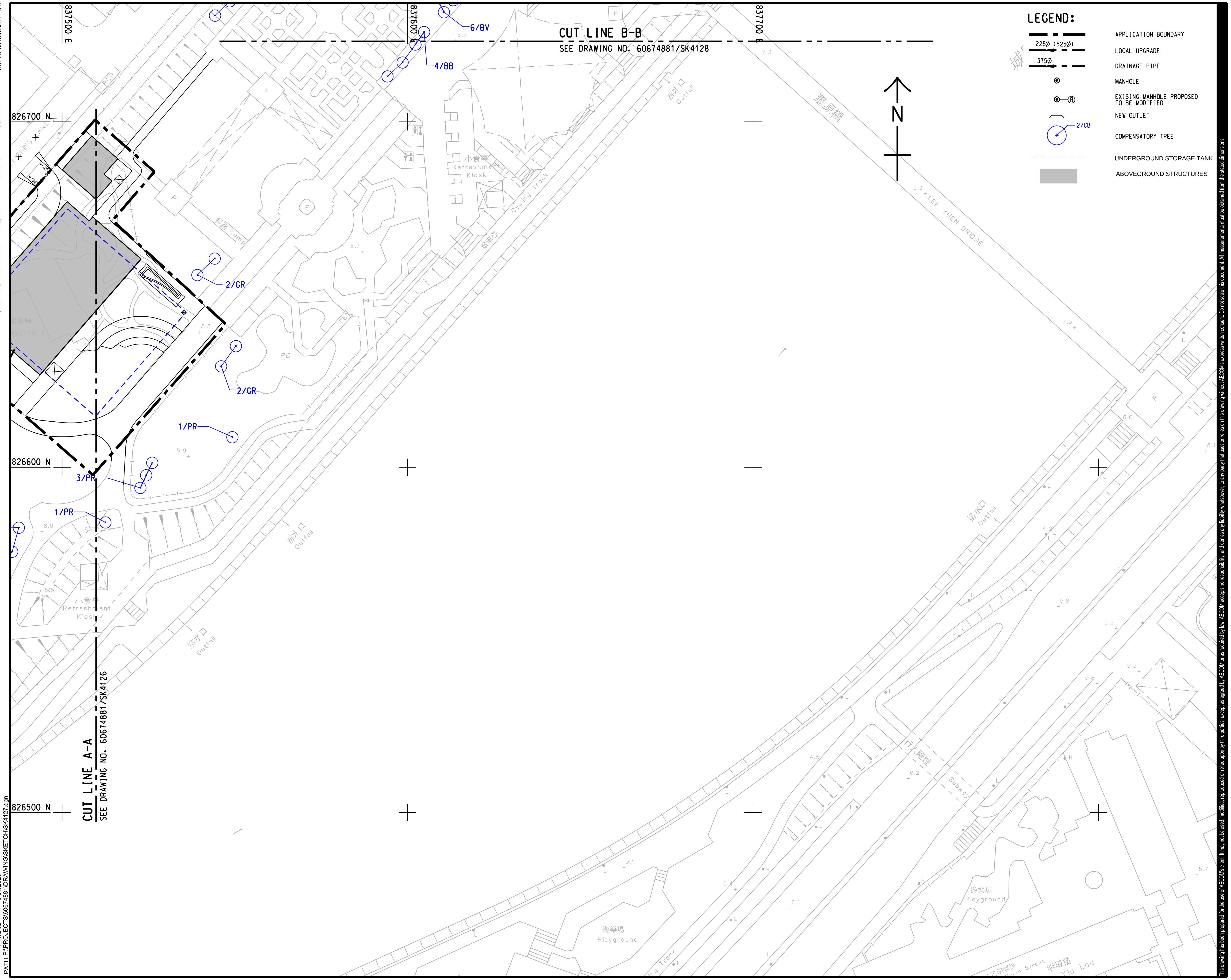

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Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm

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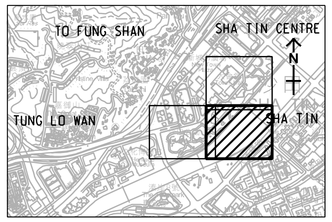
DIMENSION UNIT METRES

KEY PLAN A1 1 : 20000



PROJECT NO. 60674881

CONTRACT NO. CE 44/2021 (DS)

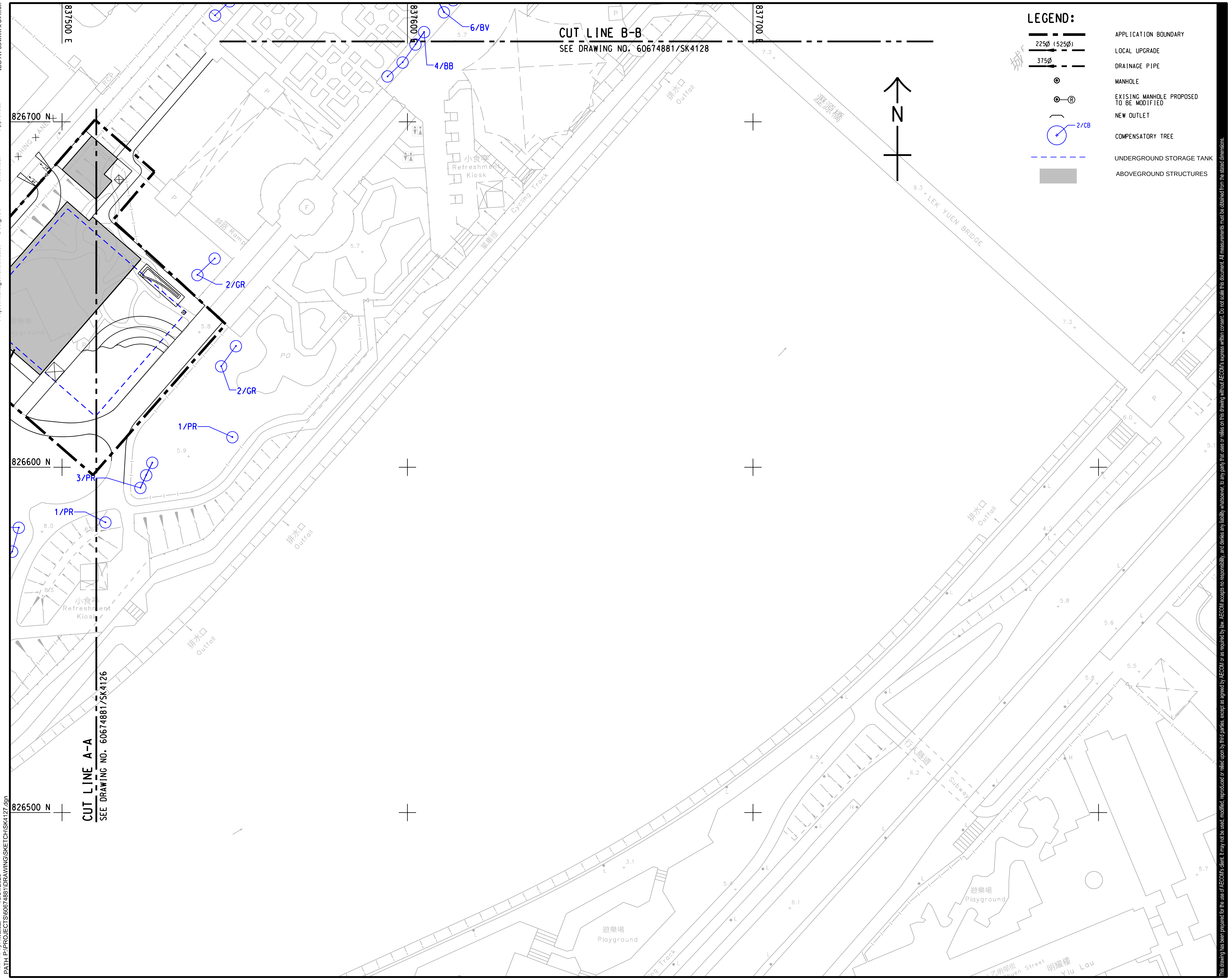
SHEET TITLE

TREE COMPENSATORY PLAN (OUTSIDE APPLICATION BOUNDARY)

SHEET 2 OF 3

SHEET NUMBER

60674881/SK4127



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SCALE: A1 1 : 500

DIMENSION UNIT: METRES

KEY PLAN A1 1 : 20000

PROJECT NO. 60674881

CONTRACT NO. CE 44/2021 (DS)

SHEET TITLE

TREE COMPENSATORY PLAN (OUTSIDE APPLICATION BOUNDARY)

SHEET 2 OF 3

SHEET NUMBER

60674881/SK4127

ISO A1 594mm x 841mm

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Project Management Initials:

Plot File by: riva.cai 10/31/2023

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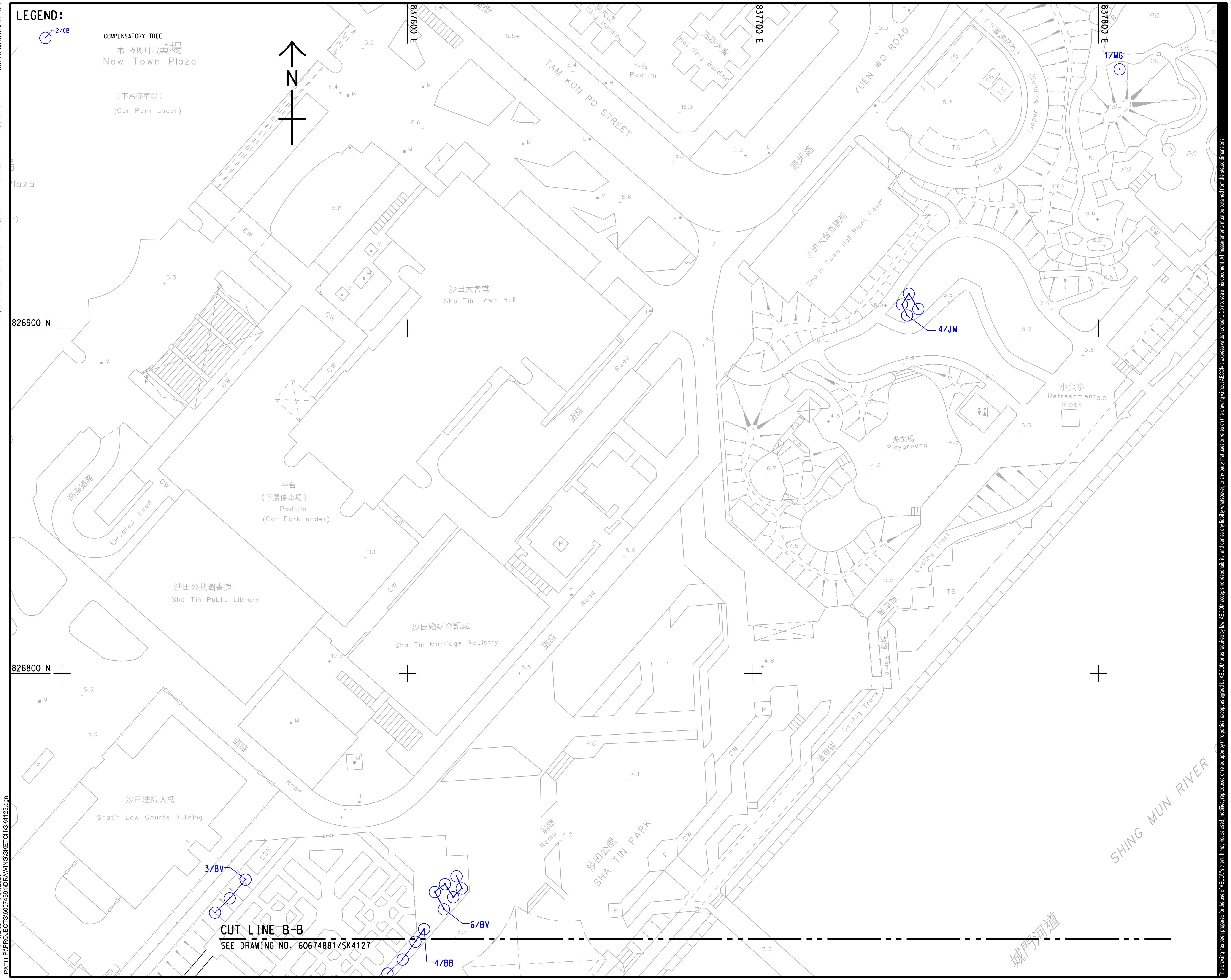

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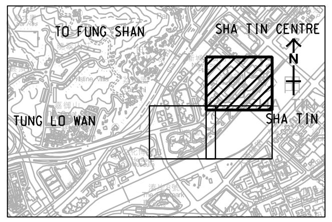
SCALE

A1 1 : 500

DIMENSION UNIT

METRES

KEY PLAN A1 1 : 20000



PROJECT NO.

60674881

CONTRACT NO.

CE 44/2021 (DS)

SHEET TITLE

TREE COMPENSATORY PLAN
(OUTSIDE APPLICATION BOUNDARY)

SHEET 3 OF 3

SHEET NUMBER

60674881/SK4128

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:
Plot File by: riva.cai 10/31/2023
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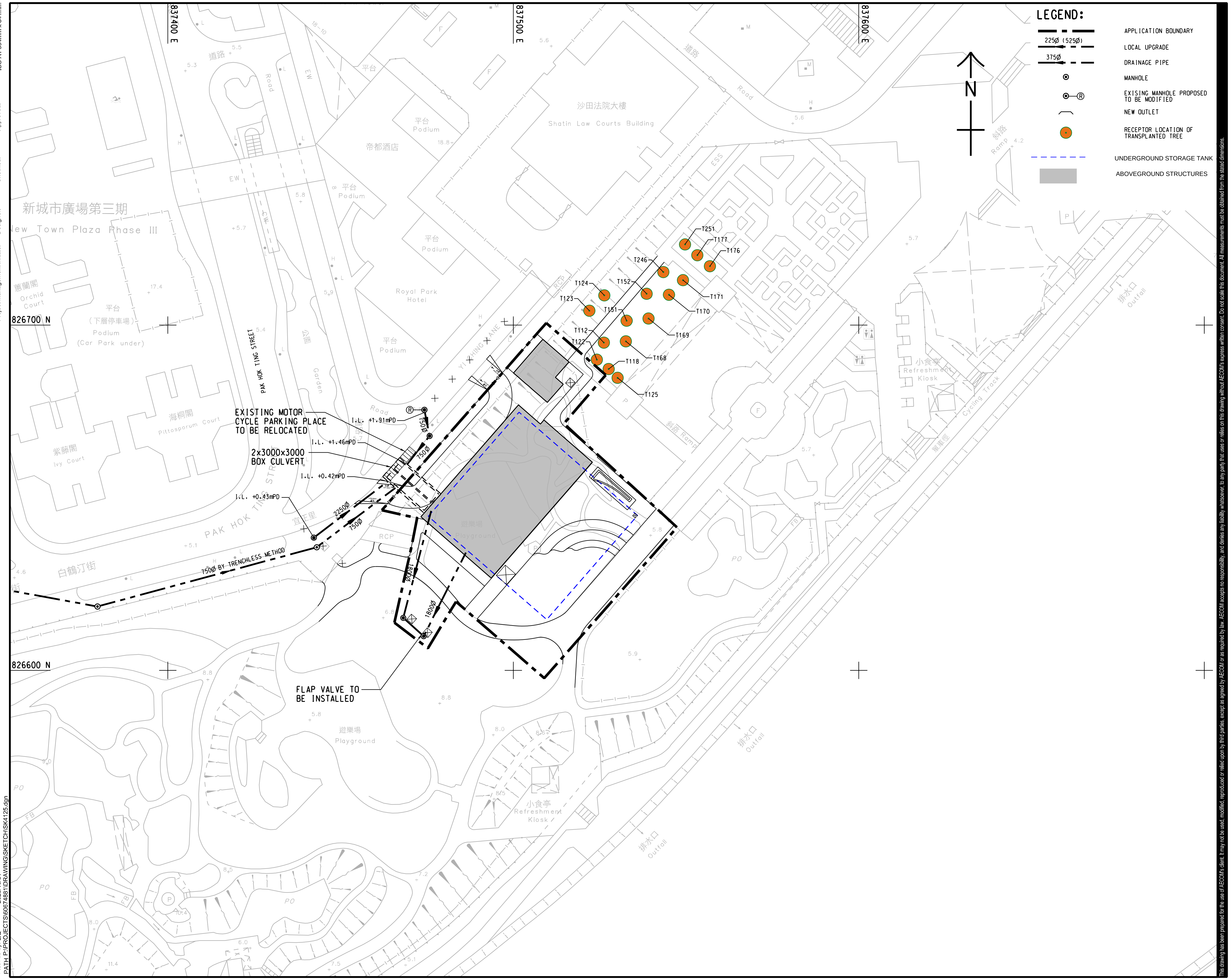
Appendix V

Tree Transplanting Plan
[FOR INFORMATION ONLY]



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PROJECT
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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

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STATUS
階段

SCALE
比例

A1 1 : 500

DIMENSION UNIT
尺寸單位

METRES

KEY PLAN
索引圖

PROJECT NO.
項目編號

60674881

CONTRACT NO.
合約編號

CE 44/2021 (DS)

SHEET TITLE
圖紙名稱

RECEPTOR LOCATION TRANSPLANTED TREES

SHEET NUMBER
圖紙編號

60674881/SK4125

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Approved:
Checked:
Designer:
Project Management Initials:
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2023/10/31
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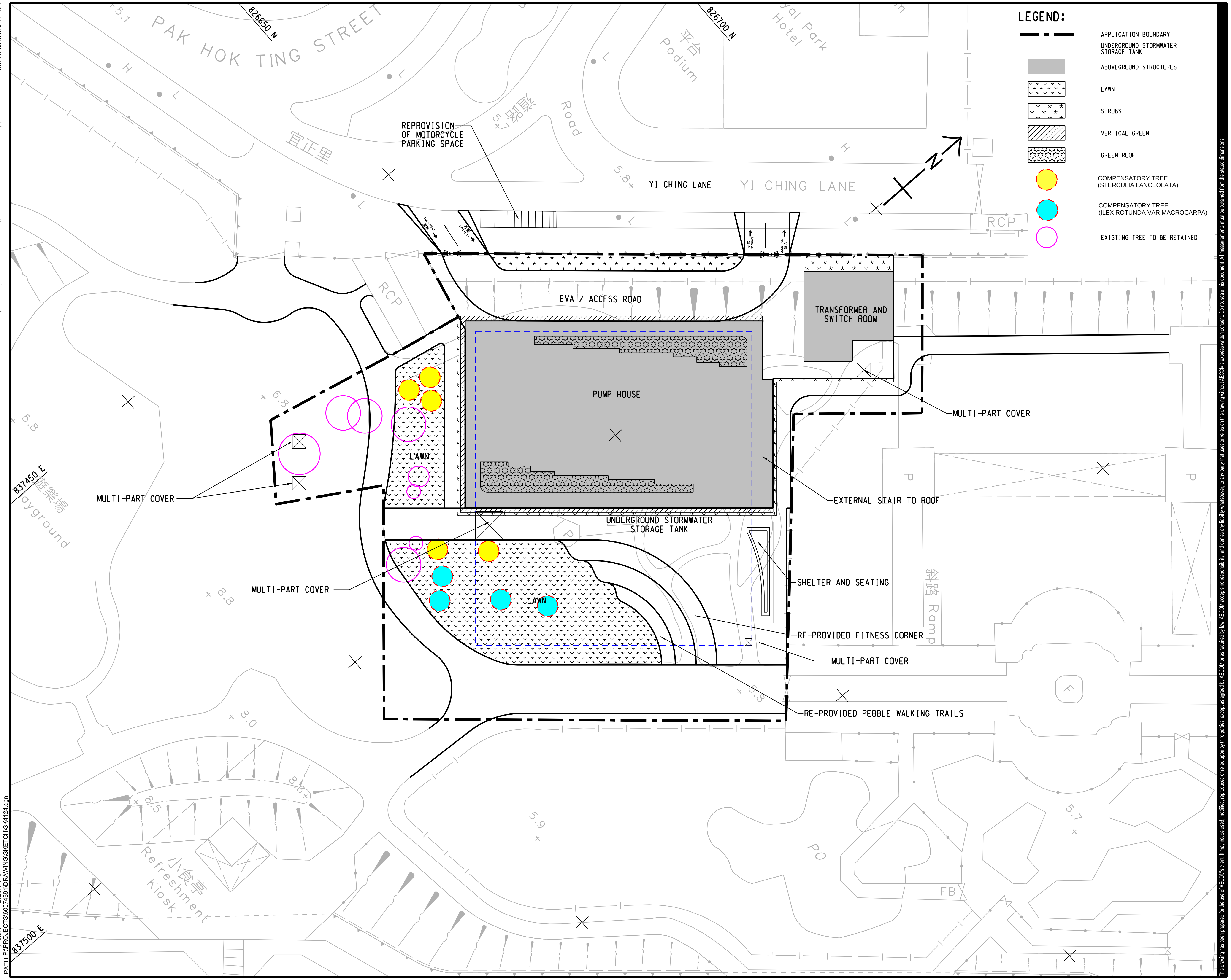
Appendix F – Landscape Layout Plan



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SCALE: A1 1 : 250
DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60674881
CONTRACT NO.: CE 44/2021 (DS)

SHEET TITLE: LANDSCAPE PLAN

SHEET NUMBER: 60674881/SK4124

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Approved:
Checked:
Designer:
Project Management Initials:
Plot File by: JiaW 2023/11/15
PATH: P:\PROJECTS\60674881\DRAWING\SKETCH\SK4124.dgn

Proposed Feature Trees

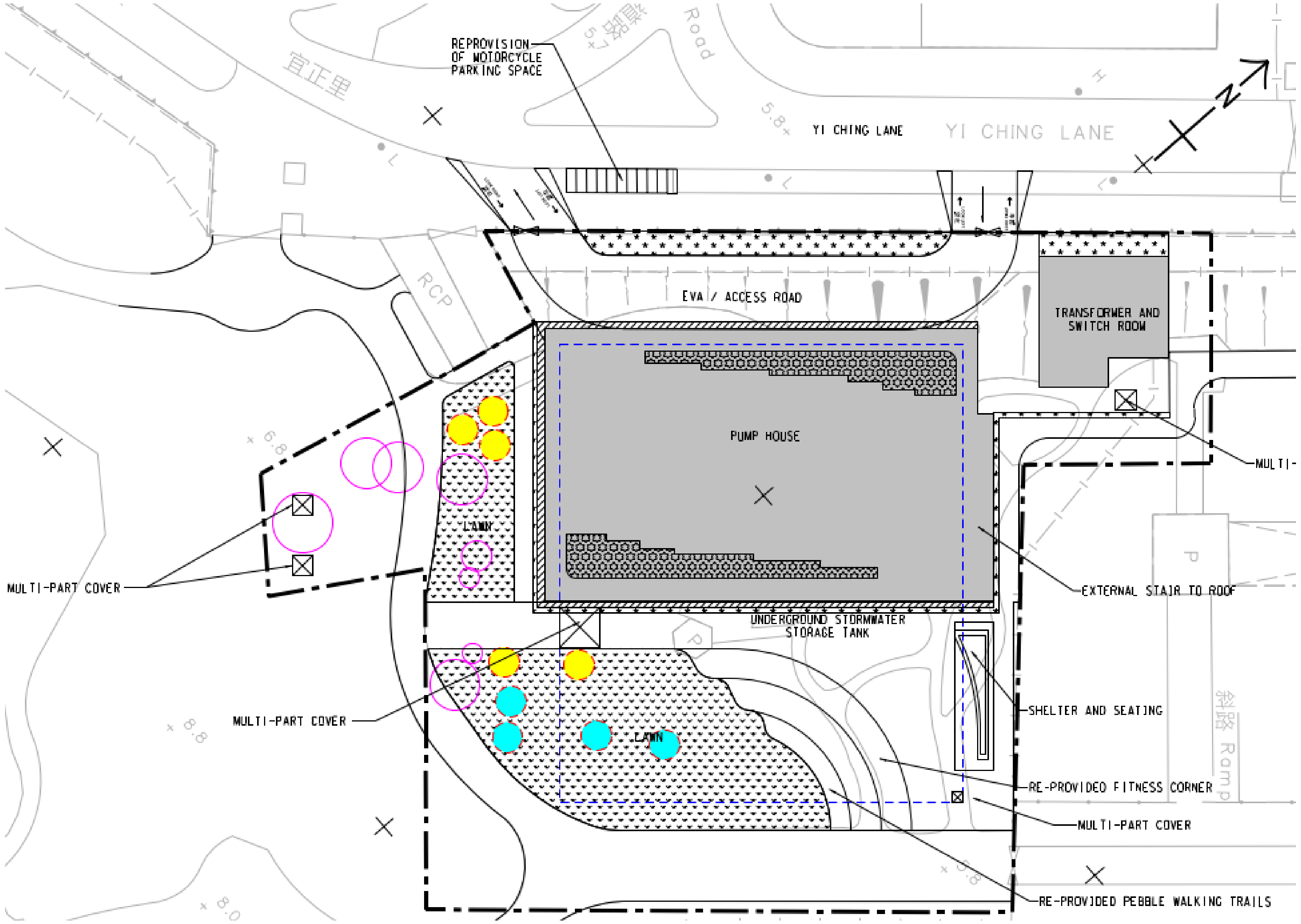
Subtle colour for a relaxing atmosphere. Refreshing. Cool. Calm.

Proposed Feature Trees

FEATURE TREES

Sterculia lanceolata
假蘋婆

Ilex rotunda Thunb. var. Microcarpa
小果鐵冬青



Tree Planting Schedule

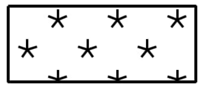
Botanical Name	Chinese Name	Size (mm)	Spacing (mm)
Feature Trees			
Sterculia lanceolata [1][2]	假蘋婆	Heavy Standard	5000
Ilex rotunda Thunb. var. Microcarpa [1][2]	小果鐵冬青	Heavy Standard	6000

Note:
* The proposed planting species is subject to change and to be agreed with maintenance authorities.
[1] Native species
[2] Recommended species in the Greening Master Plan of Shatin

Proposed Shrubs

Subtle colour for a relaxing atmosphere. Refreshing. Cool. Calm.

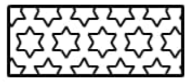
Shrubs



Gardenia jasminoides
梔子

Liriope spicata
山麥冬

Green Roof

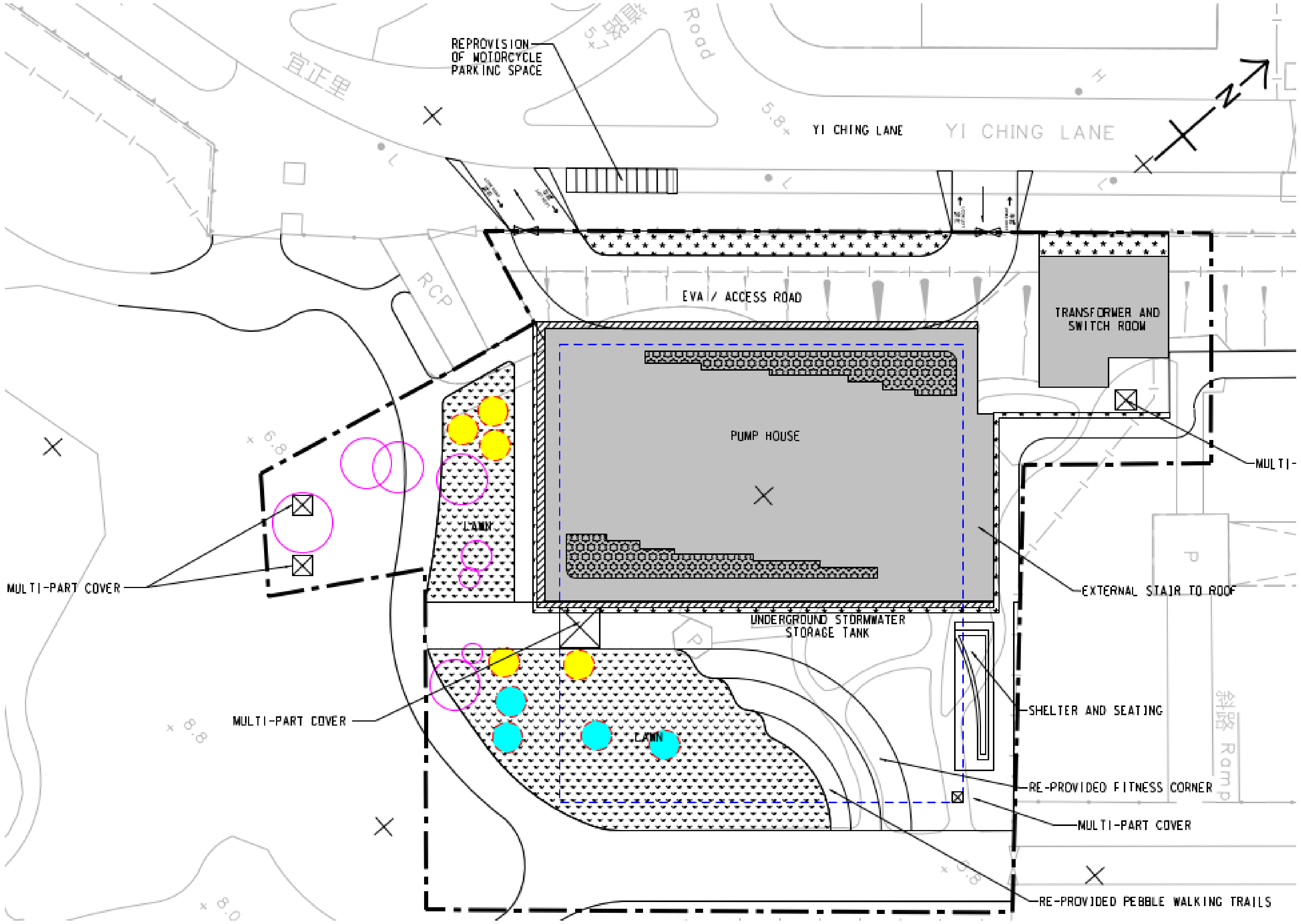


Dietes bicolor
非洲鳶尾

Loropetalum chinense
紅花檵木

Rhododendron mucronatum
錦繡杜鵑

Nephrolepis auriculata
腎蕨



Planting Schedule

Botanical Name	Chinese Name	Size (mm)	Spacing (mm)
Shrubs			
Gardenia jasminoides [1][2]	梔子	600 x 400	500
Liriope spicata [1][2]	山麥冬	150 x 200	150
Green Roof			
Dietes bicolor	非洲鳶尾	500 x 300	300
Loropetalum chinense var 'rubrum'	紅花繼木	600 x 400	500
Rhododendron pulchrum phoeniceum	錦繡杜鵑	500 x 300	400
Nephrolepis auriculata	腎蕨	300 x 300	400

Note:
* The proposed planting species is subject to change and to be agreed with maintenance authorities.
[1] Native species
[2] Recommended species in the Greening Master Plan of Shatin

Proposed hanging plants

Subtle colour for a relaxing atmosphere. Refreshing. Cool. Calm.

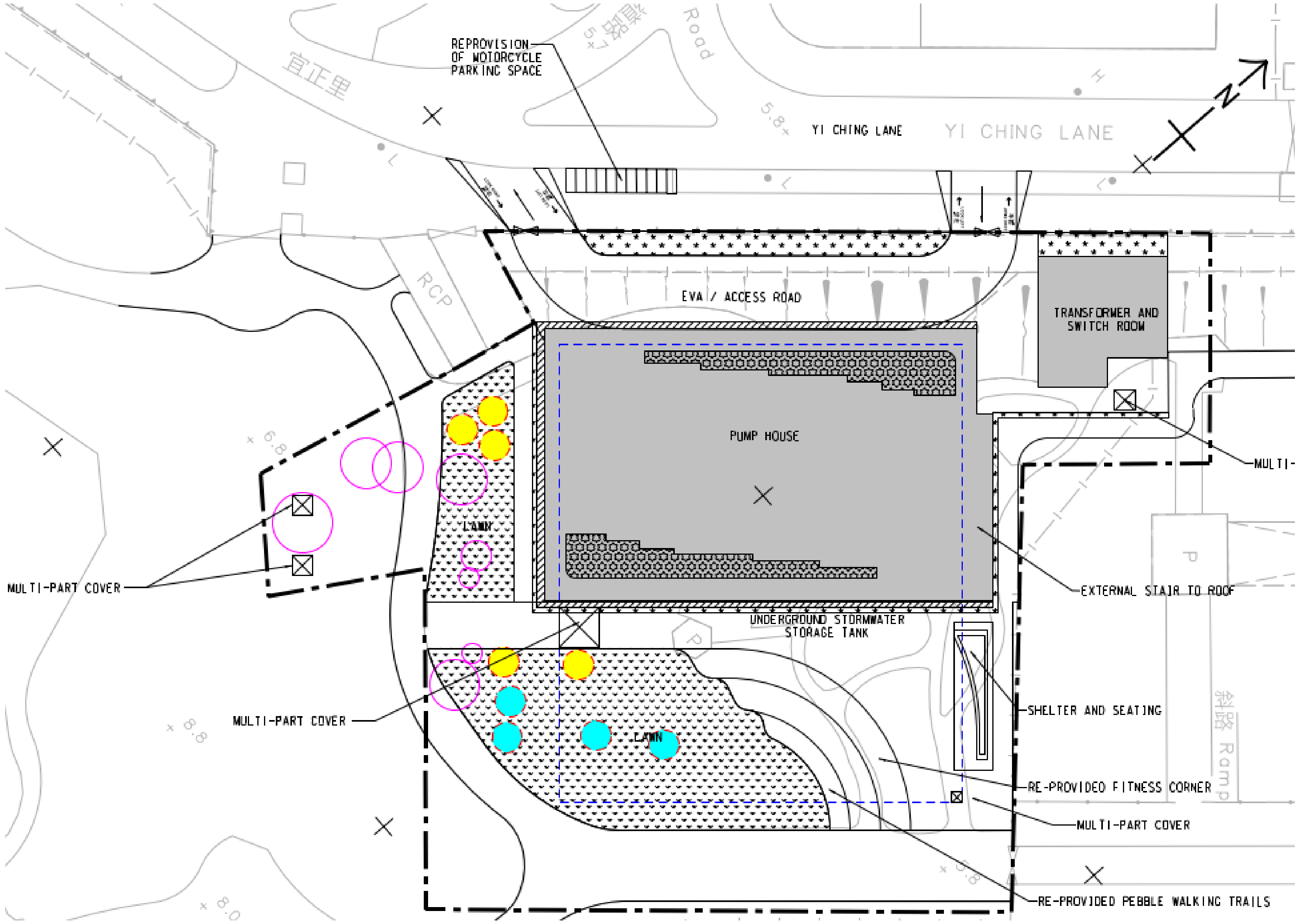
Vertical Green - Hanging plants

Bauhinia glauca
粉葉羊蹄甲

Bougainvillea spectabilis
簕杜鵑

Lawn

Zoysia matrella var pacifica
馬尼拉芝草



Schedule

Botanical Name	Chinese Name	Size (mm)	Spacing (mm)
Lawn/ Turf			
Zoysia matrella var pacifica	馬尼拉芝草	50 x 300x 300	-
Hanging plants			
Bauhinia glauca [1]	粉葉羊蹄甲	1000 x 400	500
Bougainvillea spectabilis	簕杜鵑	1000 x 400	500

Note:
* The proposed planting species is subject to change and to be agreed with maintenance authorities.
[1] Native species
[2] Recommended species in the Greening Master Plan of Shatin

Appendix G – Photomontages

View from Yi Ching Lane

View from Park (1)

View from Park (2)

View from Park (3)

Appendix H – Preliminary Environmental Review Report

渠務署
Drainage Services Department

Agreement No. CE 44/2021(DS)

Drainage Improvement Works in Sha Tin and Sai Kung – Design & Construction

Updated Preliminary Environmental Review Report

April 2022

AECOM Delivering a better world

TABLE OF CONTENTS

LIST OF TABLES

LIST Of FIGURES

LIST OF APPENDICES

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1 INTRODUCTION

1.1 Background

1.1.1.1 The Review of Drainage Master Plan in Sha Tin and Sai Kung – Feasibility Study (DMP Review) identified that the following areas in Sha Tin would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics:

(a) Sha Tin Town Centre;

(b) Chui Tin Street (near Sun Chui Estate) and San Tin Village;

(c) Tai Po Road (Ma Liu Shui), Ma Ling Path, Kau To Hang near Yucca Villa, Hang Hong Street, Pok Hong Estate, Fui Yiu Ha, Wong Chuk Yeung Village and Lai Wo Lane; and

(d) cycle track alongside Shing Mun River.

1.1.1.2 The flooding incidents reported in Wong Chuk Yeung Village on 22 July 2010 and Sha Tin Centre Street on 15 August 2015 are examples to substantiate the above findings.

1.1.1.3 The Study also identified that the areas in Sai Kung including Wong Chuk Wan, Ho Chung, Kap Pin Long New Village and Nam Shan San Tsuen would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics. The flooding incidents at Po Lo Che Road and Nam Shan San Tsuen on 30 May 2010 and Wong Chuk Wan on 7 October 2015 are some examples to substantiate the above findings.

1.1.1.4 To relieve the flood risk in the above areas, the Study has proposed implementing drainage improvement measures, mainly in form of stormwater pumping scheme and drainage upgrading works. Upon completion of the Project, the standards of flood protection at areas concerned will be largely enhanced to that specified in the standards of the Stormwater Drainage Manual (SDM) and the flood risks thereon can be significantly reduced.

1.1.1.5 New Flood walls will also be provided along various sections of Shing Mun River to protect the cycle track against flooding sue to astronomical high tide.

1.1.1.6 Without the proposed project, about 26 hectares of the areas in Sha Tin and 6 hectares of areas in Sai Kung will be subject to high flood risk. Flooding impacts on traffic and residential area in the flood prone areas will also result in losses and inconvenience to the general public.

1.1.1.7 AECOM Asia Company Limited was appointed by DSD on 20 December 2021 to undertake the "*Drainage Improvement Works in Sha Tin and Sai Kung – Design and Construction*" (hereinafter refer to the Project), of which the starting date of the Project is 29 December 2021. The Project comprises the drainage improvement works at 14 locations in Sha Tin and Sai Kung recommended under the Investigation Study as shown in **Appendix 1.1** and described in **Section 2.1**.

1.2 Purpose and Scope of the Updated Preliminary Environmental Review

1.2.1.1 The purpose of this updated PER is to reviews the findings, conclusions, and recommendations of related environmental studies/review carried out by previous consultants, DSD, EPD, HyD, CEDD and other Government departments, making particular reference to the PER Report prepared under the Investigation Study of this Project and the PER Brief.

1.2.1.2 Furthermore, the report would provide information on the nature and extent of environmental issues arising from the construction and operation of the Project and related activities that take place concurrently. This information will contribute to the decisions to be made by the Director of Environmental Protection on:

(i) the overall acceptability of any adverse environmental consequences that is likely to arise as a result of the Project;

(ii) the conditions and requirements for the detailed design, construction and operation of the Project to mitigate against adverse environmental consequences wherever practicable; and

(iii) the acceptability of residual impacts after the proposed mitigation measures is implemented.

1.2.1.3 Pursuant to Clause 3.2 of the PER Brief, the PER shall address the likely key issues described below:

(i) air quality impacts arising from construction and operation of the Project including odour impacts to the nearby sensitive receivers;

(ii) noise impacts arising from construction and operation of the Project to the nearby sensitive receivers;

(iii) water quality impacts arising from the construction and operation of the Project;

(iv) waste management implications during construction and operation of the Project;

(v) ecological impacts (both aquatic and terrestrial) arising from the construction and operation of the Project;

(vi) heritage impacts arising from the construction and operation of the Project;

(vii) landscape impacts arising from construction and operation of the Project to the nearby sensitive receivers; and

(viii) land contamination implications during construction and operation of the Project.

1.2.1.4 This Updated Preliminary Environmental Review (PER) Report covers only assessment on the proposed drainage improvement works that are not classified as Designated Projects (DPs) under the *Environmental Impact Assessment Ordinance* (*EIAO)* as reviewed in **Section 2.3**. For all DPs identified under the Study, project profiles will be prepared for application for permission to apply directly for an Environmental Permit or for application of an Environmental Impact Assessment (EIA) study brief in accordance with the *Technical Memorandum on Environmental Impact Assessment Process* (*EIAO-TM*).

1.3 Structure of this Report

1.3.1.1 The background of the Project and objective of the Report are introduced in **Section 1**. An overall description of the Project is provided in **Section 2**. The remainder of the Report is organised as follows:

- Section 3 – Air quality impact
- Section 4 – Noise impact
- Section 5 – Water quality impact
- Section 6 – Waste management implications
- Section 7 – Ecological Impact
- Section 8 – Fisheries impact
- Section 9 – Cultural heritage impact

- Section 10 – Landscape impact
- Section 11 – Land Contamination Implications
- Section 12 – Environmental monitoring and audit requirements
- Section 13 – Conclusions

2 PROJECT DESCRIPTION

2.1 Location and Scope of the Project

2.1.1 Summary of Proposed Drainage Improvement Works

2.1.1.1 This Project comprises the drainage improvement works recommended under the DMP Review Study in Sha Tin Town Centre as illustrated in **Figures 2.0 and 2.5** and summarised in **Table 2.1**.

Table 2.1 Summary of Proposed Drainage Improvement Works of the Project

Project site	Proposed Drainage Improvement Works					Summary of Proposed Works
	Stormwater Drain	Stormwater Pumping Station & Underground Storage Tank	Flood Wall	Drainage Channel	Others	
Non-Designated Projects						
Sha Tin North Drainage Basin						
1. Sha Tin Town Centre (STN1)	✓	✓				• Upgrade 550m long stormwater drains (from 450mm to 1650mm dia.) • Construct new stormwater drains: 410m long of 1650mm dia. & 30m long of 600mm to 2200mm dia. • Construct a stormwater pumping station with a 8,000 m^3 underground storage tank

2.1.1.2 Details of the proposed drainage improvement works which are non-designated projects at STN1 are described below and provided in **Appendix 1.1**. The existing drainage conditions of these Project sites and flood protection level with the implementation of the proposed drainage improvement works are presented in **Appendix 2.2**.

2.1.2 Location and Description of Proposed Drainage Improvement Works

*Sha Tin Town Centre (Stormwater Pumping Scheme at Sha Tin Town Centre (STTC)) (STN1) (**Figure 2.5** refers)*

2.1.2.1 A new 1650mm dia. pipe is proposed to be constructed from the footpath between the rail line and Tai Po Road (Sha Tin) opposite to Hilton Plaza and continue along the footpath between Hilton Plaza and Scenery Court. The proposed pipe will follow the footpath along Sha Tin Centre Street and connect to the proposed pumping station.

2.1.2.2 The existing 1500mm dia. stormwater pipe in Tai Po Road (Sha Tin) near CityLink Plaza is proposed to be upgraded to 1650mm dia., and the existing 450mm dia. stormwater pipe outside Red Cross Sha Tin Centre is proposed be upgraded to 600mm dia. and a new 750mm dia. stormwater pipe outside Wai Wah Centre is proposed to be constructed.

2.1.2.3 The proposed pipeworks fall mostly within areas zoned as "Commercial / Residential" ("C/R") and partly within "Other Specified Uses" ("O/U") on the Draft Sha Tin Outline Zoning Plan (OZP) No. S/ST/35.

2.1.2.4 New pipes ranged from 600mm to 2200mm dia. in Yi Ching Lane is proposed to be constructed and connect to the proposed pumping station.

2.1.2.5 A new stormwater pumping station at the downstream of the existing drainage network in Sha Tin Park. Since the potential flood risk around Sha Tin Town Centre is caused by the backflow from Shing Mun River into the relatively low-lying areas.

2.1.2.6 A new 1500mm dia. stormwater pipe is proposed to be constructed at the downstream of proposed pumping station and outlet to Shing Mun River.

2.1.2.7 The proposed pumping station includes an underground tank, an above-ground pump house. The pumping station consists of a pump with the maximum pump rate of $4m^3/s$ and an underground tank with the wet volume of $8000m^3$. The runoff will be discharged into the pumping station via the new drainage network and then discharged into Shing Mun River by pump. The excessive water will be stored in the underground tank.

2.1.2.8 Electric penstock is proposed to be located at the upstream of the pumping station. During rainfall event and low tide level of Shing Mun River (i.e. lower than 3.85mPD at the outfall in Shing Mun River), penstock will be closed such that stormwater will be discharged to the downstream existing 1800mm dia. pipe and the new proposed 1500mm dia. pipe by gravity.

2.1.2.9 During rainfall event and high tide level of Shing Mun River (i.e. equal or higher than 3.85mPD at the outfall in Shing Mun River), penstock will be opened such that stomwater will be diverted to the underground tank and pumping station. Then the water is discharged to the downstream existing 1800mm dia. pipe and the new proposed 1500mm dia. pipe and into Shing Mun River by pump.

2.1.2.10 The proposed stormwater pumping station and associated pipeworks fall mostly within areas zoned as "O" and partly within "C/R" on the Draft Sha Tin OZP No. S/ST/35.

2.1.3 Outline of Process Involved

2.1.3.1 As summarise in **Table 2.1** and illustrated in **Figures 2.5**, the proposed drainage improvement works of the Project to be covered under this PER comprise:

i. Construction / upgrading of stormwater drains by both open-cut and trenchless methods at STN1;

ii. Construction of stormwater pumping station and underground storage tank, at STN1; and

2.1.3.2 The proposed stormwater drains would be constructed by both conventional open-cut method and trenchless method. Major construction works involved include earthworks, pipe laying, manhole construction, backfilling and reinstatement for the stormwater drain construction. As reviewed and confirmed to be practicable by the Engineer, the construction of open-cut construction of stormwater drains would be conducted in short sections of 20 m to 30 m depending on site constraints and each work section will be separated from each other by at least 100 m to reduce overlapping of construction activities or concurrent usage of several powered mechanical equipment (PMEs). In each work section, only one construction activity would take place at a time. The construction period at each section would be short-term and the dusty construction works would be in limited scale and localized. For the stormwater drains to be constructed with trenchless method, the road breaking and excavation works would be only be confined to the jacking and receiving pits.

2.1.3.3 The construction of flood wall would be constructed by in-situ concreting method. Major construction works involved include pavement breaking by handheld breakers, concreting of structure, backfilling and reinstatement. As reviewed and confirmed to be practicable by the Engineer, the construction of flood wall would be conducted by parts in short sections of 20 m to 30 m depending on site constraints and each concurrent work section will be separated from each other by at least 100 m to reduce overlapping of construction activities or concurrent usage of several PMEs. In each work section, only one construction activity would take place at a time. The construction period at each section would be short-term and the dusty construction works would be in limited scale and localized.

2.1.3.4 The construction of the proposed stormwater pumping station would mainly involve site clearance, excavation and lateral Support (ELS), steel fixing and concreting of structure, E&M installation & pipeworks, backfilling, surface reinstatement and landscape works.

2.1.3.5 Maintenance works such as desilting of the proposed stormwater drains and stormwater pumping station would tentatively be carried out on an annual basis during dry season months when the drains are in dry condition to avoid any potential water quality impacts.

2.2 Project Programme

2.2.1.1 The investigation stage of the Project is expected to be completed by September 2021, after which the detailed design stage will begin.

2.2.1.2 Construction of the Project is scheduled to commence in year 2023 for completion / commissioning in year 2031 tentatively. The proposed drainage improvement works are anticipated to be conducted in phases.

2.3 Designated Projects

2.3.1.1 According to Part I, Schedule 2 of the Environmental Impact Assessment Ordinance (EIAO), the proposed drainage improvement works may be classified as a “designated project” (DP) if any of the following criteria is met:-

- Item I.1: A drainage channel or river training and diversion works –
  a) with a channel width of more than 100 m; or
  b) which discharges or discharge into an area which is less than 300 m from the nearest boundary of an existing or planned---
     (i) site of special scientific interest;
     (ii) site of cultural heritage;
     (iii) marine park or marine reserve;
     (iv) fish culture zone;
     (v) wild animal protection area;
     (vi) coastal protection area; or
     (vii)conservation area.
- Item I.2: A flood storage pond more than 10 ha in size.
- Item Q.1: All projects including new access roads, railways, sewers, sewage treatment facilities, earthworks, dredging works and other building works partly or wholly in an existing or gazetted proposed country park or special area, a conservation area, an existing or gazetted proposed marine park or marine reserve, a site of cultural heritage, and a site of special scientific interest.

2.3.1.2 For existing exempted DP that was built before 1 April 1998 by virtue of Section 9(2)(g) of the EIAO, if the proposed upgrading / modification works would not constitute a material change, which under Section 9(4) of the EIAO is defined as a physical addition or alteration to a DP which results in an adverse environmental impact as defined in Section 6.1 of EIAO-TM, to the exempted DP, no EP is deemed necessary for its construction and operation.

2.3.1.3 A desktop review was conducted to investigate the DP status of the proposed works based on the latest design of the works a detailed in **Table 2.2**.

Table 2.2 DP Status of Proposed Drainage Improvement Works

Location	Drainage channel / river training and diversion works? (See Table 2.1 for summary or works)	Channel width of more than 100m?	Discharge to 300m boundary of any existing / planned sensitive areas(1) list in Item I.1(b) in Part 1 of Schedule 2 of EIAO	A flood storage pond more than 10 ha in size?	Drainage improvement works partly or wholly within sensitive areas(2) listed in Schedule 2 Part 1 Item Q.1 of the EIAO?	DP?
Non-Designated Projects						
Sha Tin North Drainage Basin						
1. Sha Tin Town Centre (STN1)	No	No	--(3)	No	No	No

Notes:
(1) Sensitive areas listed in Schedule 2 Part 1 Item I.1 of the EIAO include site of special scientific interest; site of cultural heritage; marine park or marine reserve; fish culture zone; wild animal protection area; coastal protection area; or conservation area.
(2) Sensitive areas listed in Schedule 2 Part 1 Item Q.1 of the EIAO include existing or gazetted proposed country park or special area, a conservation area, existing or gazetted proposed marine park or marine reserve, a site of cultural heritage, and a site of special scientific interest.
(3) Not applicable as the works are not considered as drainage channel / river training and diversion works.
Not applicable as the works do not include provision of underground stormwater storage tank.

2.3.1.4 This PER Report covers only assessment on the below proposed drainage improvement works that are non-Designated Projects (hereinafter refer to as “the Project”), namely:

1. Sha Tin Town Centre (STN1)

2.4 Interaction with Concurrent Projects

2.4.1.1 Other existing, committed or planned projects within 500 m from the Project sites that are likely to interface or overlap with the construction and operation of the Project have been identified and are presented in **Table 2.3** and illustrated in **Figure 2.10.**

Table 2.3 Potential Concurrent Projects

Interfacing Project	Tentative Construction Period	Interfacing Location	Potential Cumulative Impacts
Widening of Tai Po Road (Sha Tin Section)	2018 - 2023	Sha Tin Town Centre	Cumulative impacts from construction of this project are not expected as there is no overlapping of its construction works. No cumulative impacts from operation of the improved amenities are excepted.
Revised Trunk Road T4 and Associated Improvement Works in Sha Tin	2023 - 2028	Sha Tin Town Centre	Given the small scale of the proposed drainage improvement works, any cumulative construction impacts of are expected to be localised or the overlapping period of the projects would be very short.

3 AIR QUALITY

3.1 Introduction

3.1.1.1 This section presents an assessment for the potential air quality impacts associated with the construction and operation of the proposed drainage improvement works of the Project.

3.2 Environmental Legislation, Standards and Guidelines

3.2.1.1 The relevant legislations, standards and guidelines applicable to the present study for the assessment of air quality impacts include:

- *Air Pollution Control Ordinance (APCO) (Cap. 311)* - this provides the power for controlling air pollutants from a variety of stationary and mobile sources and encompasses a number of Air Quality Objectives (AQOs);
- Air Pollution Control (Construction Dust) Regulation;
- Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation;
- Air Pollution Control (Fuel Restriction) Regulation; and
- Section 3 of Chapter 9: Environment in *Hong Kong Planning Standards and Guidelines* (HKPSG).

3.2.1.2 The APCO provides the statutory authority for controlling air pollutants from a variety of sources. The Ordinance includes a number of Air Quality Objectives (AQOs) which stipulate maximum concentrations for a range of pollutants, of which respirable suspended particulates (PM10 / RSP) and fine suspended particulates (PM2.5 / FSP) are relevant to this study. The relevant AQOs are listed in **Table 3.1**.

Table 3.1 Hong Kong Air Quality Objectives

Pollutants	Averaging Time	Previous AQO [4]		New AQO [5]	
		Concentration Limit, µg/m^3 [3]	No. of Exceedances to be Allowed per Calendar Year	Concentration Limit, µg/m^3 [3]	No. of Exceedances to be Allowed per Calendar Year
Respirable Suspended Particulates (PM_{10} / RSP) [1]	24 hours	100	9	100	9
	1 year	50	N/A	50	N/A
Fine Suspended Particulates ($PM_{2.5}$ / FSP) [2]	24 hours	75	9	50	18
	1 year	35	N/A	25	N/A
Nitrogen Dioxide (NO_2)	1 hour	200	18	200	18
	1 year	40	N/A	40	N/A
Sulphur Dioxide (SO_2)	10 minutes	500	3	500	3
	24 hours	125	3	50	3

Notes:
[1] Respirable suspended particulates mean suspended particles in air with a nominal aerodynamic diameter of 10 µm or less.
[2] Fine suspended particulates mean suspended particles in air with a nominal aerodynamic diameter of 2.5 µm or less.
[3] Measured at 293K and 101.325kPa
[4] Previous AQOs was put in force since 1 January 2014.
[5] The new set of AQOs came into effect on 1 January 2022.

3.2.1.3 With reference to the *Air Pollution Control (Construction Dust) Regulation*, it specifies processes that require special dust control. The Contractors are required to inform the EPD and adopt proper dust suppression measures while carrying out "Notifiable Works" (which requires prior notification by the *Regulation*) and "Regulatory Works" to meet the requirements as defined under the *Regulation*.

3.2.1.4 The *Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation* comes into operation on 1 June 2015. Under the *Regulation*, non-road mobile machinery (NRMMs), except those exempted, are required to comply with the prescribed emission standards. From 1 September 2015, all regulated machines sold or leased for use in Hong Kong must be approved or exempted with a proper label in a prescribed format issued by EPD. Starting from 1 December 2015, only approved or exempted NRMMs with a proper label are allowed to be used in specified activities and locations including construction sites. The Contractor is required to ensure the adopted machines or non-road vehicle under the Project could meet the prescribed emission standards and requirement.

3.3 Baseline Conditions

3.3.1.1 The assessment areas of Project sites covered under this PER are scattered across Sha Tin Town Centre , and its surrounding environments are summarised in **Table 3.2.**

Table 3.2 Surrounding Environments of Proposed Drainage Improvement Works of the Project

Project site	Surrounding Environments	Major Emission Source
Sha Tin		
STN1 – Sha Tin Town Centre	• Surrounded by high-rise residentials dwellings and commercial developments at Shatin Town Centre	• Vehicular emission from traffic in Shatin Town centre, including the Shatin and Tai Wai sections of Tai Po Road

3.3.1.2 As summarised in **Table 3.2**, vehicular emissions are the existing dominant air pollutant sources in all assessment areas. The air pollutants associated with traffic emission of concern are nitrogen dioxide (NO_2), Respirable Suspended Particulates (RSP) and Fine Suspended Particulates (FSP).

3.3.1.3 There is no EPD baseline air quality monitoring station in Ma On Shan and Sai Kung. Sha Tin air quality monitoring station is the general air quality monitoring station of the Environmental Protection Department (EPD) situated closest to the Project sites in Shatin and Ma On Shan (MOS1), whereas Tseung Kwan O air quality monitoring station, which came into operation starting March 2016, is the general air quality monitoring station of the EPD situated closest to the Project site in Ho Chung (HC4). Air pollutants measured at EPD's air quality monitoring station for the recent years at Sha Tin (2016 – 2020) and Tseung Kwan O (2016 – 2020) are presented in **Table 3.3** and **Table 3.4** respectively. Concentrations of all concerned pollutants including SO_2, NO_2, RSP and FSP in the past five-year were complied with the respective previous AQOs.

Table 3.3 Annual Average Concentrations of Air Pollutants at EPD's Sha Tin Air Quality Monitoring Station (2016 – 2020)

Pollutant	Parameter	Concentrations (μg/m^3)					AQO (μg/m^3)	
		2016	2017	2018	2019	2020	Previous [1]	New [2]
SO_2	4th highest 10-minutes	67	53	76	27	31	500 (3)	
	4th highest 24-hour	16	16	16	12	13	125 (3)	50 (3)
NO_2	19th highest 1-hour	137	144	149	150	136	200 (18)	
	Annual	38	34	35	32	28	40	
RSP (PM_{10})	10th highest 24-hour	66	72	65	60	54	100 (9)	
	Annual	29	31	32	28	25	50	

<table>
<tr><th rowspan="2">Pollutant</th><th rowspan="2">Parameter</th><th colspan="5">Concentrations (μg/m^3)</th><th colspan="2">AQO (μg/m^3)</th></tr>
<tr><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>Previous [1]</th><th>New [2]</th></tr>
<tr><td rowspan="2">FSP ($PM_{2.5}$)</td><td>10th highest 24-hour</td><td>44</td><td>54</td><td>40</td><td>39</td><td>32</td><td>75 (9)</td><td>50 (35)</td></tr>
<tr><td>Annual</td><td>20</td><td>21</td><td>19</td><td>17</td><td>15</td><td>35</td><td>25</td></tr>
</table>

Notes:

[1] Previous AQOs, which was put in force since 1 January 2014, are referenced to evaluate past air quality conditions. Number of exceedance allowed under the AQO is shown in ( ).

[2] The new set of AQOs came into effect on 1 January 2022.

Table 3.4 Annual Average Concentrations of Air Pollutants at EPD's Tseung Kwan O Air Quality Monitoring Station (2016 – 2020)

<table>
<tr><th rowspan="2">Pollutant</th><th rowspan="2">Parameter</th><th colspan="5">Concentrations (μg/m3)</th><th colspan="2">AQO (μg/m^3)</th></tr>
<tr><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>Previous [1]</th><th>New [2]</th></tr>
<tr><td rowspan="2">SO_2</td><td>4th highest 10-minutes</td><td>40</td><td>39</td><td>38</td><td>25</td><td>18</td><td colspan="2">500 (3)</td></tr>
<tr><td>4th highest 24-hour</td><td>13</td><td>15</td><td>11</td><td>12</td><td>7</td><td>125 (3)</td><td>50 (3)</td></tr>
<tr><td rowspan="2">NO_2</td><td>19th highest 1-hour</td><td>127</td><td>165</td><td>135</td><td>155</td><td>136</td><td colspan="2">200 (18)</td></tr>
<tr><td>Annual</td><td>- [3]</td><td>28</td><td>28</td><td>29</td><td>23</td><td colspan="2">40</td></tr>
<tr><td rowspan="2">RSP (PM_{10})</td><td>10th highest 24-hour</td><td>59</td><td>65</td><td>53</td><td>60</td><td>52</td><td colspan="2">100 (9)</td></tr>
<tr><td>Annual</td><td>- [3]</td><td>65</td><td>65</td><td>29</td><td>24</td><td colspan="2">50</td></tr>
<tr><td rowspan="2">FSP ($PM_{2.5}$)</td><td>10th highest 24-hour</td><td>41</td><td>43</td><td>32</td><td>38</td><td>29</td><td>75 (9)</td><td>50 (35)</td></tr>
<tr><td>Annual</td><td>- [3]</td><td>31</td><td>28</td><td>17</td><td>12</td><td>35</td><td>25</td></tr>
</table>

Notes:

[1] Previous AQOs, which was put in force since 1 January 2014, are referenced to evaluate past air quality conditions. Number of exceedance allowed under the AQO is shown in ( ).

[2] The new set of AQOs came into effect on 1 January 2022.

[3] Tseung Kwan O Station was commissioned on 16 March 2016 and had insufficient data in 2016.

3.4 Representative Air Sensitive Receivers

3.4.1.1 Pursuant to Clause 3.5 of the PER Brief, the air quality assessment area is defined by a distance of 500 m from the boundary of the proposed works site. The representative air sensitive receivers (ASRs) in the vicinity of the drainage improvement works were identified in accordance with the *Hong Kong Planning Standards and Guidelines* (HKPSG).

3.4.1.2 Representative ASRs in the vicinity of the drainage improvement works are summarised in **Table 3.5** and the locations are illustrated in **Figure 3.0 and 3.5.**

Table 3.5 Representative Air Sensitive Receivers

ID	Description	Type	Approximate Horizontal Distance to Subject Site Boundary, m
Sha Tin			
STN1_A1	Sha Tin Park	Recreational	3
STN1_A2	Royal Park Hotel	Hotel	5
STN1_A3	Pittosporum Court	Residential	23
STN1_A4	Hong Kong Red Cross Bradbury Shatin Centre	Office	6
STN1_A5	Hilton Plaza Block B	Residential	4
STN1_A6	Hilton Plaza	Shopping Centre	4
STN1_A7	Cotton Tree Court	Residential	6
STN1_A8	New Town Plaza	Shopping Centre	10
STN1_A9	Wai Wah Centre Block 3	Residential	21
STN1_A10	Buddhist Poh Yea Home for the Aged	Home for the Aged	84
STN1_A11	392-395 Pai Tau	Residential	60

3.5 Assessment Methodology

3.5.1 Construction Phase

3.5.1.1 As summarise in **Table 2.1** and illustrated in **Figures 3.0 and 3.5**, the key construction activities of proposed drainage improvement works of the Project to be covered under this PER comprise:

i. Construction / upgrading of stormwater drains by both open-cut and trenchless methods, at STN1; and

ii. Construction of stormwater pumping station and underground storage tank, at STN1;

3.5.1.2 Considering the nature and small scale of the proposed drainage improvement works, dust emission would be minor and localized and could be well controlled through the dust suppression measures as stipulated in the *Air Pollution Control (Construction Dust) Regulation* (Cap. 311R) and good site practices. Therefore, no quantitative assessment was undertaken for the construction dust impacts.

3.5.2 Operational Phase

3.5.2.1 In view of the nature of the proposed drainage improvement works, the Project itself would not be an air pollutant emission source and thus air quality impact would not be expected during operational phase.

3.6 Identification and Evaluation of Potential Impacts

3.6.1 Construction Phase

3.6.1.1 During construction phase, fugitive dust emissions from construction activities would be the major source of air quality impact. The major dusty construction activities would include excavation, backfilling, material handling and wind erosion from the sites. The scale of the proposed works would be limited in scale as described below.

i. <u>Construction / upgrading of stormwater drains</u>

- The construction of the proposed stormwater drains at STN1 would be laid using either trenchless method or open cut method. For trenchless method, each pipe segment would be laid in sections up to 100 meters, with a smaller excavation extent as only jacking pits and receiving pits are required. For open cut method, the pipes would be constructed in short sections of up to 20 – 30 m each time. Each work front will be separated from each other by at least 50 m.

ii. <u>Construction of stormwater pumping station and underground storage tank</u>

- The proposed stormwater pumping stations at Sha Tin Town Centre (STN1) would be in small scale with limited site area (approximately 1.3ha).

3.6.1.2 Given the nature and limited scale of the proposed drainage improvement works, potential air quality impact dust emissions would be minor and localised. With appropriate dust suppression measures as stipulated in the *Air Pollution Control (Construction Dust) Regulation* and good site practices, adverse air quality impact due to the construction of the Project is not anticipated.

3.6.1.3 Likewise, fuel combustion from the use of PMEs during construction works could be a potential source of air pollutants such as NO_2, SO_2 and CO. To improve air quality and protect public health, EPD has introduced the *Air Pollution control (Non-*

road Mobile Machinery) (Emission) Regulation on 1 June 2015 and since 1 December 2015, only approved or exempted non-road mobile machinery are allowed to be used in construction sites. In addition, all construction plants are required to use ultra-low sulphur diesel (ULSD) (defined as diesel fuel containing not more than 0.005% sulphur by weight) as stipulated in Air Pollution Control (Fuel Restriction) Regulation. Furthermore, given the localized and small scale of the Project, as well as the small number of PMEs involved, adverse air quality impacts due to emissions from the use of PMEs would be unlikely.

3.6.1.4 In order to help reduce carbon emission and pollution, timely application of temporary electricity would be made and electric vehicles should be adopted as appropriate in accordance with *DEVB TC(W) No. 13/2020 "Timely Application of Temporary Electricity and Water Supply for Public Works Contracts and Wider Use of Electric Vehicles in Public Works Contracts"* in the Project.

3.6.2 Operational Phase

3.6.2.1 The Project itself does not constitute any elements that would be an air pollutant emission source. No air quality impact would be expected during operational phase. Nonetheless, typical good site practices as listed in **Section 3.7.2** should be followed during the annual cleaning / desilting works of the proposed stormdrains to minimise any potential environmental nuisance.

3.7 Mitigation Measures

3.7.1 Construction Phase

3.7.1.1 Sufficient dust suppression measures as stipulated under the *Air Pollution Control (Construction Dust) Regulation* (Cap. 311R) and good site practices such as enclosing stockpiles of sand with three-side enclosure, covering the dusty materials with clean impervious sheet, water spraying of all access roads and site areas, and good house-keeping of the site should be properly implemented in order to minimise the construction dust generated. These measures include the followings:

a) Use of regular watering, to reduce dust emissions from exposed site surfaces and unpaved roads particularly during dry weather;

b) Use of frequent watering in particularly dusty construction areas close to ASRs;

c) Side enclosure and covering of any aggregate or dusty material storage piles to reduce emissions. Where this is not practicable owing to frequent usage, watering should be applied to aggregate fines;

d) Open temporary stockpiles should be avoided or covered. Prevent placing dusty material storage plies near ASRs;

e) Tarpaulin covering of all dusty vehicle loads transported to, from and between site locations;

f) Establishment and use of vehicle wheel and body washing facilities at the exit point of the site;

g) Imposition of speed control for vehicles on unpaved site roads. 8 km/hr is the recommended limit;

h) Routing of vehicles and positioning of construction plant should be at the maximum possible distance from ASRs; and

i) where a site boundary adjoins a road, street, service lane or other area accessible to the public (except for road opening or resurfacing work, or for construction work carried out in a construction site that is completely paved or completely covered with hardcore), hoarding of not less than 2.4 m high from ground level should be provided along the entire length of that portion of the site boundary except for a site entrance or exit.

3.7.1.2 Guidelines stipulated in EPD's *Recommended Pollution Control Clauses for Construction Contracts* should be incorporated in the contract documents to abate dust impacts. The clauses include:

- The Contractor shall observe and comply with the APCO and its subsidiary regulations, particularly the Air Pollution Control (Construction Dust) Regulation.
- The Contractor shall undertake at all times to prevent dust nuisance as a result of the construction activities.
- The Contractor shall ensure that there will be adequate water supply / storage for dust suppression.
- The Contractor shall devise, arrange methods of working and carrying out the works in such a manner so as to minimise dust impacts on the surrounding environment, and shall provide experienced personnel with suitable training to ensure that these methods are implemented.
- Before the commencement of any work, the Contractor may require submitting the methods of working, plant, equipment and air pollution control system to be used on the site for the Engineer inspection and approval.

3.7.2 Operational Phase

3.7.2.1 Regular desilting of storm drains, stormwater tanks and pump chambers is necessary to maintain flow capacity. Typically, desilting is done via manual/robotic rodding/scooping in the tanks / pipes, which will be collected at a desilting opening using lifting equipment. Water jetting is also a common method to wash away the accumulated silts inside pipes and tanks. As most of the works are conducted underground, environmental nuisances in the operational phase is not anticipated.

3.8 Evaluation of Residual Impacts

3.8.1.1 With proper implementation of the proposed mitigation measures, no adverse air quality impacts would be anticipated from the construction of the Project.

3.9 Environmental Monitoring and Audit

3.9.1.1 Weekly site audit is recommended to be undertaken during the construction phase to ensure the proposed dust suppression measures are implemented in an appropriate manner and are effective.

3.9.1.2 No EM&A is considered necessary during operational phase.

3.10 Conclusion

3.10.1.1 With the implementation of regular site watering and good construction practices for dust minimization, construction dust impacts are not expected to be significant on the surrounding sensitive receivers. Requirements of *Air Pollution Control (Construction Dust) Regulation* and *EPD's Recommended Pollution Control Clauses for Construction Contracts* are proposed to be incorporated into the contract.

3.10.1.2 No air pollution source is identified from the operation of any elements of the Project itself that no air quality impacts would be anticipated.

4 NOISE IMPACT

4.1 Introduction

4.1.1.1 This section presents an assessment of noise impacts pertinent to the construction and operation of the proposed drainage improvement works under the Project. Appropriate noise mitigation measures were recommended where necessary in order to minimize the impacts to an acceptable level as far as practicable.

4.2 Environmental Legislation, Standards and Guidelines

4.2.1 General

4.2.1.1 Noise impacts were assessed in accordance with the criteria and methodology given in the Technical Memoranda issued under the *Noise Control Ordinance (NCO)*, Hong Kong Planning Standards and Guidelines (HKPSG) and the *Professional Persons Environmental Consultative Committee Practice Note 2/93 – Noise from Construction Activities - Non-statutory* (*ProPECC PN2/93*).

4.2.1.2 The *NCO* provides the statutory framework for noise control. This defines statutory limits applicable to equipment used during the construction and operation phases of the proposed works in the study area. The NCO invokes four Technical Memoranda, which define the technical means for noise assessment:

- Technical Memorandum on Noise from Places other than Domestic Premises, Public Places or Construction Sites (IND -TM);
- Technical Memorandum on Noise from Construction Work in Designated Areas (DA -TM);
- Technical Memorandum on Noise from Construction Work other than Percussive Piling (GW -TM); and
- Technical Memorandum on Noise from Percussive Piling (PP-TM).

4.2.2 Construction Phase

Construction Noise during Non-restricted Hours

4.2.2.1 The NCO provides the statutory framework for noise control of construction work, other than percussive piling, using powered mechanical equipment (PME) between the hours of 1900 and 0700 hours or at any time on Sundays and general holiday (that is, restricted hours). For non-DP, noise control on construction activities taking place at other times is subject to the criteria in ProPECC PN 2/93. In accordance with the *ProECC PN 2/93*, the noise limit is $L_{eq\ (30\ minutes)}$ 75 dB(A) at the façades of dwellings and 70 dB(A) at the façade of schools (65 dB(A) during examinations).

Construction Noise during Restricted Hours

4.2.2.2 Between 1900 and 0700 hours and all day on Sundays and public holidays, activities involving the use of PME for the purpose of carrying out construction work is prohibited unless a construction noise permit (CNP) has been obtained. In case of any construction activities required during restricted hours, it is the Contractor’s responsibility to ensure compliance with the Construction Noise Permit (CNP) and the relevant TMs. The Contractor will be required to submit CNP application to the Noise Control Authority and abide by any conditions stated in the CNP. The Noise Control Authority will consider CNP application for construction works within restricted hours as guided by the relevant TMs issued under the NCO.

4.2.3 Operational Phase Fixed Plant Noise

4.2.3.1 Fixed plant noise emitted from the operation of proposed stormwater pumping station at STN1 is controlled by the *NCO* and *IND-TM*. With regard to the assessment of the operational noise impacts, the NCO designates acceptable noise levels (ANL) for Noise Sensitive Receivers (NSRs) on the basis of an Area Sensitivity Rating (ASR), based on the characteristics of the area within which they are located as well as the degree to which the NSRs are affected by the influencing factors such as the presence of industrial area or major roads), if any, as shown in **Table 4.1**.

Table 4.1 Area Sensitivity Ratings

Type of Area Containing NSR	Degree to which NSR is affected by Influencing Factor		
	Not Affected	Indirectly Affected	Directly Affected
Rural Area	A	B	B
Urban Area	B	C	C
Low density residential area consisting of low-rise or isolated high-rise developments	A	B	C
Area other than those above	B	B	C

4.2.3.2 As stipulated in the HKPSG, the noise standard for planning purposes for fixed noise source are (a) 5 dB(A) below the appropriate ANL shown in Table 3 of the IND-TM, or (b) the prevailing background noise levels (for quiet areas with noise level being 5 dB(A) below the ANL). The ANLs for different Area Sensitivity Ratings during different periods are given in **Table 4.2**.

Table 4.2 Fixed Plant Noise Criteria

Time Period	Fixed Plant Noise for Different Area Sensitivity Rating [$L_{eq\ 30\ min}$, dB(A)]					
	ANL, dB(A)			ANL-5, dB(A) for Fixed Plant Noise Criteria		
	ASR A	ASR B	ASR C	ASR A	ASR B	ASR C
Day (0700 to 1900 hours) Evening (1900 to 2300 hours)	60	65	70	55	60	65
Night (2300 to 0700 hours)	50	55	60	45	50	55

4.2.3.3 The proposed stormwater pumping station at STN1 is located in Shatin Park and surrounded by surrounded by high-rise residential and commercial developments at Shatin Town Centre that the area within 300 m from the Project site belongs to "urban area" (**Figure 4.5** refers). The major Tai Po Road – Sha Tin, which is considered an IF due to its annual average daily traffic (AADT) flows of over 30,000, is within 300 m from the Project site. However, the representative NSR nearby Shatin Park and facing Shing Mun River, i.e. STN1_N1, is unlikely to be affected by the IF due to the screening effects from other high-rise buildings, no line-of-sight and separation distance. As such, an ASR of "B" is adopted for the representative NSR nearby Shatin Park and facing Shing Mun River, i.e. STN1_N1.

4.2.3.4 In this regard, a noise survey in the vicinity of the representative NSRs of the proposed stormwater pumping station at STN1 were conducted in Dec 2020 to determine the background noise levels. The survey results were compared with the ANL-5 dB(A) criteria to determine the noise criteria to be adopted in this assessment. Locations of noise measurement points and measured background noise levels were shown in **Appendix 4.1**. The assessment criteria for the proposed fixed noise sources of the Project are also presented in **Appendix 4.1**.

4.3 Description of the Environment

4.3.1.1 The assessment areas of Project sites covered under this PER are located at Sha Tin Town Centre. Their surrounding environments and dominant noise sources are summarised in **Table 4.3.**

Table 4.3 Surrounding Environments of Proposed Drainage Improvement Works of the Project

Project site	Surrounding Environments	Dominant Noise Source
Sha Tin		
STN1 – Sha Tin Town Centre	• Surrounded by high-rise residentials dwellings and commercial developments at Shatin Town Centre	• A mix of traffic noise from Shatin Town centre, including the Shatin and Tai Wai sections of Tai Po Road, and rail noise from East Rail Line

4.4 Representative Noise Sensitive Receivers

4.4.1.1 Existing and planned / committed NSRs in the assessment area were identified based on observations from site visits and review of relevant land use plans including Outline Zoning Plans (OZP), information available in the Statutory Planning Portal of the Town Planning Board (TPB) and land status plans published by Lands Department. Representative NSRs during construction and operational phases were identified as shown in **Figures 4.0 and 4.5** and presented in **Table 4.4**

Table 4.4 Representative Noise Sensitive Receivers

ID	Description	Type	Approximate Horizontal Distance to Proposed Works, m			
			Stormdrain	Stormwater Pumping Station / Storage Tank	Flood Wall	Channel Deepening
Sha Tin						
STN1_N1	New Town Plaza Phase III (Block 2) Pittosporum Court	Residential	30	46	144	- [1]
STN1_N2	Hilton Plaza Block B	Residential	7	183	243	- [1]
STN1_N3	New Town Plaza Phase III (Block 5) Cotton Tree Court	Residential	5	205	>300	- [1]
STN1_N4	Wai Wah Centre Block 3	Residential	25	238	>300	- [1]
STN1_N5	Wai Wah Centre Block 4	Residential	35	>300	>300	- [1]
STN1_N6	Buddhist Poh Yea Home for the Aged	Home for the Aged	85	>300	>300	- [1]
STN1_N7	Hing Yuen Terrace	Residential	71	>300	>300	- [1]

Note:
[1] Such works is not proposed for the respective Project sites and the representative NSRs also fall outside such works proposed in other sites.

4.5 Assessment Methodology

4.5.1 Construction Phase

4.5.1.1 Construction noise impact was assessed with reference to the criteria as set out in *ProPECC PN2/93*. A construction plant inventory indicating the powered mechanical equipment (PME) used has been included in **Appendix 4.2**, and their corresponding sound power levels (SWLs) were taken from Table 3 of the GW-TM. Where no SWL is given in the *GW-TM*, reference is made to *British Standard 5228-1: 2009+A1:2014 Code of practice for noise and vibration control on construction and open sites,* EPD's Quality Powered Mechanical Equipment (QPME) and other previous similar studies or from measurements taken at other sites in Hong Kong. For each construction activity, PME was grouped according to their likely concurrent usage. The plant inventory and percentage on-time utilisation of the PME for the assessment were reviewed and confirmed to be practicable by the Engineer and suitable for completing the proposed works within the proposed works programme.

4.5.1.2 The assessment was undertaken based on the assumptions that all items of construction equipment would be located at a notional noise source point for each construction activity and that all items of equipment would be operating simultaneously unless otherwise specified. The sound pressure level (SPL) of each construction task has been calculated, depending on the number of plant items involved and the distance from the NSR. A positive 3 dB façade correction has been added to the predicted noise levels to account for the façade effect at each assessment point. Notional sources that are at distances greater than 300 m from the NSRs have been excluded from the assessment.

4.5.2 Operational Phase

4.5.2.1 During operational phase, fixed plant noise from the operation of the proposed stormwater pumping stations at STN1 would be the major source of noise impacts. Since no engineering details or design information on the fixed plants for the proposed stormwater pumping stations are available at the time of the preparation of this PER, the maximum permissible noise emission levels (Max SWL) were determined for future detailed design of the fixed plant to ensure compliance with the relevant noise criteria. The following standard acoustic formula was used for calculating the Max SWL of the fixed plant.

Max SWL = SPL + DC - FC - TC

Where*:*

SPL Sound Pressure Level, in dB(A)
Max SWL Maximum Permissible SWL, in dB(A)
DC Distance Attenuation, in dB(A) (i.e. 20logD + 8 [where D is the distance in metres])
FC Façade Correction, in dB(A) (i.e. 3 dB(A))
TC Tonality Correction, in dB(A)

4.5.2.2 It is assumed that all the fixed plant within the same location would be operated simultaneously for the worst-case scenario. Screening correction offered by buildings or other structures such as office and residential buildings is taken into account in calculating the predicted noise levels. A positive 3 dB(A) is added to the predicted noise levels at the NSRs due to the façade effect.

4.5.2.3 With reference to the *IND-TM*, corrections of tonality could be 0, 3 or 6 dB(A). A 6 dB(A) tonality correction is considered in the assessment as a worst-case assumption.

4.6 Identification and Evaluation of Environmental Impacts

4.6.1 Construction Phase

4.6.1.1 Potential source of noise impact arising from the construction of the Project would be the use of PME for various construction activities. Major construction works involved are described below:

i. Construction / upgrading of stormwater drains, at STN1

- Earthworks (including road breaking, sheet piles driving, excavation etc.), pipe laying / jacking, manhole construction, backfilling and reinstatement
- The stormwater drains would be mainly constructed by conventional open-cut method. Some sections of the stormwater drains would be constructed with trenchless method as indicated in **Figures 4.5**. With the trenchless method in place, the road breaking and excavation works would be only be confined to the jacking pit, receiving pit and the new manholes.
- Given the small size of the cutter head involved and the soft geology along the pipeworks alignment which would provide significant damping of vibrations, the ground-borne noise generated from the use micro tunnel boring machine and pipe jacking machine for trenchless construction of pipeworks would be insignificant and unlikely to cause adverse impact on the nearby NSRs.

ii. Construction of stormwater pumping station and underground storage tank, at STN1

- site clearance, excavation and lateral Support (ELS), steel fixing and concreting of structure, E&M installation & pipeworks, backfilling, surface reinstatement and landscape works & roadworks

4.6.1.2 The predicted daytime construction noise levels at the representative NSRs under the unmitigated scenario are tabulated in **Table 4.5.** Details of the calculation are presented in **Appendix 4.3**. Based on the preliminary design information, no construction works would be carried out during restricted hours.

Table 4.5 Predicted Construction Noise Levels at Representative NSR under Unmitigated Scenario

ID	Description	Type	Criteria, dB(A)	Predicted Construction Noise Level, dB(A) [1] [2]			
				Stormdrain	Stormwater Pumping Station / Storage Tank	Flood Wall	Channel Deepening
Sha Tin							
STN1_N1	New Town Plaza Phase III (Block 2) Ivy Court	Residential	75	74 – **85**	67 – **77**	**63 – 65**	/
STN1_N2	Hilton Plaza Block B	Residential	75	63 – **91**	58 – 67	/	/
STN1_N3	New Town Plaza Phase III (Block 5) Cotton Tree Court	Residential	75	66 – **100**	57 – 67	/	/
STN1_N4	Wai Wah Centre Block 3	Residential	75	61 – **87**	56 – 66	/	/
STN1_N5	Wai Wah Centre Block 4	Residential	75	60 – **85**	55 – 64	/	/
STN1_N6	Buddhist Poh Yea Home for the Aged	Home for the Aged	75	58 – **77**	/	/	/
STN1_N7	Hing Yuen Terrace	Residential	75	58 – **79**	/	/	/

Notes:
"/" NSRs outside 300 m from notional source of the proposed works were not assessed.
[1] 70 dB(A) for general school day, 65 dB(A) during examination period.
[2] **Bolded** value indicates exceedance of noise criteria of 75 dB(A) for residential uses / Home for the Aged / Place of public worship, or 70 dB(A) for educational uses for general school day; <u>underlined</u> value indicates exceedance of noise criteria of 65 dB(A) during examination period for educational uses.

4.6.1.3 As shown in **Table 4.5,** the results of predicted noise levels at the representative NSRs due to the proposed drainage improvement works are summarised below:

i. Construction / upgrading of stormwater drains, at STN1

- the predicted noise levels at the representative NSRs would be in the range of 55 to 107 dB(A) in the absence of mitigation measures.
- The unmitigated construction noise levels from stormwater drain construction were predicted to exceed the relevant noise criteria at most of the representative NSRs. Noise mitigation measures are therefore required for stormwater drain construction to alleviate the construction noise impact.

ii. Construction of stormwater pumping station and underground storage tank, at STN1

- the predicted noise levels at the representative NSRs would be in the range of 55 to 77 dB(A) for the construction of stormwater pumping stations and / or underground stormwater storage tanks in the absence of mitigation measures.
- The unmitigated construction noise levels from stormwater drain construction were predicted to exceed the relevant noise criteria at most of the representative NSRs. Noise mitigation measures are therefore required for construction of stormwater pumping stations and / or underground stormwater storage tanks to alleviate the construction noise impact.

4.6.2 Operational Phase

4.6.2.1 It is assumed that the fixed plants at the proposed stormwater pumping station would be in operation / standby for 24 hours. Hence, evening and night-time operation of the fixed noise sources have also been assumed. The maximum allowable sound power levels of the fixed noise sources of the Project for daytime / evening time and night-time are 87 dB(A) and 81 dB(A) as detailed in **Appendix 4.4**. Given that the proposed fixed plants are properly designed to meet the maximum allowable sound power levels, no adverse fixed plant noise impact would be anticipated.

4.7 Mitigation Measures

4.7.1 Construction Phase

4.7.1.1 In view of the predicted noise exceedances during the construction of the Project, the following mitigation measures have been considered:

- Good site practice;
- Use of quiet PME;
- Adoption of movable noise barriers / enclosure / insulation fabric / silencer; and
- Proper Scheduling of Construction Activities & Planning of Workfronts.

Good Site Practice

4.7.1.2 Good site practices listed below shall be adopted to abate noise impacts during the construction phase and shall be included in the contract document:

- Only well-maintained plant shall be operated on-site and plant shall be serviced regularly during the construction programme;
- Silencers or mufflers on construction equipment shall be utilized and shall be properly maintained during the construction programme;
- Mobile plant, if any, shall be sited as far away from NSRs as possible;

- Machines and plant (such as trucks) that may be in intermittent use shall be shut down between work periods or shall be throttled down to a minimum;
- Plant known to emit noise strongly in one direction shall, wherever possible, be orientated so that the noise is directed away from the nearby NSRs; and
- Material stockpiles and other structures shall be effectively utilized, wherever practicable, in screening noise from on-site construction activities.

Use of Quiet Plants

4.7.1.3 To reduce construction noise impacts on the affected NSRs during construction, quieter plants which are defined as the PME with actual SWL being less than the value specified in the *GW-TM*, and in accordance with *EPD's Quality Powered Mechanical Equipment* (QPME) list, previously approved EIA study and manufacturer catalogue of the PME were recommended. The construction plant inventory under the mitigated scenario, which has been confirmed with engineer to be practical and suitable for the proposed works, is provided in **Appendix 4.5**.

Use of Movable Noise Barriers / Enclosure / Insulation Fabric / Silencer

4.7.1.4 Movable noise barriers that can be placed close to the construction equipment and moved along with the PME are effective for screening noise from NSRs. A typical design which has been used locally is a wooden framed barrier with a cantilevered upper portion of superficial density no less than 10 kg/m² on a skid footing with internal sound absorptive lining. This measure is particularly effective for low level zone of NSRs. A longer cantilevered top cover would be required to achieve screening benefits at upper floors of NSRs. The Contractor shall be responsible for the design and actual position of the movable noise barriers with due consideration given to the position and size of the PME, and the requirement of intercepting the line-of-sight from the NSRs to the PME, as well as ensuring that the barriers shall have no opening and gap. With reference to the GW-TM, it is anticipated that properly designed noise barriers would achieve a 5 dB(A) reduction for mobile PME and a 10 dB(A) reduction for static PME. A 15 dB(A) reduction could be achieved by the provision of noise enclosure / shelter. By lapping the pilling machine with noise insulating fabric with surface mass of not less than 7kg/m^2, a noise reduction of 10 dB(A) can be achieved. A 10 dB(A) noise reduction could also be achieved with the provision of silencer for ventilation fan with reference to EPD's "*Good Practices on Pumping System Noise Control*".

Proper Scheduling of Construction Activities & Planning of Workfronts

4.7.1.5 To minimise the construction noise impacts on schools situated in close proximity of the proposed works, some construction works should be properly scheduled to avoid the examination period of the nearby schools. For stormwater drain to be constructed by open-cut method, construction works at STN5 (Lai Wo Lane) should be scheduled outside examination period of Sha Tin Junior School (STN5_N3) while the works at MOS1 (Hang Hong Street and Hang Kwong Street) within 20 m from Tsang Pik Shan Secondary School (MOS1_N3) should be scheduled outside examination period. For stormwater drain to be constructed by trenchless method, the works at STS1 (Pok Hong Estate) within 30 m from Christ College should be scheduled outside the examination period. The Contractor should keep close communication with the operator of the schools to obtain the updated schedule of examination at the time conducting the relevant construction works.

4.7.1.6 To minimise the construction noise impacts on residential dwellings and schools in close proximity to the proposed stormdrain construction by open-cut method /

trenchless method, worksfront for loading and loading of materials should be carefully planned to maintain a buffer of least 10 m from nearby noise sensitive receivers.

4.7.1.7 The construction plant inventory under the mitigated scenario, which has been confirmed with engineer to be practical and suitable for the proposed works, is provided in **Appendix 4.5**.

Mitigated Construction Noise Levels

4.7.1.8 With the adoption of quieter PME and movable noise barriers / noise Insulation fabric / silencer as presented in **Appendix 4.5**, the predicted construction noise levels at all representative NSRs would comply with the relevant criteria. The predicted mitigated construction noise level at the representative NSR is listed in **Table 4.6.** The detailed calculation is presented in **Appendix 4.6**.

Table 4.6 Predicted Construction Noise Levels at Representative NSR under Mitigated Scenario

ID	Description	Type	Criteria, dB(A)	Predicted Construction Noise Level, dB(A) [1] [2]			
				Stormdrain	Stormwater Pumping Station / Storage Tank	Flood Wall	Channel Deepening
Sha Tin							
STN1_N1	New Town Plaza Phase III (Block 2) Ivy Court	Residential	75	54 – 65	67 – 74	44 – 52	/
STN1_N2	Hilton Plaza Block B	Residential	75	43 – 70	58 – 64	/	/
STN1_N3	New Town Plaza Phase III (Block 5) Cotton Tree Court	Residential	75	46 – 75	57 – 64	/	/
STN1_N4	Wai Wah Centre Block 3	Residential	75	40 – 67	56 – 62	/	/
STN1_N5	Wai Wah Centre Block 4	Residential	75	39 – 64	55 – 61	/	/
STN1_N6	Buddhist Poh Yea Home for the Aged	Home for the Aged	75	38 – 56	/	/	/
STN1_N7	Hing Yuen Terrace	Residential	75	38 – 58	/	/	/

Notes:
"/" NSRs outside 300m from notional source of the proposed works were not assessed.
[1] 70 dB(A) for general school day, 65 dB(A) during examination period.
[2] **Bolded** value indicates exceedance of noise criteria of 75 dB(A) of place of public worship.

4.7.2 Operational Phase

4.7.2.1 Provided that the fixed plants are properly designed to meet the maximum permissible SWL, no operational phase noise impacts would be anticipated. The maximum permissible SWL should be specified as design criteria of the proposed pumping station in the contract documents. The contractor should design and select equipment that could comply with the specified design criteria in the contract.

4.7.2.2 Furthermore, the below noise reduction measures in accordance with the design guidelines set out in "*Good Practices on Ventilation System Noise Control*" and "*Good Practices on Pumping System Noise Control*" by EPD should be considered as far as practicable during the detailed design and procurement stages:

- Choose quieter plant;
- Include noise levels specification when ordering new electro-mechanical equipment for the ventilation system;
- Locate fixed plant/louvres away from any NSRs as far as practicable;
- Locate fixed plant in walled plant rooms or in specially designed enclosures;
- Locate noisy machines in a basement or a completely separate building;
- Install direct noise mitigation measures including silencers, acoustic louvres and acoustic enclosure where necessary; and
- Develop and implement a regularly scheduled plant maintenance programme so that equipment is properly operated and serviced in order to maintain controlled level of noise. The programme should be implemented by properly trained personnel.

4.8 Evaluation of Residual Impacts

4.8.1 Construction Phase

4.8.1.1 With proper implementation of the proposed mitigation measures, no residual construction noise impacts would be anticipated at all NSRs.

4.8.1.2 Due to the short separation distance between the proposed works along footpath and the concerned NSR, construction noise exceedance of up to 1 dB(A) would be expected from the use of PME for erection of formwork and steel fixing for manhole construction during pipeworks construction by open-cut method. Given the small scale of the proposed works and the transient nature of the proposed works (in the order of a 3 – 4 days), the noise exceedance would be short-term and localized, no unacceptable residual noise impacts would be anticipated.

4.8.1.3 Provided that the fixed plants are properly designed to meet the maximum permissible SWL, no operational phase noise impacts would be anticipated.

4.9 Environmental Monitoring and Audit

4.9.1.1 With the implementation of the recommended mitigation measures, no unacceptable residual construction noise impact would be anticipated. No noise monitoring during construction phase is considered necessary. Weekly site audit shall be carried out to inspect the construction activities and works areas in order to ensure the recommended mitigation measures are being implemented and are effective.

4.9.1.2 Commissioning test should be conducted prior to operation of the pumping station to ensure that fixed plant noise would comply with the relevant noise standards.

4.10 Conclusion

4.10.1.1 During the construction phase, the unmitigated noise levels at the representative NSRs would experience noise level exceeding the relevant daytime construction noise criteria from the construction of storm drains using both open-cut and trenchless methods, the construction of stormwater storage tank. To alleviate the noise impact, noise mitigation measures including the adoption of good site practices, use of quiet plant and provision of movable noise barrier / noise insulating fabric / silencer were recommended. With implementation of the recommended mitigation measures, no exceedance of the noise criteria was predicted at all NSRs .

4.10.1.2 Provided that the fixed plants for the stormwater pumping station at STN1 are properly designed to meet the maximum permissible SWL, no operational phase noise impacts would be anticipated. Commissioning test should be conducted prior to operation of the pumping station to ensure that fixed plant noise would comply with the relevant noise standards.

5 WATER QUALITY IMPACT

5.1 Introduction

5.1.1.1 This section presents the findings and recommendations of the assessment for water quality impacts associated with the construction and operation of the proposed drainage improvement works.

5.2 Environmental Legislation, Standards and Guidelines

Water Quality Objectives under Water Pollution Control Ordinance (WPCO)

5.2.1.1 The Water Pollution Control Ordinance (WPCO) provides the major statutory framework for the protection and control of water quality in Hong Kong. According to the Ordinance and its subsidiary legislation, Hong Kong waters are divided into ten Water Control Zone (WCZs). Corresponding statements of Water Quality Objectives (WQOs) are stipulated for different water regimes (marine waters, inland waters, bathing beaches subzones, secondary contact recreation subzones and fish culture subzones) in the WCZs based on their beneficial uses. The Project site at Hiram's Highway near Marina Cove (HC4) covers the Port Shelter Water Control Zone (WCZ) and the other Projects sites cover the Tolo Harbour and Channel WCZ. Relevant WQOs for this Project for the watercourses in Tolo Harbour and Channel WCZ are listed in **Table 5.1** while those for Port Shelter WCZ are listed in **Table 5.2**.

Table 5.1 Summary of Water Quality Objectives for Watercourses in Tolo Harbour and Channel WCZ

<table>
<tr><th>Parameters</th><th>Criteria</th><th>Subzone</th></tr>
<tr><td rowspan="5">Aesthetic Appearance</td><td>Waste discharges shall not cause the water to contain substances that settle to form objectionable deposits;</td><td rowspan="5">Whole Zone</td></tr>
<tr><td>Waste discharges shall not cause the water to contain substances that float as debris, scum, oil or other matter to form nuisances;</td></tr>
<tr><td>Waste discharges shall not cause water to contain substances that produce objectionable colour, odours, taste or turbidity;</td></tr>
<tr><td>Waste discharges shall not cause water to contain substances that injure or are toxic or produce adverse physiological responses in humans, animals or plants; or</td></tr>
<tr><td>Waste discharges shall not cause water to contain substances that are conductive to undesirable aquatic life or a nuisance to aquatic life.</td></tr>
<tr><td rowspan="2">E. coli</td><td>Should not exceed 1000 per 100 mL, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.</td><td>Inland Waters in Shing Mun (A, C, D, E, H, I) subzones, Tai Po (B, C) subzones and other watercourses.</td></tr>
<tr><td>Should not exceed 0 per 100 mL, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.</td><td>Inland Waters in Shing Mun (B, F, G) subzones, Lam Tsuen (C, D) subzones and Tai Po subzone A.</td></tr>
<tr><td rowspan="2">Colour</td><td>Waste discharge shall not cause the colour of water to exceed 30 Hazen units.</td><td>Inland Waters in Shing Mun (B, F, G) subzones, Lam Tsuen (C, D) subzones and Tai Po subzone A.</td></tr>
<tr><td>Waste discharge shall not cause the colour of water to exceed 50 Hazen units.</td><td>Inland Waters in Shing Mun (A, C, D, E, H, I) subzones, Tai Po (B, C) subzones and other watercourses.</td></tr>
<tr><td>pH</td><td>To be in the range of 6.0 – 9.0</td><td>Inland Waters in Shing Mun (D, E, I) subzones and other watercourses.</td></tr>
</table>

Parameters	Criteria	Subzone
	To be in the range of 6.5 – 8.5	Inland Waters in Shing Mun (A, B, C, F, G, H) subzones, Lam Tsuen (C, D) subzones and Tai Po (A, B, C) subzones.
Temperature	Not to exceed ± 2 ℃ daily temperature range due to waste discharge	Whole Zone
Suspended solids (SS)	Waste discharges shall not cause the annual median of suspended solids to exceed 25 milligrams per litre.	Inland Waters in Shing Mun (D, E, I) subzones and other watercourses.
	Waste discharges shall not cause the annual median of suspended solids to exceed 20 milligrams per litre.	Inland Waters in Shing Mun (A, B, C, F, G, H) subzones, Lam Tsuen (C, D) subzones and Tai Po (A, B, C) subzones.
Dissolve Oxygen (DO) within 2 m of the seabed	Not less than 4 mg/L or 40% saturation at any time.	Whole Zone
5-day biochemical oxygen demand (BOD_5)	(a) Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 5 milligrams per litre.	Inland Waters in Shing Mun (A, C, D, E, H, I) subzones, Tai Po (B, C) subzones and other watercourses
	(b) Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 3 milligrams per litre.	Inland Waters in Shing Mun (B, F, G) subzones, Lam Tsuen (C, D) subzones and Tai Po subzone A.
Chemical oxygen demand (COD)	(a) Waste discharges shall not cause the chemical oxygen demand to exceed 15 milligrams per litre.	Inland Waters in Shing Mun (B, F, G) subzones, Lam Tsuen (C, D) subzones and Tai Po subzone A.
	(b) Waste discharges shall not cause the chemical oxygen demand to exceed 30 milligrams per litre.	Inland Waters in Shing Mun (A, C, D, E, H, I) subzones, Tai Po (B, C) subzones and other watercourses
Ammonia	The un-ionised ammoniacal nitrogen level should not be more than 0.5 milligram per litre at any time, calculated as the annual average (arithmetic mean).	All inland watercourses
Toxins	Waste discharges shall not cause the toxicants in water to attain such a level as to produce significant toxic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to toxicant interactions with each other.	Whole Zone

Source: Statement of Water Quality Objectives (Tolo Harbour and Channel Water Control Zone).

Technical Memorandum on Effluents Discharge Standards

5.2.1.2 Discharges of effluents are subject to control under the WPCO. The "*Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters*" (TM-DSS), issued under Section 21 of the WPCO, gives guidance on permissible effluent discharges based on the type of receiving waters (foul sewers, storm water drains, inland and coastal waters). The limits control the physical, chemical and microbial quality of effluent. Any sewage from the proposed construction and operational activities shall comply with the relevant standards as given in the *TM-DSS*.

Practice Notes

5.2.1.3 The Professional Persons Environmental Consultative Committee *Practice Note on Construction Site Drainage (ProPECC PN 1/94)* issued by EPD provides good practice guidelines for dealing with various types of discharge from a construction site. Practices outlined in the PN shall be followed as far as possible during construction to minimize the water quality impact due to construction site drainage.

Hong Kong Planning Standards and Guidelines

5.2.1.4 The Hong Kong Planning Standards and Guidelines (HKPSG), Chapter 9 (Environment), provides additional guidelines against water pollution for sensitive uses such as aquaculture and fisheries zones, bathing waters and other contact recreational waters.

Technical Circular on Protection of Streams/ Rivers

5.2.1.5 The Environment, Transport and Works Bureau Technical Circular (Works) No. 5/2005 on *Protection of Natural Streams / Rivers from Adverse Impacts Arising from Construction Works* [*ETWB TC (Works)* No. *5/2005*] issued by the Development Bureau provides an administrative framework to better protect all-natural streams/rivers from the impacts of construction works. The procedures promulgated under this Circular aim to clarify and strengthen existing measures for protection of natural streams/rivers from government projects and private developments. The guidelines and precautionary mitigation measures given in the *ETWB TC (Works)* No. *5/2005* should be followed as far as possible to protect the inland watercourses at or near the Project area during the construction phase.

5.3 Baseline Conditions

5.3.1.1 The assessment areas of Project sites covered under this PER are located in Sha Tin Town Centre as illustrated in **Figure 5.1** and receiving / surrounding inland and marine water environment and the associated water quality stations maintained by EPD that are relevant of the Project sites are described in **Table 5.3.**

Table 5.3 Inland and Marine Water Environment of the Project Sites

Project site	Inland Water	Marine Water
Sha Tin		
STN1 – Sha Tin Town Centre	Shing Mun River • The Project sites within Sha Tin are situated within the catchments of	N/A

Project site	Inland Water	Marine Water
	main channel of Shing Mun River and its tributary of Fo Tan Nullah.	

Marine Water

5.3.1.2 The EPD monitoring data collected in 2019 for Harbour Subzone (Station TM2) is summarised in

5.3.1.3 **Table 5.4**. The overall WQO compliance rate of the Tolo Harbour and Channel WCZ in 2020 was 93%. Tolo Harbour consistently complied with the bacteriological WQO for secondary contact recreational uses applicable to the entire marine waters of the WCZ. Tolo Channel, however, was subject to a natural hydrological phenomenon of water column stratification and associated lower bottom DO level due to restricted water exchange with the open waters.

Table 5.4 Summary Statistics of Marine Water Quality of Tolo Harbour and Channel WCZ Collected by EPD in 202

Parameter		Harbour Subzone
		TM2
Temperature (°C)		26.3 (20.6 - 29.8)
Salinity		29.9 (24.8 - 32.8)
Dissolved Oxygen (mg/L)	Depth Average	6.1 (5.1 - 7.9)
	Bottom	6.2 (4.5 - 8.3)
Dissolved Oxygen (% saturation)	Depth Average	89 (73 - 112)
	Bottom	90 (70 - 120)
pH		8.0 (7.7 - 8.3)
Secchi Disc Depth (m)		2.4 (1.6 - 3.4)
Turbidity (NTU)		3.1 (1.5 - 5.5)
Suspended Solids (mg/L)		8.1 (1.4 - 17.0)
5-day Biochemical Oxygen Deman (mg/L)		1.7 (0.8 - 2.6)
Ammonia Nitrogen (mg/L)		0.045 (0.022 - 0.076)
Unionised Ammonia (mg/L)		0.003 (<0.001 - 0.005)
Nitrite Nitrogen (mg/L)		0.004 (<0.002 - 0.010)
Nitrate Nitrogen (mg/L)		0.039 (<0.002 - 0.215)
Total Inorganic Nitrogen (mg/L)		0.09 (0.03 - 0.27)
Total Kjeldahl Nitrogen (mg/L)		0.50 (0.22 - 0.81)
Total Nitrogen (mg/L)		0.54 (0.29 - 0.82)
Orthophosphate Phosphorus (mg/L)		0.008 (0.002 - 0.026)
Total Phosphorus (mg/L)		0.04 (<0.02 - 0.06)
Silica (as SiO_2) (mg/L)		1.48 (0.50 – 4.15)
Chlorophyll-*a* (µg/L)		5.8 (1.4 – 9.2)
E.coli (cfu/100mL)		13 (<1 - 4500)
Faecal Coliforms (cfu/100mL)		76 (6 - 32000)

Notes:
1. Data source: EPD Marine Water Quality in Hong Kong in 2020
2. Except as specified, data presented are depth-averaged values calculated by taking the means of three depths: surface, mid-depth and bottom.
3. Data presented are annual arithmetic means of depth-averaged results except for *E.coli* and faecal coliforms that are annual geometric means.
4. Data in brackets indicate the ranges.

Inland Water

5.3.1.5 The Project sites at Sha Tin are situated within the catchment of Shing Mun River are located within the study area, the corresponding water quality monitoring results at stations, namely TR19I, TR17 and TR17L, are shown in **Table 5.6** below. Shing Mun River, a major river which has three main tributaries and runs through the densely populated Sha Tin urban area, showed marked improvement during the past three decades. The WQO compliance rate of Shing Mun River was 90% in 2020. Proposed works are located outside and downstream to the water gathering ground.

Table 5.6 Summary Statistics of River Water Quality of Shing Mun River and its Tributary in 2020

Parameters	Shing Mun Main Channel	Fo Tan Nullah	
	TR19I	TR17	TR17L
Dissolved Oxygen (DO) (mg/L)	6.7 (4.4 – 8.0)	8.2 (7.5 - 9.2)	6.3 (4.1 - 7.8)
pH	8.1 (7.6 - 8.9)	8.9 (8.6 - 9.5)	7.9 (7.8 - 9.5)
Suspended Solids (SS) (mg/L)	3.5 (1.4 - 16.0)	1.3 (0.6 - 4.0)	9.0 (2.5 - 20.0)
5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	3.1 (1.7 – 8.5)	0.6 (0.2 - 1.6)	1.9 (0.9 - 2.1)
Chemical Oxygen Demand (COD) (mg/L)	13 (8 - 24)	3 (<2 - 7)	12 (5 - 19)
Oil & Grease (mg/L)	<0.5 (<0.5 - <0.5)	<0.5 (<0.5 - <0.5)	<0.5 (<0.5 - <0.5)
E. coli (cfu/100mL)	140 (40 - 630)	190 (25 - 3 600)	1 600 (210 - 8 000)
Faecal Coliforms (cfu/100mL)	2 500 (810 - 56 000)	2 200 (350 - 16 000)	13 000 (2 500 - 170 000)
Ammonia Nitrogen (mg/L)	0.130 (0.058 - 0.230)	0.022 (0.008 - 0.039)	0.130 (0.070 - 0.280)
Nitrate Nitrogen (mg/L)	0.0130 (0.014 - 0.510)	0.240 (0.190 - 0.290)	0.330 (0.044 - 0.510)
Total Kjeldahl Nitrogen (mg/L)	0.58 (0.22 - 0.92)	<0.05 <0.05 - 0.44)	0.38 (0.20 - 0.58)
Orthophosphate Phosphorus (PO_4-P) (mg/L)	0.027 (0.014 - 0.047)	0.006 (<0.002 - 0.007)	0.020 (0.013 - 0.036)
Total Phosphorus (mg/L)	0.05 (0.04 - 0.40)	<0.02 (<0.02 - 0.06)	0.05 (0.04 - 0.07)
Sulphide (mg/L)	<0.02 (<0.02 - <0.02)	<0.02 (<0.02 - <0.02)	<0.02 (<0.02 - <0.02)
Aluminium (Al) (µg/L)	<50 (<50 - <50)	60 (<50 - 166)	<50 (<50 - 202)

Parameters	Shing Mun Main Channel	Fo Tan Nullah	
	TR19I	TR17	TR17L
Cadmium (Cd) (µg/L)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - <0.1)	<0.1 (<0.1 - 0.1)
Chromium (Cr) (µg/L)	2 (2 - 4)	<1 (<1 - <1)	2 (<1 - 2)
Copper (Cu) (µg/L)	5 (3 - 6)	<1 (<1 - 3)	4 (1 - 5)
Lead (Pb) (µg/L)	<1 (<1 - <1)	<1 (<1 - <1)	<1 (<1 - <1)
Zinc (Zn) (µg/L)	<10 (<10 - 16)	<10 (<10 - 15)	11 (<10 - 19)
Flow (m^3/s)	NM	0.030 (0.016 - 0.144)	NM

Notes:
1. Data source: EPD River Water Quality in Hong Kong in 2020
2. Data presented are in annual medians of monthly samples; except those for faecal coliforms and E. coli and which are in annual geometric means.
3. Figures in brackets are annual ranges.
4. "NM" indicates no measurement taken.
5. Values at or below laboratory reporting limits are presented as laboratory reporting limits (see Appendix B of the EPD River Water Quality in Hong Kong in 2020).
6. Equal values for annual medians (or geometric means) and ranges indicate that all data are the same as or below laboratory reporting limits."

5.4 Water Sensitive Receivers

5.4.1.1 Representative water sensitive receivers (WSRs) within 500 m from the boundary of the Project are listed below and their indicative locations are illustrated in **Figure 5.1**.

- Shing Mun River;
- Secondary contact recreation areas in Shing Mun River;
- Fo Tan Nullah;
- Water Gathering Grounds;

5.5 Assessment Methodology

5.5.1.1 The background information on the existing water systems were collected and reviewed. The WSRs that may be affected by the Project construction have been identified. Potential sources of water quality impact that may arise during the construction works were described. The identified sources of potential water quality impact on the WSRs were evaluated and their impact significance determined. Mitigation measures to reduce any identified adverse impacts to acceptable levels were recommended as necessary.

5.6 Identification and Evaluation of Potential Impacts

5.6.1 Construction Phase

5.6.1.1 The proposed drainage improvement works of the Project to be covered under this

PER comprise

i. Construction / upgrading of stormwater drains by both open-cut and trenchless methods, at STN1;
ii. Construction of stormwater pumping station and underground storage tank, at STN1;

5.6.1.2 Construction of the Project would only involve land-based construction works. No marine works would be required. Potential water quality impacts arising from the construction phase include:

- General construction activities;
- Construction site runoff;
- Construction works in close proximity of inland water or within watercourse;
- Accidental spillage of chemicals and potential contamination of surface water and groundwater; and
- Sewage effluent from construction workforce.

General Construction Activities

5.6.1.3 On-site construction activities may cause water pollution from the following:

- uncontrolled discharge of debris and rubbish such as packaging, construction materials and refuse; and
- spillages of liquids stored on-site, such as oil, diesel and solvents etc., are likely to result in water quality impacts if they enter the nearby watercourse.

5.6.1.4 Good construction and site management practices for handling and disposal of construction discharges as stated in **Section 5.7.1** should be followed to ensure that litter, fuels and solvents do not enter the nearby watercourse.

Construction Site Runoff

5.6.1.5 Potential pollution sources of site run-off may include:

- Run-off and erosion of exposed bare soil and earth, drainage channel, earth working area and stockpiles;
- Wash water from dust suppression sprays and wheel washing facilities; and
- Fuel, oil and lubricants from maintenance of construction vehicles and equipment.

5.6.1.6 During rainstorms, site run-off would wash away the soil particles on unpaved land and areas with the topsoil exposed. The run-off is generally characterized by high concentrations of suspended solids. Release of uncontrolled site run-off would increase the suspended solids levels and turbidity in the nearby water environment. Site run-off may also wash away contaminated soil particles and therefore cause water pollution.

5.6.1.7 The proposed drainage improvement works are all small in scale with limited works areas. With the implementation of proper site management measures as described in **Section 5.7.1**, the construction site runoff and drainage would be well controlled. No unacceptable impact on the water quality would be anticipated.

Construction Works in Close Proximity of Inland Water

5.6.1.8 Construction activities in close proximity of the inland watercourses (e.g. construction works in close proximity of inland water such as outlet construction at Shing Mun River at STN1 may pollute the inland water bodies due to the potential release of construction wastes. Construction wastes are generally characterised by high concentration of SS and elevated pH. With the implementation of adequate construction site drainage as specified in the *ProPECC PN 1/94 "Construction Site Drainage"*, the provision of mitigation measures as described in the *ETWB TC (Works)* No. *5/2005 "Protection of natural streams / rivers from adverse impacts arising from construction works"*, as well as deployment of silt curtains / cofferdam where necessary as a preventive measure for avoiding potential dispersion of pollutants to the channels, unacceptable water quality impacts would not be anticipated.

Accidental Spillage of Chemicals and Potential Contamination of Surface Water and Groundwater

5.6.1.9 The use of chemicals such as engine oil and lubricants, and their storage as waste materials has the potential to impact water quality if spillage occurs and enters adjacent water environment. Waste oil may infiltrate into the surface soil layer, or runoff into the nearby water environment, increasing hydrocarbon levels. Groundwater pollution may also arise from the improper use and storage of chemicals and petroleum products within the site area where groundwater infiltrates into the area. Infiltration of groundwater may occur at area where there are faults and / or fissures in the rock mass. The potential impacts could however be mitigated by practical mitigation measures and good site practices (as given in **Section 5.7.1**).

Sewage Effluent from Workforce

5.6.1.10 During the construction of the Project, the workforce on site will generate sewage effluents, which are characterised by high levels of BOD, ammonia and *E*. *coli* counts. Potential water quality impacts upon the local drainage and freshwater system may arise from these sewage effluents, if uncontrolled.

5.6.1.11 Temporary sewage can be adequately treated by interim sewage treatment facilities, such as portable chemical toilets. Provided that sewage is not discharged directly into storm drains or inland waters adjacent to the construction site, and temporary sanitary facilities are used and properly maintained, adverse water quality impact would not be anticipated.

5.6.2 Operational Phase

5.6.2.1 The proposed drainage improvement works aims to mitigate the existing flooding risk in Sha Tin and Sai Kung District and the proposed works has not expanded any of the existing drainage catchment. The operation of the proposed drainage improvement works does not constitute any elements that would be water pollution sources and would not generate any new pollution load to the catchment. Maintenance works such as desilting of the proposed stormwater drains and stormwater pumping station would tentatively be carried out on an annual basis during dry season months when the drains are in dry condition to avoid any potential water quality impacts. No adverse water quality impact would be expected during operational phase.

5.7 Mitigation Measures

5.7.1 Construction Phase

Construction Site Runoff and General Construction Activities

5.7.1.1 Debris and refuse generated on-site should be collected, handled and disposed of properly to avoid entering any nearby water bodies and public drainage system. Stockpiles of cement and other construction materials should be kept covered when not being used.

5.7.1.2 Oils and fuels should only be used and stored in designated areas, which have pollution prevention facilities. To prevent spillage of fuels and solvents to any nearby storm water drain or watercourse, all fuel tanks and storage areas should be provided with locks and be sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank. Rainwater in the bunds should be cleared after each rain event. Waste oils, fuels and solvents collected within the bund should be handled and treated as chemical waste as detailed in **Section 6**.

5.7.1.3 The site practices outlined in *ProPECC PN 1/94 "Construction Site Drainage"* should be followed as far as practicable during the drainage improvement works in order to minimise surface runoff and to control erosion, and also to retain and reduce any suspended solids prior to discharge. The following measures are recommended to protect water quality, and when properly implemented should be sufficient to adequately control site discharges so as to avoid water quality impact:

- Surface run-off from construction sites should be discharged into storm drains via adequately designed sand / silt removal facilities such as sand traps, silt traps and sedimentation basins. Channels or earth bunds or sand bag barriers should be provided on site to direct stormwater to silt removal facilities. Perimeter channels at site boundaries should be provided on site boundaries where necessary to intercept storm run-off from outside the site so that it will not wash across the site. Catchpits and perimeter channels should be constructed in advance of site formation works and earthworks.
- Silt removal facilities, channels and manholes should be maintained and the deposited silt and grit should be removed regularly (as well as at the onset of and after each rainstorm) to prevent overflows and localised flooding. Before disposal at the public fill reception facilities, the deposited silt and grit should be solicited in such a way that it can be contained and delivered by dump truck instead of tanker truck. Any practical options for the diversion and realignment of drainage should comply with both engineering and environmental requirements in order to provide adequate hydraulic capacity of all drains.
- Measures should be taken to minimise the ingress of rainwater into trenches. If excavation of trenches in the wet season is necessary, they should be dug and backfilled in short sections. Rainwater pumped out from trenches or foundation excavations should be discharged into storm drains via silt removal facilities.
- Construction works should be programmed to minimise soil excavation in the wet season (i.e. April to September). If surface excavation works cannot be avoided during the wet season, temporarily exposed slope / soil surfaces should be covered by a tarpaulin or other means, as far as practicable, and temporary access roads should be protected by crushed stone or gravel, as excavation proceeds. Interception channels should be provided (e.g. along the crest / edge of the excavation) to prevent storm runoff from washing across exposed soil surfaces. Arrangements should always be in place to ensure that adequate surface protection measures can be safely carried out well before the arrival of a rainstorm.
- Open stockpiles of construction materials (e.g. aggregates, sand and fill material) on-site should be covered with tarpaulin or similar fabric during rainstorms.
- Manholes (including newly constructed ones) shall always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris from getting into the drainage system, and to prevent storm run-off from getting into foul sewers. Discharge of surface run-off into foul sewers must

always be prevented in order not to unduly overload the foul sewerage system.

- Earthworks final surfaces should be well compacted and the subsequent permanent work or surface protection should be carried out immediately after the final surfaces are formed to prevent erosion caused by rainstorms. Appropriate drainage like intercepting channels should be provided where necessary.

Boring and Drilling Water

5.7.1.4 Water used in ground boring and drilling for site investigation or rock/soil anchoring shall as far as practicable be re-circulated after sedimentation. When there is a need for final disposal, the wastewater shall be discharged into storm drains via silt removal facilities.

Wheel Washing Water

5.7.1.5 All vehicles and plant shall be cleaned before they leave a construction site to minimize the deposition of earth, mud, debris on roads. A wheel washing bay shall be provided at every site exit if practicable and wash-water shall have sand and silt settled out or removed before discharging into storm drains. The section of construction road between the wheel washing bay and the public road shall be paved with backfall to reduce vehicle tracking of soil and to prevent site run-off from entering public road drains.

Construction Works in Close Proximity of Inland Water or within Watercourse

5.7.1.6 The practices outlined in *ETWB TC (Works)* No. *5/2005 "Protection of natural streams/rivers from adverse impacts arising from construction works"* should also be adopted where applicable to minimise the water quality impacts. Silt curtain / cofferdam should also be provided where necessary as preventive measure for avoiding potential dispersion of pollutants to the inland water (e.g. construction works in close proximity of inland water such as outlet construction at Shing Mun River at STN1 and near Ho Chung River at HC4, and works within Wong Chuk Yeung Channel at STN7). Relevant mitigation measures from the *ETWB TC (Works)* No. *5/2005* are listed below:

- Construction works close to the inland waters should be carried out in dry season as far as practicable where the flow in the surface channel or stream is low.
- The use of less or smaller construction plants may be specified in areas close to the water courses to reduce the disturbance to the surface water.
- Temporary storage of materials (e.g. equipment, chemicals and fuel) and temporary stockpile of construction materials should be located well away from any watercourses during carrying out of the construction works.
- Stockpiling of construction materials and dusty materials should be covered and located away from any watercourses.
- Construction debris and spoil should be covered up and / or disposed of as soon as possible to avoid being washed into the nearby water receivers.
- Proper shoring may need to be erected in order to prevent soil or mud from slipping into the watercourses.

Accidental Spillage and Potential Contamination of Surface Water and Groundwater

5.7.1.7 Contractor must register as a chemical waste producer if chemical wastes would be produced from the construction activities. The *Waste Disposal Ordinance (Cap 354)* (WDO) and its subsidiary regulations in particular the *Waste Disposal*

(Chemical Waste) (General) Regulation shall be observed and complied with for control of chemical wastes.

5.7.1.8 Any service shop and maintenance facilities shall be located on hard standings within a bunded area, and sumps and oil interceptors shall be provided. Maintenance of vehicles and equipment involving activities with potential leakage and spillage shall only be undertaken within the areas appropriately equipped to control these discharges.

5.7.1.9 Disposal of chemical wastes shall be carried out in compliance with the *WDO. The Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* published under the Waste Disposal Ordinance details the requirements to deal with chemical wastes. General requirements are given as follows:

- Suitable containers shall be used to hold the chemical wastes to avoid leakage or spillage during storage, handling and transport.
- Chemical waste containers shall be suitably labelled, to notify and warn the personnel who are handling the wastes to avoid accidents.
- Storage area shall be selected at a safe location on site and adequate space shall be allocated to the storage area.

Sewage Effluent from Construction Workforce

5.7.1.10 The construction workforce on site will generate sewage. Sufficient chemical toilets should be provided in the works area, with a licensed waste collector employed to clean the chemical toilets on a regular basis.

5.7.1.11 Notices should be posted at conspicuous locations to remind the workers not to discharge any sewage or wastewater into the surrounding environment. Regular environmental audit of the construction site will provide an effective control of any malpractices and can encourage continual improvement of environmental performance on site. It is anticipated that sewage generation during the construction phase of the project would not cause water pollution problem after undertaking all required measures.

5.7.2 Operational Phase

5.7.2.1 Maintenance desilting of the stormdrains and stormwater pumping station should be carried during dry season months when the drains are in dry condition to avoid any potential water quality impacts.

5.8 Evaluation of Residual Impacts

5.8.1.1 With the proper implementation of the proposed mitigation measures, no adverse water quality impacts would be anticipated from the construction or operation of the Project.

5.9 Environmental Audit

5.9.1.1 Adverse water quality impact would not be anticipated during the construction of the proposed drainage improvement works at all assessed sites with the implementation of the recommended mitigation measures. Thus, water quality monitoring is considered not necessary. However, weekly site audit is recommended to be undertaken during the construction phase to ensure the proposed mitigation measures are implemented in an appropriate manner and are effective.

5.9.1.2 No adverse water quality impacts would be anticipated during the operational phase that no EM&A requirements are considered necessary.

5.10 Conclusion

5.10.1.1 The key water quality impact associated with the proposed drainage improvement works would be related to the land-based construction works, particularly those in the immediate proximity of inland water. The impact may result from construction site runoff, debris, refuse and liquid spillages from general construction activities, and sewage effluents from the construction workforce. With proper implementation of the recommended mitigation measures, no adverse water quality impacts would be anticipated.

6 WASTE MANAGEMENT IMPLICATIONS

6.1 Introduction

6.1.1.1 This section identifies the types of wastes that are likely to be generated during the construction and operation of the proposed drainage improvement works under the Project and evaluates the potential environmental impacts that may result from the handling, transport and disposal of these wastes. Mitigation measures and good site practices regarding the waste handling, storage, collection and disposal are recommended with reference to relevant waste legislation and guidelines.

6.2 Environmental Legislation, Standards and Guidelines

6.2.1 General

6.2.1.1 The following legislation relates to the handling, treatment and disposal of wastes in the Hong Kong Special Administrative Region (HKSAR) and has been used in assessing potential impacts:

- Waste Disposal Ordinance *WDO* (Cap. 354)
- Waste Disposal (Chemical Waste) (General) Regulation (Cap. 354C)
- Waste Disposal (Charges for Disposal of Construction Waste) Regulation (Cap. 354N);
- Land (Miscellaneous Provisions) Ordinance (Cap. 28); and
- Public Health and Municipal Services Ordinance (Cap. 132) - Public Cleansing and Prevention of Nuisances Regulation.

<u>Waste Disposal Ordinance</u>

6.2.1.2 The *Waste Disposal Ordinance (WDO)* prohibits any unauthorised disposal of wastes. Construction waste is defined under Cap. 354N of the *WDO* as any substance, matter or thing that is generated and abandoned from construction works regardless if it has been processed or stockpiled before being abandoned, excluding sludge, screenings or any matter removed or generated from desludging, desilting or dredging works. Under the *WDO*, waste can be disposed of only at designated waste disposal facilities licensed by the EPD.

<u>Waste Disposal (Chemical Waste) (General) Regulation (Cap.354C)</u>

6.2.1.3 Issued under the *WDO*, the *Waste Disposal (Chemical Waste) (General) Regulation (Cap.354C)* controls the possession, storage, collection, transport and disposal of chemical wastes. EPD has also issued three guidelines detailing the Contractor should comply with the regulations on chemical wastes, namely *A Guide to the Chemical Waste Control Scheme (2016), A Guide to the Registration of Chemical Waste Producers (2016) and Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes (1992).*

<u>Waste Disposal (Charges for Disposal of Construction Waste) Regulation (Cap.354N)</u>

6.2.1.4 Under the *Waste Disposal (Charges for Disposal of Construction Waste) Regulation*, construction waste delivered to a landfill for disposal must not contain more than 50% by weight of inert material. Construction waste delivered to a sorting facility for disposal must contain more than 50% by weight of inert material, and construction waste delivered to a Public Fill Reception Facilities (PFRF) for disposal must consist entirely of inert material.

Land (Miscellaneous Provisions) Ordinance (Cap.28)

6.2.1.5 The inert portion of Construction and Demolition (C&D) materials (including rocks, soil, broken concrete, building debris, etc.) may be taken to Public Fill Reception Facilities (PFRFs) operated by the Civil Engineering and Development Department (CEDD). These facilities usually form part of land reclamation schemes and are operated by the CEDD. The *Land (Miscellaneous Provisions) Ordinance* requires that individuals or companies who deliver public fill to the public filling facilities are required to obtain Dumping Licences. The licences are issued by the CEDD under delegated authority from the Director of Lands.

Public Health and Municipal Services Ordinance

6.2.1.6 *The Public Cleansing and Prevention of Nuisances Regulation* (Cap. 132BK) under the *Public Health and Municipal Services Ordinance* provides control on illegal dumping of wastes on unauthorised / unlicensed sites. The illegal dumping of wastes can lead to a fine and / or imprisonment.

6.2.2 Other Relevant Guidelines

6.2.2.1 Other relevant circulars / guidelines are applicable to waste management practices for the Project include:

- Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes (1992), EPD;
- A Guide to the Chemical Waste Control Scheme;
- A Guide to the Registration of Chemical Waste Producers;
- Environment, Transport and Works Bureau Technical Circular (Works) [ETWB TC(W)] No. 19/2005 ‘Environmental Management on Construction Site’;
- Development Bureau Technical Circular (Works) [DEVB TC(W)] No.06/2010 ‘Trip Ticket System for Disposal of C&D Materials’;
- DEVB TC(W) No. 2/2011 ‘Encouraging the Use of Recycled and other Green Materials in Public Works Projects’;
- DEVB TC(W) No. 9/2011 ‘Enhanced Control Measures for Management of Public Fill’;
- DEVB TCW No. 08/2010 ‘Enhanced Specification for Site Cleanliness and Tidiness’;
- Works Branch Technical Circular (WBTC) No. 2/93 ‘Public Dumps’;
- WBTC No. 2/93B ‘Public Filling Facilities’;
- WBTC No. 16/96 ‘Wet Soil in Public Dumps’;
- WBTC No. 12/2000 ‘Fill Management’;
- Project Administration Handbook (PAH) for Civil Engineering Works, Section 4.1.3 of Chapter 4, 2020 Edition; and
- CEDD TC No. 11/2019 ‘Management of Construction and Demolition Materials’.

6.2.2.2 The current policy related to the dumping of C&D materials is documented in the *WBTC No. 2/93, Public Dumps*. C&D materials that are wholly inert, namely public fill, should not be disposed of to landfill, but taken to public filling areas for reuse.

6.2.2.3 The *ETWB TC(W) No. 19/2005 on Environmental Management on Construction Site* includes procedures on waste management requiring contractors to reduce the C&D materials to be disposed of during the course of construction, the *Project*

Administrative Handbook for Civil Engineering Works, Section 4.1.3 "Management of Construction and Demolition Material Including Rock" (2016 Edition) published by CEDD to enhance the management of C&D materials and to minimise their generation at source. The enhancement measures include drawing up a Construction and Demolition Material Management Plan (C&DMMP) at an early design stage to minimise C&D materials generation and encourage proper management of such materials. Projects generating less than 50,000m^3 C&D materials or importing less than 50,000m^3 of fill material are exempted from the C&DMMP. Under *ETWB TC(W) No. 19/2005*, the contractor is required to prepare and implement an Environmental Management Plan (EMP) and the Waste Management Plan (WMP) becomes part of the EMP.

6.2.2.4 Under *DEVB TCW No. 6/2010 'Trip Ticket System for Disposal of Construction and Demolition Materials'*, for all contracts that are expected to generate inert C&D materials requiring disposal from site, the project office shall write to the Public Fill Committee (PFC) through Secretary of the PFC to request a designated disposal ground for incorporation into the tender documents. For contracts where the estimated amount of non-inert C&D materials requiring disposal at landfill facilities equals to or exceeds 50 m^3, the project office shall seek confirmation from the DEP in terms of the availability of landfill facilities for disposal of such materials and the DEP will designate landfill facilities, if available, for the contracts. For contracts where the estimated amount of non-inert C&D materials to be generated from the contract is less than 50 m^3, the project office is not required to apply to DEP for designated landfill facilities but it should still specify in the tender documents of the appropriate landfill facilities for disposal.

6.3 Assessment Methodology

6.3.1.1 The assessment of potential environmental impacts associated with wastes generated from the construction and operation of the proposed drainage improvement works covers the following tasks:

- Identification of the construction and operation activities of the Project which would generate waste;
- Estimation of types and quantities of waste generated;
- Assessment of potential impacts from the caused by handling, collection, transportation and re-use / disposal of wastes with respect to potential hazards, air and odour emissions, noise, wastewater discharges and transport; and
- Examination of opportunities for waste reduction and re-sue (both on-site and off-site) and the required disposal options for each waste.

6.4 Identification and Evaluation of Environmental Impacts

6.4.1 Construction Phase

6.4.1.1 The proposed drainage improvement works of the Project to be covered under this PER and the major construction works involved comprise:

i. <u>Construction / upgrading of stormwater drains, at STN1</u>

- Earthworks (including road breaking, sheet piles driving, excavation etc.), pipe laying / jacking, manhole construction, backfilling and reinstatement

ii. <u>Construction of stormwater pumping station and underground storage tank, at STN1</u>

- site clearance, excavation and lateral Support (ELS), steel fixing and concreting of structure, E&M installation & pipeworks, backfilling, surface reinstatement and landscape works & roadworks

6.4.1.2 The types of waste to be generated from all works proposed under the Project include:

- Construction and demolition (C&D) materials;
- Chemical waste; and
- General refuse.

Construction and Demolition Materials

6.4.1.3 C&D materials would be generated from the excavation works for trench construction for drains, construction of flood walls and stormwater pumping station, with an estimated total volume of approximately 41,308m^3. The C&D materials generated would comprise both inert C&D materials (i.e. public fill including soil, rock, concrete etc.) and non-inert C&D materials (i.e. C&D waste including timber, paper etc.). It is estimated approximately 41,308m^3 inert C&D materials and 207m^3 non-inert C&D materials would be generated. The proposed drainage improvement works would be conducted in phases under different works contracts. While the phasing of the proposed works would be determined in the next stage of the Study, a C&DMMP should be prepared if the total C&D materials be generated from each phase is more than 50,000 m^3. A summary of the estimated volumes of C&D materials generated during construction phase is shown in **Table 6.1** .

Table 6.1 Summary of Estimated Quantities of C&D Materials

Locations	Inert C&D Materials (m^3)		Non-inert C&D Waste (m^3)	Total C&D Materials (m^3)
	to be Reused (m^3)	to be delivered to PFRF for beneficial reuse (m^3)		
STN1 – Sha Tin Town Centre	16,303	24,799	207	41,308

6.4.1.4 The inert and non-inert C&D materials generated should be sorted on-site by Contractor and segregated for stockpiling and transportation. The inert C&D materials generated from construction works would be reused on-sites as much as possible to minimise the net amount of inert C&D materials generated from the Project. It is expected that approximately 37,623 m^3 of inert C&D material, mainly soil, could be reused on-site as backfill materials and approximately 39,878 m^3 of surplus inert C&D materials would be delivered to designated Public Fill Reception Facilities for beneficial reuse in other projects. Considering the relatively small volume of excavated materials which require disposal, it is not envisaged to have adverse impacts on the capacity of the available public filling facilities. The final destinations of the inert C&D materials will be determined, subject to the availability of public filling reception facilities, by the WMP to be submitted by the Contractors and agreed with DSD.

6.4.1.5 Inert and non-inert C&D materials should be sorted on-site. The non-inert C&D would be reused and recycled as much as possible before disposal of at landfill. Due to the inert nature of most of the C&D materials generated, handling and transportation would unlikely to raise long-term environmental concerns. However, as some locations of the construction works areas would be in close proximity to roads, watercourses and residential dwellings, improper management of waste may cause severe nuisance to local residents and environment. With the implementation of recommendations for proper management of C&D materials in

Section 6.5.1, no adverse environmental impacts caused by handling, storage, transport and disposal of C&D materials would be anticipated.

Chemical Wastes

6.4.1.6 The maintenance and servicing of construction plant and vehicles may generate some chemical wastes such as waste oil / grease, spent solvents / solutions, used oil filter and scrap batteries etc.

6.4.1.7 Since the construction activities would be carried out in close proximity to watercourses and drainage systems as well as residential dwellings, chemical wastes arising during the construction phase may pose environmental, health and safety hazards if not stored or disposed of in an appropriate manner as stipulated in the *Waste Disposal (Chemical Waste) (General) Regulations (Cap. 354C)*.

6.4.1.8 It is difficult to quantify the amount of chemical waste that would arise from the construction activities as it would be highly dependent on the contractor's on-site maintenance activities and the quantity of plant and equipment utilized. In view of the small scale of works at each Project site, it is anticipated that the quantity of chemical waste generated would be limited in the order of a few cubic meters. The amount of chemical waste to be generated would be quantified in the WMP to be prepared by the Contractors.

6.4.1.9 Materials classified as chemical waste shall require special handling and storage arrangements by the Contractor. All chemical waste shall be collected by a licensed collector and be disposed at a licensed chemical waste treatment and disposal facility such as Chemical Waste Treatment Centre (CWTC) at Tsing Yi. Unused chemical or those with remaining functional capacity would be reused and recycled on site or by licensed companies whenever possible. Mitigation and control requirements for chemical wastes are detailed in **Section 6.5.1**. Provided that the handling, storage and disposal of chemical wastes are to be in accordance with these requirements and the *Code of Practice on Packaging, Labelling and Storage of Chemical Wastes* published by EPD, adverse environmental impacts would not be anticipated.

General Refuse

6.4.1.10 During the construction phase of the Project, the workforce will generate general refuse comprising food waste, wastepaper, empty containers, etc. Improper collection or removal of general refuse would give rise to hygiene problems and adverse environmental impacts to residents, e.g. odour impacts. As tabulated in **Table 6.2**, the quantities of general refuse from each Project site would be insignificant due to the limited number of workers for such small scale of works and limited space of each works front.

Table 6.2 Summary of Estimated Quantities of General Refuse Materials

Locations	Estimated number of construction workers	Avg. generation of general refuse (kg per worker per day)	Avg. general refuse per day (kg/day)
STN1 – Sha Tin Town Centre	80	0.65	52

6.4.1.11 The general refuse should be collected on-site on a regular basis, separately from C&D materials by an appropriate waste collector to be employed by the Contractor. Prior to disposal off-site, such refuse should be temporarily put in suitably covered storage areas / bins where they should have to be regularly cleaned and maintained to avoid attracting vermin and pests. With proper on-site handling and storage as well as regular disposal of the wastes, no unacceptable environmental impact would be anticipated. Recommendations of mitigation measures for managing general refuse are presented in **Section 6.5.1**.

6.4.2 Operational Phase

6.4.2.1 During operational phase, the main waste types would be silt and debris from the maintenance of stormwater drains and pumping station, which would be similar in nature to general refuse and be disposed of at the designated landfills. Very small quantities of chemical waste (mainly lubricant oil and paints) to be disposed of at the CWTC would also be generated from the maintenance of the proposed stormwater pumping station. In view of the nature and small scale of the Project, quantity of these wastes to be generated would be limited. With proper handling, storage and disposal of these wastes, adverse environmental impacts would not be anticipated.

6.5 Mitigation Measures

6.5.1 Construction Phase

Good Site Practices

6.5.1.1 Recommendations for good site practices during the construction phase include:

- Nomination of approved personnel, such as a site manager, to be responsible for implementation of good site practices, arrangements for waste collection and effective disposal to an appropriate facility;
- Training of site personnel in site cleanliness, concepts of waste reduction, reuse and recycling, proper waste management and chemical waste handling procedures;
- Provision of enough waste reception/ disposal points, and regular collection of waste;
- Adoption of appropriate measures to minimise windblown litter and dust during transportation of waste by either covering trucks or by transporting wastes in enclosed containers;
- Provision of regular cleaning and maintenance programme for drainage systems, sumps and oil interceptors;
- Adoption of a recording system for the amount of wastes generated, recycled and disposed (including the disposal sites); and
- Preparation of WMP as part of the Environmental Management Plan in accordance with ETWB TCW No. 19/2005 and submit to the Engineer for approval.

Waste Reduction Measures

6.5.1.2 Good management and control of construction site activities / processes can minimise the generation of waste. Waste reduction is best achieved at the planning and design stage, as well as by ensuring the implementation of good site practices. Recommendations to achieve waste reduction included:

- Segregate and store different types of construction related waste in different containers, skips or stockpiles to enhance reuse or recycling of materials and their proper disposal;
- Provide separate labelled bins to segregate recyclable waste such as aluminium cans from other general refuse generated by the work force, and to

encourage collection by individual collectors;

- Recycle any unused chemicals or those with remaining functional capacity;
- Maximising the use of reusable steel formwork to reduce the amount of C&D materials;
- Adopt proper storage and site practices to minimise the potential for damage to, or contamination of construction materials;
- Plan the delivery and stock of construction materials carefully to minimise the amount of waste generated; and
- Minimise over ordering and wastage through careful planning during purchasing of construction materials.

6.5.1.3 In addition to the above good site practices and waste reduction measures, specific mitigation measures on the handling, transportation and disposal of C&D materials, chemical wastes and general refuse are recommended below.

<u>Construction and Demolition Materials</u>

6.5.1.4 Careful design, planning together with good site management can reduce over-ordering and generation of C&D materials such as concrete, mortar and cement grouts. Formwork should be designed to maximise the use of standard wooden panels, so that high reuse levels can be achieved. Alternatives such as steel formwork or plastic facing should be considered to increase the potential for reuse.

6.5.1.5 All C&D materials should be sorted on-site for reuse and / recycle where practicable prior to disposal to minimise the quantity of C&D materials to be disposed of and the associated impacts resulting from collection and transportation of C&D materials for off-site disposal. In order to monitor the delivery of inert C&D material at the designated Public Fill Reception Facility (PFRF) for future beneficial reuse in other projects and disposal of non-inert C&D materials at strategic landfill and to control fly-tipping, a trip-ticket system should be included in accordance with *ETWB TCW No. 6/2010*.

6.5.1.6 It is recommended that specific areas should be provided by the Contractors for sorting and to provide temporary storage areas (if required) for the sorted materials. Control measures for temporary stockpiles on-site should be taken in order to minimize the noise, generation of dust and pollution of water. These measures include:

- Surface of stockpiled soil should be regularly wetted with water especially during dry season;
- Disturbance of stockpile soil should be minimised;
- Stockpiled soil should be properly covered with tarpaulin especially when heavy storms are predicted; and
- Stockpiling areas should be enclosed where space is available.

<u>Chemical Wastes</u>

6.5.1.7 As chemical waste would be produced at the construction site, the Contractor is required to register with the EPD as a Chemical Waste Producer and must follow the guidelines stated in the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*. Good quality containers compatible with the chemical wastes should be used, and incompatible chemicals should be stored separately. Appropriate labels should be securely attached on each chemical waste container indicating the corresponding chemical characteristics of the chemical waste, such as explosives, flammable, oxidizing, irritant, toxic, harmful, corrosive, etc. The Contractor shall use a licensed collector to transport and dispose of the chemical wastes at the CWTC or other licensed facility in accordance with the *Waste Disposal (Chemical Waste) (General) Regulation*.

General Refuse

6.5.1.8 Recycling of waste paper, aluminium cans and plastic bottles should be encouraged, it is recommended to place clearly labelled recycling bins at designated locations with convenient access. Other general refuse should be separated from chemical and industrial waste by providing separated bins or skips for storage to maximise the recyclable volume. A reputable licensed waste collector should be employed to remove general refuse on a daily basis to minimise odour, pest and litter impacts.

6.5.2 Operation Phase

6.5.2.1 The main type of wastes generated during operational phase would be silt and debris, which would be similar in nature to general refuse, as well as very limit amount of chemical waste, from the maintenance of drainage pipes and stormwater pumping station. The waste generated from the operation and maintenance should be stored in enclosed bins or compaction units separately. Likewise, *Waste Disposal (Chemical Waste) (General) Regulation* and the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* would be strictly followed for the handling and disposal of chemical waste.

6.5.2.2 A summary of various types of waste likely to be generated during construction and operational phases, together with the recommended handling and disposal methods are shown in **Table 6.3.**

Table 6.3 Summary of Waste Handling Methods and Disposal Outlets

Waste Material Type	Handling Methods	Disposal
Construction Phase		
C&D Materials	Where possible should be reused on-site. If off-site disposal required, separate into: ▪ Non-inert C&D materials ▪ Inert C&D materials	▪ Non-inert C&D materials: Strategic landfill ▪ Inert C&D materials: Public Fill Reception Facility
Chemical Waste	Unused chemical would be recycled on-site or off-site disposal by licensed collectors. Stored on-site within suitably designed containers	▪ CWTC or other licensed facilities
General Refuse	▪ Provide on-site refuse collection facilities ▪ Provide on-site clearly labelled recycling bins for segregation of aluminium and plastic wastes, and wastepaper	▪ CWTC or other licensed facilities
Operational Phase		
Silt and Debris from Operation and Maintenance	Off-site disposal required	▪ Strategic landfill

Waste Material Type	Handling Methods	Disposal
Chemical Waste from maintenance	Off-site disposal by licensed collectors	▪ CWTC or other licensed facilities

6.6 Evaluation of Residual Impacts

6.6.1.1 With the implementation of the recommended mitigation measures for the handling, transportation and disposal of the identified waste arisings, residual impacts would not be expected during the construction and operation of the proposed Project.

6.7 Environmental Audit

6.7.1.1 Waste management would be the contractor's responsibility to ensure that all wastes produced during the construction of the Project are handled, stored and disposed of in accordance with good waste management practices and EPD's regulations and requirements. The recommended mitigation measures should form the basis of the site WMP to be developed by the Contractors at the construction stage. Regular inspection should be conducted to ensure proper management and handling of waste, and appropriate implementation of the mitigation measures.

6.7.1.2 It is expected that limited quantities of waste would be generated from the operation of the Project and adverse environmental impacts would not be anticipated with the implementation of good waste management practices. No EM&A requirement is considered necessary during the operational phase.

6.8 Conclusion

6.8.1.1 During construction phase, waste types generated from the Project would likely include C&D materials (from site clearance, excavation, concreting works etc.), chemical wastes from maintenance of construction plant and equipment, and general refuse from workforce. Provided that these wastes are handled, transported and disposed of according to the recommended good site practices and measures, adverse environmental impacts would not be anticipated during the construction phase.

6.8.1.2 During the operational phase, small quantities of screenings, silt, debris and chemical wastes would be anticipated from the operation and maintenance of stormwater pumping stations and drainage pipes/storage ponds. With implementation of the recommended mitigation measures, adverse environmental impacts would not be anticipated during operational phase.

7 ECOLOGY

7.1 Introduction

7.1.1.1 This section presents the ecological baseline resources within the assessment area and provides the assessment of potential ecological impacts arising from the construction and operation of the drainage improvement works under the Project.

7.2 Environmental Legislation, Policies, Plans, Standards, and Guidelines

7.2.1.1 The identification and assessment of ecological importance of habitats and species makes reference to the following local ordinances, regulations, standards, guidelines, and documents:

- Environmental Impact Assessment Ordinance (EIAO) (Cap. 499)
- Technical Memorandum on the EIA Process (EIAO-TM) Annexes 8 and 16
- EIAO Guidance Notes No. 3/2010, 6/2010, 7/2010, and 10/2010
- Country Parks Ordinance (Cap. 208)
- Forests and Countryside Ordinance (Cap. 96)
- Wild Animals Protection Ordinance (Cap. 170)
- Town Planning Ordinance (Cap. 131)
- Chapter 10 of the Hong Kong Planning Standards and Guidelines (HKPSG)
- Water Pollution Control Ordinance (Cap. 358)
- Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586)
- Environment, Transport and Works Bureau (ETWB) TCW No. 5/2005 Protection of Natural Streams/Rivers from Adverse Impacts arising from Construction Works
- Development Bureau (DEVB) TCW No. 4/2020 Tree Preservation
- Drainage Services Department (DSD) Practice Note No. 1/2015 Guidelines on Environmental Consideration for River Channel Design

7.2.1.2 This section also makes reference to the following international conventions and national legislation:

- The International Union for Conservation of Nature (IUCN) Red List of Threatened Species
- The List of Endangered and Protected Species of China
- The Convention on Biological Diversity (CBD), and an associated city-level Biodiversity Strategy and Action Plan (BSAP) developed by Agriculture, Fisheries and Conservation Department (AFCD) under the CBD.

7.3 Assessment Approach and Ecological Survey Methodology

<u>Assessment Area</u>

7.3.1.1 The assessment areas for ecological impact assessment include areas 500 m from the site boundaries with respect to different proposed drainage works (**Figures 7.3** refer).

<u>Literature Review</u>

7.3.1.2 Relevant reports, studies and available information were collated and reviewed to identify the ecological characteristics and resources within assessment areas. The sources reviewed included:

- AEIAR-202/2016 Sha Tin Cavern Sewage Treatment Works – EIA Report (DSD, 2016)
- Summer 2019 Report: Egretry Counts in Hong Kong with particular reference to the Mai Po Inner Deep Bay Ramsar Site (Anon, 2020)

Identification of information gap

7.3.1.4 STN1 was not covered in previous studies. The proposed drainage improvement works at these locations might result in both direct and indirect impacts on nearby ecological resources, and hence ecological surveys were conducted to provide updated and comprehensive ecological baseline information for this review.

Ecological Surveys

7.3.1.5 Habitats recorded during the ecological surveys were identified and mapped. Relative abundance and growth forms of dominant and notable plant species were recorded at the assessment area. Identification of species and distribution status in Hong Kong were made with reference to Corlett *et al.* (2000) and AFCD (2003; 2007; 2008; 2009; 2011; 2012).

7.3.1.6 Wildlife including avifauna, terrestrial insect (butterfly and odonate), herpetofauna (amphibian and reptile), mammal, and freshwater communities was surveyed both visually and aurally. Direct observation on the ardeid night roosts and flight path was conducted at selected vantage points. Active searching of potential habitats of each fauna group was undertaken, where accessible. Signs of the presence of terrestrial mammals (e.g. droppings, footprints and burrows) were recorded, while bats were recorded by acoustically. Freshwater communities were surveyed by active searching, direst observation and bankside counting at selected sampling points (**Figures 7.3** refer).

7.3.1.7 For general distribution status of the fauna species in Hong Kong, references were made to Fellowes *et al*. (2002) and the Hong Kong Biodiversity Database (AFCD, 2020a). For identification of specific faunal groups and assessment of their geographic distribution, the following resources were used: Avifauna – Viney *et al*. (2005), Carey *et al*. (2001), HKBWS (2010); Butterflies – Lo & Hui (2010); Dragonflies – Tam *et al*. (2011), Reels (2019); Amphibians – Chan *et al*. (2005); Reptiles – Chan *et al*. (2006); Terrestrial Mammals – Shek (2006); Freshwater Communities – Dudgeon (2003), Lee *et al.* (2004).

7.3.1.8 The survey methodologies and assessments have made reference to the EIAO Guidance Notes (No. 7/2010 and No. 10/2010). Ecological surveys in both wet and dry seasons were proposed, covering the active seasons of both the major floral and faunal groups. The ecological survey programmes are presented in the below **Table 7.1**.

7.3.1.9 Ecological impact assessment based on the proposed layout was undertaken and mitigation measures to avoid, minimize and compensate for any potential adverse impacts identified were proposed as appropriate.

Table 7.1 Ecological Survey Programmes

Surveys	Wet Season	Dry Season
	Jul 2020	Nov 2020
Sha Tin –STN1		
Habitat/Vegetation	√	√
Avifauna (day and night) [1]	√	√
Ardeid Flight Line [2]	√	√
Ardeid Night Roost and Pre-Roost [2]	√	√
Butterfly	√	
Odonate	√	
Herpetofauna (day and night)	√	
Mammal (day and night)	√	

Notes:
(1) Avifauna day survey includes checking on Penfold Park Egretry.
(2) Only apply to STN1

7.4 Baseline Ecological Condition

7.4.1 Literature Review

7.4.1.1 Drainage improvement works of the Project at STN1 would not take place within or near any recognised sites of conservation importance. Collated ecological information of the assessment areas on the sites of conservation importance, species of conservation importance and ecologically sensitive resources are presented below.

7.4.1.2 Penfold Park Egretry is located 350 m northwest to the Project site at STS5, across the Shing Mun River Channel. The information on the use and occupation of Penfold Park Egretry are summarised in **Table 7.2** below (Anon, 2017, 2018, 2020, 2021a, 2021b). Dredging and draining works at the lake at Penfold Park were recorded in mid-May 2019 but were subsequently suspended due to the presence of breeding ardeids (Anon, 2020).

Table 7.2 Species and Number of Nests Recorded in Penfold Park Egretry during the Waterbird Monitoring Programme from 2017 – 2021

Year	Great Egret (*Ardea alba*)	Little Egret (*Egretta garzetta*)	Black-crowned Night Heron (*Nycticorax nycticorax*)	Chinese Pond Heron (*Ardeola bacchus*)	Total No. of Nests
2017	13	34	21	6	74
2018	22	26	16	9	73
2019	21	25	25	6	77
2020	30	32	23	6	91
2021	22	35	21	7	85

7.4.1.3 From previous flight line surveys (DSD, 2016), most of the ardeids from this egretry headed toward the mouth of Shing Mun River Channel, while some were found landing and foraging at the banksides along the channel within the assessment areas (DSD, 2016).

7.4.1.4 Ardeid night roosts were recorded along Shing Mun River Channel near Man Lai Court at Tai Wai. The night roost at Tai Wai was active for at least 3 years from 2017 to 2019 but was not used by the ardeids in Dec 2019 as the birds foraging around Shing Mun River at Tai Wai and Sha Tin settled at Penfold Park for the night instead (AFCD, 2020b). Ardeids were also recorded pre-roosting on the trees outside the Hong Kong Heritage Museum according to AFCD's unpublished data.

7.4.1.5 One bird species of conservation importance, Collared Crow (*Corvus torquatus*) was recorded in a developed area within the assessment area at the bankside near Shek Mun (AFCD, 2020a; DSD, 2016). Ardeids were also recorded pre-roosting on the trees outside the Hong Kong Heritage Museum according to AFCD's unpublished data.

7.4.2 Ecological Survey Finding

7.4.2.1 Findings of the wet and dry season ecological surveys conducted between June and November 2020 are presented below. The sizes of recorded habitats present within the Project site and the assessment area in each surveyed location are presented **Appendix 7.1**. Representative photographs of the habitats and species of conservation importance are presented in **Appendix 7.2**. The lists of floral species recorded in each of the locations are provided in **Appendix 7.3**. The recorded floral species of conservation importance are summarised in **Table 7.4**.

Habitat and Vegetation

<u>Shing Mun River Cycling Track & Sha Tin Town Centre (STN1)</u>

Project Site

7.4.2.2 The Project sites comprised predominantly channelised watercourse and developed area around Sha Tin Park, Sha Tin Centre Street, Hong Kong Heritage Museum, Man Lai Road and the cycle tracks adjacent to Shing Mun River Channel. The encompassed developed area at STN1 (~1.5 ha respectively) supported mainly ruderal herbs, self-seeded plants and ornamental species. Small areas of channelised watercourse, Shing Mun River Channel, were also included in both the Project site of STN1 (~15 m). The banks of this channelised watercourse are concrete-lined with limited floristic diversity which mostly composed of locally common, exotic or ornamental species. No floral species of conservation importance were recorded within the Project sites.

Assessment Area

7.4.2.3 A total of six habitats, including woodland, shrubland, watercourse, channelised watercourse, plantation and developed area, were identified. The assessment area of STN1 partly overlapped with the western assessment area of Shing Mun River Cycling.

7.4.2.4 Multiple patches of woodland were recorded at the peripheries of the assessment areas of STN1 and Shing Mun River Cycling Track, which were located mainly along To Fung Shan Road and behind Lei Uk Tsuen in the southwest, along A Kung Kok Shan Road in the northeast, and at Yuen Chau Kok Park. Most of these woodlands were inhabited by native tree species such as *Alangium chinense*, *Aporusa dioica* and *Sterculia lanceolata* at the overstoreys; and climbers *Bauhinia glauca*, *Byttneria grandifolia* and shrub *Psychotria asiatica* at the understoreys. Some exotic planted species like *Acacia confusa* and signs of human disturbance (e.g. planting of ornamental species and fruit trees) were documented at the woodland fringes near roadsides. Several patches of plantations were found along A Kung Kok Shan Road and To Fung Shan Road with typical trees like *Acacia* *confusa*, *Delonix regia* and *Melaleuca cajuputi* subsp. *Cumingiana* planted.

7.4.2.5 Natural shrubland and several watercourses were recorded at the hillside south of A Kung Kok Shan Road. Typical shrubland species such as *Dicranopteris pedata*, *Melastoma sanguineum* and *Rhodomyrtus tomentosa* were recorded. These semi-natural watercourses were lined with riparian vegetation with width and water depth of 1 – 1.5 m. The channelised watercourse within the assessment areas was around 160 m wide, comprising several sections of Shing Mun River Channel near Sha Tin Park, Sha Tin Sports Ground and Penfold Park. The banks were modified with concrete or masonry stones embedded in concrete/mortar lining, and mainly covered by ornamental plants and self-sown trees like *Hibiscus tiliaceus* and *Leucaena leucocephala*. The remaining developed area was likewise composed of ornamental plants for landscaping, amenity and aesthetic purposes in residential areas and urban parks.

7.4.2.7 Five floral species of conservation importance were recorded in woodland within the assessment area of STN1, including *Aquilaria sinensis*, *Artocarpus hypargyreus*, *Canthium dicoccum*, *Cibotium barometz* and *Gnetum luofuense* (**Figure 7.8** refers).

Fauna

7.4.2.8 The lists of faunal species recorded in each location are provided in **Appendix 7.4**. Most of the recorded species in all of the locations are locally common and widespread. No faunal species of conservation importance were recorded within any surveyed Project sites. The recorded faunal species of conservation importance in the assessment areas and their corresponding representative photographs are summarised and presented in **Table 7.4** and **Appendix 7.2** respectively.

<u>Avifauna</u>

7.4.2.9 *F*our avifauna species of conservation importance were recorded with in the assessment area of Sha Tin Town Centre (STN1) namely Grey Heron, Great Egret, Little Egret and Black-crowned Night Heron. No avifauna species of conservation importance was recorded within assessment area of other survey Project sites. Grey Heron, Great Egret, Little Egret and Black-crowned Night Heron were recorded along the channelised watercourse (Shing Mun River Channel) in the assessment areas of STN1 (**Figures 7.8** refer).

7.4.2.10 From the surveys conducted in July 2020, a total of 38 ardeids nests were documented at Penfold Park Egretry including 9 Great Egret nests, 6 Chinese Pond Heron (*Ardeola bacchus*) nests, 12 Little Egret nests and 11 Black-crowned Night Heron nests. Most of these roosts were found in *Ficus microcarpa* and a few in *Artocarpus heterophyllus* within the park.

7.4.2.11 The extent of ardeid night roost along Shing Mun River Channel and the associated flight lines with respect to the Project sites of Shing Mun River Cycling Track and STN1 are presented in **Figures 7.11**. A small area of roost was identified around 500m and 300m west to the Project sites of Shing Mun River Cycling Track and STN1 respectively. No pre-roost area was identified during the survey.

7.4.2.12 Most of the ardeids commuted westward and eastward along Shing Mun River Channel (**Figure 7.11** refers). Around 53% of the ardeids flew westward towards Hong Kong Heritage Museum while 37% flew eastward near Man Lai Court. **Table 7.3** summarises the directions and ardeid species recorded along Shing Mun River Channel.

Table 7.3 Flight Directions of Ardeids Recorded along Shing Mun River Channel

Direction of Flight Line	No. of Ardeid Counts					
	Great Egret	Grey Heron	Little Egret	Black-crowned Night Heron	Total	Relative Percentage of Ardeid Usage
1 Westward (Within the channel)	6	-	-	27	33	53%
2 Eastward (Within the channel)	4	-	19	-	23	37%
3 Southward/ Southeastward (From Tsing Sha Highway)	-	-	1	-	1	2%
4 Eastward (From further west)	1	2	1	-	5	8%
Total	11	2	22	27	62	-

Notes:
(1) The table does not necessarily represent the actual number of ardeids along Shing Mun River Channel as the number of ardeids recorded may fly back and forth in the area.

Butterfly

7.4.2.13 No butterfly species of conservationimportance was recorded within Sha Tin Town Centre (STN1).

Odonate

Other fauna group

7.4.2.14 No mammal or aquatic faunal species of conservation importance were recorded within the assessment areas of other surveyed Project sites.

Table 7.4 Species of Conservation Importance Recorded within the Assessment Area from Current Surveys

Species Name	Distribution in Hong Kong (1)	Protection Status	Location (Habitat Recorded) (15)	
			Project Site	500 m Assessment Area
Flora				

Species Name	Distribution in Hong Kong [1]	Protection Status	Location (Habitat Recorded) [15]	
			Project Site	500 m Assessment Area
Aquilaria sinensis	Common	Near Threatened [2]; Category II [5]; Vulnerable [3] [4]; Cap. 586 [6]	-	STN1 (WL)
Artocarpus hypargyreus	Common	Near Threatened [2]; Vulnerable [3]; Endangered [4]	-	STN1 (WL)
Canthium dicoccum	Common	Vulnerable [3]	-	STN1 (WL)
Cibotium barometz	Very Common	Cap. 586 [6]; Vulnerable [2]	-	STN1 (WL)
Gnetum luofuense	Very Common	Near Threatened [3]	-	STN1 (WL)
Avifauna [8]				
Great Egret *(Ardea alba)*	Widespread and abundant [9]	PRC(RC) [10]	-	STN1 (CW)
Grey Heron (*Ardea cinerea*)	Common	PRC [10]	-	STN1 (CW)
Little Egret *(Egretta garzetta)*	Widespread and abundant [9]	PRC(RC) [10]	-	STN1 (CW)
Black-crowned Night Heron *(Nycticorax nycticorax)*	Widespread and common [9]	(LC) [10]	-	STN1 (CW)

Note for Table 7.4:
(1) Distribution and rarity of species follow: Flora: Corlett et al. (2000), AFCD (2007;2008;2009;2011); Fauna: and AFCD (2020).
(2) AFCD. (2003). Status in China.
(3) IUCN. (2021).
(4) Qin et al. (2017).
(5) Protected by List of Wild Plants Under State Protection.
(6) Cap. 586 Protection of Endangered Species of Animal and Plants Ordinance.
(7) Cap. 96 Forests and Countryside Ordinance, including the associated Chapter 96A Forestry Regulation.
(8) Cap. 170 Wild Animal Protection Ordinance. All wild birds in Hong Kong are protected under Cap. 170 Wild Animal Protection Ordinance.
(9) Allock et al. (2019).
(10) Conservation status by Fellowes et al. (2002): LC = Local Concern; PRC = Potential Regional Concern; RC = Regional Concern. Letters in parentheses indicate that the assessment is on the basis of restrictedness in breeding and/or roosting sites rather than in general occurrence.
(11) Protected by List of Wild Animals Under State Protection.
(12) Zheng & Wang. (1998).
(13) Jiang et al. (2016).
(14) CITES. (2020).
(15) Code for Habitat Type: **WL**=Woodland; **SH**=Shrubland; **WC**=Watercourse; **PL**=Plantation; **OR**=Orchard; **CW**=Channelised Watercourse; **DA**=Developed Area; **IF**=In Flight.

7.5 Evaluation of Ecological Value

7.5.1.1 The ecological importance of the recorded habitats within the Project site were evaluated in accordance with the EIAO-TM Annex 8 criteria in **Table 7.5** below. Floral and faunal species of conservation importance recorded from the recent surveys are detailed in **Table 7.4** above.

Table 7.5 Ecological evaluation of the habitats within the Project site in Shing Mun River Cycle Track and Sha Tin Town Centre (STN1)

Criteria	Channelised Watercourse	Developed Area
Naturalness	Entirely man-made.	Entirely man-made with high human disturbance.

Criteria	Channelised Watercourse	Developed Area
Size	STN1: Small (~15 m).	STS5: Small (~2.9 ha) STN1: Small (~1.5 ha).
Diversity	Low floral and faunal diversity.	Low floral and faunal diversity.
Rarity	A common habitat in Hong Kong. No species of conservation importance were recorded within the Project site.	A common habitat in Hong Kong. No species of conservation importance were recorded within the Project site.
Re-creatability	Moderate to high.	High.
Fragmentation	Not fragmented.	Not fragmented.
Ecological linkage	Not structurally and functionally linked with highly valued habitat.	Not structurally and functionally linked with highly valued habitat.
Potential value	Low.	Very low.
Nursery / Breeding ground	No records of nursery or breeding ground.	No records of nursery or breeding ground.
Age	40 – 50 years.	40 – 50 years.
Abundance / Richness of Wildlife	Low.	Low.
Ecological Value	Low.	Low.

7.6 Identification and Evaluation of Environmental Impacts

7.6.1.1 The proposed drainage improvement works of the Project (detailed in **Table 2.1**) to be covered under this PER comprise:

iii. Construction / upgrading of stormwater drains by both open-cut and trenchless methods, at STN1

iv. Construction of stormwater pumping station and underground storage tank, at STN1; and

7.6.1.2 Ecological assessment of the proposed drainage improvement works of the below sites are discussed in the below sections:

1. <u>Sha Tin Town Centre (STN1)</u>

7.6.2 Construction Phase

Direct Impact

<u>Habitat loss</u>

7.6.2.1 The proposed drainage improvement works at Sha Tin Town Centre (STN1) fall mostly within developed area habitat. All works area would be reinstated upon the completion of the construction works. Since these habitats are man-made with high human disturbance and relatively low ecological value, the impact of temporary loss of these habitats is considered negligible.

7.6.2.2 The construction of outlets (at STN1) would involve dewatering a small area of the embankment temporarily and proper mitigation measures would be implemented to contain the site runoff. In general, the proposed works on the modified watercourse habitat is temporary and only small dry areas would be affected temporarily. Given the man-made nature and low ecological value, direct impact on the modified watercourse habitat is anticipated to be minor.

Indirect Impact

Disturbances to surrounding habitats and species of conservation importance

7.6.2.3 Indirect disturbance impacts to the surrounding habitats can be resulted from increased human activities, glare, noise and dust brought by the construction works. The Project sites in the four locations are mostly surrounded by developed area with no structural nor functional linkage with any highly valued habitats. In general, given that the drainage improvement works are temporary with relatively localized disturbance, indirect impact to the surrounding habitats is anticipated to be insignificant.

7.6.2.4 A few bird and odonate species of conservation importance were recorded in vicinity of the Project sites, for example the Little Egret in Shing Mun River Cycle Track. Since these animals are highly mobile and utilize a larger area of the watercourses instead of confining to a particular locality, they would be temporarily displaced to undisturbed areas. The indirect impact to these species of conservation importance is considered minor.

7.6.2.5 The construction activities in STN1 will be restricted to daytime and the Project sites are over 100 m from the ardeids night roost, disturbance impact to the ardeid night roost along Shing Mun River Channel is anticipated to be negligible.

Impacts to water quality

7.6.2.6 Indirect impacts to water quality of the downstream of the watercourse and channelised watercourse habitats could be caused by the uncontrolled site runoff and chemical spillage during construction of flood wall and outlets. Potentially increased sedimentation and water contamination could affect the associated aquatic communities and ardeids. Given that the proposed works at the four locations are largely confined to bank section which is above water level or will be dewatered, with the implementation of good site practices and proper mitigation measures contain the site runoff and contaminants, the potential impact to water quality is anticipated to be insignificant.

7.6.3 Operational phase

7.6.3.1 No ecological impact would be anticipated from the proposed works at Project site during the operational phase.

7.7 Mitigation Measures

7.7.1.1 All site practices outlined in WSD's Conditions within Water Gathering Ground (**Appendix 5.1** refers) should be strictly followed. Adequate construction site drainage as specified in the *ProPECC PN 1/94 "Construction Site Drainage"* and mitigation measures as described in the *ETWB TC (Works)* No. *5/2005 "Protection of natural streams / rivers from adverse impacts arising from construction works"* should be adopted to minimize the potential impacts from uncontrol release of construction waste / runoff within watercourse.

7.7.1.2 Taking into account the site constraints and drainage capacity, the existing substrates of the watercourse, should be preserved off-site temporarily during construction phase and be used to reinstate the riverbed as far as practicable after works. Design of ecological-friendly riverbed lining should be considered with reference to DSD PN No. 1/2015 "Guidelines on Environmental and Ecological Considerations for River Channel Design" to minimize the impact to the hydrological features of the watercourse habitat.

Minimising disturbance impacts in construction phase

7.7.1.3 For all Project sites, proper screening (e.g. hoarding or barrier) should be provided to restrict construction activities within the Project sites and minimise the direct injuries to nearby wildlife. Besides, general good site practices should be implemented to minimise the disturbance impacts (e.g. noise, glare and dust) to the surrounding habitats and their associated wildlife arising from the construction activities, including but not limited to the following:

- Noise mitigation measures by means of movable noise barriers/enclosure, the use of Quiet Powered Mechanical Equipment (QPME) and other good site practices to limit noise emissions at source;
- Glare reduction measures such as hoarding provisioning to the adjoining habitats to minimise the impact to nearby nocturnal fauna especially avifauna and bat; and
- Dust suppression measures such as regular water spraying of unpaved roads, proper covering of dusty material storage piles to avoid and minimise emission and dispersal dust.

Minimising impacts to water quality in construction phase

7.7.1.4 The procedures promulgated under ETWB TC (Works) No. 5/2005 "Protection of Natural Streams/Rivers from Adverse Impacts arising from Construction Works" and ProPECC PN 1/94 "Construction Site Drainage" should be adopted, where applicable, to minimise the water quality impacts.

7.7.1.5 Footprint of the outlet construction in Sha Tin Town Centre (STN1) should be restricted to dry section of the watercourse, proper shoring may need to be erected in order to prevent soil or mud from slipping into the watercourses, to minimize the impacts upon the downstream section. Site runoff should be directed towards silt/sediment traps and oil/grease separators before discharge. Detailed mitigation of water quality impact is shown in Water Quality Impact Section (**Section 5.7.1** refers).

7.7.1.6 Other standard good site practices should be implemented throughout the entire construction phase in order to minimise the impacts and avoid pollution of waterbodies, which include:

- Placement of equipment or stockpile in designated Project sites and access routes selected on existing disturbed land to minimise disturbance to natural habitats, and ensure litter and fuels would not enter nearby drainages and waterbodies;
- Construction activities should be restricted to clearly demarcated works areas;
- All temporary works areas should be reinstated after completion of the works; and
- Sufficient waste skip and waste disposal point should be provided to collect general refuse and construction wastes and should be properly disposed in a timely manner.

7.8 Evaluation of Residual Impacts

7.8.1.1 With the implementation of the recommended mitigation measures, residual ecological impacts would not be expected during the construction and operation of the proposed Project.

7.9 Environmental Audit

7.9.1.1 Adverse ecological quality impact would not be anticipated during the construction of the proposed drainage improvement works at all assessed sites with the implementation of the recommended mitigation measures. Thus, ecological monitoring is considered not necessary. However, weekly site audit is recommended to be undertaken during the construction phase to ascertain the proposed mitigation measures are implemented in an appropriate manner and are effective.

7.9.1.2 No adverse ecological impacts would be anticipated during the operational phase that no EM&A requirements are considered necessary.

7.9.2 Conclusion

7.9.2.1 Proposed drainage improvement works would involve the upgrade of stormwater drains and construction of stormwater drains, pumping station, storage tank and flood wall. The Project sites in Sha Tin Town Centre (STN1) consist of watercourse, channelised watercourse, developed area, plantation and woodland habitats, which have low to low-moderate ecological values. The surrounding habitats are mostly developed areas and not of high ecological value. No species of conservation importance were spotted within the proposed Project sites.

7.9.2.2 Direct impact would be habitat loss but the habitat loss in STN1 would be temporary with negligible to minor impacts anticipated. Indirect impacts through disturbances to the surrounding habitats and species of conservation importance including the Penfold Park Egretry, the ardeid night roost and flight path along Shing Mun River Channel would be insignificant to minor. Impact on water quality would also be insignificant. Mitigation measures should be implemented to minimize the disturbances e.g. noise, glare and dust during the construction period.

7.10 Reference

Agriculture, Fisheries and Conservation Department (AFCD). 2003. Rare and Precious Plants of Hong Kong. Agriculture, Fisheries and Conservation Department, HKSAR, Hong Kong. 234pp.

Agriculture, Fisheries and Conservation Department (AFCD). (2007). *Flora of Hong Kong* Volume 1. Edited by Hong Kong Herbarium, Agriculture, Fisheries and Conservation Department & South China Botanical Garden, Chinese Academy of Sciences.

Agriculture, Fisheries and Conservation Department (AFCD). (2008). *Flora of Hong Kong* Volume 2. Edited by Hong Kong Herbarium, Agriculture, Fisheries and Conservation Department & South China Botanical Garden, Chinese Academy of Sciences.

Agriculture, Fisheries and Conservation Department (AFCD). (2009). *Flora of Hong Kong* Volume 3. Edited by Hong Kong Herbarium, Agriculture, Fisheries and Conservation Department & South China Botanical Garden, Chinese Academy of Sciences.

Agriculture, Fisheries and Conservation Department (AFCD). (2011). *Flora of Hong Kong* Volume 4. Edited by Hong Kong Herbarium, Agriculture, Fisheries and Conservation Department & South China Botanical Garden, Chinese Academy of Sciences.

Agriculture, Fisheries and Conservation Department (AFCD). (2012). *Check List of Hong Kong Plants 2012*. Agriculture, Fisheries and Conservation Department, HKSAR, Hong Kong.

Agriculture, Fisheries and Conservation Department (AFCD). (2020a). *Hong Kong Biodiversity Database*. Available at https://www.afcd.gov.hk/English/conservation/hkbiodiversity/database/search.php. Accessed September 2020.

Agriculture, Fisheries and Conservation Department (AFCD). (2020b). Territory-wide Study on Roosting Sites of Ardeids in Winter 2019/20. *Hong Kong Biodiversity. Agriculture, Fisheries and Conservation Department Newsletter*. Issue No. 26.

Allcock, J.A., Chow, G. & Welch, G. (Eds.). 2019. Hong Kong Bird Report – 2017. The Hong Kong Bird Watching Society, Hong Kong.

Anon. (2016). Summer 2016 Report: Egretry Counts in Hong Kong with particular reference to the Mai Po Inner Deep Bay Ramsar Site. Report by The Hong Kong Bird Watching Society to the Agriculture, Fisheries and Conservation Department, Hong Kong Special Administrative Region Government.

Anon. (2017). Summer 2017 Report: Egretry Counts in Hong Kong with particular reference to the Mai Po Inner Deep Bay Ramsar Site. Report by The Hong Kong Bird Watching Society to the Agriculture, Fisheries and Conservation Department, Hong Kong Special Administrative Region Government.

Anon. (2018). Summer 2018 Report: Egretry Counts in Hong Kong with particular reference to the Mai Po Inner Deep Bay Ramsar Site. Report by The Hong Kong Bird Watching Society to the Agriculture, Fisheries and Conservation Department, Hong Kong Special Administrative Region Government.

Anon. (2020). Summer 2019 Report: Egretry Counts in Hong Kong with particular reference to the Mai Po Inner Deep Bay Ramsar Site. Report by The Hong Kong Bird Watching Society to the Agriculture, Fisheries and Conservation Department, Hong Kong Special Administrative Region Government.

Anon. (2021a). Summer 2020 Report: Egretry Counts in Hong Kong with particular reference to the Mai Po Inner Deep Bay Ramsar Site. Report by The Hong Kong Bird Watching Society to the Agriculture, Fisheries and Conservation Department, Hong Kong Special Administrative Region Government.

Anon. (2021b). Summer 2021 Report: Egretry Counts in Hong Kong with particular reference to the Mai Po Inner Deep Bay Ramsar Site. Report by The Hong Kong Bird Watching Society to the Agriculture, Fisheries and Conservation Department, Hong Kong Special Administrative Region Government.

Carey, G. J., Chalmers, M. L., Diskin, D. A., Kennerley, P. R., Leader, P. J., Leven, M. R., Lewthwaite, R. W., Melville, D. S., Turnbull, M. & Young, L. (2001). *The Avifauna of Hong Kong*. Hong Kong Bird Watching Society, Hong Kong.

Chan, S. K. F., Cheung, K. S., Ho, C. Y., Lam, F. N., Tang, W. S., Lau, M. W. N. & Bogadek, A. (2005). *A Field Guide to the Amphibians of Hong Kong*. Agriculture, Fisheries and Conservation Department, Friends of the Country Parks and Cosmos Books Ltd.

Chan, S. K. F., Cheung, K. S., Ho, C. Y., Lam, F. N., Tang, W.S. & Tse, M.L. (2006). *A Field Guide to the Venomous Land Snakes of Hong Kong.* Agriculture, Fisheries and Conservation Department, Friends of the Country Parks and Cosmos Books Ltd.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). 2020. The CITES Appendices. (available online at https://cites.org/eng/app/appendices.php). Accessed September 2020.

Corlett, R., Xing, F., Ng, S. C., Chau, L. & Wong, L. (2000). *Hong Kong Vascular Plants: Distribution and Status*. Memoirs of the Hong Kong Natural History Society. Hong Kong.

Drainage Services Department (DSD) (2016). Agreement No. CE 240/2016 Sha Tin Cavern Sewage Treatment Works – EIA Report. Prepared by AECOM Asia Co. Ltd. for Drainage Services Department, The Government of the Hong Kong Special Administrative Region.

Dudgeon, D. (2003). *Hong Kong Field Guides 2: Hillstreams*. Hong Kong: The Department of Ecology & Biodiversity, The University of Hong Kong and Wan Li Book Co Ltd.

Fellowes, J. R., Lau, M. W. N., Dudgeon, D., Reels, G.T., Ades, G. W. J., Carey, G. J., Chan, B. P. L., Kendrick, R. C., Lee, K. S., Leven, M. R., Wilson, K. D. P. & Yu, Y. T. (2002). *Wild animals to watch: Terrestrial and freshwater fauna of conservation concern in Hong Kong*. Memoirs of the Hong Kong Natural History Society No. 25, 123-160.

Hong Kong Bird Watching Society (HKBWS) (2010). *A Photographic Guide to Birds of Hong Kong (Revised Edition*). Wan Li Book Co Ltd.

International Union for the Conservation of Nature (IUCN). (2021). The IUCN Red List of Threatened Species. Version 2021.1. Available at: http://www.iucnredlist.org. Accessed April 2021.

Jiang, Z.G., Jiang, J.P., Wang, Y.Z., Zhang, E., Zhang, Y.Y., Li, L.L., Xie, F., Cai, B., Cao, L., Zheng, G.M., Dong, L., Zhang, Z.W., Ding, P., Luo, Z.H., Ding, C.Q., Ma, Z.J., Tang, S.H., Cao, W.X., Li, C.W., Hu, H.J., Ma, Y., Wu, Y., Wang, Y.X., Zhou, K.Y., Liu, S.Y., Chen, Y.Y., Li, J.T., Feng, Z.J., Wang, Y., Wang, B., Li, C., Song, X.L., Cai, L., Zang, C.X., Zeng, Y., Meng, Z.B., Fang, H.X. & Ping, X.G. (2016). *Red List of China's Vertebrates*. Biodiversity Science, **24**(5): 500-551.

Lee, L. F., Lam, K. S., Ng, K. Y., Chan, K. T. and Young, L. C. (2004). *Field Guide to the Freshwater Fish of Hong Kong*. Friends of the Country Parks.

Lo, Y. F. & Hui, W. L. (2010). *Hong Kong Butterflies* (Third Edition). Hong Kong: Cosmos Books Ltd.

Qin, H. N., Yang, Y., Dong, S. Y., He, Q., Jia, Y., Zhao, L. N., Yu, S. X., Liu, H. Y., Liu, B., Yan, Y. H., Xiang, J. Y., Xia, N. H., Peng, H., Li, Z. Y., Zhang, Z. X., He, X. J., Yin, L. K., Lin, Y. L., Liu, Q. R., Hou, Y. T., Liu, Y., Liu, Q. X., Cao, W., Li, J. Q., Chen, S. L., Jin, X. H., Gao, T. G., Chen, W. L., Ma, H. Y., Geng, Y. Y., Jin, X. F., Chang, C. Y., Jiang, H., Cai, L., Zang, C. X., Wu, J. Y., Ye, J. F., Lai, Y. J., Liu, B., Lin, Q., W. & Xue, N. X. (2017). *Threatened Species List of China's Higher Plants.* Biodiversity Science, **25**(7):696-747.

Reels, G.T. (2019). An Annotated Check List of Hong Kong Dragonflies and Assessment of Their Local Conservation Significance. Faunistic Studies in South-east Asian and Pacific Island Odonata. *Journal of the International Dragonfly Fund*, 30:1-49.

Shek, C. T. (2006). *A Field Guide to the Terrestrial Mammals of Hong Kong*. Agriculture, Fisheries and Conservation Department, Hong Kong.

Tam, T.W., Leung, K.K., Kwan, B.S.P., Wu, K.K.Y., Tang, S.S.H., So, I.W.Y., Cheng, J.C.Y., Yuen, E.F.M., Tsang, Y.M., & Hui, W.L. (2011). *The Hong Kong Dragonflies*. Agriculture, Fisheries and Conservation Department, The Government of the Hong Kong Special Administrative Region.

Viney, C., Phillipps, K. & Lam, C. Y. (2005). *The Birds of Hong Kong and South China*. 8th edition. Information Services Department, The Government of the Hong Kong Special Administrative Region.

Zheng, G.M. & Wang, Q.S. (1998). *China Red Data Book of Endangered Animals: Aves*. First Edition. Beijing: Science Press.

8 FISHERIES IMPACT

8.1 Introduction

8.1.1.1 This section presents the potential fisheries impacts generated from the construction and operation of the Project. Baseline conditions for fisheries resources in the 500m assessment area were identified from the latest relevant literature. Potential direct, indirect and cumulative impacts on fisheries resources during the construction and operation of the Project were identified and evaluated.

8.1.1.2 No pond fish culture was identified within the assessment areas of STN1, pond fish culture impact assessment was hence deemed unnecessary.

9 CULTURAL HERITAGE IMPACT

9.1 Introduction

9.1.1.1 This section identifies the cultural heritage resources within the assessment area, and presents the assessment of potential direct and indirect cultural heritage impacts resulting from the construction and operation of the proposed drainage improvement works at eleven project sites. Appropriate mitigation measures are proposed to alleviate the adverse impacts if necessary. The project sites assessed in this section include:

Sha Tin North Drainage Basin

1. Sha Tin Town Centre (STN1)

9.2 Environmental Legislation, Standards and Guidelines

9.2.1.1 The assessment of potential cultural heritage impacts will be carried out by referring to the following guidelines and procedures:

- Environmental Impact Assessment Ordinance (EIAO) (Cap.499)
- Technical Memorandum on the Environmental Impact Assessment Process (EIAO-TM)
- Antiquities and Monuments Ordinance (A&MO) (Cap.53)
- Guidelines for Cultural Heritage Impact Assessment (Guidelines for CHIA)
- Hong Kong Planning Standards and Guidelines (HKPSG)
- Development Bureau Technical Circular (Works) No. 6/2009 – Heritage Impact Assessment Mechanism for Capital Works Projects

9.3 Assessment Methodology

9.3.1.1 The assessment area covers 100m from each of the project sites in Sha Tin (**Figures 2.5**). The assessment methodologies for built heritage and archaeo-logical impact assessments are described as below:

Built Heritages

9.3.1.2 A desk-top review was conducted to identify any built heritage resources based on examination on the following resources:

- List of Proposed and Declared Monuments as issued by the AMO;
- List of the 1,444 Historic Buildings and list of new items with Assessment Results by the Antiquities Advisory Board (AAB);
- Other heritage resources recorded by the AMO, including Government Historic Sites identified by AMO;
- Relevant information from AMO's website;
- All available literatures, including previous including previous EIA Studies, related publications on relevant historical issues, historical, cartographic and pictorial documentations; and
- Unpublished archival papers and records, and collection and libraries of tertiary institutions.

9.3.1.3 The potential direct and indirect impacts that may affect the built heritage resources were assessed by following the procedures and requirements of the Guidelines for Cultural Heritage Impact Assessment (Guideline for CHIA) as at 4 May 2020 and

Annexes 10 and 19 of the EIAO-TM.

Archaeology

9.3.1.4 A desk-top review was conducted to identify any potential existence of archaeological resources. Information collected for the desk-top review includes:

- AMO's List of Sites of Archaeological Interest (SAIs) in Hong Kong;
- Previous related EIA studies and archaeological reports;
- Publications on relevant historical, anthropological, archaeological and other cultural studies;
- Historical documents which could be found in the Public Records Office, Lands Registry, District Lands Office, District Office, Museum of History;
- Geological and historical maps, aerial photos and relevant visual archives; and
- Unpublished archival papers and records, and collection and libraries of tertiary institutions.

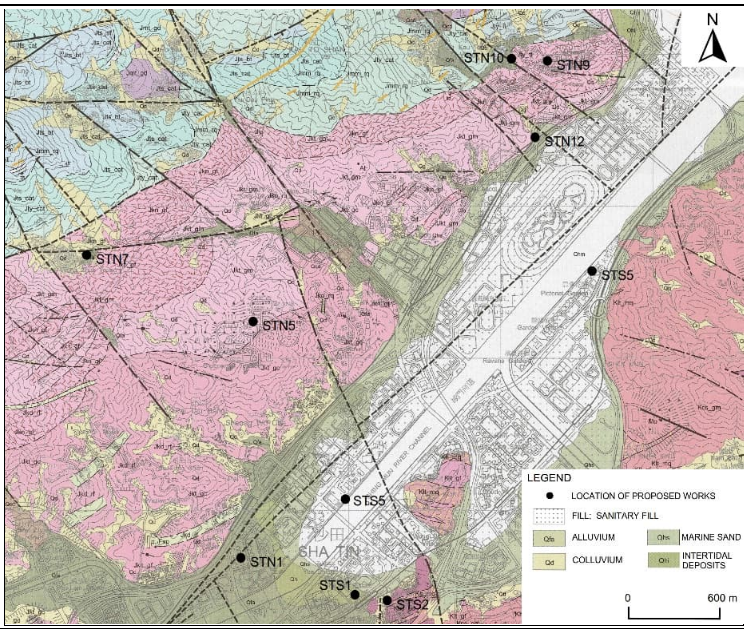
9.3.1.5 The potential archaeological impacts were assessed by following the procedures and requirements of the Guidelines for CHIA as at 4 May 2020 and Annexes 10 and 19 of the EIAO-TM.

9.4 Background of the Project Sites

9.4.1 Geological Background

Sha Tin

9.4.1.1 The project sites in Sha Tin fall into Tolo Channel Fault. The solid geology of the areas is mainly granite pluton (**Plate 9.3**). The superficial deposits of the area are debris flow deposits on the hilly ground and alluvium in the main valleys. Alluvial gravel, sand and mud covered by marine mud with subordinate sand could be identified in the low-lying, coastal and offshore areas[6]. Meanwhile, the coast of Shing Mun River has been largely reclaimed for urban development.



[6] Geotechnical Control Office. (1986). *Hong Kong Geological Survey Memoir No.1: Geology of Sha Tin*. Hong Kong: Civil Engineering Services Department.

Plate 9.1 Geological Map showing the Locations of the Proposed Works in Sha Tin[7]

9.4.2 Historical Background

9.4.2.1 Clues of human settlements in Hong Kong region can be found in historic textual records such as *Lüshi Chunqiu* (呂氏春秋)[8] and *Hanshu* (漢書)[9] written in the first century BC to first century AD. These records describe that Yue (越) ethnic groups scattered in south China. During Qin Period (211-206 BC), the region was subordinated to Panyu (番禺) County. And later Hong Kong region had been subordinated to Xin'an (新安) County since AD1573[10] until AD1912 Xin'an was renamed to Bao'an (寶安) County.

9.4.2.2 Since the 9th century onwards, Pearl River delta was an important salt production centre. Hong Kong was one of the salt production centres in Southern Song Dynasty (AD 1127 -1279). Historic textual records *Yudi Jisheng* (輿地紀勝) and *Songhuiyao Jilu* (宋會要輯錄) describe smuggling related to salt production. Five major clans including the Pangs, Lius, Haus, Mans and Tangs, settled in the New Territories since Southern Song Dynasty[11].

Sha Tin

9.4.2.3 During Ming Dynasty, Sha Tin was famous for production of fragrant wood (香木) as recorded in *Xin'an Gazetteer* (新安縣誌)[17]. In 1661, the Coastal Evacuation Order (遷界令) was implemented by the Qing government. People lived in the coastal area of Canton including the New Territories, were forced to move 25 km inland. People were allowed to move back to the New Territories in 1684 but the coastal population severely dropped. Thus, Hakka people were encouraged to move to the New Territories in the late 17th century. They developed villages at the hillside of Sha Tin and practiced agriculture. Sha Tin Kau Yeuk (九約, "Alliance of Nine Villages") was founded in late Qing Dynasty.

9.5 Baseline Conditions

9.5.1 Built Heritage

Sha Tin

9.5.1.1 No graded built heritage is identified within the 100m assessment areas of all project sites of the proposed drainage improvement works in Sha Tin.

9.5.1.2 If there are any buildings / structures both at grade level and underground which were built in or before 1969, AMO should be alerted in an early stage or once identified.

9.5.2 Archaeology

Sha Tin

9.5.2.1 No Site of Archaeological Interest (SAI) is identified within all the assessment areas

[7] Ibid.
[8] 呂不韋（秦）。《呂氏春秋·侍君覽》。載《諸子集成》 第六冊。北京：中華書局，1954年。
[9] 班固（漢）。《漢書·地理志》。 載《中華書局點校本二十五史》。北京：中華書局，1962年。
[10] 舒懋官（1819）。《嘉慶新安縣志》。載張一兵編《深圳舊誌三種》。深圳：海天出版社，2006年。
[11] 陳國成（2006）。《香港地區史研究之三：粉嶺》。香港：三聯書店。
[17] 劉蜀永（2016）。《簡明香港史 （第三版）》。香港：三聯書店。

in Sha Tin.

9.5.2.2 Though the arable lands near the coasts of Shing Mun River and Tide Cove might have certain archaeological potential before the development of Sha Tin New Town in 1970s, such landforms have been transformed into an urban landscape with reclamation and modern filled land for construction of high-rise buildings and new road networks since 1970s. The project site in Sha Tin is located at existing roads and urban landscape. Thus, the natural terrain of the assessment areas in Sha Tin has been largely modified and the potential archaeological resources may have been removed or seriously disturbed. Archaeological potential of the project sites in Sha Tin is negligible.

9.6 Identification and Evaluation of Cultural Heritage Impacts

9.6.1 Construction Phase

Built Heritage

<u>Sha Tin</u>

9.6.1.1 No graded built heritage is identified within the 100m assessment areas of all project sites of the proposed drainage improvement works in Sha Tin. No impact on graded built heritage would be anticipated at all project sites during the construction phase.

Archaeology

9.6.1.2 Archeological potential of the assessment areas is negligible. No archaeological impact would be anticipated from the proposed works at all project sites.

9.6.2 Operational Phase

Built Heritage and Archaeology

9.6.2.1 No impact would be anticipated on built heritage and archaeology at all project sites during the operational phase.

9.7 Mitigation Measures

9.7.1 Construction Phase

Built Heritage

<u>Sha Tin</u>

9.7.1.1 No mitigation measures would be required for graded built heritage at all project sites of Sha Tin during the construction phase.

Archaeology

9.7.1.2 As a precautionary measure, the contractor should inform AMO immediately when any antiquities or supposed antiquities under the Antiquities and Monuments Ordinance are discovered during the course of works.

9.7.2 Operational Phase

Built Heritage and Archaeology

9.7.2.1 No mitigation measures would be required for built heritage and archaeology at all project sites during the operational phase.

9.8 Conclusion

Built Heritage

9.8.1.1 No graded built heritage is identified within the 100m assessment areas of the project sites of the proposed drainage improvement works in Sha Tin Town Centre. No impact on built heritage would be anticipated at the project sites of Sha Tin Town Centre during the construction and operational phases. Thus, no mitigation measures would be required for built heritage.

Archaeology

Sha Tin

9.8.1.2 No SAI is identified within all the assessment areas in Sha Tin. The project sites in Sha Tin are located at filled land, urban landscape or along existing roads. Archaeological potential of the assessment areas in Sha Tin is negligible. No archaeological impact would be anticipated and no mitigation measure would be required.

9.9 Reference

AECOM. (2016). *Sai Kung Nam Pin Wai Development – Archaeological Consultancy: Archaeological Investigations and Survey-cum-Excavation Report*.

Antiquities Advisory Board. (2020). Historic Building Appraisal – Chan Ancestral Hall. Assessed in November 2020. Retrieved from https://www.aab.gov.hk/historicbuilding/en/645_Appraisal_En.pdf.

Archaeological Team of Sun Yat-sen University. (2000). *Excavation Report on C Sector of Ho Chung Site, Sai Kung, Hong Kong*. Antiquities and Monuments Office archive.

Archaeological Team of Sun Yat-sen University. (2001). *Excavation Report on West Sector of Ho Chung Site, Sai Kung, Hong Kong*. Antiquities and Monuments Office archive.

Environmental Resources Management. (2007). *Proposed Residential Development at Various Lots, D.D. 244, Nam Pin Wai, Sai Kung: Archaeological Investigation Works*.

Geotechnical Control Office. (1986). *Hong Kong Geological Survey Memoir No.1: Geology of Sha Tin*. Hong Kong: Civil Engineering Services Department.

Geotechnical Control Office. (1986). *Hong Kong Geological Survey Memoir No.2: Geology of Hong Kong Island and Kowloon*. Hong Kong: Civil Engineering Services Department.

Geotechnical Control Office. (2008). *Hong Kong Geological Survey Sha Tin Sheet 7: Solid and Superficial Geology (1:20000)*. Hong Kong: Civil Engineering and Development Department.

Geotechnical Control Office. (2012). *Hong Kong Geological Survey Hong Kong and Kowloon Sheet 11: Solid and Superficial Geology (1:20000)*. Hong Kong: Civil Engineering and Development Department.

Hase. P. H. (2003). *The Historical Heritage of Ho Chung, Pak Kong, and Sha Kok Mei, Sai Kung*. S.Y. Consultancy Services Co. Ltd.

Sewell, R.J. (1996). *Geology of Ma On Shan*. Hong Kong: Geotechnical Engineering Office, Civil Engineering Services Department.

Sewell, R.J., Tang, D.L. and Shaw, R. (2009). *Hong Kong Geology: 400-million Year Journey*. Hong Kong: Civil Engineering and Development Department.

Survey and Mapping Office. (1963). 1963-9702 (1:7800) (Flying height: 3900 ft.) [Aerial Photo]. Hong Kong: The Lands Department.

Survey and Mapping Office. (2003). CW52855 (1:8000) (Flying height: 4000 ft.) [Aerial Photo]. Hong Kong: The Lands Department.

呂不韋（秦）。《呂氏春秋·侍君覽》。載《諸子集成》 第六冊。北京：中華書局，1954年。

李慧瑩、鄒桂昌、楊祥利編（2012）。《馬鞍山風物誌：鞍山歲月：小城今昔》。香港：馬鞍山民康促進會。

班固（漢）。《漢書·地理志》。 載《中華書局點校本二十五史》。北京：中華書局，1962年。

陳國成（2006）。《香港地區史研究之三：粉嶺》。香港：三聯書店。

舒懋官（1819）。《嘉慶新安縣志》。載張一兵編《深圳舊誌三種》。深圳：海天出版社，2006年。

劉蜀永（2016）。《簡明香港史 （第三版）》。香港：三聯書店。

10 LANDSCAPE IMPACT ASSESSMENT

10.1 Introduction

10.1.1.1 This chapter is to review and evaluate any potential landscape impact arising from the construction and operation of the proposed drainage improvement works at Sha Tin Town Centre and to propose mitigation measures where necessary to alleviate any potential adverse impact identified.

10.2 Environmental Legislation, Standards and Guidelines

10.2.1.1 The following legislation, standards and guidelines are applicable to landscape impact assessment associated with the construction and operation of the project: -

- Hong Kong Planning Standards and Guidelines Chapters 4, 10 and 11;
- DEVB TCW No. 2/2012 - Allocation of Space for Quality Greening on Roads;
- DEVB TCW No. 6/2015. Maintenance of Vegetation and Hard. Landscape
- Features;
- DEVB TCW No. 4/2020 - Tree Preservation;
- DEVB TC(W) No. 5/2020 – Registration and Preservation of Old and Valuable Trees; and
- Study on Landscape Value Mapping of Hong Kong.

10.3 Assessment Methodology

10.3.1.1 The assessment methodologies for landscape impact assessment are described as below:

- Identification of the construction and operation activities of the drainage improvement works which would cause potential landscape impacts ;
- Identification of the key Landscape Resources (LRs), Landscape Characters Areas (LCAs) Sensitive Receivers (VSRs) that might subject to the impact by the drainage improvement works;
- Assessment of landscape impact due to the proposed drainage improvement works;
- Recommendation of preliminary landscape mitigation measures to the drainage improvement works to minimize any potential adverse impact identified; and
- Evaluation of the residual landscape impact.

10.4 Baseline Findings

10.4.1 General

10.4.1.1 Under this Preliminary Environmental Review, only key Landscape Resources (LRs), Landscape Characters Areas (LCAs) Se /ers(VSRs) which would be potentially affected are identified and discussed.

10.4.1.2 For Landscape Impact Assessment the extent of LIA baseline study shall only cover Landscape Resources and Landscape Character Areas that would be potentially affected by the proposed project. Landscape Resources and Landscape Character Areas that will not be affected is not included and assess.

10.4.2 Landscape Resources (LRs)

<u>Sha Tin Town Centre (STN1) & Shing Mun River Cycle Track</u>

- STN1 & Shing Mun River Cycle Track are located along northwest and northeast sides of Shing Mun River, the footprint of proposed drainage improvement works is relatively long in distance which pass along the edge of Shing Mun River [modified watercourse (LR6)]; and its extent would potentially affect the periphery of On King Street Park and Sha Tin Park [open space (LR2)]; as well as urban developed area (LR4). Some works would extend to limited area of transportation corridor (LR5) like Fo Tan road, Sha Tin Road, Yuen Wo Road, Sha Tin Rural Committee Road, Lion Bridge and Tai Po Road. While other identified LR like LR3 – Village, Squatters Planting is not likely to be affected.
- One Registered Old and Valuable Tree (OVT), OVT no. LCSD ST/16 is located in Sha Tin Park within 100m assessment area of STN1. This identified OVT has sufficient distance away from proposed works area which will not be affected.
- In the light of the above, LR3, LR4, LR5 & LR6 are considered as **low** sensitivity due to their high ability to accommodate change, while LR2 – Open Space is considered as **medium** sensitivity due to its rich variety and sizable area of vegetation including identified OVTs.

10.4.3 Landscape Character Areas (LCAs)

10.4.3.1 The preliminary findings of key LCAs which would be potentially affected by the Project, together with their sensitivity are described below. The locations of key LCAs are mapped in **Figures 10.6**.

<u>Urban Landscape (LCA3)</u>

- The proposed drainage improvement works at STN1 fall within Urban Landscape (LCA3). This LCA is mainly comprised of high-rise residential buildings at Sha Tin New Town (Pristine Villa, Peak One, Villa Le Parc etc), sitting-out areas and amenity areas. This LCA is common in Hong Kong, ability to accommodate change is medium and its sensitivity is considered as **medium**.

<u>Transportation Corridor Landscape (LCA4)</u>

- The proposed drainage improvement works at STN1 fall within Transportation Corridor Landscape (LCA4) which comprises of mainly roadside planting. As it is characterized by mostly artificial structures with very limited greenery, as well as high ability to accommodate changes, its sensitivity is considered as **low**.

10.5 Landscape Impact Assessment

10.5.1.1 The potential landscape impacts due to the proposed drainage improvements works are assessed below.

Sha Tin Town Centre (STN1)

- No pipework would be proposed within the tree protection zone of the OVT.
- Small part of STN1 would pass through LR5 while remaining long section would affect LR2 and LR4 along the northwest edge of Shing Mun River. The magnitude of change to LR5 is considered to be "**small**", the impact significance for LR5 is considered "**slight**" during both construction and operation phase; while the magnitude of change to LR2 & LR4 would be "**Intermediate**", with low sensitivity, the impact significance for LR2 & 4 are considered "**moderate**" during both construction and operation phase.

10.5.2 Landscape Mitigation Measures

10.5.2.1 Based on the potential landscape impacts identified, a series of mitigation measures are recommended below to mitigate any adverse impacts.

a. **Preservation of existing vegetation** – All existing trees to be retained or not be affected by the project shall be carefully protected during construction in accordance with DEVB TC(W) No. 4/2020 – Tree Preservation and the latest guidelines on tree preservation during development issued by GLTM Section of DEVB.

b. **Compensatory Tree Planting** – Any trees to be felled under the Project shall be compensated in accordance with DEVB TC(W) No. 4/2020 – Tree Preservation. The compensatory planting shall not be lower than the number of trees felled.

c. **Reinstatement of landscape areas** – To reinstate all landscape areas disturbed temporarily during construction on like to like basis or for better quality.

d. **Aesthetical pleasing design of all man-made structures** – design considerations in regards of layout, massing, form, materials and finishes. The design shall be sensitively designed to enhance the surrounding context.

10.5.3 Evaluation of Residual Impacts

10.5.3.1 By assuming the proposed mitigation measures are implemented, the predicted residual landscape impact of the proposed development shall bereduced to “in-substantial”, which is considered to be an acceptable level.

11 LAND CONTAMINATION IMPLICATIONS

11.1 Introduction

11.1.1.1 This section presents review of the potential land contamination impacts associated with STN1 proposed drainage improvement works under the Project.

11.2 Environmental Standards and Guidelines

11.2.1.1 The relevant environmental guidelines and standards for land contamination assessment include the following:

- Guidance Note for Contaminated Land Assessment and Remediation (Guidance Note) - The Guidance Note sets out the requirements for proper assessment and management of potentially contaminated sites such as oil installations (e.g. oil depots, petrol filling stations), gas works, power plants, shipyards/boatyards, chemical manufacturing/processing plants, steel mills/metal workshops, car repairing/dismantling workshops and scrap yards. In addition, this Guidance Note provides guidelines on how site assessments should be conducted and analysed and suggests practical remedial measures that can be adopted for the remediation of contaminated sites.
- Practice Guide for Investigation and Remediation of Contaminated Land (Practice Guide) - This guide outlines typical investigation methods and remediation strategies for the range of potential contaminants typically encountered in Hong Kong.
- Guidance Manual for Use of Risk-based Remediation Goals for Contaminated Land Management (Guidance Manual) - The Guidance Manual introduces the risk based approach in land contamination assessment and present

instructions for comparison of soil and groundwater data to the Risk-Based Remediation Goals (RBRGs) for 54 chemicals of concern (COCs) commonly found in Hong Kong. The RBRGs were derived to suit Hong Kong conditions by following the international practice of adopting a risk-based methodology for contaminated land assessment and remediation and were designed to protect the health of people who could potentially be exposed to land impacted by chemicals under four broad post restoration land use categories. The RBRGs also serve as the remediation targets if remediation is necessary.

11.3 Assessment Methodology

11.3.1.1 A site appraisal was conducted to identify any current / historical potentially contaminating land uses within the 11 locations for proposed drainage improvement works. The site appraisal, including site walkover and desktop review, was carried out with reference to the Guidance Note, Guidance Manual and Practice Guide.

11.3.1.2 The site walkover was conducted within locations for proposed drainage improvement works to identify any existing contaminative land uses and contamination sources (or 'hotspots'). For the desktop review, the following information was reviewed:

- Available records of dangerous goods, chemical wastes, chemical spillage/leakage and fire incidents from Environmental Protection Department (EPD) and Fire Services Department (FSD);
- Final Desk Study Report for Ground Investigation, Laboratory Testing and Groundwater Table Survey under the Project;
- Hong Kong Geological Survey Map (Series HGM20) – Sheet No. 7 & 8 (1:20,000); and
- Selected aerial photographs and topographic maps held by the Lands Department.

11.3.1.3 If potentially contaminated land use(s) were identified within locations for proposed drainage improvement works, the potential land contamination impacts to the Project would be evaluated and the appropriate mitigation measures would be recommended.

11.4 Identification of Potential Land Contamination Impacts

11.4.1 Proposed Works and the Potential Land Contamination Implications associated with the Existing Landuses.

11.4.1.1 The locations of proposed drainage improvement works under of the Project were described in **Section 2**, and are illustrated in **Figure 2.0 and 2.5.**

11.4.1.2 The proposed works, in the context of land contamination implications, are discussed below.

11.4.2 Review of Historical Land Uses

11.4.2.1 A review of historical aerial photographs and topographic maps available in the Survey and Mapping Office of Lands Department was undertaken. The aim of the review is to identify any historical land uses within STN1 proposed drainage improvement works that may have potential contamination implications to the Project. Findings of the review are discussed below. Aerial photographs reviewed are provided in **Appendix 11.1**.

<u>Sha Tin Town Centre (STN1)</u>

11.4.2.2 A summary of the historical land uses is presented in **Table 11.1 Error! Reference**

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Table 11.1 Summary of Historical Land Uses for STN1

Year (Photo Ref. No.)	Drawing No. in Appendix 11.1	Site Description
1963 (#1963-5453)	AP12	The Project site was mainly occupied by agricultural land and vacant land. Temporary structures and a landing strip were also observed.
1983 (#48582)	AP13	The temporary structures and agricultural land were cleared as construction sites. Existing Tai Po Road – Sha Tin, Sha Tin Centre Street and Pak Hok Ting Street were observed.
1993 (#CN03224)	AP14	Existing Yi Ching Lane and Sha Tin Park were observed.
2003 (#CW53159)	AP15	No significant land use changes were observed.
2018 (#E038805C)	AP16	No significant land use changes were observed.

11.4.2.3 Based on the review of aerial photographs, no historical potentially contaminating land uses were identified within the Project site at STN1.

11.4.3 Site Walkover

11.4.3.1 Site walkovers were conducted on 12 and 13 November 2020, and 13 April 2021 to investigate any land contamination issues associated with the current land uses within the Project sites. The site walkover checklists are attached in **Appendix 11.2**.

Sha Tin Town Centre (STN1)

11.4.3.2 The proposed drainage improvement works at STN1 covers the existing Tai Po Road – Sha Tin, Sha Tin Centre Street, Pak Hok Ting Street, Yi Ching Lane and Sha Tin Park. No potentially contaminating land uses / activities were observed during the site walkover.

11.4.3.3 Photographic records, along with the site layout plan, are shown in **Figure 11.5**. The site walkover checklist is provided in **Appendix 11.2-3**.

11.4.4 Acquisition of Information from Government Departments

11.4.4.1 The view from Environmental Protection Department (EPD) and Fire Services Department (FSD) have been sought and findings will be updated once their reply is received.

11.4.5 Site Geology

Sha Tin Town Centre (STN1)

Superficial Geology

11.4.5.1 At Sha Tin Town Centre (STN1), generally 1.5m to 9.4m thick of fill layer with silt to gravel sized was encountered on the top. A layer of marine deposits (typically clay to silt) with thickness ranging from 2m to 11m was found below the fill layer. Approximately 1.94m to 12.2m thick of alluvium (typically silt to gravel) was identified below the marine deposits. Besides, a layer of colluvium (typically clay and silt) with thickness up to 7.5m was also encountered below the marine deposits/alluvium.

Solid Geology

11.4.5.2 Saprolite encountered typically comprised highly to completely decomposed granite with thickness ranging from 0.6m to 32.25m. The inferred rockhead level varies from -41.12mPD to +25.42mPD. In general, the weathering profile appeared to become deeper towards the northeast. The bedrock was typically described as moderately strong to strong, moderately to slightly decomposed granite.

Groundwater Level

11.4.5.3 Referring to the limited groundwater monitoring records, shallow groundwater table was identified, which is generally from 0.45m to 4.51m below ground level.

Groundwater Level

11.4.5.4 Referring to the limited groundwater monitoring records, shallow groundwater table was identified, which is generally from 0.45m to 4.51m below ground level.

11.5 Evaluation of Potential Land Contamination Impacts

Sha Tin Town Centre (STN1)

11.5.1.1 Based on the findings of site appraisal, the Project site has been occupied by non-contaminating land uses (e.g. the existing park and road) and no potentially contaminating activities were observed. No land contamination impacts are anticipated for the drainage improvement works at STN1.

11.6 Environmental Monitoring and Audit

11.6.1.1 Based on the site appraisal, no land contamination impacts are anticipated for STN1 proposed drainage improvement works under the Project. As such, no environmental monitoring is considered necessary.

11.7 Conclusion

11.7.1.1 A site appraisal, in the form of desktop review and site walkover, had been carried out between December 2019 and April 2021 to identify the past and current potentially contaminating land uses within STN1 proposed drainage improvement works.

11.7.1.2 Based on findings of the site appraisal, no adverse land contamination impacts are anticipated for these locations of the proposed drainage improvement works.

12 ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENTS

12.1 Introduction

12.1.1.1 This section elaborates the requirements of environmental monitoring and audit (EM&A) for the construction and operation phases of the Project, based on the assessment results of the various environmental issues. The objectives of carrying out EM&A for the Project include the following:

- to provide a database against which any short- or long-term environmental impacts of the Project can be determined;
- to provide an early indication shall any of the environmental control measures or practices fail to achieve the acceptable standards;
- to monitor the performance of the Project and the effectiveness of mitigation measures;
- to verify the environmental impacts predicted;
- to determine project compliance with regulatory requirements, standards and government policies;
- to provide a plan for remedial action if unexpected problems or unacceptable impacts arise; and
- to provide data to enable an environmental audit.

12.1.1.2 The following sections summarize the recommended EM&A requirements for the various environmental impacts of this Project.

12.2 Air Quality Impact

12.2.1.1 Weekly site audit is recommended to be undertaken during the construction phase to ensure the proposed dust suppression measures in **Section 3** are implemented in an appropriate manner and are effective.

12.2.1.2 No EM&A is considered necessary during operational phase.

12.3 Noise Impact

12.3.1.1 With the implementation of the recommended mitigation measures in **Section 4**, no unacceptable residual construction noise impact would be anticipated. No noise monitoring during construction phase is considered necessary. Weekly site audit shall be carried out to inspect the construction activities and works areas in order to ensure the recommended mitigation measures are being implemented and are effective.

12.3.1.2 No EM&A is considered necessary during operational phase.

12.4 Water Quality Impact

12.4.1.1 No adverse water quality impact would be anticipated during the construction phase. Thus, water quality monitoring is considered not necessary. However, weekly site audit is recommended to be undertaken during the construction phase to ensure the proposed mitigation measures in **Section 5** are implemented in an appropriate manner and are effective.

12.4.1.2 No adverse water quality impacts would be anticipated during the operational phase that no EM&A requirement is considered necessary.

12.5 Waste Management Implications

12.5.1.1 Waste management would be the contractor’s responsibility to ensure that all wastes produced during the construction of the Project are handled, stored and disposed of in accordance with good waste management practices and EPD’s regulations and requirements. The recommended mitigation measures in **Section 6** shall form the basis of the site's WMP, as part of EMP, to be developed by the Contractors and submitted to Engineer for approval before construction in accordance to ETWB TCW No. 19/2005. Regular inspection shall be conducted to ensure proper management and handling of waste, and appropriate implementation of the mitigation measures.

12.5.1.2 No EM&A requirement is considered necessary during the operational phase.

12.6 Ecological Impact

12.6.1.1 Adverse ecological quality impact would not be anticipated during the construction of the proposed drainage improvement works at all assessed sites with the implementation of the recommended mitigation measures. Thus, ecological monitoring is considered not necessary. However, weekly site audit is recommended to be undertaken during the construction phase to ensure the proposed mitigation measures are implemented in an appropriate manner and are effective.

12.6.1.2 No adverse ecological impacts would be anticipated during the operational phase that no EM&A requirements are considered necessary.

12.7 Fisheries Impact

12.7.1.1 No fisheries impacts are anticipated for the Project that no EM&A requirement is considered necessary.

12.8 Cultural Heritage Impact

12.8.1.1 For the proposed works in Ho Chung (HC4), a Condition survey should be undertaken for the Grade 1 Historic Building – Che Kung Temple (Sai Kung) prior to the construction of the project. All the significant features should be recorded and their vulnerability should be assessed. The Condition Survey Report should list all proposed protective measures as well as any additional measures that are required as a result of the findings of the condition survey.

12.8.1.2 Vibration monitoring should be undertaken during the construction works to ensure that safe levels of vibration are not exceeded. The Alert, Alarm and Action (AAA) vibration limit will be set at 3/4/5 mm/s. It should be noted that the condition survey report should highlight if the limit should be lowered after the detailed study of the condition of the building. Details of monitoring should be included in the condition survey report for AMO approval.

12.8.1.3 No cultural heritage impacts are anticipated for the proposed drainage improvement works at all other sites that no EM&A requirement is considered necessary.

12.9 Landscape Impact

12.9.1.1 Tree preservation would be the contractor's responsibility to ensure all existing trees to be retained in proper condition during the construction phase in accordance with DEVB TC(W) No. 4/2020. Contract specification particularly for the tree preservation of OVT shall be included in accordance with DEVB TC(W) No. 5/2020.

12.9.1.2 No EM&A requirement is considered necessary during the operational phase.

12.10 Land Contamination Impact

12.10.1.1 No land contamination impacts are anticipated for the Project that no EM&A requirement is considered necessary.

13 CONCLUSIONS

13.1 Introduction

13.1.1.1 This PER Report has provided a review of the potential environmental impacts associated with the construction and operation of the proposed drainage improvement works that are non-DPs in STN1, based on the engineering design information available at this stage.

13.1.1.2 The assessment has been conducted, in accordance with the PER Study Brief, covering the following environmental issues:

- Air Quality Impact
- Noise Impact
- Water Quality Impact
- Waste Management Implications
- Ecological Impact
- Fisheries Impact
- Cultural Heritage Impacts
- Landscape Impacts
- Land Contamination Implications

13.1.1.3 The findings of this PER study have information on the likely nature and extent of environmental impacts arising from the construction and operation of the Project. The PER has predicted that the Project would be environmentally acceptable with the implementation of the recommended mitigation measures for construction and operation phases.

13.1.1.4 The assessment results for each environmental aspect are summarised in the following sections.

13.2 Air Quality Impact

13.2.1.1 Potential air quality impact during construction phase would be fugitive dust generated from wind erosion of the excavated areas and stockpiles, and dusty construction activities. Given the nature and limited scale of the proposed drainage improvement works, potential air quality impact dust emissions would be minor and localised. With the implementation of regular site watering and good construction practices for dust minimization, construction dust impacts are not expected to be significant on the surrounding sensitive receivers. Requirements of *Air Pollution Control (Construction Dust) Regulation* and *EPD's Recommended Pollution Control Clauses for Construction Contracts* are proposed to be incorporated into the contract.

13.2.1.2 No air pollution source is identified from the operation of any elements of the Project itself that no air quality impacts would be anticipated.

13.3 Noise Impact

13.3.1.1 During the construction phase, the unmitigated noise levels at the representative NSRs would experience noise level exceeding the relevant daytime construction noise criteria from the construction of storm drains using both open-cut and trenchless methods, construction of flood wall, as well as the construction of stormwater storage tank. To alleviate the noise impact, noise mitigation measures including the adoption of good site practices, use of quiet plant and provision of movable noise barrier / noise insulating fabric / silencer were recommended. With implementation of the recommended mitigation measures, no exceedance of the noise criteria was predicted at all NSRs.

13.3.1.2 Provided that the fixed plants for the stormwater pumping station at STN1 are properly designed to meet the maximum permissible SWL, no operational phase noise impacts would be anticipated. Commissioning test should be conducted prior to operation of the pumping station to ensure that fixed plant noise would comply with the relevant noise standards.

13.4 Water Quality Impact

13.4.1.1 The key water quality impact associated with the proposed drainage improvement works would be related to the land-based construction works, particularly those in the immediate proximity of inland water. The impact may result from construction site runoff, debris, refuse and liquid spillages from general construction activities, and sewage effluents from the construction workforce. With proper implementation of the recommended mitigation measures, no adverse water quality impacts would be anticipated.

13.4.1.2 In the operational phase, no additional pollution loading is anticipated from the improved drainage system as it has not introduced additional catchment from its original design. The operation of the proposed drainage improvement works does not constitute any elements that would be water pollution sources. No adverse water quality impacts would be anticipated.

13.5 Waste Management Implications

13.5.1.1 During construction phase, waste types generated from the Project would likely include C&D materials (from site clearance, excavation, concreting works etc.), chemical wastes from maintenance of construction plant and equipment, and general refuse from workforce. Provided that these wastes are handled, transported and disposed of according to the recommended good site practices and measures, adverse environmental impacts would not be anticipated during the construction phase.

13.5.1.2 During the operational phase, small quantities of screenings, silt, debris and chemical wastes would be anticipated from the operation and maintenance of stormwater pumping stations and drainage pipes/storage ponds. With implementation of the recommended mitigation measures, adverse environmental impacts would not be anticipated during operational phase.

13.6 Ecological Impact

13.6.1.1 The Project sites in Sha Tin Town Centre (STN1) consist of developed area , plantation and woodland habitats, which have low to low-moderate ecological values. The surrounding habitats are mostly developed areas and not of high ecological value. No species of conservation importance were spotted within the proposed Project sites.

13.6.1.2 Direct impact would be habitat loss but the habitat loss in STN1 would be temporary with negligible to minor impacts anticipated. Indirect impacts through disturbances to the surrounding habitats and species of conservation importance including the Penfold Park Egretry, the ardeid night roost and flight path along Shing Mun River Channel would be insignificant to minor. Impact on water quality would also be insignificant. Mitigation measures should be implemented to minimize the disturbances e.g. noise, glare and dust during the construction period.

13.7 Fisheries Impact

13.7.1.1 All proposed drainage improvement works in STN1 are land-based which are situated at considerable distance from the marine environment.

13.7.1.2 The proposed works would not result in direct impact to any fisheries resources and the potential indirect impacts are expected to be insignificant. No fisheries impact is anticipated during the construction and operation of the proposed improvement works, and hence, mitigation measure and environmental audit and monitoring are not necessary.

13.8 Cultural Heritage Impact

Built Heritage

13.8.1.1 No built heritage is identified within the 100m assessment areas of the project sites of the proposed drainage improvement works in STN1. No impact on built heritage would be anticipated at the project sites of STN1 during the construction and operational phases. Thus, no mitigation measures would be required for built heritage.

Archaeology

Sha Tin

13.8.1.2 No SAI is identified within all the assessment areas in Sha Tin. The project sites in Sha Tin are located at filled land, urban landscape or along existing roads. Archaeological potential of the assessment areas in Sha Tin is negligible. No archaeological impact would be anticipated and no mitigation measure would be required.

13.9 Landscape Impact

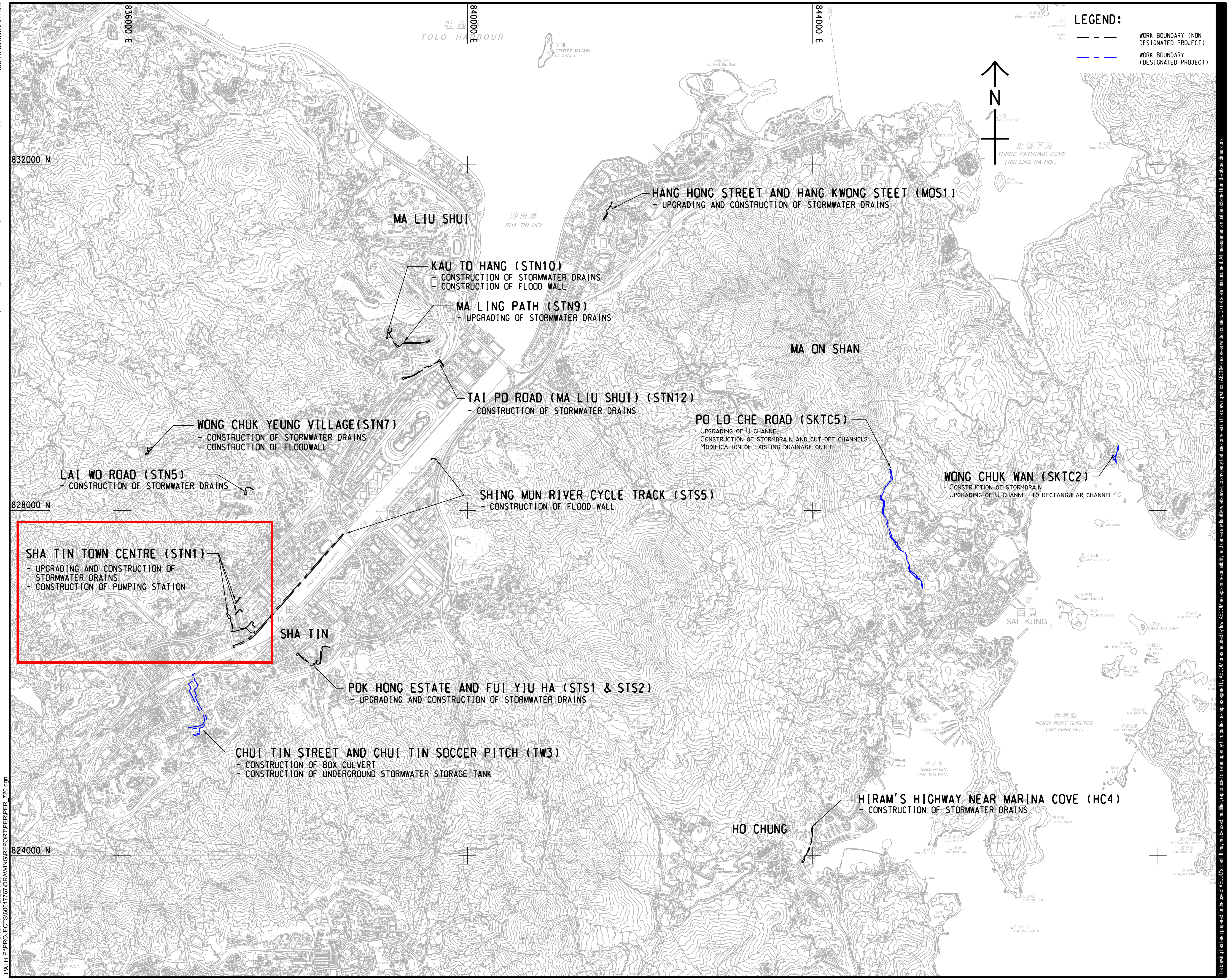
13.9.1.1 Based on the potential landscape impacts identified, a series of preliminary landscape mitigation measures in the construction and operation phase are recommended to mitigate any adverse impacts. With theimplementation of proposed mitigation measures, it is considered that the residual landscape impact will be reduced to an acceptable level.

13.10 Land Contamination

13.10.1.1 A site appraisal, in the form of desktop review and site walkover, had been carried out between December 2019 and April 2021 to identify the past and current potentially contaminating land uses STN1 proposed drainage improvement works.

13.10.1.2 Based on findings of the site appraisal, no adverse land contamination impacts are anticipated for these locations of the proposed drainage improvement works.

FIGURES



AECOM

PROJECT

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT

渠務署 Drainage Services Department

CONSULTANT

AECOM Asia Company Ltd.
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SUB-CONSULTANTS

ISSUE/REVISION

I/R	DATE	DESCRIPTION	CHK.

STATUS

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DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60617767

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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG (KEYPLAN)

SHEET NUMBER

60617767/PER/FIGURE 2.0

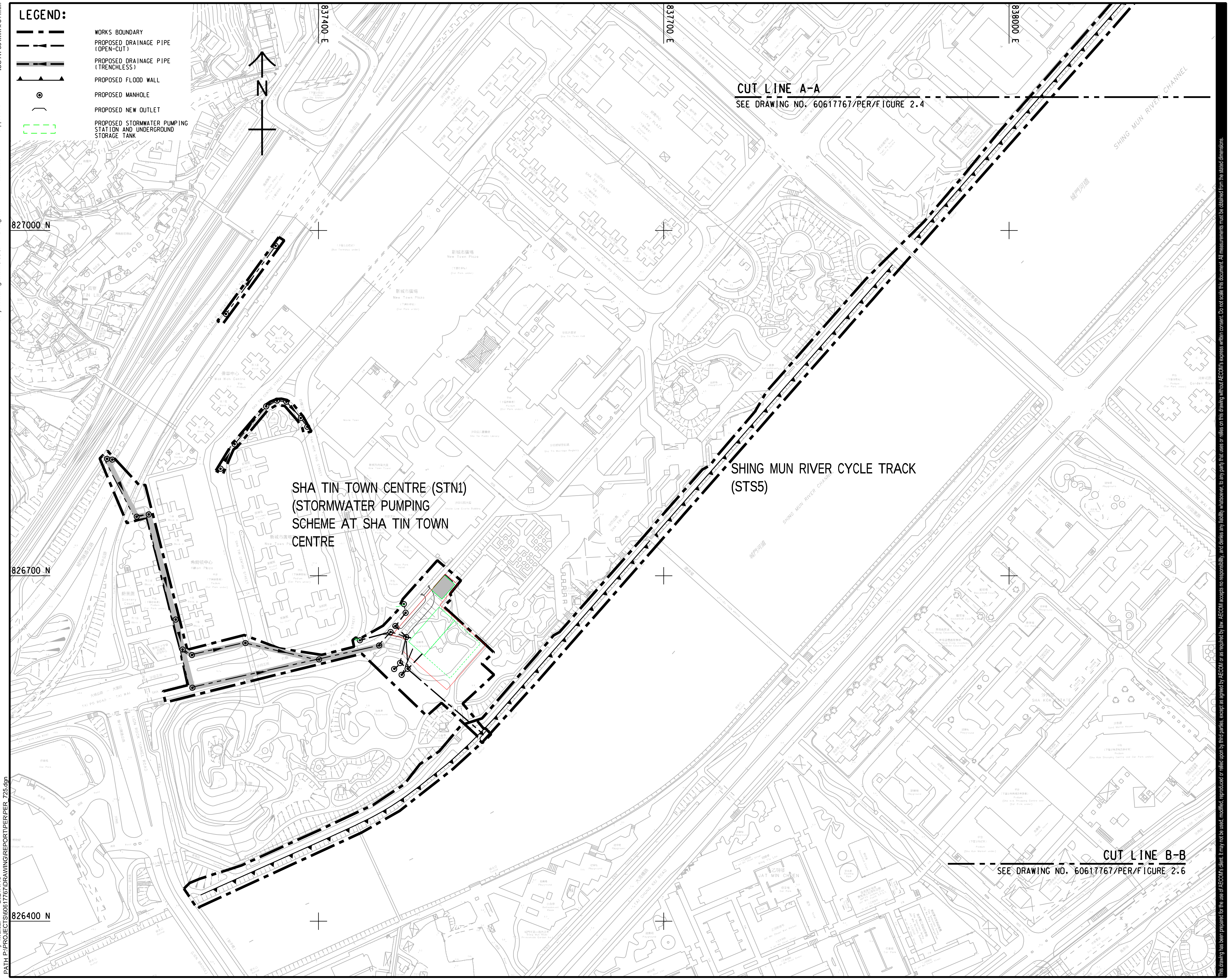
ISO A1 594mm x 841mm

Approved:

Checked:

Designer:

Project Management Initials:



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STATUS

SCALE A3 1 : 3000

DIMENSION UNIT METRES

KEY PLAN

PROJECT NO. 60617767

AGREEMENT NO. CE 15/2019 (DS)

SHEET TITLE

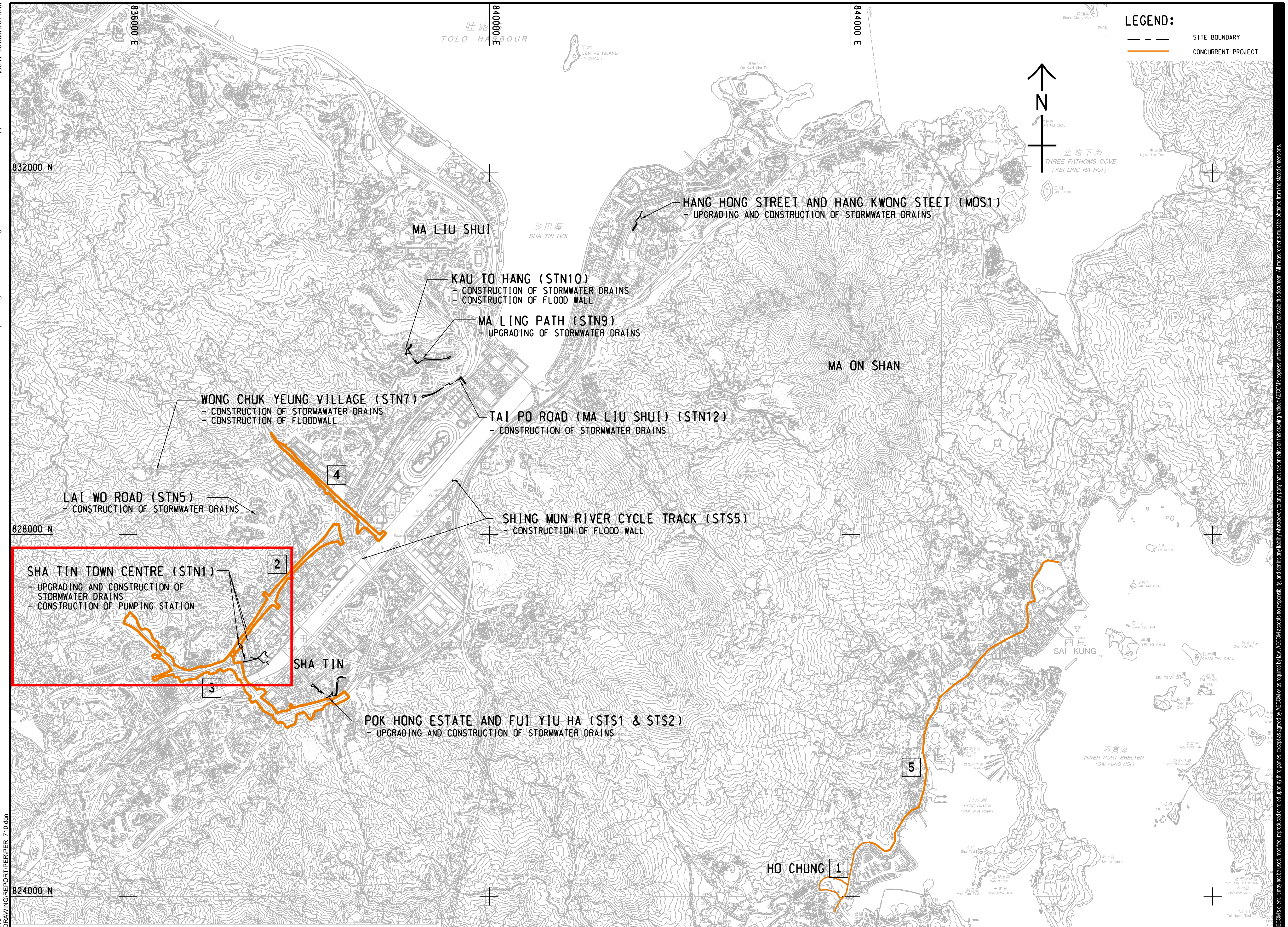
DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG

SHEET 5 OF 9

SHEET NUMBER

60617767/PER/FIGURE 2.5

Plot File by: riva.cai 2021/1/13
PATH P:\PROJECTS\60617767\DRAWING\REPORT\PER\PER_725.dgn



ID	Interfacing Project
2	Widening of Tai Po Road (Sha Tin Section)
3	Revised Trunk Road T4 and Associated Improvement Works in Sha Tin

ISO A1 594mm x 841mm

Approved:

Checked:

Designer:

Project Management Initials:

Plot File by: riva.cai 2021/5/10
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SCALE: A3 1 : 40000

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60617767

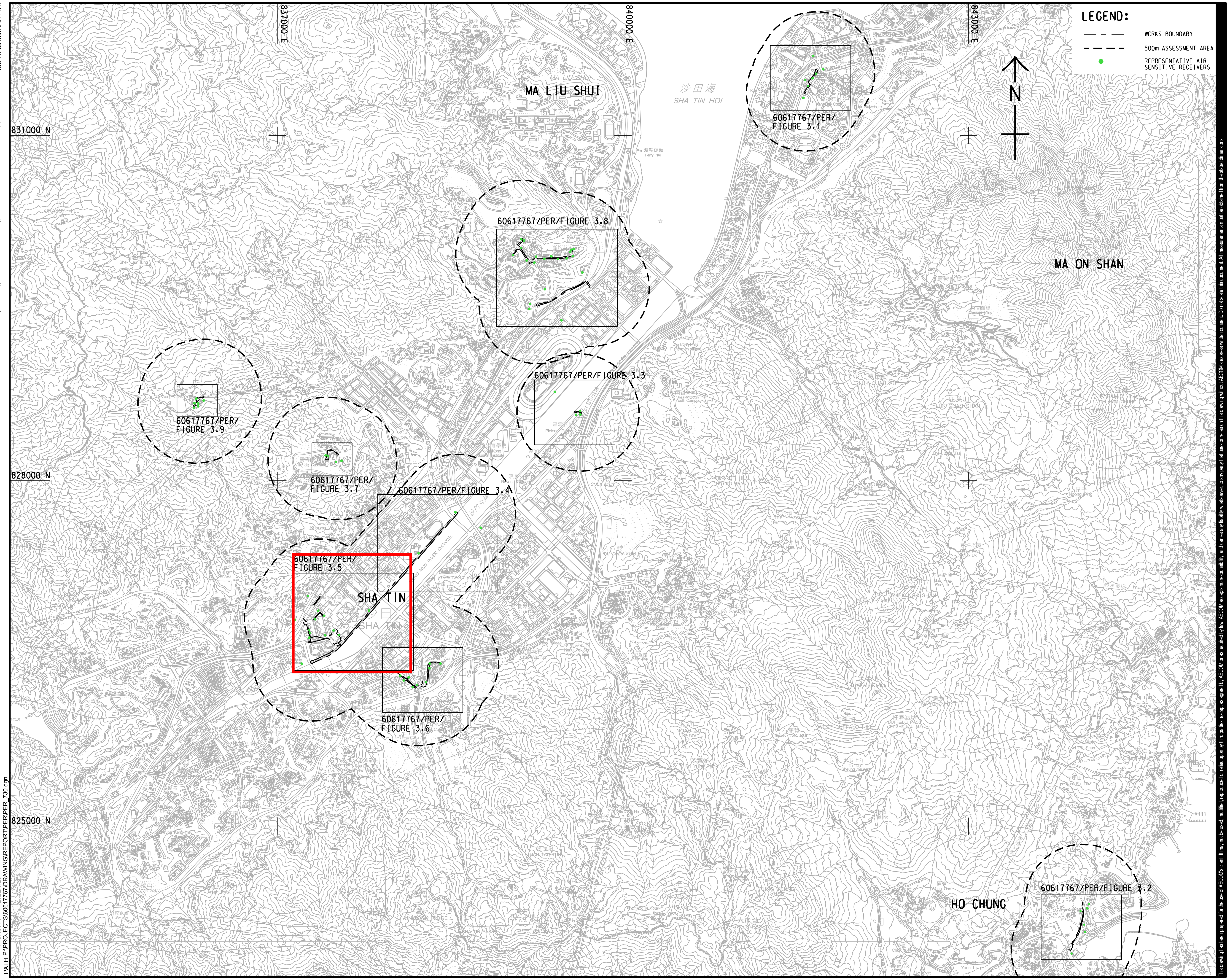
AGREEMENT NO.: CE 15/2019 (DS)

SHEET TITLE

INTERACTION WITH OTHER PROJECTS

SHEET NUMBER

60617767/PER/FIGURE 2.10



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STATUS 階段

SCALE 比例: A3 1 : 30000

DIMENSION UNIT 尺寸單位: METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號: 60617767

AGREEMENT NO. 協議編號: CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

REPRESENTATIVE AIR SENSITIVE RECEIVERS (KEY PLAN)

SHEET NUMBER 圖紙編號

60617767/PER/FIGURE 3.0

ISO A1 594mm x 841mm
Project Management Initials: Designer: Checked: Approved:
Plot File by: CAOPA 2022/1/29
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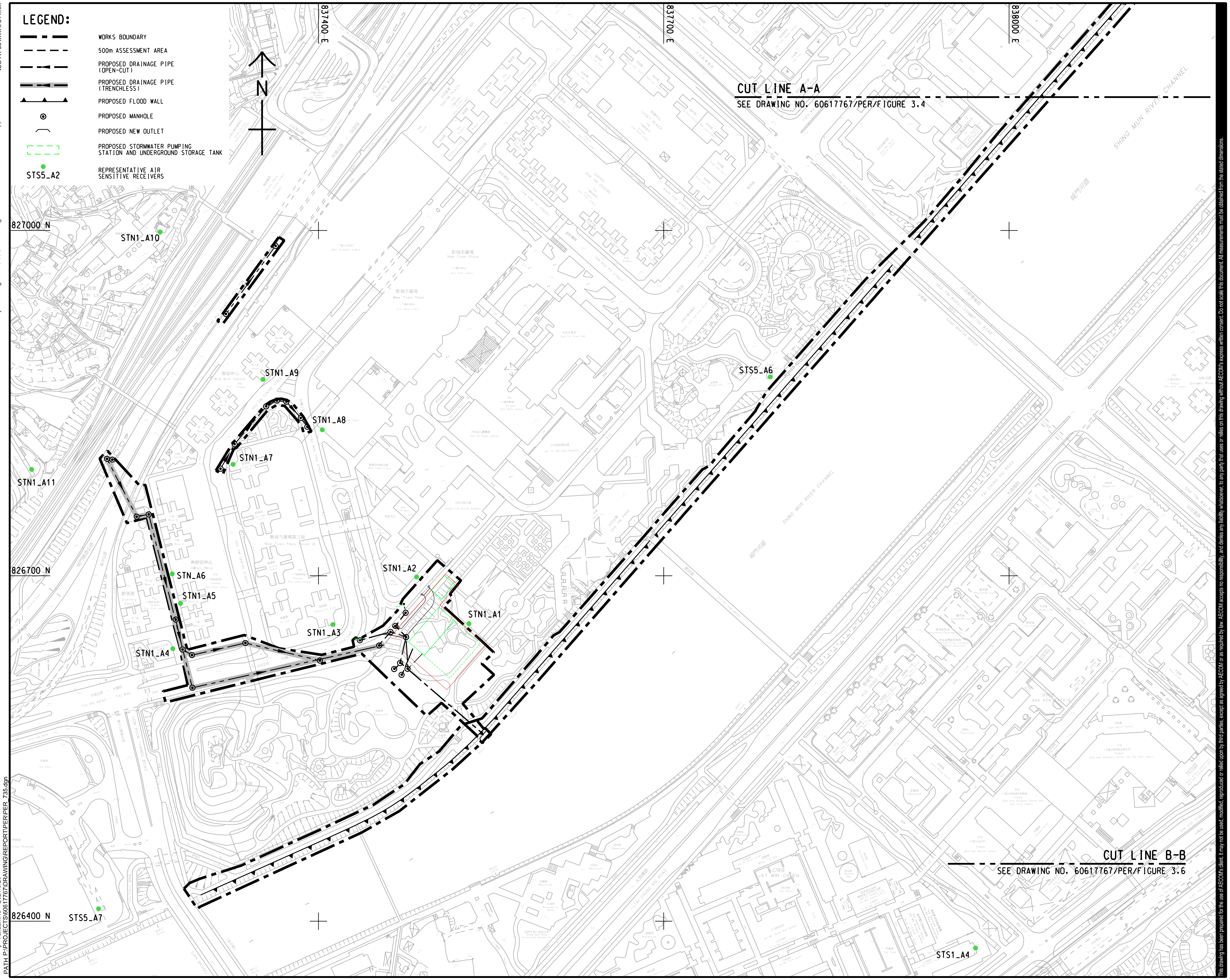

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STATUS

SCALE: A3 1 : 3000

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60617767

AGREEMENT NO.: CE 15/2019 (DS)

SHEET TITLE

REPRESENTATIVE AIR SENSITIVE RECEIVERS

SHEET 5 OF 9

SHEET NUMBER

60617767/PER/FIGURE 3.5

ISO A1 594mm x 841mm

Approved:

Checked:

Designer:

Project Management Initials:

Plot File by: Yuxuan.He 2021/5/20
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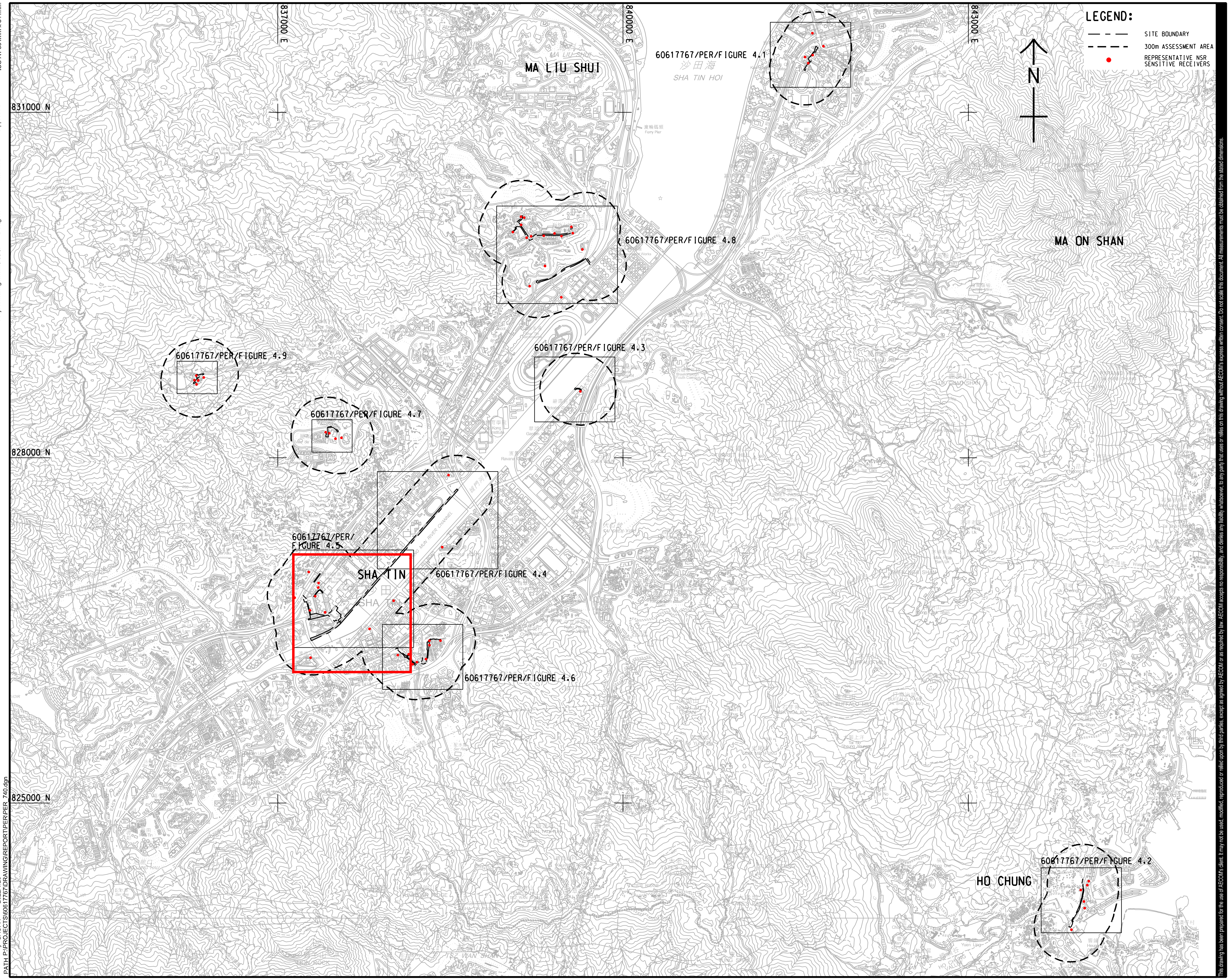

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PROJECT 項目

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SCALE 比例

A3 1 : 30000

DIMENSION UNIT 尺寸單位

METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號

60617767

AGREEMENT NO. 協議編號

CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

REPRESENTATIVE NOISE SENSITIVE RECEIVERS (KEYPLAN)

SHEET NUMBER 圖紙編號

60617767/PER/FIGURE 4.0

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:
Plot File by: CAOPA 2022/1/29
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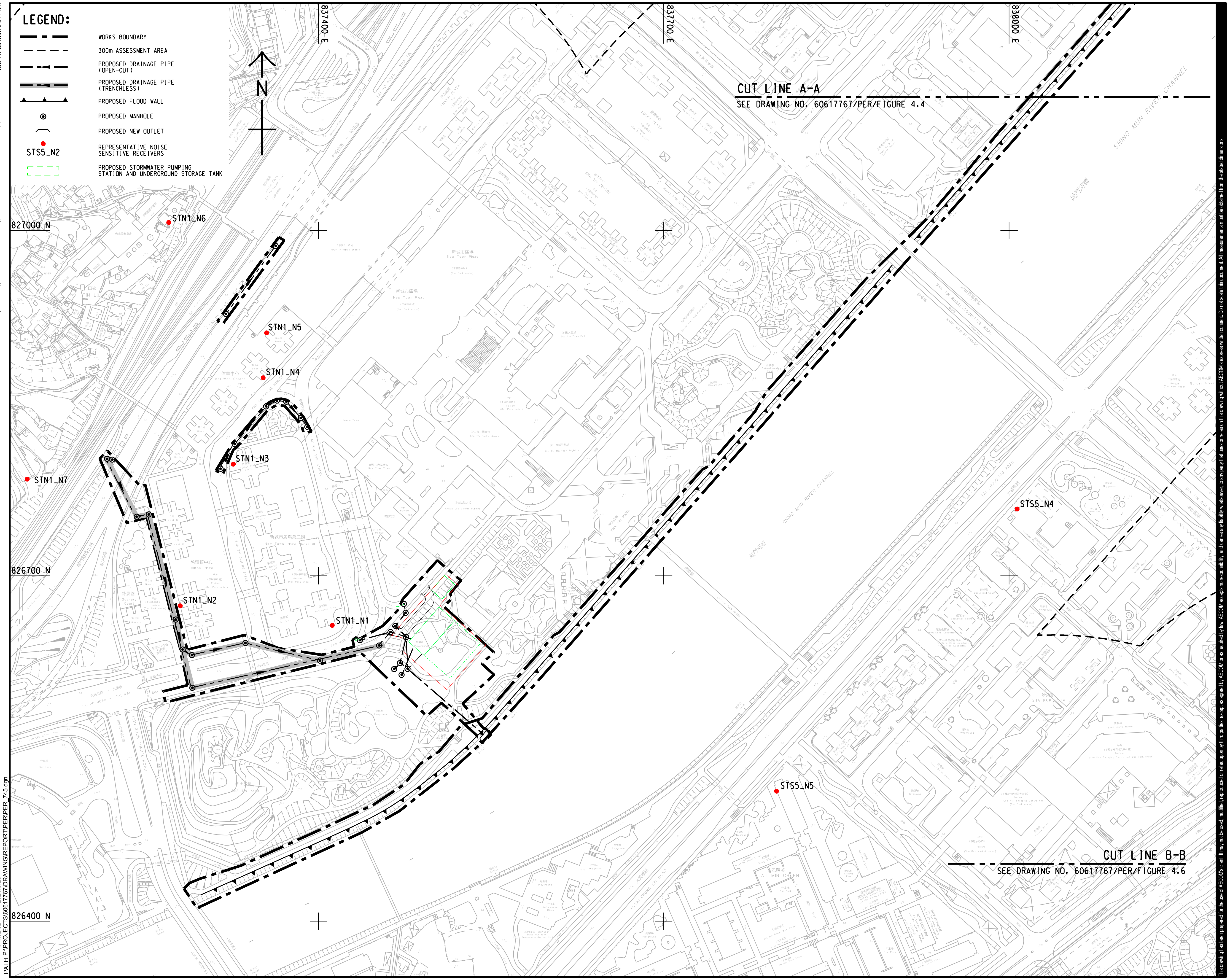

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SCALE 比例: A3 1 : 3000

DIMENSION UNIT 尺寸單位: METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號: 60617767

AGREEMENT NO. 協議編號: CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

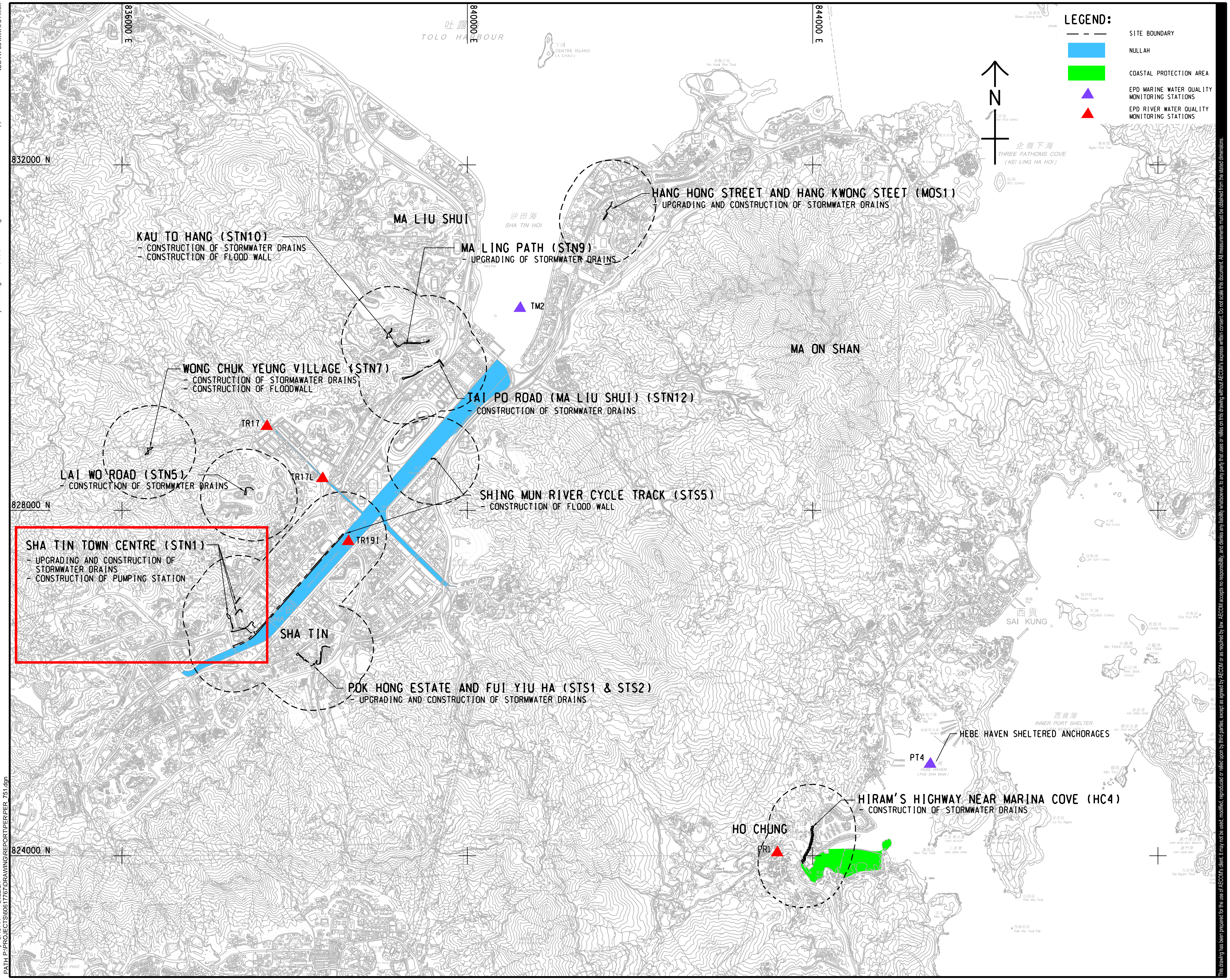
REPRESENTATIVE NOISE SENSITIVE RECEIVERS

SHEET 5 OF 9

SHEET NUMBER 圖紙編號

60617767/PER/FIGURE 4.5

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:
Plot File by: riva.cai 2021/5/20
PATH P:\PROJECTS\60617767\DRAWING\REPORT\PER\PER_745.dgn



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STATUS

SCALE: A3 1 : 40000

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60617767

AGREEMENT NO.: CE 15/2019 (DS)

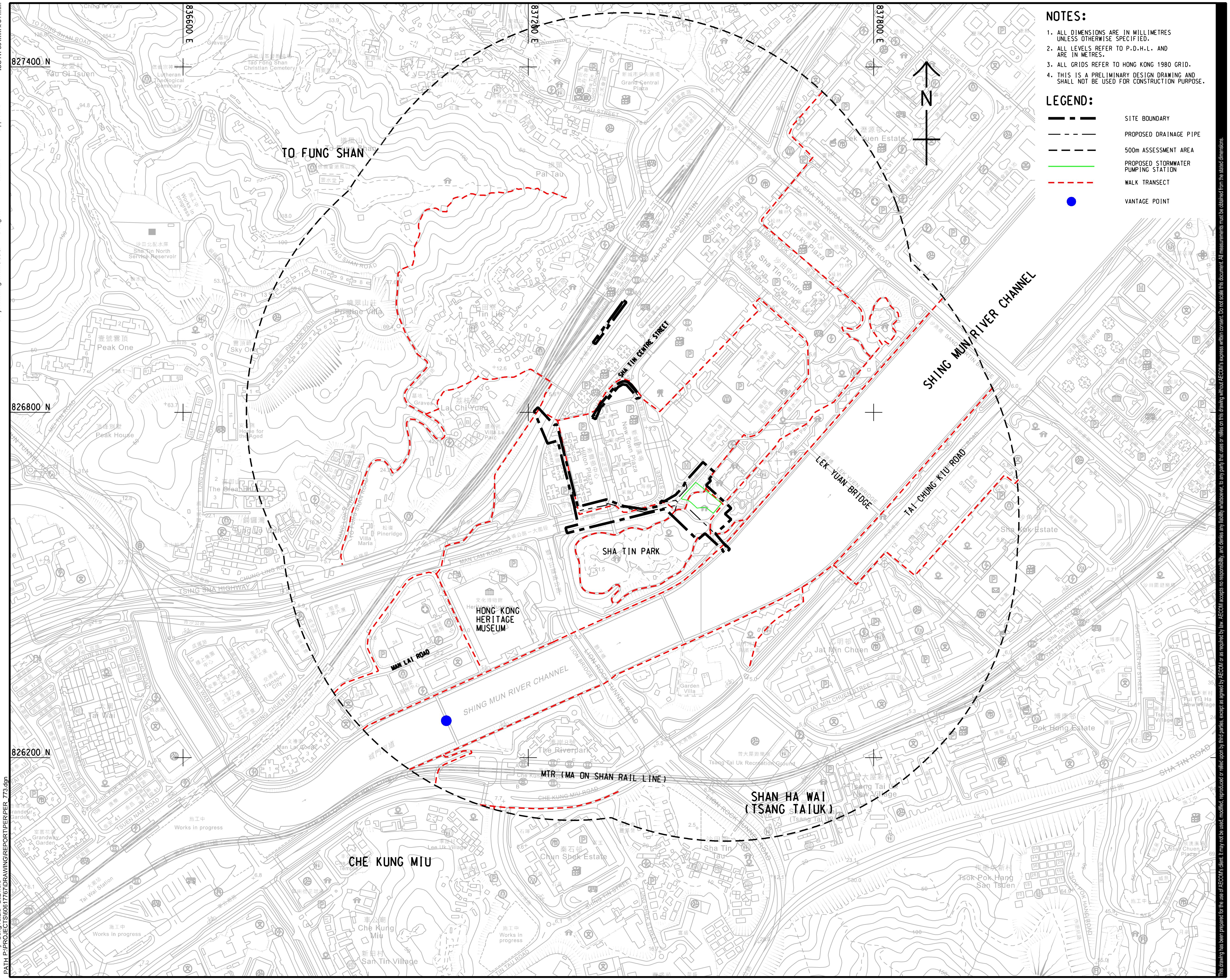
SHEET TITLE

KEY WATER SENSITIVE RECEIVERS

SHEET NUMBER

60617767/PER/FIGURE 5.1

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:
Plot File by: CAOPA 2022/2/7
PATH P:\PROJECTS\60617767\DRAWING\REPORT\PER\PER_751.dgn



Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm

Plot File by: GongYu.Liu 2021/5/5
PATH P:\PROJECTS\60617767\DRAWING\REPORT\PER\PER_773.dgn

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STATUS 階段

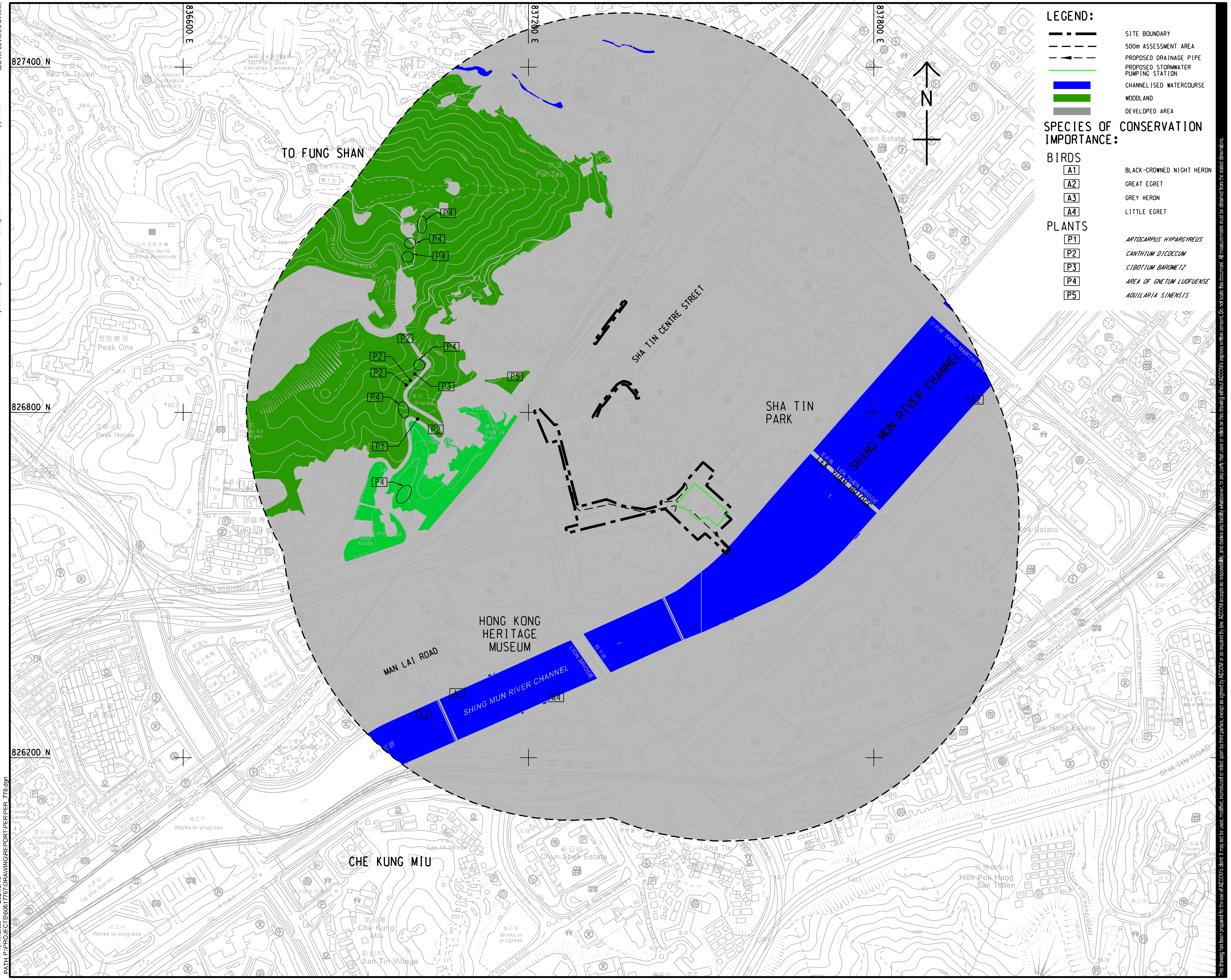
SCALE 比例 A3 1 : 6000
DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號 60617767
AGREEMENT NO. 協議編號 CE 15/2019 (DS)

SHEET TITLE 圖紙名稱
ECOLOGICAL ASSESSMENT AREA OF SHA TIN TOWN CENTRE (STN1)

SHEET NUMBER 圖紙編號
60617767/PER/FIGURE 7.3



ISO A1 594mm x 841mm

Project Management Initials: Designer: Checked: Approved:

Plot File by: riva.cai 2021/5/10

PATH: P:\PROJECTS\60617767\DRAWING\REPORT\PER\PER_778.dgn

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STATUS

SCALE A3 1 : 6000

DIMENSION UNIT METRES

KEY PLAN

PROJECT NO. 60617767

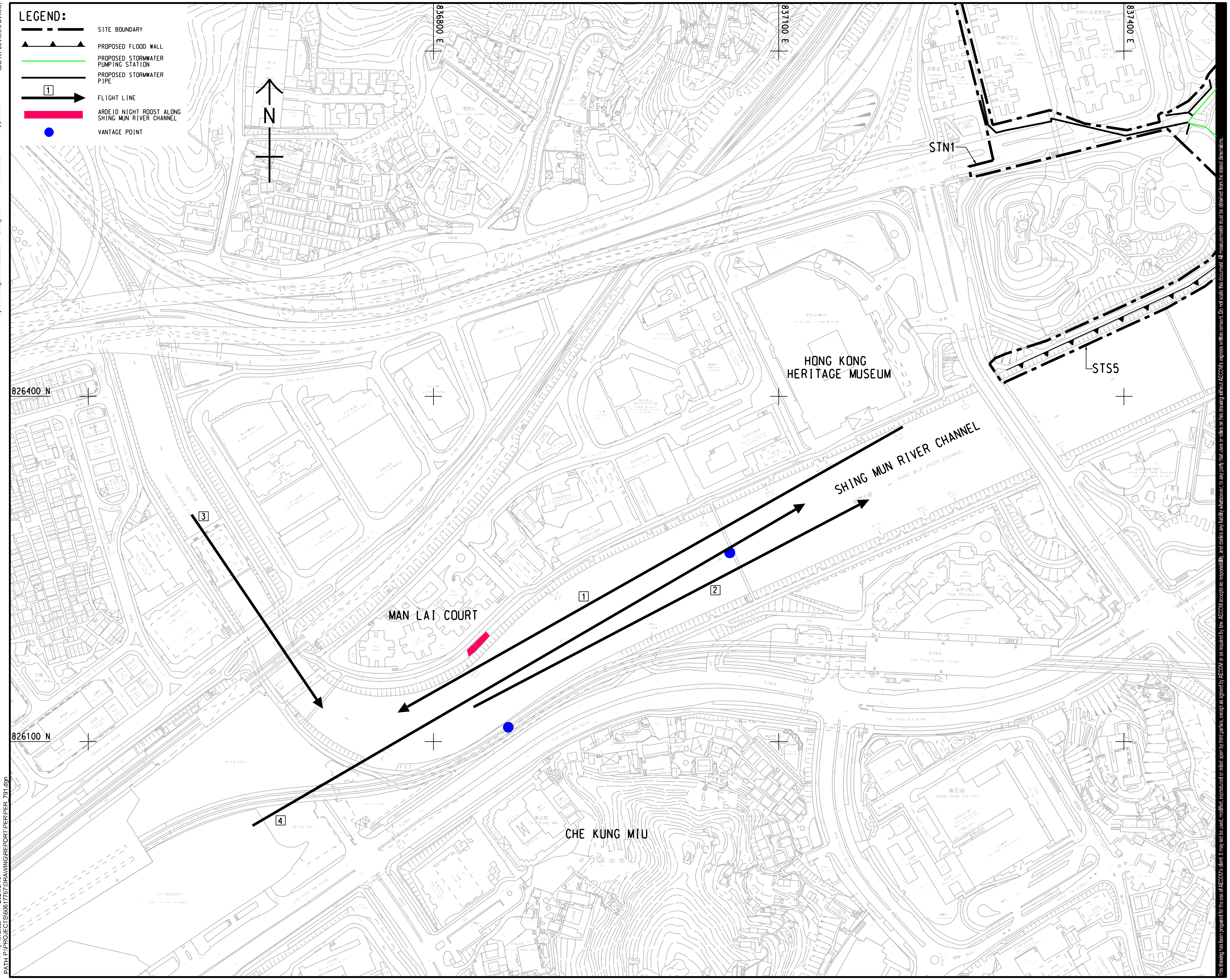
AGREEMENT NO. CE 15/2019 (DS)

SHEET TITLE

HABITAT MAP AND LOCATIONS OF SPECIES OF CONSERVATION IMPORTANCE OF SHA TIN TOWN CENTRE (STN1)

SHEET NUMBER

60617767/PER/FIGURE 7.8



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STATUS

SCALE: A3 1 : 3000

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60617767

AGREEMENT NO.: CE 15/2019 (DS)

SHEET TITLE

ARDEID NIGHT ROOST AND FLIGHT LINE ALONG SHING MUN RIVER CHANNEL

SHEET NUMBER

60617767/PER/FIGURE 7.11

ISO A1 594mm x 841mm

Approved:

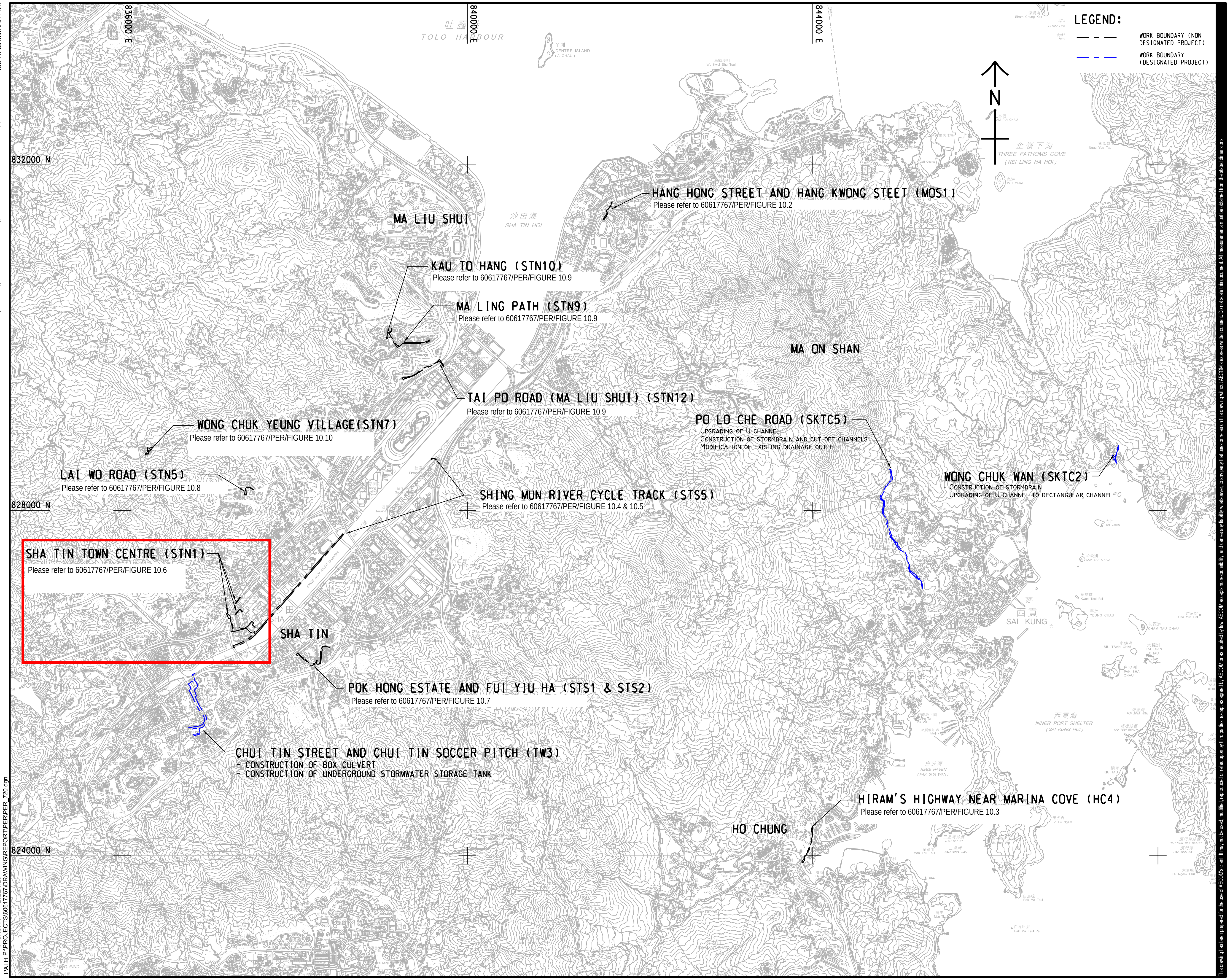
Checked:

Designer:

Project Management Initials:

Plot File by: riva.cai 2021/5/10

PATH P:\PROJECTS\60617767\DRAWING\REPORT\PER\PER_791.dgn



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I/R	DATE	DESCRIPTION	CHK.

STATUS

SCALE	DIMENSION UNIT
A3 1 : 40000	METRES

KEY PLAN

PROJECT NO.	AGREEMENT NO.
60617767	CE 15/2019 (DS)

SHEET TITLE

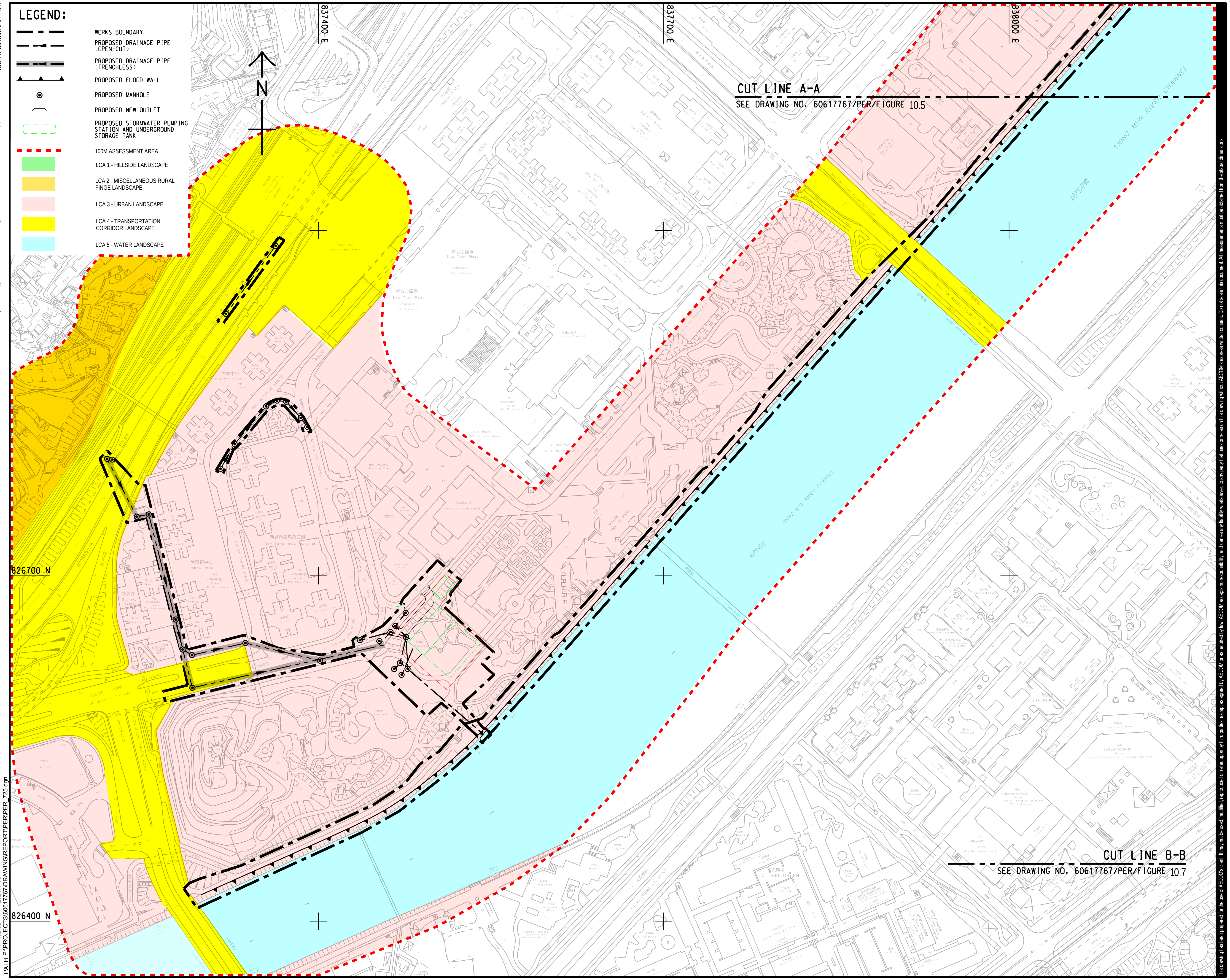
LOCATION OF LANDSCAPE CHARACTER AREAS (KEY PLAN)

SHEET NUMBER

60617767/PER/FIGURE 10.1

ISO A1 594mm x 841mm Approved: Checked: Designer: Project Management Initials:

Plot File by: CAOPA 2022/1/29
PATH P:\PROJECTS\60617767\DRAWING\REPORT\PER\PER_720.dgn



ISO A1 594mm x 841mm

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Designer:

Project Management Initials:

Plot File by: riva.cai 2021/1/13

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STATUS 階段

SCALE 比例: A3 1 : 3000

DIMENSION UNIT 尺寸單位: METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號: 60617767

AGREEMENT NO. 協議編號: CE 15/2019 (DS)

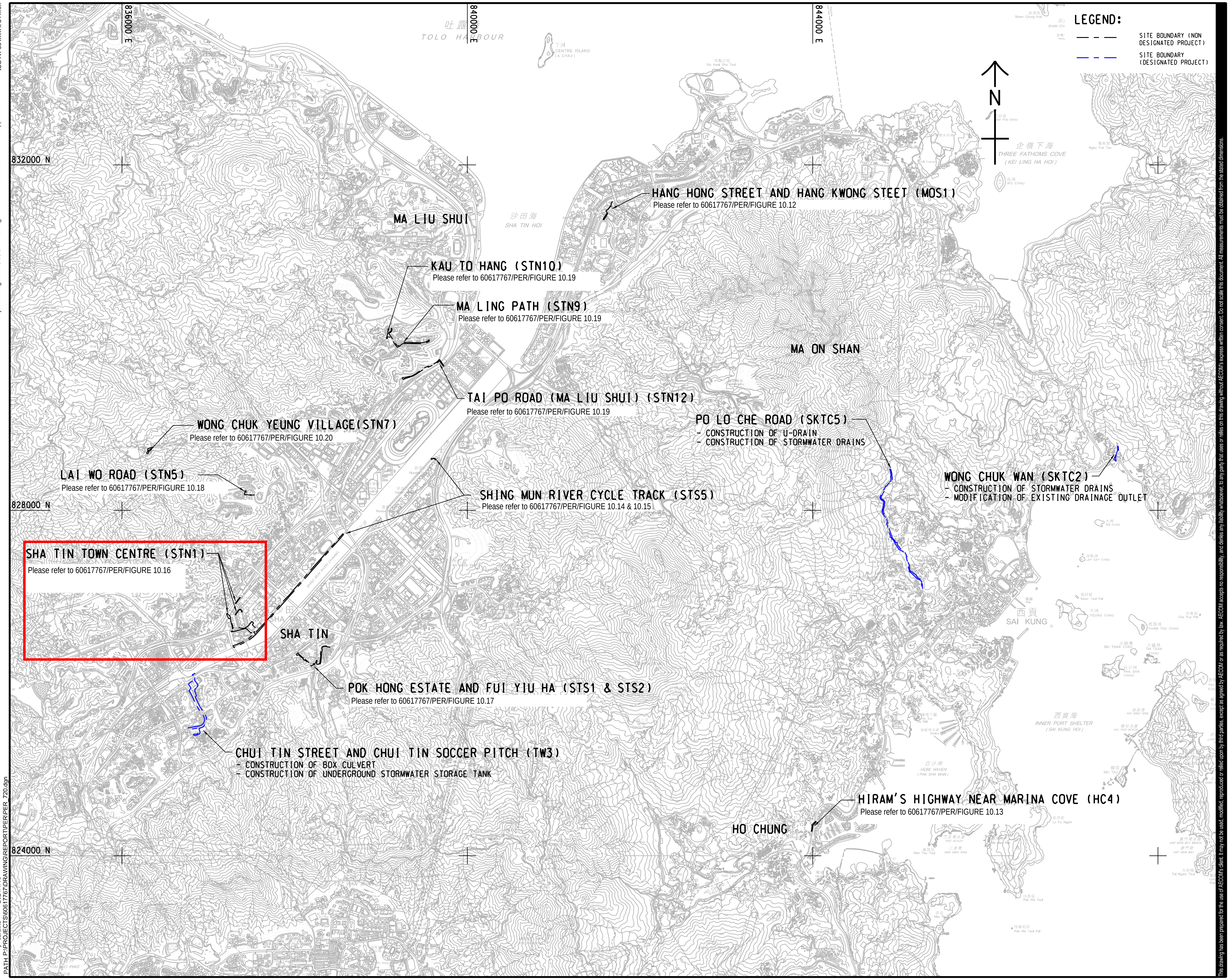
SHEET TITLE 圖紙名稱

LOCATION OF LANDSCAPE CHARACTER AREAS

SHEET 5 OF 9

SHEET NUMBER 圖紙編號

60617767/PER/FIGURE 10.6



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STATUS

SCALE: A3 1 : 40000

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60617767

AGREEMENT NO.: CE 15/2019 (DS)

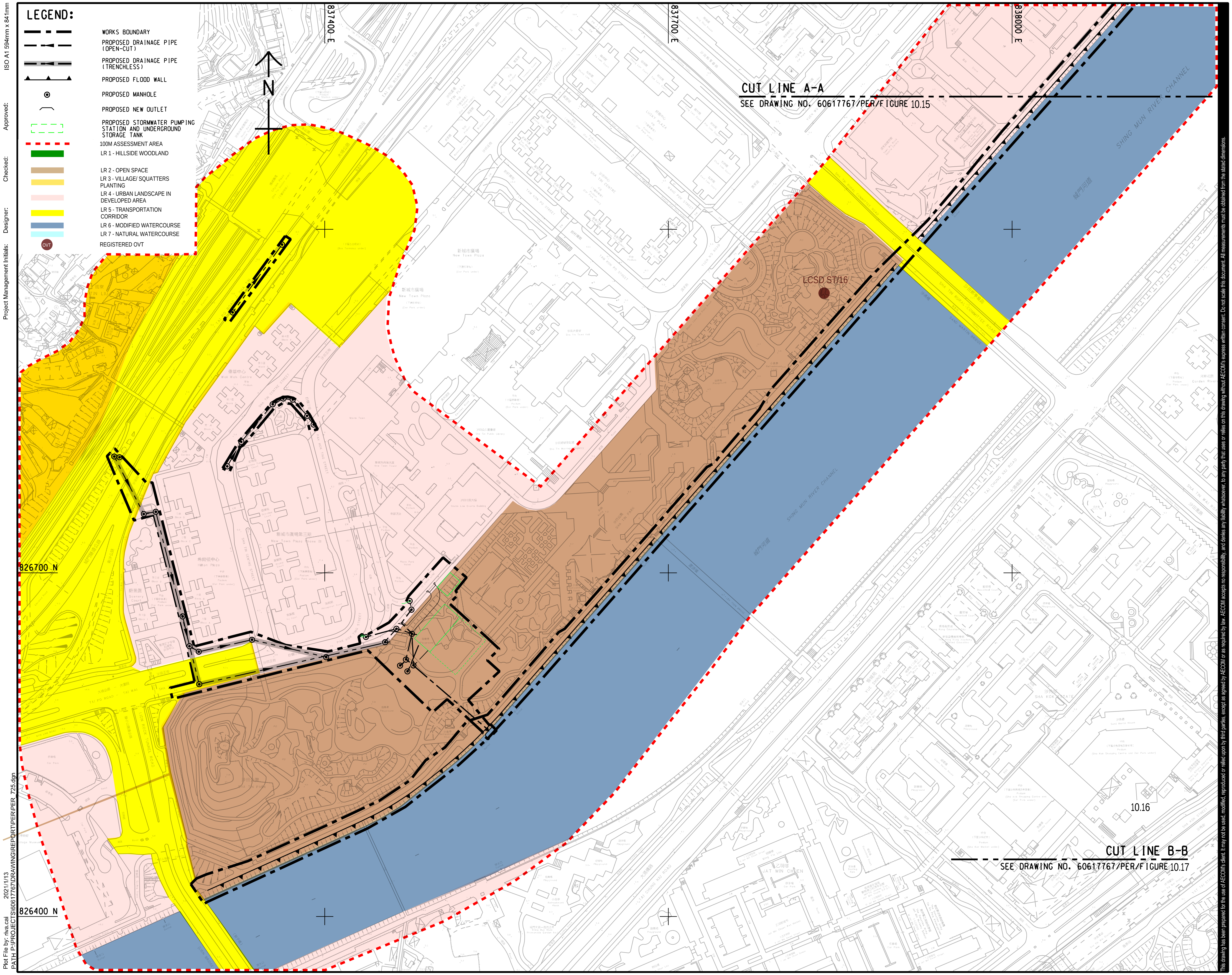
SHEET TITLE

LOCATION OF LANDSCAPE RESOURCES (KEY PLAN)

SHEET NUMBER

60617767/PER/FIGURE 10.11

Plot File by: cara.xu 2021/1/19
PATH P:\PROJECTS\60617767\DRAWING\REPORT\PER\PER_720.dgn
Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm



ISO A1 594mm x 841mm

Approved:

Checked:

Designer:

Project Management Initials:

Plot File by: riva.cai 2021/1/13
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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

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STATUS 階段

SCALE 比例: A3 1 : 3000

DIMENSION UNIT 尺寸單位: METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號: 60617767

AGREEMENT NO. 協議編號: CE 15/2019 (DS)

SHEET TITLE 圖紙名稱
LOCATION OF LANDSCAPE RESOURCES

SHEET 5 OF 9

SHEET NUMBER 圖紙編號
60617767/PER/FIGURE 10.16

ISO A1 594mm x 841mm

Approved: Checked: Designer: Project Management Initials:

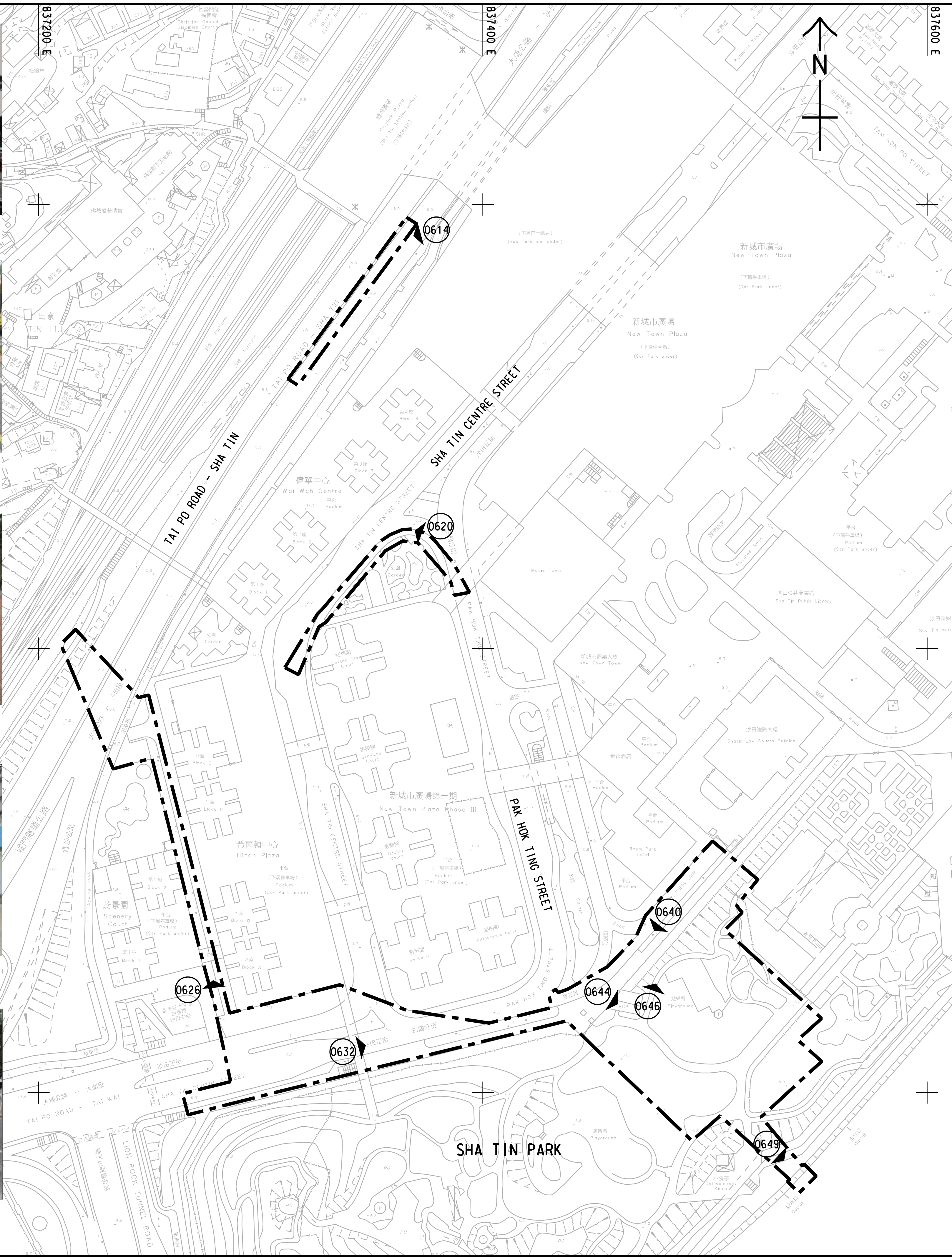

PHOTO 0614: TAI PO ROAD - SHA TIN
(DATE TAKEN: 13 NOVEMBER 2020)

PHOTO 0620: FOOTPATH AT SHA TIN CENTRE STREET
(DATE TAKEN: 13 NOVEMBER 2020)

PHOTO 0632: PAK HOK TING STREET
(DATE TAKEN: 13 NOVEMBER 2020)

PHOTO 0626: FOOTPATH
(DATE TAKEN: 13 NOVEMBER 2020)

PHOTO 0640: YI CHING LANE
(DATE TAKEN: 13 NOVEMBER 2020)

PHOTO 0644: REFUSE COLLECTION POINT OF SHA TIN PARK
(DATE TAKEN: 13 NOVEMBER 2020)

PHOTO 0646: FOOTPATH AND PLAYGROUND OF SHA TIN PARK
(DATE TAKEN: 13 NOVEMBER 2020)

PHOTO 0649: FITNESS CONRNER AT SHA TIN PARK
(DATE TAKEN: 13 NOVEMBER 2020)

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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

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SCALE 比例 A3 1 : 2000

DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號 60617767

AGREEMENT NO. 協議編號 CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

PHOTOGRAPHIC RECORDS OF SITE WALKOVER (STN1)

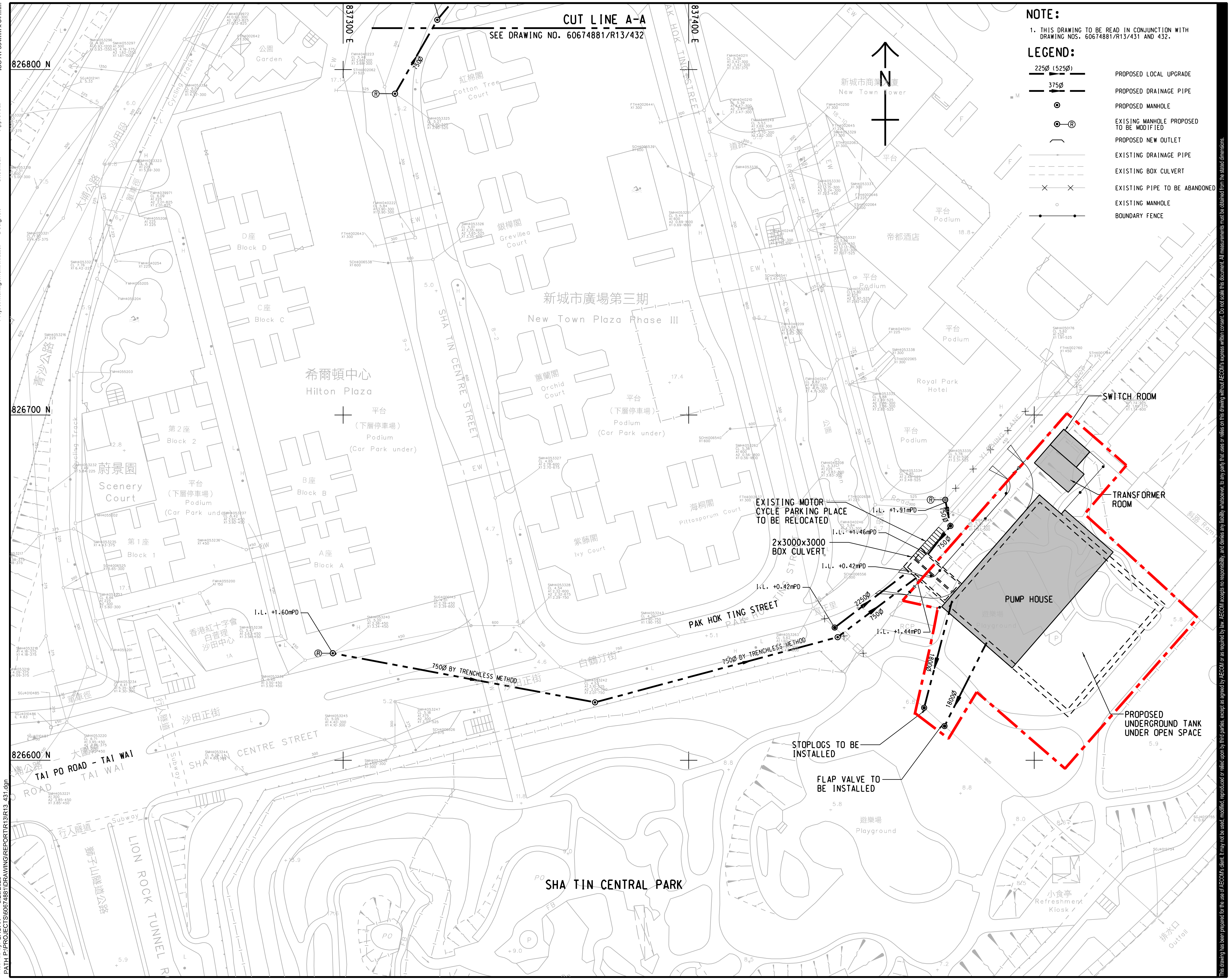
SHEET NUMBER 圖紙編號

60617767/PER/FIGURE 11.5

Plot File by: riva.cai 2020/12/30
PATH: P:\PROJECTS\60617767\DRAWING\REPORT\PER\PER_785.dgn

APPENDICES

Appendix 1.1
General Layout Plan of Drainage Improvement Works in Sha Tin and Sai Kung



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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

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STATUS
階段

SCALE
比例
A1 1 : 500

DIMENSION UNIT
尺寸單位
METRES

KEY PLAN A1 1 : 20000
索引圖

PROJECT NO.
項目編號
60674881

CONTRACT NO.
合約編號
CE 44/2021 (DS)

SHEET TITLE
圖紙名稱

PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN TOWN CENTRE (STN1)

SHEET 1 OF 2

SHEET NUMBER
圖紙編號

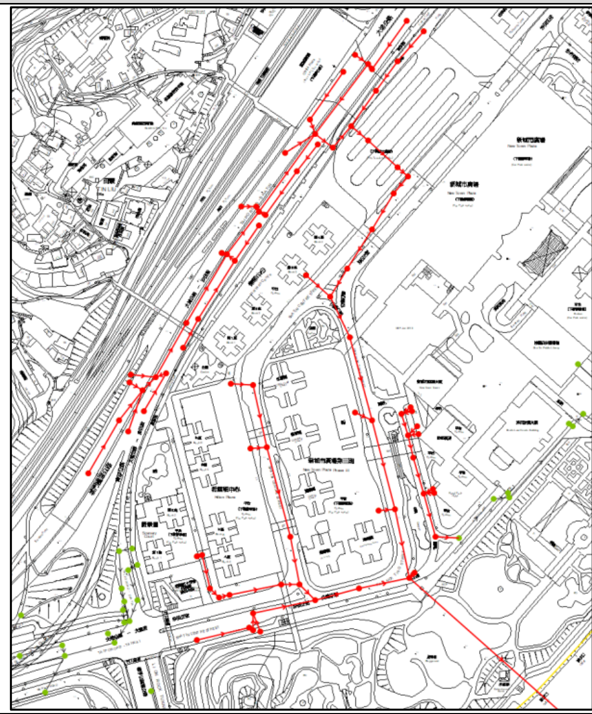
60674881/R13/431

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:

Plot File by: CAOPA 9/26/2023
PATH P:\PROJECTS\60674881\DRAWING\REPORT\R13\R13_431.dgn

Appendix 2.1
Existing Drainage Conditions of Project Sites

Appendix 2.1 Existing Drainage Condition of Project Sites

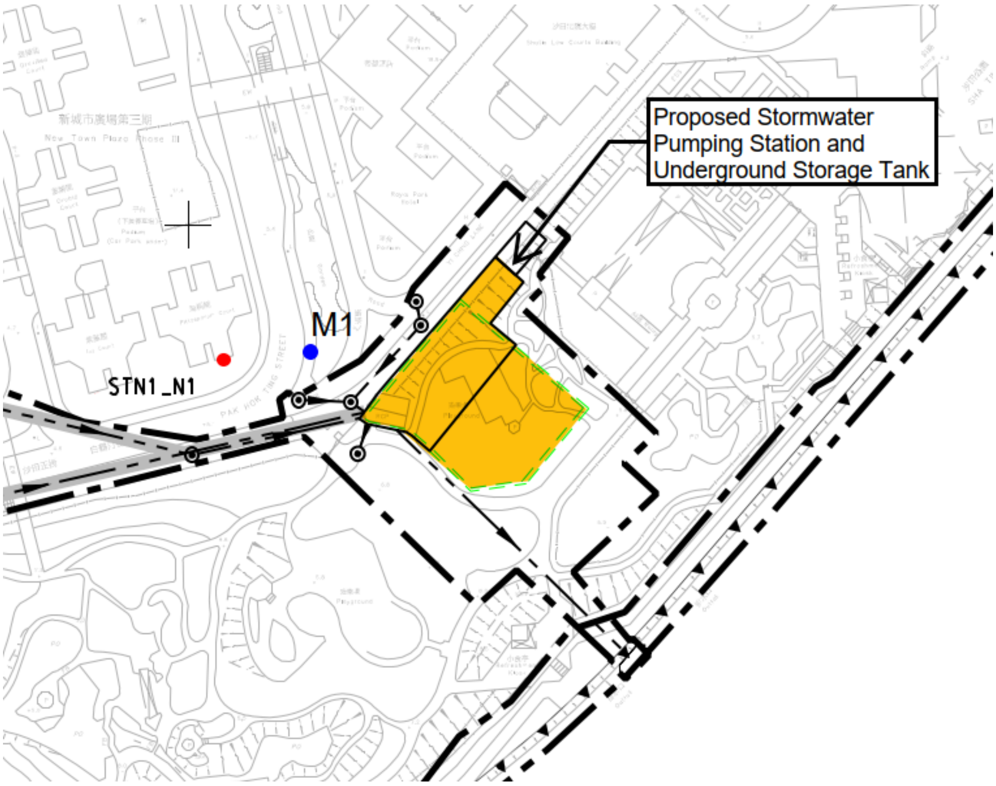
Project site	Details	Existing Layout
Sha Tin Town Centre (STN1)	• Layout of the existing drainage network at Sha Tin Town Centre is highlighted in red, which consists of drainage pipes with size varies from 225mm to 1800mm diameter connecting to the Shing Mun River. • It is found that there is flooding due to insufficient capacity of existing drainage system, high water level at Shing Mun River causing backflow to upstream drainage system and the relatively low ground level at the area susceptible to flooding. • The proposed improvement works in Sha Tin Town Centre can increase the flood protection level of the concerned area to 1-in-50 year.	

Appendix 4.1
Determination of Nosie Assessment Criteria for Operational Noise Assessment

Appendix 4.1 Determination of Fixed Plant Noise Criteria

i. Measurement Results for Prevailing Background Noise Levels

Locations of Prevailing Background Noise Measurement (M1)



Background Noise Survey Summary

Measurement Locations	Measurement Date	Time Period	Duration	Measurement Method
M1	11 Dec (Fri), 12 Dec (Sat), 14 Dec 2020 (Mon)	Normal Working Day	Continuous 24 hours	Free-field
	13 Dec 2020 (Sun)	Sunday / Public Holiday		

Background Noise Measurement Results

Measurement Location	Description	Measured Noise Levels [1][2]	
		Daytime & Evening (0700 - 2300 hours)	Night-time (2300 - 0700 hours)
M1	Sha Tin Park	55 - 66	48 - 55

Note:

[1] L90(1 hour) is used as a measure of the background noise level.

[2] As the measurements were conducted in free-field condition, +3 dB(A) have been added to the measured noise levels to represent the measurement at 1m from a building façade.

ii. Fixed Plant Noise Criteria Adopted for Representative Receiver

NSR ID	Description	Area Sensitivity Rating	Planning Criteria (ANL-5), dB(A)		Fixed Plant Noise Criteria Adopted[1], dB(A)	
			Daytime & Evening	Night-time	Daytime & Evening	Night-time
STN1_N1	New Town Plaza Phase III (Block 2) Pittosporum	B	60	50	55	48

Note:

[1] The minimum background noise levels with façade correction are adopted as fixed plant noise criteria as they are lower than the ANL-5 dB(A) planning criteria .

Appendix 4.2
Construction Plant Inventory under Unmitigated Scenario

Appendix 4.2 Construction Plant Inventory under Unmitigated Scenario

1 **Pipeworks constructed by Open-Cut Method**

1.1 **Earthwork**

1.1a Breaking of Road Surface

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Breaker, excavator mounted (hydraulic)	CNP028	1	122	70%	0	120
					Total SWL, dB(A)	**120**

1.1b Sheet Piles Driving

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Power rammer (petrol)	CNP169	1	108	70%	0	106
Excavator/loader, wheeled/tracked	CNP081	1	112	70%	0	110
Generator, standard	CNP101	1	108	100%	0	108
					Total SWL, dB(A)	**113**

1.1c Trench Excavation

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator/loader, wheeled/tracked	CNP081	1	112	70%	0	110
					Total SWL, dB(A)	**110**

1.1d Trench Shoring

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Ventilation fan	CNP241	1	108	100%	0	108
Generator, standard	CNP101	1	108	100%	0	108
					Total SWL, dB(A)	**111**

1.2 **Pipe Laying**

1.2a Blinding Concrete Laying / Pipe Bedding Laying / Pipe Laying

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Concrete lorry mixer	CNP044	1	109	50%	0	106
Poker, vibratory, hand-held	CNP170	1	113	70%	0	111
Water pump (petrol)	CNP282	2	103	100%	0	106
Crane, mobile/barge mounted (diesel)	CNP048	1	112	70%	0	110
					Total SWL, dB(A)	**115**

1.3 **Manhole Construction**

1.3a Erection of formwork and steel fixing

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Saw, circular, wood	CNP201	1	108	50%	0	105
Bar bender and cutter (electric)	CNP021	1	90	70%	0	88
Generator, standard	CNP101	1	108	100%	0	108
					Total SWL, dB(A)	**110**

1.3b Concreting of Manhole

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Concrete lorry mixer	CNP044	1	109	50%	0	106
Poker, vibratory, hand-held	CNP170	1	113	70%	0	111
					Total SWL, dB(A)	**113**

1.4 **Backfilling**

1.4a Backfilling / Sheet Piles Extraction & Shoring Removal

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator/loader, wheeled/tracked	CNP081	1	112	70%	0	110
Roller, vibratory	CNP186	1	108	50%	0	105
					Total SWL, dB(A)	**112**

1.5 **Reinstatement**

1.5a Surface Reinstatement

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Concrete lorry mixer	CNP044	1	109	50%	0	106
Poker, vibratory, hand-held	CNP170	1	113	70%	0	111
					Total SWL, dB(A)	**113**

1.6 **Loading and Unloading**

1.6a Loading and Unloading of Materials

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Dump truck, gross vehicle weight > 38 tonne	CNP067	1	117	30%	0	112
					Total SWL, dB(A)	**112**

Appendix 4.2 Construction Plant Inventory under Unmitigated Scenario

2 **Pipeworks constructed by Trenchless Method**

2.1 **Earthwork**

2.1a Breaking of Road Surface

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Breaker, excavator mounted (hydraulic)	CNP028	1	122	70%	0	120
					Total SWL, dB(A)	**120**

2.1b Sheet Piles Driving

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Power rammer (petrol)	CNP169	1	108	70%	0	106
Excavator/loader, wheeled/tracked	CNP081	1	112	70%	0	110
Generator, standard	CNP101	1	108	100%	0	108
					Total SWL, dB(A)	**113**

2.1c Excavation of Jacking and Receiving Pits

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator/loader, wheeled/tracked	CNP081	1	112	70%	0	110
					Total SWL, dB(A)	**110**

2.1d Trench Shoring

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Ventilation fan	CNP241	1	108	100%	0	108
Generator, standard	CNP101	1	108	100%	0	108
					Total SWL, dB(A)	**111**

2.2 **Pipe Laying**

2.2a Pipe Jacking

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Crane, mobile/barge mounted (diesel)	CNP048	1	112	70%	0	110
Winch (electric)	CNP262	1	95	50%	0	92
Grout mixer	CNP105	1	90	80%	0	89
Lorry, with crane, 5.5 tonne < gross vehicle weig	CNP145	1	105	30%	0	100
Pipe jacking machine (1)(2)	No air-borne noise impact					
Grout pump (1)(2)	No air-borne noise impact					
Tunnel boring machine (1)(2)	No air-borne noise impact					
					Total SWL, dB(A)	**111**

2.3 **Manhole Construction**

2.3a Erection of formwork and steel fixing

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Saw, circular, wood	CNP201	1	108	50%	0	105
Bar bender and cutter (electric)	CNP021	1	90	70%	0	88
Generator, standard	CNP101	1	108	100%	0	108
					Total SWL, dB(A)	**110**

2.3b Concreting of Manhole

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Concrete lorry mixer	CNP044	1	109	50%	0	106
Poker, vibratory, hand-held	CNP170	1	113	70%	0	111
					Total SWL, dB(A)	**113**

2.4 **Backfilling**

2.4a Backfilling / Sheet Piles Extraction & Shoring Removal

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator/loader, wheeled/tracked	CNP081	1	112	70%	0	110
Roller, vibratory	CNP186	1	108	50%	0	105
					Total SWL, dB(A)	**112**

2.5 **Reinstatement**

2.5a Surface Reinstatement

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Concrete lorry mixer	CNP044	1	109	50%	0	106
Poker, vibratory, hand-held	CNP170	1	113	70%	0	111
					Total	**113**

2.6 **Loading and Unloading**

2.6a Loading and Unloading of Materials

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Dump truck, gross vehicle weight > 38 tonne	CNP067	1	117	30%	0	112
					Total	**112**

Notes:

(1) Pipe jacking system, grout pump and tunnel boring machine would be located at the bottom of the pit which is about 6m below ground level. The noise of the machines would be effectively shielded from the sensitive receivers and thus would not be considered as a potential noise source in the construction

(2) With reference to AEIAR-192/2015 - "Desalination Plant at Tseung Kwan O", given the small size of the cutter head involved and the soft geology along the pipeworks alignment (soil layer for all sites) which would provide significant damping of vibrations, the ground-borne noise generated from the use micro tunnel boring machine and pipe jacking machine for trenchless construction of pipeworks would be insignificant and unlikely to cause adverse impact on the nearby NSRs.

Appendix 4.2 Construction Plant Inventory under Unmitigated Scenario

3 **Construction of Pumping Station and Storage Tank**

3.1 **Site Clearance, Excavation and Lateral Support (ELS)**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator/loader, wheeled/tracked	CNP081	1	112	30%	0	107
Breaker, excavator mounted (hydraulic)	CNP028	1	122	30%	0	117
Dump Truck with grab, 5.5 tonne < gross vehicle weight ≦ 38 tonne	OCNP(1)	1	105	20%	0	98
Roller, Vibratory	CNP186	1	108	30%	0	103
Water Pump, Submersible (Electric)	CNP283	1	85	80%	0	84
Piling, oscillator	CNP165	1	115	40%	0	111
Mobile Crane	CNP048	1	112	20%	0	105
Drill/Grinder, Hand-held (Electric)	CNP065	1	98	20%	0	91
Lorry, with crane/grab, 5.5 tonne < gross vehicle weight <= 38 tonne	OCNP(1)	1	105	30%	0	100
Air compressor, air flow > 10m³/min and ≦ 30 m³/min	CNP002	1	102	40%	0	98
Generator, super silenced, 70dB(A) at 7m [2]	CNP103	1	95	100%	0	95
					Total SWL, dB(A)	**119**

3.2 **Steel Fixing and Concreting of Structure**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Mobile crane	CNP048	1	112	30%	0	107
Lorry, with crane/grab, 5.5 tonne < gross vehicle weight <= 38 tonne	OCNP(1)	1	105	30%	0	100
Bar bender and cutter	CNP021	1	90	50%	0	87
Poker, vibratory, hand-held (electric)	OCNP(1)	1	102	20%	0	95
Concrete lorry mixer	CNP044	1	109	30%	0	104
Water Pump, Submersible (Electric)	CNP283	1	85	80%	0	84
Generator, super silenced, 70dB(A) at 7m [2]	CNP103	1	95	80%	0	94
					Total SWL, dB(A)	**109**

3.3 **E&M Installation & Pipeworks**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Mobile crane	CNP048	1	112	30%	0	107
Breaker, excavator mounted (hydraulic)	CNP028	1	122	30%	0	117
Lorry, with crane/grab, 5.5 tonne < gross vehicle weight <= 38 tonne	OCNP(1)	1	105	30%	0	100
Water Pump, Submersible (Electric)	CNP283	1	85	80%	0	84
Drill/Grinder, Hand-held (Electric)	CNP065	1	98	30%	0	93
Generator, super silenced, 70dB(A) at 7m [2]	CNP103	1	95	80%	0	94
					Total SWL, dB(A)	**117**

3.4 **Backfilling**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Backhoe	CNP081	1	112	30%	0	107
Dump Truck with grab, 5.5 tonne < gross vehicle weight ≦ 38 tonne	OCNP(1)	1	105	50%	0	102
Roller, Vibratory	CNP186	1	108	20%	0	101
Water Pump, Submersible (Electric)	CNP283	1	85	80%	0	84
Generator, super silenced, 70dB(A) at 7m [2]	CNP103	1	95	80%	0	94
					Total SWL, dB(A)	**109**

3.5 **Surface Reinstatement**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Vibratory Roller	CNP186	1	108	70%	0	106
Dump Truck	CNP067	1	117	30%	0	112
					Total SWL, dB(A)	**113**

3.6 **Landscape Works & Roadworks**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Backhoe	CNP081	1	112	30%	0	107
Roller, Vibratory	CNP186	1	108	30%	0	103
Poker, vibratory, hand-held (electric)	OCNP(1)	1	102	20%	0	95
Concrete lorry mixer	CNP044	1	109	50%	0	106
Breaker, hand-held, mass > 35kg	CNP026	1	114	50%	0	111
Lorry, with crane/grab, 5.5 tonne < gross vehicle weight <= 38 tonne	OCNP(1)	1	105	30%	0	100
Dump Truck with grab, 5.5 tonne < gross vehicle weight ≦ 38 tonne	OCNP(1)	1	105	50%	0	102
Generator, super silenced, 70dB(A) at 7m [2]	CNP103	1	95	70%	0	93
					Total SWL, dB(A)	**114**

Note:

(1) The PME item was made reference to EPD's guidance Sound power levels of other commonly used PME.
(https://www.epd.gov.hk/epd/sites/default/files/epd/english/application_for_licences/guidance/files/OtherSWLe.pdf)

Appendix 4.3
Predicted Construction Nosie Level under Unmitigated Scenario

Appendix 4.3 Construction Plant Inventory under Unmitigated Scenario
Calculation of Construction Noise Levels (Unmitigated Scenario)

1 Pipeworks constructed by Open-Cut Method

ID [1]	Description	Nature	Notional Distance to Proposed Works, m [1]	Predicted Construction Noise Level at NSR for Pipeworks Construction, $L_{eq\ (30\ mins)}$ dB(A) [2][3][4]										Maximum Construction Noise Level at NSR, $L_{eq\ (30\ mins)}$ dB(A)	Noise Criteria, $L_{eq\ (30\ mins)}$ dB(A) [5]	Max Noise Exceedance, $L_{eq\ (30\ mins)}$ dB(A) [6]
				Earthwork				Pipe Laying	Manhole Construction		Backfilling	Reinstatement	Loading and Unloading			
				1.1a	1.1b	1.1c	1.1d	1.2a	1.3a	1.3b	1.4a	1.5a	1.6a			
				SWL: 120 dB(A)	SWL: 113 dB(A)	SWL: 110 dB(A)	SWL: 111 dB(A)	SWL: 115 dB(A)	SWL: 110 dB(A)	SWL: 113 dB(A)	SWL: 112 dB(A)	SWL: 113 dB(A)	SWL: 112 dB(A)			
STN1_N1	New Town Plaza Phase III (Block 2) Ivy Court	Residential	32	**85**	**78**	75	**76**	**80**	75	**77**	**76**	**77**	**77**	**85**	75	10
STN1_N2	Hilton Plaza Block B	Residential	122	74	67	64	64	68	63	66	65	66	65	74	75	0
STN1_N3	New Town Plaza Phase III (Block 5) Cotton Tree Court	Residential	6	**100**	**93**	**90**	**91**	**95**	**90**	**92**	**91**	**92**	**92**	**100**	75	25
STN1_N4	Wai Wah Centre Block 3	Residential	26	**87**	**80**	**77**	**78**	**82**	**77**	**79**	**78**	**79**	**79**	**87**	75	12
STN1_N5	Wai Wah Centre Block 4	Residential	34	**85**	**78**	75	75	**80**	74	**77**	**76**	**77**	**76**	**85**	75	10
STN1_N6	Buddhist Poh Yea Home for the Aged	Home for the Aged	84	**77**	70	67	67	72	66	69	68	69	68	**77**	75	2
STN1_N7	Hing Yuen Terrace	Residential	222	69	61	59	59	63	58	61	60	61	60	69	75	0

Notes:

(1) No pipeworks constructed by open-cut method is proposed for STS5, STN7 & STN12. Their representative NSRs also fall outside 300 m from notional source of works proposed in other sites and hence were not assessed.
NSRs outside 300m from notional source of the proposed works were not assessed.

(2) A +3 dB(A) façade correction was added to the predicted noise level to account for the façade effect at the NSR.
Distance Attenuation in dB(A) = 20 log D + 8, where D is distance in metres, was taken into account in the noise prediction.

(3) Only one construction activity would be undertaken at any one time within each workfront.

(4) **Bolded** values indicate exceedance of EIAO-TM noise criteria of 75 dB(A) for residential dwelling / place of public worship / home for the aged, or 70 dB(A) for educational institution during normal school days; while underlined value indicates exceedance of EIAO-TM noise criteria of 65 dB(A) for educational institution during examination period.

(5) EIAO-TM noise criteria adopted: 75 dB(A) for residential dwelling / place of public worship / home for the aged; 70 dB(A) during normal school days / 65 dB(A) during examination period for educational institution.

(6) For educational instituion, "maximum noise exceedance for general school day / maximum noise exceedance during examination period".

Appendix 4.3 Construction Plant Inventory under Unmitigated Scenario
Calculation of Construction Noise Levels (Unmitigated Scenario)

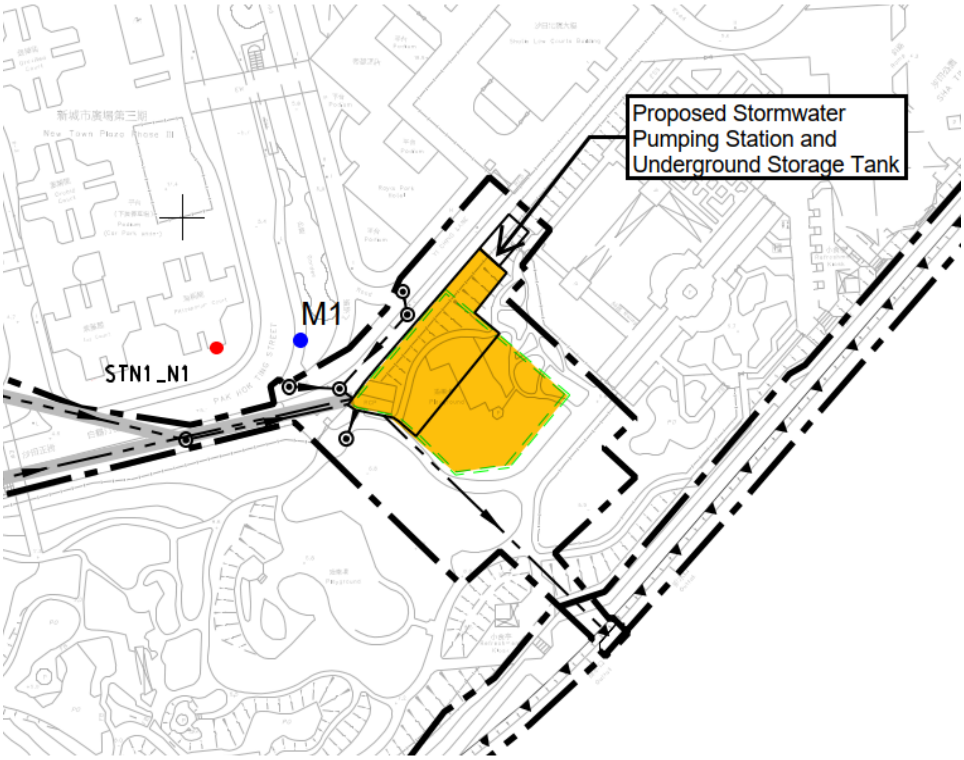
3 Construction of Pumping Station and Storage Tank

ID	Description	Nature	Notional Distance to Proposed Works, m (1)(2)	Predicted Construction Noise Level at NSR for Pipeworks Construction, $L_{eq (30 mins)}$ dB(A) (3)(4)(5)						Maximum Construction Noise Level at NSR, $L_{eq (30 mins)}$ dB(A)	Noise Criteria, $L_{eq (30 mins)}$ dB(A) (6)	Max Noise Exceedance, $L_{eq (30 mins)}$ dB(A)
				Site Clearance and ELS	Steel Fixing and Concreting of Structure	E&M Installation & Pipeworks	Backfilling	Surface Reinstatement	Landscape Works & Roadworks			
				3.1	3.2	3.3	3.4	3.5	3.6			
				SWL: 119 dB(A)	SWL: 109 dB(A)	SWL: 117 dB(A)	SWL: 109 dB(A)	SWL: 113 dB(A)	SWL: 114 dB(A)			
STN1_N1	New Town Plaza Phase III (Block 2) Ivy Court	Residential	67	**77**	68	**76**	67	71	73	**77**	75	2
STN1_N2	Hilton Plaza Block B	Residential	204	67	58	66	58	62	63	67	75	0
STN1_N3	New Town Plaza Phase III (Block 5) Cotton Tree Court	Residential	213	67	58	66	57	61	63	67	75	0
STN1_N4	Wai Wah Centre Block 3	Residential	252	66	56	64	56	60	61	66	75	0
STN1_N5	Wai Wah Centre Block 4	Residential	290	64	55	63	55	59	60	64	75	0
STN1_N6	Buddhist Poh Yea Home for the Aged	Home for the Aged	>300	-	-	-	-	-	-	-	75	-
STN1_N7	Hing Yuen Terrace	Residential	>300	-	-	-	-	-	-	-	75	-

Notes:
(1) No construction of pumping station and storage tank is proposed for all other Project sites and their representative NSRs also fall outside 300 m from notional source of works proposed in other sites and hence were not assessed.
(2) NSRs outside 300m from notional source of the proposed works were not assessed.
(3) A +3 dB(A) façade correction was added to the predicted noise level to account for the façade effect at the NSR.
Distance Attenuation in dB(A) = 20 log D + 8, where D is distance in metres, was taken into account in the noise prediction.
(4) Only one construction activity would be undertaken at any one time within each workfront.
(5) **Bolded** values indicate exceedance of EIAO-TM noise criteria of 75 dB(A) for residential dwelling / home for the aged.
(5) EIAO-TM noise criteria adopted: 75 dB(A) for residential dwelling / home for the aged.

Appendix 4.4
Determination of Maximum Allowable Sound Power Level

Appendix 4.4 **Determination of Maximum Allowable Sound Power Level**



NSR ID	Description	Fixed Plant Noise Criteria [1], dB(A)		Horizontal Distance from NSR to Proposed Pumping Station, m	Correction, dB(A)			Maximum Allowable SWL, dB(A)	
		Daytime & Evening	Night-time		Distance	Tonality	Façade	Daytime & Evening	Night-time
STN1_N1	New Town Plaza Phase III (Block 2) Pittosporum Court	55	48	46	41	6	3	87	80

Note:

[1] Determination of fixed plant noise criteria is presented in **Appendix 4.1**

Appendix 4.5
Construction Plant Inventory under Mitigated Scenario

Appendix 4.5 Construction Plant Inventory under Mitigated Scenario

1 **Pipeworks constructed by Open-Cut Method**

- Mitigation Measures for STN1, STN5#, STN9, STN10 and STS1

1.1 **Earthwork**

1.1a Breaking of Road Surface

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Hand-held Percussive Breaker	QPME EPD-10306 or equivalent	1	104	70%	-10	92
					Total SWL, dB(A)	**92**

1.1b Sheet Piles Driving

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Giken Piler and Power-pack	Manufacture Catalog (2)	1	94	70%	0	92
Excavator, wheeled/tracked	QPME EPD-09105 or equivalent	1	91	70%	0	89
					Total SWL, dB(A)	**94**

1.1c Trench Excavation

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator, wheeled/tracked	QPME EPD-09105 or equivalent	1	91	70%	0	89
					Total SWL, dB(A)	**89**

1.1d Trench Shoring

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Air blower (electric)	OCNP(1)	1	95	100%	0	95
Generator	QPME EPD-08950 or equivalent	1	80	100%	0	80
					Total SWL, dB(A)	**95**

1.2 **Pipe Laying**

1.2a Blinding Concrete Laying / Pipe Bedding Laying / Pipe Laying

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Concrete lorry mixer	BS C6-23	1	100	50%	-5	92
Poker, vibratory, hand-held (electric)	CNP173	1	94	70%	-10	82
Water pump (electric)	CNP281	2	88	100%	-10	81
Crane, mobile	QPME EPD-05797 or equivalent	1	91	70%	-5	84
Generator	QPME EPD-08950 or equivalent	1	80	100%	-10	70
					Total SWL, dB(A)	**93**

1.3 **Manhole Construction**

1.3a Erection of formwork and steel fixing

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Saw, circular, wood	CNP201	1	108	50%	-10	95
Bar bender and cutter (electric)	CNP021	1	90	70%	-10	78
Generator	QPME EPD-08950 or equivalent	1	80	100%	-10	70
					Total SWL, dB(A)	**95**

1.3b Concreting of Manhole

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Generator	QPME EPD-08950 or equivalent	1	80	100%	0	80
Concrete lorry mixer	BS C6-23	1	100	50%	-5	92
Poker, vibratory, hand-held (electric)	CNP173	1	94	70%	-10	82
					Total SWL, dB(A)	**93**

1.4 **Backfilling**

1.4a Backfilling / Sheet Piles Extraction & Shoring Removal

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator, wheeled/tracked	QPME EPD-09105 or equivalent	1	91	70%	0	89
Roller, vibratory	QPME EPD-06997 or equivalent	1	94	50%	0	91
					Total SWL, dB(A)	**93**

1.5 **Reinstatement**

1.5a Surface Reinstatement

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Concrete lorry mixer	BS C6-23	1	100	50%	-5	92
Poker, vibratory, hand-held (electric)	CNP173	1	94	70%	-10	82
					Total SWL, dB(A)	**92**

1.6 **Loading and Unloading**

1.6a Loading and Unloading of Materials* #

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item, dB(A)	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Dump Truck with grab, 5.5 tonne < gross vehicle weight ≦ 38 tonne	OCNP(1)	1	105	30%	0	100
					Total SWL, dB(A)	**100**

* *Works area for loading and loading of materials should be set at at least 10 m from residential dwelling and 20 m from educational institute.*

Notes:

\# Pipeworks constructed by Open-Cut Method at STN5 (Lai Wo Lane) should be scheduled outside examination period of Sha Tin Junior School.

(1) The PME item was made reference to EPD's guidance Sound power levels of other commonly used PME. (https://www.epd.gov.hk/epd/sites/default/files/epd/english/application_for_licences/guidance/files/OtherSWLe.pdf)

(2) Noise level of Giken Piler and Power-pack at 7m is 69dB(A) with reference to AEIAR-127/2008 "EIA Report of Tsim Sha Tsui Station Northern Subway".

(3) Noise reduction assumed: 5 dB(A) for moveable PME & 10 dB(A) for stationary PME with the provision of movable noise barrier.

(4) PME in different groups will not be in use concurrently. The group with higher SWL has been adopted as the worst case scenario.

Appendix 4.5 Construction Plant Inventory under Mitigated Scenario

1 **Pipeworks constructed by Open-Cut Method**

- Mitigation Measures for MOS1# & STS2

1.1 **Earthwork**

1.1a Breaking of Road Surface

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Hand-held Percussive Breaker	QPME EPD-10306 or equivalent	1	104	70%	-15	87
					Total SWL, dB(A)	**87**

1.1b Sheet Piles Driving

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Giken Piler and Power-pack	Manufacture Catalog (2)	1	94	70%	-10	82
Excavator, wheeled/tracked	QPME EPD-09105 or equivalent	1	91	70%	-5	84
					Total SWL, dB(A)	**87**

1.1c Trench Excavation

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Excavator, wheeled/tracked	QPME EPD-09105 or equivalent	1	91	70%	-5	84
					Total SWL, dB(A)	**84**

1.1d Trench Shoring

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Air blower (electric)	OCNP(1)	1	95	100%	-10	85
Generator	QPME EPD-08950 or equivalent	1	80	100%	-10	70
					Total SWL, dB(A)	**85**

1.2 **Pipe Laying**

1.2a Blinding Concrete Laying / Pipe Bedding Laying / Pipe Laying

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Concrete mixer (electric)	CNP045	1	96	50%	-10	83
Poker, vibratory, hand-held (electric)	CNP173	1	94	70%	-15	77
Water pump (electric)	CNP281	2	88	100%	-10	81
Crane, mobile	QPME EPD-05797 or equivalent	1	91	70%	-5	84
Generator	QPME EPD-08950 or equivalent	1	80	100%	-10	70
					Total SWL, dB(A)	**88**

1.3 **Manhole**

1.3a Erection of formwork and steel fixing

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Saw, circular, wood	CNP201	1	108	50%	-15	90
Bar bender and cutter (electric)	CNP021	1	90	70%	-15	73
Generator	QPME EPD-08950 or equivalent	1	80	100%	-15	65
					Total SWL, dB(A)	**90**

1.3b Concreting of Manhole

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Generator	QPME EPD-08950 or equivalent	1	80	100%	-10	70
Concrete mixer (electric)	CNP045	1	96	50%	-5	88
Poker, vibratory, hand-held (electric)	CNP173	1	94	70%	-15	77
					Total SWL, dB(A)	**88**

1.4 **Backfilling**

1.4a Backfilling / Sheet Piles Extraction & Shoring Removal

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator, wheeled/tracked	QPME EPD-09105 or equivalent	1	91	70%	-5	84
Roller, vibratory	QPME EPD-06997 or equivalent	1	94	50%	-5	86
					Total SWL, dB(A)	**88**

1.5 **Reinstatement**

1.5a Surface Reinstatement

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Concrete mixer (electric)	CNP045	1	96	50%	-5	88
Poker, vibratory, hand-held (electric)	CNP173	1	94	70%	-10	82
					Total SWL, dB(A)	**89**

1.6 **Loading and Unloading**

1.6a Loading and Unloading of Materials*

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Dump Truck with grab, 5.5 tonne < gross vehicle weight ≦ 38 tonne	OCNP(1)	1	105	30%	0	100
					Total SWL, dB(A)	**100**

* *Works area for loading and loading of materials should be set at at least 10 m from residential dwelling and 20 m from educational institute.*

Notes:

\# *Pipeworks constructed by Open-Cut Method within 20 m from Tsang Pik Shan Secondary School at **MOS1 (Hang Hong Street and Hang Kwong Street)** should be scheduled outside examination period.*

(1) The PME item was made reference to EPD's guidance Sound power levels of other commonly used PME. (https://www.epd.gov.hk/epd/sites/default/files/epd/english/application_for_licences/guidance/files/OtherSWLe.pdf)

(2) Noise level of Giken Piler and Power-pack at 7m is 69dB(A) with reference to AEIAR-127/2008 "EIA Report of Tsim Sha Tsui Station Northern Subway".

(3) Noise reduction assumed: 5 dB(A) for moveable PME & 10 dB(A) for stationary PME with the provision of movable noise barrier; 10 dB(A) for the provision of noise insultating fabric for pilling machine; 15 dB(A) for stationary PME with the provision of enclosure / shelter.

(4) PME in different groups will not be in use concurrently. The group with higher SWL has been adopted as the worst case scenario.

Appendix 4.5 Construction Plant Inventory under Mitigated Scenario

2 **Pipeworks constructed by Trenchless Method**

- Mitigation Measures for STN12

2.1 **Earthwork**

2.1a Breaking of Road Surface

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item.	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Breaker, mini-robot mounted	OCNP(1)	1	115	70%	0	113
					Total SWL, dB(A)	**113**

2.1b Sheet Piles Driving

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item.	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Power rammer (petrol)	CNP169	1	108	70%	0	106
Excavator/loader, wheeled/tracked	CNP081	1	112	70%	0	110
Generator, standard	CNP101	1	108	100%	0	108
					Total SWL, dB(A)	**113**

2.1c Excavation of Jacking and Receiving Pits

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item.	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator/loader, wheeled/tracked	CNP081	1	112	70%	0	110
					Total SWL, dB(A)	**110**

2.1d Trench Shoring

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item.	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Ventilation fan	CNP241	1	108	100%	0	108
Generator, standard	CNP101	1	108	100%	0	108
					Total SWL, dB(A)	**111**

2.2 **Pipe Laying**

2.2a Pipe Jacking

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item.	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Crane, mobile/barge mounted (diesel)	CNP048	1	112	70%	0	110
Winch (electric)	CNP262	1	95	50%	0	92
Grout mixer	CNP105	1	90	80%	0	89
Lorry, with crane, 5.5 tonne < gross vehicle weight < 38 tonne	CNP145	1	105	30%	0	100
Pipe jacking machine (2)(3)		No air-borne noise impact				
Grout pump (2)(3)		No air-borne noise impact				
Tunnel boring machine (2)(3)		No air-borne noise impact				
					Total SWL, dB(A)	**111**

2.3 **Manhole**

2.3a Erection of formwork and steel fixing

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item.	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Saw, circular, wood	CNP201	1	108	50%	0	105
Bar bender and cutter (electric)	CNP021	1	90	70%	0	88
Generator, standard	CNP101	1	108	100%	0	108
					Total SWL, dB(A)	**110**

2.3b Concreting of Manhole

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item.	On-time %	Barrier Correction, dB(A) (3)	Sub-total SWL, dB(A)
Generator, standard	CNP101	1	108	100%	0	108
Concrete lorry mixer	CNP044	1	109	50%	0	106
Poker, vibratory, hand-held	CNP170	1	113	70%	0	111
					Total SWL, dB(A)	**114**

2.4 **Backfilling**

2.4a Backfilling / Sheet Piles Extraction & Shoring Removal

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item.	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator/loader, wheeled/tracked	CNP081	1	112	70%	0	110
Roller, vibratory	CNP186	1	108	50%	0	105
					Total SWL, dB(A)	**112**

2.5 **Reinstatement**

2.5a Surface Reinstatement

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item.	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Concrete lorry mixer	CNP044	1	109	50%	0	106
Poker, vibratory, hand-held	CNP170	1	113	70%	0	111
					Total	**113**

2.6 **Loading and Unloading**

2.6a Loading and Unloading of Materials

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item.	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Dump truck, gross vehicle weight > 38 tonne	CNP067	1	117	30%	0	112
					Total	**112**

Notes:

(1) The PME item was made reference to EPD's guidance Sound power levels of other commonly used PME. (https://www.epd.gov.hk/epd/sites/default/files/epd/english/application_for_licences/guidance/files/OtherSWLe.pdf)

(2) Pipe jacking system, grout pump and tunnel boring machine would be located at the bottom of the pit which is about 6m below ground level. The noise of the machines would be effectively shielded from the sensitive receivers and thus would not be considered as a potential noise source in the construction noise assessment.

(3) With reference to AEIAR-192/2015 - "Desalination Plant at Tseung Kwan O", given the small size of the cutter head involved and the soft geology along the pipeworks alignment which would provide significant damping of vibrations, the ground-borne noise generated from the use micro tunnel boring machine and pipe jacking machine for trenchless construction of pipeworks would be insignificant and unlikely to cause adverse impact on the nearby NSRs.

(4) PME in different groups will not be in use concurrently. The group with higher SWL has been adopted as the worst case scenario.

Appendix 4.5 Construction Plant Inventory under Mitigated Scenario

2 **Pipeworks constructed by Trenchless Method**

- Mitigation Measures for STN1, STN5, STS1#, STS2

2.1 **Earthwork**

2.1a Breaking of Road Surface

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Hand-held Percussive Breaker	QPME EPD-10306 or equivalent	1	104	70%	-10	92
					Total SWL, dB(A)	**92**

2.1b Sheet Piles Driving

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (5)	Sub-total SWL, dB(A)
Giken Piler and Power-pack	Manufacture Catalog (2)	1	94	70%	0	92
Excavator, wheeled/tracked	QPME EPD-09105 or equivalent	1	91	70%	0	89
					Total SWL, dB(A)	**94**

2.1c Excavation of Jacking and Receiving Pits

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator, wheeled/tracked	QPME EPD-09105 or equivalent	1	91	70%	0	89
					Total SWL, dB(A)	**89**

2.1d Trench Shoring

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (5)	Sub-total SWL, dB(A)
Air blower (electric)	OCNP(1)	1	95	100%	0	95
Generator	QPME EPD-08950 or equivalent	1	80	100%	0	80
					Total SWL, dB(A)	**95**

2.2 **Pipe Laying**

2.2a Pipe Jacking

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (5)	Sub-total SWL, dB(A)
Crane, mobile	QPME EPD-05797 or equivalent	1	91	70%	-5	84
Winch (electric)	CNP262	1	95	50%	-15	77
Grout mixer	CNP105	1	90	80%	-15	74
Lorry, with crane, 5.5 tonne < gross vehicle weight < 38 tonne	CNP145	1	105	30%	-5	95
Pipe jacking machine (3)		No air-borne noise impact				
Grout pump (3)		No air-borne noise impact				
Tunnel boring machine (3)		No air-borne noise impact				
					Total SWL, dB(A)	**95**

2.3 **Manhole**

2.3a Erection of formwork and steel fixing

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (5)	Sub-total SWL, dB(A)
Saw, circular, wood	CNP201	1	108	50%	-10	95
Bar bender and cutter (electric)	CNP021	1	90	70%	-10	78
Generator	QPME EPD-08950 or equivalent	1	80	100%	-10	70
					Total SWL, dB(A)	**95**

2.3b Concreting of Manhole

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (5)	Sub-total SWL, dB(A)
Generator	QPME EPD-08950 or equivalent	1	80	100%	-10	70
Concrete lorry mixer	BS C6-23	1	100	50%	-5	92
Poker, vibratory, hand-held (electric)	CNP173	1	94	70%	-10	82
					Total SWL, dB(A)	**92**

2.4 **Backfilling**

2.4a Backfilling / Sheet Piles Extraction & Shoring Removal

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator, wheeled/tracked	QPME EPD-09105 or equivalent	1	91	70%	0	89
Roller, vibratory	QPME EPD-06997 or equivalent	1	94	50%	0	91
					Total SWL, dB(A)	**93**

2.5 **Reinstatement**

2.5a Surface Reinstatement

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A) (5)	Sub-total SWL, dB(A)
Concrete lorry mixer	BS C6-23	1	100	50%	-5	92
Poker, vibratory, hand-held (electric)	CNP173	1	94	70%	-10	82
					Total	**92**

2.6 **Loading and Unloading**

2.6a Loading and Unloading of Materials*

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Dump Truck with grab, 5.5 tonne < gross vehicle weight ≦ 38 tor	OCNP(1)	1	105	30%	0	100
					Total	**100**

* *Works area for loading and loading of materials should be set at at least 10 m from residential dwelling.*

Notes:

\# Pipeworks constructed by Trenchless Method within 30 m from Christ College at STS1 (Pok Hong Estate) should be scheduled outside examination period.

(1) The PME item was made reference to EPD's guidance Sound power levels of other commonly used PME. (https://www.epd.gov.hk/epd/sites/default/files/epd/english/application_for_licences/guidance/files/OtherSWLe.pdf)

(2) Noise level of Giken Piler and Power-pack at 7m is 69dB(A) with reference to AEIAR-127/2008 "EIA Report of Tsim Sha Tsui Station Northern Subway".

(3) Pipe jacking system, grout pump and tunnel boring machine would be located at the bottom of the pit which is about 6m below ground level. The noise of the machines would be effectively shielded from the sensitive receivers and thus would not be considered as a potential noise source in the construction noise assessment.

(4) With reference to AEIAR-192/2015 - "Desalination Plant at Tseung Kwan O", given the small size of the cutter head involved and the soft geology along the pipeworks alignment which would provide significant damping of vibrations, the ground-borne noise generated from the use micro tunnel boring machine and pipe jacking machine for trenchless construction of pipeworks would be insignificant and unlikely to cause adverse impact on the nearby NSRs.

(5) Noise reduction assumed: 5 dB(A) for moveable PME & 10 dB(A) for stationary PME with the provision of movable noise barrier; 15 dB(A) for stationary PME with the provision of enclosure / shelter.

(6) PME in different groups will not be in use concurrently. The group with higher SWL has been adopted as the worst case scenario.

Appendix 4.5 Construction Plant Inventory under Mitigated Scenario

3 **Construction of Pumping Station and Storage Tank**

3.1 **Site Clearance, Excavation and Lateral Support (ELS)**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator/loader, wheeled/tracked	CNP081	1	112	30%	0	107
Breaker, mini-robot mounted	OCNP(1)	1	115	30%	0	110
Dump Truck with grab, 5.5 tonne < gross vehicle weight ≦ 38 tonne	OCNP(1)	1	105	20%	0	98
Roller, vibratory	CNP186	1	108	30%	0	103
Water pump, submersible (electric)	CNP283	1	85	80%	0	84
Piling, large diameter bored, oscillator	CNP165	1	115	40%	0	111
Crane, mobile/barge mounted (diesel)	CNP048	1	112	20%	0	105
Drill/grinder, hand-held (electric)	CNP065	1	98	20%	0	91
Lorry, with crane/grab, 5.5 tonne < gross vehicle weight <= 38 tonne	OCNP(1)	1	105	30%	0	100
Air Compressor, air flow > 10m3/min and < 30m	CNP002	1	102	40%	0	98
Generator, super silenced, 70dB(A) at 7m	CNP103	1	95	100%	0	95
					Total SWL, dB(A)	**115**

3.2 **Steel Fixing and Concreting of Structure**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Crane, mobile/barge mounted (diesel)	CNP048	1	112	30%	0	107
Lorry, with crane/grab, 5.5 tonne < gross vehicle weight <= 38 tonne	OCNP(1)	1	105	30%	0	100
Bar bender and cutter (electric)	CNP021	1	90	50%	0	87
Poker, vibratory, hand-held (electric)	OCNP(1)	1	102	20%	0	95
Concrete lorry mixer	CNP044	1	109	30%	0	104
Water pump, submersible (electric)	CNP283	1	85	80%	0	84
Generator, super silenced, 70dB(A) at 7m	CNP103	1	95	80%	0	94
					Total SWL, dB(A)	**109**

3.3 **E&M Installation & Pipeworks**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Crane, mobile/barge mounted (diesel)	CNP048	1	112	30%	0	107
Breaker, mini-robot mounted	OCNP(1)	1	115	30%	0	110
Lorry, with crane/grab, 5.5 tonne < gross vehicle weight <= 38 tonne	OCNP(1)	1	105	30%	0	100
Water pump, submersible (electric)	CNP283	1	85	80%	0	84
Drill/grinder, hand-held (electric)	CNP065	1	98	30%	0	93
Generator, super silenced, 70dB(A) at 7m	CNP103	1	95	80%	0	94
					Total SWL, dB(A)	**112**

3.4 **Backfilling**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator/loader, wheeled/tracked	CNP081	1	112	30%	0	107
Dump Truck with grab, 5.5 tonne < gross vehicle weight ≦ 38 tonne	OCNP(1)	1	105	50%	0	102
Roller, vibratory	CNP186	1	108	20%	0	101
Water pump, submersible (electric)	CNP283	1	85	80%	0	84
Generator, super silenced, 70dB(A) at 7m	CNP103	1	95	80%	0	94
					Total SWL, dB(A)	**109**

3.5 **Surface Reinstatement**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Roller, vibratory	CNP186	1	108	70%	0	106
Dump truck, gross vehicle weight > 38 tonne	CNP067	1	117	30%	0	112
					Total SWL, dB(A)	**113**

3.6 **Landscape Works & Roadworks**

Powered Mechanical Equipment (PME)	Reference	No. of Items	SWL / Item,	On-time %	Barrier Correction, dB(A)	Sub-total SWL, dB(A)
Excavator/loader, wheeled/tracked	CNP081	1	112	30%	0	107
Roller, vibratory	CNP186	1	108	30%	0	103
Poker, vibratory, hand-held (electric)	OCNP(1)	1	102	20%	0	95
Concrete lorry mixer	CNP044	1	109	50%	0	106
Breaker, hand-held, mass > 35kg	CNP026	1	114	50%	0	111
Lorry, with crane/grab, 5.5 tonne < gross vehicle weight <= 38 tonne	OCNP(1)	1	105	30%	0	100
Dump Truck with grab, 5.5 tonne < gross vehicle weight ≦ 38 tonne	OCNP(1)	1	105	50%	0	102
Generator, super silenced, 70dB(A) at 7m	CNP103	1	95	70%	0	93
					Total SWL, dB(A)	**114**

Note:

(1) The PME item was made reference to EPD's guidance Sound power levels of other commonly used PME. (https://www.epd.gov.hk/epd/sites/default/files/epd/english/application_for_licences/guidance/files/OtherSWLe.pdf)

Appendix 4.6
Predicted Construction Nosie Level under Mitigated Scenario

Appendix 4.6-1 Construction Plant Inventory under Mitigated Scenario
Calculation of Construction Noise Levels (Mitigated Scenario)

1 Pipeworks constructed by Open-Cut Method
- Mitigation Measures for HC4, STN1, STN5, STN7, STN9, STN10 and STS1 are presented in **Appendix 4.5-1A.**
- Mitigation Measures for MOS1 & STS2 are presented in **Appendix 4.5-1B.**

ID	Description	Nature	Notional Distance to Proposed Works(1), m	Predicted Construction Noise Level at NSR for Pipeworks Construction, $L_{eq (30 mins)}$ dB(A) (2)(3)										Maximum Construction Noise Level at NSR, $L_{eq (30 mins)}$ dB(A)	Noise Criteria, $L_{eq (30 mins)}$ dB(A) (4)	Max Noise Exceedance, $L_{eq (30 mins)}$ dB(A)
				Earthwork#				Pipe Laying#	Manhole#		Backfilling#	Re-instatement#	Loading and Unloading*#			
				1.1a	1.1b	1.1c	1.1d	1.2a	1.3a	1.3b	1.4a	1.5a	1.6a			
				SWL: 92 dB(A)	SWL: 94 dB(A)	SWL: 89 dB(A)	SWL: 95 dB(A)	SWL: 93 dB(A)	SWL: 95 dB(A)	SWL: 93 dB(A)	SWL: 93 dB(A)	SWL: 92 dB(A)	SWL: 100 dB(A)			
STN1_N1	New Town Plaza Phase III (Block 2) Ivy Court	Residential	32	57	59	54	60	58	60	58	58	57	65	65	75	0
STN1_N2	Hilton Plaza Block B	Residential	122	46	48	43	48	47	48	46	47	46	53	53	75	0
STN1_N3	New Town Plaza Phase III (Block 5) Cotton Tree Court	Residential	6 (Min 10 m from 1.6a*)	72	74	69	75	73	75	72	73	72	75	75	75	0
STN1_N4	Wai Wah Centre Block 3	Residential	26	59	61	56	62	60	62	60	60	59	67	67	75	0
STN1_N5	Wai Wah Centre Block 4	Residential	34	57	59	54	60	58	60	57	58	57	64	64	75	0
STN1_N6	Buddhist Poh Yea Home for the Aged	Home for the Aged	84	49	51	46	52	50	52	49	50	49	56	56	75	0
STN1_N7	Hing Yuen Terrace	Residential	222	41	42	38	43	41	43	41	41	41	48	48	75	0

***** Works area for loading and loading of materials should be set at at least 10 m from any NSRs.
# Pipeworks constructed by Open-Cut Method at **HC4 (Hiram's Highway near Marina Cove)** and **STN5 (Lai Wo Lane)** should be scheduled outside examination period of The Woodland Sai Kung Pre-School and Sha Tin Junior School respectively.

Appendix 4.6-2 Construction Plant Inventory under Mitigated Scenario
Calculation of Construction Noise Levels (Mitigated Scenario)

2 Pipeworks constructed by Trenchless Method
- Mitigation Measures forSTN12 are presented in **Appendix 4.5-2A.**
- Mitigation Measures for HC4, STN1, STN5, STN7, STS1 and STS2 are presented in **Appendix 4.5-2B.**

ID	Description	Nature	Notional Distance to Proposed Works, m (1)(2)	Predicted Construction Noise Level at NSR for Pipeworks Construction, $L_{eq\ (30\ mins)}$ dB(A) (1)(3)(4)										Maximum Construction Noise Level at NSR, $L_{eq\ (30\ mins)}$ dB(A)	Noise Criteria, $L_{eq\ (30\ mins)}$ dB(A) (5)	Max Noise Exceedance, $L_{eq\ (30\ mins)}$ dB(A)
				Earthwork#				Pipe Laying#	Manhole#		Backfilling#	Reinstatement#	Loading and Unloading*#			
				2.1a SWL: 92 dB(A)	2.1b SWL: 94 dB(A)	2.1c SWL: 89 dB(A)	2.1d SWL: 95 dB(A)	2.2a SWL: 95 dB(A)	2.3a SWL: 95 dB(A)	2.3b SWL: 92 dB(A)	2.4a SWL: 93 dB(A)	2.5a SWL: 92 dB(A)	2.6a SWL: 100 dB(A)			
STN1_N1	New Town Plaza Phase III (Block 2) Ivy Court	Residential	35	57	58	54	59	59	59	57	58	57	64	64	75	0
STN1_N2	Hilton Plaza Block B	Residential	17	63	65	60	66	66	66	63	64	63	70	70	75	0
STN1_N3	New Town Plaza Phase III (Block 5) Cotton Tree Court	Residential	83	49	51	46	52	52	52	49	50	49	56	56	75	0
STN1_N4	Wai Wah Centre Block 3	Residential	159	43	45	40	46	46	46	43	44	43	51	51	75	0
STN1_N5	Wai Wah Centre Block 4	Residential	183	42	44	39	45	45	45	42	43	42	50	50	75	0
STN1_N6	Buddhist Poh Yea Home for the Aged	Home for the Aged	210	41	43	38	44	44	44	41	42	41	48	48	75	0
STN1_N7	Hing Yuen Terrace	Residential	69	51	52	48	53	53	53	51	51	51	58	58	75	0

* Works area for loading and loading of materials should be set at at least 10 m from residential dwelling and 20 m from educational institute.
# Pipeworks constructed by Trenchless Method at within 30 m from Christ College at STS1 (Pok Hong Estate) should be scheduled outside examination period.

Notes:
(1) The manholes along the pipeworks to be cosntructed by trenchless method would be used as jacking / receiving pit.
(2) No pipeworks constructed by trenchless method is proposed for MOS1, STN9, STN10 & STS5. Their representative NSRs that fall outside 300 m from notional source of works proposed in other sites and hence were not assessed.
(3) A +3 dB(A) façade correction was added to the predicted noise level to account for the façade effect at the NSR.
Distance Attenuation in dB(A) = 20 log D + 8, where D is distance in metres, was taken into account in the noise prediction.
(4) Only one construction activity would be undertaken at any one time within each workfront.
(5) EIAO-TM noise criteria adopted: 75 dB(A) for residential dwelling / place of public worship / home for the aged; 70 dB(A) during normal school days / 65 dB(A) during examination period for educational institution.

Appendix 4.6-3 Construction Plant Inventory under Mitigated Scenario

Calculation of Construction Noise Levels (Mitigated Scenario)

3 Construction of Pumping Station and Storage Tank

ID	Description	Nature	Notional Distance to Proposed Works, m (1)(2)	Predicted Construction Noise Level at NSR for Pipeworks Construction, $L_{eq\ (30\ mins)}$ dB(A) (3)(4)						Maximum Construction Noise Level at NSR, $L_{eq\ (30\ mins)}$ dB(A)	Noise Criteria, $L_{eq\ (30\ mins)}$ dB(A) (5)	Max Noise Exceedance, $L_{eq\ (30\ mins)}$ dB(A)
				Site Clearance and ELS	Steel Fixing and Concreting of Structure	E&M Installation & Pipeworks	Backfilling	Surface Reinstatement	Landscape Works & Roadworks			
				3.1	3.2	3.3	3.4	3.5	3.6			
				SWL: 115 dB(A)	SWL: 109 dB(A)	SWL: 112 dB(A)	SWL: 109 dB(A)	SWL: 113 dB(A)	SWL: 114 dB(A)			
STN1_N1	New Town Plaza Phase III (Block 2) Ivy Court	Residential	67	74	68	70	67	71	73	74	75	0
STN1_N2	Hilton Plaza Block B	Residential	204	64	58	61	58	62	63	64	75	0
STN1_N3	New Town Plaza Phase III (Block 5) Cotton Tree Court	Residential	213	64	58	60	57	61	63	64	75	0
STN1_N4	Wai Wah Centre Block 3	Residential	252	62	56	59	56	60	61	62	75	0
STN1_N5	Wai Wah Centre Block 4	Residential	290	61	55	58	55	59	60	61	75	0
STN1_N6	Buddhist Poh Yea Home for the Aged	Home for the Aged	>300	-	-	-	-	-	-	-	75	-
STN1_N7	Hing Yuen Terrace	Residential	>300	-	-	-	-	-	-	-	75	-

Notes:

(1) No construction of pumping station and storage tank is proposed for all other Project sites and their representative NSRs also fall outside 300 m from notional source of works proposed in other sites and hence were not assessed.
(2) NSRs outside 300m from notional source of the proposed works were not assessed.
(3) A +3 dB(A) façade correction was added to the predicted noise level to account for the façade effect at the NSR.
Distance Attenuation in dB(A) = 20 log D + 8, where D is distance in metres, was taken into account in the noise prediction.
(4) Only one construction activity would be undertaken at any one time within each workfront.
(5) EIAO-TM noise criteria adopted: 75 dB(A) for residential dwelling / home for the aged.

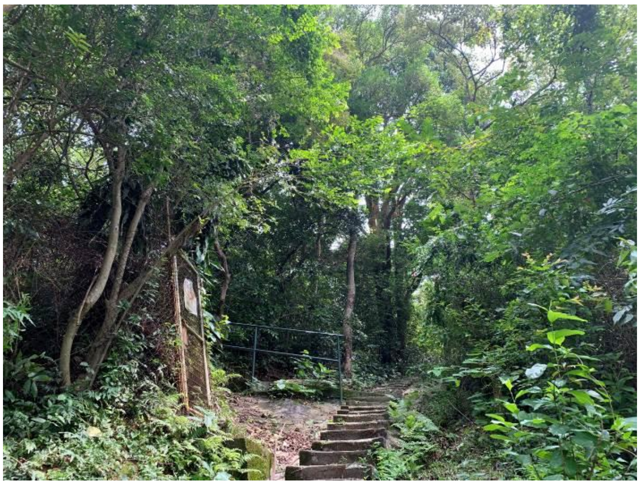
Appendix 7.1
Areas of the Habitats Present within the Assessment Area

Appendix 7.1 Areas of the Habitats Present within the Assessment Area

Habitats	Area of the Identified Habitat (ha)		
	Project Site	500 m Assessment Area	Total
Sha Tin Town Centre (STN1)			
Channelised Watercourse	~15 m	16.5	16.5
Plantation	-	3.0	3.0
Woodland	-	23.6	23.6
Developed Area	1.5	139.1	140.6

Appendix 7.2
Representative Photographs of Habitat Types and Species of Conservation Importance Recorded within the Assessment Area

Sha Tin Town Centre (STN1)

	
Woodland	Channelised Watercourse
	
Plantation	Developed Area
	
Aquilaria sinensis	*Artocarpus hypargyreus*

AECOM	Agreement No. CE15/2019(DS) Drainage Improvement Works in Sha Tin and Sai Kung – Investigation	SCALE	N.T.S.	DATE	Apr-2021
		CHECK	LAMCCG	DRAWN	MAKYLS
	Representative Photographs of Habitat Types and Species of Conservation Importance Recorded within the Assessment Area	JOB NO.	60617767	APPENDIX NO. 7.2	REV -

Canthium dicoccum

Cibotium barometz

Gnetum luofuense

Black-crowned Night Heron

Grey Heron

Great Egret

AECOM	Agreement No. CE15/2019(DS) Drainage Improvement Works in Sha Tin and Sai Kung – Investigation	**SCALE**	N.T.S.	**DATE**	Apr-2021
		CHECK	LAMCCG	**DRAWN**	MAKYLS
	Representative Photographs of Habitat Types and Species of Conservation Importance Recorded within the Assessment Area	**JOB NO.**	60617767	**APPENDIX NO.** 7.2	**REV** -

Little Egret

AECOM	Agreement No. CE15/2019(DS) Drainage Improvement Works in Sha Tin and Sai Kung – Investigation	**SCALE**	N.T.S.	**DATE**	Apr-2021
		CHECK	LAMCCG	**DRAWN**	MAKYLS
	Representative Photographs of Habitat Types and Species of Conservation Importance Recorded within the Assessment Area	**JOB NO.**	60617767	**APPENDIX NO.** 7.2	**REV** -

Appendix 7.3
Flora Species Recorded within the Assessment Areas

Table 2. Floral Species Recorded within the Assessment Area of Sha Tin Town Centre (STN1)

Scientific Name	Chinese Name	Origin[1]	Growth Form[2]	Status in HK[1]	Project Site[3]		500m Assessment Area[3]			
					CH	DA	CH	PL	WL	DA
Acacia confusa	台灣相思	Exotic	Tree	Widely cultivated		**	**	**	**	**
Acacia mangium	大葉相思	Exotic	Tree	Widely cultivated					*	**
Acalypha hispida	狗尾紅	Exotic	Shrub	Cultivated						**
Acronychia pedunculata	山油柑	Native	Tree	Very common					**	
Adiantum flabellulatum	扇葉鐵線蕨	Native	Herb	Very common					*	
Agave angustifolia	狹葉龍舌蘭	Exotic	Herb	Cultivated						*
Ageratum conyzoides	藿香薊	Exotic	Herb	Common						*
Aglaia odorata var. *microphyllina*	小葉米仔蘭	Exotic	Shrub/Tree	Cultivated					*	**
Alangium chinense	八角楓	Native	Shrub/Tree	Common					**	*
Albizia lebbeck	大葉合歡	Exotic	Tree	Cultivated		*				*
Aleurites moluccana	石栗	Exotic	Tree	Widely cultivated		*	*			**
Allamanda cathartica	軟枝黃蟬	Exotic	Shrub	Commonly cultivated		**				***
Allamanda schottii	硬枝黃蟬	Exotic	Shrub	Commonly cultivated			**			***
Alocasia macrorrhizos	海芋	Native	Herb	Very common		*		*	**	*
Alpinia zerumbet	豔山薑	Native	Herb	Very common						*
Alpinia zerumbet 'Variegata'	花葉豔山薑	Exotic	Herb	Cultivated		*				
Ampelopsis cantoniensis	廣東蛇葡萄	Native	Climber	Very common					*	
Aporusa dioica	銀柴	Native	Tree	Very common					**	
Aquilaria sinensis	**土沉香**	**Native**	**Tree**	**Common; Protected under Cap. 586, listed as "Vulnerable" in China Plant Red Data Book, IUCN Red List and TSLCHP, under State protection (Category II) in China (AFCD 2003)**					*	
Araucaria heterophylla	異葉南洋杉	Exotic	Tree	Cultivated (IUCN: Vulnerable); the recorded specimen is planted		*				*
Archidendron lucidum	亮葉猴耳環	Native	Tree	Common					*	
Archontophoenix alexandrae	假檳榔	Exotic	Tree	Commonly cultivated		*				**
Artocarpus heterophyllus	菠蘿蜜	Exotic	Tree	Cultivated						*
Artocarpus hypargyreus	**白桂木**	**Native**	**Tree**	**Regarded as Common in Corlett *et al.* (2000). Status in China as "Near Threatened" (AFCD 2003) and Endangered (TSLCHP 2017), classified as "Vulnerable" on the IUCN Red List**					*	
Arundo donax	蘆竹	Native	Herb	Restricted						*
Asparagus densiflorus 'Sprengeri'	非洲天門冬	Exotic	Climber/Shrub	-		*				**

Scientific Name	Chinese Name	Origin[1]	Growth Form[2]	Status in HK[1]	Project Site[3]		500m Assessment Area[3]			
					CH	DA	CH	PL	WL	DA
Axonopus compressus	地毯草	Exotic	Herb	Common and naturalized		**				**
Bambusa sp.	竹屬	-	Bamboo	-					*	*
Bambusa ventricosa	佛肚竹	Exotic	Bamboo	Cultivated						*
Bambusa vulgaris 'Vittata'	黃金間碧竹	Exotic	Bamboo	Widely cultivated						*
Bauhinia glauca	羊蹄甲藤	Native	Climber	Very common					**	
Bauhinia purpurea	紅花羊蹄甲	Exotic	Tree	Cultivated						*
Bauhinia variegata	宮粉羊蹄甲	Exotic	Tree	Cultivated		*	*	**	*	**
Bauhinia x blakeana	洋紫荊	Native	Tree	Cultivated		**				***
Bidens alba	白花鬼針草	Exotic	Herb	Very common	*	**	**	**	**	**
Bischofia javanica	秋楓	Native	Tree	Common					*	*
Blechnum orientale	烏毛蕨	Native	Herb	Very common					*	
Boehmeria nivea	苧麻	Exotic	Shrub	Common					*	
Bombax ceiba	木棉	Exotic	Tree	Cultivated		*			*	*
Bothriochloa bladhii	臭根子草	Native	Herb	Very common			**			
Bothriochloa ischaemum	白羊草	Native	Herb	Common			**			
Bougainvillea spectabilis	簕杜鵑	Exotic	Climber/Shrub	Cultivated		*			*	*
Bridelia tomentosa	土蜜樹	Native	Shrub/Tree	Very common	*	*	*			*
Byttneria grandifolia	刺果藤	Native	Climber	Very common					**	
Calathea makoyana	孔雀冬葉	Exotic	Herb	Cultivated						**
Calliandra haematocephala	紅絨球	Exotic	Shrub	Cultivated		**				***
Callicarpa kochiana	枇杷葉紫珠	Native	Shrub	Common						*
Callistemon viminalis	串錢柳	Exotic	Tree	Cultivated		*	*			**
Camellia japonica	山茶	Exotic	Shrub/Tree	Cultivated						*
Canna indica	美人蕉	Exotic	Herb	Cultivated						*
Canna x generalis	大花美人蕉	Exotic	Herb	Cultivated						*
Canthium dicoccum	**魚骨木**	**Native**	**Shrub/Tree**	**Classified as "Vulnerable" in IUCN Red List based on the assessment of its range in Sri Lanka but is regarded as Common in AFCD (2009)**					*	
Carica papaya	番木瓜	Exotic	Tree	Cultivated						*
Carmona microphylla	福建茶	Exotic	Shrub	Cultivated						**
Caryota maxima	魚尾葵	Exotic	Tree	Cultivated		*			*	*
Caryota mitis	短穗魚尾葵	Exotic	Shrub	Cultivated		**				**
Cassia fistula	豬腸豆	Exotic	Tree	Cultivated						**
Cassytha filiformis	無根藤	Native	Climber	Very common					*	
Castanopsis fissa	黧蒴錐	Native	Tree	Common					*	
Casuarina equisetifolia	木麻黃	Exotic	Tree	Cultivated			**			
Catharanthus roseus	長春花	Exotic	Herb/Shrub	Common		*	*			*
Celtis sinensis	朴	Native	Tree	Common and widely planted			*	*	*	*

Appendix 7.3 Floral Species Recorded within the Assessment Areas

Scientific Name	Chinese Name	Origin[1]	Growth Form[2]	Status in HK[1]	Project Site[3]		500m Assessment Area[3]			
					CH	DA	CH	PL	WL	DA
Celtis timorensis	樟葉朴	Native	Tree	Restricted					*	*
Cibotium barometz	**金毛狗**	**Native**	**Herb**	**Regarded as Very Common in Corlett *et al*. (2000). Protected under Cap. 586. Status in China as "Vulnerable", under State protection (Category II) in China (AFCD 2003)**					*	
Cinnamomum burmannii	陰香	Native	Tree	Common, also cultivated			**			*
Cinnamomum camphora	樟	Native	Tree	Common, also cultivated					*	*
Cinnamomum parthenoxylon	黃樟	Native	Tree	Common						*
Citrus maxima	柚	Exotic	Tree	Cultivated					*	
Citrus reticulata	桔	Exotic	Tree	Cultivated						*
Clausena lansium	黃皮	Exotic	Tree	Cultivated					*	*
Clerodendranthus spicatus	腎茶, 貓鬚草	Exotic	Herb	Common						*
Clerodendrum japonicum	赬桐	Exotic	Shrub	Common, cultivated and apparently nautralized					*	
Cocculus orbiculatus	木防己	Native	Climber	Common			**			
Codiaeum variegatum	變葉木	Exotic	Shrub	Cultivated		*				**
Coleus scutellarioides	五彩蘇,洋紫蘇	Exotic	Herb	Cultivated		*				
Commelina diffusa	節節草	Native	Herb	Common					*	
Cordyline fruticosa	朱蕉	Exotic	Shrub	Cultivated		*				*
Corymbia citriodora	檸檬桉	Exotic	Tree	Cultivated						*
Cratoxylum cochinchinense	黃牛木	Native	Shrub/Tree	Very common					*	
Cupressus funebris	柏木, 垂柏	Exotic	Tree	Cultivated						*
Cycas revoluta	蘇鐵	Exotic	Tree	Cultivated						*
Cyclosorus parasiticus	華南毛蕨	Native	Herb	Very common		*		*	*	*
Cynodon dactylon	狗牙根	Native	Herb	Very common	**	**	**			**
Cyperus involucratus	風車草	Exotic	Herb	Cultivated or naturalized						*
Cyrtococcum patens	弓果黍	Native	Herb	Very common		*				*
Dalbergia benthamii	兩廣黃檀	Native	Climber	Common					**	
Daphniphyllum calycinum	牛耳楓	Native	Shrub	Common					*	
Delonix regia	鳳凰木	Exotic	Tree	Cultivated		*		*	*	*
Dendranthema morifolium	菊花	Exotic	Herb	Cultivated						*
Desmos chinensis	假鷹爪	Native	Climber/Shrub	Common					**	*
Dieffenbachia seguine	花葉萬年青	Exotic	Herb	Cultivated						*
Digitaria ciliaris	升馬唐	Native	Herb	Very common		*				*
Dimocarpus longan	龍眼	Exotic	Tree	Cultivated (IUCN: Near Threatened; TSLCHP: Vulnerable); the recorded specimen is planted		*	*		*	*
Dioscorea bulbifera	黃獨	Native	Climber	Common					*	

Appendix 7.3 Floral Species Recorded within the Assessment Areas

Scientific Name	Chinese Name	Origin[1]	Growth Form[2]	Status in HK[1]	Project Site[3]		500m Assessment Area[3]			
					CH	DA	CH	PL	WL	DA
Diospyros eriantha	烏柿	Native	Shrub/Tree	Very common					*	
Diploclisia glaucescens	蒼白秤鈎風	Native	Climber	Common					*	
Dracaena fragrans	巴西鐵樹	Exotic	Shrub	Cultivated					*	**
Dracaena marginata	紅邊鐵樹	Exotic	Shrub	Planted		*				**
Dracontomelon duperreanum	人面子	Exotic	Tree	Cultivated					*	
Duranta erecta	假連翹	Exotic	Climber/Shrub	Cultivated		**				***
Duranta erecta 'Variegata'	花葉假連翹	Exotic	Shrub	Cultivated						**
Dypsis lutescens	散尾葵	Exotic	Shrub	Cultivated (IUCN: Near Threatened); the recorded specimen is planted						**
Elaeocarpus hainanensis	水石榕	Exotic	Tree	Cultivated						*
Emilia sonchifolia	一點紅	Native	Herb	Very common		*			*	*
Epipremnum aureum	綠蘿	Exotic	Climber	Cultivated						*
Eragrostis atrovirens	鼠婦草	Native	Herb	Common			**			
Eragrostis tenella	鯽魚草	Native	Herb	Very common		**				
Eriobotrya japonica	枇杷	Exotic	Tree	Cultivated					*	
Eucalyptus exserta	窿緣桉	Exotic	Tree	Cultivated						*
Eucalyptus robusta	大葉桉	Exotic	Tree	Cultivated					*	
Euphorbia antiquorum	火殃簕	Exotic	Tree	Cultivated		*				
Euphorbia hirta	大飛揚草	Exotic	Herb	Very common	*	*	*			*
Euphorbia thymifolia	小飛揚	Native	Herb	Very common		*				*
Excoecaria cochinchinensis	紅背桂	Exotic	Shrub	Cultivated						**
Fagraea ceilanica	灰莉	Exotic	Tree	Cultivated		***				**
Ficus benjamina	垂葉榕	Exotic	Tree	Cultivated					*	**
Ficus carica	無花果	Exotic	Shrub/Tree	Cultivated						*
Ficus elastica	印度榕	Exotic	Tree	Cultivated		*				*
Ficus hirta	粗葉榕	Native	Shrub/Tree	Common					*	
Ficus hispida	對葉榕	Native	Shrub/Tree	Very common		**	*	**	**	*
Ficus microcarpa	細葉榕	Native	Tree	Common and widely cultivated	*	*	**			***
Ficus microcarpa 'Golden Leaf'	黃金榕	Exotic	Shrub	Cultivated		***				**
Ficus pumila	薜荔	Native	Climber	Very common						*
Ficus religiosa	菩提樹	Exotic	Tree	Restricted but widely planted and locally naturalized		*				*
Ficus rumphii	心葉榕	Exotic	Tree	Cultivated					*	
Ficus subpisocarpa	筆管榕	Native	Tree	Common			*			*
Ficus variegata	青果榕	Native	Tree	Common					*	
Ficus virens	大葉榕	Native	Tree	Common		*			*	
Fimbristylis sieboldii	鏽鱗飄拂草	Native	Herb	Common			**			
Flueggea virosa	白飯樹	Native	Shrub	Common			*			
Garcinia oblongifolia	黃牙果	Native	Shrub/Tree	Very common					**	

Appendix 7.3 Floral Species Recorded within the Assessment Areas

Scientific Name	Chinese Name	Origin[1]	Growth Form[2]	Status in HK[1]	Project Site[3]		500m Assessment Area[3]			
					CH	DA	CH	PL	WL	DA
Garcinia subelliptica	菲島福木	Exotic	Tree	-		*				**
Ginkgo biloba	銀杏	Exotic	Tree	Cultivated; (IUCN: Endangered; TSLCHP: Critically Endangered); the recorded specimen is cultivated						*
Glochidion zeylanicum	香港算盤子	Native	Shrub/Tree	Common					*	
Gnetum luofuense	**羅浮買麻藤**	**Native**	**Climber**	**Regarded as Very Common by Corlett *et al.* (2000), classified as "Near Threatened" in IUCN Red List but locally very common in Hong Kong (AFCD 2007)**					*	
Grevillea robusta	銀樺	Exotic	Tree	Cultivated		*				**
Hedyotis corymbosa	傘房花耳草	Native	Herb	Very common		*	*			*
Hibiscus rosa-sinensis	大紅花	Exotic	Shrub	Commonly cultivated		**				***
Hibiscus schizopetalus	吊燈花	Exotic	Shrub	Commonly cultivated						*
Hibiscus tiliaceus	黃槿	Native	Tree	Very common		*	**			**
Hymenocallis littoralis	水鬼蕉	Exotic	Herb	Cultivated						*
Imperata cylindrica var. *major*	絲茅	Native	Herb	Very common		*				*
Ipomoea cairica	五爪金龍	Exotic	Herb	Very common				*	*	
Ipomoea triloba	三裂葉薯	Exotic	Herb	Common			*			*
Ixora chinensis	龍船花	Native	Shrub	Restricted, also widely cultivated		**			*	***
Ixora coccinea	橙紅龍船花	Exotic	Shrub	Often planted		**				**
Ixora coccinea f. *lutea*	黃龍船花	Exotic	Shrub	Cultivated						**
Ixora stricta	細葉龍船花	Exotic	Shrub	Cultivated						***
Jacaranda mimosifolia	藍花楹	Exotic	Tree	Often planted (IUCN: Vulnerable); the recorded specimen is planted						*
Juniperus chinensis	圓柏	Exotic	Tree	Cultivated		*				
Juniperus chinensis 'Kaizuca'	龍柏	Exotic	Tree	Cultivated						*
Khaya senegalensis	非洲桃花心木	Exotic	Tree	Cultivated (IUCN: Vulnerable); the recorded specimen is planted						**
Kyllinga nemoralis	單穗水蜈蚣	Native	Herb	Very common					*	
Kyllinga polyphylla	香根水蜈蚣	Exotic	Herb	Common		**				
Lagerstroemia speciosa	大花紫薇	Exotic	Tree	Cultivated		*			*	**
Lantana camara	馬纓丹	Exotic	Shrub	Very common			*			*
Lantana montevidensis	鋪地臭金鳳	Exotic	Shrub	Often planted						**
Lantana montevidensis	鋪地臭金鳳	Exotic	Shrub	Often planted			**			
Lasianthus chinensis	粗葉木	Native	Shrub	Common					*	
Leucaena leucocephala	銀合歡	Exotic	Shrub/Tree	Cultivated or naturalized		*	*	**	**	**
Ligustrum sinense	山指甲	Exotic	Shrub/Tree	Common, also widely cultivated					**	**

Scientific Name	Chinese Name	Origin[1]	Growth Form[2]	Status in HK[1]	Project Site[3]		500m Assessment Area[3]			
					CH	DA	CH	PL	WL	DA
Liquidambar formosana	楓香	Native	Tree	Common, also widely planted		*				*
Liriope muscari 'Variegata'	金邊闊葉山麥冬	Exotic	Herb	Cultivated						**
Litchi chinensis	荔枝	Exotic	Tree	Cultivated					*	*
Litsea cubeba	木薑子	Native	Shrub/Tree	Common					*	
Litsea glutinosa	潺槁	Native	Tree	Very common					*	*
Litsea rotundifolia var. *oblongifolia*	豺皮樟	Native	Shrub/Tree	Very common					**	
Livistona chinensis	蒲葵	Exotic	Tree	Cultivated		*			*	**
Lophatherum gracile	淡竹葉	Native	Herb	Very common					**	
Lophostemon confertus	紅膠木	Exotic	Tree	Cultivated					*	
Loropetalum chinense f. *rubrum*	紅花檵木	Exotic	Shrub	Cultivated		*				***
Lygodium japonicum	海金沙	Native	Climber/Herb	Very common		*			*	
Macaranga tanarius var. *tomentosa*	血桐	Native	Tree	Common		*	*	**	**	**
Magnolia grandiflora	荷花玉蘭	Exotic	Tree	Protected under Cap. 96A, but the recorded specimen is planted		*				*
Mallotus paniculatus	白楸	Native	Shrub/Tree	Very common					**	
Malvaviscus penduliflorus	垂花懸鈴花	Exotic	Shrub	Cultivated						**
Mangifera indica	杧果	Exotic	Tree	Cultivated						*
Melaleuca bracteata	黃金香柳	Exotic	Tree	Cultivated						*
Melaleuca cajuputi subsp. *cumingiana*	白千層	Exotic	Tree	Cultivated		*		*		**
Melia azedarach	苦楝	Exotic	Tree	Cultivated or naturalized						*
Melinis repens	紅毛草	Exotic	Herb	Very common			**			
Michelia figo	含笑	Exotic	Shrub	Regarded as Very Rare in Corlett *et al*. (2000), but also planted for ornamental, protected under Cap. 96A; the recorded specimen is planted						*
Michelia x *alba*	白蘭	Exotic	Tree	Widely cultivated		*				*
Microcos nervosa	布渣葉	Native	Shrub/Tree	Common			*		*	*
Microstegium ciliatum	剛莠竹	Native	Herb	Very common					*	
Mikania micrantha	薇甘菊	Exotic	Climber/Herb	Very common		*	*	*	*	**
Miscanthus sinensis	芒	Native	Herb	Very common					*	
Morinda parvifolia	雞眼藤	Native	Climber/Shrub	Very common					*	
Murraya paniculata	九里香	Exotic	Tree	Cultivated or naturalized						*
Mussaenda pubescens	玉葉金花	Native	Climber/Shrub	Very common					*	
Nelumbo nucifera	荷花	Exotic	Herb	Cultivated						*
Neottopteris nidus	巢蕨	Native	Herb	Regarded as Restricted in Corlett *et al* (2000). Protected under Cap. 96A; the recorded specimen is planted						*
Nephrolepis auriculata	腎蕨	Native	Herb	Common		*				

Scientific Name	Chinese Name	Origin[1]	Growth Form[2]	Status in HK[1]	Project Site[3]		500m Assessment Area[3]			
					CH	DA	CH	PL	WL	DA
Neyraudia reynaudiana	類蘆	Native	Herb	Very common			**			*
Nymphaea sp.	睡蓮	Exotic	Herb	Cultivated						*
Odontonema tubiforme	紅樓花	Exotic	Shrub	Cultivated					*	
Ophiopogon japonicus	麥冬	Native	Herb	Common		**				
Osmanthus fragrans	桂花, 木犀	Exotic	Shrub/Tree	Cultivated						**
Oxalis corniculata	酢醬草	Native	Herb	Very common		**				**
Pachira aquatica	瓜栗	Exotic	Tree	Planted for ornamental purpose						*
Paederia scandens	雞矢藤	Native	Herb	Very common		*	*		*	*
Panicum brevifolium	短葉黍	Native	Herb	Very common						*
Panicum maximum	大黍	Exotic	Herb	Very common			**		**	***
Parthenocissus dalzielii	爬牆虎	Exotic	Climber	Cultivated						*
Paspalum conjugatum	兩耳草	Native	Herb	Common					*	
Passiflora foetida	龍珠果	Exotic	Climber	Very common						*
Passiflora suberosa	南美西番蓮	Exotic	Climber	Common				*	*	
Peltophorum pterocarpum	盾柱木	Exotic	Tree	Cultivated						*
Pericampylus glaucus	細圓藤	Native	Climber	Restricted					*	
Persicaria chinensis	火炭母	Native	Herb	Very common				*	*	
Philodendron bipinnatifidum	裂葉喜樹蕉	Exotic	Herb	Cultivated		***				*
Phoenix roebelenii	日本葵	Exotic	Tree	Cultivated						*
Photinia benthamiana	閩粵石楠	Native	Shrub/Tree	Common						*
Phyllanthus reticulatus	小果葉下珠	Native	Shrub	Common					**	
Phyllanthus urinaria	葉下珠	Native	Herb	Common		*				*
Pilea microphylla	小葉冷水花	Exotic	Herb	Very common					*	*
Pinus elliottii	濕地松	Exotic	Tree	Widely planted						*
Platycladus orientalis	側柏	Exotic	Tree	Often planted (IUCN: Near Threatened); the recorded specimen is planted						*
Plumeria rubra	雞蛋花	Exotic	Tree	Commonly cultivated		*				*
Podocarpus macrophyllus	羅漢松	Native	Tree	Restricted and often planted					*	*
Psychotria asiatica	山大刀	Native	Shrub/Tree	Very common					**	
Pteris ensiformis	劍葉鳳尾蕨	Native	Herb	Common				*	*	
Pteris semipinnata	半邊旗	Native	Herb	Very common					**	*
Pteris vittata	蜈蚣草	Native	Herb	Very common					*	
Pterocarpus indicus	紫檀	Exotic	Tree	Common (IUCN: Vulnerable; TSLCHP: Critically Endangered); the recorded specimen is planted		*				**
Punica granatum	安石榴	Exotic	Shrub/Tree	Cultivated						*
Pyrostegia venusta	炮仗花	Exotic	Climber	Cultivated						*
Ravenala madagascariensis	旅人蕉	Exotic	Tree	Cultivated						*
Rhaphiolepis indica	車輪梅	Native	Shrub/Tree	Very common						*

Appendix 7.3 Floral Species Recorded within the Assessment Areas

Scientific Name	Chinese Name	Origin[1]	Growth Form[2]	Status in HK[1]	Project Site[3]		500m Assessment Area[3]			
					CH	DA	CH	PL	WL	DA
Rhapis excelsa	棕竹	Native	Shrub	Common		**			*	**
Rhododendron pulchrum var. *phoeniceum*	紫杜鵑	Exotic	Shrub	All *Rhododendron* species are protected under Cap. 96A, but the recorded specimen was in cultivated form						**
Rhododendron sp.	杜鵑屬植物	-	Shrub	Wild population is protected under Cap. 96A, the recorded specimen is planted		**				**
Rhus succedanea	野漆樹	Native	Shrub/Tree	Common					*	
Roystonea regia	王棕	Exotic	Tree	Often planted		*				*
Salix babylonica	垂柳	Exotic	Tree	Cultivated						*
Sansevieria trifasciata	虎尾蘭	Exotic	Herb	Cultivated					*	
Sapindus saponaria	無患子	Native	Tree	Restricted					*	
Sapium discolor	山烏桕	Native	Tree	Very common					*	
Sapium sebiferum	烏桕	Native	Tree	Common			*			
Schefflera arboricola	鵝掌藤	Exotic	Climber/Shrub	Often planted		***				***
Schefflera arboricola 'Variegata'	花葉鵝掌藤	Exotic	Climbing Shrub	Cultivated		**				**
Schefflera heptaphylla	鴨腳木	Native	Shrub/Tree	Very common		*			**	
Schima superba	木荷	Native	Tree	Common					*	*
Scolopia saeva	廣東刺柊	Native	Shrub/Tree	Common					*	
Scoparia dulcis	野甘草	Exotic	Herb/Shrub	Common			**			
Senna surattensis	黃槐	Exotic	Shrub/Tree	Often planted						**
Smilax china	金剛藤	Native	Climber	Very common					*	
Smilax glabra	土茯苓	Native	Climber	Very common					*	
Solanum americanum	少花龍葵	Exotic	Herb	Very common		*				
Solanum pseudocapsicum var. *diflorum*	瑪瑙珠	Exotic	Herb	-					*	
Solanum torvum	水茄	Exotic	Shrub	Common						*
Spathiphyllum floribundum	白鶴芋	Exotic	Herb	Cultivated						**
Spathodea campanulata	火焰木	Exotic	Tree	Cultivated						**
Sporobolus fertilis	鼠尾粟	Native	Herb	Very common		*	*			*
Sterculia lanceolata	假蘋婆	Native	Tree	Very common		*			**	*
Sterculia monosperma	蘋婆	Exotic	Tree	Restricted but also cultivated						*
Strelitzia nicolai	大鶴望蘭	Exotic	Tree	Cultivated						*
Strelitzia reginae	鶴望蘭, 天堂鳥蕉	Exotic	Herb	Cultivated						*
Strophanthus divaricatus	羊角拗	Native	Climber/Shrub	Common					**	
Strychnos angustiflora	牛眼馬錢	Native	Climber	Common					*	
Synedrella nodiflora	金腰箭	Exotic	Herb	Very common					*	
Syngonium auritum	長耳合果芋	Exotic	Herb	Commonly cultivated					*	*
Syngonium podophyllum	合果芋	Exotic	Herb	Often planted					*	
Syzygium cumini	海南蒲桃	Exotic	Tree	Cultivated						*
Syzygium hancei	韓氏蒲桃	Native	Shrub/Tree	Common					*	

Appendix 7.3 Floral Species Recorded within the Assessment Areas

Scientific Name	Chinese Name	Origin[1]	Growth Form[2]	Status in HK[1]	Project Site[3]		500m Assessment Area[3]			
					CH	DA	CH	PL	WL	DA
Syzygium jambos	蒲桃	Exotic	Tree	Cultivated and naturalized		*			*	*
Syzygium levinei	山蒲桃	Native	Shrub/Tree	Common					**	
Taxodium distichum	落羽杉	Exotic	Tree	Cultivated						*
Terminalia catappa	欖仁樹	Exotic	Tree	Cultivated						**
Terminalia mantaly	小葉欖仁	Exotic	Tree	Cultivated		*				**
Terminalia mantaly cv.Tricolor	錦葉欖仁	Exotic	Tree	-						*
Tetracera asiatica	錫葉藤	Native	Climber	Very common					*	
Thevetia peruviana	黃花夾竹桃	Exotic	Tree	Commonly cultivated						**
Thryallis gracilis	金英	Exotic	Shrub	Cultivated						*
Tibouchina semidecandra	巴西野牡丹	Exotic	Shrub	Cultivated						**
Tradescantia spathacea	蚌花	Exotic	Herb	Cultivated						**
Trema tomentosa	山黃麻	Native	Shrub/Tree	Common					**	
Tridax procumbens	羽芒菊	Exotic	Herb	Very common		**	**			**
Uvaria macrophylla	紫玉盤	Native	Climber/Shrub	Common					**	
Vernonia cinerea	夜香牛	Native	Herb	Very common		*				
Vitex quinata	山牡荊	Native	Tree	Common						*
Wedelia trilobata	三裂葉蟛蜞菊	Exotic	Herb	Common, also widely cultivated	**	**	**		**	***
Wisteria sinensis	紫藤	Exotic	Climber	Cultivated						*
Youngia japonica	黃鵪菜	Native	Herb	Very common		*				*
Zanthoxylum piperitum	胡椒木	Exotic	Shrub	Cultivated						**
			Total no. of species recorded	**285**	**6**	**88**	**41**	**16**	**119**	**190**

Notes:

1. Origin and Status in HK refer to:
   a. Cap. 96 = Chapter 96 Forests and Countryside Ordinance, including the associated Chapter 96A Forestry Regulation
   b. Cap. 586 = Chapter 586 Protection of Endangered Species of Animal and Plants Ordinance
   c. Corlett *et al.* (2000);
   d. AFCD (2003);
   e. AFCD (2007);
   f. AFCD (2008);
   g. AFCD (2009);
   h. AFCD (2011a);
   i. AFCD (2012);
   j. IUCN (2021);
   k. Qin *et al.* (2017) (Threatened Species List of China's Higher Plants = TSLCHP);
   l. Status in China Red Data Book is retrieved from AFCD (2003).

   In this study, plant species is regarded as floral species of conservation importance if it is protected under Cap. 96A, Cap. 586, documented as rare/protected species in AFCD (2003), or its wild population (i.e. not cultivated specimens) has conservation status under international or regional conservation inventory (e.g. IUCN Red List of Threatened Species, China Red Data Book, Threatened Species List of China's Higher Plants).
2. Growth form follows AFCD (2012).
3. Habitats: **CH**=Channelised Watercourse; **PL**=Plantation; **WL**=Woodland; **DA**=Developed Area.

Code for abundance: **** = Abundant, *** = Frequent, ** = Occasional, * = Scarce

Appendix 7.4
Fauna Species Recorded within the Assessment Areas

2. Sha Tin Town Centre (STN1)

Table 2a. Avifauna Species Recorded within the Assessment Area of STN1

Species	Conservation and Protection Status[1]	Principal Status[2]	Status in Hong Kong Bird Report	Wetland-dependent?	Project Site[3]	500m Assessment Area[3]			
					DA	CW	DA	PL	WL
Black-crowned Night Heron *Nycticorax nycticorax*	**(LC)**	**P**	**Common resident and migrant mainly in Deep Bay wetlands and at scattered breeding colonies, mostly around Starling Inlet and Tolo Harbour**	**Y**		**+**			
Grey Heron *Ardea cinerea*	**PRC**	**W**	**Common in wetlands and some coastal areas, mainly in the Deep Bay area, present all year with highest numbers in winter and very low numbers in summer**	**Y**		**+**			
Great Egret *Ardea alba*	**PRC (RC)**	**P**	**Abundant, present all year in wetlands, mainly in the Deep Bay area although breeding populations are found mainly around Starling Inlet and Tolo Harbour, migrants and winter visitors occur**	**Y**		**+**			
Little Egret *Egretta garzetta*	**PRC (RC)**	**P**	**Abundant, present all year in wetland areas throughout HK, mostly in the Deep Bay area**	**Y**		**+**			
Spotted Dove *Spilopelia chinensis*	-	R	Abundant resident in diverse habitats in urban and rural areas	N	+		++	+	+
Common Emerald Dove *Chalcophaps indica*	-	R	Uncommon but widespread resident, locally common in some areas, in closed-canopy shrubland and forest habitats	N					+
Hair-crested Drongo *Dicrurus hottentottus*	-	M,Su,W	Common winter visitor, migrant and locally common resident in wooded areas	N					+
Red-billed Blue Magpie *Urocissa erythroryncha*	-	R	Common resident of closed-canopy shrubland	N					+
Large-billed Crow *Corvus macrorhynchos*	-	R	Common resident of open rural and wooded urban-edge habitats	N				+	
Red-whiskered Bulbul *Pycnonotus jocosus*	-	R	Abundant resident in most habitats except woodland interior	N	++		+		++
Chinese Bulbul *Pycnonotus sinensis*	-	R	Abundant all year, with migrants and winter visitors occurring, present in nearly all habitats, the most abundant and widespread species in HK	N					+
Mountain Tailorbird *Phyllergates cucullatus*	-	-	Uncommon resident and locally common winter visitor in closed-canopy shrubland and woodland	N					+
Common Tailorbird *Orthotomus sutorius*	-	R	Widespread and common resident in diverse shrubland and wooded habitats	N					+
Masked Laughingthrush *Pterorhinus perspicillatus*	-	R	Abundant resident in diverse urban and rural lightly-wooded habitats	N					+
Crested Myna *Acridotheres cristatellus*	-	R	Abundant resident of lowland habitats including urban areas	N		+	+		
Black-collared Starling *Gracupica nigricollis*	-	R	Common resident of open-country, village edge and urban habitats	N		+	++		
Asian Brown Flycatcher *Muscicapa dauurica*	-	M,W	Common autumn passage migrant and winter visitor to open and closed-canopy woodland areas	N					+
Daurian Redstart *Phoenicurus auroreus*	-	W	Common winter visitor to shrubland and open woodland	N					+
Fork-tailed Sunbird *Aethopyga christinae*	-	R	Common and widespread resident and winter visitor in woodland and shrubland	N					+

Species	Conservation and Protection Status[1]	Principal Status[2]	Status in Hong Kong Bird Report	Wetland-dependent?	Project Site[3]	500m Assessment Area[3]			
					DA	CW	DA	PL	WL
Eurasian Tree Sparrow *Passer montanus*	-	R	Abundant resident of lowland habitats, commensal with man; higher numbers sometimes recorded in fish pond areas and on offshore islands in spring	N	++	+	+++		
White Wagtail *Motacilla alba*	-	W,R	A widespread species although most records and high counts from northwest NT	N		+			

Notes for Table 2a:
1. Conservation and protection status refer to Fellowes *et al*. (2002), Red List of China's Vertebrates (Jiang *et al.* 2016), IUCN (2021), China State Major Protection Status, CITES (2020), Cap. 170 and Cap. 586.
   Conservation status by Fellowes *et al.* (2002): LC = Local Concern; PRC = Potential Regional Concern; RC = Regional Concern. Letters in parentheses indicate that the assessment is on the basis of restrictedness in breeding and/or roosting sites rather than in general occurrence.
   Cap. 170. Wild Animal Protection Ordinance. All wild birds in Hong Kong are protected under Cap. 170
2. Principal Status follows Carey *et al*. (2001): P = Present all year, exact composition unknown; R = Resident; W = Winter Visitor; Su = Summer Visitor; M = Migrant.
3. Habitats: **DA** = Developed Area; **CW** = Channelised Watercourse; **PL** = Plantation; **WL** = Woodland.

Code for abundance: ++++ = Abundant, +++ = Frequent, ++ = Occasional, + = Scarce

Table 2b. Herpetofauna Species Recorded within the Assessment Area of STN1

Species	Conservation and Protection Status[1]	Status in HK[2]	Project Site[3]	500 m Assessment Area[3]			
			DA	CW	DA	PL	WL
Amphibian							
Asian Common Toad *Duttaphrynus melanostictus*	-	Widely distributed in Hong Kong.			+		+
Asiatic Painted Frog *Kaloula pulchra*	-	Widely distributed in Hong Kong.			+	+	+
Brown Tree Frog *Polypedates megacephalus*	-	Widely distributed throughout Hong Kong.					+
Greenhouse Frog *Eleutherodactylus planirostris*		Introduced species				+	
Reptile							
Changeable Lizard *Calotes versicolor*	-	Widely distributed throughout Hong Kong.			+		
Long-tailed Skink *Eutropis longicaudata*	-	Widely distributed throughout Hong Kong.			+		

Notes for Table 2b:
1. Conservation and protection status refer to Fellowes *et al*. (2002), Red List of China's Vertebrates (Jiang *et al.* 2016), IUCN (2021), China State Major Protection Status, CITES (2020), Cap. 170 and Cap. 586.
2. Status in HK follows AFCD (2020).
3. Habitats: **DA** = Developed Area; **CW** = Channelised Watercourse; **PL** = Plantation; **WL** = Woodland.

Code for abundance: ++++ = Abundant, +++ = Frequent, ++ = Occasional, + = Scarce

Table 2c. Butterfly Species Recorded within the Assessment Area of STN1

Species	Conservation and Protection Status[1]	Status in HK[2]	Project Site[3]	500 m Assessment Area			
			DA	CW	DA	PL	WL
Pale Grass Blue *Pseudozizeeria maha*	-	Very Common			+		

Species	Conservation and Protection Status[1]	Status in HK[2]	Project Site[3]	500 m Assessment Area			
			DA	CW	DA	PL	WL
Common Indian Crow *Euploea core*	-	Common					+
Great Egg-fly *Hypolimnas bolina*	-	Common					+
Common Sailer *Neptis hylas*	-	Very Common					+
Common Palmfly *Elymnias hypermnestra*	-	Common					+
Common Jay *Graphium doson*	-	Common			+		
Common Bluebottle *Graphium sarpedon*	-	Very Common			+		
Red Helen *Papilio helenus*	-	Very Common				+	
Common Mormon *Papilio polytes*	-	Very Common					+
Spangle *Papilio protenor*	-	Very Common				+	
Lemon Emigrant *Catopsilia pomona*	-	Common					+
Three-spot Grass Yellow *Eurema blanda*	-	Common					+
Common Grass Yellow *Eurema hecabe*	-	Very Common					+

Notes for Table 2c:
1. Conservation and protection status refer to Fellowes *et al*. (2002), Red List of China's Vertebrates (Jiang *et al.* 2016), IUCN (2021), China State Major Protection Status, CITES (2020), Cap. 170 and Cap. 586.
2. Status in HK follows AFCD (2020).
3. Habitats: **DA** = Developed Area; **CW** = Channelised Watercourse; **PL** = Plantation; **WL** = Woodland.

Code for abundance: ++++ = Abundant, +++ = Frequent, ++ = Occasional, + = Scarce

Table 2d. Odonate Species Recorded within the Assessment Area of STN1

Species	Conservation and Protection Status[1]	Status in HK[2]	Project Site[3]	500 m Assessment Area			
			DA	CW	DA	PL	WL
Red-faced Skimmer *Orthetrum chrysis*	-	Abundant				+	
Common Blue Skimmer *Orthetrum glaucum*	-	Abundant					+
Wandering Glider *Pantala flavescens*	-	Abundant				+++	+++

Notes for Table 2d:
1. Conservation and protection status refer to Fellowes *et al*. (2002), Red List of China's Vertebrates (Jiang *et al.* 2016), IUCN (2021), China State Major Protection Status, CITES (2020), Cap. 170 and Cap. 586.
2. Status in HK follows AFCD (2020).
3. Habitats: **DA** = Developed Area; **CW** = Channelised Watercourse; **PL** = Plantation; **WL** = Woodland.

Code for abundance: ++++ = Abundant, +++ = Frequent, ++ = Occasional, + = Scarce

Appendix 11.1
Reviewed Aerial Photographs

AECOM

PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT 業主

渠務署
Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
www.aecom.com

SUB-CONSULTANTS 分判工程顧問公司

ISSUE/REVISION 修訂

I/R 修訂	DATE 日期	DESCRIPTION	CHK.

STATUS 階段

SCALE 比例

A3 1 : 6000

DIMENSION UNIT

METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號

60617767

AGREEMENT NO.

CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

AERIAL PHOTOGRAPH 1963
(STS1, STS2, STS5 & STN1)

SHEET NUMBER 圖紙編號

60617767/PER_APP/AP12

Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm

Plot File by: CAOPA 2020/12/8
PATH p:\projects\60617767\drawing\report\per_app\PER_APP_712.dgn

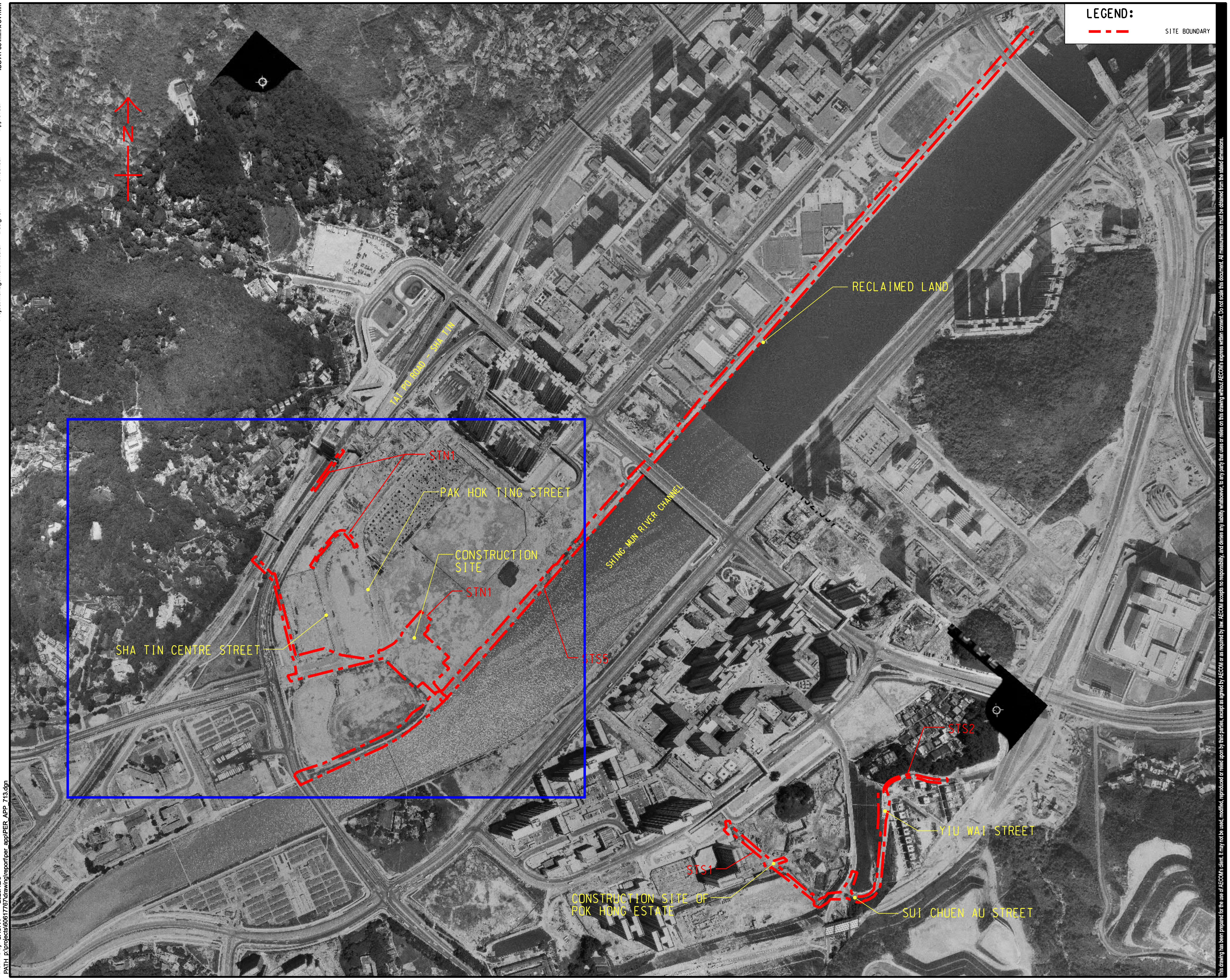
ISO A1 594mm x 841mm

Approved:

Checked:

Designer:

Project Management Initials:



AECOM

PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT 業主

渠務署 Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
www.aecom.com

SUB-CONSULTANTS 分判工程顧問公司

ISSUE/REVISION 修訂

I/R	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

SCALE 比例	**DIMENSION UNIT** 尺寸單位
A3 1 : 6000	METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號	**AGREEMENT NO.** 協議編號
60617767	CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

AERIAL PHOTOGRAPH 1983 (STS1, STS2, STS5 & STN1)

SHEET NUMBER 圖紙編號

60617767/PER_APP/AP13

Plot File by: CAOPA 2020/12/8
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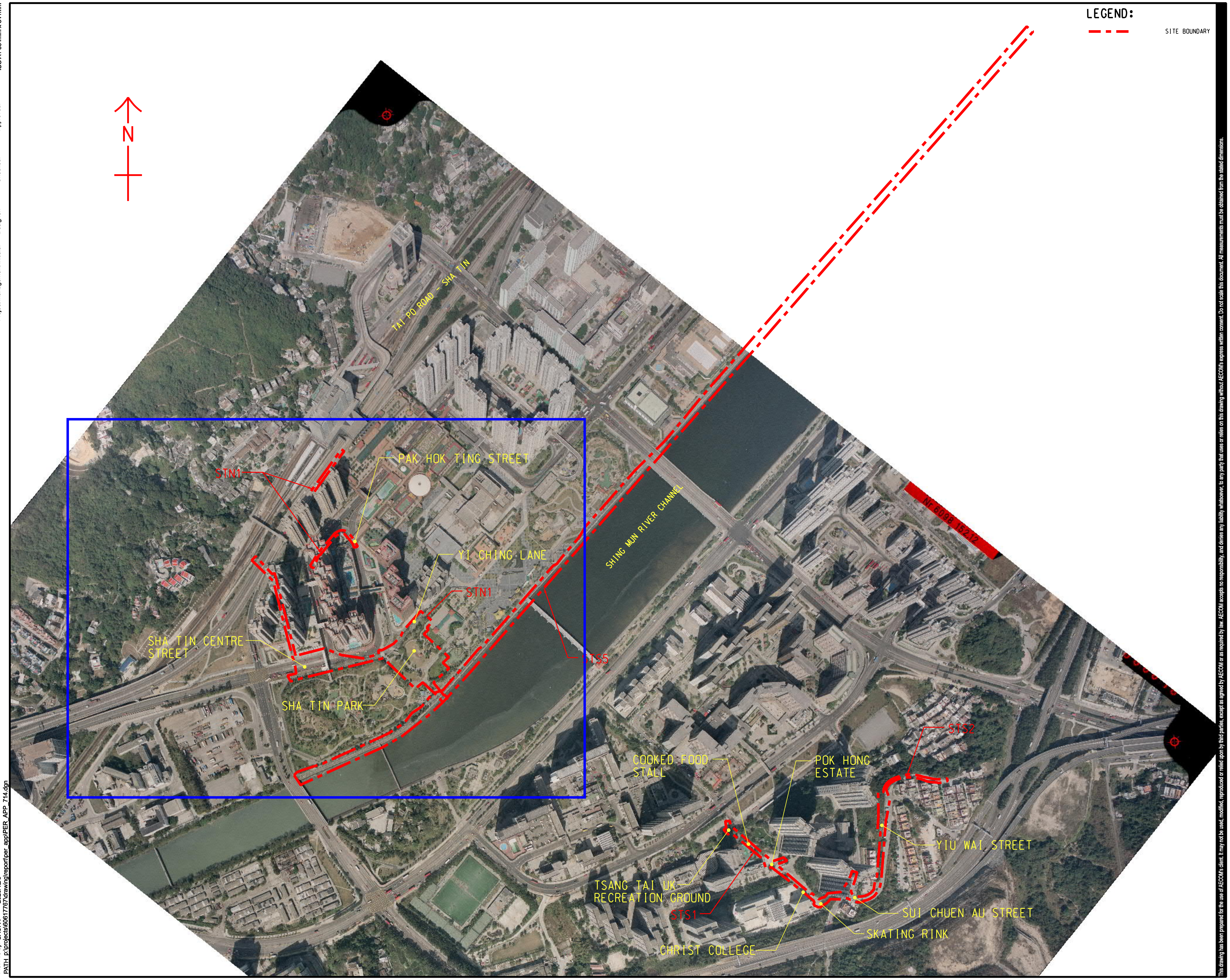


Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm

Plot File by: CAOPA 2020/12/8
PATH p:\projects\60617767\drawing\report\per_app\PER_APP_714.dgn

AECOM

PROJECT

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT

渠務署 Drainage Services Department

CONSULTANT

AECOM Asia Company Ltd.
www.aecom.com

SUB-CONSULTANTS

ISSUE/REVISION

I/R	DATE	DESCRIPTION	CHK.

STATUS

SCALE: A3 1 : 6000

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60617767

AGREEMENT NO.: CE 15/2019 (DS)

SHEET TITLE

AERIAL PHOTOGRAPH 1993
(STS1, STS2 & STN1)

SHEET NUMBER

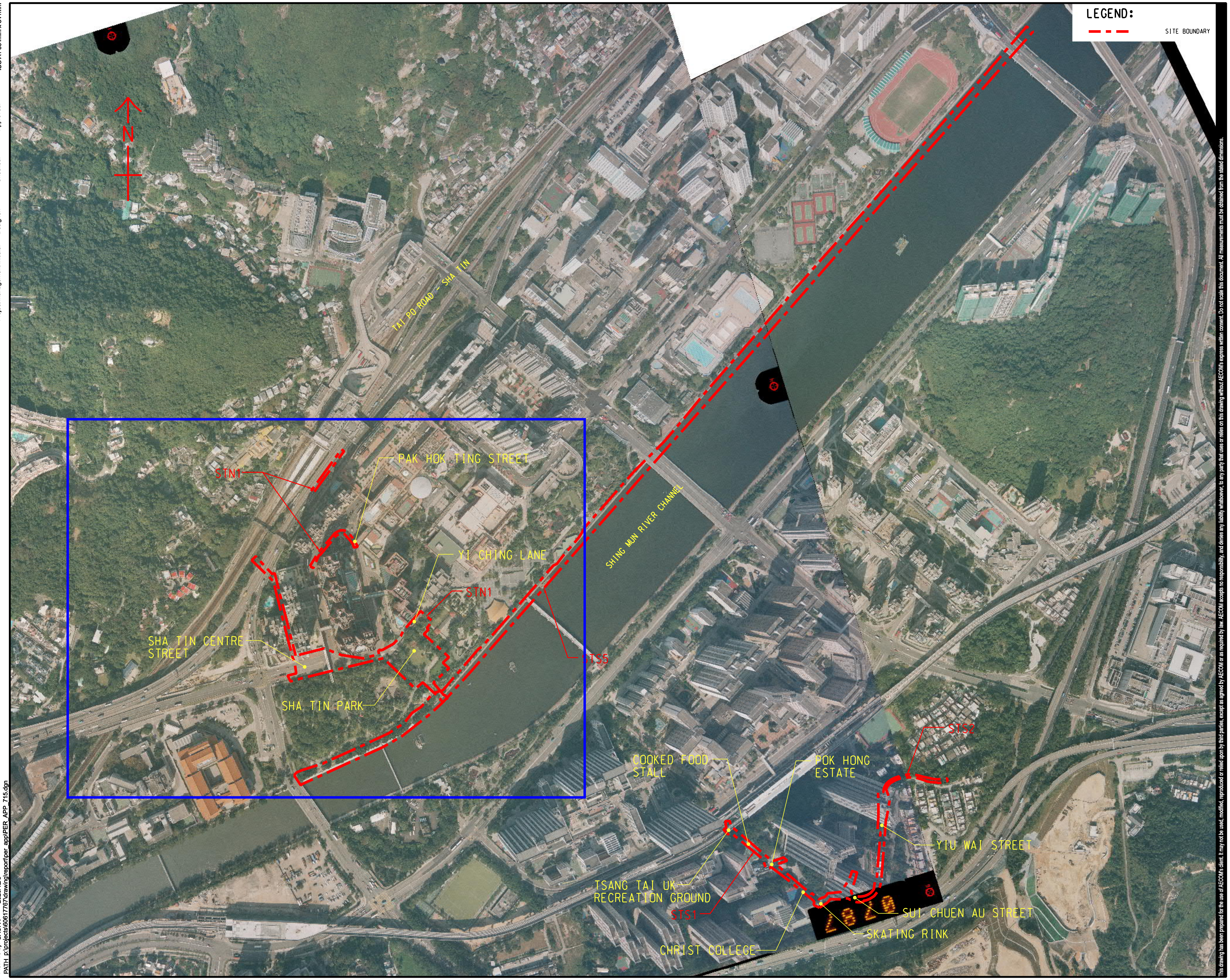
60617767/PER_APP/AP14

Approved:

Checked:

Designer:

Project Management Initials:



AECOM

PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT 業主

渠務署 Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
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SUB-CONSULTANTS 分判工程顧問公司

ISSUE/REVISION 修訂

I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

SCALE 比例: A3 1 : 6000

DIMENSION UNIT 尺寸單位: METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號: 60617767

AGREEMENT NO. 協議編號: CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

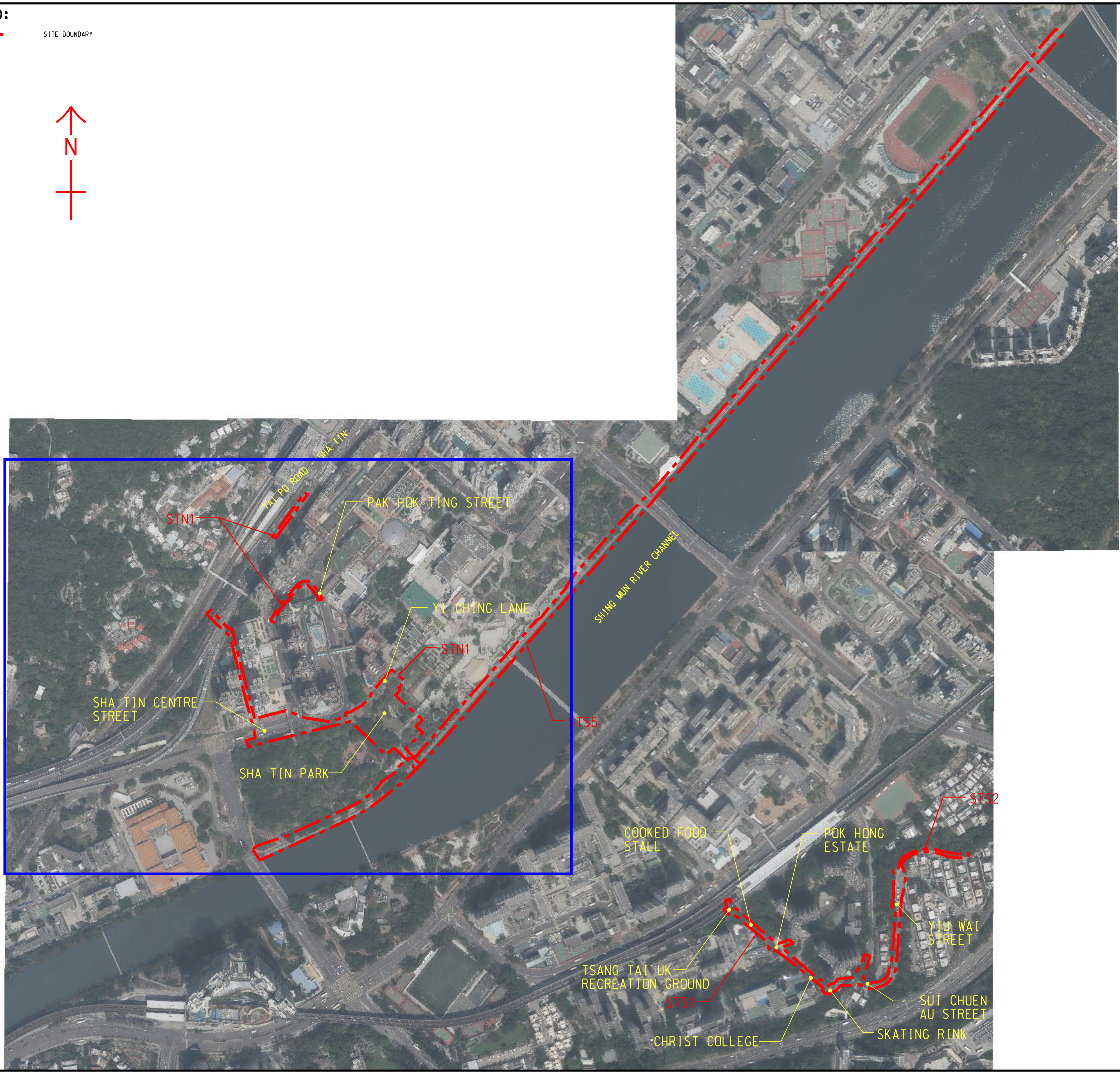
AERIAL PHOTOGRAPH 2003
(STS1, STS2, STS5 & STN1)

SHEET NUMBER 圖紙編號

60617767/PER_APP/AP15

LEGEND:

SITE BOUNDARY



AECOM

PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT 業主

渠務署 Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
www.aecom.com

SUB-CONSULTANTS 分判工程顧問公司

ISSUE/REVISION 修訂

I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

SCALE 比例: A3 1 : 6000

DIMENSION UNIT 尺寸單位: METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號: 60617767

AGREEMENT NO. 協議編號: CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

AERIAL PHOTOGRAPH 2018 (STS1, STS2, STS5 & STN1)

SHEET NUMBER 圖紙編號

60617767/PER_APP/AP16

Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm

Plot File by: CAOPA 2020/12/8
PATH p:\projects\60617767\drawing\report\per_app\PER_APP_716.dgn

Appendix 11.2
Site Walkover Checklists

Annex C-1

Site Walkover Checklist

GENERAL SITE DETAILS

~~SITE OWNER~~/CLIENT Drainage Services Department (DSD)

PROPERTY ADDRESS Tai Po Road – Sha Tin / Sha Tin Centre Street / Pak Hok Ting Street /

Yi Ching Lane / Sha Tin Park, Sha Tin

(Proposed Drainage Improvement Works at Sha Tin Town Centre) (STN1)

PERSON CONDUCTING THE QUESTIONNAIRE

NAME Mr. Robert Yuen / Kin Au

POSITION Graduate Environmental Consultant, AECOM

AUTHORIZED OWNER/CLIENT REPRESENTATIVE (IF APPLICABLE)

NAME Not Available

POSITION --

TELEPHONE --

SITE ACTIVITIES

Briefly describe activities carried out on site, including types of products/chemicals/materials handled. Obtain a flow schematic if possible.

Number of employees:

Full-time: N/A

Part-time: N/A

Temporary/Seasonal: N/A

Maximum no. of people on site at any time: N/A

Typical hours of operation: N/A

Number of shifts: N/A

Days per week: N/A

Weeks per year: N/A

Scheduled plant shut-down: N/A

Detail the main sources of energy at the site:

Gas	~~Yes~~/No
Electricity	~~Yes~~/No
Coal	~~Yes~~/No
Oil	~~Yes~~/No
Other	~~Yes~~/No

SITE DESCRIPTION

This section is intended to gather information on site setting and environmental receptors on, adjacent or close to the site.

What is the total site area: Approx. 1.4 ha

What area of the site is covered by buildings (%): 0 %

Please list all current and previous owners/occupiers if possible. Government land

Is a site plan available? If yes, please attach. Yes/~~No~~ Refer to Figure 11.3

Are there any other parties on site as tenants or sub-tenants? ~~Yes~~/No

If yes, identify those parties:

Describe surrounding land use (residential, industrial, rural, etc.) and identify neighbouring facilities and types of industry.

North: Sha Tin Station

South: Shing Mun River Channel

East: Hilton Plaza (Commercial / Residential), New Town Plaza Phase III (Commercial / Residential)

West: Scenery Court (Residential), Hong Kong Red Cross Bradbury Shatin Centre

Annex C1

Site Walkover Checklist

Describe the topography of the area (flat terrain, rolling hills, mountains, by a large body of water, vegetation, etc.).

Generally flat terrain, with river channel at the south of the site.

State the size and location of the nearest residential communities.

Hilton Plaza (10 m northeast of the site, area of about 7,600 m^2).

Are there any sensitive habitats nearby, such as nature reserves, parks, wetlands or sites of special scientific interest?

No.

*Questionnaire with Existing/Previous Site Owner or Occupier**

	Yes/No	Notes*
1. What are the main activities/operations at the above address?	--	Park and roads.
2. How long have you been occupying the site?	N/A	
3. Were you the first occupant on site? (If yes, what was the usage of the site prior to occupancy.)	N/A	
4. Prior to your occupancy, who occupied the site?	N/A	
5. What were the main activities/operations during their occupancy?	N/A	
6. Have there been any major changes in operations carried out at the site in the last 10 years?	N/A	
7. Have any polluting activities been carried out in the vicinity of the site in the past?	N/A	
8. To the best of your knowledge, has the site ever been used as a petrol filling station/car service garage?	N/A	Based on the review of historical information and site observation, no petrol filing station / car service garage were noted within the site.
9. Are there any boreholes/wells or natural springs either on the site or in the surrounding area?	N/A	
10. Do you have any registered hazardous installations as defined under relevant ordinances? (If yes, please provide details.)	N/A	No registered hazardous installations were observed on site.
11. Are any chemicals used in your daily operations? (If yes, please provide details.)	N/A	No chemicals were observed on site.
• Where do you store these chemicals?	N/A	
12. Material inventory lists, including quantities and locations available? (If yes, how often are these inventories updated?)	N/A	
13. Has the facility produced a separate hazardous substance inventory?	N/A	No hazardous substances were observed on site.
14. Have there ever been any incidents or accidents (e.g. spills, fires, injuries, etc.) involving any of these materials? (If yes, please provide details.)	N/A	

* No interview was able to be conducted. Notes shown are based on observation from site walkover.

		Yes/No	Notes*
15.	How are materials received (e.g. rail, truck, etc.) and stored on site (e.g. drums, tanks, carboys, bags, silos, cisterns, vaults and cylinders)?	N/A	
16.	Do you have any underground storage tanks? (If yes, please provide details.)	N/A	
	• How many underground storage tanks do you have on site?	N/A	
	• What are the tanks constructed of?	N/A	
	• What are the contents of these tanks?	N/A	
	• Are the pipelines above or below ground?	N/A	
	• If the pipelines are below ground, has any leak and integrity testing been performed?	N/A	
	• Have there been any spills associated with these tanks?	N/A	
17.	Are there any disused underground storage tanks?	N/A	
18.	Do you have regular check for any spillage and monitoring of chemicals handled? (If yes, please provide details.)	N/A	No chemicals were observed within the site.
19.	How are the wastes disposed of?	N/A	General wastes were collected in the refuse collection point to landfills.
20.	Have you ever received any notices of violation of environmental regulations or received public complaints? (If yes, please provide details.)	N/A	
21.	Have any spills occurred on site? (If yes, please provide details.)	N/A	No traces of oil stains and stressed vegetation observed on site.
	• When did the spill occur?	N/A	
	• What were the substances spilled?	N/A	
	• What was the quantity of material spilled?	N/A	
	• Did you notify the relevant departments of the spill?	N/A	
	• What were the actions taken to clean up the spill?	N/A	
	• What were the areas affected?	N/A	
22.	Do you have any records of major renovation of your site or re-arrangement of underground utilities, pipe work/underground tanks (If yes, please provide details.)	N/A	
23.	Have disused underground tanks been removed or otherwise secured (e.g. concrete, sand, etc.)?	N/A	
24.	Are there any known contaminations on site? (If yes, please provide details.)	N/A	
25.	Has the site ever been remediated? (If yes, please provide details.)	N/A	

* No interview was able to be conducted. Notes shown are based on observation from site walkover.

Annex C1

Site Walkover Checklist

Observations

		Yes/No	Notes
1.	Are chemical storage areas provided with secondary containment (i.e. bund walls and floors)?	N/A	No chemicals or chemical storage areas were observed on site.
2.	What are the conditions of the bund walls and floors?	N/A	
3.	Are any surface water drains located near to drum storage and unloading areas?	No	No drums observed.
4.	Are any solid or liquid waste (other than wastewater) generated at the site? (If yes, please provide details.)	No	
5.	Is there a storage site for the wastes?	N/A	No wastes were observed within the site.
6.	Is there an on-site landfill?	No	
7.	Were any stressed vegetation noted on site during the site reconnaissance? (If yes, please indicate location and approximate size.)	No	
8.	Were any stained surfaces noted on-site during the site reconnaissance? (If yes, please provide details.)	No	
9.	Are there any potential off-site sources of contamination?	No	
10.	Does the site have any equipment which might contain polychlorinated biphenyls (PCBs)?	No	
11.	Are there any sumps, effluent pits, interceptors or lagoons on site?	No	
12.	Any noticeable odours during site walkover?	No	
13.	Are any of the following chemicals used on site: fuels, lubricating oils, hydraulic fluids, cleaning solvents, used chemical solutions, acids, anti-corrosive paints, thinners, coal, ash, oily tanks and bilge sludge, metal wastes, wood preservatives and polyurethane foam?	No	

Appendix 11.3
Acquisition of Information from Government Departments

Au, Kin

From: Au, Kin
Sent: Tuesday, January 26, 2021 4:08 PM
To: kwlaw@epd.gov.hk
Cc: Ng, Lok Yi Chloe; Yuen, Robert; Ma, Sauping; Lam, Tsz Yau Avery
Subject: RE: [EXTERNAL] Re: Agreement No. CE 15/2019 (DS) Drainage Improvement Works in Sha Tin and Sai Kung – Investigation - Request for Info of CWP & Chemical Spillage Accident
Attachments: Finalised layout_ST_Lot&Address.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Ms. Law,

As part of the land contamination assessment and following the *Practice Guide for Investigation and Remediation of Contaminated Land* issued by EPD, we have to collect historical information regarding the past and present activities of the concerned site. Further to your email reply dated December 4 on the captioned, we would like to request for the following information regarding the updated works boundary of Sha Tin district as indicated in **Finalised layout_ST_Lot&Address.pdf** attached:

1. Current and past (as early as the records are available) registered Chemical Waste Producer(s) within the updated works boundary (preferably with the registration date, status (moved out or active), nature and quantity of the chemical waste); and

2. Reported accidents of spillage / leakage of chemicals within the updated works boundary.

Please feel free to contact our Ms. Chloe Ng at 3922 9305 or Mr. Kin Au at 3922 9507 should you have any queries.

Thank you very much for your kind assistance.

Regards,
Kin Au
Graduate Environmental Consultant, Environment, Hong Kong
D +852-3922-9507
kin.au@aecom.com

From: kwlaw@epd.gov.hk <kwlaw@epd.gov.hk>
Sent: Friday, December 4, 2020 11:12 AM
To: Au, Kin <kin.au@aecom.com>
Cc: Lam, Tsz Yau Avery <Avery.Lam@aecom.com>; Ng, Lok Yi Chloe <Chloe.Ng@aecom.com>; Yuen, Robert <robert.yuen@aecom.com>; Ma, Sauping <sauping.ma@aecom.com>
Subject: [EXTERNAL] Re: Agreement No. CE 15/2019 (DS) Drainage Improvement Works in Sha Tin and Sai Kung – Investigation - Request for Info of CWP & Chemical Spillage Accident

Dear Mr. Au,

I refer to your email dated 1 December 2020 on the captioned.

Regarding your enquiries in the email, this Regional Office (North)/Shatin has no record of spillage or leakage of chemicals within the Project sites within Shatin District for the past 5 years. You may like to check with other relevant parties or departments for such information as appropriate, including the EPD/Regional Office (East).

As registered chemical waste producers within the Project sites are concerned, a register of chemical waste producers is available for inspection in the Territorial Control Office of this department. If you would like to inspect, please contact Mr. Leung Chi-keung, Dennis at 2835 1017 for making appointment to view the records.

Should you have any query on the matter, please contact me at 2158 5841.

Regards,
Polly Law
Shatin Section
Regional Office (North)/EPD
Tel.: 2158 5841

From: "Au, Kin" <kin.au@aecom.com>
To: "kwlaw@epd.gov.hk" <kwlaw@epd.gov.hk>
Cc: "Yuen, Robert" <robert.yuen@aecom.com>, "Ng, Lok Yi Chloe" <Chloe.Ng@aecom.com>, "Lam, Tsz Yau Avery" <Avery.Lam@aecom.com>, "Ma, Sauping" <sauping.ma@aecom.com>
Date: 01/12/2020 18:09
Subject: Agreement No. CE 15/2019 (DS) Drainage Improvement Works in Sha Tin and Sai Kung – Investigation - Request for Info of CWP & Chemical Spillage Accident

---

Dear Ms. Law,

As part of the land contamination assessment and following the *Practice Guide for Investigation and Remediation of Contaminated Land* issued by EPD, we have to collect historical information regarding the past and present activities of the concerned site. Further to our letter ref. AYFW:DCXY:etly:60617767/02-0094 (2020010234W) dated 10 September 2020 and your reply with ref.: EP 540/P5/1 dated 17 September 2020, we would like to request for the following information regarding the updated works boundary of Sha Tin and Sai Kung as indicated in **Combined Drawings (LRP)** attached:

1. Current and past (as early as the records are available) registered Chemical Waste Producer(s) within the updated works boundary (preferably with the registration date, status (moved out or active), nature and quantity of the chemical waste); and

2. Reported accidents of spillage / leakage of chemicals within the updated works boundary.

Please feel free to contact our Ms. Chloe Ng at 3922 9305 or Mr. Kin Au at 3922 9507 should you have any queries.

Thank you very much for your kind assistance.

Regards,

Kin Au
Graduate Environmental Consultant, Environment, Hong Kong
D +852-3922-9507
kin.au@aecom.com

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138 Shatin Rural Committee Road,
Shatin, Hong Kong
T +852 3922 9000 F +852 3922 9797
www.aecom.com/hk/

Au, Kin

From:	yhso@epd.gov.hk
Sent:	Tuesday, January 26, 2021 5:55 PM
To:	Au, Kin
Subject:	[EXTERNAL] Re: FW: Agreement No. CE 15/2019 (DS) Drainage Improvement Works in Sha Tin and Sai Kung – Investigation - Request for Info of CWP & Chemical Spillage Accident
Follow Up Flag:	Follow up
Flag Status:	Flagged

Dear Mr Au,

Neither Chemical Waste Producer(s) nor reported chemical spillage / leakage accidents was found as per our record for the concernen area.

YH So
Ag. SI(RE)41
Tel: 21177554

From: "Au, Kin" <kin.au@aecom.com>
To: "yhso@epd.gov.hk" <yhso@epd.gov.hk>
Cc: "Ng, Lok Yi Chloe" <Chloe.Ng@aecom.com>, "Yuen, Robert" <robert.yuen@aecom.com>, "Lam, Tsz Yau Avery" <Avery.Lam@aecom.com>, "Ma, Sauping" <sauping.ma@aecom.com>
Date: 26/01/2021 16:08
Subject: FW: Agreement No. CE 15/2019 (DS) Drainage Improvement Works in Sha Tin and Sai Kung – Investigation - Request for Info of CWP & Chemical Spillage Accident

---

Mr. So,

As part of the land contamination assessment and following the *Practice Guide for Investigation and Remediation of Contaminated Land* issued by EPD, we have to collect historical information regarding the past and present activities of the concerned site. Further to our letter ref. AYFW:DCXY:etly:60617767/02-0094 (2020010233W) dated 10 September 2020 and your reply with ref.: EP 640/G1/2 PT.III dated 16 November 2020, we would like to request for the following information regarding the updated works boundary of proposed sites in Sai Kung district as indicated in **Finalised layout_SK_Lot&Address.pdf** attached:

1. Current and past (as early as the records are available) registered Chemical Waste Producer(s) within the updated works boundary (preferably with the registration date, status (moved out or active), nature and quantity of the chemical waste); and

2. Reported accidents of spillage / leakage of chemicals within the updated works boundary.

Please feel free to contact our Ms. Chloe Ng at 3922 9305 or Mr. Kin Au at 3922 9507 should you have any queries. Thank you very much for your kind assistance.

Regards,

Kin Au
Graduate Environmental Consultant, Environment, Hong Kong
D +852-3922-9507
kin.au@aecom.com

From: Au, Kin
Sent: Friday, December 4, 2020 2:19 PM
To: yhso@epd.gov.hk
Cc: Yuen, Robert <robert.yuen@aecom.com>; Ng, Lok Yi Chloe <Chloe.Ng@aecom.com>; Lam, Tsz Yau Avery <Avery.Lam@aecom.com>; Ma, Sauping <sauping.ma@aecom.com>
Subject: Agreement No. CE 15/2019 (DS) Drainage Improvement Works in Sha Tin and Sai Kung – Investigation - Request for Info of CWP & Chemical Spillage Accident

Mr. So,

As part of the land contamination assessment and following the *Practice Guide for Investigation and Remediation of Contaminated Land* issued by EPD, we have to collect historical information regarding the past and present activities of the concerned site. Further to our letter ref. AYFW:DCXY:etly:60617767/02-0094 (2020010233W) dated 10 September 2020 and your reply with ref.: EP 640/G1/2 PT.III dated 16 November 2020, we would like to request for the following information regarding the updated works boundary of proposed sites in Sai Kung district as indicated in **LRP_SK.pdf** attached:

1. Current and past (as early as the records are available) registered Chemical Waste Producer(s) within the updated works boundary (preferably with the registration date, status (moved out or active), nature and quantity of the chemical waste); and
2. Reported accidents of spillage / leakage of chemicals within the updated works boundary.

Please feel free to contact our Ms. Chloe Ng at 3922 9305 or Mr. Kin Au at 3922 9507 should you have any queries.
Thank you very much for your kind assistance.

Regards,

Kin Au
Graduate Environmental Consultant, Environment, Hong Kong
D +852-3922-9507
kin.au@aecom.com

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13/F Grand Central Plaza, Tower 2,
138 Shatin Rural Committee Road,
Shatin, Hong Kong
T +852 3922 9000 F +852 3922 9797
www.aecom.com/hk/[attachment "Finalised layout_SK_Lot&Address.pdf" deleted by YH SO/EPD/HKSARG]

Au, Kin

From: Au, Kin
Sent: Friday, January 29, 2021 4:02 PM
To: hkfsdenq@hkfsd.gov.hk
Cc: Yuen, Robert; Ng, Lok Yi Chloe; Lam, Tsz Yau Avery; Ma, Sauping
Subject: FW: Agreement No. CE 15/2019 (DS) Drainage Improvement Works in Sha Tin and Sai Kung – Investigation - Request for Information about Dangerous Goods Store and Incidents Records
Attachments: Finalised layout_STSK_PER_PP.pdf

Dear Mr. Kong,

As part of the land contamination assessment and following the *Practice Guide for Investigation and Remediation of Contaminated Land* issued by EPD, we have to collect historical information regarding the past and present activities of the concerned site. Further to our letter ref. AYFW:DCXY:etly:60617767/02-0022(2019015222W) dated 16 December 2019 and your reply with ref.: (104) in FSD GR 6-5/4 R Pt. 25 dated 13 January 2020, we would like to request for the following information regarding the updated works boundary of Sha Tin and Sai Kung as indicated in **Finalised layout_STSK_PER_PP** attached:

1. Records of current and past (as early as the records are available) registration of Dangerous Goods storage (with type of dangerous goods, storage method, quantity, licence no., date of issue and storage location) within the updated works boundary;
2. Any records of reported accidents of spillage/leakage of dangerous goods stored within the updated works boundary; and
3. Any records of fire incidents within the updated works boundary.

Please feel free to contact our Ms. Chloe Ng at 3922 9305 or Mr. Kin Au at 3922 9507 should you have any queries.

Thank you very much for your kind assistance.

Regards,
Kin Au
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From: Au, Kin
Sent: Tuesday, December 1, 2020 6:10 PM
To: hkfsdenq@hkfsd.gov.hk
Cc: Yuen, Robert <robert.yuen@aecom.com>; Ng, Lok Yi Chloe <Chloe.Ng@aecom.com>; Lam, Tsz Yau Avery <Avery.Lam@aecom.com>; Ma, Sauping <sauping.ma@aecom.com>
Subject: Agreement No. CE 15/2019 (DS) Drainage Improvement Works in Sha Tin and Sai Kung – Investigation - Request for Information about Dangerous Goods Store and Incidents Records

Dear Mr. Kong,

As part of the land contamination assessment and following the *Practice Guide for Investigation and Remediation of Contaminated Land* issued by EPD, we have to collect historical information regarding the past and present activities of the concerned site. Further to our letter ref. AYFW:DCXY:etly:60617767/02-0022(2019015222W) dated 16 December 2019 and your reply with ref.: (104) in FSD GR 6-5/4 R Pt. 25 dated 13 January 2020, we would like to request for the following information regarding the updated works boundary of Sha Tin and Sai Kung as indicated in **Combined Drawings (LRP)** attached:

1. Records of current and past (as early as the records are available) registration of Dangerous Goods storage (with type of dangerous goods, storage method, quantity, licence no., date of issue and storage location) within the updated works boundary;
2. Any records of reported accidents of spillage/leakage of dangerous goods stored within the updated works boundary; and
3. Any records of fire incidents within the updated works boundary.

Please feel free to contact our Ms. Chloe Ng at 3922 9305 or Mr. Kin Au at 3922 9507 should you have any queries.

Thank you very much for your kind assistance.

Regards,

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FIRE SERVICES DEPARTMENT
FIRE SERVICES HEADQUARTERS BUILDING.
No.1 Hong Chong Road,
Tsim Sha Tsui East, Kowloon,
Hong Kong.

本處檔號 OUR REF. : (71) in FSD GR 6-5/4 R Pt. 31
來函檔號 YOUR REF. : AYFW:DCXY:etly:60617767/02-0022(2019015222W)
電子郵件 E-mail : hkfsdenq@hkfsd.gov.hk
圖文傳真 FAX NO. : 2739 5879
電 話 TEL NO. : 2733 7741

3 February 2021

AECOM Asia Co. Ltd
8/F, Grand Central Plaza, Tower 2,
138 Shatin Rural Committee Road,
Shatin, Hong Kong.
(Attn: Mr. KIN AU, Graduate Environmental Consultant, Environment, Hong Kong)

By fax (3922 9797) only

Dear Mr. AU,

Agreement No. CE 15/2019 (DS)
Drainage Improvement Works in Sha Tin and Sai Kung - Investigation
Request for Information of Dangerous Goods & Incident Records

I refer to your email of 29.1.2021 regarding the captioned subject.

Your case is being handled, and a reply will be furnished to you as soon as possible. Please be advised that due to time lapse, this Department can only provide the following information for your requested information:

(i) Dangerous Goods Licence Record: from the year of 1990 to present moment.
(ii) Incident Record: Past three years of fire and special services incidents.

Should you have further questions, please feel free to contact the undersigned.

Yours sincerely,

(NG Wing-chit)
for Director of Fire Services

Appendix I – Traffic Impact Assessment Report

渠務署
Drainage Services Department

Agreement No. CE 44/2021(DS)

Drainage Improvement Works in Sha Tin and Sai Kung – Design & Construction

Updated TIA Report for

Sha Tin Town Centre Stormwater Storage and Pumping Facility

October 2023

AECOM Delivering a better world

TABLE OF CONTENTS

TABLES

DRAWINGS

APPENDICES

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1 Introduction

1.1 Background

1.1.1 The Review of Drainage Master Plan in Sha Tin and Sai Kung – Feasibility Study (the Study) identified that the following areas in Sha Tin would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics: -

(a) Sha Tin Town Centre;

(b) Chui Tin Street (near Sun Chui Estate) and San Tin Village;

(c) Tai Po Road – Ma Liu Shui, Ma Ling Path, Kau To Hang near Yucca Villa, Hang Hong Street, Pok Hong Estate, Fui Yiu Ha, Wong Chuk Yeung Village and Lai Wo Lane; and

(d) Cycle track alongside Shing Mun River.

1.1.2 The flooding incidents reported in Wong Chuk Yeung Village on 22 July 2010 and Sha Tin Centre Street on 15 August 2015 are examples to substantiate the above findings.

1.1.3 The Study also identified that the areas in Sai Kung including Wong Chuk Wan, Ho Chung, Kap Pin Long New Village and Nam Shan San Tsuen would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics. The flooding incidents at Po Lo Che Road and Nam Shan San Tsuen on 30 May 2010 and Wong Chuk Wan on 7 October 2015 are some examples to substantiate the above findings.

1.1.4 To relieve the flood risk in the above areas, the Study has proposed implementing drainage improvement measures, mainly in form of stormwater pumping scheme and drainage upgrading works. Upon completion of the Project, the standards of flood protection at areas concerned will be largely enhanced to that specified in the standards of the Stormwater Drainage Manual (SDM) and the flood risks thereon can be significantly reduced.

1.1.5 New flood walls will also be provided along various sections of Shing Mun River to protect the cycle track against flooding due to the astronomical high tide.

1.1.6 Without the proposed project, about 26 hectares of the areas in Sha Tin and 6 hectares of areas in Sai Kung will be subject to high flood risk. Flooding impacts on traffic and residential area in the flood prone areas will also result in losses and inconvenience to the general public.

1.1.7 In May 2018, Development Bureau (DEVB) signed out a Project Definition Statement (PDS) to justify and define the scope of the "Drainage Improvement Works in Sha Tin and Sai Kung". The Drainage Services Department (DSD) then completed a Technical Feasibility Statement (TFS) confirming its technical feasibility. The TFS was subsequently approved by DEVB in August 2018. The project was included into Cat B under PWP Item No. 4182CD in September 2018.

1.2 Description of the Assignment

1.2.1 AECOM Asia Company Limited (AECOM) has been appointed by DSD to undertake the "Drainage Improvement Works in Sha Tin and Sai Kung – Investigation" ("the Study") on 11 October 2019.

1.2.2 The Study comprises the drainage improvement works in locations as illustrated on the Key Plan of **Figure Nos. 1.1.1 – 1.1.3** and are described in the following: -

1.2.3 Stormwater pumping scheme at Sha Tin Town Centre, including an underground storage tank, a pump house and associated pipeworks and electrical and mechanical (E&M) works, as well as drainage upgrading works around Sha Tin Town Centre such as Pak Hok Tin Street, Sha Tin Centre Street, Man Lai Road and ancillary works including reinstatement of playgrounds and associated facilities;

1.2.4 Stormwater pumping scheme at Chui Tin Street Soccer Pitch including an underground storage tank and associated pumps, pipeworks and E&M works, as well as drainage upgrading works around Sun Tin Village, Kak Tin Street, Chui Tin Street and Che Kung Miu Road and ancillary works including reinstatement of soccer pitch and associated facilities;

1.2.5 Drainage upgrading works at Fui Yiu Ha, Ma Ling Path, Kau To Hang, Hang Hong Street, Tai Po Road – Ma Liu Shui, Pok Hong Estate, Wong Chuk Yeung Village and Lai Wo Lane, Po Lo Che Road, Ho Chung and Wong Chuk Wan; and

1.2.6 Flood walls along Shing Mun River to protect the cycle track against flooding due to astronomical high tide.

1.3 Drainage Improvement Work Summary

Stormwater Storage Scheme at Sha Tin Town Centre (STN1) - Figure Nos. 1.9.1 –1.9.2

1.3.1 First part of the recommended drainage improvement works at Sha Tin Town Centre is to provide a new 750mm diameter pipe near the footpath outside Hilton Plaza and Scenery Court. The proposed pipe will lay across Sha Tin Centre Street and follow the footpath along Sha Tin Centre Street and connect to the proposed pumping station.

1.3.2 Second part is to upgrade the existing 1,500mm diameter stormwater pipe in Tai Po Road – Sha Tin near Citylink Plaza to 1,650mm diameter, upgrade the existing 450mm diameter stormwater pipe outside Red Cross Sha Tin Centre to 600mm diameter and a new 750mm diameter stormwater pipe outside Wai Wah Centre.

1.3.3 The last part of this scheme is to provide a new stormwater pumping station at the downstream of the existing drainage network in Sha Tin Park. Since the potential flood risk around Sha Tin Town Centre is caused by the backflow from Shing Mun River into the relatively low-lying areas.

1.3.4 The proposed pumping station includes an underground tank, an above-ground pump house, new pipes ranged from 600mm to 2,200mm in diameter at Yi Ching Lane. The pumping station consists of a pump with the maximum pump rate of $4m^3/s$ and an underground tank with the wet volume of $6,000m^3$. The runoff will be discharged into the pumping station via the new drainage network and then discharged into Shing Mun River by pump. The excessive water will be stored in the underground tank.

1.4 TIA Objectives The objectives of this Traffic Impact Assessment (TIA) under the Project detailed in Clause 3.13 of the Project Scope by carrying out traffic impact assessment of the proposed works with details of the assessment results, identify the potential impacts and recommend mitigation and improvement measures, with due and proper regard to the following: -

(a) To identify and describe the elements of the community and the existing traffic characteristics likely to be affected by the Project, and/or likely to cause adverse impacts upon the Project, including both the existing and proposed road network during the construction and the management/maintenance stages;

(b) To introduce a structured and systematic approach to identifying, assessing and mitigating potential adverse traffic impacts which might arise from the Project during the construction and subsequent management/maintenance stages;

(c) arrangement schemes during construction to accommodate existing traffic flow at the time of construction and subsequent management/maintenance of the proposed works of the Project so that any adverse traffic impacts can be kept minimum and mitigated to acceptable level;

(d) To assess the transport impact and impact on pedestrian/cycle traffic and to provide relevant/updated traffic (vehicular/pedestrian/cycle) counts in the TIA;

(e) To identify, assess and specify methods, measures and standards to be included in the detailed design and construction of the Project which are necessary to mitigate these impacts and reduce them to acceptable levels;

(f) To demonstrate that with all mitigation measures introduced, the Project will have no detrimental traffic impacts within the project site and to the areas adjacent to the Project;

(g) To assess the long-term traffic impact on the road network arising from the project during operation and maintenance stage, and propose associated mitigation measures; and

(h) To enable an agreement in principle to be reached among relevant Government departments on the “area traffic management measures” and “traffic diversion schedules” during construction and subsequent management/maintenance stages of the Project. The final TIA Report will then serve as guidelines for making detailed proposals by the Employer’s Agent and contractors in the construction and subsequent management/maintenance stages.

2 Existing Traffic conditionExisting Road Network

Stormwater Storage Scheme at Sha Tin Town Centre (STN1)

2.1.1 There are 2 nos. concerned sections to Sha Tin Centre Street. Nearer to its Junction with Lion Rock Tunnel Road and Tai Po Road – Tai Wai, it is a dual carriageway with 2 nos. lanes running eastbound and 4 nos. lanes running westbound into the mentioned junction. At the section between Hilton Plaza and New Town Plaza Phase 3, it is a northbound one-way 3-lane single carriageway serving local accesses. It is also a key public transport routing for Sha Tin with large demands to loading/ unloading and pick-up/ set-down along the kerb side.

2.1.2 Pak Hok Ting Street is a southbound one-way 3-lane single carriageway that connects with Sha Tin Centre Street to its north and south to form a circular route around New Town Plaza Phase 3. It provides connections to service road for Royal Park Hotel and Yi Ching Lane.

2.1.3 Yi Ching Lane is a short single 2-lane carriageway that provides access to/from Royal Park Hotel Carpark and Sha Tin Magistrates' Courts. There are 20 nos. of motorcycle parking spaces at Yi Ching Lane and the utilization rate 80%-100% during 10:00-22:00.

2.1.4 The concerned section of Tai Po Road – Sha Tin is a dual 3-lane primary distributor connecting Tolo Highway to Shing Mun Tunnel Road and Tsing Sha Highway. According to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021) by the Highways Department (HyD), Tai Po Road – Sha Tin falls within the list of Traffic Sensitive Routes (as of 17.7.2020) where a Day-time Ban on temporary traffic management (TTM) shall apply.

2.2 Traffic Surveys

2.2.1 In order to assess the traffic impact induced by the drainage improvement works to the local roads, footpath and cycle track network, traffic surveys were conducted at various times according to the weekdays and weekends of December 2020.

2.2.2 Subsequently, owing to the outbreak of COVID-19 which may have caused some earlier survey results to be unrepresentative, such as the results near schools when the schools were not opened during the earlier survey period, supplementary surveys have been conducted in December 2021 to capture the traffic condition as it returns to normal.

2.2.3 **Table 2-2 Summary of Conducted Traffic Surveys**

2.2.4 summarises the type of surveys conducted and their associated survey hours.

Table 2-2 Summary of Conducted Traffic Surveys

Survey Type	Survey Period (Survey Time)
Manual Classified Traffic Count Survey	AM/ PM Peaks (07:30 - 09:30, 17:00 – 19:00) School Peaks (07:30 - 09:30, 12:30 – 16:30) Public Holiday Peak (10:00 – 22:00) 24-Hour
Traffic Queue Survey	AM/ PM Peaks (07:30 - 09:30, 17:00 – 19:00)
Bus Stop/ Roadside Lay-by Utilisation Survey	AM/ PM Peaks (07:30 - 09:30, 17:00 – 19:00)
Parking Inventory Survey	Daytime (10:00 – 22:00)
Pedestrian Count Survey	AM/ PM Peaks (07:30 - 09:30, 17:00 – 19:00) School Peaks (07:30 - 09:30, 12:30 – 16:30) Public Holiday Peak (10:00 – 22:00)
Cycle Count Survey	AM/ PM Peaks (07:30 - 09:30, 17:00 – 19:00) Public Holiday Peak (10:00 – 22:00)

Note:
School hours are limited to half day classes due to the impact of COVID-19. Therefore, the survey hours of the PM school Peak have been adjusted.

2.3 Traffic Survey Validation

2.3.1 The earlier traffic surveys had taken place during a period of the fourth wave of the COVID-19 coronavirus outbreak that covered the entire year of 2020 may cause alterations to typical traffic and pedestrian travel patterns, as schools have been closed to prevent the spreading of the coronavirus. In recognition of the that, supplementary surveys were carried out to locations that were most hit by the pandemic.

2.3.2 The collected traffic survey data was compared against the traffic flow in other relevant reference TIA reports obtained from the public domain for which traffic surveys were conducted at similar periods to those carried out for this project.

2.3.3 The results of the comparison of traffic flow revealed that those for the captioned report is similar in pattern and the collected data would be more conversative than the reference reports. Therefore, it is deemed that the collected traffic survey data would be representative of the critical scenario of traffic for the study period.

2.4 Assessment Peak Hour

2.4.1 For the traffic impact assessment, study peak hours for the AM Peak, PM Peak and the Public Holiday Peak were derived based on the traffic survey results. A summary of the derived peak hour is summarised in **Table 2-3**.

Table 2-3 Selected Peak Hour for Assessment

Peak Hour	Survey Type		
	Traffic	Pedestrian	Cycle
AM Peak	8:00 – 9:00		
PM Peak	18:00 – 19:00		
Public Holiday Peak	12:30 – 13:30	Maximum Hourly Flow	
AM School Peak	07:30 – 08:30	07:30 – 08:30	-
PM School Peak	12:45 – 13:45	12:45 – 13:45	-
Night-Time (1)	Maximum Hourly Flow	-	-

Note:
(1) Applies to Tai Po Road – Sha Tin traffic due to the road being under a Day-Time Ban for road works as stated in the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021). Works can only be carried out between the hours of 1900 – 0700 the following day.

2.5 2020 Base Year Traffic Assessment

2.5.1 The assessed junctions are indicated in **Figure Nos. 2.3**. The existing traffic flows during AM and PM Peaks are presented in **Figure Nos. 2.1.5**.

2.5.2 Based on these traffic flows, road link and junction capacity assessments were carried out to determine the existing traffic conditions in the study area. The junction and link performance results are summarised in **Table 2-4** and **Table 2-5** respectively.

2.5.3 The calculations for the 2020 base year traffic assessments are attached in **Appendix A**.

Table 2-4 2020 Base Year Junction Performance Summary

Works ID (District)	Junction ID	Location	Junction Type (1)	2020 Base Year RC (2) (in %) / DFC (3)		
				AM Peak	PM Peak	School Peak / PH Peak
STN1 (Sha Tin)	J22	Southern Junction of Pak Hok Ting Street / Sha Tin Centre Street	P	0.12	0.14	-
STN1 (Sha Tin)	J23	Junction of Yi Ching Lane / Access Road near Royal Park Hotel	P	0.12	0.20	-
STN1 (Sha Tin)	J24	Northern Junction of Pak Hok Ting Street / Sha Tin Centre Street	S	>100%	>100%	-

Notes:
(1) S – Signalised Junction, R – Roundabout, P – Priority Junction
(2) A positive RC indicates that the junction is operating with spare capacity. A negative RC indicates that the junction is overloaded, resulting in traffic queues and long delay time.
(3) A DFC ratio less than 1.0 indicates that the junction is operating within design capacity. A DFC ratio greater than 1.0 indicates that the junction is overloaded, resulting in traffic queues and longer delay time to the minor arm traffic.

2.5.4 Results in **Table 2-4** indicated that all assessed junctions for the works at Sha Tin Town Centre (STN1) are operating within their design capacities.

Table 2-5 2020 Base Year Road Link Performance Summary

Works ID (District)	Link ID	Location	Direction	Capacity (pcu/hr) (1) (2)	2020 Base Year					
					AM Peak		PM Peak		Night Time(5) (2300-0000)	
					Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)
STN1 (Sha Tin)	L4	Car Park Access of Hilton Plaza	Out	500	20	0.04	20	0.04	-	-
STN1 (Sha Tin)	L5	Tai Po Road - Sha Tin near Wai Wah Centre	EB	6100	6290	1.03	5830	0.96	-	-
			WB	6100	4810	0.79	5410	0.89	2830	0.46
STN1 (Sha Tin)	L26	Sha Tin Centre Street (Between Lion Rock Tunnel Road and Pak Hok Ting Street)	EB	2025	710	0.35	530	0.26	-	-
			WB	3325	800	0.24	800	0.24	-	-
STN1 (Sha Tin)	L27	Yi Ching Lane	EB	580	50	0.09	40	0.07	-	-
			WB	580	20	0.03	40	0.07	-	-
STN1 (Sha Tin)	L28	Royal Plaza Hotel Access Road	SB	580	100	0.17	120	0.21	-	-
STN1 (Sha Tin)	L29	Sha Tin Centre Street (near Wai Wah Centre)	NB	900(4)	770	0.86	600	0.67	-	-
STN1 (Sha Tin)	L30	Pak Hok Ting Street (near Wai Wah Centre)	SB	2875	790	0.27	750	0.26	-	-

Note:
(1) Capacity of road links (except single-track access road) make reference to the "Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement".
(2) Capacity of single-track access roads is assumed to be 100 pcu/hr for 2-way traffic.
(3) A V/C ratio less than 0.85 indicates that the road link is operating within design capacity. A V/C ratio greater than 1.0 indicates that the road link is overloaded.
(4) Capacity of Sha Tin Centre Street (near Wai Wah Centre) make reference to the "Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement", single 1-lane carriageway, width > 4m, frontage 3: capacity limited by waiting vehicle and junctions as the slow and fast lanes were occupied by frequent roadside activities.
(5) The traffic count was conducted in July 2023 by others.

2.5.5 Results in **Table 2-5** indicated that all assessed road links are operating within their design capacities. The existing road link flows during AM, PM and Public Holiday Peaks are presented in **Figure Nos. 2.5.10 – 2.5.11**.

2.6 Study Pedestrian Footpath Network

2.6.1 The pedestrian footpath assessment framework is based on the level of service (LOS) documented in the Highway Capacity Manual 2000 (HCM) and the conditions for different LOS for footpath and stairways are summarised in **Table 2-6** and **Table 2-7**. The existing pedestrian flows during AM, PM and School/Public Holiday Peaks are presented in **Figure Nos. 2.6.16.**

Table 2-6 Pedestrian Assessment Framework for Footpath

Level of Service (LOS)	Pedestrian Space (m^2/ped)	Flow Rate(ped/min/m)	Average Speed (m/s)	Description
A	>5.6	≤16	> 1.30	Pedestrians move in desired paths without altering their movements in response to other pedestrians Walking speeds are freely selected and conflicts between pedestrians are unlikely.
B	>3.7-5.6	>16-23	> 1.27 – 1.30	There is sufficient area for pedestrians to select walking speeds freely, to bypass other pedestrians and to avoid crossing conflicts. At this level, pedestrians begin to aware of other pedestrians and to respond to their presence when selecting a walking path.
C	>2.2-3.7	>23-33	> 1.22 – 1.27	Space is sufficient for normal walking speeds and for bypassing other pedestrians in primarily unidirectional streams. Reverse-direction or crossing movements can cause minor conflicts, and speeds and flow rate are somewhat lower.
D	>1.4-2.2	>33-49	> 1.14 – 1.22	Freedom to select individual walking speed and to bypass other pedestrians is restricted. Crossing or reverse-flow movements face a high probability of conflicts, requiring reasonably fluid flow, but friction and interaction between pedestrians is likely.
E	>0.75-1.4	>49-75	> 0.75 – 1.14	Virtually all pedestrians restrict their normal walking speed frequently adjusting their gait. At the lower range, forward movement is possible only by shuffling. Space is not sufficient for passing slower pedestrians. Crossing- or reverse-flow movements are possible only with extreme difficulties. Design volumes approach the limit of walkway capacity, with stoppages and interruptions to flow.
F	≤0.75	Varies	≤ 0.75	All walking speeds are severely restricted, and forward progress is made only by shuffling. There is frequent, unavoidable contact with other pedestrians. Crossing- and reverse-flow movements are virtually impossible. Flow is sporadic and unstable. Space is more characteristic of queued pedestrians than of moving pedestrian streams.

Table 2-7 Pedestrian Assessment Framework for Stairway

Level of Service (LOS)	Pedestrian Space (m^2/ped)	Flow Rate (ped/min/m)	Average Horizon Speed (m/s)	V/C Ratio
A	>1.9	≤16	> 0.53	≤ 0.33
B	>1.6-1.9	>16-20	> 0.53	> 0.33-0.41
C	>1.1-1.6	>20-26	> 0.48-0.53	> 0.41-0.53
D	>0.7-1.1	>26-36	> 0.42-0.48	> 0.53-0.73
E	>0.5-0.7	>36-49	> 0.40-0.42	> 0.73-1.00
F	≤0.5	Varies	≤ 0.40	Varies

2.6.2 Pedestrian capacity assessments were carried out based on the Level of Service (LOS) categories as mentioned in **Table 2-6** and the results for the existing conditions are summarised in **Table 2-8**.

Table 2-8 Study Pedestrian Footpath Performance Assessment

Link ID (District)	Footpath ID	Link No.	Location Description (Stairway = S)	Actual Width (m)	Effective Width (m) (2)	Without TTMS								
						Pedestrian 15-minute Flow Rate (ped/15-min)			Two-Way Pedestrian Flow (ped/min/m)			Level of Service (LOS)		
						AM Peak	PM Peak	School Peak (4) / Public Holiday Peak	AM Peak	PM Peak	School Peak (4) / Public Holiday Peak	AM Peak	PM Peak	School Peak (4) / Public Holiday Peak
STN1 (Sha Tin)	P15	1	Footpath at Hilton Plaza Car Park Vehicular Exit	5.1	4.1	38	65	-	0.61	1.05	-	A	A	-
STN1 (Sha Tin)	P16	1	Sha Tin Park Access (Yi Ching Lane)	6.8	5.8	44	20	-	0.51	0.23	-	A	A	-
		2	Southern Footpath of Yi Ching Lane (near Sha Tin Park)	3.8	2.8	8	2	-	0.2	0.05	-	A	A	-
		3	Southern Footpath of Pak Hok Ting Street (near Sha Tin Park)	3.6	2.6	7	3	-	0.19	0.08	-	A	A	-

Notes:
(1) Footpath link consists of 2 nos. of footpaths
(2) 0.5m dead width on both sides to be deducted
(3) 0.5m dead width only on one side to be deducted due to site terrain and existing traffic management facilities
(4) The AM school peak is regarded more critical in comparison to the PM school peak as the pedestrian flow would be more concentrated. Therefore, assessment for School Peak refers to the AM school peak

(5) As pedestrian footpaths along village paths are less well defined, footpath of min. 1.5m in width is assumed for assessment purposes

2.6.3 With reference to TPDM Volume 6 Chapter 10.4, Level of Service (LOS) C would be a desirable level of service for footpath width assessments, the assessed footpath links in the study area as shown in **Table 2-8** are operating satisfactorily.

3 Temporary Traffic Management Schemes (TTMS)

3.1 Overview

3.1.1 The proposed TTMS have been developed based on the proposed drainage alignment under investigation. The Contractor should further develop detailed TTMS design based on the actual construction method to suit the works. The design of the TTMS shall comply with the latest issues of “Code of Practice for Lightings, Signing and Guarding of Road Works” and “Guidelines on Traffic Impact Assessment & Day-Time Ban Requirements for Road Works on Traffic Sensitive Routes” from the Highways Department, the latest issue of “Transport Planning and Design Manual” from Transport Department, and any further advices from relevant government authorities.

3.1.2 Also, the detailed implementation of TTMS at construction stage should be in compliance with the latest issue of “Code of Practice for Lightings, Signing and Guarding of Road Works” and “Guidelines on Traffic Impact Assessment & Day-Time Ban Requirements for Road Works on Traffic Sensitive Routes” from Highways Department, the latest issue of “Transport Planning and Design Manual” from Transport Department, and comments from Traffic Management Liaison Group (TMLG) meetings.

3.1.3 Sightlines shall be maintained during TTMS implementation.

3.1.4 The affected road surfaces, footpaths and cycle tracks shall be temporarily decked outside of the working period to resume the original traffic, pedestrian and cycle movements. Nonetheless, as trenchless method will be adopted for part of the works, to facilitate placing of jacking and receiving pits for undertaking the trenchless method, some TTMS shall be of full-time basis.

3.1.5 The details of each of the proposed TTMS provided in the following sub-sections of **Chapter 3.2** of this report.

3.2 Proposed TTMS Detailed Description

Stormwater Storage Scheme at Sha Tin Town Centre (STN1) (Refer to Figure Nos. 3.8.1 to 3.8.4)

<u>Sha Tin Centre Street / Pak Hok Ting Street (Southern Section)</u>

3.2.1 The proposed TTMS consists of a trenchless section running across Sha Tin Centre Street from the footpath near the cycle parking area adjacent to Hilton Plaza EVA, it then connects to another trenchless section runs along the southern footpath of Sha Tin Centre Street towards the proposed pumping station near Yi Ching Lane.

3.2.2 A minimum 1.5m pedestrian footpath will be maintained adjacent the works area at Sha Tin Centre Street. At other locations where the location of the works area would potentially lead to insufficient pedestrian footpath width of 1.5m, temporary decking will be provided to maintain pedestrian movements.

3.2.3 The cycle parking nearest to the Hilton Plaza EVA to be temporarily relocated to facilitate the works.

Yi Ching Lane

3.2.4 The proposed TTMS for the drainage improvement works include sections of the southern footpath of Yi Ching Lane along the proposed pumping station, section of the single 2-lane carriageway adjacent to the Royal Plaza Hotel and the section of carriageway connecting to Pak Hok Ting street outside the Sha Tin Park pedestrian access. The road marking, traffic sign, street furniture layout plan and swept path for the permanent run-in of the pumping station is provided in **Figure 3.8.4**.

3.2.5 For the works over the footpath, a minimum 1.5m wide footpath is to be maintained to maintain pedestrian movements. The motorcycle parking to the south of Yi Ching Lane required to be temporarily relocated to facilitate the works. For the works at the single 2-lane carriageway, it is proposed to setback the road kerb to allow the passing of traffic.

Sha Tin Park and Shing Mun River Promenade

3.2.6 The proposed TTMS runs across the footpaths within the park and directed out to the Shing Mun River crossing the promenade. A minimum 1.5m wide footpath shall be maintained throughout the park, while along the promenade, a minimum 1.8m wide of temporary cycle track and a minimum 1.5m wide temporary pedestrian footpath for pedestrian and cycle thoroughfare.

Sha Tin Centre Street / Pak Hok Ting Street (Northern Section)

3.2.7 The proposed TTMS runs from a point at the middle lane of the carriageway of Sha Tin Centre Street, cutting onto the eastern footpath and runs along the footpath. It then cuts onto the middle lane of the carriageway of Pak Hok Ting Street.

3.2.8 In order to minimise disruption by the works to local traffic, 2 nos. of existing traffic lanes shall be maintained during the works on the carriageways of Sha Tin Centre Street and Pak Hok Ting Street. The loading/ unloading bay at Sha Tin Centre Street along the works area would not be affected by the construction works. Works shall be carried out in stages on a lane-by-lane basis where necessary. The length of works area for each stage is about 15m.

3.2.9 According to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021), Sha Tin Centre Street is under a Day-Time Ban for road works. The working time period of the works shall be between the hours of 2100 – 0700 of the following day.

3.2.10 For the TTMS along the footpath adjacent to New Town Plaza Phase 3, temporary decking is proposed to be provided to maintain a minimum 1.5m pedestrian footpath. For the TTMS section adjacent to the private park, the footpath is proposed to be temporarily suspended. Pedestrian shall be temporarily diverted to use the footpath just north of New Town Plaza Phase 3.

Tai Po Road - Sha Tin

3.2.11 The proposed TTMS is located on the offside traffic lane along the westbound carriageway near Wai Wah Centre.

3.2.12 2 nos. of existing traffic lanes shall be maintained during construction works.

3.2.13 According to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021), Tai Po Road – Sha Tin is under a Day-Time Ban for road works. Based on the traffic assessment at night-time period, the working time period of the works will be between the hours of 2100 – 0700 of the following day.

3.3 Construction Traffic Volume

3.3.1 Construction traffic have been estimated with reference to the number of trips from similar projects. The quantification of construction traffic is shown in **Table 3-1**.

Table 3-1 Estimated Construction Traffic Generation and Attraction

Traffic Direction	Number of goods vehicles (vehicles per day)	Maximum number of goods vehicles (vehicles per hour)	pcu factor	Maximum number of goods vehicles (pcu per hour)
Alignment installation (site STN1)				
Generation	8	2	2.5	5
Attraction	8	2	2.5	5
Pumping Station (site STN1)				
Generation	15	3	2.5	8
Attraction	15	3	2.5	8
Alignment installation and Pumping Station (site STN1)				
Total Generation				**13**
Total Attraction				**13**

3.4 Construction Traffic Routing

3.4.1 Based on experience from other similar projects, construction materials would be stored at depot locating at rural areas in New Territories. Excavation soils would be delivered to landfill in Tseung Kwan O.

3.4.2 Therefore, construction traffic routing assumptions of the following were adopted: -

- Materials Inbound: To / From North District direction;
- Materials Outbound: To / From Tseung Kwan O direction.

3.4.3 The construction traffic for the drainage works involved for drainage alignment installations and pumping station installations are distributed across the road network of Sha Tin and Sai Kung. Therefore, for the assessment, construction traffic will be distributed according to the construction site locations and the directions of which the construction vehicles are destined based on the type of materials to be transported.

3.4.4 The proposed construction vehicle routings for the works locations are illustrated in **Figure Nos. 3.20.**

3.4.5 The assessment results in the future years are shown in **Section 5** of this report.

4 Traffic Forecast

4.1 Forecast Year

4.1.1 The proposed drainage improvement works are divided into 2 phases. **Table 4-1** summaries the construction works associated with each phase and their tentative works period.

Table 4-1 Tentative Works Programme Summary

Phase	Involved Works	Works ID	Tentative Works Period
1	- Stormwater Storage Scheme at Sha Tin Town Centre - Shing Mun River Floodwall - Po Lo Che Road - Wong Chuk Wan - Ma Ling Path - Kau To Hang - Lai Wo Lane - Wong Chuk Yeung	STN1, SKTC2, SKTC5, STS5, STN5, STN7, STN9, STN10	07/2023 – 03/2028
2	- Stormwater Pumping Scheme at Chui Tin Street Soccer Pitch - Chui Tin Street - Hang Hong Street and Hang Kwong Street - Fui Yiu Ha - Pok Hong Estate - Tai Po Road (Ma Liu Shui)	TW3, MOS1, STS1 & STS2, STN12	12/2025 – 07/2031

4.1.2 Based on **Table 4-1**, the drainage improvement work phases will be completed separately. Considering the background traffic would be at its highest at the furthest year of the two phases. Therefore, the year 2028 has been taken as the design year of the construction traffic impact assessment for Phase 1.

4.1.3 The implementation programme may vary the design year of the construction traffic impact assessment and may be updated subject to further discussion with DSD and would be in line with Report on Implementation Strategy, Form of Procurement and Contract Strategy of this Project.

4.1.4 Owing to the Coronavirus outbreak, the surveyed traffic flows are considered not conservative enough for building up traffic model for this assessment. Therefore, the 2016-based Territorial Population and Employment Data Matrix (TPEDM) issued by the Planning Department (PlanD) is adopted as input planning data to establish the rate of growth for future year traffic model for the design years. A summary of the population and employment distribution for Sha Tin, Ma On Shan and other areas in the North-East are shown in **Table 4-2**.

Table 4-2 2016-based Territorial Population and Employment Data Matrix (TPEDM)

Area	Population			Growth p.a. (%)		Employment			Growth p.a. (%)	
	2016	2021	2026	2016 to 2021	2021 to 2026	2016	2021	2026	2016 to 2021	2021 to 2026
Sha Tin	456,300	491,900	482,850	1.5%	-0.4%	196,600	193,000	191,800	-0.4%	-0.1%
Ma On Shan	213,500	219,200	236,450	0.5%	1.5%	33,200	33,850	38,800	0.4%	2.8%
Sai Kung (1)	63,850	67,200	68,400	1.03%	0.35%	27,550	27,100	29,150	-0.3%	1.5%

Note: (1) South-East New Territories (Other Area) from 2016-based TPEDM

4.1.5 Based on the growth rates shown in **Table 4-2**, in a conservative approach, the future traffic on road sections in Sha Tin, Ma On Shan and Sai Kung by applying of the growth rate per annum of 1.0%, 3.0% and 3.0% respectively based on the observed traffic flows.

5 Traffic Impact Assessment

5.1 Traffic Assessments

5.1.1 The forecasted traffic flows for the study year of 2028 during AM and PM Peaks are presented in **Figure Nos. 5.1.5 and 5.1.25**.

5.1.2 The forecasted road link flows for the study year of 2028 during AM and PM Peaks are presented in **Figure Nos. 5.1.16 – 5.1.17 and 5.1.31 – 5.1.32.**

5.1.3 Appropriate TTMS have been derived as mentioned in **Section 3.2** and the traffic assessments for junctions and road links in association with the derived TTMS were conducted. A summary of the assessment results can be found in **Table 5-1 – Table 5-4**, with the Reference Scenarios indicating “Without TTMS” and Design Scenarios indicating “With TTMS”. The detailed calculations are attached in **Appendix A**.

Table 5-1 2028 Reference Year Junction Performance Summary (Without TTMS)

Works ID (District)	Junction ID	Location	Junction Type (1)	2028 Reference Year (Without TTMS) RC (2) (in %) / DFC (3)		
				AM Peak	PM Peak	Public Holiday Peak
STN1 (Sha Tin)	J22	Southern Junction of Pak Hok Ting Street / Sha Tin Centre Street	P	0.14	0.15	-
STN1 (Sha Tin)	J23	Junction of Yi Ching Lane / Access Road near Royal Park Hotel	P	0.13	0.22	-
STN1 (Sha Tin)	J24	Northern Junction of Pak Hok Ting Street / Sha Tin Centre Street	S	>100%	>100%	-

Notes:
(1) S – Signalised Junction, R – Roundabout, P – Priority Junction
(2) A positive RC indicates that the junction is operating with spare capacity. A negative RC indicates that the junction is overloaded, resulting in traffic queues and long delay time.
(3) A DFC ratio less than 1.0 indicates that the junction is operating within design capacity. A DFC ratio greater than 1.0 indicates that the junction is overloaded, resulting in traffic queues and longer delay time to the minor arm traffic.

Table 5-2 2028 Reference Year Road Link Performance Summary (Without TTMS)

Works ID (District)	Link ID	Location	Direction	Capacity (pcu/hr) (1) (2)	2028 Reference Year (Without TTMS)					
					AM Peak		PM Peak		Night Time (2300-0000)	
					Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)
STN1 (Sha Tin)	L4	Car Park Access of Hilton Plaza	Out	500	22	0.04	22	0.04	-	-
STN1 (Sha Tin)	L5	Tai Po Road - Sha Tin near Wai Wah Centre	EB	6100	6811	1.12	6313	1.03	-	-
			WB	6100	5209	0.85	5858	0.96	2970	0.49
STN1 (Sha Tin)	L26	Sha Tin Centre Street (Between Lion Rock Tunnel Road and Pak Hok Ting Street)	EB	2025	769	0.38	574	0.28	-	-
			WB	3325	866	0.26	866	0.26	-	-
STN1 (Sha Tin)	L27	Yi Ching Lane	EB	580	54	0.09	43	0.07	-	-
			WB	580	22	0.04	43	0.07	-	-
STN1 (Sha Tin)	L28	Royal Plaza Hotel Access Road	SB	580	108	0.19	130	0.22	-	-
STN1 (Sha Tin)	L29	Sha Tin Centre Street (near Wai Wah Centre)	NB	900(4)	834	0.93	650	0.72	202(5)	0.22
STN1 (Sha Tin)	L30	Pak Hok Ting Street (near Wai Wah Centre)	SB	2875	855	0.30	812	0.28	-	-

Note:

(1) Capacity of road links (except single-track access road) make reference to the “Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement”.

(2) Capacity of single track access roads is assumed to be 100 pcu/hr for 2-way traffic.

(3) A V/C ratio less than 0.85 indicates that the road link is operating within design capacity. A V/C ratio greater than 1.0 indicates that the road link is overloaded.

(4) Capacity of Sha Tin Centre Street (near Wai Wah Centre) make reference to the “Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement”, single 1-lane carriageway, width > 4m, frontage 3: capacity limited by waiting vehicle and junctions as the slow and fast lanes were occupied by frequent roadside activities.

(5) Night time (2200-2300) traffic flow at Sha Tin Centre Street (near Wai Wah Centre) is estimated by making reference to the hourly variation of the traffic flow at Tai Po Road – Sha Tin Westbound.

Table 5-3 2028 Design Year Road Link Performance Summary (Without TTMS)

Works ID (District)	Junction ID	Location	Junction Type (1)	2028 Design Year (With TTMS) RC (2) (in %) / DFC (3)		
				AM Peak	PM Peak	Public Holiday Peak
STN1 (Sha Tin)	J22	Southern Junction of Pak Hok Ting Street / Sha Tin Centre Street	P	0.14	0.15	-
STN1 (Sha Tin)	J23	Junction of Yi Ching Lane / Access Road near Royal Park Hotel	P	0.13	0.24	-
STN1 (Sha Tin)	J24	Northern Junction of Pak Hok Ting Street / Sha Tin Centre Street	S	>100%	>100%	-

Notes:
(1) S – Signalised Junction, R – Roundabout, P – Priority Junction
(2) A positive RC indicates that the junction is operating with spare capacity. A negative RC indicates that the junction is overloaded, resulting in traffic queues and long delay time.
(3) A DFC ratio less than 1.0 indicates that the junction is operating within design capacity. A DFC ratio greater than 1.0 indicates that the junction is overloaded, resulting in traffic queues and longer delay time to the minor arm traffic.

Table 5-4 2028 Design Year Road Link Performance Summary (With TTMS)

Works ID (District)	Link ID	Location	Direction	Capacity (pcu/hr) (1) (2)	2028 Design Year (With TTMS)					
					AM Peak		PM Peak		Night Time (0000-0100)	
					Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)
STN1 (Sha Tin)	L4	Car Park Access of Hilton Plaza	Out	500	22	0.04	22	0.04	-	-
STN1 (Sha Tin)	L5	Tai Po Road - Sha Tin near Wai Wah Centre	WB	4000	-	-	-	-	2983	0.75
STN1 (Sha Tin)	L26	Sha Tin Centre Street (Between Lion Rock Tunnel Road and Pak Hok Ting Street)	EB	2025	782	0.39	587	0.29	-	-
			WB	3325	879	0.26	879	0.26	-	-
STN1 (Sha Tin)	L27	Yi Ching Lane	EB	410	67	0.16	56	0.14	-	-
			WB	410	35	0.09	56	0.14	-	-
STN1 (Sha Tin)	L28	Royal Plaza Hotel Access Road	SB	580	121	0.21	143	0.25	-	-
STN1 (Sha Tin)	L29	Sha Tin Centre Street (near Wai Wah Centre)	NB	500(4)	-	-	-	-	215(5)	0.43
STN1 (Sha Tin)	L30	Pak Hok Ting Street (near Wai Wah Centre)	SB	1800	868	0.48	825	0.46	-	-

Note:
(1) Capacity of road links (except single-track access road) make reference to the “Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement”.
(2) Capacity of single track access roads is assumed to be 100 pcu/hr for 2-way traffic
(3) A V/C ratio less than 0.85 indicates that the road link is operating within design capacity. A V/C ratio greater than 1.0 indicates that the road link is overloaded.
(4) Capacity of Sha Tin Centre Street (near Wai Wah Centre) make reference to “Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement”, single 1-lane carriageway, width <= 3.5m, frontage 3: capacity limited by waiting vehicle and junctions as the slow lane were occupied by frequent roadside activities.
(5) Night time (2200-2300) traffic flow at Sha Tin Centre Street (near Wai Wah Centre) is estimated by making reference to the hourly variation of the traffic flow at Tai Po Road – Sha Tin Westbound.

5.1.4 Results in **Tables 5-1 - 5-4** indicated that all of those assessed remain within their design capacity during the reference and design scenarios.

5.2 Pedestrian Assessments

5.2.1 The pedestrian footpaths in association with the derived TTMS were also conducted. A summary of the assessment results can be found in **Table 5-10**.

Table 5-10 Study Pedestrian Footpath Performance Assessment (With TTMS)

Works ID (District)	Footpath ID	Link No.	Location Description (Stairway = S, Crossing = C)	Actual Width (m)	Effective Width (m) (1)	With TTMS: Two-Way Pedestrian Flow (ped/min/m)			With TTMS: Level of Service (LOS)		
						AM Peak	PM Peak	School Peak / PH Peak	AM Peak	PM Peak	School Peak / PH Peak
STN1 (Sha Tin)	P15	1	Footpath at Hilton Plaza Car Park Vehicular Exit	1.5	0.5	5.03	8.63	-	A	A	-
STN1 (Sha Tin	P16	1	Sha Tin Park Access (Yi Ching Lane)	1.5	0.5	5.9	2.67	-	A	A	-
		2	Southern Footpath of Yi Ching Lane (near Sha Tin Park)	1.5	0.5	1.13	0.27	-	A	A	-
		3	Southern Footpath of Pak Hok Ting Street (near Sha Tin Park)	1.5	0.5	1	0.43	-	A	A	-

Notes:
(1) Footpath link consists of 2 nos. of footpaths
(2) 0.5m dead width on both sides to be deducted
(3) 0.5m dead width only on one side to be deducted due to site terrain and existing traffic management facilities
(4) The AM school peak is regarded more critical in comparison to the PM school peak as the pedestrian flow would be more concentrated. Therefore, assessment for School Peak refers to the AM school peak

5.2.2 Results in **Table 5-10** show that the study pedestrian footpaths are operating at a satisfactory level at time period that TTMS to be implemented.

6 Summary and Conclusions

6.1 Summary

6.1.1 AECOM has been appointed by DSD to undertake the "Drainage Improvement Works in Sha Tin and Sai Kung – Investigation" ("the Study") on 11 October 2019.

6.1.2 The drainage improvement works are proposed to be split into 2 phases completed separately. Considering the background traffic would be at its highest at the furthest year of the two phases. Therefore, the year 2028 has been taken as the design year of the construction traffic impact assessment for STN1.

6.1.3 **Table 6-1** summarises the proposed works period for the proposed TTMS.

Table 6-1 Proposed Works Period of TTMS (Phase 1)

Works ID	Works Location	Proposed Year	Proposed Works Days	Proposed Time Period
STN1	Stormwater Storage Scheme at Sha Tin Town Centre (except Tai Po Road – Sha Tin Westbound and Sha Tin Centre Street)	2028	All Days	24 Hour (1)
	Tai Po Road – Sha Tin Westbound	2028	All Days	0000 to 0530(2)
	Sha Tin Centre Street carriageway	2028	All Days	2200 to 0600(3)

Note:
(1) The proposed time period denotes the time that the carriageway would be occupied. The actual proposed working hours would be between typical hours of 08:00 to 18:00, with the works equipment occupying the works area outside of the actual works period.
(2) Works at Tai Po Road – Sha Tin can only be carried out between the hours of 1900 – 0700 the following day according to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021). Based on the traffic assessment at night-time period, the working time period of the works will be between the hours of 0000 to 0530.
(3) Works at Sha Tin Centre Street can only be carried out between the hours of 1900 – 0700 the following day according to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021). The working time period proposed in this TIA is as a guideline and the actual working time period should be determined by the contractors based on updated traffic conditions, on-site trial runs and obtain approvals from all relevant authorities prior to commencement of the actual construction.
(4) The speed limit at Tai Po Road – Sha Tin westbound near the works area would be lowered to 50 km/hour during the working period and subject to review by all relevant authorities prior to commencement of the actual construction.

6.1.4 It is noted that under the current excavation permit application requirements by the Highways Department (HyD), contractors are required to submit detailed TTMS schemes using latest road/junction layout, updated traffic counts, conduct on-site trial runs and obtain approvals from all relevant authorities prior to commencement of the actual construction. The TTMS proposed in this TIA are as a guideline and requirement for their preparation of detailed TTMS during construction stage.

6 Summary and Conclusions

6.1 Summary

6.1.1 AECOM has been appointed by DSD to undertake the "Drainage Improvement Works in Sha Tin and Sai Kung – Investigation" ("the Study") on 11 October 2019.

6.1.2 The drainage improvement works are proposed to be split into 2 phases completed separately. Considering the background traffic would be at its highest at the furthest year of the two phases. Therefore, the year 2028 has been taken as the design year of the construction traffic impact assessment for STN1.

6.1.3 **Table 6-1** summarises the proposed works period for the proposed TTMS.

Table 6-1 Proposed Works Period of TTMS (Phase 1)

Works ID	Works Location	Proposed Year	Proposed Works Days	Proposed Time Period
STN1	Stormwater Storage Scheme at Sha Tin Town Centre (except Tai Po Road – Sha Tin Westbound and Sha Tin Centre Street)	2028	All Days	24 Hour (1)
	Tai Po Road – Sha Tin Westbound	2028	All Days	0000 to 0530(2)
	Sha Tin Centre Street carriageway	2028	All Days	2200 to 0600(3)
	Yi Ching Lane	2028	Weekdays	0900 to 1700 (5)
	Pak Hok Ting Street (near Wai Wah Centre)	2028	Weekdays	0900 to 1700 (5)

Note:
(1) The proposed time period denotes the time that the carriageway would be occupied. The actual proposed working hours would be between typical hours of 08:00 to 18:00, with the works equipment occupying the works area outside of the actual works period.
(2) Works at Tai Po Road – Sha Tin can only be carried out between the hours of 1900 – 0700 the following day according to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021). Based on the traffic assessment at night-time period, the working time period of the works will be between the hours of 0000 to 0530.
(3) Works at Sha Tin Centre Street can only be carried out between the hours of 1900 – 0700 the following day according to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021). The working time period proposed in this TIA is as a guideline and the actual working time period should be determined by the contractors based on updated traffic conditions, on-site trial runs and obtain approvals from all relevant authorities prior to commencement of the actual construction.
(4) The speed limit at Tai Po Road – Sha Tin westbound near the works area would be lowered to 50 km/hour during the working period and subject to review by all relevant authorities prior to commencement of the actual construction.
(5) The actual proposed working hours would be between typical hours of 09:00 to 17:00, with the works equipment occupying the works area outside of the actual works period and the works would be carried out in stages.

6.1.4 It is noted that under the current excavation permit application requirements by the Highways Department (HyD), contractors are required to submit detailed TTMS schemes using latest road/junction layout, updated traffic counts, conduct on-sitetrial runs and obtain approvals from all relevant authorities prior to commence-mentof the actual construction. The TTMS proposed in this TIA are as a guide-line and requirement for their preparation of detailed TTMS during construction stage.

6.2 Conclusion

6.2.1 In conclusion, the TIA has demonstrated that the proposed drainage improvement works would not adversely affect to the surrounding road network provided that the proposed temporary traffic management and requirements are adhered to.

FIGURES

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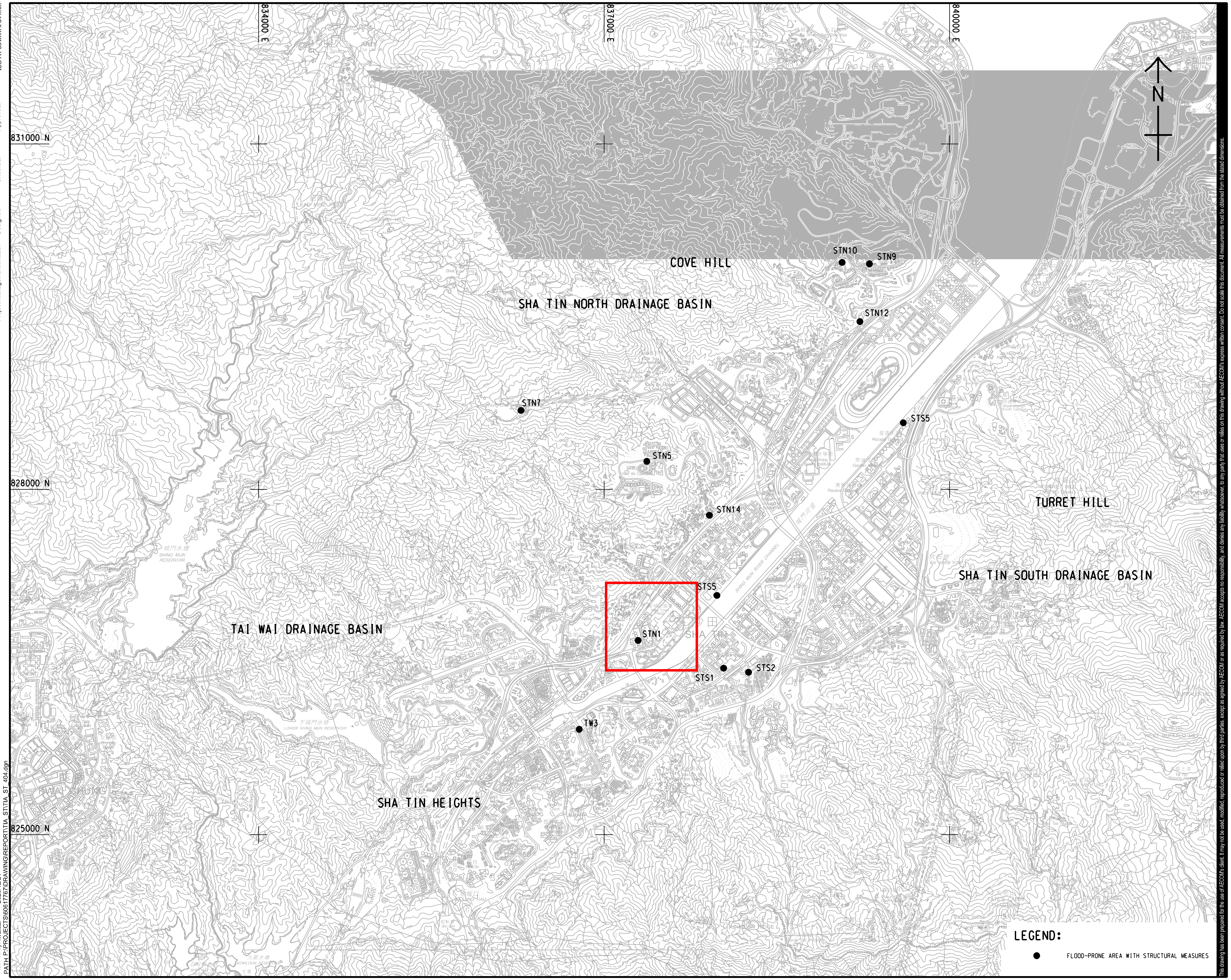

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PROJECT

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT

渠務署
Drainage Services Department

CONSULTANT

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SCALE: A3 1 : 30000

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60617767

AGREEMENT NO.: CE 15/2019 (DS)

SHEET TITLE

PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN (KEY PLAN)

SHEET NUMBER

60617767/TIA_ST/FIGURE 1.1.3

Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm

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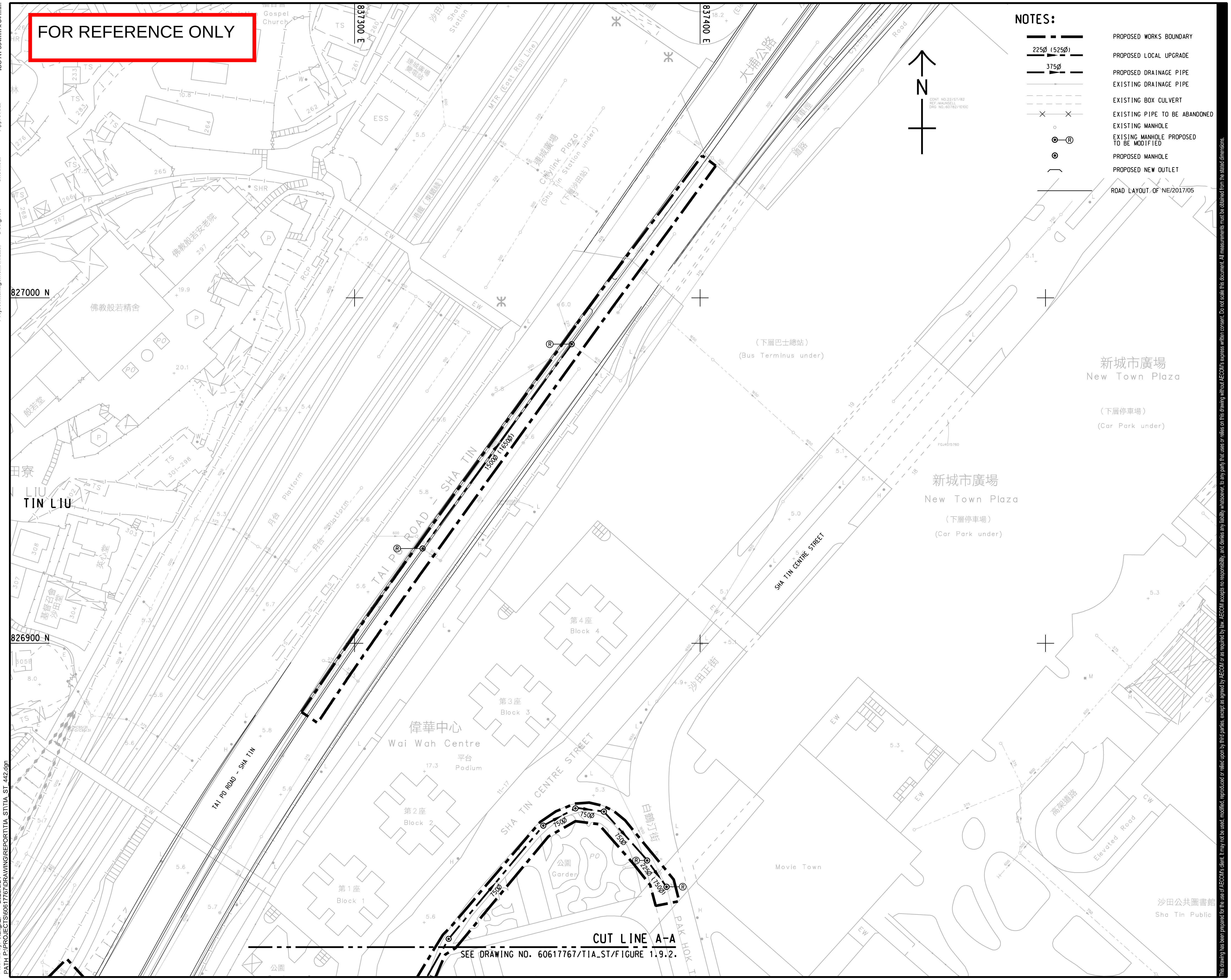

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PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT 業主

渠務署 Drainage Services Department

CONSULTANT 工程顧問公司

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I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

SCALE 比例 A3 1 : 1000

DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖 A3 1 : 40000

PROJECT NO. 項目編號 60617767

AGREEMENT NO. 協議編號 CE 15/2019 (DS)

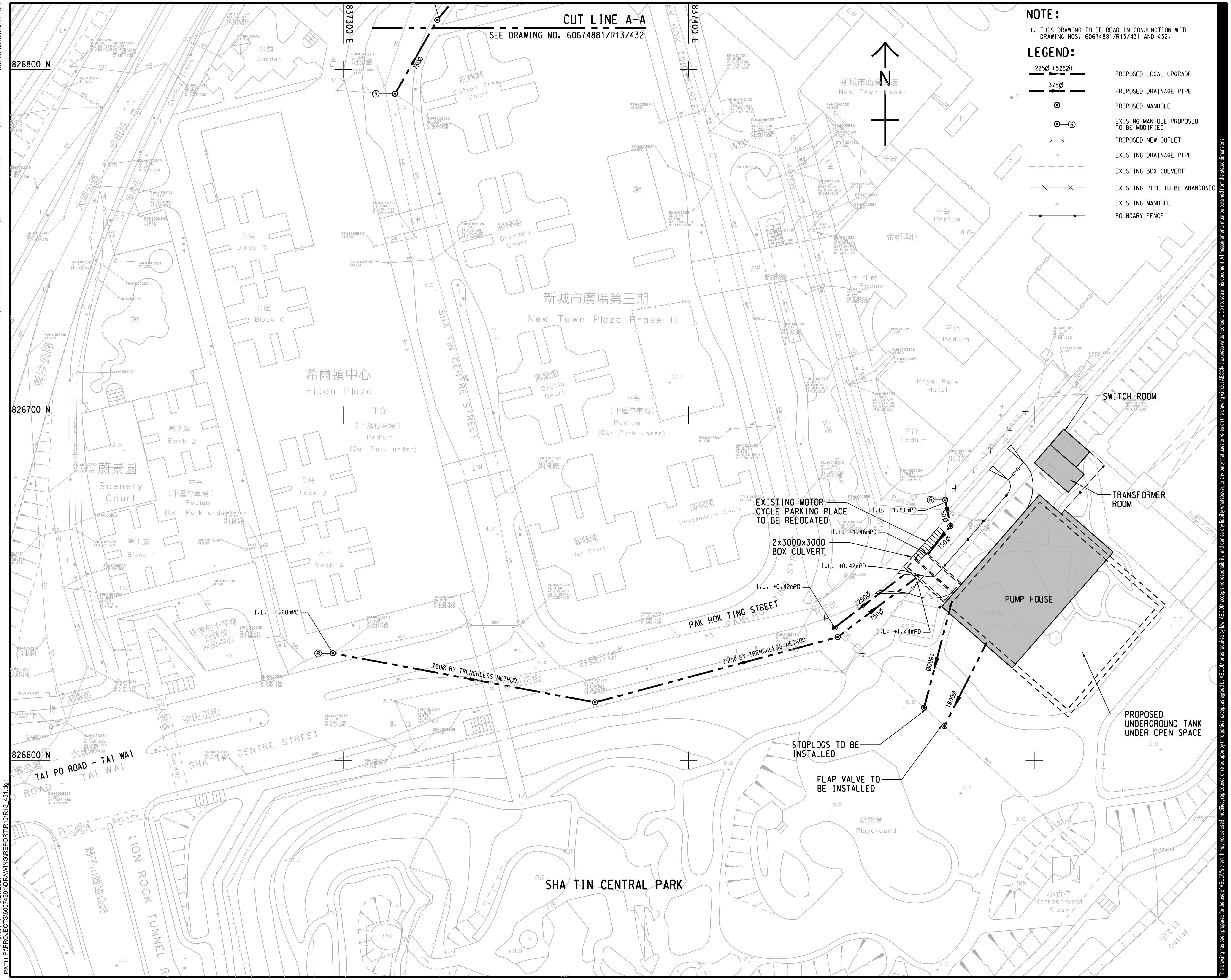
SHEET TITLE 圖紙名稱

PROPOSED WORKS AREA AT SHA TIN TOWN CENTRE (STN1)

SHEET 2 OF 2

SHEET NUMBER 圖紙編號

60617767/TIA_ST/FIGURE 1.9.1



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PROJECT
項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT
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STATUS
狀態

SCALE 比例 A1 1 : 500
DIMENSION UNIT 尺寸單位 METRES

KEY PLAN A1 1 : 20000
索引圖

PROJECT NO. 項目編號 60674881
CONTRACT NO. 合約編號 CE 44/2021 (DS)

SHEET TITLE
圖紙名稱

PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN TOWN CENTRE (STN1)

SHEET 1 OF 2

SHEET NUMBER
圖紙編號

60674881/R13/431

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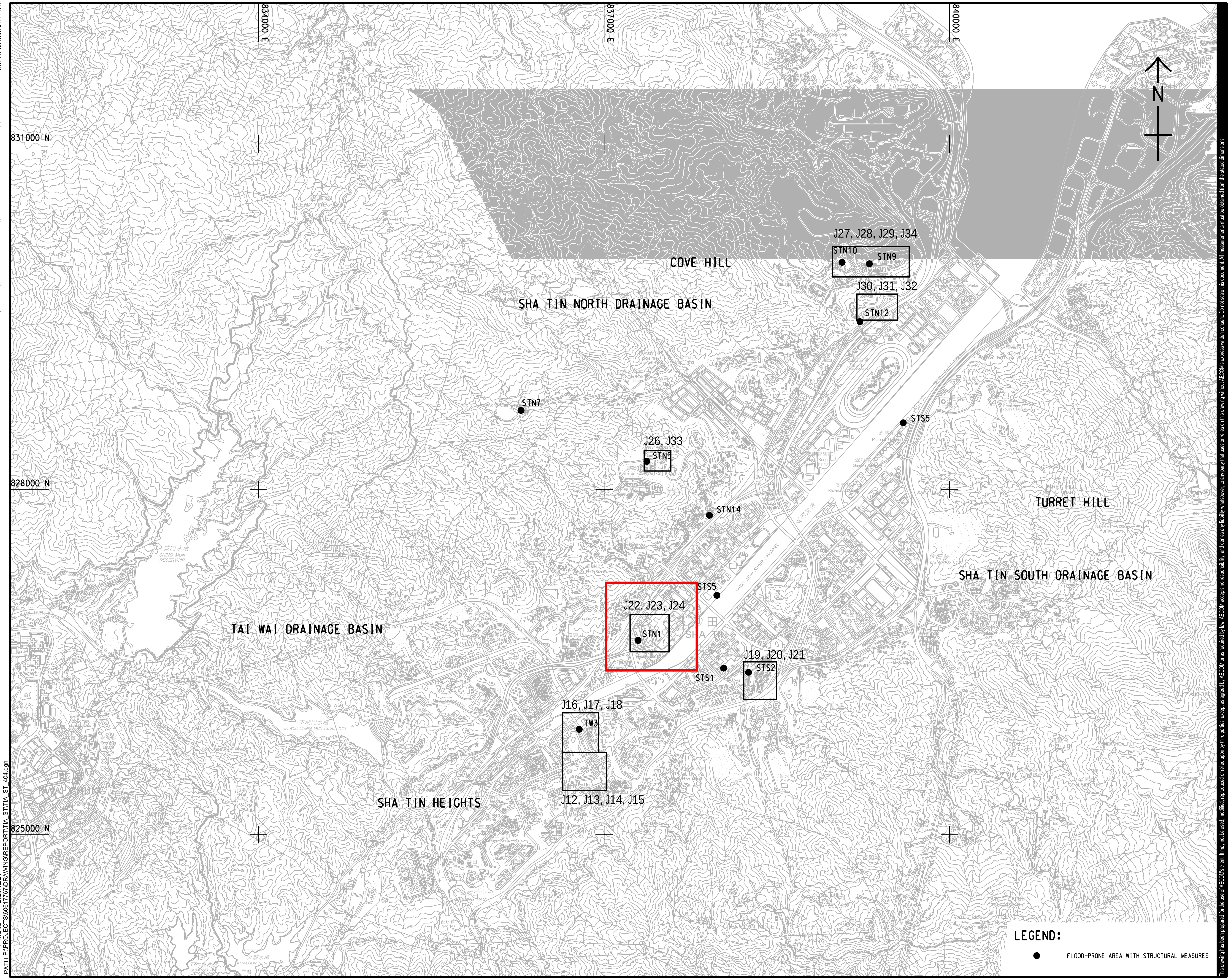

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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

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STATUS

SCALE	DIMENSION UNIT
A3 1 : 30000	METRES

KEY PLAN

PROJECT NO.	AGREEMENT NO.
60617767	CE 15/2019 (DS)

SHEET TITLE

CRITICAL JUNTIONS AT SHA TIN
(KEY PLAN)

SHEET NUMBER

FIGURE 2.3

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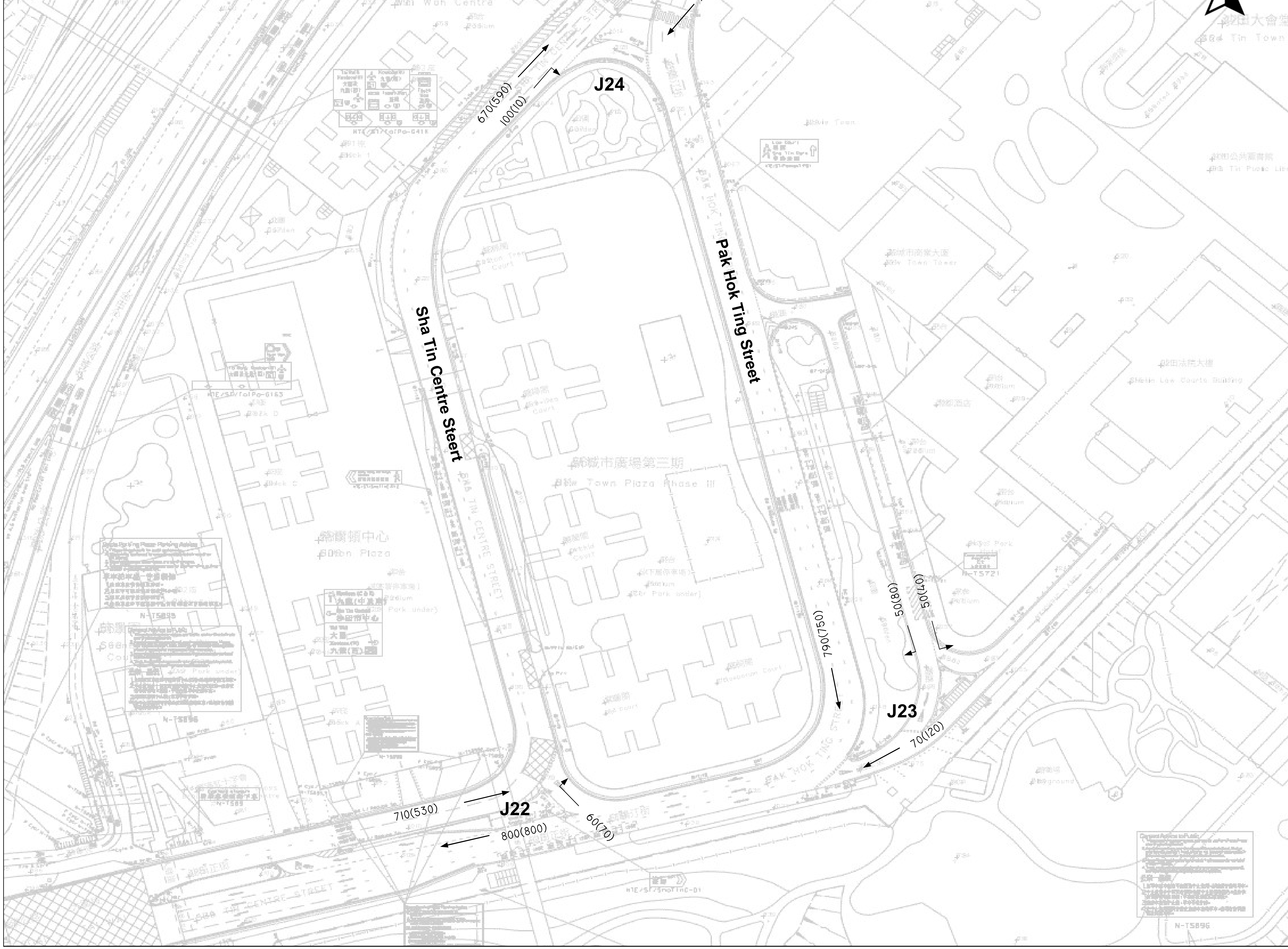
Project Management Initials:
Plot File by: riva.cai 2020/12/21
PATH P:\PROJECTS\60617767\DRAWING\REPORT\TIA_ST\TIA_ST_404.dgn

LEGEND:

100(100) → AM(PM) PEAK HOURLY TRAFFIC FLOW (PCU/HR)

J1 JUNCTION NO.



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STATUS

SCALE | **DIMENSION UNIT**

NOT TO SCALE

KEY PLAN

PROJECT NO. | **CONTRACT NO.**

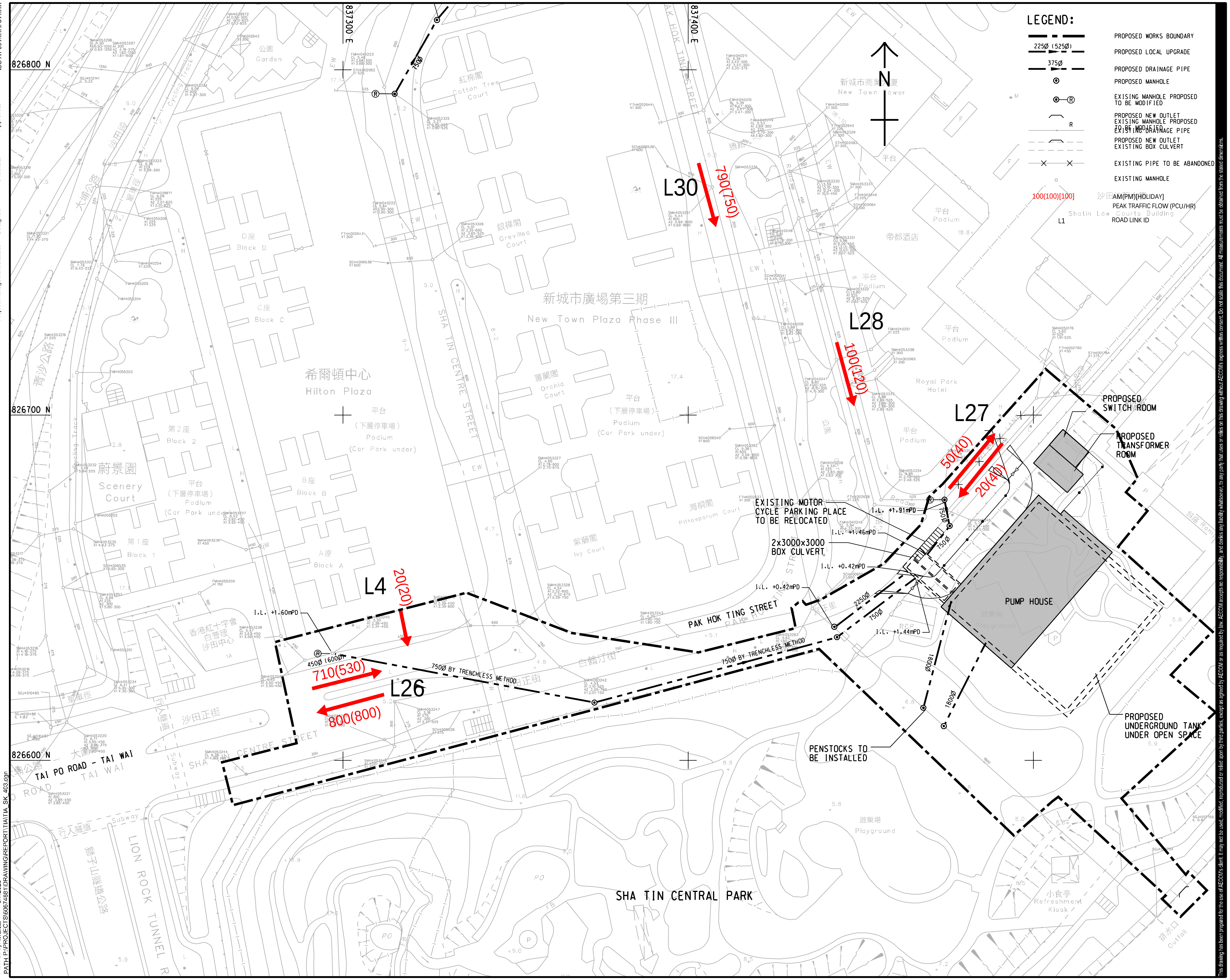
60617767

SHEET TITLE

YEAR 2020
JUNCTION TRAFFIC FLOW
(SHEET 5 OF 6)

SHEET NUMBER

FIGURE 2.1.5



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SCALE	DIMENSION UNIT
A1 1 : 500	METRES

KEY PLAN

PROJECT NO.	CONTRACT NO.
60674881	CE 44/2021 (DS)

SHEET TITLE

YEAR 2020
ROAD LINK FLOW
(SHEET 10 OF 17)

SHEET NUMBER

60674881/TIA_SK/FIG 2.5.10

Project Management Initials: Designer: Checked: Approved:

ISO A1 594mm x 841mm

Plot File by: riva.cai 3/7/2023

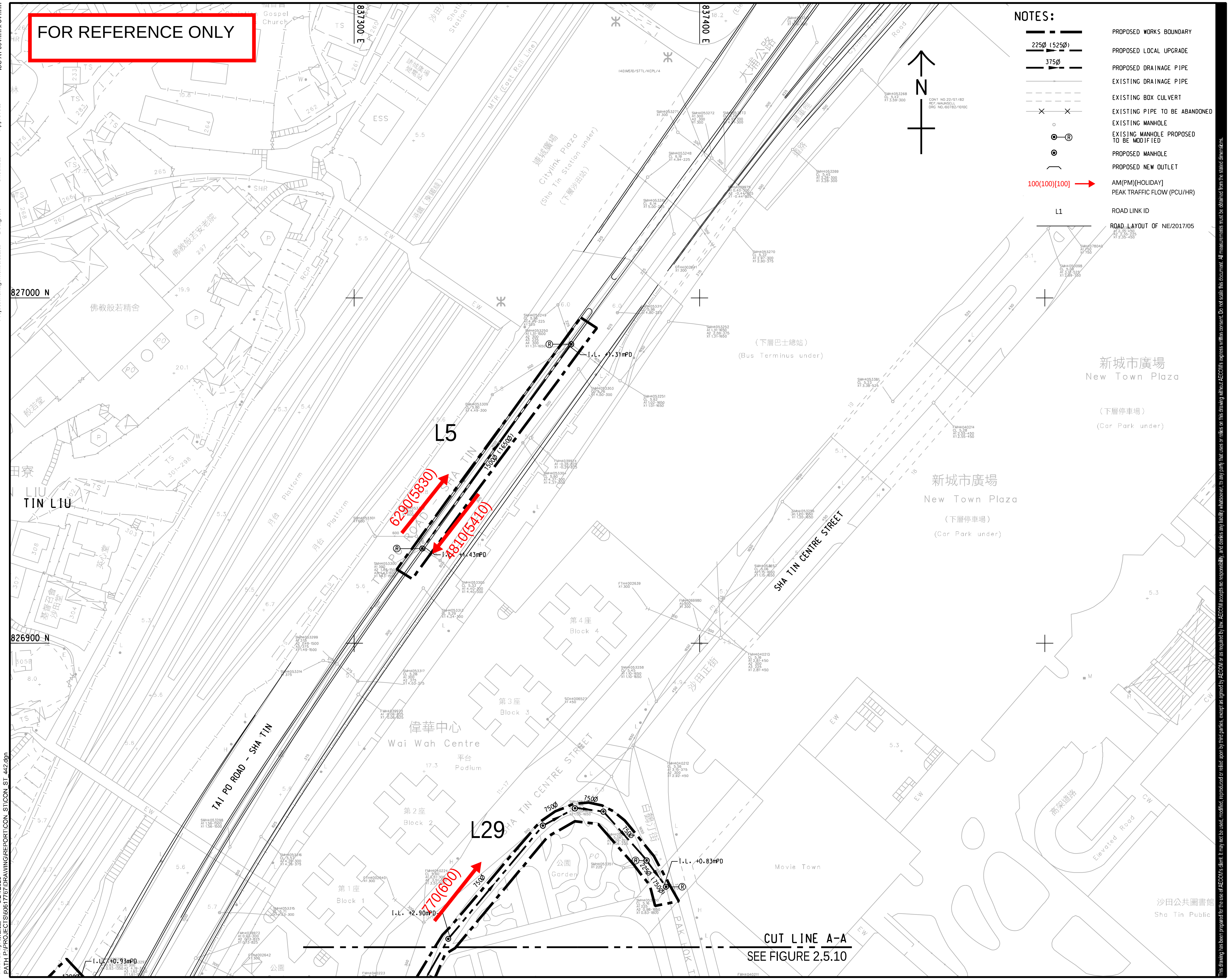
ISO A1 594mm x 841mm

Approved:

Checked:

Designer:

Project Management Initials:



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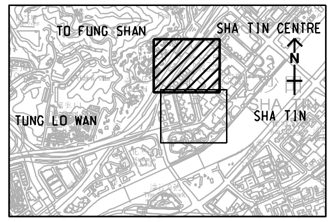
SCALE: A3 1 : 1000

DIMENSION UNIT: METRES

KEY PLAN A3 1 : 40000



PROJECT NO.: 60617767

AGREEMENT NO.: CE 15/2019 (DS)

SHEET TITLE

YEAR 2020
ROAD LINK FLOW
(SHEET 11 OF 17)

SHEET NUMBER

FIGURE 2.5.11

Plot File by: riva.cai 8/24/2023
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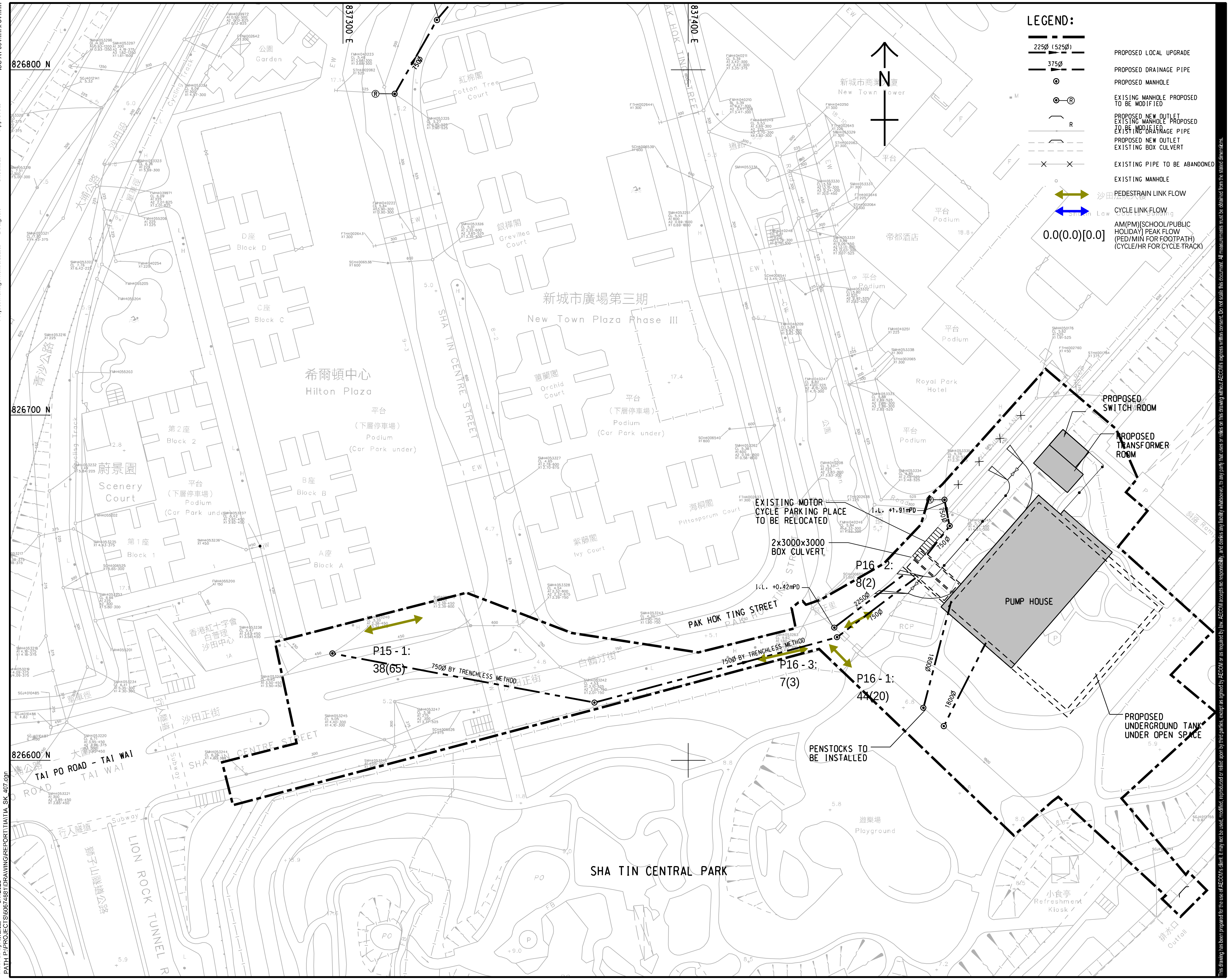

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SCALE: A1 1 : 500

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60674881

CONTRACT NO.: CE 44/2021 (DS)

SHEET TITLE

YEAR 2020
PEDESTRIAN FLOW AND CYCLE FLOW
(SHEET 15 OF 17)

SHEET NUMBER

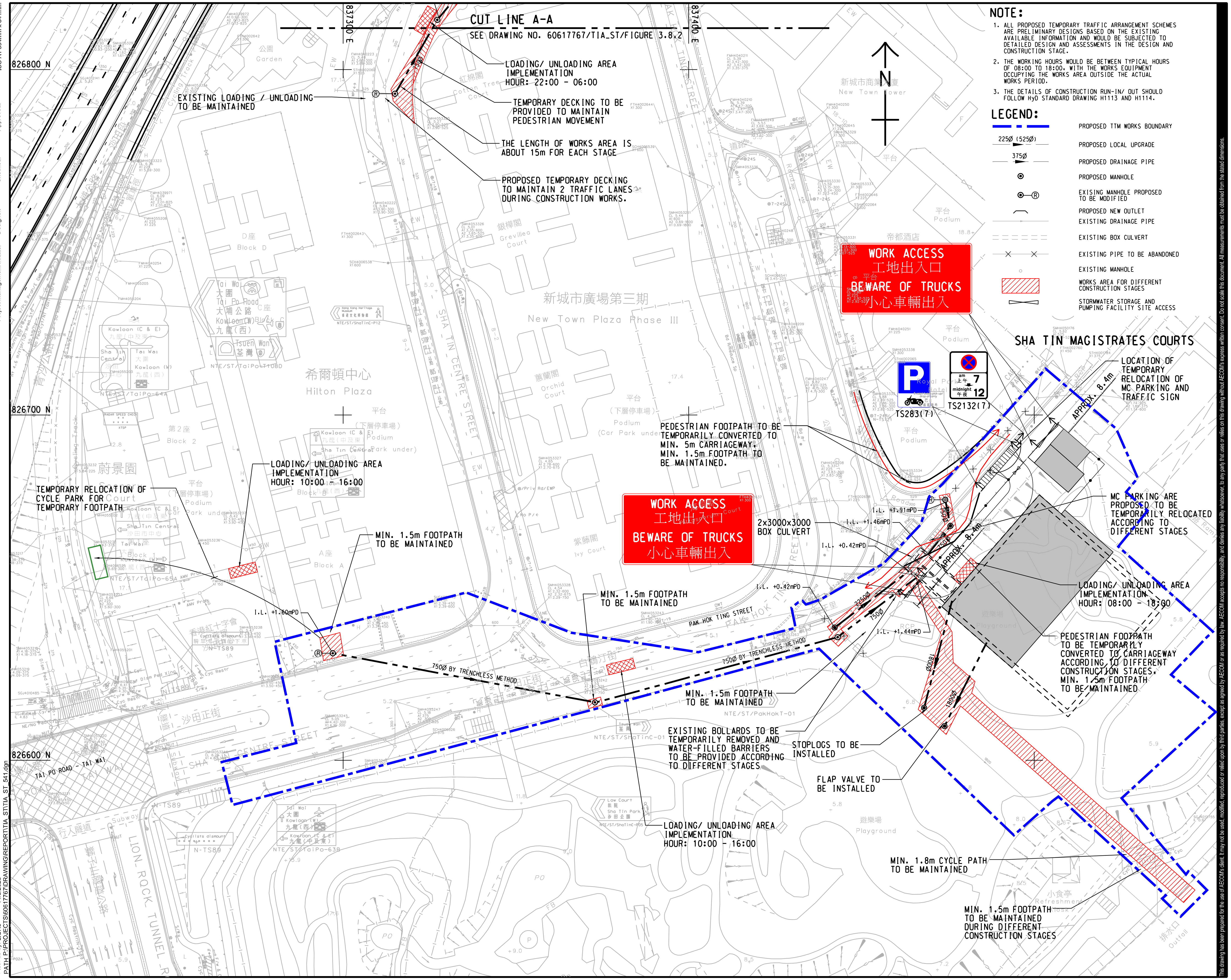
60674881/TIA_SK/FIG 2.6.16

NOTE:

1. ALL PROPOSED TEMPORARY TRAFFIC ARRANGEMENT SCHEMES ARE PRELIMINARY DESIGNS BASED ON THE EXISTING AVAILABLE INFORMATION AND WOULD BE SUBJECTED TO DETAILED DESIGN AND ASSESSMENTS IN THE DESIGN AND CONSTRUCTION STAGE.
2. THE WORKING HOURS WOULD BE BETWEEN TYPICAL HOURS OF 08:00 TO 18:00, WITH THE WORKS EQUIPMENT OCCUPYING THE WORKS AREA OUTSIDE THE ACTUAL WORKS PERIOD.
3. THE DETAILS OF CONSTRUCTION RUN-IN/ OUT SHOULD FOLLOW HyD STANDARD DRAWING H1113 AND H1114.

LEGEND:

- PROPOSED TTM WORKS BOUNDARY
- 225Ø (525Ø) PROPOSED LOCAL UPGRADE
- 375Ø PROPOSED DRAINAGE PIPE
- PROPOSED MANHOLE
- EXISING MANHOLE PROPOSED TO BE MODIFIED
- PROPOSED NEW OUTLET
- EXISTING DRAINAGE PIPE
- EXISTING BOX CULVERT
- EXISTING PIPE TO BE ABANDONED
- EXISTING MANHOLE
- WORKS AREA FOR DIFFERENT CONSTRUCTION STAGES
- STORMWATER STORAGE AND PUMPING FACILITY SITE ACCESS



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SCALE 比例 A3 1 : 1000

DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖 A3 1 : 40000

PROJECT NO. 項目編號 60617767

AGREEMENT NO. 協議編號 CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

PROPOSED TEMPORARY TRAFFIC ARRANGEMENT FOR SHA TIN TOWN CENTRE (STN1)

SHEET 1 OF 2

SHEET NUMBER 圖紙編號

60617767/TIA_ST/FIGURE 3.8.1

ISO A1 594mm x 841mm
Project Management Initials: Designer: Checked: Approved:
Plot File by: LIUH9 11/3/2023
PATH: P:\PROJECTS\60617767\DRAWING\REPORT\TIA_ST\TIA_ST_541.dgn

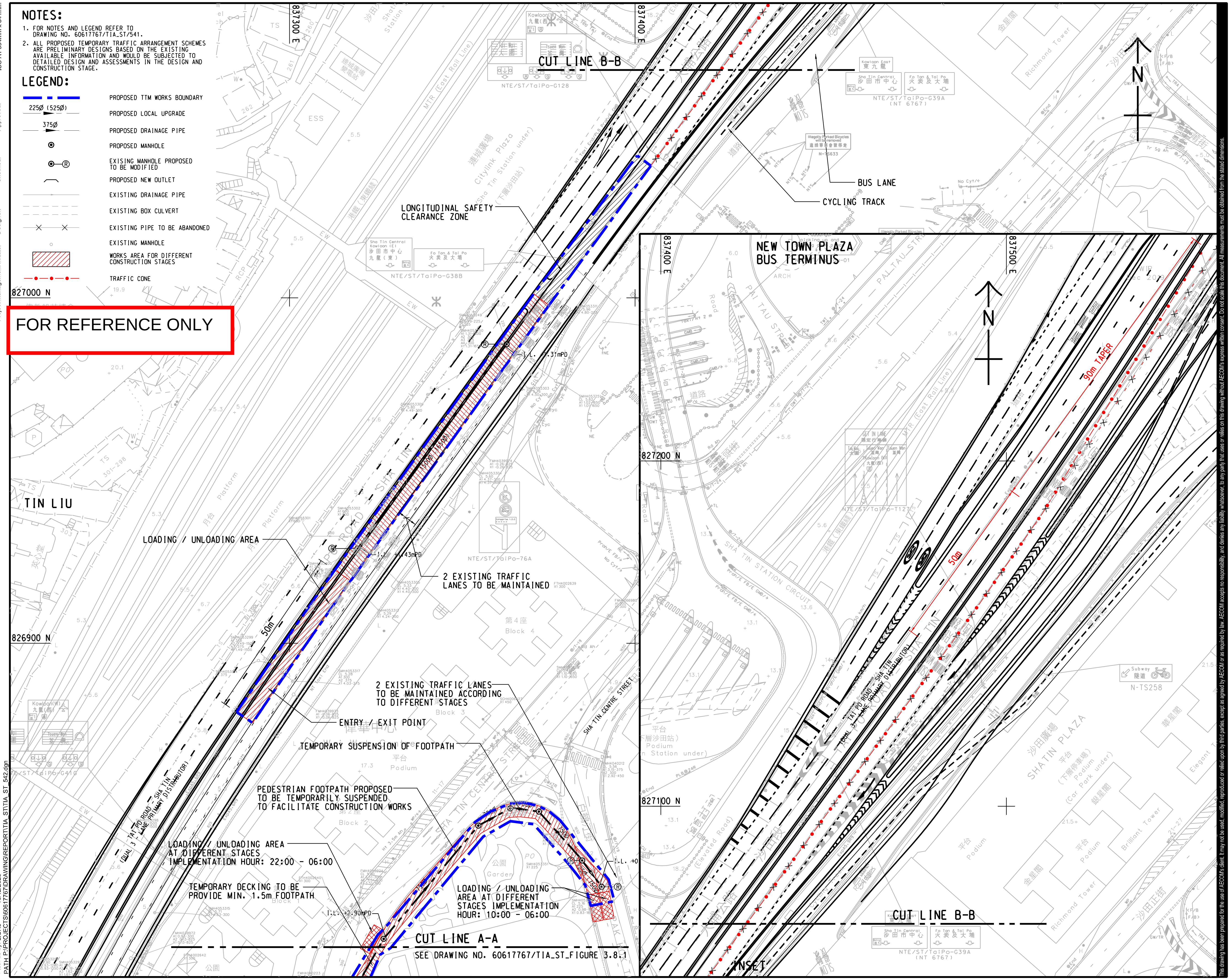
NOTES:

1. FOR NOTES AND LEGEND REFER TO DRAWING NO. 60617767/TIA_ST/541.
2. ALL PROPOSED TEMPORARY TRAFFIC ARRANGEMENT SCHEMES ARE PRELIMINARY DESIGNS BASED ON THE EXISTING AVAILABLE INFORMATION AND WOULD BE SUBJECTED TO DETAILED DESIGN AND ASSESSMENTS IN THE DESIGN AND CONSTRUCTION STAGE.

LEGEND:

- PROPOSED TTM WORKS BOUNDARY
- 225Ø (525Ø) PROPOSED LOCAL UPGRADE
- 375Ø PROPOSED DRAINAGE PIPE
- PROPOSED MANHOLE
- EXISING MANHOLE PROPOSED TO BE MODIFIED
- PROPOSED NEW OUTLET
- EXISTING DRAINAGE PIPE
- EXISTING BOX CULVERT
- EXISTING PIPE TO BE ABANDONED
- EXISTING MANHOLE
- WORKS AREA FOR DIFFERENT CONSTRUCTION STAGES
- TRAFFIC CONE

FOR REFERENCE ONLY



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STATUS

SCALE: A3 1 : 1000

DIMENSION UNIT: METRES

KEY PLAN A3 1 : 40000

PROJECT NO. 60617767

AGREEMENT NO. CE 15/2019 (DS)

SHEET TITLE
PROPOSED TEMPORARY TRAFFIC ARRANGEMENT FOR SHA TIN TOWN CENTRE (STN1)
SHEET 2 OF 2

SHEET NUMBER
60617767/TIA_ST/FIGURE 3.8.2

ISO A1 594mm x 841mm
Approved: Checked: Designer: Project Management Initials:
Plot File by: LIUH9 10/12/2023
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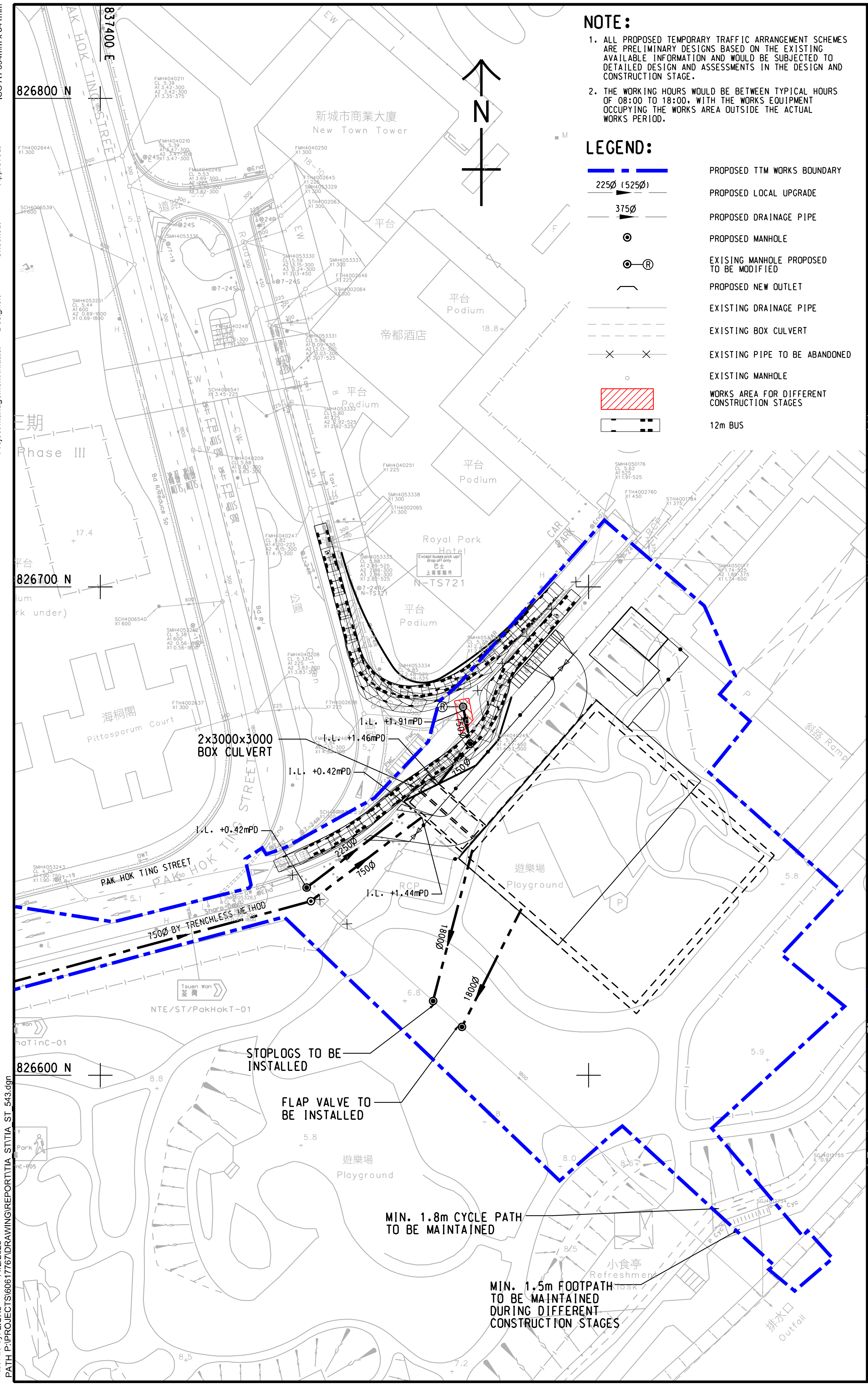

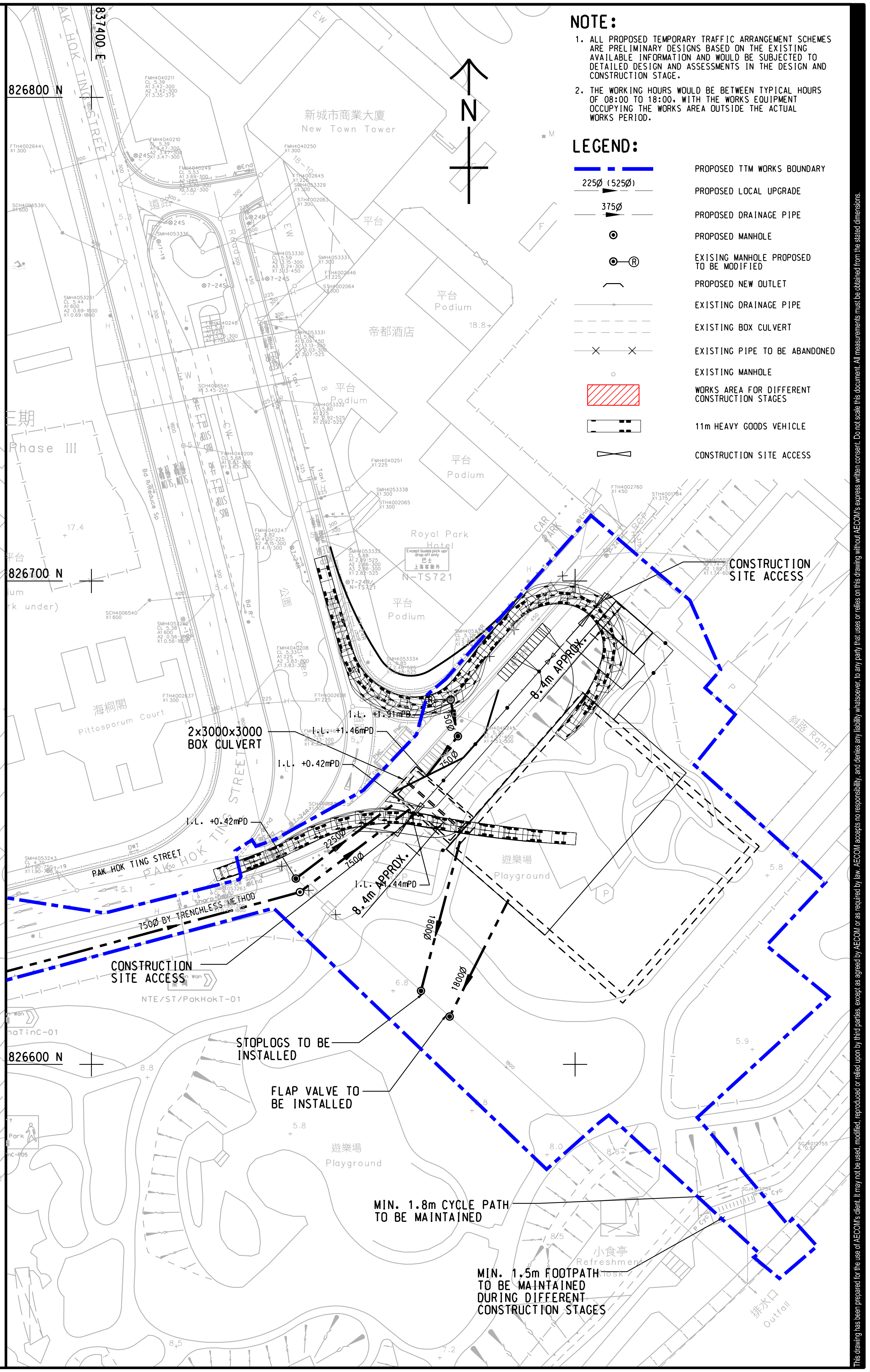

ISO A1 594mm x 841mm

Approved:

Checked:

Designer:

Project Management Initials:

Plot File by: LIUH9 11/2/2023

PATH P:\PROJECTS\60617767\DRAWING\REPORT\TIA_ST\TIA_ST_543.dgn

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STATUS 階段

SCALE 比例 A3 1 : 1000

DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號 60617767

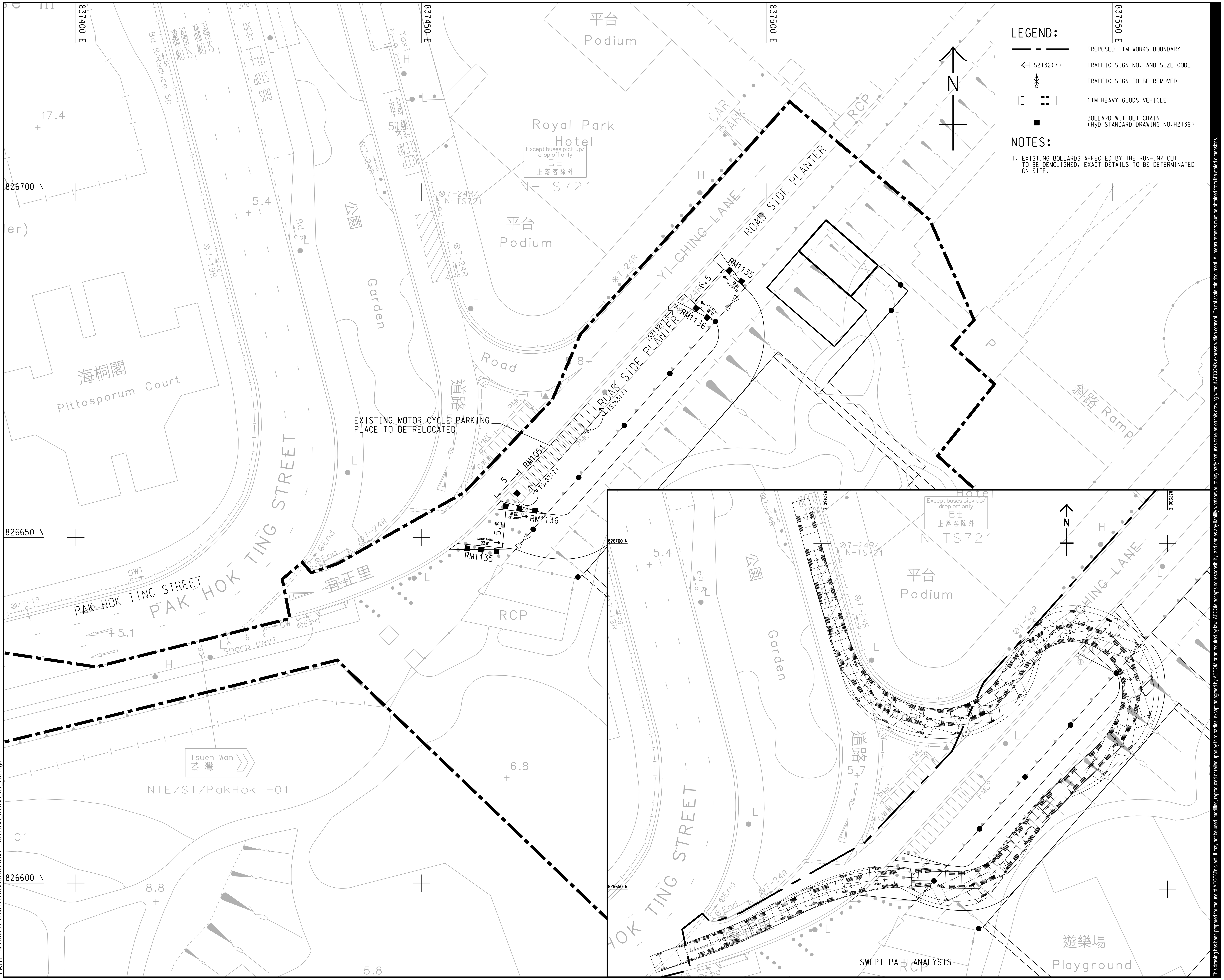
AGREEMENT NO. 協議編號 CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

PROPOSED TEMPORARY TRAFFIC ARRANGEMENT FOR SHA TIN TOWN CENTRE (STN1) - SWEPT PATH ANALYSIS SHEET 1 OF 2

SHEET NUMBER 圖紙編號

60617767/TIA_ST/FIGURE 3.8.3



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STATUS 階段

SCALE 比例: A3 1 : 500

DIMENSION UNIT 尺寸單位: METRES

KEY PLAN 索引圖 A3 1 : 40000

PROJECT NO. 項目編號: 60617767

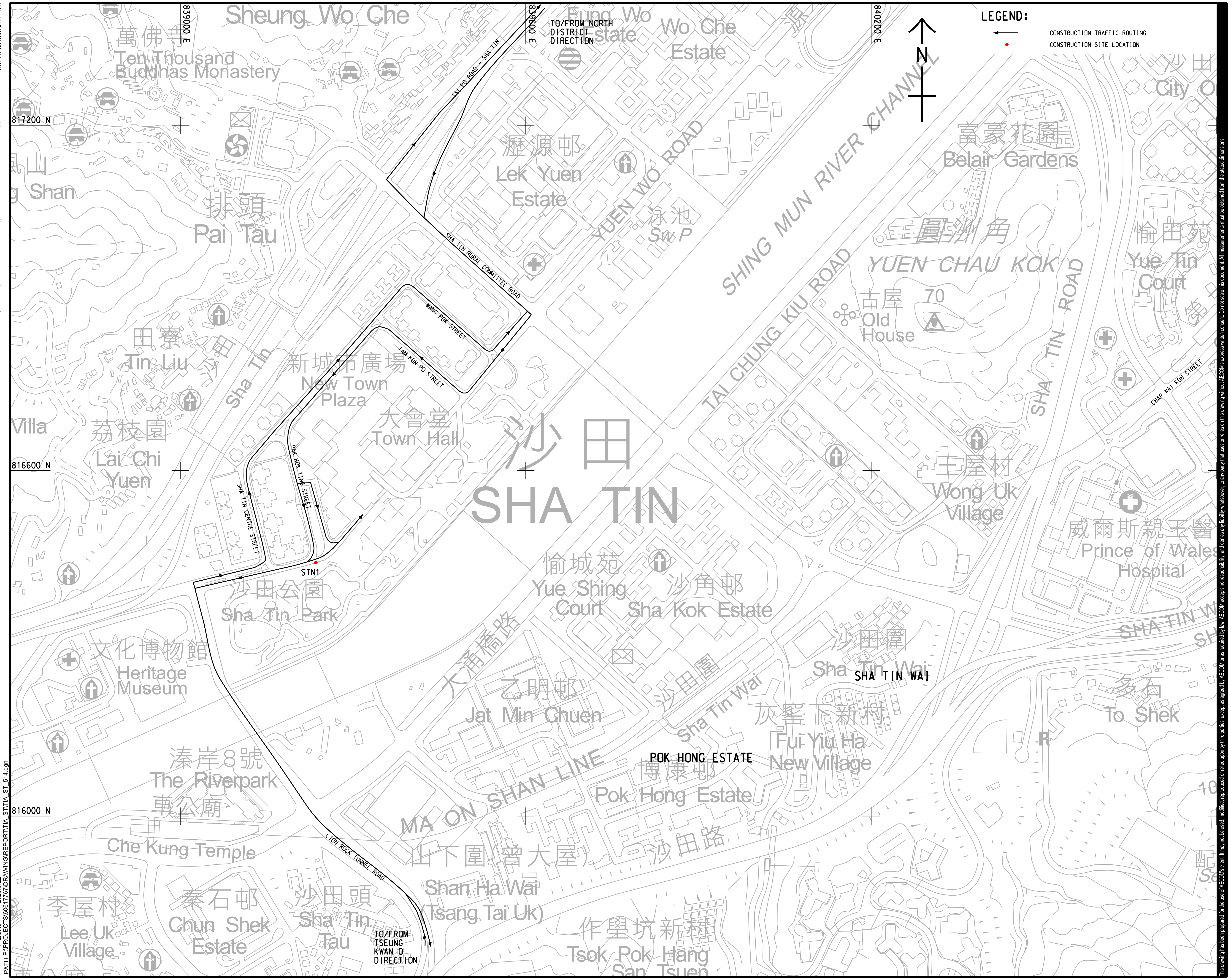
AGREEMENT NO. 協議編號: CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

PUMPING STATION RUN-IN/ OUT ROAD MARKING AND TRAFFIC SIGN LAYOUT PLAN

SHEET NUMBER 圖紙編號

60617767/TIA_ST/FIGURE 3.8.4



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SCALE	DIMENSION UNIT
A3 1 : 6000	METRES

KEY PLAN

PROJECT NO.	AGREEMENT NO.
60617767	CE 15/2019 (DS)

SHEET TITLE

PROPOSED CONSTUCTION TRAFFIC ROUTING FOR SHA TIN TOWN CENTRE (STN1)

SHEET 1 OF 2

SHEET NUMBER

60617767/TIA_ST/FIGURE 3.20

ISO A1 594mm x 841mm
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Project Management Initials:
Plot File by: LIUH9 2023/5/22
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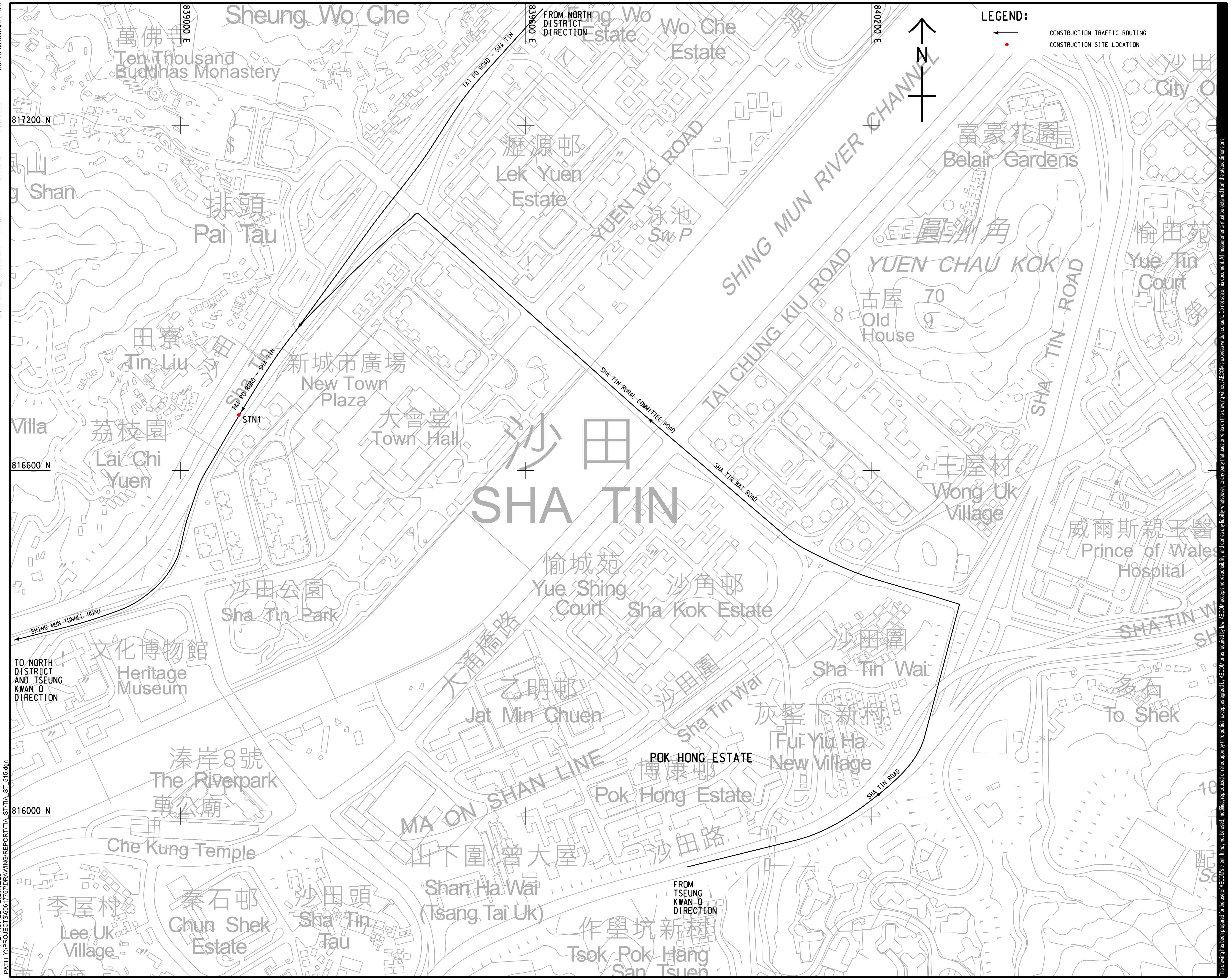

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SCALE 比例
A3 1 : 6000

DIMENSION UNIT 尺寸單位
METRES

KEY PLAN 索引圖

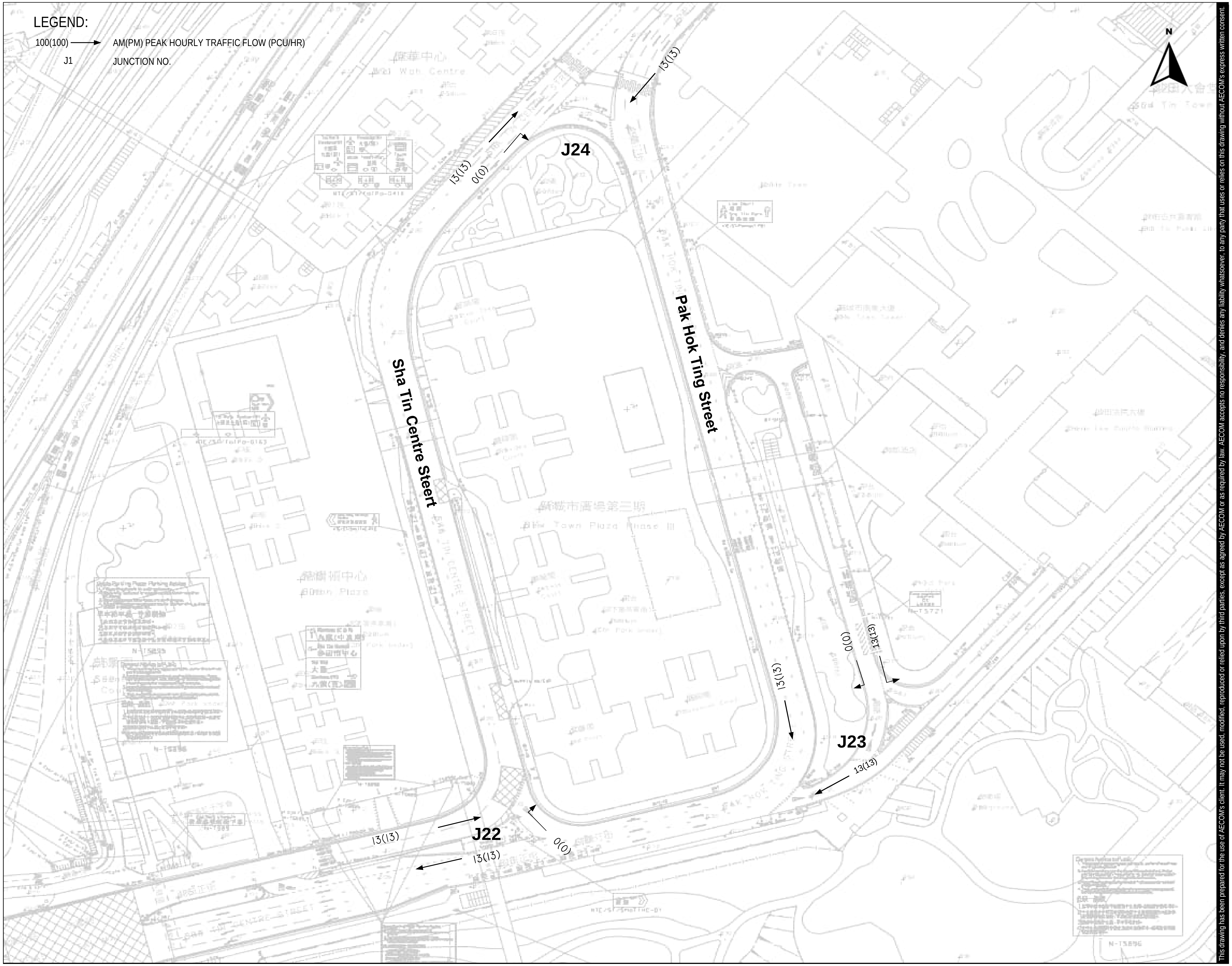
PROJECT NO. 項目編號
60617767

AGREEMENT NO. 協議編號
CE 15/2019 (DS)

SHEET TITLE 圖紙名稱
PROPOSED CONSTUCTION TRAFFIC ROUTING FOR SHA TIN TOWN CENTRE (STN1)

SHEET 2 OF 2

SHEET NUMBER 圖紙編號
60617767/TIA_ST/FIGURE 3.21



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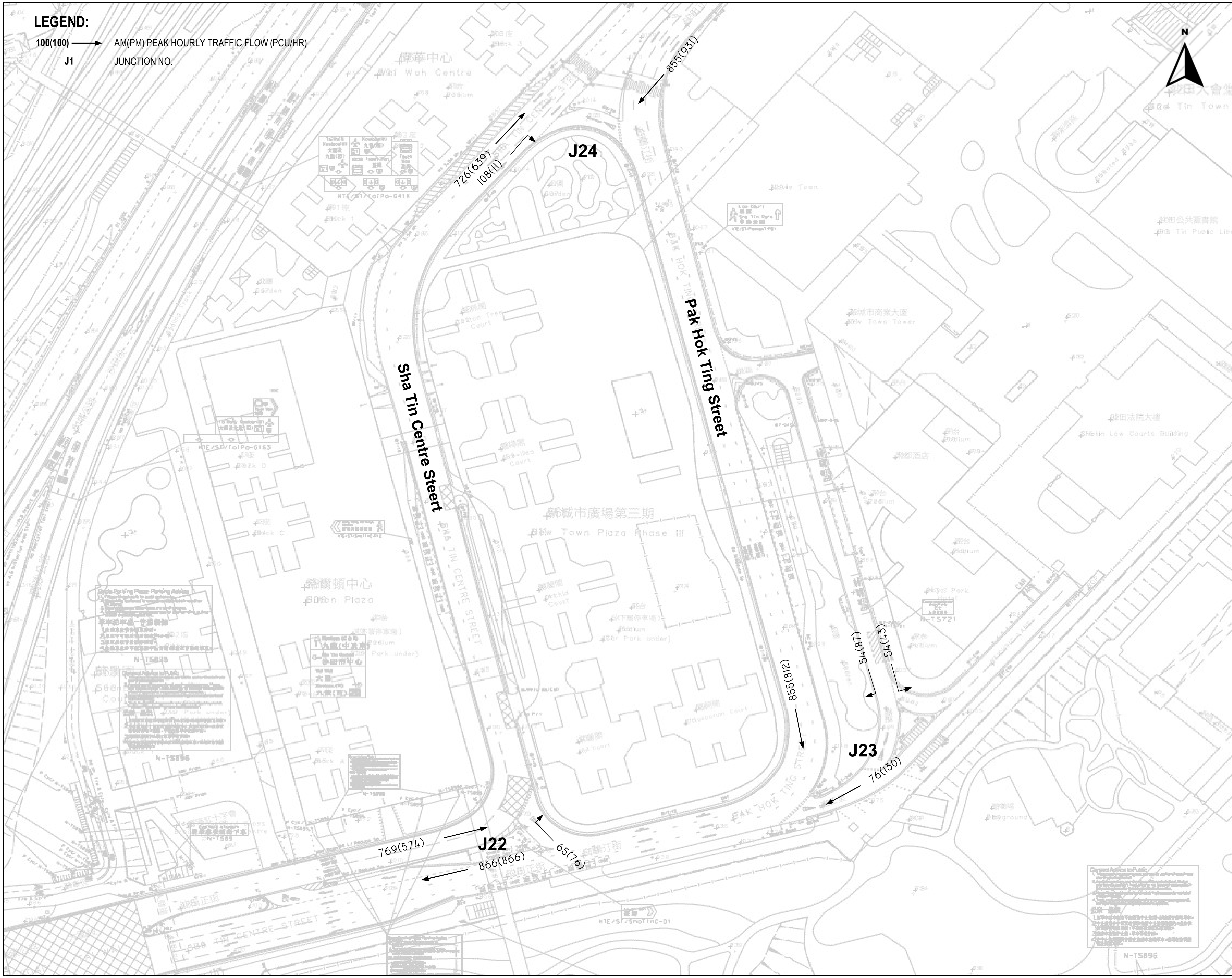
PROJECT NO. | CONTRACT NO.
60617767

SHEET TITLE
YEAR 2028
CONSTRUCTION TRAFFIC FLOW
(SHEET 3 OF 4)

SHEET NUMBER
FIGURE 3.28



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PROJECT NO. **CONTRACT NO.**

60617767

SHEET TITLE

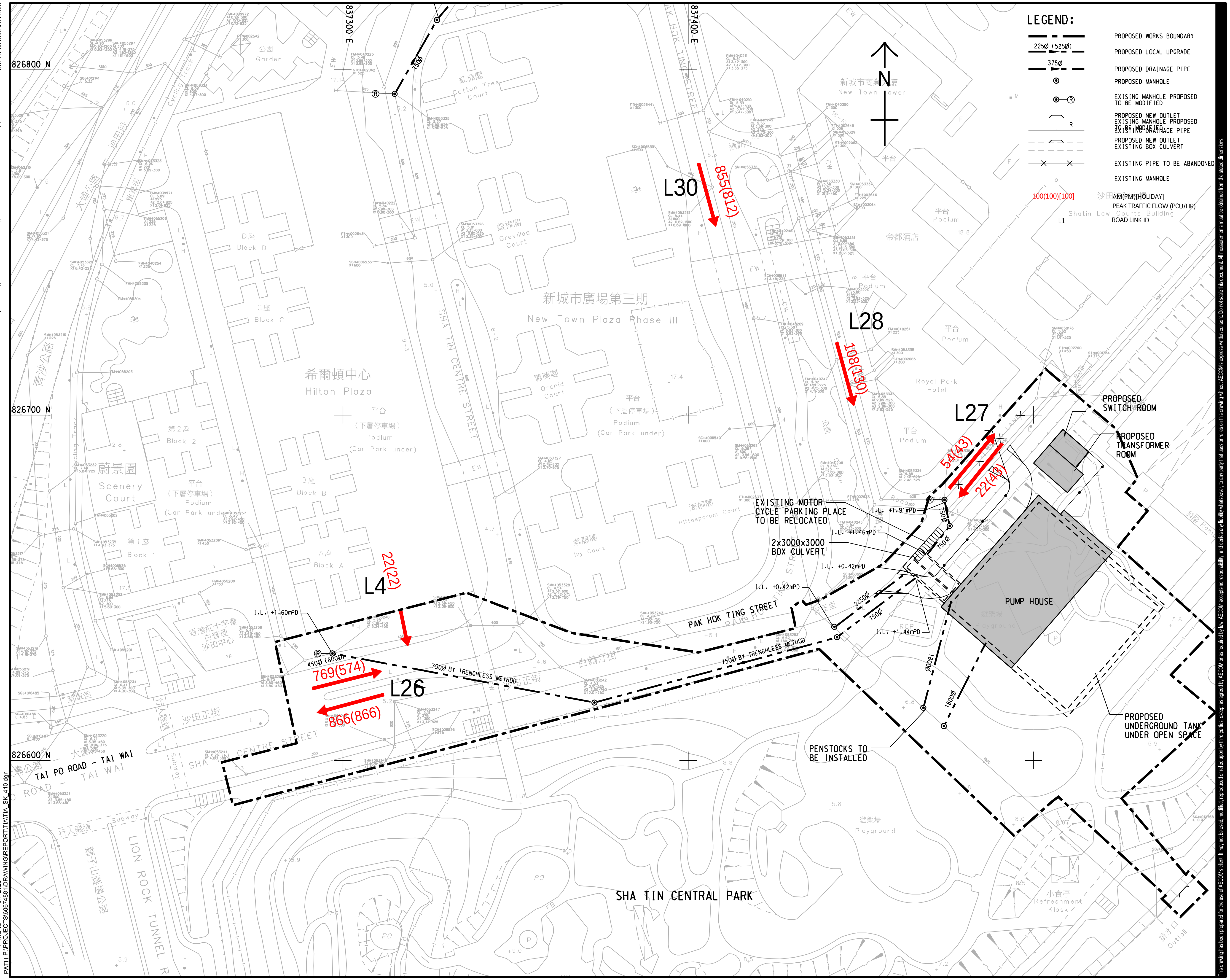
YEAR 2028

FORECAST JUNCTION TRAFFIC FLOW

(SHEET 5 OF 6)

SHEET NUMBER

FIGURE 5.1.5



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KEY PLAN

PROJECT NO.	CONTRACT NO.
60674881	CE 44/2021 (DS)

SHEET TITLE

YEAR 2028
FORECAST ROAD LINK FLOW
(SHEET 10 OF 17)

SHEET NUMBER

60674881/TIA_SK/FIG 5.1.16

ISO A1 594mm x 841mm
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Project Management Initials:

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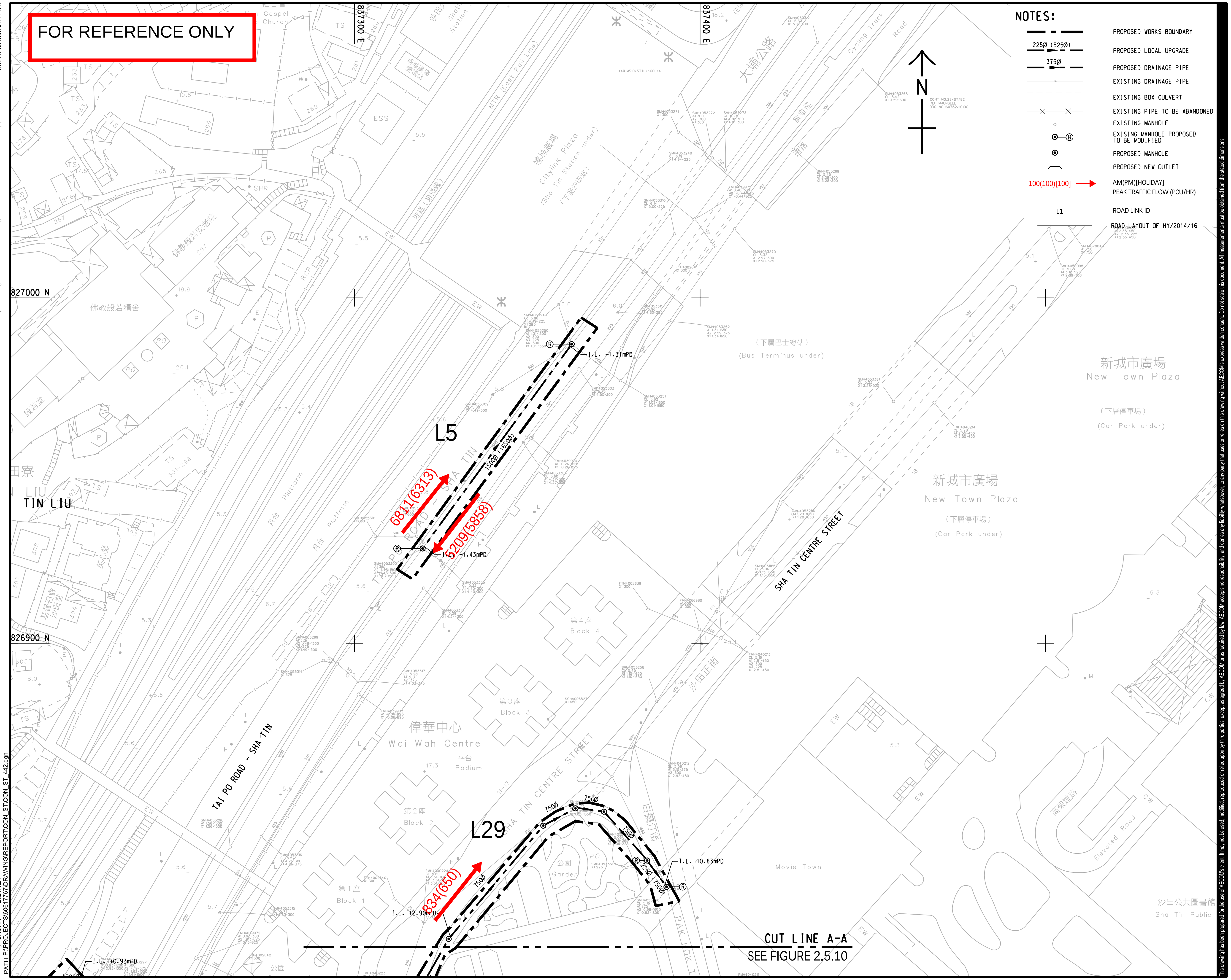

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DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖 A3 1 : 40000

PROJECT NO. 項目編號 60617767

AGREEMENT NO. 協議編號 CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

YEAR 2028
FORECAST ROAD LINK FLOW
(SHEET 11 OF 17)

SHEET NUMBER 圖紙編號

FIGURE 5.1.17

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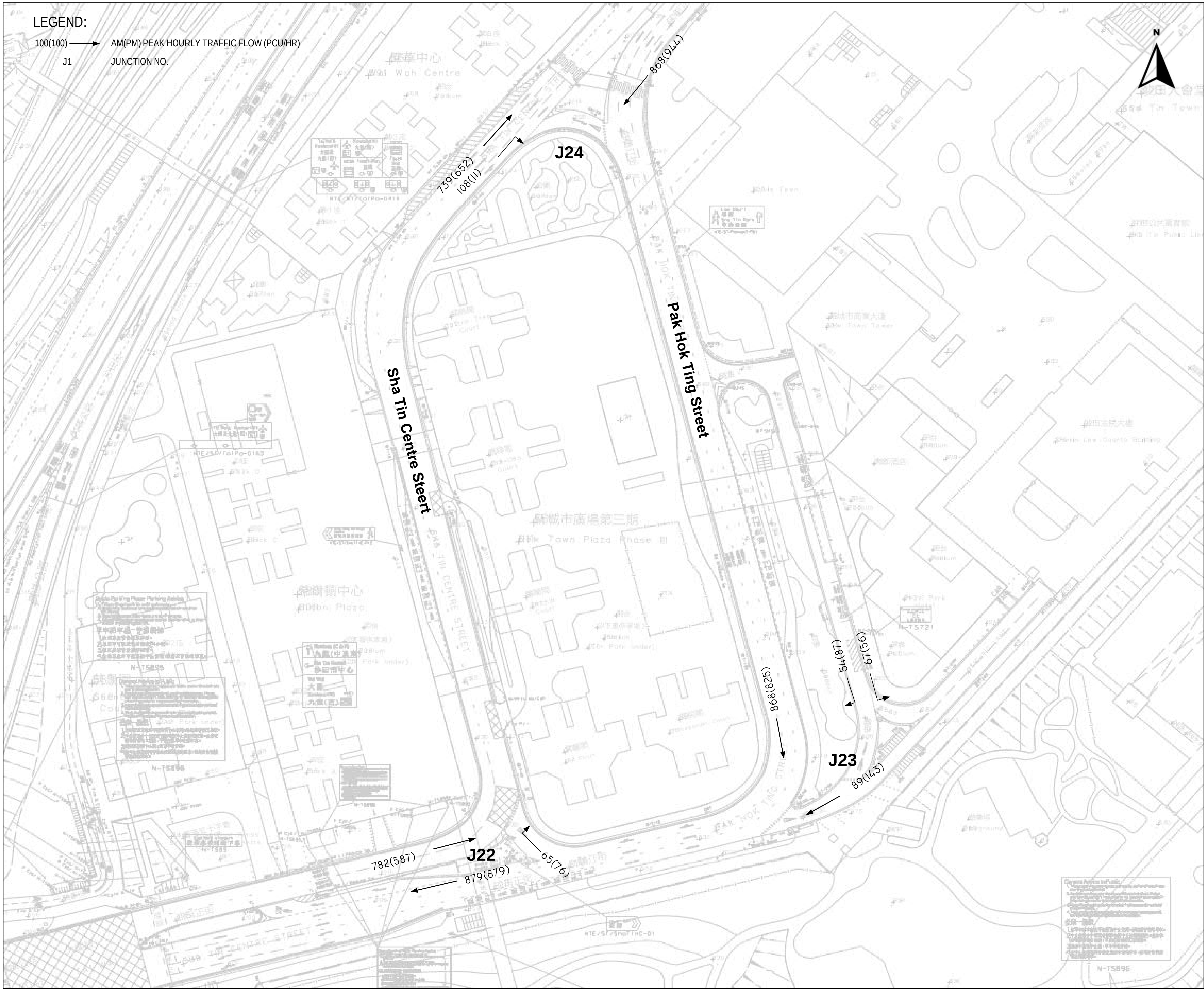

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KEY PLAN

PROJECT NO.	CONTRACT NO.
60617767	

SHEET TITLE

YEAR 2028

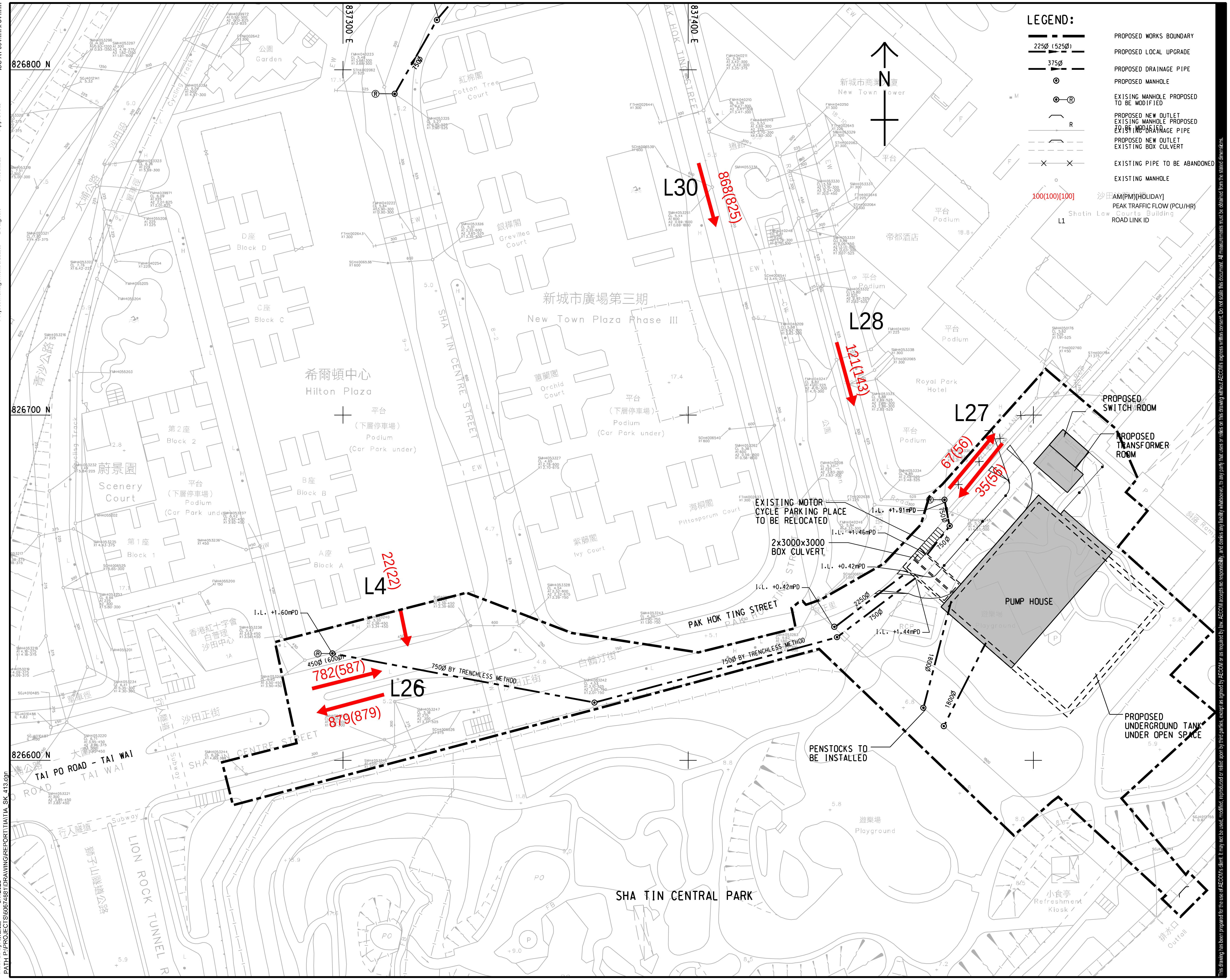
FORECAST JUNCTION TRAFFIC FLOW

(WITH TTMS)

(SHEET 2 OF 3)

SHEET NUMBER

FIGURE 5.1.25



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SCALE: A1 1 : 500

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60674881

CONTRACT NO.: CE 44/2021 (DS)

SHEET TITLE

YEAR 2028
FORECAST ROAD LINK FLOW (WITH TTMS)
(SHEET 5 OF 10)

SHEET NUMBER

60674881/TIA_SK/FIG 5.1.31

ISO A1 594mm x 841mm
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Checked:
Designer:
Project Management Initials:
Plot File by: riva.cai 3/7/2023
PATH: P:\PROJECTS\60674881\DRAWING\REPORT\TIA\TIA_SK_413.dgn

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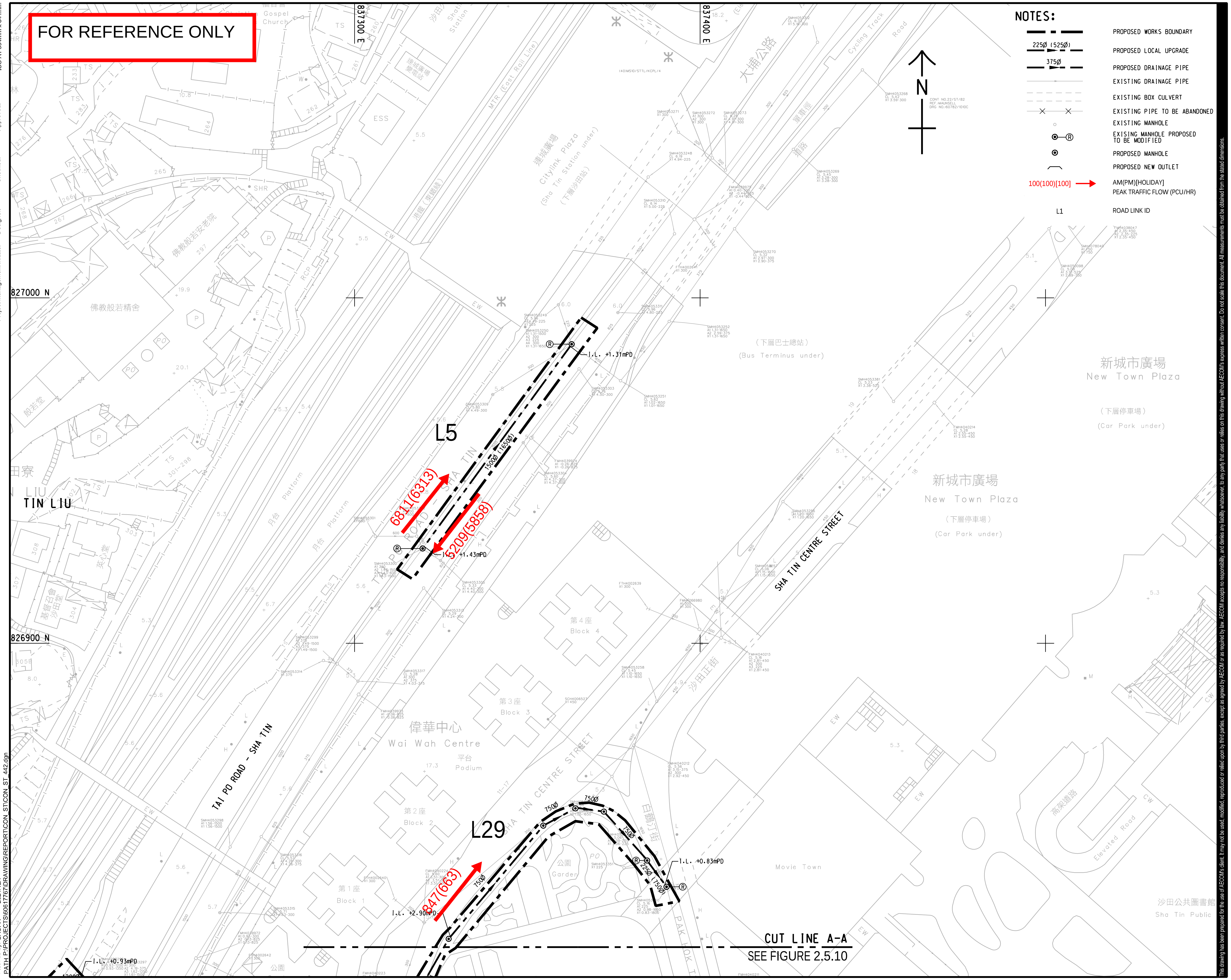

ISO A1 594mm x 841mm

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Project Management Initials:

Plot File by: CAOPA 2021/12/7

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STATUS

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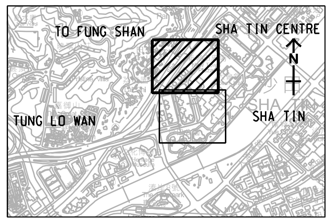
DIMENSION UNIT METRES

KEY PLAN A3 1 : 40000



PROJECT NO. 60617767

AGREEMENT NO. CE 15/2019 (DS)

SHEET TITLE

YEAR 2028
FORECAST ROAD LINK FLOW (WITH TTMS)
(SHEET 6 OF 10)

SHEET NUMBER

FIGURE 5.1.32

APPENDIX A

DETAILED JUNCTION CALCULATION SHEETS

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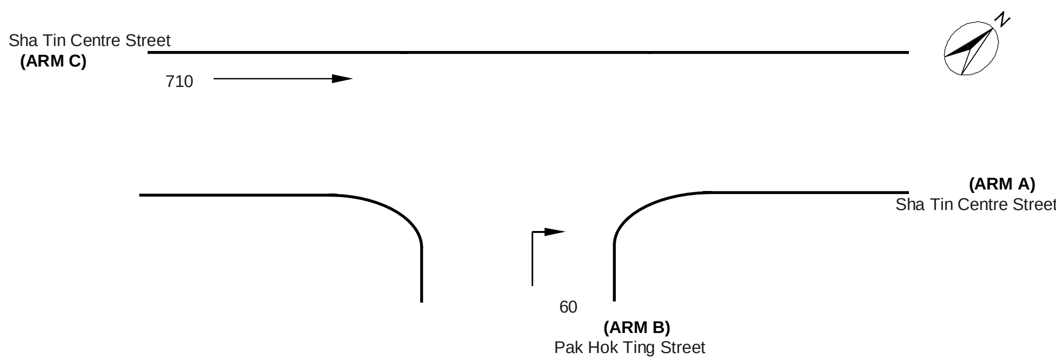
PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2020 AM Traffic Flows	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



J22

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	9	(metres)	W c-b	=		(metres)	W b-a	=	4.7	(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=		(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	710	(pcu/hr)	Vl b-a	=	100	(metres)
q a-c	=	0	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=		(metres)
								Vr b-c	=		(metres)
								q b-a	=	60	(pcu/hr)
								q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

THE CAPACITY OF MOVEMENT :

Q b-a	=	489
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	489

CRITICAL DFC = 0.12

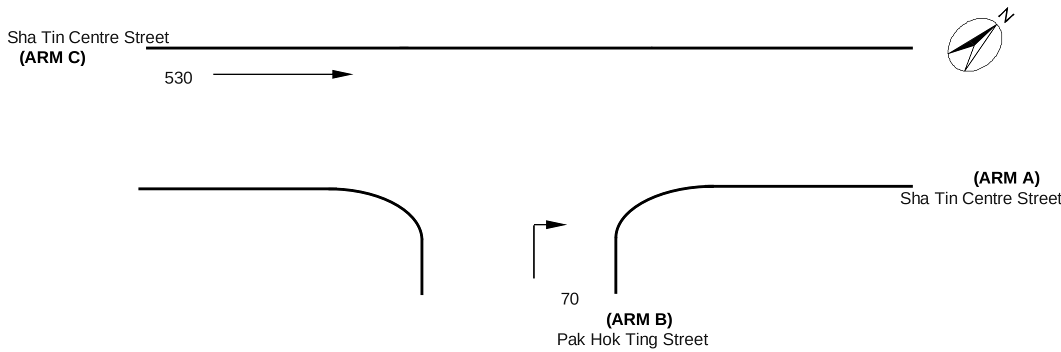
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.12
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.12

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2020 PM Traffic Flows	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



NOTES : (GEOMETRIC INPUT DATA)

J22

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	9	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	0	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	530	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=	4.7	(metres)
W b-c	=		(metres)
Vl b-a	=	100	(metres)
Vr b-a	=		(metres)
Vr b-c	=		(metres)
q b-a	=	70	(pcu/hr)
q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

`

THE CAPACITY OF MOVEMENT :

Q b-a	=	516
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	516

CRITICAL DFC = 0.14

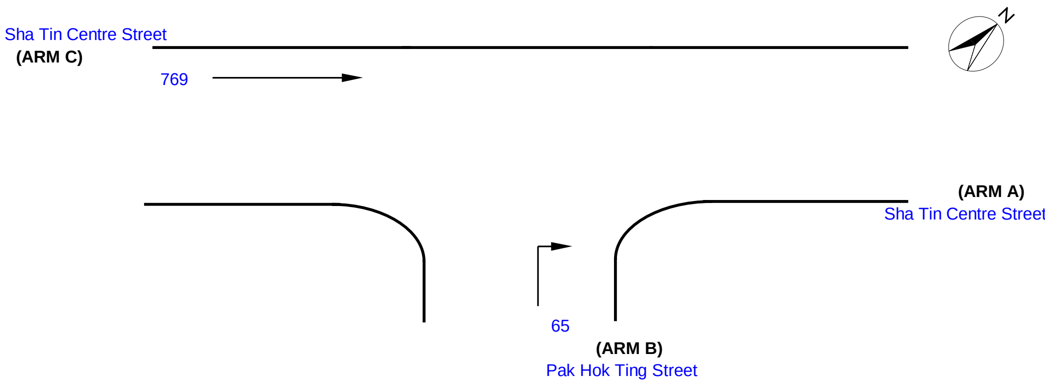
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.14
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.14

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2028 AM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



J22

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	9	(metres)	W c-b	=		(metres)	W b-a	=	4.7	(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=		(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	769	(pcu/hr)	Vl b-a	=	100	(metres)
q a-c	=	0	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=		(metres)
								Vr b-c	=		(metres)
								q b-a	=	65	(pcu/hr)
								q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

THE CAPACITY OF MOVEMENT :

Q b-a	=	481
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	481

CRITICAL DFC = 0.14

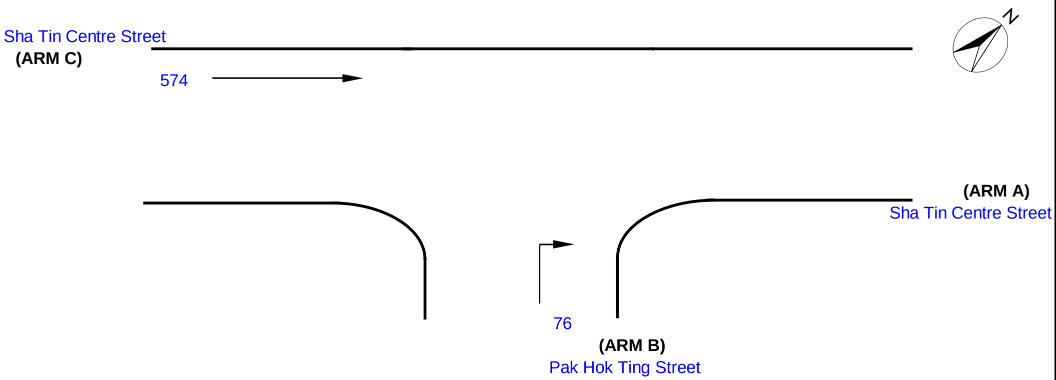
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.14
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.14

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2028 PM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



NOTES : (GEOMETRIC INPUT DATA)

J22

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)			*MAJOR ROAD (ARM C)*			*MINOR ROAD (ARM B)*		
W	=	9 (metres)	W c-b	=	(metres)	W b-a	=	4.7 (metres)
W cr	=	(metres)	Vr c-b	=	(metres)	W b-c	=	(metres)
q a-b	=	0 (pcu/hr)	q c-a	=	574 (pcu/hr)	Vl b-a	=	100 (metres)
q a-c	=	0 (pcu/hr)	q c-b	=	0 (pcu/hr)	Vr b-a	=	(metres)
						Vr b-c	=	(metres)
						q b-a	=	76 (pcu/hr)
						q b-c	=	0 (pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

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THE CAPACITY OF MOVEMENT :

Q b-a	=	510
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	510

CRITICAL DFC = 0.15

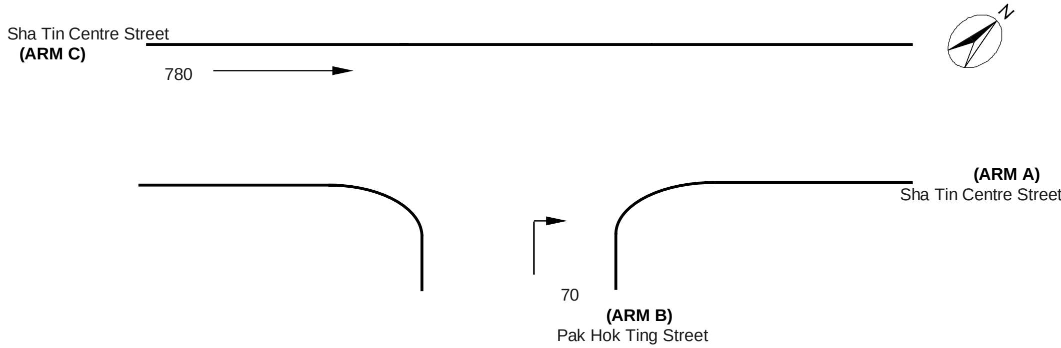
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.15
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.15

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2031 AM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



NOTES : (GEOMETRIC INPUT DATA)

J22

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	9	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	0	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	780	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=	4.7	(metres)
W b-c	=		(metres)
Vl b-a	=	100	(metres)
Vr b-a	=		(metres)
Vr b-c	=		(metres)
q b-a	=	70	(pcu/hr)
q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

THE CAPACITY OF MOVEMENT :

Q b-a	=	479
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	479

CRITICAL DFC = 0.15

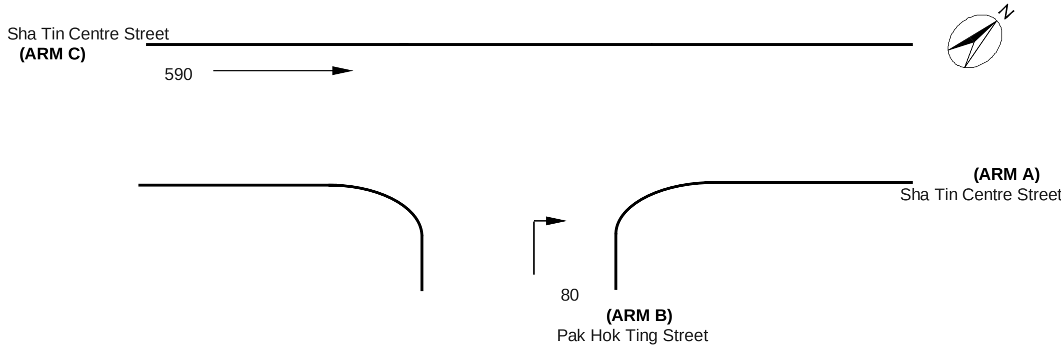
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.15
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.15

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2031 PM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



NOTES : (GEOMETRIC INPUT DATA)

J22

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	9	(metres)	W c-b	=		(metres)	W b-a	=	4.7	(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=		(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	590	(pcu/hr)	Vl b-a	=	100	(metres)
q a-c	=	0	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=		(metres)
								Vr b-c	=		(metres)
								q b-a	=	80	(pcu/hr)
								q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

THE CAPACITY OF MOVEMENT :

Q b-a	=	507
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	507

CRITICAL DFC = 0.16

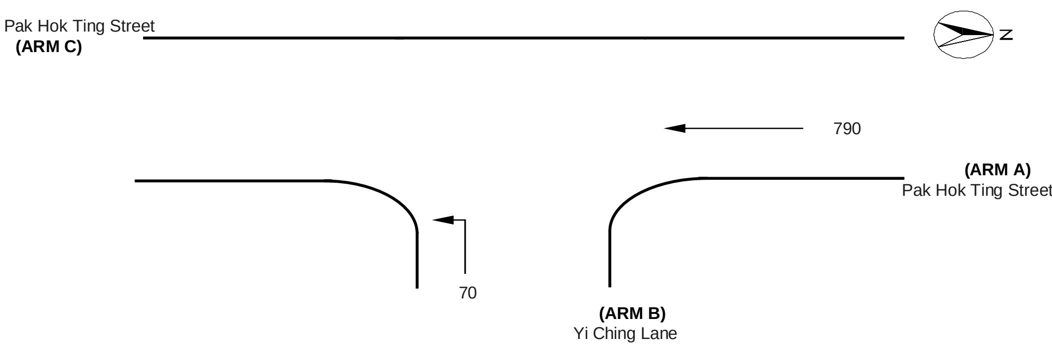
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.16
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.16

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2020 AM Traffic Flows	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



J23

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)			*MAJOR ROAD (ARM C)*			*MINOR ROAD (ARM B)*		
W	=	10 (metres)	W c-b	=	(metres)	W b-a	=	(metres)
W cr	=	(metres)	Vr c-b	=	(metres)	W b-c	=	4.7 (metres)
q a-b	=	0 (pcu/hr)	q c-a	=	0 (pcu/hr)	Vl b-a	=	(metres)
q a-c	=	790 (pcu/hr)	q c-b	=	0 (pcu/hr)	Vr b-a	=	100 (metres)
						Vr b-c	=	100 (metres)
						q b-a	=	0 (pcu/hr)
						q b-c	=	70 (pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	257
Q b-c	=	601
Q c-b	=	326
Q b-ac	=	601

CRITICAL DFC = 0.12

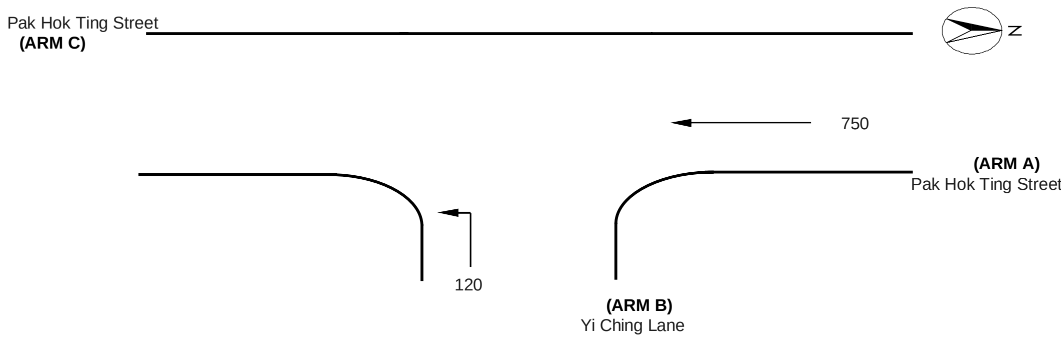
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.12
DFC c-b	=	0.00
DFC b-ac	=	0.12

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2020 PM Traffic Flows	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



NOTES : (GEOMETRIC INPUT DATA)

J23

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	10	(metres)	W c-b	=		(metres)	W b-a	=		(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=	4.7	(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	0	(pcu/hr)	Vl b-a	=		(metres)
q a-c	=	750	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=	100	(metres)
								Vr b-c	=	100	(metres)
								q b-a	=	0	(pcu/hr)
								q b-c	=	120	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	263
Q b-c	=	611
Q c-b	=	332
Q b-ac	=	611

CRITICAL DFC = 0.20

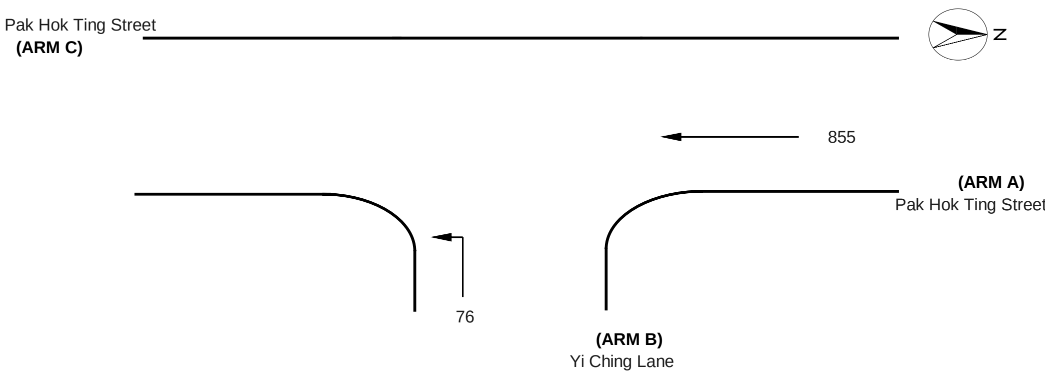
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.20
DFC c-b	=	0.00
DFC b-ac	=	0.20

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2028 AM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



NOTES : (GEOMETRIC INPUT DATA)

J23

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	10	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	855	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	0	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=		(metres)
W b-c	=	4.7	(metres)
Vl b-a	=		(metres)
Vr b-a	=	100	(metres)
Vr b-c	=	100	(metres)
q b-a	=	0	(pcu/hr)
q b-c	=	76	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	248
Q b-c	=	584
Q c-b	=	317
Q b-ac	=	584

CRITICAL DFC = 0.13

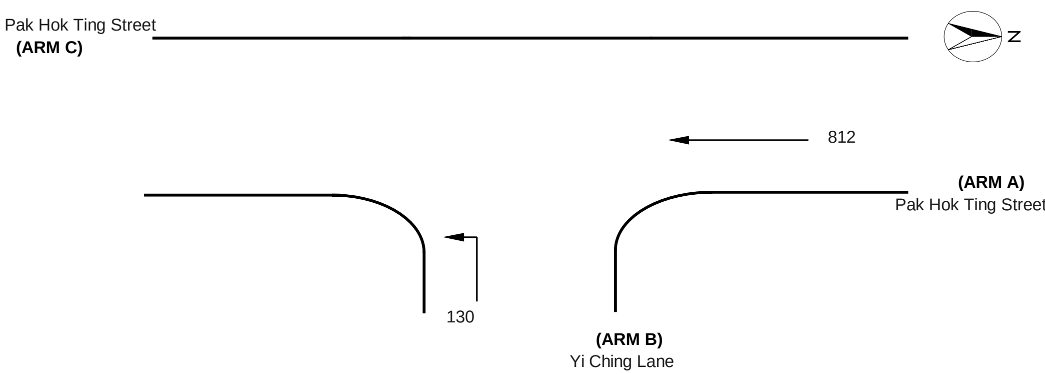
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.13
DFC c-b	=	0.00
DFC b-ac	=	0.13

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2028 PM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



J23

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	10	(metres)	W c-b	=		(metres)	W b-a	=		(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=	4.7	(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	0	(pcu/hr)	Vl b-a	=		(metres)
q a-c	=	812	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=	100	(metres)
								Vr b-c	=	100	(metres)
								q b-a	=	0	(pcu/hr)
								q b-c	=	130	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	254
Q b-c	=	595
Q c-b	=	323
Q b-ac	=	595

CRITICAL DFC = 0.22

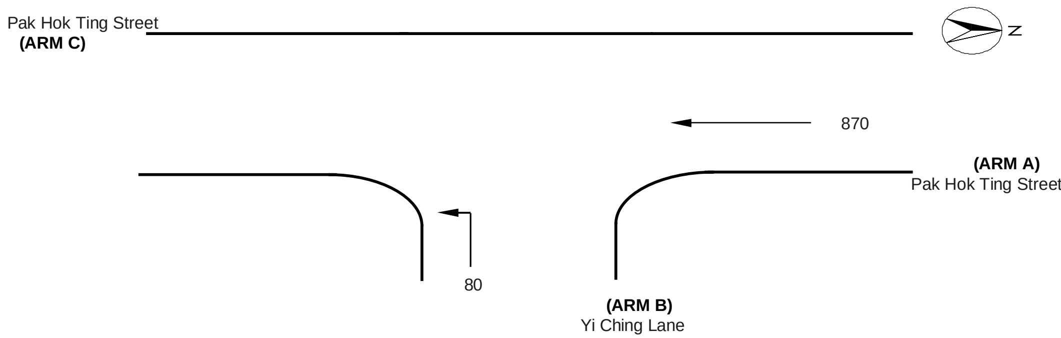
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.22
DFC c-b	=	0.00
DFC b-ac	=	0.22

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2031 AM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



NOTES : (GEOMETRIC INPUT DATA)

J23

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	10	(metres)	W c-b	=		(metres)	W b-a	=		(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=	4.7	(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	0	(pcu/hr)	Vl b-a	=		(metres)
q a-c	=	870	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=	100	(metres)
								Vr b-c	=	100	(metres)
								q b-a	=	0	(pcu/hr)
								q b-c	=	80	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	246
Q b-c	=	580
Q c-b	=	315
Q b-ac	=	580

CRITICAL DFC = 0.14

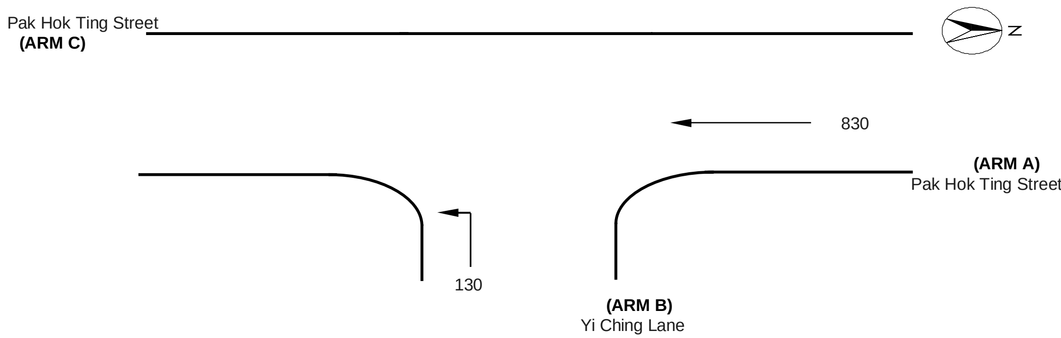
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.14
DFC c-b	=	0.00
DFC b-ac	=	0.14

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2031 PM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



J23

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	10	(metres)	W c-b	=		(metres)	W b-a	=		(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=	4.7	(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	0	(pcu/hr)	Vl b-a	=		(metres)
q a-c	=	830	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=	100	(metres)
								Vr b-c	=	100	(metres)
								q b-a	=	0	(pcu/hr)
								q b-c	=	130	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	252
Q b-c	=	590
Q c-b	=	321
Q b-ac	=	590

CRITICAL DFC = 0.22

COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.22
DFC c-b	=	0.00
DFC b-ac	=	0.22

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2020 AM Traffic Flows	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

J24

No. of stages per cycle	N =	2	
Cycle time	C =	77	sec
Sum(y)	Y =	0.128	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu

Optimum Cycle C_o	$= (1.5\times L+5)/(1-Y)$ =		66	sec
Min. Cycle Time C_m	$= L/(1-Y)$	=	40	sec
Y_{ult}	$= 0.9-0.0075\times L$	=	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y\times100\%$	=	398.3	%
Practical Cycle Time C_p	$= 0.9\times L/(0.9-Y)$	=	41	sec
Y_{max}	$= 1-L/C$	=	0.545	

Stage/Phase Diagrams

Stage 1	Stage 2			

I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\% =$ 284%

MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
	A	1	3.500	3				1		0		6175		670		670			6175	0.109		36		0.000	0
	B	1	3.500	3				1		0		6175		790		790			6175	0.128	0.128	42	41	0.235	0

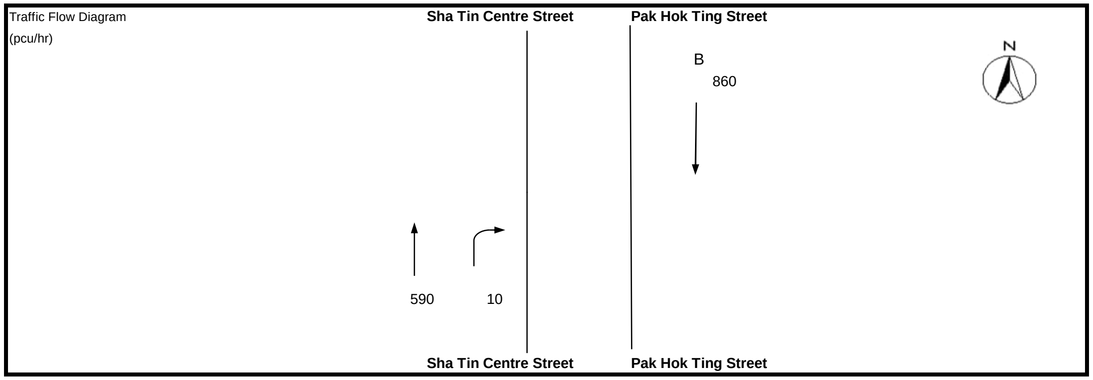
Pedestrain Crossing			GM		FGM		Total		CRITICAL
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2020 PM Traffic Flows	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

J24

Traffic Flow Diagram (pcu/hr)



No. of stages per cycle		N =	2	
Cycle time		C =	82	sec
Sum(y)		Y =	0.139	
Lost time		L =	35	sec
Total Flow		=	12,350	pcu
Optimum Cycle C_o	$= (1.5\times L+5)/(1-Y)$	=	67	sec
Min. Cycle Time C_m	$= L/(1-Y)$	=	41	sec
Y_{ult}	$= 0.9-0.0075\times L$	=	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y\times 100\%$	=	357.7	%
Practical Cycle Time C_p	$= 0.9\times L/(0.9-Y)$	=	41	sec
Y_{max}	$= 1-L/C$	=	0.573	

Stage/Phase Diagrams

Stage 1	Stage 2			

I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\%$ = 270%

MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
↑	A	1	3.500	3				1		0		6175		590		590			6175	0.096		32		0.000	0
↑	B	1	3.500	3				1		0		6175		860		860			6175	0.139	0.139	47	46	0.243	0

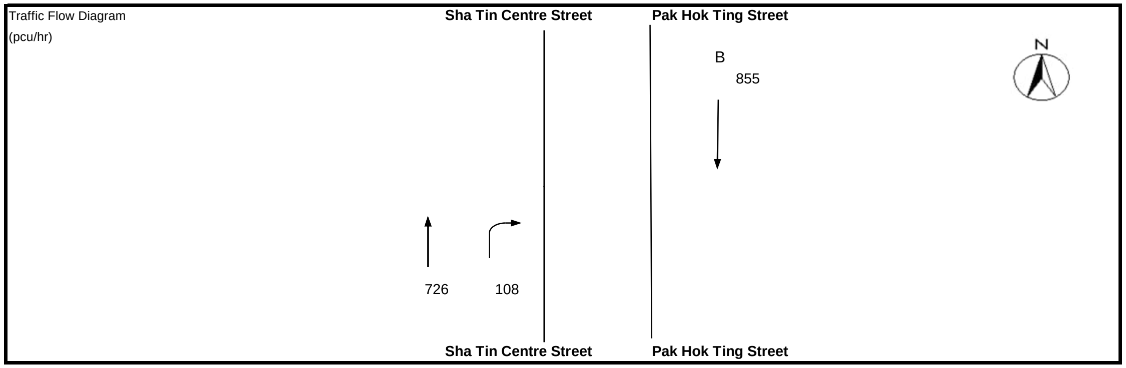
Pedestrian Crossing			GM		FGM		Total		
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2028 AM Reference Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

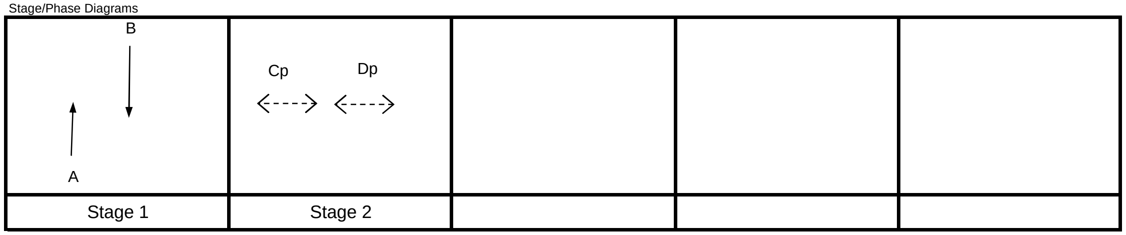
J24

Traffic Flow Diagram
(pcu/hr)



No. of stages per cycle	N =	2	
Cycle time	C =	77	sec
Sum(y)	Y =	0.138	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5\times L+5)/(1-Y) =$	67	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	41	sec
Y_{ult}	$= 0.9-0.0075\times L =$	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y \times 100\% =$	360.4	%
Practical Cycle Time C_p	$= 0.9\times L/(0.9-Y) =$	41	sec
Y_{max}	$= 1-L/C =$	0.545	

Stage/Phase Diagrams



I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\% =$ 255%

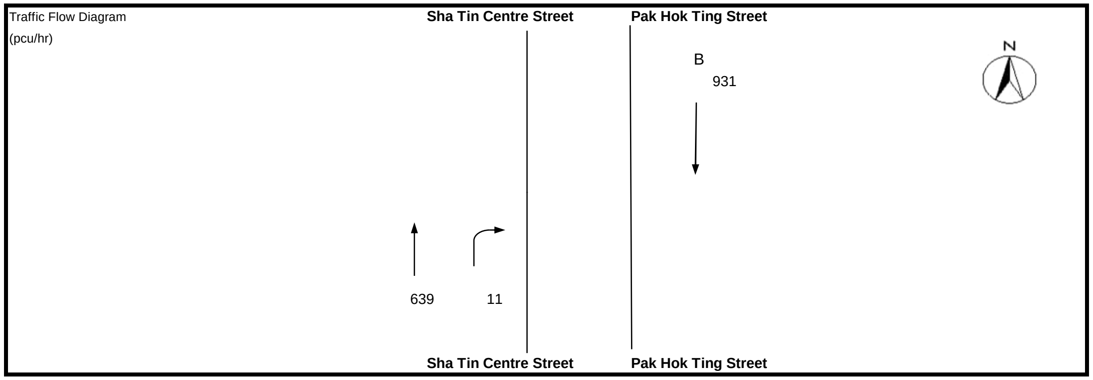
MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
↑	A	1	3.500	3				1		0		6175		726		726			6175	0.118		36		0.000	0
↑	B	1	3.500	3				1		0		6175		855		855			6175	0.138	0.138	42	41	0.254	0

Pedestrain Crossing			GM		FGM		Total		CRITICAL
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2028 PM Reference Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

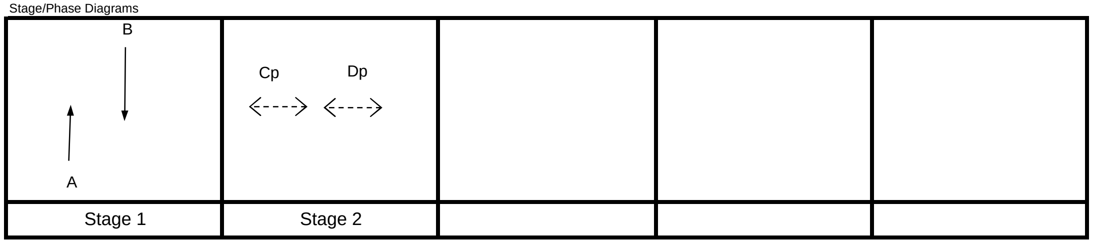
J24



No. of stages per cycle	N =	2	
Cycle time	C =	82	sec
Sum(y)	Y =	0.151	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu

Optimum Cycle C_o	$= (1.5\times L+5)/(1-Y) =$		68	sec
Min. Cycle Time C_m	$= L/(1-Y)$	=	41	sec
Y_{ult}	$= 0.9-0.0075\times L$	=	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y\times 100\%$	=	322.8	%
Practical Cycle Time C_p	$= 0.9\times L/(0.9-Y)$	=	42	sec
Y_{max}	$= 1-L/C$	=	0.573	

Stage/Phase Diagrams



I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\% =$ 242%

MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
↑	A	1	3.500	3				1		0		6175		639		639			6175	0.103		32		0.000	0
↑	B	1	3.500	3				1		0		6175		931		931			6175	0.151	0.151	47	46	0.263	0

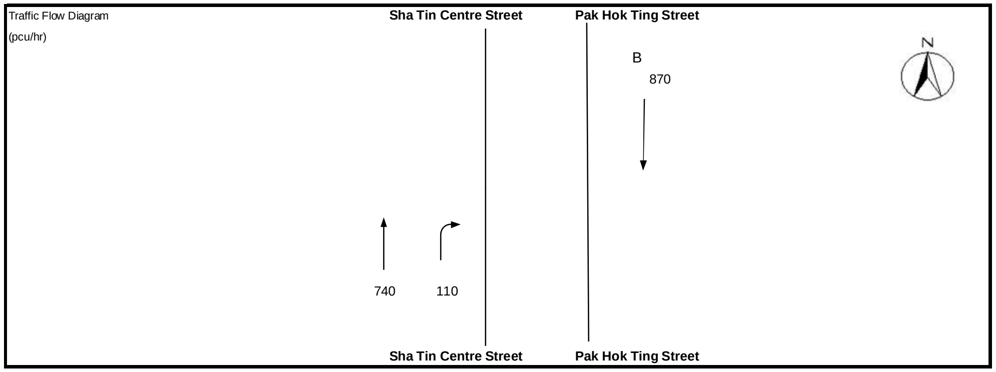
Pedestrian Crossing			GM		FGM		Total		
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2031 AM Reference Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

J24

Traffic Flow Diagram
(pcu/hr)



No. of stages per cycle	N =	2	
Cycle time	C =	77	sec
Sum(y)	Y =	0.141	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5 \times L+5)/(1-Y) =$	67	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	41	sec
Y_{ult}	$= 0.9-0.0075 \times L =$	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y \times 100\% =$	352.5	%
Practical Cycle Time C_p	$= 0.9 \times L/(0.9-Y) =$	41	sec
Y_{max}	$= 1-L/C =$	0.545	

Stage/Phase Diagrams

Stage 1	Stage 2			

I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9 \times Y_{max} - Y)/Y \times 100\% =$ 248%

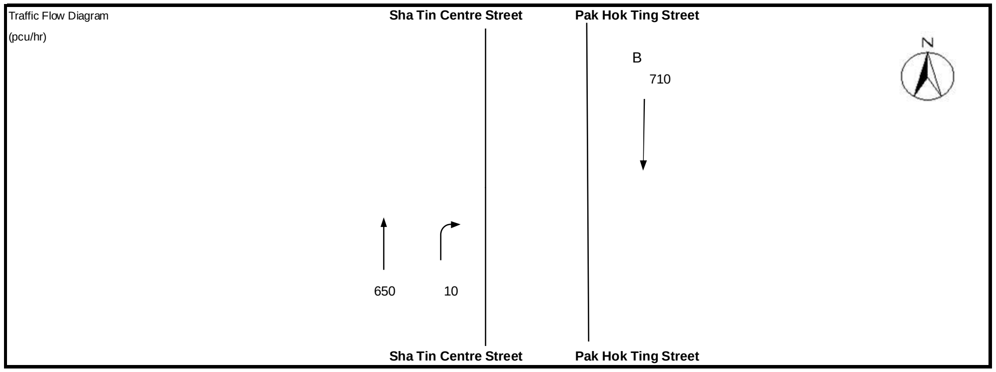
MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
↑	A	1	3.500	3				1		0		6175		740		740			6175	0.120		36		0.000	0
↑	B	1	3.500	3				1		0		6175		870		870			6175	0.141	0.141	42	41	0.258	0

Pedestrain Crossing			GM		FGM		Total		Critical
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

JUNCTION CAPACITY CALCULATION

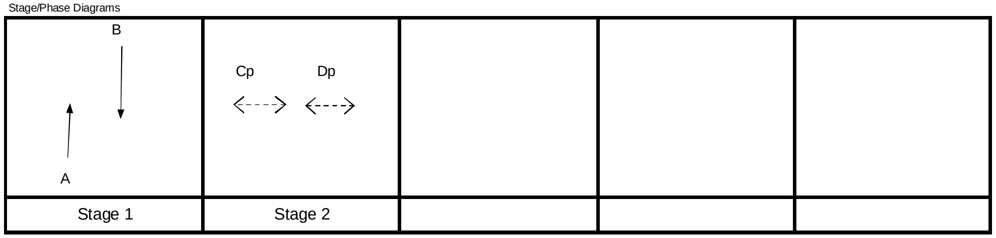
Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2031 PM Reference Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

J24



No. of stages per cycle	N =	2	
Cycle time	C =	82	sec
Sum(y)	Y =	0.115	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5\times L+5)/(1-Y) =$	65	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	40	sec
Y_{ult}	$= 0.9-0.0075\times L =$	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Yx100\% =$	454.4	%
Practical Cycle Time C_p	$= 0.9\times L/(0.9-Y) =$	40	sec
Y_{max}	$= 1-L/C =$	0.573	

Stage/Phase Diagrams



I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\% =$ 349%

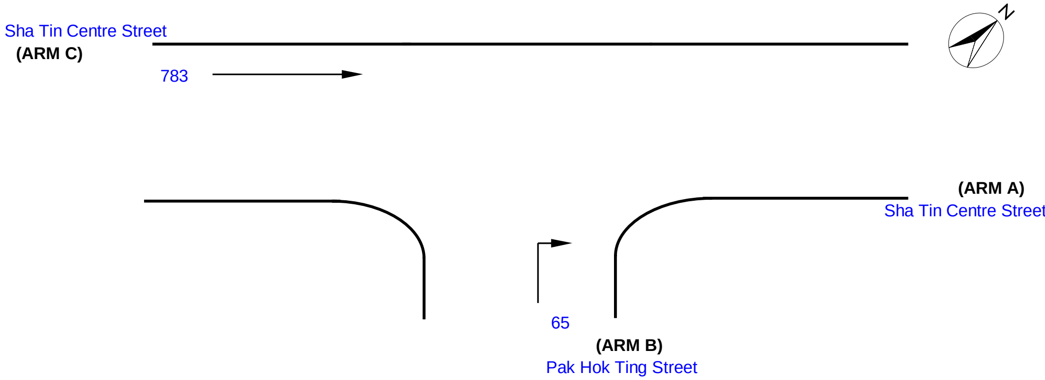
MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
	A	1	3.500	3				1		0		6175		650		650			6175	0.105		43		0.000	0
	B	1	3.500	3				1		0		6175		710		710			6175	0.115	0.115	47	46	0.201	0

Pedestrain Crossing			GM		FGM		Total		Critical
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2028TTM AM Design Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



J22

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)			*MAJOR ROAD (ARM C)*			*MINOR ROAD (ARM B)*		
W	=	9 (metres)	W c-b	=	(metres)	W b-a	=	4.7 (metres)
W cr	=	(metres)	Vr c-b	=	(metres)	W b-c	=	(metres)
q a-b	=	0 (pcu/hr)	q c-a	=	783 (pcu/hr)	Vl b-a	=	100 (metres)
q a-c	=	0 (pcu/hr)	q c-b	=	0 (pcu/hr)	Vr b-a	=	(metres)
						Vr b-c	=	(metres)
						q b-a	=	65 (pcu/hr)
						q b-c	=	0 (pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

THE CAPACITY OF MOVEMENT :

Q b-a	=	479
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	479

CRITICAL DFC = 0.14

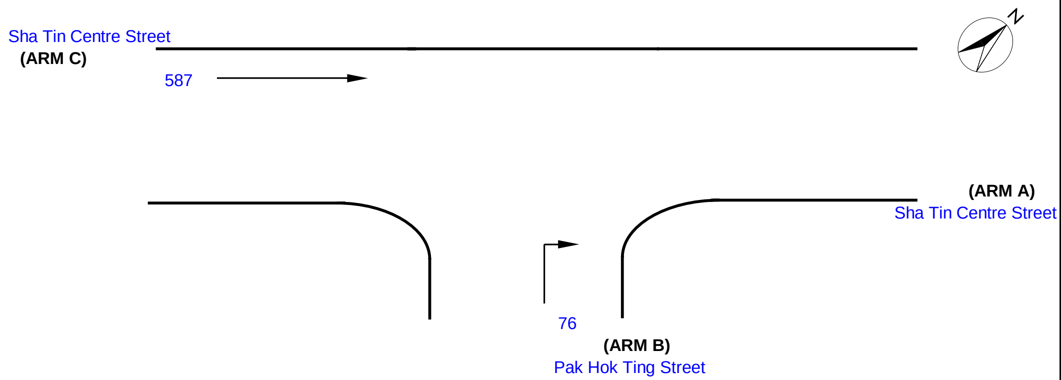
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.14
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.14

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2028TTM PM Design Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



NOTES : (GEOMETRIC INPUT DATA)

J22

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)			*MAJOR ROAD (ARM C)*			*MINOR ROAD (ARM B)*		
W	=	9 (metres)	W c-b	=	(metres)	W b-a	=	4.7 (metres)
W cr	=	(metres)	Vr c-b	=	(metres)	W b-c	=	(metres)
q a-b	=	0 (pcu/hr)	q c-a	=	587 (pcu/hr)	Vl b-a	=	100 (metres)
q a-c	=	0 (pcu/hr)	q c-b	=	0 (pcu/hr)	Vr b-a	=	(metres)
						Vr b-c	=	(metres)
						q b-a	=	76 (pcu/hr)
						q b-c	=	0 (pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

THE CAPACITY OF MOVEMENT :

Q b-a	=	508
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	508

CRITICAL DFC = 0.15

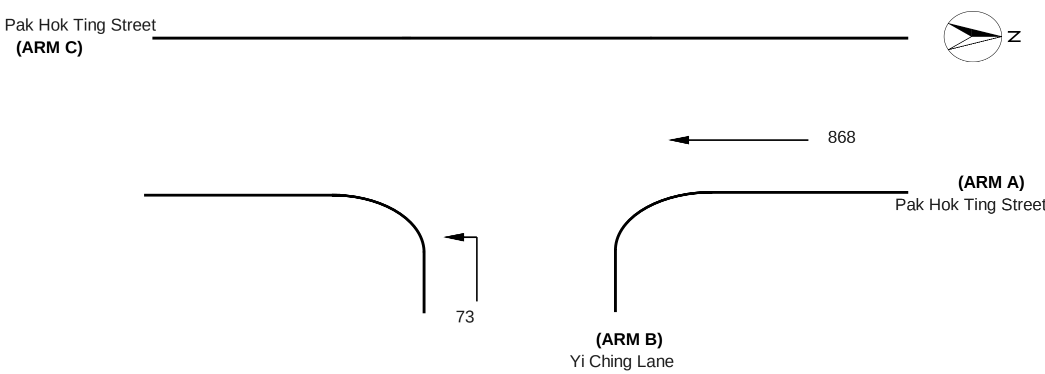
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.15
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.15

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2028TTM AM Design Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



J23

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	10	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	868	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	0	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=		(metres)
W b-c	=	4.7	(metres)
Vl b-a	=		(metres)
Vr b-a	=	100	(metres)
Vr b-c	=	100	(metres)
q b-a	=	0	(pcu/hr)
q b-c	=	73	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	247
Q b-c	=	581
Q c-b	=	315
Q b-ac	=	581

CRITICAL DFC = 0.13

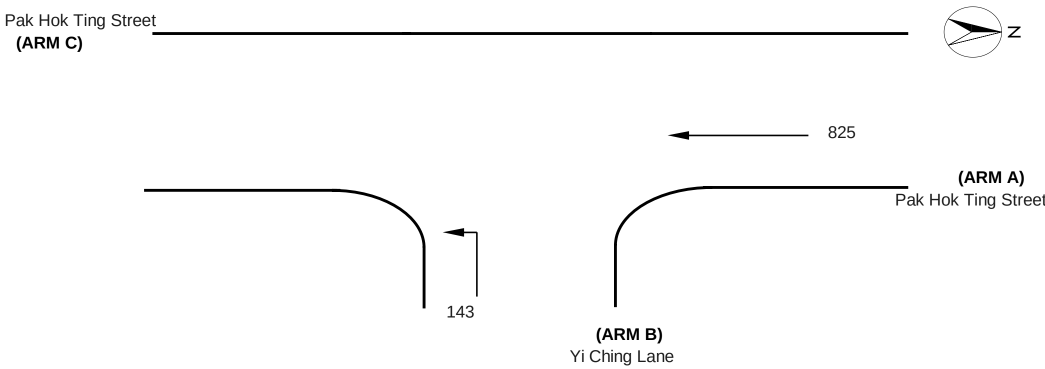
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.13
DFC c-b	=	0.00
DFC b-ac	=	0.13

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2028TTM PM Design Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



J23

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	10	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	825	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	0	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=		(metres)
W b-c	=	4.7	(metres)
Vl b-a	=		(metres)
Vr b-a	=	100	(metres)
Vr b-c	=	100	(metres)
q b-a	=	0	(pcu/hr)
q b-c	=	143	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

`

THE CAPACITY OF MOVEMENT :

Q b-a	=	253
Q b-c	=	592
Q c-b	=	322
Q b-ac	=	592

CRITICAL DFC = 0.24

COMPARISION OF DESIGN FLOW TO CAPACITY :

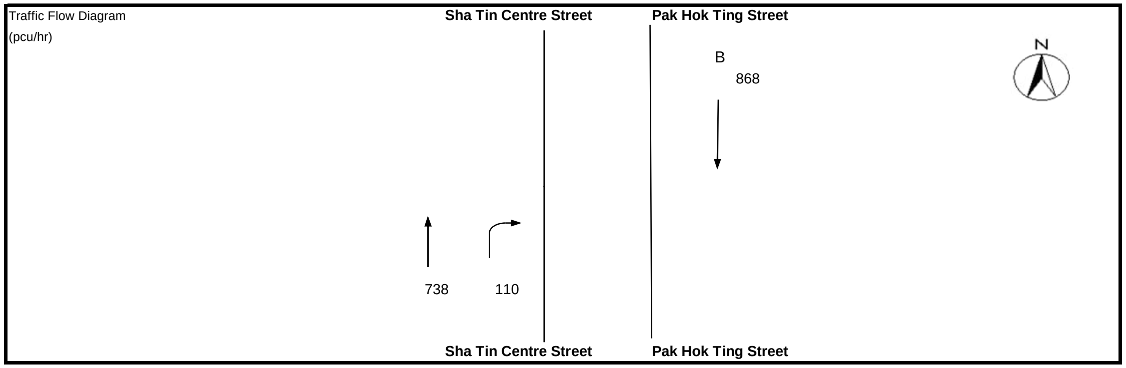
DFC b-a	=	0.00
DFC b-c	=	0.24
DFC c-b	=	0.00
DFC b-ac	=	0.24

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2028TTM AM Design Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

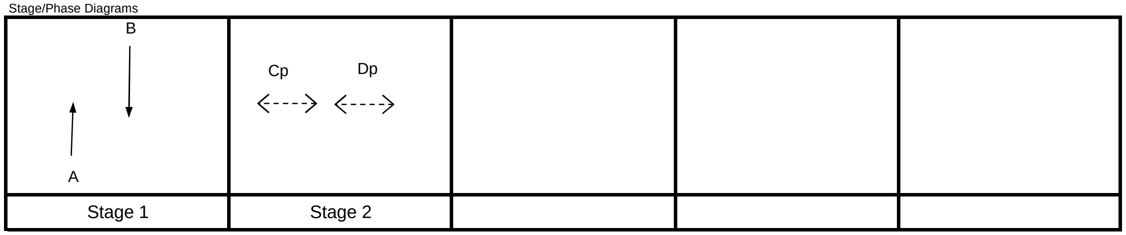
J24

Traffic Flow Diagram (pcu/hr)



No. of stages per cycle	N =	2	
Cycle time	C =	77	sec
Sum(y)	Y =	0.141	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5\times L+5)/(1-Y) =$	67	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	41	sec
Y_{ult}	$= 0.9-0.0075\times L =$	0.638	
R.C.$_{ult}$	$= (Y_{ult}-Y)/Y\times100\% =$	353.5	%
Practical Cycle Time C_p	$= 0.9\times L/(0.9-Y) =$	41	sec
Y_{max}	$= 1-L/C =$	0.545	

Stage/Phase Diagrams



I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\% =$ 249%

MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
↑	A	1	3.500	3				1		0		6175		738		738			6175	0.120		36		0.000	0
↑	B	1	3.500	3				1		0		6175		868		868			6175	0.141	0.141	42	41	0.258	0

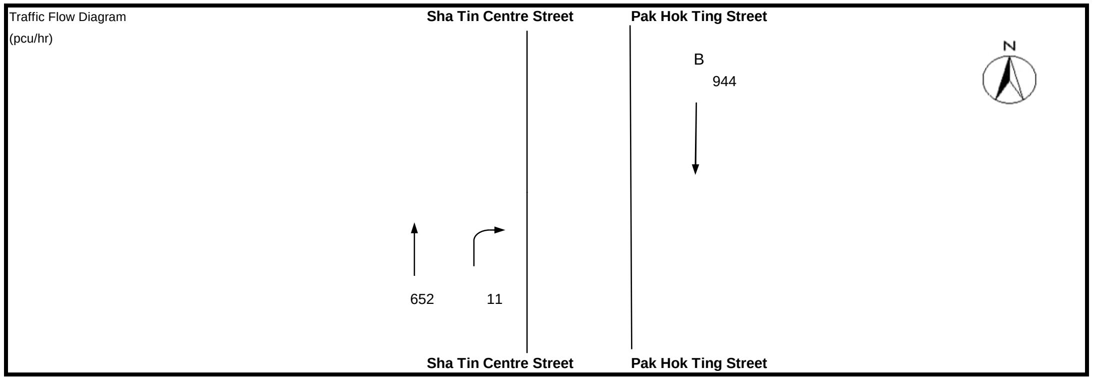
Pedestrian Crossing			GM		FGM		Total		CRITICAL
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2028TTM PM Design Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

J24

Traffic Flow Diagram
(pcu/hr)



No. of stages per cycle	N =	2	
Cycle time	C =	82	sec
Sum(y)	Y =	0.153	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5\times L+5)/(1-Y) =$	68	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	41	sec
Y_{ult}	$= 0.9-0.0075\times L =$	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y\times100\% =$	317.0	%
Practical Cycle Time C_p	$= 0.9\times L/(0.9-Y) =$	42	sec
Y_{max}	$= 1-L/C =$	0.573	

Stage/Phase Diagrams

Stage 1	Stage 2			

I/G = 5 G = 18 I/G = 13

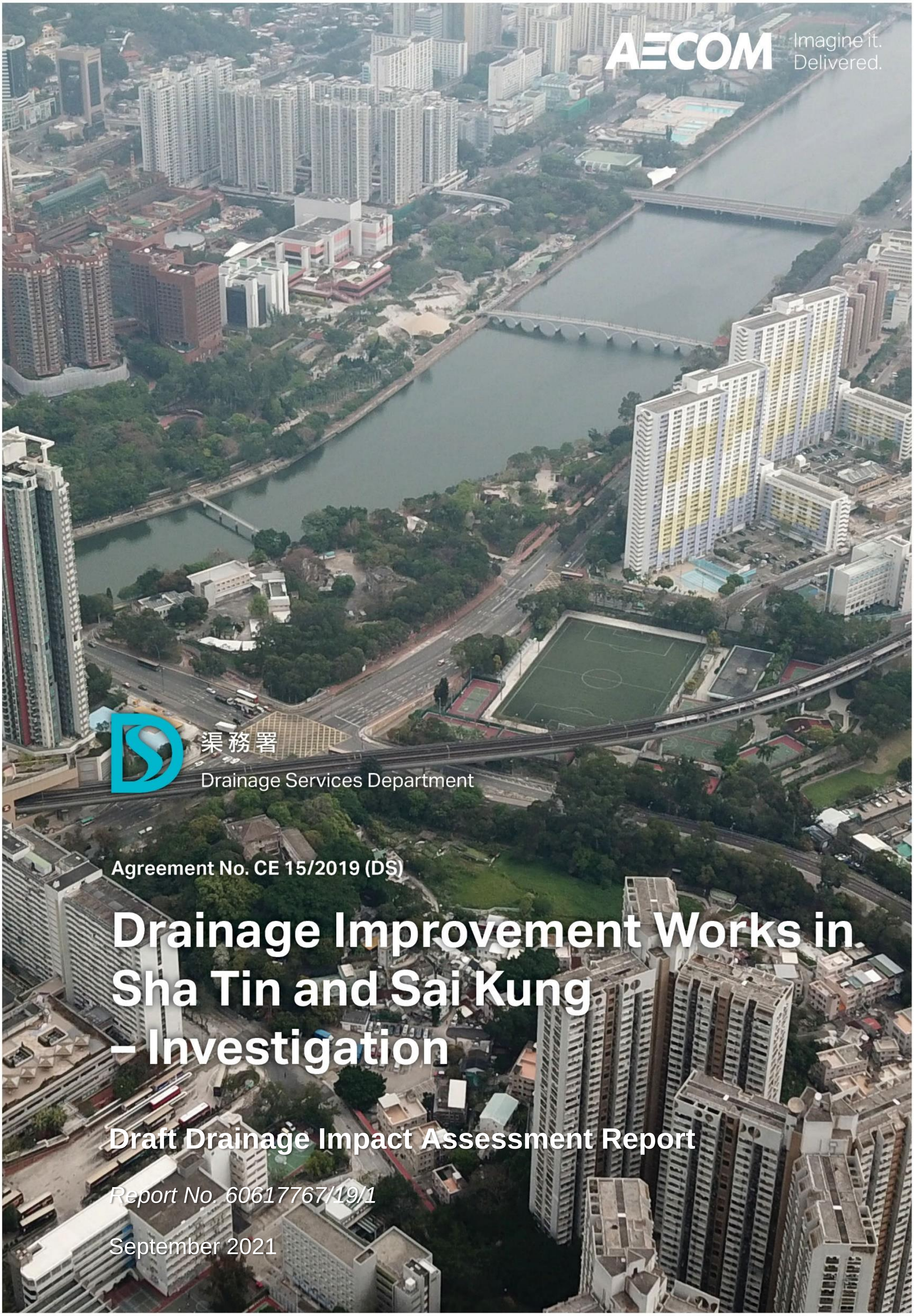
Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\% =$ 237%

MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
	A	1	3.500	3				1		0		6175		652		652			6175	0.106		32		0.000	0
	B	1	3.500	3				1		0		6175		944		944			6175	0.153	0.153	47	46	0.267	0

Pedestrian Crossing			GM		FGM		Total		CRITICAL y
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

Appendix J – Drainage Impact Assessment Report



AECOM Imagine it. Delivered.

渠務署
Drainage Services Department

Agreement No. CE 15/2019 (DS)

Drainage Improvement Works in Sha Tin and Sai Kung – Investigation

Draft Drainage Impact Assessment Report

Report No. 60617767/19/1

September 2021

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background

1.1.1.1 The Review of Drainage Master Plan in Sha Tin and Sai Kung – Feasibility Study (DMP Review) identified that the following areas in Sha Tin would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics:

(a) Sha Tin Town Centre;

(b) Chui Tin Street (near Sun Chui Estate) and San Tin Village;

(c) Tai Po Road (Ma Liu Shui), Ma Ling Path, Kau To Hang near Yucca Villa, Hang Hong Street, Pok Hong Estate, Fui Yiu Ha, Wong Chuk Yeung Village and Lai Wo Lane; and

(d) Cycle track alongside Shing Mun River.

1.1.1.2 The flooding incidents reported in Wong Chuk Yeung Village on 22 July 2010 and Sha Tin Centre Street on 15 August 2015 are examples to substantiate the above findings.

1.1.1.3 DMP Review also identified that the areas in Sai Kung including Wong Chuk Wan, Ho Chung, Kap Pin Long New Village and Nam Shan San Tsuen would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics. The flooding incidents at Po Lo Che Road and Nam Shan San Tsuen on 30 May 2010 and Wong Chuk Wan on 7 October 2015 are some examples to substantiate the above findings.

1.1.1.4 To relieve the flood risk in the above areas, DMP Review has proposed implementing drainage improvement measures, mainly in form of stormwater pumping scheme and drainage upgrading works. Upon completion of the Project, the standards of flood protection at areas concerned will be largely enhanced to that specified in the standards of the Stormwater Drainage Manual (SDM) and the flood risks thereon can be significantly reduced.

1.1.1.5 New flood walls will also be provided along various sections of Shing Mun River to protect the cycle track against flooding due to the astronomical high tide.

1.1.1.6 Without the proposed project, about 26 hectares of the areas in Sha Tin and 6 hectares of areas in Sai Kung will be subject to high flood risk. Flooding impacts on traffic and residential area in the flood prone areas will also result in losses and inconvenience to the general public.

1.1.1.7 In May 2018, Development Bureau (DEVB) signed out a Project Definition Statement (PDS) to justify and define the scope of the “Drainage Improvement Works in Sha Tin and Sai Kung”. The Drainage Services Department (DSD) then completed a Technical Feasibility Statement (TFS) confirming its technical feasibility. The TFS was subsequently approved by DEVB in August 2018. The project was included into Cat B under PWP Item No. 4182CD in September 2018.

1.1.1.8 AECOM Asia Company Limited (AECOM) has been appointed by DSD to undertake the “Drainage Improvement Works in Sha Tin and Sai Kung – Investigation” (“the Study”) on 11 October 2019.

1.1.1.9 The scope of the Project mainly comprises adoptive review, investigations, options appraisals, impact assessments, preliminary design and public consultation.

1.2 Scope of the Project

1.2.1.1 The major drainage improvement works recommended in DMP Review for Sha Tin and Sai Kung are described below.

(a) Stormwater Pumping Scheme at Sha Tin Town Centre

To effectively mitigate the flood risk in the low-lying areas of Sha Tin Town Centre, a pumping station is proposed at Sha Tin Park to isolate the concerned areas from the influence of the water level in Shing Mun River during high tide condition. It also includes an above-ground pump house, electrical and mechanical (E&M) works and associated pipeworks. The proposed works also include a number of new pipes and pipe upgrade around Sha Tin Town Centre such as Pak Hok Ting Street, Sha Tin Centre Street and Man Lai Road.

(b) Stormwater Pumping Scheme at Chui Tin Street Soccer Pitch

To protect the low-lying San Tin Wai (San Tin Village) from flooding in the high tide condition, a new pumping station is proposed at Chui Tin Street Soccer Pitch. It also includes an above-ground switch and transformer room in a fenced maintenance area outside Che Kung Temple. The proposed works also include a new twin-cell box culverts and pipes around San Tin Village, Kak Tin Street, Chui Tin Street and Che Kung Miu Road.

(c) Local Upgrade to the Drainage Network

Drainage upgrading works at Fui Yiu Ha, Ma Ling Path, Kau To Hang, Hang Hong Street, Tai Po Road (Ma Liu Shui), Pok Hong Estate, Wong Chuk Yeung Village and Lai Wo Lane, Po Lo Che Road, Ho Chung and Wong Chuk Wan were proposed to alleviate the local flood risk in these locations.

(d) Flood Management for Shing Mun River

Flood walls were proposed along both sides of Shing Mun River to protect the cycle track against flooding due to astronomical high tide. An early alert and flood warning system was developed as a non-structural measure for Shing Mun River where structural measure is considered to be impracticable. This system was designed primarily to detect the potential flooding in the cycle track and subways so that the public can be alerted in advance and undertake the appropriate responses to prevent threat to life.

1.3 Objectives of the Report

1.3.1.1 The objective of the Drainage Impact Assessment (DIA) is to introduce a structural and systematic approach to identifying, assessing and mitigating potential adverse drainage impacts which might arise from the Project.

1.3.1.2 With the implementation of necessary mitigation measures if required, the Project shall not cause an unacceptable increase in the risk of flooding in areas upstream of, adjacent to or downstream of the project site both during construction and upon completion.

1.3.1.3 According to Clause 3.10 of the Study Brief, the consultant:

(a) Prepares and submits the project profile for the DIA with details as outlined in Appendix A of ETWB TC(W) No. 2/2006;

(b) Agrees with DSD on the approach, assumptions, the climate change scenario recommended in the updated version of DSD Stormwater Drainage Manual or any updated report, methodologies and hydraulic model for the DIA;

(c) Undertakes the DIA following the scope and requirements set out in Appendix B of ETWB TC(W) No. 2/2006 and in accordance with the standards set out in the most updated version of DSD Stormwater Drainage Manual or as agreed with DSD;

(d) Obtains and reviews the latest version of the Geographic Information System (GIS) and hydraulic models in the vicinity of the Project area and develops a calibrated and verified GIS and hydraulic models for the Project based on the latest available information by incorporating the proposed works of the Project as well as the proposed/as-constructed works of other interfacing projects/studies to assess, through the process of hydraulic analysis, the impact due to the Project on the existing drainage system. The failing of Inter-reservoirs Transfer Scheme (IRTS) operation should also be considered in the hydraulic assessment;

(e) Recommends and implements all necessary measures to mitigate adverse drainage impacts arising from the Project and as identified by the DIA;

(f) Recommends all measures necessary to prevent every anticipated and unacceptable drainage impacts arising from the proposed works during construction; and

(g) Recommends measures to prevent unacceptable drainage impacts arising from the operation of the Project.

2 METHODOLOGY OF DRAINAGE IMPACT ASSESSMENT

2.1 Hydraulic Model

2.1.1.1 1D/2D hydraulic models were constructed in InfoWorks ICM (Version 6.0 for Sai Kung; Version 6.5 for Ma On Shan; Version 7.5 for Sha Tin) under DMP Review. InfoWorks ICM 8.5 is used in this Project.

2.2 Hydrological Parameters

2.2.1 *SCS CN value*

2.2.1.1 The SCS Curve Number for the DMP Review are adopted as they had been calibrated. The SCS Curve Number adopted for rural catchment under AMC II condition, CN(II), for different land uses are presented in **Table 2.1**.

Table 2.1 Recommended SCS Curve Number for Different Land Uses

Land Use	SCS Curve Number, CN(II) (Sha Tin)	SCS Curve Number, CN(II) (Sai Kung)
Agriculture and Upland		
Woodland	67	66
Scrubland	70	69
Grassland	78	78
Agriculture	78	78
Drainage		
River Channel	100	-
Reservoir	100	-
Wetland	100	100
Highway and Road		
Major Road and Junction	100	100
Special Use		
Government, Institution or Community	90	90
Fire Station	-	-
Hospital	-	-
Cemetery	65	65
Racecourse	-	-
Urban		
Commercial / Residential	95	95
Comprehensive Development Area	-	95
Residential	95	95
Village		
Village	78	80
Storage and Industrial		
Industrial	90	90
Open Space	90	90
Rail		

Land Use	SCS Curve Number, CN(II) (Sha Tin)	SCS Curve Number, CN(II) (Sai Kung)
Rail	100	-
Boulder and Rocky Area		
Boulder and Rocky Area	100	100

2.2.2 *Time of Concentration*

2.2.2.1 The design rainfall intensities were determined with consideration for the maximum time of concentration. The time of concentration is defined as the time needed for water to flow from the remotest point in the catchment to the outlet. In the deterministic rational method, the critical rainfall duration is considered to be equal to the time of concentration and this assumption is also made for most runoff routing models.

2.2.2.2 The time of concentration (t_c) for an urban drainage system was estimated by the following equations:

$$t_c = t_o + t_f$$

where
t_c = time of concentration (minutes)
t_o = inlet time (water travelling time from the remotest point to reach the most upstream point of the urban drainage system)
t_f = flow time

2.2.2.3 In view of generally good agreement between the time of observed and simulated peak flow in the calibration process, it is considered suitable to adopt the Brandsby William's Equation for estimating the time of concentration for the rural catchments. It is given as:

$$t_o = \frac{0.14465L}{H^{0.2}A^{0.1}}$$

where
t_o = time of concentration of a natural catchment (min.)
A = catchment area (m^2)
H = average slope (m per 100 m), measured along the line of natural flow, from the summit of the catchment to the point under consideration
L = distance (on plan) measured on the line of natural flow between the summit and the point under consideration (m)

2.2.2.4 Based on the longest flow path for the Sha Tin Area via catchment for Shing Mun Reservoir and then Shing Mun River with an outfall to Tolo Harbour, the time of concentration is computed to be approximately 111 mins.

2.2.2.5 In the consideration of the above estimated time of concentration of about 2 hours, a 4-hr design rainfall profile was adopted.

2.2.3 *Fixed Runoff Coefficient*

2.2.3.1 Fixed Percentage Runoff method is adopted for the runoff volume model of urban catchment.

2.2.3.2 The recommended fixed runoff coefficients to be adopted thus are:

Paved area	0.90
Unpaved area	0.30

2.3 Hydraulic Parameters

2.3.1 *Roughness Coefficient*

2.3.1.1 The values of surface roughness, ks, and Manning coefficient, n, to be adopted are summarized in **Table 2.2** and
2.3.1.2 **Table 2.3**.

Table 2.2 Adopted Values of Surface Roughness, k_s

Description	Surface Roughness (mm)
Existing Pipeline / Culvert	3.0
Proposed Pipeline / Culvert	3.0

Table 2.3 Adopted Values of Manning's Coefficient, n

Description	Manning Coefficient
Engineered channels	
concrete lining	0.020
stone pitching / masonry / channel bed with few rubbles / rockfill	0.025
grasscrete lining (grass) grasscrete lining (grass with few weeds)	0.025 0.030
gabion gabion (grass with some weeds) gabion (dense weeds) gabion (deformed cage and dense weeds)	0.035 0.040 0.045 0.050
Natural Stream	
grass and few rubbles	0.030

grass with some weeds and gravels	0.040
dense weeds	0.045
dense weeds and gravels/cobbles/few boulders; or cobbles with large boulders	0.050
dense weeds with few shrubs and large boulders	0.060

2.3.2 *Siltation*

2.3.2.1 The following siltation (or sometimes called sediment depth) based on the recommendation given in Section 9.3 of SDM2018 was applied in the model, for assessing the drainage performance of the pipeline system (except WSD catchwater pipes):

- 5% reduction in flow area for gradients greater than 1 in 25
- 10% reduction in flow area for other cases

2.3.2.2 For those cross-sections of the watercourses extracted from the sounding record by CEDD and LiDAR data, and those surveyed under this Project which indicate the exact conditions of the watercourses, no additional siltation was added in the hydraulic model.

2.3.3 *Manhole Headloss*

2.3.3.1 Headloss condition has to be specified at each end of a conduit. Normal head loss condition was generally assumed, and the head loss equation used is as follows:

$$\Delta h = k_u k_s k_v \frac{v^2}{2g}$$

where

Δh = headloss
k_u = user defined headloss factor
k_s = surcharge ratio coefficient
k_v = velocity coefficient
v = flow velocity (m/s)
g = acceleration due to gravity (m/s^2)

2.3.3.2 According to the recommended values by InfoWorks ICM, the chosen user defined head loss factors are shown in **Table 2.4**.

Table 2.4 User Defined Headloss Factor

Bend (degree)	Head loss Value (k_u)
30	3.3
60	6.0

90	6.6
>90	8.0

2.4 Design Criteria

2.4.1 *Design Return Periods*

2.4.1.1 The drainage system shall be assessed based on the design criteria for the return periods of 2, 5, 10, 20, 50, 100 and 200 years as defined in the Stormwater Drainage Manual (SDM).

2.4.2 *Combination of Rainfall and Sea Level*

2.4.2.1 Since the hydraulic performance of the drainage system is affected by both rainfall and sea level, the design flood levels of the drainage system are to be assessed based on the joint probabilities of rainfall dominated and sea level dominated events.

2.4.2.2 The following approximate pragmatic rule for determining the T-year flood level in the fluvial-tidal zone of a drainage system is adopted. Take the T-year flood level as the higher of those flood levels due to the following two cases:

Case A: an X-year sea level in conjunction with a T-year rainfall
Case B: a T-year sea level in conjunction with an X-year rainfall

In the above rule,
X=10, when T=50, 100 or 200
X=2, when T=2, 5 or 10
X=5, when T=20

2.4.2.3 A summary of design event combinations is shown in **Table 2.5**.

Table 2.5 Design Return Period Combinations of Rain and Tide Events

Flood Protection Return Period	The More Critical of the 2 Cases	
	Case I	Case II
200-year	200-year rain + 10-year sea level	10-year rain + 200-year sea level
100-year	100-year rain + 10-year sea level	10-year rain + 100-year sea level
50-year	50-year rain + 10-year sea level	10-year rain + 50-year sea level
20-year	20-year rain + 5-year sea level	5-year rain + 20-year sea level
10-year	10-year rain + 2-year sea level	2-year rain + 10-year sea level
5-year	5-year rain + 2-year sea level	2-year rain + 5-year sea level
2-year	2-year rain + 2-year sea level	N/A

2.4.3 *Design Rainfall*

(i) Rainfall Profile

2.4.3.1 As recommended in SDM, a symmetrically distributed rainfall with the following formulation based on RO (1991) was adopted for the rainfall profile in DMP Review.

$$F(t) = \begin{cases} \dfrac{a[b+2(1-c)t]}{(2t+b)^{c+1}} & , \quad 0 \le t \le \dfrac{t_d}{2} \\ F(-t) & , \quad -\dfrac{t_d}{2} \le t \le 0 \end{cases}$$

where

$F(t)$ = Rate of rainfall or instantaneous intensity in mm/hr at time t (in minutes)
t_d = Rainfall duration (in minutes) $t_d \leqslant 240$
a,b,c = Storm constants given in **Table 2.6** and **Table 2.7**

Table 2.6 Storm Constants of HKO Headquarters (SDM2018)

Return Period (T)	a	b	c
2	499.8	4.26	0.494
5	480.2	3.36	0.429
10	471.9	3.02	0.397
20	463.6	2.76	0.369
50	451.3	2.46	0.337
100	440.8	2.26	0.316
200	429.5	2.05	0.295

Table 2.7 Storm Constants of Tai Mo Shan Area (SDM2018)

Return Period (T)	a	b	c
2	1743.9	22.12	0.694
5	2183.2	27.12	0.682
10	2251.3	27.46	0.661
20	2159.2 1	25.79	0.633
50	1740.1	19.78	0.570
100	1307.3	12.85	0.501
200	1005.0	7.01	0.434

(ii) Rainfall Duration

2.4.3.2 After the review of time of concentration for each catchment in DMP Review, a 4-hour design event was considered sufficient to ensure that the peak intensity in both short and longer duration events have been considered throughout the Study Area.

2.4.3.3 Therefore, same rainfall duration will be adopted in this Project. A 4-hour design rainfalls for various return periods were generated using the symmetrically rainfall profile and used as an input in the hydrological model.

(iii) Storm Constants

2.4.3.4 Stormwater Drainage Manual (SDM) has been updated and released in year 2018. In SDM2018, Hong Kong is divided into 4 rainfall zones according to their rainfall characteristics. Each zone has a set of storm constants

2.4.3.5 As shown in **Figure 2.1**, part of Tai Wai Catchment falls into Tai Mo Shan area. Therefore, the storm constants of Tai Mo Shan (SDM2018 (TMS)) is applied to this part of Tai Wai Catchment. And the storm constants of HKO Headquarters (SDM2018 (HKO)) will be adopted in the remaining area of Tai Wai, Sha Tin, Ma On Shan and Sai Kung.

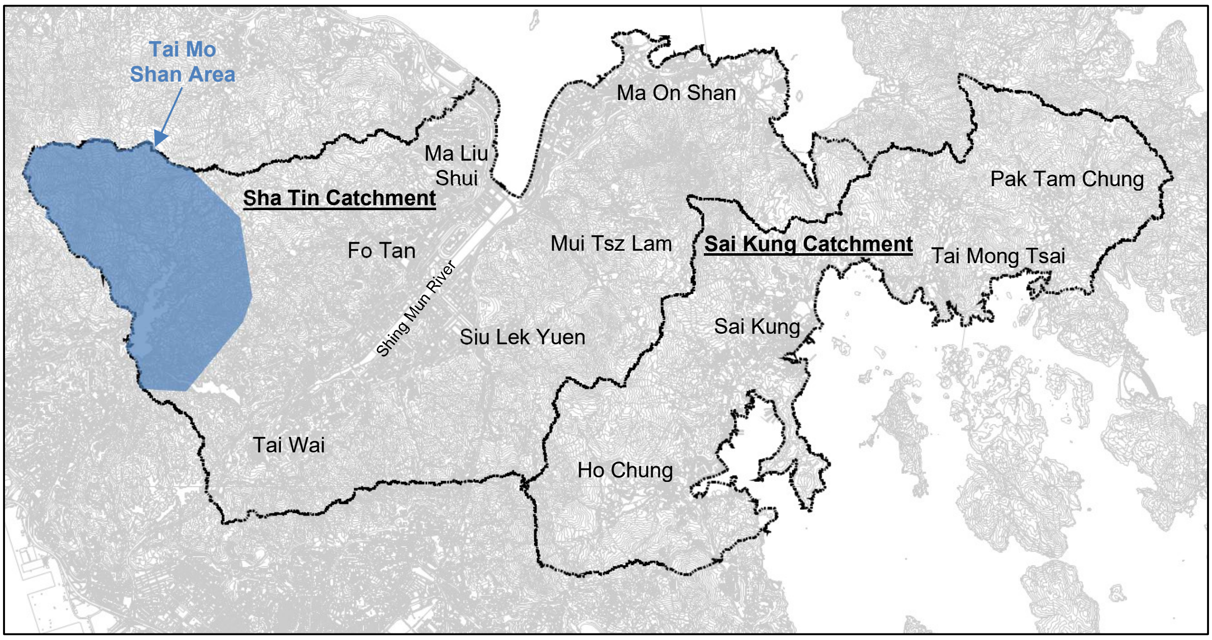


Figure 2.1 Tai Mo Shan Area within Study Boundary

2.4.3.6 The latest storm constants in SDM 2018 was adopted for the review and design of the proposed drainage improvement works in this Project. The adopted storm constants of HKO Headquarters and Tai Mo Shan Area are provided in **Table 2.6** and **Table 2.7** respectively.

(iv) Areal Reduction Factor

2.4.3.7 To account for the spatial variability of rainfall across a catchment, it can be done by multiplying the design rainfall with an areal reduction factor. An areal reduction factor of 1.0 was adopted in this Project.

2.4.4 *Design Sea Level*

2.4.4.1 The latest design sea levels in SDM 2018 was adopted for the review and design of the proposed drainage improvement works in this Project. The adopted design sea levels are provided in **Table 2.8**.

Table 2.8 Design Sea Levels at Sha Tin and Sai Kung in SDM2018

Location	Design Sea Level Quantiles (mPD)						
	2yr	5yr	10yr	20yr	50yr	100yr	200yr
Sha Tin (Tide Gauge: Tai Po Kau)	2.91	3.20	3.45	3.73	4.19	4.60	5.10
Sai Kung (Tide Gauge: North Point / Quarry Bay)	2.73	2.94	3.09	3.24	3.45	3.63	3.81

2.4.5 *Climate Change Scenario*

The potential rise in mean sea level and increase in rainfall due to the effect of climate change have been considered in this Project. The projection of rainfall increase and sea level rise presented in **Table 2.9** will be added to the design rainfall and sea levels respectively. The projected rainfall and sea levels will be used to assess the hydraulic performance of the proposed drainage improvement works.

Table 2.9 Rainfall Increase and Sea Level Rise due to Climate Change Scenario

Climate Chang Scenario	Rainfall Increase	Sea Level Rise (m)
Mid 21st Century (2041-2060)	10.4%	0.23

2.4.6 *Freeboard*

A 300mm freeboard was adopted for assessing the total drainage system to account for inaccuracies in flood level computations in this Project. In the situations of super-elevations at bends and wave run-ups, additional freeboard will also be taken into account. Under normal circumstance, a 200mm allowance is considered adequate to cover super-elevations at bends and wave run-ups if both apply.

2.4.7 *Interface with WSD Facilities*

2.4.7.1 The scenario assuming the absence of WSD facilities is the critical scenario and therefore was adopted for the formulation and design of the drainage improvement works in this Project. Failing of Inter-reservoirs Transfer Scheme (IRTS) is considered with no flow transferred through the IRTS tunnel to Lower Shing Mun Reservoir.

3 DRAINAGE IMPACT ASSESSMENT

3.1 Sha Tin Town Centre

3.1.1 *Model Set-up*

3.1.1.1 Layout of the existing drainage network at Sha Tin Town Centre is shown in **Figure 3.1** below. The concerned existing drain is highlighted in red, which consists of drainage pipes with size varies from 225mm to 1800mm diameter connecting to the Shing Mun River.

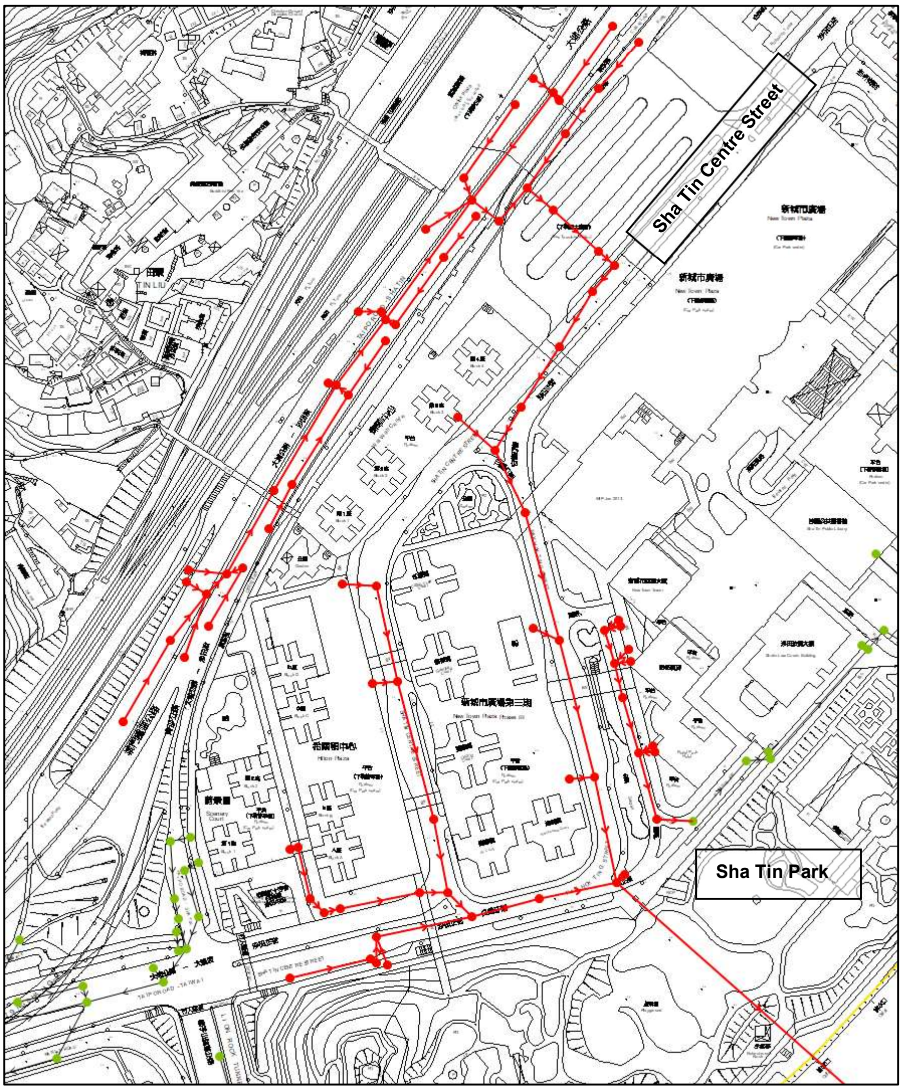


Figure 3.1 Existing Drainage Network at Sha Tin Town Centre

3.1.1.2 Drainage catchment of the existing network is shown in **Figure 3.2**. The catchment area upstream of concerned existing drain is about 15.1ha (highlighted in red).

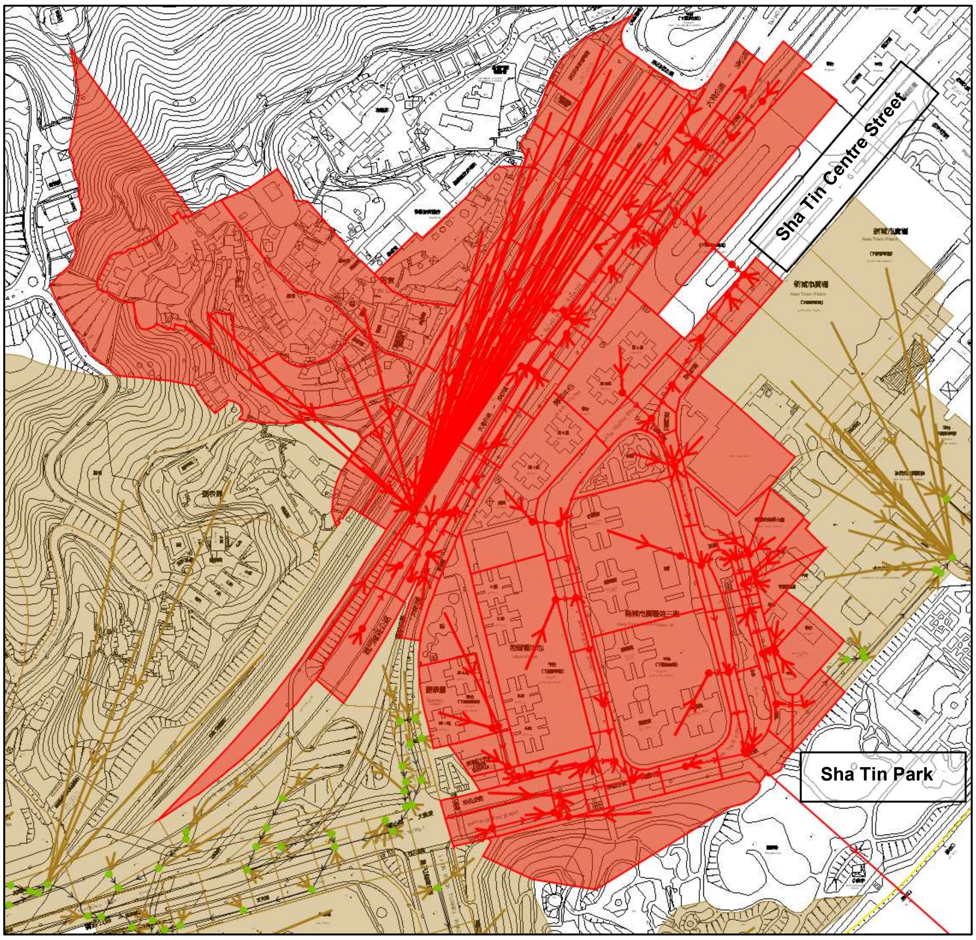


Figure 3.2 Drainage Catchment of Existing Network at Sha Tin Town Centre

3.1.1.3 The recommended drainage improvement works consists of a stormwater pumping scheme to mitigate the flood risk as shown in **Drawing Nos. 60617767/DIW_ST/441** to **444**.

3.1.1.4 First part of the recommended drainage improvement works at Sha Tin Town Centre is to provide a new 1650mm dia. pipe from the footpath between the rail line and Tai Po Road (Sha Tin) opposite to Hilton Plaza and continue along the footpath between Hilton Plaza and Scenery Court. The proposed pipe will follow the footpath along Sha Tin Centre Street and connect to the proposed pumping station.

3.1.1.5 Second part is to upgrade of the existing 1500mm dia. stormwater pipe in Tai Po Road (Sha Tin) near CityLink Plaza to 1650mm dia., upgrade of the existing 450mm dia. stormwater pipe outside Red Cross Sha Tin Centre to 600mm dia. and a new 750mm dia. stormwater pipe outside Wai Wah Centre.

3.1.1.6 The last part of this scheme is to provide a new stormwater pumping station at the downstream of the existing drainage network in Sha Tin Park. Since the potential flood risk around Sha Tin Town Centre is caused by the backflow from Shing Mun River into the relatively low-lying areas.

3.1.1.7 The proposed pumping station includes an underground tank, an above-ground pump house, new pipes ranged from 600mm to 2200mm dia. in Yi Ching Lane. The pumping station consists of a pump with the maximum pump rate of 4m^3/s and an underground tank with the wet volume of 8000m^3. The runoff will be discharged into the pumping station via the new drainage network and then discharged into Shing Mun River by pumps. The excessive water will be stored in the underground tank.

3.1.1.8 Drainage catchment of the proposed network is shown in **Figure 3.3**. The catchment area upstream of the concerned proposed drain is about 15.1ha (highlighted in red).

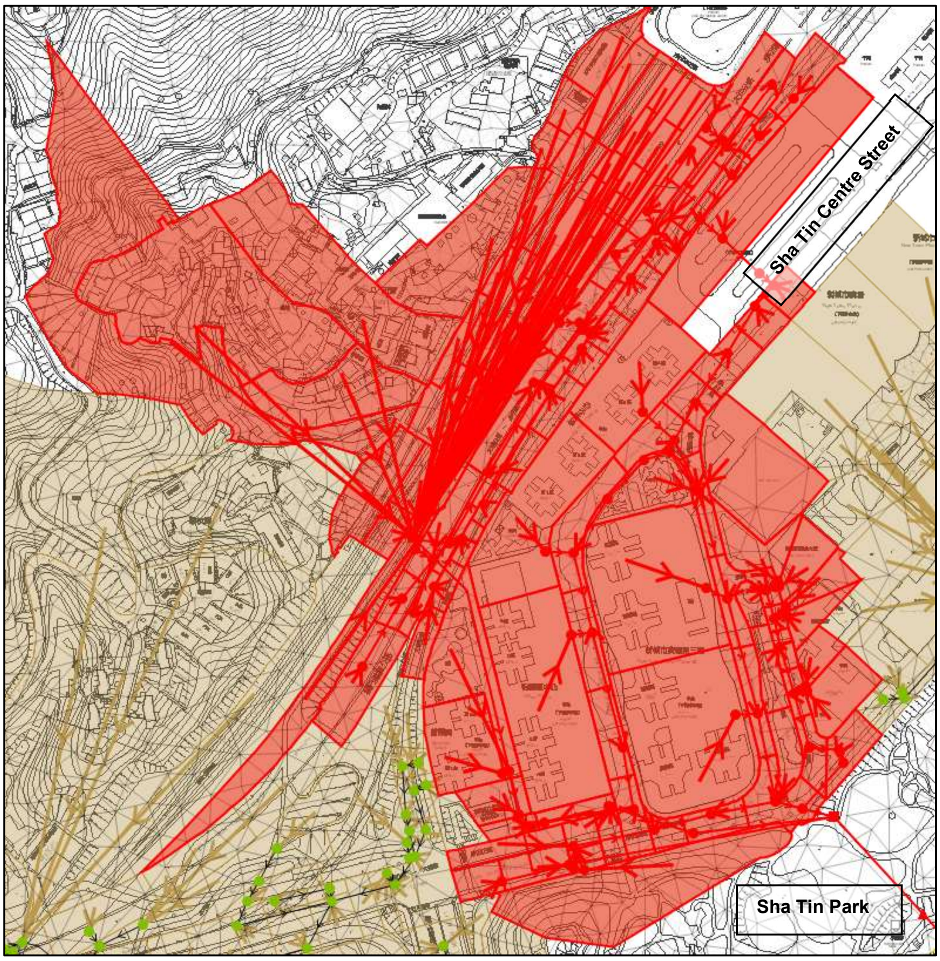


Figure 3.3 Drainage Catchment of Proposed Network at Sha Tin Town Centre

3.1.2 *Hydraulic Performance of the Existing Network*

3.1.2.1 Drainage system at Sha Tin Town Centre should be designed to have 50-year protection level as the flooding was occurred at the branch system. Therefore, two cases of 50-year flooding events have been modeled: (i) 50-year rain + 10-year sea level; and (ii) 10-year rain + 50-year sea level.

3.1.2.2 As drainage system at Sha Tin Town Centre is located near the Shing Mun River, its hydraulic performance is determined by the sea level dominated case, i.e. 10-year rain + 50-year sea level. Therefore, results of the sea level dominated case are discussed in this report. Results of rain dominated case can be found in the InfoWorks ICM model.

3.1.2.3 It is found that there is flooding due to insufficient capacity of existing drainage system, high water level at Shing Mun River causing backflow to upstream drainage system and the relatively low ground level at the area susceptible to flooding. The maximum flood depth is estimated to be 0.46m at the junction of Sha Tin Centre Street and Pak Hok Ting Street as shown in the flood maps attached in this report. Besides, a flooding incident has been reported on 15 August 2015 at New Town Plaza Bus Station. Therefore, hydraulic performance of Sha Tin Town Centre drainage system cannot achieve the required 50-year flood protection standard.

3.1.3 *Hydraulic Performance of the Proposed Network*

3.1.3.1 In order to bring up the protection level at Sha Tin Town Centre to 50-year, drainage improvement works is proposed as discussed in above sections.

3.1.3.2 After implementing the proposed drainage improvement works, it is found that there is no flooding from the proposed drainage system under 50-year events with sufficient freeboard as shown in the flood maps attached in this report. Therefore, hydraulic performance of proposed drainage system of Sha Tin Town Centre is satisfactory.

4 CONCLUSION

4.1.1.1 An integrated hydrological and 1D/2D hydraulic model was developed in InfoWorks ICM to conduct the drainage impact assessment for Sha Tin Town Centre

4.1.1.2 This DIA has assessed the potential drainage impacts arising from the proposed drainage improvement works under this Project by adopting the new design criteria and parameters provided in SDM(2018).

4.1.1.3 With the provision of the drainage improvement works proposed in this Project, the flood risks in all the concerned areas can be significantly reduced..

4.1.1.4 It is concluded that there is no adverse drainage impact due to the proposed drainage improvement works.

Drawings

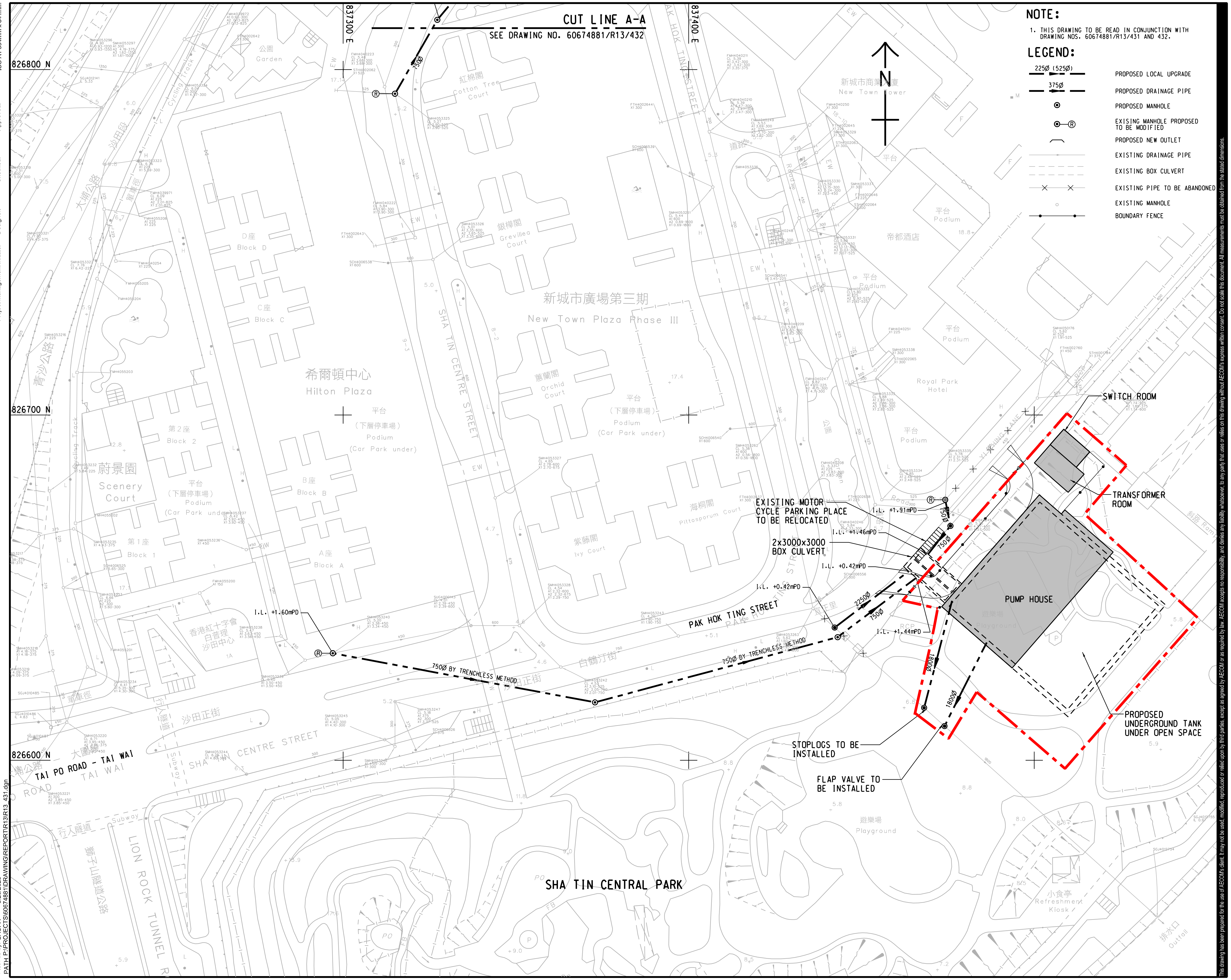
ISO A1 594mm x 841mm

Approved:

Checked:

Designer:

Project Management Initials:



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PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT 業主

渠務署 Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
www.aecom.com

SUB-CONSULTANTS 分判工程顧問公司

ISSUE/REVISION 修訂

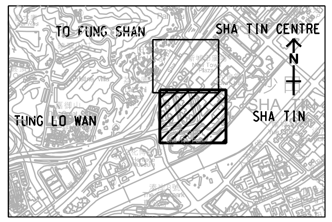
I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

SCALE 比例 A1 1 : 500

DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖 A1 1 : 20000



PROJECT NO. 項目編號 60674881

CONTRACT NO. 合約編號 CE 44/2021 (DS)

SHEET TITLE 圖紙名稱

PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN TOWN CENTRE (STN1)

SHEET 1 OF 2

SHEET NUMBER 圖紙編號

60674881/R13/431

ISO A1 594mm x 841mm

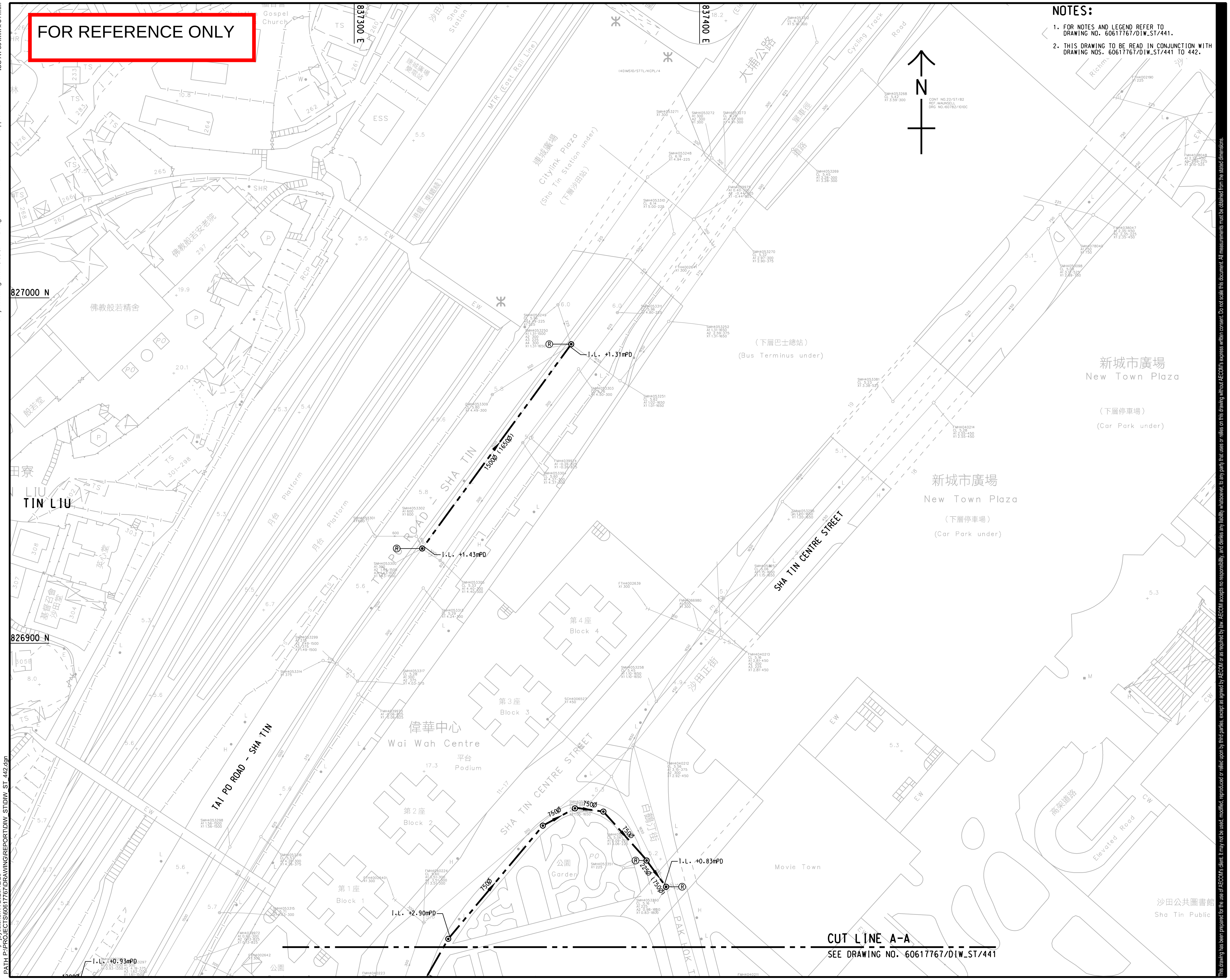
Approved:

Checked:

Designer:

Project Management Initials:

FOR REFERENCE ONLY



NOTES:

1. FOR NOTES AND LEGEND REFER TO DRAWING NO. 60617767/DIW_ST/441.
2. THIS DRAWING TO BE READ IN CONJUNCTION WITH DRAWING NOS. 60617767/DIW_ST/441 TO 442.

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PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT 業主

渠務署 Drainage Services Department

CONSULTANT 工程顧問公司

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SUB-CONSULTANTS 分判工程顧問公司

ISSUE/REVISION 修訂

I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

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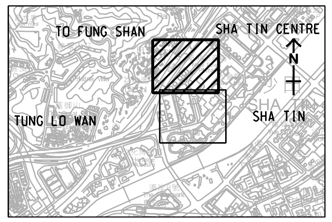
DIMENSION UNIT 尺寸單位: METRES

KEY PLAN 索引圖 A3 1 : 40000



PROJECT NO. 項目編號: 60617767

AGREEMENT NO. 協議編號: CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN TOWN CENTRE (STN1)

SHEET 2 OF 2

SHEET NUMBER 圖紙編號

60617767/DIW_ST/442

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Appendix A
Flood Extent Maps

Restricted. Not to be disclosed

Appendix K – Sewerage Impact Assessment Report

渠務署
Drainage Services Department

Agreement No. CE 44/2021(DS)

Drainage Improvement Works in Sha Tin and Sai Kung – Design & Construction

Updated Sewerage Impact Assessment (SIA) Report

January 2022

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TABLE OF CONTENTS

DRAWINGS

1 INTRODUCTION

1.1 Background

1.1.1.1 The Review of Drainage Master Plan in Sha Tin and Sai Kung – Feasibility Study (DMP Review Study) identified that the following areas in Sha Tin would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics:

(a) Sha Tin Town Centre;

(b) Chui Tin Street (near Sun Chui Estate) and San Tin Village;

(c) Tai Po Road (Ma Liu Shui), Ma Ling Path, Kau To Hang near Yucca Villa, Hang Hong Street, Pok Hong Estate, Fui Yiu Ha, Wong Chuk Yeung Village and Lai Wo Lane; and

(d) cycle track alongside Shing Mun River.

1.1.1.2 The flooding incidents reported in Wong Chuk Yeung Village on 22 July 2010 and Sha Tin Centre Street on 15 August 2015 are examples to substantiate the above findings.

1.1.1.3 The DMP Review Study also identified that the areas in Sai Kung including Wong Chuk Wan, Ho Chung, Kap Pin Long New Village and Nam Shan San Tsuen would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics. The flooding incidents at Po Lo Che Road and Nam Shan San Tsuen on 30 May 2010 and Wong Chuk Wan on 7 October 2015 are some examples to substantiate the above findings.

1.1.1.4 To relieve the flood risk in the above areas, the DMP Review Study has proposed implementing drainage improvement measures, mainly in form of stormwater pumping scheme and drainage upgrading works. Upon completion of the proposed improvement measures, the standards of flood protection at areas concerned will be largely enhanced to that specified in the standards of the Stormwater Drainage Manual (SDM) and the flood risks thereon can be significantly reduced.

1.1.1.5 New flood walls will also be provided along various sections of Shing Mun River to protect the cycle track against flooding due to the astronomical high tide.

1.1.1.6 Without the proposed project, about 26 hectares of the areas in Sha Tin and 6 hectares of areas in Sai Kung will be subject to high flood risk. Flooding impacts on traffic and residential area in the flood prone areas will also result in losses and inconvenience to the general public.

1.1.1.7 In May 2018, Development Bureau (DEVB) signed out a Project Definition Statement (PDS) to justify and define the scope of the “Drainage Improvement Works in Sha Tin and Sai Kung” (the Project). The Drainage Services Department (DSD) then completed a Technical Feasibility Statement (TFS) confirming its technical feasibility. The TFS was subsequently approved by DEVB in August 2018. The Project was included into Cat B under PWP Item No. 4182CD in September 2018.

1.1.1.8 In October 2019, DSD commissioned Agreement No. CE 6/2018(DS) "Drainage Improvement Works in Sha Tin and Sai Kung – Investigation" (referred to hereinafter as the "Investigation Study") to carry out various reviews, survey, investigation, impact assessments and preliminary design for the Project. The Project comprises the drainage improvement works recommended under the DMP Review Study as shown in **Appendix A** and as described below:

(a) Stormwater pumping scheme at Sha Tin Town Centre, including an underground storage tank, a pump house and associated pipeworks and electrical and mechanical (E&M) works, as well as drainage upgrading works around Sha Tin Town Centre such as Pak Hok Tin Street, Sha Tin Centre Street, Man Lai Road and ancillary works including reinstatement of playgrounds and associated facilities;

(b) Stormwater pumping scheme at Chui Tin Street Soccer Pitch including an underground storage tank and associated pumps, pipeworks and E&M works, as well as drainage upgrading works around Sun Tin Village, Kak Tin Street, Chui Tin Street and Che Kung Miu Road and ancillary works including reinstatement of soccer pitch and associated facilities;

(c) Drainage upgrading works at Fui Yiu Ha, Ma Ling Path, Kau To Hang, Hang Hong Street, Tai Po Road (Ma Liu Shui), Pok Hong Estate, Wong Chuk Yeung Village and Lai Wo Lane, Po Lo Che Road, Ho Chung and Wong Chuk Wan; and

(d) Flood walls along Shing Mun River to protect the cycle track against flooding due to astronomical high tide.

1.1.1.9 AECOM Asia Company Limited was appointed by DSD on 20 December 2021 to undertake Agreement No. 44/2020(DS) "Drainage Improvement Works in Sha Tin and Sai Kung" (referred to hereinafter as "the Project") of, of which the starting date of the Project is 29 December 2021.

The scope of the Project mainly comprises adoptive review, investigations, surveys, investigations, impact assessments, public consultation, detailed design, tendering, construction to the commissioning of the works.

1.2 Scope of the Project

1.2.1.1 The major drainage improvement works recommended in DMP Review for Sha Tin and Sai Kung are described below. Details of the proposed drainage improvement works are presented in the attached drawings.

(a) Stormwater Pumping Scheme at Sha Tin Town Centre

To effectively mitigate the flood risk in the low-lying areas of Sha Tin Town Centre, a pumping station is proposed at Sha Tin Park to isolate the concerned areas from the influence of the water level in Shing Mun River during high tide condition. The proposed pumping station has an underground wet volume of 14000m^3 and maximum pump rate of 2m^3/s. It also includes an above-ground pump house, electrical and mechanical (E&M) works and associated pipeworks. The proposed works also include a number of new pipes and pipe upgrade around Sha Tin Town Centre such as Pak Hok Ting Street, Sha Tin Centre Street and Man Lai Road.

(b) Stormwater Pumping Scheme at Chui Tin Street Soccer Pitch

To protect the low-lying San Tin Wai (San Tin Village) from flooding in the high tide condition, a new pumping station is proposed at Chui Tin Street Soccer Pitch. The proposed pumping station has an underground wet volume of 1,200m^3 and maximum pump rate of 0.25m^3/s. It also includes an above-ground switch and transformer room in a fenced maintenance area outside Che Kung Temple. The proposed works also include a new twin-cell box culverts and pipes around San Tin Village, Kak Tin Street, Chui Tin Street and Che Kung Miu Road.

(c) Local Upgrade to the Drainage Network

Drainage upgrading works at Fui Yiu Ha, Ma Ling Path, Kau To Hang, Hang Hong Street, Tai Po Road (Ma Liu Shui), Pok Hong Estate, Wong Chuk Yeung Village and Lai Wo Lane, Po Lo Che Road, Ho Chung and Wong Chuk Wan were proposed to alleviate the local flood risk in these locations.

(d) Flood Management for Shing Mun River

2.1km long of flood walls were proposed along both sides of Shing Mun River to protect the cycle track against flooding due to astronomical high tide. An early alert and flood warning system was developed as a non-structural measure for Shing Mun River where structural measure is considered to be impracticable. This system was designed primarily to detect the potential flooding in the cycle track and subways so that the public can be alerted in advance and undertake the appropriate responses to prevent threat to life.

1.3 Objectives of the Report

1.3.1.1 The objective of the Sewerage Impact Assessment (SIA) is to introduce a structural and systematic approach to identifying, assessing and mitigating potential adverse sewerage impacts which might arise from the Project.

1.3.1.2 According to Clause 6.13.2 of the Study Brief, the Consultant:

(a) Undertakes the SIA in accordance with the standards set out in DSD Sewerage Manual and latest version of the EPD's "Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning" and to the satisfaction of EPD;

(b) if required by the Employer's Agent, obtains and reviews the latest version of the GIS and mathematical models in the vicinity of the Project area based on the latest available information by incorporating the proposed works of the Project into the models to assess the impact due to the Project on the existing and planned downstream sewerage system;

(c) further to sub-Clause (b) above, provides if requested by the Employer's Agent and in an agreed format the updated parts of the GIS and mathematical models with incorporation of the features given in Appendix D of the Scope and prepared with due regard to the information, requirements and procedures contained in the "Guidelines for Sewer Networks Hydraulic Model-Build and

Verification" and also in the "Requirements on Submission of InfoWorks CS Models and Related Information", or any updated version prepared by EPD;

(d) recommends and implements all necessary measures to mitigate adverse sewerage impacts arising from the Project;

(e) monitors the sewerage performance of the Project during construction; and

(f) takes all measures necessary to prevent every anticipated and unacceptable sewerage impacts arising during project construction.

2 SEWERAGE IMPACT ASSESSMENT

2.1 Flow and Load Estimation

2.1.1.1 Since only drainage works are proposed for flood mitigation purpose, no additional sewage flow and loading to the existing sewerage system are envisaged.

2.2 Impact on Existing Sewerage System

2.2.1.1 The Drainage Record Plans collected from the DSD, results from underground utilities surveys, design drawings for sewer systems at Hiram's Highway and the contract drawings of DC/2019/09 – Provision of Village Sewerage in Sai Kung have been reviewed to identify the potential interfaces between the proposed drainage improvement works and the existing sewerage system. Part-prints of drainage record plan at the proposed drainage improvement work locations are attached in **Drawings**.

2.2.1.2 Detailed checking on the underground space has been carried out to study whether the recommended drainage improvement works would be in the vicinity of the existing sewer systems. The findings are discussed below.

2.2.1.3 No existing sewer system is identified crossing the proposed drainage works.

2.3 Sha Tin Town Centre

2.3.1.1 First part of the recommended drainage improvement works at Sha Tin Town Centre is to provide a new 1650mm and 1800mm dia. pipe from the footpath between the rail line and Tai Po Road (Sha Tin) opposite to Hilton Plaza and continue along the footpath between Hilton Plaza and Scenery Court. The proposed pipe will follow the footpath along Sha Tin Centre Street and connect to the proposed pumping station.

2.3.1.2 Second part is to upgrade of the existing 1500mm dia. stormwater pipe in Tai Po Road (Sha Tin) near CityLink Plaza to 1650mm dia., upgrade of the existing 450mm dia. stormwater pipe outside Red Cross Sha Tin Centre to 600mm dia. and a new 750mm dia. stormwater pipe outside Wai Wah Centre.

2.3.1.3 The last part of this scheme is to provide a new stormwater pumping station at the downstream of the existing drainage network in Sha Tin Park. Since the potential flood risk around Sha Tin Town Centre is caused by the backflow from Shing Mun River into the relatively low-lying areas.

2.3.1.4 The proposed pumping station includes an underground tank, an above-ground pump house, new pipes ranged from 600mm to 2200mm dia. in Yi Ching Lane. The pumping station consists of a pump with the maximum pump rate of 4m^3/s and an underground tank with the wet volume of 8000m^3. The runoff will be discharged into the pumping station via the new drainage network and then discharged into Shing Mun River by pump. The excessive water will be stored in the underground tank as shown in **Drawing Nos. 60617767/SIA_ST/441** to **442**.

2.3.1.5 No existing sewer system is identified crossing the proposed drainage works.

3 MONITORING MEASURES FOR POTENTIAL SEWERAGE IMPACTS

3.1.1.1 Unauthorized connections of sewers to the drainage systems are not uncommon in Hong Kong, especially in rural areas such as villages. This could impose adverse impacts on both sewerage and drainage systems. If this occurs to the proposed drainage improvement works, monitoring measures could be conducted to identify the sources and locations causing the sewerage impacts, before further rectifying the systems.

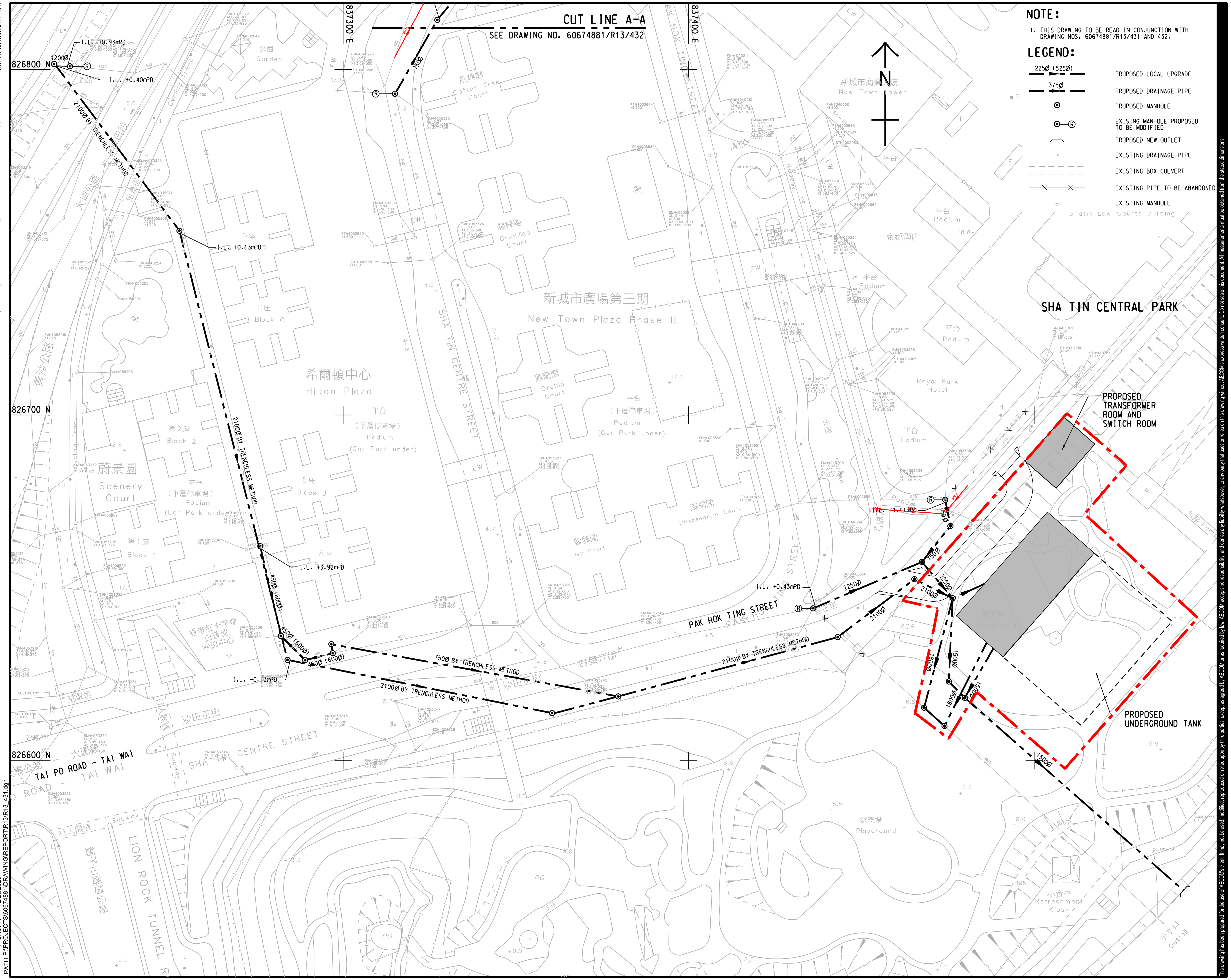
3.1.1.2 Typical monitoring measures consist of a pollution source identification survey and a flow survey. The former is the visual inspection of the drainage outlets along the systems to identify outlets with substandard water quality (e.g. debris, colour, odour, etc.), and to identify outlets with relatively stable flows. Subsequently, water quality sampling and testing would be conducted to verify the existing water quality conditions of selected outlets. While the latter is to install flow sensors at the selected drainage outlets to detect any anomalies in flow.

4 SUMMARY

4.1.1.1 No additional sewage flow and loadings will be caused by the proposed drainage improvement works.

4.1.1.2 In the case of potential sewerage impacts caused by unauthorized connections of sewers to the proposed drainage improvement works, monitoring measures with a pollution source identification survey and a flow survey could be conducted to identify the sources and locations causing the sewerage impacts.

Drawings



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Project Management Initials: Designer: Checked: Approved:

Plot File by: CAOPA 2/23/2023
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AECOM

PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT 業主

渠務署 Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
www.aecom.com

SUB-CONSULTANTS 分判工程顧問公司

ISSUE/REVISION 修訂

I/R	DATE	DESCRIPTION	CHK.

STATUS 階段

SCALE 比例 A1 1 : 500

DIMENSION UNIT 尺寸單位 METRES

KEY PLAN A1 1 : 20000

PROJECT NO. 60617767

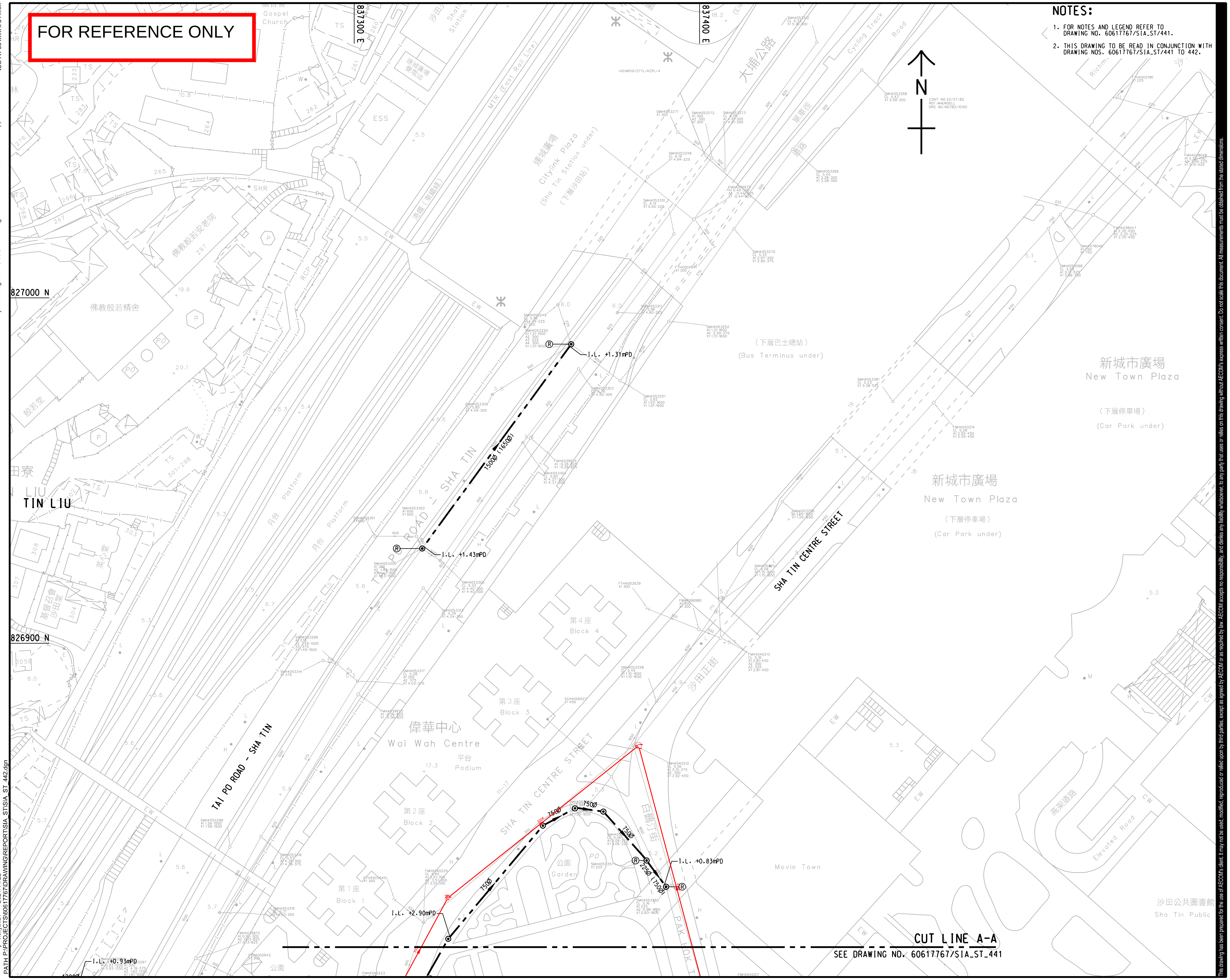
AGREEMENT NO. CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

EXISTING SEWERAGE SYSTEM NEAR PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN TOWN CENTRE (STN1) SHEET 1 OF 2

SHEET NUMBER 圖紙編號

60617767/SIA_ST/441



NOTES:

1. FOR NOTES AND LEGEND REFER TO DRAWING NO. 60617767/SIA_ST/441.
2. THIS DRAWING TO BE READ IN CONJUNCTION WITH DRAWING NOS. 60617767/SIA_ST/441 TO 442.

AECOM

PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT 業主

渠務署 Drainage Services Department

CONSULTANT 工程顧問公司

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SUB-CONSULTANTS 分判工程顧問公司

ISSUE/REVISION 修訂

I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

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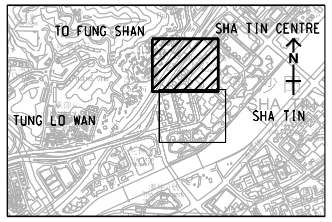
DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖 A3 1 : 40000



PROJECT NO. 項目編號 60617767

AGREEMENT NO. 協議編號 CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

EXISTING SEWERAGE SYSTEM NEAR PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN TOWN CENTRE (STN1) SHEET 2 OF 2

SHEET NUMBER 圖紙編號

60617767/SIA_ST/442

Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm

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Appendix L – Geotechnical Assessment Report

渠務署
Drainage Services Department

Agreement No. CE 44/2021(DS)

Drainage Improvement Works in Sha Tin and Sai Kung – Design & Construction

Draft Geotechnical Assessment Report

Report No. 60667488/10/0

March 2022

AECOM Delivering a better world

TABLE OF CONTENTS

TABLES

FIGURES

DRAWINGS

APPENDICES

1 INTRODUCTION

1.1 Background

1.1.1.1 The Review of Drainage Master Plan in Sha Tin and Sai Kung – Feasibility Study (DMP Review) identified that the following areas in Sha Tin would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics:

(a) Sha Tin Town Centre,

(b) Chui Tin Street (near Sun Chui Estate) and San Tin Village,

(c) Tai Po Road (Ma Liu Shui), Ma Ling Path, Kau To Hang near Yucca Villa, Hang Hong Street, Pok Hong Estate, Fui Yiu Ha, Wong Chuk Yeung Village and Lai Wo Lane, and

(d) Cycle track alongside Shing Mun River.

1.1.1.2 The flooding incidents reported in Wong Chuk Yeung Village on 22 July 2010 and Sha Tin Centre Street on 15 August 2015 are examples to substantiate the above findings.

1.1.1.3 DMP Review also identified that the areas in Sai Kung including Wong Chuk Wan, Ho Chung, Kap Pin Long New Village and Nam Shan San Tsuen would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics. The flooding incidents at Po Lo Che Road and Nam Shan San Tsuen on 30 May 2010 and Wong Chuk Wan on 7 October 2015 are some examples to substantiate the above findings.

1.1.1.4 To relieve the flood risk in the above areas, DMP Review has proposed implementing drainage improvement measures, mainly in form of stormwater pumping scheme and drainage upgrading works. Upon completion of the Project, the standards of flood protection at areas concerned will be largely enhanced to that specified in the standards of the Stormwater Drainage Manual (SDM) and the flood risks thereon can be significantly reduced.

1.1.1.5 Without the proposed project, about 26 hectares of the areas in Sha Tin and 6 hectares of areas in Sai Kung will be subject to high flood risk. Flooding impacts on traffic and residential area in the flood prone areas will also result in losses and inconvenience to the general public.

1.1.1.6 In May 2018, Development Bureau (DEVB) signed out a Project Definition Statement (PDS) to justify and define the scope of the "Drainage Improvement Works in Sha Tin and Sai Kung". The Drainage Services Department (DSD) then completed a Technical Feasibility Statement (TFS) confirming its technical feasibility. The TFS was subsequently approved by DEVB in August 2018. The Project was included into Cat B under PWP Item No. 4182CD in September 2018.

1.1.1.7 In October 2019, DSD commissioned Agreement No. CE 6/2018(DS) "Drainage Improvement Works in Sha Tin and Sai Kung – Investigation" (referred to hereinafter as the "Investigation Study") to carry out various reviews, survey, investigation, impact assessments and preliminary design for the Project. The Investigation Study recommended the drainage improvement works in Sha Tin and

Sai Kung as shown in the attached drawings and as described below:

(a) Stormwater pumping scheme at Sha Tin Town Centre, including an underground storage tank, a pump house and associated pipeworks and electrical and mechanical (E&M) works, as well as drainage upgrading works around Sha Tin Town Centre such as Pak Hok Tin Street, Sha Tin Centre Street, Man Lai Road and ancillary works including reinstatement of playgrounds and associated facilities;

(b) Stormwater pumping scheme at Chui Tin Street Soccer Pitch including an underground storage tank and associated pumps, pipeworks and E&M works, as well as drainage upgrading works around Sun Tin Village, Kak Tin Street, Chui Tin Street and Che Kung Miu Road and ancillary works including reinstatement of soccer pitch and associated facilities;

(c) Drainage upgrading works at Fui Yiu Ha, Ma Ling Path, Kau To Hang, Hang Hong Street, Tai Po Road (Ma Liu Shui), Pok Hong Estate, Wong Chuk Yeung Village and Lai Wo Lane, Po Lo Che Road, Ho Chung and Wong Chuk Wan; and

(d) Flood walls along Shing Mun River to protect the cycle track against flooding due to astronomical high tide.

1.1.1.8 AECOM Asia Company Limited was appointed by DSD on 20 December 2021 to undertake Agreement No. 44/2020(DS) "Drainage Improvement Works in Sha Tin and Sai Kung – Design & Construction" (referred to hereinafter as "the Project"), of which the *starting date* of the Project is 29 December 2021.

1.1.1.9 The proposed drainage improvement works are located at the following areas:

Hang Hong Street and Hang Kwong Street (MOS1)
Wong Chuk Wan (SKTC2)
Po Lo Che Road (SKTC5)
Hiram's Highway Near Marina Cove (HC4)
Chui Tin Street and Chui Tin Street Soccer Pitch (TW3)
Pok Hong Estate and Fui Yiu Ha (STS1 and STS2)
Shing Mun River Cycle Track (STS5)
Sha Tin Town Centre (STN1)
Lai Wo Lane (STN5)
Wong Chuk Yeung Village (STN7)
Ma Ling Path and Kau To Hang (STN9 and STN10)
Tai Po Road (Ma Liu Shui) (STN12)

1.2 Scope of the Project

1.2.1.1 The scope of this Project mainly comprises adoptive review, investigations, options appraisals, impact assessments, preliminary design and public consultation.

1.2.1.2 Details of the proposed drainage improvement works are presented on **Drawings No. 60617767/GAR/318** to **60617767/GAR/319**.

1.3 Scope of this Report

1.3.1.1 The scope of this Geotechnical Assessment Report is summarised as the follows:

(a) review the Geotechnical Assessment Report prepared under the Investigation Study of the Project, and incorporates the review findings in the Preliminary Review Report and the Adoptive Review Report.

(b) review the preliminary geotechnical design and recommends alternative schemes which could bring benefits to the Project in terms of cost and programme.

(c) submit the necessary submission to GEO timely in accordance with PAH and the technical guidance note documents listed in the GEO Technical Guidance Note (TGN) No.1, but not limited to, ETWB TC(W) Nos. 29/2002, 4/2004, 20/2004 and 13/2005.

2 SITE DESCRIPTIONS AND BACKGROUND STUDY

2.1 General

2.1.1.1 Majority of the proposed drainage improvement works are along existing road and open areas, parks. The following describe the general setting of the sites and the proposed works.

(a) Sha Tin Town Centre (STN1) site is within the road networks of Shatin Town Centre and the Sha Tin Park adjacent to Shing Mun River. The site is mostly on flat land with isolated existing slope features. It is proposed to install about 850m long new drainage pipes with associated manholes by both cut and cover and trenchless methods. There is also a proposed pump house and CLP transformer room at the park.

2.1.1.2 The available geological and geotechnical information obtained from the Geotechnical Information Unit (GIU), Civil Engineering and Development Department (CEDD), Lands Department (LandsD) and major utility undertakers have been collated to review.

2.1.1.3 These background geotechnical/geological information of the site are primarily retrieved from the published geological information (e.g. geological maps/memoirs), GI reports from GEO Geotechnical Information Unit, aerial photographs, existing landslide-related inventories from GEO (i.e. Enhanced Natural Terrain Landslide Inventory (ENTLI), Large Landslide Study (LLS), Reported Landslide Incidents (RLI), Historical Landslide Catchment Inventory (HLCI)), existing registered features in Slope information System (SIS), land status and existing underground utility records.

2.2 Published Geology

2.2.1.1 According to the 1:20,000 Hong Kong Geological Map Sheet 7, 2nd Edition (GEO, 2008) and Map Sheet 8 (GEO, 1989), the sites at Sai Kung generally comprises coarse ash crystal tuff of Tai Mo Shan Formation (JTM) and Long Harbour Formation (Krl_cat). A layer of colluvium (Qd) and alluvium (Qfa) is identified as superficial soil.

2.2.1.2 According to the 1:20,000 Hong Kong Geological Map Sheet 7, 2nd Edition (GEO, 2008), the sites at Ma On Shan and Sha Tin predominantly comprises coarse-grained granite of Shui Chuen O Granite (Kcs_gc), medium-grained granite of Sha Tin Granite (Jkt_gm) and porphyritic fine-grained granite with some equigranular medium-grained granite of Needle Hill Granite (Jkn_gf). A layer of fill, colluvium (Qd), alluvium (Qfa), intertidal deposits (Qhi) and marine sand (Qhs) is recorded as superficial soil.

2.2.1.3 Several inferred faults trending northwest and northeast directions are dissecting the sites at Sha Tin and Ma On Shan.

2.2.1.4 The geological plans covering the Sites are presented in **Figure 2.1** and **Figure 2.2**.

2.3 Aerial Photograph Interpretation

2.3.1.1 A preliminary Aerial Photograph Interpretation (API) has been carried out for the sites. The findings are presented in **Appendix B**.

2.4 Archival Ground Investigation Records

2.4.1.1 The previous GI information relevant to the proposed drainage improvement works have been gathered from the archival GI records kept in the Geotechnical Information Unit (GIU) in GEO. The locations of the previously existing GI stations are presented in **Drawings No. 60617767/GAR/301** to **60617767/GAR/327**, whereas the encountered geological strata in these GI stations are summarised in **Appendix C.**

2.5 Previous Field and Laboratory Testing Records

2.5.1.1 Previous in-situ field and laboratory testing results have been retrieved from archival GI records. The findings are summarised in **Appendix D.** The field tests generally included standard penetration tests and permeability tests, whereas the laboratory tests typically included particle size distribution (PSD) test, bulk/dry density test, moisture content test, Atterberg limits and plasticity index tests, triaxial test, consolidation tests, compaction test, chemical tests, unconfined compressive strength test and point load test on rock.

2.5.1.2 Summaries of the previous in-situ field test and laboratory test data are presented in **Desk Study Report** of Agreement No. CE 15/2019 (DS).

2.6 Previous Groundwater Monitoring Records

2.6.1.1 Previous ground water monitoring records have been retrieved from GIU of GEO and project specific GI record. There were 15 standpipes and 28 piezometers installations located in the vicinity of the sites. The location of the standpipes and piezometers are shown on **Figure 2.26** to **Figure 2.52,** whereas the groundwater monitoring data are summarised in **Appendix E**.

2.7 Landslide and Natural Terrain Instability Records

2.7.1.1 Existing landslides related data are presented in **Figure 2.9**, showing the following information:

(i) Natural terrain landslides as identified in the ENTLI database

(ii) Large landslides as identified in the Large Landslide database

(iii) Reported landslide incidents

(iv) Historical Landslide Catchments (HLC)

2.7.1.2 Under this Study, no natural terrain catchments are identified at a location where the hillside is sloping at more than 15° within 100m horizontally upslope of the site boundaries and overlooking Group 1, 2 or 3 facilities in the sites. In accordance with GEO Report 138 (GEO, 2016), the sites are not satisfied the "Inclusion" guidelines and therefore not likely to be affected by natural terrain hazards.

2.8 Existing Registered Man-Made Feature

2.8.1.1 There are about 70 registered man-made features affected or to be affected to the proposed development in SKTC2, SKTC5, HC4, TW3, STS1 and STS2, STN1, STN5, STN9 and STN10, and STN12. The summary of their attribute data is presented in **Appendix F**.

2.8.1.2 The locations of the Man-Made Features are presented in **Figure 2.21**.

2.9 Land Status

2.9.1.1 The land status of the sites is shown in **Appendix G**.

2.9.1.2 Following the preliminary review of the land status, the proposed ground investigation works were mainly located within government land and some were located in the vicinity of private lots. In view of this, consultation with the relevant stakeholders are needed to be carried out prior to the proposed ground investigation works.

2.10 Existing Utilities

2.10.1.1 Various utilities are identified in the vicinity of the sites. The major utility undertakers WSD, CLP, Town Gas, HKT, HKCG and TGT were requested to provide information on their existing utilities/services located within or in the vicinity of the sites.

3 PROJECT SPECIFIC GROUND INVESTIGATION FIELD WORKS

3.1 General

3.1.1.1 The GI field works were undertaken by DrilTech Ground Engineering Limited under CEDD Contract No. GE/2019/16 Ground Investigation – New Territories East, which aimed to provide geological information across Study Areas. The field GI works were commenced on 20 August 2020 and completed on 10 July 2021.

3.1.1.2 The project specific ground investigation works comprised the following:

- 1 no. borehole (DH1) in STN1

3.1.1.3 The as-built locations of the boreholes and trial pit are shown in **Drawings No. 60582845/GAR/319**. A summary of the geological conditions encountered in the project specific boreholes are included in **Appendix B**. The findings of the ground investigation are discussed in **Section 4**.

3.1.1.4 5 nos. of Casagrande type piezometers and 5 nos. of standpipes were installed in each borehole. A total of 7 days monitoring was carried out after installation of the standpipes and piezometers at STN1 between 28 September and 22 October 2020. The 7 days monitoring of standpipes and piezometers at SKTC2 was carried out between 08 and 16 June 2021. A summary of the level of installation and the groundwater monitoring records till to June 2021 are provided in **Appendix E**.

3.1.1.5 The samples of soil and rock from the boreholes and trial pit were taken for laboratory testing by Soils & Materials Engineering Company, Ltd. The laboratory tests were conducted from 02 February to 09 March 2021. A summary of the soil and rock laboratory tests is included as **Appendix D**.

4 GEOLOGY AND GROUND CONDITION

4.1 General

4.1.1.1 A study of the available geological and geotechnical information has been reviewed to identify any geological or geotechnical constraints which may affect the feasibility of the project, and especially any issues which need further investigation in order to demonstrate the feasibility of the project. The review will also allow the costs and programme of the investigation to be estimated more reliably.

4.1.1.2 The published geological information covering the proposed drainage improvements and their surroundings have been reviewed, including the 1:20,000 and 1:100,000-scale geological maps, and the accompanying geological memoirs. The site conditions have been investigated based on the published geological and geotechnical information and the available ground investigation records.

4.1.1.3 The general geological plans of the sites are shown in **Figure 2.2**.

4.2 Superficial Geology

4.2.1.1 At STN1, generally 1.5m to 9.4m thick of fill layer with silt to gravel sized was encountered on the top. A layer of marine deposits (clay/silt/sand) with thickness ranging from 2m to 11m was found below the fill layer. Approximately 1.94m to 12.2m thick of alluvium (typically silt to gravel) was identified below the marine deposits. Besides, a layer of colluvium (clay/silt/sand) with thickness up to 7.5m was also encountered below the marine deposits/alluvium. A geological section for the proposed STN1 Pump House and CLP Transform Room is shown on **Drawings No. 60582845/GAR/351**.

4.2.1.2 A summary of the identified strata of the superficial geology at each area is presented in **Table 4.1**.

Table 4.1 Summary of superficial geology

Site	Maximum Thickness of Strata (m)				Proposed works
	Fill	Marine Deposit	Alluvium	Colluviu m	
Sha Tin Town Centre (STN1)	9.4	11	112.2	7.5	About 850m long new drainage pipes up to 1650mm diameter with associated manholes by both cut and cover and trenchless methods. There is also a proposed pump house and CLP transformer room of about 13m excavation depth

4.3 Solid Geology

4.3.1.1 At STN1, saprolite encountered typically comprised highly to completely decomposed granite with thickness ranging from 0.6m to 45.77m. The inferred rockhead level varies from -41.12mPD to +25.42mPD. In general, the weathering profile appeared to become deeper towards the northeast. The bedrock was typically described as moderately strong to strong, moderately to slightly decomposed granite. A geological section for the proposed STN1 Pump House and CLP Transform Room is shown on **Drawings No. 60582845/GAR/351**.

4.3.1.2 A summary of the identified strata of the solid geology at each area is presented in **Table 4.2**.

Table 4.2 Summary of solid geology

Site	Maximum Thickness of Saprolite (m)	Deepest Inferred Rockhead (mPD)
Sha Tin Town Centre (STN1)	45.77	-41.12

4.4 Structural Geology

4.4.1.1 The northwest and northeast trending inferred faults traverse STN1. Fault breccia with thickness up to 6.36m was encountered in the available ground investigation records.

4.5 Hydrogeological Condition

4.5.1.1 Shallow groundwater table was identified at STN1, which is generally from 0.45m to 4.51m below ground level.

4.5.1.2 Project specific groundwater monitoring was conducted at STN1. The groundwater table was relatively shallow at these three sites, which range from 1.76m to 4.49m below ground level.

4.5.1.3 The locations of the GI station with the highest and lowest ground water monitoring records are presented in **Figure 2.42 to Figure 2.43**.

5 DESIGN PARAMETERS

5.1 Soils

5.1.1.1 All the field tests and laboratory test data carried out from the project specific and existing ground investigation (GI) information in the vicinity of the study area, are taken into consideration to find the maximum, minimum and average values of various soil parameters. The range of soil parameters obtained from both existing and project specific GI are summarised in **Appendix D**.

5.1.1.2 The field tests include standard penetration tests (SPT) and permeability tests; and the laboratory tests were conducted including particle size distribution (PSD) test, bulk/dry density test, moisture content test, Atterberg limits and plasticity index tests, triaxial tests, consolidation tests, compaction test, and chemical tests. The relevant test results obtained from field and laboratory test data are presented and summarised in **Appendix D, Table D1**.

5.1.2 **Soil Strength**

5.1.2.1 The consolidated drained (CD) and undrained (CU) triaxial compression test results from the available GIs in the study areas were reviewed to determine the effective strength parameters (c' and φ'). The results of the triaxial test for different soil materials are presented in **Appendix D, Chart D2**.

5.1.2.2 Owing to the lack of unconsolidated undrained (UU) triaxial compression and shear vane test results, an empirical correlation relating the undrained shear strength of fine-grained soils to the standard penetration test blowcount (SPT N value) was adopted instead. According to Stroud (1974), the relationship is expressed as $c_u/N = 4.5$ where c_u is the undrained shear strength parameter and N is the SPT N value. The SPT N values against depth for different soil types are shown in **Appendix D, Chart D3**.

5.1.3 **Soil Stiffness**

5.1.3.1 The drained modulus of elasticity E' can be estimated by empirical correlation to the standard penetration test blowcount (SPT N). The correlation $E' = f\,N$ is adopted, where f is a correlation factor that relates the drained Young's modulus E' to the SPT N value. The correlation factor is taken as $f = 1.0$.

5.1.4 **Soil Permeability**

5.1.4.1 Constant or falling head permeability tests were performed in drillholes for various soil materials. The permeability of each soil material is summarized in **Appendix D, Table D2**.

5.2 Rocks

5.2.1.1 Laboratory tests for intact rocks were conducted to determine the relevant strength and stiffness parameters; these include the uniaxial compressive strength tests and point load tests. The results of the tests are presented in **Appendix D, Table D5 and Chart D4**.

5.2.2 **Rock strength**

5.2.2.1 Point load tests (PL) and uniaxial compressive strength test (UCS) were performed on rock samples in the study area. The result of the rock tests is summarised in **Appendix D, Table D5**.

5.2.2.2 As suggested by Broch and Franklin (1972), the results of the point load test can be correlated to uniaxial compressive strength values by multiplying the point load index $I_{s\ (50)}$ by 24. The correlated uniaxial compressive strength values are presented in **Appendix D, Table D5**.

5.2.3 **Rock Stiffness**

5.2.3.1 The tangent, secant and average modulus of elasticity and Poisson's ratio have been determined for rock samples and cores in the study area. The stiffness parameters are presented in **Appendix D, Table D5**.

5.3 Recommended Geotechnical Design Parameters

5.3.1 **Recommended Design Soil Parameters**

5.3.1.1 Based on the best available data, the range of parameters, the data plots and the engineering judgement, the soil parameters recommended for the design are summarised in **Table 5.1**.

5.3.1.2 For the effective cohesion *c*' and the effective angle of internal friction *φ*' of different soil types, the corresponding *s*'-*t* plots and recommended design lines are presented in **Appendix D, Chart D2**.

5.3.1.3 For the design SPT N values, the standard penetration tests (SPT) N values were plotted for different soil types, and the recommended design lines are presented in **Appendix D, Chart D3**.

5.3.1.4 It should be noted that the available GI information including both existing GI and the project specific GI at each area is relatively limited. The recommended design parameters are therefore considered as tentative only and they should be reviewed when further GI data is available.

5.3.2 **Recommended Design Rock Parameters**

5.3.2.1 Based on the available laboratory test results, the geotechnical rock parameters recommended for the subsequent for the subsequent design are summarised in **Table 5.2**.

Table 5.1 Summary of design soil parameters

<table>
<tr><th>Soil Parameter</th><th>Soil Type</th><th>Design Value</th></tr>
<tr><td rowspan="8">Bulk Unit Weight, γ_{bulk}</td><td>Fill</td><td>19.0 kN/m^3</td></tr>
<tr><td>Marine Sand</td><td>19.0 kN/m^3</td></tr>
<tr><td>Marine Silt/Clay</td><td>17.0 kN/m^3</td></tr>
<tr><td>Alluvial Sand</td><td>19.0 kN/m^3</td></tr>
<tr><td>Alluvial Silt/Clay</td><td>18.0 kN/m^3</td></tr>
<tr><td>Colluvium</td><td>19.0 kN/m^3</td></tr>
<tr><td>Residual Soil (Granite, Tuff)</td><td>19.0 kN/m^3</td></tr>
<tr><td>CDG, CDT, HDG</td><td>19.0 kN/m^3</td></tr>
<tr><td rowspan="6">Drained Shear Strength Parameters, c' & φ'</td><td>Fill</td><td>STN1: c' = 0 kPa, φ' = 30°(**)</td></tr>
<tr><td>Marine Sand</td><td>STN1:c' = 0 kPa, φ' = 33°(***)</td></tr>
<tr><td>Alluvial Silt/Clay</td><td>STN1: c' = 2 kPa, φ' = 29°</td></tr>
<tr><td>Alluvial Sand/Gravel</td><td>STN1: c' = 0 kPa, φ' = 36°</td></tr>
<tr><td>Colluvium</td><td>STN1:
c' = 0 kPa, φ' = 28°(***)</td></tr>
<tr><td>CDG</td><td>STN1: c' = 5 kPa, φ' = 37°</td></tr>
<tr><td>Undrained Shear Strength(*), c_u</td><td>Alluvial Silt/Clay</td><td>STN1: For $z \leq 8.5$ m, $c_u = 35.2$ kPa
For $z > 8.5$ m, $c_u = 18.8z - 124.4$ kPa</td></tr>
<tr><td colspan="3">* Vane shear and UU test data are not available, c_u is correlated using Stroud (1974), with c_u/N = 4.5 (see Section 5.1.2).
** Existing data is limited and variable for Fill at STN1. The design parameters proposed are to be verified by further works.
*** Test data is not available and conservative values are assumed.</td></tr>
</table>

Table 5.2 Summary of design rock parameters

Rock Parameter	Rock Type	Design Value
Unconfined Uniaxial Compressive Strength	Slightly Decomposed Granite	**STN1**: 70.0 MPa
Modulus of Elasticity	Slightly Decomposed Granite	**STN1**: No GI information available
Poisson's Ratio	Slightly Decomposed Granite	**STN1**: No GI information available
* Test data is not available at SKTC5 and values are assumed based on SKTC2 GI data. Site-specific GI for SKTC5 is recommended.		

5.4 Design Groundwater Levels

5.4.1 Highest possible groundwater level

5.4.1.1 The highest possible groundwater level is assumed to be existing ground level. This groundwater level is used for checking of uplift/buoyancy force due to underground water acting on a structure against a minimum FoS of 1.1.

5.4.2 Highest anticipated groundwater level

5.4.2.1 The measured groundwater levels from both existing GI and the project specific GI, as shown on **Figure 2.42** to **Figure 2.43.** A summary of all available groundwater monitoring records is presented in **Appendix E**.

5.4.2.2 It is noted that the duration of the groundwater monitoring at each standpipe/piezometer location is relatively limited. For areas with major geotechnical works including STN1, the highest anticipated groundwater level is recommended by taking into account both the measured data and the tidal information recorded at Tai Po Kau from Ports Work Design Manual.

5.4.2.3 The highest anticipated groundwater level is taken as the higher value of (a) 0.5m above the measured highest groundwater level and (b) 1m above the mean higher high water level at Tai Po Kau (i.e. 2.0 mPD, Ports Work Design Manual). This groundwater level is used for checking of uplift/buoyancy force due to underground water acting on a structure against a minimum FoS of 1.5. The measured highest groundwater levels are summarised in Table 5.3.

5.4.3 Lowest anticipated groundwater level

5.4.3.1 Similarly to the highest anticipated groundwater level, due to limited duration of the groundwater monitoring at each standpipe/piezometer, for areas with major geotechnical works including STN1, the lowest anticipated groundwater level is recommended by taking into account both the measured data and the tidal information recorded at Tai Po Kau from Ports Work Design Manual.

5.4.3.2 The lowest anticipated groundwater level is assumed to be the lower of (a) measured lowest groundwater level and (b) the mean sea level at Tai Po Kau (i.e. 1.2 mPD, Ports Work Design Manual). This groundwater level is used for checking of compression capacity of foundations when uplift/buoyancy force due to underground water is a beneficial action. The measured lowest groundwater levels are summarised in **Table 5.3**.

Table 5.3 Summary of measured groundwater levels

Area	**Measured highest groundwater level**		**Measured lowest groundwater level**	
	mPD	mbgl	mPD	mbgl
Sha Tin Town Centre (STN1)	2.11	3.95	2.08	3.98

6 EXISTING REGISTERED MAN-MADE FEATURES

6.1 Background Information of Existing Features

6.1.1.1 There are about 4 registered man-made features located in the close vicinity of the proposed drainage improvement works. The summary of their attributes is presented in **Table F1** in **Appendix F1**. The location of the man-made features is presented in **Figure F1** to **Figure F5** in **Appendix F2**.

6.1.1.2 The slope information of the exiting features discussed above have been archived from the Slope Information System (SIS) and are enclosed in **Appendix F3**.

6.2 Types of Proposed Works

6.2.1.1 With respect to the impact assessment of the existing features, there are the following main types of drainage improvement works proposed:

A) Trench excavations for proposed covered channels and drainage pipes of various sizes and depths;

B) Manholes, launching shafts and reception shafts for the trenchless methods;

C) Box culverts to be constructed by the cut and cover method;

D) Trenchless method for installation of drainage pipes of various diameters.

6.2.1.2 Work types A), B) and C) are to be constructed by excavations from the ground surface and supported by excavation and lateral support (ELS) systems. Potential impacts of these works to the existing features and mitigation measures are discussed in **Section 6.3**.

6.2.1.3 Work type D) involves trenchless methods or pipejacking for installation of drainage pipes. Generic types of operations, potential impacts to existing features and the potential mitigation measures are discussed in **Section 6.4**.

6.3 Impact Assessment of the Proposed ELS Excavations

6.3.1.1 For the proposed works which are close to the slope toes of the existing features, excavations may cause adverse impacts to the stability of slopes. Design of the temporary ELS for the excavation works should be carried out in the detailed design and construction stages, taking due account of all relevant considerations to minimize the influence on the existing features.

6.3.1.2 For the proposed works close to the crest of the existing features, the impacts to the existing slope are expected to be less than those caused by excavations at slope toes. Nevertheless, Design of the temporary ELS for the excavation works should be carried out in the detailed design and construction stages, to minimise the potential impacts to existing features.

6.3.1.3 **Table 6.1** shows a summary of the existing features which are located close to the proposed temporary ELS excavations.

Table 6.1 Existing features adjacent to proposed ELS excavations

Feature No.	Proposed works at toe or crest	Tentative Distance to proposed work	Proposed work	Factors may affect existing feature	Recommended control measures
Sha Tin Town Centre (STN1)					
7SE-C/FR 216	Toe	< 1m	1500mm diameter pipe	Slope stability; Temporary ELS stability; Damming up of GWL; Ground settlement; Vibration	Impact assessment of proposed works; Excavation supported by a temporary ELS system; Dewatering and settlement assessments; Vibration control and monitoring
7SW-D/FR 89	Toe	4m	750mm diameter pipe, manholes and pumphouse		
7SW-D/FR 85	Toe	< 1m	750mm diameter pipe, manholes and pumphouse		

6.3.1.4 Trench excavation works are common for shallow excavation works of utilities or channel installation of less than 1.2m. The lateral support is provided after the excavation to maintain a stable trench for works. However, if this shallow excavation is within 30m distance from the slope toe, the impact to the slope stability could be significant due to the shallow unsupported excavation. Temporary ELS works should be designed and provided to support such excavations and an impact assessment of the proposed works should be carried out.

6.3.1.6 Based on the assessment, an unsupported excavation will reduce the stability of the existing slope. A temporary ELS system is required. The temporary ELS system reduces the magnitude of stress relief and ground movements due to the excavation. If the excavation works is at a distance less than 2 times of the excavation depth from the slope toe, a lateral support wall should be installed to support the ground before excavation and further support by struts during excavation in subsequent stages. The lateral support wall should be designed for adequate toe stability according to the Geoguide 1 and other GEO publications.

6.3.1.7 The temporary ELS system should be also designed to avoid damming up of groundwater levels in the existing features. During excavation groundwater levels outside the excavation should be monitored to ensure that there is no rise of groundwater level.

6.3.1.8 When dewatering is required for the excavation of the proposed works, the groundwater levels outside the excavation are likely to drop and may induce ground settlements outside the excavation. The necessity of hydraulic cut off shall be assessed and designed in the detailed design stage to limit the settlement. The magnitude of induced settlements should be monitored and limited during the construction stage.

6.3.1.9 For excavations near the crest of existing slopes, it is best that these excavations are not be opened up during the wet season. If such works have to be excavated during the wet season, the excavations should be protected against the ingress of runoff from the surface. Upstands should be provided to avoid rainwater infiltration into the slope. Pumping from sumps with sufficient capacity should always be provided for all excavations. Sufficient standby pumps should also be provided. It is necessary to ensure the excavation is not flooded and the pumps are functioning during inclement weather.

6.3.1.10 The installation of the ELS walls should not cause excessive vibrations to the existing features. During wall installation, the peak particle velocities (PPV) at three orthogonal axes should be measured at ground levels of the existing features. The maximum PPV should not exceed 15 mm/sec and 7.5 mm/sec (PNAP APP-137, Buildings Department) for transient vibration and continuous vibration, respectively.

6.3.1.11 All structures including covered channels, drainage pipes, shafts and culverts should be designed with structural capacities adequate to resist pressures from the ground with consideration of active soil pressure from the existing slope features.

6.4 Impact Assessment of the Proposed Trenchless Excavations

6.4.1 General

6.4.1.1 The length over which a pipejack can be installed is dependent upon a number of interrelated and variable factors: the stability and friction characteristics of the geology to be tunnelled through, the self-weight and strength of the pipes, the diameter of pipe, the type of tunnelling equipment, and the available jacking reaction. The major constraint will be the nature of the ground and the ground water characteristics. However, the distance that can be achieved is optimised by the use of a range of techniques such as Interjack stations and lubricant.

6.4.1.2 For pipeline installation in great depths, the TBM pipejacking technique is an effective means due to its fast operation, no requirement or only small scale diversion of existing utilities and services, and avoidance of temporary traffic diversion etc. However, extensive time is required to ascertain the locations of the jacking pit and receiving pit by inspection pits on the utility and other site constraints.

6.4.1.3 **Table 6.2** shows a summary of the existing features which are located close to the proposed trenchless works for drainage pipes.

Table 6.2 Existing features adjacent to proposed trenchless works

Feature No.	Distance to proposed work	Type of proposed works
Sha Tin Town Centre (STN1)		
7SW-D/F 156	0m	Trenchless excavation of 1650 mm pipe

6.4.2 Mode of operations

6.4.2.1 The construction pits for the jacking pipes installation is undertaken either by hand or machine within a shield, or by a tunnel boring machine (TBM). Three modes of operations are commonly adopted for pipejacking works in Hong Kong. They are 1) hand-dug tunnel, 2) earth pressure balance TBM and 3) slurry pressure balance

TBM.

1) Hand-dug tunnel – an open-face shield in which manual excavation takes place, for 1200mm internal diameter and above, and for very limited drive lengths on the grounds of health and safety. However, the use of hand-dug method for tunnel diameter smaller than 3m is prohibited by Labour Department on the construction safety considerations unless substantial safety measures (e.g. evacuation shaft at 25m spacing).

2) Earth pressure balance machine (EPB) – a 'full-face' tunnel boring machine in which the excavated material is transported from the face by a balanced screw auger or screw conveyor. The face is supported by slurry mud cake at the front of TBM under pressure behind the cutter head. Pressure is controlled by the rate of passage of excavated material through the balanced screw auger or valves on the screw conveyor.

3) Pressurised slurry machine – a 'full-face' tunnel boring machine in which the excavated material is transported from the face suspended in a slurry. Various cutting heads are available to suit a broad range of ground conditions and may incorporate internal crushers to deal with gravels and small boulders. The tunnel face stability was maintained by the application of slurry in the ground, under a pressure of about 10% higher than the ground and groundwater pressure, in front of the TBM.

6.4.2.2 EPB machines generally are suitable for finer-grained soils and slurry machines for coarser grained soils. However, due to the constrain on the size of the soil removal equipment in an EPB machine, 1.7m diameter tunnel is too small for EPB machine. Therefore, slurry type TBM may be the preferable type of tunnelling machine for this project.

6.4.3 Ground conditions and impact to slope features

6.4.3.1 As proposed trenchless works are in close vicinity of a relatively large number of existing man-made features along Po Lo Che Road at SKTC5, a preliminary generic review of the ground conditions, hydraulic conditions and potential impacts to the features is carried out and presented below.

6.4.3.2 According to the available GI records, the excavation of pipelines may involve various geologies such as Fill, Colluvium and hard rock. Full face slurry operated TBM is considered suitable to excavate through. However, within the Fill and Colluvium layers, cobbles and boulders are observed and also mix ground condition is anticipated when the TBM driving through the interface of hard and soft materials. Under these situations, challenges on the TBM tunnelling will be encountered to maintain the face pressure to ensure the face stability and also the alignment of pipe jacking.

6.4.3.3 In addition, as the proposed pipe jacking alignment is locating at close vicinity of the slope toe, the impact assessment due to the sloping ground effect (i.e. unbalance ground pressure) should be carried out.

6.4.3.4 In view of the above issues, ground treatment works may be required where sensitive receivers are found. Alternatively, to mitigate the above issues and minimize the ground treatment works, a deeper alignment option can be adopted to drive the TBM within uniform and competent geological stratum.

6.4.3.5 The hydraulic conductivity of soft and mixed ground is generally high at hillside. Measures such as grout treatment from the ground surface may be required to prevent excessive water ingress and associated instability which may cause undue ground movements. Particular attention should also be paid to assessing the invert stability of pipelines in soft ground if a large piezometric head is present.

6.4.3.6 On the impacts to the existing features, one of concern is the construction of pipelines close to mountainous slopes that could be inherently unstable from the onset of construction. The use of slurry type TBM can reduce soil movement while the excavated face can be stabilized and supported by slurry.

6.4.3.7 When the tunnels are placed deeper within the stiffer and uniform ground stratum, the impact on slope can be reduced as the result of lesser ground volume loss and better ground arching effect in competent ground conditions.

6.4.3.8 To prevent propagation of the land slide on the existing slopes, additional measures such as ground treatment or retaining wall tied back with anchors shall be adopted at uphill at where the slope feature is sensitive to the destress or ground movement due to tunnelling.

6.4.3.9 A sensitivity assessment on the impacts of a typical trenchless work near existing features was carried out and is enclosed in **Appendix F5**.

6.5 Summary

6.5.1.1 The design and construction of both ELS excavations and the trenchless methods for the proposed works should ensure that the existing slope and retaining wall features are not adversely affected. The requirements include the assessment of stability of the existing slopes and retaining walls, groundwater levels, ground settlement, vibrations, and stability of the shaft excavations and the faces of the trenchless excavations.

7 PROPOSED FOUNDATION TYPES

7.1 Sha Tin Town Centre (STN1)

7.1.1 STTC Storage Tank and Pump House

7.1.1.1 **Uplifting Check**: The total dead load of the storage tank for uplift check is 204191 kN, and the total load of the structure is 532050 kN. The calculated FoS against uplifting is less than the required minimum FoS of 1.5 under the highest anticipated groundwater level and is less than the required minimum FoS of 1.1 under the highest possible groundwater level. Consequently, raft foundation is not workable. Pile foundation is required and pile tension capacity checking is required.

7.1.1.2 **Foundation Option 1 (Socket H-pile)**: The structure can be supported by socket H-piles. Socket H-pile (SKHP) founded on Cat. 1(c) rock may be adopted to transfer the loading from the structure to a competent bearing stratum. All vertical loads are taken by shaft friction between Cat. 1(c) rock and cement grout with an allowable friction of 700 kPa and an allowable bond stress between steel and grout of 480 kPa when grouting under water. A total number of 72 SKHPs are required with a socket length of 7m in Cat. 1(c) rock.

7.1.1.3 **Foundation Option 2 (Driven H-pile):** An alternative option is that the structure is supported by driven H-piles (DHP). Based on project specific borehole STN1-DH1, the piles may be driven to -36.8 mPD and the available embedded pile length is about 30m. A total of 180 numbers of piles is required. However, two existing boreholes 17822/BH4 and 17822/BH6 indicate that the Cat. 1(c) rock may be as high as -32 mPD, which results in an available embedded pile length of about 25 m. The total number of piles required may have to be increased to 238 due to the potential shallow presence of rockhead.

7.1.1.4 **Foundation Option 3 (Mini-pile)**: Mini-piles founded on Cat. 1(c) rock may be adopted to carry down the loading from underground structure to foundation and to the ground. All vertical loads are taken by shaft friction between Cat. 1(c) rock and cement grout with an allowable friction of 700 kPa and an allowable bond stress between steel and grout of 800 kPa. A total number of 240 mini-piles are required with a socket length of 7m in Cat. 1(c) rock.

7.1.1.5 The preliminary calculations of the three options are shown in **Appendix H**.

7.1.1.6 It is recommended to conduct further GI at Sha Tin Town Centre (STN1), since there is no available borehole located within the footprint of the proposed structure, as shown on **Drawing No. 60617767/GAR/319**. Boreholes with 20 to 30m spacing are recommended for detailed design. Before construction pre-drilling should be carried out such that the tip of every pile should be within 5m distance from a pre-drilling hole.

7.1.2 STTC CLP Transformer Room and Switch Room

7.1.2.1 **Uplifting Check**: The proposed structure is at the ground level and therefore uplifting check is not required.

7.1.2.2 **Bearing Capacity**: The total design load is 20010 kN which corresponds to a design loading of 98 kPa. There are four layers of soils underlying the structure, i.e. Fill, Marine Deposit (Sand), Alluvium (Clay and Sand) and CDG. The bearing capacity of each layer is checked and are acceptable. The allowable bearing capacity of the ground is sufficient to satisfy the design load of the Transformer Room and Switch Room.

7.1.2.3 **Settlement**: The total settlement of the four underlying soil layers is calculated. Load spread to the top of each layer is considered in the calculation. It is noted that the SPT N values vary widely in the CDG, and therefore the layer is further separated to two sub-layers in settlement calculations, i.e. CDG(1) with a Young's modulus of 30 MPa and CDG(2) with a Yong's modulus of 70 MPa. The total settlement of all soil layers underlying the structure is about 65 mm.

7.1.2.4 **Foundation Option 1 (Raft foundation)**: As the allowable bearing capacity of the ground is sufficient for the design loading of the structure, raft foundation may be considered. However, it is noted that the estimated total settlement is about 65 mm, which exceeds the criterion for maximum total settlement of 30 mm in CoP of Foundations (BD, 2017), Clause 2.3.2(2). Furthermore, as the adjacent STTC Pump House is to be supported by pile foundations, differential settlements between the Transformer and Switch Room and the STTC Pump House may be a concern.

7.1.2.5 For the reasons above, in order to reduce the settlements of the Transformer and Switch Room, the underlying soils including the existing Fill, the Marine Deposits and the Alluvium may need to be excavated and backfilled with compacted fill. It should be noted that the extent of backfill should include soils present not only within the footprint of the structure but also within the influence zone of the foundation (i.e. load spread), which is commonly approximated as a ratio of 2 (vertical) to 1 (horizontal) from the edge of the footprint of the structure.

7.1.2.6 **Foundation Option 2 (Socket H-pile):** If the differential settlement between the Transformer and Switch Room and the STTC Pump House is a concern, the Transformer Room and Switch Room may also be supported by socket H-piles (SKHP) found on Cat. 1(c) rock. Design methodology for the piles is the same as for the STTC Storage Tank and Pump House. A total number of 9 piles is required with a socket length of 7m in Cat. 1(c) rock.

7.1.2.7 **Foundation Option 3 (Driven H-pile)**: Alternatively, driven H-piles (DHP) is also an option for the Transformer Room and Switch Room. Depending on the available embedded pile length for shaft resistance (refer to the design of DHPs for the STTC Pump House), the required number of driven piles varies from 9 to 12 for low and high presence of Cat. 1(c) rock, respectively.

7.1.2.8 **Foundation Option 4 (Mini-pile)**: Mini-piles founded on Cat. 1(c) rock may be adopted. All vertical loads are taken by shaft friction between Cat. 1(c) rock. A total number of 15 mini-piles are required with a socket length of 7m in Cat. 1(c) rock.

7.1.2.9 The preliminary calculations of different options are shown in **Appendix H**.

7.1.2.10 Further GI works are recommended, since there is no available borehole located within the footprint of the proposed structure, as shown on **Drawing No. 60617767/GAR/319**. Boreholes with 20 to 30m spacing are recommended for detailed design. Before construction pre-drilling should be carried out such that the tip of every pile should be within 5m distance from a pre-drilling hole.

7.2 Comparison on Piling Schemes

7.2.1.1 Comparisons between Driven H-piles and Socket H-piles are made in terms of cost effectiveness, constructability, duration of works and environmental impact as shown in the **Table 7.1**.

Table 7.1 Comparison on different piling schemes

Types of piles	Advantages	Disadvantages
Socket H-piles	1. Non percussive pile: low noise, low vibration – less disturbance to neighbours. 2. Able to penetrate hard materials.	1. Embedment depends on the presence of bedrock which may increase costs when rockhead is deep. 2. Risk of loosening soils during pile excavation and causing ground loss and settlements.
Driven H-piles	1. Relatively low cost. 2. Ease of handling and driving.	1. Pile load test is required. 2. Percussive piles: high noise and vibration - more disturbance to neighbours. 3. Operation duration may be restricted subject to the CNP application, usually limited to 3 working hours per day in urban areas in Hong Kong. 4. Pile section may become damaged during driving. 5. Predrilling may be required if encountering hard materials, such as boulders. 6. Available length for pile shaft resistance is limited when the rockhead is high and accordingly a large number of piles may be required.
Mini-pile	1. Rigs are relatively small and may be used for sites with difficult access or limited headroom. 2. Usually able to overcome obstructions in the ground.	1. Structural capacity is derived solely from the steel bars. Contributions from the grout and steel casing is ignored because of the relatively high stress in the steel bars and strain incompatibility. 2. A relatively large number of mini-piles is usually required

Types of piles	Advantages	Disadvantages
	3. Can be installed at an inclination to resist the horizontal loads.	as compared to socket H-piles. 3. Piles are relative slender and the allowable buckling capacity should be checked in weak/soft ground.

7.3 Cost Effectiveness, Time Implication and Constructability

7.3.1.1 Raft foundation, Driven H-piles, Socket H-piles and mini piles have been proposed. Comparison has been made in respect of construction cost effectiveness, time implication and potential issues and are shown in **Table 7.2**.

Table 7.2 General comparison for proposed foundation types

Foundation Type	Cost	Time	Potential Issues
Raft Foundation	Low cost	Short construction time	1. Differential movements or tilts between the empty storage tank and other heavier structure potions may be a concern under certain load cases. 2. Special attention on raft foundations and structural members is required under certain load cases.
Socket H-piles	Relatively high cost	Longer construction time than raft foundation but shorter than driven H-piles	1. Risk of loosening soils during pile excavation and causing ground loss and hence settlements.
Driven H-piles	Relatively high cost	Longest construction time because the working hour and number of pile rigs for percussive piling may be limited by the noise impact brought along and pile load test is required	1. Pile load test is required. 2. High noise and vibration - More disturbance to neighbours. 3. Not suitable for site next to sensitive structures or utility installations. 4. Operation duration may be restricted subject to the CNP application, usually limited to 3 working hours

Foundation Type	Cost	Time	Potential Issues
			per day in urban areas in Hong Kong. 5. Pre-boring is required if encountering obstructions.
Mini-pile	Relatively high cost	Longer construction time than raft foundation and socket H-piles due to large number of piles required	1. A relatively large number of mini-piles is usually required as compared to socket H-piles. 2. Depending on ground conditions, compression capacity may be limited due to slenderness and weak/soft ground.

8 TEMPORARY EXCAVATION AND LATERAL SUPPORT WORKS FOR THE PUMPHOUSES

8.1 Overview of Excavation Methods

8.1.1.1 For this project, the excavations for the two storage tanks and pump houses at STN1 and TW3 are approximately 12 to 13m deep. The excavations for the box culvert at CTS at TW3 are approximately 5 to 7m deep.

8.1.2 Bottom-Up Method

8.1.2.1 Deep excavation of bottom-up method is conventionally adopted for sites without time constraints on the topside development.

8.1.2.2 This method involves first sinking temporary sheet piles / pipe piles / diaphragm walls to the required depths below ground, digging and removing soil, installing temporary steel strutting and then completing excavation with a concrete slab base and open to the sky. After the completion of excavation, the building work then rises from the concrete slab base.

8.1.3 Top-Down Method

8.1.3.1 Top-down method begins by sinking sheet piles / pipe piles / diaphragm walls, plus central supporting ‘plunge’ columns (can be temporary or permanent), and then excavating enough of the earth to complete a ground-level slab. This slab is substantial enough to carry the weight of construction equipment including cranes and incorporates openings though which soil can be lifted up and removed. The excavation then takes place under the ground slab, and permanent floors are cast on the way down to the desired depth. It also means that simultaneously construction above ground can start or the topside space can be available before completion of the underground structure.

8.1.3.2 A comparison of the two construction methods is presented in **Table 8.1** below.

8.1.4 Recommendations

8.1.4.1 The conventional bottom-up method is likely to be more appropriate for the excavations for the three structures, as the main works proposed are underground structures and there is not much time constraints on the topside development.

Table 8.1 Comparison of top-down method and bottom-up method

Method	Advantages	Disadvantages
Bottom-Up Method	1. Less complex in design 2. Fewer constraints to the design of permanent structures 3. Heavy foundations, such as large-diameter piled foundations for the high rise are required and are generally installed from the ground	1. Construction is usually slower and more expensive than the top-down approach. 2. It is not possible to carry out simultaneous upwards and downwards construction until the bottom of the basement is concreted.

Method	Advantages	Disadvantages
	surface before excavation for top down and for bottom up. 4. Waterproofing can be installed around the whole outside, including the outside the permanent walls. 5. Access for cranes is not restricted up and down the sides of the excavation. For sites large enough to have a perimeter area to accommodate construction equipment, and when the excavation is not wide then this method is quicker than the top-down approach.	3. Cranes can be located only on firm ground outside the excavation or on heavy-capacity temporary decks within the excavated area. For wide sites cranes may not be able to reach the middle of the excavation, whereas the top-down method can provide openings at many locations across the site area. 4. For very deep projects, the thickness of the temporary walls plus the permanent walls is greater than for the top-down method using diaphragm walls plus skin wall. Therefore, bottom-up working needs more space for the combined walls or the finished floor area is smaller. 5. The temporary walls serve little or no purpose after completion and, therefore, are wasted. 6. If the scheme design is for bottom-up construction, the time for tendering might be longer since contractors need to prepare a tender design.
Top-Down Method	1. This offers very quick site coverage which includes a robust working platform. The superstructure construction can proceed at the same time as the substructure 2. For large sites, openings can be provided in the floors at many locations within the site and not just around the perimeter. 3. For smaller sites, the ground floor structure provides a site working area and a temporary steel decking is not required. 4. Temporary propping is replaced by the use of the permanent slabs/beams. Requires little or	1. Complex in design. 2. Because work needs to be carried out through openings in the slab, access is only via the openings below the slabs during excavation. 3. The excavation works and substructure construction are slower and more expensive due to the restrictions on the size of the plant and the limited access. 4. Holes may have to be left in the slabs to provide access for the subsequent excavation. 5. Vertical support for the permanent slabs is required in the temporary condition.

Method	Advantages	Disadvantages
	no temporary steel shoring – producing good cost savings. 5. For combined development that includes a substantial structure above ground, the top-down approach makes it possible to get an early start on construction.	6. Inability to install external waterproofing. 7. The stiffer construction during the intermediate construction stages attracts higher loads into the permanent structure.

8.2 STTC Storage Tank and Pump House

8.2.1.1 The excavation for the STTC Storage Tank and Pump House at STN1 is approximately 55 by 45m on plan and about 13m deep.

8.2.1.2 A geological section A-A across the proposed structure is prepared and shown on **Drawing No. 60617767/GAR/351**.

8.2.1.3 Based on the project specific GI drillhole STN1-DH1, the soils to be excavated include Fill (predominantly Sands with sandy silty Clays and fine Gravel), Marine Deposits (silty Sands with fine to coarse gravel) and Alluvial Deposits (sandy silty Clays and silty Sands).

8.2.1.4 The soils below the excavation level are predominantly CDG, which consists of mainly clayey silty fine to coarse Sand with some fine gravel. From the existing GI drillhole 15076/BH-5, there may be a layer of Colluvium (clayey silty Sands with gravel) of about 2m thick below the excavation level. The CDG below the Colluvium is over 20m thick.

8.2.1.5 Corestones are not identified in the project specific GI drillhole STN1-DH1, or two existing GI drillholes 15076/BH-5 and 17822/BH4. However, boulders are identified between 12.4 and 13.0m depths in the Colluvium layer from existing drillhole 17822/BH4. This should be considered in the selection of the temporary ELS system.

8.2.1.6 The temporary ELS scheme comprises a number of structural elements. For the vertical walls, considering the depth of the excavation and the ground conditions, pipe pile walls may be used. As the ground is predominantly sandy, grout curtain is required behind the pipe pile wall to serve as water cut-off. Alternatively, the pipe piles may also be clutched together to prevent water seepage through the wall.

8.2.1.7 The cut-off toe level of the piles should be determined to provide a minimum FoS of 2.0 against toe kickout stability as well as a minimum FoS of 2.0 against hydraulic failure (i.e. piping). The preliminary cut-off toe level of the pile wall was calculated to be -24.10mPD, with a FoS of 2.04 against toe kickout stability and a FoS > 2.00 against hydraulic failure. The calculations for toe kickout stability and hydraulic failure checking are presented in **Appendix J1**.

8.2.1.8 The maximum allowable groundwater drawdown is 1m outside the excavation. Ground settlements due to groundwater drawdown should be assessed, and the maximum settlement due to drawdown was determined to be 14.2mm.

Calculations for groundwater drawdown induced settlement are enclosed in **Appendix J1**.

8.2.1.9 The pipe pile walls are to be supported by temporary multi-level struts. For this excavation 4 levels of struts are required. The pipe pile walls should be designed with circular hollow section of sufficient structural capacity such that it can withstand the maximum axial force, shear force and bending moment calculated via Plaxis 2D, and similarly the temporary struts should be designed with member sizes that can withstand the maximum axial load. The structural checking for walls, main struts and secondary struts is enclosed in **Appendix J1**.

8.2.1.10 The walls and strut elements should also be designed to limit the total ground settlements outside the site boundary to within 25mm. The total settlement is the sum of ground settlement due to wall installation, bulk excavation, and groundwater drawdown. The maximum total settlement was calculated to be 23.4mm, which is within the 25mm limit. Calculations for ground settlements are enclosed in **Appendix J1**.

8.2.1.11 The pipe piles transfer soil pressures to walers running along the inside of the wall. Struts extend across the excavation to equilibrate soil forces from the walers. The buckling length of struts in the horizontal plane can be reduced by employing bracing members. Kingposts are required for long struts to assist in supporting their dead weight. The kingposts also reduce the unrestrained length for buckling of struts in the vertical plane. The member sizes for walers, bracing members and kingposts are presented in **Appendix J1**.

8.3 Comparison on Different Temporary ELS Schemes

8.3.1.1 There are different commonly used temporary ELS schemes in Hong Kong. Some comparisons between common wall types are shown in the **Table 8.2**.

Table 8.2 Comparison on different temporary ELS schemes

Scheme	Advantages	Disadvantages
Sheet pile walls	1. Relatively fast and cost effective. 2. Act as groundwater cut-off as well. 3. Small piling rig and setup area. 4. Common in Hong Kong and experienced contractors available in market and hence more competitive price.	1. Not able to penetrate through hard materials, such as boulders. 2. Preboring is required when there are obstructions during installation, which causes longer construction time and higher cost. 3. Low in bending moment capacity and wall stiffness. Limited excavation depth.
Pipe pile walls	1. Fast and easier in construction. 2. Smaller piling rig and setup area than diaphragm walls. 3. No on-site silo is required.	1. Localized ground loss may occur during eccentric pile drilling.

Scheme	Advantages	Disadvantages
	4. Easier in penetrating through hard materials, such as boulders. 5. Common in Hong Kong and experienced contractors available in market and hence more competitive price.	2. Water tightness subject to performance of grout curtain, but difficult to verify on site. 3. Difficult in grouting when encountering localized fill clay materials. 4. The wall cannot act as a permanent wall. 5. Relatively lower in bending moment capacity and wall stiffness and Less excavation depth comparing with diaphragm walls.
Diaphragm walls	1. Better in water tightness. 2. Less noise or vibration will be generated. 3. Relatively higher in bending moment capacity and wall stiffness. Applicable to deeper excavation. 4. Can serve as a permanent wall. 5. Better control on adjacent ground settlement due to excavation works.	1. A large working area is required for silo setup. 2. Higher construction cost and longer time. 3. Limited experience contractor is available and less competitive in price. 4. Special treatment required for disposal of slurry.

9 CONCLUSIONS AND RECOMMENDATION

9.1 Additional Ground Investigation

9.1.1.1 It is recommended to conduct further GI at STN1, since there is no available borehole located within the footprint of the proposed structure. The project specific borehole STN1-DN1 is about 70m away from the structure.

9.1.1.2 Boreholes with 20 to 30m spacing are recommended for detailed design for the foundation design of the pump houses. Pre-drilling should be carried out for pile foundations such that the tip of every pile should be within 5m distance from a pre-drilling hole.

9.2 Proposed Foundation Types for the Pumphouses and Culverts at Sha Tin Town Centre (STN1)

9.2.1.1 For the STTC Storage Tank and Pump House at STN1, pile foundation is required for uplift control of the underground structure. Socket H-piles or mini-piles socketed in rock, or driven H-piles may be adopted. Temporary ELS in form of pipe pile walls together with a shoring system may be adopted to facilitate the construction.

9.2.1.2 For the STTC CLP Transformer Room and Switch Room at STN1, the bearing capacity of the ground are acceptable for a raft foundation, however, it is noted that the estimated total settlement may be too high due to the presence of multiple soil layers identified. As the adjacent STTC Pump House is to be supported by pile foundations, differential settlements between the Transformer and Switch Room and the STTC Pump House may be a concern. As a result, pile foundation may be considered as the foundation scheme.

9.3 Assessment of Impacts to the Existing Features

9.3.1.1 For shallow excavations for drainage pipes/channels proposed within 30m distance from existing slopes, the impact to slope stability could be significant due to an unsupported excavation. Temporary ELS works should be provided to support such excavations, including excavations less than 1.2m in depth, and an impact assessment of the proposed works should be carried out. Shoring and bracing design is required unless the impact assessment demonstrates the existing slopes and/or retaining walls are not adversely affected (i.e. no reduction in FoS for slope/retaining wall stability) by the excavation.

9.3.1.2 If the excavation is at a distance less than 2 times of the excavation depth from the existing slope toe, a lateral support wall should be installed to support the ground before excavation and further supported by struts during excavation in subsequent stages. The lateral support wall should be designed for adequate toe stability according to the Geoguide 1 and other GEO publications.

9.3.1.3 During the temporary ELS excavations, the groundwater levels, vibration and ground settlements should be monitored and should be kept within acceptable limits.

9.3.1.4 The design and construction of the proposed manholes and shafts should also ensure that the existing slope and retaining wall features are not adversely affected.

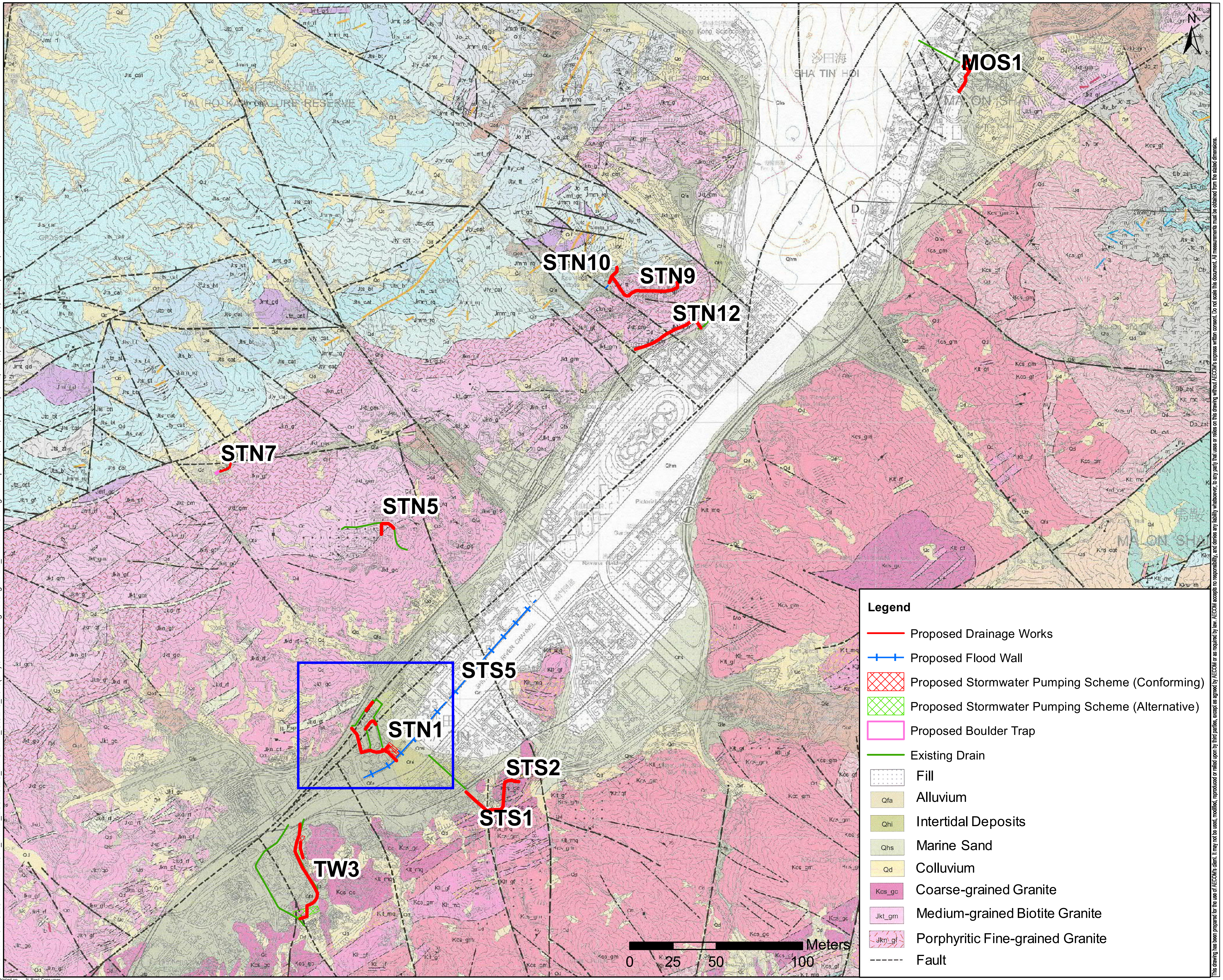
The requirements include the assessment of stability of the existing slopes and retaining walls, groundwater levels, ground settlement, vibrations during wall installation, and the stability of the shaft excavations and the faces of the trenchless excavations.

9.3.1.5 The proposed trenchless works are in close vicinity of relatively a large number of existing man-made features. One of concern is the construction of pipelines close to mountainous slopes that could be inherently unstable from the onset of construction. The use of slurry type TBM can reduce soil movement while the excavated face can be stabilized and supported by slurry. Impact assessment due to the sloping ground effect should be carried out during the design of the trenchless works. Ground treatment works may be required where sensitive receivers are found. Alternatively, as a mitigation measure and to minimize potential ground treatment works, a deeper alignment option can be adopted to drive the TBM within uniform and competent geological stratum.

9.4 Conclusion

9.4.1.1 In conclusion, from geotechnical point of view, it is anticipated that the proposed construction works would not impose any adverse effect on the adjacent ground and structures so that the development is geotechnically feasible.

Figures



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60617767	CE 15/2019 (DS)

SHEET TITLE

Published Geological Map - MOS1, TW3, STS1, STS2, STS5, STN1, STN5, STN7, STN9, STN10 and STN12

SHEET NUMBER

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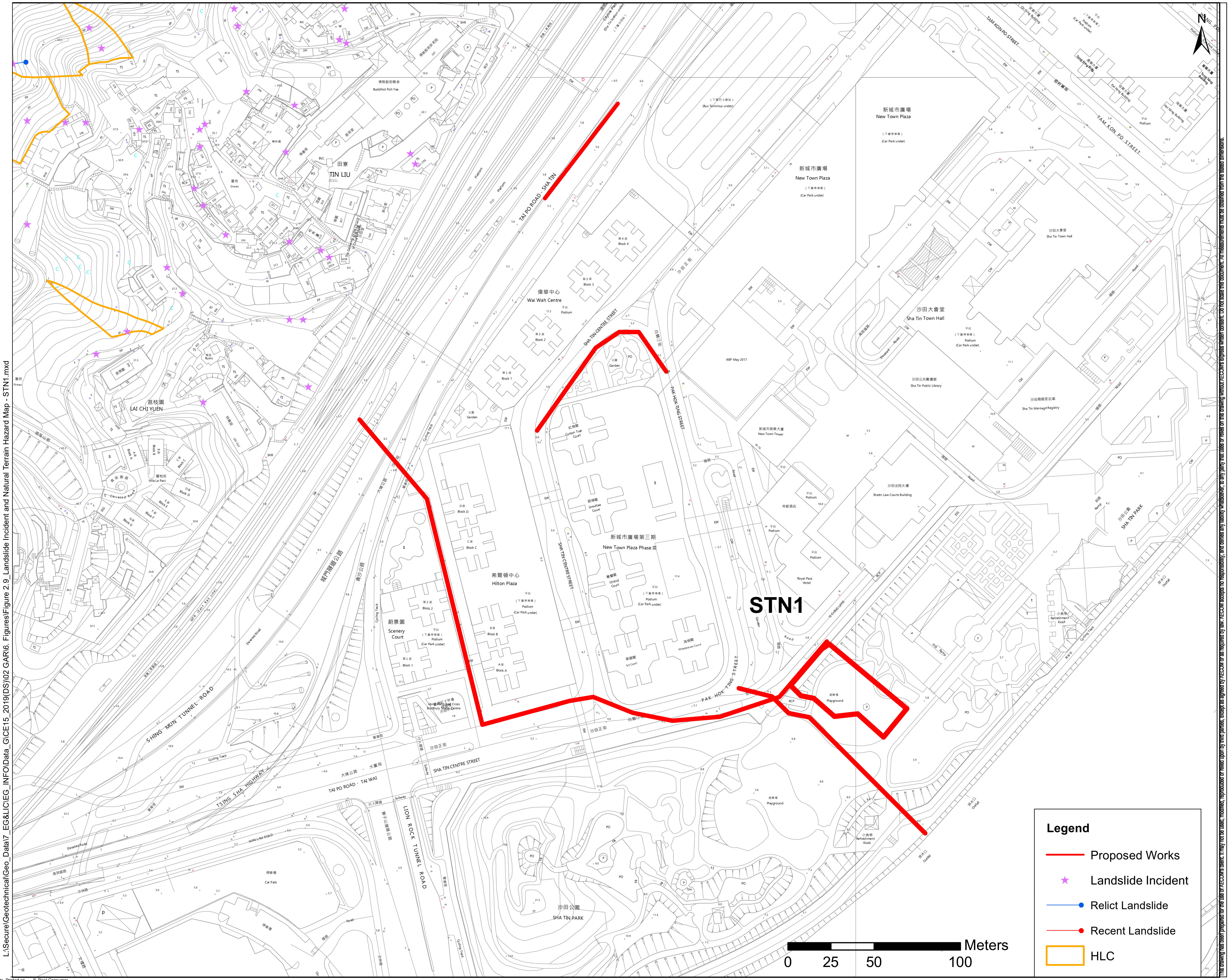

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SHEET TITLE 圖紙名稱

Landslide Incident and Natural Terrain Hazard Map - STN1

SHEET NUMBER 圖紙編號

Figure 2.9

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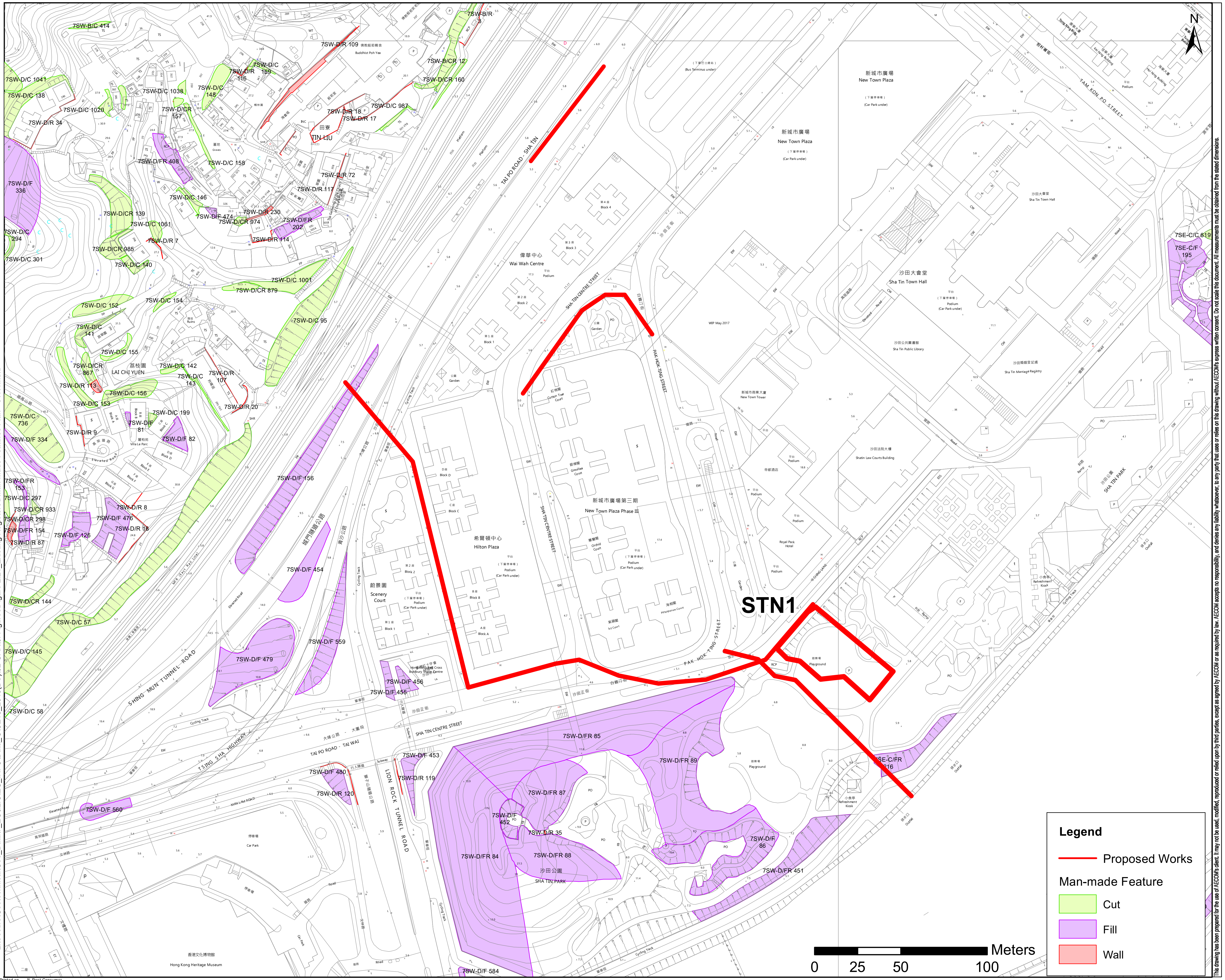

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Existing Registered Man-Made Features Plan - STN1

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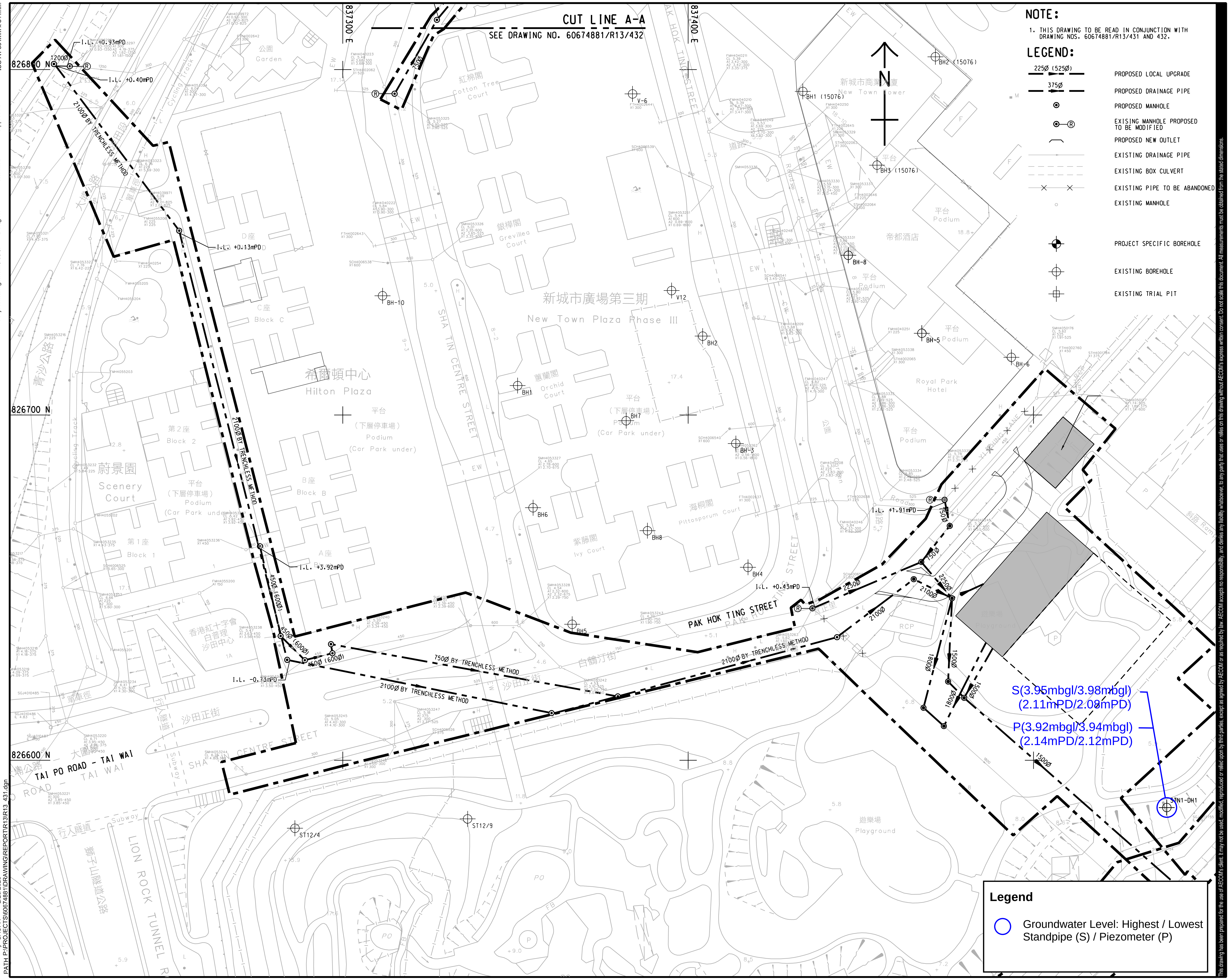

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225Ø (525Ø)	PROPOSED LOCAL UPGRADE
375Ø	PROPOSED DRAINAGE PIPE
	PROPOSED MANHOLE
	EXISING MANHOLE PROPOSED TO BE MODIFIED
	PROPOSED NEW OUTLET
	EXISTING DRAINAGE PIPE
	EXISTING BOX CULVERT
	EXISTING PIPE TO BE ABANDONED
	EXISTING MANHOLE
	PROJECT SPECIFIC BOREHOLE
	EXISTING BOREHOLE
	EXISTING TRIAL PIT

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TO FUNG SHAN; SHA TIN CENTRE; TUNG LO WAN; SHA TIN

PROJECT NO. 項目編號: 60617767

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SHEET TITLE 圖紙名稱

Measured Groundwater Levels - STN1

SHEET NUMBER 圖紙編號

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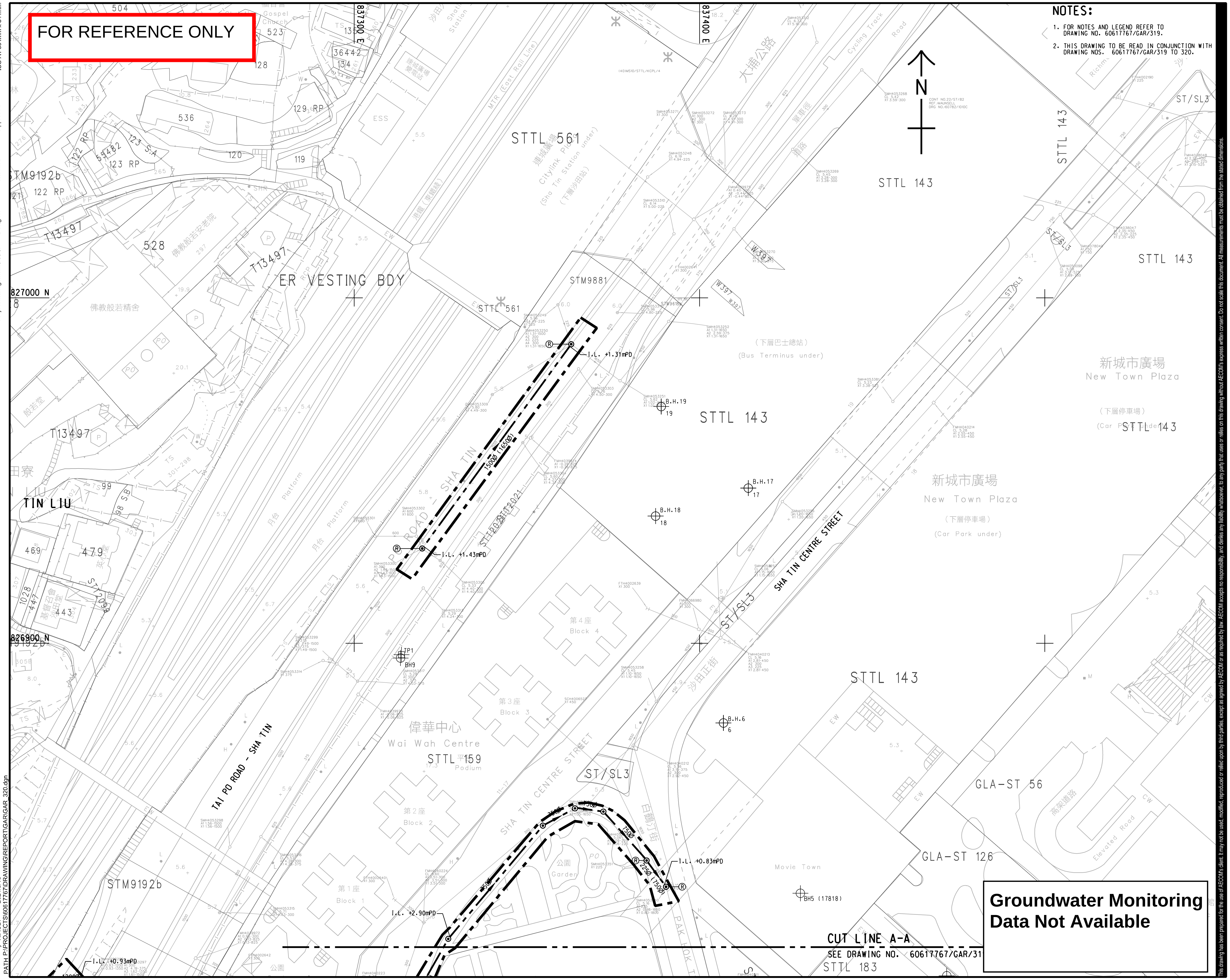

Groundwater Monitoring Data Not Available

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Measured Groundwater Levels - STN1

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Appendix A

Drawings

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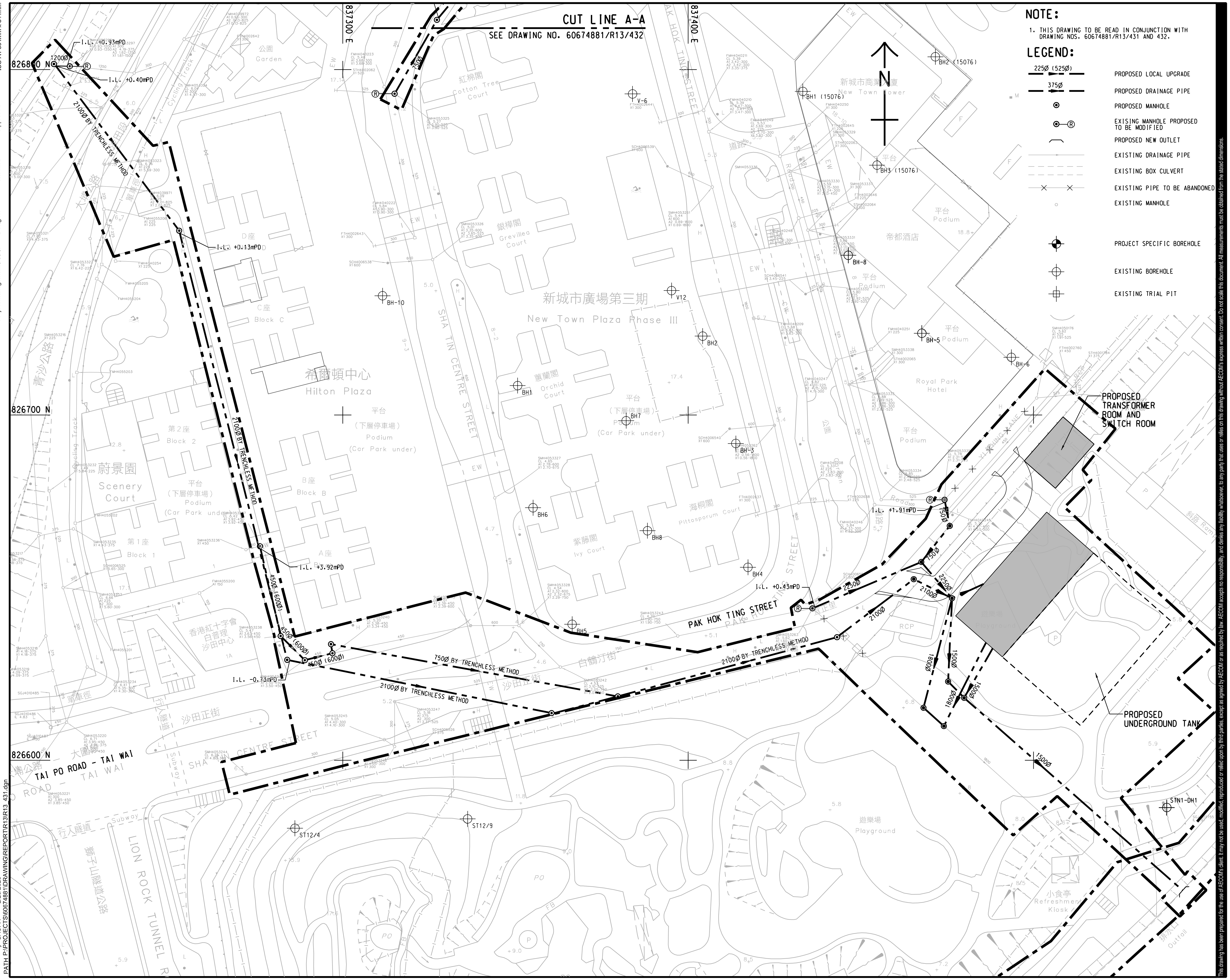

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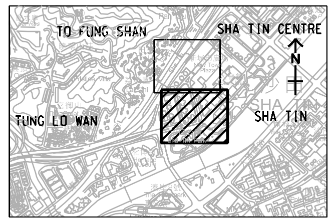

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SHEET TITLE 圖紙名稱

PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN TOWN CENTRE (STN1)

SHEET 1 OF 2

SHEET NUMBER 圖紙編號

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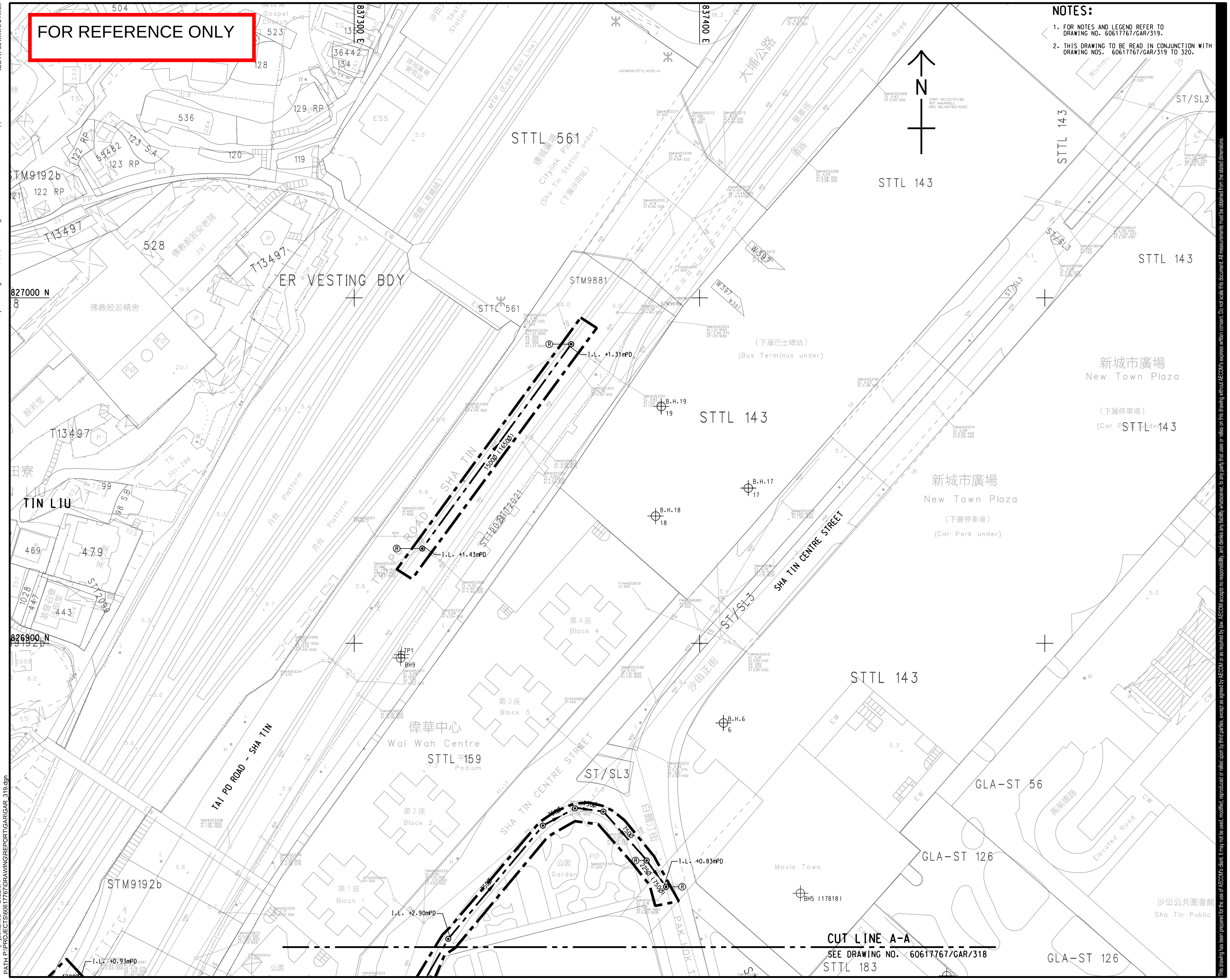

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PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN TOWN CENTRE (STN1)

SHEET 2 OF 2

SHEET NUMBER

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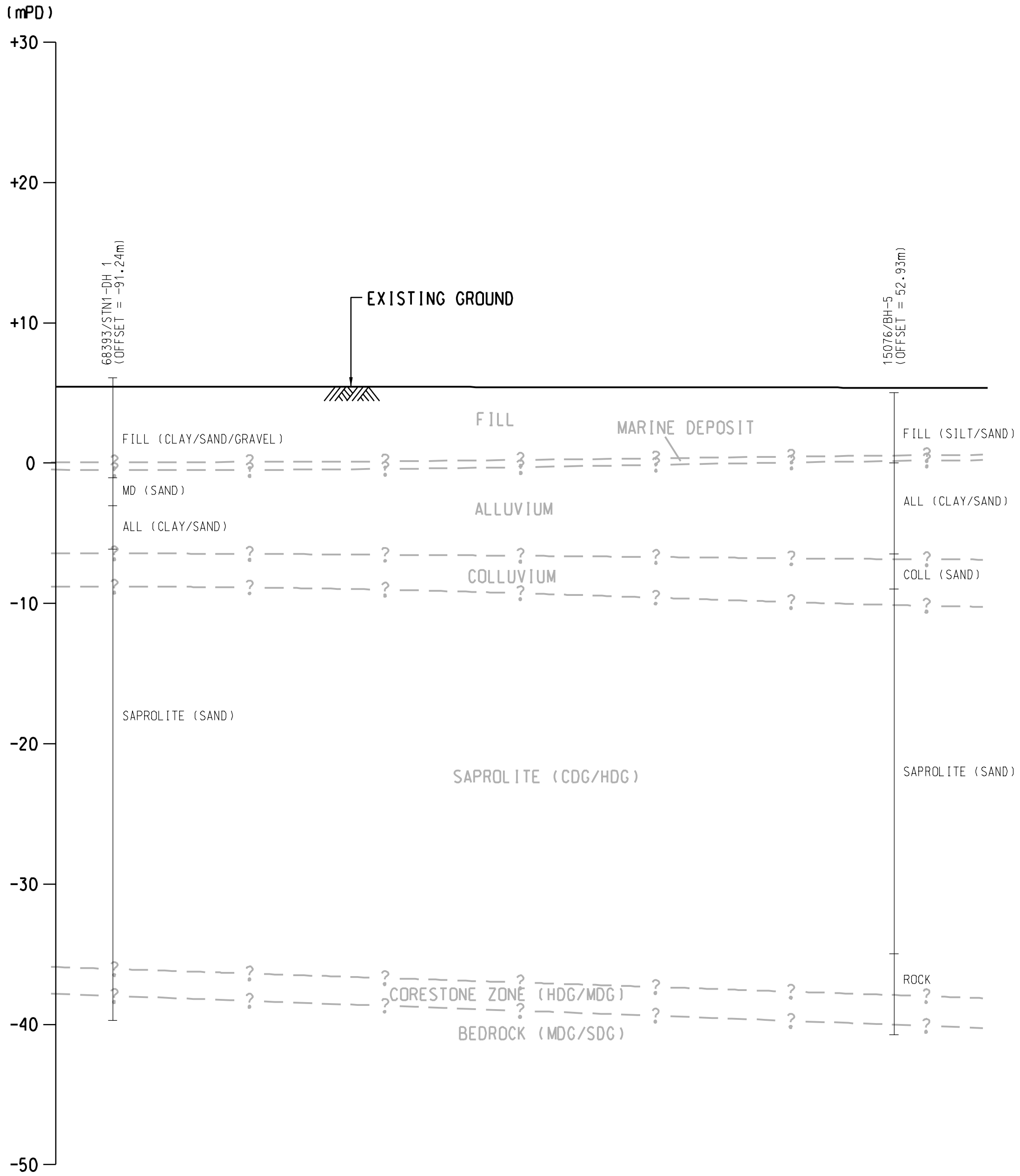

SECTION A - A
STN1 PUMP HOUSE AND
CLP TRANSFORMER ROOM

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GEOLOGICAL SECTIONS A-A AND B-B

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Appendix B

Aerial Photo Interpretation Report

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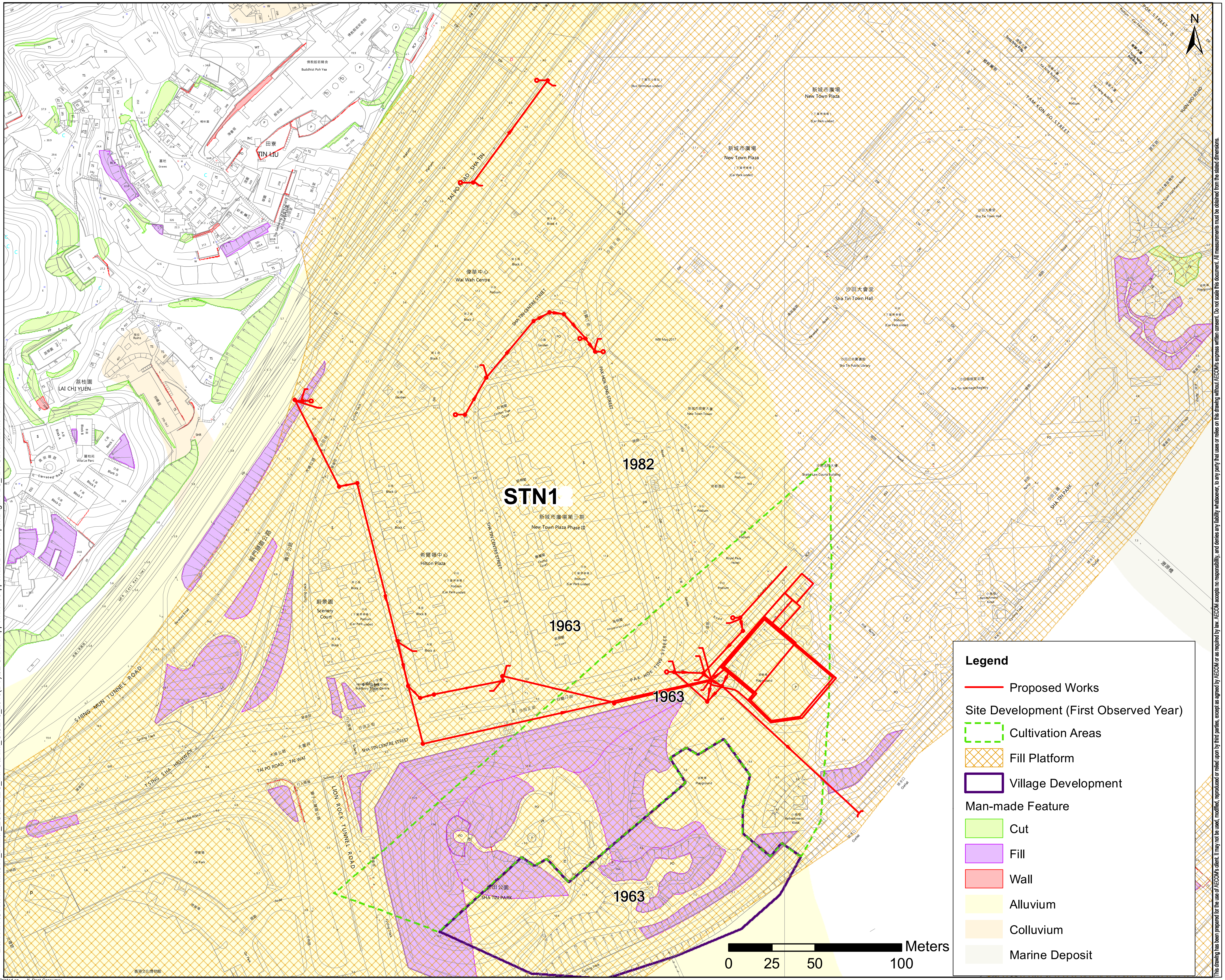
E1 DETAILED OBSERVATIONS

A review of the available aerial photographs from 1963 to the recent years has been carried out to determine the site development history, past instability, geomorphology and hydrogeological setting of the Sites and the terrain in the relevant vicinity. The key observations are summarised on Figure B1 to Figure B12.

Site	DETAILED OBSERVATIONS
Shing Mun River Cycle Track (STS5) and Sha Tin New Town (STN1)	• The Site is located along the edges of the existing Shing Mun River Channel. Prior to the completion of reclamation works in 1982, alluvial deposits and marine deposits appeared to have accumulated along the river channel. Some rural developments and an airfield were formed to the northwest of the proposed pump house near Sha Tin New Town (STN1).



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ISSUE/REVISION 修訂

I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

SCALE 比例: A3 1:2,000

DIMENSION UNIT 尺寸單位: METERS

KEY PLAN 索引圖

PROJECT NO. 項目編號: 60617767

AGREEMENT NO. 協議編號: CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

API Observations - STN1

SHEET NUMBER 圖紙編號

Figure B8

Appendix C

Summary of Available Ground Investigation Records

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Table C - Summary of Existing & Project Specific GI Records

Location	GIU Report No.	GI Station No.	GI Type	Orientation	Easting	Northing	Ground Level (mPD)	GI Depth (mBGL)	GI Base (mPD)	Base of Fill (mBGL)	Base of Fill (mPD)	Base of Marine Deposit (mBGL)	Base of Marine Deposit (mPD)	Base of Alluvium (mBGL)	Base of Alluvium (mPD)	Base of Colluvium (mBGL)	Base of Colluvium (mPD)	Base of Saprolite (mBGL)	Base of Saprolite (mPD)	Cat 1(c) Rockhead (mBGL)	Cat 1(c) Rockhead (mPD)	Geology below Superficial Deposits	Remark
STN1	02620	AD6	DH	Vertical	837063.00	826484.50	2.80	10.45	-7.65	1.50	1.30			10.45*	-7.65*								
STN1	02620	AD7	DH	Vertical	837112.30	826369.00	2.78	10.00	-7.22	2.00	0.78			10.00*	-7.22*								
STN1	06612	81	DH	Vertical	837059.24	826579.48	5.85	17.62	-11.77	4.45	1.35			9.50	-3.65			14.05	-8.34	14.05*	-8.34*	Granite	
STN1	06612	82	DH	Vertical	837072.80	826609.36	5.09	12.40	-7.31	5.00	3.09			7.52	-2.41			8.80	-3.71	8.80*	-3.71*	Granite	
STN1	06612	83	DH	Vertical	837082.41	826596.81	5.88	22.15	-16.27	5.50	0.38			13.26	-7.38			18.72	-12.84	18.72*	-12.84*	Granite	
STN1	06612	84	DH	Vertical	837093.02	826626.39	5.00	19.72	-14.72	5.50	-0.50			7.50	-2.50			16.14	-11.14	16.14*	-11.14*	Granite	
STN1	06612	86	DH	Vertical	837113.28	826640.64	5.16	15.93	-10.77	6.50	-1.34			9.00	-3.84			12.33	-7.17	12.33*	-7.17*	Granite	
STN1	06612	88	DH	Vertical	837142.51	826648.70	6.47	20.45	-13.98	1.80	5.67			14.00	-7.53			18.18	-11.71	18.18*	-11.71*	Granite	
STN1	14555	BH-10	DH	Vertical	837311.50	826734.50	35.30	26.15	9.15									21.07	16.65	21.07*	16.65*	Granite	
STN1	14636	ST12/4	DH	Vertical	837286.14	826580.33	5.74	27.45	-21.71	3.50	2.24	8.50	-2.76	15.50	-9.76			27.45*	-21.71*			Granite	
STN1	14636	ST12/9	DH	Vertical	837336.14	826583.04	5.75	28.26	-22.51	4.00	1.75	15.00	-9.25					28.26*	-22.51*			Granite	
STN1	15076	BH1	DH	Vertical	837433.21	826793.68	5.26	49.20	-43.94	4.00	1.26	8.50	-3.24	14.00	-8.74	17.00	-11.74	41.95	-36.69	43.05	-37.79	Granite	
STN1	15076	BH-2	DH	Vertical	837471.60	826803.71	4.98	73.77	-68.79	4.00	0.98	10.50	-5.52	16.50	-11.52			55.00	-50.02	69.15	-64.17	Granite	
STN1	15076	BH3	DH	Vertical	837454.70	826772.32	5.08	49.72	-44.64	4.00	1.08	10.00	-4.92	16.00	-10.92	19.00	-13.92	44.40	-39.32	44.40	-39.32	Granite	
STN1	15076	BH-5	DH	Vertical	837467.68	826723.66	5.03	45.72	-40.69	5.00	0.03	8.50	-3.47	11.50	-6.47	14.00	-8.97	40.70	-35.67	40.70	-35.67	Granite	
STN1	15076	BH-6	DH	Vertical	837493.61	826716.69	5.19	48.40	-43.21	4.00	1.19	8.50	-3.31	12.50	-7.31	17.00	-11.81	41.90	-36.71	43.20	-38.01	Granite	
STN1	15076	BH7	DH	Vertical	837382.05	826698.33	5.40	50.40	-45.00	4.00	1.40	8.50	-3.10	12.50	-7.10	17.50	-12.10	43.10	-37.70	45.30	-39.90	Granite	
STN1	15076	BH-8	DH	Vertical	837446.38	826746.23	5.03	51.65	-46.62	4.00	1.03	8.50	-3.47	15.50	-10.47	19.00	-13.97	44.10	-39.07	46.15	-41.12	Granite	
STN1	15401	BH2	DH	Vertical	837404.22	826722.82	5.28	47.78	-42.50	4.00	1.28	8.00	-2.72	16.00	-10.72			41.90	-36.62	42.75	-37.47	Granite	
STN1	15401	BH-5	DH	Vertical	837467.68	826723.66	5.03	45.72	-40.69	5.00	0.03	8.50	-3.47	11.50	-6.47	14.00	-8.97	40.00	-34.97	40.00	-34.97	Granite	
STN1	15401	BH7	DH	Vertical	837382.05	826698.33	5.40	50.40	-45.00	4.00	1.40	8.50	-3.10	12.50	-3.10	17.50	-12.10	43.10	-37.70	45.30	-39.90	Granite	
STN1	15401	BH-8	DH	Vertical	837446.38	826746.23	5.03	51.65	-46.62	4.00	1.03	8.50	-3.47	15.50	-10.47	19.00	-13.97	44.10	-39.07	46.15	-41.12	Granite	
STN1	15401	V12	DH	Vertical	837395.20	826736.02	5.49	51.88	-46.39	3.00	2.49	9.45	-4.01	17.50	-12.01			41.95	-39.46	48.07*	-42.58*	Granite	
STN1	15401	V-6	DH	Vertical	837383.91	826792.95	5.42	40.54	-35.12	4.50	0.92	9.00	-3.58	17.50	-12.08			33.00	-27.58	39.04*	-33.62*	Granite	
STN1	17818	B.H.17	DH	Vertical	837414.13	826944.92	5.05	51.12	-46.07	2.50	2.55	7.00	-1.95	18.00	-12.95			46.10	-41.05	46.10	-41.05	Granite	
STN1	17818	B.H.18	DH	Vertical	837387.28	826936.82	5.90	44.40	-38.50	3.00	2.90	10.00	-4.10	20.00	-14.10			37.20	-31.30	38.30	-32.40	Granite	
STN1	17818	B.H.19	DH	Vertical	837388.92	826968.54	6.05	44.35	-38.30	4.00	2.05	10.00	-3.95	14.50	-8.45			38.20	-32.15	41.10*	-39.14*	Granite	
STN1	17818	B.H.5	DH	Vertical	837429.23	826827.60	5.60	49.80	-44.20	4.50	1.10	10.00	-4.40	18.00	-12.40			43.18	-37.58	43.18	-37.58	Granite	
STN1	17818	B.H.6	DH	Vertical	837406.94	826876.92	5.15	45.90	-40.75	3.15	2.00	7.00	-1.85	18.00	-12.85			41.02	-35.87	41.02*	-35.87*	Granite	
STN1	17822	BH1	DH	Vertical	837350.62	826708.50	5.50	46.65	-41.15	4.00	1.50	8.50	-3.00	14.00	-8.50	16.00	-10.50	41.65	-36.15	42.80	-37.30	Granite	
STN1	17822	BH-3	DH	Vertical	837413.81	826691.73	5.23	34.04	-28.81	4.00	1.23	8.50	-3.27	11.50	-6.27	17.50	-12.27	28.90	-23.67	28.90	-23.67	Granite	
STN1	17822	BH4	DH	Vertical	837417.33	826655.89	5.29	43.30	-38.01	5.00	0.29	7.00	-1.71	11.50	-6.21	14.50	-9.21	37.85	-32.56	37.85	-32.56	Granite	
STN1	17822	BH5	DH	Vertical	837366.42	826639.39	4.70	37.80	-33.10	3.50	-3.50	7.00	-2.30	14.00	-9.30	17.00	-12.30	32.00	-27.30	32.00	-27.30	Granite	
STN1	17822	BH6	DH	Vertical	837355.09	826673.13	5.17	47.43	-42.26	2.50	2.67	7.00	-1.83	13.80	-8.63	14.00	-8.83	37.15	-31.98	37.15	-31.98	Granite	
STN1	17822	BH-7	DH	Vertical	837382.05	826698.33	5.40	37.58	-32.18	4.00	1.40	8.50	-3.10	15.50	-10.10			32.25	-26.85	32.25	-26.85	Granite	
STN1	17822	BH8	DH	Vertical	837388.23	826666.49	5.46	33.28	-27.82	3.00	2.40	9.00	-3.60	11.50	-6.10	19.00	-13.60	28.08	-22.68	28.08*	-22.68*	Granite	
STN1	28736	BH9	W+RC	Vertical	837313.42	826895.72	5.45	25.65	-20.20	6.00	-0.55			9.60	-4.15			19.40	-13.95	20.50	-15.05	Granite	
STN1	28736	TP1	TP	Vertical	837313.70	826896.67	5.48	2.00	3.48	2.00*	3.48*												
STN1	39240	DH11	DH	Vertical	837056.00	826543.00	5.37	17.83	-12.46	6.10	-0.73			12.20	-6.83					12.20	-6.83	Granite	Fault Breccia at 15.35-17.83 mBGL
STN1	39240	DH9	DH	Vertical	837085.00	826576.00	6.26	26.34	-20.08	9.40	-3.14			12.35	-6.09			20.16	-13.90	20.95	-14.69	Granite	
STN1	50839	TL/BH 7	RC	Vertical	837163.23	826724.40	31.06	11.29	19.77	3.70	27.36			5.64	25.42					5.64	25.42		
STN1	52323	ST-DH 2	RC	Vertical	837172.00	826728.00	6.15	18.46	-12.31	5.10	0.05			12.10	-5.95			12.70	-6.55	12.70	-6.55	Fault Breccia	Fault Breccia at 12.10-18.46 mBGL

Appendix D

Summary of Available Laboratory Test Results

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Table D1 - Summary of Soil Index, Triaxial and Compaction Tests

Location	GIU Report No.	GI Station No.	GI Type	Geological Origin	Top Sample Depth (m)	Bottom Sample Depth (m)	Moisture Content (%)	Bulk Density (Mg/m^3)	Dry Density (Mg/m^3)	Particle Density/Specific Gravity	L.L. (%)	P.L. (%)	P.I. (%)	L.I.	P.Size/Gravel	P.Size/Sand	P.Size/Silt	P.Size/Clay	Triaxial Test, s' (kPa)	Triaxial Test, t (kPa)	Type of Triaxial	Compaction Test, Optimum MC (%)	Compaction Test, Max Dry Density (Mg/m^3)
STN1	02620	AD6	DH	ALL (Clay)	5.00	5.45	29.40	1.90	1.47						0.00	38.00	40.00	22.00					
STN1	02620	AD6	DH	ALL (Sand)	7.00	7.45	18.20	2.06	1.74						13.00	66.00	14.00	7.00					
STN1	02620	AD7	DH	ALL (Sand)	3.00	3.45	16.90	1.73	1.48						13.00	76.00	5.00	6.00					
STN1	02620	AD7	DH	ALL (Clay)	4.00	4.45	28.60	1.97	1.53						1.00	23.00	37.00	39.00					
STN1	28736	BH9	W+RC	FILL (Sand)	3.50	4.50	24.00	1.96	1.56		57.00	37.00	20.00	0.60	29.00	39.00	20.00	12.00	79.00	51.00	CUS		
STN1	28736	BH9	W+RC	ALL (Sand)	7.10	7.55	13.00	2.21	1.90		50.00	27.00	23.00	1.39	44.00	53.00	1.00	2.00					
STN1	39240	DH11	DH	ALL (Sand)	7.00	8.00									20.00	54.00	16.00	10.00	104.20 236.40 484.90	62.10 140.30 269.10	CUM		
STN1	39240	DH9	DH	FILL (Sand)	4.40	5.40									32.00	58.00	10.00						
STN1	39240	DH9	DH	CDG (Sand)	13.50	14.50									23.00	56.00	14.00	7.00	162.90 338.10 575.10	107.50 208.20 345.70	CUM		
STN1	52323	ST-DH2	RC	FILL (Sand)	4.10	4.55	22.00	1.99		2.60		N-P			27.00	59.00	10.00	4.00	20.50 34.40 53.60	7.70 11.20 18.70	CUM		
STN1	52323	ST-DH2	RC	ALL (Sand)	8.10	9.10	15.00	2.16		2.63	28.00	15.00	13.00	1.14	26.00	46.00	15.00	13.00	151.80	94.30	CUS		
STN1	52323	ST-DH2	RC	ALL (Sand)	8.10	9.10													184.80	116.20	CUS		
STN1	52323	ST-DH2	RC	ALL (Sand)	8.10	9.10													279.90	169.70	CUS		
STN1	52323	ST-DH2	RC	ALL (Sand)	10.10	11.10	18.00	2.09		2.63	36.00	16.00	20.00	0.62	17.00	50.00	16.00	17.00	97.10	60.40	CUS		
STN1	52323	ST-DH2	RC	ALL (Sand)	10.10	11.10													196.00	114.20	CUS		
STN1	52323	ST-DH2	RC	ALL (Sand)	10.10	11.10													214.10	126.50	CUS		
STN1	Project Specific GI	DH1	DH	ALL (Sand)	7.10	7.55	17.00	2.10		2.62					11.00	78.00	8.00	3.00	538.50 758.90 962.50	377.70 529.30 641.00	CUM		
STN1	Project Specific GI	DH1	DH	ALL (Sand/Clay)	9.10	10.10				2.63													
STN1	Project Specific GI	DH1	DH	ALL (Silt)	10.20	10.65	29.00	1.92		2.64	41.00	20.00	21.00	0.61	0.00	19.00	42.00	39.00	102.00 195.00 329.70	59.60 91.00 162.90	CUM		
STN1	Project Specific GI	DH1	DH	CDG (Silt)	14.20	15.20	31.00	1.92		2.65	44.00	26.00	19.00	2.42	15.00	50.00	18.00	17.00	211.70	138.90	CUS		
STN1	Project Specific GI	DH1	DH	CDG (Sand)	18.20	19.20	24.00	1.97		2.63	54.00	31.00	23.00	0.96	33.00	37.00	18.00	12.00	295.70	167.60	CUS		
STN1	Project Specific GI	DH1	DH	CDG (Sand)	20.80	21.80	27.00	2.01		2.62	40.00	22.00	18.00	3.18	31.00	43.00	17.00	9.00	247.00	147.10	CUS		

Table D2 - Summary of Soil Permeability Tests

Location	GIU Report No.	GI Station No.	GI Type	Orientation	Easting	Northing	Ground Level (mPD)	GI Depth (mBGL)	GI Base (mPD)	Geological Origin	Top Testing Depth (m)	Bottom Testing Depth (m)	Type of Permeability Test	Permeability, K (m/s)
STN1	17818	B.H.6	DH	Vertical	837406.94	826876.92	5.15	45.90	-40.75	FILL	9.50	11.15	Constant Head	3.45E-05
STN1	50839	TL/BH 7	RC	Vertical	837163.23	826724.40	31.06	11.29	19.77	FILL	2.70	4.20	Falling Head	1.25E-05
STN1	Project Specific GI	DH1	DH	Vertical	837538.60	826586.33	6.06	45.77	-39.71	ALL (Sand)	7.15	8.65	Constant Head	1.85E-06
STN1	Project Specific GI	DH1	DH	Vertical	837538.60	826586.33	6.06	45.77	-39.71	CDG	16.50	18.00	Constant Head	2.24E-06

Table D3 - Summary of Soil Consolidation Tests

Location	GIU Report No.	GI Station No.	GI Type	Geological Origin	Top Sample Depth (m)	Bottom Sample Depth (m)	Consolidation Test, Min C_v (m^2/yr)	Consolidation Test, Max C_v (m^2/yr)	Consolidation Test, Min m_v (m^2/MN)	Consolidation Test, Max m_v (m^2/MN)	Compression Index (C_c)	Recompression Index (C_r)	Compression Ratio (CR)
STN1	28736	BH9	W+RC	ALL (Sand)	7.10	7.55	0.81	27.12	0.04	0.29	0.120	-	0.079
STN1	Project Specific GI	DH1	DH	ALL (Sand/Clay)	9.10	10.10	0.68	6.34	0.05	0.77	0.130	-	0.076

Table D4 - Summary of Soil and Groundwater Chemical Tests

Location	GIU Report No.	GI Station No.	GI Type	Geological Origin	Top Sample Depth (m)	Bottom Sample Depth (m)	Total Sulphate in Soil (%)	Water-Soluble Sulphate in Soil (%)	Sulphate Content in Ground Water (g/L)	Water-Soluble Choride in Soil (%)	Organic Content (%)	pH	Soil Resistivity to 20°C (Ωm)
STN1	02620	AD6	DH	ALL	5.00	5.45	0.13					7.90	
STN1	52323	ST-DH 2	RC	FILL	4.10	4.55	0.06	0.06		<0.01		4.90	
STN1	52323	ST-DH 2	RC	FILL	4.10	4.55	0.06	0.06		<0.01		4.90	
STN1	52323	ST-DH 2	RC	FILL	4.10	4.55	0.06	0.06		<0.01		4.90	
STN1	52323	ST-DH 2	RC	ALL	8.10	9.10	<0.01	<0.01		<0.01		6.40	
STN1	52323	ST-DH 2	RC	ALL	8.10	9.10	<0.01	<0.01		<0.01		6.40	
STN1	52323	ST-DH 2	RC	ALL	8.10	9.10	<0.01	<0.01		<0.01		6.40	
STH1	Project Specific GI	DH1	DH	ALL	7.10	7.55	0.03	0.02		0.02	0.30	8.30	24.50
STH1	Project Specific GI	DH1	DH	ALL	10.20	10.65	0.03	0.02		0.02	0.30	8.40	18.80
STH1	Project Specific GI	DH1	DH	CDG	14.20	15.20	0.03	0.02		0.11	<0.1	7.70	4.00
STH1	Project Specific GI	DH1	DH	CDG	18.20	19.20	0.04	0.01		0.11	<0.1	7.20	6.00
STH1	Project Specific GI	DH1	DH	CDG	20.80	21.80	0.04	0.03		0.09	<0.1	8.10	5.00

Table D5 - Summary of Rock Material Tests

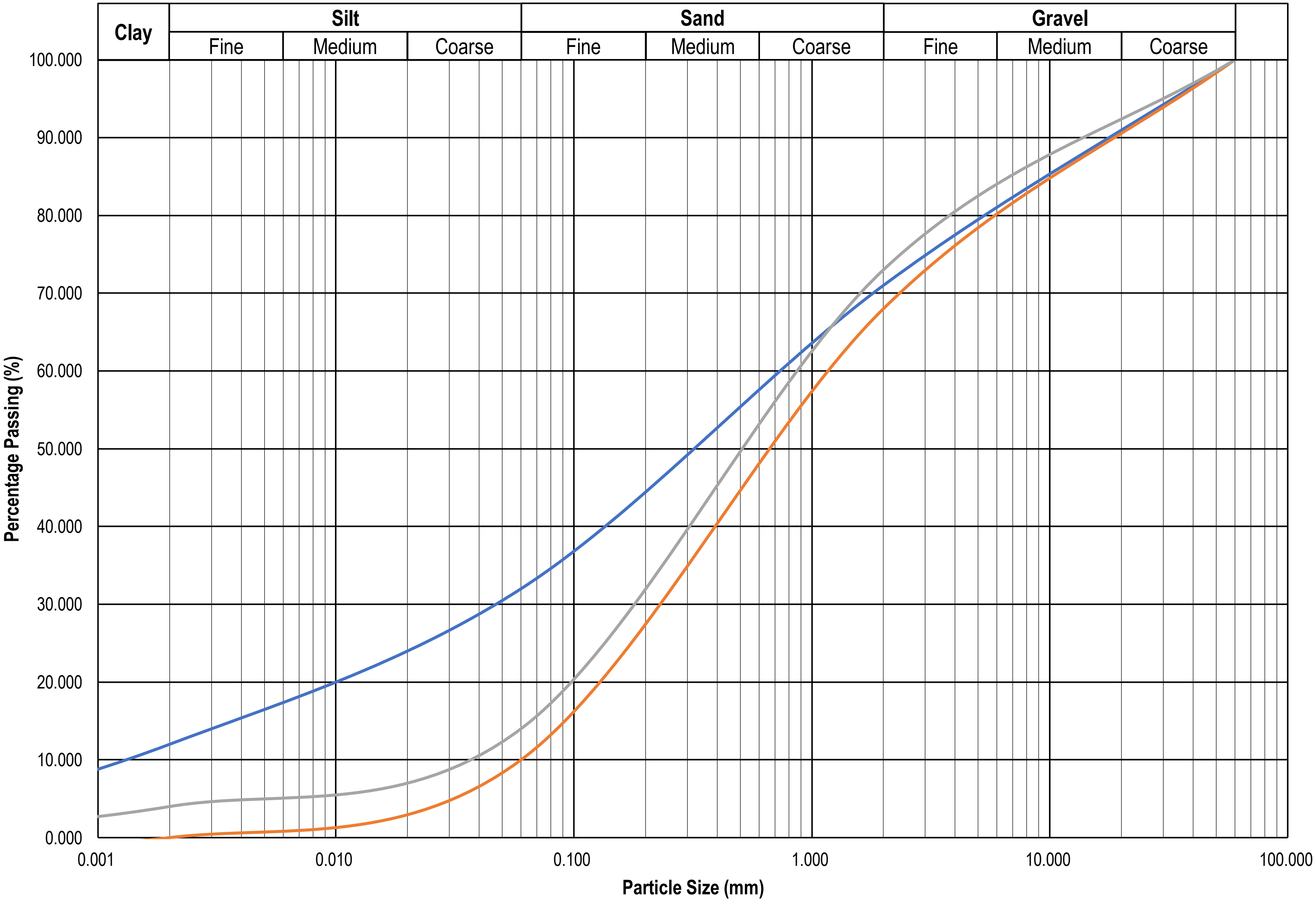
Location	GIU Report No.	GI Station No.	GI Type	Geological Origin	Top Sample Depth (m)	Bottom Sample Depth (m)	Point Load Index, $I_{s\,(50)}$ (MPa)	Correlated Uniaxial Compressive Strength* (MPa)	Failure Mode	Unconfined Uniaxial Compressive Strength (MPa)	Failure Mode	Modulus of Elasticity (Tangent) (GPa)	Modulus of Elasticity (Secant) (GPa)	Modulus of Elasticity (Average) (GPa)	Poisson's Ratio (Tangent)	Poisson's Ratio (Secant)	Poisson's Ratio (Average)
STN1	39240	DH11	DH	SDG	12.68					119.20	M						
STN1	39240	DH11	DH	SDG	14.16		4.18	100.32	M								
STN1	39240	DH11	DH	SD Breccia	15.84		3.64	87.36	M								
STN1	39240	DH9	DH	SDG	23.09		2.07	49.68	M								
STN1	39240	DH9	DH	SDG	23.34		1.60	38.40	J								

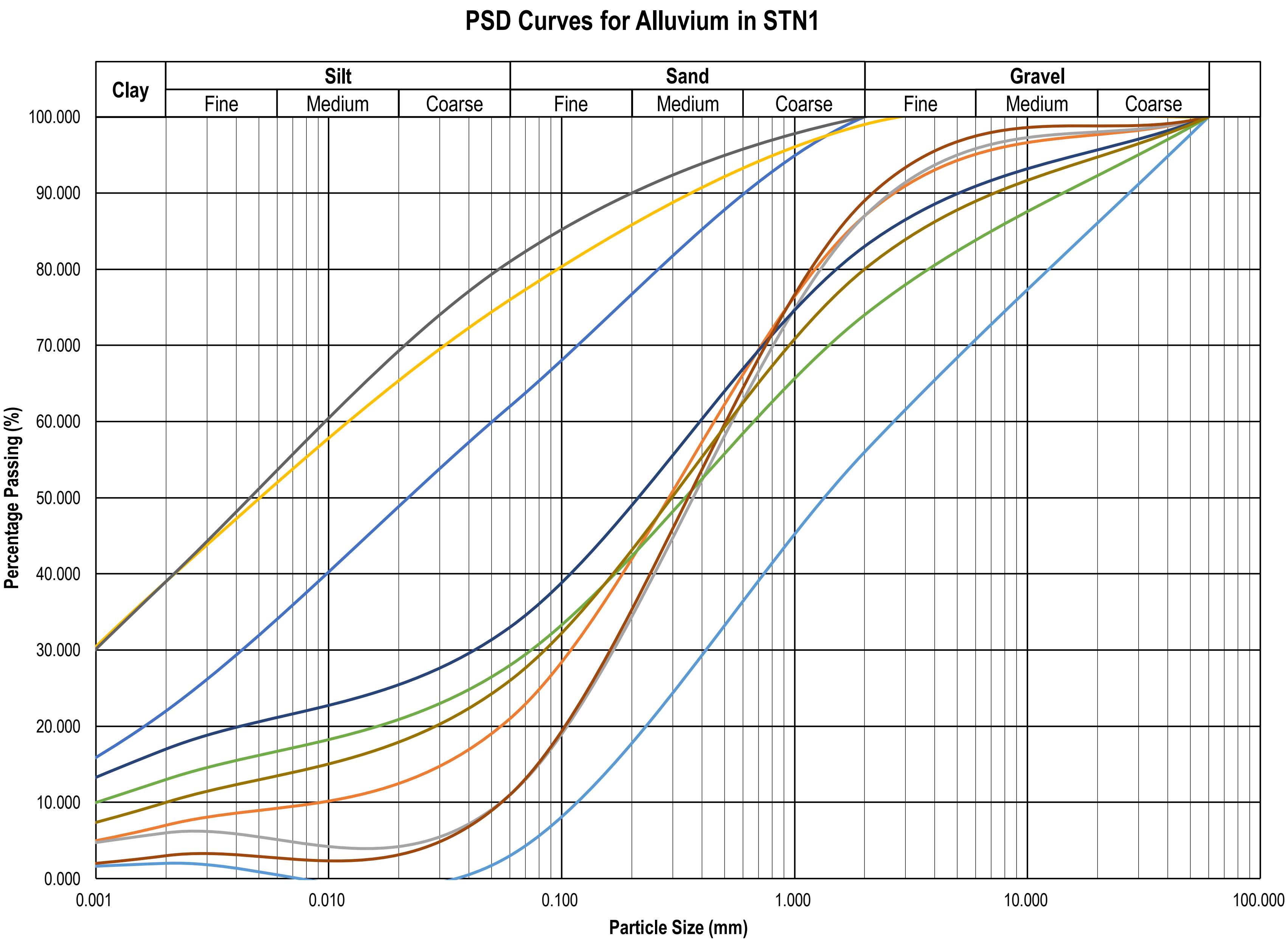
*Point load indices are correlated to uniaxial compressive strength (UCS) by the following relationship: UCS = 24 $I_{s\,(50)}$ (Broch and Franklin, 1942).

Chart D1

PSD Curves

PSD Curves for Fill in STN1




PSD Curves for Alluvium in STN1
Clay
Silt
Fine
Medium
Coarse
Sand
Fine
Medium
Coarse
Gravel
Fine
Medium
Coarse
100.000
90.000
80.000
70.000
60.000
50.000
40.000
30.000
20.000
10.000
0.000
Percentage Passing (%)
0.001
0.010
0.100
1.000
10.000
100.000
Particle Size (mm)

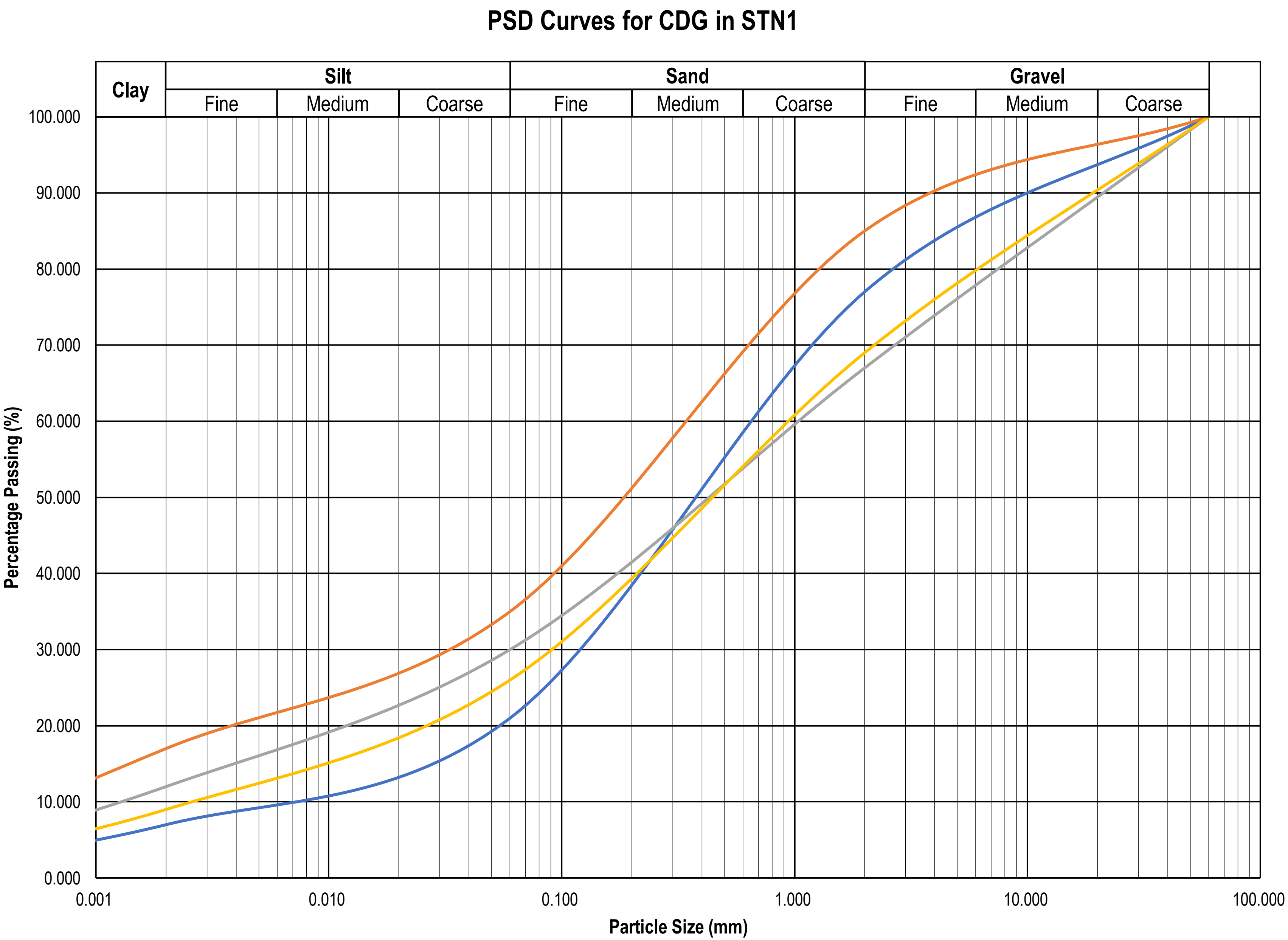
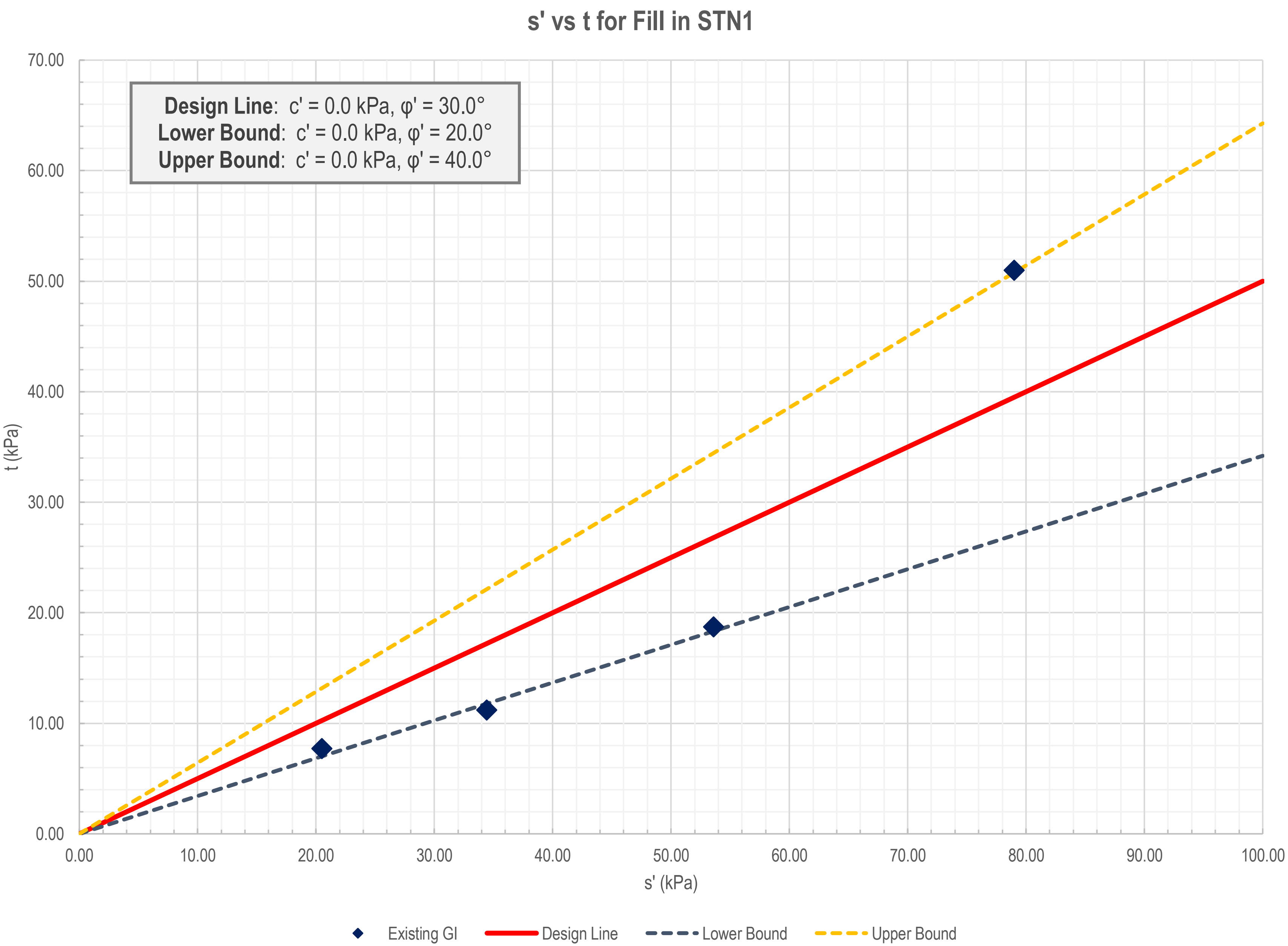
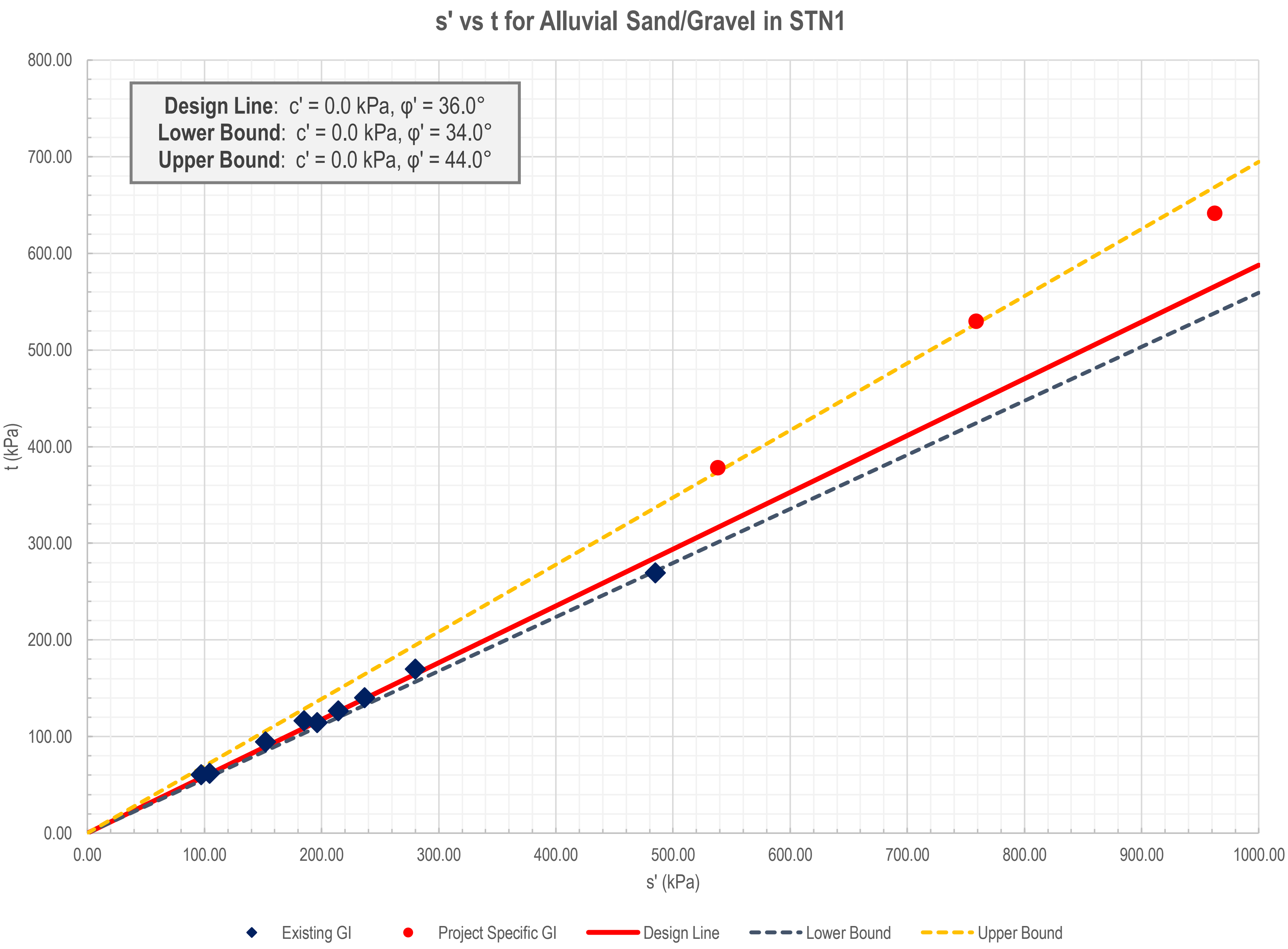
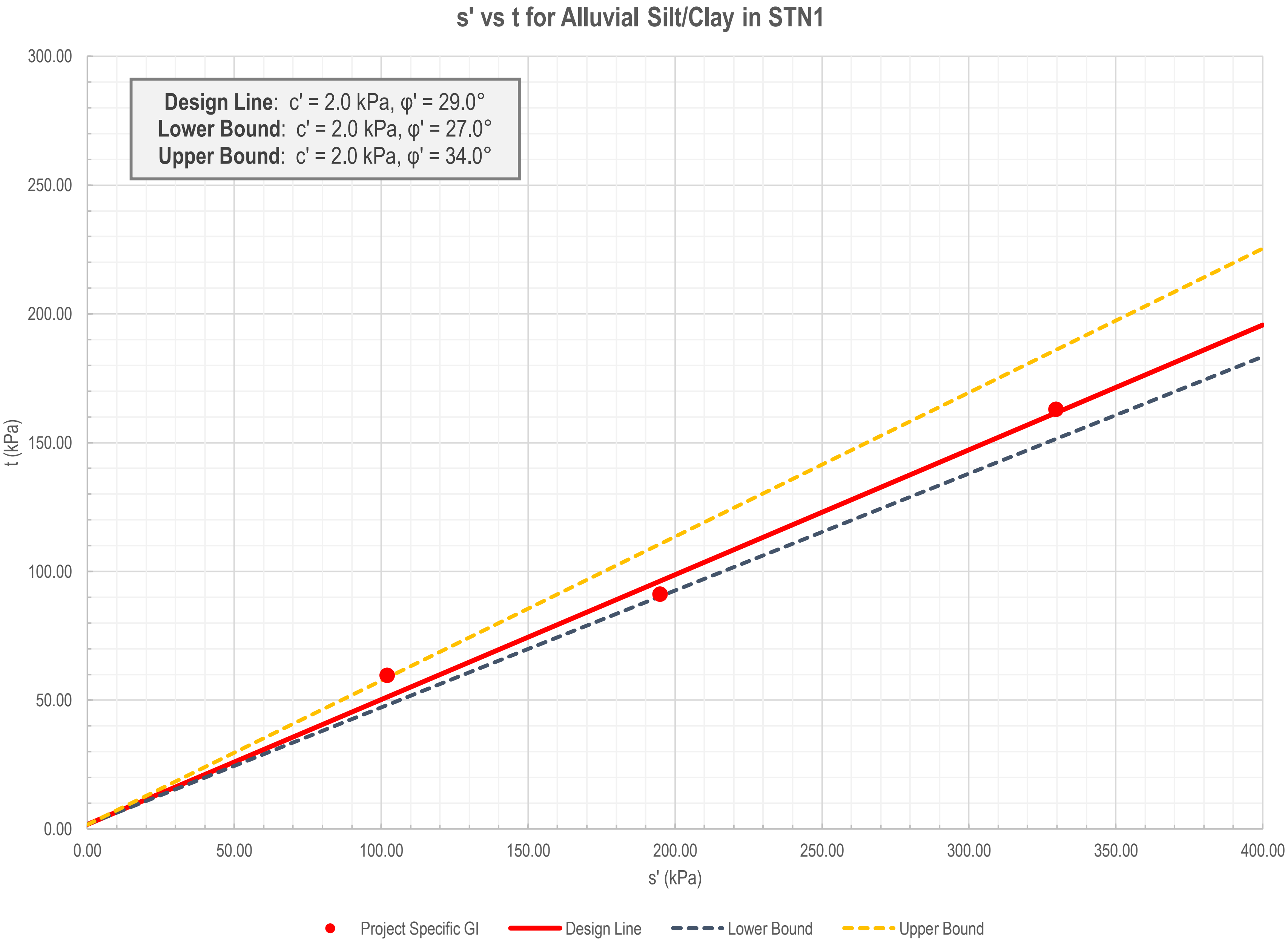

PSD Curves for CDG in STN1
Clay
Silt
Sand
Gravel
Fine
Medium
Coarse
Fine
Medium
Coarse
Fine
Medium
Coarse
Percentage Passing (%)
100.000
90.000
80.000
70.000
60.000
50.000
40.000
30.000
20.000
10.000
0.000
0.001
0.010
0.100
1.000
10.000
100.000
Particle Size (mm)

Chart D2

s' vs. t Plots


s' vs t for Fill in STN1
Design Line: c' = 0.0 kPa, φ' = 30.0°
Lower Bound: c' = 0.0 kPa, φ' = 20.0°
Upper Bound: c' = 0.0 kPa, φ' = 40.0°
t (kPa)
s' (kPa)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
Existing GI
Design Line
Lower Bound
Upper Bound


s' vs t for Alluvial Sand/Gravel in STN1
Design Line: c' = 0.0 kPa, φ' = 36.0°
Lower Bound: c' = 0.0 kPa, φ' = 34.0°
Upper Bound: c' = 0.0 kPa, φ' = 44.0°
t (kPa)
s' (kPa)
0.00
100.00
200.00
300.00
400.00
500.00
600.00
700.00
800.00
900.00
1000.00
Existing GI
Project Specific GI
Design Line
Lower Bound
Upper Bound


s' vs t for Alluvial Silt/Clay in STN1
Design Line: c' = 2.0 kPa, φ' = 29.0°
Lower Bound: c' = 2.0 kPa, φ' = 27.0°
Upper Bound: c' = 2.0 kPa, φ' = 34.0°
t (kPa)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
s' (kPa)
Project Specific GI
Design Line
Lower Bound
Upper Bound

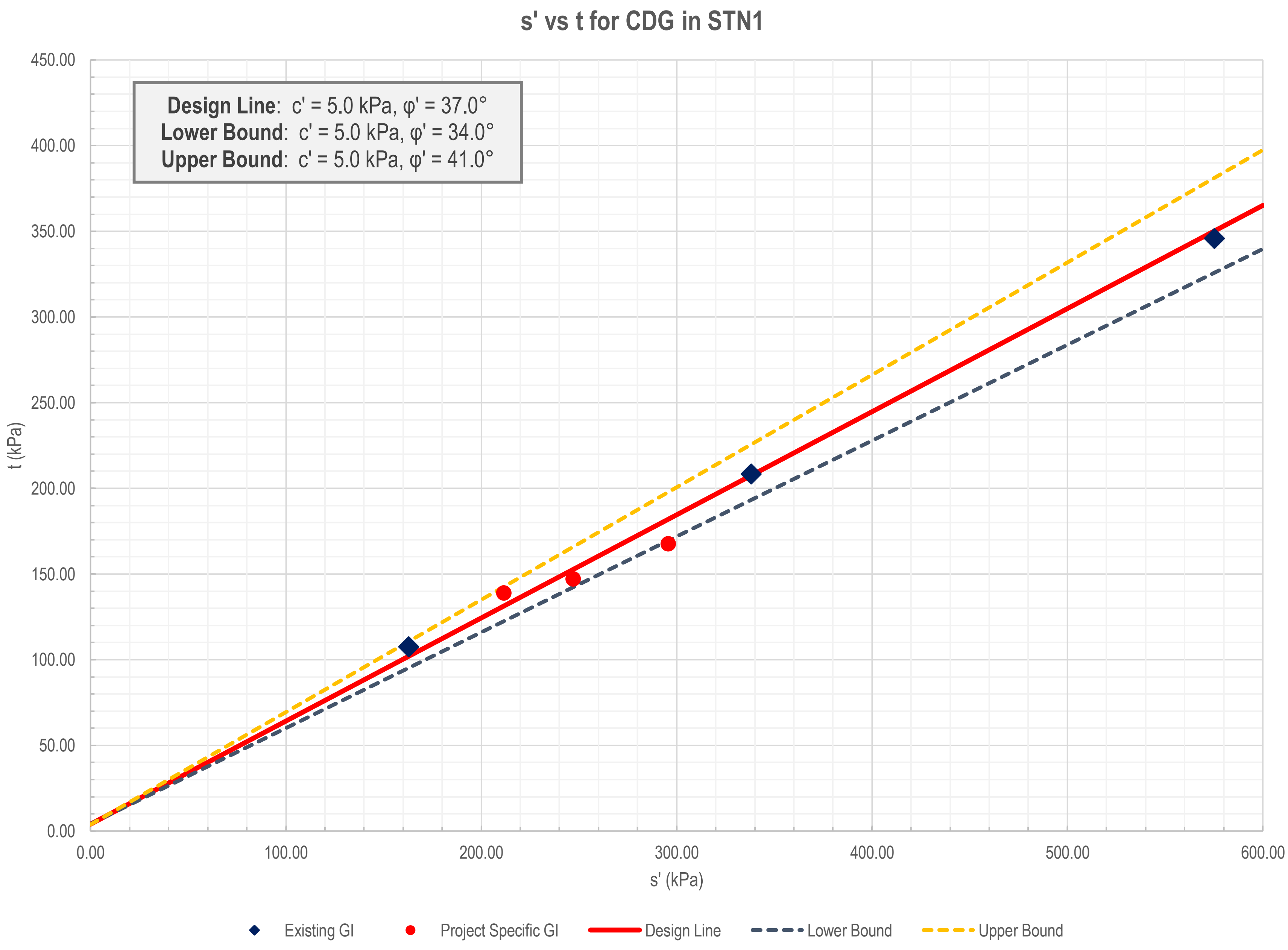
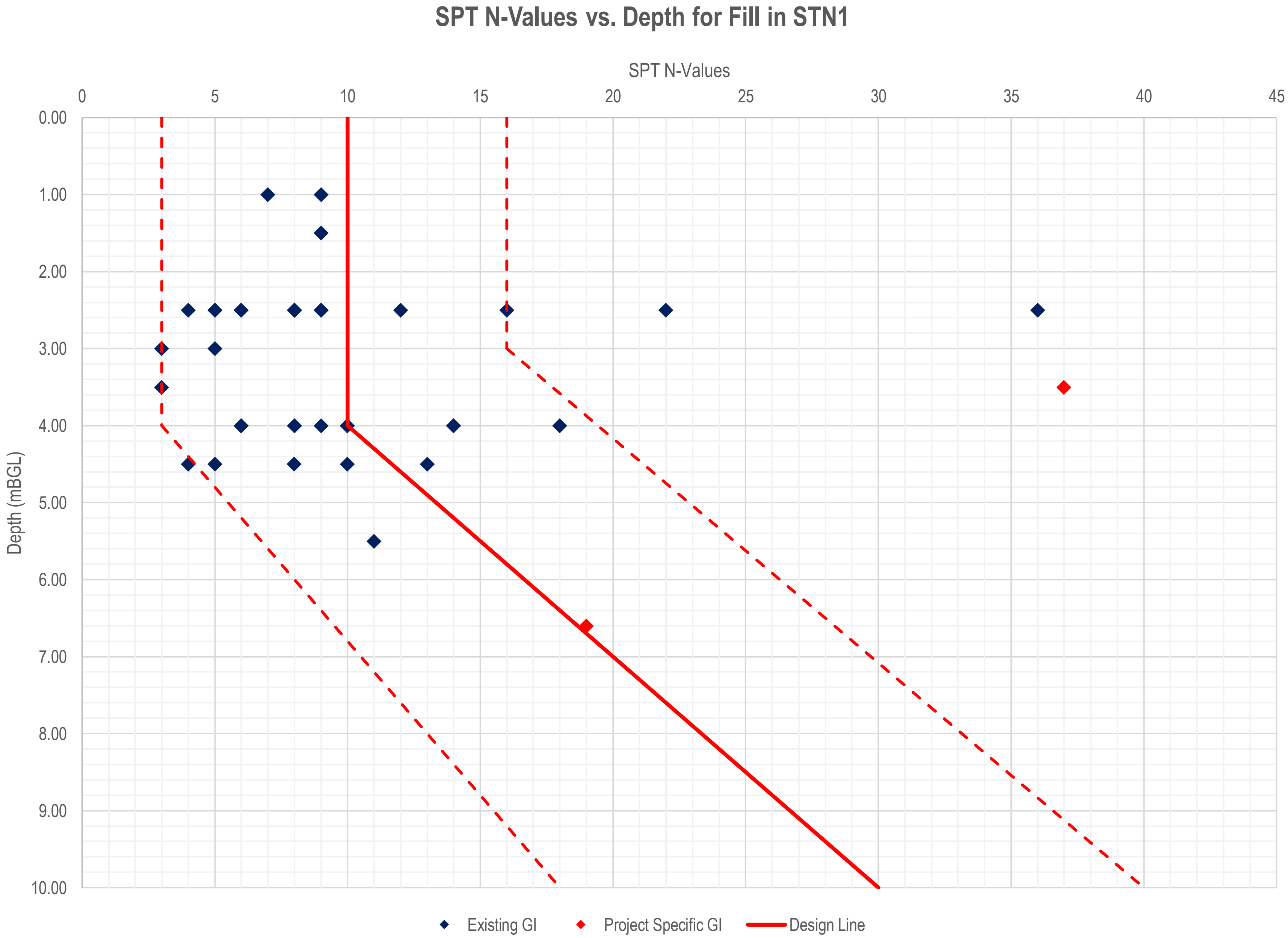
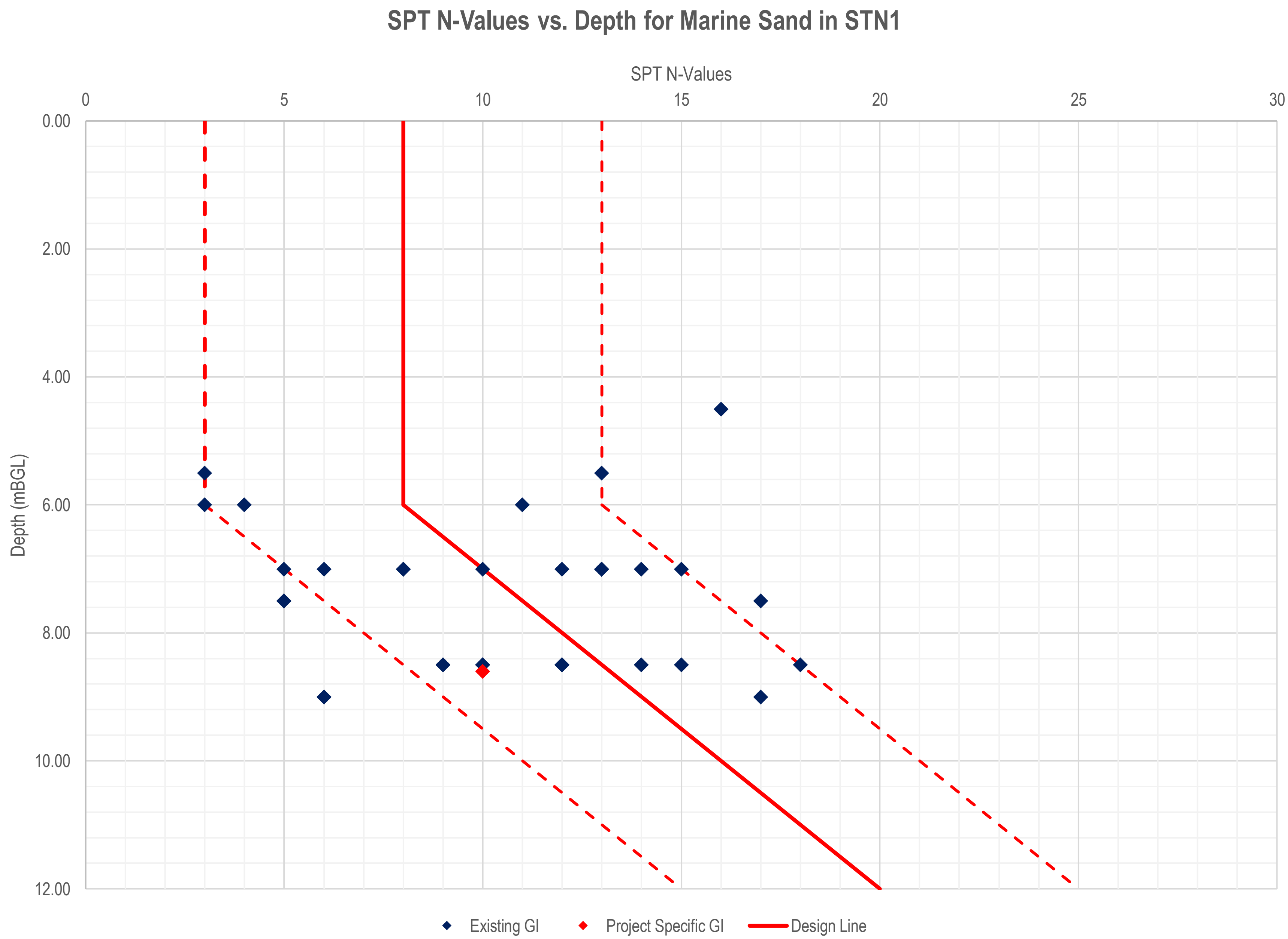

s' vs t for CDG in STN1
Design Line: c' = 5.0 kPa, φ' = 37.0°
Lower Bound: c' = 5.0 kPa, φ' = 34.0°
Upper Bound: c' = 5.0 kPa, φ' = 41.0°
t (kPa)
s' (kPa)
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
400.00
450.00
0.00
100.00
200.00
300.00
400.00
500.00
600.00
Existing GI
Project Specific GI
Design Line
Lower Bound
Upper Bound

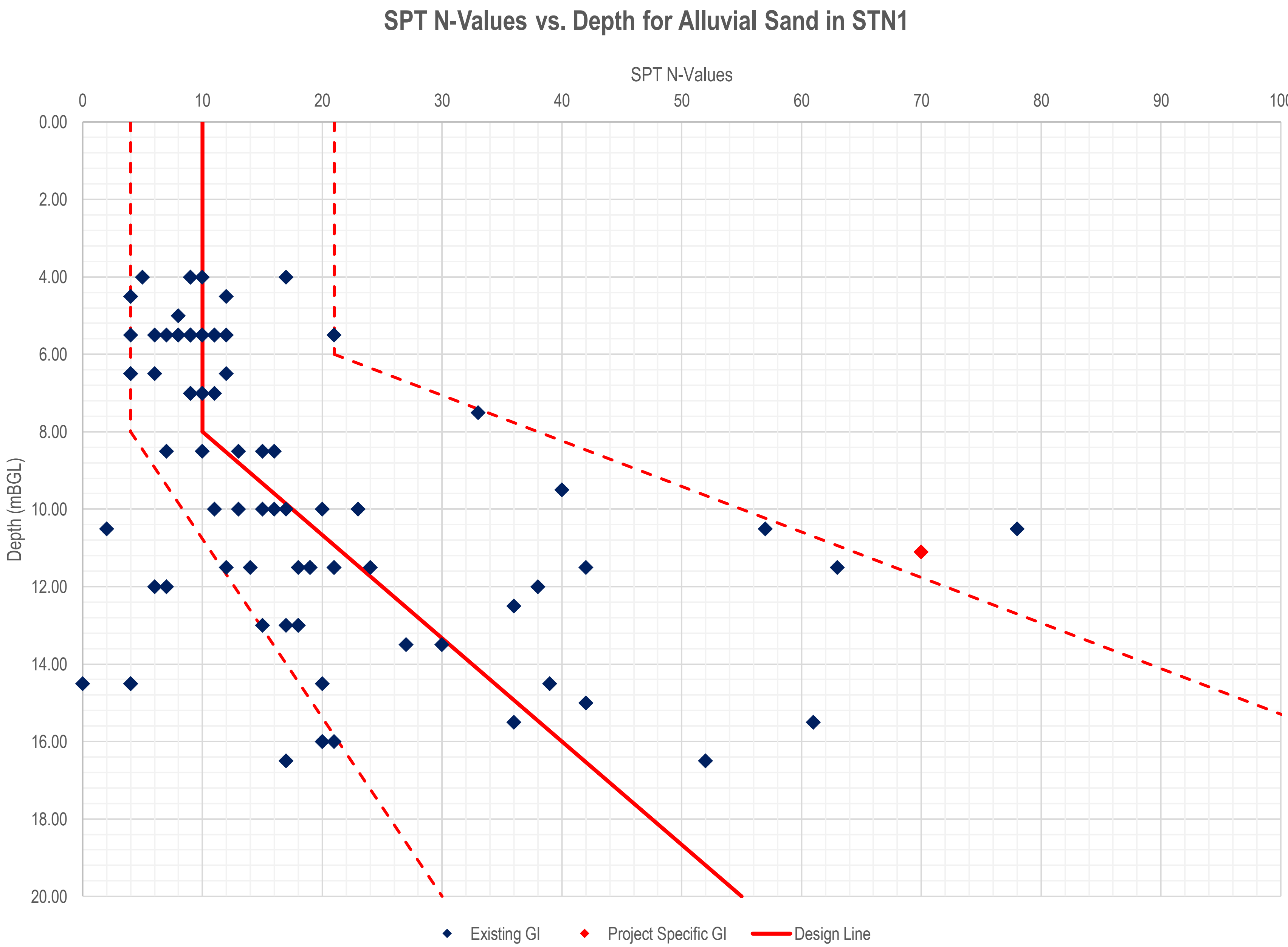
Chart D3

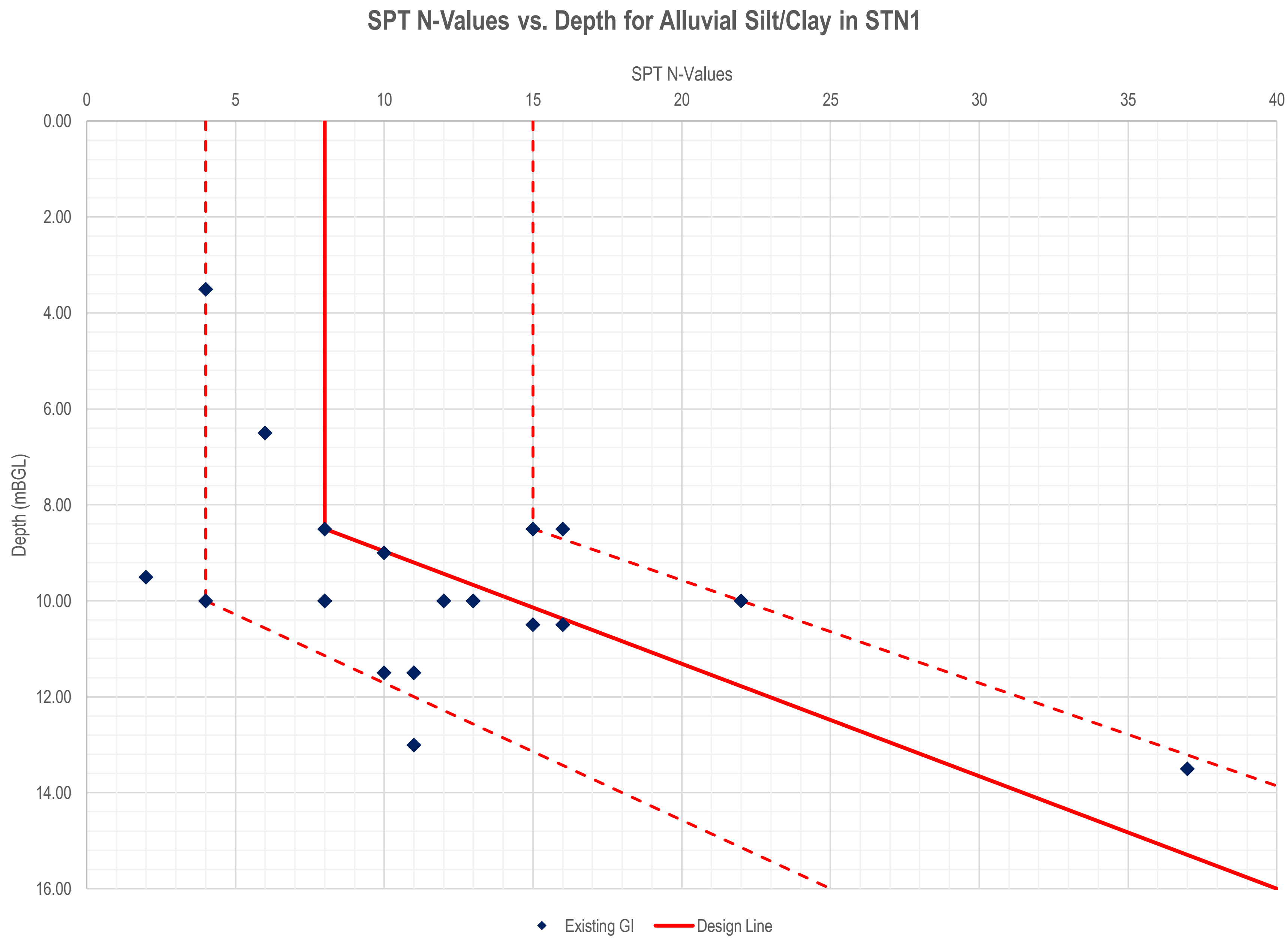
Standard Penetration Test (SPT) N-Value vs. Depth Plots

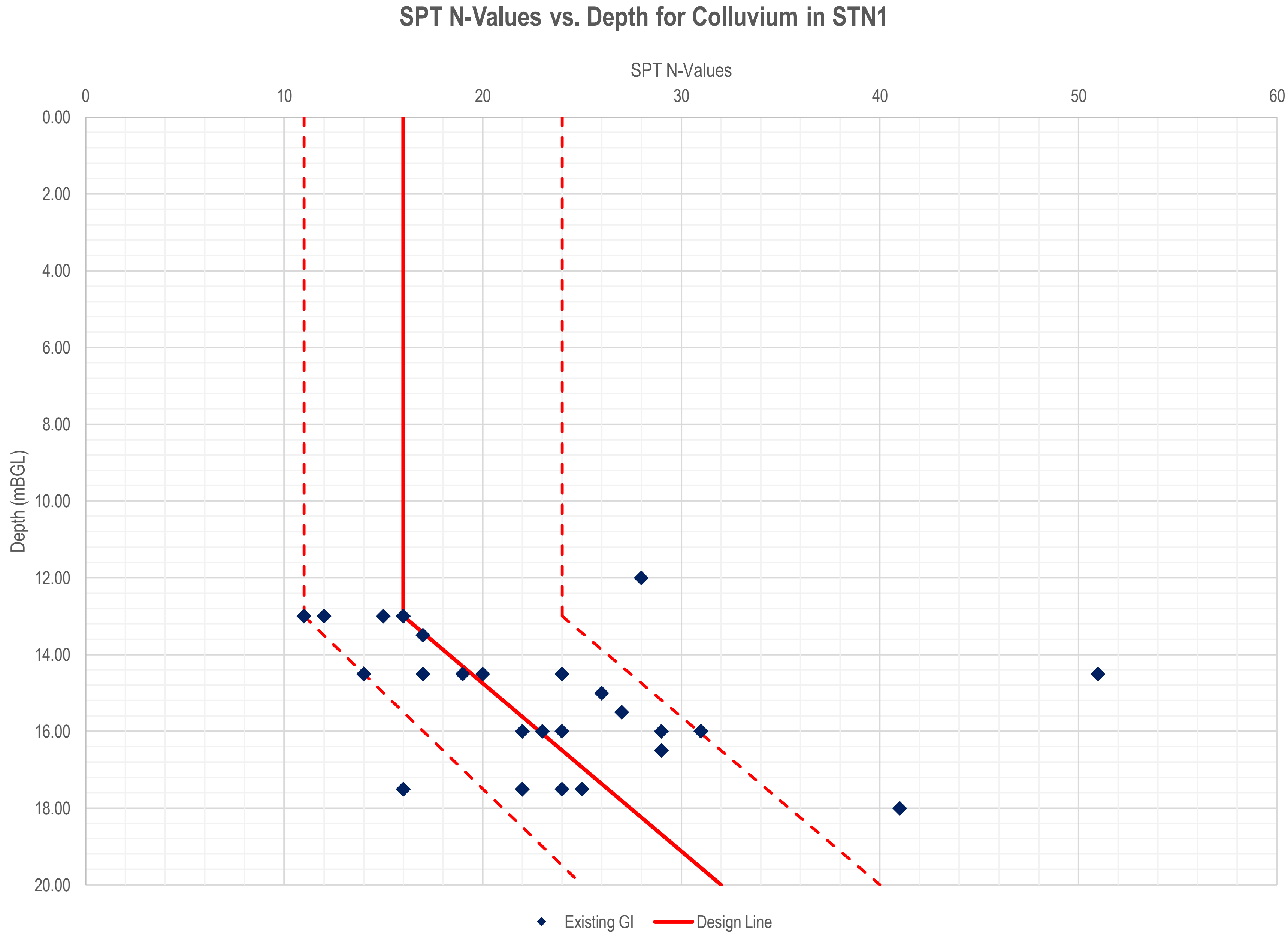
Soil Type	Design Line for SPT N Value
STN1	
Fill	For $z \leq 4.0$ m, $N = 10$. For $z > 4.0$ m, $N = 3.333z - 3.333$.
Marine Sand	For $z \leq 6.0$ m, $N = 8$. For $z > 6.0$ m, $N = 2.0z - 4.0$.
Alluvial Sand	For $z \leq 8.0$ m, $N = 10$. For $z > 8.0$ m, $N = 3.75z - 20.0$.
Alluvial Silt/Clay	For $z \leq 8.5$ m, $N = 8$. For $z > 8.5$ m, $N = 4.267z - 28.267$.
Colluvium	For $z \leq 13.0$ m, $N = 16$. For $z > 13.0$ m, $N = 2.286z - 13.714$.
Completely Decomposed Granite	For $z \leq 20.0$ m, $N = 35$. For $z > 20.0$ m, $N = 1.625z + 2.5$.
Highly Decomposed Granite	No sufficient GI information available.


SPT N-Values vs. Depth for Fill in STN1
SPT N-Values
0
5
10
15
20
25
30
35
40
45
Depth (mBGL)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
Existing GI
Project Specific GI
Design Line


SPT N-Values vs. Depth for Marine Sand in STN1
SPT N-Values
0
5
10
15
20
25
30
0.00
2.00
4.00
6.00
8.00
10.00
12.00
Depth (mBGL)
Existing GI
Project Specific GI
Design Line


SPT N-Values vs. Depth for Alluvial Sand in STN1
SPT N-Values
0
10
20
30
40
50
60
70
80
90
100
Depth (mBGL)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Existing GI
Project Specific GI
Design Line


SPT N-Values vs. Depth for Alluvial Silt/Clay in STN1
SPT N-Values
0
5
10
15
20
25
30
35
40
Depth (mBGL)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
Existing GI
Design Line


SPT N-Values vs. Depth for Colluvium in STN1
SPT N-Values
0
10
20
30
40
50
60
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Depth (mBGL)
Existing GI
Design Line

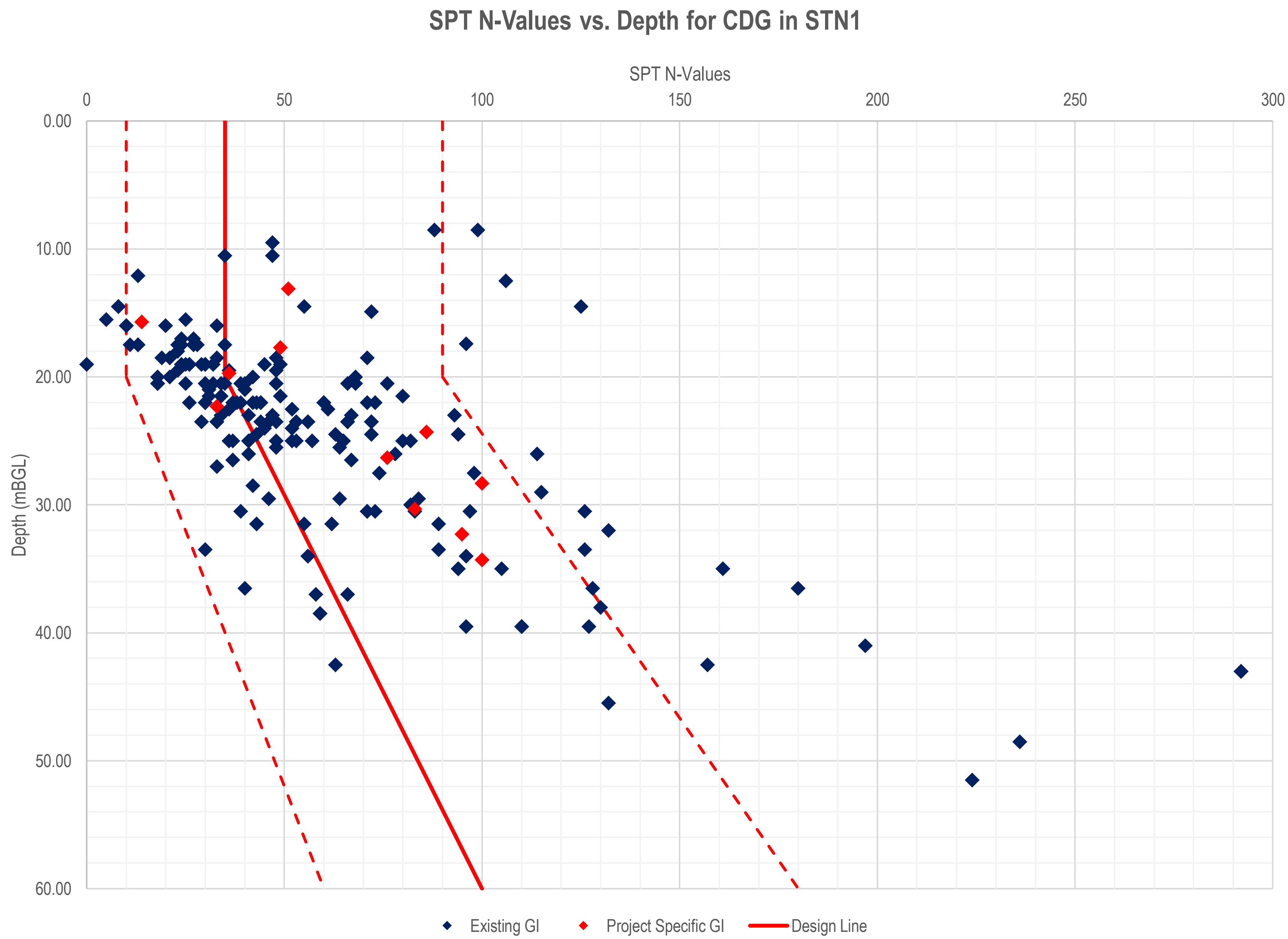
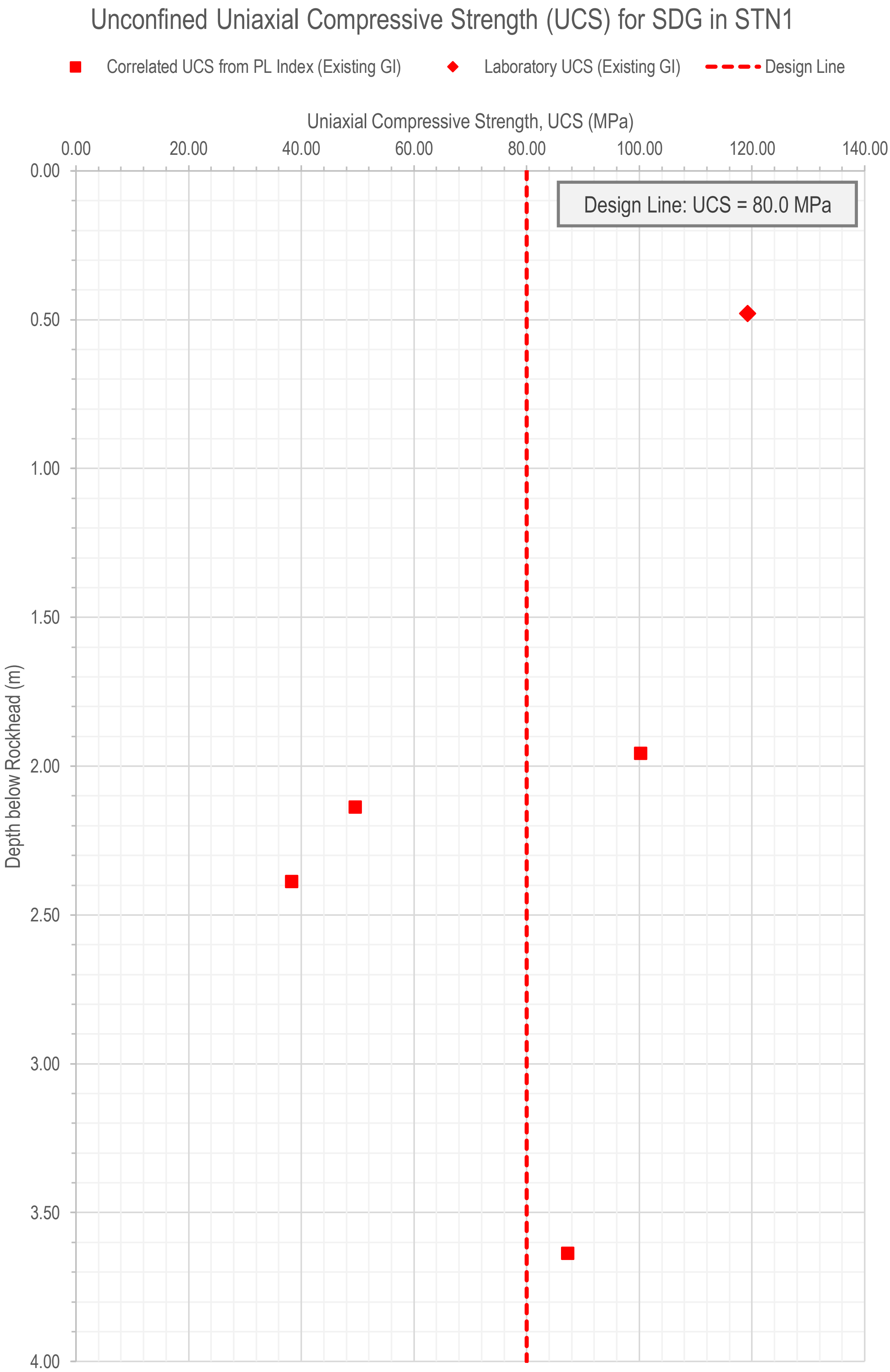

SPT N-Values vs. Depth for CDG in STN1
SPT N-Values
0
50
100
150
200
250
300
Depth (mBGL)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
Existing GI
Project Specific GI
Design Line

Chart D4

Unconfined Uniaxial Compressive Strength vs. Depth Plots


Unconfined Uniaxial Compressive Strength (UCS) for SDG in STN1
Correlated UCS from PL Index (Existing GI)
Laboratory UCS (Existing GI)
Design Line
Uniaxial Compressive Strength, UCS (MPa)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
Design Line: UCS = 80.0 MPa
Depth below Rockhead (m)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00

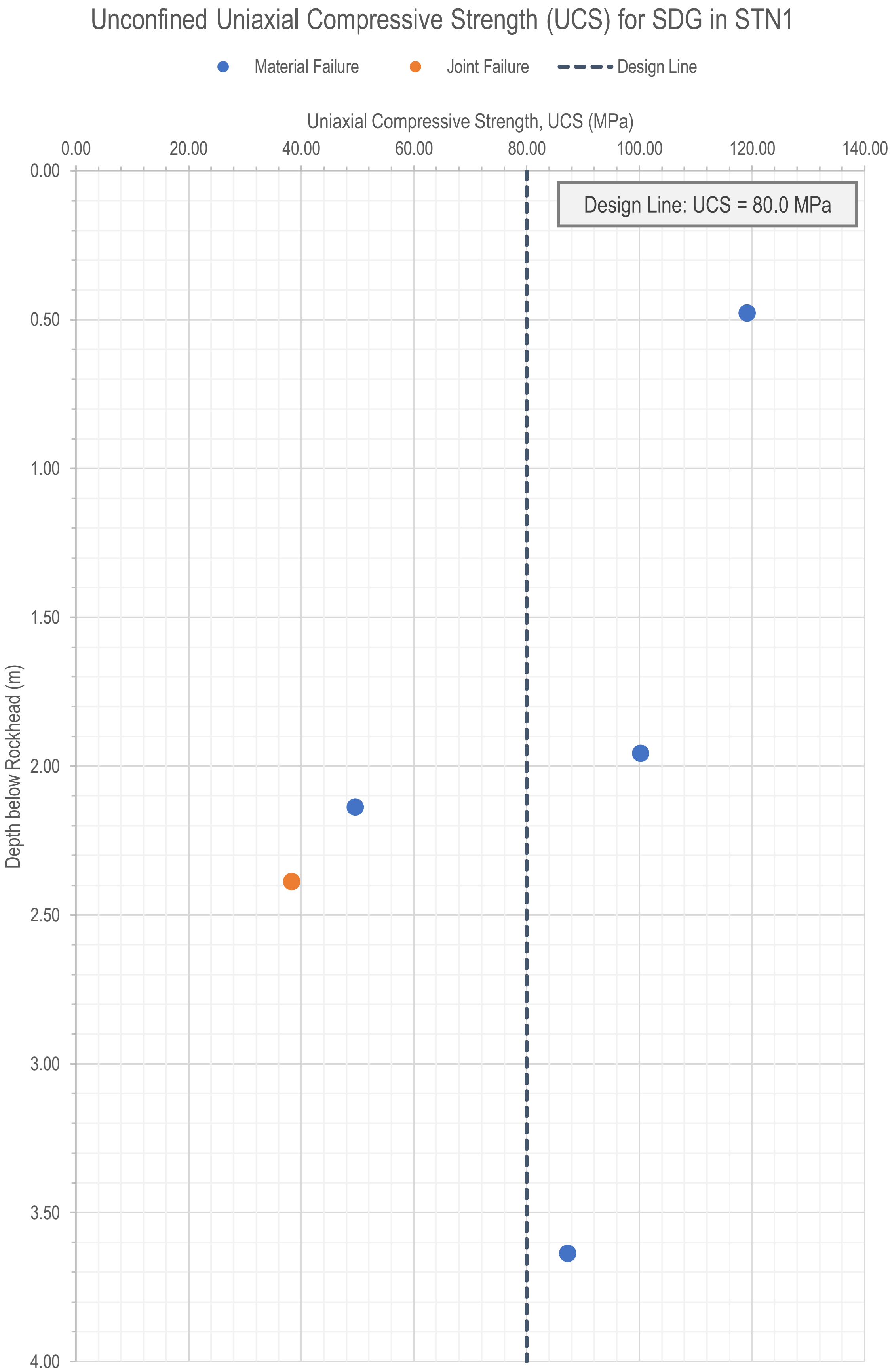
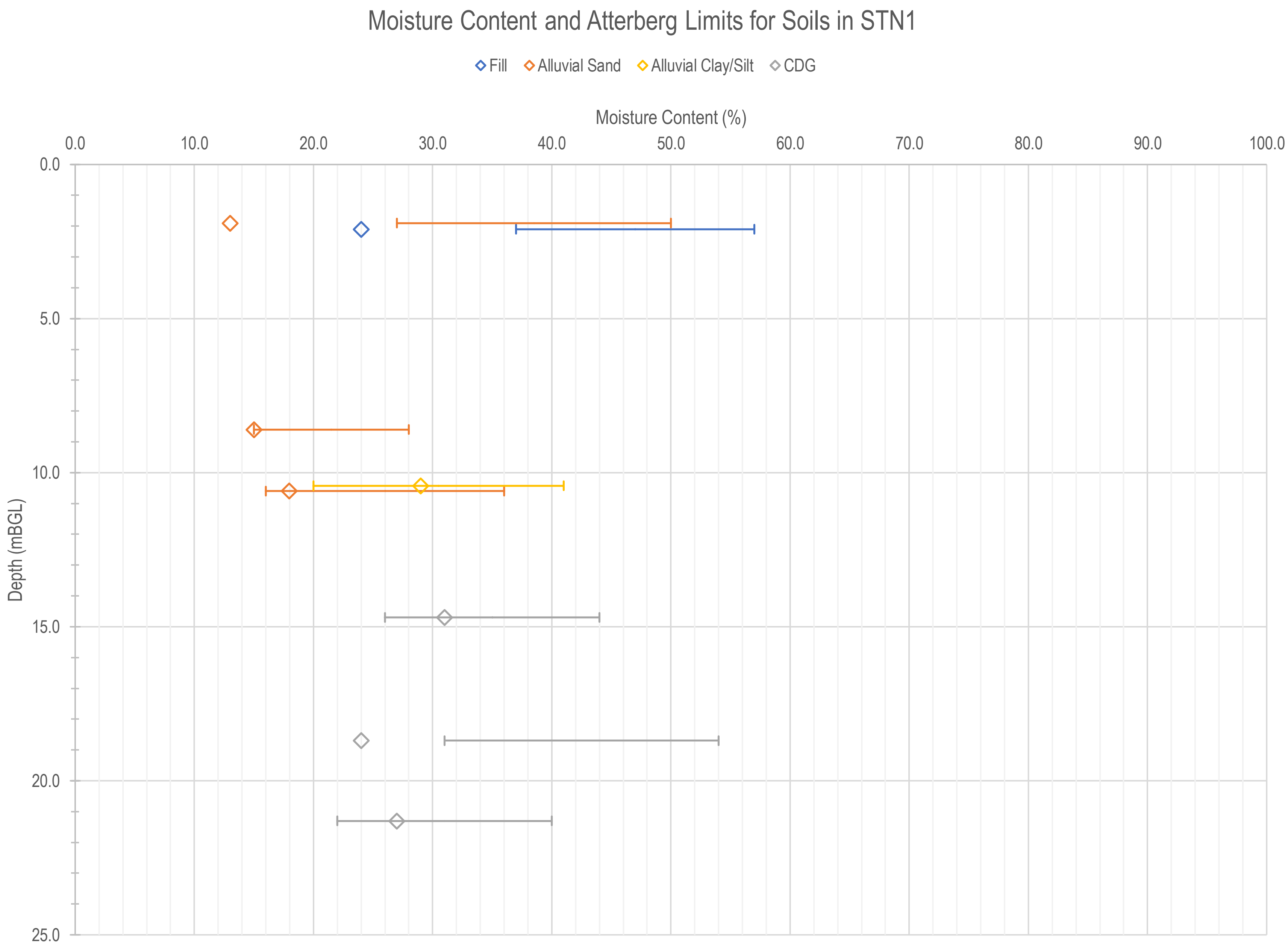

Unconfined Uniaxial Compressive Strength (UCS) for SDG in STN1
Material Failure
Joint Failure
Design Line
Uniaxial Compressive Strength, UCS (MPa)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
Design Line: UCS = 80.0 MPa
Depth below Rockhead (m)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00

Chart D5

Moisture Content and Atterberg Limit Plots


Moisture Content and Atterberg Limits for Soils in STN1
Fill
Alluvial Sand
Alluvial Clay/Silt
CDG
Moisture Content (%)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
Depth (mBGL)
0.0
5.0
10.0
15.0
20.0
25.0

Appendix E

Summary of Groundwater Monitoring Records

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Table E - Summary of Existing & Project Specific Groundwater Monitoring Records

Location	GIU Report No.	GI Station No.	GI Type	Orientation	Easting	Northing	Ground Level (mPD)	GI Depth (mBGL)	GI Base (mPD)	Standpipe (S) / Piezometer (P)	Tip Depth (mBGL)	Tip Level (mPD)	Start Date	End Date	Minimum GWL (mBGL)	Maximum GWL (mBGL)	Lowest GWL (mPD)	Highest GWL (mPD)
STN1	50839	TL/BH 7	RC	Vertical	837163.23	826724.40	31.06	11.29	19.77	P	4.50	26.56	20-Nov-09	27-Nov-09	1.60	1.70	29.36	29.46
STN1	50839	TL/BH 7	RC	Vertical	837163.23	826724.40	31.06	11.29	19.77	P	9.50	21.56	20-Nov-09	27-Nov-09	1.44	1.55	29.51	29.62
STN1	Project Specific GI	DH1	DH	Vertical	837538.60	826586.33	6.06	45.77	-39.71	S	16.00	-9.94	8-Oct-20	16-Oct-20	3.95	3.98	2.08	2.11
STN1	Project Specific GI	DH1	DH	Vertical	837538.60	826586.33	6.06	45.77	-39.71	P	45.00	-38.94	8-Oct-20	16-Oct-20	3.92	3.94	2.12	2.14

Appendix F

Existing Feature Assessment

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Appendix F1
Background Information of the Registered

Table F1 Background Information of the Registered Features

Feature No.	Within or Adjacent to the Site	Maintenance Responsibility	Information from the Slope Information System (SIS)						
			Slope Part			Wall Part			Consequence-to-life Category
			Height	Length	Avg. Angle	Height	Length	Avg. Angle	
			(m)	(m)	(deg)	(m)	(m)	(deg)	
Sha Tin Town Centre (STN1)									
7SE-C/FR 216	Within	ArchSD	2.4	105	15	2.5	60	90	2
7SW-D/F 156	Within	HyD	6	160	30	-	-	-	1
7SW-D/FR 89	Adjacent	ArchSD	4.2	117	13	0.8	74	90	1
7SW-D/FR 85	Within	ArchSD	15	170	25	0.8	170	90	2

Appendix G

Land Status Plans

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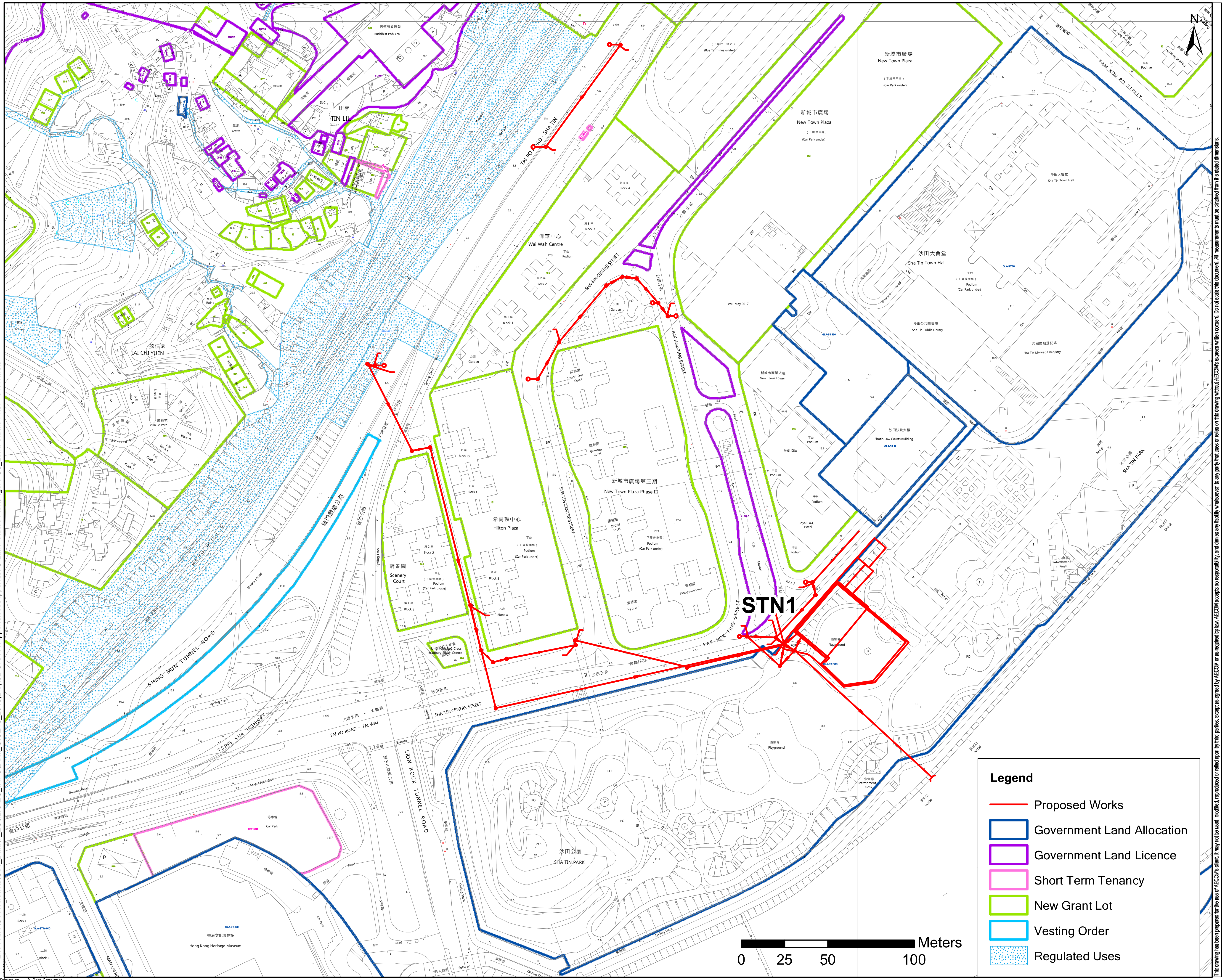


AECOM

PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT 業主

渠務署
Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
www.aecom.com

SUB-CONSULTANTS 分判工程顧問公司

ISSUE/REVISION 修訂

I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

SCALE 比例		**DIMENSION UNIT** 尺寸單位
A3	1:2,000	METERS

KEY PLAN 索引圖

PROJECT NO. 項目編號	**AGREEMENT NO.** 協議編號
60617767	CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

Land Status Plan - STN1

SHEET NUMBER 圖紙編號

Figure G8

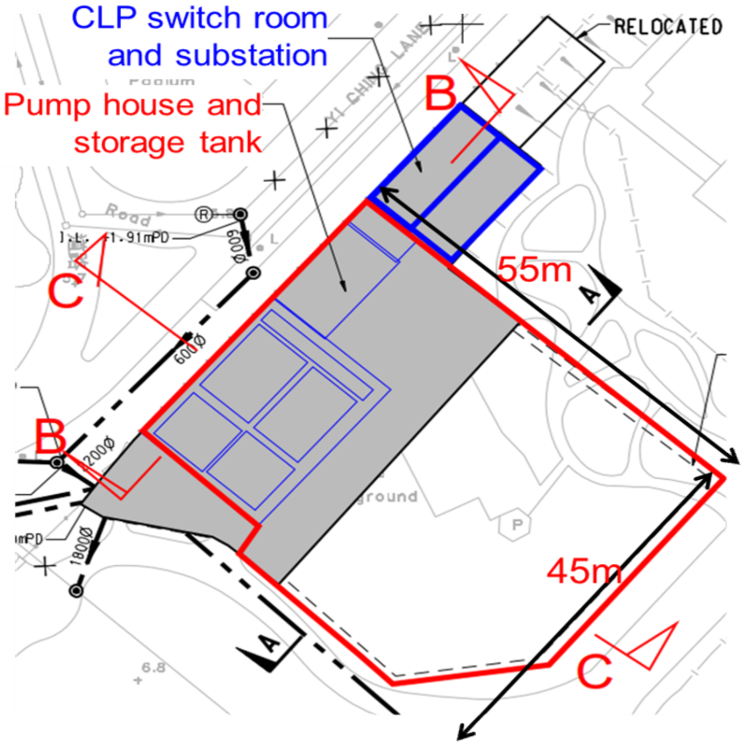
ISO A3 29.7mm x 42mm
Approved: SJW
Checked: FWKS
Designer: AWYC
DEC 2019
Plot File by: AWYC
L:\Secure\Geotechnical\Geo_Data\7_EG&LIC\EG_INFO\Data_G\CE15_2019(DS)\02 GAR\7. Appendices\Appendix G Land Status Plan\Figure G8_Land Status Plan - STN1.mxd
Printed on ___% Post-Consumer Recycled Content Paper

Appendix H

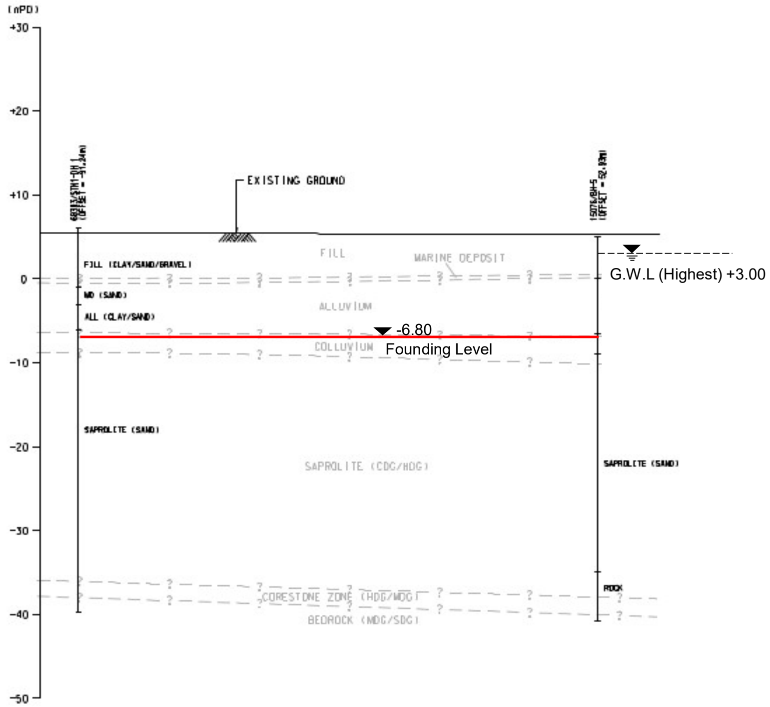
Preliminary Foundation Calculations

STTC Storage Tank and Pump House

AECOM	Contract: CE 15/2019(DS) STSK Drainage Improvement Works GAR	Job ref. 60617767
	Calculated by WF Checked by KP	Date 21-Sep-2021



Plan View of STTC Storage Tank



SECTION B - B
STN1 PUMP HOUSE AND
CLP TRANSFORMER ROOM

AECOM	Contract:	CE 15/2019(DS) STSK Drainage Improvement Works GAR			Job ref.	60617767
	Calculated by	WF	Checked by	KP	Date	21-Sep-2021

STTC Storage Tank

Uplift Checking

	W		L	H
Structual size	45.00		55.00	12.50
Footprint area	2475	m2		
Ground level	6.00	mPD		
Highest possible groundwater level	6.00	mPD	**(= existing ground level)**	
Highest anticipated groundwater level	3.00	mPD	**(= max(measured highest + 0.5m, mean higher high + 1m))**	
Lowest anticipated groundwater level	1.20	mPD	**(= min(measured lowest, mean sea level))**	
Thickness of backfill above structure	2.00	m		
Founding level	-6.80	mPD		
Selfweight of storage tank	204191	kN		
Weight of backfill soil	44000	kN		
Water load, access load, E&M equipment, selfweight of aboveground structure	283859	kN		
Total dead load for uplift check	**248191**	kN	**(= selfweight of underground structure + backfill soil)**	
Total load	**532050**	kN		

Uplift Checking

Total dead load	248191	kN	
Total water pressure	242550	kN	**(highest anticipated groundwater table)**
Factor of Safety	**1.023**	<1.5	**COP for Foundations 2017,5.1.6**
		i.e requires pile tension capacity checking, raft foundation is not workable due to the floatation case	
Total water pressure	316800	kN	**(highest possible groundwater table)**
Factor of Safety	**0.783**	<1.1	**COP for Foundations 2017,5.1.6**
		i.e requires pile tension capacity checking, raft foundation is not workable due to the floatation case	

AECOM	Contract:	CE 15/2019(DS) STSK Drainage Improvement Works GAR	Job ref.	60617767
	Calculated by WF	Checked by KP	Date	21-Sep-2021

STTC Storage Tank
Socketed Piles Design

	W	L	H
Structual size	45.00	55.00	12.50
Footprint area	2475 m2		

Ground level	6.00 mPD	
Highest possible groundwater level	6.00 mPD	**(= existing ground level)**
Highest anticipated groundwater level	3.00 mPD	**(= max(measured highest + 0.5m, mean higher high + 1m))**
Lowest anticipated groundwater level	1.20 mPD	**(= min(measured lowest, mean sea level))**
Thickness of backfill above structure	2.00 m	
Founding level	-6.80 mPD	
Top layer CDG level	-6.20 mPD	

Selfweight of storage tank	204191 kN	
Weight of backfill soil	44000 kN	
Water load, access load, E&M equipment, selfweight of aboveground structure	283859 kN	
Total dead load for uplift check	**248191** kN	**(= selfweight of underground structure + backfill soil)**
Total load	**532050** kN	**(= selfweight of underground structure + backfill soil + water + SDL + LL)**
Total load for compression check	**334050** kN	**(= total load less water pressure, using lowest anticipated groundwater level)**

Mean unit weight of in-situ soil	19.0 kN/m^3
Total uplift force (DL-1.5u)	**-115634** kN

Socketed steel H-Piles Design

Socket H Pile Axial Capacity Check

Size of H pile	Each Pile Capacity (kN)	Designed Nos. of Pile	Total Pile Capacity (kN)	Spacing in 45m side (m)	Spacing in 55m side (m)	Nos. of Piles in 45m side	Nos. of Piles in 55m side
305 x 305 x 223 kg/m	6106	72	**439632**	6.0	6.5	8	9

sectional area of steel,mm2
28400
Steel grade MPa
430
28400X430/1000*0.5=6106
(0.5 refer to COP Foundation P.30)

***Total Pile Capacity >Total load for compression check**

Friction between grout and rock

Bond Friction under compression	700 kPa	**COP for Foundations 2017, Table 2.2 Category 1c**
Pile diameter	550 mm	
Socket Length	**7** m	
Each Pile Friction	**8467**	>Each Pile Capacity = 6106 i.e OK

Bond Stress between steel and grout

Bond Stress between steel and grout	480 kPa	
Perimeter of steel	1918 mm	
Socket Length	**7** m	
Each Pile Bond Stress	**6444**	>Each Pile Capacity = 6106 i.e OK

Socket H Pile Tension Capacity Check

Bond Friction under tension 350 kPa **COP for Foundations 2017, Table 2.2 Category 1c**

Size of H pile	Socket Length	Each Pile Tension	Designed Nos.	Total Pile
305 x 305 x 223 kg/m	7	4233	72	**304797**

> Total Uplift Force

sectional area of steel,mm2
28400
Steel grade MPa
430

Inferred rockhead level is approx. -32 to -40mPD
Assume the pile cut-off level = -6.18mPD
Approx. length of each pile = 33 to 42m, including 7m rock socket

AECOM	Contract:	CE 15/2019(DS) STSK Drainage Improvement Works GAR		Job ref.	60617767
	Calculated by	WF	Checked by KP	Date	21-Sep-2021

STTC Storage Tank

Mini-Piles Design

	W	L	H
Structual size	45.00	55.00	12.50
Footprint area	2475 m2		

Ground level	6.00 mPD	
Highest possible groundwater level	6.00 mPD	**(= existing ground level)**
Highest anticipated groundwater level	3.00 mPD	**(= max(measured highest + 0.5m, mean higher high + 1m))**
Lowest anticipated groundwater level	1.20 mPD	**(= min(measured lowest, mean sea level))**
Thickness of backfill above structure	2.00 m	
Founding level	-6.80 mPD	
Top layer CDG level	-6.20 mPD	
Selfweight of storage tank	204191 kN	
Weight of backfill soil	44000 kN	
Water load, access load, E&M equipment, selfweight of aboveground structure	283859 kN	
Total dead load for uplift check	**248191** kN	**(= selfweight of underground structure + backfill soil)**
Total load	**532050** kN	**(= selfweight of underground structure + backfill soil + water + SDL + LL)**
Total load for compression check	**334050** kN	**(= total load less water pressure, using lowest anticipated groundwater level)**
Mean unit weight of in-situ soil	19.0 kN/m^3	
Total uplift force (DL-1.5u)	**-115634** kN	

Mini-Piles Design

Mini-Pile Axial Capacity Check

Size of Mini-Pile	Each Pile Capacity (kN)	Designed Nos. of Pile	Total Pile Capacity (kN)	Spacing in 45m side (m)	Spacing in 55m side (m)	Nos. of Piles in 45m side	Nos. of Piles in 55m side
$50^2 \times \pi / 4$ kg/m	1716.09	240	**411863**	3.0	3.5	15	16

***Total Pile Capacity >Total load for compression check**

sectional area of single steel,mm2
1963.50
Steel grade MPa
460 — **COP for the Structure Use of Steel 2011, Clause 3.1.3**
4X1963.5X460/1000*0.475=1706.09 — **0.475 from COP for Foundations 2017, Clause 5.4.8**

Friction between grout and rock

Bond Friction under compression	700 kPa	**COP for Foundations 2017, Table 2.2 Category 1c**
Pile diameter	200 mm	
Socket Length	**7** m	
Each Pile Friction	**3079**	>Each Pile Capacity = 1716 i.e OK

Bond Stress between steel and grout

Bond Stress between steel and grout	800 kPa	**COP for Foundations 2017, Clause 5.4.8 (2) (c)**
Perimeter of steel	357.1 mm	**COP for Foundations 2017, Clause 5.4.8 (2) (e)**
Socket Length	**7** m	
Each Pile Bond Stress	**2000**	>Each Pile Capacity = 1716 i.e OK

Mini-Pile Tension Capacity Check

Bond Friction under tension — 350 kPa — **COP for Foundations 2017, Table 2.2 Category 1c**

Size of Mini-Pile	Socket Length (m)	Each Pile Tension Capacity (kN)	Designed Nos. of Pile	Tension Capacity (kN)
$50^2 \times \pi / 4$ kg/m	7	1539	240	**369451**

> Total Uplift Force

sectional area of single steel,mm2
1963.5
Steel grade MPa
460

Inferred rockhead level is approx. -32 to -40mPD
Assume the pile cut-off level = -7.30mPD
Approx. length of each pile = 33 to 42m, including 7m rock socket

Mini-Pile Soil Cone Check

Designed Nos. of Pile	Pile Level (mPD)	Soil Column +Cone Volume	Effective weight of soil
240	-39	73321.86	**673828**

> Total Uplift Force

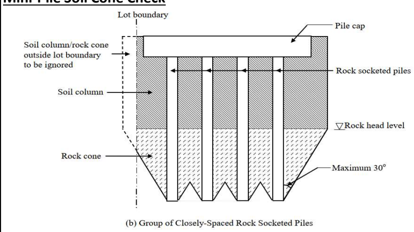


Figure 5.1 Configuration of Rock Cone/Soil Column for Rock Socketed Piles

AECOM	Contract:	CE 15/2019(DS) STSK Drainage Improvement Works GAR	Job ref.	60617767
	Calculated by WF	Checked by KP	Date	21-Sep-2021

STTC Storage Tank

Driven Piles Design

	W	L	H	
Structual size	45.00	55.00	12.50	
Footprint area	2475 m2			
Ground level	6.00 mPD			
Highest possible groundwater level	6.00 mPD			**(= existing ground level)**
Highest anticipated groundwater level	3.00 mPD			**(= max(measured highest + 0.5m, mean higher high + 1m))**
Lowest anticipated groundwater level	1.20 mPD			**(= min(measured lowest, mean sea level))**
Thickness of backfill above structure	2.00 m			
Founding level	-6.80 mPD			
Top layer CDG level	-6.80 mPD			
Selfweight of storage tank	204191 kN			
Weight of backfill soil	44000 kN			
Water load, access load, E&M equipment, selfweight of aboveground structure	283859 kN			
Total dead load for uplift check	**248191** kN			**(= selfweight of underground structure + backfill soil)**
Total load	**532050** kN			**(= selfweight of underground structure + backfill soil + water + SDL + LL)**
Total load for compression check	**334050** kN			**(= total load less water pressure, using lowest anticipated groundwater level)**
Shaft resisteance coefficient	0.3			**GEO Publication No. 1/2006, Table 6.3 Dirven small dispalcement piles**
Factor Safety	1.5			
Factored shaft resistenance coeff.	0.2			
Mean unit weight of in-situ soil	19.0 kN/m^3			
Total uplift force (DL-1.5u)	**-115634** kN			

Driven Pile Bearing Capacity Check

Size of Driven Pile	Each Pile Capacity (kN)	Nos. of Pile	Total Pile Capacity (kN)	Spacing in 45m side (m)	Spacing in 55m side (m)	Nos. of Piles in 45m side	Nos. of Piles in 55m side
305 x 305 x 223 kg/m	3650	180	**657000**	3.5	4	12	15
sectional area of steel,mm2	3650	238	**868700**	3	3	14	17
28400							
Steel grade, MPa							
430							
28400X430/1000*0.3=3650							
(0.3 refer to COP Foundation P.30)							

***Total Pile Capacity > Total load for compression check**

Driven Pile Shaft Resistance Check

Size of Driven Pile	Pile Perimeter (m)	Nos. of Pile	Embedded length	Pile Top effective stress	Pile Bottom effective stress	Each Pile Capacity (kN)	Total Pile Capacity (kN)	Pile Toe Level (mPD)
305 x 305 x 223 kg/m	1.2	180	30	163.2	403.2	2039.0	**367027**	**-36.80**
sectional area of steel,mm2	1.2	238	25	163.2	363.2	1579.2	**375850**	**-31.80**
28400								
Steel grade, MPa								
430								
28400X430/1000*0.3=3650								
(0.3 refer to COP Foundation P.30)								

***Total Pile Capacity > Total load for compression check**

Soil Cone Checking

Designed Nos. of Pile	Pile Toe Level (mPD)	Soil Column +Cone Volume (m3)	Effective weight of soil cone (kN)
180	-36.8	23924.76	**191398**
238	-31.8	19937.30	**159498**

***Total Effective Weight> Total load for uplift check**

STTC CLP Transformer Room and Switch Room

AECOM	Contract:	CE 15/2019(DS) STSK Drainage Improvement Works GAR			Job ref.	60617767
	Calculated by	WF	Checked by	KP	Date	21-Sep-2021

STTC CLP Transformer Room & Switch Room

Check of Bearing Capacity (STN1, Switching Room, Fill, Drained Case)

Based on BD CoP for Foundations 2017, Clause 2.2.4 - Allowable Bearing Pressure from Bearing Capacity Equation Method

Foundation Geometries					
Ground level	GL	=	6.00	mPD	
Groundwater level	GWL	=	3.00	mPD	**(= max(measured highest + 0.5m, mean higher high + 1m))**
Founding level	FL	=	6.00	mPD	
Thickness of backfill above structure	D_b	=	0.00	m	
Shorter dimension of foundation	B_f	=	12.0	m	
Longer dimension of foundation	L_f	=	17.0	m	
Sloping inclination in front of the footing	ω	=	0.0	°	
Inclination of the base of the footing	α_f	=	0.0	°	
Load Conditions					
Vertical load from structure	P	=	20010	kN	**(Total Load)**
Vertical pressure from structure	p	=	98	kPa	
Vertical pressure from backfill soil	p_b	=	0	kPa	
Design surcharge	p_d	=	0	kPa	
Total design loading at FL	q_0	=	98	kPa	
Horizontal component of the applied load	H	=	0	kN	
Eccentricity of load along B direction	e_B	=	0.0	m	
Eccentricity of load along L direction	e_L	=	0.0	m	
Soil parameters					
Layer top level	Z_s	=	6.00	mPD	
Effective cohesion of soil	c'	=	0.0	kPa	
Angle of shearing resistance	ϕ'	=	30.0	°	
Bulk unit weight of in-situ soil	γ_s	=	19.0	kN/m^3	
Effective unit weight	γ_s'	=	9.0	kN/m^3	
Factor of safety	F	=	3.0		

Calculations:

Geometry features										
D_f	=	GL - FL	=	6 - 6				=	**0.00**	m
B_f'	=	$B_f - 2e_B$	=	12 - 2*0				=	**12.0**	m
L_f'	=	$L_f - 2e_L$	=	17 - 2*0				=	**17.0**	m
m_i along B_f'	=	$(2 + B_f'/L_f')$	/	$(1 + B_f'/L_f')$	=	2.71/1.71		=	**1.59**	
m_i along L_f'	=	$(2 + L_f'/B_f')$	/	$(1 + L_f'/B_f')$	=	3.42/2.42		=	**1.41**	
m_i	=	$\max(m_i)$						=	**1.59**	
Overburden pressure										
q	=	γ_s	*	$\min(3, B_f, D_f)$	=	19*0		=	**0.00**	kPa
q'	=	γ_s'	*	$\min(3, B_f, D_f)$	=	9*0		=	**0.00**	kPa
q_o	=	γ_s'	*	D_f	=	9*0		=	**0.00**	kPa
Bearing capacity Factors										
N_c	=	$(N_q - 1)$	*	$\cot\phi'$						
	=	17.40	*	1.73				=	**30.14**	
N_γ	=	$2*(N_q+1)$	*	$\tan\phi'$						
	=	38.80	*	0.58				=	**22.40**	
N_q	=	$\exp(\pi*\tan\phi')$	*	$\tan^2(45°+\phi'/2)$						
	=	6.13	*	3.00				=	**18.40**	
Shape factors										
ζ_{cs}	=	1.00	+	B_f/L_f	*	N_q/N_c				
	=	1.00	+	0.71	*	0.61		=	**1.43**	
$\zeta_{\gamma s}$	=	1.00	-	$0.4*B_f/L_f$						
	=	1.00	-	0.71				=	**0.29**	
ζ_{qs}	=	1.00	+	B_f/L_f	*	$\tan\phi'$				
	=	1.00	+	0.01	*	0.58		=	**1.01**	
Inclination factors										
ζ_{ci}	=	ζ_{qi}	-	$(1-\zeta_{qi})$	/	$(N_c\tan\phi')$				
	=	1.00	-	0.00	/	17.40		=	**1.00**	
$\zeta_{\gamma i}$	=	[1 -	H	/	$(P+B_f'L_f'c'\cot\phi')$	]^	$(m_i + 1)$			
	=	(1 -	0	/	20010	)^	2.59	=	**1.00**	
ζ_{qi}	=	[1 -	H	/	$(P+B_f'L_f'c'\cot\phi')$	]^	m_i			
	=	(1 -	0	/	20010	)^	1.59	=	**1.00**	

Tilt factors

ζ_{ct}	=	ζ_{qt}	-	$(1-\zeta_{qt})$	/	$(N_c\tan\phi')$			
	=	1.00	-	0.00	/	17.40	=	**1.00**	
$\zeta_{\gamma t}$	=	(	1.00	-	$\alpha_f\tan\phi'$	)^2			
	=	(	1.00	-	0.00	)^2	=	**1.00**	
ζ_{qt}	≈	$\zeta_{\gamma t}$					=	**1.00**	

Ground sloping factors

ζ_{cg}	=	exp(	-2ω	*	$\tan\phi'$	)			
	=	exp(	0.00	*	0.58	)	=	**1.00**	
$\zeta_{\gamma g}$	≈	ζ_{qg}					=	**1.00**	
ζ_{qg}	=	$(1 - \tan\omega)^2$ for $\omega \leq 45°$		or	0 for $\omega > 45°$				
	=	1.00		or	0.00		=	**1.00**	

Ultimate and allowable bearing pressure

q_u (≤ 3000 kPa)	=	$c'N_c\zeta_{cs}\zeta_{ci}\zeta_{ct}\zeta_{cg}$	+	$0.5B_f'\gamma_s'N_\gamma\zeta_{\gamma s}\zeta_{\gamma i}\zeta_{\gamma t}\zeta_{\gamma g}$	+	$qN_q\zeta_{qs}\zeta_{qi}\zeta_{qt}\zeta_{qg}$			
	=	0	+	355.80	+	0.00			
	=	355.80	≤	3000			=	**355.80**	kPa
q_a	=	$(q_u - q_o)$	/	F	+	q_o			
	=	355.80	/	3	+	0.00	=	**118.60**	kPa

Design loading

Load spreading factor	V:H	=	2.0			
Net loading on footing	p_{net}	=	$p - \gamma_s D_f$	=	**98.09**	kPa
Distance from layer top to footing base	D_L	=	$FL - Z_s$	=	**0.0**	m
Resized B after load spreading	B'	=	$B_f' + 2D_L/(V:H)$	=	**12**	m
Resized L after load spreading	L'	=	$L_f' + 2D_L/(V:H)$	=	**17**	m
Load after spreading	p'	=	$p_{net}*B_f'*L_f'/(B'*L') + \gamma_s D_f$	=	**98.1**	kPa

Check of bearing capacity

Check of design loading against allowable bearing pressure:	98.09 ≤ 118.6	**OK!**

AECOM	Contract:	CE 15/2019(DS) STSK Drainage Improvement Works GAR		Job ref.	60617767
	Calculated by	WF	Checked by KP	Date	21-Sep-2021

STTC CLP Transformer Room & Switch Room

Check of Bearing Capacity (STN1, Switching Room, MD (Sand), Drained Case)

Based on BD CoP for Foundations 2017, Clause 2.2.4 - Allowable Bearing Pressure from Bearing Capacity Equation Method

Foundation Geometries

Ground level	GL	=	6.00	mPD	
Groundwater level	GWL	=	3.00	mPD	**(= max(measured highest + 0.5m, mean higher high + 1m))**
Founding level	FL	=	6.00	mPD	
Thickness of backfill above structure	D_b	=	0.00	m	
Shorter dimension of foundation	B_f	=	12.0	m	
Longer dimension of foundation	L_f	=	17.0	m	
Sloping inclination in front of the footing	ω	=	0.0	°	
Inclination of the base of the footing	α_f	=	0.0	°	
Load Conditions					
Vertical load from structure	P	=	20010	kN	**(Total Load)**
Vertical pressure from structure	p	=	98	kPa	
Vertical pressure from backfill soil	p_b	=	0	kPa	
Design surcharge	p_d	=	0	kPa	
Total design loading at FL	q_0	=	98	kPa	
Horizontal component of the applied load	H	=	0	kN	
Eccentricity of load along B direction	e_B	=	0.0	m	
Eccentricity of load along L direction	e_L	=	0.0	m	
Soil parameters					
Layer top level	Z_s	=	-1.10	mPD	
Effective cohesion of soil	c'	=	0.0	kPa	
Angle of shearing resistance	ϕ'	=	33.0	°	
Bulk unit weight of in-situ soil	γ_s	=	19.0	kN/m^3	
Effective unit weight	γ_s'	=	9.0	kN/m^3	
Factor of safety	F	=	3.0		

Calculations:

Geometry features										
D_f	=	GL - FL	=	6 - 6				=	**0.00**	m
B_f'	=	$B_f - 2e_B$	=	12 - 2*0				=	**12.0**	m
L_f'	=	$L_f - 2e_L$	=	17 - 2*0				=	**17.0**	m
m_i along B_f'	=	$(2 + B_f'/L_f')$	/	$(1 + B_f'/L_f')$	=	2.71/1.71		=	**1.59**	
m_i along L_f'	=	$(2 + L_f'/B_f')$	/	$(1 + L_f'/B_f')$	=	3.42/2.42		=	**1.41**	
m_i	=	$\max(m_i)$						=	**1.59**	
Overburden pressure										
q	=	γ_s	*	$\min(3, B_f, D_f)$	=	19*0		=	**0.00**	kPa
q'	=	γ_s'	*	$\min(3, B_f, D_f)$	=	9*0		=	**0.00**	kPa
q_o	=	γ_s'	*	D_f	=	9*0		=	**0.00**	kPa
Bearing capacity Factors										
N_c	=	$(N_q - 1)$	*	$\cot\phi'$						
	=	25.09	*	1.54				=	**38.64**	
N_γ	=	$2*(N_q+1)$	*	$\tan\phi'$						
	=	54.18	*	0.65				=	**35.19**	
N_q	=	$\exp(\pi*\tan\phi')$	*	$\tan^2(45°+\phi'/2)$						
	=	7.69	*	3.39				=	**26.09**	
Shape factors										
ζ_{cs}	=	1.00	+	B_f/L_f	*	N_q/N_c				
	=	1.00	+	0.71	*	0.68		=	**1.48**	
$\zeta_{\gamma s}$	=	1.00	-	$0.4*B_f/L_f$						
	=	1.00	-	0.71				=	**0.29**	
ζ_{qs}	=	1.00	+	B_f/L_f	*	$\tan\phi'$				
	=	1.00	+	0.01	*	0.65		=	**1.01**	
Inclination factors										
ζ_{ci}	=	ζ_{qi}	-	$(1-\zeta_{qi})$	/	$(N_c\tan\phi')$				
	=	1.00	-	0.00	/	25.09		=	**1.00**	
$\zeta_{\gamma i}$	=	[1 -	H	/	$(P+B_f'L_f'c'\cot\phi')$	]^	$(m_i + 1)$			
	=	(1 -	0	/	20010	)^	2.59	=	**1.00**	
ζ_{qi}	=	[1 -	H	/	$(P+B_f'L_f'c'\cot\phi')$	]^	m_i			
	=	(1 -	0	/	20010	)^	1.59	=	**1.00**	

Tilt factors

ζ_{ct}	=	ζ_{qt}	-	$(1-\zeta_{qt})$	/	$(N_c\tan\phi')$			
	=	1.00	-	0.00	/	25.09	=	**1.00**	
$\zeta_{\gamma t}$	=	(	1.00	-	$\alpha_f\tan\phi'$	)^2			
	=	(	1.00	-	0.00	)^2	=	**1.00**	
ζ_{qt}	≈	$\zeta_{\gamma t}$					=	**1.00**	
Ground sloping factors									
ζ_{cg}	=	exp(	-2ω	*	$\tan\phi'$	)			
	=	exp(	0.00	*	0.65	)	=	**1.00**	
$\zeta_{\gamma g}$	≈	ζ_{qg}					=	**1.00**	
ζ_{qg}	=	$(1-\tan\omega)^2$ for $\omega \le 45^o$		or	0 for $\omega > 45^o$				
	=	1.00		or	0.00		=	**1.00**	

Ultimate and allowable bearing pressure

q_u (≤ 3000 kPa)	=	$c'N_c\zeta_{cs}\zeta_{ci}\zeta_{ct}\zeta_{cg}$	+	$0.5B_f'\gamma_s'N_\gamma\zeta_{\gamma s}\zeta_{\gamma i}\zeta_{\gamma t}\zeta_{\gamma g}$	+	$qN_q\zeta_{qs}\zeta_{qi}\zeta_{qt}\zeta_{qg}$			
	=	0	+	558.86	+	0.00			
	=	558.86	≤	3000			=	**558.86**	kPa
q_a	=	$(q_u - q_o)$	/	F	+	q_o			
	=	558.86	/	3	+	0.00	=	**186.29**	kPa

Design loading

Load spreading factor	V:H	=	2.0			
Net loading on footing	p_{net}	=	$p - \gamma_s D_f$	=	**98.09**	kPa
Distance from layer top to footing base	D_L	=	$FL - Z_s$	=	**7.1**	m
Resized B after load spreading	B'	=	$B_f' + 2D_L/(V:H)$	=	**19.1**	m
Resized L after load spreading	L'	=	$L_f' + 2D_L/(V:H)$	=	**24.1**	m
Load after spreading	p'	=	$p_{net}*B_f'*L_f'/(B'*L') + \gamma_s D_f$	=	**43.5**	kPa

Check of bearing capacity

Check of design loading against allowable bearing pressure: 43.47 ≤ 186.29 **OK!**

AECOM	Contract:	CE 15/2019(DS) STSK Drainage Improvement Works GAR			Job ref.	60617767
	Calculated by	WF	Checked by	KP	Date	21-Sep-2021

STTC CLP Transformer Room & Switch Room

Check of Bearing Capacity (STN1, Switching Room, Alluvium, Undrained Case)

Based on BD CoP for Foundations 2017, Clause 2.2.4 - Allowable Bearing Pressure from Bearing Capacity Equation Method

Foundation Geometries

Ground level	GL	=	6.00	mPD	
Groundwater level	GWL	=	3.00	mPD	**(= max(measured highest + 0.5m, mean higher high + 1m))**
Founding level	FL	=	6.00	mPD	
Thickness of backfill above structure	D_b	=	0.00	m	
Shorter dimension of foundation	B_f	=	12.0	m	
Longer dimension of foundation	L_f	=	17.0	m	**(assuming L_f/B_f=100 for strip foundation)**
Sloping inclination in front of the footing	ω	=	0.0	°	
Inclination of the base of the footing	α_f	=	0.0	°	
Load Conditions					
Vertical load from structure	P	=	20010	kN	**(Total Load)**
Vertical pressure from structure	p	=	98	kPa	
Vertical pressure from backfill soil	p_b	=	0	kPa	
Design surcharge	p_d	=	0	kPa	
Total design loading at FL	q	=	98	kPa	
Horizontal component of the applied load	H	=	0	kN	
Eccentricity of load along B direction	e_B	=	0.0	m	
Eccentricity of load along L direction	e_L	=	0.0	m	
Soil parameters					
Layer top level	Z_s	=	-3.10	mPD	
Effective cohesion of soil	c'	=	46.7	kPa	**(For z > 8.5 m, c_u=18.8*z-124.4 kPa)**
Angle of shearing resistance	ϕ'	=	0.0	°	
Bulk unit weight of in-situ soil	γ_s	=	18.0	kN/m^3	
Effective unit weight	γ_s'	=	8.0	kN/m^3	
Factor of safety	F	=	3.0		

Calculations:

Geometry features									
D_f	=	GL - FL	=	6 - 6			=	**0.00**	m
B_f'	=	B_f - $2e_B$	=	12 - 2*0			=	**12.0**	m
L_f'	=	L_f - $2e_L$	=	17 - 2*0			=	**17.0**	m
m_i along B_f'	=	$(2 + B_f'/L_f')$	/	$(1 + B_f'/L_f')$	=	2.71/1.71	=	**1.59**	
m_i along L_f'	=	$(2 + L_f'/B_f')$	/	$(1 + L_f'/B_f')$	=	3.42/2.42	=	**1.41**	
m_i	=	max(m_i)					=	**1.59**	
Overburden pressure									
q	=	γ_s	*	min(3, B_f, D_f)	=	18*0	=	**0.00**	kPa
q'	=	γ_s'	*	min(3, B_f, D_f)	=	8*0	=	**0.00**	kPa
q_o	=	γ_s'	*	D_f	=	8*0	=	**0.00**	kPa
Bearing capacity Factors									
N_c	=	2	+	π			=	**5.14**	
N_γ							=	**0.00**	
N_q							=	**1.00**	
Shape factors									
ζ_{cs}	=	1.00	+	$0.2*B_f/L_f$	=	1 + 0.2*12/17	=	**1.14**	
ζ_{qs}							=	**1.00**	
Inclination factors									
ζ_{ci}	=	0.5 + 0.5sqrt[1 - H/(c'$B_f'L_f'$)]			= 0.5 + 0.5*sqrt(1 - 0/9526.8)		=	**1.00**	
ζ_{qi}							=	**1.00**	
Tilt factors									
ζ_{ct}	=	1.00	-	$2\alpha_f/(\pi + 2)$	=	1.00 - 2*0/(π + 2)	=	**1.00**	
ζ_{qt}							=	**1.00**	
Ground sloping factors									
ζ_{cg}	=	1.00	-	$2\omega/(\pi + 2)$	=	1.00 - 2*0/(π + 2)	=	**1.00**	
ζ_{qg}							=	**1.00**	
Ultimate and allowable bearing pressure									
q_u (≤ 3000 kPa)	=	$c'N_c\zeta_{cs}\zeta_{ci}\zeta_{ct}\zeta_{cg}$	+	$0.5B_f'\gamma_s'N_\gamma\zeta_{\gamma s}\zeta_{\gamma i}\zeta_{\gamma t}\zeta_{\gamma g}$	+	$qN_q\zeta_{qs}\zeta_{qi}\zeta_{qt}\zeta_{qg}$			
	=	274.01	+	0.00	+	0.00			
	=	274.01	≤	3000			=	**274.0**	kPa
q_a	=	$(q_u - q_o)$	/	F	+	q_o			
	=	274.01	/	3	+	0.00	=	**91.3**	kPa

Design loading

Load spreading factor	V:H	=	2.0			
Net loading on footing	p_{net}	=	$p - \gamma_s D_f$	=	**98.1**	kPa
Distance from layer top to footing base	D_L	=	$FL - Z_s$	=	**9.1**	m
Resized B after load spreading	B'	=	$B_f' + 2D_L/(V{:}H)$	=	**21.1**	m
Resized L after load spreading	L'	=	$L_f' + 2D_L/(V{:}H)$	=	**26.1**	m
Load after spreading	p'	=	$p_{net} * B_f' * L_f'/(B' * L') + \gamma_s D_f$	=	**36.3**	kPa

Check of bearing capacity

Check of design loading against allowable bearing pressure:	**36.3 ≤ 91.3**	**OK!**

AECOM	Contract:	CE 15/2019(DS) STSK Drainage Improvement Works GAR			Job ref.	60617767
	Calculated by	WF	Checked by	KP	Date	21-Sep-2021

STTC CLP Transformer Room & Switch Room

Check of Immediate Settlement for Shallow Foundation (STN1, Switiching Room)

Based on Craig's Soil Mechanics (8th Edition), Clause 8.6 - Settlements from Elastic Theory

Ground level		GL	=	6.00	mPD	
Groundwater level		GWL	=	3.00	mPD	**(= max(measured highest + 0.5m, mean higher high + 1m))**
Unit weight	Fill			19.00	kN/m^3	
	MD (Sand)			19.00	kN/m^3	
	Alluvial Deposit			18.00	kN/m^3	
	CDG			19.00	kN/m^3	
Young's modulus	Fill			10.00	MPa	**E=1.0*SPTN**
	MD (Sand)			10.00	MPa	**E=1.0*SPTN**
	Alluvial Deposit			30.00	MPa	**E=1.0*SPTN**
	CDG1			30.00	MPa	**E=1.0*SPTN**
	CDG2			70.00	MPa	**E=1.0*SPTN**

Foundation Geometries

Founding level	FL	=	6.00	mPD	
Foundation buried depth	d	=	0.00	m	
Shorter dimension of foundation	B_f	=	12.0	m	
Longer dimension of foundation	L_f	=	17.0	m	

Load Conditions

Vertical load from structure	P	=	20010	kN	**(Total Load)**
Vertical pressure from structure	p	=	98	kPa	
Vertical pressure from backfill soil	p_b	=	0	kPa	
Design surcharge	p_d	=	0	kPa	
Net effective stress at FL	q_0	=	98	kPa	

Settlement of the First layer (Fill)

Top of layer	TL	=	6.00	mPD
Bottom of layer	BL	=	-1.10	mPD
Layer depth	D1	=	7.10	m
Net effective stress at mid-layer	$q_{net,(1)}$	=	62.62	kPa
Settlement of the first layer	s1	=	$D1*\sigma_v'/E$	
		=	**44.5**	mm

Settlement of the second layer (MD)

Top of layer	TL	=	-1.10	mPD
Bottom of layer	BL	=	-3.10	mPD
Layer depth	D2	=	2.00	m
Effective sress at the top surface	$q_{net,(2)}$	=	39.66	kPa
Settlement of the second layer	s2	=	$D2*\sigma_v'/E$	
		=	**7.9**	mm

Settlement of the third layer (Alluvium)

Top of layer	TL	=	-3.10	mPD
Bottom of layer	BL	=	-9.14	mPD
Layer depth	D2	=	6.04	m
Effective sress at the top surface	$q_{net,(3)}$	=	28.49	kPa
Settlement of the second layer	s2	=	$D2*\sigma_v'/E$	
		=	**5.7**	mm

Settlement of the fourth layer (CDG1)

Top of layer	TL	=	-9.14	mPD
Bottom of layer	BL	=	-18.80	mPD
Layer depth	D3	=	9.66	m
Net effective stress at mid-layer	$q_{net,(4)}$	=	16.93	kPa
Settlement of the third layer	s3	=	$D3*\sigma_v'/E$	
		=	**5.5**	mm

Settlement of the fifth layer (CDG2)

Top of layer	TL	=	-18.80	mPD
Bottom of layer	BL	=	-25.33	mPD
Layer depth	D3	=	6.53	m
Net effective stress at mid-layer	$q_{net,(4)}$	=	11.08	kPa
Settlement of the third layer	s3	=	$D3*\sigma_v'/E$	
		=	**1.0**	mm

Calculations:

Total vertical settlement	s	=	**64.6**	mm

AECOM	Contract:	CE 15/2019(DS) STSK Drainage Improvement Works GAR			Job ref.	60617767
	Calculated by	WF	Checked by	KP	Date	20-Aug-2021

STTC CLP Transformer Room & Switch Room
Socketed Piles Design

	W		L	H
Structual size	12.00		17.00	0.00
Footprint area	204	m2		

Ground level	6.00	mPD	
Highest possible groundwater level	6.00	mPD	**(= existing ground level)**
Highest anticipated groundwater level	3.00	mPD	**(= max(measured highest + 0.5m, mean higher high + 1m))**
Lowest anticipated groundwater level	1.20	mPD	**(= min(measured lowest, mean sea level))**
Thickness of backfill above structure	0.00	m	
Founding level	6.00	mPD	
Top layer CDG level	-6.20	mPD	
Selfweight of storage tank	20010	kN	
Weight of backfill soil	0	kN	
Water load, access load, E&M equipment, selfweight of aboveground structure	0	kN	
Total dead load for uplift check	20010	kN	**(= selfweight of underground structure + backfill soil)**
Total load	20010	kN	**(= selfweight of underground structure + backfill soil + water + SDL + LL)**
Total load for compression check	**20010**	kN	**(= total load less water pressure, using lowest anticipated groundwater level)**
Mean unit weight of in-situ soil	19.0	kN/m^3	
Total uplift force (DL-1.5u)	**20010**	kN	

Socket H Pile Axial Capacity Check

Size of H pile	Each Pile Capacity (kN)	Designed Nos. of Pile	Total Pile Capacity (kN)	Spacing in 12m side (m)	Spacing in 17m side (m)	Nos. of Piles in 12m side	Nos. of Piles in 17m side
305 x 305 x 223 kg/m	6106	9	**54954**	5.5	8.0	3	3
sectional area of steel,mm2			***Total Pile Capacity > Total load for compression check**				
28400							
Steel grade MPa							
430							
28400X430/1000*0.5=6106							
(0.5 refer to COP Foundation P.30)							

Friction between grout and rock

Bond Friction under compression	700	kPa	**COP for Foundations 2017, Table 2.2 Category 1c**
Pile diameter	550	mm	
Socket Length	**7**	m	
Each Pile Friction	**8467**	>Each Pile Capacity = 6106 i.e OK	

Bond Stress between steel and grout

Bond Stress between steel and grout	480	kPa
perimeter of steel	1918	mm
Socket Length	**7**	m
Each Pile Bond Stress	**6444**	>Each Pile Capacity = 6106 i.e OK

Socket H Pile Tension Capacity Check (Not Required)

AECOM	Contract:	CE 15/2019(DS) STSK Drainage Improvement Works GAR		Job ref.	60617767
	Calculated by	WF	Checked by KP	Date	21-Sep-2021

STTC CLP Transformer Room & Switch Room

Mini-Piles Design

	W	L	H	
Structual size	12.00	17.00	0.00	
Footprint area	204	m2		

Ground level	6.00	mPD	
Highest possible groundwater level	6.00	mPD	**(= existing ground level)**
Highest anticipated groundwater level	3.00	mPD	**(= max(measured highest + 0.5m, mean higher high + 1m))**
Lowest anticipated groundwater level	1.20	mPD	**(= min(measured lowest, mean sea level))**
Thickness of backfill above structure	0.00	m	
Founding level	6.00	mPD	
Top layer CDG level	-6.20	mPD	
Selfweight of storage tank	20010	kN	
Weight of backfill soil	0	kN	
Water load, access load, E&M equipment, selfweight of aboveground structure	0	kN	
Total dead load for uplift check	20010	kN	**(= selfweight of underground structure + backfill soil)**
Total load	20010	kN	**(= selfweight of underground structure + backfill soil + water + SDL + LL)**
Total load for compression check	**20010**	kN	**(= total load less water pressure, using lowest anticipated groundwater level)**
Mean unit weight of in-situ soil	19.0	kN/m^3	
Total uplift force (DL-1.5u)	**20010**	kN	

Mini-Pile Axial Capacity Check

Size of Mini-Pile	Each Pile Capacity (kN)	Designed Nos. of Pile	Total Pile Capacity (kN)	Spacing in 12m side (m)	Spacing in 17m side (m)	Nos. of Piles in 12m side	Nos. of Piles in 17m side
$50^2 \times \pi / 4$ kg/m	1716.09	15	**25741**	5.5	4.0	3	5
sectional area of single steel,mm2			***Total Pile Capacity > Total load for compression check**				
1963.495							
Steel grade MPa							
460			**COP for the Structure Use of Steel 2011, Clause 3.1.3**				
4X1963.5X460/1000*0.475=1706.09			**0.475 from COP for Foundations 2017, Clause 5.4.8**				

Friction between grout and rock

Bond Friction under compression	700	kPa	**COP for Foundations 2017, Table 2.2 Category 1c**
Pile diameter	200	mm	
Socket Length	**7**	m	
Each Pile Friction	**3079**	>Each Pile Capacity = 1716 i.e OK	

Bond Stress between steel and grout

Bond Stress between steel and grout	800	kPa	**COP for Foundations 2017, Clause 5.4.8 (2) (c)**
perimeter of steel	357.1	mm	**COP for Foundations 2017, Clause 5.4.8 (2) (e)**
Socket Length	**7**	m	
Each Pile Bond Stress	**2000**	>Each Pile Capacity = 1716 i.e OK	

Mini-Pile Tension Capacity Check (Not Required)

AECOM	Contract:	CE 15/2019(DS) STSK Drainage Improvement Works GAR	Job ref.	60617767
	Calculated by WF	Checked by KP	Date	21-Sep-2021

STTC CLP Transformer Room & Switch Room

Driven Piles Design

	W		L	H	
Structual size	12.00		17.00	0.00	
Footprint area	204	m2			
Ground level	6.00	mPD			
Highest possible groundwater level	6.00	mPD			**(= existing ground level)**
Highest anticipated groundwater level	3.00	mPD			**(= max(measured highest + 0.5m, mean higher high + 1m))**
Lowest anticipated groundwater level	1.20	mPD			**(= min(measured lowest, mean sea level))**
Thickness of backfill above structure	0.00	m			
Founding level	6.00	mPD			
Top layer CDG level	-6.20	mPD			
Selfweight of storage tank	20010	kN			
Weight of backfill soil	0	kN			
Water load, access load, E&M equipment, selfweight of aboveground structure	0	kN			
Total dead load for uplift check	20010	kN			**(= selfweight of underground structure + backfill soil)**
Total load	20010	kN			**(= selfweight of underground structure + backfill soil + water + SDL + LL)**
Total load for compression check	**20010**	kN			**(= total load less water pressure, using lowest anticipated groundwater level)**
Shaft resisteance coefficient	0.3				**GEO Publication No. 1/2006, Table 6.3 Dirven small dispalcement piles**
Factor Safety	1.5				
Factored shaft resistenance coeff.	0.2				
Mean unit weight of in-situ soil	19.0	kN/m^3			
Total uplift force (DL-1.5u)	**20010**	kN			

Driven Pile Bearing Capacity Check

Size of Driven Pile	Each Pile Capacity (kN)	Nos. of Pile	Total Pile Capacity (kN)	Spacing in 12m side (m)	Spacing in 17m side (m)	Nos. of Piles in 12m side	Nos. of Piles in 17m side
305 x 305 x 223 kg/m	3650	**9**	**32850**	5	7	3	3
sectional area of steel,mm2	3650	**12**	**43800**	5	5	3	4
28400							
Steel grade, MPa							
430							
28400X430/1000*0.3=3650							
(0.3 refer to COP Foundation P.30)			***Total Pile Capacity > Total load for compression check**				

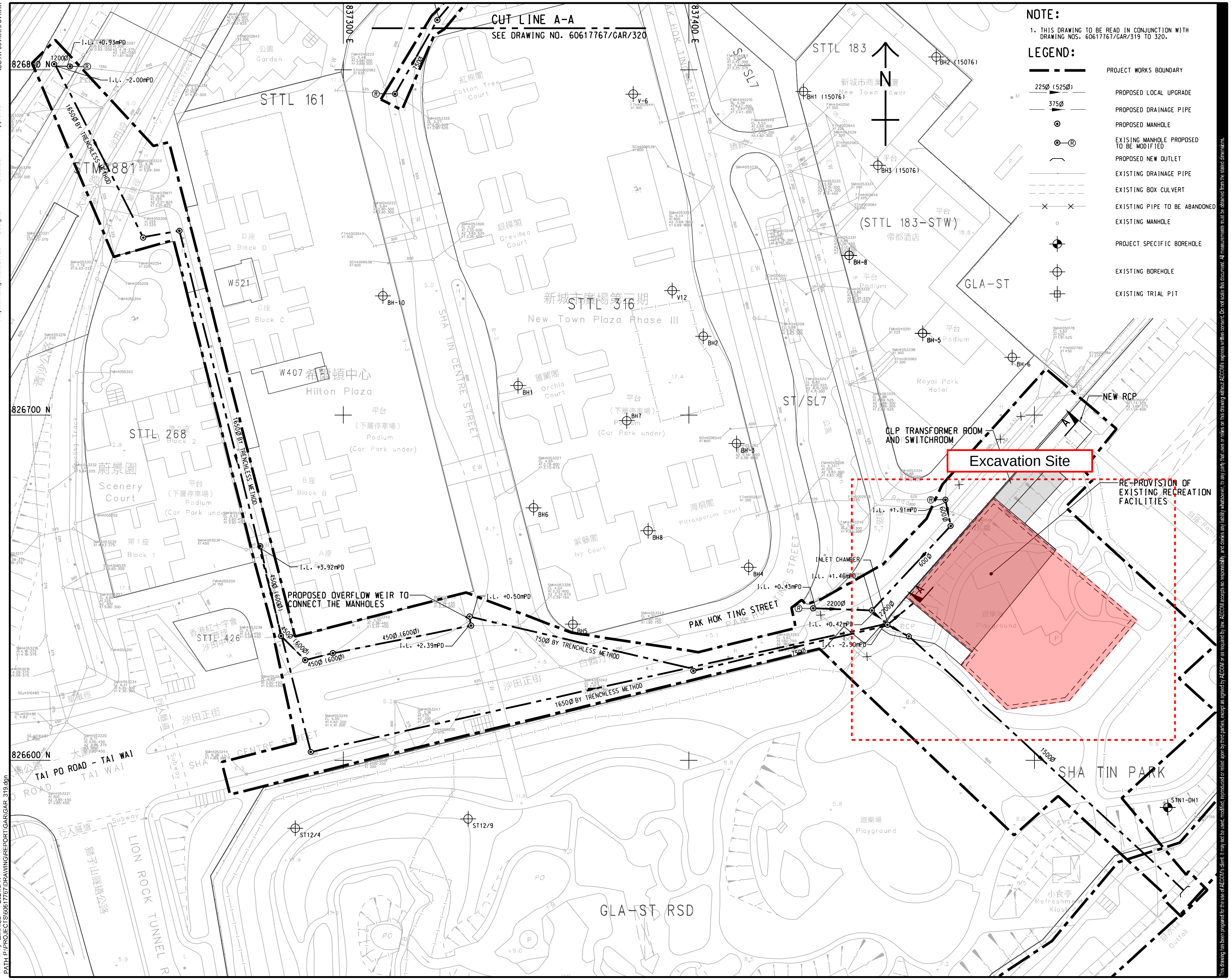
Driven Pile Shaft Resistance Check

Size of Driven Pile	Pile Perimeter (m)	Nos. of Pile	Embedded length	Pile Top effective stress	Pile Bottom effective stress	Each Pile Capacity (kN)	Total Pile Capacity (kN)	Pile Level (mPD)
305 x 305 x 223 kg/m	1.2	9	30	231.8	471.8	2533.0	**22797**	**-36.20**
sectional area of steel,mm2	1.2	12	25	231.8	431.8	1990.8	**23890**	**-31.20**
28400								
Steel grade, Mpa								
430								
28400X430/1000*0.3=3650								
(0.3 refer to COP Foundation P.30)			***Total Pile Capacity > Total load for compression check**					

Soil Cone Checking (Not Required)

Appendix J2

STTC Storage Tank and Pump House



AECOM

PROJECT

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT

渠務署 Drainage Services Department

CONSULTANT

AECOM Asia Company Ltd.
www.aecom.com

SUB-CONSULTANTS

ISSUE/REVISION

I/R	DATE	DESCRIPTION	CHK.

STATUS

SCALE: A3 1 : 1000

DIMENSION UNIT: METRES

KEY PLAN A3 1 : 40000

PROJECT NO.: 60617767

AGREEMENT NO.: CE 15/2019 (DS)

SHEET TITLE

PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN TOWN CENTRE (STN1)

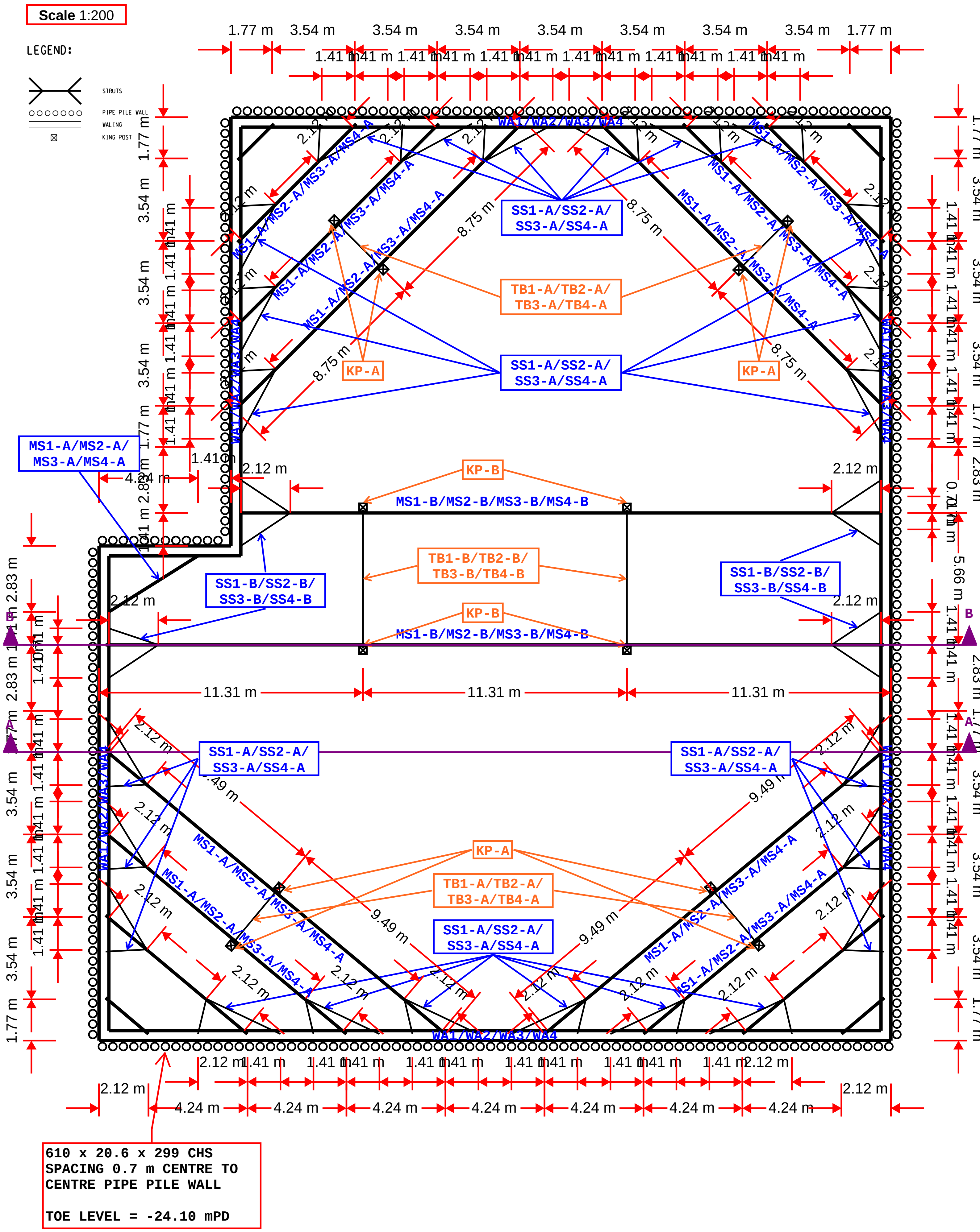
SHEET 1 OF 2

SHEET NUMBER

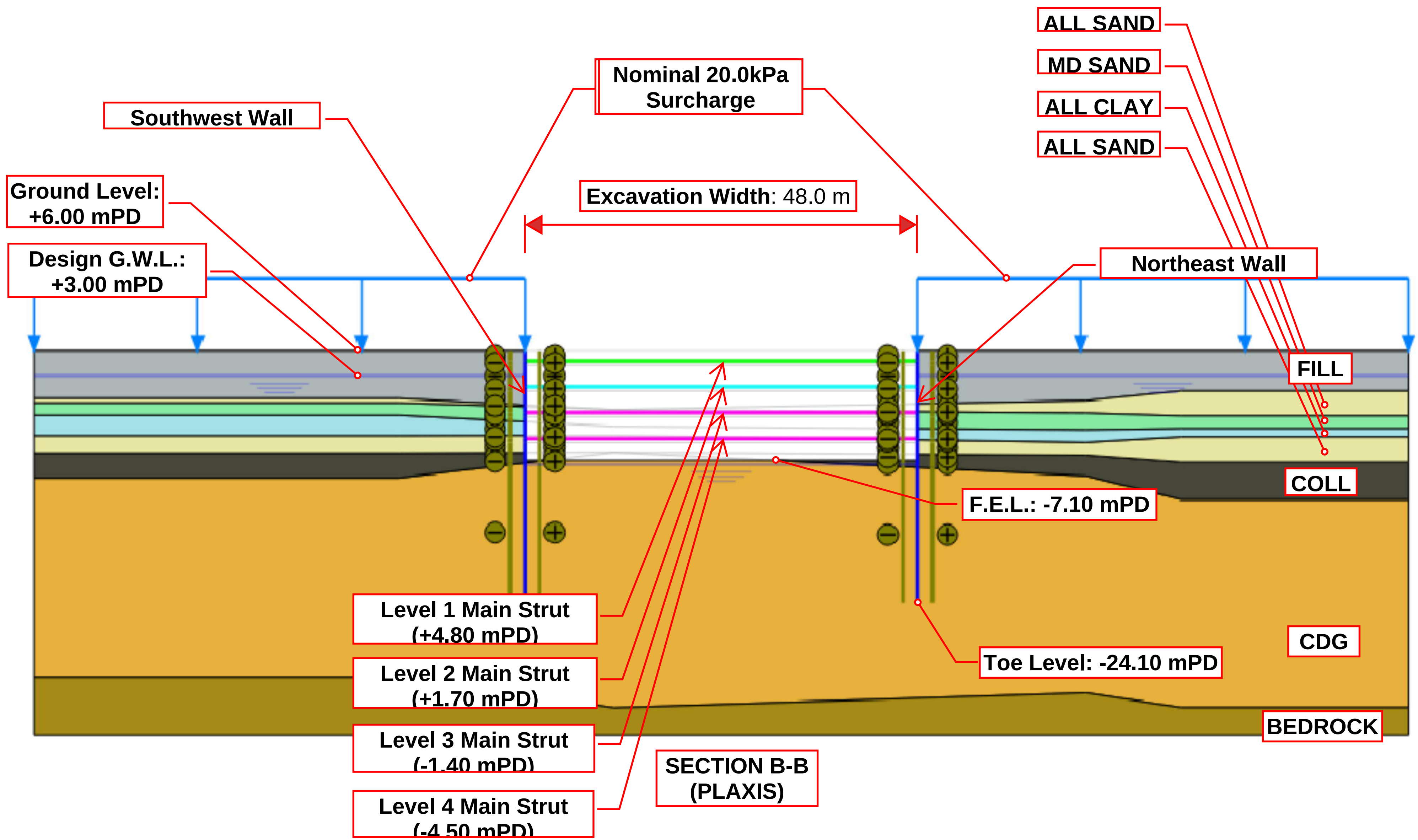
60617767/GAR/319

Plot File by: alnin.diu 2021/8/17
PATH: P:\PROJECTS\60617767\DRAWING\REPORT\GAR\GAR_319.dgn

ISO A1 594mm x 841mm


Scale 1:200
LEGEND:
STRUTS
PIPE PILE WALL
WALING
KING POST
WA1/WA2/WA3/WA4
SS1-A/SS2-A/
SS3-A/SS4-A
TB1-A/TB2-A/
TB3-A/TB4-A
KP-A
MS1-A/MS2-A/MS3-A/MS4-A
MS1-A/MS2-A/
MS3-A/MS4-A
KP-B
MS1-B/MS2-B/MS3-B/MS4-B
TB1-B/TB2-B/
TB3-B/TB4-B
SS1-B/SS2-B/
SS3-B/SS4-B
B
A
11.31 m
8.75 m
9.49 m
2.12 m
4.24 m
1.77 m
3.54 m
1.41 m
2.83 m
5.66 m
0.71 m
610 x 20.6 x 299 CHS
SPACING 0.7 m CENTRE TO
CENTRE PIPE PILE WALL
TOE LEVEL = -24.10 mPD

MEMBER ID	TYPE	LEVEL	SECTION SIZE	STEEL GRADE
MS1-A	MAIN STRUT	+4.80 mPD	DOUBLE 305 x 305 x 158 UC	S355
MS2-A	MAIN STRUT	+1.70 mPD	DOUBLE 305 x 305 x 198 UC	S355
MS3-A	MAIN STRUT	-1.40 mPD	DOUBLE 356 x 406 x 393 UC	S355
MS4-A	MAIN STRUT	-4.50 mPD	DOUBLE 356 x 406 x 393 UC	S355
MS1-B	MAIN STRUT	+4.80 mPD	DOUBLE 305 x 305 x 240 UC	S355
MS2-B	MAIN STRUT	+1.70 mPD	DOUBLE 356 x 406 x 340 UC	S355
MS3-B	MAIN STRUT	-1.40 mPD	DOUBLE 356 x 406 x 393 UC	S355
MS4-B	MAIN STRUT	-4.50 mPD	DOUBLE 356 x 406 x 393 UC	S355
SS1-A	SECONDARY STRUT	+4.80 mPD	SINGLE 203 x 203 x 46 UC	S355
SS2-A	SECONDARY STRUT	+1.70 mPD	SINGLE 203 x 203 x 86 UC	S355
SS3-A	SECONDARY STRUT	-1.40 mPD	SINGLE 203 x 203 x 86 UC	S355
SS4-A	SECONDARY STRUT	-4.50 mPD	SINGLE 203 x 203 x 86 UC	S355
SS1-B	SECONDARY STRUT	+4.80 mPD	SINGLE 203 x 203 x 46 UC	S355
SS2-B	SECONDARY STRUT	+1.70 mPD	SINGLE 203 x 203 x 46 UC	S355
SS3-B	SECONDARY STRUT	-1.40 mPD	SINGLE 203 x 203 x 46 UC	S355
SS4-B	SECONDARY STRUT	-4.50 mPD	SINGLE 203 x 203 x 46 UC	S355
W1	WALING	+4.80 mPD	SINGLE 457 x 191 x 89 UB	S355
W2	WALING	+1.70 mPD	SINGLE 610 x 229 x 125 UB	S355
W3	WALING	-1.40 mPD	SINGLE 610 x 229 x 140 UB	S355
W4	WALING	-4.50 mPD	SINGLE 610 x 229 x 140 UB	S355
KP-A	KING POST	-	305 x 305 x 198 UC	S355
KP-B	KING POST	-	305 x 305 x 198 UC	S355
TB1-A	TIE BEAM	+4.80 mPD	SINGLE 203 x 102 x 23 UB	S355
TB2-A	TIE BEAM	+1.70 mPD	SINGLE 203 x 102 x 23 UB	S355
TB3-A	TIE BEAM	-1.40 mPD	SINGLE 203 x 102 x 23 UB	S355
TB4-A	TIE BEAM	-4.50 mPD	SINGLE 203 x 102 x 23 UB	S355
TB1-B	TIE BEAM	+4.80 mPD	SINGLE 203 x 133 x 30 UB	S355
TB2-B	TIE BEAM	+1.70 mPD	SINGLE 203 x 133 x 30 UB	S355
TB3-B	TIE BEAM	-1.40 mPD	SINGLE 203 x 133 x 30 UB	S355
TB4-B	TIE BEAM	-4.50 mPD	SINGLE 203 x 133 x 30 UB	S355



Southwest Wall
Nominal 20.0kPa Surcharge
ALL SAND
MD SAND
ALL CLAY
ALL SAND
Ground Level: +6.00 mPD
Design G.W.L.: +3.00 mPD
Excavation Width: 48.0 m
Northeast Wall
FILL
COLL
F.E.L.: -7.10 mPD
CDG
Toe Level: -24.10 mPD
BEDROCK
Level 1 Main Strut (+4.80 mPD)
Level 2 Main Strut (+1.70 mPD)
Level 3 Main Strut (-1.40 mPD)
Level 4 Main Strut (-4.50 mPD)
SECTION B-B (PLAXIS)

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.1
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	8-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	8-Oct-21

Toe Stability Calculation

(Page 1 of 3 of this calculation)

Location: **STN Pumping Station**
Wall Type: **Pipe Pile Wall (Southwest)**

Design Case: 1
Excavation Stage: Excavation to bottom level

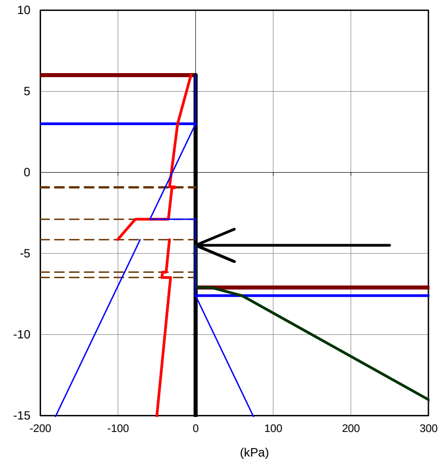
For undrained soils, if active pressure < water press., set active press. equal to water press.?: no (yes or no)

Ground level on retained side:	6.00 mPD	Water level on exc. side:	-7.60 mPD		
Water level on retained side	3.00 mPD	Bottom strut level:	-4.50 mPD	Pore pressure distribution type:	1
Excavation level:	-7.10 mPD	Toe level of wall:	-24.10 mPD	*(1, 2 or 3 - Refer to definitions on next page)*	
Allowable wall moment capacity, M_W:	0.0 kNm/m	Surcharge on retained side:	20.0 kPa	Base of impermeable layer on exc.	
(Set as zero if only one layer of struts)		Surcharge on exc. side:	0.0 kPa	side (for Type 3 only):	n/a mRL

Soil Properties

Soil No.	Name	γ_{bulk} (kN/m^3)	Drained / Undrained*	c' (kPa)	$C_{u,ref}$ (kPa)	Y_{ref}	C_u / z (kPa/m)	c_w/c	K_a	K_p
1	Fill (30°)	19.0	Drained	0.0				0.00	0.30	3.04
2	Marine Sand (33°)	19.0	Drained	0.0				0.00	0.27	3.40
3	Alluvial Clay	18.0	Undrained		36.0	-2.5	19.2	0.00	1.00	1.00
4	Alluvial Sand (36°)	19.0	Drained	0.0				0.00	0.24	4.08
5	Colluvium (30°)	19.0	Drained	0.0				0.00	0.27	3.04
6	CDG (37°)	19.0	Drained	5.0				0.00	0.23	4.16
7										
8										
9										

* "Undrained" = calculations based on total stress parameters (zero water pressure modelled)



Stratification - Retained Side

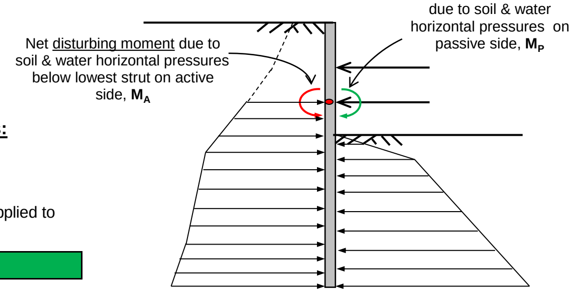
Top	Bottom	Soil No.	Name
6.00	-0.89	1	Fill (30°)
-0.89	-0.95	4	Alluvial Sand (36°)
-0.95	-2.89	2	Marine Sand (33°)
-2.89	-4.15	3	Alluvial Clay
-4.15	-6.15	4	Alluvial Sand (36°)
-6.15	-6.48	5	Colluvium (30°)
-6.48	-40.00	6	CDG (37°)
-			-
-			-

(FBH1)

Stratification - Excavated Side

Top	Bottom	No.	Name
-7.10	-40.00	6	CDG (37°)
-			-
-			-
-			-
-			-
-			-
-			-
-			-
-			-

(FBH1)



Reduction for Pile Width & Spacing:

Pile width, D:	1.00	m
Spacing:	1.00	m
Reduct factor below exc. level:	1.00	

(applicable to soldier piles, etc…)
(factor equals 1.0 for spacing <= 3D)

Factor of safety against overturning about the bottom strut layer is calculated as follows:

Factor of Safety, FOS = M_P / (M_A - M_W)

where M_W is the allowable moment capacity of the wall at the bottom strut layer

Required FOS = 2.00 (may be as low as 1.0 if partial reduction factors applied to soil shear strength and in deriving K_a and K_p)

FOS provided = 2.04 > Required FOS - o.k!

(Refer to detailed calculations on next pages)

AECOM AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.2
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	8-Oct-21
		Sha Tin and Sai Kung - Investigation	Chkd.:	KP	Date:	8-Oct-21

Location: **STN Pumping Station** **Design Case:** **1**

Wall Type: **Pipe Pile Wall (Southwest)** **Excavation Stage:** Excavation to bottom level

(Page 2 of 3 of this calculation)

Calculate Forces and Moments on Active Side

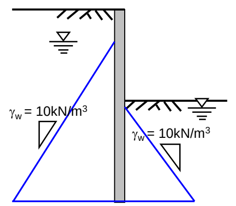
Top	Bottom	H (m)	Soil No.	Drained / Undrained	γ (kN/m^3)	Surcharge (kPa)	σ_v (kPa) Top	σ_v (kPa) Bot	u (kPa) Top	u (kPa) Bot	σ_v' (kPa) Top	σ_v' (kPa) Bot
6.00	3.00	3.00	1	Drained	19.0	20.0	20.0	77.0	0.0	0.0	20.0	77.0
3.00	-0.89	3.89	1	Drained	19.0	20.0	77.0	150.9	0.0	38.9	77.0	112.0
-0.89	-0.95	0.06	4	Drained	19.0	20.0	150.9	152.1	38.9	39.5	112.0	112.6
-0.95	-2.89	1.94	2	Drained	19.0	20.0	152.1	188.9	39.5	58.9	112.6	130.0
-2.89	-4.15	1.26	3	Undrained	18.0	20.0	188.9	211.6	0.0	0.0	188.9	211.6
-4.15	-4.50	0.35	4	Drained	19.0	20.0	211.6	218.2	71.5	75.0	140.1	143.2
-4.50	-6.15	1.65	4	Drained	19.0	20.0	218.2	249.6	75.0	91.5	143.2	158.1
-6.15	-6.48	0.33	5	Drained	19.0	20.0	249.6	255.9	91.5	94.8	158.1	161.1
-6.48	-7.10	0.62	6	Drained	19.0	20.0	255.9	267.6	94.8	101.0	161.1	166.6
-7.10	-24.10	17.00	6	Drained	19.0	20.0	267.6	590.6	101.0	271.0	166.6	319.6

Top	Bottom	Soil No.	Name	K_a	c' (kPa)	C_u (kPa)	c_w/c	K_{ac}	σ_H or σ_H' (kPa) Top	σ_H or σ_H' (kPa) Bot
6.00	3.00	1	Fill (30°)	0.30	0.0	0.00	0.00	1.10	6.0	23.1
3.00	-0.89	1	Fill (30°)	0.30	0.0	0.00	0.00	1.10	23.1	33.6
-0.89	-0.95	4	Alluvial Sand (36°)	0.24	0.0	0.00	0.00	0.98	26.9	27.0
-0.95	-2.89	2	Marine Sand (33°)	0.27	0.0	0.00	0.00	1.04	30.4	35.1
-2.89	-4.15	3	Alluvial Clay	1.00	0.0	55.58	0.00	2.00	77.7	100.4
-4.15	-4.50	4	Alluvial Sand (36°)	0.24	0.0	0.00	0.00	0.98	33.6	34.4
-4.50	-6.15	4	Alluvial Sand (36°)	0.24	0.0	0.00	0.00	0.98	34.4	37.9
-6.15	-6.48	5	Colluvium (30°)	0.27	0.0	0.00	0.00	1.04	42.7	43.5
-6.48	-7.10	6	CDG (37°)	0.23	5.0	0.00	0.00	0.96	32.2	33.5
-7.10	-24.10	6	CDG (37°)	0.23	5.0	0.00	0.00	0.96	33.5	68.7

Top	Bottom	Soil No.	Red. Fact.	Soil Loads and Moments: Rectangular Force (kN/m)	Soil Rectangular Moment (kNm/m)	Soil Triangular Force (kN/m)	Soil Triangular Moment (kNm/m)	Water Loads and Moments: Rectangular Force (kN/m)	Water Rectangular Moment (kNm/m)	Water Triangular Force (kN/m)	Water Triangular Moment (kNm/m)
6.00	3.00	1	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.00	-0.89	1	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.89	-0.95	4	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.95	-2.89	2	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-2.89	-4.15	3	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-4.15	-4.50	4	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-4.50	-6.15	4	1.00	56.7	46.8	2.9	3.2	123.8	102.1	13.6	15.0
-6.15	-6.48	5	1.00	14.1	25.6	0.1	0.2	30.2	54.8	0.5	1.0
-6.48	-7.10	6	1.00	20.0	45.8	0.4	1.0	58.8	134.6	1.9	4.6
-7.10	-24.10	6	1.00	570.0	6327.4	299.1	4167.7	1717.0	19058.7	1445.0	20133.7
			Totals:		**6,445.5**		**4,172.1**		**19,350.2**		**20,154.3**

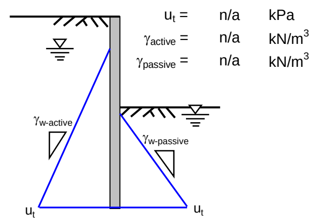
Total disturbing moment, M_A = **50,122.1** **kNm/m**

Definitions of Pore Pressure Distributions:



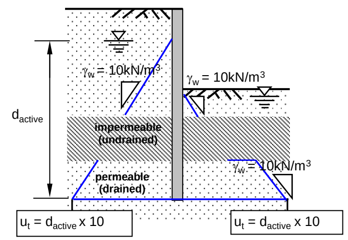
Type 1

Impermeable boundary between active & passive sides



Type 2

Steady-state flow with equilibrium of pore pressure at toe of wall (u_t) from Figure 33 of GEOGuide 1



Type 3

Permeable layer beneath impermeable layer on passive side & permeable layer extends across wall boundary
<active side recharges passive side>

AECOM

AECOM Asia Co. Ltd.

Project No.:	60617767			Sheet:	A.3
Project Name:	Drainage Improvement Works In	By:	JL	Date:	8-Oct-21
	Sha Tin and Sai Kung - Investigation	Chkd.:	KP	Date:	8-Oct-21

Location: STN Pumping Station
Wall Type: Pipe Pile Wall (Southwest)

Design Case: 1
Excavation Stage: Excavation to bottom level

Calculate Forces and Moments on Passive Side

Top	Bottom	H (m)	Soil No.	Drained / Undrained	γ (kN/m^3)	Surcharge (kPa)	σ_v (kPa)		u (kPa)		σ_v' (kPa)	
							Top	Bot	Top	Bot	Top	Bot
-4.50	-7.10	2.60	no soil	Drained	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0
-7.10	-7.60	0.50	6	Drained	19.0	0.0	0.00	9.50	0.0	0.0	0.0	9.5
-7.60	-24.10	16.50	6	Drained	19.0	0.0	9.50	323.00	0.0	165.0	9.5	158.0

Top	Bottom	Soil No.	Name	K_p	c' (kPa)	C_u (kPa)	c_w/c	K_{pc}	σ_H or σ_H' (kPa)	
									Top	Bot
-4.50	-7.10	no soil	-	0.00	0.0	0.00	0.00	0.00	0.0	0.0
-7.10	-7.60	6	CDG (37°)	4.16	5.0	0.00	0.00	4.08	20.4	59.9
-7.60	-24.10	6	CDG (37°)	4.16	5.0	0.00	0.00	4.08	59.9	677.7

Top	Bottom	Soil No.	Red. Fact.	Soil Loads and Moments				Water Loads and Moments			
				Rectangular		Triangular		Rectangular		Triangular	
				Force (kN/m)	Moment (kNm/m)	Force (kN/m)	Moment (kNm/m)	Force (kN/m)	Moment (kNm/m)	Force (kN/m)	Moment (kNm/m)
-4.50	-7.10	no soil	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-7.10	-7.60	6	1.00	10.2	29.1	9.9	29.0	0.0	0.0	0.0	0.0
-7.60	-24.10	6	1.00	988.6	11220.8	5096.5	71860.9	0.0	0.0	1361.3	19193.6
				Totals:	**11,249.8**		**71,889.9**		**0.0**		**19,193.6**

Total restoring moment, M_P = 102,333.4 kNm/m

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.1
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	8-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	8-Oct-21

Toe Stability Calculation

(Page 1 of 3 of this calculation)

Location: **STN Pumping Station**
Wall Type: **Pipe Pile Wall (Northeast)**

Design Case: **1**
Excavation Stage: Excavation to bottom level

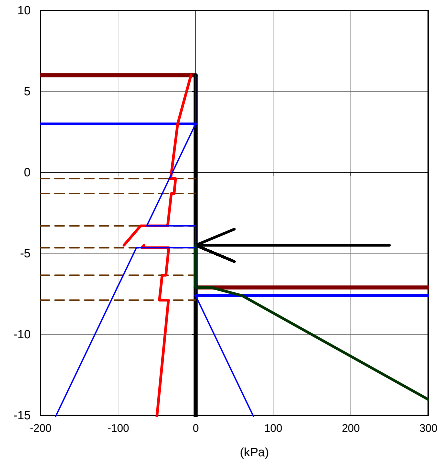
For undrained soils, if active pressure < water press., set active press. equal to water press.?: no (yes or no)

Ground level on retained side:	6.00 mPD	Water level on exc. side:	-7.60 mPD		
Water level on retained side	3.00 mPD	Bottom strut level:	-4.50 mPD	Pore pressure distribution type:	1
Excavation level:	-7.10 mPD	Toe level of wall:	-24.10 mPD	*(1, 2 or 3 - Refer to definitions on next page)*	
Allowable wall moment capacity, M_W:	0.0 kNm/m	Surcharge on retained side:	20.0 kPa	Base of impermeable layer on exc.	
(Set as zero if only one layer of struts)		Surcharge on exc. side:	0.0 kPa	side (for Type 3 only):	n/a mRL

Soil Properties

Soil No.	Name	γ_{bulk} (kN/m^3)	Drained / Undrained*	c' (kPa)	$C_{u,ref}$ (kPa)	Y_{ref}	C_u / z (kPa/m)	c_w/c	K_a	K_p
1	Fill (30°)	19.0	Drained	0.0				0.00	0.30	3.04
2	Marine Sand (33°)	19.0	Drained	0.0				0.00	0.27	3.40
3	Alluvial Clay	18.0	Undrained		36.0	-2.5	19.2	0.00	1.00	1.00
4	Alluvial Sand (36°)	19.0	Drained	0.0				0.00	0.24	4.08
5	Colluvium (30°)	19.0	Drained	0.0				0.00	0.27	3.04
6	CDG (37°)	19.0	Drained	5.0				0.00	0.23	4.16
7										
8										
9										

* "Undrained" = calculations based on total stress parameters (zero water pressure modelled)



Stratification - Retained Side

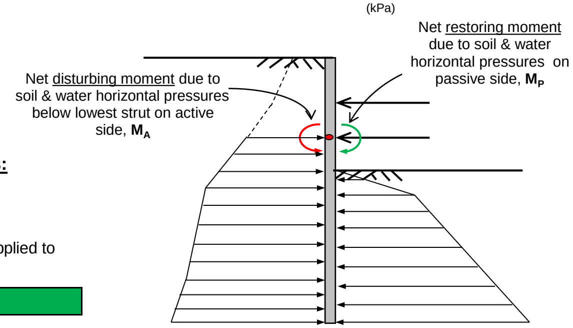
Top	Bottom	Soil No.	Name
6.00	-0.38	1	Fill (30°)
-0.38	-1.30	4	Alluvial Sand (36°)
-1.30	-3.30	2	Marine Sand (33°)
-3.30	-4.65	3	Alluvial Clay
-4.65	-6.34	4	Alluvial Sand (36°)
-6.34	-7.88	5	Colluvium (30°)
-7.88	-40.00	6	CDG (37°)
-			-
-			-

(FBH1)

Stratification - Excavated Side

Top	Bottom	No.	Name
-7.10	-40.00	6	CDG (37°)
-			-
-			-
-			-
-			-
-			-
-			-
-			-
-			-

(FBH1)



Reduction for Pile Width & Spacing:

Pile width, D:	1.00	m
Spacing:	1.00	m
Reduct factor below exc. level:	1.00	

(applicable to soldier piles, etc…)
(factor equals 1.0 for spacing <= 3D)

Factor of safety against overturning about the bottom strut layer is calculated as follows:

Factor of Safety, FOS = M_P / (M_A - M_W)

where M_W is the allowable moment capacity of the wall at the bottom strut layer

Required FOS = 2.00 (may be as low as 1.0 if partial reduction factors applied to soil shear strength and in deriving K_a and K_p)

FOS provided = 2.04 > Required FOS - o.k!

(Refer to detailed calculations on next pages)

Location: **STN Pumping Station** **Design Case:** **1**

Wall Type: **Pipe Pile Wall (Northeast)** **Excavation Stage:** Excavation to bottom level

Calculate Forces and Moments on Active Side

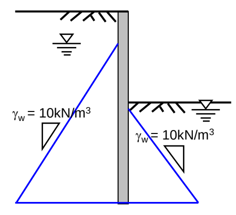
Top	Bottom	H (m)	Soil No.	Drained / Undrained	γ (kN/m^3)	Surcharge (kPa)	σ_v (kPa)		u (kPa)		σ_v' (kPa)	
							Top	Bot	Top	Bot	Top	Bot
6.00	3.00	3.00	1	Drained	19.0	20.0	20.0	77.0	0.0	0.0	20.0	77.0
3.00	-0.38	3.38	1	Drained	19.0	20.0	77.0	141.2	0.0	33.8	77.0	107.4
-0.38	-1.30	0.92	4	Drained	19.0	20.0	141.2	158.7	33.8	43.0	107.4	115.7
-1.30	-3.30	2.00	2	Drained	19.0	20.0	158.7	196.7	43.0	63.0	115.7	133.7
-3.30	-4.50	1.20	3	Undrained	18.0	20.0	196.7	218.3	0.0	0.0	196.7	218.3
-4.50	-4.65	0.15	3	Undrained	18.0	20.0	218.3	221.0	0.0	0.0	218.3	221.0
-4.65	-6.34	1.69	4	Drained	19.0	20.0	221.0	253.1	76.5	93.4	144.5	159.7
-6.34	-7.10	0.76	5	Drained	19.0	20.0	253.1	267.6	93.4	101.0	159.7	166.6
-7.10	-7.88	0.78	5	Drained	19.0	20.0	267.6	282.4	101.0	108.8	166.6	173.6
-7.88	-24.10	16.22	6	Drained	19.0	20.0	282.4	590.6	108.8	271.0	173.6	319.6

Top	Bottom	Soil No.	Name	K_a	c' (kPa)	C_u (kPa)	c_w/c	K_{ac}	σ_H or σ_H' (kPa)	
									Top	Bot
6.00	3.00	1	Fill (30°)	0.30	0.0	0.00	0.00	1.10	6.0	23.1
3.00	-0.38	1	Fill (30°)	0.30	0.0	0.00	0.00	1.10	23.1	32.2
-0.38	-1.30	4	Alluvial Sand (36°)	0.24	0.0	0.00	0.00	0.98	25.8	27.8
-1.30	-3.30	2	Marine Sand (33°)	0.27	0.0	0.00	0.00	1.04	31.2	36.1
-3.30	-4.50	3	Alluvial Clay	1.00	0.0	62.88	0.00	2.00	70.9	92.5
-4.50	-4.65	3	Alluvial Clay	1.00	0.0	75.84	0.00	2.00	66.6	69.3
-4.65	-6.34	4	Alluvial Sand (36°)	0.24	0.0	0.00	0.00	0.98	34.7	38.3
-6.34	-7.10	5	Colluvium (30°)	0.27	0.0	0.00	0.00	1.04	43.1	45.0
-7.10	-7.88	5	Colluvium (30°)	0.27	0.0	0.00	0.00	1.04	45.0	46.9
-7.88	-24.10	6	CDG (37°)	0.23	5.0	0.00	0.00	0.96	35.1	68.7

Top	Bottom	Soil No.	Red. Fact.	Soil Loads and Moments				Water Loads and Moments			
				Rectangular		Triangular		Rectangular		Triangular	
				Force (kN/m)	Moment (kNm/m)	Force (kN/m)	Moment (kNm/m)	Force (kN/m)	Moment (kNm/m)	Force (kN/m)	Moment (kNm/m)
6.00	3.00	1	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.00	-0.38	1	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.38	-1.30	4	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-1.30	-3.30	2	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-3.30	-4.50	3	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-4.50	-4.65	3	1.00	10.0	0.7	0.2	0.0	0.0	0.0	0.0	0.0
-4.65	-6.34	4	1.00	58.6	58.3	3.1	3.9	129.3	128.6	14.3	18.2
-6.34	-7.10	5	1.00	32.8	72.8	0.7	1.6	71.0	157.6	2.9	6.8
-7.10	-7.88	5	1.00	35.1	104.9	0.7	2.3	78.8	235.6	3.0	9.5
-7.88	-24.10	6	1.00	569.7	6546.2	272.3	3864.8	1764.7	20276.8	1315.4	18670.5
			Totals:		**6,782.9**		**3,872.7**		**20,798.6**		**18,705.0**

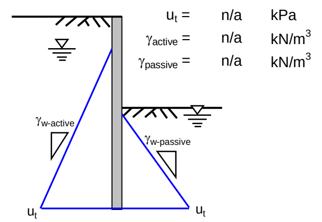
Total disturbing moment, M_A = 50,159.2 kNm/m

Definitions of Pore Pressure Distributions:



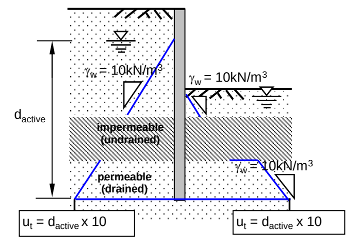
Type 1

Impermeable boundary between active & passive sides



Type 2

Steady-state flow with equilibrium of pore pressure at toe of wall (u_t) from Figure 33 of GEOGuide 1



Type 3

Permeable layer beneath impermeable layer on passive side & permeable layer extends across wall boundary <active side recharges passive side>

AECOM Asia Co. Ltd.

Project No.:	60617767			Sheet:	A.3
Project Name:	Drainage Improvement Works In	By:	JL	Date:	8-Oct-21
	Sha Tin and Sai Kung - Investigation	Chkd.:	KP	Date:	8-Oct-21

Location: **STN Pumping Station**
Wall Type: **Pipe Pile Wall (Northeast)**

Design Case: **1**
Excavation Stage: Excavation to bottom level

Calculate Forces and Moments on Passive Side

Top	Bottom	H (m)	Soil No.	Drained / Undrained	γ (kN/m^3)	Surcharge (kPa)	σ_v (kPa)		u (kPa)		σ_v' (kPa)	
							Top	Bot	Top	Bot	Top	Bot
-4.50	-7.10	2.60	no soil	Drained	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0
-7.10	-7.60	0.50	6	Drained	19.0	0.0	0.00	9.50	0.0	0.0	0.0	9.5
-7.60	-24.10	16.50	6	Drained	19.0	0.0	9.50	323.00	0.0	165.0	9.5	158.0

Top	Bottom	Soil No.	Name	K_p	c' (kPa)	C_u (kPa)	c_w/c	K_{pc}	σ_H or σ_H' (kPa)	
									Top	Bot
-4.50	-7.10	no soil	-	0.00	0.0	0.00	0.00	0.00	0.0	0.0
-7.10	-7.60	6	CDG (37°)	4.16	5.0	0.00	0.00	4.08	20.4	59.9
-7.60	-24.10	6	CDG (37°)	4.16	5.0	0.00	0.00	4.08	59.9	677.7

Top	Bottom	Soil No.	Red. Fact.	Soil Loads and Moments				Water Loads and Moments			
				Rectangular		Triangular		Rectangular		Triangular	
				Force (kN/m)	Moment (kNm/m)	Force (kN/m)	Moment (kNm/m)	Force (kN/m)	Moment (kNm/m)	Force (kN/m)	Moment (kNm/m)
-4.50	-7.10	no soil	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-7.10	-7.60	6	1.00	10.2	29.1	9.9	29.0	0.0	0.0	0.0	0.0
-7.60	-24.10	6	1.00	988.6	11220.8	5096.5	71860.9	0.0	0.0	1361.3	19193.6
				Totals:	**11,249.8**		**71,889.9**		**0.0**		**19,193.6**

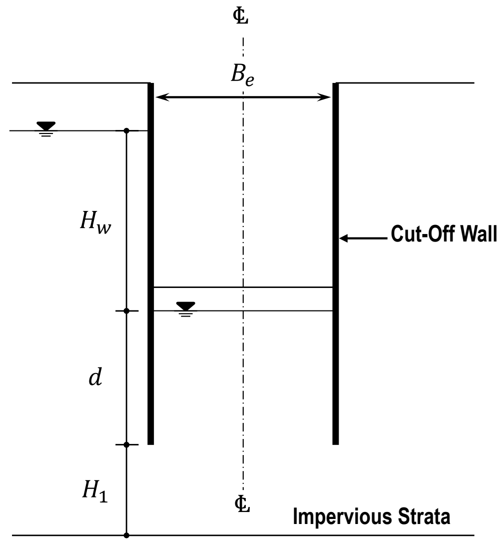
Total restoring moment, M_P = **102,333.4** **kNm/m**

AECOM AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.1
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	8-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	8-Oct-21

Hydraulic Stability Check

In accordance with GEOGuide 1 Figure 36 - Penetration of cut-off wall to prevent hydraulic failure in homogenous sand

Location: **CTS Pumping Station**



Design Water Level on Retained Side	-	=	+3.00	mPD
Design Water Level on Excavated Side	-	=	-7.60	mPD
Toe Level of Wall	-	=	-24.10	mPD
Level of Impervious Strata	-	=	-40.00	mPD
Width of Excavation	B_e	=	40.0	m
Net Hydrostatic Head	H_w	=	10.60	m
Penetration Depth	**d**	=	16.50	m
Distance between Toe Level and Impervious Strata	H_1	=	15.90	m
Penetration Required / Net Hydrostatic Head	d/H_w	=	1.56	
Width of Excavation / Net Hydrostatic Head	B_e/H_w	=	3.77	
	H_1/H_w	=	1.50	

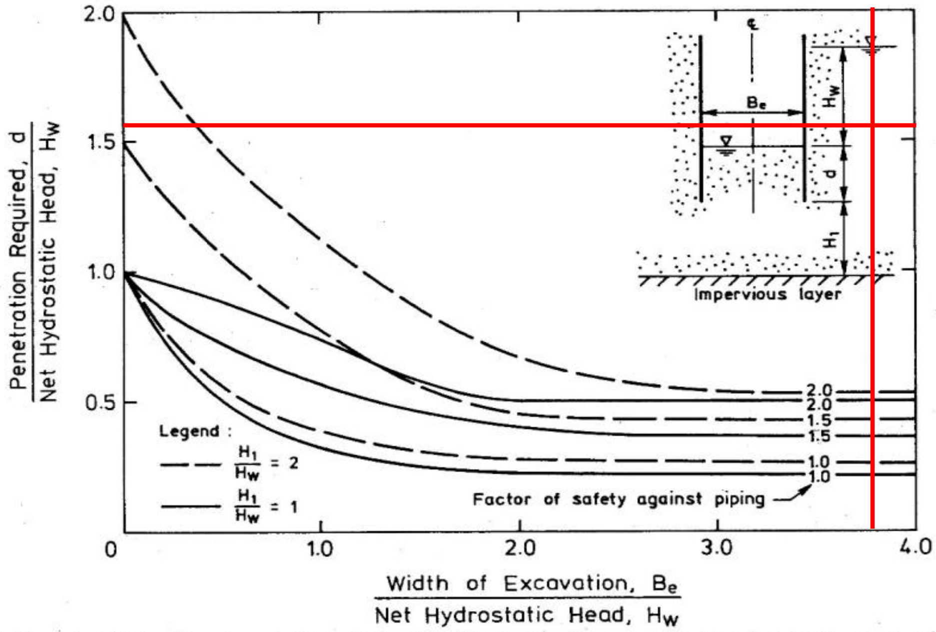
From Figure 36(b), Factor of Safety **>** **2** **for dense sand**

AECOM AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.2
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	8-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	8-Oct-21

Hydraulic Stability Check

In accordance with GEOGuide 1 Figure 36 - Penetration of cut-off wall to prevent hydraulic failure in homogenous sand

Location: **CTS Pumping Station**



(b) Penetration Required for Cut-off Wall in Dense Sand of Limited Depth

PLAXIS Report

STN Pumphouse - Section A-A

1.1.1.1.1.1 Materials - Soil and interfaces - Mohr-Coulomb (1/2)

Identification		Fill	Alluvial Sand	Alluvial Clay	Marine Sand	Colluvium
Identification number		1	2	3	4	5
Drainage type		Drained	Drained	Undrained (B)	Drained	Drained
Colour						
Comments						
γ_{unsat}	kN/m³	19.00	19.00	18.00	19.00	19.00
γ_{sat}	kN/m³	19.00	19.00	18.00	19.00	19.00
Dilatancy cut-off		No	No	No	No	No
e_{init}		0.5000	0.5000	0.5000	0.5000	0.5000
e_{min}		0.000	0.000	0.000	0.000	0.000
e_{max}		999.0	999.0	999.0	999.0	999.0
Rayleigh α		0.000	0.000	0.000	0.000	0.000
Rayleigh β		0.000	0.000	0.000	0.000	0.000
E	kN/m²	10.00E3	10.00E3	8000	8000	16.00E3
ν (nu)		0.3000	0.3000	0.3000	0.3000	0.3000
G	kN/m²	3846	3846	3077	3077	6154
E_{oed}	kN/m²	13.46E3	13.46E3	10.77E3	10.77E3	21.54E3
c_{ref}	kN/m²	0.000	0.000	36.00	0.000	0.000

Identification		Fill	Alluvial Sand	Alluvial Clay	Marine Sand	Colluvium
φ (phi)	°	30.00	36.00	0.000	33.00	30.00
ψ (psi)	°	0.000	0.000	0.000	0.000	0.000
V_s	m/s	44.56	44.56	40.95	39.86	56.37
V_p	m/s	83.37	83.37	76.61	74.57	105.5
Set to default values		No	No	No	No	No
E_{inc}	kN/m²/m	3333	3750	3750	2000	2286
y_{ref}	m	2.000	-2.000	-2.500	0.000	-7.000
c_{inc}	kN/m²/m	0.000	0.000	19.20	0.000	0.000
y_{ref}	m	2.000	-2.000	-2.500	0.000	-7.000
Tension cut-off		Yes	Yes	Yes	Yes	Yes
Tensile strength	kN/m²	0.000	0.000	0.000	0.000	0.000
Undrained behaviour		Standard	Standard	Standard	Standard	Standard
Skempton-B		0.9783	0.9783	0.9783	0.9783	0.9783
ν_u		0.4950	0.4950	0.4950	0.4950	0.4950
$K_{w,ref}$ / n	kN/m²	375.0E3	375.0E3	300.0E3	300.0E3	600.0E3
$C_{v,ref}$	m²/day	0.000	0.000	0.000	0.000	0.000
Stiffness		Standard	Standard	Standard	Standard	Standard
Strength		Manual	Manual	Manual	Manual	Manual
R_{inter}		0.6700	0.6700	0.6700	0.6700	0.6700
Consider gap closure		Yes	Yes	Yes	Yes	Yes
δ_{inter}		0.000	0.000	0.000	0.000	0.000

Identification		Fill	Alluvial Sand	Alluvial Clay	Marine Sand	Colluvium
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m^3/day/m	0.000	0.000	0.000	0.000	0.000
R	m^2 K/kW	0.000	0.000	0.000	0.000	0.000
K_0 determination		Automatic	Automatic	Automatic	Automatic	Automatic
$K_{0,x} = K_{0,z}$		Yes	Yes	Yes	Yes	Yes
$K_{0,x}$		0.5000	0.4122	0.5000	0.4554	0.5000
$K_{0,z}$		0.5000	0.4122	0.5000	0.4554	0.5000
Data set		Standard	Standard	Standard	Standard	Standard
Type		Coarse	Coarse	Coarse	Coarse	Coarse
< 2 µm	%	10.00	10.00	10.00	10.00	10.00
2 µm - 50 µm	%	13.00	13.00	13.00	13.00	13.00
50 µm - 2 mm	%	77.00	77.00	77.00	77.00	77.00
Use defaults		None	None	None	None	None
k_x	m/day	0.000	0.000	0.000	0.000	0.000
k_y	m/day	0.000	0.000	0.000	0.000	0.000
$-\psi_{unsat}$	m	10.00E3	10.00E3	10.00E3	10.00E3	10.00E3
e_{init}		0.5000	0.5000	0.5000	0.5000	0.5000
S_s	1/m	0.000	0.000	0.000	0.000	0.000
c_k		1000E12	1000E12	1000E12	1000E12	1000E12
c_s	kJ/t/K	0.000	0.000	0.000	0.000	0.000
λ_s	kW/m/K	0.000	0.000	0.000	0.000	0.000

Identification		Fill	Alluvial Sand	Alluvial Clay	Marine Sand	Colluvium
ρ_s	t/m³	0.000	0.000	0.000	0.000	0.000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric	Volumetric
α_s	1/K	0.000	0.000	0.000	0.000	0.000
D_v	m²/day	0.000	0.000	0.000	0.000	0.000
f_{Tv}		0.000	0.000	0.000	0.000	0.000
Unfrozen water content		None	None	None	None	None

1.1.1.1.1.2 Materials - Soil and interfaces - Mohr-Coulomb (2/2)

Identification		CDG
Identification number		6
Drainage type		Drained
Colour		
Comments		
γ_{unsat}	kN/m³	19.00
γ_{sat}	kN/m³	19.00
Dilatancy cut-off		No
e_{init}		0.5000
e_{min}		0.000
e_{max}		999.0
Rayleigh α		0.000
Rayleigh β		0.000
E	kN/m²	35.00E3
ν (nu)		0.3000
G	kN/m²	13.46E3

Identification		CDG
E_{oed}	kN/m²	47.12E3
c_{ref}	kN/m²	5.000
φ (phi)	°	37.00
ψ (psi)	°	0.000
V_s	m/s	83.37
V_p	m/s	156.0
Set to default values		No
E_{inc}	kN/m²/m	1625
y_{ref}	m	-14.00
c_{inc}	kN/m²/m	0.000
y_{ref}	m	-14.00
Tension cut-off		Yes
Tensile strength	kN/m²	0.000
Undrained behaviour		Standard
Skempton-B		0.9783
ν_u		0.4950
$K_{w,ref}$ / n	kN/m²	1.313E6
Stiffness		Standard
Strength		Manual

Identification		CDG
R_{inter}		0.6700
Consider gap closure		Yes
δ_{inter}		0.000
Cross permeability		Impermeable
Drainage conductivity, dk	m^3/day/m	0.000
R	m^2 K/kW	0.000
K_0 determination		Automatic
$K_{0,x} = K_{0,z}$		Yes
$K_{0,x}$		0.3982
$K_{0,z}$		0.3982
Data set		Standard
Type		Coarse
< 2 μm	%	10.00
2 μm - 50 μm	%	13.00
50 μm - 2 mm	%	77.00
Use defaults		None
k_x	m/day	0.000
k_y	m/day	0.000
$-\psi_{unsat}$	m	10.00E3

Identification		CDG
e_{init}		0.5000
S_s	1/m	0.000
c_k		1000E12
c_s	kJ/t/K	0.000
λ_s	kW/m/K	0.000
ρ_s	t/m³	0.000
Solid thermal expansion		Volumetric
α_s	1/K	0.000
D_v	m²/day	0.000
f_{Tv}		0.000
Unfrozen water content		None

1.1.1.1.2 Materials - Soil and interfaces - Linear elastic

Identification		Bedrock
Identification number		7
Drainage type		Drained
Colour		
Comments		
γ_{unsat}	kN/m³	19.00
γ_{sat}	kN/m³	19.00
Dilatancy cut-off		No
e_{init}		0.5000
e_{min}		0.000
e_{max}		999.0
Rayleigh α		0.000
Rayleigh β		0.000
E	kN/m²	300.0E3
ν (nu)		0.000
G	kN/m²	150.0E3
E_{oed}	kN/m²	300.0E3

Identification		Bedrock
V_s	m/s	278.3
V_p	m/s	393.6
Set to default values		Yes
E_{inc}	kN/m²/m	0.000
y_{ref}	m	0.000
Undrained behaviour		Standard
Skempton-B		0.9933
ν_u		0.4950
$K_{w,ref} / n$	kN/m²	14.85E6
Stiffness		Standard
Strength		Rigid
R_{inter}		1.000
Consider gap closure		Yes
δ_{inter}		0.000
Cross permeability		Impermeable
Drainage conductivity, dk	m³/day/m	0.000
R	m² K/kW	0.000
K_0 determination		Automatic
$K_{0,x} = K_{0,z}$		Yes

Identification		Bedrock
$K_{0,x}$		0.5000
$K_{0,z}$		0.5000
Data set		Standard
Type		Coarse
< 2 µm	%	10.00
2 µm - 50 µm	%	13.00
50 µm - 2 mm	%	77.00
Use defaults		None
k_x	m/day	0.000
k_y	m/day	0.000
$-\psi_{unsat}$	m	10.00E3
e_{init}		0.5000
S_s	1/m	0.000
c_k		1000E12
c_s	kJ/t/K	0.000
λ_s	kW/m/K	0.000
ρ_s	t/m³	0.000
Solid thermal expansion		Volumetric
α_s	1/K	0.000

Identification		Bedrock
D_v	m²/day	0.000
f_{Tv}		0.000
Unfrozen water content		None

1.1.1.2 Materials - Plates -

Identification		610 x 20.6 x 299 CHS Spacing 0.7 m S355
Identification number		1
Comments		
Colour		
Material type		Elastoplastic
Isotropic		Yes
EA_1	kN/m	11.16E6
EA_2	kN/m	11.16E6
EI	kN m²/m	485.7E3
d	m	0.7227
w	kN/m/m	4.190
ν (nu)		0.000
M_p	kN m/m	3528
$N_{p,1}$	kN/m	18.78E3
$N_{p,2}$	kN/m	18.78E3
Rayleigh α		0.000
Rayleigh β		0.000

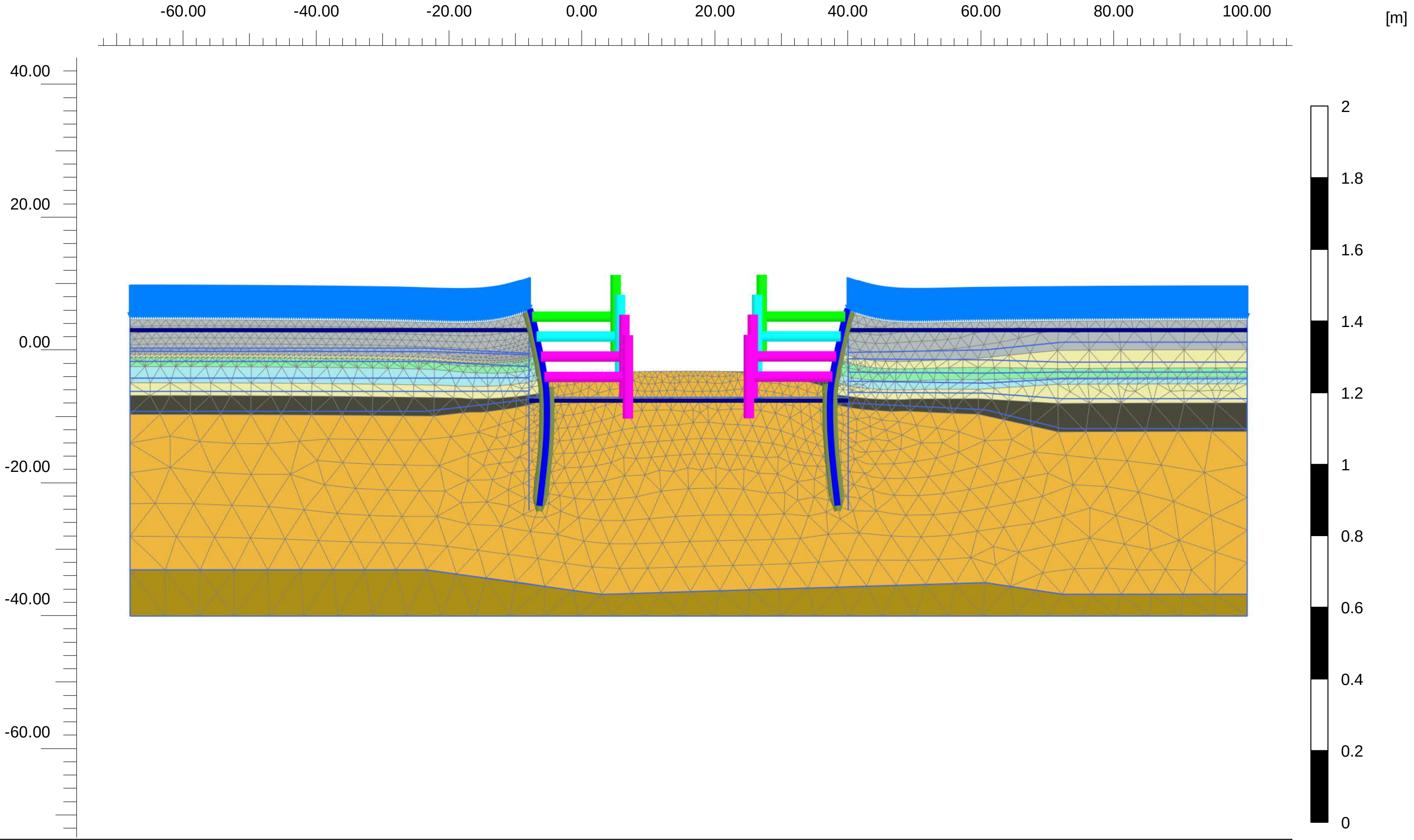
Identification		610 x 20.6 x 299 CHS Spacing 0.7 m S355
Prevent punching		Yes
Identification number		1
c	kJ/t/K	0.000
λ	kW/m/K	0.000
ρ	t/m^3	0.000
α	1/K	0.000

1.1.1.3 Materials - Anchors -

Identification		Double 305 x 305 x 158 UC Grade 50	Double 305 x 305 x 198 UC Grade 50	Double 356 x 406 x 393 UC Grade 50
Identification number		1	2	3
Comments				
Colour				
Material type		Elastoplastic	Elastoplastic	Elastoplastic
EA	kN	4.864E6	6.098E6	12.12E6
$L_{spacing}$	m	5.000	5.000	5.000
$\lvert F_{max,tens} \rvert$	kN	0.000	0.000	0.000
$\lvert F_{max,comp} \rvert$	kN	1.000E12	1.000E12	1.000E12
Identification number		1	2	3
c	kJ/t/K	0.000	0.000	0.000
λ	kW/m/K	0.000	0.000	0.000
ρ	t/m³	0.000	0.000	0.000
α	1/K	0.000	0.000	0.000
Identification number		1	2	3
c	kJ/t/K	0.000	0.000	0.000
λ	kW/m/K	0.000	0.000	0.000
ρ	t/m³	0.000	0.000	0.000
α	1/K	0.000	0.000	0.000

Identification		Double 305 x 305 x 158 UC Grade 50	Double 305 x 305 x 198 UC Grade 50	Double 356 x 406 x 393 UC Grade 50
A	m²	0.000	0.000	0.000
Identification number		1	2	3
c	kJ/t/K	0.000	0.000	0.000
λ	kW/m/K	0.000	0.000	0.000
ρ	t/m³	0.000	0.000	0.000
α	1/K	0.000	0.000	0.000
A	m²	0.000	0.000	0.000

Output Version 21.0.0.223

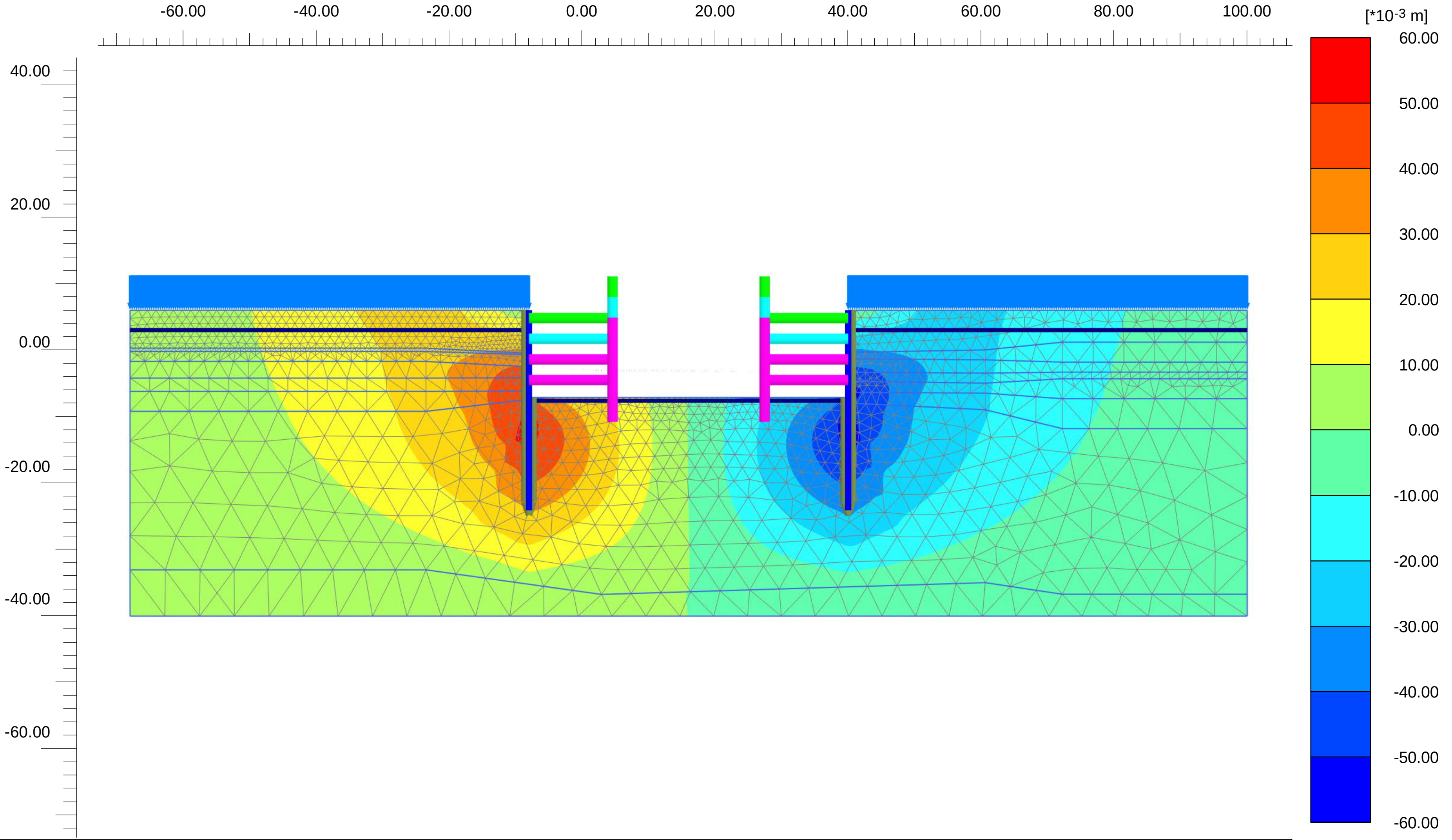


Deformed mesh |u| (scaled up 50.0 times)

Maximum value = 0.07871 m (Element 4018 at Node 30597)

Project description			Date
STN Pumphouse			18/10/2021
Project filename	Step	Company	
STN Pumphouse_SectionAA	42	AECOM- CSS	

Output Version 21.0.0.223



Total displacements u_x (scaled up 50.0 times)

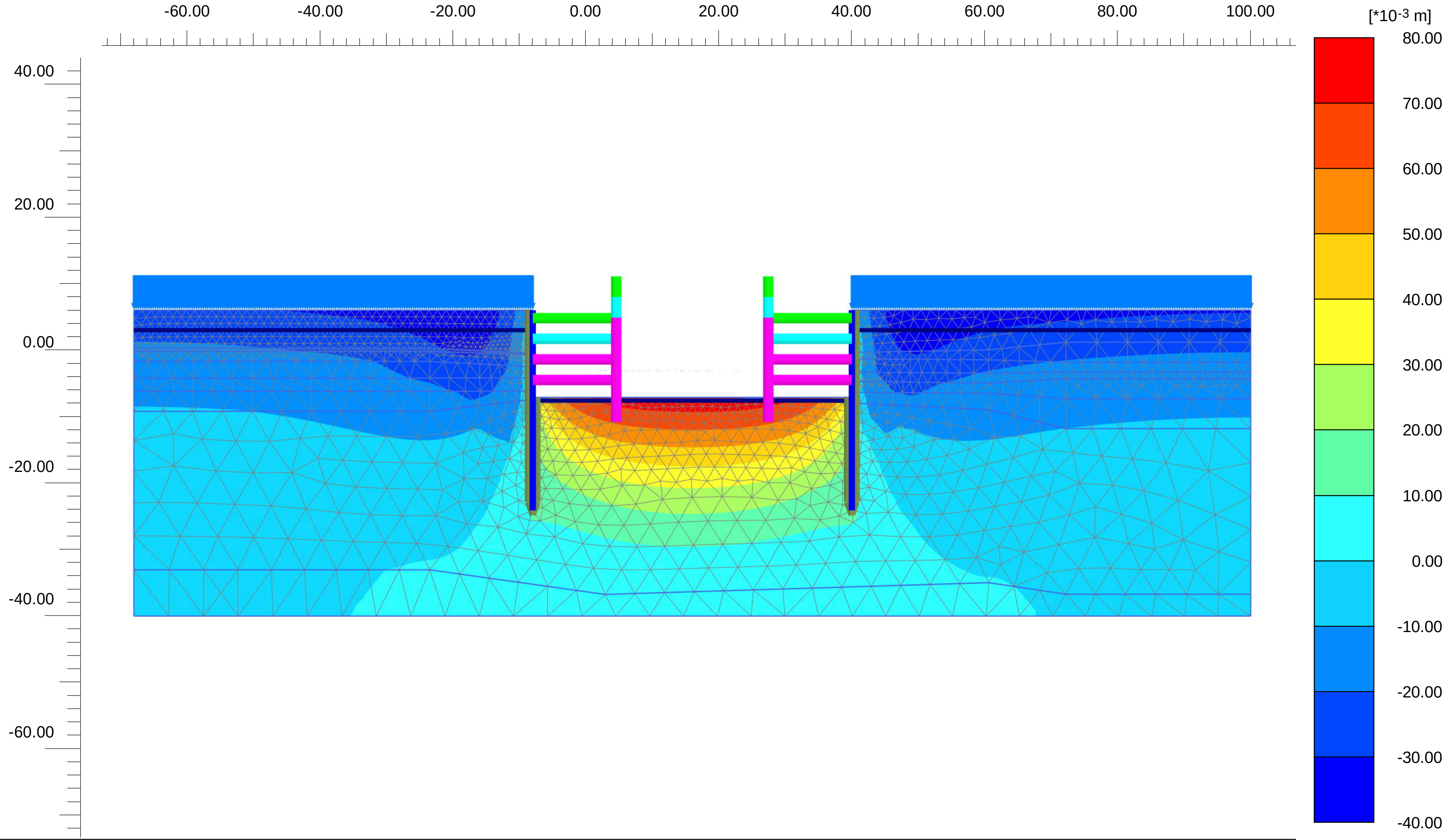
Maximum value = 0.05440 m (Element 5281 at Node 10070)

Minimum value = -0.05557 m (Element 5038 at Node 33988)

Project description	Date
STN Pumphouse	18/10/2021

Project filename	Step	Company
STN Pumphouse_SectionAA	42	AECOM- CSS

Output Version 21.0.0.223



Total displacements u_y (scaled up 50.0 times)

Maximum value = 0.07851 m (Element 5236 at Node 22851)

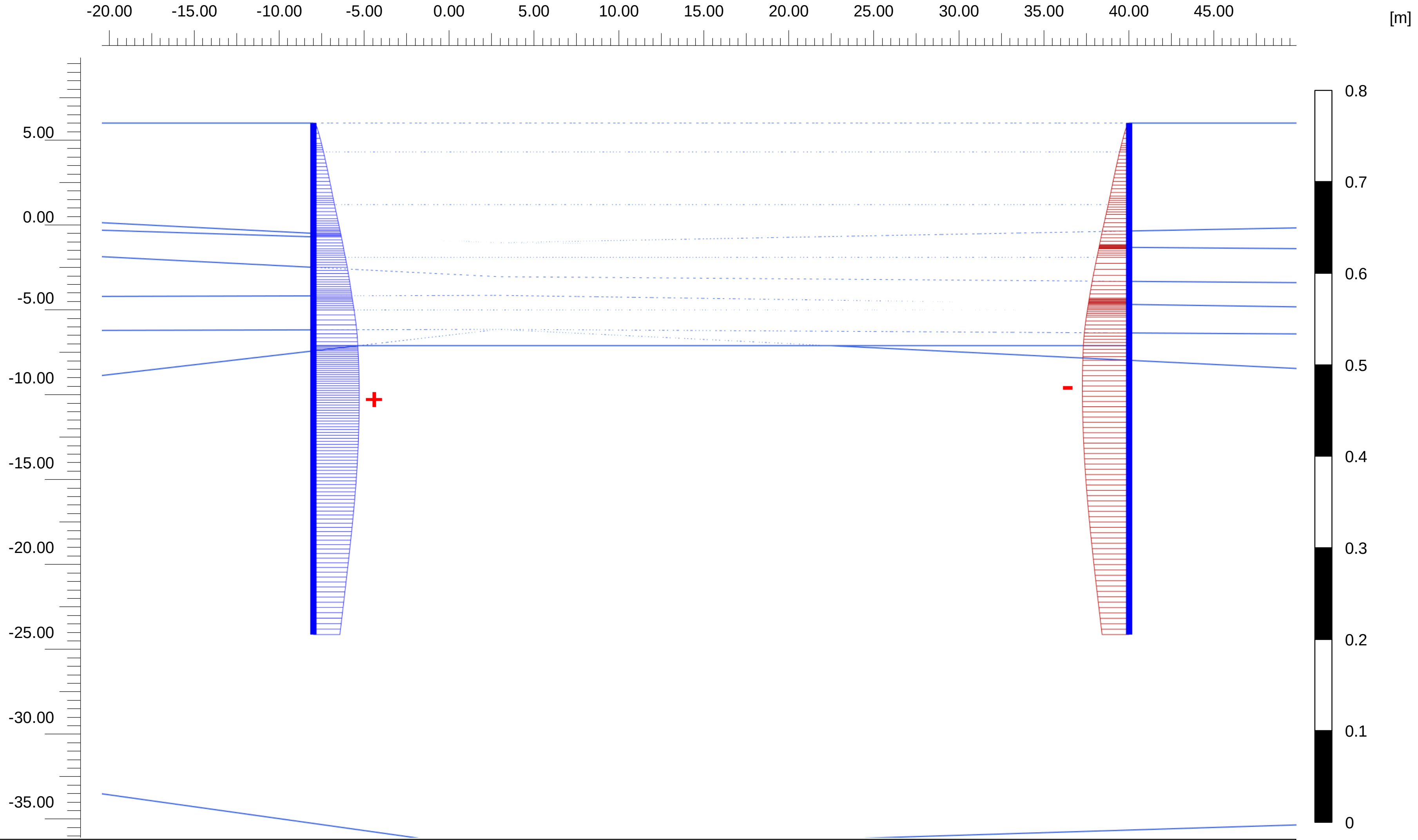
Minimum value = -0.03885 m (Element 412 at Node 5573)

Project description		Date
STN Pumphouse		18/10/2021

Project filename	Step	Company
STN Pumphouse_SectionAA	42	AECOM- CSS

Structural element	Node	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]	Φ_z [°]	Length [m]
FixedEndAnchor_1_1	14080	1	-8.000	4.800	-167.726	-627.135	0.000	0.000	16.130
FixedEndAnchor_2_1	43684	1	40.000	4.800	-160.655	-633.647	0.000	180.000	16.130
FixedEndAnchor_3_1	12529	1	-8.000	1.700	-1081.281	-1309.884	0.000	0.000	16.130
FixedEndAnchor_4_1	43167	1	40.000	1.700	-1103.544	-1322.171	0.000	180.000	16.130
FixedEndAnchor_5_1	9928	1	-8.000	-1.400	-1459.506	-1538.191	0.000	0.000	16.130
FixedEndAnchor_6_1	41541	1	40.000	-1.400	-1487.900	-1561.395	0.000	180.000	16.130
FixedEndAnchor_7_1	9014	1	-8.000	-4.500	-1535.594	-1535.594	0.000	0.000	16.130
FixedEndAnchor_8_1	39219	1	40.000	-4.500	-1467.365	-1467.365	0.000	180.000	16.130

Output Version 21.0.0.223



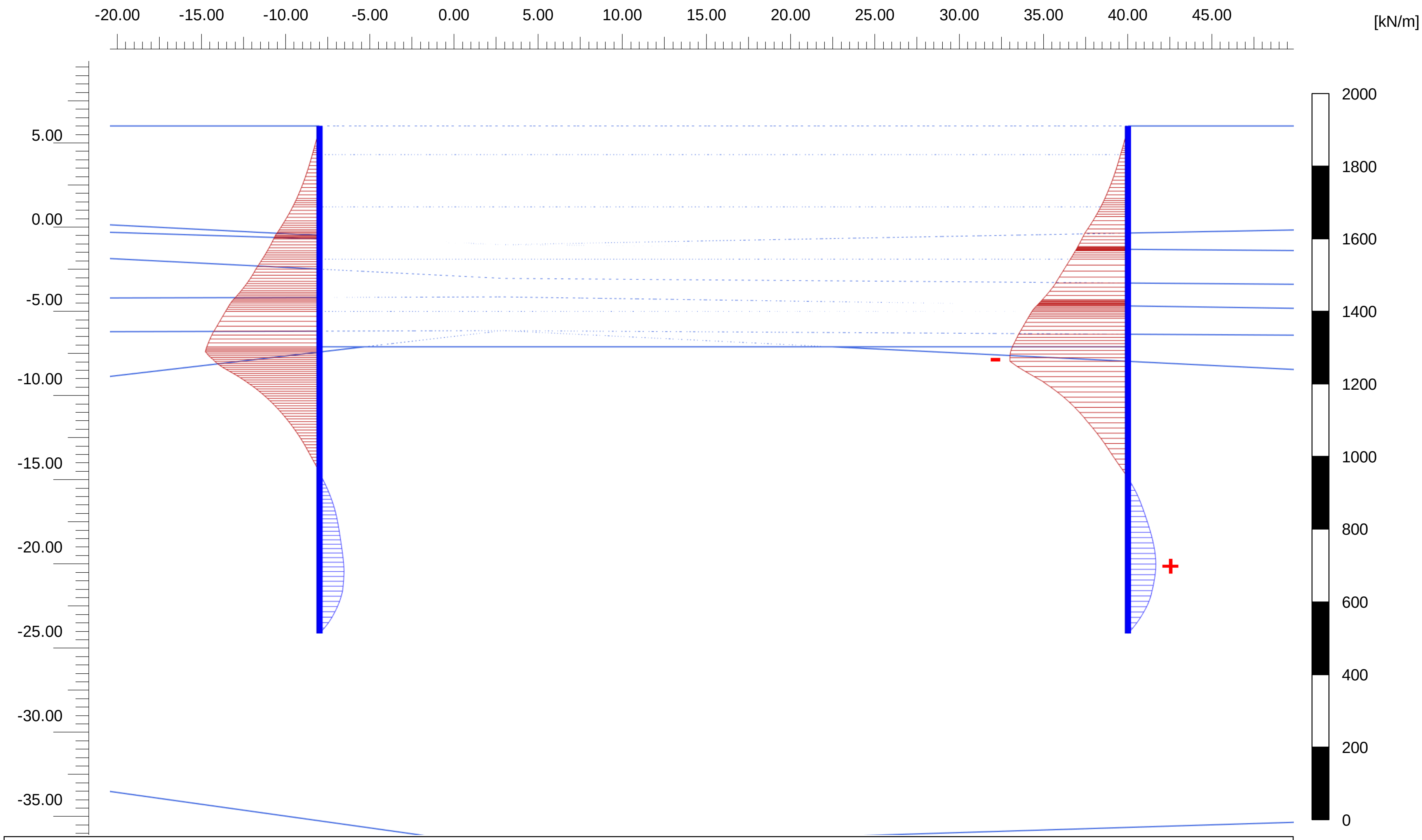
Total displacements u_x (scaled up 50.0 times)

Maximum value = 0.05389 m (Element 48 at Node 10075)

Minimum value = -0.05503 m (Element 65 at Node 33722)

Project description			Date
STN Pumphouse			18/10/2021
Project filename	Step	Company	
STN Pumphouse_SectionAA	42	AECOM- CSS	

Output Version 21.0.0.223



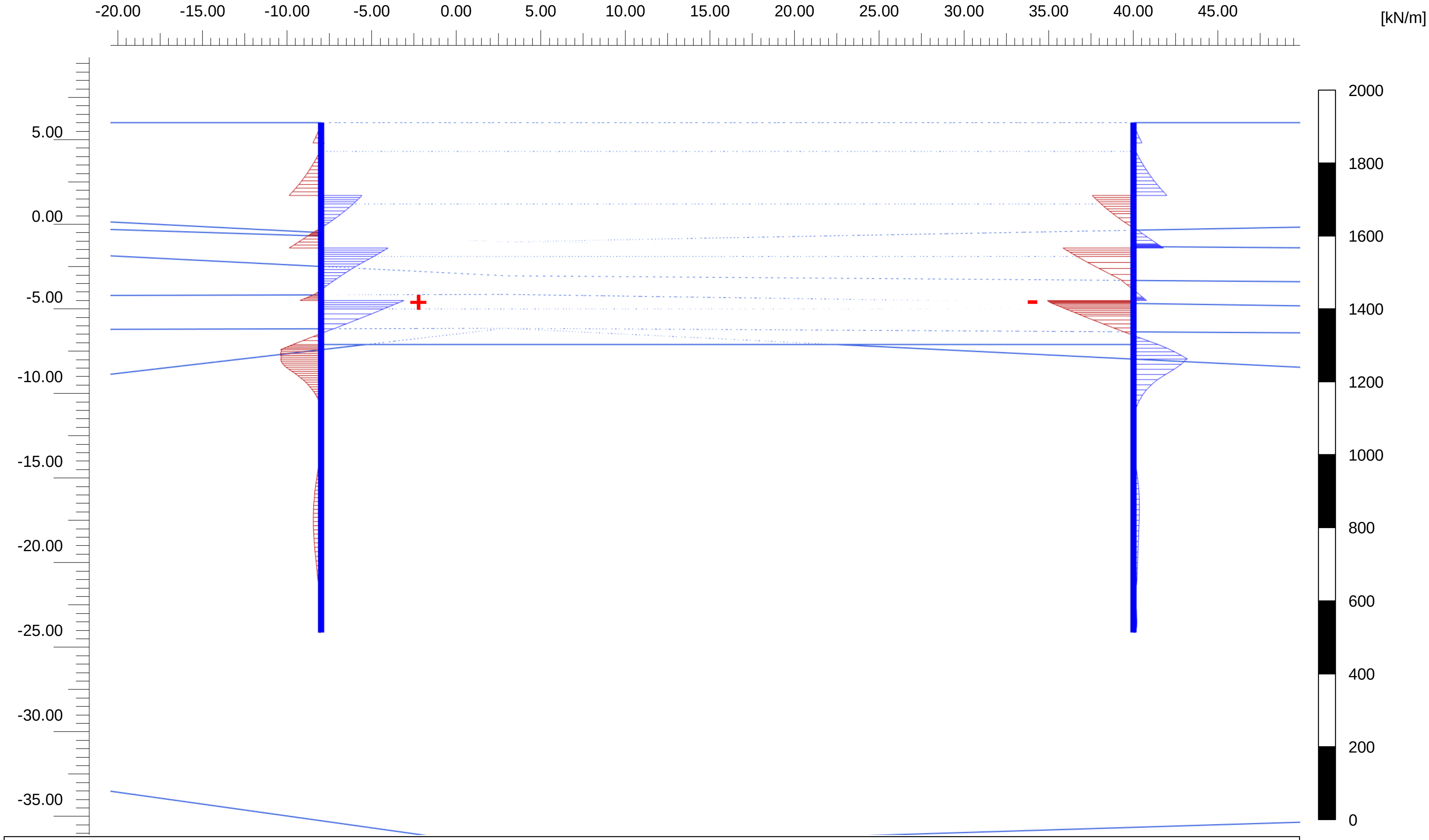
Axial forces N (scaled up 0.0200 times)

Maximum value = 82.76 kN/m (Element 73 at Node 27054)

Minimum value = -350.5 kN/m (Element 42 at Node 35206)

Project description			Date
STN Pumphouse			18/10/2021
Project filename	Step	Company	
STN Pumphouse_SectionAA	42	AECOM- CSS	

Output Version 21.0.0.223



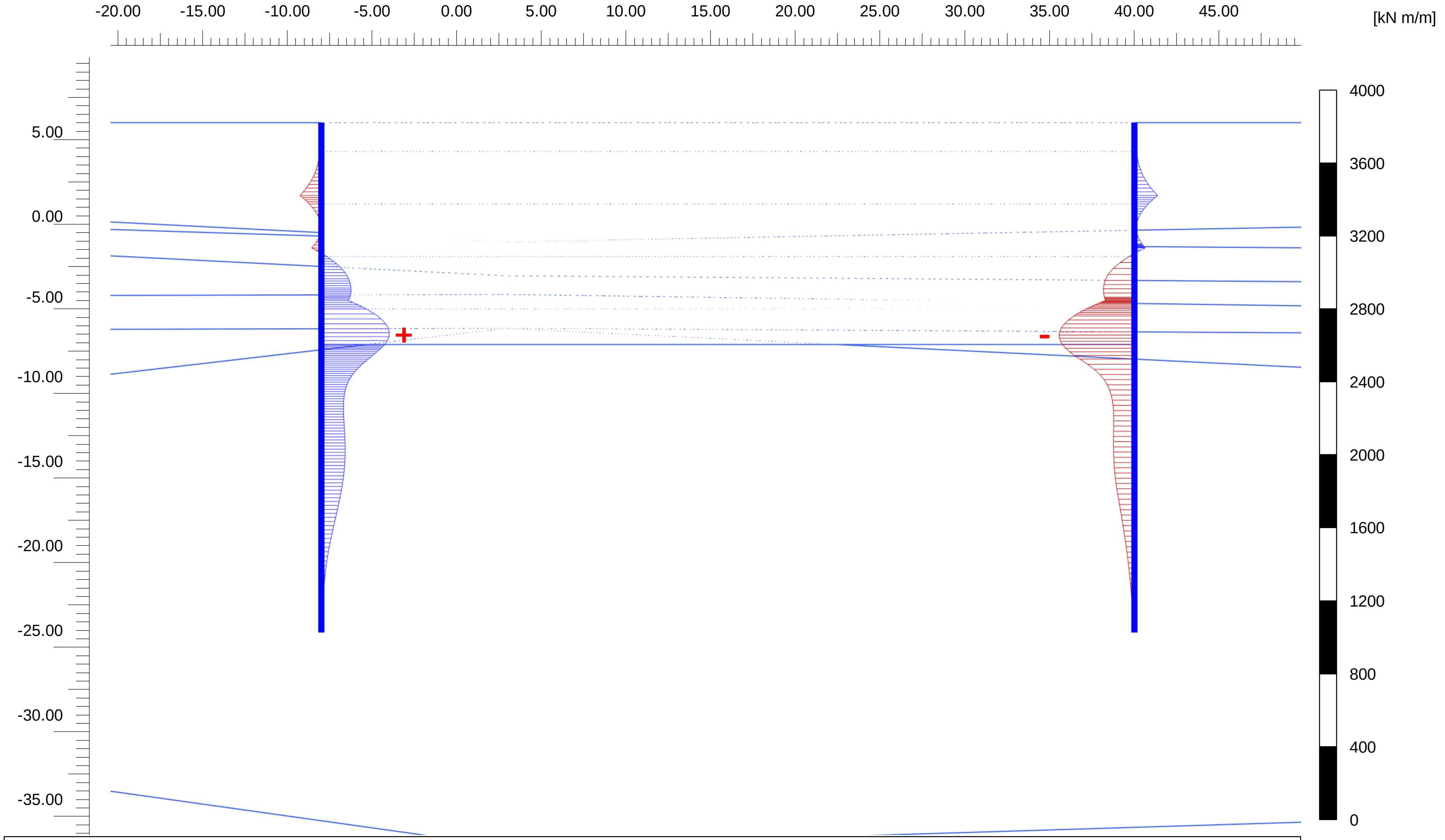
Shear forces Q (scaled up 0.0200 times)

Maximum value = 244.7 kN/m (Element 34 at Node 9014)

Minimum value = -254.7 kN/m (Element 33 at Node 39219)

Project description		Date
STN Pumphouse		18/10/2021
Project filename	Step	Company
STN Pumphouse_SectionAA	42	AECOM- CSS

Output Version 21.0.0.223



Bending moments M (scaled up 0.0100 times)

Maximum value = 401.2 kN m/m (Element 39 at Node 9032)

Minimum value = -444.5 kN m/m (Element 40 at Node 35724)

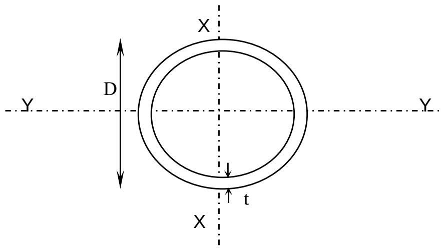
Project description		Date
STN Pumphouse		18/10/2021
Project filename	Step	Company
STN Pumphouse_SectionAA	42	AECOM- CSS

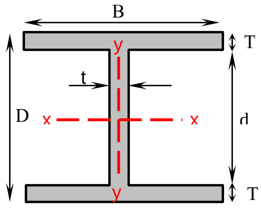
AECOM	Drainage Improvement Works in Kwun Tong Investigation Excavation and Lateral Support Works Design Structural Design of Pipe Pile Wall STN Pumping Station - Type A	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

Structural Steel Design - Pipe Pile Wall

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan





H-Section

1. Section Properties

Try Section : **610 x 20.6 x 299 CHS** | **S355** | **Hot Rolled**

Maximum pipe pile spacing **S** = 0.70 m

Circular Hollow Section

Depth of Section	**D**	=	610 mm	Plastic Modulus (X-Axis)	S_x	=	7159000 mm^3
Thickness	**t**	=	20.6 mm	Plastic Modulus (Y-Axis)	S_y	=	7159000 mm^3
Second Moment of Area (X-Axis)	I_x	=	1.658E+09 mm^4	Area of Section	A_g	=	38100 mm^2
Second Moment of Area (Y-Axis)	I_y	=	1.658E+09 mm^4	Mass per Length	**w**	=	299.00 kg/m
Elastic Modulus (X-Axis)	Z_x	=	5437000 mm^3	Design Strength	p_y	=	345 N/mm^2
Elastic Modulus (X-Axis)	Z_y	=	5437000 mm^3				

Elastic Modulus of steel **E** = 205000.00 MPa

PLAXIS Input Values

EA/m	=	(205000 x 1000) x (38100 / 10^6) / 0.7	=	**1.116E+07**	kN/m
EIx/m	=	(205000 x 1000) x (1658400000 / 10^12) / 0.7	=	**4.857E+05**	kNm^2/m
EIy/m	=	(205000 x 1000) x (1658400000 / 10^12) / 0.7	=	**4.857E+05**	kNm^2/m
w/m	=	(299) x 9.81 / 1000 / 0.7	=	**4.190**	kN/m/m

2. Ultimate Design Load

From "Plaxis" results,

Maximum bending moment, Mx	=	444.50	kNm/m
Maximum bending moment, My	=	0.00	kNm/m
Maximum shear force, V	=	256.60	kN/m
Maximum axial force, Fc	=	350.50	kN/m
Load Factor	=	1.4	

Design Bending Moment (Major Axis)	M_x	=	435.6	kNm per pile	Design Shear Force	**V**	=	251.5 kN per pile
Design Bending Moment (Minor Axis)	M_y	=	0.0	kNm per pile	Axial Force	F_c	=	343.5 kN per pile

3. Section Classification

(Table 7.2)

CLA

$e = [275 / p_y]^{1/2} = 0.9$ D/t = 29.6 < $40\ e^2$ (Plastic)

(Table 7.2, CHS under compression due to bending)

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 29.6 < 70e = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area $\mathbf{A_v}$ = 22860 + 0 = 22860 mm^2

Shear Capacity $\mathbf{V_c}$ = $p_yA_v/(3)^{0.5}$ *(Eqn. 8.1)*

= 4553.4 + 0.0

= 4553 kN

Design Shear Force **V** = 251.5 kN < V_c = 4553 kN ***Check Shear OK***

Since, $0.6V_c$ = 2732 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 2470 kNm $1.2p_yZ_x$ = 2251 kNm

$\mathbf{M_{cx}}$ = **2251 kNm** > M_x = 435.6 kNm ***Major Moment Capacity OK***

Major Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 2470 kNm $1.2p_yZ_y$ = 2251 kNm

$\mathbf{M_{cy}}$ = **2251 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{343.5}{13144.5} + \frac{435.6}{2250.9} + \frac{0.0}{2250.9}$$

$$= 0.03 + 0.19 + 0.00$$

$$= 0.220$$

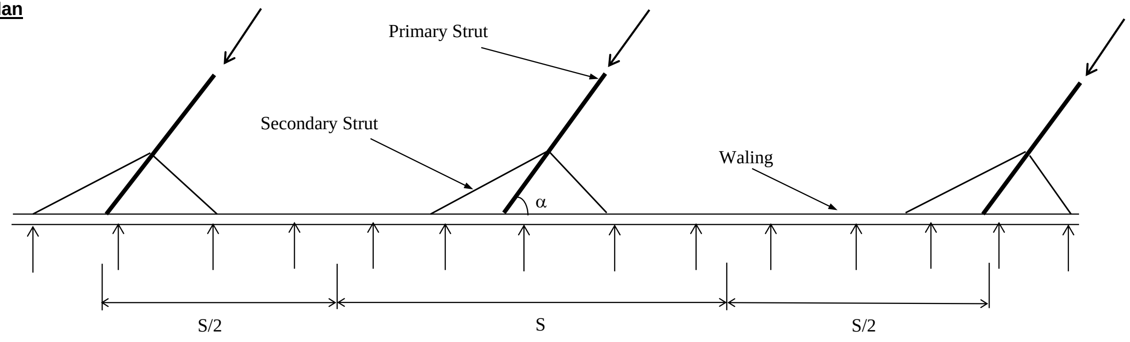
$$< 1$$

Cross-section Capacity OK

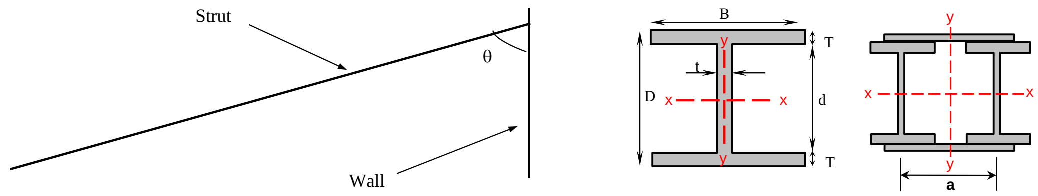
Structural Steel Design - Level 1 Main Strut (+4.80 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section



1. Section Properties

Try Section : | **Double** | **305 x 305 x 158 UC** | **Grade 50** | **Hot Rolled**

Depth of Section	**D**	= 327.2	mm	Elastic Modulus (X-Axis)	$\mathbf{Z_x}$	=	4740000	mm^3	
Width of Section	**B**	= 310.6	mm	Elastic Modulus (Y-Axis)	$\mathbf{Z_y}$	=	3930000	mm^3	
Web Thickness	**t**	= 15.7	mm	Plastic Modulus (X-Axis)	$\mathbf{S_x}$	=	5360000	mm^3	
Flange Thickness	**T**	= 25.0	mm	Plastic Modulus (Y-Axis)	$\mathbf{S_y}$	=	6243060	mm^3	
Depth between Fillets	**d**	= 246.6	mm	Buckling Parameter	**u**	=	0.852		
Second Moment of Area (X-Axis)	$\mathbf{I_x}$	= 7.740E+08	mm^4	Torsional Index	**x**	=	12.5		
Second Moment of Area (Y-Axis)	$\mathbf{I_y}$	= 1.220E+09	mm^4	Area of Section	$\mathbf{A_g}$	=	40200	mm^2	
Radius of Gyration (X-Axis)	$\mathbf{r_x}$	= 139.0	mm	Mass per Length	**w**	=	316.0	kg/m	
Radius of Gyration (Y-Axis)	$\mathbf{r_y}$	= 174.2	mm	Design Strength	$\mathbf{p_y}$	=	345	N/mm^2	
Modulus of Elasticity	**E**	= 205000	MPa	Distance Between Centre Lines	**a**	=	310.6	mm	***Spacing OK***

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	126.73	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (40,200 / 10^6) x sin(50)^2 x sin(90)^2		=	**4.864E+06**	kN
Minimum inclination of strut to waling, α	=	50.19	degree			
Load in the direction of strut, P_α	=	F / sin α	= 126.73 / sin 50.2	=	165.0	kN/m
Maximum strut spacing, S	=	5.00	m			
Maximum compression, P	=	P_α x S	= 164.96 x 5.00	=	824.8	kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	13.67	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	= 13.67 / sin 90.0	=	13.67	m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	10.67	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	= 10.67 / sin 90.0	=	10.67	m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (316.0 x 9.81 + 2.0 x 310.6 x 2) x 10^-3 x 13.7^2		=	101.4	kNm
Maximum Shear Force (unfactored)	=	0.5 x (316.0 x 9.81 +2.0 x 310.6 x 2) x 10^-3 x 13.7		=	29.7	kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	$\mathbf{M_x}$	= 709.8	kNm	Design Shear Force	**V**	=	207.7	kN
Design Bending Moment (Y-Axis)	$\mathbf{M_y}$	= 0.0	kNm	Axial Force	$\mathbf{F_c}$	=	1154.8	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 6.2 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 15.7 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 15.7 < 70ε = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 10274 mm^2

Shear Capacity V_c = $p_y A_v/(3)$^0.5

= 2046 kN

Design Shear Force **V** = 207.7 kN < P_v = 2046 kN ***Check Shear OK***

Since, $0.6V_c$ = 1228 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 1849 kNm $1.2p_yZ_x$ = 1962 kNm

$\mathbf{M_{cx}}$ = **1849 kNm** > M_x = 709.8 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 2154 kNm $1.2p_yZ_y$ = 1627 kNm

$\mathbf{M_{cy}}$ = **1627 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) L_y = 10.67 m

Effective Length L_{Ey} = 1.0 L = 10.7 m *(Clause 8.3.4)*

Minor Axis Slenderness λ = L_{Ey} / r_y = 61.2

Buckling parameter **u** = 0.85 *(Clause 8.3.5.3)*

λ / x = 4.90

Slenderness factor ν = $1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.821

β_w = 1.000 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness λ_{LT} = $u\nu\lambda(\beta_w)^{0.5}$ = 42.8 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength p_y = 345.00 N/mm^2

Buckling strength p_b = 302.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment M_b = 1618.7 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor m_{LT} = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 660.12 < M_b = 1618.7 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 709.81 < M_{cx} = 1849.2 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{1154.8}{13869.0} + \frac{709.8}{1849.2} + \frac{0.0}{1627.0}$$

= 0.08 + 0.38 + 0.00

= 0.47

< 1 ***Cross-section Capacity OK***

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**			
Unrestrain length (X-Axis)	L_x	=	13.67 m			
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	13.67 m	*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	98.3 ≈ 100	
Maximum Thickness	**T**	=	25.0 mm	≤	40 mm	
Type of Section		=	Rolled H-section ≤ 40mm			
Designation of buckling curves for different section types:				Buckling Curve	b)	*(Table 8.7)*
p_c in Table 8.8	a)	=	169.00 N/mm^2			
p_c in Table 8.8	b)	=	154.00 N/mm^2			
p_c in Table 8.8	c)	=	139.00 N/mm^2			
p_c in Table 8.8	d)	=	125.00 N/mm^2			
Compressive Strength	p_{cx}	=	154.00 N/mm^2			*(Table 8.8(b))*
Axis of buckling		=	**y-y**			
Unrestrain length (Y-Axis)	L_y	=	10.67 m			
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	10.67 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	61.2 ≈ 62	
Maximum Thickness	**T**	=	25.0 mm	≤	40 mm	
Type of Section		=	Rolled H-section ≤ 40mm			
Designation of buckling curves for different section types:				Buckling Curve	c)	*(Table 8.7)*
p_c in Table 8.8	a)	=	286.00 N/mm^2			
p_c in Table 8.8	b)	=	261.00 N/mm^2			
p_c in Table 8.8	c)	=	236.00 N/mm^2			
p_c in Table 8.8	d)	=	212.00 N/mm^2			
Compressive Strength	p_{cy}	=	236.00 N/mm^2			*(Table 8.8(c))*
Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	154.0 N/mm^2	
Moment equivalent factor m for flexural buckling						
	m_x	=	0.95			*(Table 8.9)*
	m_y	=	0.95			*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{1154.8}{6190.8} + \frac{674.3}{1849.2} + \frac{0.0}{1627.0}$$

$$= 0.19 + 0.36 + 0.00$$

$$= 0.55$$

$$< 1$$

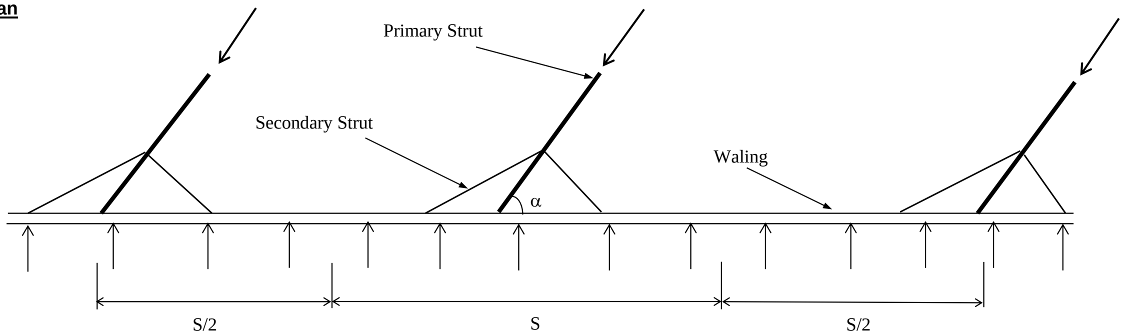
Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-A	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

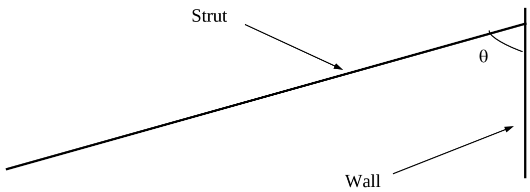
Structural Steel Design - Level 2 Main Strut (+1.70 mPD)

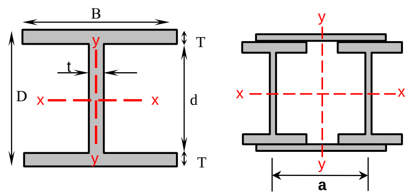
(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section





1. Section Properties

Try Section :	Double	305 x 305 x 198 UC	Grade 50	Hot Rolled

Depth of Section	**D**	=	339.9	mm	Elastic Modulus (X-Axis)	Z_x	=	5980000	mm^3
Width of Section	**B**	=	314.1	mm	Elastic Modulus (Y-Axis)	Z_y	=	4990000	mm^3
Web Thickness	**t**	=	19.2	mm	Plastic Modulus (X-Axis)	S_x	=	6880000	mm^3
Flange Thickness	**T**	=	31.4	mm	Plastic Modulus (Y-Axis)	S_y	=	7915320	mm^3
Depth between Fillets	**d**	=	246.6	mm	Buckling Parameter	**u**	=	0.854	
Second Moment of Area (X-Axis)	I_x	=	1.016E+09	mm^4	Torsional Index	**x**	=	10.2	
Second Moment of Area (Y-Axis)	I_y	=	1.567E+09	mm^4	Area of Section	A_g	=	50400	mm^2
Radius of Gyration (X-Axis)	r_x	=	142.0	mm	Mass per Length	**w**	=	396.0	kg/m
Radius of Gyration (Y-Axis)	r_y	=	176.3	mm	Design Strength	p_y	=	345	N/mm^2
Modulus of Elasticity	**E**	=	205000	MPa	Distance Between Centre Lines	**a**	=	314.1	mm *Spacing OK*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	264.43	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (50,400 / 10^6) x sin(50)^2 x sin(90)^2		=	**6.098E+06**	kN
Minimum inclination of strut to waling, α	=	50.19	degree			
Load in the direction of strut, P_α	=	F / sin α	= 264.43 / sin 50.2	=	344.2	kN/m
Maximum strut spacing, S	=	5.00	m			
Maximum compression, P	=	P_α x S	= 344.22 x 5.00	=	1721.1	kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	13.67	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	= 13.67 / sin 90.0	=	13.67	m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	10.67	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	= 10.67 / sin 90.0	=	10.67	m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (396.0 x 9.81 + 2.0 x 314.1 x 2) x 10^-3 x 13.7^2		=	120.1	kNm
Maximum Shear Force (unfactored)	=	0.5 x (396.0 x 9.81 +2.0 x 314.1 x 2) x 10^-3 x 13.7		=	35.1	kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	M_x	=	840.4	kNm	Design Shear Force	**V**	=	245.9	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	2409.5	kN

3. Section Classification
(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 5.0 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 12.8 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance
(Clause 8.4.6)

d/t = 12.8 < 70ε = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity
(Clause 8.2.1)

Shear Area A_v = 13052 mm^2

Shear Capacity $V_c = p_yA_v/(3)$^0.5

= 2600 kN

Design Shear Force V = 245.9 kN < P_v = 2600 kN ***Check Shear OK***

Since, $0.6V_c$ = 1560 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)
(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 2374 kNm $1.2p_yZ_x$ = 2476 kNm

M_{cx} = 2374 kNm > M_x = 840.4 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 2731 kNm $1.2p_yZ_y$ = 2066 kNm

M_{cy} = 2066 kNm > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling
(Clause 8.3)

Unrestrain length (Y-Axis)	L_y	= 10.67 m		
Effective Length	L_{Ey}	= 1.0 L	= 10.7 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	= L_{Ey} / r_y	= 60.5	
Buckling parameter	u	= 0.85		*(Clause 8.3.5.3)*
	λ / x	= 5.93		
Slenderness factor	ν	= $1/(1+0.05(\lambda/x)^2)^{0.25}$		*(Clause 8.3.5.3 Eqn 8.27)*
		= 0.776		
	β_w	= 1.000		*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	= $u\nu\lambda(\beta_w)^{0.5}$	= 40.1	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	= 345.00 N/mm^2		
Buckling strength	p_b	= 302.0 N/mm^2		*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	= 2077.8 kNm		*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	= 0.93		*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 781.55 < M_b = 2077.8 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 840.38 < M_{cx} = 2373.6 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check
(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{2409.5}{17388.0} + \frac{840.4}{2373.6} + \frac{0.0}{2065.9}$$

$$= 0.14 + 0.35 + 0.00$$

$$= 0.49$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling = **x-x**

Unrestrain length (X-Axis) L_x = 13.67 m

Effective Length (X-Axis) L_{Ex} = 1.0 L_x = 13.67 m *(Clause 8.3.4)*

Major Axis Slenderness λ_x = L_{Ex} / r_x = 96.3 ≈ 98

Maximum Thickness **T** = 31.4 mm ≤ 40 mm

Type of Section = Rolled H-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve b) *(Table 8.7)*

p_c in Table 8.8 a) = 175.00 N/mm^2

p_c in Table 8.8 b) = 159.00 N/mm^2

p_c in Table 8.8 c) = 143.00 N/mm^2

p_c in Table 8.8 d) = 128.00 N/mm^2

Compressive Strength p_{cx} = 159.00 N/mm^2 *(Table 8.8(b))*

Axis of buckling = **y-y**

Unrestrain length (Y-Axis) L_y = 10.67 m

Effective Length (Y-Axis) L_{Ey} = 1.0 L_y = 10.67 m *(Clause 8.3.4)*

Minor Axis Slenderness λ_y = L_{Ey} / r_y = 60.5 ≈ 62

Maximum Thickness **T** = 31.4 mm ≤ 40 mm

Type of Section = Rolled H-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve c) *(Table 8.7)*

p_c in Table 8.8 a) = 286.00 N/mm^2

p_c in Table 8.8 b) = 261.00 N/mm^2

p_c in Table 8.8 c) = 236.00 N/mm^2

p_c in Table 8.8 d) = 212.00 N/mm^2

Compressive Strength p_{cy} = 236.00 N/mm^2 *(Table 8.8(c))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 159.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{2409.5}{8013.6} + \frac{798.4}{2373.6} + \frac{0.0}{2065.9}$$

$$= 0.30 + 0.34 + 0.00$$

$$= 0.64$$

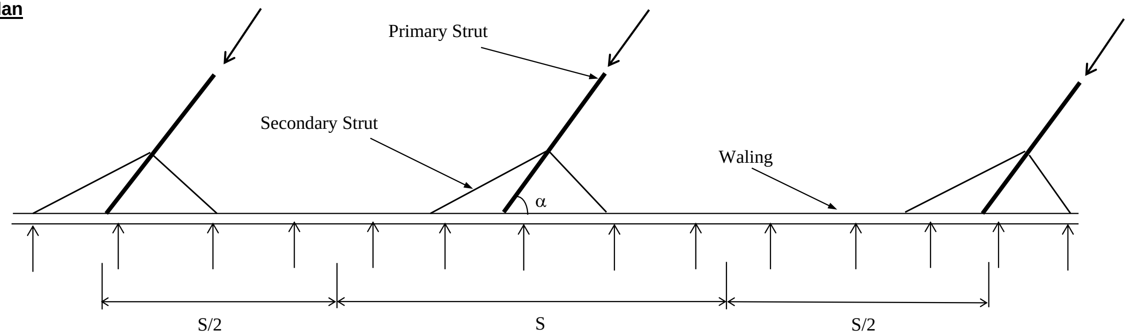
$$< 1$$

Overall Capacity OK

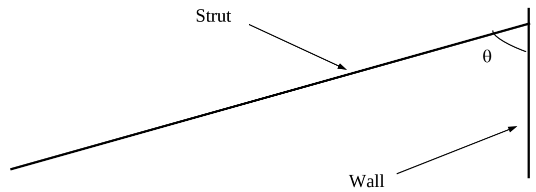
Structural Steel Design - Level 3 Main Strut (-1.40 mPD)

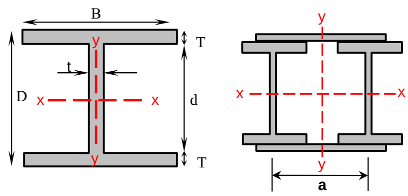
(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section





1. Section Properties

Try Section :	Double	356 x 406 x 393 UC	Grade 50	Hot Rolled

Depth of Section	D	=	419.1	mm	Elastic Modulus (X-Axis)	Z_x	=	14000000	mm^3	
Width of Section	B	=	407.0	mm	Elastic Modulus (Y-Axis)	Z_y	=	12920000	mm^3	
Web Thickness	t	=	30.6	mm	Plastic Modulus (X-Axis)	S_x	=	16460000	mm^3	
Flange Thickness	T	=	49.2	mm	Plastic Modulus (Y-Axis)	S_y	=	20390700	mm^3	
Depth between Fillets	d	=	290.2	mm	Buckling Parameter	u	=	0.837		
Second Moment of Area (X-Axis)	I_x	=	2.940E+09	mm^4	Torsional Index	x	=	7.86		
Second Moment of Area (Y-Axis)	I_y	=	5.258E+09	mm^4	Area of Section	A_g	=	100200	mm^2	
Radius of Gyration (X-Axis)	r_x	=	171.0	mm	Mass per Length	w	=	786.0	kg/m	
Radius of Gyration (Y-Axis)	r_y	=	229.1	mm	Design Strength	p_y	=	335	N/mm^2	
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=	407.0	mm	*Spacing OK*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	312.28	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (100,200 / 10^6) x sin(50)^2 x sin(90)^2			=	**1.212E+07** kN
Minimum inclination of strut to waling, α	=	50.19	degree			
Load in the direction of strut, P_α	=	F / sin α	=	312.28 / sin 50.2	=	406.5 kN/m
Maximum strut spacing, S	=	5.00	m			
Maximum compression, P	=	P_α x S	=	406.50 x 5.00	=	2032.5 kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	13.67	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	=	13.67 / sin 90.0	=	13.67 m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	10.67	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	=	10.67 / sin 90.0	=	10.67 m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (786.0 x 9.81 + 2.0 x 407.0 x 2) x 10^-3 x 13.7^2			=	218.1 kNm
Maximum Shear Force (unfactored)	=	0.5 x (786.0 x 9.81 +2.0 x 407.0 x 2) x 10^-3 x 13.7			=	63.8 kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	M_x	=	1526.5	kNm	Design Shear Force	V	=	446.7	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	2845.5	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$ b/T = 4.1 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 9.5 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 9.5 < 70ε = 63.4

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 25649 mm^2

Shear Capacity V_c = $p_yA_v/(3)^{\wedge}0.5$

= 4961 kN

Design Shear Force **V** = 446.7 kN < P_v = 4961 kN ***Check Shear OK***

Since, $0.6V_c$ = 2976 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 5514 kNm $1.2p_yZ_x$ = 5628 kNm

$\mathbf{M_{cx}}$ = **5514 kNm** > M_x = 1526.5 kNm ***Major Moment Capacity OK***

Minor Axis M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 6831 kNm $1.2p_yZ_y$ = 5194 kNm

$\mathbf{M_{cy}}$ = **5194 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis)	L_y	=	10.67 m		
Effective Length	L_{Ey}	=	1.0 L	= 10.7 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_{Ey} / r_y	= 46.6	
Buckling parameter	u	=	0.84		*(Clause 8.3.5.3)*
	λ / x	=	5.93		
Slenderness factor	ν	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$		*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.776		
	β_w	=	1.000		*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$u\nu\lambda(\beta_w)^{0.5}$	= 30.3	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	335.00 N/mm^2		
Buckling strength	p_b	=	324.0 N/mm^2		*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	5333.0 kNm		*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93		*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 1419.65 < M_b = 5333.0 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 1526.51 < M_{cx} = 5514.1 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{2845.5}{33567.0} + \frac{1526.5}{5514.1} + \frac{0.0}{5193.8}$$

$$= 0.08 + 0.28 + 0.00$$

$$= 0.36$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	13.67 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	13.67 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	79.9	≈ 80	
Maximum Thickness	**T**	=	49.2 mm	>	40 mm		
Type of Section		=	Rolled H-section > 40mm				
Designation of buckling curves for different section types:				Buckling Curve	c)		*(Table 8.7)*
p_c in Table 8.8 a)		=	229.00 N/mm²				
p_c in Table 8.8 b)		=	204.00 N/mm²				
p_c in Table 8.8 c)		=	182.00 N/mm²				
p_c in Table 8.8 d)		=	163.00 N/mm²				
Compressive Strength	p_{cx}	=	182.00 N/mm²				*(Table 8.8(c))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	10.67 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	10.67 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	46.6	≈ 48	
Maximum Thickness	**T**	=	49.2 mm	>	40 mm		
Type of Section		=	Rolled H-section > 40mm				
Designation of buckling curves for different section types:				Buckling Curve	d)		*(Table 8.7)*
p_c in Table 8.8 a)		=	305.00 N/mm²				
p_c in Table 8.8 b)		=	287.00 N/mm²				
p_c in Table 8.8 c)		=	267.00 N/mm²				
p_c in Table 8.8 d)		=	246.00 N/mm²				
Compressive Strength	p_{cy}	=	246.00 N/mm²				*(Table 8.8(d))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 182.0 N/mm²

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{2845.5}{18236.4} + \frac{1450.2}{5514.1} + \frac{0.0}{5193.8}$$

$$= 0.16 + 0.26 + 0.00$$

$$= 0.42$$

$$< 1$$

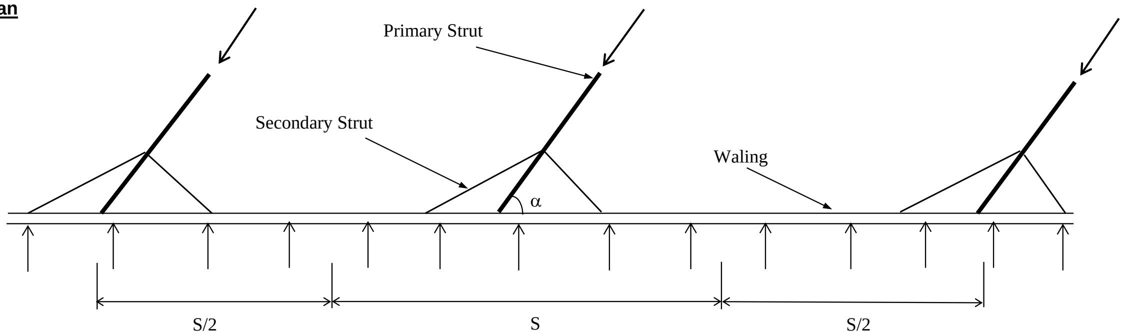
Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-A	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

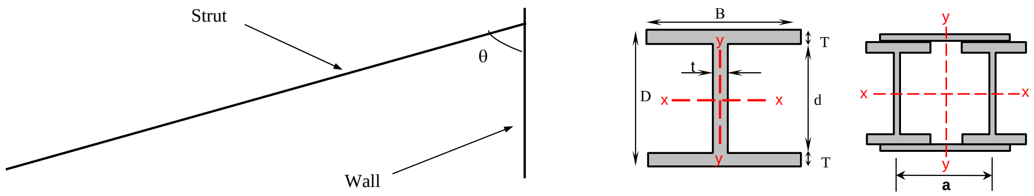
Structural Steel Design - Level 4 Main Strut (-4.50 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section



1. Section Properties

Try Section :	Double	356 x 406 x 393 UC	Grade 50	Hot Rolled

Depth of Section	D	=	419.1	mm	Elastic Modulus (X-Axis)	Z_x	=	14000000	mm^3
Width of Section	B	=	407.0	mm	Elastic Modulus (Y-Axis)	Z_y	=	12920000	mm^3
Web Thickness	t	=	30.6	mm	Plastic Modulus (X-Axis)	S_x	=	16460000	mm^3
Flange Thickness	T	=	49.2	mm	Plastic Modulus (Y-Axis)	S_y	=	20390700	mm^3
Depth between Fillets	d	=	290.2	mm	Buckling Parameter	u	=	0.837	
Second Moment of Area (X-Axis)	I_x	=	2.940E+09	mm^4	Torsional Index	x	=	7.86	
Second Moment of Area (Y-Axis)	I_y	=	5.258E+09	mm^4	Area of Section	A_g	=	100200	mm^2
Radius of Gyration (X-Axis)	r_x	=	171.0	mm	Mass per Length	w	=	786.0	kg/m
Radius of Gyration (Y-Axis)	r_y	=	229.1	mm	Design Strength	p_y	=	335	N/mm^2
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=	407.0	mm *Spacing OK*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	307.12	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (100,200 / 10^6) x sin(50)^2 x sin(90)^2			=	**1.212E+07** kN
Minimum inclination of strut to waling, α	=	50.19	degree			
Load in the direction of strut, P_α	=	F / sin α	=	307.12 / sin 50.2	=	399.8 kN/m
Maximum strut spacing, S	=	5.00	m			
Maximum compression, P	=	P_α x S	=	399.78 x 5.00	=	1998.9 kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	13.67	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	=	13.67 / sin 90.0	=	13.67 m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	10.67	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	=	10.67 / sin 90.0	=	10.67 m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (786.0 x 9.81 + 2.0 x 407.0 x 2) x 10^-3 x 13.7^2			=	218.1 kNm
Maximum Shear Force (unfactored)	=	0.5 x (786.0 x 9.81 +2.0 x 407.0 x 2) x 10^-3 x 13.7			=	63.8 kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	M_x	=	1526.5	kNm	Design Shear Force	V	=	446.7	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	2798.5	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 4.1 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 9.5 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 9.5 < 70ε = 63.4

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area $\mathbf{A_v}$ = 25649 mm^2

Shear Capacity $\mathbf{V_c}$ = $p_yA_v/(3)$^0.5

= 4961 kN

Design Shear Force **V** = 446.7 kN < P_v = 4961 kN ***Check Shear OK***

Since, $0.6V_c$ = 2976 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 5514 kNm $1.2p_yZ_x$ = 5628 kNm

$\mathbf{M_{cx}}$ = **5514 kNm** > M_x = 1526.5 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 6831 kNm $1.2p_yZ_y$ = 5194 kNm

$\mathbf{M_{cy}}$ = **5194 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) $\mathbf{L_y}$ = 10.67 m

Effective Length $\mathbf{L_{Ey}}$ = 1.0 L = 10.7 m *(Clause 8.3.4)*

Minor Axis Slenderness **λ** = L_{Ey} / r_y = 46.6

Buckling parameter **u** = 0.84 *(Clause 8.3.5.3)*

λ / x = 5.93

Slenderness factor **ν** = $1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.776

$\mathbf{\beta_w}$ = 1.000 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness $\mathbf{\lambda_{LT}}$ = $u\nu\lambda(\beta_w)^{0.5}$ = 30.3 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength $\mathbf{p_y}$ = 335.00 N/mm^2

Buckling strength $\mathbf{p_b}$ = 324.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment $\mathbf{M_b}$ = 5333.0 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor $\mathbf{m_{LT}}$ = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$\mathbf{m_{LT}M_x}$ = 1419.65 < M_b = 5333.0 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and $\mathbf{M_x}$ = 1526.51 < M_{cx} = 5514.1 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{2798.5}{33567.0} + \frac{1526.5}{5514.1} + \frac{0.0}{5193.8}$$

= 0.08 + 0.28 + 0.00

= 0.36

< 1 ***Cross-section Capacity OK***

9. Member Buckling Resistance Check *(Clause 8.9.2)*

Axis of buckling		=	**x-x**					
Unrestrain length (X-Axis)	L_x	=	13.67	m				
Effective Length (X-Axis)	L_{Ex}	=	1.0	L_x	=	13.67 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x		=	79.9 ≈	80	
Maximum Thickness	**T**	=	49.2	mm	>	40 mm		
Type of Section		=	Rolled H-section > 40mm					
Designation of buckling curves for different section types:					Buckling Curve	c)		*(Table 8.7)*
p_c in Table 8.8	a)	=	229.00	N/mm^2				
p_c in Table 8.8	b)	=	204.00	N/mm^2				
p_c in Table 8.8	c)	=	182.00	N/mm^2				
p_c in Table 8.8	d)	=	163.00	N/mm^2				
Compressive Strength	p_{cx}	=	182.00	N/mm^2				*(Table 8.8(c))*
Axis of buckling		=	**y-y**					
Unrestrain length (Y-Axis)	L_y	=	10.67	m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0	L_y	=	10.67 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y		=	46.6 ≈	48	
Maximum Thickness	**T**	=	49.2	mm	>	40 mm		
Type of Section		=	Rolled H-section > 40mm					
Designation of buckling curves for different section types:					Buckling Curve	d)		*(Table 8.7)*
p_c in Table 8.8	a)	=	305.00	N/mm^2				
p_c in Table 8.8	b)	=	287.00	N/mm^2				
p_c in Table 8.8	c)	=	267.00	N/mm^2				
p_c in Table 8.8	d)	=	246.00	N/mm^2				
Compressive Strength	p_{cy}	=	246.00	N/mm^2				*(Table 8.8(d))*
Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}		=	182.0 N/mm^2		
Moment equivalent factor m for flexural buckling								
	m_x	=	0.95					*(Table 8.9)*
	m_y	=	0.95					*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{2798.5}{18236.4} + \frac{1450.2}{5514.1} + \frac{0.0}{5193.8}$$

$$= 0.15 + 0.26 + 0.00$$

$$= 0.42$$

$$< 1$$

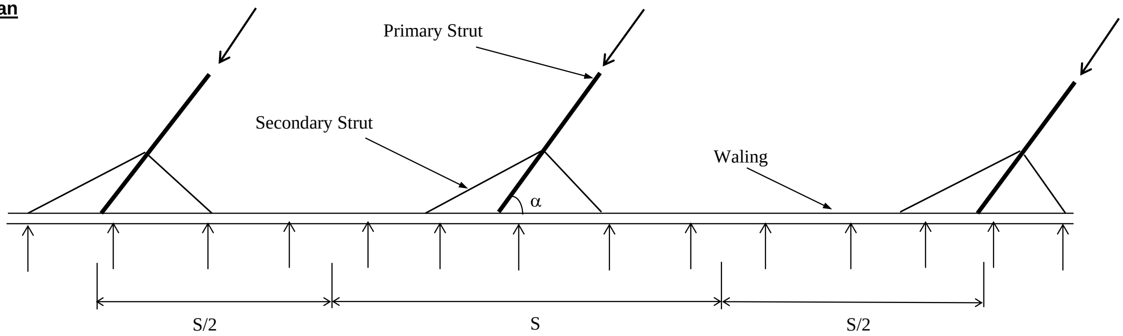
Overall Capacity OK

	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-A	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

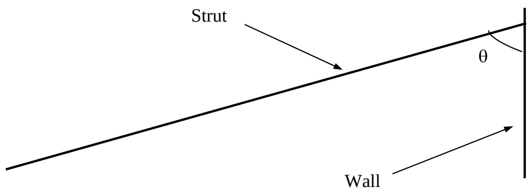
Structural Steel Design - Level 1 Secondary Strut (+4.80 mPD)

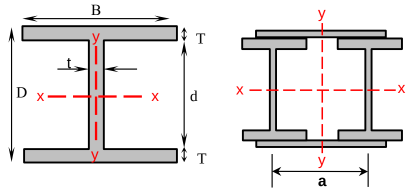
(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section





1. Section Properties

Try Section :	Single	203 x 203 x 46 UC	Grade 50	Hot Rolled

Depth of Section	D	=	203.2	mm	Elastic Modulus (X-Axis)	Z_x	=	449000	mm^3
Width of Section	B	=	203.2	mm	Elastic Modulus (Y-Axis)	Z_y	=	150000	mm^3
Web Thickness	t	=	7.3	mm	Plastic Modulus (X-Axis)	S_x	=	497000	mm^3
Flange Thickness	T	=	11.0	mm	Plastic Modulus (Y-Axis)	S_y	=	230000	mm^3
Depth between Fillets	d	=	160.9	mm	Buckling Parameter	u	=	0.846	
Second Moment of Area (X-Axis)	I_x	=	4.560E+07	mm^4	Torsional Index	x	=	17.7	
Second Moment of Area (Y-Axis)	I_y	=	1.540E+07	mm^4	Area of Section	A_g	=	5880	mm^2
Radius of Gyration (X-Axis)	r_x	=	88.1	mm	Mass per Length	w	=	46.0	kg/m
Radius of Gyration (Y-Axis)	r_y	=	51.2	mm	Design Strength	p_y	=	355	N/mm^2
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=		mm *Neglect Spacing*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	126.73	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (5,880 / 10^6) x sin(30)^2 x sin(90)^2			=	**3.096E+05** kN
Minimum inclination of strut to waling, α	=	30.45	degree			
Load in the direction of strut, P_α	=	F / sin α	=	126.73 / sin 30.4	=	250.1 kN/m
Maximum strut spacing, S	=	2.00	m			
Maximum compression, P	=	P_α x S	=	250.07 x 2.00	=	500.1 kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	4.55	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	=	4.55 / sin 90.0	=	4.55 m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	4.55	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	=	4.55 / sin 90.0	=	4.55 m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (46.0 x 9.81 + 2.0 x 203.2 x 1) x 10^-3 x 4.5^2			=	2.2 kNm
Maximum Shear Force (unfactored)	=	0.5 x (46.0 x 9.81 +2.0 x 203.2 x 1) x 10^-3 x 4.5			=	2.0 kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	M_x	=	6.2	kNm	Design Shear Force	V	=	5.5	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	700.2	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$ b/T = 9.2 < 13.0 ε (Semi-compact) *(Table 7.1, Outstand element of compression flange)*

d/t = 22.0 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Semi-Compact Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 22.0 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 1483 mm^2

Shear Capacity V_c = $p_yA_v/(3)$^0.5

= 304 kN

Design Shear Force **V** = 5.5 kN < P_v = 304 kN ***Check Shear OK***

Since, $0.6V_c$ = 182 kN > V ***Low Shear***

6. Check Moment Capacity (for semi-compact sections)

(Clause 8.2.2)

Major Axis $M_{cx} = p_yZ_x$

M_{cx} = **159 kNm** > M_x = 6.2 kNm ***Major Moment Capacity OK***

Minor Axis $M_{cy} = p_yZ_y$

M_{cy} = **53 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) L_y = 4.55 m

Effective Length L_{Ey} = 1.0 L = 4.5 m *(Clause 8.3.4)*

Minor Axis Slenderness λ = L_{Ey} / r_y = 88.9

Buckling parameter **u** = 0.85 *(Clause 8.3.5.3)*

λ / x = 5.02

Slenderness factor ν = $1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.816

β_w = 0.903 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness λ_{LT} = $u\nu\lambda(\beta_w)^{0.5}$ = 58.3 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength p_y = 355.00 N/mm^2

Buckling strength p_b = 257.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment M_b = 115.4 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor m_{LT} = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 5.77 < M_b = 115.4 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 6.21 < M_{cx} = 159.4 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{700.2}{2087.4} + \frac{6.2}{159.4} + \frac{0.0}{53.3}$$

= 0.34 + 0.04 + 0.00

= 0.37

< 1 ***Cross-section Capacity OK***

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**			
Unrestrain length (X-Axis)	L_x	=	4.55 m			
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	4.55 m	*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	51.6 ≈ 52	
Maximum Thickness	T	=	11.0 mm	≤	40 mm	
Type of Section		=	Rolled H-section ≤ 40mm			
Designation of buckling curves for different section types:				Buckling Curve	b)	*(Table 8.7)*
	p_c in Table 8.8 a)	=	315.00 N/mm^2			
	p_c in Table 8.8 b)	=	293.00 N/mm^2			
	p_c in Table 8.8 c)	=	270.00 N/mm^2			
	p_c in Table 8.8 d)	=	246.00 N/mm^2			
Compressive Strength	p_{cx}	=	293.00 N/mm^2			*(Table 8.8(b))*
Axis of buckling		=	**y-y**			
Unrestrain length (Y-Axis)	L_y	=	4.55 m			
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	4.55 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	88.9 ≈ 90	
Maximum Thickness	T	=	11.0 mm	≤	40 mm	
Type of Section		=	Rolled H-section ≤ 40mm			
Designation of buckling curves for different section types:				Buckling Curve	c)	*(Table 8.7)*
	p_c in Table 8.8 a)	=	201.00 N/mm^2			
	p_c in Table 8.8 b)	=	181.00 N/mm^2			
	p_c in Table 8.8 c)	=	163.00 N/mm^2			
	p_c in Table 8.8 d)	=	146.00 N/mm^2			
Compressive Strength	p_{cy}	=	163.00 N/mm^2			*(Table 8.8(c))*
Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	163.0 N/mm^2	
Moment equivalent factor m for flexural buckling						
	m_x	=	0.95			*(Table 8.9)*
	m_y	=	0.95			*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{700.2}{958.4} + \frac{5.9}{159.4} + \frac{0.0}{53.3}$$

$$= 0.73 + 0.04 + 0.00$$

$$= 0.77$$

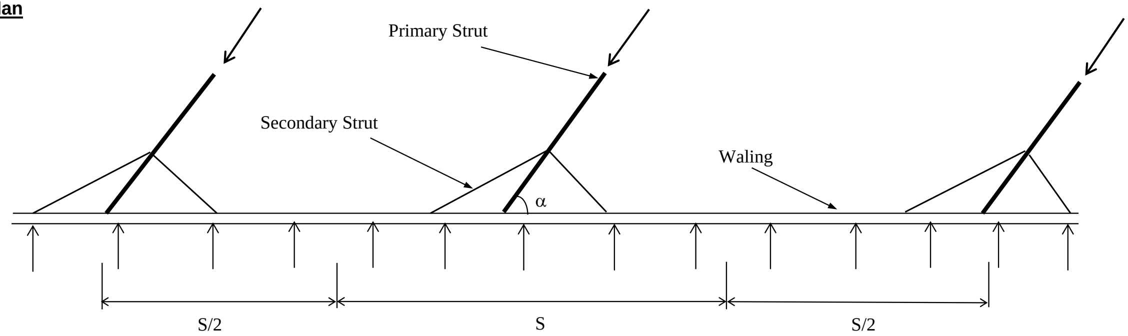
$$< 1$$

Overall Capacity OK

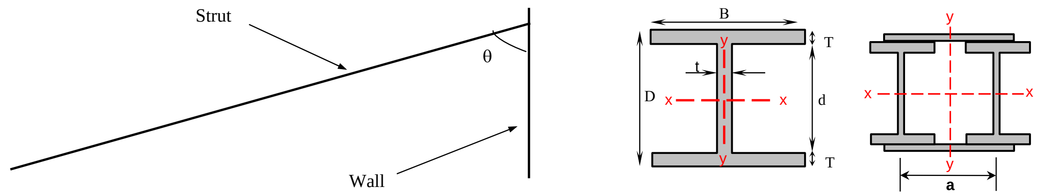
Structural Steel Design - Level 2 Secondary Strut (+1.70 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section



1. Section Properties

Try Section :	Single	203 x 203 x 86 UC	Grade 50	Hot Rolled

Depth of Section	D	=	222.3	mm	Elastic Modulus (X-Axis)	Z_x	=	851000	mm^3
Width of Section	B	=	208.8	mm	Elastic Modulus (Y-Axis)	Z_y	=	300000	mm^3
Web Thickness	t	=	13.0	mm	Plastic Modulus (X-Axis)	S_x	=	979000	mm^3
Flange Thickness	T	=	20.5	mm	Plastic Modulus (Y-Axis)	S_y	=	456000	mm^3
Depth between Fillets	d	=	160.9	mm	Buckling Parameter	u	=	0.85	
Second Moment of Area (X-Axis)	I_x	=	9.460E+07	mm^4	Torsional Index	x	=	10.2	
Second Moment of Area (Y-Axis)	I_y	=	3.120E+07	mm^4	Area of Section	A_g	=	11000	mm^2
Radius of Gyration (X-Axis)	r_x	=	92.7	mm	Mass per Length	w	=	86.0	kg/m
Radius of Gyration (Y-Axis)	r_y	=	53.3	mm	Design Strength	p_y	=	345	N/mm^2
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=		mm *Neglect Spacing*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	264.43	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (11,000 / 10^6) x sin(30)^2 x sin(90)^2			=	**5.791E+05** kN
Minimum inclination of strut to waling, α	=	30.45	degree			
Load in the direction of strut, P_α	=	F / sin α	=	264.43 / sin 30.4	=	521.8 kN/m
Maximum strut spacing, S	=	2.00	m			
Maximum compression, P	=	P_α x S	=	521.81 x 2.00	=	1043.6 kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	4.55	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	=	4.55 / sin 90.0	=	4.55 m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	4.55	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	=	4.55 / sin 90.0	=	4.55 m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (86.0 x 9.81 + 2.0 x 208.8 x 1) x 10^-3 x 4.5^2			=	3.3 kNm
Maximum Shear Force (unfactored)	=	0.5 x (86.0 x 9.81 +2.0 x 208.8 x 1) x 10^-3 x 4.5			=	2.9 kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	M_x	=	9.1	kNm	Design Shear Force	V	=	8.0	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	1461.1	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 5.1 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 12.4 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 12.4 < 70ε = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 2890 mm^2

Shear Capacity V_c = $p_yA_v/(3)$^0.5

= 576 kN

Design Shear Force V = 8.0 kN < P_v = 576 kN ***Check Shear OK***

Since, $0.6V_c$ = 345 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 338 kNm $1.2p_yZ_x$ = 352 kNm

M_{cx} = 338 kNm > M_x = 9.1 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 157 kNm $1.2p_yZ_y$ = 124 kNm

M_{cy} = 124 kNm > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) L_y = 4.55 m

Effective Length L_{Ey} = 1.0 L = 4.5 m *(Clause 8.3.4)*

Minor Axis Slenderness λ = L_{Ey} / r_y = 85.4

Buckling parameter u = 0.85 *(Clause 8.3.5.3)*

λ / x = 8.37

Slenderness factor ν = $1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.686

β_w = 1.000 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness λ_{LT} = $u\nu\lambda(\beta_w)^{0.5}$ = 49.8 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength p_y = 345.00 N/mm^2

Buckling strength p_b = 285.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment M_b = 279.0 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor m_{LT} = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 8.49 < M_b = 279.0 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 9.13 < M_{cx} = 337.8 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{1461.1}{3795.0} + \frac{9.1}{337.8} + \frac{0.0}{124.2}$$

= 0.38 + 0.03 + 0.00

= 0.41

< 1 ***Cross-section Capacity OK***

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling = **x-x**

Unrestrain length (X-Axis) L_x = 4.55 m

Effective Length (X-Axis) L_{Ex} = 1.0 L_x = 4.55 m *(Clause 8.3.4)*

Major Axis Slenderness λ_x = L_{Ex} / r_x = 49.1 ≈ 50

Maximum Thickness **T** = 20.5 mm ≤ 40 mm

Type of Section = Rolled H-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve b) *(Table 8.7)*

p_c in Table 8.8 a) = 310.00 N/mm^2

p_c in Table 8.8 b) = 290.00 N/mm^2

p_c in Table 8.8 c) = 268.00 N/mm^2

p_c in Table 8.8 d) = 247.00 N/mm^2

Compressive Strength p_{cx} = 290.00 N/mm^2 *(Table 8.8(b))*

Axis of buckling = **y-y**

Unrestrain length (Y-Axis) L_y = 4.55 m

Effective Length (Y-Axis) L_{Ey} = 1.0 L_y = 4.55 m *(Clause 8.3.4)*

Minor Axis Slenderness λ_y = L_{Ey} / r_y = 85.4 ≈ 86

Maximum Thickness **T** = 20.5 mm ≤ 40 mm

Type of Section = Rolled H-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve c) *(Table 8.7)*

p_c in Table 8.8 a) = 212.00 N/mm^2

p_c in Table 8.8 b) = 190.00 N/mm^2

p_c in Table 8.8 c) = 170.00 N/mm^2

p_c in Table 8.8 d) = 152.00 N/mm^2

Compressive Strength p_{cy} = 170.00 N/mm^2 *(Table 8.8(c))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 170.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{1461.1}{1870.0} + \frac{8.7}{337.8} + \frac{0.0}{124.2}$$

= 0.78 + 0.03 + 0.00

= 0.81

< 1

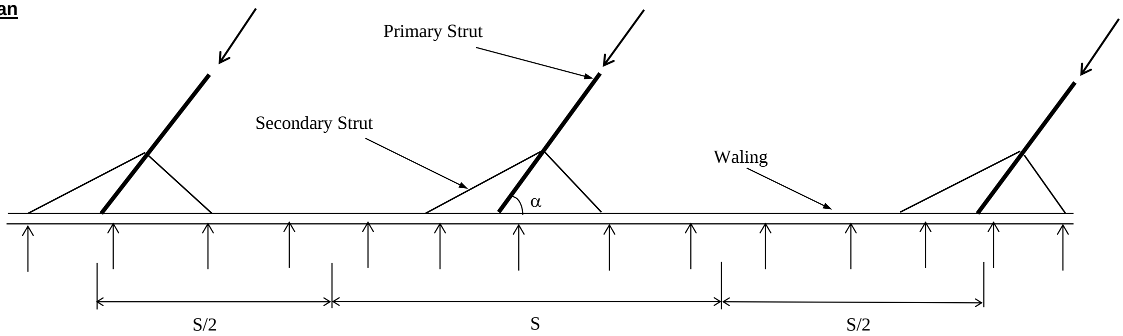
Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation	Job No.:	60617767
	Excavation and Lateral Support Works Design	By:	JL
	Structural Design	Chkd:	KP
	STN Pumping Station - Type-A	Date:	18-Oct-21

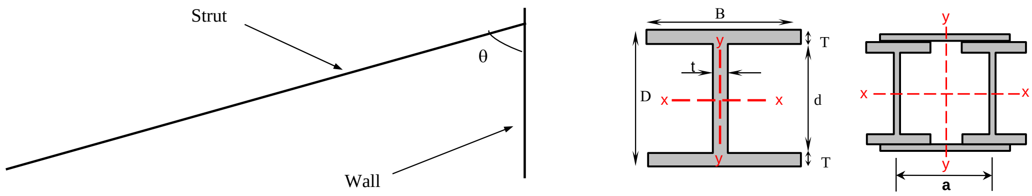
Structural Steel Design - Level 3 Secondary Strut (-1.40 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section



1. Section Properties

Try Section :	Single	203 x 203 x 86 UC	Grade 50	Hot Rolled

Depth of Section	D	=	222.3	mm	Elastic Modulus (X-Axis)	Z_x	=	851000	mm^3
Width of Section	B	=	208.8	mm	Elastic Modulus (Y-Axis)	Z_y	=	300000	mm^3
Web Thickness	t	=	13.0	mm	Plastic Modulus (X-Axis)	S_x	=	979000	mm^3
Flange Thickness	T	=	20.5	mm	Plastic Modulus (Y-Axis)	S_y	=	456000	mm^3
Depth between Fillets	d	=	160.9	mm	Buckling Parameter	u	=	0.85	
Second Moment of Area (X-Axis)	I_x	=	9.460E+07	mm^4	Torsional Index	x	=	10.2	
Second Moment of Area (Y-Axis)	I_y	=	3.120E+07	mm^4	Area of Section	A_g	=	11000	mm^2
Radius of Gyration (X-Axis)	r_x	=	92.7	mm	Mass per Length	w	=	86.0	kg/m
Radius of Gyration (Y-Axis)	r_y	=	53.3	mm	Design Strength	p_y	=	345	N/mm^2
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=		mm *Neglect Spacing*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	312.28	kN/m (From PLAXIS)		
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (11,000 / 10^6) x sin(30)^2 x sin(90)^2		=	**5.791E+05** kN
Minimum inclination of strut to waling, α	=	30.45	degree		
Load in the direction of strut, P_α	=	F / sin α	= 312.28 / sin 30.4	=	616.2 kN/m
Maximum strut spacing, S	=	2.00	m		
Maximum compression, P	=	P_α x S	= 616.22 x 2.00	=	1232.4 kN
Inclination of strut to wall, θ	=	90.00	degree		
Unrestrain length of strut on plan (X-Axis), L_x'	=	4.55	m		
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	= 4.55 / sin 90.0	=	4.55 m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	4.55	m		
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	= 4.55 / sin 90.0	=	4.55 m
Construction Load, Q_c	=	2.00	kPa		
Maximum Bending Moment (unfactored)	=	0.125 x (86.0 x 9.81 + 2.0 x 208.8 x 1) x 10^-3 x 4.5^2		=	3.3 kNm
Maximum Shear Force (unfactored)	=	0.5 x (86.0 x 9.81 +2.0 x 208.8 x 1) x 10^-3 x 4.5		=	2.9 kN
Load Factor	=	1.40			

Design Bending Moment (X-Axis)	M_x	=	9.1	kNm	Design Shear Force	V	=	8.0	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	1725.4	kN

3. Section Classification

(Table 7.1)

ε = $[275 / p_y]^{1/2}$ = 0.9

b/T = 5.1 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 12.4 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 12.4 < 70ε = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 2890 mm^2

Shear Capacity V_c = $p_yA_v/(3)$^0.5

= 576 kN

Design Shear Force V = 8.0 kN < P_v = 576 kN ***Check Shear OK***

Since, $0.6V_c$ = 345 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 338 kNm $1.2p_yZ_x$ = 352 kNm

M_{cx} = 338 kNm > M_x = 9.1 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 157 kNm $1.2p_yZ_y$ = 124 kNm

M_{cy} = 124 kNm > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) L_y = 4.55 m

Effective Length L_{Ey} = 1.0 L = 4.5 m *(Clause 8.3.4)*

Minor Axis Slenderness λ = L_{Ey} / r_y = 85.4

Buckling parameter u = 0.85 *(Clause 8.3.5.3)*

λ / x = 8.37

Slenderness factor ν = $1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.686

β_w = 1.000 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness λ_{LT} = $u\nu\lambda(\beta_w)^{0.5}$ = 49.8 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength p_y = 345.00 N/mm^2

Buckling strength p_b = 285.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment M_b = 279.0 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor m_{LT} = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 8.49 < M_b = 279.0 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 9.13 < M_{cx} = 337.8 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{1725.4}{3795.0} + \frac{9.1}{337.8} + \frac{0.0}{124.2}$$

= 0.45 + 0.03 + 0.00

= 0.48

< 1 ***Cross-section Capacity OK***

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling = **x-x**

Unrestrain length (X-Axis) L_x = 4.55 m

Effective Length (X-Axis) L_{Ex} = 1.0 L_x = 4.55 m *(Clause 8.3.4)*

Major Axis Slenderness λ_x = L_{Ex} / r_x = 49.1 ≈ 50

Maximum Thickness **T** = 20.5 mm ≤ 40 mm

Type of Section = Rolled H-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve b) *(Table 8.7)*

p_c in Table 8.8 a) = 310.00 N/mm^2

p_c in Table 8.8 b) = 290.00 N/mm^2

p_c in Table 8.8 c) = 268.00 N/mm^2

p_c in Table 8.8 d) = 247.00 N/mm^2

Compressive Strength p_{cx} = 290.00 N/mm^2 *(Table 8.8(b))*

Axis of buckling = **y-y**

Unrestrain length (Y-Axis) L_y = 4.55 m

Effective Length (Y-Axis) L_{Ey} = 1.0 L_y = 4.55 m *(Clause 8.3.4)*

Minor Axis Slenderness λ_y = L_{Ey} / r_y = 85.4 ≈ 86

Maximum Thickness **T** = 20.5 mm ≤ 40 mm

Type of Section = Rolled H-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve c) *(Table 8.7)*

p_c in Table 8.8 a) = 212.00 N/mm^2

p_c in Table 8.8 b) = 190.00 N/mm^2

p_c in Table 8.8 c) = 170.00 N/mm^2

p_c in Table 8.8 d) = 152.00 N/mm^2

Compressive Strength p_{cy} = 170.00 N/mm^2 *(Table 8.8(c))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 170.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{1725.4}{1870.0} + \frac{8.7}{337.8} + \frac{0.0}{124.2}$$

$$= 0.92 + 0.03 + 0.00$$

$$= 0.95$$

$$< 1$$

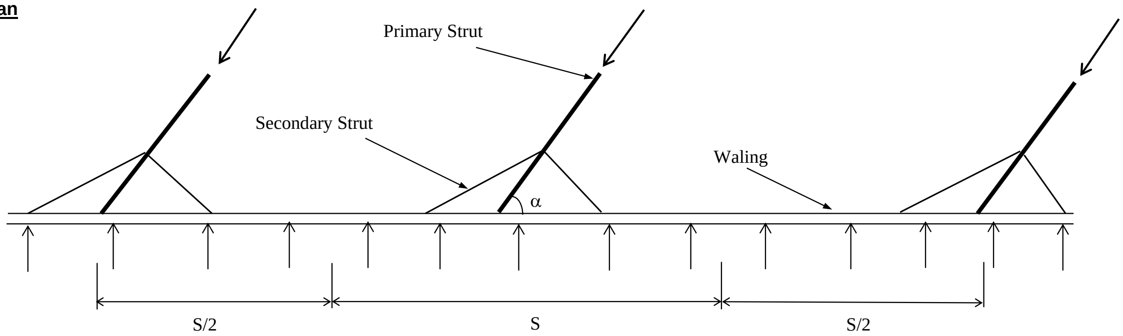
Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-A	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

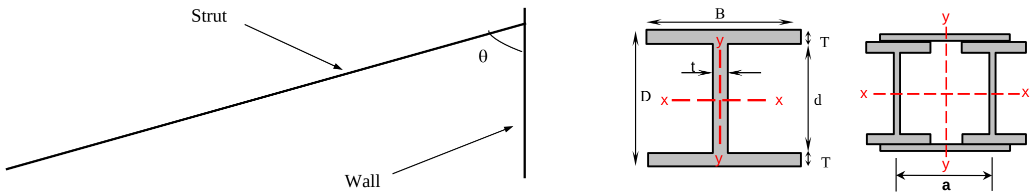
Structural Steel Design - Level 4 Secondary Strut (-4.50 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section



1. Section Properties

Try Section :	Single	203 x 203 x 86 UC	Grade 50	Hot Rolled

Depth of Section	**D**	=	222.3	mm	Elastic Modulus (X-Axis)	Z_x	=	851000	mm^3
Width of Section	**B**	=	208.8	mm	Elastic Modulus (Y-Axis)	Z_y	=	300000	mm^3
Web Thickness	**t**	=	13.0	mm	Plastic Modulus (X-Axis)	S_x	=	979000	mm^3
Flange Thickness	**T**	=	20.5	mm	Plastic Modulus (Y-Axis)	S_y	=	456000	mm^3
Depth between Fillets	**d**	=	160.9	mm	Buckling Parameter	**u**	=	0.85	
Second Moment of Area (X-Axis)	I_x	=	9.460E+07	mm^4	Torsional Index	**x**	=	10.2	
Second Moment of Area (Y-Axis)	I_y	=	3.120E+07	mm^4	Area of Section	A_g	=	11000	mm^2
Radius of Gyration (X-Axis)	r_x	=	92.7	mm	Mass per Length	**w**	=	86.0	kg/m
Radius of Gyration (Y-Axis)	r_y	=	53.3	mm	Design Strength	p_y	=	345	N/mm^2
Modulus of Elasticity	**E**	=	205000	MPa	Distance Between Centre Lines	**a**	=		mm *Neglect Spacing*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	307.12	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (11,000 / 10^6) x sin(30)^2 x sin(90)^2			=	**5.791E+05** kN
Minimum inclination of strut to waling, α	=	30.45	degree			
Load in the direction of strut, P_α	=	F / sin α	=	307.12 / sin 30.4	=	606.0 kN/m
Maximum strut spacing, S	=	2.00	m			
Maximum compression, P	=	P_α x S	=	606.03 x 2.00	=	1212.1 kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	4.55	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	=	4.55 / sin 90.0	=	4.55 m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	4.55	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	=	4.55 / sin 90.0	=	4.55 m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (86.0 x 9.81 + 2.0 x 208.8 x 1) x 10^-3 x 4.5^2			=	3.3 kNm
Maximum Shear Force (unfactored)	=	0.5 x (86.0 x 9.81 +2.0 x 208.8 x 1) x 10^-3 x 4.5			=	2.9 kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	M_x	=	9.1	kNm	Design Shear Force	**V**	=	8.0	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	1696.9	kN

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-A	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 5.1 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 12.4 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 12.4 < 70ε = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area	A_v	=	2890 mm^2				
Shear Capacity	V_c	=	$p_yA_v/(3)$^0.5				
		=	576 kN				
Design Shear Force	V	=	8.0 kN	<	P_v =	576 kN	***Check Shear OK***
Since,	$0.6V_c$	=	345 kN	>	V		***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 338 kNm $1.2p_yZ_x$ = 352 kNm

M_{cx} = 338 kNm > M_x = 9.1 kNm   ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 157 kNm $1.2p_yZ_y$ = 124 kNm

M_{cy} = 124 kNm > M_y = 0.0 kNm   ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis)	L_y	=	4.55 m		
Effective Length	L_{Ey}	=	1.0 L	= 4.5 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_{Ey} / r_y	= 85.4	
Buckling parameter	u	=	0.85		*(Clause 8.3.5.3)*
	λ / x	=	8.37		
Slenderness factor	ν	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$		*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.686		
	β_w	=	1.000		*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$u\nu\lambda(\beta_w)^{0.5}$	= 49.8	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	345.00 N/mm^2		
Buckling strength	p_b	=	285.0 N/mm^2		*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	279.0 kNm		*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93		*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 8.49 < M_b = 279.0 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 9.13 < M_{cx} = 337.8 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{1696.9}{3795.0} + \frac{9.1}{337.8} + \frac{0.0}{124.2}$$

= 0.45 + 0.03 + 0.00

= 0.47

< 1

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	4.55 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	4.55 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	49.1	≈ 50	
Maximum Thickness	T	=	20.5 mm	≤	40 mm		
Type of Section		=	Rolled H-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8	a)	=	310.00 N/mm^2				
p_c in Table 8.8	b)	=	290.00 N/mm^2				
p_c in Table 8.8	c)	=	268.00 N/mm^2				
p_c in Table 8.8	d)	=	247.00 N/mm^2				
Compressive Strength	p_{cx}	=	290.00 N/mm^2				*(Table 8.8(b))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	4.55 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	4.55 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	85.4	≈ 86	
Maximum Thickness	T	=	20.5 mm	≤	40 mm		
Type of Section		=	Rolled H-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	c)		*(Table 8.7)*
p_c in Table 8.8	a)	=	212.00 N/mm^2				
p_c in Table 8.8	b)	=	190.00 N/mm^2				
p_c in Table 8.8	c)	=	170.00 N/mm^2				
p_c in Table 8.8	d)	=	152.00 N/mm^2				
Compressive Strength	p_{cy}	=	170.00 N/mm^2				*(Table 8.8(c))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 170.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{1696.9}{1870.0} + \frac{8.7}{337.8} + \frac{0.0}{124.2}$$

$$= 0.91 + 0.03 + 0.00$$

$$= 0.93$$

$$< 1$$

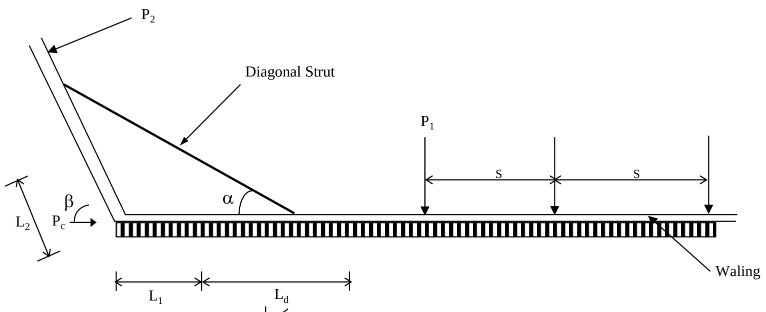
Overall Capacity OK

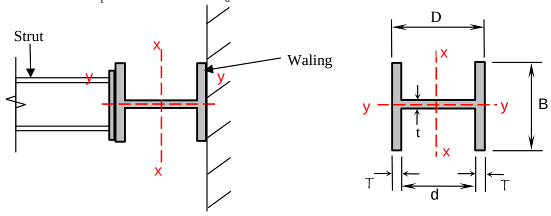
	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-A	Job No.: By: Chkd: Date:	60617767 JL KP 20-Oct-21

Structural Steel Design - Level 1 Waling (+4.80 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan





1. Section Properties

Try Section :	Single	457 x 191 x 89 UB	Grade 50	Hot Rolled

Depth of Section	**D**	=	463.6	mm	Elastic Modulus (X-Axis)	Z_x	=	1770000	mm^3
Width of Section	**B**	=	192.0	mm	Elastic Modulus (Y-Axis)	Z_y	=	217708	mm^3
Web Thickness	**t**	=	10.6	mm	Plastic Modulus (X-Axis)	S_x	=	2010000	mm^3
Flange Thickness	**T**	=	17.7	mm	Plastic Modulus (Y-Axis)	S_y	=	338000	mm^3
Depth between Fillets	**d**	=	407.9	mm	Buckling Parameter	**u**	=	0.879	
Second Moment of Area (X-Axis)	I_x	=	4.100E+08	mm^4	Torsional Index	**x**	=	28.3	
Second Moment of Area (Y-Axis)	I_y	=	2.090E+07	mm^4	Area of Section	A_g	=	11400	mm^2
Radius of Gyration (X-Axis)	r_x	=	190.0	mm	Mass per Length	**w**	=	89.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	42.8	mm	Design Strength	p_y	=	345	N/mm^2
					Root Radius	**r**	=	10.2	mm
Modulus of Elasticity	**E**	=	205000	MPa	Distance Between Centre Lines	**a**	=		mm *Neglect Spacing*

2. Ultimate Design Load

Resolve perpendicular to adjacent waling ➪ $P_c \sin\beta = P_1 L_1 \cos\beta + P_2 L_2$

Compressive Force (corner) ➪ $P_c = (P_1 L_1 \cos\beta + P_2 L_2) / \sin\beta$

		Case 1	Case 2	Case 3	Case 4
Inclined prop load from Plaxis, P_{i1}	=	126.73 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_1	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_1 = P_{i1} \sin\theta_1$	=	126.7 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclined prop load from Plaxis, P_{i2}	=	126.73 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_2	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_2 = P_{i2} \sin\theta_2$	=	126.7 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Intersection angle of end waling, β	=	90.0 °	90.0 °	90.0 °	90.0 °
Load bearing width of waling at corner, L_1	=	0.00 m	0.00 m	0.00 m	0.00 m
Load bearing width of waling at corner, L_2	=	0.00 m	0.00 m	0.00 m	0.00 m
Compressive Force (corner), P_c	=	0.0 kN	0.0 kN	0.0 kN	0.0 kN

Maximum horizontal pressure, P	=	126.73	kN/m
Maximum strut spacing, S	=	3.00	m
Load bearing width of diagonal strut, L_d	=	5.00	m
Minimum inclination of diagonal strut, α	=	50.19	°
Construction Load, Q_c	=	2.00	kPa

Maximum bending moment, Mx	=	P x S^2 / 8	=	126.73 x 3.00 x 3.00/8	= 142.57 kNm
Maximum bending moment, My	=	Self Weight + Construction Load	=	(89.0 x 9.8 + 2.0 x 463.6) / 1000 x 3.0^2 /	= 1.62 kNm
Maximum shear force, V	=	P x S / 2	=	126.73 x 3.00 / 2	= 190.09 kN
Compressive Force (corner)	=	Max. of P_c	=	Max. of (0, 0, 0, 0)	= 0.00 kN
Compressive Force (1% Strut Force)	=	P x S x 1%	=	126.73 x 3.00 x 1%	= 3.80 kN
Compressive Force (diagonal strut)	=	P x S / tan α	=	126.73 x 5.00 / tan 50.194428907	= 528.04 kN
Load Factor	=	1.4			

Design Bending Moment (Major Axis)	M_x	=	199.6	kNm	Design Shear Force	V	=	266.1	kN
Design Bending Moment (Minor Axis)	M_y	=	2.3	kNm	Axial Force	F_c	=	744.6	kN

3. Section Classification

(Table 7.1)

e = $[275 / p_y]^{1/2}$ = 0.9

b/T =	5.4	<	8.0 e	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t =	38.5	<	80 e	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 38.5 < 70e = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area	A_v	=	4914 mm^2				
Shear Capacity	V_c	=	p_yA_v/(3)^0.5				
		=	979 kN				
Design Shear Force	V	=	266.1 kN	<	P_v =	979 kN	***Check Shear OK***
Since,	$0.6V_c$	=	587 kN	>	V		***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis	M_{cx}	=	Lesser of	p_yS_x	and	$1.2p_yZ_x$		
	p_yS_x	=		693 kNm		$1.2p_yZ_x$ =	733 kNm	
	M_{cx}	=		**693 kNm**	>	M_x =	199.6 kNm	***Major Moment Capacity OK***
Minor Axis	M_{cy}	=	Lesser of	p_yS_y	and	$1.2p_yZ_y$		
	p_yS_y	=		117 kNm		$1.2p_yZ_y$ =	90 kNm	
	M_{cy}	=		**90 kNm**	>	M_y =	2.3 kNm	***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrained Span Length	L	=	3.00 m			
Effective Length	L_E	=	1.0 L	=	3.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_E / r_y	=	70.1	
Buckling parameter	u	=	0.88			*(Clause 8.3.5.3)*
	λ / x	=	2.48			
Slenderness factor	ν	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$			*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.935			
	β_w	=	1.000			*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$uv\lambda(\beta_w)^{0.5}$	=	57.6	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	345.00 N/mm^2			
Buckling strength	p_b	=	251.0 N/mm^2			*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	504.5 kNm			*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93			*(Table 8.4a for no intermediate lateral restraint)*
	$m_{LT}M_x$	=	185.63	<	M_b = 504.5 kNm	*(Clause 8.3.5.2 Eqn 8.18)*
and	M_x	=	199.60	<	M_{cx} = 693.5 kNm	*(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{744.6}{3933.0} + \frac{199.6}{693.5} + \frac{2.3}{90.1}$$

$$= 0.19 + 0.29 + 0.03$$

$$= 0.50$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	x-x				
Unrestrain length (X-Axis)	L_x	=	3.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	3.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	15.8	≈ 20	
Maximum Thickness	T	=	17.7 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	342.00 N/mm²				
p_c in Table 8.8 b)		=	339.00 N/mm²				
p_c in Table 8.8 c)		=	336.00 N/mm²				
p_c in Table 8.8 d)		=	332.00 N/mm²				
Compressive Strength	p_{cx}	=	342.00 N/mm²				*(Table 8.8(a))*
Axis of buckling		=	y-y				
Unrestrain length (Y-Axis)	L_y	=	3.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	3.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	70.1	≈ 72	
Maximum Thickness	T	=	17.7 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	258.00 N/mm²				
p_c in Table 8.8 b)		=	232.00 N/mm²				
p_c in Table 8.8 c)		=	207.00 N/mm²				
p_c in Table 8.8 d)		=	185.00 N/mm²				
Compressive Strength	p_{cy}	=	232.00 N/mm²				*(Table 8.8(b))*
Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	232.0 N/mm²		
Moment equivalent factor m for flexural buckling							
	m_x	=	0.95				*(Table 8.9)*
	m_y	=	0.95				*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{744.6}{2644.8} + \frac{189.6}{693.5} + \frac{2.2}{90.1}$$

$$= 0.28 + 0.27 + 0.02$$

$$= 0.58$$

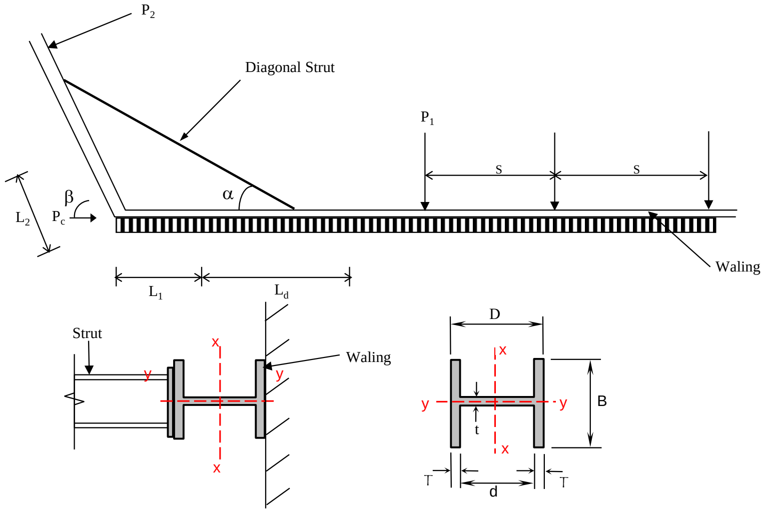
$$< 1$$

Overall Capacity OK

Structural Steel Design - Level 2 Waling (+1.70 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



1. Section Properties

Try Section :	Single	610 x 229 x 125 UB	Grade 50	Hot Rolled

Depth of Section	**D**	=	611.9	mm	Elastic Modulus (X-Axis)	Z_x	=	3220000	mm^3
Width of Section	**B**	=	229.0	mm	Elastic Modulus (Y-Axis)	Z_y	=	343231	mm^3
Web Thickness	**t**	=	11.9	mm	Plastic Modulus (X-Axis)	S_x	=	3680000	mm^3
Flange Thickness	**T**	=	19.6	mm	Plastic Modulus (Y-Axis)	S_y	=	536000	mm^3
Depth between Fillets	**d**	=	547.3	mm	Buckling Parameter	**u**	=	0.873	
Second Moment of Area (X-Axis)	I_x	=	9.860E+08	mm^4	Torsional Index	**x**	=	34	
Second Moment of Area (Y-Axis)	I_y	=	3.930E+07	mm^4	Area of Section	A_g	=	16000	mm^2
Radius of Gyration (X-Axis)	r_x	=	249.0	mm	Mass per Length	**w**	=	125.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	49.6	mm	Design Strength	p_y	=	345	N/mm^2
					Root Radius	**r**	=	12.7	mm
Modulus of Elasticity	**E**	=	205000	MPa	Distance Between Centre Lines	**a**	=		mm *Neglect Spacing*

2. Ultimate Design Load

Resolve perpendicular to adjacent waling ⇨ $P_c \sin\beta = P_1 L_1 \cos\beta + P_2 L_2$

Compressive Force (corner) ⇨ $P_c = (P_1 L_1 \cos\beta + P_2 L_2) / \sin\beta$

		Case 1	Case 2	Case 3	Case 4
Inclined prop load from Plaxis, P_{i1}	=	264.43 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_1	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_1 = P_{i1} \sin\theta_1$	=	264.4 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclined prop load from Plaxis, P_{i2}	=	264.43 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_2	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_2 = P_{i2} \sin\theta_2$	=	264.4 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Intersection angle of end waling, β	=	90.0 °	90.0 °	90.0 °	90.0 °
Load bearing width of waling at corner, L_1	=	0.00 m	0.00 m	0.00 m	0.00 m
Load bearing width of waling at corner, L_2	=	0.00 m	0.00 m	0.00 m	0.00 m
Compressive Force (corner), P_c	=	0.0 kN	0.0 kN	0.0 kN	0.0 kN

Maximum horizontal pressure, P	=	264.43	kN/m
Maximum strut spacing, S	=	3.00	m
Load bearing width of diagonal strut, L_d	=	5.00	m
Minimum inclination of diagonal strut, α	=	50.19	°
Construction Load, Q_c	=	2.00	kPa

Maximum bending moment, Mx	= $P \times S^2 / 8$	=	264.43 x 3.00 x 3.00/8	=	297.49 kNm
Maximum bending moment, My	= Self Weight + Construction Load	=	(125.0 x 9.8 + 2.0 x 611.9) / 1000 x 3.0^2	=	2.21 kNm
Maximum shear force, V	= P x S / 2	=	264.43 x 3.00 / 2	=	396.65 kN
Compressive Force (corner)	= Max. of P_c	=	Max. of (0, 0, 0, 0)	=	0.00 kN
Compressive Force (1% Strut Force)	= P x S x 1%	=	264.43 x 3.00 x 1%	=	7.93 kN
Compressive Force (diagonal strut)	= P x S / tan α	=	264.43 x 5.00 / tan 50.194428907	=	1101.81 kN
Load Factor	= 1.4				

Design Bending Moment (Major Axis) M_x = 416.5 kNm — Design Shear Force V = 555.3 kN

Design Bending Moment (Minor Axis) M_y = 3.1 kNm — Axial Force F_c = 1553.6 kN

3. Section Classification

(Table 7.1)

$e = [275 / p_y]^{1/2}$ = 0.9

b/T = 5.8 < 8.0 e (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 46.0 < 80 e (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 46.0 < 70e = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 7282 mm^2

Shear Capacity V_c = $p_y A_v/(3)$^0.5

= 1450 kN

Design Shear Force V = 555.3 kN < P_v = 1450 kN ***Check Shear OK***

Since, $0.6V_c$ = 870 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 1270 kNm — $1.2p_yZ_x$ = 1333 kNm

M_{cx} = **1270 kNm** > M_x = 416.5 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 185 kNm — $1.2p_yZ_y$ = 142 kNm

M_{cy} = **142 kNm** > M_y = 3.1 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrained Span Length	L	= 3.00 m		
Effective Length	L_E	= 1.0 L	= 3.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	= L_E / r_y	= 60.5	
Buckling parameter	u	= 0.87		*(Clause 8.3.5.3)*
	λ / x	= 1.78		
Slenderness factor	ν	= $1/(1+0.05(\lambda/x)^2)^{0.25}$		*(Clause 8.3.5.3 Eqn 8.27)*
		= 0.964		
	β_w	= 1.000		*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	= $u\nu\lambda(\beta_w)^{0.5}$	= 50.9	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	= 345.00 N/mm^2		
Buckling strength	p_b	= 268.0 N/mm^2		*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	= 986.2 kNm		*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	= 0.93		*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 387.33 < M_b = 986.2 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 416.48 < M_{cx} = 1269.6 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{1553.6}{5520.0} + \frac{416.5}{1269.6} + \frac{3.1}{142.1}$$

$$= 0.28 + 0.33 + 0.02$$

$$= 0.63$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	3.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	3.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	12.0	≈ 15	
Maximum Thickness	T	=	19.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	345.00 N/mm^2				
p_c in Table 8.8 b)		=	345.00 N/mm^2				
p_c in Table 8.8 c)		=	345.00 N/mm^2				
p_c in Table 8.8 d)		=	345.00 N/mm^2				
Compressive Strength	p_{cx}	=	345.00 N/mm^2				*(Table 8.8(a))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	3.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	3.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	60.5	≈ 62	
Maximum Thickness	T	=	19.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	286.00 N/mm^2				
p_c in Table 8.8 b)		=	261.00 N/mm^2				
p_c in Table 8.8 c)		=	236.00 N/mm^2				
p_c in Table 8.8 d)		=	212.00 N/mm^2				
Compressive Strength	p_{cy}	=	261.00 N/mm^2				*(Table 8.8(b))*

Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	261.0 N/mm^2		
Moment equivalent factor m for flexural buckling							
	m_x	=	0.95				*(Table 8.9)*
	m_y	=	0.95				*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{1553.6}{4176.0} + \frac{395.7}{1269.6} + \frac{2.9}{142.1}$$

$$= 0.37 + 0.31 + 0.02$$

$$= 0.70$$

$$< 1$$

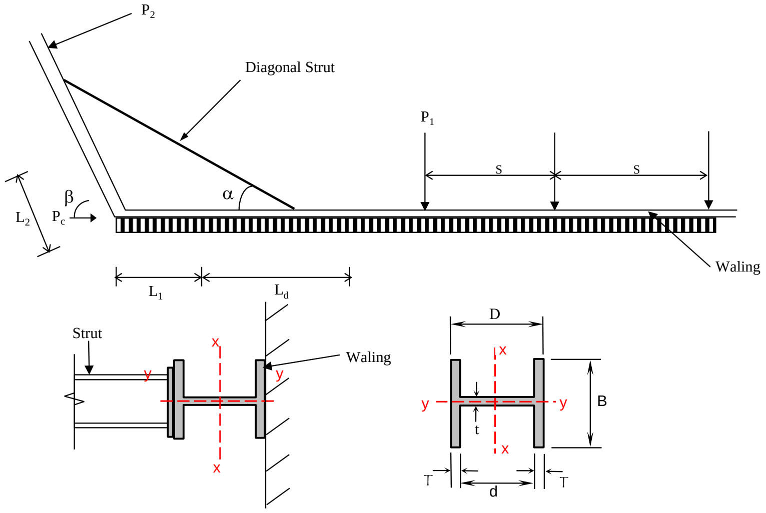
Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-A	Job No.: By: Chkd: Date:	60617767 JL KP 20-Oct-21

Structural Steel Design - Level 3 Waling (-1.40 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



1. Section Properties

Try Section :	Single	610 x 229 x 140 UB	Grade 50	Hot Rolled

Depth of Section	**D**	=	617.0	mm	Elastic Modulus (X-Axis)	Z_x	=	3630000	mm^3
Width of Section	**B**	=	230.1	mm	Elastic Modulus (Y-Axis)	Z_y	=	392003	mm^3
Web Thickness	**t**	=	13.1	mm	Plastic Modulus (X-Axis)	S_x	=	4150000	mm^3
Flange Thickness	**T**	=	22.1	mm	Plastic Modulus (Y-Axis)	S_y	=	612000	mm^3
Depth between Fillets	**d**	=	547.3	mm	Buckling Parameter	**u**	=	0.875	
Second Moment of Area (X-Axis)	I_x	=	1.120E+09	mm^4	Torsional Index	**x**	=	30.5	
Second Moment of Area (Y-Axis)	I_y	=	4.510E+07	mm^4	Area of Section	A_g	=	17800	mm^2
Radius of Gyration (X-Axis)	r_x	=	250.0	mm	Mass per Length	**w**	=	140.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	50.3	mm	Design Strength	p_y	=	345	N/mm^2
					Root Radius	**r**	=	12.7	mm
Modulus of Elasticity	**E**	=	205000	MPa	Distance Between Centre Lines	**a**	=		mm *Neglect Spacing*

2. Ultimate Design Load

Resolve perpendicular to adjacent waling ➪ $P_c \sin\beta = P_1 L_1 \cos\beta + P_2 L_2$

Compressive Force (corner) ➪ $P_c = (P_1 L_1 \cos\beta + P_2 L_2) / \sin\beta$

		Case 1	Case 2	Case 3	Case 4
Inclined prop load from Plaxis, P_{i1}	=	312.28 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_1	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_1 = P_{i1} \sin\theta_1$	=	312.3 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclined prop load from Plaxis, P_{i2}	=	312.28 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_2	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_2 = P_{i2} \sin\theta_2$	=	312.3 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Intersection angle of end waling, β	=	90.0 °	90.0 °	90.0 °	90.0 °
Load bearing width of waling at corner, L_1	=	0.00 m	0.00 m	0.00 m	0.00 m
Load bearing width of waling at corner, L_2	=	0.00 m	0.00 m	0.00 m	0.00 m
Compressive Force (corner), P_c	=	0.0 kN	0.0 kN	0.0 kN	0.0 kN

Maximum horizontal pressure, P	=	312.28	kN/m
Maximum strut spacing, S	=	3.00	m
Load bearing width of diagonal strut, L_d	=	5.00	m
Minimum inclination of diagonal strut, α	=	50.19	°
Construction Load, Q_c	=	2.00	kPa

Maximum bending moment, Mx	= $P \times S^2 / 8$	=	312.28 x 3.00 x 3.00/8	=	351.31 kNm
Maximum bending moment, My	= Self Weight + Construction Load	=	(140.0 x 9.8 + 2.0 x 617.0) / 1000 x 3.0^2	=	2.35 kNm
Maximum shear force, V	= P x S / 2	=	312.28 x 3.00 / 2	=	468.42 kN
Compressive Force (corner)	= Max. of P_c	=	Max. of (0, 0, 0, 0)	=	0.00 kN
Compressive Force (1% Strut Force)	= P x S x 1%	=	312.28 x 3.00 x 1%	=	9.37 kN
Compressive Force (diagonal strut)	= P x S / tan α	=	312.28 x 5.00 / tan 50.194428907	=	1301.16 kN
Load Factor	= 1.4				

Design Bending Moment (Major Axis)	M_x	=	491.8	kNm	Design Shear Force	V	=	655.8	kN
Design Bending Moment (Minor Axis)	M_y	=	3.3	kNm	Axial Force	F_c	=	1834.7	kN

3. Section Classification

(Table 7.1)

$e = [275 / p_y]^{1/2}$ = 0.9

b/T =	5.2	<	8.0 e	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t =	41.8	<	80 e	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 41.8 < 70e = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area	A_v	=	8083 mm^2				
Shear Capacity	V_c	=	$p_yA_v/(3)^{0.5}$				
		=	1610 kN				
Design Shear Force	V	=	655.8 kN	<	P_v =	1610 kN	***Check Shear OK***
Since,	$0.6V_c$	=	966 kN	>	V		***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis	M_{cx}	=	Lesser of	p_yS_x	and	$1.2p_yZ_x$		
	p_yS_x	=	1432 kNm			$1.2p_yZ_x$ =	1503 kNm	
	M_{cx}	=	**1432 kNm**	>		M_x =	491.8 kNm	***Major Moment Capacity OK***
Minor Axis	M_{cy}	=	Lesser of	p_yS_y	and	$1.2p_yZ_y$		
	p_yS_y	=	211 kNm			$1.2p_yZ_y$ =	162 kNm	
	M_{cy}	=	**162 kNm**	>		M_y =	3.3 kNm	***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrained Span Length	L	=	3.00 m		
Effective Length	L_E	=	1.0 L	= 3.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_E / r_y	= 59.6	
Buckling parameter	u	=	0.88		*(Clause 8.3.5.3)*
	λ / x	=	1.95		
Slenderness factor	ν	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$		*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.957		
	β_w	=	1.000		*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$u\nu\lambda(\beta_w)^{0.5}$	= 49.9	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	345.00 N/mm^2		
Buckling strength	p_b	=	285.0 N/mm^2		*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	1182.8 kNm		*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93		*(Table 8.4a for no intermediate lateral restraint)*

	$m_{LT}M_x$	=	457.41	<	M_b = 1182.8 kNm	*(Clause 8.3.5.2 Eqn 8.18)*
and	M_x	=	491.84	<	M_{cx} = 1431.8 kNm	*(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{1834.7}{6141.0} + \frac{491.8}{1431.8} + \frac{3.3}{162.3}$$

$$= 0.30 + 0.34 + 0.02$$

$$= 0.66$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	3.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	3.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	12.0	≈ 15	
Maximum Thickness	T	=	22.1 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	345.00 N/mm^2				
p_c in Table 8.8 b)		=	345.00 N/mm^2				
p_c in Table 8.8 c)		=	345.00 N/mm^2				
p_c in Table 8.8 d)		=	345.00 N/mm^2				
Compressive Strength	p_{cx}	=	345.00 N/mm^2				*(Table 8.8(a))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	3.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	3.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	59.6	≈ 60	
Maximum Thickness	T	=	22.1 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	291.00 N/mm^2				
p_c in Table 8.8 b)		=	266.00 N/mm^2				
p_c in Table 8.8 c)		=	241.00 N/mm^2				
p_c in Table 8.8 d)		=	218.00 N/mm^2				
Compressive Strength	p_{cy}	=	266.00 N/mm^2				*(Table 8.8(b))*

Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	266.0 N/mm^2	
Moment equivalent factor m for flexural buckling						
	m_x	=	0.95			*(Table 8.9)*
	m_y	=	0.95			*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{1834.7}{4734.8} + \frac{467.2}{1431.8} + \frac{3.1}{162.3}$$

$$= 0.39 + 0.33 + 0.02$$

$$= 0.73$$

$$< 1$$

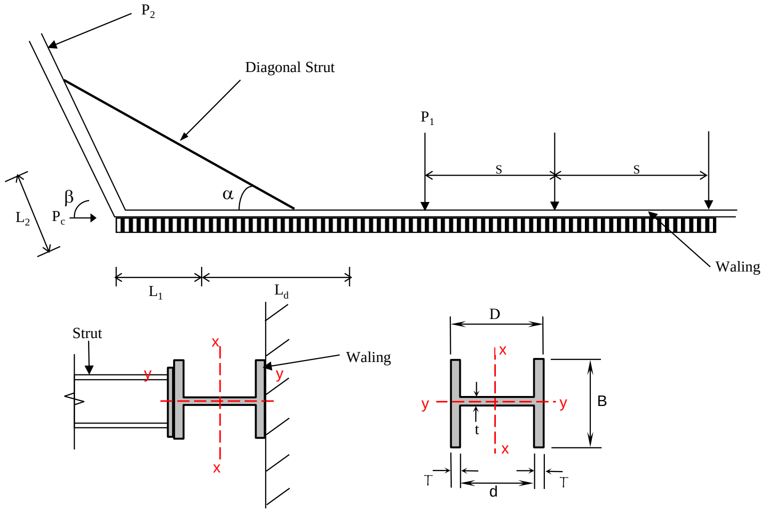
Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-A	Job No.: By: Chkd: Date:	60617767 JL KP 20-Oct-21

Structural Steel Design - Level 4 Waling (-4.50 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



1. Section Properties

Try Section :	Single	610 x 229 x 140 UB	Grade 50	Hot Rolled

Depth of Section	D	=	617.0	mm	Elastic Modulus (X-Axis)	Z_x	=	3630000	mm^3
Width of Section	B	=	230.1	mm	Elastic Modulus (Y-Axis)	Z_y	=	392003	mm^3
Web Thickness	t	=	13.1	mm	Plastic Modulus (X-Axis)	S_x	=	4150000	mm^3
Flange Thickness	T	=	22.1	mm	Plastic Modulus (Y-Axis)	S_y	=	612000	mm^3
Depth between Fillets	d	=	547.3	mm	Buckling Parameter	u	=	0.875	
Second Moment of Area (X-Axis)	I_x	=	1.120E+09	mm^4	Torsional Index	x	=	30.5	
Second Moment of Area (Y-Axis)	I_y	=	4.510E+07	mm^4	Area of Section	A_g	=	17800	mm^2
Radius of Gyration (X-Axis)	r_x	=	250.0	mm	Mass per Length	w	=	140.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	50.3	mm	Design Strength	p_y	=	345	N/mm^2
					Root Radius	r	=	12.7	mm
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=		mm *Neglect Spacing*

2. Ultimate Design Load

Resolve perpendicular to adjacent waling ➪ $P_c \sin\beta = P_1 L_1 \cos\beta + P_2 L_2$

Compressive Force (corner) ➪ $P_c = (P_1 L_1 \cos\beta + P_2 L_2) / \sin\beta$

		Case 1	Case 2	Case 3	Case 4
Inclined prop load from Plaxis, P_{i1}	=	307.12 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_1	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_1 = P_{i1} \sin\theta_1$	=	307.1 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclined prop load from Plaxis, P_{i2}	=	307.12 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_2	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_2 = P_{i2} \sin\theta_2$	=	307.1 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Intersection angle of end waling, β	=	90.0 °	90.0 °	90.0 °	90.0 °
Load bearing width of waling at corner, L_1	=	0.00 m	0.00 m	0.00 m	0.00 m
Load bearing width of waling at corner, L_2	=	0.00 m	0.00 m	0.00 m	0.00 m
Compressive Force (corner), P_c	=	0.0 kN	0.0 kN	0.0 kN	0.0 kN

Maximum horizontal pressure, P	=	307.12	kN/m
Maximum strut spacing, S	=	3.00	m
Load bearing width of diagonal strut, L_d	=	5.00	m
Minimum inclination of diagonal strut, α	=	50.19	°
Construction Load, Q_c	=	2.00	kPa

Maximum bending moment, Mx	= $P \times S^2 / 8$	=	307.12 x 3.00 x 3.00/8	=	345.51 kNm
Maximum bending moment, My	= Self Weight + Construction Load	=	(140.0 x 9.8 + 2.0 x 617.0) / 1000 x 3.0^2	=	2.35 kNm
Maximum shear force, V	= P x S / 2	=	307.12 x 3.00 / 2	=	460.68 kN
Compressive Force (corner)	= Max. of P_c	=	Max. of (0, 0, 0, 0)	=	0.00 kN
Compressive Force (1% Strut Force)	= P x S x 1%	=	307.12 x 3.00 x 1%	=	9.21 kN
Compressive Force (diagonal strut)	= P x S / tan α	=	307.12 x 5.00 / tan 50.194428907	=	1279.66 kN
Load Factor	= 1.4				

Design Bending Moment (Major Axis)	M_x	=	483.7	kNm	Design Shear Force	V	=	644.9	kN
Design Bending Moment (Minor Axis)	M_y	=	3.3	kNm	Axial Force	F_c	=	1804.4	kN

3. Section Classification

(Table 7.1)

$e = [275 / p_y]^{1/2}$ = 0.9

b/T = 5.2	<	8.0 e	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t = 41.8	<	80 e	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 41.8 < 70e = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area	A_v	=	8083 mm^2				
Shear Capacity	V_c	=	$p_yA_v/(3)$^0.5				
		=	1610 kN				
Design Shear Force	V	=	644.9 kN	<	P_v =	1610 kN	***Check Shear OK***
Since,	$0.6V_c$	=	966 kN	>	V		***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis	M_{cx}	=	Lesser of p_yS_x	and	$1.2p_yZ_x$			
	p_yS_x	=	1432 kNm		$1.2p_yZ_x$ =	1503 kNm		
	M_{cx}	=	**1432 kNm**	>	M_x =	483.7 kNm	***Major Moment Capacity OK***
Minor Axis	M_{cy}	=	Lesser of p_yS_y	and	$1.2p_yZ_y$			
	p_yS_y	=	211 kNm		$1.2p_yZ_y$ =	162 kNm		
	M_{cy}	=	**162 kNm**	>	M_y =	3.3 kNm	***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrained Span Length	L	=	3.00 m			
Effective Length	L_E	=	1.0 L	=	3.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_E / r_y	=	59.6	
Buckling parameter	u	=	0.88			*(Clause 8.3.5.3)*
	λ / x	=	1.95			
Slenderness factor	v	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$			*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.957			
	β_w	=	1.000			*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$uv\lambda(\beta_w)^{0.5}$	=	49.9	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	345.00 N/mm^2			
Buckling strength	p_b	=	285.0 N/mm^2			*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	1182.8 kNm			*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93			*(Table 8.4a for no intermediate lateral restraint)*

	$m_{LT}M_x$	=	449.85	<	M_b =	1182.8 kNm	*(Clause 8.3.5.2 Eqn 8.18)*
and	M_x	=	483.71	<	M_{cx} =	1431.8 kNm	*(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{1804.4}{6141.0} + \frac{483.7}{1431.8} + \frac{3.3}{162.3}$$

$$= 0.29 + 0.34 + 0.02$$

$$= 0.65$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**			
Unrestrain length (X-Axis)	L_x	=	3.00 m			
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	= 3.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	= 12.0	≈ 15	
Maximum Thickness	T	=	22.1 mm	≤ 40 mm		
Type of Section		=	Rolled I-section ≤ 40mm			
Designation of buckling curves for different section types:				Buckling Curve	a)	*(Table 8.7)*
p_c in Table 8.8 a)		=	345.00 N/mm^2			
p_c in Table 8.8 b)		=	345.00 N/mm^2			
p_c in Table 8.8 c)		=	345.00 N/mm^2			
p_c in Table 8.8 d)		=	345.00 N/mm^2			
Compressive Strength	p_{cx}	=	345.00 N/mm^2			*(Table 8.8(a))*
Axis of buckling		=	**y-y**			
Unrestrain length (Y-Axis)	L_y	=	3.00 m			
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	= 3.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	= 59.6	≈ 60	
Maximum Thickness	T	=	22.1 mm	≤ 40 mm		
Type of Section		=	Rolled I-section ≤ 40mm			
Designation of buckling curves for different section types:				Buckling Curve	b)	*(Table 8.7)*
p_c in Table 8.8 a)		=	291.00 N/mm^2			
p_c in Table 8.8 b)		=	266.00 N/mm^2			
p_c in Table 8.8 c)		=	241.00 N/mm^2			
p_c in Table 8.8 d)		=	218.00 N/mm^2			
Compressive Strength	p_{cy}	=	266.00 N/mm^2			*(Table 8.8(b))*
Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	= 266.0 N/mm^2		
Moment equivalent factor m for flexural buckling						
	m_x	=	0.95			*(Table 8.9)*
	m_y	=	0.95			*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{1804.4}{4734.8} + \frac{459.5}{1431.8} + \frac{3.1}{162.3}$$

$$= 0.38 + 0.32 + 0.02$$

$$= 0.72$$

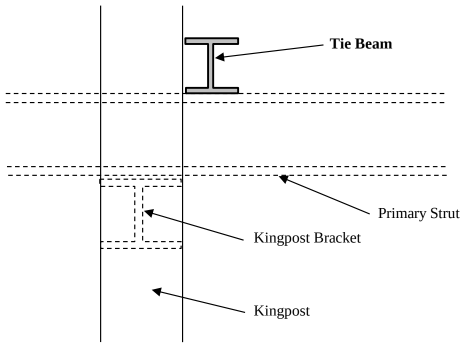
$$< 1$$

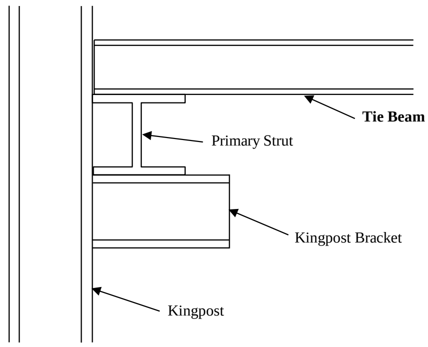
Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation	Job No.:	60617767
	Excavation and Lateral Support Works Design	By:	JL
	Structural Design	Chkd:	KP
	STN Pumping Station - Type-A	Date:	18-Oct-21

Structural Steel Design - Level 1 Tie Beam (+4.80 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")





1. Section Properties

Try Section :	Single	203 x 102 x 23 UB	Grade 50	Hot Rolled

Depth of Section	**D**	=	203.2	mm	Elastic Modulus (X-Axis)	$\mathbf{Z_x}$	=	206000	mm^3
Width of Section	**B**	=	101.6	mm	Elastic Modulus (Y-Axis)	$\mathbf{Z_y}$	=	32087	mm^3
Web Thickness	**t**	=	5.2	mm	Plastic Modulus (X-Axis)	$\mathbf{S_x}$	=	232000	mm^3
Flange Thickness	**T**	=	9.3	mm	Plastic Modulus (Y-Axis)	$\mathbf{S_y}$	=	49500	mm^3
Depth between Fillets	**d**	=	169.4	mm	Buckling Parameter	**u**	=	0.89	
Second Moment of Area (X-Axis)	$\mathbf{I_x}$	=	2.091E+07	mm^4	Torsional Index	**x**	=	22.5	
Second Moment of Area (Y-Axis)	$\mathbf{I_y}$	=	1.630E+06	mm^4	Area of Section	$\mathbf{A_g}$	=	2900	mm^2
Radius of Gyration (X-Axis)	$\mathbf{r_x}$	=	84.9	mm	Mass per Length	**w**	=	23.00	kg/m
Radius of Gyration (Y-Axis)	$\mathbf{r_y}$	=	23.7	mm	Design Strength	$\mathbf{p_y}$	=	355	N/mm^2
Modulus of Elasticity	**E**	=	205000.00	MPa					

2. Ultimate Design Load

Maximum inclined prop load from Plaxis	=	126.73	kN/m	(From PLAXIS)			
Minimum inclination of strut to waling, α	=	50.19	degree				
Load in the direction of strut, P_α	=	F / sin α		=	126.73 / sin 50.2	=	165.0 kN/m
Maximum strut spacing, S	=	5.00	m				
Maximum compression, P	=	P_α x S		=	164.96 x 5.00	=	824.8 kN
No. of tie beam provided to each strut	=	1					
No. of parallel strut supported by each tie beam	=	2					
Inclination of tie beam, θ	=	90.00	degree				
Unrestrain length of tie beam on plan (X-Axis), L_x'	=	3.91	m				
Actual unrestrain length of tie beam (X-Axis), L_x	=	L_x' / sin θ		=	3.91 / sin 90.0	=	3.91 m
Unrestrain length of tie beam on plan (Y-Axis), L_y'	=	3.91	m				
Actual unrestrain length of tie beam (Y-Axis), L_y	=	L_y' / sin θ		=	3.91 / sin 90.0	=	3.91 m
Construction Load, Qc	=	2.00	kPa				
Maximum Axial Force (unfactored)	=	2.5% P_α x S		x	2	=	41.24 kN
Maximum Bending Moment (unfactored)	=	0.125 x (23.0 x 9.81 + 2.0 x 101.6) / 1000 x 3.91^2				=	0.82 kNm
Maximum Shear Force (unfactored)	=	0.5 x (23.0 x 9.81 + 2.0 x 101.6) /1000 x 3.91				=	0.84 kN
Load Factor	=	1.40					

Design Bending Moment (X-Axis)	$\mathbf{M_x}$	=	1.1	kNm	Design Shear Force	**V**	=	1.2	kN
Design Bending Moment (Y-Axis)	$\mathbf{M_y}$	=	0.0	kNm	Axial Force	$\mathbf{F_c}$	=	57.7	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 5.5 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 32.6 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 32.6 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area $\mathbf{A_v}$ = 1057 mm^2

Shear Capacity $\mathbf{V_c}$ = $p_yA_v/(3)^{0.5}$

= 217 kN

Design Shear Force **V** = 1.2 kN < P_v = 217 kN ***Check Shear OK***

Since, $0.6V_c$ = 130 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 82 kNm $1.2p_yZ_x$ = 88 kNm

$\mathbf{M_{cx}}$ = **82 kNm** > M_x = 1.1 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 18 kNm $1.2p_yZ_y$ = 14 kNm

$\mathbf{M_{cy}}$ = **14 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) $\mathbf{L_y}$ = 3.91 m

Effective Length $\mathbf{L_{Ey}}$ = 1.0 L = 3.9 m *(Clause 8.3.4)*

Minor Axis Slenderness $\boldsymbol{\lambda}$ = L_{Ey} / r_y = 164.7

Buckling parameter **u** = 0.89 *(Clause 8.3.5.3)*

$\boldsymbol{\lambda / x}$ = 7.32

Slenderness factor **v** = $1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.722

$\boldsymbol{\beta_w}$ = 1.000 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness $\boldsymbol{\lambda_{LT}}$ = $uv\lambda(\beta_w)^{0.5}$ = 105.8 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength $\mathbf{p_y}$ = 355.00 N/mm^2

Buckling strength $\mathbf{p_b}$ = 120.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment $\mathbf{M_b}$ = 27.8 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor $\mathbf{m_{LT}}$ = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$\mathbf{m_{LT}M_x}$ = 1.06 < M_b = 27.8 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and $\mathbf{M_x}$ = 1.14 < M_{cx} = 82.4 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{57.7}{1029.5} + \frac{1.1}{82.4} + \frac{0.0}{13.7}$$

$$= 0.06 + 0.01 + 0.00$$

$$= 0.07$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling = **x-x**

Unrestrain length (X-Axis) L_x = 3.91 m

Effective Length (X-Axis) L_{Ex} = 1.0 L_x = 3.91 m *(Clause 8.3.4)*

Major Axis Slenderness λ_x = L_{Ex} / r_x = 46.0 ≈ 46

Maximum Thickness **T** = 9.3 mm ≤ 40 mm

Type of Section = Rolled I-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve a) *(Table 8.7)*

p_c in Table 8.8 a) = 325.00 N/mm^2

p_c in Table 8.8 b) = 306.00 N/mm^2

p_c in Table 8.8 c) = 286.00 N/mm^2

p_c in Table 8.8 d) = 265.00 N/mm^2

Compressive Strength p_{cx} = 325.00 N/mm^2 *(Table 8.8(a))*

Axis of buckling = **y-y**

Unrestrain length (Y-Axis) L_y = 3.91 m

Effective Length (Y-Axis) L_{Ey} = 1.0 L_y = 3.91 m *(Clause 8.3.4)*

Minor Axis Slenderness λ_y = L_{Ey} / r_y = 164.7 ≈ 165

Maximum Thickness **T** = 9.3 mm ≤ 40 mm

Type of Section = Rolled I-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve b) *(Table 8.7)*

p_c in Table 8.8 a) = 69.00 N/mm^2

p_c in Table 8.8 b) = 65.00 N/mm^2

p_c in Table 8.8 c) = 61.00 N/mm^2

p_c in Table 8.8 d) = 57.00 N/mm^2

Compressive Strength p_{cy} = 65.00 N/mm^2 *(Table 8.8(b))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 65.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{57.7}{188.5} + \frac{1.1}{82.4} + \frac{0.0}{13.7}$$

$$= 0.31 + 0.01 + 0.00$$

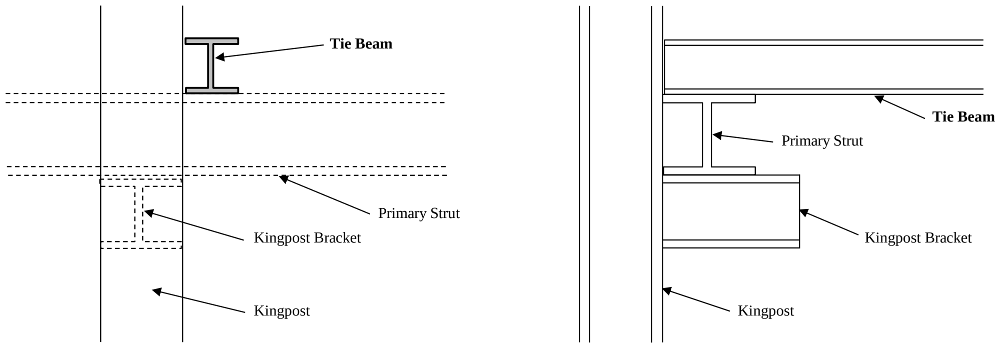
$$= 0.32$$

$$< 1$$

Overall Capacity OK

Structural Steel Design - Level 2 Tie Beam (+1.70 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")



1. Section Properties

Try Section :	Single	203 x 102 x 23 UB	Grade 50	Hot Rolled

Depth of Section	**D**	=	203.2	mm	Elastic Modulus (X-Axis)	Z_x	=	206000	mm^3
Width of Section	**B**	=	101.6	mm	Elastic Modulus (Y-Axis)	Z_y	=	32087	mm^3
Web Thickness	**t**	=	5.2	mm	Plastic Modulus (X-Axis)	S_x	=	232000	mm^3
Flange Thickness	**T**	=	9.3	mm	Plastic Modulus (Y-Axis)	S_y	=	49500	mm^3
Depth between Fillets	**d**	=	169.4	mm	Buckling Parameter	**u**	=	0.89	
Second Moment of Area (X-Axis)	I_x	=	2.091E+07	mm^4	Torsional Index	**x**	=	22.5	
Second Moment of Area (Y-Axis)	I_y	=	1.630E+06	mm^4	Area of Section	A_g	=	2900	mm^2
Radius of Gyration (X-Axis)	r_x	=	84.9	mm	Mass per Length	**w**	=	23.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	23.7	mm	Design Strength	p_y	=	355	N/mm^2
Modulus of Elasticity	**E**	=	205000.00	MPa					

2. Ultimate Design Load

Maximum inclined prop load from Plaxis	=	264.43	kN/m	(From PLAXIS)			
Minimum inclination of strut to waling, α	=	50.19	degree				
Load in the direction of strut, P_α	=	F / sin α	=	264.43 / sin 50.2	=	344.2	kN/m
Maximum strut spacing, S	=	5.00	m				
Maximum compression, P	=	P_α x S	=	344.22 x 5.00	=	1721.1	kN
No. of tie beam provided to each strut	=	1					
No. of parallel strut supported by each tie beam	=	2					
Inclination of tie beam, θ	=	90.00	degree				
Unrestrain length of tie beam on plan (X-Axis), L_x'	=	3.91	m				
Actual unrestrain length of tie beam (X-Axis), L_x	=	L_x' / sin θ	=	3.91 / sin 90.0	=	3.91	m
Unrestrain length of tie beam on plan (Y-Axis), L_y'	=	3.91	m				
Actual unrestrain length of tie beam (Y-Axis), L_y	=	L_y' / sin θ	=	3.91 / sin 90.0	=	3.91	m
Construction Load, Qc	=	2.00	kPa				
Maximum Axial Force (unfactored)	=	2.5% P_α x S	x	2	=	86.05	kN
Maximum Bending Moment (unfactored)	=	0.125 x (23.0 x 9.81 + 2.0 x 101.6) / 1000 x 3.91^2			=	0.82	kNm
Maximum Shear Force (unfactored)	=	0.5 x (23.0 x 9.81 + 2.0 x 101.6) /1000 x 3.91			=	0.84	kN
Load Factor	=	1.40					

Design Bending Moment (X-Axis)	M_x	=	1.1	kNm	Design Shear Force	**V**	=	1.2	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	120.5	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T =	5.5	<	8.0 ε	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t =	32.6	<	80 ε	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 32.6 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area $\mathbf{A_v}$ = 1057 mm^2

Shear Capacity $\mathbf{V_c}$ = $p_yA_v/(3)^{0.5}$

= 217 kN

Design Shear Force **V** = 1.2 kN < P_v = 217 kN ***Check Shear OK***

Since, $0.6V_c$ = 130 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 82 kNm $1.2p_yZ_x$ = 88 kNm

$\mathbf{M_{cx}}$ = **82 kNm** > M_x = 1.1 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 18 kNm $1.2p_yZ_y$ = 14 kNm

$\mathbf{M_{cy}}$ = **14 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) $\mathbf{L_y}$ = 3.91 m

Effective Length $\mathbf{L_{Ey}}$ = 1.0 L = 3.9 m *(Clause 8.3.4)*

Minor Axis Slenderness $\boldsymbol{\lambda}$ = L_{Ey} / r_y = 164.7

Buckling parameter **u** = 0.89 *(Clause 8.3.5.3)*

$\boldsymbol{\lambda / x}$ = 7.32

Slenderness factor $\boldsymbol{v}$ = $1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.722

$\boldsymbol{\beta_w}$ = 1.000 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness $\boldsymbol{\lambda_{LT}}$ = $uv\lambda(\beta_w)^{0.5}$ = 105.8 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength $\mathbf{p_y}$ = 355.00 N/mm^2

Buckling strength $\mathbf{p_b}$ = 120.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment $\mathbf{M_b}$ = 27.8 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor $\mathbf{m_{LT}}$ = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$\mathbf{m_{LT}M_x}$ = 1.06 < M_b = 27.8 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and $\mathbf{M_x}$ = 1.14 < M_{cx} = 82.4 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{120.5}{1029.5} + \frac{1.1}{82.4} + \frac{0.0}{13.7}$$

$$= 0.12 + 0.01 + 0.00$$

$$= 0.13$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check *(Clause 8.9.2)*

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	3.91 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	3.91 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	46.0	≈ 46	
Maximum Thickness	**T**	=	9.3 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	325.00 N/mm^2				
p_c in Table 8.8 b)		=	306.00 N/mm^2				
p_c in Table 8.8 c)		=	286.00 N/mm^2				
p_c in Table 8.8 d)		=	265.00 N/mm^2				
Compressive Strength	p_{cx}	=	325.00 N/mm^2				*(Table 8.8(a))*
Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	3.91 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	3.91 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	164.7	≈ 165	
Maximum Thickness	**T**	=	9.3 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	69.00 N/mm^2				
p_c in Table 8.8 b)		=	65.00 N/mm^2				
p_c in Table 8.8 c)		=	61.00 N/mm^2				
p_c in Table 8.8 d)		=	57.00 N/mm^2				
Compressive Strength	p_{cy}	=	65.00 N/mm^2				*(Table 8.8(b))*
Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	65.0 N/mm^2		
Moment equivalent factor m for flexural buckling							
	m_x	=	0.95				*(Table 8.9)*
	m_y	=	0.95				*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{120.5}{188.5} + \frac{1.1}{82.4} + \frac{0.0}{13.7}$$

$$= 0.64 + 0.01 + 0.00$$

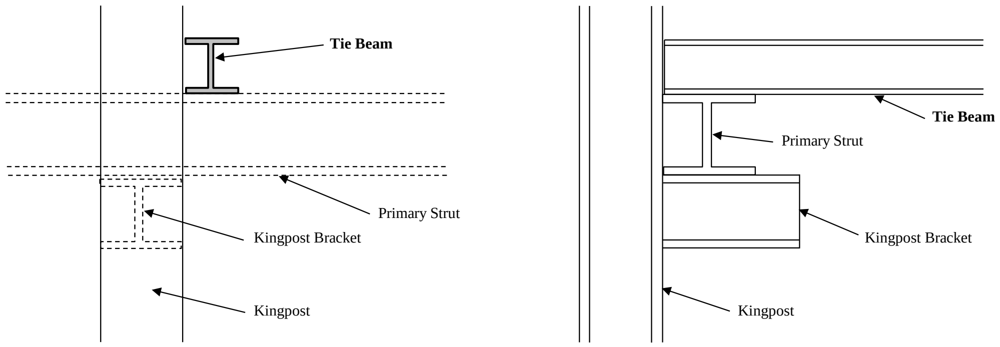
$$= 0.65$$

$$< 1$$

Overall Capacity OK

Structural Steel Design - Level 3 Tie Beam (-1.40 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")



1. Section Properties

Try Section :	Single	203 x 102 x 23 UB	Grade 50	Hot Rolled

Depth of Section	**D**	=	203.2	mm	Elastic Modulus (X-Axis)	Z_x	=	206000	mm^3
Width of Section	**B**	=	101.6	mm	Elastic Modulus (Y-Axis)	Z_y	=	32087	mm^3
Web Thickness	**t**	=	5.2	mm	Plastic Modulus (X-Axis)	S_x	=	232000	mm^3
Flange Thickness	**T**	=	9.3	mm	Plastic Modulus (Y-Axis)	S_y	=	49500	mm^3
Depth between Fillets	**d**	=	169.4	mm	Buckling Parameter	**u**	=	0.89	
Second Moment of Area (X-Axis)	I_x	=	2.091E+07	mm^4	Torsional Index	**x**	=	22.5	
Second Moment of Area (Y-Axis)	I_y	=	1.630E+06	mm^4	Area of Section	A_g	=	2900	mm^2
Radius of Gyration (X-Axis)	r_x	=	84.9	mm	Mass per Length	**w**	=	23.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	23.7	mm	Design Strength	p_y	=	355	N/mm^2
Modulus of Elasticity	**E**	=	205000.00	MPa					

2. Ultimate Design Load

Maximum inclined prop load from Plaxis	=	312.28	kN/m	(From PLAXIS)			
Minimum inclination of strut to waling, α	=	50.19	degree				
Load in the direction of strut, P_α	=	F / sin α	=	312.28 / sin 50.2	=	406.5	kN/m
Maximum strut spacing, S	=	5.00	m				
Maximum compression, P	=	P_α x S	=	406.50 x 5.00	=	2032.5	kN
No. of tie beam provided to each strut	=	1					
No. of parallel strut supported by each tie beam	=	2					
Inclination of tie beam, θ	=	90.00	degree				
Unrestrain length of tie beam on plan (X-Axis), L_x'	=	3.91	m				
Actual unrestrain length of tie beam (X-Axis), L_x	=	L_x' / sin θ	=	3.91 / sin 90.0	=	3.91	m
Unrestrain length of tie beam on plan (Y-Axis), L_y'	=	3.91	m				
Actual unrestrain length of tie beam (Y-Axis), L_y	=	L_y' / sin θ	=	3.91 / sin 90.0	=	3.91	m
Construction Load, Qc	=	2.00	kPa				
Maximum Axial Force (unfactored)	=	2.5% P_α x S	x	2	=	101.62	kN
Maximum Bending Moment (unfactored)	=	0.125 x (23.0 x 9.81 + 2.0 x 101.6) / 1000 x 3.91^2			=	0.82	kNm
Maximum Shear Force (unfactored)	=	0.5 x (23.0 x 9.81 + 2.0 x 101.6) /1000 x 3.91			=	0.84	kN
Load Factor	=	1.40					

Design Bending Moment (X-Axis)	M_x	=	1.1	kNm	Design Shear Force	**V**	=	1.2	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	142.3	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 5.5 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 32.6 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 32.6 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 1057 mm^2

Shear Capacity V_c = $p_yA_v/(3)^{0.5}$

= 217 kN

Design Shear Force V = 1.2 kN < P_v = 217 kN ***Check Shear OK***

Since, $0.6V_c$ = 130 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 82 kNm $1.2p_yZ_x$ = 88 kNm

M_{cx} = 82 kNm > M_x = 1.1 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 18 kNm $1.2p_yZ_y$ = 14 kNm

M_{cy} = 14 kNm > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis)	L_y	=	3.91 m	
Effective Length	L_{Ey}	=	1.0 L = 3.9 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_{Ey} / r_y = 164.7	
Buckling parameter	u	=	0.89	*(Clause 8.3.5.3)*
	λ / x	=	7.32	
Slenderness factor	v	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$	*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.722	
	β_w	=	1.000	*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$uv\lambda(\beta_w)^{0.5}$ = 105.8	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	355.00 N/mm^2	
Buckling strength	p_b	=	120.0 N/mm^2	*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	27.8 kNm	*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93	*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 1.06 < M_b = 27.8 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 1.14 < M_{cx} = 82.4 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{142.3}{1029.5} + \frac{1.1}{82.4} + \frac{0.0}{13.7}$$

= 0.14 + 0.01 + 0.00

= 0.15

< 1

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**			
Unrestrain length (X-Axis)	L_x	=	3.91 m			
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	= 3.91 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	= 46.0	≈ 46	
Maximum Thickness	T	=	9.3 mm	≤ 40 mm		
Type of Section		=	Rolled I-section ≤ 40mm			
Designation of buckling curves for different section types:				Buckling Curve	a)	*(Table 8.7)*
p_c in Table 8.8 a)		=	325.00 N/mm^2			
p_c in Table 8.8 b)		=	306.00 N/mm^2			
p_c in Table 8.8 c)		=	286.00 N/mm^2			
p_c in Table 8.8 d)		=	265.00 N/mm^2			
Compressive Strength	p_{cx}	=	325.00 N/mm^2			*(Table 8.8(a))*

Axis of buckling		=	**y-y**			
Unrestrain length (Y-Axis)	L_y	=	3.91 m			
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	= 3.91 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	= 164.7	≈ 165	
Maximum Thickness	T	=	9.3 mm	≤ 40 mm		
Type of Section		=	Rolled I-section ≤ 40mm			
Designation of buckling curves for different section types:				Buckling Curve	b)	*(Table 8.7)*
p_c in Table 8.8 a)		=	69.00 N/mm^2			
p_c in Table 8.8 b)		=	65.00 N/mm^2			
p_c in Table 8.8 c)		=	61.00 N/mm^2			
p_c in Table 8.8 d)		=	57.00 N/mm^2			
Compressive Strength	p_{cy}	=	65.00 N/mm^2			*(Table 8.8(b))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 65.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{142.3}{188.5} + \frac{1.1}{82.4} + \frac{0.0}{13.7}$$

$$= 0.75 + 0.01 + 0.00$$

$$= 0.77$$

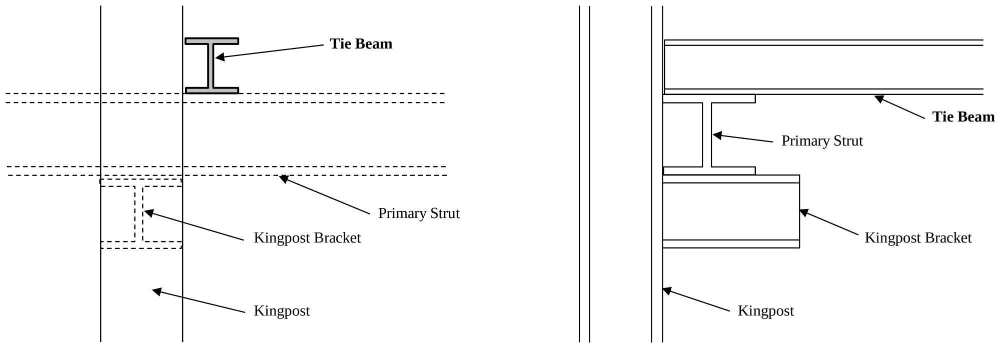
$$< 1$$

Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-A	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

Structural Steel Design - Level 4 Tie Beam (-4.50 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")



1. Section Properties

Try Section : | **Single** | **203 x 102 x 23 UB** | **Grade 50** | **Hot Rolled**

Depth of Section	**D**	= 203.2	mm	Elastic Modulus (X-Axis)	Z_x	=	206000	mm^3
Width of Section	**B**	= 101.6	mm	Elastic Modulus (Y-Axis)	Z_y	=	32087	mm^3
Web Thickness	**t**	= 5.2	mm	Plastic Modulus (X-Axis)	S_x	=	232000	mm^3
Flange Thickness	**T**	= 9.3	mm	Plastic Modulus (Y-Axis)	S_y	=	49500	mm^3
Depth between Fillets	**d**	= 169.4	mm	Buckling Parameter	**u**	=	0.89	
Second Moment of Area (X-Axis)	I_x	= 2.091E+07	mm^4	Torsional Index	**x**	=	22.5	
Second Moment of Area (Y-Axis)	I_y	= 1.630E+06	mm^4	Area of Section	A_g	=	2900	mm^2
Radius of Gyration (X-Axis)	r_x	= 84.9	mm	Mass per Length	**w**	=	23.00	kg/m
Radius of Gyration (Y-Axis)	r_y	= 23.7	mm	Design Strength	p_y	=	355	N/mm^2
Modulus of Elasticity	**E**	= 205000.00	MPa					

2. Ultimate Design Load

Maximum inclined prop load from Plaxis	=	307.12	kN/m	(From PLAXIS)			
Minimum inclination of strut to waling, α	=	50.19	degree				
Load in the direction of strut, P_α	=	F / sin α	=	307.12 / sin 50.2	=	399.8	kN/m
Maximum strut spacing, S	=	5.00	m				
Maximum compression, P	=	P_α x S	=	399.78 x 5.00	=	1998.9	kN
No. of tie beam provided to each strut	=	1					
No. of parallel strut supported by each tie beam	=	2					
Inclination of tie beam, θ	=	90.00	degree				
Unrestrain length of tie beam on plan (X-Axis), L_x'	=	3.91	m				
Actual unrestrain length of tie beam (X-Axis), L_x	=	L_x' / sin θ	=	3.91 / sin 90.0	=	3.91	m
Unrestrain length of tie beam on plan (Y-Axis), L_y'	=	3.91	m				
Actual unrestrain length of tie beam (Y-Axis), L_y	=	L_y' / sin θ	=	3.91 / sin 90.0	=	3.91	m
Construction Load, Qc	=	2.00	kPa				
Maximum Axial Force (unfactored)	=	2.5% P_α x S	x	2	=	99.94	kN
Maximum Bending Moment (unfactored)	=	0.125 x (23.0 x 9.81 + 2.0 x 101.6) / 1000 x 3.91^2			=	0.82	kNm
Maximum Shear Force (unfactored)	=	0.5 x (23.0 x 9.81 + 2.0 x 101.6) /1000 x 3.91			=	0.84	kN
Load Factor	=	1.40					

Design Bending Moment (X-Axis)	M_x	= 1.1	kNm	Design Shear Force	**V**	=	1.2	kN
Design Bending Moment (Y-Axis)	M_y	= 0.0	kNm	Axial Force	F_c	=	139.9	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T =	5.5	<	8.0 ε	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t =	32.6	<	80 ε	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 32.6 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area $\mathbf{A_v}$ = 1057 mm^2

Shear Capacity $\mathbf{V_c}$ = $p_yA_v/(3)^{0.5}$

= 217 kN

Design Shear Force **V** = 1.2 kN < P_v = 217 kN ***Check Shear OK***

Since, $0.6V_c$ = 130 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 82 kNm; $1.2p_yZ_x$ = 88 kNm

$\mathbf{M_{cx}}$ = **82 kNm** > M_x = 1.1 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 18 kNm; $1.2p_yZ_y$ = 14 kNm

$\mathbf{M_{cy}}$ = **14 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis)	$\mathbf{L_y}$	=	3.91 m	
Effective Length	$\mathbf{L_{Ey}}$	=	1.0 L = 3.9 m	*(Clause 8.3.4)*
Minor Axis Slenderness	$\boldsymbol{\lambda}$	=	L_{Ey} / r_y = 164.7	
Buckling parameter	**u**	=	0.89	*(Clause 8.3.5.3)*
	$\boldsymbol{\lambda / x}$	=	7.32	
Slenderness factor	$\boldsymbol{\nu}$	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$	*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.722	
	$\boldsymbol{\beta_w}$	=	1.000	*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	$\boldsymbol{\lambda_{LT}}$	=	$u\nu\lambda(\beta_w)^{0.5}$ = 105.8	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	$\mathbf{p_y}$	=	355.00 N/mm^2	
Buckling strength	$\mathbf{p_b}$	=	120.0 N/mm^2	*(Table 8.3a for rolled section)*
Buckling resistance moment	$\mathbf{M_b}$	=	27.8 kNm	*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	$\mathbf{m_{LT}}$	=	0.93	*(Table 8.4a for no intermediate lateral restraint)*

$\mathbf{m_{LT}M_x}$ = 1.06 < M_b = 27.8 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and $\mathbf{M_x}$ = 1.14 < M_{cx} = 82.4 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{139.9}{1029.5} + \frac{1.1}{82.4} + \frac{0.0}{13.7}$$

$$= 0.14 + 0.01 + 0.00$$

$$= 0.15$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	3.91 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	3.91 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	46.0	≈ 46	
Maximum Thickness	T	=	9.3 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	325.00 N/mm^2				
p_c in Table 8.8 b)		=	306.00 N/mm^2				
p_c in Table 8.8 c)		=	286.00 N/mm^2				
p_c in Table 8.8 d)		=	265.00 N/mm^2				
Compressive Strength	p_{cx}	=	325.00 N/mm^2				*(Table 8.8(a))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	3.91 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	3.91 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	164.7	≈ 165	
Maximum Thickness	T	=	9.3 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	69.00 N/mm^2				
p_c in Table 8.8 b)		=	65.00 N/mm^2				
p_c in Table 8.8 c)		=	61.00 N/mm^2				
p_c in Table 8.8 d)		=	57.00 N/mm^2				
Compressive Strength	p_{cy}	=	65.00 N/mm^2				*(Table 8.8(b))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 65.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{139.9}{188.5} + \frac{1.1}{82.4} + \frac{0.0}{13.7}$$

$$= 0.74 + 0.01 + 0.00$$

$$= 0.76$$

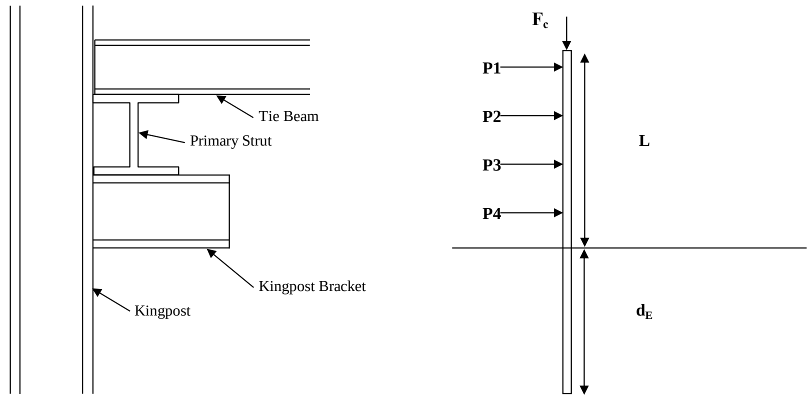
$$< 1$$

Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-A	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

Structural Steel Design - Kingpost

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")



1. Section Properties

Try Section : 305 x 305 x 198 UC | Grade 55 | Hot Rolled

Depth of Section	**D**	=	339.9	mm	Elastic Modulus (X-Axis)	Z_x	=	2990000	mm^3
Width of Section	**B**	=	314.1	mm	Elastic Modulus (Y-Axis)	Z_y	=	1030000	mm^3
Web Thickness	**t**	=	19.2	mm	Plastic Modulus (X-Axis)	S_x	=	3440000	mm^3
Flange Thickness	**T**	=	31.4	mm	Plastic Modulus (Y-Axis)	S_y	=	1580000	mm^3
Depth between Fillets	**d**	=	246.6	mm	Buckling Parameter	**u**	=	0.854	
Second Moment of Area (X-Axis)	I_x	=	5.08E+08	mm^4	Torsional Index	**x**	=	10.2	
Second Moment of Area (Y-Axis)	I_y	=	1.62E+08	mm^4	Area of Section	A_g	=	25200	mm^2
Radius of Gyration (X-Axis)	r_x	=	142.0	mm	Mass per Length	**w**	=	198.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	80.2	mm	Design Strength	p_y	=	440	N/mm^2
Modulus of Elasticity	**E**	=	205000.00	MPa					

2. Ultimate Design Load

Strut Level (mPD)	Strut Section	Mass per Length, w (kg/m)	Max. Unrestrained Length (m)	Max. Strut Compressive Force (kN)	Self-Weight of Strut (kN)	Lateral Load from Strut (2.5% of Axial Force) (kN)
4.80	Double 305 x 305 x 158 UC	316.00	13.67	824.82	42.37	20.62
1.70	Double 305 x 305 x 198 UC	396.00	13.67	1721.08	53.10	43.03
-1.40	Double 356 x 406 x 393 UC	786.00	13.67	2032.48	105.39	50.81
-4.50	Double 356 x 406 x 393 UC	786.00	13.67	1998.90	105.39	49.97

Strut Level (mPD)	Tie Beam Section	Mass per Length, w (kg/m)	Length (m)	Self-Weight of Tie Beam (kN)
4.80	Single 203 x 102 x 23 UB	23.00	3.91	0.88
1.70	Single 203 x 102 x 23 UB	23.00	3.91	0.88
-1.40	Single 203 x 102 x 23 UB	23.00	3.91	0.88
-4.50	Single 203 x 102 x 23 UB	23.00	3.91	0.88

Kingpost Top Level	=	+4.80	mPD
Final Excavation Level	=	-7.10	mPD
Length of Kingpost, L	=	11.90	m
Depth of Embedment, d_E	=	36.90	m
Design Eccentricity for Axial Loads	=	473.45	mm

Maximum Axial Force (unfactored)	=	Total self-weight of kingpost, tie beams and struts + 2.5% of total strut axial force	=	568.99	kN
Maximum Bending Moment (unfactored)	=	Total unfactored moment due to eccentricity	=	77.9	kNm
Maximum Shear Force (unfactored)	=	--	=	0.0	kN
Load Factor	=	1.40			

Design Bending Moment (X-Axis)	M_x	=	109.0	kNm	Design Shear Force	V	=	0.0	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	796.6	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.8$

b/T =	5.0	<	8.0 ε	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t =	12.8	<	80 ε	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 12.8 < 70ε = 55.3

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area	A_v	=	6526 mm^2				
Shear Capacity	V_c	=	$p_yA_v/(3)$^0.5				
		=	1658 kN				
Design Shear Force	V	=	0.0 kN	<	P_v =	1658 kN	***Check Shear OK***
Since,	$0.6V_c$	=	995 kN	>	V		***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis	M_{cx}	=	Lesser of p_yS_x	and	$1.2p_yZ_x$		
	p_yS_x	=	1514 kNm		$1.2p_yZ_x$ =	1579 kNm	
	M_{cx}	=	**1514 kNm**	>	M_x =	109.0 kNm	***Major Moment Capacity OK***
Minor Axis	M_{cy}	=	Lesser of p_yS_y	and	$1.2p_yZ_y$		
	p_yS_y	=	695 kNm		$1.2p_yZ_y$ =	544 kNm	
	M_{cy}	=	**544 kNm**	>	M_y =	0.0 kNm	***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Length of Kingpost	L	=	11.90 m		
Effective Length	L_E	=	2.0 L	= 23.8 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_{Ey} / r_y	= 296.8	
Buckling parameter	u	=	0.85		*(Clause 8.3.5.3)*
	λ / x	=	29.09		
Slenderness factor	ν	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$		*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.390		
	β_w	=	1.000		*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$u\nu\lambda(\beta_w)^{0.5}$	= 98.8	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	440.00 N/mm^2		
Buckling strength	p_b	=	149.0 N/mm^2		*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	512.6 kNm		*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93		*(Table 8.4a for no intermediate lateral restraint)*

	$m_{LT}M_x$	=	101.36	<	M_b =	512.6 kNm	*(Clause 8.3.5.2 Eqn 8.18)*
and	M_x	=	108.99	<	M_{cx} =	1513.6 kNm	*(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{796.6}{11088.0} + \frac{109.0}{1513.6} + \frac{0.0}{543.8}$$

$$= 0.07 + 0.07 + 0.00$$

$$= 0.14$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**			
Length of Kingpost	L_x	=	11.90 m			
Effective Length	L_{Ex}	=	2.0 L_x	=	23.80 m	*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	167.6 ≈ 170	
Maximum Thickness	T	=	31.4 mm	≤	40 mm	
Type of Section		=	Rolled H-section ≤ 40mm			
Designation of buckling curves for different section types:				Buckling Curve	b)	*(Table 8.7)*
p_c in Table 8.8 a)		=	66.00 N/mm^2			
p_c in Table 8.8 b)		=	64.00 N/mm^2			
p_c in Table 8.8 c)		=	60.00 N/mm^2			
p_c in Table 8.8 d)		=	57.00 N/mm^2			
Compressive Strength	p_{cx}	=	64.00 N/mm^2			*(Table 8.8(b))*

Axis of buckling		=	**y-y**			
Unrestrain length (Y-Axis)	L_y	=	11.90 m			
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	11.90 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	148.4 ≈ 150	
Maximum Thickness	T	=	31.4 mm	≤	40 mm	
Type of Section		=	Rolled H-section ≤ 40mm			
Designation of buckling curves for different section types:				Buckling Curve	c)	*(Table 8.7)*
p_c in Table 8.8 a)		=	84.00 N/mm^2			
p_c in Table 8.8 b)		=	80.00 N/mm^2			
p_c in Table 8.8 c)		=	76.00 N/mm^2			
p_c in Table 8.8 d)		=	71.00 N/mm^2			
Compressive Strength	p_{cy}	=	76.00 N/mm^2			*(Table 8.8(c))*

Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	64.0 N/mm^2	
Moment equivalent factor m for flexural buckling						
	m_x	=	0.95			*(Table 8.9)*
	m_y	=	0.95			*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{796.6}{1612.8} + \frac{103.5}{1513.6} + \frac{0.0}{543.8}$$

$$= 0.49 + 0.07 + 0.00$$

$$= 0.56$$

$$< 1$$

Overall Capacity OK

10. Frictional and End-Bearing Resistance Check (for Granular Soils)

(Pile design based on "Code of Practice for Foundations 2017 (BD)" and "Foundation Design and Construction (GEO Publication No. 1/2006)")

For the **effective stress method**, the ultimate shaft resistance is given by: $\tau_s = c' + K_s\,\sigma'_v\,\tan(\delta_s)$ *GEO Publication No. 1/2006 Equation 6.4*

For the **beta method**, the ultimate shaft resistance is given by: $\tau_s = \beta\,\sigma'_v$ *GEO Publication No. 1/2006 Equation 6.5*

Soil Properties

Soil	γ (kN/m^3)	Eff. Stress / Beta Method	c' (kPa)	ϕ' (deg.)	β
Colluvium	19.00	Eff. Stress	0.0	30.0	
CDG	19.00	Eff. Stress	5.0	37.0	

Soil Stratification

Soil	Top (mPD)	Bottom (mPD)
Colluvium	-7.10	-7.88
CDG	-7.88	-16.00
CDG	-16.00	-22.00
CDG	-22.00	-28.00
CDG	-28.00	-34.00
CDG	-34.00	-40.00

Final Excavation Level	=	-7.10	mPD
Design Groundwater Level	=	-7.60	mPD
Design Rockhead Level	=	-40.00	mPD
Depth of Embedment in Soil, $d_{E,soil}$	=	32.90	m
Surface Area of Section Per Metre, A_s	=	1.87	m^2/m
Area of Section, A_g	=	25200	mm^2

Factor of Safety against Ground Failure	=	3.0	*GEO Publication No. 1/2006 Table 6.1*
Mobilisation Factor for End-Bearing Resistance, f_b	=	5.0	*GEO Publication No. 1/2006 Table 6.2*
Mobilisation Factor for Shaft Resistance, f_s	=	1.5	*GEO Publication No. 1/2006 Table 6.2*
K_s / K_o	=	0.67	*GEO Publication No. 1/2006 Section 6.4.4.3*
δ_s / ϕ'	=	0.67	

Top (mPD)	Bottom (mPD)	Soil	γ (kN/m^3)	σ_v (kPa)		u (kPa)		σ_v' (kPa)	
				Top	Bottom	Top	Bottom	Top	Bottom
-7.10	-7.60	Colluvium	19.00	0.0	9.5	0.0	0.0	0.0	9.5
-7.60	-7.88	Colluvium	19.00	9.5	14.8	0.0	2.7	9.5	12.1
-7.88	-16.00	CDG	19.00	14.8	169.1	2.7	82.3	12.1	86.8
-16.00	-22.00	CDG	19.00	169.1	283.1	82.3	141.1	86.8	142.0
-22.00	-28.00	CDG	19.00	283.1	397.1	141.1	199.9	142.0	197.2
-28.00	-34.00	CDG	19.00	397.1	511.1	199.9	258.7	197.2	252.4
-34.00	-40.00	CDG	19.00	511.1	625.1	258.7	317.5	252.4	307.6
-	-	-	-	-	-	-	-	-	-

Top (mPD)	Bottom (mPD)	Soil	c' (kPa)	ϕ' (deg.)	K_o = 1 - sin(ϕ')	K_s	δ_s	β
-7.10	-7.60	Colluvium	0.0	30.0	0.500	0.335	20.1	-
-7.60	-7.88	Colluvium	0.0	30.0	0.500	0.335	20.1	-
-7.88	-16.00	CDG	5.0	37.0	0.398	0.267	24.8	-
-16.00	-22.00	CDG	5.0	37.0	0.398	0.267	24.8	-
-22.00	-28.00	CDG	5.0	37.0	0.398	0.267	24.8	-
-28.00	-34.00	CDG	5.0	37.0	0.398	0.267	24.8	-
-34.00	-40.00	CDG	5.0	37.0	0.4	0.267	24.8	-
-	-	-	-	-	-	-	-	-

Top (mPD)	Bottom (mPD)	Soil	Mobilised Shaft Resistance, τ_s (kPa)		Mobilised Shaft Resistance, Q_s (kN)
			Top	Bottom	
-7.10	-7.60	Colluvium	0.0	1.2	0.5
-7.60	-7.88	Colluvium	1.2	1.5	0.7
-7.88	-16.00	CDG	6.5	15.7	168.4
-16.00	-22.00	CDG	15.7	22.5	214.2
-22.00	-28.00	CDG	22.5	29.3	290.5
-28.00	-34.00	CDG	29.3	36.1	366.9
-34.00	-40.00	CDG	36.1	42.9	443.2
-	-	-	-	-	-

Ultimate Shaft Resistance, Q_s	=	1484.4	kN	
Allowable Shaft Resistance, Q_s / f_s	=	989.6	kN	
	>	796.6	kN	*Frictional Resistance OK*
Vertical Effective Stress at Base, σ'_{vo}	=	307.6	kPa	
Bearing Capacity Factor, N_q	=	120		*GEO Publication No. 1/2006 Figure 6.2*
Ultimate Base Resistance, $Q_b = N_q\ \sigma'_{vo}\ A_g$	=	930.1	kN	
Allowable Base Resistance, Q_b / f_b	=	186.0	kN	
	<	796.6	kN	*End-Bearing Resistance Not OK*
Ultimate Pile Resistance, $Q_s + Q_b$	=	2414.5	kN	
Allowable Pile Resistance, $(Q_s + Q_b)$ / FoS	=	804.8	kN	
	>	796.6	kN	*Pile Resistance OK*

Insufficient Pile Resistance If Driven H-Pile is Used, Socketed-H Pile is Needed

11. Socketed-H Pile Design

Depth of Embedment in Soil, $d_{E,soil}$	=	32.90	m
Total Depth of Embedment, d_E	=	36.90	m
Socket Length	=	4.00	m
Factor of Safety	=	3.0	

Bond Friction between Rock and Grout

Category of Rock		Allowable bond or friction between rock and concrete or grout for piles (kPa)
		Under compression (Fs)
Grade III or better, i.e., Cat. 1(a) - 1(c)	◉	700
Grade IV or worse, i.e., Cat. 1(d) or 2	○	300

BD CoP Foundation Table 2.2

Minimum Grout Cover	=	40	mm	*BD CoP Foundation Clause 5.4.2 (2)*
Socket Diameter	=	700	mm	*Socket Diameter OK*
Bond Friction between Rock and Grout	=	6157.5	kN	
Allowable Bearing Capacity	=	2052.5	kN	
	>	796.6	kN	*Friction between Rock and Grout OK*

Bond Friction between Rock and Grout

Allowable Bond Stress between Steel and Grout	=	400	kPa	
Surface Area of Section Per Metre, A_s	=	1.87	m^2/m	
Bond Friction bewteen Steel and Grout	=	2992.0	kN	
Allowable Bearing Capacity	=	997.3	kN	
	>	796.6	kN	*Friction between Steel and Grout OK*

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.1
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section A-A**

Groundwater Drawdown Induced Settlement - Southwest Wall

The calculation of ground settlement due to dewatering and subsequent drawdown behind wall assumes that full consolidation has taken place.
Therefore, the change in the porewater pressure is equal to the change in the soil's effective stress.

Initial Groundwater Level	H_0	=	+3.00	mPD
Groundwater Level After Drawdown	H_1	=	+2.00	mPD
Design Groundwater Drawdown	δH	=	1.00	m
Unit Weight of Water	γ_w	=	9.81	kN/m^3
Change in Vertical Effective Stress	$\Delta\sigma_v'$	=	9.81	kPa

(Immediately Behind Wall)

Soil Type	Top Level (mPD)	Bottom Level (mPD)	Thickness of Soil Layer (m)	E'_{ref} (kN/m^2)	E_{inc} (kN/m^2)	Y_{ref} (mPD)	Modulus of Elasticity, E' (kN/m^2)	Change in Stress, $\Delta\sigma_v'$ (kPa)	Change in Strain, $\Delta\varepsilon_v'$	Differential Settlement (mm)
Fill (Dry)	6.00	3.00	3.00	10000	3333	2.00	10000	0.00	0.000E+00	0.000
Fill	3.00	2.00	1.00	10000	3333	2.00	10000	9.81	9.810E-04	-0.981
	2.00	-0.89	2.89	10000	3333	2.00	14816	9.81	6.621E-04	-1.914
Alluvial Sand	-0.89	-0.95	0.06	10000	3750	-2.00	10000	9.81	9.810E-04	-0.059
Marine Sand	-0.95	-2.89	1.94	8000	2000	0.00	11840	9.81	8.285E-04	-1.607
Alluvial Clay	-2.89	-4.15	1.26	8000	4267	-2.50	12352	9.81	7.942E-04	-1.001
Alluvial Sand	-4.15	-6.15	2.00	10000	3750	-2.00	21813	9.81	4.497E-04	-0.899
Colluvium	-6.15	-6.48	0.33	16000	2286	-7.00	16000	9.81	6.131E-04	-0.202
CDG	-6.48	-14.00	7.52	35000	1625	-14.00	35000	9.81	2.803E-04	-2.108
	-14.00	-19.20	5.20	35000	1625	-14.00	39225	9.81	2.501E-04	-1.300
	-19.20	-24.40	5.20	35000	1625	-14.00	47675	9.81	2.058E-04	-1.070
	-24.40	-29.60	5.20	35000	1625	-14.00	56125	9.81	1.748E-04	-0.909
	-29.60	-34.80	5.20	35000	1625	-14.00	64575	9.81	1.519E-04	-0.790
	-34.80	-40.00	5.20	35000	1625	-14.00	73025	9.81	1.343E-04	-0.699

(Design R.H.)

Maximum Settlement due to Groundwater Drawdown, $S_{d,max}$	-13.539	mm

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section A-A**

Groundwater Drawdown Induced Settlement - Northeast Wall

The calculation of ground settlement due to dewatering and subsequent drawdown behind wall assumes that full consolidation has taken place.
Therefore, the change in the porewater pressure is equal to the change in the soil's effective stress.

Initial Groundwater Level	H_0	=	+3.00	mPD
Groundwater Level After Drawdown	H_1	=	+2.00	mPD
Design Groundwater Drawdown	δH	=	1.00	m
Unit Weight of Water	γ_w	=	9.81	kN/m^3
Change in Vertical Effective Stress	$\Delta\sigma_v'$	=	9.81	kPa

(Immediately Behind Wall)

Soil Type	Top Level (mPD)	Bottom Level (mPD)	Thickness of Soil Layer (m)	E'_{ref} (kN/m^2)	E_{inc} (kN/m^2)	Y_{ref} (mPD)	Modulus of Elasticity, E' (kN/m^2)	Change in Stress, $\Delta\sigma_v'$ (kPa)	Change in Strain, $\Delta\varepsilon_v'$	Differential Settlement (mm)
Fill (Dry)	6.00	3.00	3.00	10000	3333	2.00	10000	0.00	0.000E+00	0.000
Fill	3.00	2.00	1.00	10000	3333	2.00	10000	9.81	9.810E-04	-0.981
	2.00	-0.38	2.38	10000	3333	2.00	13966	9.81	7.024E-04	-1.672
Alluvial Sand	-0.38	-1.30	0.92	10000	3750	-2.00	10000	9.81	9.810E-04	-0.903
Marine Sand	-1.30	-3.30	2.00	8000	2000	0.00	12600	9.81	7.786E-04	-1.557
Alluvial Clay	-3.30	-4.65	1.35	8000	4267	-2.50	14294	9.81	6.863E-04	-0.927
Alluvial Sand	-4.65	-6.34	1.69	10000	3750	-2.00	23106	9.81	4.246E-04	-0.718
Colluvium	-6.34	-7.88	1.54	16000	2286	-7.00	16251	9.81	6.036E-04	-0.930
CDG	-7.88	-14.00	6.12	35000	1625	-14.00	35000	9.81	2.803E-04	-1.715
	-14.00	-19.20	5.20	35000	1625	-14.00	39225	9.81	2.501E-04	-1.300
	-19.20	-24.40	5.20	35000	1625	-14.00	47675	9.81	2.058E-04	-1.070
	-24.40	-29.60	5.20	35000	1625	-14.00	56125	9.81	1.748E-04	-0.909
	-29.60	-34.80	5.20	35000	1625	-14.00	64575	9.81	1.519E-04	-0.790
	-34.80	-40.00	5.20	35000	1625	-14.00	73025	9.81	1.343E-04	-0.699

(Design R.H.)

Maximum Settlement due to Groundwater Drawdown, $S_{d,max}$	-14.169	mm

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.3
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

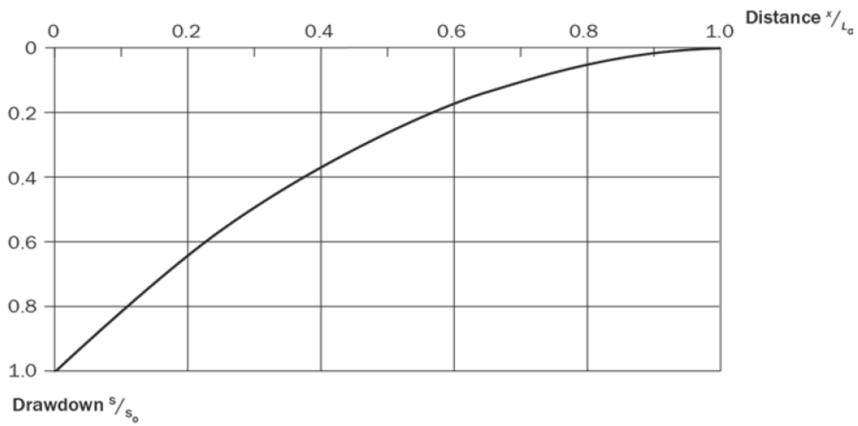
Location: **STN Pumping Station - Section A-A**

Vertical Settlement Behind Wall due to Groundwater Drawdown

(According to CIRIA C750 - Groundwater Control: Design and Practice)

The groundwater drawdown behind wall is estimated by the dimensionless drawdown curve for horizontal plane flow, as shown in Figure 6.16 of CIRIA C750.

			Southwest Wall	Northeast Wall
Design Groundwater Drawdown	δH	=	1.00 m	1.00 m
Permeability of Soil	k	=	1.00E-04 m/s	1.00E-04 m/s
Empirical Calibration Factor	C	=	3000	3000
Distance of Influence, $L_0 = C\delta Hk^{1/2}$		=	30.00 m	30.00 m



Legend for Figure 6.16 of CIRIA C750

x = Horizontal Distance from Wall (m)

L_0 = Distance of Influence (m)

s = Drawdown at Horizontal Distance x (m)

$s_0 = \delta H$ = Drawdown Immediately Behind Wall (m)

s/s_0 = Dimensionless Drawdown

x/L_0 = Normalised Distance from Wall

Figure 6.16 of CIRIA C750: Normalised drawdown curve for horizontal plane low

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section A-A**

Vertical Settlement Behind Wall due to Wall Installation

The vertical settlement behind wall due to effects of wall installation is obtained from PLAXIS 2D. Past experience of pipe pile wall installation in Hong Kong has shown that the associated ground movements are very small, typically less than 5 mm. In some cases, no movement was observed (Morton et al., 1980).

Vertical Settlement Behind Wall due to Excavation

The vertical settlement behind wall due to effects of excavation is obtained from PLAXIS 2D. The soil heave immediately behind the wall due to elastic unloading associated with the use of elastoplastic Mohr-Coulomb model has not been corrected.

Estimated Total Settlement Behind Wall due to Wall Installation, Excavation and Groundwater Drawdown

The estimated total settlement behind wall due to the combined effects of wall installation, excavation and groundwater drawdown is summarised in the following table.

			Southwest Wall	Northeast Wall
Maximum Total Settlement	$S_{T,max}$	=	-22.634 mm	-21.985 mm

Table Legend

x = Horizontal Distance from Wall (m)
S_w = Vertical Settlement due to Wall Installation (mm)
S_e = Vertical Settlement due to Excavation, from PLAXIS 2D (mm)
x/L_0 = Normalised Distance from Wall
s/s_0 = Dimensionless Drawdown
S_d = Vertical Settlement due to Groundwater Drawdown (mm)
S_T = Total Vertical Settlement (mm)

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.5
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section A-A**

Estimated Total Settlement - Southwest Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
0.000	-2.329	8.342	0.000	1.000	-13.539	-7.526
0.007	-2.323	8.301	0.000	1.000	-13.533	-7.555
0.007	-2.323	8.301	0.000	1.000	-13.533	-7.555
1.300	-1.780	3.597	0.043	0.918	-12.424	-10.607
1.300	-1.780	3.597	0.043	0.918	-12.424	-10.607
1.311	-1.778	3.589	0.044	0.917	-12.414	-10.603
1.311	-1.778	3.589	0.044	0.917	-12.414	-10.603
2.603	-1.558	-0.915	0.087	0.835	-11.307	-13.780
2.603	-1.558	-0.915	0.087	0.835	-11.307	-13.780
2.615	-1.556	-0.964	0.087	0.834	-11.296	-13.817
2.615	-1.556	-0.964	0.087	0.834	-11.296	-13.817
3.907	-1.385	-5.718	0.130	0.759	-10.271	-17.373
3.907	-1.385	-5.718	0.130	0.759	-10.271	-17.373
3.920	-1.383	-5.759	0.131	0.758	-10.261	-17.403
3.920	-1.383	-5.759	0.131	0.758	-10.261	-17.403
5.211	-1.235	-9.516	0.174	0.685	-9.270	-20.021
5.211	-1.235	-9.516	0.174	0.685	-9.270	-20.021
5.224	-1.234	-9.547	0.174	0.684	-9.260	-20.041
5.224	-1.234	-9.547	0.174	0.684	-9.260	-20.041
6.515	-1.101	-12.289	0.217	0.614	-8.316	-21.706
6.515	-1.101	-12.289	0.217	0.614	-8.316	-21.706
6.528	-1.100	-12.311	0.218	0.614	-8.307	-21.719
6.528	-1.100	-12.311	0.218	0.614	-8.307	-21.719
7.820	-0.980	-14.136	0.261	0.549	-7.433	-22.550
7.820	-0.980	-14.136	0.261	0.549	-7.433	-22.550
7.832	-0.979	-14.150	0.261	0.548	-7.425	-22.554
7.832	-0.979	-14.150	0.261	0.548	-7.425	-22.554
9.124	-0.871	-15.196	0.304	0.485	-6.567	-22.634
9.124	-0.871	-15.196	0.304	0.485	-6.567	-22.634
9.137	-0.870	-15.203	0.305	0.485	-6.560	-22.633
9.137	-0.870	-15.203	0.305	0.485	-6.560	-22.633
10.428	-0.772	-15.619	0.348	0.433	-5.861	-22.252
10.428	-0.772	-15.619	0.348	0.433	-5.861	-22.252
10.441	-0.771	-15.621	0.348	0.432	-5.854	-22.246
10.441	-0.771	-15.621	0.348	0.432	-5.854	-22.246
11.733	-0.683	-15.553	0.391	0.381	-5.154	-21.390
11.733	-0.683	-15.553	0.391	0.381	-5.154	-21.390
11.745	-0.682	-15.550	0.392	0.380	-5.147	-21.380
11.745	-0.682	-15.550	0.392	0.380	-5.147	-21.380
13.037	-0.602	-15.131	0.435	0.332	-4.495	-20.228
13.037	-0.602	-15.131	0.435	0.332	-4.495	-20.228
13.050	-0.602	-15.126	0.435	0.332	-4.488	-20.215
13.050	-0.602	-15.126	0.435	0.332	-4.488	-20.215
14.341	-0.530	-14.474	0.478	0.284	-3.847	-18.851
14.341	-0.530	-14.474	0.478	0.284	-3.847	-18.851
14.354	-0.529	-14.466	0.478	0.284	-3.841	-18.836
14.354	-0.529	-14.466	0.478	0.284	-3.841	-18.836
15.646	-0.464	-13.684	0.522	0.241	-3.258	-17.407

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.6
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section A-A**

Estimated Total Settlement - Southwest Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
15.646	-0.464	-13.684	0.522	0.241	-3.258	-17.407
15.659	-0.464	-13.676	0.522	0.240	-3.253	-17.392
15.659	-0.464	-13.676	0.522	0.240	-3.253	-17.392
16.950	-0.406	-12.847	0.565	0.202	-2.728	-15.981
16.950	-0.406	-12.847	0.565	0.202	-2.728	-15.981
16.963	-0.405	-12.839	0.565	0.201	-2.723	-15.966
16.963	-0.405	-12.839	0.565	0.201	-2.723	-15.966
18.254	-0.353	-12.022	0.608	0.164	-2.221	-14.596
18.254	-0.353	-12.022	0.608	0.164	-2.221	-14.596
18.267	-0.353	-12.013	0.609	0.164	-2.217	-14.584
18.267	-0.353	-12.013	0.609	0.164	-2.217	-14.584
19.559	-0.307	-11.240	0.652	0.134	-1.809	-13.356
19.559	-0.307	-11.240	0.652	0.134	-1.809	-13.356
19.572	-0.306	-11.233	0.652	0.133	-1.805	-13.344
19.572	-0.306	-11.233	0.652	0.133	-1.805	-13.344
20.863	-0.265	-10.544	0.695	0.103	-1.397	-12.206
20.863	-0.265	-10.544	0.695	0.103	-1.397	-12.206
20.876	-0.265	-10.538	0.696	0.103	-1.393	-12.196
20.876	-0.265	-10.538	0.696	0.103	-1.393	-12.196
22.167	-0.229	-10.034	0.739	0.081	-1.090	-11.353
22.167	-0.229	-10.034	0.739	0.081	-1.090	-11.353
22.180	-0.228	-10.029	0.739	0.080	-1.088	-11.345
22.180	-0.228	-10.029	0.739	0.080	-1.088	-11.345
23.472	-0.196	-9.589	0.782	0.059	-0.796	-10.582
23.472	-0.196	-9.589	0.782	0.059	-0.796	-10.582
23.485	-0.196	-9.583	0.783	0.059	-0.793	-10.572
23.485	-0.196	-9.583	0.783	0.059	-0.793	-10.572
24.776	-0.168	-9.198	0.826	0.042	-0.572	-9.938
24.776	-0.168	-9.198	0.826	0.042	-0.572	-9.938
24.789	-0.167	-9.196	0.826	0.042	-0.570	-9.933
24.789	-0.167	-9.196	0.826	0.042	-0.570	-9.933
26.080	-0.143	-8.886	0.869	0.029	-0.395	-9.424
26.080	-0.143	-8.886	0.869	0.029	-0.395	-9.424
26.093	-0.142	-8.878	0.870	0.029	-0.394	-9.414
26.093	-0.142	-8.878	0.870	0.029	-0.394	-9.414
27.385	-0.121	-8.486	0.913	0.017	-0.236	-8.843
27.385	-0.121	-8.486	0.913	0.017	-0.236	-8.843
27.398	-0.120	-8.480	0.913	0.017	-0.235	-8.835
27.398	-0.120	-8.480	0.913	0.017	-0.235	-8.835
28.689	-0.101	-8.179	0.956	0.009	-0.118	-8.398
28.689	-0.101	-8.179	0.956	0.009	-0.118	-8.398
28.702	-0.101	-8.169	0.957	0.009	-0.117	-8.388
28.702	-0.101	-8.169	0.957	0.009	-0.117	-8.388
29.993	-0.085	-7.866	1.000	0.000	-0.001	-7.951
29.993	-0.085	-7.866	1.000	0.000	-0.001	-7.951
30.006	-0.085	-7.870	1.000	0.000	0.000	-7.955
30.006	-0.085	-7.870	1.000	0.000	0.000	-7.955
31.298	-0.070	-7.580	1.000	0.000	0.000	-7.650

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.7
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section A-A**

Estimated Total Settlement - Southwest Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
31.298	-0.070	-7.580	1.000	0.000	0.000	-7.650
31.311	-0.070	-7.572	1.000	0.000	0.000	-7.642
31.311	-0.070	-7.572	1.000	0.000	0.000	-7.642
32.602	-0.058	-7.311	1.000	0.000	0.000	-7.368
32.602	-0.058	-7.311	1.000	0.000	0.000	-7.368
32.615	-0.058	-7.309	1.000	0.000	0.000	-7.366
32.615	-0.058	-7.309	1.000	0.000	0.000	-7.366
33.906	-0.047	-7.047	1.000	0.000	0.000	-7.094
33.906	-0.047	-7.047	1.000	0.000	0.000	-7.094
33.920	-0.047	-7.043	1.000	0.000	0.000	-7.090
33.920	-0.047	-7.043	1.000	0.000	0.000	-7.090
35.211	-0.037	-6.804	1.000	0.000	0.000	-6.842
35.211	-0.037	-6.804	1.000	0.000	0.000	-6.842
35.224	-0.037	-6.801	1.000	0.000	0.000	-6.839
35.224	-0.037	-6.801	1.000	0.000	0.000	-6.839
36.515	-0.029	-6.578	1.000	0.000	0.000	-6.607
36.515	-0.029	-6.578	1.000	0.000	0.000	-6.607
36.528	-0.029	-6.575	1.000	0.000	0.000	-6.605
36.528	-0.029	-6.575	1.000	0.000	0.000	-6.605
37.820	-0.023	-6.366	1.000	0.000	0.000	-6.389
37.820	-0.023	-6.366	1.000	0.000	0.000	-6.389
37.833	-0.023	-6.365	1.000	0.000	0.000	-6.387
37.833	-0.023	-6.365	1.000	0.000	0.000	-6.387
39.124	-0.017	-6.162	1.000	0.000	0.000	-6.178
39.124	-0.017	-6.162	1.000	0.000	0.000	-6.178
39.137	-0.017	-6.160	1.000	0.000	0.000	-6.177
39.137	-0.017	-6.160	1.000	0.000	0.000	-6.177
40.428	-0.012	-5.971	1.000	0.000	0.000	-5.983
40.428	-0.012	-5.971	1.000	0.000	0.000	-5.983
40.441	-0.012	-5.970	1.000	0.000	0.000	-5.982
40.441	-0.012	-5.970	1.000	0.000	0.000	-5.982
41.733	-0.008	-5.792	1.000	0.000	0.000	-5.800
41.733	-0.008	-5.792	1.000	0.000	0.000	-5.800
41.746	-0.008	-5.791	1.000	0.000	0.000	-5.799
41.746	-0.008	-5.791	1.000	0.000	0.000	-5.799
43.037	-0.004	-5.627	1.000	0.000	0.000	-5.631
43.037	-0.004	-5.627	1.000	0.000	0.000	-5.631
43.050	-0.004	-5.625	1.000	0.000	0.000	-5.629
43.050	-0.004	-5.625	1.000	0.000	0.000	-5.629
44.341	-0.001	-5.478	1.000	0.000	0.000	-5.479
44.341	-0.001	-5.478	1.000	0.000	0.000	-5.479
44.354	-0.001	-5.476	1.000	0.000	0.000	-5.477
44.354	-0.001	-5.476	1.000	0.000	0.000	-5.477
45.646	0.001	-5.350	1.000	0.000	0.000	-5.348
45.646	0.001	-5.350	1.000	0.000	0.000	-5.348
45.659	0.001	-5.347	1.000	0.000	0.000	-5.346
45.659	0.001	-5.347	1.000	0.000	0.000	-5.346
46.950	0.003	-5.228	1.000	0.000	0.000	-5.225

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.8
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section A-A**

Estimated Total Settlement - Southwest Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
46.950	0.003	-5.228	1.000	0.000	0.000	-5.225
46.963	0.003	-5.225	1.000	0.000	0.000	-5.222
46.963	0.003	-5.225	1.000	0.000	0.000	-5.222
48.254	0.005	-5.113	1.000	0.000	0.000	-5.108
48.254	0.005	-5.113	1.000	0.000	0.000	-5.108
48.267	0.005	-5.110	1.000	0.000	0.000	-5.105
48.267	0.005	-5.110	1.000	0.000	0.000	-5.105
49.559	0.006	-4.998	1.000	0.000	0.000	-4.991
49.559	0.006	-4.998	1.000	0.000	0.000	-4.991
49.572	0.006	-4.996	1.000	0.000	0.000	-4.990
49.572	0.006	-4.996	1.000	0.000	0.000	-4.990
50.863	0.007	-4.906	1.000	0.000	0.000	-4.898
50.863	0.007	-4.906	1.000	0.000	0.000	-4.898
50.876	0.007	-4.905	1.000	0.000	0.000	-4.898
50.876	0.007	-4.905	1.000	0.000	0.000	-4.898
52.167	0.008	-4.830	1.000	0.000	0.000	-4.822
52.167	0.008	-4.830	1.000	0.000	0.000	-4.822
52.180	0.008	-4.829	1.000	0.000	0.000	-4.821
52.180	0.008	-4.829	1.000	0.000	0.000	-4.821
53.472	0.009	-4.763	1.000	0.000	0.000	-4.754
53.472	0.009	-4.763	1.000	0.000	0.000	-4.754
53.485	0.009	-4.762	1.000	0.000	0.000	-4.753
53.485	0.009	-4.762	1.000	0.000	0.000	-4.753
54.776	0.010	-4.707	1.000	0.000	0.000	-4.697
54.776	0.010	-4.707	1.000	0.000	0.000	-4.697
54.789	0.010	-4.707	1.000	0.000	0.000	-4.698
54.789	0.010	-4.707	1.000	0.000	0.000	-4.698
56.081	0.010	-4.660	1.000	0.000	0.000	-4.650
56.081	0.010	-4.660	1.000	0.000	0.000	-4.650
56.094	0.010	-4.662	1.000	0.000	0.000	-4.652
56.094	0.010	-4.662	1.000	0.000	0.000	-4.652
57.385	0.010	-4.649	1.000	0.000	0.000	-4.638
57.385	0.010	-4.649	1.000	0.000	0.000	-4.638
57.399	0.010	-4.654	1.000	0.000	0.000	-4.644
57.399	0.010	-4.654	1.000	0.000	0.000	-4.644
58.691	0.010	-4.588	1.000	0.000	0.000	-4.578
58.691	0.010	-4.588	1.000	0.000	0.000	-4.578
58.706	0.010	-4.588	1.000	0.000	0.000	-4.577
58.706	0.010	-4.588	1.000	0.000	0.000	-4.577
60.000	0.011	-4.578	1.000	0.000	0.000	-4.567

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.9
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section A-A**

Estimated Total Settlement - Northeast Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
0.000	-2.361	9.057	0.000	1.000	-14.169	-7.474
0.007	-2.355	9.016	0.000	1.000	-14.163	-7.502
0.007	-2.355	9.016	0.000	1.000	-14.163	-7.502
1.298	-1.802	3.927	0.043	0.918	-13.004	-10.879
1.298	-1.802	3.927	0.043	0.918	-13.004	-10.879
1.310	-1.800	3.932	0.044	0.917	-12.994	-10.862
1.310	-1.800	3.932	0.044	0.917	-12.994	-10.862
2.602	-1.581	-0.329	0.087	0.835	-11.834	-13.744
2.602	-1.581	-0.329	0.087	0.835	-11.834	-13.744
2.615	-1.579	-0.379	0.087	0.834	-11.823	-13.781
2.615	-1.579	-0.379	0.087	0.834	-11.823	-13.781
3.908	-1.408	-5.125	0.130	0.759	-10.748	-17.281
3.908	-1.408	-5.125	0.130	0.759	-10.748	-17.281
3.921	-1.407	-5.167	0.131	0.758	-10.738	-17.312
3.921	-1.407	-5.167	0.131	0.758	-10.738	-17.312
5.213	-1.259	-8.839	0.174	0.685	-9.700	-19.797
5.213	-1.259	-8.839	0.174	0.685	-9.700	-19.797
5.230	-1.257	-8.878	0.174	0.684	-9.687	-19.822
5.230	-1.257	-8.878	0.174	0.684	-9.687	-19.822
6.519	-1.125	-11.490	0.217	0.614	-8.701	-21.316
6.519	-1.125	-11.490	0.217	0.614	-8.701	-21.316
7.808	-1.006	-13.185	0.260	0.550	-7.788	-21.979
7.808	-1.006	-13.185	0.260	0.550	-7.788	-21.979
7.824	-1.005	-13.201	0.261	0.549	-7.776	-21.982
7.824	-1.005	-13.201	0.261	0.549	-7.776	-21.982
7.837	-1.004	-13.214	0.261	0.548	-7.767	-21.985
7.837	-1.004	-13.214	0.261	0.548	-7.767	-21.985
9.131	-0.895	-14.132	0.304	0.485	-6.868	-21.896
9.131	-0.895	-14.132	0.304	0.485	-6.868	-21.896
10.426	-0.797	-14.449	0.348	0.433	-6.135	-21.381
10.426	-0.797	-14.449	0.348	0.433	-6.135	-21.381
10.440	-0.796	-14.450	0.348	0.432	-6.127	-21.373
10.440	-0.796	-14.450	0.348	0.432	-6.127	-21.373
11.735	-0.706	-14.324	0.391	0.381	-5.393	-20.424
11.735	-0.706	-14.324	0.391	0.381	-5.393	-20.424
11.750	-0.705	-14.321	0.392	0.380	-5.384	-20.410
11.750	-0.705	-14.321	0.392	0.380	-5.384	-20.410
13.044	-0.625	-13.896	0.435	0.332	-4.700	-19.221
13.044	-0.625	-13.896	0.435	0.332	-4.700	-19.221
14.338	-0.551	-13.293	0.478	0.284	-4.028	-17.872
14.338	-0.551	-13.293	0.478	0.284	-4.028	-17.872
14.353	-0.550	-13.285	0.478	0.284	-4.020	-17.856
14.353	-0.550	-13.285	0.478	0.284	-4.020	-17.856
15.648	-0.484	-12.591	0.522	0.241	-3.409	-16.484
15.648	-0.484	-12.591	0.522	0.241	-3.409	-16.484
15.664	-0.483	-12.582	0.522	0.240	-3.402	-16.467
15.664	-0.483	-12.582	0.522	0.240	-3.402	-16.467
16.956	-0.424	-11.863	0.565	0.201	-2.852	-15.139

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.10
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section A-A**

Estimated Total Settlement - Northeast Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
16.956	-0.424	-11.863	0.565	0.201	-2.852	-15.139
18.249	-0.370	-11.182	0.608	0.164	-2.327	-13.878
18.249	-0.370	-11.182	0.608	0.164	-2.327	-13.878
18.264	-0.370	-11.174	0.609	0.164	-2.322	-13.866
18.264	-0.370	-11.174	0.609	0.164	-2.322	-13.866
19.556	-0.322	-10.615	0.652	0.134	-1.894	-12.831
19.556	-0.322	-10.615	0.652	0.134	-1.894	-12.831
19.568	-0.321	-10.609	0.652	0.133	-1.890	-12.821
19.568	-0.321	-10.609	0.652	0.133	-1.890	-12.821
20.865	-0.278	-10.146	0.695	0.103	-1.462	-11.886
20.865	-0.278	-10.146	0.695	0.103	-1.462	-11.886
20.880	-0.278	-10.143	0.696	0.103	-1.457	-11.877
20.880	-0.278	-10.143	0.696	0.103	-1.457	-11.877
22.175	-0.239	-9.700	0.739	0.080	-1.139	-11.079
22.175	-0.239	-9.700	0.739	0.080	-1.139	-11.079
23.471	-0.205	-9.289	0.782	0.059	-0.833	-10.327
23.471	-0.205	-9.289	0.782	0.059	-0.833	-10.327
23.489	-0.205	-9.282	0.783	0.059	-0.829	-10.316
23.489	-0.205	-9.282	0.783	0.059	-0.829	-10.316
24.783	-0.175	-8.802	0.826	0.042	-0.598	-9.574
24.783	-0.175	-8.802	0.826	0.042	-0.598	-9.574
26.077	-0.148	-8.421	0.869	0.029	-0.414	-8.983
26.077	-0.148	-8.421	0.869	0.029	-0.414	-8.983
26.091	-0.148	-8.415	0.870	0.029	-0.412	-8.975
26.091	-0.148	-8.415	0.870	0.029	-0.412	-8.975
27.383	-0.124	-8.036	0.913	0.017	-0.247	-8.407
27.383	-0.124	-8.036	0.913	0.017	-0.247	-8.407
27.394	-0.124	-8.035	0.913	0.017	-0.246	-8.406
27.394	-0.124	-8.035	0.913	0.017	-0.246	-8.406
28.687	-0.103	-7.696	0.956	0.009	-0.124	-7.923
28.687	-0.103	-7.696	0.956	0.009	-0.124	-7.923
28.701	-0.103	-7.693	0.957	0.009	-0.123	-7.919
28.701	-0.103	-7.693	0.957	0.009	-0.123	-7.919
29.998	-0.085	-7.406	1.000	0.000	0.000	-7.492
29.998	-0.085	-7.406	1.000	0.000	0.000	-7.492
31.296	-0.069	-7.127	1.000	0.000	0.000	-7.197
31.296	-0.069	-7.127	1.000	0.000	0.000	-7.197
31.312	-0.069	-7.123	1.000	0.000	0.000	-7.193
31.312	-0.069	-7.123	1.000	0.000	0.000	-7.193
32.607	-0.055	-6.870	1.000	0.000	0.000	-6.925
32.607	-0.055	-6.870	1.000	0.000	0.000	-6.925
33.903	-0.043	-6.651	1.000	0.000	0.000	-6.694
33.903	-0.043	-6.651	1.000	0.000	0.000	-6.694
33.916	-0.043	-6.649	1.000	0.000	0.000	-6.692
33.916	-0.043	-6.649	1.000	0.000	0.000	-6.692
35.214	-0.033	-6.446	1.000	0.000	0.000	-6.479
35.214	-0.033	-6.446	1.000	0.000	0.000	-6.479
35.227	-0.033	-6.444	1.000	0.000	0.000	-6.477

AECOM AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.11
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section A-A**

Estimated Total Settlement - Northeast Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
35.227	-0.033	-6.444	1.000	0.000	0.000	-6.477
36.523	-0.024	-6.251	1.000	0.000	0.000	-6.274
36.523	-0.024	-6.251	1.000	0.000	0.000	-6.274
37.818	-0.016	-6.060	1.000	0.000	0.000	-6.076
37.818	-0.016	-6.060	1.000	0.000	0.000	-6.076
37.833	-0.016	-6.059	1.000	0.000	0.000	-6.074
37.833	-0.016	-6.059	1.000	0.000	0.000	-6.074
39.130	-0.009	-5.867	1.000	0.000	0.000	-5.876
39.130	-0.009	-5.867	1.000	0.000	0.000	-5.876
40.427	-0.003	-5.736	1.000	0.000	0.000	-5.739
40.427	-0.003	-5.736	1.000	0.000	0.000	-5.739
40.439	-0.003	-5.734	1.000	0.000	0.000	-5.737
40.439	-0.003	-5.734	1.000	0.000	0.000	-5.737
41.736	0.002	-5.569	1.000	0.000	0.000	-5.567
41.736	0.002	-5.569	1.000	0.000	0.000	-5.567
41.748	0.002	-5.567	1.000	0.000	0.000	-5.566
41.748	0.002	-5.567	1.000	0.000	0.000	-5.566
43.045	0.006	-5.403	1.000	0.000	0.000	-5.397
43.045	0.006	-5.403	1.000	0.000	0.000	-5.397
44.343	0.009	-5.275	1.000	0.000	0.000	-5.266
44.343	0.009	-5.275	1.000	0.000	0.000	-5.266
44.358	0.009	-5.273	1.000	0.000	0.000	-5.264
44.358	0.009	-5.273	1.000	0.000	0.000	-5.264
45.653	0.012	-5.169	1.000	0.000	0.000	-5.157
45.653	0.012	-5.169	1.000	0.000	0.000	-5.157
46.948	0.014	-5.048	1.000	0.000	0.000	-5.033
46.948	0.014	-5.048	1.000	0.000	0.000	-5.033
46.964	0.014	-5.047	1.000	0.000	0.000	-5.032
46.964	0.014	-5.047	1.000	0.000	0.000	-5.032
48.261	0.016	-4.939	1.000	0.000	0.000	-4.922
48.261	0.016	-4.939	1.000	0.000	0.000	-4.922
49.558	0.018	-4.867	1.000	0.000	0.000	-4.849
49.558	0.018	-4.867	1.000	0.000	0.000	-4.849
49.574	0.018	-4.866	1.000	0.000	0.000	-4.848
49.574	0.018	-4.866	1.000	0.000	0.000	-4.848
50.869	0.019	-4.800	1.000	0.000	0.000	-4.781
50.869	0.019	-4.800	1.000	0.000	0.000	-4.781
52.164	0.021	-4.722	1.000	0.000	0.000	-4.702
52.164	0.021	-4.722	1.000	0.000	0.000	-4.702
52.180	0.021	-4.722	1.000	0.000	0.000	-4.701
52.180	0.021	-4.722	1.000	0.000	0.000	-4.701
53.477	0.021	-4.656	1.000	0.000	0.000	-4.634
53.477	0.021	-4.656	1.000	0.000	0.000	-4.634
54.774	0.022	-4.614	1.000	0.000	0.000	-4.592
54.774	0.022	-4.614	1.000	0.000	0.000	-4.592
54.790	0.022	-4.614	1.000	0.000	0.000	-4.592
54.790	0.022	-4.614	1.000	0.000	0.000	-4.592
56.085	0.023	-4.587	1.000	0.000	0.000	-4.564

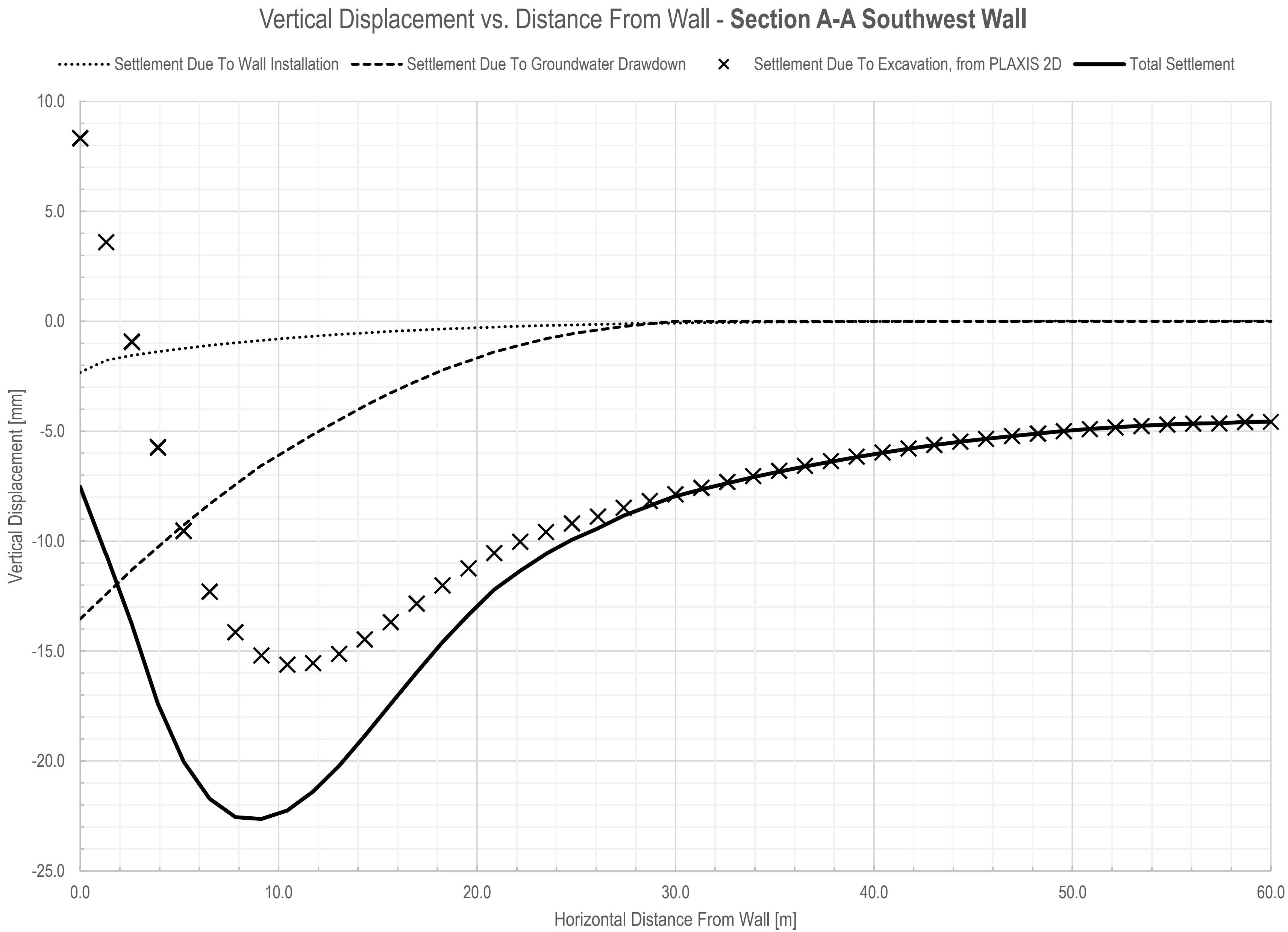
AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.12
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

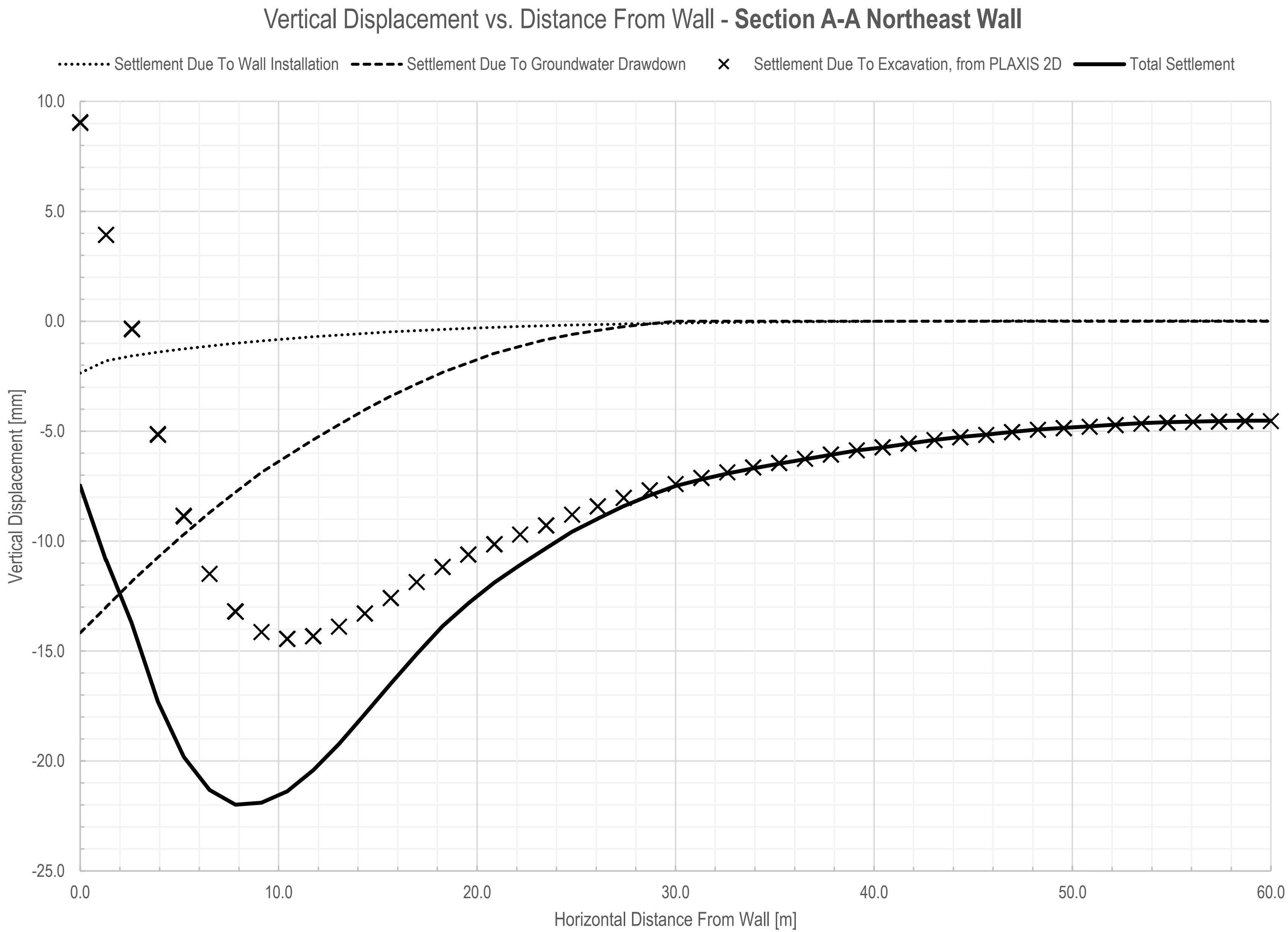
Location: **STN Pumping Station - Section A-A**

Estimated Total Settlement - Northeast Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
56.085	0.023	-4.587	1.000	0.000	0.000	-4.564
57.380	0.023	-4.562	1.000	0.000	0.000	-4.539
57.380	0.023	-4.562	1.000	0.000	0.000	-4.539
57.394	0.023	-4.561	1.000	0.000	0.000	-4.539
57.394	0.023	-4.561	1.000	0.000	0.000	-4.539
58.692	0.023	-4.546	1.000	0.000	0.000	-4.523
58.692	0.023	-4.546	1.000	0.000	0.000	-4.523
58.708	0.023	-4.545	1.000	0.000	0.000	-4.522
58.708	0.023	-4.545	1.000	0.000	0.000	-4.522
60.000	0.023	-4.546	1.000	0.000	0.000	-4.522



Vertical Displacement vs. Distance From Wall - **Section A-A Southwest Wall**
Settlement Due To Wall Installation
Settlement Due To Groundwater Drawdown
Settlement Due To Excavation, from PLAXIS 2D
Total Settlement
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
Vertical Displacement [mm]
0.0
10.0
20.0
30.0
40.0
50.0
60.0
Horizontal Distance From Wall [m]



Vertical Displacement vs. Distance From Wall - **Section A-A Northeast Wall**
Settlement Due To Wall Installation
Settlement Due To Groundwater Drawdown
Settlement Due To Excavation, from PLAXIS 2D
Total Settlement
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
Vertical Displacement [mm]
0.0
10.0
20.0
30.0
40.0
50.0
60.0
Horizontal Distance From Wall [m]

PLAXIS Report

STN Pumphouse - Section BB

1.1.1.1.1.1 Materials - Soil and interfaces - Mohr-Coulomb (1/2)

Identification		Fill	Alluvial Sand	Alluvial Clay	Marine Sand	Colluvium
Identification number		1	2	3	4	5
Drainage type		Drained	Drained	Undrained (B)	Drained	Drained
Colour						
Comments						
γ_{unsat}	kN/m³	19.00	19.00	18.00	19.00	19.00
γ_{sat}	kN/m³	19.00	19.00	18.00	19.00	19.00
Dilatancy cut-off		No	No	No	No	No
e_{init}		0.5000	0.5000	0.5000	0.5000	0.5000
e_{min}		0.000	0.000	0.000	0.000	0.000
e_{max}		999.0	999.0	999.0	999.0	999.0
Rayleigh α		0.000	0.000	0.000	0.000	0.000
Rayleigh β		0.000	0.000	0.000	0.000	0.000
E	kN/m²	10.00E3	10.00E3	8000	8000	16.00E3
ν (nu)		0.3000	0.3000	0.3000	0.3000	0.3000
G	kN/m²	3846	3846	3077	3077	6154
E_{oed}	kN/m²	13.46E3	13.46E3	10.77E3	10.77E3	21.54E3
c_{ref}	kN/m²	0.000	0.000	36.00	0.000	0.000

Identification		Fill	Alluvial Sand	Alluvial Clay	Marine Sand	Colluvium
φ (phi)	°	30.00	36.00	0.000	33.00	30.00
ψ (psi)	°	0.000	0.000	0.000	0.000	0.000
V_s	m/s	44.56	44.56	40.95	39.86	56.37
V_p	m/s	83.37	83.37	76.61	74.57	105.5
Set to default values		No	No	No	No	No
E_{inc}	kN/m²/m	3333	3750	3750	2000	2286
y_{ref}	m	2.000	-2.000	-2.500	0.000	-7.000
c_{inc}	kN/m²/m	0.000	0.000	19.20	0.000	0.000
y_{ref}	m	2.000	-2.000	-2.500	0.000	-7.000
Tension cut-off		Yes	Yes	Yes	Yes	Yes
Tensile strength	kN/m²	0.000	0.000	0.000	0.000	0.000
Undrained behaviour		Standard	Standard	Standard	Standard	Standard
Skempton-B		0.9783	0.9783	0.9783	0.9783	0.9783
ν_u		0.4950	0.4950	0.4950	0.4950	0.4950
$K_{w,ref}$ / n	kN/m²	375.0E3	375.0E3	300.0E3	300.0E3	600.0E3
$C_{v,ref}$	m²/day	0.000	0.000	0.000	0.000	0.000
Stiffness		Standard	Standard	Standard	Standard	Standard
Strength		Manual	Manual	Manual	Manual	Manual
R_{inter}		0.6700	0.6700	0.6700	0.6700	0.6700
Consider gap closure		Yes	Yes	Yes	Yes	Yes
δ_{inter}		0.000	0.000	0.000	0.000	0.000

Identification		Fill	Alluvial Sand	Alluvial Clay	Marine Sand	Colluvium
Cross permeability		Impermeable	Impermeable	Impermeable	Impermeable	Impermeable
Drainage conductivity, dk	m^3/day/m	0.000	0.000	0.000	0.000	0.000
R	m^2 K/kW	0.000	0.000	0.000	0.000	0.000
K_0 determination		Automatic	Automatic	Automatic	Automatic	Automatic
$K_{0,x} = K_{0,z}$		Yes	Yes	Yes	Yes	Yes
$K_{0,x}$		0.5000	0.4122	0.5000	0.4554	0.5000
$K_{0,z}$		0.5000	0.4122	0.5000	0.4554	0.5000
Data set		Standard	Standard	Standard	Standard	Standard
Type		Coarse	Coarse	Coarse	Coarse	Coarse
< 2 μm	%	10.00	10.00	10.00	10.00	10.00
2 μm - 50 μm	%	13.00	13.00	13.00	13.00	13.00
50 μm - 2 mm	%	77.00	77.00	77.00	77.00	77.00
Use defaults		None	None	None	None	None
k_x	m/day	0.000	0.000	0.000	0.000	0.000
k_y	m/day	0.000	0.000	0.000	0.000	0.000
$-\psi_{unsat}$	m	10.00E3	10.00E3	10.00E3	10.00E3	10.00E3
e_{init}		0.5000	0.5000	0.5000	0.5000	0.5000
S_s	1/m	0.000	0.000	0.000	0.000	0.000
c_k		1000E12	1000E12	1000E12	1000E12	1000E12
c_s	kJ/t/K	0.000	0.000	0.000	0.000	0.000
λ_s	kW/m/K	0.000	0.000	0.000	0.000	0.000

Identification		Fill	Alluvial Sand	Alluvial Clay	Marine Sand	Colluvium
ρ_s	t/m³	0.000	0.000	0.000	0.000	0.000
Solid thermal expansion		Volumetric	Volumetric	Volumetric	Volumetric	Volumetric
α_s	1/K	0.000	0.000	0.000	0.000	0.000
D_v	m²/day	0.000	0.000	0.000	0.000	0.000
f_{Tv}		0.000	0.000	0.000	0.000	0.000
Unfrozen water content		None	None	None	None	None

1.1.1.1.1.2 Materials - Soil and interfaces - Mohr-Coulomb (2/2)

Identification		CDG
Identification number		6
Drainage type		Drained
Colour		
Comments		
γ_{unsat}	kN/m³	19.00
γ_{sat}	kN/m³	19.00
Dilatancy cut-off		No
e_{init}		0.5000
e_{min}		0.000
e_{max}		999.0
Rayleigh α		0.000
Rayleigh β		0.000
E	kN/m²	35.00E3
ν (nu)		0.3000
G	kN/m²	13.46E3

Identification		CDG
E_{oed}	kN/m²	47.12E3
c_{ref}	kN/m²	5.000
φ (phi)	°	37.00
ψ (psi)	°	0.000
V_s	m/s	83.37
V_p	m/s	156.0
Set to default values		No
E_{inc}	kN/m²/m	1625
y_{ref}	m	-14.00
c_{inc}	kN/m²/m	0.000
y_{ref}	m	-14.00
Tension cut-off		Yes
Tensile strength	kN/m²	0.000
Undrained behaviour		Standard
Skempton-B		0.9783
ν_u		0.4950
$K_{w,ref}$ / n	kN/m²	1.313E6
Stiffness		Standard
Strength		Manual

Identification		CDG
R_{inter}		0.6700
Consider gap closure		Yes
δ_{inter}		0.000
Cross permeability		Impermeable
Drainage conductivity, dk	m^3/day/m	0.000
R	m^2 K/kW	0.000
K_0 determination		Automatic
$K_{0,x} = K_{0,z}$		Yes
$K_{0,x}$		0.3982
$K_{0,z}$		0.3982
Data set		Standard
Type		Coarse
< 2 μm	%	10.00
2 μm - 50 μm	%	13.00
50 μm - 2 mm	%	77.00
Use defaults		None
k_x	m/day	0.000
k_y	m/day	0.000
$-\psi_{unsat}$	m	10.00E3

Identification		CDG
e_{init}		0.5000
S_s	1/m	0.000
c_k		1000E12
c_s	kJ/t/K	0.000
λ_s	kW/m/K	0.000
ρ_s	t/m³	0.000
Solid thermal expansion		Volumetric
α_s	1/K	0.000
D_v	m²/day	0.000
f_{Tv}		0.000
Unfrozen water content		None

1.1.1.1.2 Materials - Soil and interfaces - Linear elastic

Identification		Bedrock
Identification number		7
Drainage type		Drained
Colour		
Comments		
γ_{unsat}	kN/m³	19.00
γ_{sat}	kN/m³	19.00
Dilatancy cut-off		No
e_{init}		0.5000
e_{min}		0.000
e_{max}		999.0
Rayleigh α		0.000
Rayleigh β		0.000
E	kN/m²	300.0E3
ν (nu)		0.000
G	kN/m²	150.0E3
E_{oed}	kN/m²	300.0E3

Identification		Bedrock
V_s	m/s	278.3
V_p	m/s	393.6
Set to default values		Yes
E_{inc}	kN/m²/m	0.000
y_{ref}	m	0.000
Undrained behaviour		Standard
Skempton-B		0.9933
ν_u		0.4950
$K_{w,ref}$ / n	kN/m²	14.85E6
Stiffness		Standard
Strength		Rigid
R_{inter}		1.000
Consider gap closure		Yes
δ_{inter}		0.000
Cross permeability		Impermeable
Drainage conductivity, dk	m³/day/m	0.000
R	m² K/kW	0.000
K_0 determination		Automatic
$K_{0,x} = K_{0,z}$		Yes

Identification		Bedrock
$K_{0,x}$		0.5000
$K_{0,z}$		0.5000
Data set		Standard
Type		Coarse
< 2 μm	%	10.00
2 μm - 50 μm	%	13.00
50 μm - 2 mm	%	77.00
Use defaults		None
k_x	m/day	0.000
k_y	m/day	0.000
$-\psi_{unsat}$	m	10.00E3
e_{init}		0.5000
S_s	1/m	0.000
c_k		1000E12
c_s	kJ/t/K	0.000
λ_s	kW/m/K	0.000
ρ_s	t/m³	0.000
Solid thermal expansion		Volumetric
α_s	1/K	0.000

Identification		Bedrock
D_v	m²/day	0.000
f_{Tv}		0.000
Unfrozen water content		None

1.1.1.2 Materials - Plates -

Identification		610 x 20.6 x 299 CHS Spacing 0.7 m S355
Identification number		1
Comments		
Colour		
Material type		Elastoplastic
Isotropic		Yes
EA_1	kN/m	11.16E6
EA_2	kN/m	11.16E6
EI	kN m²/m	485.7E3
d	m	0.7227
w	kN/m/m	4.190
ν (nu)		0.000
M_p	kN m/m	3528
$N_{p,1}$	kN/m	18.78E3
$N_{p,2}$	kN/m	18.78E3
Rayleigh α		0.000
Rayleigh β		0.000

Identification		610 x 20.6 x 299 CHS Spacing 0.7 m S355
Prevent punching		Yes
Identification number		1
c	kJ/t/K	0.000
λ	kW/m/K	0.000
ρ	t/m^3	0.000
α	1/K	0.000

1.1.1.3 Materials - Anchors -

Identification		Double 356 x 406 x 340 UC Grade 50	Double 305 x 305 x 240 UC Grade 50	Double 356 x 406 x 393 UC Grade 50
Identification number		1	2	3
Comments				
Colour				
Material type		Elastoplastic	Elastoplastic	Elastoplastic
EA	kN	17.75E6	12.55E6	20.54E6
$L_{spacing}$	m	8.000	8.000	8.000
$\vert F_{max,tens}\vert$	kN	0.000	0.000	0.000
$\vert F_{max,comp}\vert$	kN	1.000E12	1.000E12	1.000E12
Identification number		1	2	3
c	kJ/t/K	0.000	0.000	0.000
λ	kW/m/K	0.000	0.000	0.000
ρ	t/m³	0.000	0.000	0.000
α	1/K	0.000	0.000	0.000
Identification number		1	2	3
c	kJ/t/K	0.000	0.000	0.000
λ	kW/m/K	0.000	0.000	0.000
ρ	t/m³	0.000	0.000	0.000
α	1/K	0.000	0.000	0.000

Identification		Double 356 x 406 x 340 UC Grade 50	Double 305 x 305 x 240 UC Grade 50	Double 356 x 406 x 393 UC Grade 50
A	m^2	0.000	0.000	0.000
Identification number		1	2	3
c	kJ/t/K	0.000	0.000	0.000
λ	kW/m/K	0.000	0.000	0.000
ρ	t/m^3	0.000	0.000	0.000
α	1/K	0.000	0.000	0.000
A	m^2	0.000	0.000	0.000

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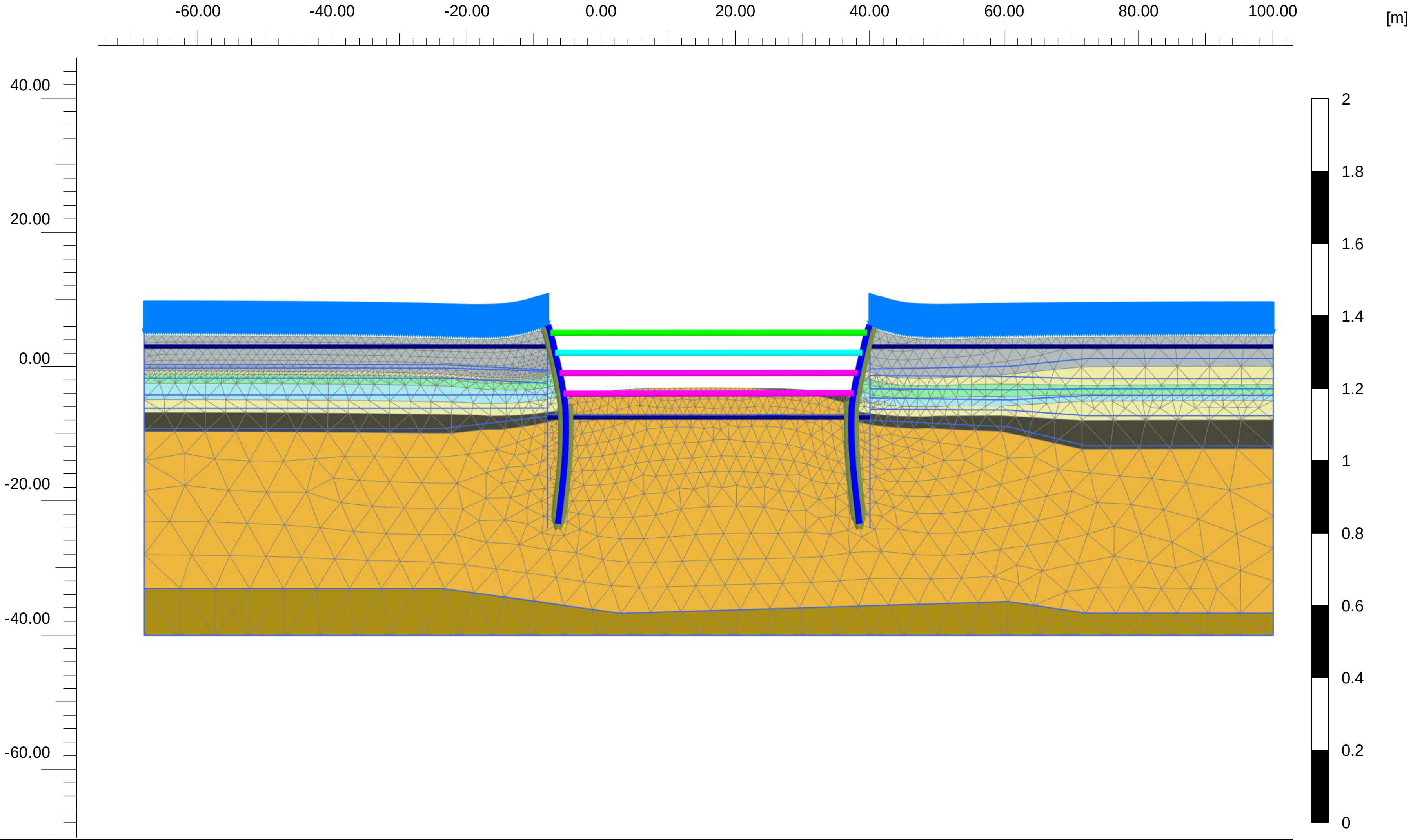
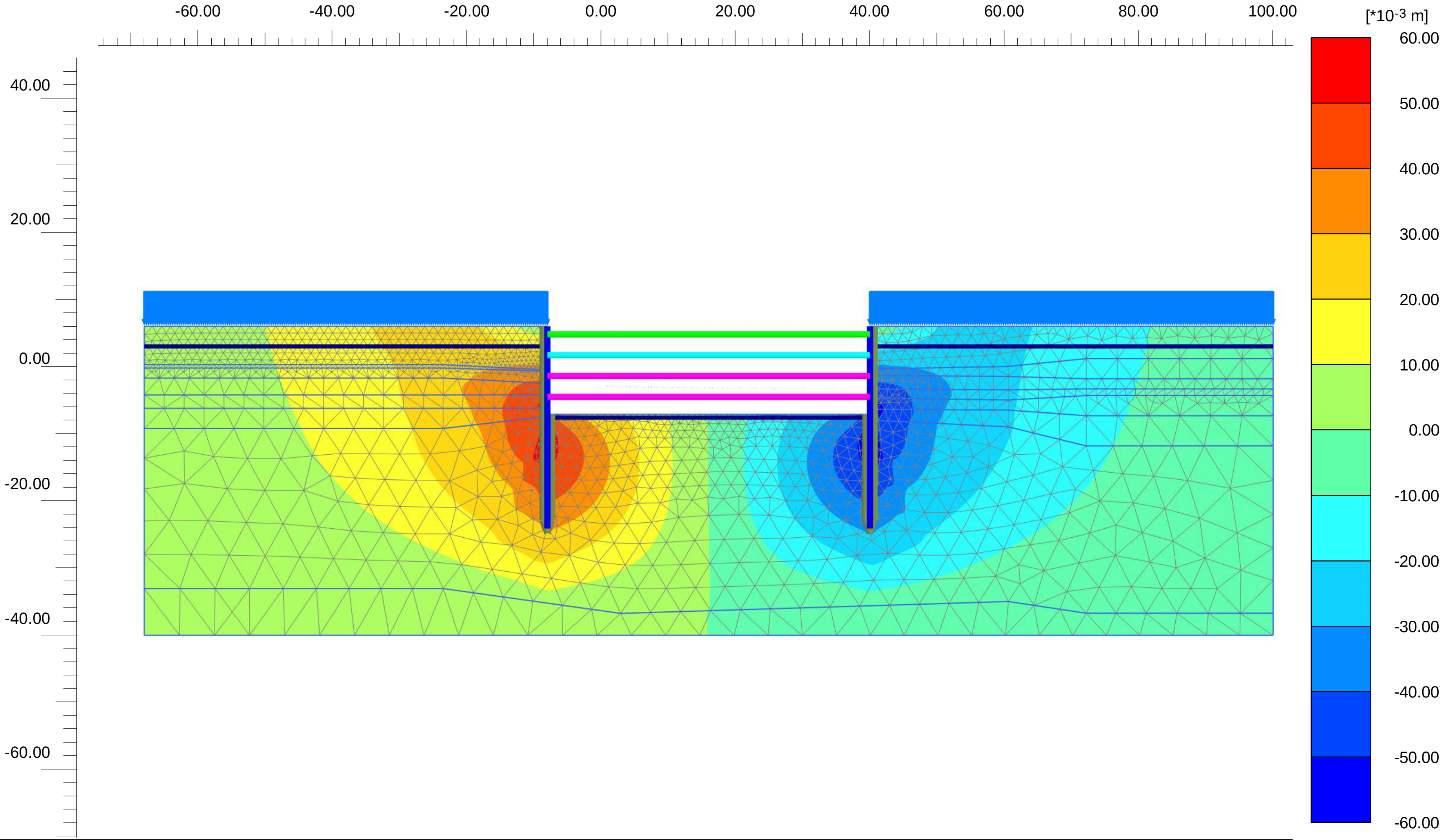


Deformed mesh |u| (scaled up 50.0 times)

Maximum value = 0.07875 m (Element 4018 at Node 30597)

	Project description STN Pumphouse			*Date* 18/10/2021
	Project filename STN Pumphouse_SectionBB	*Step* 39	*Company* AECOM- CSS	



Total displacements u_x (scaled up 50.0 times)

Maximum value = 0.05537 m (Element 5282 at Node 10030)

Minimum value = -0.05632 m (Element 4109 at Node 35200)

Project description	Date
STN Pumphouse	18/10/2021

Project filename	Step	Company
STN Pumphouse_SectionBB	39	AECOM- CSS

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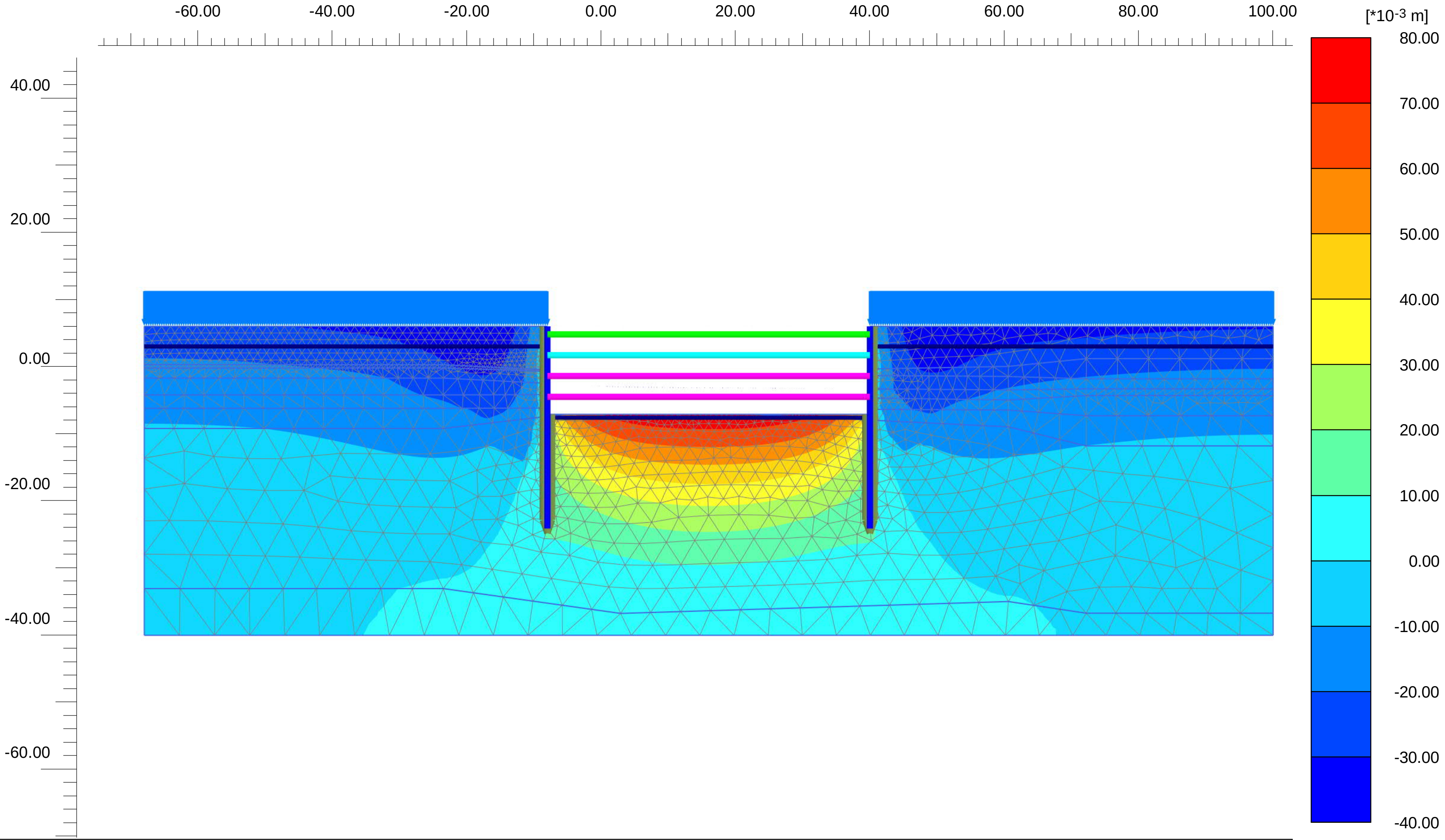

Total displacements u_y (scaled up 50.0 times)

Maximum value = 0.07853 m (Element 5236 at Node 22851)

Minimum value = -0.03954 m (Element 412 at Node 5573)

Project description	*Date*
STN Pumphouse	18/10/2021

Project filename	*Step*	*Company*
STN Pumphouse_SectionBB	39	AECOM- CSS

Structural element	Node	Local number	X [m]	Y [m]	N [kN]	N_{min} [kN]	N_{max} [kN]
NodeToNodeAnchor_1_1	14080	1	-8.000	4.800	-237.096	-1032.862	0.000
Element 1-1 (Node-to-node anchor)	43684	2	40.000	4.800	-237.096	-1032.862	0.000
NodeToNodeAnchor_2_1	12529	1	-8.000	1.700	-1859.719	-2033.185	0.000
Element 2-2 (Node-to-node anchor)	43167	2	40.000	1.700	-1859.719	-2033.185	0.000
NodeToNodeAnchor_3_1	9928	1	-8.000	-1.400	-2364.780	-2364.780	0.000
Element 3-3 (Node-to-node anchor)	41541	2	40.000	-1.400	-2364.780	-2364.780	0.000
NodeToNodeAnchor_4_1	9014	1	-8.000	-4.500	-2200.770	-2200.770	0.000
Element 4-4 (Node-to-node anchor)	39219	2	40.000	-4.500	-2200.770	-2200.770	0.000

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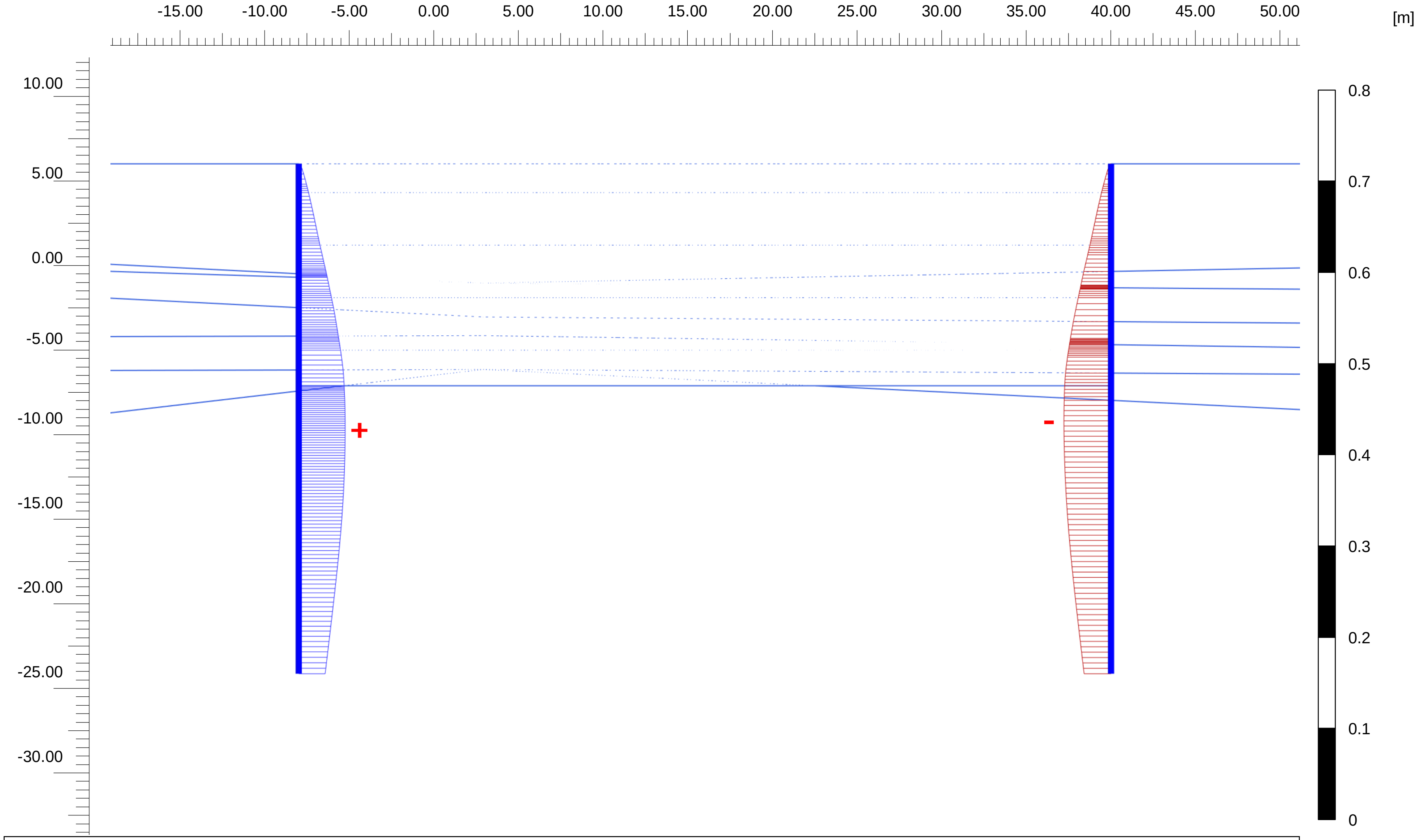


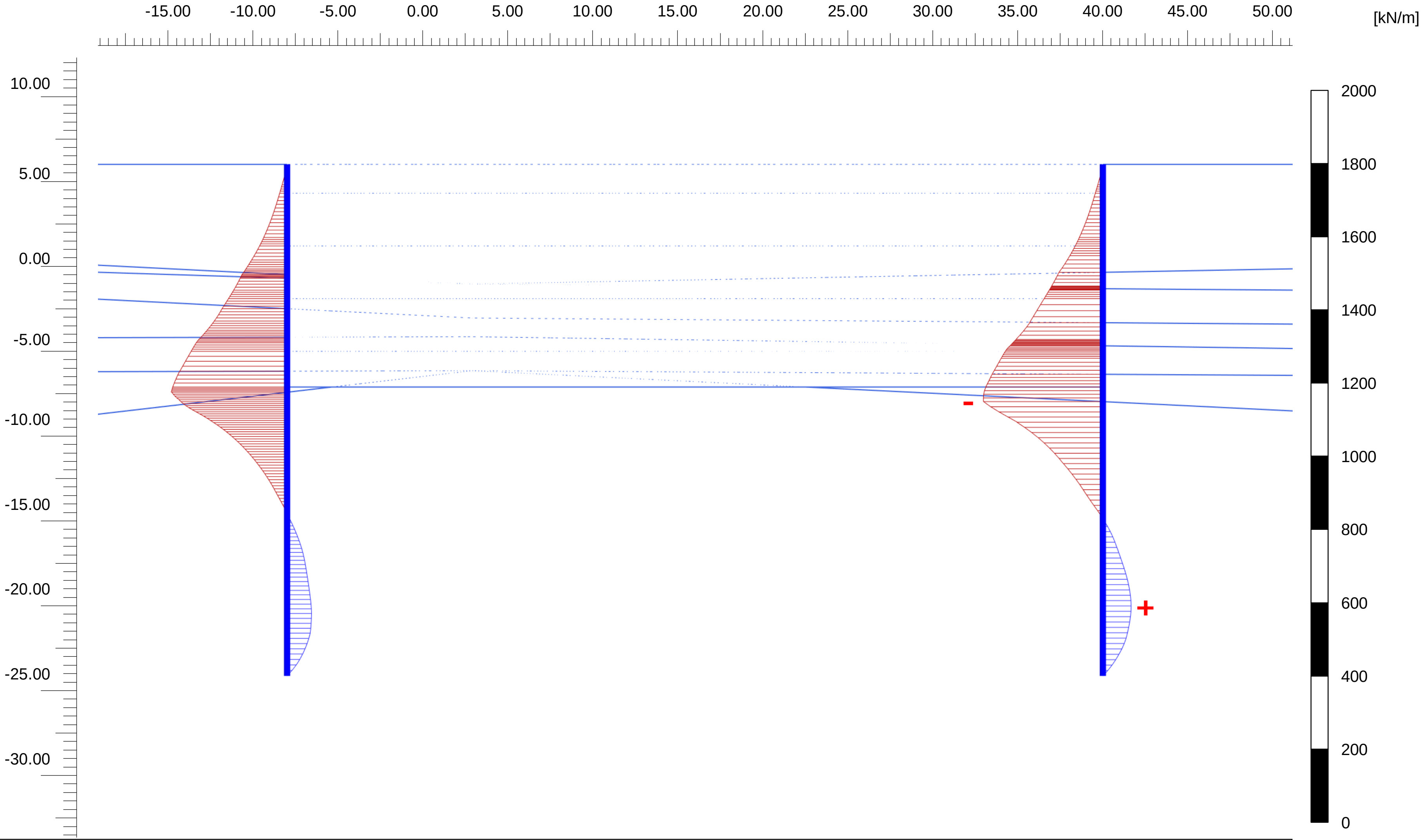
Total displacements u_x (scaled up 50.0 times)

Maximum value = 0.05485 m (Element 47 at Node 10033)

Minimum value = -0.05570 m (Element 64 at Node 34339)

Project description STN Pumphouse			*Date* 18/10/2021
Project filename STN Pumphouse_SectionBB	*Step* 39	*Company* AECOM- CSS	

Output Version 21.0.0.223



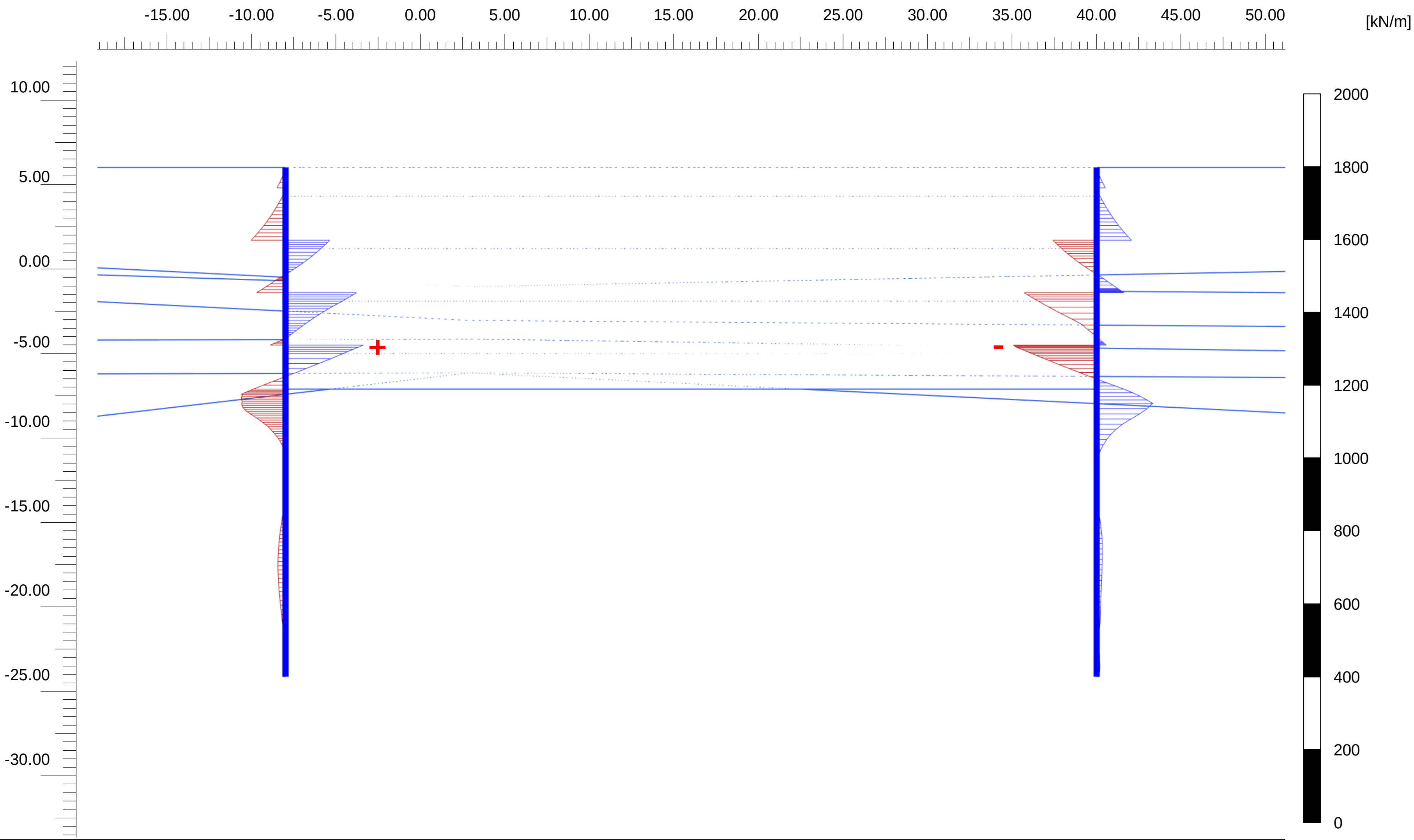
Axial forces N (scaled up 0.0200 times)

Maximum value = 83.07 kN/m (Element 73 at Node 27054)

Minimum value = -351.5 kN/m (Element 42 at Node 35203)

Project description	Date
STN Pumphouse	18/10/2021

Project filename	Step	Company
STN Pumphouse_SectionBB	39	AECOM- CSS

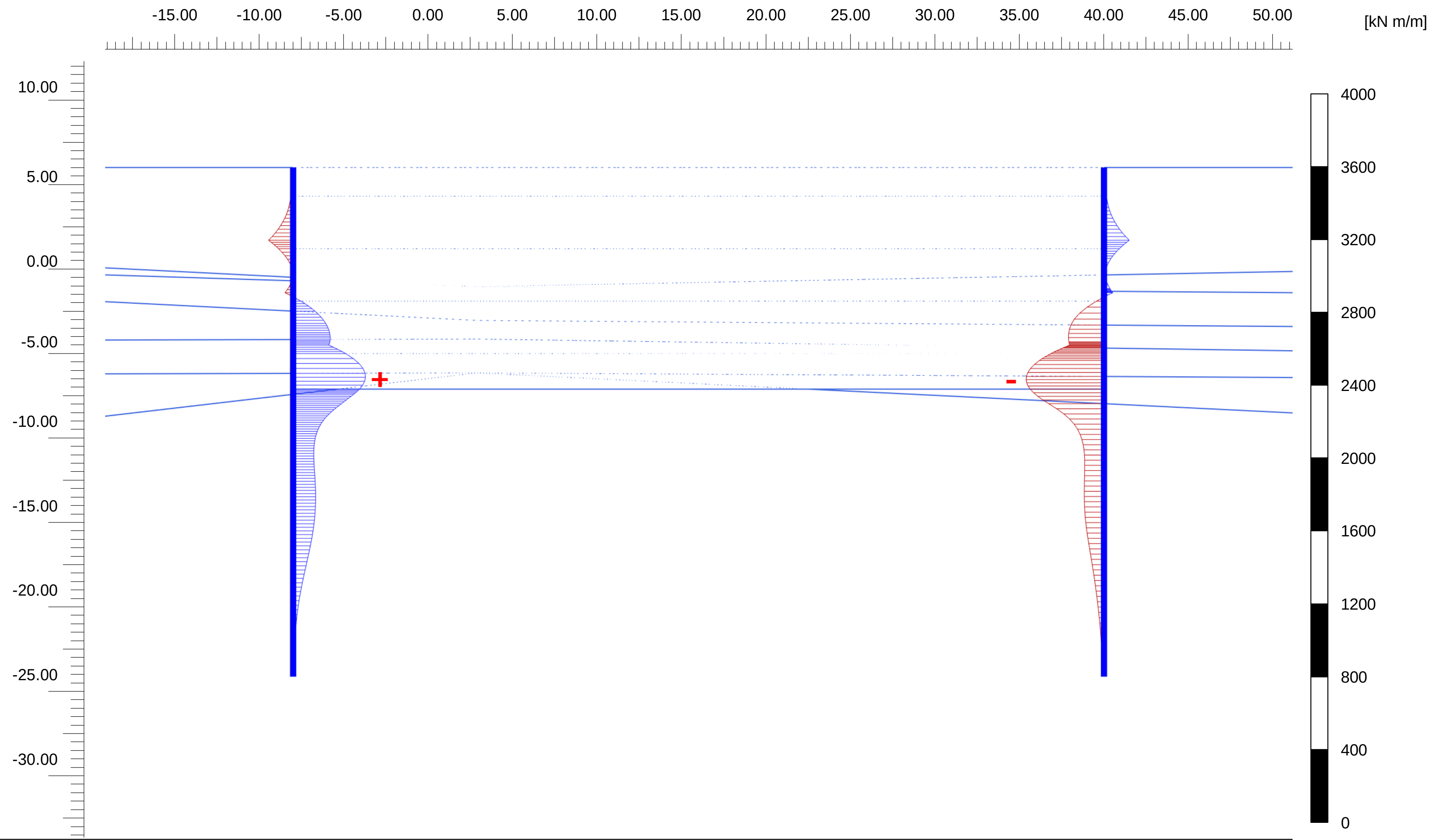


Shear forces Q (scaled up 0.0200 times)

Maximum value = 229.8 kN/m (Element 34 at Node 9014)

Minimum value = -246.4 kN/m (Element 33 at Node 39219)

	Project description STN Pumphouse		*Date* 18/10/2021
	Project filename STN Pumphouse_SectionBB	*Step* 39	*Company* AECOM- CSS



Bending moments M (scaled up 0.0100 times)

Maximum value = 428.2 kN m/m (Element 39 at Node 9032)

Minimum value = -460.8 kN m/m (Element 40 at Node 35724)

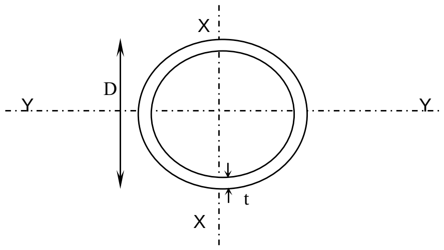
Project description		Date
STN Pumphouse		18/10/2021
Project filename	Step	Company
STN Pumphouse_SectionBB	39	AECOM- CSS

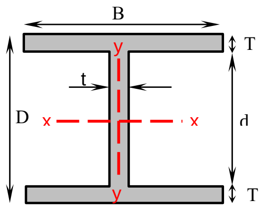
AECOM	Drainage Improvement Works in Kwun Tong Investigation Excavation and Lateral Support Works Design Structural Design of Pipe Pile Wall STN Pumping Station - Type B	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

Structural Steel Design - Pipe Pile Wall

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan





H-Section

1. Section Properties

Try Section : 610 x 20.6 x 299 CHS | S355 | Hot Rolled

Maximum pipe pile spacing	**S**	=	0.70 m				
Circular Hollow Section							
Depth of Section	**D**	=	610 mm	Plastic Modulus (X-Axis)	S_x	=	7159000 mm^3
Thickness	**t**	=	20.6 mm	Plastic Modulus (Y-Axis)	S_y	=	7159000 mm^3
Second Moment of Area (X-Axis)	I_x	=	1.658E+09 mm^4	Area of Section	A_g	=	38100 mm^2
Second Moment of Area (Y-Axis)	I_y	=	1.658E+09 mm^4	Mass per Length	**w**	=	299.00 kg/m
Elastic Modulus (X-Axis)	Z_x	=	5437000 mm^3	Design Strength	p_y	=	345 N/mm^2
Elastic Modulus (X-Axis)	Z_y	=	5437000 mm^3				
Elastic Modulus of steel	**E**	=	205000.00 MPa				

PLAXIS Input Values

EA/m	=	(205000 x 1000) x (38100 / 10^6) / 0.7	=	**1.116E+07**	kN/m
EIx/m	=	(205000 x 1000) x (1658400000 / 10^12) / 0.7	=	**4.857E+05**	kNm^2/m
EIy/m	=	(205000 x 1000) x (1658400000 / 10^12) / 0.7	=	**4.857E+05**	kNm^2/m
w/m	=	(299) x 9.81 / 1000 / 0.7	=	**4.190**	kN/m/m

2. Ultimate Design Load

From "Plaxis" results,

Maximum bending moment, Mx	=	460.80	kNm/m
Maximum bending moment, My	=	0.00	kNm/m
Maximum shear force, V	=	246.80	kN/m
Maximum axial force, Fc	=	351.50	kN/m
Load Factor	=	1.4	

Design Bending Moment (Major Axis)	M_x	=	451.6	kNm per pile	Design Shear Force	**V**	=	241.9 kN per pile
Design Bending Moment (Minor Axis)	M_y	=	0.0	kNm per pile	Axial Force	F_c	=	344.5 kN per pile

3. Section Classification

(Table 7.2)

CLA

$e = [275 / p_y]^{1/2} = 0.9$ D/t = 29.6 < 40 e^2 (Plastic)

(Table 7.2, CHS under compression due to bending)

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 29.6 < 70e = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area	$\mathbf{A_v}$	=	22860	+	0 =	22860 mm^2		
Shear Capacity	$\mathbf{V_c}$	= $p_y A_v/(3)$^0.5						*(Eqn. 8.1)*
		=	4553.4	+	0.0			
		=	4553 kN					
Design Shear Force	**V**	=	241.9 kN	<	V_c =	4553 kN	***Check Shear OK***	
Since,	$0.6V_c$	=	2732 kN	>	V		***Low Shear***	

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis	M_{cx}	= Lesser of	p_yS_x	and	$1.2p_yZ_x$			
	p_yS_x	=	2470 kNm		$1.2p_yZ_x$ =	2251 kNm		
	$\mathbf{M_{cx}}$	=	**2251 kNm**	>	M_x =	451.6 kNm	***Major Moment Capacity OK***	
Major Axis	M_{cy}	= Lesser of	p_yS_y	and	$1.2p_yZ_y$			
	p_yS_y	=	2470 kNm		$1.2p_yZ_y$ =	2251 kNm		
	$\mathbf{M_{cy}}$	=	**2251 kNm**	>	M_y =	0.0 kNm	***Minor Moment Capacity OK***	

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{344.5}{13144.5} + \frac{451.6}{2250.9} + \frac{0.0}{2250.9}$$

$$= 0.03 + 0.20 + 0.00$$

$$= 0.227$$

$$< 1$$

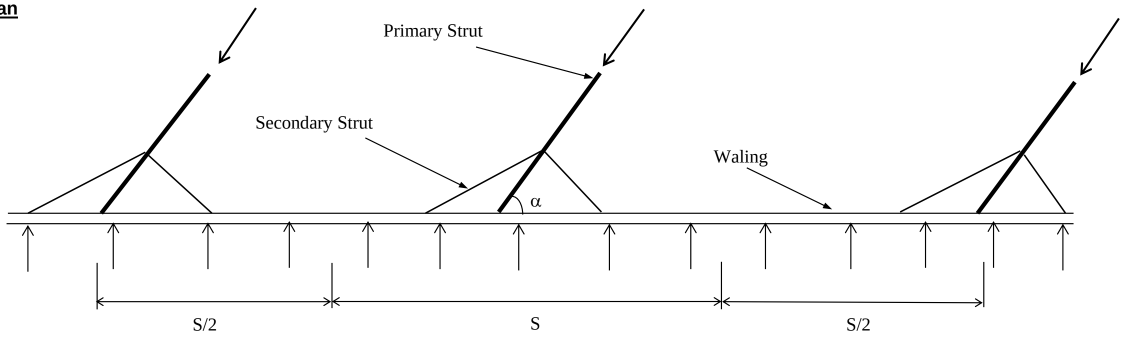
Cross-section Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

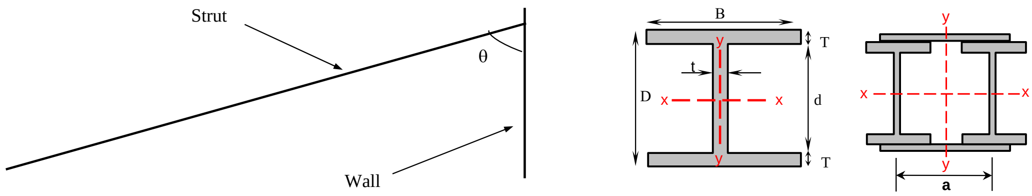
Structural Steel Design - Level 1 Main Strut (+4.80 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section



1. Section Properties

Try Section :	Double	305 x 305 x 240 UC	Grade 50	Hot Rolled

Depth of Section	**D**	=	352.6	mm	Elastic Modulus (X-Axis)	Z_x	=	7280000	mm^3
Width of Section	**B**	=	317.9	mm	Elastic Modulus (Y-Axis)	Z_y	=	6130000	mm^3
Web Thickness	**t**	=	23.0	mm	Plastic Modulus (X-Axis)	S_x	=	8500000	mm^3
Flange Thickness	**T**	=	37.7	mm	Plastic Modulus (Y-Axis)	S_y	=	9727740	mm^3
Depth between Fillets	**d**	=	246.6	mm	Buckling Parameter	**u**	=	0.854	
Second Moment of Area (X-Axis)	I_x	=	1.284E+09	mm^4	Torsional Index	**x**	=	8.73	
Second Moment of Area (Y-Axis)	I_y	=	1.950E+09	mm^4	Area of Section	A_g	=	61200	mm^2
Radius of Gyration (X-Axis)	r_x	=	145.0	mm	Mass per Length	**w**	=	480.0	kg/m
Radius of Gyration (Y-Axis)	r_y	=	178.5	mm	Design Strength	p_y	=	345	N/mm^2
Modulus of Elasticity	**E**	=	205000	MPa	Distance Between Centre Lines	**a**	=	317.9	mm *Spacing OK*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	129.11	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (61,200 / 10^6) x sin(90)^2 x sin(90)^2		=	**1.255E+07**	kN
Minimum inclination of strut to waling, α	=	90.00	degree			
Load in the direction of strut, P_α	=	F / sin α	= 129.11 / sin 90.0	=	129.1	kN/m
Maximum strut spacing, S	=	8.00	m			
Maximum compression, P	=	P_α x S	= 129.11 x 8.00	=	1032.9	kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	16.00	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	= 16.00 / sin 90.0	=	16.00	m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	16.00	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	= 16.00 / sin 90.0	=	16.00	m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (480.0 x 9.81 + 2.0 x 317.9 x 2) x 10^-3 x 16.0^2		=	191.4	kNm
Maximum Shear Force (unfactored)	=	0.5 x (480.0 x 9.81 +2.0 x 317.9 x 2) x 10^-3 x 16.0		=	47.8	kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	M_x	=	2143.4	kNm	Design Shear Force	**V**	=	535.8	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	1446.0	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 4.2 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 10.7 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 10.7 < 70ε = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area $\mathbf{A_v}$ = 16220 mm^2

Shear Capacity $\mathbf{V_c}$ = $p_yA_v/(3)$^0.5

= 3231 kN

Design Shear Force **V** = 535.8 kN < P_v = 3231 kN ***Check Shear OK***

Since, $0.6V_c$ = 1938 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 2933 kNm $1.2p_yZ_x$ = 3014 kNm

$\mathbf{M_{cx}}$ = **2933 kNm** > M_x = 2143.4 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 3356 kNm $1.2p_yZ_y$ = 2538 kNm

$\mathbf{M_{cy}}$ = **2538 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) $\mathbf{L_y}$ = 16.00 m

Effective Length $\mathbf{L_{Ey}}$ = 1.0 L = 16.0 m *(Clause 8.3.4)*

Minor Axis Slenderness $\boldsymbol{\lambda}$ = L_{Ey} / r_y = 89.6

Buckling parameter **u** = 0.85 *(Clause 8.3.5.3)*

$\boldsymbol{\lambda / x}$ = 10.27

Slenderness factor $\boldsymbol{\nu}$ = $1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.632

$\boldsymbol{\beta_w}$ = 1.000 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness $\boldsymbol{\lambda_{LT}}$ = $u\nu\lambda(\beta_w)^{0.5}$ = 48.4 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength $\mathbf{p_y}$ = 345.00 N/mm^2

Buckling strength $\mathbf{p_b}$ = 285.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment $\mathbf{M_b}$ = 2422.5 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor $\mathbf{m_{LT}}$ = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$\mathbf{m_{LT}M_x}$ = 1993.34 < M_b = 2422.5 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and $\mathbf{M_x}$ = 2143.38 < M_{cx} = 2932.5 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{1446.0}{21114.0} + \frac{2143.4}{2932.5} + \frac{0.0}{2537.8}$$

= 0.07 + 0.73 + 0.00

= 0.80

< 1 ***Cross-section Capacity OK***

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	16.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	16.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	110.3	≈ 112	
Maximum Thickness	**T**	=	37.7 mm	≤	40 mm		
Type of Section		=	Rolled H-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	140.00 N/mm^2				
p_c in Table 8.8 b)		=	129.00 N/mm^2				
p_c in Table 8.8 c)		=	117.00 N/mm^2				
p_c in Table 8.8 d)		=	106.00 N/mm^2				
Compressive Strength	p_{cx}	=	129.00 N/mm^2				*(Table 8.8(b))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	16.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	16.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	89.6	≈ 90	
Maximum Thickness	**T**	=	37.7 mm	≤	40 mm		
Type of Section		=	Rolled H-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	c)		*(Table 8.7)*
p_c in Table 8.8 a)		=	199.00 N/mm^2				
p_c in Table 8.8 b)		=	179.00 N/mm^2				
p_c in Table 8.8 c)		=	161.00 N/mm^2				
p_c in Table 8.8 d)		=	144.00 N/mm^2				
Compressive Strength	p_{cy}	=	161.00 N/mm^2				*(Table 8.8(c))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 129.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{1446.0}{7894.8} + \frac{2036.2}{2932.5} + \frac{0.0}{2537.8}$$

$$= 0.18 + 0.69 + 0.00$$

$$= 0.88$$

$$< 1$$

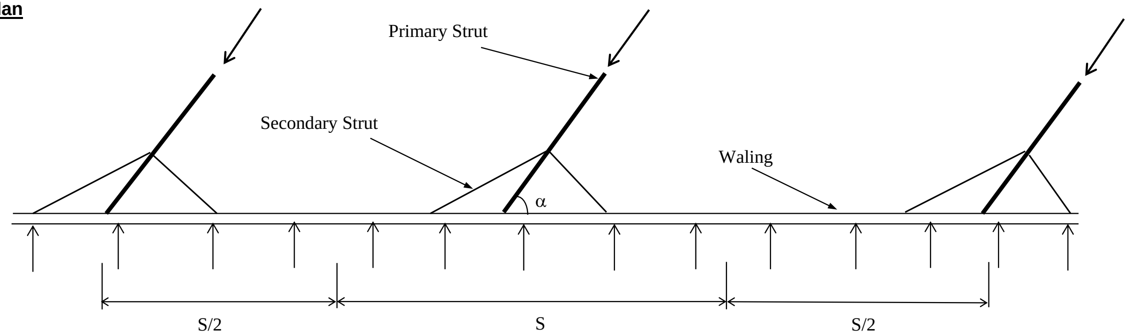
Overall Capacity OK

	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

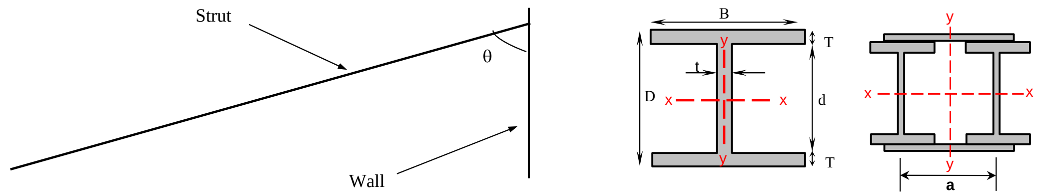
Structural Steel Design - Level 2 Main Strut (+1.70 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section



1. Section Properties

Try Section :	Double	356 x 406 x 340 UC	Grade 50	Hot Rolled

Depth of Section	D	=	406.4	mm	Elastic Modulus (X-Axis)	Z_x	=	12060000	mm^3
Width of Section	B	=	403.0	mm	Elastic Modulus (Y-Axis)	Z_y	=	11050000	mm^3
Web Thickness	t	=	26.5	mm	Plastic Modulus (X-Axis)	S_x	=	13980000	mm^3
Flange Thickness	T	=	42.9	mm	Plastic Modulus (Y-Axis)	S_y	=	17449900	mm^3
Depth between Fillets	d	=	290.2	mm	Buckling Parameter	u	=	0.836	
Second Moment of Area (X-Axis)	I_x	=	2.440E+09	mm^4	Torsional Index	x	=	8.85	
Second Moment of Area (Y-Axis)	I_y	=	4.452E+09	mm^4	Area of Section	A_g	=	86600	mm^2
Radius of Gyration (X-Axis)	r_x	=	168.0	mm	Mass per Length	w	=	680.0	kg/m
Radius of Gyration (Y-Axis)	r_y	=	226.7	mm	Design Strength	p_y	=	335	N/mm^2
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=	403.0	mm *Spacing OK*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	254.15	kN/m (From PLAXIS)		
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (86,600 / 10^6) x sin(90)^2 x sin(90)^2		=	**1.775E+07** kN
Minimum inclination of strut to waling, α	=	90.00	degree		
Load in the direction of strut, P_α	=	F / sin α	= 254.15 / sin 90.0	=	254.1 kN/m
Maximum strut spacing, S	=	8.00	m		
Maximum compression, P	=	P_α x S	= 254.15 x 8.00	=	2033.2 kN
Inclination of strut to wall, θ	=	90.00	degree		
Unrestrain length of strut on plan (X-Axis), L_x'	=	16.00	m		
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	= 16.00 / sin 90.0	=	16.00 m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	16.00	m		
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	= 16.00 / sin 90.0	=	16.00 m
Construction Load, Q_c	=	2.00	kPa		
Maximum Bending Moment (unfactored)	=	0.125 x (680.0 x 9.81 + 2.0 x 403.0 x 2) x 10^-3 x 16.0^2		=	265.0 kNm
Maximum Shear Force (unfactored)	=	0.5 x (680.0 x 9.81 +2.0 x 403.0 x 2) x 10^-3 x 16.0		=	66.3 kN
Load Factor	=	1.40			

Design Bending Moment (X-Axis)	M_x	=	2968.6	kNm	Design Shear Force	V	=	742.1	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	2846.5	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T =	4.7	<	8.0 ε	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t =	11.0	<	80 ε	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 11.0 < 70ε = 63.4

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area **A_v** = 21539 mm^2

Shear Capacity **V_c** = $p_yA_v/(3)$^0.5

= 4166 kN

Design Shear Force **V** = 742.1 kN < P_v = 4166 kN ***Check Shear OK***

Since, $0.6V_c$ = 2500 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 4683 kNm $1.2p_yZ_x$ = 4848 kNm

M_{cx} = 4683 kNm > M_x = 2968.6 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 5846 kNm $1.2p_yZ_y$ = 4442 kNm

M_{cy} = 4442 kNm > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis)	**L_y**	=	16.00 m	
Effective Length	**L_{Ey}**	=	1.0 L = 16.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	**λ**	=	L_{Ey} / r_y = 70.6	
Buckling parameter	**u**	=	0.84	*(Clause 8.3.5.3)*
	λ / x	=	7.97	
Slenderness factor	**ν**	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$	*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.699	
	β_w	=	1.000	*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	**λ_{LT}**	=	$u\nu\lambda(\beta_w)^{0.5}$ = 41.3	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	**p_y**	=	335.00 N/mm^2	
Buckling strength	**p_b**	=	294.0 N/mm^2	*(Table 8.3a for rolled section)*
Buckling resistance moment	**M_b**	=	4110.1 kNm	*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	**m_{LT}**	=	0.93	*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 2760.76 < M_b = 4110.1 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and **M_x** = 2968.56 < M_{cx} = 4683.3 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{2846.5}{29011.0} + \frac{2968.6}{4683.3} + \frac{0.0}{4442.1}$$

= 0.10 + 0.63 + 0.00

= 0.73

< 1 ***Cross-section Capacity OK***

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	16.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	16.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	95.2	≈ 96	
Maximum Thickness	T	=	42.9 mm	>	40 mm		
Type of Section		=	Rolled H-section > 40mm				
Designation of buckling curves for different section types:				Buckling Curve	c)		*(Table 8.7)*
p_c in Table 8.8 a)		=	179.00 N/mm^2				
p_c in Table 8.8 b)		=	162.00 N/mm^2				
p_c in Table 8.8 c)		=	145.00 N/mm^2				
p_c in Table 8.8 d)		=	130.00 N/mm^2				
Compressive Strength	p_{cx}	=	145.00 N/mm^2				*(Table 8.8(c))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	16.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	16.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	70.6	≈ 72	
Maximum Thickness	T	=	42.9 mm	>	40 mm		
Type of Section		=	Rolled H-section > 40mm				
Designation of buckling curves for different section types:				Buckling Curve	d)		*(Table 8.7)*
p_c in Table 8.8 a)		=	253.00 N/mm^2				
p_c in Table 8.8 b)		=	227.00 N/mm^2				
p_c in Table 8.8 c)		=	203.00 N/mm^2				
p_c in Table 8.8 d)		=	182.00 N/mm^2				
Compressive Strength	p_{cy}	=	182.00 N/mm^2				*(Table 8.8(d))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 145.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{2846.5}{12557.0} + \frac{2820.1}{4683.3} + \frac{0.0}{4442.1}$$

$$= 0.23 + 0.60 + 0.00$$

$$= 0.83$$

$$< 1$$

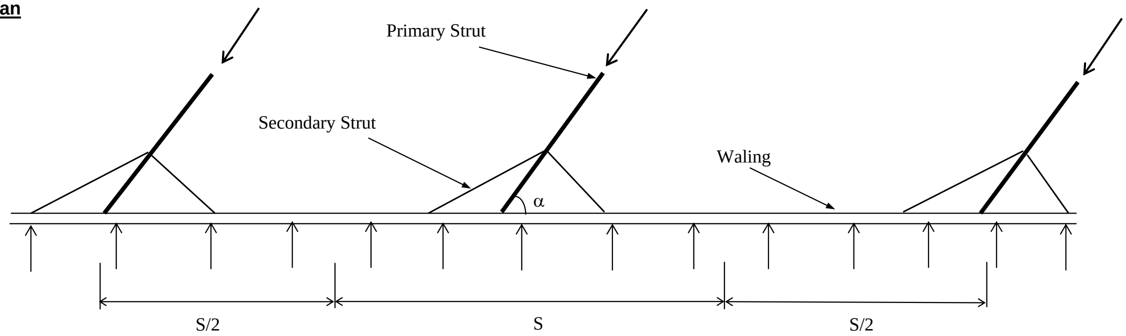
Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

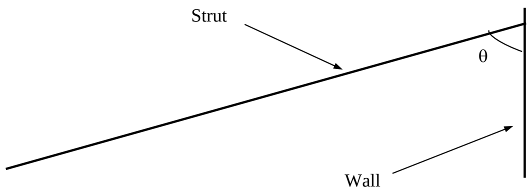
Structural Steel Design - Level 3 Main Strut (-1.40 mPD)

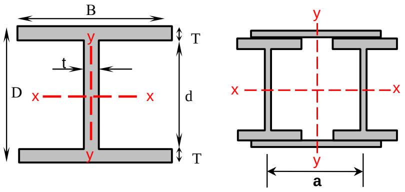
(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section





1. Section Properties

Try Section : **Double** | **356 x 406 x 393 UC** | **Grade 50** | **Hot Rolled**

Depth of Section	**D**	=	419.1	mm	Elastic Modulus (X-Axis)	$\mathbf{Z_x}$	=	14000000	mm^3
Width of Section	**B**	=	407.0	mm	Elastic Modulus (Y-Axis)	$\mathbf{Z_y}$	=	12920000	mm^3
Web Thickness	**t**	=	30.6	mm	Plastic Modulus (X-Axis)	$\mathbf{S_x}$	=	16460000	mm^3
Flange Thickness	**T**	=	49.2	mm	Plastic Modulus (Y-Axis)	$\mathbf{S_y}$	=	20390700	mm^3
Depth between Fillets	**d**	=	290.2	mm	Buckling Parameter	**u**	=	0.837	
Second Moment of Area (X-Axis)	$\mathbf{I_x}$	=	2.940E+09	mm^4	Torsional Index	**x**	=	7.86	
Second Moment of Area (Y-Axis)	$\mathbf{I_y}$	=	5.258E+09	mm^4	Area of Section	$\mathbf{A_g}$	=	100200	mm^2
Radius of Gyration (X-Axis)	$\mathbf{r_x}$	=	171.0	mm	Mass per Length	**w**	=	786.0	kg/m
Radius of Gyration (Y-Axis)	$\mathbf{r_y}$	=	229.1	mm	Design Strength	$\mathbf{p_y}$	=	335	N/mm^2
Modulus of Elasticity	**E**	=	205000	MPa	Distance Between Centre Lines	**a**	=	407.0	mm *Spacing OK*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	295.60	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (100,200 / 10^6) x sin(90)^2 x sin(90)^2		=	**2.054E+07**	kN
Minimum inclination of strut to waling, α	=	90.00	degree			
Load in the direction of strut, P_α	=	F / sin α	= 295.60 / sin 90.0	=	295.6	kN/m
Maximum strut spacing, S	=	8.00	m			
Maximum compression, P	=	P_α x S	= 295.60 x 8.00	=	2364.8	kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	16.00	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	= 16.00 / sin 90.0	=	16.00	m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	16.00	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	= 16.00 / sin 90.0	=	16.00	m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (786.0 x 9.81 + 2.0 x 407.0 x 2) x 10^-3 x 16.0^2		=	298.8	kNm
Maximum Shear Force (unfactored)	=	0.5 x (786.0 x 9.81 +2.0 x 407.0 x 2) x 10^-3 x 16.0		=	74.7	kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	$\mathbf{M_x}$	=	3347.0	kNm	Design Shear Force	**V**	=	836.7	kN
Design Bending Moment (Y-Axis)	$\mathbf{M_y}$	=	0.0	kNm	Axial Force	$\mathbf{F_c}$	=	3310.7	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T =	4.1	<	8.0 ε	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t =	9.5	<	80 ε	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 9.5 < 70ε = 63.4

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 25649 mm^2

Shear Capacity V_c = $p_yA_v/(3)$^0.5

= 4961 kN

Design Shear Force **V** = 836.7 kN < P_v = 4961 kN ***Check Shear OK***

Since, $0.6V_c$ = 2976 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 5514 kNm $1.2p_yZ_x$ = 5628 kNm

$\mathbf{M_{cx}}$ = **5514 kNm** > M_x = 3347.0 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 6831 kNm $1.2p_yZ_y$ = 5194 kNm

$\mathbf{M_{cy}}$ = **5194 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis)	L_y	=	16.00 m	
Effective Length	L_{Ey}	=	1.0 L = 16.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_{Ey} / r_y = 69.8	
Buckling parameter	u	=	0.84	*(Clause 8.3.5.3)*
	λ / x	=	8.89	
Slenderness factor	ν	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$	*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.670	
	β_w	=	1.000	*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$u\nu\lambda(\beta_w)^{0.5}$ = 39.2	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	335.00 N/mm^2	
Buckling strength	p_b	=	309.0 N/mm^2	*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	5086.1 kNm	*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93	*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 3112.69 < M_b = 5086.1 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 3346.98 < M_{cx} = 5514.1 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{3310.7}{33567.0} + \frac{3347.0}{5514.1} + \frac{0.0}{5193.8}$$

$$= 0.10 + 0.61 + 0.00$$

$$= 0.71$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	16.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	16.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	93.6	≈ 94	
Maximum Thickness	T	=	49.2 mm	>	40 mm		
Type of Section		=	Rolled H-section > 40mm				
Designation of buckling curves for different section types:				Buckling Curve	c)		*(Table 8.7)*
p_c in Table 8.8 a)		=	185.00 N/mm^2				
p_c in Table 8.8 b)		=	167.00 N/mm^2				
p_c in Table 8.8 c)		=	149.00 N/mm^2				
p_c in Table 8.8 d)		=	134.00 N/mm^2				
Compressive Strength	p_{cx}	=	149.00 N/mm^2				*(Table 8.8(c))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	16.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	16.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	69.8	≈ 70	
Maximum Thickness	T	=	49.2 mm	>	40 mm		
Type of Section		=	Rolled H-section > 40mm				
Designation of buckling curves for different section types:				Buckling Curve	d)		*(Table 8.7)*
p_c in Table 8.8 a)		=	259.00 N/mm^2				
p_c in Table 8.8 b)		=	233.00 N/mm^2				
p_c in Table 8.8 c)		=	209.00 N/mm^2				
p_c in Table 8.8 d)		=	187.00 N/mm^2				
Compressive Strength	p_{cy}	=	187.00 N/mm^2				*(Table 8.8(d))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 149.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{3310.7}{14929.8} + \frac{3179.6}{5514.1} + \frac{0.0}{5193.8}$$

$$= 0.22 + 0.58 + 0.00$$

$$= 0.80$$

$$< 1$$

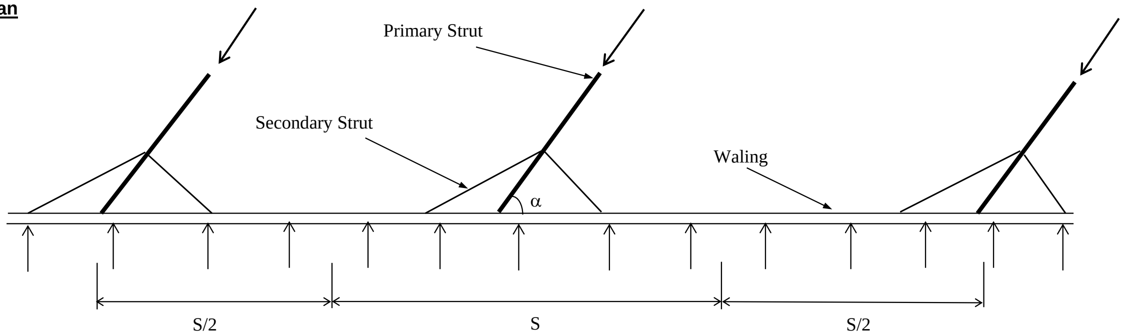
<u>Overall Capacity OK</u>

	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

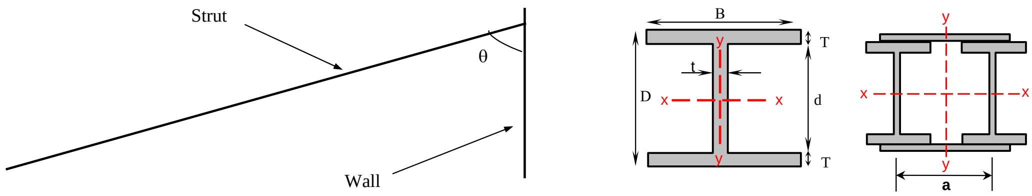
Structural Steel Design - Level 4 Main Strut (-4.50 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section



1. Section Properties

Try Section :	Double	356 x 406 x 393 UC	Grade 50	Hot Rolled

Depth of Section	D	=	419.1	mm	Elastic Modulus (X-Axis)	Z_x	=	14000000	mm^3	
Width of Section	B	=	407.0	mm	Elastic Modulus (Y-Axis)	Z_y	=	12920000	mm^3	
Web Thickness	t	=	30.6	mm	Plastic Modulus (X-Axis)	S_x	=	16460000	mm^3	
Flange Thickness	T	=	49.2	mm	Plastic Modulus (Y-Axis)	S_y	=	20390700	mm^3	
Depth between Fillets	d	=	290.2	mm	Buckling Parameter	u	=	0.837		
Second Moment of Area (X-Axis)	I_x	=	2.940E+09	mm^4	Torsional Index	x	=	7.86		
Second Moment of Area (Y-Axis)	I_y	=	5.258E+09	mm^4	Area of Section	A_g	=	100200	mm^2	
Radius of Gyration (X-Axis)	r_x	=	171.0	mm	Mass per Length	w	=	786.0	kg/m	
Radius of Gyration (Y-Axis)	r_y	=	229.1	mm	Design Strength	p_y	=	335	N/mm^2	
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=	407.0	mm	*Spacing OK*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	275.10	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (100,200 / 10^6) x sin(90)^2 x sin(90)^2		=	**2.054E+07**	kN
Minimum inclination of strut to waling, α	=	90.00	degree			
Load in the direction of strut, P_α	=	F / sin α	= 275.10 / sin 90.0	=	275.1	kN/m
Maximum strut spacing, S	=	8.00	m			
Maximum compression, P	=	P_α x S	= 275.10 x 8.00	=	2200.8	kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	16.00	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	= 16.00 / sin 90.0	=	16.00	m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	16.00	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	= 16.00 / sin 90.0	=	16.00	m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (786.0 x 9.81 + 2.0 x 407.0 x 2) x 10^-3 x 16.0^2		=	298.8	kNm
Maximum Shear Force (unfactored)	=	0.5 x (786.0 x 9.81 +2.0 x 407.0 x 2) x 10^-3 x 16.0		=	74.7	kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	M_x	=	3347.0	kNm	Design Shear Force	V	=	836.7	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	3081.1	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T =	4.1	<	8.0 ε	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t =	9.5	<	80 ε	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 9.5 < 70ε = 63.4

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 25649 mm^2

Shear Capacity V_c = $p_yA_v/(3)$^0.5

= 4961 kN

Design Shear Force **V** = 836.7 kN < P_v = 4961 kN ***Check Shear OK***

Since, $0.6V_c$ = 2976 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 5514 kNm $1.2p_yZ_x$ = 5628 kNm

$\mathbf{M_{cx}}$ = **5514 kNm** > M_x = 3347.0 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 6831 kNm $1.2p_yZ_y$ = 5194 kNm

$\mathbf{M_{cy}}$ = **5194 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis)	L_y	=	16.00 m	
Effective Length	L_{Ey}	=	1.0 L = 16.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_{Ey} / r_y = 69.8	
Buckling parameter	u	=	0.84	*(Clause 8.3.5.3)*
	λ / x	=	8.89	
Slenderness factor	ν	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$	*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.670	
	β_w	=	1.000	*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$u\nu\lambda(\beta_w)^{0.5}$ = 39.2	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	335.00 N/mm^2	
Buckling strength	p_b	=	309.0 N/mm^2	*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	5086.1 kNm	*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93	*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 3112.69 < M_b = 5086.1 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 3346.98 < M_{cx} = 5514.1 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{3081.1}{33567.0} + \frac{3347.0}{5514.1} + \frac{0.0}{5193.8}$$

= 0.09 + 0.61 + 0.00

= 0.70

< 1 ***Cross-section Capacity OK***

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	16.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	16.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	93.6	≈ 94	
Maximum Thickness	**T**	=	49.2 mm	>	40 mm		
Type of Section		=	Rolled H-section > 40mm				
Designation of buckling curves for different section types:				Buckling Curve	c)		*(Table 8.7)*
p_c in Table 8.8 a)		=	185.00 N/mm^2				
p_c in Table 8.8 b)		=	167.00 N/mm^2				
p_c in Table 8.8 c)		=	149.00 N/mm^2				
p_c in Table 8.8 d)		=	134.00 N/mm^2				
Compressive Strength	p_{cx}	=	149.00 N/mm^2				*(Table 8.8(c))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	16.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	16.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	69.8	≈ 70	
Maximum Thickness	**T**	=	49.2 mm	>	40 mm		
Type of Section		=	Rolled H-section > 40mm				
Designation of buckling curves for different section types:				Buckling Curve	d)		*(Table 8.7)*
p_c in Table 8.8 a)		=	259.00 N/mm^2				
p_c in Table 8.8 b)		=	233.00 N/mm^2				
p_c in Table 8.8 c)		=	209.00 N/mm^2				
p_c in Table 8.8 d)		=	187.00 N/mm^2				
Compressive Strength	p_{cy}	=	187.00 N/mm^2				*(Table 8.8(d))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 149.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{3081.1}{14929.8} + \frac{3179.6}{5514.1} + \frac{0.0}{5193.8}$$

$$= 0.21 + 0.58 + 0.00$$

$$= 0.78$$

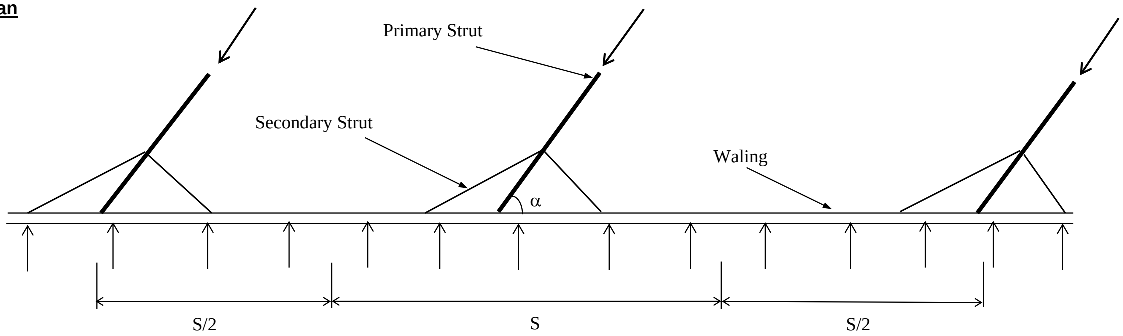
$$< 1$$

Overall Capacity OK

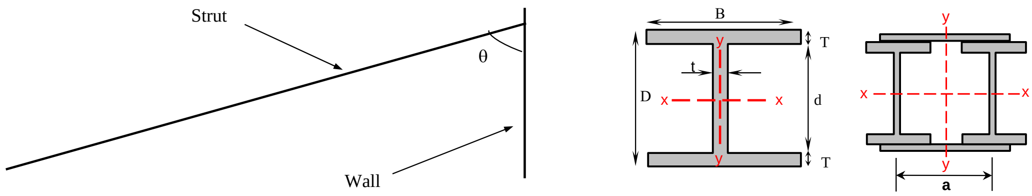
Structural Steel Design - Level 1 Secondary Strut (+4.80 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section



1. Section Properties

Try Section :	Single	203 x 203 x 46 UC	Grade 50	Hot Rolled

Depth of Section	D	=	203.2	mm	Elastic Modulus (X-Axis)	Z_x	=	449000	mm^3
Width of Section	B	=	203.2	mm	Elastic Modulus (Y-Axis)	Z_y	=	150000	mm^3
Web Thickness	t	=	7.3	mm	Plastic Modulus (X-Axis)	S_x	=	497000	mm^3
Flange Thickness	T	=	11.0	mm	Plastic Modulus (Y-Axis)	S_y	=	230000	mm^3
Depth between Fillets	d	=	160.9	mm	Buckling Parameter	u	=	0.846	
Second Moment of Area (X-Axis)	I_x	=	4.560E+07	mm^4	Torsional Index	x	=	17.7	
Second Moment of Area (Y-Axis)	I_y	=	1.540E+07	mm^4	Area of Section	A_g	=	5880	mm^2
Radius of Gyration (X-Axis)	r_x	=	88.1	mm	Mass per Length	w	=	46.0	kg/m
Radius of Gyration (Y-Axis)	r_y	=	51.2	mm	Design Strength	p_y	=	355	N/mm^2
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=		mm *Neglect Spacing*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	129.11	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (5,880 / 10^6) x sin(72)^2 x sin(90)^2		=	**1.085E+06**	kN
Minimum inclination of strut to waling, α	=	71.57	degree			
Load in the direction of strut, P_α	=	F / sin α	= 129.11 / sin 71.6	=	136.1	kN/m
Maximum strut spacing, S	=	2.00	m			
Maximum compression, P	=	P_α x S	= 136.09 x 2.00	=	272.2	kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	3.16	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	= 3.16 / sin 90.0	=	3.16	m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	3.16	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	= 3.16 / sin 90.0	=	3.16	m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (46.0 x 9.81 + 2.0 x 203.2 x 1) x 10^-3 x 3.2^2		=	1.1	kNm
Maximum Shear Force (unfactored)	=	0.5 x (46.0 x 9.81 +2.0 x 203.2 x 1) x 10^-3 x 3.2		=	1.4	kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	M_x	=	3.0	kNm	Design Shear Force	V	=	3.8	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	381.1	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 9.2 < 13.0 ε (Semi-compact) *(Table 7.1, Outstand element of compression flange)*

d/t = 22.0 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Semi-Compact Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 22.0 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 1483 mm^2

Shear Capacity V_c = $p_yA_v/(3)$^0.5

= 304 kN

Design Shear Force **V** = 3.8 kN < P_v = 304 kN ***Check Shear OK***

Since, $0.6V_c$ = 182 kN > V ***Low Shear***

6. Check Moment Capacity (for semi-compact sections)

(Clause 8.2.2)

Major Axis $M_{cx} = p_yZ_x$

M_{cx} = **159 kNm** > M_x = 3.0 kNm ***Major Moment Capacity OK***

Minor Axis $M_{cy} = p_yZ_y$

M_{cy} = **53 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) L_y = 3.16 m

Effective Length L_{Ey} = 1.0 L = 3.2 m *(Clause 8.3.4)*

Minor Axis Slenderness $\lambda = L_{Ey} / r_y$ = 61.8

Buckling parameter **u** = 0.85 *(Clause 8.3.5.3)*

λ / x = 3.49

Slenderness factor $\nu = 1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.888

β_w = 0.903 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness $\lambda_{LT} = u\nu\lambda(\beta_w)^{0.5}$ = 44.1 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength p_y = 355.00 N/mm^2

Buckling strength p_b = 309.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment M_b = 138.7 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor m_{LT} = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 2.79 < M_b = 138.7 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 3.00 < M_{cx} = 159.4 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{381.1}{2087.4} + \frac{3.0}{159.4} + \frac{0.0}{53.3}$$

$$= 0.18 + 0.02 + 0.00$$

$$= 0.20$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling = **x-x**

Unrestrain length (X-Axis) L_x = 3.16 m

Effective Length (X-Axis) L_{Ex} = 1.0 L_x = 3.16 m *(Clause 8.3.4)*

Major Axis Slenderness λ_x = L_{Ex} / r_x = 35.9 ≈ 40

Maximum Thickness **T** = 11.0 mm ≤ 40 mm

Type of Section = Rolled H-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve b) *(Table 8.7)*

p_c in Table 8.8 a) = 333.00 N/mm^2

p_c in Table 8.8 b) = 318.00 N/mm^2

p_c in Table 8.8 c) = 301.00 N/mm^2

p_c in Table 8.8 d) = 283.00 N/mm^2

Compressive Strength p_{cx} = 318.00 N/mm^2 *(Table 8.8(b))*

Axis of buckling = **y-y**

Unrestrain length (Y-Axis) L_y = 3.16 m

Effective Length (Y-Axis) L_{Ey} = 1.0 L_y = 3.16 m *(Clause 8.3.4)*

Minor Axis Slenderness λ_y = L_{Ey} / r_y = 61.8 ≈ 62

Maximum Thickness **T** = 11.0 mm ≤ 40 mm

Type of Section = Rolled H-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve c) *(Table 8.7)*

p_c in Table 8.8 a) = 293.00 N/mm^2

p_c in Table 8.8 b) = 266.00 N/mm^2

p_c in Table 8.8 c) = 241.00 N/mm^2

p_c in Table 8.8 d) = 217.00 N/mm^2

Compressive Strength p_{cy} = 241.00 N/mm^2 *(Table 8.8(c))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 241.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{381.1}{1417.1} + \frac{2.9}{159.4} + \frac{0.0}{53.3}$$

$$= 0.27 + 0.02 + 0.00$$

$$= 0.29$$

$$< 1$$

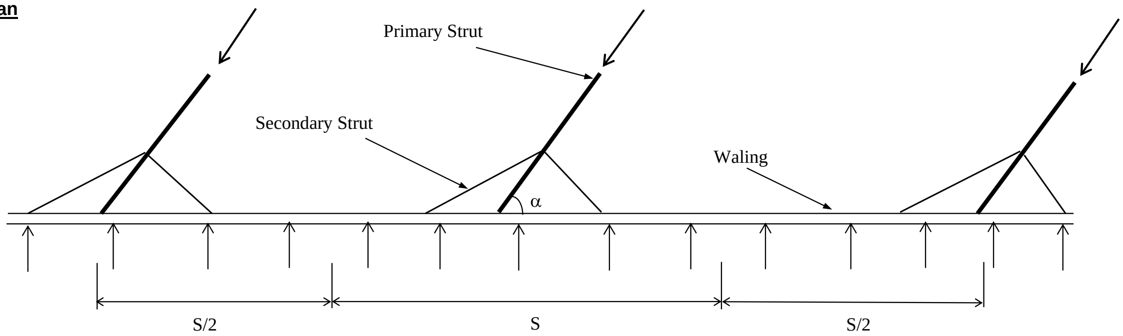
Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 20-Oct-21

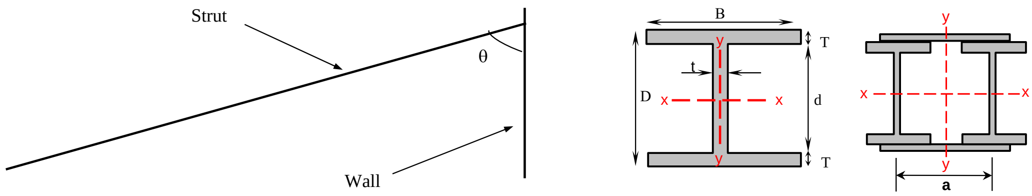
Structural Steel Design - Level 2 Secondary Strut (+1.70 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section



1. Section Properties

Try Section :	Single	203 x 203 x 46 UC	Grade 50	Hot Rolled

Depth of Section	**D**	=	203.2	mm	Elastic Modulus (X-Axis)	$\mathbf{Z_x}$	=	449000	mm^3
Width of Section	**B**	=	203.2	mm	Elastic Modulus (Y-Axis)	$\mathbf{Z_y}$	=	150000	mm^3
Web Thickness	**t**	=	7.3	mm	Plastic Modulus (X-Axis)	$\mathbf{S_x}$	=	497000	mm^3
Flange Thickness	**T**	=	11.0	mm	Plastic Modulus (Y-Axis)	$\mathbf{S_y}$	=	230000	mm^3
Depth between Fillets	**d**	=	160.9	mm	Buckling Parameter	**u**	=	0.846	
Second Moment of Area (X-Axis)	$\mathbf{I_x}$	=	4.560E+07	mm^4	Torsional Index	**x**	=	17.7	
Second Moment of Area (Y-Axis)	$\mathbf{I_y}$	=	1.540E+07	mm^4	Area of Section	$\mathbf{A_g}$	=	5880	mm^2
Radius of Gyration (X-Axis)	$\mathbf{r_x}$	=	88.1	mm	Mass per Length	**w**	=	46.0	kg/m
Radius of Gyration (Y-Axis)	$\mathbf{r_y}$	=	51.2	mm	Design Strength	$\mathbf{p_y}$	=	355	N/mm^2
Modulus of Elasticity	**E**	=	205000	MPa	Distance Between Centre Lines	**a**	=		mm *Neglect Spacing*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	254.15	kN/m (From PLAXIS)			
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (5,880 / 10^6) x sin(72)^2 x sin(90)^2		=	**1.085E+06**	kN
Minimum inclination of strut to waling, α	=	71.57	degree			
Load in the direction of strut, P_α	=	F / sin α	= 254.15 / sin 71.6	=	267.9	kN/m
Maximum strut spacing, S	=	2.00	m			
Maximum compression, P	=	P_α x S	= 267.90 x 2.00	=	535.8	kN
Inclination of strut to wall, θ	=	90.00	degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	3.16	m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	= 3.16 / sin 90.0	=	3.16	m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	3.16	m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	= 3.16 / sin 90.0	=	3.16	m
Construction Load, Q_c	=	2.00	kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (46.0 x 9.81 + 2.0 x 203.2 x 1) x 10^-3 x 3.2^2		=	1.1	kNm
Maximum Shear Force (unfactored)	=	0.5 x (46.0 x 9.81 +2.0 x 203.2 x 1) x 10^-3 x 3.2		=	1.4	kN
Load Factor	=	1.40				

Design Bending Moment (X-Axis)	$\mathbf{M_x}$	=	3.0	kNm	Design Shear Force	**V**	=	3.8	kN
Design Bending Moment (Y-Axis)	$\mathbf{M_y}$	=	0.0	kNm	Axial Force	$\mathbf{F_c}$	=	750.1	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 9.2 < 13.0 ε (Semi-compact) *(Table 7.1, Outstand element of compression flange)*

d/t = 22.0 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Semi-Compact Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 22.0 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 1483 mm^2

Shear Capacity V_c = $p_yA_v/(3)$^0.5

= 304 kN

Design Shear Force **V** = 3.8 kN < P_v = 304 kN ***Check Shear OK***

Since, $0.6V_c$ = 182 kN > V ***Low Shear***

6. Check Moment Capacity (for semi-compact sections)

(Clause 8.2.2)

Major Axis $M_{cx} = p_yZ_x$

M_{cx} = **159 kNm** > M_x = 3.0 kNm ***Major Moment Capacity OK***

Minor Axis $M_{cy} = p_yZ_y$

M_{cy} = **53 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis)	L_y	=	3.16 m		
Effective Length	L_{Ey}	=	1.0 L	= 3.2 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_{Ey} / r_y	= 61.8	
Buckling parameter	u	=	0.85		*(Clause 8.3.5.3)*
	λ / x	=	3.49		
Slenderness factor	ν	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$		*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.888		
	β_w	=	0.903		*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$u\nu\lambda(\beta_w)^{0.5}$	= 44.1	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	355.00 N/mm^2		
Buckling strength	p_b	=	309.0 N/mm^2		*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	138.7 kNm		*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93		*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 2.79 < M_b = 138.7 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 3.00 < M_{cx} = 159.4 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{750.1}{2087.4} + \frac{3.0}{159.4} + \frac{0.0}{53.3}$$

$$= 0.36 + 0.02 + 0.00$$

$$= 0.38$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	3.16 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	3.16 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	35.9	≈ 40	
Maximum Thickness	T	=	11.0 mm	≤	40 mm		
Type of Section		=	Rolled H-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	333.00 N/mm^2				
p_c in Table 8.8 b)		=	318.00 N/mm^2				
p_c in Table 8.8 c)		=	301.00 N/mm^2				
p_c in Table 8.8 d)		=	283.00 N/mm^2				
Compressive Strength	p_{cx}	=	318.00 N/mm^2				*(Table 8.8(b))*
Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	3.16 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	3.16 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	61.8	≈ 62	
Maximum Thickness	T	=	11.0 mm	≤	40 mm		
Type of Section		=	Rolled H-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	c)		*(Table 8.7)*
p_c in Table 8.8 a)		=	293.00 N/mm^2				
p_c in Table 8.8 b)		=	266.00 N/mm^2				
p_c in Table 8.8 c)		=	241.00 N/mm^2				
p_c in Table 8.8 d)		=	217.00 N/mm^2				
Compressive Strength	p_{cy}	=	241.00 N/mm^2				*(Table 8.8(c))*
Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	241.0 N/mm^2		
Moment equivalent factor m for flexural buckling							
	m_x	=	0.95				*(Table 8.9)*
	m_y	=	0.95				*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{750.1}{1417.1} + \frac{2.9}{159.4} + \frac{0.0}{53.3}$$

$$= 0.53 + 0.02 + 0.00$$

$$= 0.55$$

$$< 1$$

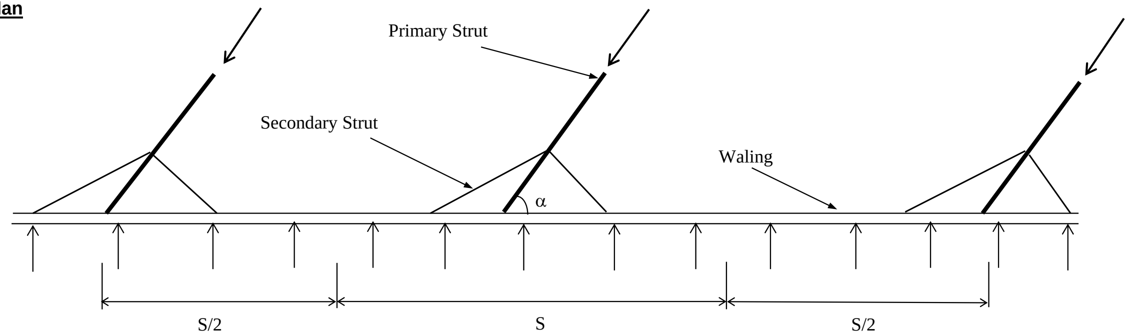
Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation	Job No.:	60617767
	Excavation and Lateral Support Works Design	By:	JL
	Structural Design	Chkd:	KP
	STN Pumping Station - Type-B	Date:	20-Oct-21

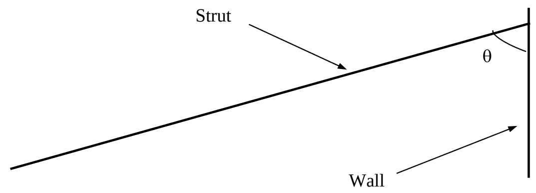
Structural Steel Design - Level 3 Secondary Strut (-1.40 mPD)

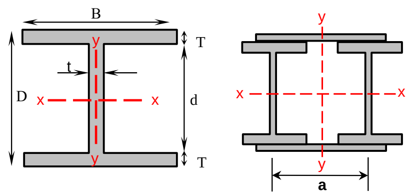
(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section





1. Section Properties

Try Section :	Single	203 x 203 x 46 UC	Grade 50	Hot Rolled

Depth of Section	D	=	203.2	mm	Elastic Modulus (X-Axis)	Z_x	=	449000	mm^3
Width of Section	B	=	203.2	mm	Elastic Modulus (Y-Axis)	Z_y	=	150000	mm^3
Web Thickness	t	=	7.3	mm	Plastic Modulus (X-Axis)	S_x	=	497000	mm^3
Flange Thickness	T	=	11.0	mm	Plastic Modulus (Y-Axis)	S_y	=	230000	mm^3
Depth between Fillets	d	=	160.9	mm	Buckling Parameter	u	=	0.846	
Second Moment of Area (X-Axis)	I_x	=	4.560E+07	mm^4	Torsional Index	x	=	17.7	
Second Moment of Area (Y-Axis)	I_y	=	1.540E+07	mm^4	Area of Section	A_g	=	5880	mm^2
Radius of Gyration (X-Axis)	r_x	=	88.1	mm	Mass per Length	w	=	46.0	kg/m
Radius of Gyration (Y-Axis)	r_y	=	51.2	mm	Design Strength	p_y	=	355	N/mm^2
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=		mm

Neglect Spacing

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	295.60 kN/m	(From PLAXIS)		
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (5,880 / 10^6) x sin(72)^2 x sin(90)^2		=	**1.085E+06** kN
Minimum inclination of strut to waling, α	=	71.57 degree			
Load in the direction of strut, P_α	=	F / sin α	= 295.60 / sin 71.6	=	311.6 kN/m
Maximum strut spacing, S	=	2.00 m			
Maximum compression, P	=	P_α x S	= 311.59 x 2.00	=	623.2 kN
Inclination of strut to wall, θ	=	90.00 degree			
Unrestrain length of strut on plan (X-Axis), L_x'	=	3.16 m			
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	= 3.16 / sin 90.0	=	3.16 m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	3.16 m			
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	= 3.16 / sin 90.0	=	3.16 m
Construction Load, Q_c	=	2.00 kPa			
Maximum Bending Moment (unfactored)	=	0.125 x (46.0 x 9.81 + 2.0 x 203.2 x 1) x 10^-3 x 3.2^2		=	1.1 kNm
Maximum Shear Force (unfactored)	=	0.5 x (46.0 x 9.81 +2.0 x 203.2 x 1) x 10^-3 x 3.2		=	1.4 kN
Load Factor	=	1.40			

Design Bending Moment (X-Axis)	M_x	=	3.0	kNm	Design Shear Force	V	=	3.8	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	872.4	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 9.2 < 13.0 ε (Semi-compact) *(Table 7.1, Outstand element of compression flange)*

d/t = 22.0 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Semi-Compact Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 22.0 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 1483 mm^2

Shear Capacity V_c = $p_yA_v/(3)$^0.5

= 304 kN

Design Shear Force **V** = 3.8 kN < P_v = 304 kN ***Check Shear OK***

Since, $0.6V_c$ = 182 kN > V ***Low Shear***

6. Check Moment Capacity (for semi-compact sections)

(Clause 8.2.2)

Major Axis $M_{cx} = p_yZ_x$

M_{cx} = **159 kNm** > M_x = 3.0 kNm ***Major Moment Capacity OK***

Minor Axis $M_{cy} = p_yZ_y$

M_{cy} = **53 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) L_y = 3.16 m

Effective Length L_{Ey} = 1.0 L = 3.2 m *(Clause 8.3.4)*

Minor Axis Slenderness λ = L_{Ey} / r_y = 61.8

Buckling parameter **u** = 0.85 *(Clause 8.3.5.3)*

λ / x = 3.49

Slenderness factor ν = $1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.888

β_w = 0.903 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness λ_{LT} = $u\nu\lambda(\beta_w)^{0.5}$ = 44.1 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength p_y = 355.00 N/mm^2

Buckling strength p_b = 309.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment M_b = 138.7 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor m_{LT} = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 2.79 < M_b = 138.7 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 3.00 < M_{cx} = 159.4 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{872.4}{2087.4} + \frac{3.0}{159.4} + \frac{0.0}{53.3}$$

= 0.42 + 0.02 + 0.00

= 0.44

< 1 ***Cross-section Capacity OK***

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling = **x-x**

Unrestrain length (X-Axis) L_x = 3.16 m

Effective Length (X-Axis) L_{Ex} = 1.0 L_x = 3.16 m *(Clause 8.3.4)*

Major Axis Slenderness λ_x = L_{Ex} / r_x = 35.9 ≈ 40

Maximum Thickness **T** = 11.0 mm ≤ 40 mm

Type of Section = Rolled H-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve b) *(Table 8.7)*

p_c in Table 8.8 a) = 333.00 N/mm^2

p_c in Table 8.8 b) = 318.00 N/mm^2

p_c in Table 8.8 c) = 301.00 N/mm^2

p_c in Table 8.8 d) = 283.00 N/mm^2

Compressive Strength p_{cx} = 318.00 N/mm^2 *(Table 8.8(b))*

Axis of buckling = **y-y**

Unrestrain length (Y-Axis) L_y = 3.16 m

Effective Length (Y-Axis) L_{Ey} = 1.0 L_y = 3.16 m *(Clause 8.3.4)*

Minor Axis Slenderness λ_y = L_{Ey} / r_y = 61.8 ≈ 62

Maximum Thickness **T** = 11.0 mm ≤ 40 mm

Type of Section = Rolled H-section ≤ 40mm

Designation of buckling curves for different section types: Buckling Curve c) *(Table 8.7)*

p_c in Table 8.8 a) = 293.00 N/mm^2

p_c in Table 8.8 b) = 266.00 N/mm^2

p_c in Table 8.8 c) = 241.00 N/mm^2

p_c in Table 8.8 d) = 217.00 N/mm^2

Compressive Strength p_{cy} = 241.00 N/mm^2 *(Table 8.8(c))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 241.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{872.4}{1417.1} + \frac{2.9}{159.4} + \frac{0.0}{53.3}$$

= 0.62 + 0.02 + 0.00

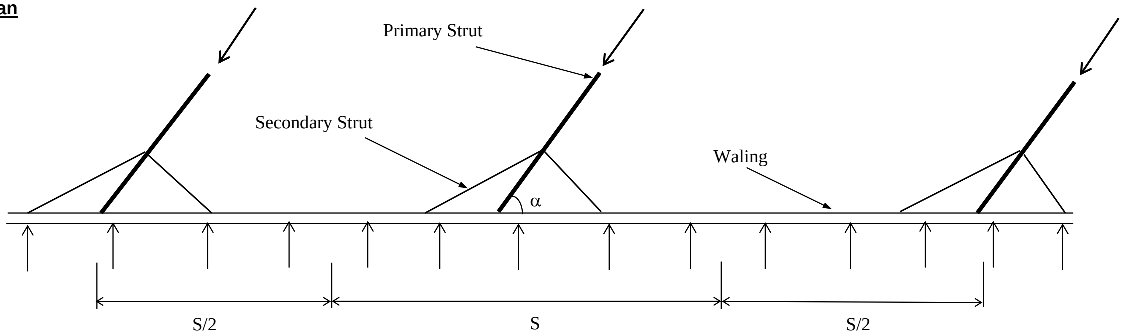
= 0.63

< 1 ***Overall Capacity OK***

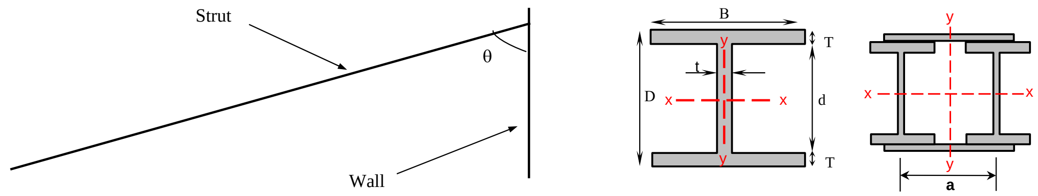
Structural Steel Design - Level 4 Secondary Strut (-4.50 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



Section



1. Section Properties

Try Section :	Single	203 x 203 x 46 UC	Grade 50	Hot Rolled

Depth of Section	D	=	203.2	mm	Elastic Modulus (X-Axis)	Z_x	=	449000	mm^3	
Width of Section	B	=	203.2	mm	Elastic Modulus (Y-Axis)	Z_y	=	150000	mm^3	
Web Thickness	t	=	7.3	mm	Plastic Modulus (X-Axis)	S_x	=	497000	mm^3	
Flange Thickness	T	=	11.0	mm	Plastic Modulus (Y-Axis)	S_y	=	230000	mm^3	
Depth between Fillets	d	=	160.9	mm	Buckling Parameter	u	=	0.846		
Second Moment of Area (X-Axis)	I_x	=	4.560E+07	mm^4	Torsional Index	x	=	17.7		
Second Moment of Area (Y-Axis)	I_y	=	1.540E+07	mm^4	Area of Section	A_g	=	5880	mm^2	
Radius of Gyration (X-Axis)	r_x	=	88.1	mm	Mass per Length	w	=	46.0	kg/m	
Radius of Gyration (Y-Axis)	r_y	=	51.2	mm	Design Strength	p_y	=	355	N/mm^2	
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=		mm	*Neglect Spacing*

2. Ultimate Design Load

Maximum inclined prop load, F (from Plaxis)	=	275.10	kN/m (From PLAXIS)				
Stiffness of strut for Plaxis input, EA $\sin^2(\alpha)\sin^2(\theta)$	=	(205,000 x 10^3) x (5,880 / 10^6) x sin(72)^2 x sin(90)^2			=	**1.085E+06**	kN
Minimum inclination of strut to waling, α	=	71.57	degree				
Load in the direction of strut, P_α	=	F / sin α	=	275.10 / sin 71.6	=	290.0	kN/m
Maximum strut spacing, S	=	2.00	m				
Maximum compression, P	=	P_α x S	=	289.98 x 2.00	=	580.0	kN
Inclination of strut to wall, θ	=	90.00	degree				
Unrestrain length of strut on plan (X-Axis), L_x'	=	3.16	m				
Actual unrestrain length of strut (X-Axis), L_x	=	L_x' / sin θ	=	3.16 / sin 90.0	=	3.16	m
Unrestrain length of strut on plan (Y-Axis), L_y'	=	3.16	m				
Actual unrestrain length of strut (Y-Axis), L_y	=	L_y' / sin θ	=	3.16 / sin 90.0	=	3.16	m
Construction Load, Q_c	=	2.00	kPa				
Maximum Bending Moment (unfactored)	=	0.125 x (46.0 x 9.81 + 2.0 x 203.2 x 1) x 10^-3 x 3.2^2			=	1.1	kNm
Maximum Shear Force (unfactored)	=	0.5 x (46.0 x 9.81 +2.0 x 203.2 x 1) x 10^-3 x 3.2			=	1.4	kN
Load Factor	=	1.40					

Design Bending Moment (X-Axis)	M_x	=	3.0	kNm	Design Shear Force	V	=	3.8	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	811.9	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 9.2 < 13.0 ε (Semi-compact) *(Table 7.1, Outstand element of compression flange)*

d/t = 22.0 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Semi-Compact Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 22.0 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 1483 mm^2

Shear Capacity V_c = $p_yA_v/(3)$^0.5

= 304 kN

Design Shear Force **V** = 3.8 kN < P_v = 304 kN ***Check Shear OK***

Since, $0.6V_c$ = 182 kN > V ***Low Shear***

6. Check Moment Capacity (for semi-compact sections)

(Clause 8.2.2)

Major Axis $M_{cx} = p_yZ_x$

M_{cx} = **159 kNm** > M_x = 3.0 kNm ***Major Moment Capacity OK***

Minor Axis $M_{cy} = p_yZ_y$

M_{cy} = **53 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis)	L_y	=	3.16 m		
Effective Length	L_{Ey}	=	1.0 L	= 3.2 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_{Ey} / r_y	= 61.8	
Buckling parameter	u	=	0.85		*(Clause 8.3.5.3)*
	λ / x	=	3.49		
Slenderness factor	ν	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$		*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.888		
	β_w	=	0.903		*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$u\nu\lambda(\beta_w)^{0.5}$	= 44.1	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	355.00 N/mm^2		
Buckling strength	p_b	=	309.0 N/mm^2		*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	138.7 kNm		*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93		*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 2.79 < M_b = 138.7 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 3.00 < M_{cx} = 159.4 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{811.9}{2087.4} + \frac{3.0}{159.4} + \frac{0.0}{53.3}$$

$$= 0.39 + 0.02 + 0.00$$

$$= 0.41$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	3.16 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	3.16 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	35.9 ≈	40	
Maximum Thickness	**T**	=	11.0 mm	≤	40 mm		
Type of Section		=	Rolled H-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	333.00 N/mm^2				
p_c in Table 8.8 b)		=	318.00 N/mm^2				
p_c in Table 8.8 c)		=	301.00 N/mm^2				
p_c in Table 8.8 d)		=	283.00 N/mm^2				
Compressive Strength	p_{cx}	=	318.00 N/mm^2				*(Table 8.8(b))*
Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	3.16 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	3.16 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	61.8 ≈	62	
Maximum Thickness	**T**	=	11.0 mm	≤	40 mm		
Type of Section		=	Rolled H-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	c)		*(Table 8.7)*
p_c in Table 8.8 a)		=	293.00 N/mm^2				
p_c in Table 8.8 b)		=	266.00 N/mm^2				
p_c in Table 8.8 c)		=	241.00 N/mm^2				
p_c in Table 8.8 d)		=	217.00 N/mm^2				
Compressive Strength	p_{cy}	=	241.00 N/mm^2				*(Table 8.8(c))*
Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	241.0 N/mm^2		
Moment equivalent factor m for flexural buckling							
	m_x	=	0.95				*(Table 8.9)*
	m_y	=	0.95				*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{811.9}{1417.1} + \frac{2.9}{159.4} + \frac{0.0}{53.3}$$

$$= 0.57 + 0.02 + 0.00$$

$$= 0.59$$

$$< 1$$

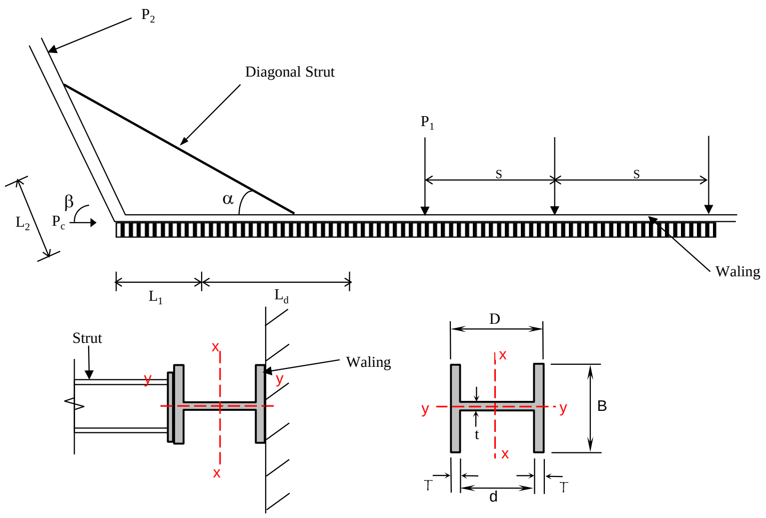
Overall Capacity OK

	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 20-Oct-21

Structural Steel Design - Level 1 Waling (+4.80 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



1. Section Properties

Try Section :	Single	457 x 191 x 89 UB	Grade 50	Hot Rolled

Depth of Section	D	=	463.6	mm	Elastic Modulus (X-Axis)	Z_x	=	1770000	mm^3
Width of Section	B	=	192.0	mm	Elastic Modulus (Y-Axis)	Z_y	=	217708	mm^3
Web Thickness	t	=	10.6	mm	Plastic Modulus (X-Axis)	S_x	=	2010000	mm^3
Flange Thickness	T	=	17.7	mm	Plastic Modulus (Y-Axis)	S_y	=	338000	mm^3
Depth between Fillets	d	=	407.9	mm	Buckling Parameter	u	=	0.879	
Second Moment of Area (X-Axis)	I_x	=	4.100E+08	mm^4	Torsional Index	x	=	28.3	
Second Moment of Area (Y-Axis)	I_y	=	2.090E+07	mm^4	Area of Section	A_g	=	11400	mm^2
Radius of Gyration (X-Axis)	r_x	=	190.0	mm	Mass per Length	w	=	89.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	42.8	mm	Design Strength	p_y	=	345	N/mm^2
					Root Radius	r	=	10.2	mm
Modulus of Elasticity	E	=	205000	MPa	Distance Between Centre Lines	a	=		mm *Neglect Spacing*

2. Ultimate Design Load

Resolve perpendicular to adjacent waling ➩ $P_c \sin\beta = P_1 L_1 \cos\beta + P_2 L_2$

Compressive Force (corner) ➩ $P_c = (P_1 L_1 \cos\beta + P_2 L_2) / \sin\beta$

		Case 1	Case 2	Case 3	Case 4
Inclined prop load from Plaxis, P_{i1}	=	129.11 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_1	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_1 = P_{i1} \sin\theta_1$	=	129.1 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclined prop load from Plaxis, P_{i2}	=	129.11 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_2	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_2 = P_{i2} \sin\theta_2$	=	129.1 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Intersection angle of end waling, β	=	90.0 °	90.0 °	90.0 °	90.0 °
Load bearing width of waling at corner, L_1	=	0.00 m	0.00 m	0.00 m	0.00 m
Load bearing width of waling at corner, L_2	=	0.00 m	0.00 m	0.00 m	0.00 m
Compressive Force (corner), P_c	=	0.0 kN	0.0 kN	0.0 kN	0.0 kN

Maximum horizontal pressure, P	=	129.11	kN/m
Maximum strut spacing, S	=	4.00	m
Load bearing width of diagonal strut, L_d	=	0.00	m
Minimum inclination of diagonal strut, α	=	90.00	°
Construction Load, Q_c	=	2.00	kPa

Maximum bending moment, Mx	=	P x S^2 / 8	=	129.11 x 4.00 x 4.00/8	=	258.22 kNm
Maximum bending moment, My	=	Self Weight + Construction Load	=	(89.0 x 9.8 + 2.0 x 463.6) / 1000 x 4.0^2 /	=	2.88 kNm
Maximum shear force, V	=	P x S / 2	=	129.11 x 4.00 / 2	=	258.22 kN
Compressive Force (corner)	=	Max. of P_c	=	Max. of (0, 0, 0, 0)	=	0.00 kN
Compressive Force (1% Strut Force)	=	P x S x 1%	=	129.11 x 4.00 x 1%	=	5.16 kN
Compressive Force (diagonal strut)	=	P x S / tan α	=	129.11 x 0.00 / tan 90	=	0.00 kN
Load Factor	=	1.4				

Design Bending Moment (Major Axis)	M_x	=	361.5	kNm	Design Shear Force	V	=	361.5	kN
Design Bending Moment (Minor Axis)	M_y	=	4.0	kNm	Axial Force	F_c	=	7.2	kN

3. Section Classification

(Table 7.1)

e = $[275 / p_y]^{1/2}$ = 0.9

b/T =	5.4	<	8.0	e	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t =	38.5	<	80	e	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 38.5 < 70e = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area	A_v	=	4914 mm^2				
Shear Capacity	V_c	=	p_yA_v/(3)^0.5				
		=	979 kN				
Design Shear Force	V	=	361.5 kN	<	P_v =	979 kN	***Check Shear OK***
Since,	$0.6V_c$	=	587 kN	>	V		***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis	M_{cx}	=	Lesser of p_yS_x	and	$1.2p_yZ_x$		
	p_yS_x	=	693 kNm		$1.2p_yZ_x$ =	733 kNm	
	M_{cx}	=	**693 kNm**	>	M_x =	361.5 kNm	***Major Moment Capacity OK***
Minor Axis	M_{cy}	=	Lesser of p_yS_y	and	$1.2p_yZ_y$		
	p_yS_y	=	117 kNm		$1.2p_yZ_y$ =	90 kNm	
	M_{cy}	=	**90 kNm**	>	M_y =	4.0 kNm	***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrained Span Length	L	=	4.00 m			
Effective Length	L_E	=	1.0 L	=	4.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_E / r_y	=	93.4	
Buckling parameter	u	=	0.88			*(Clause 8.3.5.3)*
	λ / x	=	3.30			
Slenderness factor	ν	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$			*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.897			
	β_w	=	1.000			*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$u\nu\lambda(\beta_w)^{0.5}$	=	73.7	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	345.00 N/mm^2			
Buckling strength	p_b	=	202.0 N/mm^2			*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	406.0 kNm			*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93			*(Table 8.4a for no intermediate lateral restraint)*

	$m_{LT}M_x$	=	336.20	<	M_b =	406.0 kNm	*(Clause 8.3.5.2 Eqn 8.18)*
and	M_x	=	361.50	<	M_{cx} =	693.5 kNm	*(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{7.2}{3933.0} + \frac{361.5}{693.5} + \frac{4.0}{90.1}$$

$= 0.00 + 0.52 + 0.04$

$= 0.57$

< 1

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	x-x				
Unrestrain length (X-Axis)	L_x	=	4.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	4.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	21.1	≈ 25	
Maximum Thickness	T	=	17.7 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	338.00 N/mm²				
p_c in Table 8.8 b)		=	332.00 N/mm²				
p_c in Table 8.8 c)		=	326.00 N/mm²				
p_c in Table 8.8 d)		=	318.00 N/mm²				
Compressive Strength	p_{cx}	=	338.00 N/mm²				*(Table 8.8(a))*

Axis of buckling		=	y-y				
Unrestrain length (Y-Axis)	L_y	=	4.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	4.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	93.4	≈ 94	
Maximum Thickness	T	=	17.7 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	187.00 N/mm²				
p_c in Table 8.8 b)		=	169.00 N/mm²				
p_c in Table 8.8 c)		=	151.00 N/mm²				
p_c in Table 8.8 d)		=	136.00 N/mm²				
Compressive Strength	p_{cy}	=	169.00 N/mm²				*(Table 8.8(b))*

Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	169.0 N/mm²	
Moment equivalent factor m for flexural buckling						
	m_x	=	0.95			*(Table 8.9)*
	m_y	=	0.95			*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{7.2}{1926.6} + \frac{343.4}{693.5} + \frac{3.8}{90.1}$$

$= 0.00 + 0.50 + 0.04$

$= 0.54$

< 1

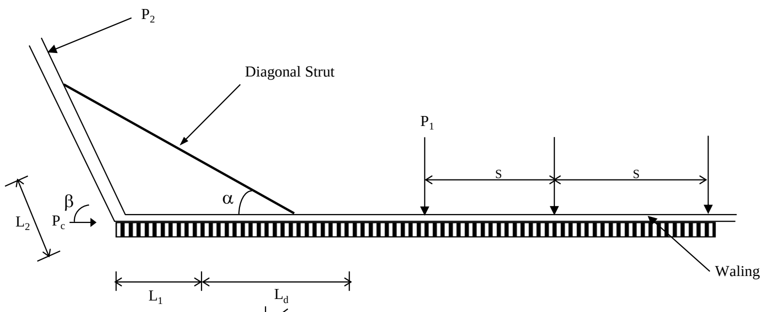
Overall Capacity OK

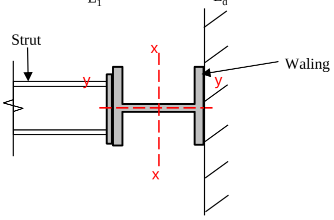
AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 20-Oct-21

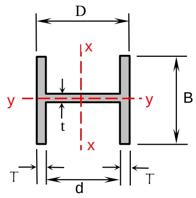
Structural Steel Design - Level 2 Waling (+1.70 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan







1. Section Properties

Try Section :	Single	610 x 229 x 125 UB	Grade 50	Hot Rolled

Depth of Section	**D**	=	611.9	mm	Elastic Modulus (X-Axis)	$\mathbf{Z_x}$	=	3220000	mm^3
Width of Section	**B**	=	229.0	mm	Elastic Modulus (Y-Axis)	$\mathbf{Z_y}$	=	343231	mm^3
Web Thickness	**t**	=	11.9	mm	Plastic Modulus (X-Axis)	$\mathbf{S_x}$	=	3680000	mm^3
Flange Thickness	**T**	=	19.6	mm	Plastic Modulus (Y-Axis)	$\mathbf{S_y}$	=	536000	mm^3
Depth between Fillets	**d**	=	547.3	mm	Buckling Parameter	**u**	=	0.873	
Second Moment of Area (X-Axis)	$\mathbf{I_x}$	=	9.860E+08	mm^4	Torsional Index	**x**	=	34	
Second Moment of Area (Y-Axis)	$\mathbf{I_y}$	=	3.930E+07	mm^4	Area of Section	$\mathbf{A_g}$	=	16000	mm^2
Radius of Gyration (X-Axis)	$\mathbf{r_x}$	=	249.0	mm	Mass per Length	**w**	=	125.00	kg/m
Radius of Gyration (Y-Axis)	$\mathbf{r_y}$	=	49.6	mm	Design Strength	$\mathbf{p_y}$	=	345	N/mm^2
					Root Radius	**r**	=	12.7	mm
Modulus of Elasticity	**E**	=	205000	MPa	Distance Between Centre Lines	**a**	=		mm

Neglect Spacing

2. Ultimate Design Load

Resolve perpendicular to adjacent waling ➪ $P_c \sin\beta = P_1 L_1 \cos\beta + P_2 L_2$

Compressive Force (corner) ➪ $P_c = (P_1 L_1 \cos\beta + P_2 L_2) / \sin\beta$

		Case 1	Case 2	Case 3	Case 4
Inclined prop load from Plaxis, P_{i1}	=	254.15 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_1	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_1 = P_{i1} \sin\theta_1$	=	254.1 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclined prop load from Plaxis, P_{i2}	=	254.15 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_2	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_2 = P_{i2} \sin\theta_2$	=	254.1 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Intersection angle of end waling, β	=	90.0 °	90.0 °	90.0 °	90.0 °
Load bearing width of waling at corner, L_1	=	0.00 m	0.00 m	0.00 m	0.00 m
Load bearing width of waling at corner, L_2	=	0.00 m	0.00 m	0.00 m	0.00 m
Compressive Force (corner), P_c	=	0.0 kN	0.0 kN	0.0 kN	0.0 kN

Maximum horizontal pressure, P	=	254.15	kN/m
Maximum strut spacing, S	=	4.00	m
Load bearing width of diagonal strut, L_d	=	0.00	m
Minimum inclination of diagonal strut, α	=	90.00	°
Construction Load, Q_c	=	2.00	kPa

Maximum bending moment, Mx	=	P x S^2 / 8	=	254.15 x 4.00 x 4.00/8	=	508.30 kNm
Maximum bending moment, My	=	Self Weight + Construction Load	=	(125.0 x 9.8 + 2.0 x 611.9) / 1000 x 4.0^2	=	3.92 kNm
Maximum shear force, V	=	P x S / 2	=	254.15 x 4.00 / 2	=	508.30 kN
Compressive Force (corner)	=	Max. of P_c	=	Max. of (0, 0, 0, 0)	=	0.00 kN
Compressive Force (1% Strut Force)	=	P x S x 1%	=	254.15 x 4.00 x 1%	=	10.17 kN
Compressive Force (diagonal strut)	=	P x S / tan α	=	254.15 x 0.00 / tan 90	=	0.00 kN
Load Factor	=	1.4				

Design Bending Moment (Major Axis)	M_x	=	711.6	kNm	Design Shear Force	V	=	711.6 kN
Design Bending Moment (Minor Axis)	M_y	=	5.5	kNm	Axial Force	F_c	=	14.2 kN

3. Section Classification

(Table 7.1)

$e = [275 / p_y]^{1/2}$ = 0.9

b/T =	5.8	<	8.0 e	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t =	46.0	<	80 e	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 46.0 < 70e = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area	A_v	=	7282 mm^2				
Shear Capacity	V_c	=	p_yA_v/(3)^0.5				
		=	1450 kN				
Design Shear Force	V	=	711.6 kN	<	P_v =	1450 kN	***Check Shear OK***
Since,	$0.6V_c$	=	870 kN	>	V		***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis	M_{cx}	=	Lesser of p_yS_x	and	$1.2p_yZ_x$		
	p_yS_x	=	1270 kNm		$1.2p_yZ_x$ =	1333 kNm	
	M_{cx}	=	**1270 kNm**	>	M_x =	711.6 kNm	***Major Moment Capacity OK***
Minor Axis	M_{cy}	=	Lesser of p_yS_y	and	$1.2p_yZ_y$		
	p_yS_y	=	185 kNm		$1.2p_yZ_y$ =	142 kNm	
	M_{cy}	=	**142 kNm**	>	M_y =	5.5 kNm	***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrained Span Length	L	=	4.00 m			
Effective Length	L_E	=	1.0 L	=	4.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_E / r_y	=	80.7	
Buckling parameter	u	=	0.87			*(Clause 8.3.5.3)*
	λ / x	=	2.37			
Slenderness factor	ν	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$			*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.940			
	β_w	=	1.000			*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$u\nu\lambda(\beta_w)^{0.5}$	=	66.2	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	345.00 N/mm^2			
Buckling strength	p_b	=	218.0 N/mm^2			*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	802.2 kNm			*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93			*(Table 8.4a for no intermediate lateral restraint)*
	$m_{LT}M_x$	=	661.80	<	M_b = 802.2 kNm	*(Clause 8.3.5.2 Eqn 8.18)*
and	M_x	=	711.61	<	M_{cx} = 1269.6 kNm	*(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{14.2}{5520.0} + \frac{711.6}{1269.6} + \frac{5.5}{142.1}$$

$$= 0.00 + 0.56 + 0.04$$

$$= 0.60$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	4.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	4.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	16.1	≈ 20	
Maximum Thickness	T	=	19.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	342.00 N/mm^2				
p_c in Table 8.8 b)		=	339.00 N/mm^2				
p_c in Table 8.8 c)		=	336.00 N/mm^2				
p_c in Table 8.8 d)		=	332.00 N/mm^2				
Compressive Strength	p_{cx}	=	342.00 N/mm^2				*(Table 8.8(a))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	4.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	4.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	80.7	≈ 82	
Maximum Thickness	T	=	19.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	225.00 N/mm^2				
p_c in Table 8.8 b)		=	202.00 N/mm^2				
p_c in Table 8.8 c)		=	180.00 N/mm^2				
p_c in Table 8.8 d)		=	161.00 N/mm^2				
Compressive Strength	p_{cy}	=	202.00 N/mm^2				*(Table 8.8(b))*

Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	202.0 N/mm^2		
Moment equivalent factor m for flexural buckling							
	m_x	=	0.95				*(Table 8.9)*
	m_y	=	0.95				*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{14.2}{3232.0} + \frac{676.0}{1269.6} + \frac{5.2}{142.1}$$

$$= 0.00 + 0.53 + 0.04$$

$$= 0.57$$

$$< 1$$

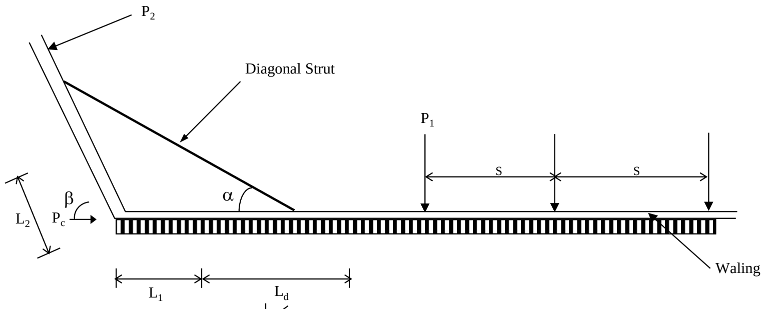
Overall Capacity OK

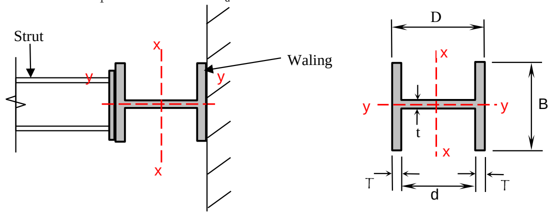
	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 20-Oct-21

Structural Steel Design - Level 3 Waling (-1.40 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan





1. Section Properties

Try Section :	Single	610 x 229 x 140 UB	Grade 50	Hot Rolled

Depth of Section	**D**	=	617.0	mm	Elastic Modulus (X-Axis)	Z_x	=	3630000	mm^3	
Width of Section	**B**	=	230.1	mm	Elastic Modulus (Y-Axis)	Z_y	=	392003	mm^3	
Web Thickness	**t**	=	13.1	mm	Plastic Modulus (X-Axis)	S_x	=	4150000	mm^3	
Flange Thickness	**T**	=	22.1	mm	Plastic Modulus (Y-Axis)	S_y	=	612000	mm^3	
Depth between Fillets	**d**	=	547.3	mm	Buckling Parameter	**u**	=	0.875		
Second Moment of Area (X-Axis)	I_x	=	1.120E+09	mm^4	Torsional Index	**x**	=	30.5		
Second Moment of Area (Y-Axis)	I_y	=	4.510E+07	mm^4	Area of Section	A_g	=	17800	mm^2	
Radius of Gyration (X-Axis)	r_x	=	250.0	mm	Mass per Length	**w**	=	140.00	kg/m	
Radius of Gyration (Y-Axis)	r_y	=	50.3	mm	Design Strength	p_y	=	345	N/mm^2	
					Root Radius	**r**	=	12.7	mm	
Modulus of Elasticity	**E**	=	205000	MPa	Distance Between Centre Lines	**a**	=		mm	*Neglect Spacing*

2. Ultimate Design Load

Resolve perpendicular to adjacent waling ➪ $P_c \sin\beta = P_1 L_1 \cos\beta + P_2 L_2$

Compressive Force (corner) ➪ $P_c = (P_1 L_1 \cos\beta + P_2 L_2) / \sin\beta$

		Case 1	Case 2	Case 3	Case 4
Inclined prop load from Plaxis, P_{i1}	=	295.60 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_1	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_1 = P_{i1} \sin\theta_1$	=	295.6 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclined prop load from Plaxis, P_{i2}	=	295.60 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_2	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_2 = P_{i2} \sin\theta_2$	=	295.6 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Intersection angle of end waling, β	=	90.0 °	90.0 °	90.0 °	90.0 °
Load bearing width of waling at corner, L_1	=	0.00 m	0.00 m	0.00 m	0.00 m
Load bearing width of waling at corner, L_2	=	0.00 m	0.00 m	0.00 m	0.00 m
Compressive Force (corner), P_c	=	0.0 kN	0.0 kN	0.0 kN	0.0 kN

Maximum horizontal pressure, P	=	295.60	kN/m
Maximum strut spacing, S	=	4.00	m
Load bearing width of diagonal strut, L_d	=	0.00	m
Minimum inclination of diagonal strut, α	=	90.00	°
Construction Load, Q_c	=	2.00	kPa

Maximum bending moment, Mx	= $P \times S^2 / 8$	=	295.60 x 4.00 x 4.00/8	=	591.20 kNm
Maximum bending moment, My	= Self Weight + Construction Load	=	(140.0 x 9.8 + 2.0 x 617.0) / 1000 x 4.0^2	=	4.17 kNm
Maximum shear force, V	= P x S / 2	=	295.60 x 4.00 / 2	=	591.20 kN
Compressive Force (corner)	= Max. of P_c	=	Max. of (0, 0, 0, 0)	=	0.00 kN
Compressive Force (1% Strut Force)	= P x S x 1%	=	295.60 x 4.00 x 1%	=	11.82 kN
Compressive Force (diagonal strut)	= P x S / tan α	=	295.60 x 0.00 / tan 90	=	0.00 kN
Load Factor	= 1.4				

Design Bending Moment (Major Axis)	M_x	=	827.7	kNm	Design Shear Force	V	=	827.7	kN
Design Bending Moment (Minor Axis)	M_y	=	5.8	kNm	Axial Force	F_c	=	16.6	kN

3. Section Classification

(Table 7.1)

$e = [275 / p_y]^{1/2} = 0.9$

b/T = 5.2 < 8.0 e (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 41.8 < 80 e (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 41.8 < 70e = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 8083 mm^2

Shear Capacity V_c = $p_yA_v/(3)$^0.5

= 1610 kN

Design Shear Force V = 827.7 kN < P_v = 1610 kN ***Check Shear OK***

Since, $0.6V_c$ = 966 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 1432 kNm $1.2p_yZ_x$ = 1503 kNm

M_{cx} = **1432 kNm** > M_x = 827.7 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 211 kNm $1.2p_yZ_y$ = 162 kNm

M_{cy} = **162 kNm** > M_y = 5.8 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrained Span Length	L	=	4.00 m	
Effective Length	L_E	=	1.0 L = 4.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_E / r_y = 79.5	
Buckling parameter	u	=	0.88	*(Clause 8.3.5.3)*
	λ / x	=	2.61	
Slenderness factor	v	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$	*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.930	
	β_w	=	1.000	*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$uv\lambda(\beta_w)^{0.5}$ = 64.6	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	345.00 N/mm^2	
Buckling strength	p_b	=	234.0 N/mm^2	*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	971.1 kNm	*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93	*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 769.74 < M_b = 971.1 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 827.67 < M_{cx} = 1431.8 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{16.6}{6141.0} + \frac{827.7}{1431.8} + \frac{5.8}{162.3}$$

$$= 0.00 + 0.58 + 0.04$$

$$= 0.62$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	4.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	4.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	16.0	≈ 20	
Maximum Thickness	T	=	22.1 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	342.00 N/mm^2				
p_c in Table 8.8 b)		=	339.00 N/mm^2				
p_c in Table 8.8 c)		=	336.00 N/mm^2				
p_c in Table 8.8 d)		=	332.00 N/mm^2				
Compressive Strength	p_{cx}	=	342.00 N/mm^2				*(Table 8.8(a))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	4.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	4.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	79.5	≈ 80	
Maximum Thickness	T	=	22.1 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	232.00 N/mm^2				
p_c in Table 8.8 b)		=	208.00 N/mm^2				
p_c in Table 8.8 c)		=	185.00 N/mm^2				
p_c in Table 8.8 d)		=	165.00 N/mm^2				
Compressive Strength	p_{cy}	=	208.00 N/mm^2				*(Table 8.8(b))*

Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	208.0 N/mm^2		
Moment equivalent factor m for flexural buckling							
	m_x	=	0.95				*(Table 8.9)*
	m_y	=	0.95				*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{16.6}{3702.4} + \frac{786.3}{1431.8} + \frac{5.5}{162.3}$$

$$= 0.00 + 0.55 + 0.03$$

$$= 0.59$$

$$< 1$$

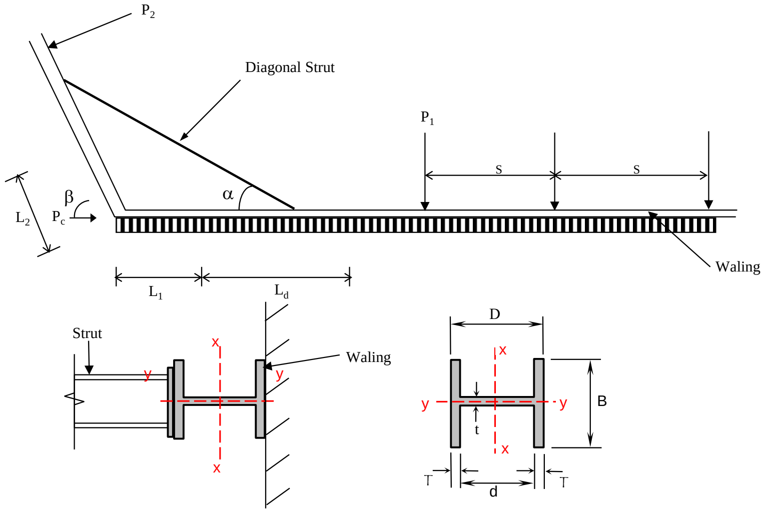
Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 20-Oct-21

Structural Steel Design - Level 4 Waling (-4.50 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")

Plan



1. Section Properties

Try Section :	Single	610 x 229 x 140 UB	Grade 50	Hot Rolled

Depth of Section	**D**	=	617.0	mm	Elastic Modulus (X-Axis)	Z_x	=	3630000	mm^3
Width of Section	**B**	=	230.1	mm	Elastic Modulus (Y-Axis)	Z_y	=	392003	mm^3
Web Thickness	**t**	=	13.1	mm	Plastic Modulus (X-Axis)	S_x	=	4150000	mm^3
Flange Thickness	**T**	=	22.1	mm	Plastic Modulus (Y-Axis)	S_y	=	612000	mm^3
Depth between Fillets	**d**	=	547.3	mm	Buckling Parameter	**u**	=	0.875	
Second Moment of Area (X-Axis)	I_x	=	1.120E+09	mm^4	Torsional Index	**x**	=	30.5	
Second Moment of Area (Y-Axis)	I_y	=	4.510E+07	mm^4	Area of Section	A_g	=	17800	mm^2
Radius of Gyration (X-Axis)	r_x	=	250.0	mm	Mass per Length	**w**	=	140.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	50.3	mm	Design Strength	p_y	=	345	N/mm^2
					Root Radius	**r**	=	12.7	mm
Modulus of Elasticity	**E**	=	205000	MPa	Distance Between Centre Lines	**a**	=		mm *Neglect Spacing*

2. Ultimate Design Load

Resolve perpendicular to adjacent waling ➪ $P_c \sin\beta = P_1 L_1 \cos\beta + P_2 L_2$

Compressive Force (corner) ➪ $P_c = (P_1 L_1 \cos\beta + P_2 L_2) / \sin\beta$

		Case 1	Case 2	Case 3	Case 4
Inclined prop load from Plaxis, P_{i1}	=	275.10 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_1	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_1 = P_{i1} \sin\theta_1$	=	275.1 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclined prop load from Plaxis, P_{i2}	=	275.10 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Inclination of strut to wall, θ_2	=	90.0 °	90.0 °	90.0 °	90.0 °
Horizontal pressure, $P_2 = P_{i2} \sin\theta_2$	=	275.1 kN/m	0.0 kN/m	0.0 kN/m	0.0 kN/m
Intersection angle of end waling, β	=	90.0 °	90.0 °	90.0 °	90.0 °
Load bearing width of waling at corner, L_1	=	0.00 m	0.00 m	0.00 m	0.00 m
Load bearing width of waling at corner, L_2	=	0.00 m	0.00 m	0.00 m	0.00 m
Compressive Force (corner), P_c	=	0.0 kN	0.0 kN	0.0 kN	0.0 kN

Maximum horizontal pressure, P	=	275.10	kN/m
Maximum strut spacing, S	=	4.00	m
Load bearing width of diagonal strut, L_d	=	0.00	m
Minimum inclination of diagonal strut, α	=	90.00	°
Construction Load, Q_c	=	2.00	kPa

Maximum bending moment, Mx	= P x S^2 / 8	= 275.10 x 4.00 x 4.00/8	=	550.19 kNm
Maximum bending moment, My	= Self Weight + Construction Load	= (140.0 x 9.8 + 2.0 x 617.0) / 1000 x 4.0^2	=	4.17 kNm
Maximum shear force, V	= P x S / 2	= 275.10 x 4.00 / 2	=	550.19 kN
Compressive Force (corner)	= Max. of P_c	= Max. of (0, 0, 0, 0)	=	0.00 kN
Compressive Force (1% Strut Force)	= P x S x 1%	= 275.10 x 4.00 x 1%	=	11.00 kN
Compressive Force (diagonal strut)	= P x S / tan α	= 275.10 x 0.00 / tan 90	=	0.00 kN
Load Factor	= 1.4			

Design Bending Moment (Major Axis) M_x = 770.3 kNm   Design Shear Force V = 770.3 kN
Design Bending Moment (Minor Axis) M_y = 5.8 kNm   Axial Force F_c = 15.4 kN

3. Section Classification

(Table 7.1)

e = $[275 / p_y]^{1/2}$ = 0.9

b/T = 5.2 < 8.0 e (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 41.8 < 80 e (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 41.8 < 70e = 62.5

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 8083 mm^2

Shear Capacity V_c = $p_yA_v/(3)^{0.5}$

= 1610 kN

Design Shear Force V = 770.3 kN < P_v = 1610 kN ***Check Shear OK***

Since, $0.6V_c$ = 966 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 1432 kNm $1.2p_yZ_x$ = 1503 kNm

M_{cx} = **1432 kNm** > M_x = 770.3 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 211 kNm $1.2p_yZ_y$ = 162 kNm

M_{cy} = **162 kNm** > M_y = 5.8 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrained Span Length	L	=	4.00 m	
Effective Length	L_E	=	1.0 L = 4.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_E / r_y = 79.5	
Buckling parameter	u	=	0.88	*(Clause 8.3.5.3)*
	λ / x	=	2.61	
Slenderness factor	v	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$	*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.930	
	β_w	=	1.000	*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$uv\lambda(\beta_w)^{0.5}$ = 64.6	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	345.00 N/mm^2	
Buckling strength	p_b	=	234.0 N/mm^2	*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	971.1 kNm	*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93	*(Table 8.4a for no intermediate lateral restraint)*
	$m_{LT}M_x$	=	716.35 < M_b = 971.1 kNm	*(Clause 8.3.5.2 Eqn 8.18)*
and	M_x	=	770.27 < M_{cx} = 1431.8 kNm	*(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{15.4}{6141.0} + \frac{770.3}{1431.8} + \frac{5.8}{162.3}$$

$$= 0.00 + 0.54 + 0.04$$

$$= 0.58$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	4.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	4.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	16.0	≈ 20	
Maximum Thickness	T	=	22.1 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	342.00 N/mm²				
p_c in Table 8.8 b)		=	339.00 N/mm²				
p_c in Table 8.8 c)		=	336.00 N/mm²				
p_c in Table 8.8 d)		=	332.00 N/mm²				
Compressive Strength	p_{cx}	=	342.00 N/mm²				*(Table 8.8(a))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	4.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	4.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	79.5	≈ 80	
Maximum Thickness	T	=	22.1 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	232.00 N/mm²				
p_c in Table 8.8 b)		=	208.00 N/mm²				
p_c in Table 8.8 c)		=	185.00 N/mm²				
p_c in Table 8.8 d)		=	165.00 N/mm²				
Compressive Strength	p_{cy}	=	208.00 N/mm²				*(Table 8.8(b))*

Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	208.0 N/mm²	
Moment equivalent factor m for flexural buckling						
	m_x	=	0.95			*(Table 8.9)*
	m_y	=	0.95			*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{15.4}{3702.4} + \frac{731.8}{1431.8} + \frac{5.5}{162.3}$$

$$= 0.00 + 0.51 + 0.03$$

$$= 0.55$$

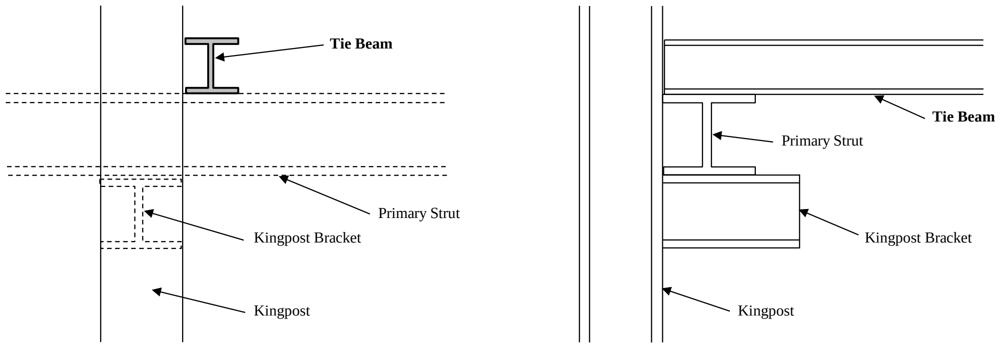
$$< 1$$

Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

Structural Steel Design - Level 1 Tie Beam (+4.80 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")



1. Section Properties

Try Section :	Single	203 x 133 x 30 UB	Grade 50	Hot Rolled

Depth of Section	**D**	=	206.8	mm	Elastic Modulus (X-Axis)	Z_x	=	279000	mm^3
Width of Section	**B**	=	133.8	mm	Elastic Modulus (Y-Axis)	Z_y	=	57399	mm^3
Web Thickness	**t**	=	6.3	mm	Plastic Modulus (X-Axis)	S_x	=	313000	mm^3
Flange Thickness	**T**	=	9.6	mm	Plastic Modulus (Y-Axis)	S_y	=	88100	mm^3
Depth between Fillets	**d**	=	172.3	mm	Buckling Parameter	**u**	=	0.882	
Second Moment of Area (X-Axis)	I_x	=	2.890E+07	mm^4	Torsional Index	**x**	=	21.5	
Second Moment of Area (Y-Axis)	I_y	=	3.840E+06	mm^4	Area of Section	A_g	=	3800	mm^2
Radius of Gyration (X-Axis)	r_x	=	87.2	mm	Mass per Length	**w**	=	30.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	31.8	mm	Design Strength	p_y	=	355	N/mm^2
Modulus of Elasticity	**E**	=	205000.00	MPa					

2. Ultimate Design Load

Maximum inclined prop load from Plaxis	=	129.11	kN/m	(From PLAXIS)			
Minimum inclination of strut to waling, α	=	90.00	degree				
Load in the direction of strut, P_α	=	F / sin α		=	129.11 / sin 90.0	=	129.1 kN/m
Maximum strut spacing, S	=	8.00	m				
Maximum compression, P	=	P_α x S		=	129.11 x 8.00	=	1032.9 kN
No. of tie beam provided to each strut	=	2					
No. of parallel strut supported by each tie beam	=	2					
Inclination of tie beam, θ	=	90.00	degree				
Unrestrain length of tie beam on plan (X-Axis), L_x'	=	8.00	m				
Actual unrestrain length of tie beam (X-Axis), L_x	=	L_x' / sin θ		=	8.00 / sin 90.0	=	8.00 m
Unrestrain length of tie beam on plan (Y-Axis), L_y'	=	8.00	m				
Actual unrestrain length of tie beam (Y-Axis), L_y	=	L_y' / sin θ		=	8.00 / sin 90.0	=	8.00 m
Construction Load, Qc	=	2.00	kPa				
Maximum Axial Force (unfactored)	=	1.25% P_α x S		x	2	=	25.82 kN
Maximum Bending Moment (unfactored)	=	0.125 x (30.0 x 9.81 + 2.0 x 133.8) / 1000 x 8.00^2				=	4.50 kNm
Maximum Shear Force (unfactored)	=	0.5 x (30.0 x 9.81 + 2.0 x 133.8) /1000 x 8.00				=	2.25 kN
Load Factor	=	1.40					

Design Bending Moment (X-Axis)	M_x	=	6.3	kNm	Design Shear Force	V	=	3.1	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	36.2	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 7.0 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 27.3 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 27.3 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 1303 mm^2

Shear Capacity V_c = $p_yA_v/(3)^{0.5}$

= 267 kN

Design Shear Force **V** = 3.1 kN < P_v = 267 kN ***Check Shear OK***

Since, $0.6V_c$ = 160 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 111 kNm $1.2p_yZ_x$ = 119 kNm

$\mathbf{M_{cx}}$ = **111 kNm** > M_x = 6.3 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 31 kNm $1.2p_yZ_y$ = 24 kNm

$\mathbf{M_{cy}}$ = **24 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) L_y = 8.00 m

Effective Length L_{Ey} = 1.0 L = 8.0 m *(Clause 8.3.4)*

Minor Axis Slenderness λ = L_{Ey} / r_y = 251.7

Buckling parameter **u** = 0.88 *(Clause 8.3.5.3)*

λ / x = 11.71

Slenderness factor **v** = $1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.597

β_w = 1.000 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness λ_{LT} = $uv\lambda(\beta_w)^{0.5}$ = 132.6 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength p_y = 355.00 N/mm^2

Buckling strength p_b = 85.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment M_b = 26.6 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor m_{LT} = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 5.85 < M_b = 26.6 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 6.29 < M_{cx} = 111.1 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{36.2}{1349.0} + \frac{6.3}{111.1} + \frac{0.0}{24.5}$$

$$= 0.03 + 0.06 + 0.00$$

$$= 0.08$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check *(Clause 8.9.2)*

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	8.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	8.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	91.7	≈ 92	
Maximum Thickness	T	=	9.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	194.00 N/mm^2				
p_c in Table 8.8 b)		=	176.00 N/mm^2				
p_c in Table 8.8 c)		=	158.00 N/mm^2				
p_c in Table 8.8 d)		=	142.00 N/mm^2				
Compressive Strength	p_{cx}	=	194.00 N/mm^2				*(Table 8.8(a))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	8.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	8.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	251.7	≈ 260	
Maximum Thickness	T	=	9.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	29.00 N/mm^2				
p_c in Table 8.8 b)		=	28.00 N/mm^2				
p_c in Table 8.8 c)		=	27.00 N/mm^2				
p_c in Table 8.8 d)		=	25.00 N/mm^2				
Compressive Strength	p_{cy}	=	28.00 N/mm^2				*(Table 8.8(b))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 28.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{36.2}{106.4} + \frac{6.0}{111.1} + \frac{0.0}{24.5}$$

$$= 0.34 + 0.05 + 0.00$$

$$= 0.39$$

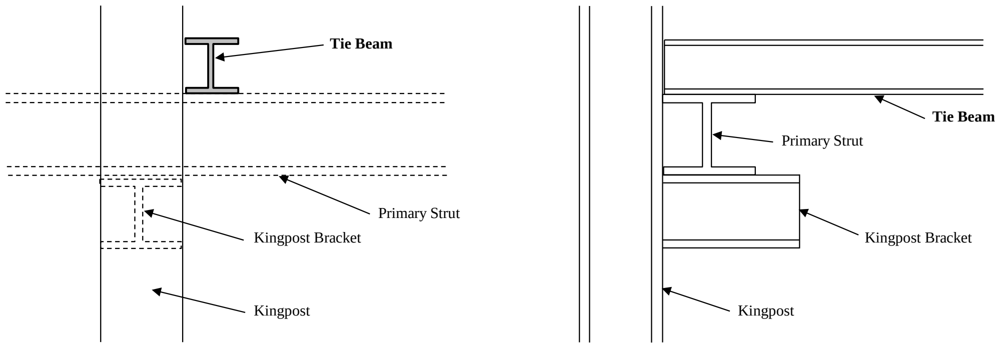
$$< 1$$

Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

Structural Steel Design - Level 2 Tie Beam (+1.70 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")



1. Section Properties

Try Section :	Single	203 x 133 x 30 UB	Grade 50	Hot Rolled

Depth of Section	D	=	206.8	mm	Elastic Modulus (X-Axis)	Z_x	=	279000	mm^3
Width of Section	B	=	133.8	mm	Elastic Modulus (Y-Axis)	Z_y	=	57399	mm^3
Web Thickness	t	=	6.3	mm	Plastic Modulus (X-Axis)	S_x	=	313000	mm^3
Flange Thickness	T	=	9.6	mm	Plastic Modulus (Y-Axis)	S_y	=	88100	mm^3
Depth between Fillets	d	=	172.3	mm	Buckling Parameter	u	=	0.882	
Second Moment of Area (X-Axis)	I_x	=	2.890E+07	mm^4	Torsional Index	x	=	21.5	
Second Moment of Area (Y-Axis)	I_y	=	3.840E+06	mm^4	Area of Section	A_g	=	3800	mm^2
Radius of Gyration (X-Axis)	r_x	=	87.2	mm	Mass per Length	w	=	30.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	31.8	mm	Design Strength	p_y	=	355	N/mm^2
Modulus of Elasticity	E	=	205000.00	MPa					

2. Ultimate Design Load

Maximum inclined prop load from Plaxis	=	254.15	kN/m	(From PLAXIS)			
Minimum inclination of strut to waling, α	=	90.00	degree				
Load in the direction of strut, P_α	=	F / sin α	=	254.15 / sin 90.0	=	254.1	kN/m
Maximum strut spacing, S	=	8.00	m				
Maximum compression, P	=	P_α x S	=	254.15 x 8.00	=	2033.2	kN
No. of tie beam provided to each strut	=	2					
No. of parallel strut supported by each tie beam	=	2					
Inclination of tie beam, θ	=	90.00	degree				
Unrestrain length of tie beam on plan (X-Axis), L_x'	=	8.00	m				
Actual unrestrain length of tie beam (X-Axis), L_x	=	L_x' / sin θ	=	8.00 / sin 90.0	=	8.00	m
Unrestrain length of tie beam on plan (Y-Axis), L_y'	=	8.00	m				
Actual unrestrain length of tie beam (Y-Axis), L_y	=	L_y' / sin θ	=	8.00 / sin 90.0	=	8.00	m
Construction Load, Qc	=	2.00	kPa				
Maximum Axial Force (unfactored)	=	1.25% P_α x S	x	2	=	50.83	kN
Maximum Bending Moment (unfactored)	=	0.125 x (30.0 x 9.81 + 2.0 x 133.8) / 1000 x 8.00^2			=	4.50	kNm
Maximum Shear Force (unfactored)	=	0.5 x (30.0 x 9.81 + 2.0 x 133.8) /1000 x 8.00			=	2.25	kN
Load Factor	=	1.40					

Design Bending Moment (X-Axis)	M_x	=	6.3	kNm	Design Shear Force	V	=	3.1	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	71.2	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T =	7.0	<	8.0 ε	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t =	27.3	<	80 ε	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 27.3 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area $\mathbf{A_v}$ = 1303 mm^2

Shear Capacity $\mathbf{V_c}$ = $p_yA_v/(3)^{0.5}$

= 267 kN

Design Shear Force **V** = 3.1 kN < P_v = 267 kN ***Check Shear OK***

Since, $0.6V_c$ = 160 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 111 kNm $1.2p_yZ_x$ = 119 kNm

$\mathbf{M_{cx}}$ = **111 kNm** > M_x = 6.3 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 31 kNm $1.2p_yZ_y$ = 24 kNm

$\mathbf{M_{cy}}$ = **24 kNm** > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis) $\mathbf{L_y}$ = 8.00 m

Effective Length $\mathbf{L_{Ey}}$ = 1.0 L = 8.0 m *(Clause 8.3.4)*

Minor Axis Slenderness **λ** = L_{Ey} / r_y = 251.7

Buckling parameter **u** = 0.88 *(Clause 8.3.5.3)*

λ / x = 11.71

Slenderness factor **ν** = $1/(1+0.05(\lambda/x)^2)^{0.25}$ *(Clause 8.3.5.3 Eqn 8.27)*

= 0.597

$\boldsymbol{\beta_w}$ = 1.000 *(Clause 8.3.5.3 Eqn 8.28, 8.29)*

Equivalent Slenderness $\boldsymbol{\lambda_{LT}}$ = $u\nu\lambda(\beta_w)^{0.5}$ = 132.6 *(Clause 8.3.5.3 Eqn 8.25)*

Design strength $\mathbf{p_y}$ = 355.00 N/mm^2

Buckling strength $\mathbf{p_b}$ = 85.0 N/mm^2 *(Table 8.3a for rolled section)*

Buckling resistance moment $\mathbf{M_b}$ = 26.6 kNm *(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*

Equivalent uniform moment factor $\mathbf{m_{LT}}$ = 0.93 *(Table 8.4a for no intermediate lateral restraint)*

$\mathbf{m_{LT}M_x}$ = 5.85 < M_b = 26.6 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and $\mathbf{M_x}$ = 6.29 < M_{cx} = 111.1 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{71.2}{1349.0} + \frac{6.3}{111.1} + \frac{0.0}{24.5}$$

= 0.05 + 0.06 + 0.00

= 0.11

< 1 ***Cross-section Capacity OK***

9. Member Buckling Resistance Check *(Clause 8.9.2)*

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	8.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	8.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	91.7	≈ 92	
Maximum Thickness	**T**	=	9.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	194.00 N/mm^2				
p_c in Table 8.8 b)		=	176.00 N/mm^2				
p_c in Table 8.8 c)		=	158.00 N/mm^2				
p_c in Table 8.8 d)		=	142.00 N/mm^2				
Compressive Strength	p_{cx}	=	194.00 N/mm^2				*(Table 8.8(a))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	8.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	8.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	251.7	≈ 260	
Maximum Thickness	**T**	=	9.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	29.00 N/mm^2				
p_c in Table 8.8 b)		=	28.00 N/mm^2				
p_c in Table 8.8 c)		=	27.00 N/mm^2				
p_c in Table 8.8 d)		=	25.00 N/mm^2				
Compressive Strength	p_{cy}	=	28.00 N/mm^2				*(Table 8.8(b))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 28.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{71.2}{106.4} + \frac{6.0}{111.1} + \frac{0.0}{24.5}$$

$$= 0.67 + 0.05 + 0.00$$

$$= 0.72$$

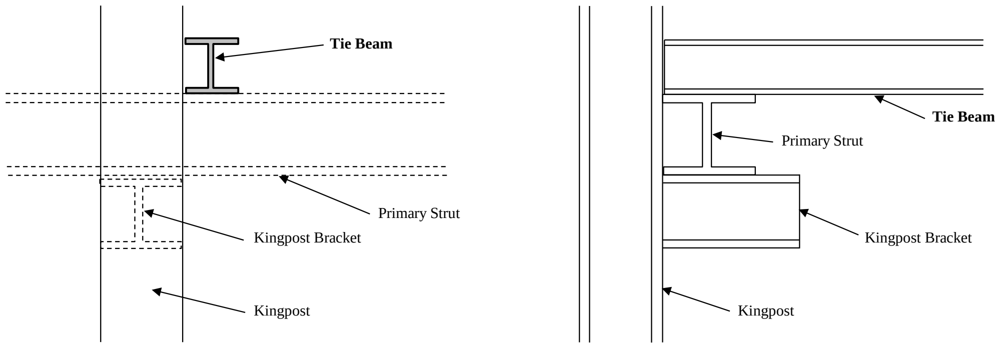
$$< 1$$

Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

Structural Steel Design - Level 3 Tie Beam (-1.40 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")



1. Section Properties

Try Section :	Single	203 x 133 x 30 UB	Grade 50	Hot Rolled

Depth of Section	**D**	=	206.8	mm	Elastic Modulus (X-Axis)	Z_x	=	279000	mm^3
Width of Section	**B**	=	133.8	mm	Elastic Modulus (Y-Axis)	Z_y	=	57399	mm^3
Web Thickness	**t**	=	6.3	mm	Plastic Modulus (X-Axis)	S_x	=	313000	mm^3
Flange Thickness	**T**	=	9.6	mm	Plastic Modulus (Y-Axis)	S_y	=	88100	mm^3
Depth between Fillets	**d**	=	172.3	mm	Buckling Parameter	**u**	=	0.882	
Second Moment of Area (X-Axis)	I_x	=	2.890E+07	mm^4	Torsional Index	**x**	=	21.5	
Second Moment of Area (Y-Axis)	I_y	=	3.840E+06	mm^4	Area of Section	A_g	=	3800	mm^2
Radius of Gyration (X-Axis)	r_x	=	87.2	mm	Mass per Length	**w**	=	30.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	31.8	mm	Design Strength	p_y	=	355	N/mm^2
Modulus of Elasticity	**E**	=	205000.00	MPa					

2. Ultimate Design Load

Maximum inclined prop load from Plaxis	=	295.60	kN/m	(From PLAXIS)			
Minimum inclination of strut to waling, α	=	90.00	degree				
Load in the direction of strut, P_α	=	F / sin α		=	295.60 / sin 90.0	=	295.6 kN/m
Maximum strut spacing, S	=	8.00	m				
Maximum compression, P	=	P_α x S		=	295.60 x 8.00	=	2364.8 kN
No. of tie beam provided to each strut	=	2					
No. of parallel strut supported by each tie beam	=	2					
Inclination of tie beam, θ	=	90.00	degree				
Unrestrain length of tie beam on plan (X-Axis), L_x'	=	8.00	m				
Actual unrestrain length of tie beam (X-Axis), L_x	=	L_x' / sin θ		=	8.00 / sin 90.0	=	8.00 m
Unrestrain length of tie beam on plan (Y-Axis), L_y'	=	8.00	m				
Actual unrestrain length of tie beam (Y-Axis), L_y	=	L_y' / sin θ		=	8.00 / sin 90.0	=	8.00 m
Construction Load, Qc	=	2.00	kPa				
Maximum Axial Force (unfactored)	=	1.25%	P_α x S	x	2	=	59.12 kN
Maximum Bending Moment (unfactored)	=	0.125 x (30.0 x 9.81 + 2.0 x 133.8) / 1000 x 8.00^2				=	4.50 kNm
Maximum Shear Force (unfactored)	=	0.5 x (30.0 x 9.81 + 2.0 x 133.8) /1000 x 8.00				=	2.25 kN
Load Factor	=	1.40					

Design Bending Moment (X-Axis)	M_x	=	6.3	kNm	Design Shear Force	V	=	3.1	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	82.8	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.9$

b/T = 7.0	<	8.0 ε	(Plastic)	*(Table 7.1, Outstand element of compression flange)*
d/t = 27.3	<	80 ε	(Plastic)	*(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 27.3 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area A_v = 1303 mm^2

Shear Capacity V_c = $p_yA_v/(3)^{0.5}$

= 267 kN

Design Shear Force **V** = 3.1 kN < P_v = 267 kN ***Check Shear OK***

Since, $0.6V_c$ = 160 kN > V ***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis

M_{cx} = Lesser of p_yS_x and $1.2p_yZ_x$

p_yS_x = 111 kNm; $1.2p_yZ_x$ = 119 kNm

M_{cx} = 111 kNm > M_x = 6.3 kNm ***Major Moment Capacity OK***

Minor Axis

M_{cy} = Lesser of p_yS_y and $1.2p_yZ_y$

p_yS_y = 31 kNm; $1.2p_yZ_y$ = 24 kNm

M_{cy} = 24 kNm > M_y = 0.0 kNm ***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis)	L_y	=	8.00 m	
Effective Length	L_{Ey}	=	1.0 L = 8.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_{Ey} / r_y = 251.7	
Buckling parameter	u	=	0.88	*(Clause 8.3.5.3)*
	λ / x	=	11.71	
Slenderness factor	v	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$	*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.597	
	β_w	=	1.000	*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$uv\lambda(\beta_w)^{0.5}$ = 132.6	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	355.00 N/mm^2	
Buckling strength	p_b	=	85.0 N/mm^2	*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	26.6 kNm	*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93	*(Table 8.4a for no intermediate lateral restraint)*

$m_{LT}M_x$ = 5.85 < M_b = 26.6 kNm *(Clause 8.3.5.2 Eqn 8.18)*

and M_x = 6.29 < M_{cx} = 111.1 kNm *(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_gp_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{82.8}{1349.0} + \frac{6.3}{111.1} + \frac{0.0}{24.5}$$

$$= 0.06 + 0.06 + 0.00$$

$$= 0.12$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	8.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	8.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	91.7	≈ 92	
Maximum Thickness	T	=	9.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	194.00 N/mm^2				
p_c in Table 8.8 b)		=	176.00 N/mm^2				
p_c in Table 8.8 c)		=	158.00 N/mm^2				
p_c in Table 8.8 d)		=	142.00 N/mm^2				
Compressive Strength	p_{cx}	=	194.00 N/mm^2				*(Table 8.8(a))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	8.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	8.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	251.7	≈ 260	
Maximum Thickness	T	=	9.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	29.00 N/mm^2				
p_c in Table 8.8 b)		=	28.00 N/mm^2				
p_c in Table 8.8 c)		=	27.00 N/mm^2				
p_c in Table 8.8 d)		=	25.00 N/mm^2				
Compressive Strength	p_{cy}	=	28.00 N/mm^2				*(Table 8.8(b))*

Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	=	28.0 N/mm^2	
Moment equivalent factor m for flexural buckling						
	m_x	=	0.95			*(Table 8.9)*
	m_y	=	0.95			*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{82.8}{106.4} + \frac{6.0}{111.1} + \frac{0.0}{24.5}$$

$$= 0.78 + 0.05 + 0.00$$

$$= 0.83$$

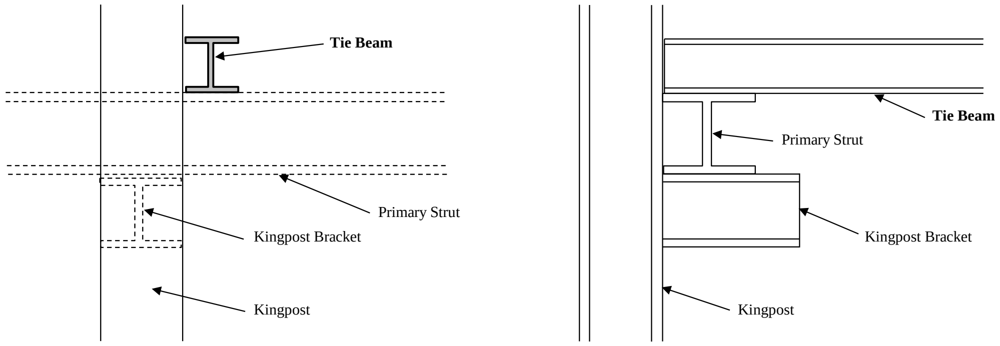
$$< 1$$

Overall Capacity OK

AECOM	Drainage Improvement Works in Shatin and Sai Kung Investigation Excavation and Lateral Support Works Design Structural Design STN Pumping Station - Type-B	Job No.: By: Chkd: Date:	60617767 JL KP 18-Oct-21

Structural Steel Design - Level 4 Tie Beam (-4.50 mPD)

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")



1. Section Properties

Try Section : | **Single** | **203 x 133 x 30 UB** | **Grade 50** | **Hot Rolled**

Depth of Section	**D**	=	206.8	mm	Elastic Modulus (X-Axis)	Z_x	=	279000	mm^3
Width of Section	**B**	=	133.8	mm	Elastic Modulus (Y-Axis)	Z_y	=	57399	mm^3
Web Thickness	**t**	=	6.3	mm	Plastic Modulus (X-Axis)	S_x	=	313000	mm^3
Flange Thickness	**T**	=	9.6	mm	Plastic Modulus (Y-Axis)	S_y	=	88100	mm^3
Depth between Fillets	**d**	=	172.3	mm	Buckling Parameter	**u**	=	0.882	
Second Moment of Area (X-Axis)	I_x	=	2.890E+07	mm^4	Torsional Index	**x**	=	21.5	
Second Moment of Area (Y-Axis)	I_y	=	3.840E+06	mm^4	Area of Section	A_g	=	3800	mm^2
Radius of Gyration (X-Axis)	r_x	=	87.2	mm	Mass per Length	**w**	=	30.00	kg/m
Radius of Gyration (Y-Axis)	r_y	=	31.8	mm	Design Strength	p_y	=	355	N/mm^2
Modulus of Elasticity	**E**	=	205000.00	MPa					

2. Ultimate Design Load

Maximum inclined prop load from Plaxis	=	275.10	kN/m	(From PLAXIS)			
Minimum inclination of strut to waling, α	=	90.00	degree				
Load in the direction of strut, P_α	=	F / sin α	=	275.10 / sin 90.0	=	275.1	kN/m
Maximum strut spacing, S	=	8.00	m				
Maximum compression, P	=	P_α x S	=	275.10 x 8.00	=	2200.8	kN
No. of tie beam provided to each strut	=	2					
No. of parallel strut supported by each tie beam	=	2					
Inclination of tie beam, θ	=	90.00	degree				
Unrestrain length of tie beam on plan (X-Axis), L_x'	=	8.00	m				
Actual unrestrain length of tie beam (X-Axis), L_x	=	L_x' / sin θ	=	8.00 / sin 90.0	=	8.00	m
Unrestrain length of tie beam on plan (Y-Axis), L_y'	=	8.00	m				
Actual unrestrain length of tie beam (Y-Axis), L_y	=	L_y' / sin θ	=	8.00 / sin 90.0	=	8.00	m
Construction Load, Qc	=	2.00	kPa				
Maximum Axial Force (unfactored)	=	1.25% P_α x S	x	2	=	55.02	kN
Maximum Bending Moment (unfactored)	=	0.125 x (30.0 x 9.81 + 2.0 x 133.8) / 1000 x 8.00^2			=	4.50	kNm
Maximum Shear Force (unfactored)	=	0.5 x (30.0 x 9.81 + 2.0 x 133.8) /1000 x 8.00			=	2.25	kN
Load Factor	=	1.40					

Design Bending Moment (X-Axis)	M_x	=	6.3	kNm	Design Shear Force	V	=	3.1	kN
Design Bending Moment (Y-Axis)	M_y	=	0.0	kNm	Axial Force	F_c	=	77.0	kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2}$ = 0.9

b/T = 7.0 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 27.3 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 27.3 < 70ε = 61.6

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area	A_v	=	1303 mm^2				
Shear Capacity	V_c	=	$p_yA_v/(3)^{0.5}$				
		=	267 kN				
Design Shear Force	V	=	3.1 kN	<	P_v =	267 kN	***Check Shear OK***
Since,	$0.6V_c$	=	160 kN	>	V		***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis	M_{cx}	=	Lesser of	p_yS_x	and	$1.2p_yZ_x$		
	p_yS_x	=	111 kNm			$1.2p_yZ_x$ =	119 kNm	
	M_{cx}	=	**111 kNm**	>		M_x =	6.3 kNm	***Major Moment Capacity OK***
Minor Axis	M_{cy}	=	Lesser of	p_yS_y	and	$1.2p_yZ_y$		
	p_yS_y	=	31 kNm			$1.2p_yZ_y$ =	24 kNm	
	M_{cy}	=	**24 kNm**	>		M_y =	0.0 kNm	***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Unrestrain length (Y-Axis)	L_y	=	8.00 m			
Effective Length	L_{Ey}	=	1.0 L	=	8.0 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ	=	L_{Ey} / r_y	=	251.7	
Buckling parameter	u	=	0.88			*(Clause 8.3.5.3)*
	λ / x	=	11.71			
Slenderness factor	v	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$			*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.597			
	β_w	=	1.000			*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	λ_{LT}	=	$uv\lambda(\beta_w)^{0.5}$	=	132.6	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	p_y	=	355.00 N/mm^2			
Buckling strength	p_b	=	85.0 N/mm^2			*(Table 8.3a for rolled section)*
Buckling resistance moment	M_b	=	26.6 kNm			*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	m_{LT}	=	0.93			*(Table 8.4a for no intermediate lateral restraint)*

	$m_{LT}M_x$	=	5.85	<	M_b =	26.6 kNm	*(Clause 8.3.5.2 Eqn 8.18)*
and	M_x	=	6.29	<	M_{cx} =	111.1 kNm	*(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{77.0}{1349.0} + \frac{6.3}{111.1} + \frac{0.0}{24.5}$$

= 0.06 + 0.06 + 0.00

= 0.11

< 1

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**				
Unrestrain length (X-Axis)	L_x	=	8.00 m				
Effective Length (X-Axis)	L_{Ex}	=	1.0 L_x	=	8.00 m		*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	=	91.7	≈ 92	
Maximum Thickness	**T**	=	9.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	a)		*(Table 8.7)*
p_c in Table 8.8 a)		=	194.00 N/mm^2				
p_c in Table 8.8 b)		=	176.00 N/mm^2				
p_c in Table 8.8 c)		=	158.00 N/mm^2				
p_c in Table 8.8 d)		=	142.00 N/mm^2				
Compressive Strength	p_{cx}	=	194.00 N/mm^2				*(Table 8.8(a))*

Axis of buckling		=	**y-y**				
Unrestrain length (Y-Axis)	L_y	=	8.00 m				
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	=	8.00 m		*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	=	251.7	≈ 260	
Maximum Thickness	**T**	=	9.6 mm	≤	40 mm		
Type of Section		=	Rolled I-section ≤ 40mm				
Designation of buckling curves for different section types:				Buckling Curve	b)		*(Table 8.7)*
p_c in Table 8.8 a)		=	29.00 N/mm^2				
p_c in Table 8.8 b)		=	28.00 N/mm^2				
p_c in Table 8.8 c)		=	27.00 N/mm^2				
p_c in Table 8.8 d)		=	25.00 N/mm^2				
Compressive Strength	p_{cy}	=	28.00 N/mm^2				*(Table 8.8(b))*

Design Compressive Strength p_c = min. of p_{cx} & p_{cy} = 28.0 N/mm^2

Moment equivalent factor m for flexural buckling

m_x = 0.95 *(Table 8.9)*

m_y = 0.95 *(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{77.0}{106.4} + \frac{6.0}{111.1} + \frac{0.0}{24.5}$$

$$= 0.72 + 0.05 + 0.00$$

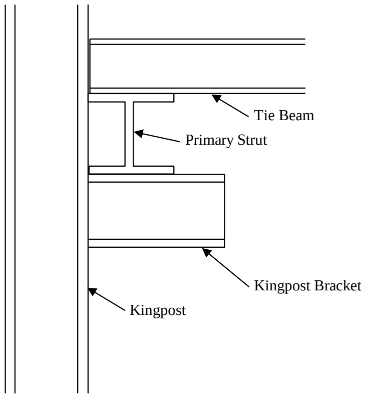
$$= 0.78$$

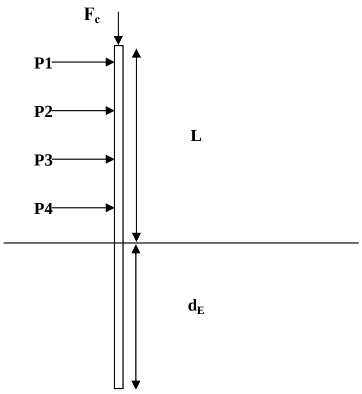
$$< 1$$

Overall Capacity OK

Structural Steel Design - Kingpost

(Structural steel design based on "Code of Practice for the Structural Use of Steel 2011"
with reference to "The Design and Construction of Sheet-Piled Cofferdams by B P Williams and D Waite")





1. Section Properties

Try Section : 305 x 305 x 198 UC | Grade 55 | Hot Rolled

Depth of Section	**D**	=	339.9	mm	Elastic Modulus (X-Axis)	Z_x	=	2990000 mm^3
Width of Section	**B**	=	314.1	mm	Elastic Modulus (Y-Axis)	Z_y	=	1030000 mm^3
Web Thickness	**t**	=	19.2	mm	Plastic Modulus (X-Axis)	S_x	=	3440000 mm^3
Flange Thickness	**T**	=	31.4	mm	Plastic Modulus (Y-Axis)	S_y	=	1580000 mm^3
Depth between Fillets	**d**	=	246.6	mm	Buckling Parameter	**u**	=	0.854
Second Moment of Area (X-Axis)	I_x	=	5.08E+08	mm^4	Torsional Index	**x**	=	10.2
Second Moment of Area (Y-Axis)	I_y	=	1.62E+08	mm^4	Area of Section	A_g	=	25200 mm^2
Radius of Gyration (X-Axis)	r_x	=	142.0	mm	Mass per Length	**w**	=	198.00 kg/m
Radius of Gyration (Y-Axis)	r_y	=	80.2	mm	Design Strength	p_y	=	440 N/mm^2
Modulus of Elasticity	**E**	=	205000.00	MPa				

2. Ultimate Design Load

Strut Level (mPD)	Strut Section	Mass per Length, w (kg/m)	Max. Unrestrained Length (m)	Max. Strut Compressive Force (kN)	Self-Weight of Strut (kN)	Lateral Load from Strut (2.5% of Axial Force) (kN)
4.80	Double 305 x 305 x 240 UC	480.00	16.00	1032.86	75.34	25.82
1.70	Double 356 x 406 x 340 UC	680.00	16.00	2033.19	106.73	50.83
-1.40	Double 356 x 406 x 393 UC	786.00	16.00	2364.78	123.37	59.12
-4.50	Double 356 x 406 x 393 UC	786.00	16.00	2200.77	123.37	55.02

Strut Level (mPD)	Tie Beam Section	Mass per Length, w (kg/m)	Length (m)	Self-Weight of Tie Beam (kN)
4.80	Single 203 x 133 x 30 UB	30.00	8.00	2.35
1.70	Single 203 x 133 x 30 UB	30.00	8.00	2.35
-1.40	Single 203 x 133 x 30 UB	30.00	8.00	2.35
-4.50	Single 203 x 133 x 30 UB	30.00	8.00	2.35

Kingpost Top Level	=	+4.80	mPD
Final Excavation Level	=	-7.10	mPD
Length of Kingpost, L	=	11.90	m
Depth of Embedment, d_E	=	37.90	m
Design Eccentricity for Axial Loads	=	473.45	mm

Maximum Axial Force (unfactored)	=	Total self-weight of kingpost, tie beams and struts + 2.5% of total strut axial force	=	725.75	kN
Maximum Bending Moment (unfactored)	=	Total unfactored moment due to eccentricity	=	90.3	kNm
Maximum Shear Force (unfactored)	=	--	=	0.0	kN
Load Factor	=	1.40			

Design Bending Moment (X-Axis) $\mathbf{M_x}$ = 126.5 kNm — Design Shear Force $\mathbf{V}$ = 0.0 kN

Design Bending Moment (Y-Axis) $\mathbf{M_y}$ = 0.0 kNm — Axial Force $\mathbf{F_c}$ = 1016.1 kN

3. Section Classification

(Table 7.1)

$\varepsilon = [275 / p_y]^{1/2} = 0.8$

b/T = 5.0 < 8.0 ε (Plastic) *(Table 7.1, Outstand element of compression flange)*

d/t = 12.8 < 80 ε (Plastic) *(Table 7.1, Web with neutral axis at mid-depth)*

Class of Section = ***Plastic Section***

4. Shear Buckling Resistance

(Clause 8.4.6)

d/t = 12.8 < 70ε = 55.3

Therefore, ***Not Required to Check for Shear Buckling***

5. Check Shear Capacity

(Clause 8.2.1)

Shear Area	$\mathbf{A_v}$	=	6526 mm^2				
Shear Capacity	$\mathbf{V_c}$	=	$p_yA_v/(3)$^0.5				
		=	1658 kN				
Design Shear Force	$\mathbf{V}$	=	0.0 kN	<	P_v =	1658 kN	***Check Shear OK***
Since,	$0.6V_c$	=	995 kN	>	V		***Low Shear***

6. Check Moment Capacity (for plastic or compact sections)

(Clause 8.2.2)

Major Axis	M_{cx}	= Lesser of	p_yS_x	and	$1.2p_yZ_x$		
	p_yS_x	=	1514 kNm		$1.2p_yZ_x$ =	1579 kNm	
	$\mathbf{M_{cx}}$	=	**1514 kNm**	>	M_x =	126.5 kNm	***Major Moment Capacity OK***
Minor Axis	M_{cy}	= Lesser of	p_yS_y	and	$1.2p_yZ_y$		
	p_yS_y	=	695 kNm		$1.2p_yZ_y$ =	544 kNm	
	$\mathbf{M_{cy}}$	=	**544 kNm**	>	M_y =	0.0 kNm	***Minor Moment Capacity OK***

7. Check Lateral Torsional Buckling

(Clause 8.3)

Length of Kingpost	$\mathbf{L}$	=	11.90 m			
Effective Length	$\mathbf{L_E}$	=	2.0 L	=	23.8 m	*(Clause 8.3.4)*
Minor Axis Slenderness	$\boldsymbol{\lambda}$	=	L_{Ey} / r_y	=	296.8	
Buckling parameter	$\mathbf{u}$	=	0.85			*(Clause 8.3.5.3)*
	$\boldsymbol{\lambda / x}$	=	29.09			
Slenderness factor	$\boldsymbol{\nu}$	=	$1/(1+0.05(\lambda/x)^2)^{0.25}$			*(Clause 8.3.5.3 Eqn 8.27)*
		=	0.390			
	$\boldsymbol{\beta_w}$	=	1.000			*(Clause 8.3.5.3 Eqn 8.28, 8.29)*
Equivalent Slenderness	$\boldsymbol{\lambda_{LT}}$	=	$uv\lambda(\beta_w)^{0.5}$	=	98.8	*(Clause 8.3.5.3 Eqn 8.25)*
Design strength	$\mathbf{p_y}$	=	440.00 N/mm^2			
Buckling strength	$\mathbf{p_b}$	=	149.0 N/mm^2			*(Table 8.3a for rolled section)*
Buckling resistance moment	$\mathbf{M_b}$	=	512.6 kNm			*(Clause 8.3.5.2 Eqn 8.20, 8.21, 8.22, 8.23, 8.24)*
Equivalent uniform moment factor	$\mathbf{m_{LT}}$	=	0.93			*(Table 8.4a for no intermediate lateral restraint)*

	$\mathbf{m_{LT}M_x}$	=	117.61	<	M_b =	512.6 kNm	*(Clause 8.3.5.2 Eqn 8.18)*
and	$\mathbf{M_x}$	=	126.46	<	M_{cx} =	1513.6 kNm	*(Clause 8.3.5.2 Eqn 8.19)*

Lateral Torsional Buckling Resistance OK

8. Cross-section Capacity Check

(Clause 8.9.1)

$$\frac{F_c}{A_g p_y} + \frac{M_x}{M_{cx}} + \frac{M_y}{M_{cy}} = \frac{1016.1}{11088.0} + \frac{126.5}{1513.6} + \frac{0.0}{543.8}$$

$$= 0.09 + 0.08 + 0.00$$

$$= 0.18$$

$$< 1$$

Cross-section Capacity OK

9. Member Buckling Resistance Check

(Clause 8.9.2)

Axis of buckling		=	**x-x**		
Length of Kingpost	L_x	=	11.90 m		
Effective Length	L_{Ex}	=	2.0 L_x	= 23.80 m	*(Clause 8.3.4)*
Major Axis Slenderness	λ_x	=	L_{Ex} / r_x	= 167.6 ≈ 170	
Maximum Thickness	T	=	31.4 mm	≤ 40 mm	
Type of Section		=	Rolled H-section ≤ 40mm		
Designation of buckling curves for different section types:				Buckling Curve b)	*(Table 8.7)*
p_c in Table 8.8 a)		=	66.00 N/mm^2		
p_c in Table 8.8 b)		=	64.00 N/mm^2		
p_c in Table 8.8 c)		=	60.00 N/mm^2		
p_c in Table 8.8 d)		=	57.00 N/mm^2		
Compressive Strength	p_{cx}	=	64.00 N/mm^2		*(Table 8.8(b))*

Axis of buckling		=	**y-y**		
Unrestrain length (Y-Axis)	L_y	=	11.90 m		
Effective Length (Y-Axis)	L_{Ey}	=	1.0 L_y	= 11.90 m	*(Clause 8.3.4)*
Minor Axis Slenderness	λ_y	=	L_{Ey} / r_y	= 148.4 ≈ 150	
Maximum Thickness	T	=	31.4 mm	≤ 40 mm	
Type of Section		=	Rolled H-section ≤ 40mm		
Designation of buckling curves for different section types:				Buckling Curve c)	*(Table 8.7)*
p_c in Table 8.8 a)		=	84.00 N/mm^2		
p_c in Table 8.8 b)		=	80.00 N/mm^2		
p_c in Table 8.8 c)		=	76.00 N/mm^2		
p_c in Table 8.8 d)		=	71.00 N/mm^2		
Compressive Strength	p_{cy}	=	76.00 N/mm^2		*(Table 8.8(c))*

Design Compressive Strength	p_c	=	min. of p_{cx} & p_{cy}	= 64.0 N/mm^2	
Moment equivalent factor m for flexural buckling					
	m_x	=	0.95		*(Table 8.9)*
	m_y	=	0.95		*(Table 8.9)*

$$\frac{F_c}{A_g p_c} + \frac{m_x M_x}{M_{cx}} + \frac{m_y M_y}{M_{cy}} = \frac{1016.1}{1612.8} + \frac{120.1}{1513.6} + \frac{0.0}{543.8}$$

$$= 0.63 + 0.08 + 0.00$$

$$= 0.71$$

$$< 1$$

Overall Capacity OK

10. Frictional and End-Bearing Resistance Check (for Granular Soils)

(Pile design based on "Code of Practice for Foundations 2017 (BD)" and "Foundation Design and Construction (GEO Publication No. 1/2006)")

For the **effective stress method**, the ultimate shaft resistance is given by: $\tau_s = c' + K_s\,\sigma'_v\,\tan(\delta_s)$ *GEO Publication No. 1/2006 Equation 6.4*

For the **beta method**, the ultimate shaft resistance is given by: $\tau_s = \beta\,\sigma'_v$ *GEO Publication No. 1/2006 Equation 6.5*

Soil Properties

Soil	γ (kN/m^3)	Eff. Stress / Beta Method	c' (kPa)	ϕ' (deg.)	β
Colluvium	19.00	Eff. Stress	0.0	30.0	
CDG	19.00	Eff. Stress	5.0	37.0	

Soil Stratification

Soil	Top (mPD)	Bottom (mPD)
Colluvium	-7.10	-7.88
CDG	-7.88	-16.00
CDG	-16.00	-22.00
CDG	-22.00	-28.00
CDG	-28.00	-34.00
CDG	-34.00	-40.00

Final Excavation Level	=	-7.10	mPD
Design Groundwater Level	=	-7.60	mPD
Design Rockhead Level	=	-40.00	mPD
Depth of Embedment in Soil, $d_{E,soil}$	=	32.90	m
Surface Area of Section Per Metre, A_s	=	1.87	m^2/m
Area of Section, A_g	=	25200	mm^2

Factor of Safety against Ground Failure	=	3.0	*GEO Publication No. 1/2006 Table 6.1*
Mobilisation Factor for End-Bearing Resistance, f_b	=	5.0	*GEO Publication No. 1/2006 Table 6.2*
Mobilisation Factor for Shaft Resistance, f_s	=	1.5	*GEO Publication No. 1/2006 Table 6.2*
K_s / K_o	=	0.67	*GEO Publication No. 1/2006 Section 6.4.4.3*
δ_s / ϕ'	=	0.67	

Top (mPD)	Bottom (mPD)	Soil	γ (kN/m^3)	σ_v (kPa)		u (kPa)		σ_v' (kPa)	
				Top	Bottom	Top	Bottom	Top	Bottom
-7.10	-7.60	Colluvium	19.00	0.0	9.5	0.0	0.0	0.0	9.5
-7.60	-7.88	Colluvium	19.00	9.5	14.8	0.0	2.7	9.5	12.1
-7.88	-16.00	CDG	19.00	14.8	169.1	2.7	82.3	12.1	86.8
-16.00	-22.00	CDG	19.00	169.1	283.1	82.3	141.1	86.8	142.0
-22.00	-28.00	CDG	19.00	283.1	397.1	141.1	199.9	142.0	197.2
-28.00	-34.00	CDG	19.00	397.1	511.1	199.9	258.7	197.2	252.4
-34.00	-40.00	CDG	19.00	511.1	625.1	258.7	317.5	252.4	307.6
-	-	-	-	-	-	-	-	-	-

Top (mPD)	Bottom (mPD)	Soil	c' (kPa)	ϕ' (deg.)	$K_o = 1 - \sin(\phi')$	K_s	δ_s	β
-7.10	-7.60	Colluvium	0.0	30.0	0.500	0.335	20.1	-
-7.60	-7.88	Colluvium	0.0	30.0	0.500	0.335	20.1	-
-7.88	-16.00	CDG	5.0	37.0	0.398	0.267	24.8	-
-16.00	-22.00	CDG	5.0	37.0	0.398	0.267	24.8	-
-22.00	-28.00	CDG	5.0	37.0	0.398	0.267	24.8	-
-28.00	-34.00	CDG	5.0	37.0	0.398	0.267	24.8	-
-34.00	-40.00	CDG	5.0	37.0	0.4	0.267	24.8	-
-	-	-	-	-	-	-	-	-

Top (mPD)	Bottom (mPD)	Soil	Mobilised Shaft Resistance, τ_s (kPa)		Mobilised Shaft Resistance, Q_s (kN)
			Top	Bottom	
-7.10	-7.60	Colluvium	0.0	1.2	0.5
-7.60	-7.88	Colluvium	1.2	1.5	0.7
-7.88	-16.00	CDG	6.5	15.7	168.4
-16.00	-22.00	CDG	15.7	22.5	214.2
-22.00	-28.00	CDG	22.5	29.3	290.5
-28.00	-34.00	CDG	29.3	36.1	366.9
-34.00	-40.00	CDG	36.1	42.9	443.2
-	-	-	-	-	-

Ultimate Shaft Resistance, Q_s	=	1484.4	kN	
Allowable Shaft Resistance, Q_s / f_s	=	989.6	kN	
	<	1016.1	kN	***Frictional Resistance Not OK***
Vertical Effective Stress at Base, σ'_{vo}	=	307.6	kPa	
Bearing Capacity Factor, N_q	=	120		*GEO Publication No. 1/2006 Figure 6.2*
Ultimate Base Resistance, $Q_b = N_q\ \sigma'_{vo}\ A_g$	=	930.1	kN	
Allowable Base Resistance, Q_b / f_b	=	186.0	kN	
	<	1016.1	kN	***End-Bearing Resistance Not OK***
Ultimate Pile Resistance, $Q_s + Q_b$	=	2414.5	kN	
Allowable Pile Resistance, $(Q_s + Q_b)$ / FoS	=	804.8	kN	
	<	1016.1	kN	***Pile Resistance Not OK***

Insufficient Pile Resistance If Driven H-Pile is Used, Socketed-H Pile is Needed

11. Socketed-H Pile Design

Depth of Embedment in Soil, $d_{E,soil}$	=	32.90	m
Total Depth of Embedment, d_E	=	37.90	m
Socket Length	=	5.00	m
Factor of Safety	=	3.0	

Bond Friction between Rock and Grout

BD CoP Foundation Table 2.2

Category of Rock		Allowable bond or friction between rock and concrete or grout for piles (kPa)
		Under compression (Fs)
Grade III or better, i.e., Cat. 1(a) - 1(c)	◉	700
Grade IV or worse, i.e., Cat. 1(d) or 2	○	300

Minimum Grout Cover	=	40	mm	*BD CoP Foundation Clause 5.4.2 (2)*
Socket Diameter	=	700	mm	***Socket Diameter OK***
Bond Friction between Rock and Grout	=	7696.9	kN	
Allowable Bearing Capacity	=	2565.6	kN	
	>	1016.1	kN	***Friction between Rock and Grout OK***

Bond Friction between Rock and Grout

Allowable Bond Stress between Steel and Grout	=	400	kPa	
Surface Area of Section Per Metre, A_s	=	1.87	m^2/m	
Bond Friction bewteen Steel and Grout	=	3740.0	kN	
Allowable Bearing Capacity	=	1246.7	kN	
	>	1016.1	kN	***Friction between Steel and Grout OK***

AECOM AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.1
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section B-B**

Groundwater Drawdown Induced Settlement - Southwest Wall

The calculation of ground settlement due to dewatering and subsequent drawdown behind wall assumes that full consolidation has taken place.
Therefore, the change in the porewater pressure is equal to the change in the soil's effective stress.

Initial Groundwater Level	H_0	=	+3.00	mPD
Groundwater Level After Drawdown	H_1	=	+2.00	mPD
Design Groundwater Drawdown	δH	=	1.00	m
Unit Weight of Water	γ_w	=	9.81	kN/m^3
Change in Vertical Effective Stress	$\Delta\sigma_v'$	=	9.81	kPa

(Immediately Behind Wall)

Soil Type	Top Level (mPD)	Bottom Level (mPD)	Thickness of Soil Layer (m)	E'_{ref} (kN/m^2)	E_{inc} (kN/m^2)	Y_{ref} (mPD)	Modulus of Elasticity, E' (kN/m^2)	Change in Stress, $\Delta\sigma_v'$ (kPa)	Change in Strain, $\Delta\varepsilon_v'$	Differential Settlement (mm)
Fill (Dry)	6.00	3.00	3.00	10000	3333	2.00	10000	0.00	0.000E+00	0.000
Fill	3.00	2.00	1.00	10000	3333	2.00	10000	9.81	9.810E-04	-0.981
	2.00	-0.89	2.89	10000	3333	2.00	14816	9.81	6.621E-04	-1.914
Alluvial Sand	-0.89	-0.95	0.06	10000	3750	-2.00	10000	9.81	9.810E-04	-0.059
Marine Sand	-0.95	-2.89	1.94	8000	2000	0.00	11840	9.81	8.285E-04	-1.607
Alluvial Clay	-2.89	-4.15	1.26	8000	4267	-2.50	12352	9.81	7.942E-04	-1.001
Alluvial Sand	-4.15	-6.15	2.00	10000	3750	-2.00	21813	9.81	4.497E-04	-0.899
Colluvium	-6.15	-6.48	0.33	16000	2286	-7.00	16000	9.81	6.131E-04	-0.202
CDG	-6.48	-14.00	7.52	35000	1625	-14.00	35000	9.81	2.803E-04	-2.108
	-14.00	-19.20	5.20	35000	1625	-14.00	39225	9.81	2.501E-04	-1.300
	-19.20	-24.40	5.20	35000	1625	-14.00	47675	9.81	2.058E-04	-1.070
	-24.40	-29.60	5.20	35000	1625	-14.00	56125	9.81	1.748E-04	-0.909
	-29.60	-34.80	5.20	35000	1625	-14.00	64575	9.81	1.519E-04	-0.790
	-34.80	-40.00	5.20	35000	1625	-14.00	73025	9.81	1.343E-04	-0.699

(Design R.H.)

Maximum Settlement due to Groundwater Drawdown, $S_{d,max}$	-13.539	mm

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.2
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section B-B**

Groundwater Drawdown Induced Settlement - Northeast Wall

The calculation of ground settlement due to dewatering and subsequent drawdown behind wall assumes that full consolidation has taken place. Therefore, the change in the porewater pressure is equal to the change in the soil's effective stress.

Initial Groundwater Level	H_0	=	+3.00	mPD
Groundwater Level After Drawdown	H_1	=	+2.00	mPD
Design Groundwater Drawdown	δH	=	1.00	m
Unit Weight of Water	γ_w	=	9.81	kN/m^3
Change in Vertical Effective Stress	$\Delta\sigma_v'$	=	9.81	kPa

(Immediately Behind Wall)

Soil Type	Top Level (mPD)	Bottom Level (mPD)	Thickness of Soil Layer (m)	E'_{ref} (kN/m^2)	E_{inc} (kN/m^2)	Y_{ref} (mPD)	Modulus of Elasticity, E' (kN/m^2)	Change in Stress, $\Delta\sigma_v'$ (kPa)	Change in Strain, $\Delta\varepsilon_v'$	Differential Settlement (mm)
Fill (Dry)	6.00	3.00	3.00	10000	3333	2.00	10000	0.00	0.000E+00	0.000
Fill	3.00	2.00	1.00	10000	3333	2.00	10000	9.81	9.810E-04	-0.981
	2.00	-0.38	2.38	10000	3333	2.00	13966	9.81	7.024E-04	-1.672
Alluvial Sand	-0.38	-1.30	0.92	10000	3750	-2.00	10000	9.81	9.810E-04	-0.903
Marine Sand	-1.30	-3.30	2.00	8000	2000	0.00	12600	9.81	7.786E-04	-1.557
Alluvial Clay	-3.30	-4.65	1.35	8000	4267	-2.50	14294	9.81	6.863E-04	-0.927
Alluvial Sand	-4.65	-6.34	1.69	10000	3750	-2.00	23106	9.81	4.246E-04	-0.718
Colluvium	-6.34	-7.88	1.54	16000	2286	-7.00	16251	9.81	6.036E-04	-0.930
CDG	-7.88	-14.00	6.12	35000	1625	-14.00	35000	9.81	2.803E-04	-1.715
	-14.00	-19.20	5.20	35000	1625	-14.00	39225	9.81	2.501E-04	-1.300
	-19.20	-24.40	5.20	35000	1625	-14.00	47675	9.81	2.058E-04	-1.070
	-24.40	-29.60	5.20	35000	1625	-14.00	56125	9.81	1.748E-04	-0.909
	-29.60	-34.80	5.20	35000	1625	-14.00	64575	9.81	1.519E-04	-0.790
	-34.80	-40.00	5.20	35000	1625	-14.00	73025	9.81	1.343E-04	-0.699

(Design R.H.)

Maximum Settlement due to Groundwater Drawdown, $S_{d,max}$	-14.169	mm

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	Project Name:	Drainage Improvement Works In	By: JL	Date:	18-Oct-21
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ELS Predicted Settlement Calculation

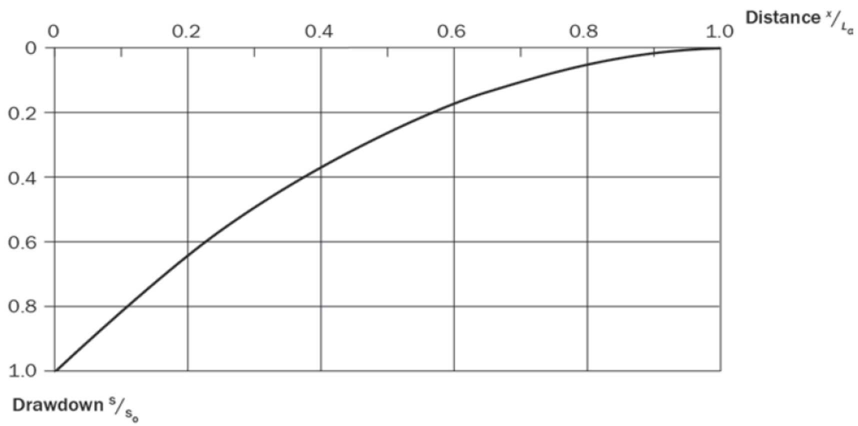
Location: **STN Pumping Station - Section B-B**

Vertical Settlement Behind Wall due to Groundwater Drawdown

(According to CIRIA C750 - Groundwater Control: Design and Practice)

The groundwater drawdown behind wall is estimated by the dimensionless drawdown curve for horizontal plane flow, as shown in Figure 6.16 of CIRIA C750.

			Southwest Wall	Northeast Wall
Design Groundwater Drawdown	δH	=	1.00 m	1.00 m
Permeability of Soil	k	=	1.00E-04 m/s	1.00E-04 m/s
Empirical Calibration Factor	C	=	3000	3000
Distance of Influence, $L_0 = C\delta Hk^{1/2}$		=	30.00 m	30.00 m



Legend for Figure 6.16 of CIRIA C750

x = Horizontal Distance from Wall (m)

L_0 = Distance of Influence (m)

s = Drawdown at Horizontal Distance x (m)

$s_0 = \delta H$ = Drawdown Immediately Behind Wall (m)

s/s_0 = Dimensionless Drawdown

x/L_0 = Normalised Distance from Wall

Figure 6.16 of CIRIA C750: Normalised drawdown curve for horizontal plane low

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.4
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section B-B**

Vertical Settlement Behind Wall due to Wall Installation

The vertical settlement behind wall due to effects of wall installation is obtained from PLAXIS 2D. Past experience of pipe pile wall installation in Hong Kong has shown that the associated ground movements are very small, typically less than 5 mm. In some cases, no movement was observed (Morton et al., 1980).

Vertical Settlement Behind Wall due to Excavation

The vertical settlement behind wall due to effects of excavation is obtained from PLAXIS 2D. The soil heave immediately behind the wall due to elastic unloading associated with the use of elastoplastic Mohr-Coulomb model has not been corrected.

Estimated Total Settlement Behind Wall due to Wall Installation, Excavation and Groundwater Drawdown

The estimated total settlement behind wall due to the combined effects of wall installation, excavation and groundwater drawdown is summarised in the following table.

			Southwest Wall	Northeast Wall
Maximum Total Settlement	$S_{T,max}$	=	-23.369 mm	-22.538 mm

Table Legend

x = Horizontal Distance from Wall (m)
S_w = Vertical Settlement due to Wall Installation (mm)
S_e = Vertical Settlement due to Excavation, from PLAXIS 2D (mm)
x/L_0 = Normalised Distance from Wall
s/s_0 = Dimensionless Drawdown
S_d = Vertical Settlement due to Groundwater Drawdown (mm)
S_T = Total Vertical Settlement (mm)

AECOM AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.5
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section B-B**

Estimated Total Settlement - Southwest Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
0.000	-2.329	8.652	0.000	1.000	-13.539	-7.216
0.007	-2.323	8.609	0.000	1.000	-13.533	-7.247
0.007	-2.323	8.609	0.000	1.000	-13.533	-7.247
1.300	-1.780	3.609	0.043	0.918	-12.424	-10.595
1.300	-1.780	3.609	0.043	0.918	-12.424	-10.595
1.311	-1.778	3.598	0.044	0.917	-12.414	-10.594
1.311	-1.778	3.598	0.044	0.917	-12.414	-10.594
2.603	-1.558	-1.174	0.087	0.835	-11.307	-14.039
2.603	-1.558	-1.174	0.087	0.835	-11.307	-14.039
2.615	-1.556	-1.225	0.087	0.834	-11.296	-14.078
2.615	-1.556	-1.225	0.087	0.834	-11.296	-14.078
3.907	-1.385	-6.183	0.130	0.759	-10.271	-17.838
3.907	-1.385	-6.183	0.130	0.759	-10.271	-17.838
3.920	-1.383	-6.225	0.131	0.758	-10.261	-17.870
3.920	-1.383	-6.225	0.131	0.758	-10.261	-17.870
5.211	-1.235	-10.122	0.174	0.685	-9.270	-20.627
5.211	-1.235	-10.122	0.174	0.685	-9.270	-20.627
5.224	-1.234	-10.154	0.174	0.684	-9.260	-20.648
5.224	-1.234	-10.154	0.174	0.684	-9.260	-20.648
6.515	-1.101	-12.980	0.217	0.614	-8.316	-22.397
6.515	-1.101	-12.980	0.217	0.614	-8.316	-22.397
6.528	-1.100	-13.002	0.218	0.614	-8.307	-22.410
6.528	-1.100	-13.002	0.218	0.614	-8.307	-22.410
7.820	-0.980	-14.866	0.261	0.549	-7.433	-23.279
7.820	-0.980	-14.866	0.261	0.549	-7.433	-23.279
7.832	-0.979	-14.880	0.261	0.548	-7.425	-23.284
7.832	-0.979	-14.880	0.261	0.548	-7.425	-23.284
9.124	-0.871	-15.930	0.304	0.485	-6.567	-23.369
9.124	-0.871	-15.930	0.304	0.485	-6.567	-23.369
9.137	-0.870	-15.937	0.305	0.485	-6.560	-23.368
9.137	-0.870	-15.937	0.305	0.485	-6.560	-23.368
10.428	-0.772	-16.334	0.348	0.433	-5.861	-22.967
10.428	-0.772	-16.334	0.348	0.433	-5.861	-22.967
10.441	-0.771	-16.335	0.348	0.432	-5.854	-22.960
10.441	-0.771	-16.335	0.348	0.432	-5.854	-22.960
11.733	-0.683	-16.228	0.391	0.381	-5.154	-22.065
11.733	-0.683	-16.228	0.391	0.381	-5.154	-22.065
11.745	-0.682	-16.225	0.392	0.380	-5.147	-22.054
11.745	-0.682	-16.225	0.392	0.380	-5.147	-22.054
13.037	-0.602	-15.751	0.435	0.332	-4.495	-20.848
13.037	-0.602	-15.751	0.435	0.332	-4.495	-20.848
13.050	-0.602	-15.745	0.435	0.332	-4.488	-20.834
13.050	-0.602	-15.745	0.435	0.332	-4.488	-20.834
14.341	-0.530	-15.027	0.478	0.284	-3.847	-19.404
14.341	-0.530	-15.027	0.478	0.284	-3.847	-19.404
14.354	-0.529	-15.019	0.478	0.284	-3.841	-19.389
14.354	-0.529	-15.019	0.478	0.284	-3.841	-19.389
15.646	-0.464	-14.164	0.522	0.241	-3.258	-17.886

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.6
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section B-B**

Estimated Total Settlement - Southwest Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
15.646	-0.464	-14.164	0.522	0.241	-3.258	-17.886
15.659	-0.464	-14.155	0.522	0.240	-3.253	-17.871
15.659	-0.464	-14.155	0.522	0.240	-3.253	-17.871
16.950	-0.406	-13.250	0.565	0.202	-2.728	-16.384
16.950	-0.406	-13.250	0.565	0.202	-2.728	-16.384
16.963	-0.405	-13.241	0.565	0.201	-2.723	-16.369
16.963	-0.405	-13.241	0.565	0.201	-2.723	-16.369
18.254	-0.353	-12.351	0.608	0.164	-2.221	-14.925
18.254	-0.353	-12.351	0.608	0.164	-2.221	-14.925
18.267	-0.353	-12.342	0.609	0.164	-2.217	-14.912
18.267	-0.353	-12.342	0.609	0.164	-2.217	-14.912
19.559	-0.307	-11.500	0.652	0.134	-1.809	-13.616
19.559	-0.307	-11.500	0.652	0.134	-1.809	-13.616
19.572	-0.306	-11.492	0.652	0.133	-1.805	-13.603
19.572	-0.306	-11.492	0.652	0.133	-1.805	-13.603
20.863	-0.265	-10.763	0.695	0.103	-1.397	-12.425
20.863	-0.265	-10.763	0.695	0.103	-1.397	-12.425
20.876	-0.265	-10.757	0.696	0.103	-1.393	-12.415
20.876	-0.265	-10.757	0.696	0.103	-1.393	-12.415
22.167	-0.229	-10.233	0.739	0.081	-1.090	-11.553
22.167	-0.229	-10.233	0.739	0.081	-1.090	-11.553
22.180	-0.228	-10.228	0.739	0.080	-1.088	-11.544
22.180	-0.228	-10.228	0.739	0.080	-1.088	-11.544
23.472	-0.196	-9.788	0.782	0.059	-0.796	-10.781
23.472	-0.196	-9.788	0.782	0.059	-0.796	-10.781
23.485	-0.196	-9.784	0.783	0.059	-0.793	-10.773
23.485	-0.196	-9.784	0.783	0.059	-0.793	-10.773
24.776	-0.168	-9.355	0.826	0.042	-0.572	-10.094
24.776	-0.168	-9.355	0.826	0.042	-0.572	-10.094
24.789	-0.167	-9.352	0.826	0.042	-0.570	-10.089
24.789	-0.167	-9.352	0.826	0.042	-0.570	-10.089
26.080	-0.143	-9.036	0.869	0.029	-0.395	-9.574
26.080	-0.143	-9.036	0.869	0.029	-0.395	-9.574
26.093	-0.142	-9.029	0.870	0.029	-0.394	-9.565
26.093	-0.142	-9.029	0.870	0.029	-0.394	-9.565
27.385	-0.121	-8.603	0.913	0.017	-0.236	-8.960
27.385	-0.121	-8.603	0.913	0.017	-0.236	-8.960
27.398	-0.120	-8.592	0.913	0.017	-0.235	-8.947
27.398	-0.120	-8.592	0.913	0.017	-0.235	-8.947
28.689	-0.101	-8.247	0.956	0.009	-0.118	-8.467
28.689	-0.101	-8.247	0.956	0.009	-0.118	-8.467
28.702	-0.101	-8.237	0.957	0.009	-0.117	-8.456
28.702	-0.101	-8.237	0.957	0.009	-0.117	-8.456
29.993	-0.085	-7.924	1.000	0.000	-0.001	-8.009
29.993	-0.085	-7.924	1.000	0.000	-0.001	-8.009
30.006	-0.085	-7.927	1.000	0.000	0.000	-8.011
30.006	-0.085	-7.927	1.000	0.000	0.000	-8.011
31.298	-0.070	-7.655	1.000	0.000	0.000	-7.726

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.7
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section B-B**

Estimated Total Settlement - Southwest Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
31.298	-0.070	-7.655	1.000	0.000	0.000	-7.726
31.311	-0.070	-7.654	1.000	0.000	0.000	-7.724
31.311	-0.070	-7.654	1.000	0.000	0.000	-7.724
32.602	-0.058	-7.380	1.000	0.000	0.000	-7.438
32.602	-0.058	-7.380	1.000	0.000	0.000	-7.438
32.615	-0.058	-7.379	1.000	0.000	0.000	-7.437
32.615	-0.058	-7.379	1.000	0.000	0.000	-7.437
33.906	-0.047	-7.102	1.000	0.000	0.000	-7.149
33.906	-0.047	-7.102	1.000	0.000	0.000	-7.149
33.920	-0.047	-7.096	1.000	0.000	0.000	-7.143
33.920	-0.047	-7.096	1.000	0.000	0.000	-7.143
35.211	-0.037	-6.861	1.000	0.000	0.000	-6.898
35.211	-0.037	-6.861	1.000	0.000	0.000	-6.898
35.224	-0.037	-6.858	1.000	0.000	0.000	-6.896
35.224	-0.037	-6.858	1.000	0.000	0.000	-6.896
36.515	-0.029	-6.633	1.000	0.000	0.000	-6.662
36.515	-0.029	-6.633	1.000	0.000	0.000	-6.662
36.528	-0.029	-6.630	1.000	0.000	0.000	-6.659
36.528	-0.029	-6.630	1.000	0.000	0.000	-6.659
37.820	-0.023	-6.415	1.000	0.000	0.000	-6.437
37.820	-0.023	-6.415	1.000	0.000	0.000	-6.437
37.833	-0.023	-6.413	1.000	0.000	0.000	-6.436
37.833	-0.023	-6.413	1.000	0.000	0.000	-6.436
39.124	-0.017	-6.205	1.000	0.000	0.000	-6.222
39.124	-0.017	-6.205	1.000	0.000	0.000	-6.222
39.137	-0.017	-6.204	1.000	0.000	0.000	-6.220
39.137	-0.017	-6.204	1.000	0.000	0.000	-6.220
40.428	-0.012	-6.007	1.000	0.000	0.000	-6.019
40.428	-0.012	-6.007	1.000	0.000	0.000	-6.019
40.441	-0.012	-6.006	1.000	0.000	0.000	-6.018
40.441	-0.012	-6.006	1.000	0.000	0.000	-6.018
41.733	-0.008	-5.830	1.000	0.000	0.000	-5.838
41.733	-0.008	-5.830	1.000	0.000	0.000	-5.838
41.746	-0.008	-5.830	1.000	0.000	0.000	-5.838
41.746	-0.008	-5.830	1.000	0.000	0.000	-5.838
43.037	-0.004	-5.666	1.000	0.000	0.000	-5.670
43.037	-0.004	-5.666	1.000	0.000	0.000	-5.670
43.050	-0.004	-5.666	1.000	0.000	0.000	-5.670
43.050	-0.004	-5.666	1.000	0.000	0.000	-5.670
44.341	-0.001	-5.515	1.000	0.000	0.000	-5.516
44.341	-0.001	-5.515	1.000	0.000	0.000	-5.516
44.354	-0.001	-5.514	1.000	0.000	0.000	-5.515
44.354	-0.001	-5.514	1.000	0.000	0.000	-5.515
45.646	0.001	-5.377	1.000	0.000	0.000	-5.376
45.646	0.001	-5.377	1.000	0.000	0.000	-5.376
45.659	0.001	-5.376	1.000	0.000	0.000	-5.375
45.659	0.001	-5.376	1.000	0.000	0.000	-5.375
46.950	0.003	-5.247	1.000	0.000	0.000	-5.243

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.8
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section B-B**

Estimated Total Settlement - Southwest Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
46.950	0.003	-5.247	1.000	0.000	0.000	-5.243
46.963	0.003	-5.245	1.000	0.000	0.000	-5.241
46.963	0.003	-5.245	1.000	0.000	0.000	-5.241
48.254	0.005	-5.121	1.000	0.000	0.000	-5.116
48.254	0.005	-5.121	1.000	0.000	0.000	-5.116
48.267	0.005	-5.120	1.000	0.000	0.000	-5.115
48.267	0.005	-5.120	1.000	0.000	0.000	-5.115
49.559	0.006	-5.020	1.000	0.000	0.000	-5.014
49.559	0.006	-5.020	1.000	0.000	0.000	-5.014
49.572	0.006	-5.020	1.000	0.000	0.000	-5.014
49.572	0.006	-5.020	1.000	0.000	0.000	-5.014
50.863	0.007	-4.929	1.000	0.000	0.000	-4.922
50.863	0.007	-4.929	1.000	0.000	0.000	-4.922
50.876	0.007	-4.927	1.000	0.000	0.000	-4.920
50.876	0.007	-4.927	1.000	0.000	0.000	-4.920
52.167	0.008	-4.854	1.000	0.000	0.000	-4.845
52.167	0.008	-4.854	1.000	0.000	0.000	-4.845
52.180	0.008	-4.852	1.000	0.000	0.000	-4.843
52.180	0.008	-4.852	1.000	0.000	0.000	-4.843
53.472	0.009	-4.788	1.000	0.000	0.000	-4.779
53.472	0.009	-4.788	1.000	0.000	0.000	-4.779
53.485	0.009	-4.787	1.000	0.000	0.000	-4.778
53.485	0.009	-4.787	1.000	0.000	0.000	-4.778
54.776	0.010	-4.731	1.000	0.000	0.000	-4.721
54.776	0.010	-4.731	1.000	0.000	0.000	-4.721
54.789	0.010	-4.732	1.000	0.000	0.000	-4.722
54.789	0.010	-4.732	1.000	0.000	0.000	-4.722
56.081	0.010	-4.683	1.000	0.000	0.000	-4.673
56.081	0.010	-4.683	1.000	0.000	0.000	-4.673
56.094	0.010	-4.686	1.000	0.000	0.000	-4.676
56.094	0.010	-4.686	1.000	0.000	0.000	-4.676
57.385	0.010	-4.659	1.000	0.000	0.000	-4.649
57.385	0.010	-4.659	1.000	0.000	0.000	-4.649
57.399	0.010	-4.664	1.000	0.000	0.000	-4.653
57.399	0.010	-4.664	1.000	0.000	0.000	-4.653
58.691	0.010	-4.612	1.000	0.000	0.000	-4.601
58.691	0.010	-4.612	1.000	0.000	0.000	-4.601
58.706	0.010	-4.611	1.000	0.000	0.000	-4.601
58.706	0.010	-4.611	1.000	0.000	0.000	-4.601
60.000	0.011	-4.604	1.000	0.000	0.000	-4.593

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.9
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section B-B**

Estimated Total Settlement - Northeast Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
0.000	-2.361	9.074	0.000	1.000	-14.169	-7.456
0.007	-2.355	9.032	0.000	1.000	-14.163	-7.486
0.007	-2.355	9.032	0.000	1.000	-14.163	-7.486
1.298	-1.802	3.747	0.043	0.918	-13.004	-11.060
1.298	-1.802	3.747	0.043	0.918	-13.004	-11.060
1.310	-1.800	3.750	0.044	0.917	-12.994	-11.044
1.310	-1.800	3.750	0.044	0.917	-12.994	-11.044
2.602	-1.581	-0.663	0.087	0.835	-11.834	-14.078
2.602	-1.581	-0.663	0.087	0.835	-11.834	-14.078
2.615	-1.579	-0.714	0.087	0.834	-11.823	-14.117
2.615	-1.579	-0.714	0.087	0.834	-11.823	-14.117
3.908	-1.408	-5.574	0.130	0.759	-10.748	-17.731
3.908	-1.408	-5.574	0.130	0.759	-10.748	-17.731
3.921	-1.407	-5.618	0.131	0.758	-10.738	-17.762
3.921	-1.407	-5.618	0.131	0.758	-10.738	-17.762
5.213	-1.259	-9.360	0.174	0.685	-9.700	-20.318
5.213	-1.259	-9.360	0.174	0.685	-9.700	-20.318
5.230	-1.257	-9.400	0.174	0.684	-9.687	-20.344
5.230	-1.257	-9.400	0.174	0.684	-9.687	-20.344
6.519	-1.125	-12.043	0.217	0.614	-8.701	-21.869
6.519	-1.125	-12.043	0.217	0.614	-8.701	-21.869
7.808	-1.006	-13.739	0.260	0.550	-7.788	-22.533
7.808	-1.006	-13.739	0.260	0.550	-7.788	-22.533
7.824	-1.005	-13.755	0.261	0.549	-7.776	-22.536
7.824	-1.005	-13.755	0.261	0.549	-7.776	-22.536
7.837	-1.004	-13.767	0.261	0.548	-7.767	-22.538
7.837	-1.004	-13.767	0.261	0.548	-7.767	-22.538
9.131	-0.895	-14.663	0.304	0.485	-6.868	-22.427
9.131	-0.895	-14.663	0.304	0.485	-6.868	-22.427
10.426	-0.797	-14.945	0.348	0.433	-6.135	-21.876
10.426	-0.797	-14.945	0.348	0.433	-6.135	-21.876
10.440	-0.796	-14.945	0.348	0.432	-6.127	-21.868
10.440	-0.796	-14.945	0.348	0.432	-6.127	-21.868
11.735	-0.706	-14.774	0.391	0.381	-5.393	-20.873
11.735	-0.706	-14.774	0.391	0.381	-5.393	-20.873
11.750	-0.705	-14.770	0.392	0.380	-5.384	-20.860
11.750	-0.705	-14.770	0.392	0.380	-5.384	-20.860
13.044	-0.625	-14.294	0.435	0.332	-4.700	-19.619
13.044	-0.625	-14.294	0.435	0.332	-4.700	-19.619
14.338	-0.551	-13.636	0.478	0.284	-4.028	-18.215
14.338	-0.551	-13.636	0.478	0.284	-4.028	-18.215
14.353	-0.550	-13.627	0.478	0.284	-4.020	-18.198
14.353	-0.550	-13.627	0.478	0.284	-4.020	-18.198
15.648	-0.484	-12.877	0.522	0.241	-3.409	-16.770
15.648	-0.484	-12.877	0.522	0.241	-3.409	-16.770
15.664	-0.483	-12.867	0.522	0.240	-3.402	-16.753
15.664	-0.483	-12.867	0.522	0.240	-3.402	-16.753
16.956	-0.424	-12.092	0.565	0.201	-2.852	-15.368

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.10
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section B-B**

Estimated Total Settlement - Northeast Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
16.956	-0.424	-12.092	0.565	0.201	-2.852	-15.368
18.249	-0.370	-11.377	0.608	0.164	-2.327	-14.074
18.249	-0.370	-11.377	0.608	0.164	-2.327	-14.074
18.264	-0.370	-11.370	0.609	0.164	-2.322	-14.062
18.264	-0.370	-11.370	0.609	0.164	-2.322	-14.062
19.556	-0.322	-10.785	0.652	0.134	-1.894	-13.000
19.556	-0.322	-10.785	0.652	0.134	-1.894	-13.000
19.568	-0.321	-10.779	0.652	0.133	-1.890	-12.991
19.568	-0.321	-10.779	0.652	0.133	-1.890	-12.991
20.865	-0.278	-10.298	0.695	0.103	-1.462	-12.037
20.865	-0.278	-10.298	0.695	0.103	-1.462	-12.037
20.880	-0.278	-10.294	0.696	0.103	-1.457	-12.029
20.880	-0.278	-10.294	0.696	0.103	-1.457	-12.029
22.175	-0.239	-9.832	0.739	0.080	-1.139	-11.210
22.175	-0.239	-9.832	0.739	0.080	-1.139	-11.210
23.471	-0.205	-9.402	0.782	0.059	-0.833	-10.440
23.471	-0.205	-9.402	0.782	0.059	-0.833	-10.440
23.489	-0.205	-9.394	0.783	0.059	-0.829	-10.428
23.489	-0.205	-9.394	0.783	0.059	-0.829	-10.428
24.783	-0.175	-8.890	0.826	0.042	-0.598	-9.662
24.783	-0.175	-8.890	0.826	0.042	-0.598	-9.662
26.077	-0.148	-8.488	0.869	0.029	-0.414	-9.050
26.077	-0.148	-8.488	0.869	0.029	-0.414	-9.050
26.091	-0.148	-8.483	0.870	0.029	-0.412	-9.042
26.091	-0.148	-8.483	0.870	0.029	-0.412	-9.042
27.383	-0.124	-8.082	0.913	0.017	-0.247	-8.453
27.383	-0.124	-8.082	0.913	0.017	-0.247	-8.453
27.394	-0.124	-8.082	0.913	0.017	-0.246	-8.452
27.394	-0.124	-8.082	0.913	0.017	-0.246	-8.452
28.687	-0.103	-7.743	0.956	0.009	-0.124	-7.970
28.687	-0.103	-7.743	0.956	0.009	-0.124	-7.970
28.701	-0.103	-7.740	0.957	0.009	-0.123	-7.966
28.701	-0.103	-7.740	0.957	0.009	-0.123	-7.966
29.998	-0.085	-7.442	1.000	0.000	0.000	-7.527
29.998	-0.085	-7.442	1.000	0.000	0.000	-7.527
31.296	-0.069	-7.159	1.000	0.000	0.000	-7.229
31.296	-0.069	-7.159	1.000	0.000	0.000	-7.229
31.312	-0.069	-7.155	1.000	0.000	0.000	-7.224
31.312	-0.069	-7.155	1.000	0.000	0.000	-7.224
32.607	-0.055	-6.898	1.000	0.000	0.000	-6.953
32.607	-0.055	-6.898	1.000	0.000	0.000	-6.953
33.903	-0.043	-6.675	1.000	0.000	0.000	-6.719
33.903	-0.043	-6.675	1.000	0.000	0.000	-6.719
33.916	-0.043	-6.673	1.000	0.000	0.000	-6.716
33.916	-0.043	-6.673	1.000	0.000	0.000	-6.716
35.214	-0.033	-6.476	1.000	0.000	0.000	-6.508
35.214	-0.033	-6.476	1.000	0.000	0.000	-6.508
35.227	-0.033	-6.473	1.000	0.000	0.000	-6.506

AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.11
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section B-B**

Estimated Total Settlement - Northeast Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
35.227	-0.033	-6.473	1.000	0.000	0.000	-6.506
36.523	-0.024	-6.278	1.000	0.000	0.000	-6.301
36.523	-0.024	-6.278	1.000	0.000	0.000	-6.301
37.818	-0.016	-6.079	1.000	0.000	0.000	-6.094
37.818	-0.016	-6.079	1.000	0.000	0.000	-6.094
37.833	-0.016	-6.078	1.000	0.000	0.000	-6.093
37.833	-0.016	-6.078	1.000	0.000	0.000	-6.093
39.130	-0.009	-5.888	1.000	0.000	0.000	-5.897
39.130	-0.009	-5.888	1.000	0.000	0.000	-5.897
40.427	-0.003	-5.757	1.000	0.000	0.000	-5.761
40.427	-0.003	-5.757	1.000	0.000	0.000	-5.761
40.439	-0.003	-5.755	1.000	0.000	0.000	-5.759
40.439	-0.003	-5.755	1.000	0.000	0.000	-5.759
41.736	0.002	-5.587	1.000	0.000	0.000	-5.585
41.736	0.002	-5.587	1.000	0.000	0.000	-5.585
41.748	0.002	-5.585	1.000	0.000	0.000	-5.584
41.748	0.002	-5.585	1.000	0.000	0.000	-5.584
43.045	0.006	-5.421	1.000	0.000	0.000	-5.415
43.045	0.006	-5.421	1.000	0.000	0.000	-5.415
44.343	0.009	-5.290	1.000	0.000	0.000	-5.281
44.343	0.009	-5.290	1.000	0.000	0.000	-5.281
44.358	0.009	-5.289	1.000	0.000	0.000	-5.280
44.358	0.009	-5.289	1.000	0.000	0.000	-5.280
45.653	0.012	-5.186	1.000	0.000	0.000	-5.174
45.653	0.012	-5.186	1.000	0.000	0.000	-5.174
46.948	0.014	-5.065	1.000	0.000	0.000	-5.050
46.948	0.014	-5.065	1.000	0.000	0.000	-5.050
46.964	0.014	-5.064	1.000	0.000	0.000	-5.049
46.964	0.014	-5.064	1.000	0.000	0.000	-5.049
48.261	0.016	-4.955	1.000	0.000	0.000	-4.939
48.261	0.016	-4.955	1.000	0.000	0.000	-4.939
49.558	0.018	-4.882	1.000	0.000	0.000	-4.864
49.558	0.018	-4.882	1.000	0.000	0.000	-4.864
49.574	0.018	-4.880	1.000	0.000	0.000	-4.862
49.574	0.018	-4.880	1.000	0.000	0.000	-4.862
50.869	0.019	-4.815	1.000	0.000	0.000	-4.796
50.869	0.019	-4.815	1.000	0.000	0.000	-4.796
52.164	0.021	-4.736	1.000	0.000	0.000	-4.716
52.164	0.021	-4.736	1.000	0.000	0.000	-4.716
52.180	0.021	-4.736	1.000	0.000	0.000	-4.715
52.180	0.021	-4.736	1.000	0.000	0.000	-4.715
53.477	0.021	-4.671	1.000	0.000	0.000	-4.649
53.477	0.021	-4.671	1.000	0.000	0.000	-4.649
54.774	0.022	-4.629	1.000	0.000	0.000	-4.607
54.774	0.022	-4.629	1.000	0.000	0.000	-4.607
54.790	0.022	-4.628	1.000	0.000	0.000	-4.606
54.790	0.022	-4.628	1.000	0.000	0.000	-4.606
56.085	0.023	-4.601	1.000	0.000	0.000	-4.579

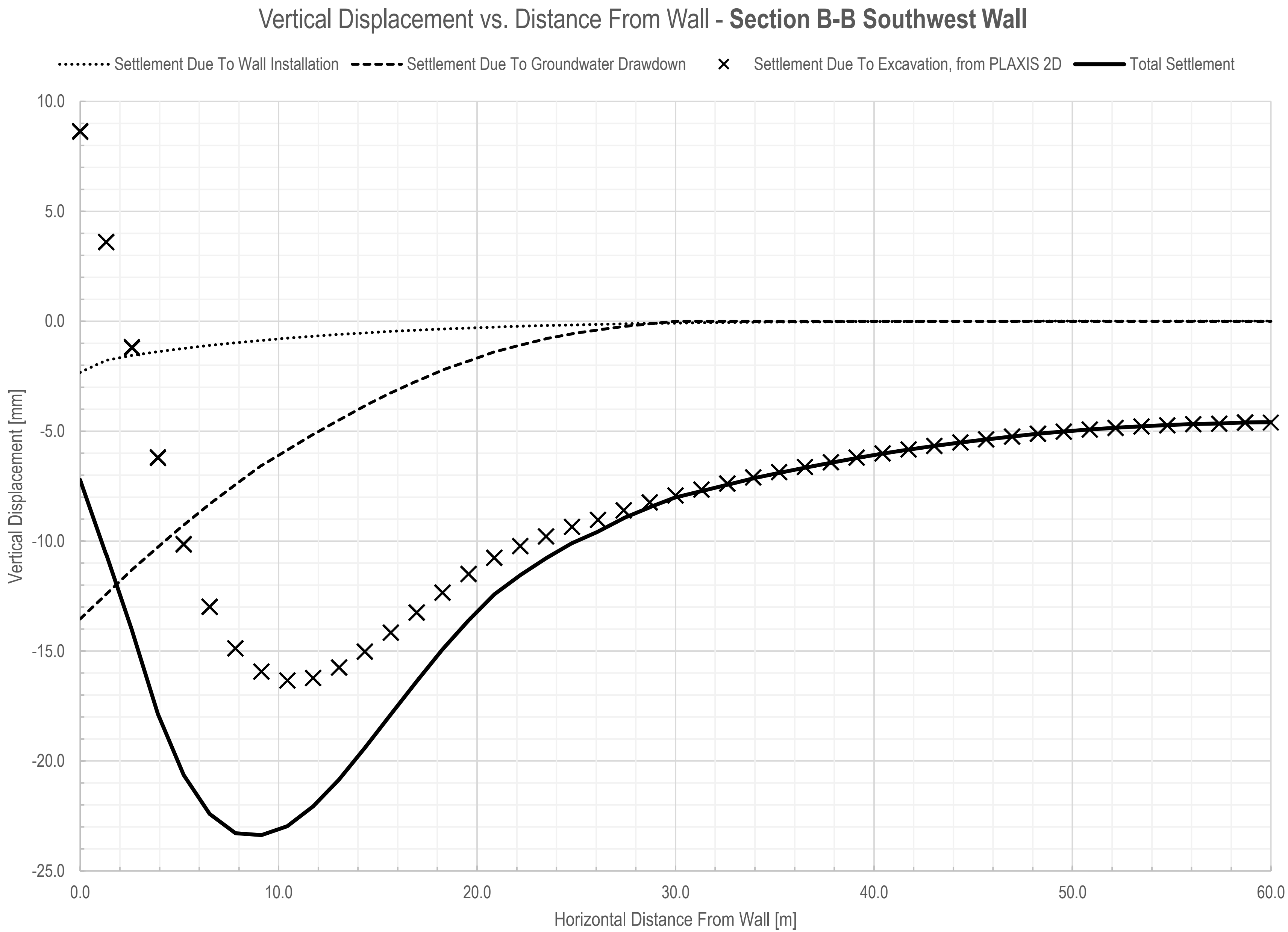
AECOM Asia Co. Ltd.	Project No.:	60617767			Sheet:	A.12
	Project Name:	Drainage Improvement Works In	By:	JL	Date:	18-Oct-21
		Sha Tin and Sai Kung - Investigation	Checked:	KP	Date:	18-Oct-21

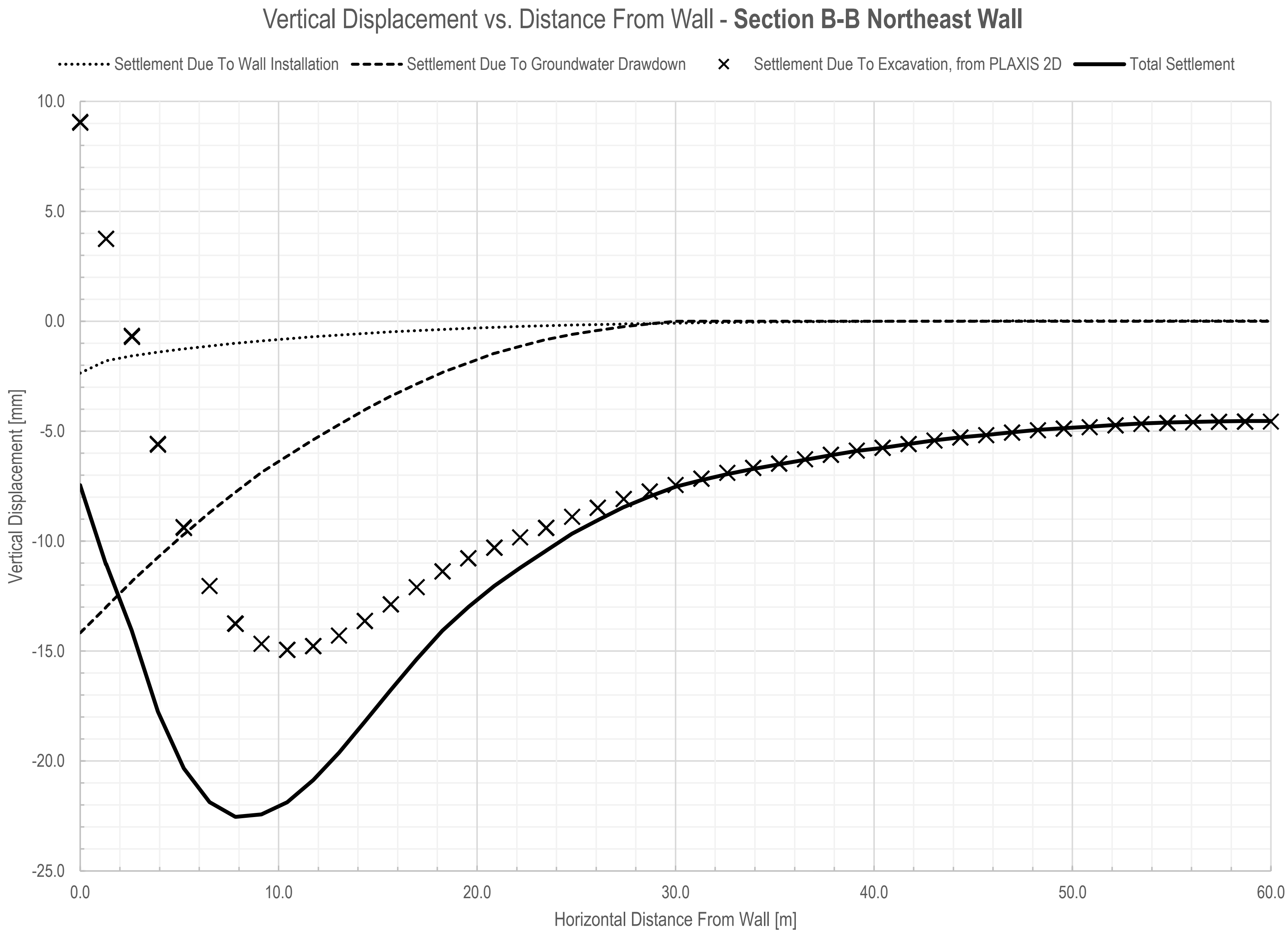
ELS Predicted Settlement Calculation

Location: **STN Pumping Station - Section B-B**

Estimated Total Settlement - Northeast Wall

x [m]	S_w [mm]	S_e [mm]	x/L_0	s/s_0	S_d [mm]	S_T [mm]
56.085	0.023	-4.601	1.000	0.000	0.000	-4.579
57.380	0.023	-4.577	1.000	0.000	0.000	-4.554
57.380	0.023	-4.577	1.000	0.000	0.000	-4.554
57.394	0.023	-4.577	1.000	0.000	0.000	-4.554
57.394	0.023	-4.577	1.000	0.000	0.000	-4.554
58.692	0.023	-4.560	1.000	0.000	0.000	-4.537
58.692	0.023	-4.560	1.000	0.000	0.000	-4.537
58.708	0.023	-4.560	1.000	0.000	0.000	-4.537
58.708	0.023	-4.560	1.000	0.000	0.000	-4.537
60.000	0.023	-4.560	1.000	0.000	0.000	-4.537


Vertical Displacement vs. Distance From Wall - Section B-B Southwest Wall
Settlement Due To Wall Installation
Settlement Due To Groundwater Drawdown
Settlement Due To Excavation, from PLAXIS 2D
Total Settlement
Vertical Displacement [mm]
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
Horizontal Distance From Wall [m]


Vertical Displacement vs. Distance From Wall - **Section B-B Northeast Wall**
Settlement Due To Wall Installation
Settlement Due To Groundwater Drawdown
Settlement Due To Excavation, from PLAXIS 2D
Total Settlement
Vertical Displacement [mm]
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
Horizontal Distance From Wall [m]

☐Urgent ☐Return receipt ☐Expand Group ☐Restricted ☐Prevent Copy

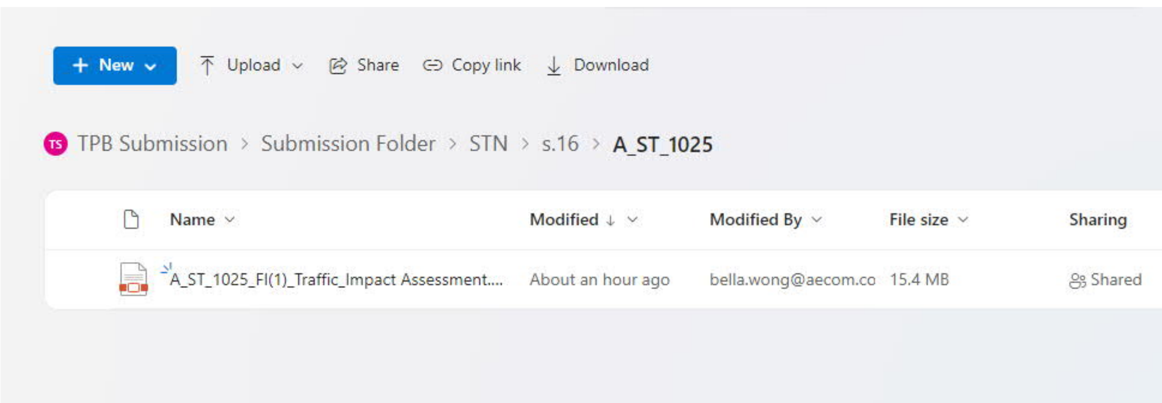
寄件者: Wong, Yuen Mei Bella <Bella.Wong@aecom.com>
寄件日期: 2024年01月05日星期五 11:29
收件者: TPB Submission/PLAND
副本: Elizabeth NG/PLAND; Kenneth Hong Kiu LEE/PLAND
主旨: RE: Submission of Further Information (Soft Copy) for s.16 Planning application No. A/ST/1025
附件: Submit_Hardcopies on 5 Jan 2024 cover.pdf; Withdrawl_Hardcopies on 4 Jan 2024 cover.pdf

類別: Internet Email

Dear Sir/Madam

s.16 Planning Application No. A/ST/1025 – Submission of Further Information

1. Please be informed 4 hardcopies, "Further Information-A_ST_1025_FI(1)_Traffic_Impact Assessment" , had been delivered to the Secretariat of the Board at 15/F, North Point Government Offices, 333 Java Road on 5 January 2024 morning.



2. Please note that I would like to withdraw 4 very thick hardcopies, "Further Information", which were delivered to the Secretariat of the Board at 15/F, North Point Government Offices, 333 Java Road on 4 January 2024 afternoon.

3. To avoid confusion, the cover page of that concerned hardcopies are attached for your reference.

Regards
Bella Wong
Senior Engineer, Water

From: Wong, Yuen Mei Bella
Sent: Thursday, January 4, 2024 6:11 PM
To: 'tpbsubmission@pland.gov.hk' <tpbsubmission@pland.gov.hk>
Cc: Elizabeth NG/PLAND <eng@pland.gov.hk>; 'Kenneth Hong Kiu LEE/PLAND' <khklee@pland.gov.hk>
Subject: RE: Submission of Further Information (Soft Copy) for s.16 Planning application No. A/ST/1025

Appendix I – Traffic Impact Assessment Report

渠務署
Drainage Services Department

Agreement No. CE 44/2021(DS)

Drainage Improvement Works in Sha Tin and Sai Kung – Design & Construction

Updated TIA Report for

Sha Tin Town Centre Stormwater Storage and Pumping Facility

AECOM Delivering a better world

TABLE OF CONTENTS

TABLES

DRAWINGS

APPENDICES

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1 Introduction

1.1 Background

1.1.1 The Review of Drainage Master Plan in Sha Tin and Sai Kung – Feasibility Study (the Study) identified that the following areas in Sha Tin would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics: -

(a) Sha Tin Town Centre;

(b) Chui Tin Street (near Sun Chui Estate) and San Tin Village;

(c) Tai Po Road – Ma Liu Shui, Ma Ling Path, Kau To Hang near Yucca Villa, Hang Hong Street, Pok Hong Estate, Fui Yiu Ha, Wong Chuk Yeung Village and Lai Wo Lane; and

(d) Cycle track alongside Shing Mun River.

1.1.2 The flooding incidents reported in Wong Chuk Yeung Village on 22 July 2010 and Sha Tin Centre Street on 15 August 2015 are examples to substantiate the above findings.

1.1.3 The Study also identified that the areas in Sai Kung including Wong Chuk Wan, Ho Chung, Kap Pin Long New Village and Nam Shan San Tsuen would be subject to high flood risk having taken into account the dilapidated drainage networks and updated hydrological statistics. The flooding incidents at Po Lo Che Road and Nam Shan San Tsuen on 30 May 2010 and Wong Chuk Wan on 7 October 2015 are some examples to substantiate the above findings.

1.1.4 To relieve the flood risk in the above areas, the Study has proposed implementing drainage improvement measures, mainly in form of stormwater pumping scheme and drainage upgrading works. Upon completion of the Project, the standards of flood protection at areas concerned will be largely enhanced to that specified in the standards of the Stormwater Drainage Manual (SDM) and the flood risks thereon can be significantly reduced.

1.1.5 New flood walls will also be provided along various sections of Shing Mun River to protect the cycle track against flooding due to the astronomical high tide.

1.1.6 Without the proposed project, about 26 hectares of the areas in Sha Tin and 6 hectares of areas in Sai Kung will be subject to high flood risk. Flooding impacts on traffic and residential area in the flood prone areas will also result in losses and inconvenience to the general public.

1.1.7 In May 2018, Development Bureau (DEVB) signed out a Project Definition Statement (PDS) to justify and define the scope of the "Drainage Improvement Works in Sha Tin and Sai Kung". The Drainage Services Department (DSD) then completed a Technical Feasibility Statement (TFS) confirming its technical feasibility. The TFS was subsequently approved by DEVB in August 2018. The project was included into Cat B under PWP Item No. 4182CD in September 2018.

1.2 Description of the Assignment

1.2.1 AECOM Asia Company Limited (AECOM) has been appointed by DSD to undertake the "Drainage Improvement Works in Sha Tin and Sai Kung – Investigation" ("the Study") on 11 October 2019.

1.2.2 The Study comprises the drainage improvement works in locations as illustrated on the Key Plan of **Figure Nos. 1.1.1 – 1.1.3** and are described in the following: -

1.2.3 Stormwater pumping scheme at Sha Tin Town Centre, including an underground storage tank, a pump house and associated pipeworks and electrical and mechanical (E&M) works, as well as drainage upgrading works around Sha Tin Town Centre such as Pak Hok Tin Street, Sha Tin Centre Street, Man Lai Road and ancillary works including reinstatement of playgrounds and associated facilities;

1.2.4 Stormwater pumping scheme at Chui Tin Street Soccer Pitch including an underground storage tank and associated pumps, pipeworks and E&M works, as well as drainage upgrading works around Sun Tin Village, Kak Tin Street, Chui Tin Street and Che Kung Miu Road and ancillary works including reinstatement of soccer pitch and associated facilities;

1.2.5 Drainage upgrading works at Fui Yiu Ha, Ma Ling Path, Kau To Hang, Hang Hong Street, Tai Po Road – Ma Liu Shui, Pok Hong Estate, Wong Chuk Yeung Village and Lai Wo Lane, Po Lo Che Road, Ho Chung and Wong Chuk Wan; and

1.2.6 Flood walls along Shing Mun River to protect the cycle track against flooding due to astronomical high tide.

1.3 Drainage Improvement Work Summary

Stormwater Storage Scheme at Sha Tin Town Centre (STN1) - Figure Nos. 1.9.1 –1.9.2

1.3.1 First part of the recommended drainage improvement works at Sha Tin Town Centre is to provide a new 2,100mm diameter pipe from the footpath between the rail line and Tai Po Road – Sha Tin opposite to Hilton Plaza and continue along the footpath between Hilton Plaza and Scenery Court. The proposed pipe will follow the footpath along Sha Tin Centre Street and connect to the proposed pumping station.

1.3.2 Second part is to upgrade the existing 1,500mm diameter stormwater pipe in Tai Po Road – Sha Tin near Citylink Plaza to 1,650mm diameter, upgrade the existing 450mm diameter stormwater pipe outside Red Cross Sha Tin Centre to 600mm diameter and a new 750mm diameter stormwater pipe outside Wai Wah Centre.

1.3.3 The last part of this scheme is to provide a new stormwater pumping station at the downstream of the existing drainage network in Sha Tin Park. Since the potential flood risk around Sha Tin Town Centre is caused by the backflow from Shing Mun River into the relatively low-lying areas.

1.3.4 The proposed pumping station includes an underground tank, an above-ground pump house, new pipes ranged from 600mm to 2,200mm in diameter at Yi Ching Lane. The pumping station consists of a pump with the maximum pump rate of $4m^3/s$ and an underground tank with the wet volume of $6,000m^3$. The runoff will be discharged into the pumping station via the new drainage network and then discharged into Shing Mun River by pump. The excessive water will be stored in the underground tank.

1.4 TIA Objectives

The objectives of this Traffic Impact Assessment (TIA) under the Project detailed in Clause 3.13 of the Project Scope by carrying out traffic impact assessment of the proposed works with details of the assessment results, identify the potential impacts and recommend mitigation and improvement measures, with due and proper regard to the following: -

(a) To identify and describe the elements of the community and the existing traffic characteristics likely to be affected by the Project, and/or likely to cause adverse impacts upon the Project, including both the existing and proposed road network during the construction and the management/maintenance stages;

(b) To introduce a structured and systematic approach to identify, assess and mitigate potential adverse traffic impacts which might arise from the Project during the construction and subsequent management/maintenance stages;

(c) arrangement schemes during construction to accommodate existing traffic flow at the time of construction and subsequent management/maintenance of the proposed works of the Project so that any adverse traffic impacts can be kept minimum and mitigated to acceptable level;

(d) To assess the transport impact and impact on pedestrian/cycle traffic and to provide relevant/updated traffic (vehicular/pedestrian/cycle) counts in the TIA;

(e) To identify, assess and specify methods, measures and standards to be included in the detailed design and construction of the Project which are necessary to mitigate these impacts and reduce them to acceptable levels;

(f) To demonstrate that with all mitigation measures introduced, the Project will have no detrimental traffic impacts within the project site and to the areas adjacent to the Project;

(g) To assess the long-term traffic impact on the road network arising from the project during operation and maintenance stage, and propose associated mitigation measures; and

(h) To enable an agreement in principle to be reached among relevant Government departments on the “area traffic management measures” and “traffic diversion schedules” during construction and subsequent management/maintenance stages of the Project. The final TIA Report will then serve as guidelines for making detailed proposals by the Employer’s Agent and contractors in the construction and subsequent management/maintenance stages.

2 Existing Traffic conditionExisting Road Network

Stormwater Storage Scheme at Sha Tin Town Centre (STN1)

2.1.1 There are 2 nos. concerned sections to Sha Tin Centre Street. Nearer to its Junction with Lion Rock Tunnel Road and Tai Po Road – Tai Wai, it is a dual carriageway with 2 nos. lanes running eastbound and 4 nos. lanes running westbound into the mentioned junction. At the section between Hilton Plaza and New Town Plaza Phase 3, it is a northbound one-way 3-lane single carriageway serving local accesses. It is also a key public transport routing for Sha Tin with large demands to loading/ unloading and pick-up/ set-down along the kerb side.

2.1.2 Pak Hok Ting Street is a southbound one-way 3-lane single carriageway that connects with Sha Tin Centre Street to its north and south to form a circular route around New Town Plaza Phase 3. It provides connections to service road for Royal Park Hotel and Yi Ching Lane.

2.1.3 Yi Ching Lane is a short single 2-lane carriageway that provides access to/from Royal Park Hotel Carpark and Sha Tin Magistrates' Courts. There are 23 nos. of motorcycle parking spaces at Yi Ching Lane and the utilization rate 80%-100% during 10:00-22:00.

2.1.4 The concerned section of Tai Po Road – Sha Tin is a dual 3-lane primary distributor connecting Tolo Highway to Shing Mun Tunnel Road and Tsing Sha Highway. According to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021) by the Highways Department (HyD), Tai Po Road – Sha Tin falls within the list of Traffic Sensitive Routes (as of 17.7.2020) where a Day-time Ban on temporary traffic management (TTM) shall apply.

2.2 Traffic Surveys

2.2.1 In order to assess the traffic impact induced by the drainage improvement works to the local roads, footpath and cycle track network, traffic surveys were conducted at various times according to the weekdays and weekends of December 2020.

2.2.2 Subsequently, owing to the outbreak of COVID-19 which may have caused some earlier survey results to be unrepresentative, such as the results near schools when the schools were not opened during the earlier survey period, supplementary surveys have been conducted in December 2021 to capture the traffic condition as it returns to normal.

2.2.3 Table 2-2summarises the type of surveys conducted and their associated survey hours.

Table 2-2 Summary of Conducted Traffic Surveys

Survey Type	Survey Period (Survey Time)
Manual Classified Traffic Count Survey	AM/ PM Peaks (07:30 - 09:30, 17:00 – 19:00) School Peaks (07:30 - 09:30, 12:30 – 16:30) Public Holiday Peak (10:00 – 22:00) 24-Hour
Traffic Queue Survey	AM/ PM Peaks (07:30 - 09:30, 17:00 – 19:00)
Bus Stop/ Roadside Lay-by Utilisation Survey	AM/ PM Peaks (07:30 - 09:30, 17:00 – 19:00)
Parking Inventory Survey	Daytime (10:00 – 22:00)
Pedestrian Count Survey	AM/ PM Peaks (07:30 - 09:30, 17:00 – 19:00) School Peaks (07:30 - 09:30, 12:30 – 16:30) Public Holiday Peak (10:00 – 22:00)
Cycle Count Survey	AM/ PM Peaks (07:30 - 09:30, 17:00 – 19:00) Public Holiday Peak (10:00 – 22:00)

Note:
School hours are limited to half day classes due to the impact of COVID-19. Therefore, the survey hours of the PM school Peak have been adjusted.

2.3 Traffic Survey Validation

2.3.1 The earlier traffic surveys had taken place during a period of the fourth wave of the COVID-19 coronavirus outbreak that covered the entire year of 2020 may cause alterations to typical traffic and pedestrian travel patterns, as schools have been closed to prevent the spreading of the coronavirus. In recognition of the that, supplementary surveys were carried out to locations that were most hit by the pandemic.

2.3.2 The collected traffic survey data was compared against the traffic flow in other relevant reference TIA reports obtained from the public domain for which traffic surveys were conducted at similar periods to those carried out for this project.

2.3.3 The results of the comparison of traffic flow revealed that those for the captioned report is similar in pattern and the collected data would be more conversative than the reference reports. Therefore, it is deemed that the collected traffic survey data would be representative of the critical scenario of traffic for the study period.

2.4 Assessment Peak Hour

2.4.1 For the traffic impact assessment, study peak hours for the AM Peak, PM Peak and the Public Holiday Peak were derived based on the traffic survey results. A summary of the derived peak hour is summarised in **Table 2-3**.

Table 2-3 Selected Peak Hour for Assessment

Peak Hour	Survey Type		
	Traffic	Pedestrian	Cycle
AM Peak	8:00 – 9:00		
PM Peak	18:00 – 19:00		
Public Holiday Peak	12:30 – 13:30	Maximum Hourly Flow	
AM School Peak	07:30 – 08:30	07:30 – 08:30	-
PM School Peak	12:45 – 13:45	12:45 – 13:45	-
Night-Time (1)	Maximum Hourly Flow	-	-

Note:
(1) Applies to Tai Po Road – Sha Tin traffic due to the road being under a Day-Time Ban for road works as stated in the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021). Works can only be carried out between the hours of 1900 – 0700 the following day.

2.5 2020 Base Year Traffic Assessment

2.5.1 The assessed junctions are indicated in **Figure Nos. 2.3**. The existing traffic flows during AM and PM Peaks are presented in **Figure Nos. 2.1.5**.

2.5.2 Based on these traffic flows, road link and junction capacity assessments were carried out to determine the existing traffic conditions in the study area. The junction and link performance results are summarised in **Table 2-4** and **Table 2-5** respectively.

2.5.3 The calculations for the 2020 base year traffic assessments are attached in **Appendix A**.

Table 2-4 2020 Base Year Junction Performance Summary

Works ID (District)	Junction ID	Location	Junction Type (1)	2020 Base Year		
				RC (2) (in %) / DFC (3)		
				AM Peak	PM Peak	School Peak / PH Peak
STN1 (Sha Tin)	J22	Southern Junction of Pak Hok Ting Street / Sha Tin Centre Street	P	0.12	0.14	-
STN1 (Sha Tin)	J23	Junction of Yi Ching Lane / Access Road near Royal Park Hotel	P	0.12	0.20	-
STN1 (Sha Tin)	J24	Northern Junction of Pak Hok Ting Street / Sha Tin Centre Street	S	>100%	>100%	-

Notes:
(1) S – Signalised Junction, R – Roundabout, P – Priority Junction
(2) A positive RC indicates that the junction is operating with spare capacity. A negative RC indicates that the junction is overloaded, resulting in traffic queues and long delay time.
(3) A DFC ratio less than 1.0 indicates that the junction is operating within design capacity. A DFC ratio greater than 1.0 indicates that the junction is overloaded, resulting in traffic queues and longer delay time to the minor arm traffic.

2.5.4 Results in **Table 2-4** indicated that all assessed junctions for the works at Sha Tin Town Centre (STN1) are operating within their design capacities.

Table 2-5 2020 Base Year Road Link Performance Summary

Works ID (District)	Link ID	Location	Direction	Capacity (pcu/hr) (1) (2)	2020 Base Year					
					AM Peak		PM Peak		Night Time(5) (2300-0000)	
					Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)
STN1 (Sha Tin)	L4	Car Park Access of Hilton Plaza	Out	500	20	0.04	20	0.04	-	-
STN1 (Sha Tin)	L5	Tai Po Road - Sha Tin near Wai Wah Centre	EB	6100	6290	1.03	5830	0.96	-	-
			WB	6100	4810	0.79	5410	0.89	2830	0.46
STN1 (Sha Tin)	L26	Sha Tin Centre Street (Between Lion Rock Tunnel Road and Pak Hok Ting Street)	EB	2025	710	0.35	530	0.26	-	-
			WB	3325	800	0.24	800	0.24	-	-
STN1 (Sha Tin)	L27	Yi Ching Lane	EB	580	50	0.09	40	0.07	-	-
			WB	580	20	0.03	40	0.07	-	-
STN1 (Sha Tin)	L28	Royal Plaza Hotel Access Road	SB	580	100	0.17	120	0.21	-	-
STN1 (Sha Tin)	L29	Sha Tin Centre Street (near Wai Wah Centre)	NB	900(4)	770	0.86	600	0.67	-	-
STN1 (Sha Tin)	L30	Pak Hok Ting Street (near Wai Wah Centre)	SB	2875	790	0.27	750	0.26	-	-

Note:
(1) Capacity of road links (except single-track access road) make reference to the “Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement”.
(2) Capacity of single-track access roads is assumed to be 100 pcu/hr for 2-way traffic.
(3) A V/C ratio less than 0.85 indicates that the road link is operating within design capacity. A V/C ratio greater than 1.0 indicates that the road link is overloaded.
(4) Capacity of Sha Tin Centre Street (near Wai Wah Centre) make reference to the “Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement”, single 1-lane carriageway, width > 4m, frontage 3: capacity limited by waiting vehicle and junctions as the slow and fast lanes were occupied by frequent roadside activities.
(5) The traffic count was conducted in July 2023 by others.

2.5.5 Results in **Table 2-5** indicated that all assessed road links are operating within their design capacities. The existing road link flows during AM, PM and Public Holiday Peaks are presented in **Figure Nos. 2.5.10 – 2.5.11**.

2.6 Study Pedestrian Footpath Network

2.6.1 The pedestrian footpath assessment framework is based on the level of service (LOS) documented in the Highway Capacity Manual 2000 (HCM) and the conditions for different LOS for footpath and stairways are summarised in **Table 2-6** and **Table 2-7**. The existing pedestrian flows during AM, PM and School/Public Holiday Peaks are presented in **Figure Nos. 2.6.16.**

Table 2-6 Pedestrian Assessment Framework for Footpath

Level of Service (LOS)	Pedestrian Space (m^2/ped)	Flow Rate(ped/min/m)	Average Speed (m/s)	Description
A	>5.6	≤16	> 1.30	Pedestrians move in desired paths without altering their movements in response to other pedestrians Walking speeds are freely selected and conflicts between pedestrians are unlikely.
B	>3.7-5.6	>16-23	> 1.27 – 1.30	There is sufficient area for pedestrians to select walking speeds freely, to bypass other pedestrians and to avoid crossing conflicts. At this level, pedestrians begin to aware of other pedestrians and to respond to their presence when selecting a walking path.
C	>2.2-3.7	>23-33	> 1.22 – 1.27	Space is sufficient for normal walking speeds and for bypassing other pedestrians in primarily unidirectional streams. Reverse-direction or crossing movements can cause minor conflicts, and speeds and flow rate are somewhat lower.
D	>1.4-2.2	>33-49	> 1.14 – 1.22	Freedom to select individual walking speed and to bypass other pedestrians is restricted. Crossing or reverse-flow movements face a high probability of conflicts, requiring reasonably fluid flow, but friction and interaction between pedestrians is likely.
E	>0.75-1.4	>49-75	> 0.75 – 1.14	Virtually all pedestrians restrict their normal walking speed frequently adjusting their gait. At the lower range, forward movement is possible only by shuffling. Space is not sufficient for passing slower pedestrians. Crossing- or reverse-flow movements are possible only with extreme difficulties. Design volumes approach the limit of walkway capacity, with stoppages and interruptions to flow.
F	≤0.75	Varies	≤ 0.75	All walking speeds are severely restricted, and forward progress is made only by shuffling. There is frequent, unavoidable contact with other pedestrians. Crossing- and reverse-flow movements are virtually impossible. Flow is sporadic and unstable. Space is more characteristic of queued pedestrians than of moving pedestrian streams.

Table 2-7 Pedestrian Assessment Framework for Stairway

Level of Service (LOS)	Pedestrian Space (m^2/ped)	Flow Rate (ped/min/m)	Average Horizon Speed (m/s)	V/C Ratio
A	>1.9	≤16	> 0.53	≤ 0.33
B	>1.6-1.9	>16-20	> 0.53	> 0.33-0.41
C	>1.1-1.6	>20-26	> 0.48-0.53	> 0.41-0.53
D	>0.7-1.1	>26-36	> 0.42-0.48	> 0.53-0.73
E	>0.5-0.7	>36-49	> 0.40-0.42	> 0.73-1.00
F	≤0.5	Varies	≤ 0.40	Varies

2.6.2 Pedestrian capacity assessments were carried out based on the Level of Service (LOS) categories as mentioned in **Table 2-6** and the results for the existing conditions are summarised in **Table 2-8**.

Table 2-8 Study Pedestrian Footpath Performance Assessment

Link ID (District)	Footpath ID	Link No.	Location Description (Stairway = S)	Actual Width (m)	Effective Width (m) (2)	Without TTMS								
						Pedestrian 15-minute Flow Rate (ped/15-min)			Two-Way Pedestrian Flow (ped/min/m)			Level of Service (LOS)		
						AM Peak	PM Peak	School Peak (4) / Public Holiday Peak	AM Peak	PM Peak	School Peak (4) / Public Holiday Peak	AM Peak	PM Peak	School Peak (4) / Public Holiday Peak
STN1 (Sha Tin)	P15	1	Footpath at Hilton Plaza Car Park Vehicular Exit	5.1	4.1	38	65	-	0.61	1.05	-	A	A	-
STN1 (Sha Tin)	P16	1	Sha Tin Park Access (Yi Ching Lane)	6.8	5.8	44	20	-	0.51	0.23	-	A	A	-
		2	Southern Footpath of Yi Ching Lane (near Sha Tin Park)	3.8	2.8	8	2	-	0.2	0.05	-	A	A	-
		3	Southern Footpath of Pak Hok Ting Street (near Sha Tin Park)	3.6	2.6	7	3	-	0.19	0.08	-	A	A	-

Notes:
(1) Footpath link consists of 2 nos. of footpaths
(2) 0.5m dead width on both sides to be deducted
(3) 0.5m dead width only on one side to be deducted due to site terrain and existing traffic management facilities
(4) The AM school peak is regarded more critical in comparison to the PM school peak as the pedestrian flow would be more concentrated. Therefore, assessment for School Peak refers to the AM school peak
(5) As pedestrian footpaths along village paths are less well defined, footpath of min. 1.5m in width is assumed for assessment purposes

2.6.3 With reference to TPDM Volume 6 Chapter 10.4, Level of Service (LOS) C would be a desirable level of service for footpath width assessments, the assessed footpath links in the study area as shown in **Table 2-8** are operating satisfactorily.

3 Temporary Traffic Management Schemes (TTMS)

3.1 Overview

3.1.1 The proposed TTMS have been developed based on the proposed drainage alignment under investigation. The Contractor should further develop detailed TTMS design based on the actual construction method to suit the works. The design of the TTMS shall comply with the latest issues of "Code of Practice for Lightings, Signing and Guarding of Road Works" and "Guidelines on Traffic Impact Assessment & Day-Time Ban Requirements for Road Works on Traffic Sensitive Routes" from the Highways Department, the latest issue of "Transport Planning and Design Manual" from Transport Department, and any further advices from relevant government authorities.

3.1.2 Also, the detailed implementation of TTMS at construction stage should be in compliance with the latest issue of "Code of Practice for Lightings, Signing and Guarding of Road Works" and "Guidelines on Traffic Impact Assessment & Day-Time Ban Requirements for Road Works on Traffic Sensitive Routes" from Highways Department, the latest issue of "Transport Planning and Design Manual" from Transport Department, and comments from Traffic Management Liaison Group (TMLG) meetings.

3.1.3 Sightlines shall be maintained during TTMS implementation.

3.1.4 The affected road surfaces, footpaths and cycle tracks shall be temporarily decked outside of the working period to resume the original traffic, pedestrian and cycle movements. Nonetheless, as trenchless method will be adopted for part of the works, to facilitate placing of jacking and receiving pits for undertaking the trenchless method, some TTMS shall be of full-time basis.

3.1.5 The details of each of the proposed TTMS provided in the following sub-sections of **Chapter 3.2** of this report.

3.2 Proposed TTMS Detailed Description

Stormwater Storage Scheme at Sha Tin Town Centre (STN1) (Refer to Figure Nos. 3.8.1 to 3.8.4)

<u>Sha Tin Centre Street / Pak Hok Ting Street (Southern Section)</u>

3.2.1 The proposed TTMS consists of a trenchless section running across Sha Tin Centre Street from the footpath near the cycle parking area adjacent to Hilton Plaza EVA, it then connects to another trenchless section runs along the southern footpath of Sha Tin Centre Street towards the proposed pumping station near Yi Ching Lane.

3.2.2 A minimum 1.5m pedestrian footpath will be maintained adjacent the works area at Sha Tin Centre Street. At other locations where the location of the works area would potentially lead to insufficient pedestrian footpath width of 1.5m, temporary decking will be provided to maintain pedestrian movements.

3.2.3 The cycle parking nearest to the Hilton Plaza EVA to be temporarily relocated to facilitate the works.

Yi Ching Lane

3.2.4 The proposed TTMS for the drainage improvement works include sections of the southern footpath of Yi Ching Lane along the proposed pumping station, section of the single 2-lane carriageway adjacent to the Royal Plaza Hotel and the section of carriageway connecting to Pak Hok Ting street outside the Sha Tin Park pedestrian access. The road marking, traffic sign, street furniture layout plan and swept path for the permanent run-in of the pumping station is provided in **Figure 3.8.4**.

3.2.5 For the works over the footpath, a minimum 1.5m wide footpath is to be maintained to maintain pedestrian movements. The motorcycle parking to the south of Yi Ching Lane required to be temporarily relocated to facilitate the works. For the works at the single 2-lane carriageway, it is proposed to setback the road kerb to allow the passing of traffic.

Sha Tin Park and Shing Mun River Promenade

3.2.6 The proposed TTMS runs across the footpaths within the park and directed out to the Shing Mun River crossing the promenade. A minimum 1.5m wide footpath shall be maintained throughout the park, while along the promenade, a minimum 1.8m wide of temporary cycle track and a minimum 1.5m wide temporary pedestrian footpath for pedestrian and cycle thoroughfare.

Sha Tin Centre Street / Pak Hok Ting Street (Northern Section)

3.2.7 The proposed TTMS runs from a point at the middle lane of the carriageway of Sha Tin Centre Street, cutting onto the eastern footpath and runs along the footpath. It then cuts onto the middle lane of the carriageway of Pak Hok Ting Street.

3.2.8 In order to minimise disruption by the works to local traffic, 2 nos. of existing traffic lanes shall be maintained during the works on the carriageways of Sha Tin Centre Street and Pak Hok Ting Street. The loading/ unloading bay at Sha Tin Centre Street along the works area would not be affected by the construction works. Works shall be carried out in stages on a lane-by-lane basis where necessary. The length of works area for each stage is about 15m.

3.2.9 According to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021), Sha Tin Centre Street is under a Day-Time Ban for road works. The working time period of the works shall be between the hours of 2100 – 0700 of the following day.

3.2.10 For the TTMS along the footpath adjacent to New Town Plaza Phase 3, temporary decking is proposed to be provided to maintain a minimum 1.5m pedestrian footpath. For the TTMS section adjacent to the private park, the footpath is proposed to be temporarily suspended. Pedestrian shall be temporarily diverted to use the footpath just north of New Town Plaza Phase 3.

Tai Po Road - Sha Tin

3.2.11 The proposed TTMS is located on the offside traffic lane along the westbound carriageway near Wai Wah Centre.

3.2.12 2 nos. of existing traffic lanes shall be maintained during construction works.

3.2.13 According to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021), Tai Po Road – Sha Tin is under a Day-Time Ban for road works. Based on the traffic assessment at night-time period, the working time period of the works will be between the hours of 2100 – 0700 of the following day.

3.3 Construction Traffic Volume

3.3.1 Construction traffic have been estimated with reference to the number of trips from similar projects. The quantification of construction traffic is shown in **Table 3-1**.

Table 3-1 Estimated Construction Traffic Generation and Attraction

Traffic Direction	Number of goods vehicles (vehicles per day)	Maximum number of goods vehicles (vehicles per hour)	pcu factor	Maximum number of goods vehicles (pcu per hour)
Alignment installation (site STN1)				
Generation	8	2	2.5	5
Attraction	8	2	2.5	5
Pumping Station (site STN1)				
Generation	15	3	2.5	8
Attraction	15	3	2.5	8
Alignment installation and Pumping Station (site STN1)				
Total Generation				**13**
Total Attraction				**13**

3.4 Construction Traffic Routing

3.4.1 Based on experience from other similar projects, construction materials would be stored at depot locating at rural areas in New Territories. Excavation soils would be delivered to landfill in Tseung Kwan O.

3.4.2 Therefore, construction traffic routing assumptions of the following were adopted: -

- Materials Inbound: To / From North District direction;
- Materials Outbound: To / From Tseung Kwan O direction.

3.4.3 The construction traffic for the drainage works involved for drainage alignment installations and pumping station installations are distributed across the road network of Sha Tin and Sai Kung. Therefore, for the assessment, construction traffic will be distributed according to the construction site locations and the directions of which the construction vehicles are destined based on the type of materials to be transported.

3.4.4 The proposed construction vehicle routings for the works locations are illustrated in **Figure Nos. 3.20.**

3.4.5 The assessment results in the future years are shown in **Section 5** of this report.

4 Traffic Forecast

4.1 Forecast Year

4.1.1 The proposed drainage improvement works are divided into 2 phases. **Table 4-1** summaries the construction works associated with each phase and their tentative works period.

Table 4-1 Tentative Works Programme Summary

Phase	Involved Works	Works ID	Tentative Works Period
1	- Stormwater Storage Scheme at Sha Tin Town Centre - Shing Mun River Floodwall - Po Lo Che Road - Wong Chuk Wan - Ma Ling Path - Kau To Hang - Lai Wo Lane - Wong Chuk Yeung	STN1, SKTC2, SKTC5, STS5, STN5, STN7, STN9, STN10	05/2025 – 12/2028
2	- Stormwater Pumping Scheme at Chui Tin Street Soccer Pitch - Chui Tin Street - Hang Hong Street and Hang Kwong Street - Fui Yiu Ha - Pok Hong Estate - Tai Po Road (Ma Liu Shui)	TW3, MOS1, STS1 & STS2, STN12	12/2025 – 07/2031

4.1.2 Based on **Table 4-1**, the drainage improvement work phases will be completed separately. Considering the background traffic would be at its highest at the furthest year of the two phases. Therefore, the year 2028 has been taken as the design year of the construction traffic impact assessment for Phase 1.

4.1.3 The implementation programme may vary the design year of the construction traffic impact assessment and may be updated subject to further discussion with DSD and would be in line with Report on Implementation Strategy, Form of Procurement and Contract Strategy of this Project.

4.1.4 Owing to the Coronavirus outbreak, the surveyed traffic flows are considered not conservative enough for building up traffic model for this assessment. Therefore, the 2019-based Territorial Population and Employment Data Matrix (TPEDM) issued by the Planning Department (PlanD) have been reviewed and is adopted as input planning data to establish the rate of growth for future year traffic model for the design years. A summary of the population and employment distribution for Sha Tin are shown in **Table 4-2**.

Table 4-2 2019-based Territorial Population and Employment Data Matrix (TPEDM)

Area	Population			Growth p.a. (%)		Employment			Growth p.a. (%)	
	2019	2026	2031	2019 to 2026	2026 to 2031	2019	2026	2031	2019 to 2026	2026 to 2031
Sha Tin	483,000	493,750	461,000	0.3%	-1.4%	200,050	186,250	179,400	-1.02%	-0.8%

4.1.5 Based on the growth rates shown in **Tables 4-2**, in a conservative approach, the future traffic on road sections in Sha Tin by applying of the growth rate per annum of 1.0% based on the observed traffic flows.

5 Traffic Impact Assessment

5.1 Traffic Assessments

5.1.1 The forecasted traffic flows for the study year of 2028 during AM and PM Peaks are presented in **Figure Nos. 5.1.5 and 5.1.25**.

5.1.2 The forecasted road link flows for the study year of 2028 during AM and PM Peaks are presented in **Figure Nos. 5.1.16 – 5.1.17 and 5.1.31 – 5.1.32.**

5.1.3 Appropriate TTMS have been derived as mentioned in **Section 3.2** and the traffic assessments for junctions and road links in association with the derived TTMS were conducted. A summary of the assessment results can be found in **Table 5-1 – Table 5-4**, with the Reference Scenarios indicating "Without TTMS" and Design Scenarios indicating "With TTMS". The detailed calculations are attached in **Appendix A**.

Table 5-1 2028 Reference Year Junction Performance Summary (Without TTMS)

Works ID (District)	Junction ID	Location	Junction Type (1)	2028 Reference Year (Without TTMS)		
				RC (2) (in %) / DFC (3)		
				AM Peak	PM Peak	Public Holiday Peak
STN1 (Sha Tin)	J22	Southern Junction of Pak Hok Ting Street / Sha Tin Centre Street	P	0.14	0.15	-
STN1 (Sha Tin)	J23	Junction of Yi Ching Lane / Access Road near Royal Park Hotel	P	0.13	0.22	-
STN1 (Sha Tin)	J24	Northern Junction of Pak Hok Ting Street / Sha Tin Centre Street	S	>100%	>100%	-

Notes:
(1) S – Signalised Junction, R – Roundabout, P – Priority Junction
(2) A positive RC indicates that the junction is operating with spare capacity. A negative RC indicates that the junction is overloaded, resulting in traffic queues and long delay time.
(3) A DFC ratio less than 1.0 indicates that the junction is operating within design capacity. A DFC ratio greater than 1.0 indicates that the junction is overloaded, resulting in traffic queues and longer delay time to the minor arm traffic.

Table 5-2 2028 Reference Year Road Link Performance Summary (Without TTMS)

Works ID (District)	Link ID	Location	Direction	Capacity (pcu/hr) (1) (2)	2028 Reference Year (Without TTMS)					
					AM Peak		PM Peak		Night Time (2300-0000)	
					Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)
STN1 (Sha Tin)	L4	Car Park Access of Hilton Plaza	Out	500	22	0.04	22	0.04	-	-
STN1 (Sha Tin)	L5	Tai Po Road - Sha Tin near Wai Wah Centre	EB	6100	6811	1.12	6313	1.03	-	-
			WB	6100	5209	0.85	5858	0.96	2970	0.49
STN1 (Sha Tin)	L26	Sha Tin Centre Street (Between Lion Rock Tunnel Road and Pak Hok Ting Street)	EB	2025	769	0.38	574	0.28	-	-
			WB	3325	866	0.26	866	0.26	-	-
STN1 (Sha Tin)	L27	Yi Ching Lane	EB	580	54	0.09	43	0.07	-	-
			WB	580	22	0.04	43	0.07	-	-
STN1 (Sha Tin)	L28	Royal Plaza Hotel Access Road	SB	580	108	0.19	130	0.22	-	-
STN1 (Sha Tin)	L29	Sha Tin Centre Street (near Wai Wah Centre)	NB	900(4)	834	0.93	650	0.72	202(5)	0.22
STN1 (Sha Tin)	L30	Pak Hok Ting Street (near Wai Wah Centre)	SB	2875	855	0.30	812	0.28	-	-

Note:
(1) Capacity of road links (except single-track access road) make reference to the "Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement".
(2) Capacity of single track access roads is assumed to be 100 pcu/hr for 2-way traffic.
(3) A V/C ratio less than 0.85 indicates that the road link is operating within design capacity. A V/C ratio greater than 1.0 indicates that the road link is overloaded.
(4) Capacity of Sha Tin Centre Street (near Wai Wah Centre) make reference to the "Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement", single 1-lane carriageway, width > 4m, frontage 3: capacity limited by waiting vehicle and junctions as the slow and fast lanes were occupied by frequent roadside activities.
(5) Night time (2200-2300) traffic flow at Sha Tin Centre Street (near Wai Wah Centre) is estimated by making reference to the hourly variation of the traffic flow at Tai Po Road – Sha Tin Westbound.

Table 5-3 2028 Design Year Road Link Performance Summary (Without TTMS)

Works ID (District)	Junction ID	Location	Junction Type (1)	2028 Design Year (With TTMS) RC (2) (in %) / DFC (3)		
				AM Peak	PM Peak	Public Holiday Peak
STN1 (Sha Tin)	J22	Southern Junction of Pak Hok Ting Street / Sha Tin Centre Street	P	0.14	0.15	-
STN1 (Sha Tin)	J23	Junction of Yi Ching Lane / Access Road near Royal Park Hotel	P	0.13	0.24	-
STN1 (Sha Tin)	J24	Northern Junction of Pak Hok Ting Street / Sha Tin Centre Street	S	>100%	>100%	-

Notes:
(1) S – Signalised Junction, R – Roundabout, P – Priority Junction
(2) A positive RC indicates that the junction is operating with spare capacity. A negative RC indicates that the junction is overloaded, resulting in traffic queues and long delay time.
(3) A DFC ratio less than 1.0 indicates that the junction is operating within design capacity. A DFC ratio greater than 1.0 indicates that the junction is overloaded, resulting in traffic queues and longer delay time to the minor arm traffic.

Table 5-4 2028 Design Year Road Link Performance Summary (With TTMS)

Works ID (District)	Link ID	Location	Direction	Capacity (pcu/hr) (1) (2)	2028 Design Year (With TTMS)					
					AM Peak		PM Peak		Night Time (0000-0100)	
					Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)	Flow (pcu/hr)	V/C Ratio (3)
STN1 (Sha Tin)	L4	Car Park Access of Hilton Plaza	Out	500	22	0.04	22	0.04	-	-
STN1 (Sha Tin)	L5	Tai Po Road - Sha Tin near Wai Wah Centre	WB	4000	-	-	-	-	2983	0.75
STN1 (Sha Tin)	L26	Sha Tin Centre Street (Between Lion Rock Tunnel Road and Pak Hok Ting Street)	EB	2025	782	0.39	587	0.29	-	-
			WB	3325	879	0.26	879	0.26	-	-
STN1 (Sha Tin)	L27	Yi Ching Lane	EB	410	67	0.16	56	0.14	-	-
			WB	410	35	0.09	56	0.14	-	-
STN1 (Sha Tin)	L28	Royal Plaza Hotel Access Road	SB	580	121	0.21	143	0.25	-	-
STN1 (Sha Tin)	L29	Sha Tin Centre Street (near Wai Wah Centre)	NB	500(4)	-	-	-	-	215(5)	0.43
STN1 (Sha Tin)	L30	Pak Hok Ting Street (near Wai Wah Centre)	SB	1800	868	0.48	825	0.46	-	-

Note:
(1) Capacity of road links (except single-track access road) make reference to the "Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement".
(2) Capacity of single track access roads is assumed to be 100 pcu/hr for 2-way traffic
(3) A V/C ratio less than 0.85 indicates that the road link is operating within design capacity. A V/C ratio greater than 1.0 indicates that the road link is overloaded.
(4) Capacity of Sha Tin Centre Street (near Wai Wah Centre) make reference to "Agreement No. CE67/2009 (TT) Comprehensive Transport Study Model Enhancement - Feasibility Study – Technical Report on CTS Model Enhancement", single 1-lane carriageway, width <= 3.5m, frontage 3: capacity limited by waiting vehicle and junctions as the slow lane were occupied by frequent roadside activities.
(5) Night time (2200-2300) traffic flow at Sha Tin Centre Street (near Wai Wah Centre) is estimated by making reference to the hourly variation of the traffic flow at Tai Po Road – Sha Tin Westbound.

5.1.4 Results in **Tables 5-1 - 5-4** indicated that all of those assessed remain within their design capacity during the reference and design scenarios.

5.2 Pedestrian Assessments

5.2.1 The pedestrian footpaths in association with the derived TTMS were also conducted. A summary of the assessment results can be found in **Table 5-10**.

Table 5-10 Study Pedestrian Footpath Performance Assessment (With TTMS)

Works ID (District)	Footpath ID	Link No.	Location Description (Stairway = S, Crossing = C)	Actual Width (m)	Effective Width (m) (1)	With TTMS: Two-Way Pedestrian Flow (ped/min/m)			With TTMS: Level of Service (LOS)		
						AM Peak	PM Peak	School Peak / PH Peak	AM Peak	PM Peak	School Peak / PH Peak
STN1 (Sha Tin)	P15	1	Footpath at Hilton Plaza Car Park Vehicular Exit	1.5	0.5	5.03	8.63	-	A	A	-
STN1 (Sha Tin	P16	1	Sha Tin Park Access (Yi Ching Lane)	1.5	0.5	5.9	2.67	-	A	A	-
		2	Southern Footpath of Yi Ching Lane (near Sha Tin Park)	1.5	0.5	1.13	0.27	-	A	A	-
		3	Southern Footpath of Pak Hok Ting Street (near Sha Tin Park)	1.5	0.5	1	0.43	-	A	A	-

Notes:
(1) Footpath link consists of 2 nos. of footpaths
(2) 0.5m dead width on both sides to be deducted
(3) 0.5m dead width only on one side to be deducted due to site terrain and existing traffic management facilities
(4) The AM school peak is regarded more critical in comparison to the PM school peak as the pedestrian flow would be more concentrated. Therefore, assessment for School Peak refers to the AM school peak

5.2.2 Results in **Table 5-10** show that the study pedestrian footpaths are operating at a satisfactory level at time period that TTMS to be implemented.

6 Summary and Conclusions

6.1 Summary

6.1.1 AECOM has been appointed by DSD to undertake the "Drainage Improvement Works in Sha Tin and Sai Kung – Investigation" ("the Study") on 11 October 2019.

6.1.2 The drainage improvement works are proposed to be split into 2 phases completed separately. Considering the background traffic would be at its highest at the furthest year of the two phases. Therefore, the year 2028 has been taken as the design year of the construction traffic impact assessment for STN1.

6.1.3 **Table 6-1** summarises the proposed works period for the proposed TTMS.

Table 6-1 Proposed Works Period of TTMS (Phase 1)

Works ID	Works Location	Proposed Year	Proposed Works Days	Proposed Time Period
STN1	Stormwater Storage Scheme at Sha Tin Town Centre (except Tai Po Road – Sha Tin Westbound and Sha Tin Centre Street)	2028	All Days	24 Hour (1)
	Tai Po Road – Sha Tin Westbound	2028	All Days	0000 to 0530(2)
	Sha Tin Centre Street carriageway	2028	All Days	2200 to 0600(3)
	Yi Ching Lane	2028	Weekdays	0900 to 1700 (5)
	Pak Hok Ting Street (near Wai Wah Centre)	2028	Weekdays	0900 to 1700 (5)

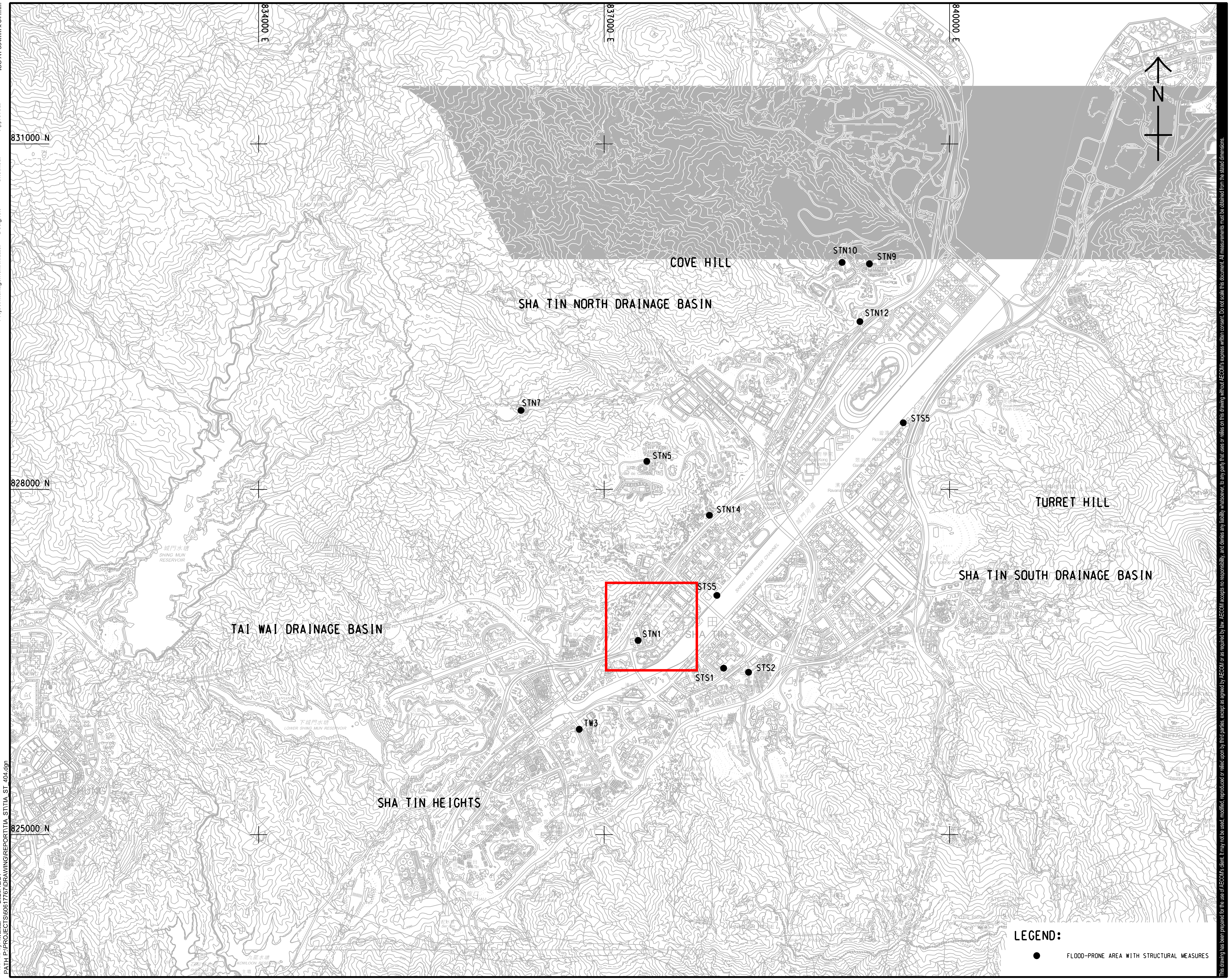
Note:
(1) The proposed time period denotes the time that the carriageway would be occupied. The actual proposed working hours would be between typical hours of 08:00 to 18:00, with the works equipment occupying the works area outside of the actual works period.
(2) Works at Tai Po Road – Sha Tin can only be carried out between the hours of 1900 – 0700 the following day according to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021). Based on the traffic assessment at night-time period, the working time period of the works will be between the hours of 0000 to 0530.
(3) Works at Sha Tin Centre Street can only be carried out between the hours of 1900 – 0700 the following day according to the Guidance Note "Guidelines on Traffic Impact Assessment & Day-time Ban Requirements for Road Works on Traffic Sensitive Routes" (RD/GN/021). The working time period proposed in this TIA is as a guideline and the actual working time period should be determined by the contractors based on updated traffic conditions, on-site trial runs and obtain approvals from all relevant authorities prior to commencement of the actual construction.
(4) The speed limit at Tai Po Road – Sha Tin westbound near the works area would be lowered to 50 km/hour during the working period and subject to review by all relevant authorities prior to commencement of the actual construction.
(5) The actual proposed working hours would be between typical hours of 09:00 to 17:00, with the works equipment occupying the works area outside of the actual works period and the works would be carried out in stages.

6.1.4 It is noted that under the current excavation permit application requirements by the Highways Department (HyD), contractors are required to submit detailed TTMS schemes using latest road/junction layout, updated traffic counts, conduct on-site trial runs and obtain approvals from all relevant authorities prior to commencement of the actual construction. The TTMS proposed in this TIA are as a guideline and requirement for their preparation of detailed TTMS during construction stage.

6.2 Conclusion

6.2.1 In conclusion, the TIA has demonstrated that the proposed drainage improvement works would not adversely affect to the surrounding road network provided that the proposed temporary traffic management and requirements are adhered to.

FIGURES



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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

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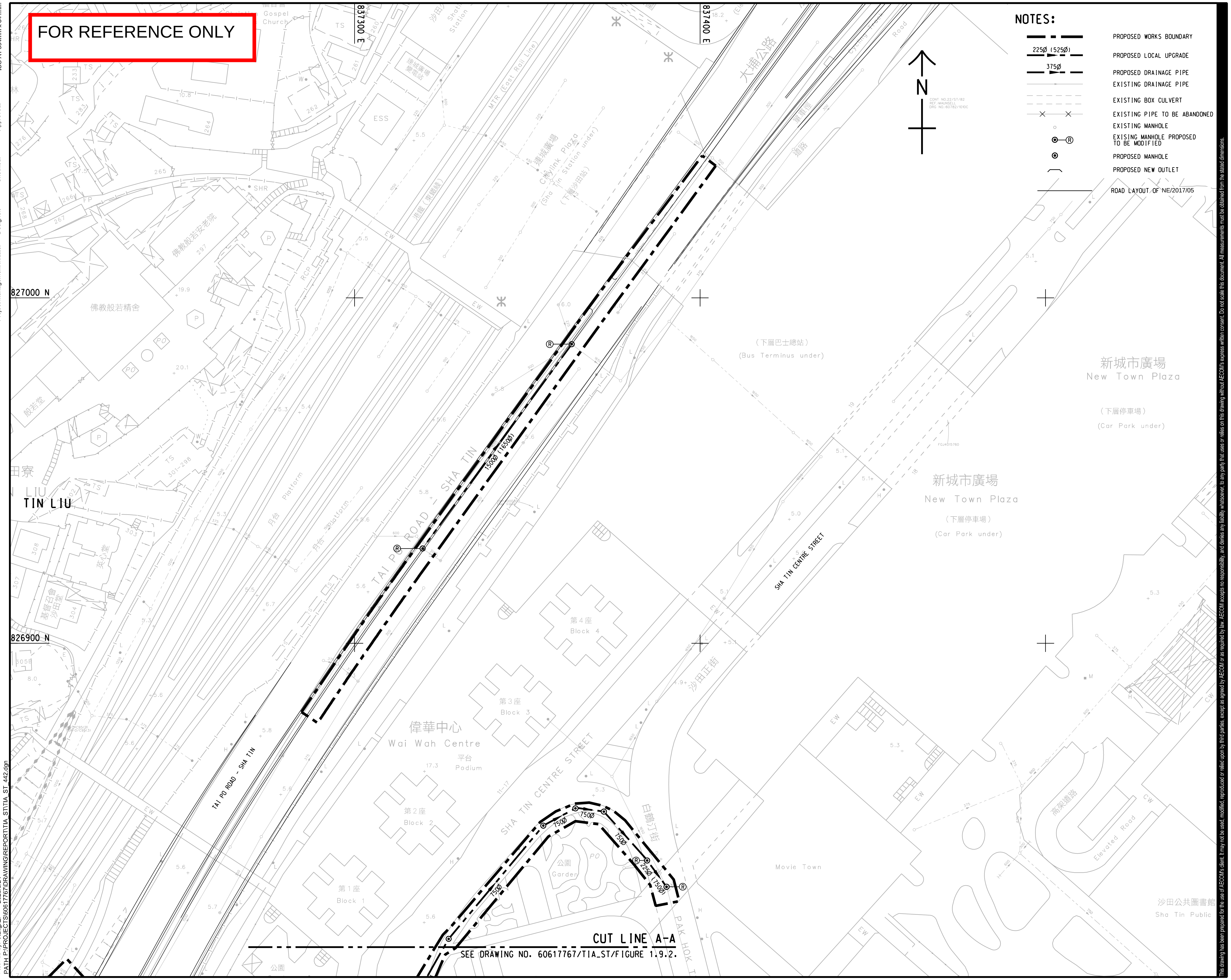
AGREEMENT NO. 協議編號: CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN (KEY PLAN)

SHEET NUMBER 圖紙編號

60617767/TIA_ST/FIGURE 1.1.3



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AGREEMENT NO.: CE 15/2019 (DS)

SHEET TITLE

PROPOSED WORKS AREA AT SHA TIN TOWN CENTRE (STN1)

SHEET 2 OF 2

SHEET NUMBER

60617767/TIA_ST/FIGURE 1.9.1

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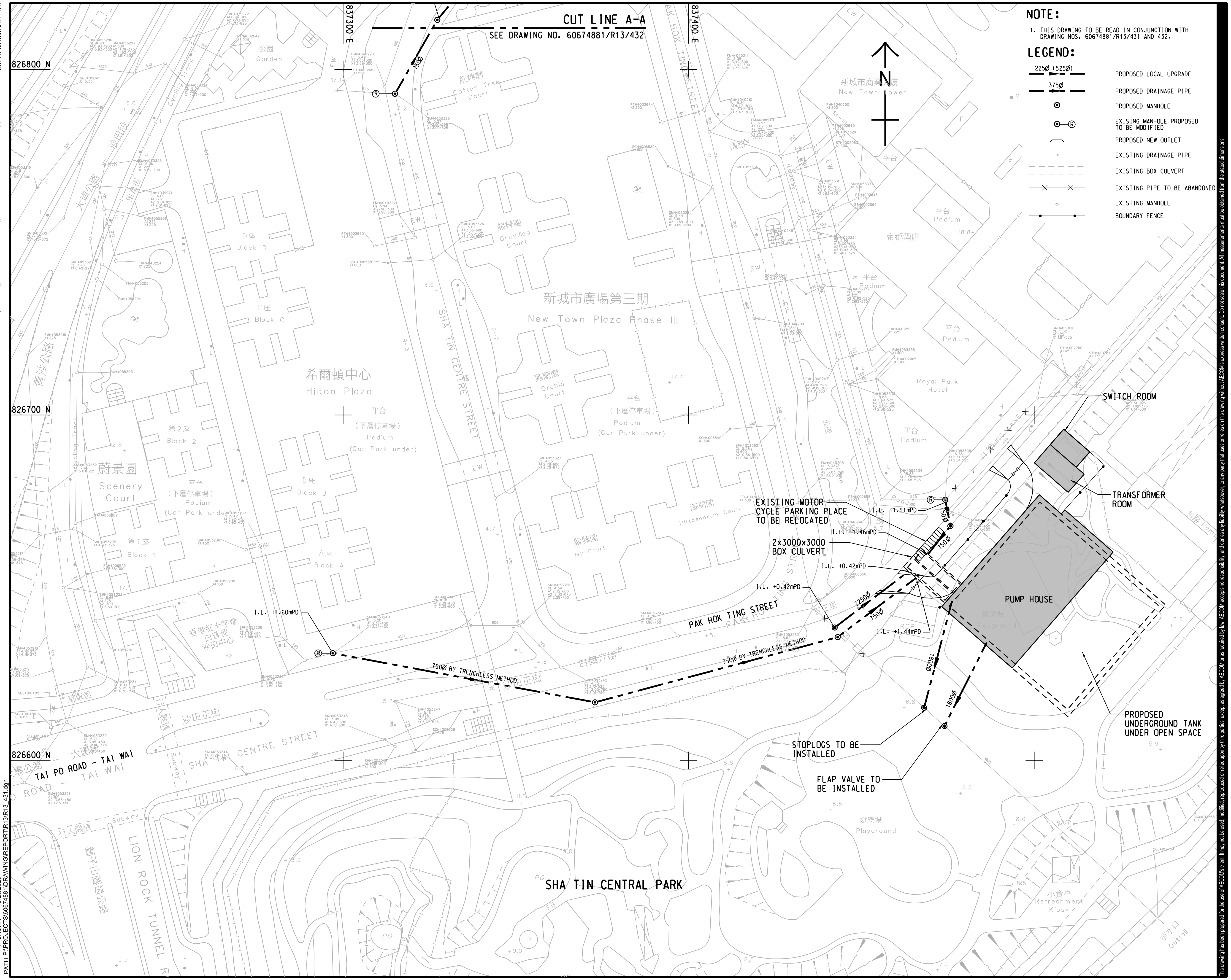

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CONTRACT NO. 合約編號 CE 44/2021 (DS)

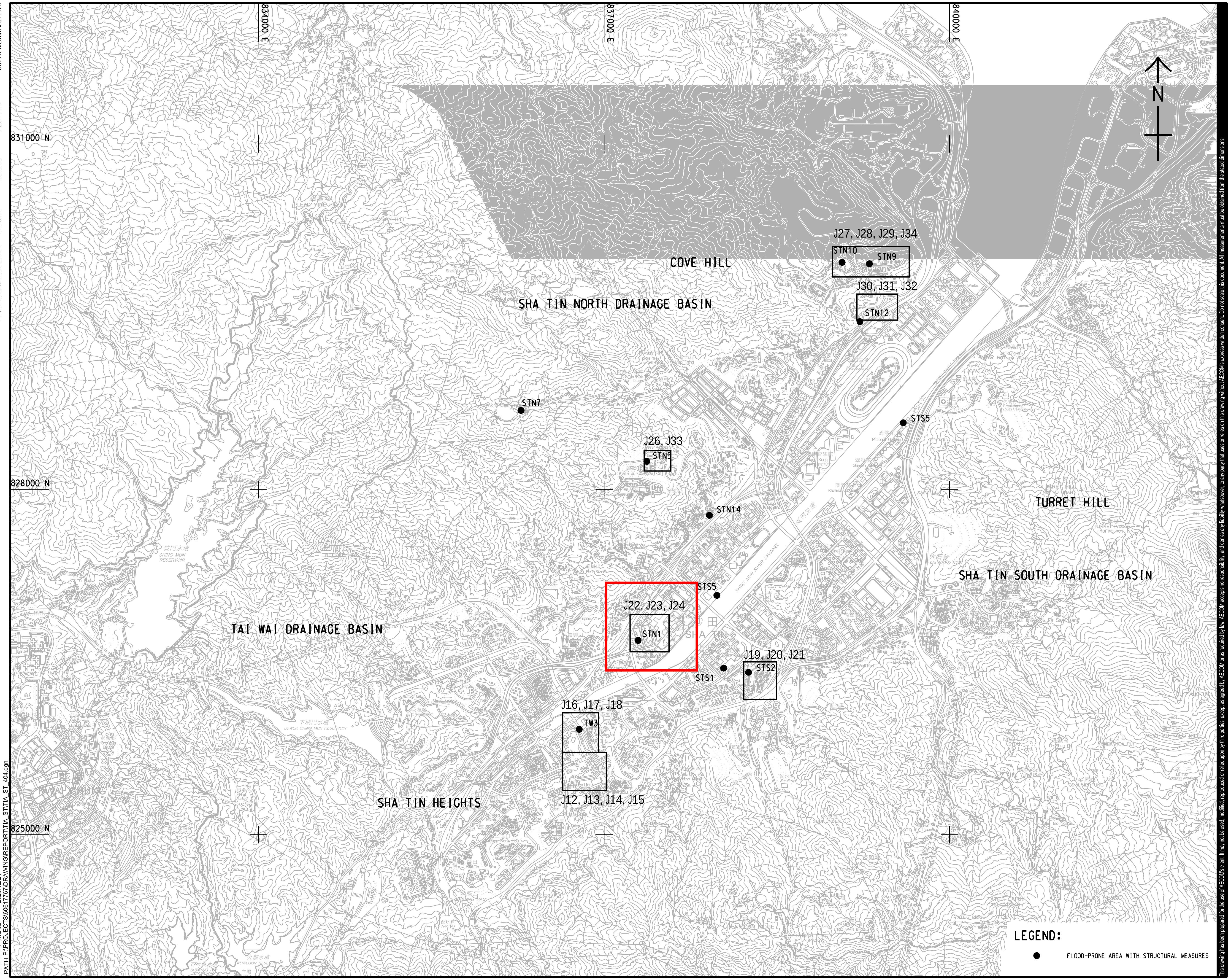
SHEET TITLE 圖紙名稱

PROPOSED DRAINAGE IMPROVEMENT WORKS AT SHA TIN TOWN CENTRE (STN1)

SHEET 1 OF 2

SHEET NUMBER 圖紙編號

60674881/R13/431



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AGREEMENT NO.: CE 15/2019 (DS)

SHEET TITLE

CRITICAL JUNTIONS AT SHA TIN
(KEY PLAN)

SHEET NUMBER

FIGURE 2.3

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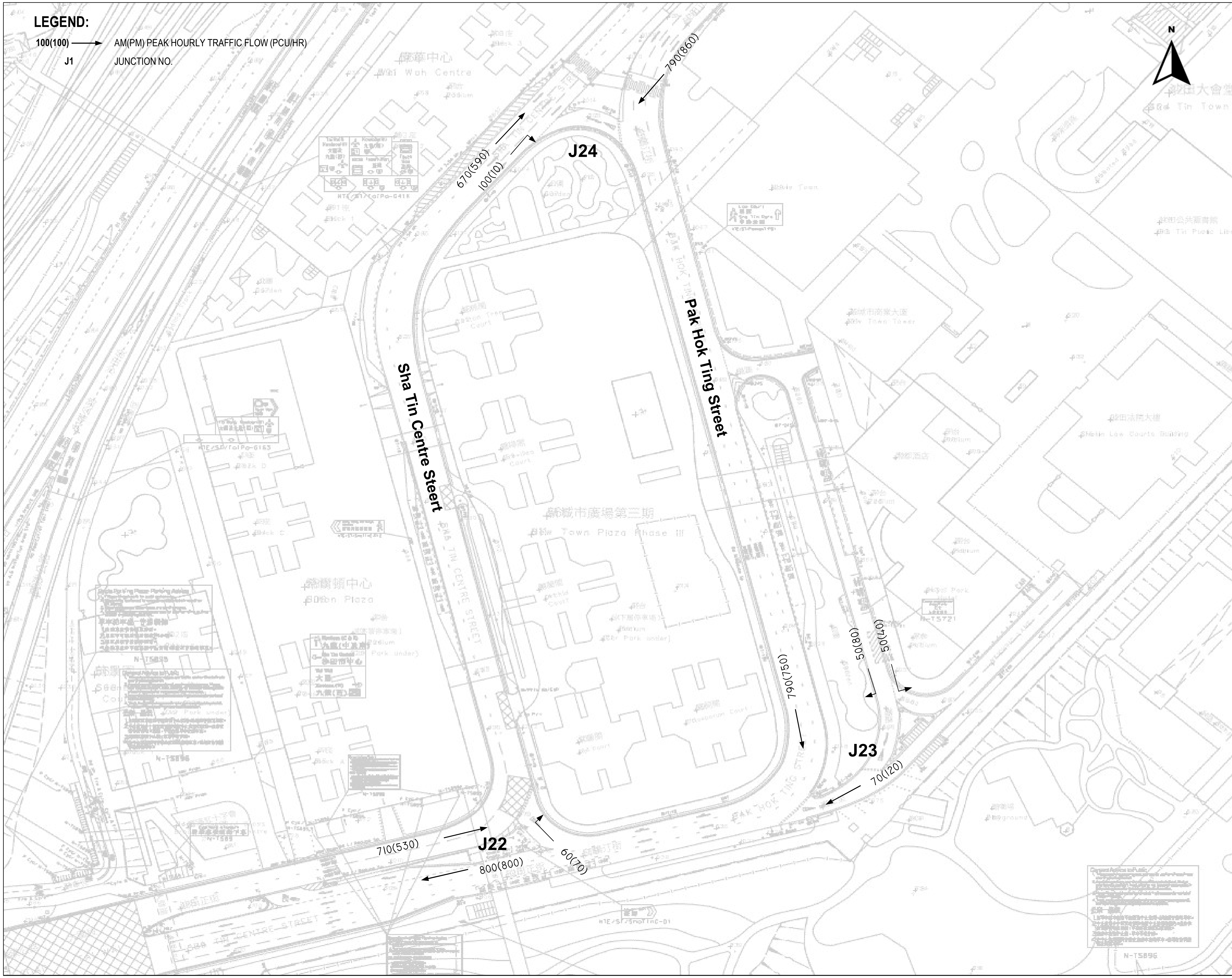

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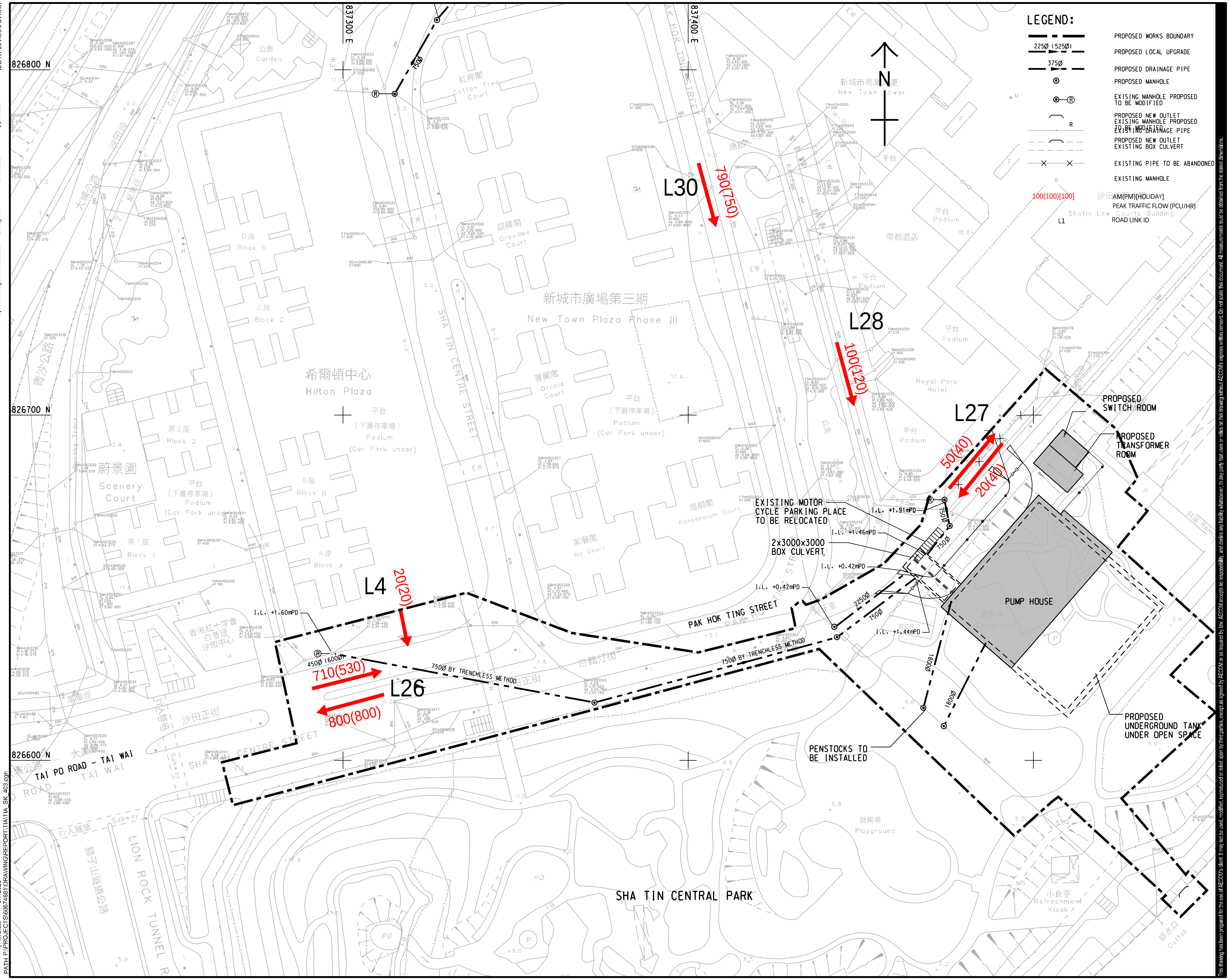
SHEET TITLE

YEAR 2020
JUNCTION TRAFFIC FLOW
(SHEET 5 OF 6)

SHEET NUMBER

FIGURE 2.1.5



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SHEET TITLE

YEAR 2020
ROAD LINK FLOW
(SHEET 10 OF 17)

SHEET NUMBER

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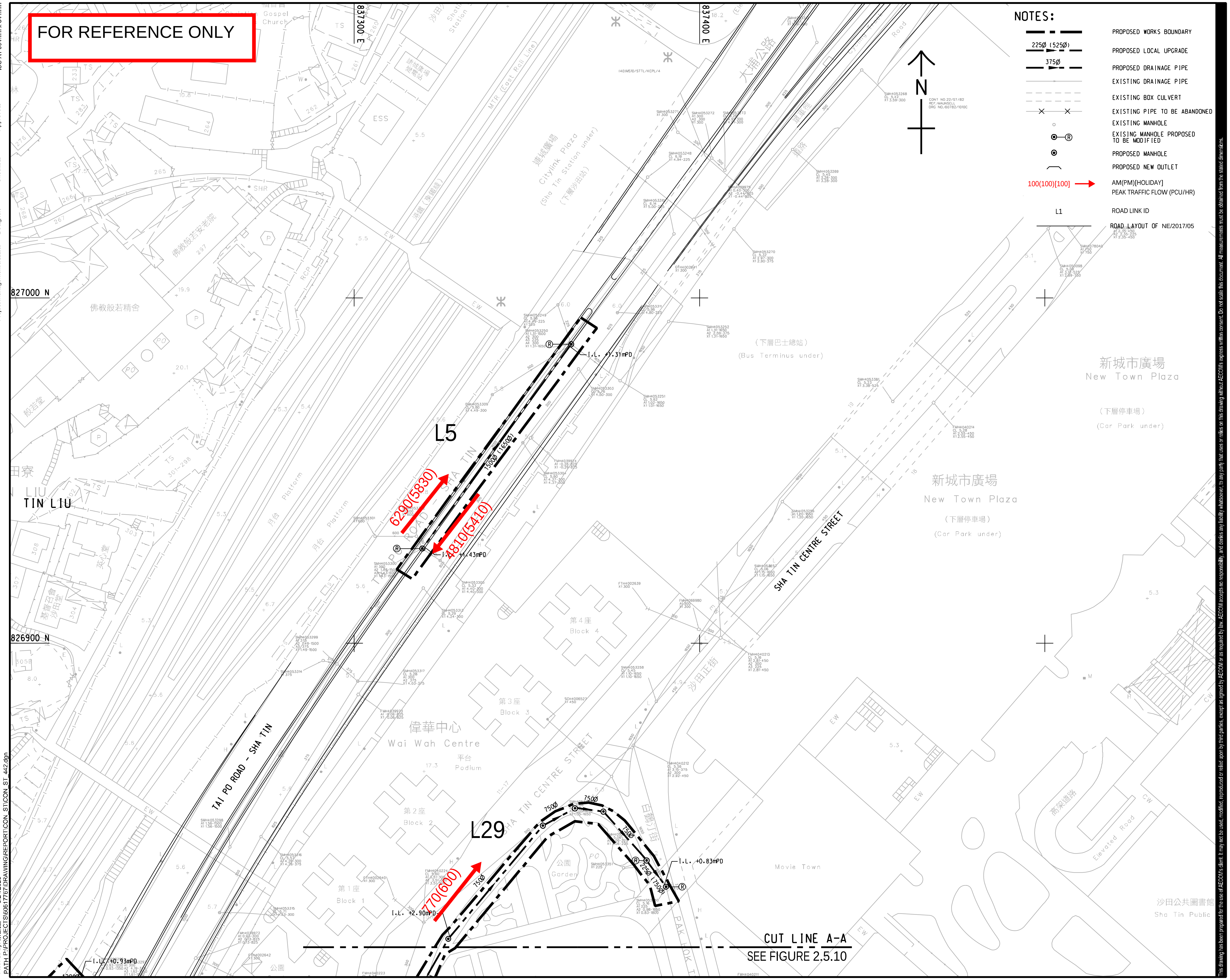

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SHEET TITLE

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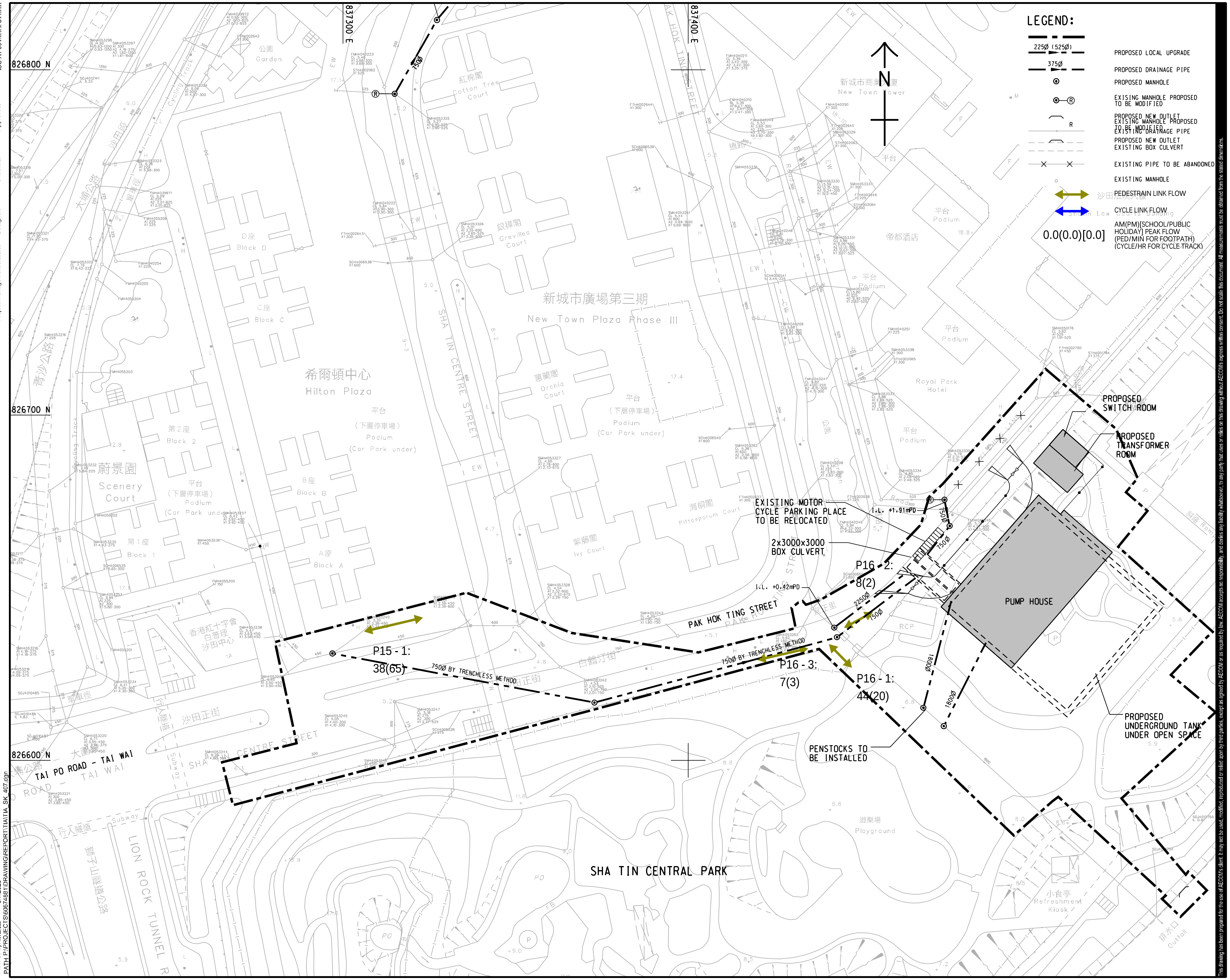
ROAD LINK FLOW
(SHEET 11 OF 17)

SHEET NUMBER

FIGURE 2.5.11



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PEDESTRIAN FLOW AND CYCLE FLOW
(SHEET 15 OF 17)

SHEET NUMBER

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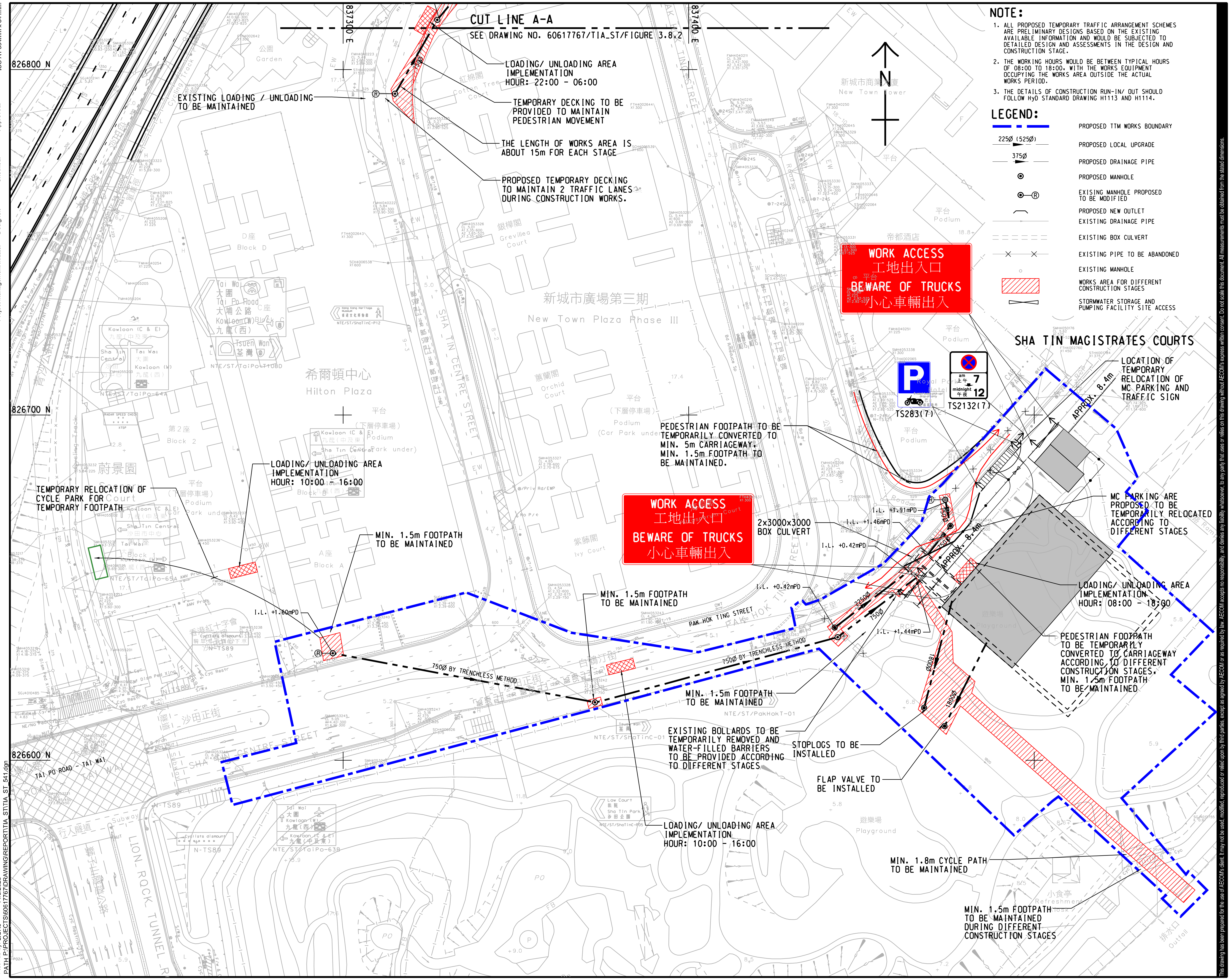

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2. THE WORKING HOURS WOULD BE BETWEEN TYPICAL HOURS OF 08:00 TO 18:00, WITH THE WORKS EQUIPMENT OCCUPYING THE WORKS AREA OUTSIDE THE ACTUAL WORKS PERIOD.
3. THE DETAILS OF CONSTRUCTION RUN-IN/ OUT SHOULD FOLLOW HyD STANDARD DRAWING H1113 AND H1114.

LEGEND:

- PROPOSED TTM WORKS BOUNDARY
- 225Ø (525Ø) PROPOSED LOCAL UPGRADE
- 375Ø PROPOSED DRAINAGE PIPE
- PROPOSED MANHOLE
- EXISING MANHOLE PROPOSED TO BE MODIFIED
- PROPOSED NEW OUTLET
- EXISTING DRAINAGE PIPE
- EXISTING BOX CULVERT
- EXISTING PIPE TO BE ABANDONED
- EXISTING MANHOLE
- WORKS AREA FOR DIFFERENT CONSTRUCTION STAGES
- STORMWATER STORAGE AND PUMPING FACILITY SITE ACCESS

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AGREEMENT NO. 協議編號: CE 15/2019 (DS)

SHEET TITLE 圖紙名稱
PROPOSED TEMPORARY TRAFFIC ARRANGEMENT FOR SHA TIN TOWN CENTRE (STN1)

SHEET 1 OF 2

SHEET NUMBER 圖紙編號
60617767/TIA_ST/FIGURE 3.8.1

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LEGEND:

- PROPOSED TTM WORKS BOUNDARY
- 225Ø (525Ø) PROPOSED LOCAL UPGRADE
- 375Ø PROPOSED DRAINAGE PIPE
- PROPOSED MANHOLE
- EXISING MANHOLE PROPOSED TO BE MODIFIED
- PROPOSED NEW OUTLET
- EXISTING DRAINAGE PIPE
- EXISTING BOX CULVERT
- EXISTING PIPE TO BE ABANDONED
- EXISTING MANHOLE
- WORKS AREA FOR DIFFERENT CONSTRUCTION STAGES
- TRAFFIC CONE

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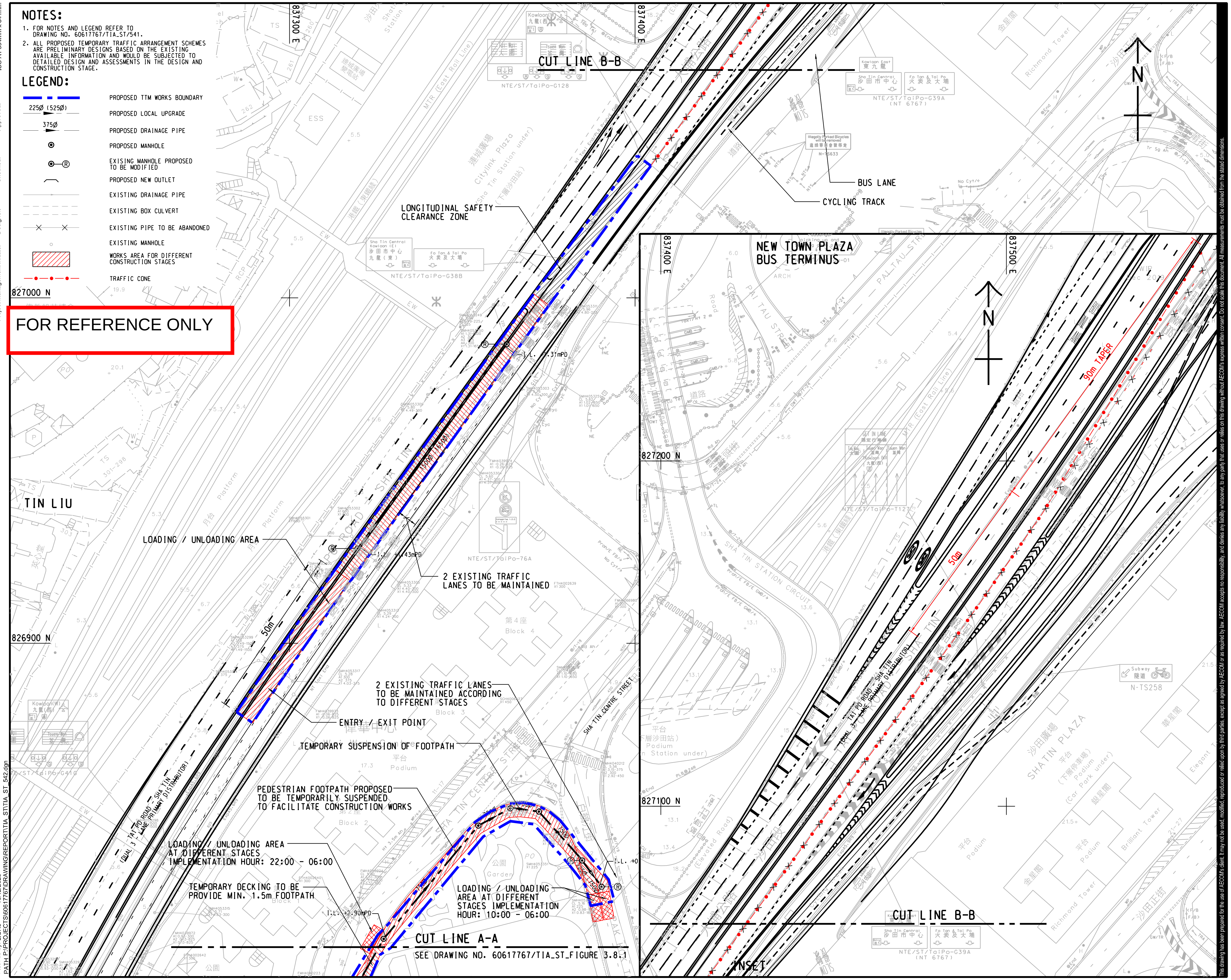

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SHA TIN

PROJECT NO. 項目編號 60617767

AGREEMENT NO. 協議編號 CE 15/2019 (DS)

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PROPOSED TEMPORARY TRAFFIC ARRANGEMENT FOR SHA TIN TOWN CENTRE (STN1)

SHEET 2 OF 2

SHEET NUMBER 圖紙編號

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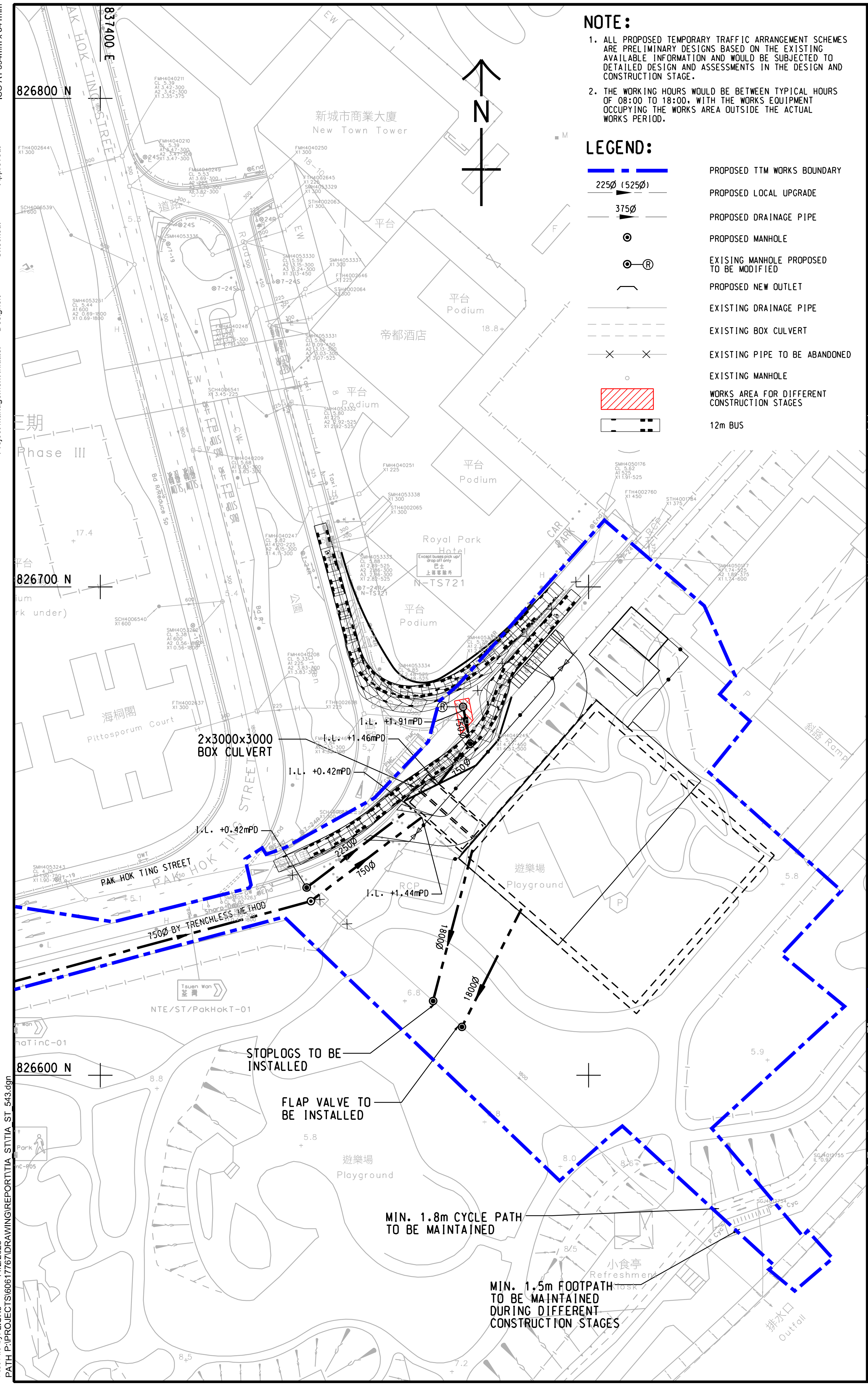

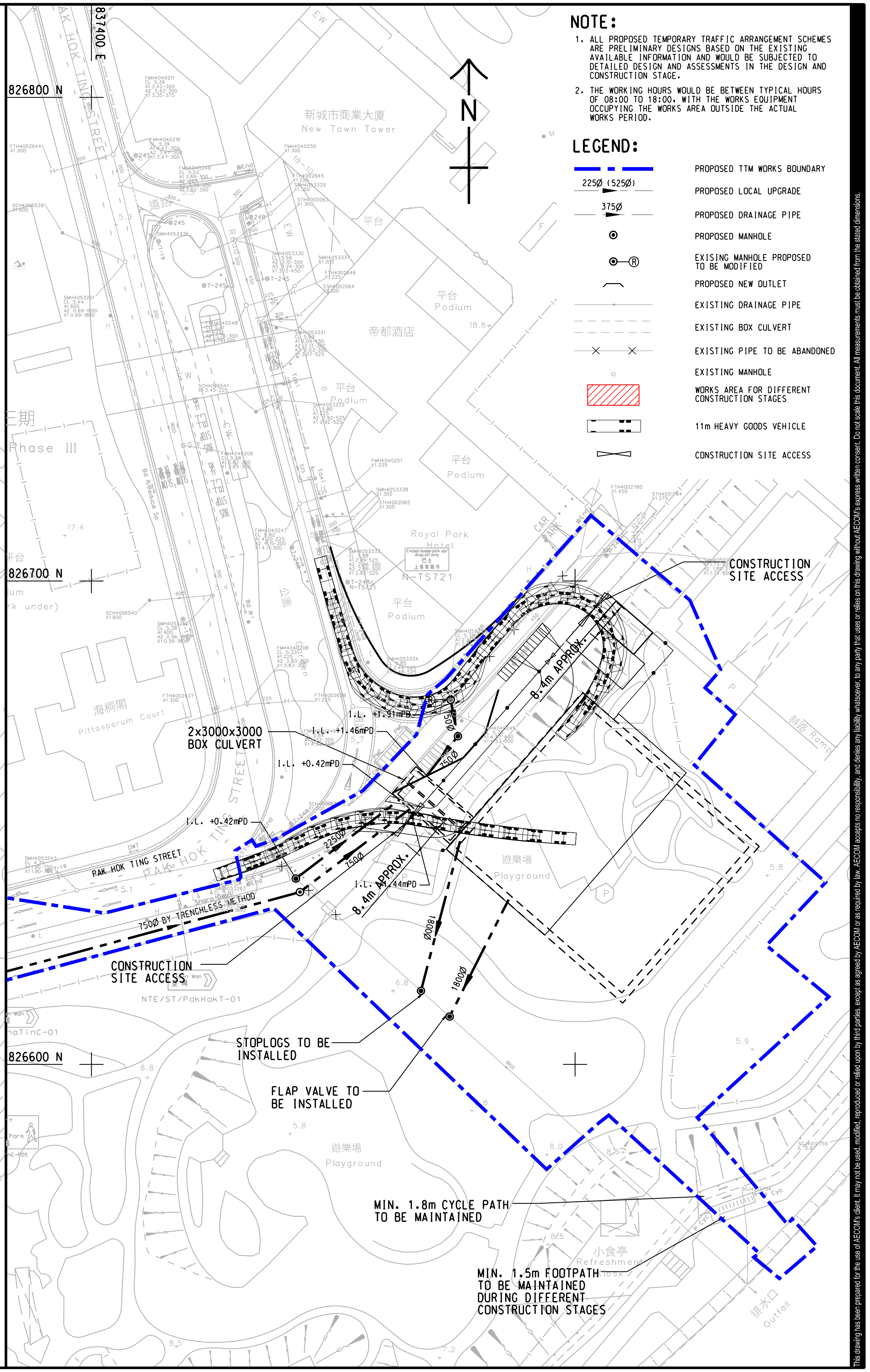

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PROPOSED TEMPORARY TRAFFIC ARRANGEMENT FOR SHA TIN TOWN CENTRE (STN1) - SWEPT PATH ANALYSIS SHEET 1 OF 2

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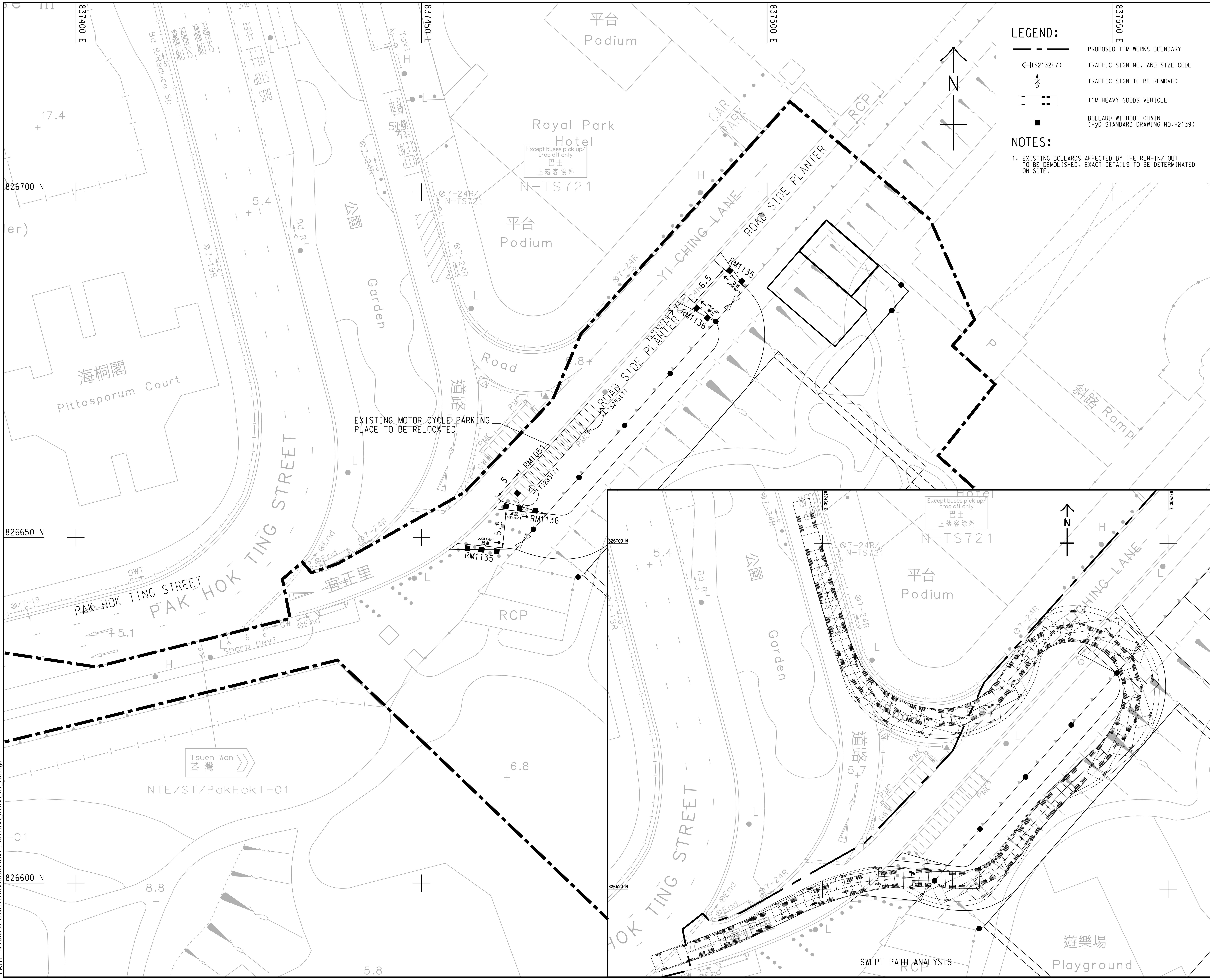

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PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

CLIENT 業主

渠務署
Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
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ISSUE/REVISION 修訂

I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 覆核

STATUS 階段

SCALE 比例 A3 1 : 500

DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖 A3 1 : 40000

SHA TIN CENTRE
TUNG LO WAN

PROJECT NO. 項目編號 60617767

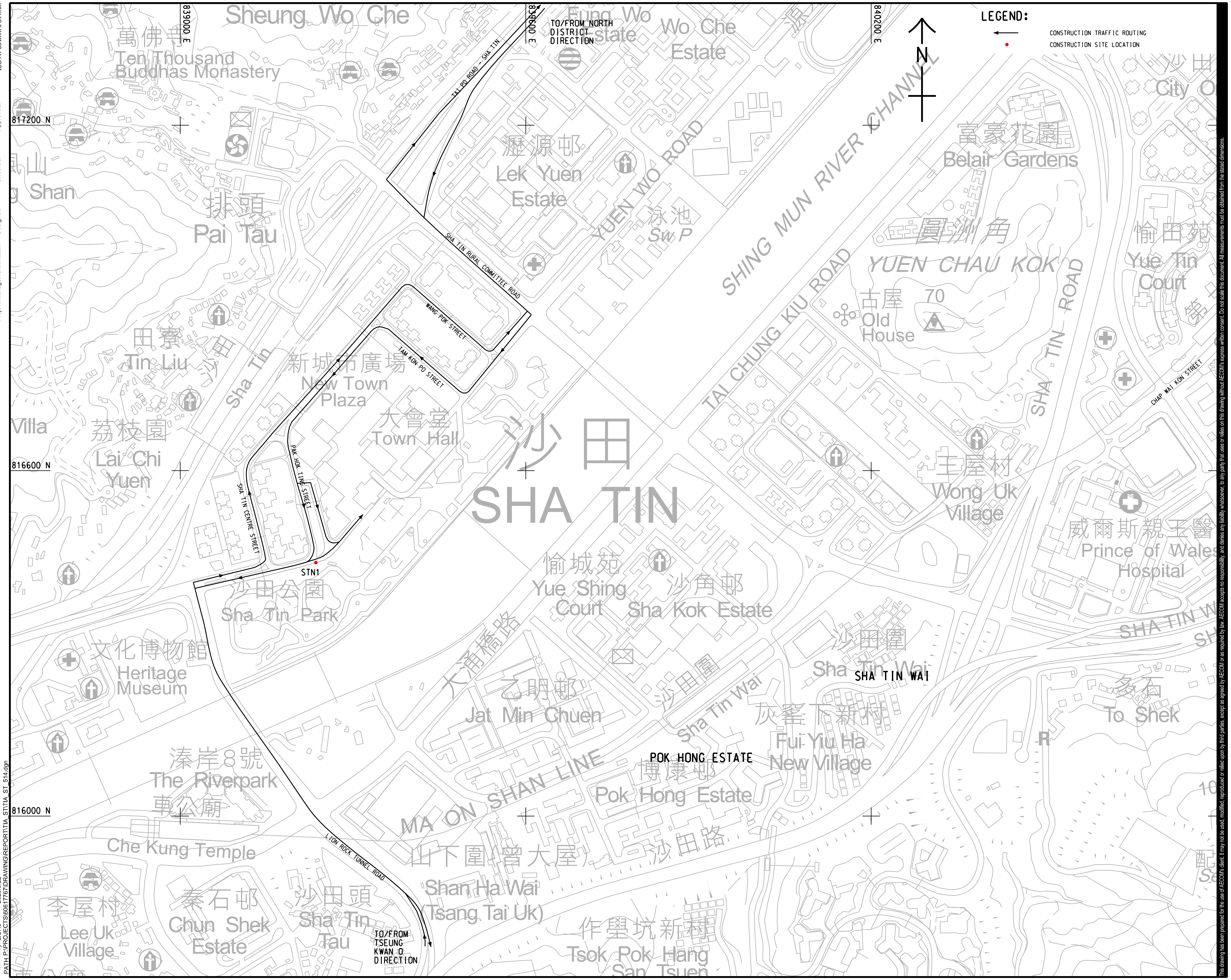
AGREEMENT NO. 協議編號 CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

PUMPING STATION RUN-IN/ OUT ROAD MARKING AND TRAFFIC SIGN LAYOUT PLAN

SHEET NUMBER 圖紙編號

60617767/TIA_ST/FIGURE 3.8.4



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PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

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STATUS 階段

SCALE 比例	DIMENSION UNIT 尺寸單位
A3 1 : 6000	METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號	AGREEMENT NO. 協議編號
60617767	CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

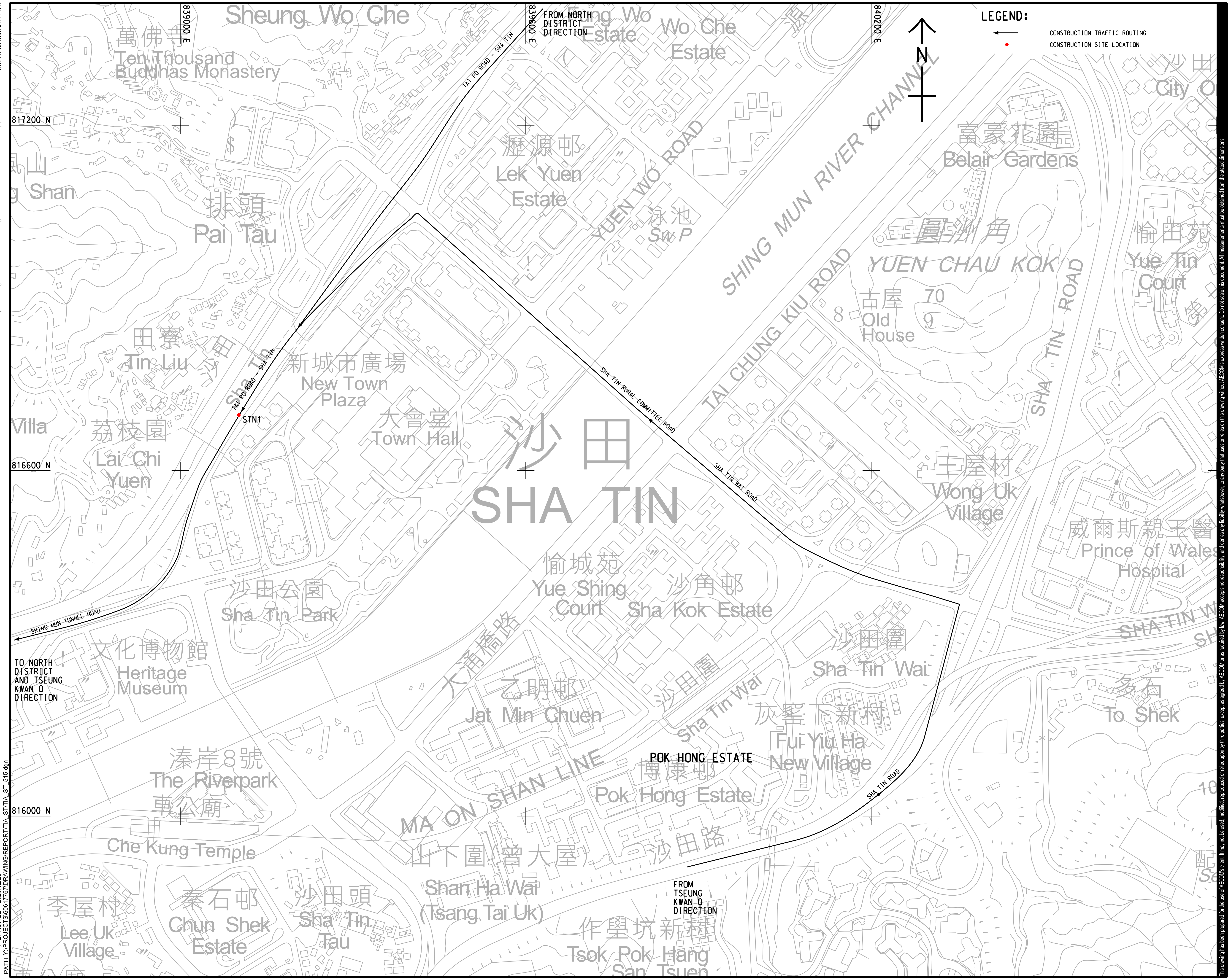
PROPOSED CONSTUCTION TRAFFIC ROUTING FOR SHA TIN TOWN CENTRE (STN1)

SHEET 1 OF 2

SHEET NUMBER 圖紙編號

60617767/TIA_ST/FIGURE 3.20

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:
Plot File by: LIUH9 2023/5/22
PATH P:\PROJECTS\60617767\DRAWING\REPORT\TIA_ST\TIA_ST_514.dgn



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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

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STATUS

SCALE: A3 1 : 6000

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60617767

AGREEMENT NO.: CE 15/2019 (DS)

SHEET TITLE

PROPOSED CONSTUCTION TRAFFIC ROUTING FOR SHA TIN TOWN CENTRE (STN1)

SHEET 2 OF 2

SHEET NUMBER

60617767/TIA_ST/FIGURE 3.21

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:
Plot File by: ZHAOHQ2 2020/12/29
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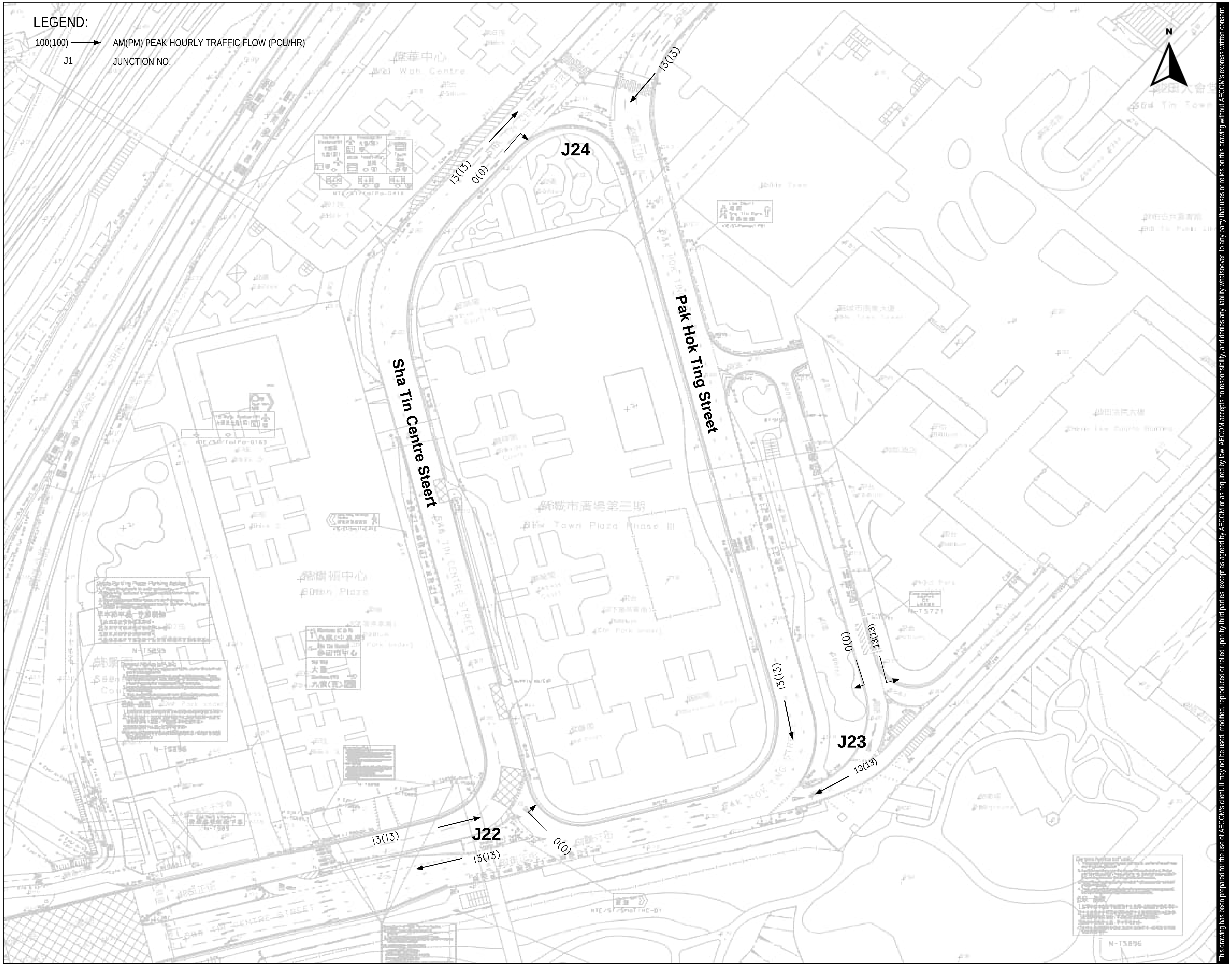

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STATUS

SCALE	DIMENSION UNIT
NOT TO SCALE	

KEY PLAN

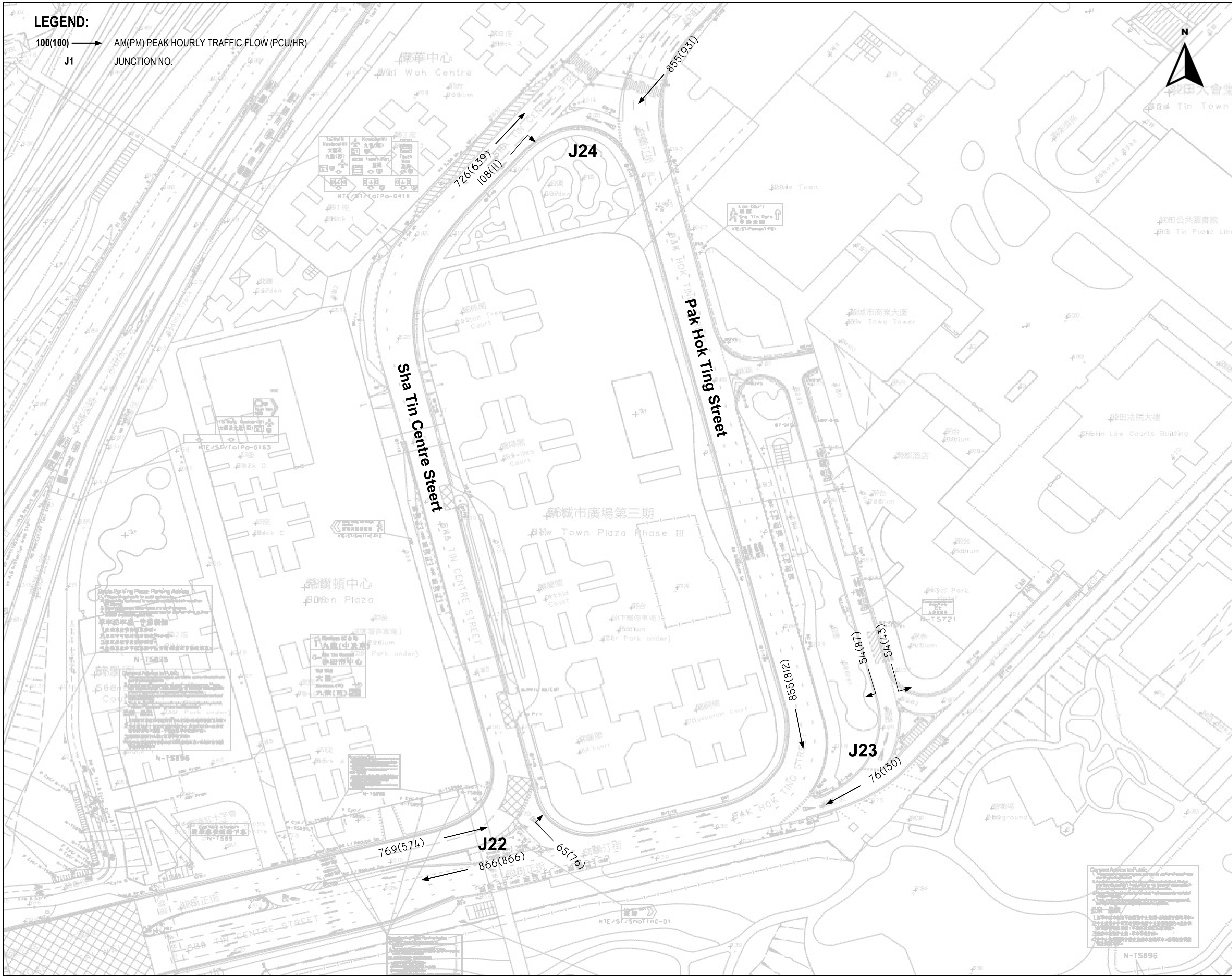
PROJECT NO.	CONTRACT NO.
60617767	

SHEET TITLE

YEAR 2028
CONSTRUCTION TRAFFIC FLOW
(SHEET 3 OF 4)

SHEET NUMBER

FIGURE 3.28



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SCALE **DIMENSION UNIT**

NOT TO SCALE

KEY PLAN

PROJECT NO. **CONTRACT NO.**

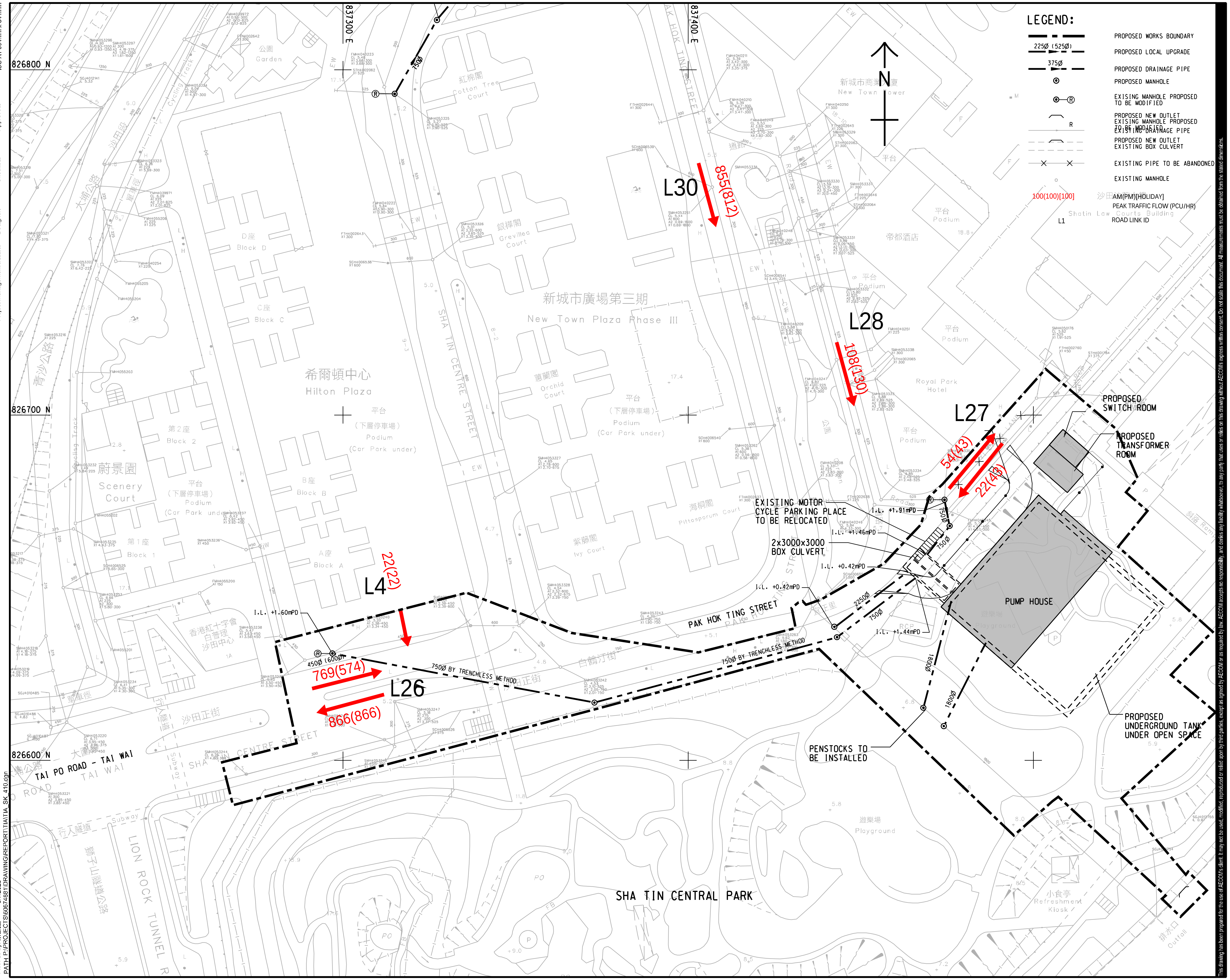
60617767

SHEET TITLE

YEAR 2028
FORECAST JUNCTION TRAFFIC FLOW
(SHEET 5 OF 6)

SHEET NUMBER

FIGURE 5.1.5



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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

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STATUS

SCALE A1 1 : 500

DIMENSION UNIT METRES

KEY PLAN

PROJECT NO. 60674881

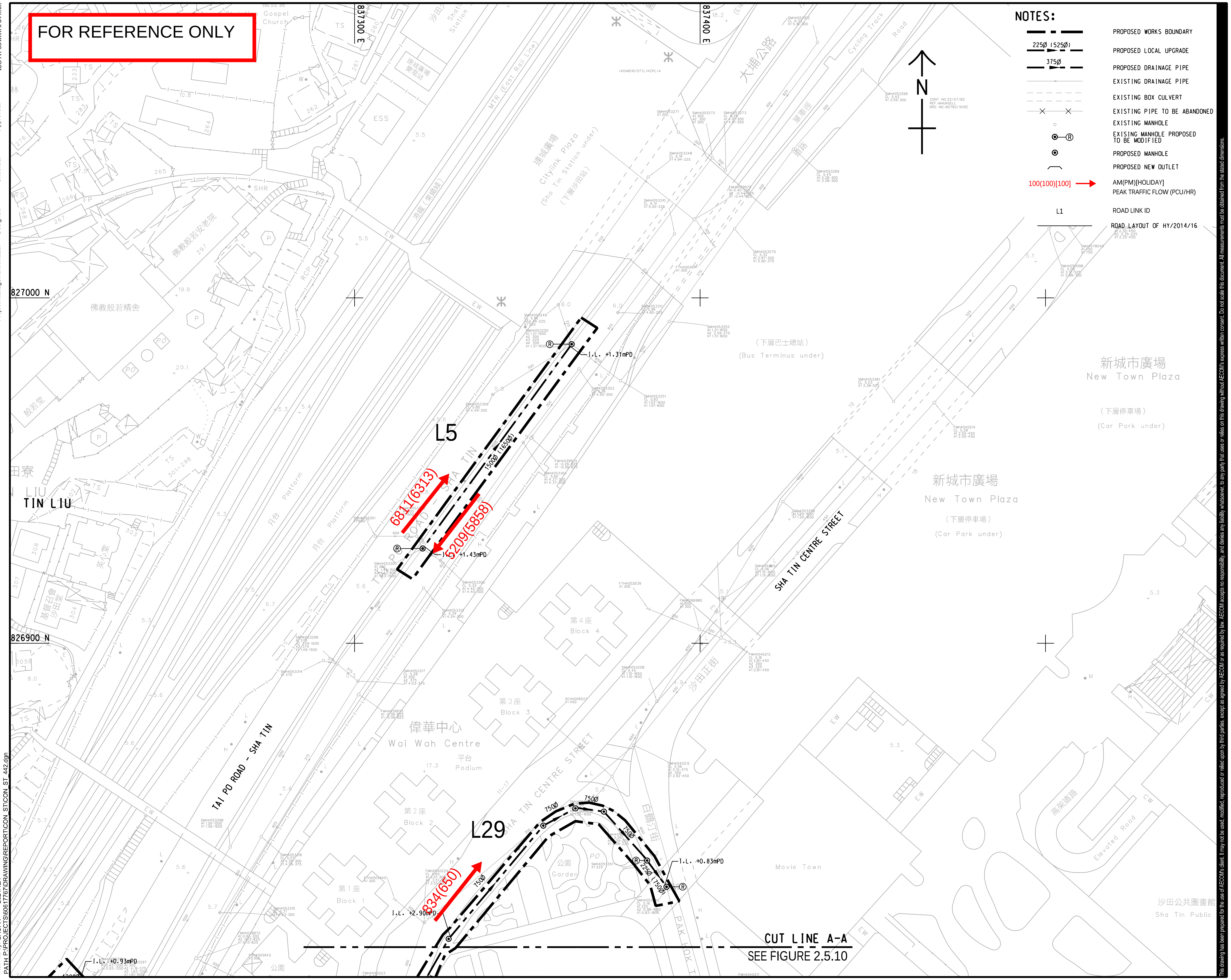
CONTRACT NO. CE 44/2021 (DS)

SHEET TITLE

YEAR 2028
FORECAST ROAD LINK FLOW
(SHEET 10 OF 17)

SHEET NUMBER 60674881/TIA_SK/FIG 5.1.16

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:
Plot File by: riva.cai 3/7/2023
PATH: P:\PROJECTS\60674881\DRAWING\REPORT\TIA\TIA_SK_410.dgn



Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm
Plot File by: CAOPA 2021/12/7 PATH P:\PROJECTS\60617767\DRAWING\REPORT\CON_ST\CON_ST_442.dgn

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PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

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STATUS 階段

SCALE 比例 A3 1 : 1000

DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖 A3 1 : 40000

PROJECT NO. 項目編號 60617767

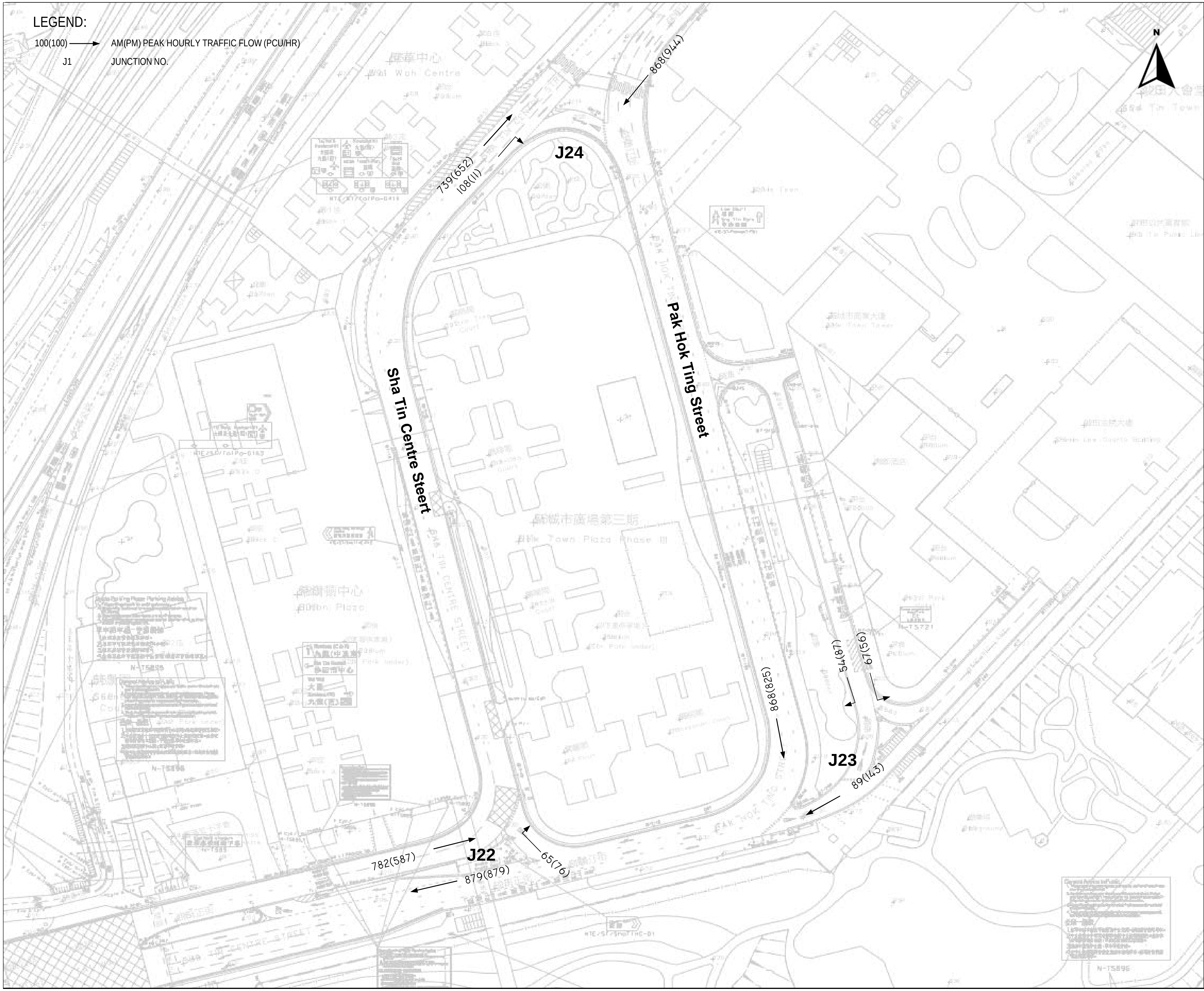
AGREEMENT NO. 協議編號 CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

YEAR 2028
FORECAST ROAD LINK FLOW
(SHEET 11 OF 17)

SHEET NUMBER 圖紙編號

FIGURE 5.1.17



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SCALE	**DIMENSION UNIT**
NOT TO SCALE	

KEY PLAN

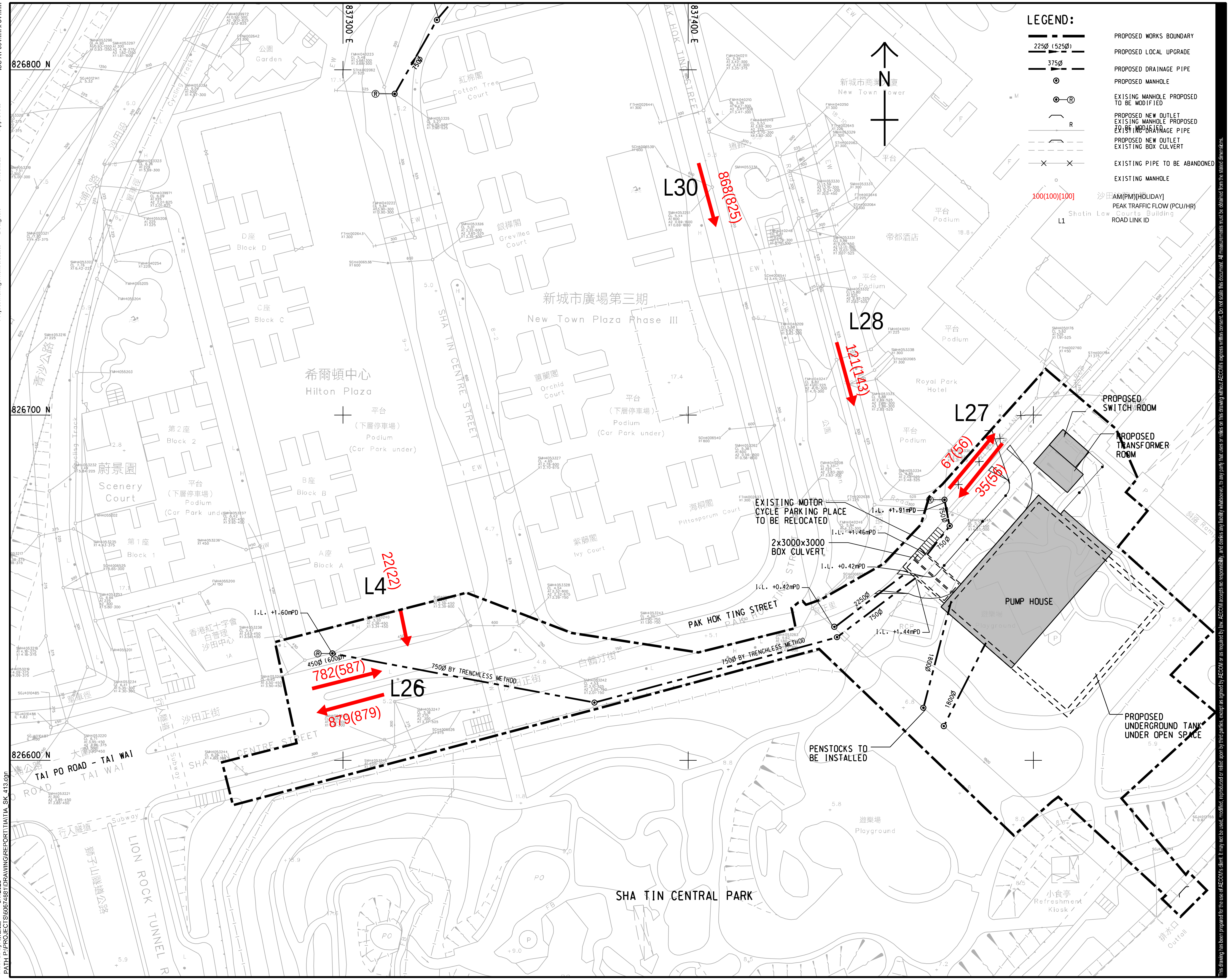
PROJECT NO.	**CONTRACT NO.**
60617767	

SHEET TITLE

YEAR 2028
FORECAST JUNCTION TRAFFIC FLOW
(WITH TTMS)
(SHEET 2 OF 3)

SHEET NUMBER

FIGURE 5.1.25



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STATUS

SCALE: A1 1 : 500

DIMENSION UNIT: METRES

KEY PLAN

PROJECT NO.: 60674881

CONTRACT NO.: CE 44/2021 (DS)

SHEET TITLE

YEAR 2028
FORECAST ROAD LINK FLOW (WITH TTMS)
(SHEET 5 OF 10)

SHEET NUMBER

60674881/TIA_SK/FIG 5.1.31

ISO A1 594mm x 841mm
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Checked:
Designer:
Project Management Initials:
Plot File by: riva.cai 3/7/2023
PATH: P:\PROJECTS\60674881\DRAWING\REPORT\TIA\TIA_SK_413.dgn

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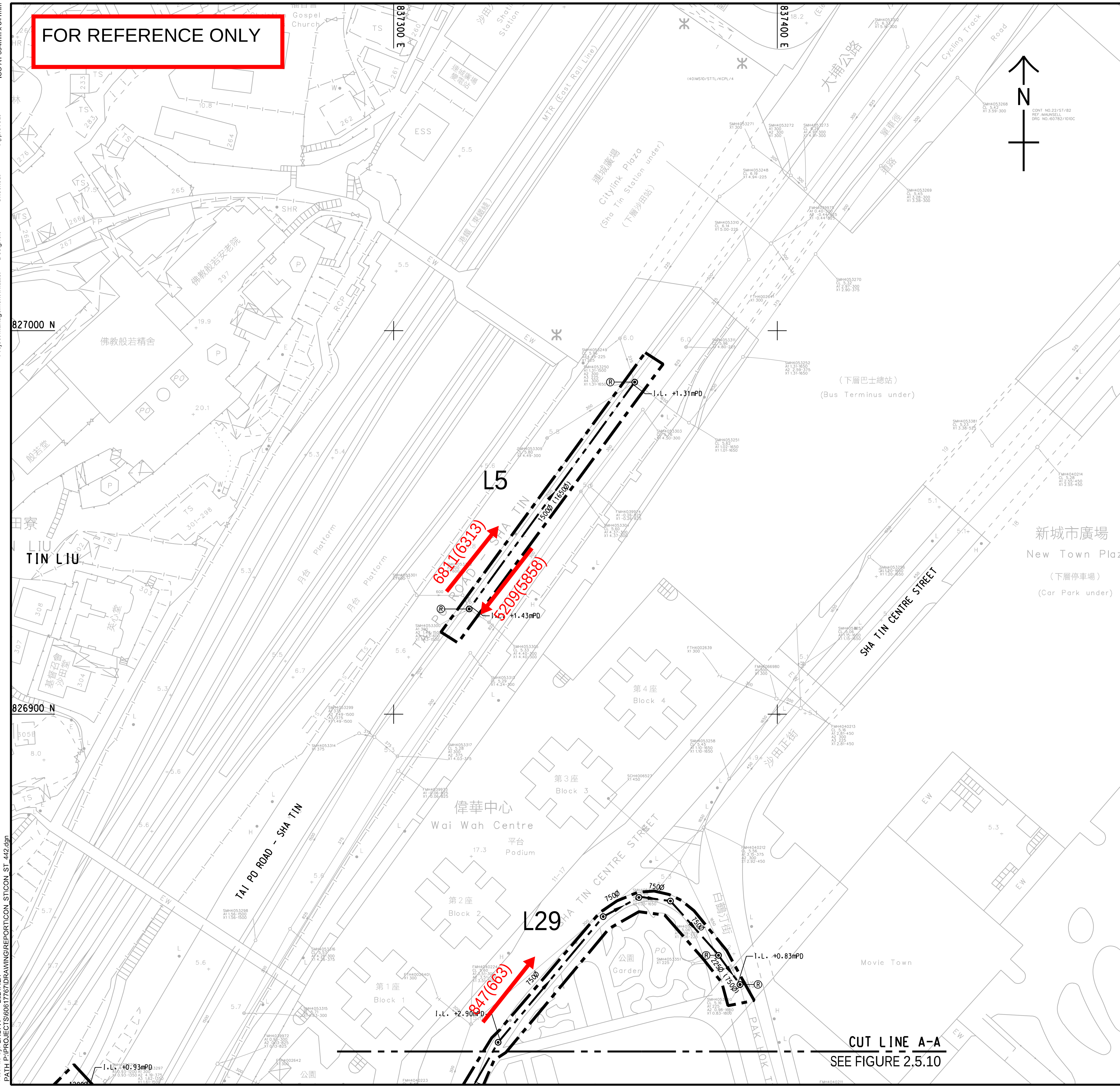

NOTES:

- PROPOSED WORKS BOUNDARY
- 225Ø (525Ø) PROPOSED LOCAL UPGRADE
- 375Ø PROPOSED DRAINAGE PIPE
- EXISTING DRAINAGE PIPE
- EXISTING BOX CULVERT
- EXISTING PIPE TO BE ABANDONED
- EXISTING MANHOLE
- EXISING MANHOLE PROPOSED TO BE MODIFIED
- PROPOSED MANHOLE
- PROPOSED NEW OUTLET
- 100(100)[100] AM(PM)[HOLIDAY] PEAK TRAFFIC FLOW (PCU/HR)
- L1 ROAD LINK ID

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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - INVESTIGATION

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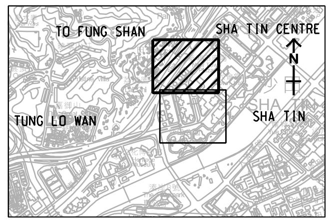
STATUS 階段

SCALE 比例 A3 1 : 1000

DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖 A3 1 : 40000



PROJECT NO. 項目編號 60617767

AGREEMENT NO. 協議編號 CE 15/2019 (DS)

SHEET TITLE 圖紙名稱

YEAR 2028
FORECAST ROAD LINK FLOW (WITH TTMS)
(SHEET 6 OF 10)

SHEET NUMBER 圖紙編號

FIGURE 5.1.32

ISO A1 594mm x 841mm
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Designer:
Project Management Initials:
Plot File by: CAOPA 2021/12/7
PATH P:\PROJECTS\60617767\DRAWING\REPORT\CON ST\CON_ST_442.dgn

APPENDIX A

DETAILED JUNCTION CALCULATION SHEETS

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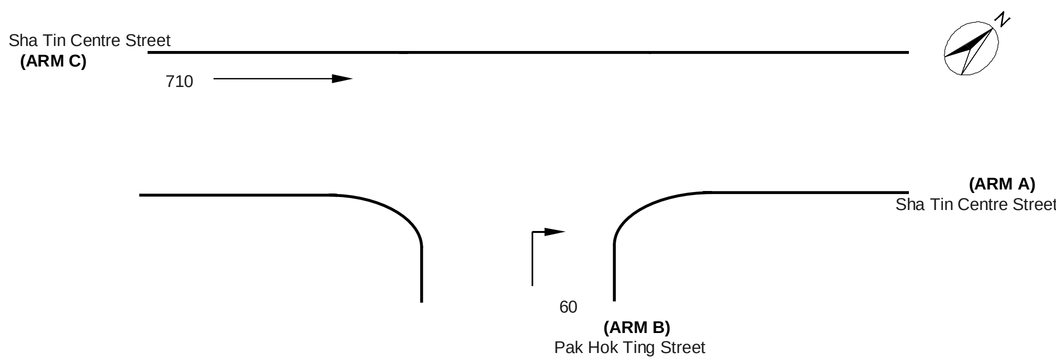
PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2020 AM Traffic Flows	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



J22

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	9	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	0	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	710	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=	4.7	(metres)
W b-c	=		(metres)
Vl b-a	=	100	(metres)
Vr b-a	=		(metres)
Vr b-c	=		(metres)
q b-a	=	60	(pcu/hr)
q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

THE CAPACITY OF MOVEMENT :

Q b-a	=	489
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	489

CRITICAL DFC = 0.12

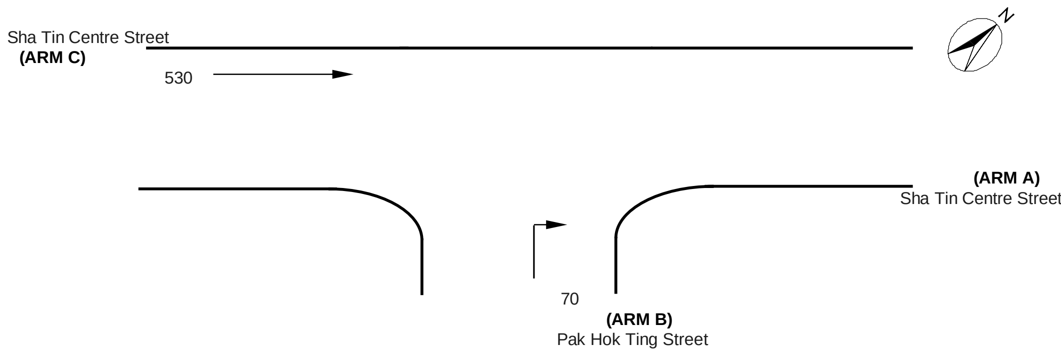
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.12
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.12

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2020 PM Traffic Flows	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



NOTES : (GEOMETRIC INPUT DATA)

J22

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	9	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	0	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	530	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=	4.7	(metres)
W b-c	=		(metres)
Vl b-a	=	100	(metres)
Vr b-a	=		(metres)
Vr b-c	=		(metres)
q b-a	=	70	(pcu/hr)
q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

`

THE CAPACITY OF MOVEMENT :

Q b-a	=	516
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	516

CRITICAL DFC = 0.14

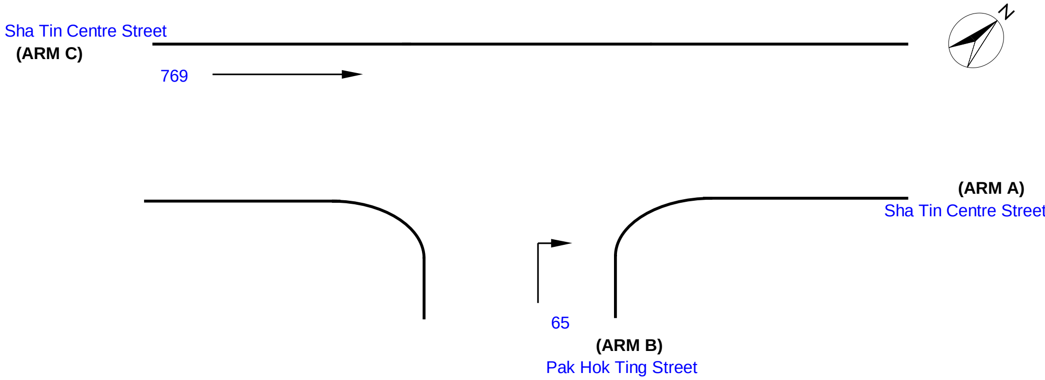
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.14
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.14

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2028 AM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



NOTES : (GEOMETRIC INPUT DATA)

J22

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)			*MAJOR ROAD (ARM C)*			*MINOR ROAD (ARM B)*		
W	=	9 (metres)	W c-b	=	(metres)	W b-a	=	4.7 (metres)
W cr	=	(metres)	Vr c-b	=	(metres)	W b-c	=	(metres)
q a-b	=	0 (pcu/hr)	q c-a	=	769 (pcu/hr)	Vl b-a	=	100 (metres)
q a-c	=	0 (pcu/hr)	q c-b	=	0 (pcu/hr)	Vr b-a	=	(metres)
						Vr b-c	=	(metres)
						q b-a	=	65 (pcu/hr)
						q b-c	=	0 (pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

THE CAPACITY OF MOVEMENT :

Q b-a	=	481
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	481

CRITICAL DFC = 0.14

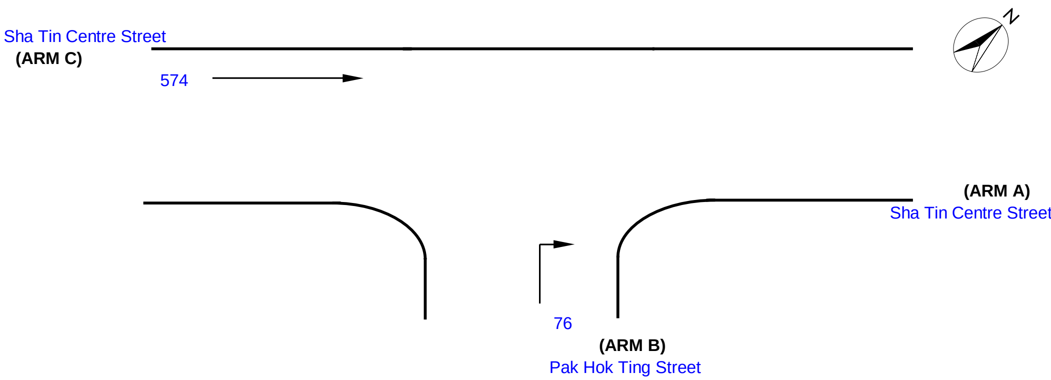
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.14
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.14

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2028 PM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



J22

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	9	(metres)	W c-b	=		(metres)	W b-a	=	4.7	(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=		(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	574	(pcu/hr)	Vl b-a	=	100	(metres)
q a-c	=	0	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=		(metres)
								Vr b-c	=		(metres)
								q b-a	=	76	(pcu/hr)
								q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

`

THE CAPACITY OF MOVEMENT :

Q b-a	=	510
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	510

CRITICAL DFC = 0.15

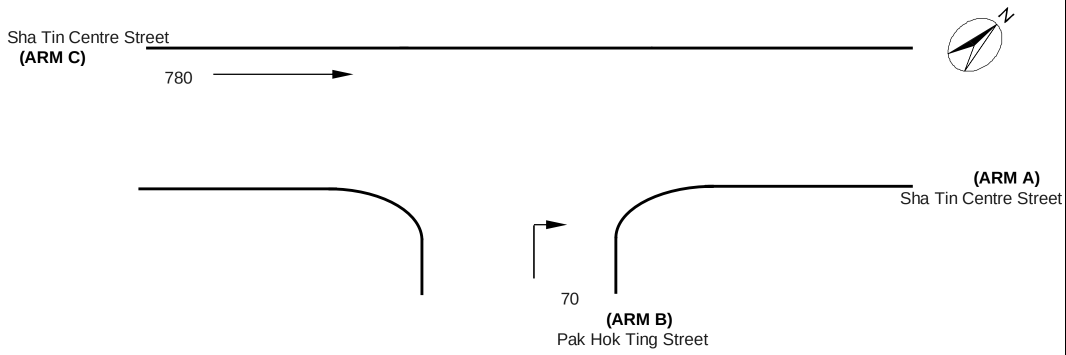
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.15
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.15

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2031 AM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



NOTES : (GEOMETRIC INPUT DATA)

J22

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	9	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	0	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	780	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=	4.7	(metres)
W b-c	=		(metres)
Vl b-a	=	100	(metres)
Vr b-a	=		(metres)
Vr b-c	=		(metres)
q b-a	=	70	(pcu/hr)
q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

`

THE CAPACITY OF MOVEMENT :

Q b-a	=	479
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	479

CRITICAL DFC = 0.15

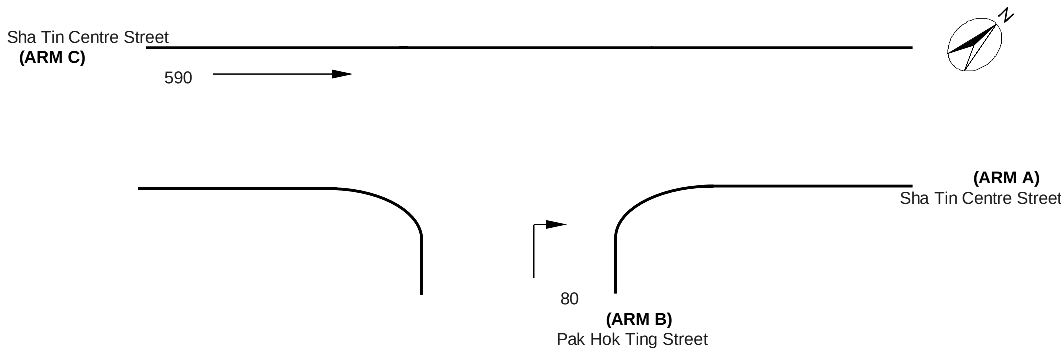
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.15
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.15

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2031 PM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



NOTES : (GEOMETRIC INPUT DATA)

J22

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	9	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	0	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	590	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=	4.7	(metres)
W b-c	=		(metres)
Vl b-a	=	100	(metres)
Vr b-a	=		(metres)
Vr b-c	=		(metres)
q b-a	=	80	(pcu/hr)
q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

THE CAPACITY OF MOVEMENT :

Q b-a	=	507
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	507

CRITICAL DFC = 0.16

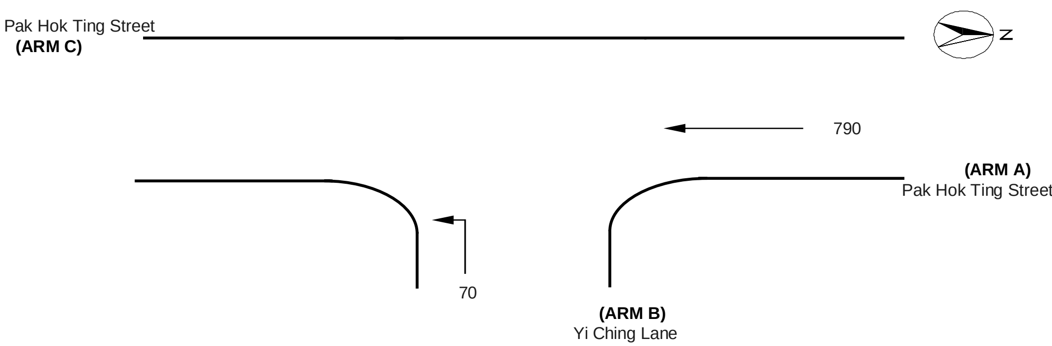
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.16
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.16

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2020 AM Traffic Flows	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



NOTES : (GEOMETRIC INPUT DATA)

J23

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	10	(metres)	W c-b	=		(metres)	W b-a	=		(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=	4.7	(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	0	(pcu/hr)	Vl b-a	=		(metres)
q a-c	=	790	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=	100	(metres)
								Vr b-c	=	100	(metres)
								q b-a	=	0	(pcu/hr)
								q b-c	=	70	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

`

THE CAPACITY OF MOVEMENT :

Q b-a	=	257
Q b-c	=	601
Q c-b	=	326
Q b-ac	=	601

CRITICAL DFC = 0.12

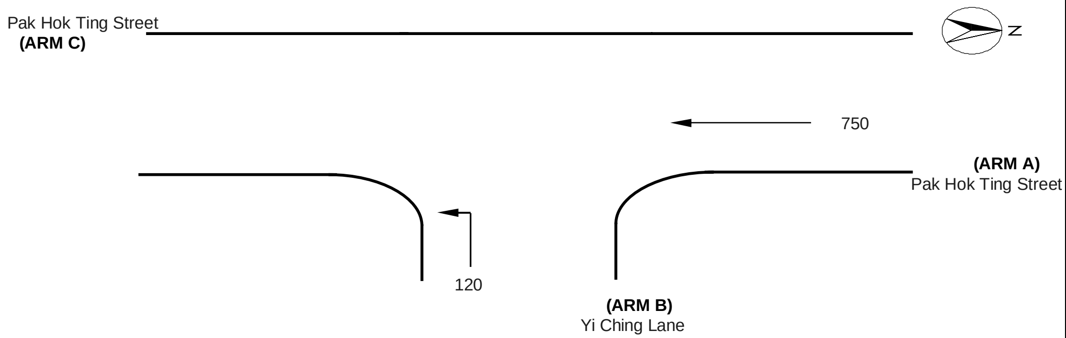
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.12
DFC c-b	=	0.00
DFC b-ac	=	0.12

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2020 PM Traffic Flows	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



NOTES : (GEOMETRIC INPUT DATA)

J23

W	=	Major Road Width (6.4 - 20.0)
W cr	=	Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	=	Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	=	Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	=	Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	=	Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	=	Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	=	Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	=	Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	=	Stream-specific B-A
E	=	Stream-specific B-C
F	=	Stream-specific C-B
Y	=	(1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	10	(metres)	W c-b	=		(metres)	W b-a	=		(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=	4.7	(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	0	(pcu/hr)	Vl b-a	=		(metres)
q a-c	=	750	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=	100	(metres)
								Vr b-c	=	100	(metres)
								q b-a	=	0	(pcu/hr)
								q b-c	=	120	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

`

THE CAPACITY OF MOVEMENT :

Q b-a	=	263
Q b-c	=	611
Q c-b	=	332
Q b-ac	=	611

CRITICAL DFC = 0.20

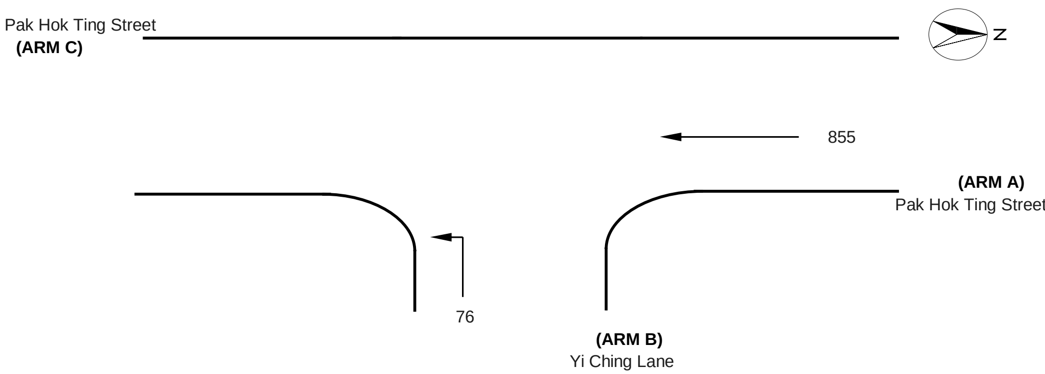
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.20
DFC c-b	=	0.00
DFC b-ac	=	0.20

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2028 AM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



NOTES : (GEOMETRIC INPUT DATA)

J23

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	10	(metres)	W c-b	=		(metres)	W b-a	=		(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=	4.7	(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	0	(pcu/hr)	Vl b-a	=		(metres)
q a-c	=	855	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=	100	(metres)
								Vr b-c	=	100	(metres)
								q b-a	=	0	(pcu/hr)
								q b-c	=	76	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	248
Q b-c	=	584
Q c-b	=	317
Q b-ac	=	584

CRITICAL DFC = 0.13

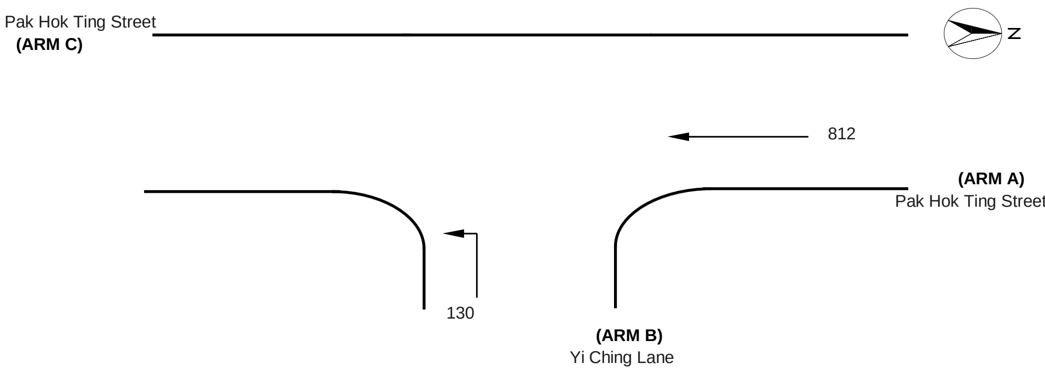
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.13
DFC c-b	=	0.00
DFC b-ac	=	0.13

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2028 PM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



NOTES : (GEOMETRIC INPUT DATA)

J23

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	10	(metres)	W c-b	=		(metres)	W b-a	=		(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=	4.7	(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	0	(pcu/hr)	Vl b-a	=		(metres)
q a-c	=	812	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=	100	(metres)
								Vr b-c	=	100	(metres)
								q b-a	=	0	(pcu/hr)
								q b-c	=	130	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	254
Q b-c	=	595
Q c-b	=	323
Q b-ac	=	595

CRITICAL DFC = 0.22

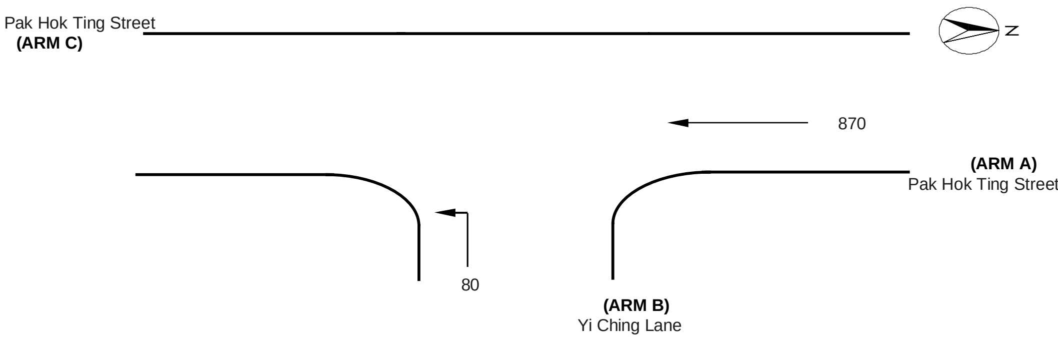
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.22
DFC c-b	=	0.00
DFC b-ac	=	0.22

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2031 AM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



J23

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	10	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	870	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	0	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=		(metres)
W b-c	=	4.7	(metres)
Vl b-a	=		(metres)
Vr b-a	=	100	(metres)
Vr b-c	=	100	(metres)
q b-a	=	0	(pcu/hr)
q b-c	=	80	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	246
Q b-c	=	580
Q c-b	=	315
Q b-ac	=	580

CRITICAL DFC = 0.14

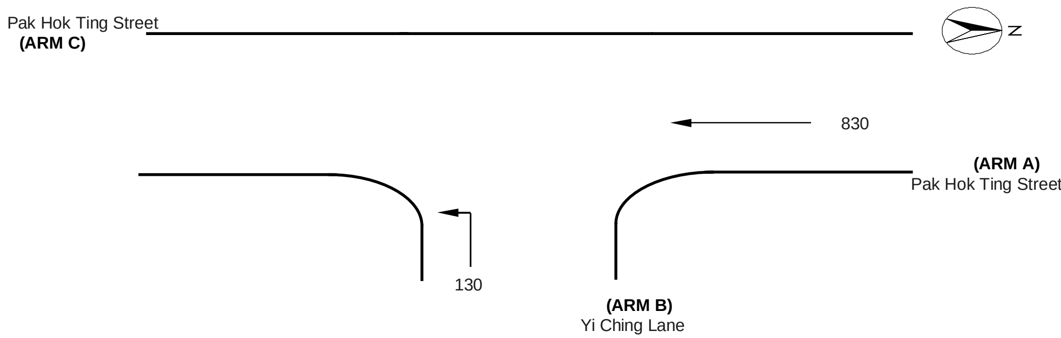
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.14
DFC c-b	=	0.00
DFC b-ac	=	0.14

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2031 PM Reference Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : Dec 20



NOTES : (GEOMETRIC INPUT DATA)

J23

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	10	(metres)	W c-b	=		(metres)	W b-a	=		(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=	4.7	(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	0	(pcu/hr)	Vl b-a	=		(metres)
q a-c	=	830	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=	100	(metres)
								Vr b-c	=	100	(metres)
								q b-a	=	0	(pcu/hr)
								q b-c	=	130	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

`

THE CAPACITY OF MOVEMENT :

Q b-a	=	252
Q b-c	=	590
Q c-b	=	321
Q b-ac	=	590

CRITICAL DFC = 0.22

COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.22
DFC c-b	=	0.00
DFC b-ac	=	0.22

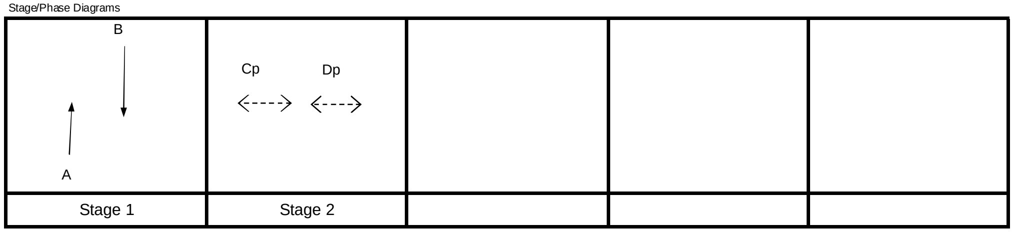
JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2020 AM Traffic Flows	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

J24

No. of stages per cycle	N =	2	
Cycle time	C =	77	sec
Sum(y)	Y =	0.128	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5 \times L+5)/(1-Y) =$	66	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	40	sec
Y_{ult}	$= 0.9-0.0075 \times L =$	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y \times 100\% =$	398.3	%
Practical Cycle Time C_p	$= 0.9 \times L/(0.9-Y) =$	41	sec
Y_{max}	$= 1-L/C =$	0.545	

Stage/Phase Diagrams



I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\% =$ 284%

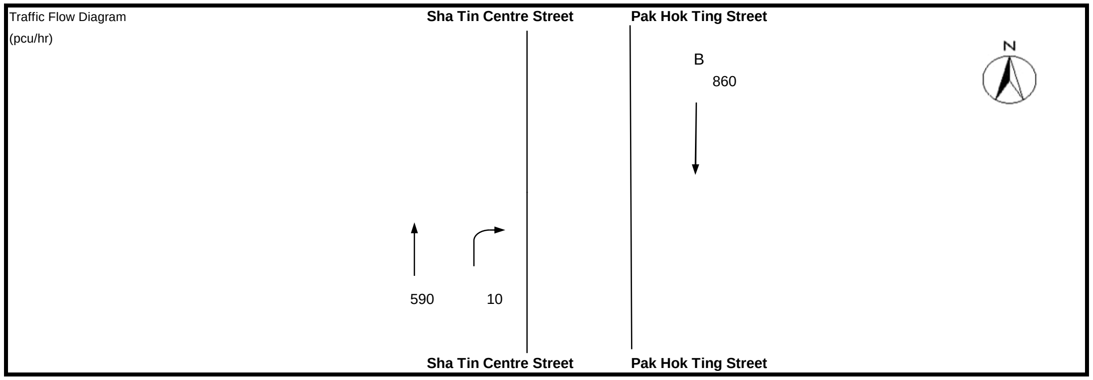
MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
	A	1	3.500	3				1		0		6175		670		670			6175	0.109		36		0.000	0
	B	1	3.500	3				1		0		6175		790		790			6175	0.128	0.128	42	41	0.235	0
Pedestrain Crossing				GM		FGM		Total																	
	Cp	2	min.	18	+	10	=	28	sec												*				
	Dp	2	min.	18	+	10	=	28	sec																
			min.		+		=	0	sec																
			min.		+		=	0	sec																
			min.		+		=	0	sec																
			min.		+		=	0	sec																

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2020 PM Traffic Flows	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

J24

Traffic Flow Diagram
(pcu/hr)



No. of stages per cycle		N = 2	
Cycle time		C = 82	sec
Sum(y)		Y = 0.139	
Lost time		L = 35	sec
Total Flow		= 12,350	pcu
Optimum Cycle C_o	$= (1.5 \times L+5)/(1-Y) =$	67	sec
Min. Cycle Time C_m	$= L/(1-Y)$ =	41	sec
Y_{ult}	$= 0.9-0.0075 \times L$ =	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y \times 100\%$ =	357.7	%
Practical Cycle Time C_p	$= 0.9 \times L/(0.9-Y)$ =	41	sec
Y_{max}	= 1-L/C =	0.573	

Stage/Phase Diagrams

Stage 1	Stage 2			

I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\% =$ 270%

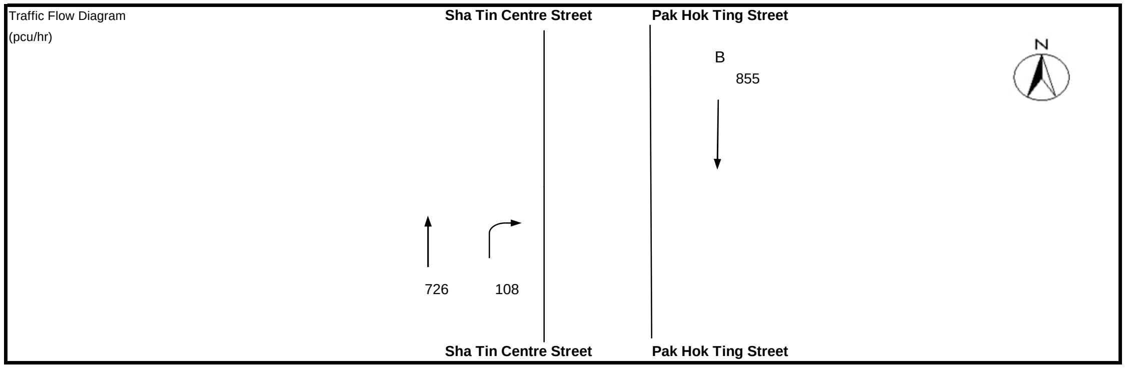
MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
	A	1	3.500	3				1		0		6175		590		590			6175	0.096		32		0.000	0
	B	1	3.500	3				1		0		6175		860		860			6175	0.139	0.139	47	46	0.243	0

Pedestrian Crossing			GM		FGM		Total		Critical
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2028 AM Reference Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

J24

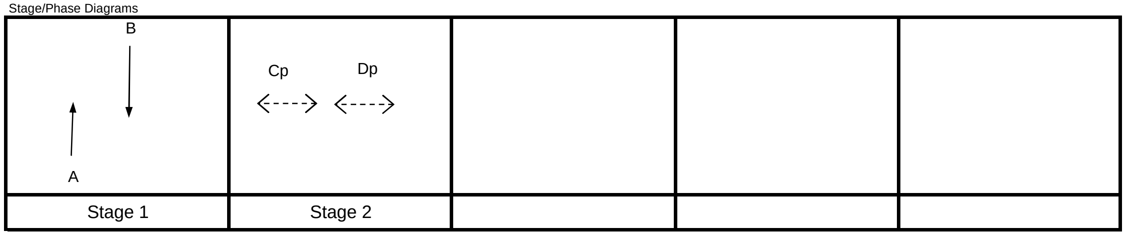


No. of stages per cycle	N =	2	
Cycle time	C =	77	sec
Sum(y)	Y =	0.138	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5 \times L+5)/(1-Y) =$	67	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	41	sec
Y_{ult}	$= 0.9-0.0075 \times L =$	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y \times 100\% =$	360.4	%
Practical Cycle Time C_p	$= 0.9 \times L/(0.9-Y) =$	41	sec
Y_{max}	$= 1-L/C =$	0.545	

Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\% =$ 255%

Stage/Phase Diagrams



I/G = 5 G = 18 I/G = 13

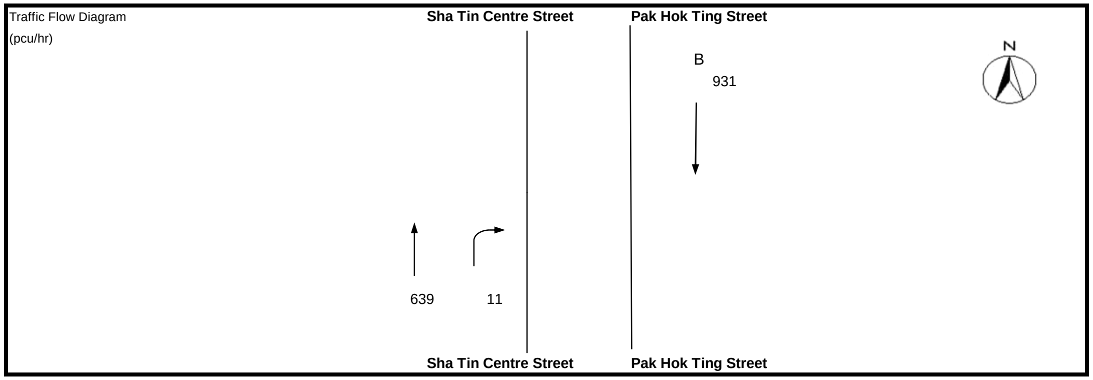
MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Y(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
↑	A	1	3.500	3				1		0		6175		726		726			6175	0.118		36		0.000	0
↑	B	1	3.500	3				1		0		6175		855		855			6175	0.138	0.138	42	41	0.254	0

Pedestrain Crossing			GM		FGM		Total		
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

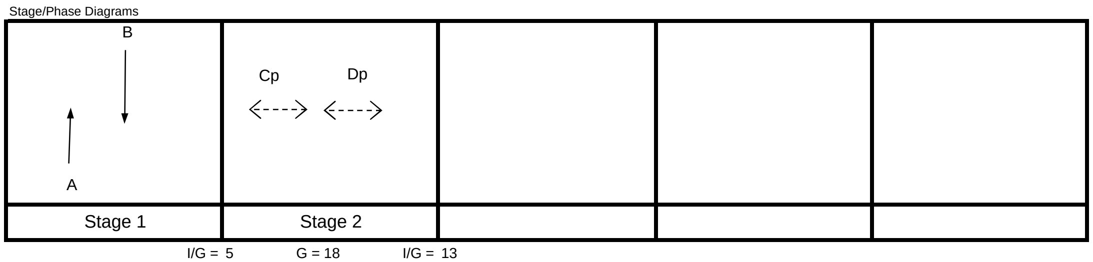
JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2028 PM Reference Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

J24



No. of stages per cycle	N =	2	
Cycle time	C =	82	sec
Sum(y)	Y =	0.151	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5\times L+5)/(1-Y) =$	68	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	41	sec
Y_{ult}	$= 0.9-0.0075\times L =$	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y\times100\% =$	322.8	%
Practical Cycle Time C_p	$= 0.9\times L/(0.9-Y) =$	42	sec
Y_{max}	$= 1-L/C =$	0.573	



Critical Case : B,Cp

R.C.(C) $= (0.9\times Y_{max}-Y)/Y\times100\% =$ 242%

MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
↑	A	1	3.500	3				1		0		6175		639		639			6175	0.103		32		0.000	0
↑	B	1	3.500	3				1		0		6175		931		931			6175	0.151	0.151	47	46	0.263	0

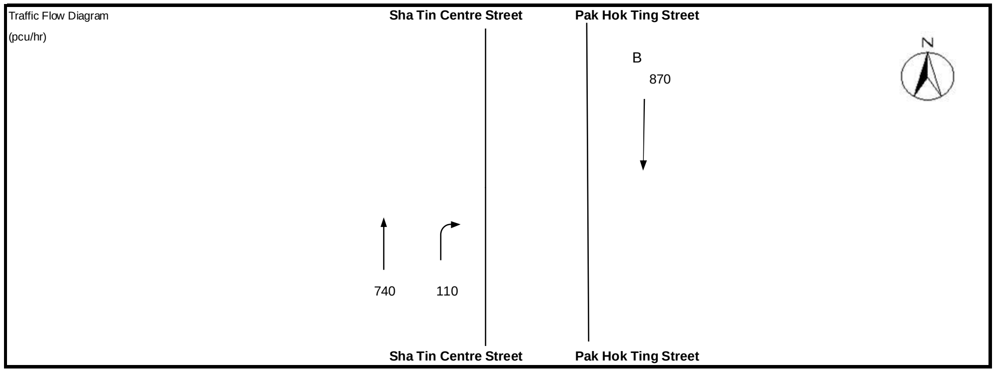
Pedestrian Crossing				GM		FGM		Total		
Cp	2	min.		18	+	10	=	28	sec	*
Dp	2	min.		18	+	10	=	28	sec	
		min.			+		=	0	sec	
		min.			+		=	0	sec	
		min.			+		=	0	sec	
		min.			+		=	0	sec	

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2031 AM Reference Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

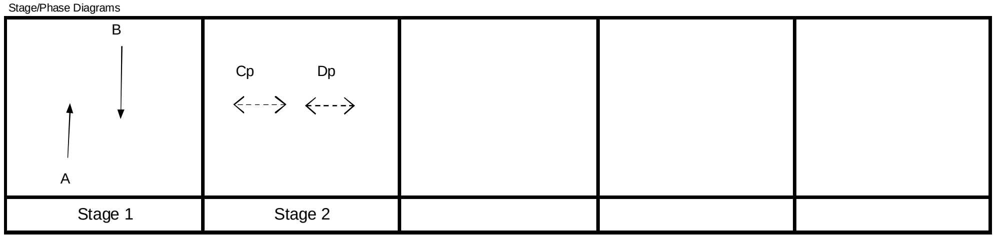
J24

Traffic Flow Diagram
(pcu/hr)



No. of stages per cycle	N =	2	
Cycle time	C =	77	sec
Sum(y)	Y =	0.141	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5 \times L+5)/(1-Y) =$	67	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	41	sec
Y_{ult}	$= 0.9-0.0075 \times L =$	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y \times 100\% =$	352.5	%
Practical Cycle Time C_p	$= 0.9 \times L/(0.9-Y) =$	41	sec
Y_{max}	$= 1-L/C =$	0.545	

Stage/Phase Diagrams



I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9 \times Y_{max}-Y)/Y \times 100\% =$ 248%

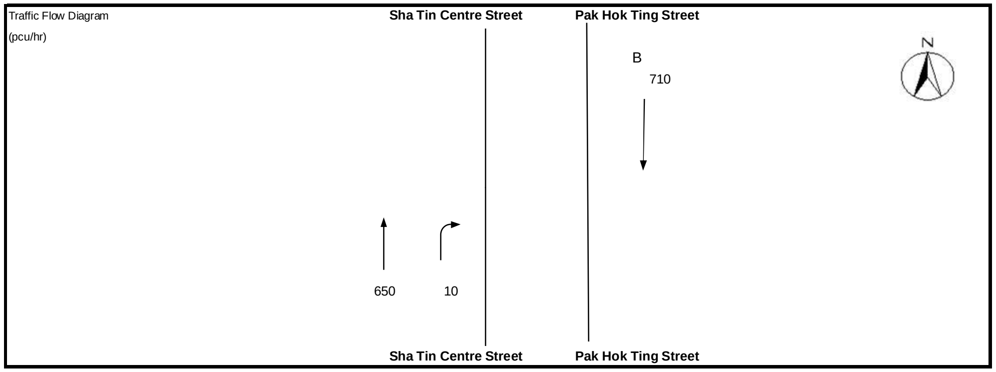
MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
↑	A	1	3.500	3				1		0		6175		740		740			6175	0.120		36		0.000	0
↑	B	1	3.500	3				1		0		6175		870		870			6175	0.141	0.141	42	41	0.258	0

Pedestrain Crossing			GM		FGM		Total		CRITICAL
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

JUNCTION CAPACITY CALCULATION

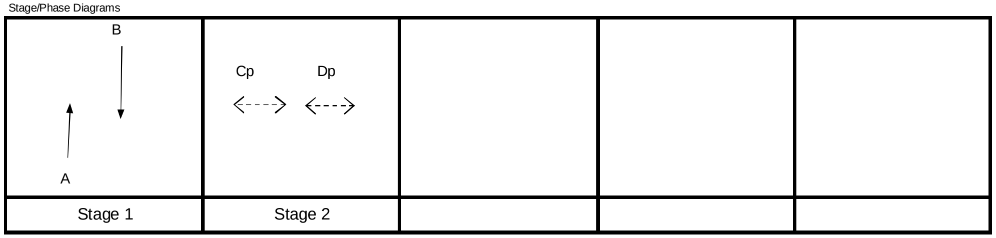
Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2031 PM Reference Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

J24



No. of stages per cycle	N =	2	
Cycle time	C =	82	sec
Sum(y)	Y =	0.115	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5\times L+5)/(1-Y) =$	65	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	40	sec
Y_{ult}	$= 0.9-0.0075\times L =$	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Yx100\% =$	454.4	%
Practical Cycle Time C_p	$= 0.9\times L/(0.9-Y) =$	40	sec
Y_{max}	$= 1-L/C =$	0.573	

Stage/Phase Diagrams



I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\% =$ 349%

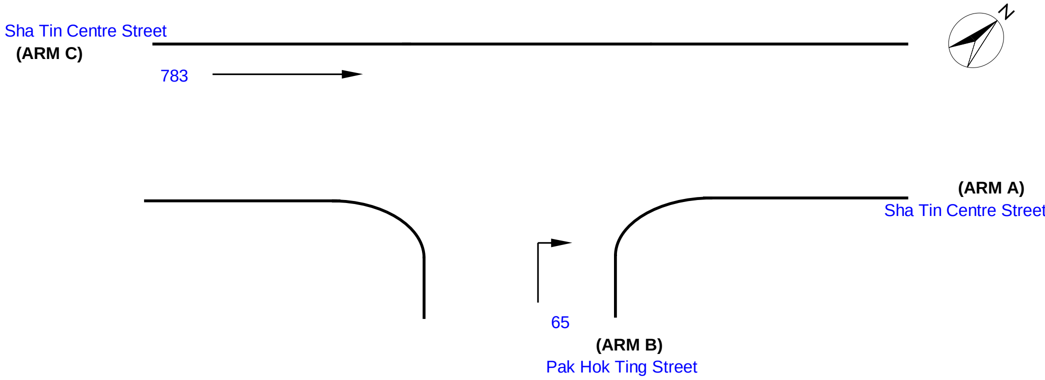
MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
↑	A	1	3.500	3				1		0		6175		650		650			6175	0.105		43		0.000	0
↑	B	1	3.500	3				1		0		6175		710		710			6175	0.115	0.115	47	46	0.201	0

Pedestrain Crossing			GM		FGM		Total		CRITICAL
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2028TTM AM Design Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



J22

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	9	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	0	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	783	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=	4.7	(metres)
W b-c	=		(metres)
Vl b-a	=	100	(metres)
Vr b-a	=		(metres)
Vr b-c	=		(metres)
q b-a	=	65	(pcu/hr)
q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

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THE CAPACITY OF MOVEMENT :

Q b-a	=	479
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	479

CRITICAL DFC = 0.14

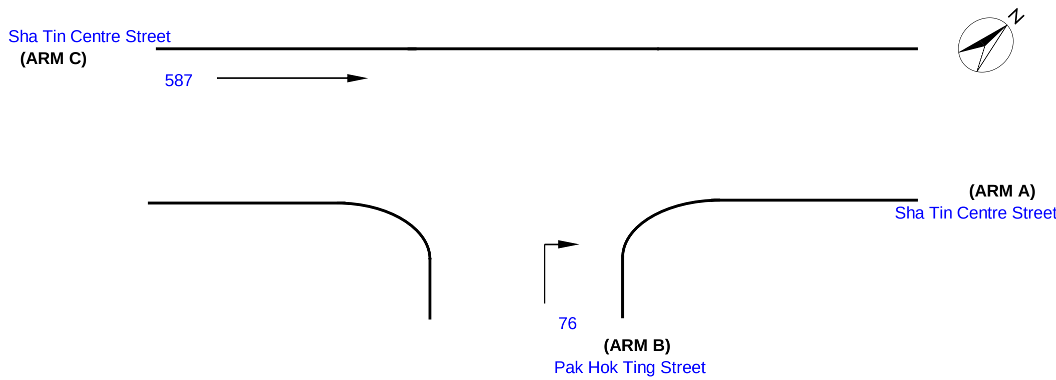
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.14
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.14

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J22 - Pak Hok Ting Street / Sha Tin Centre Street	2028TTM PM Design Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



NOTES : (GEOMETRIC INPUT DATA)

J22

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	9	(metres)	W c-b	=		(metres)	W b-a	=	4.7	(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=		(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	587	(pcu/hr)	Vl b-a	=	100	(metres)
q a-c	=	0	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=		(metres)
								Vr b-c	=		(metres)
								q b-a	=	76	(pcu/hr)
								q b-c	=	0	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.950639
E	=	0.585955
F	=	0.585955
Y	=	0.689500

`

THE CAPACITY OF MOVEMENT :

Q b-a	=	508
Q b-c	=	437
Q c-b	=	437
Q b-ac	=	508

CRITICAL DFC = 0.15

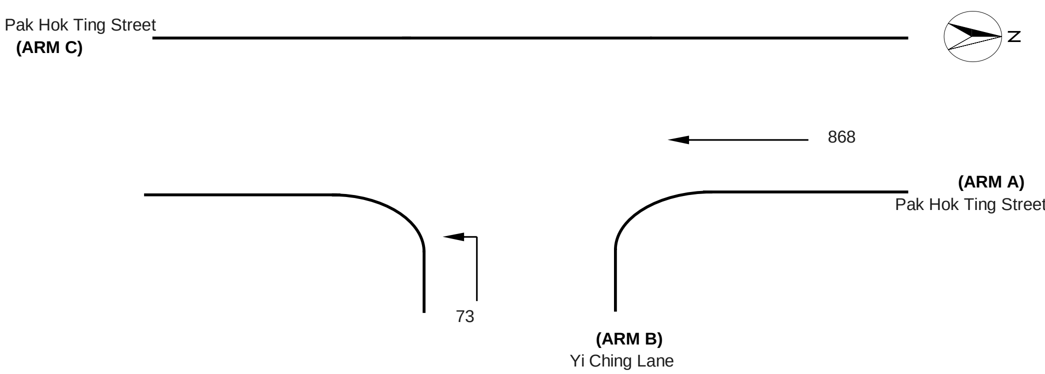
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.15
DFC b-c	=	0.00
DFC c-b	=	0.00
DFC b-ac	=	0.15

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2028TTM AM Design Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



NOTES : (GEOMETRIC INPUT DATA)

J23

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)

W	=	10	(metres)
W cr	=		(metres)
q a-b	=	0	(pcu/hr)
q a-c	=	868	(pcu/hr)

MAJOR ROAD (ARM C)

W c-b	=		(metres)
Vr c-b	=		(metres)
q c-a	=	0	(pcu/hr)
q c-b	=	0	(pcu/hr)

MINOR ROAD (ARM B)

W b-a	=		(metres)
W b-c	=	4.7	(metres)
Vl b-a	=		(metres)
Vr b-a	=	100	(metres)
Vr b-c	=	100	(metres)
q b-a	=	0	(pcu/hr)
q b-c	=	73	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	247
Q b-c	=	581
Q c-b	=	315
Q b-ac	=	581

CRITICAL DFC = 0.13

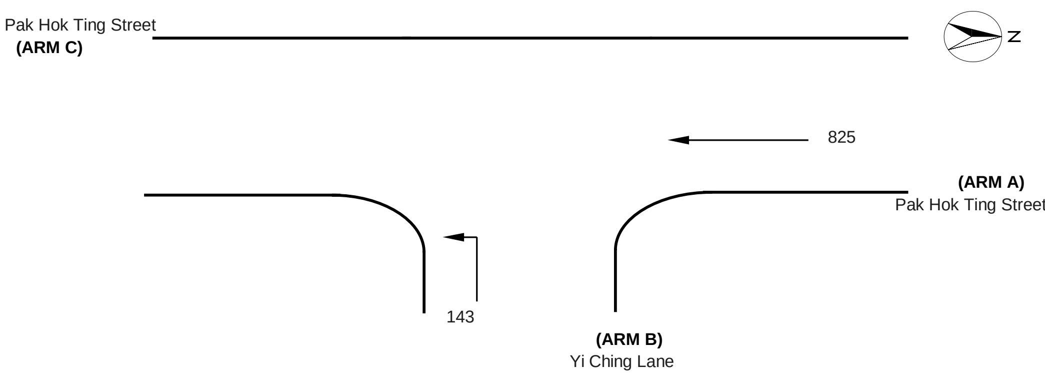
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.13
DFC c-b	=	0.00
DFC b-ac	=	0.13

PRIORITY JUNCTION CAPACITY CALCULATION

AECOM

Junction J23 - Yi Ching Lane / Pak Hok Ting Street	2028TTM PM Design Case	Designed By : JY	Checked By : HY	Job No. : 60617767	Date : May 23



J23

NOTES : (GEOMETRIC INPUT DATA)

W	= Major Road Width (6.4 - 20.0)
W cr	= Central Reserve width (1.2 - 9.0, kerbed central reserve only)
W b-a	= Lane width available to vehicle waiting in stream b-a (2.05 - 4.70)
W b-c	= Lane width available to vehicle waiting in stream b-c (2.05 - 4.70)
W c-b	= Lane width available to vehicle waiting in stream c-b (2.05 - 4.70)
Vl b-a	= Visibility to the left for vehicles waiting in stream b-a (22.0 - 250.0)
Vr b-a	= Visibility to the right for vehicles waiting in stream b-a (17.0 - 250.0)
Vr b-c	= Visibilitu to the right for vehicles waiting in stream b-c (17.0 - 250.0)
Vr c-b	= Visibility to the right for vehicles waiting in stream c-b (17.0 - 250.0)
D	= Stream-specific B-A
E	= Stream-specific B-C
F	= Stream-specific C-B
Y	= (1-0.0345W)

GEOMETRIC DETAILS:

MAJOR ROAD (ARM A)				*MAJOR ROAD (ARM C)*				*MINOR ROAD (ARM B)*			
W	=	10	(metres)	W c-b	=		(metres)	W b-a	=		(metres)
W cr	=		(metres)	Vr c-b	=		(metres)	W b-c	=	4.7	(metres)
q a-b	=	0	(pcu/hr)	q c-a	=	0	(pcu/hr)	Vl b-a	=		(metres)
q a-c	=	825	(pcu/hr)	q c-b	=	0	(pcu/hr)	Vr b-a	=	100	(metres)
								Vr b-c	=	100	(metres)
								q b-a	=	0	(pcu/hr)
								q b-c	=	143	(pcu/hr)

GEOMETRIC FACTORS :

D	=	0.587019
E	=	1.078923
F	=	0.585955
Y	=	0.655000

THE CAPACITY OF MOVEMENT :

Q b-a	=	253
Q b-c	=	592
Q c-b	=	322
Q b-ac	=	592

CRITICAL DFC = 0.24

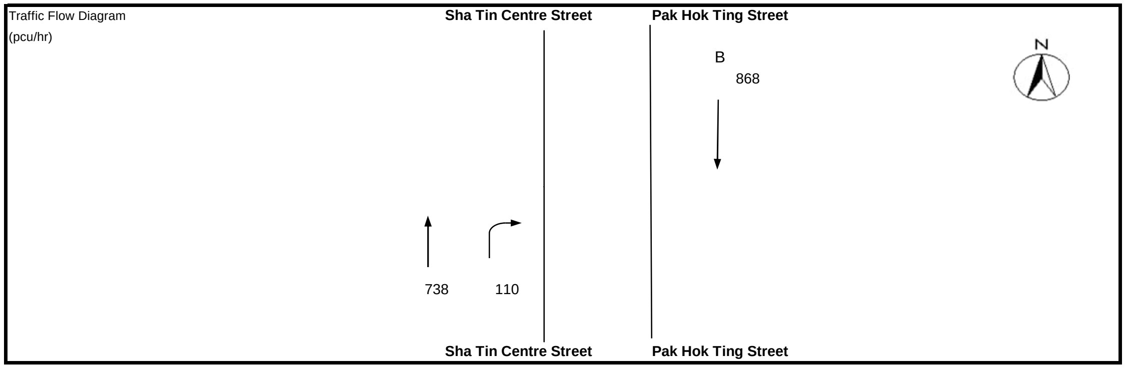
COMPARISION OF DESIGN FLOW TO CAPACITY :

DFC b-a	=	0.00
DFC b-c	=	0.24
DFC c-b	=	0.00
DFC b-ac	=	0.24

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2028TTM AM Design Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

Traffic Flow Diagram
(pcu/hr)



J24

No. of stages per cycle	N =	2	
Cycle time	C =	77	sec
Sum(y)	Y =	0.141	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5\times L+5)/(1-Y) =$	67	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	41	sec
Y_{ult}	$= 0.9-0.0075\times L =$	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y\times100\% =$	353.5	%
Practical Cycle Time C_p	$= 0.9\times L/(0.9-Y) =$	41	sec
Y_{max}	$= 1-L/C =$	0.545	

Stage/Phase Diagrams

Stage 1	Stage 2			

I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9xY_{max}-Y)/Yx100\% =$ 249%

MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
↑	A	1	3.500	3				1		0		6175		738		738			6175	0.120		36		0.000	0
↑	B	1	3.500	3				1		0		6175		868		868			6175	0.141	0.141	42	41	0.258	0

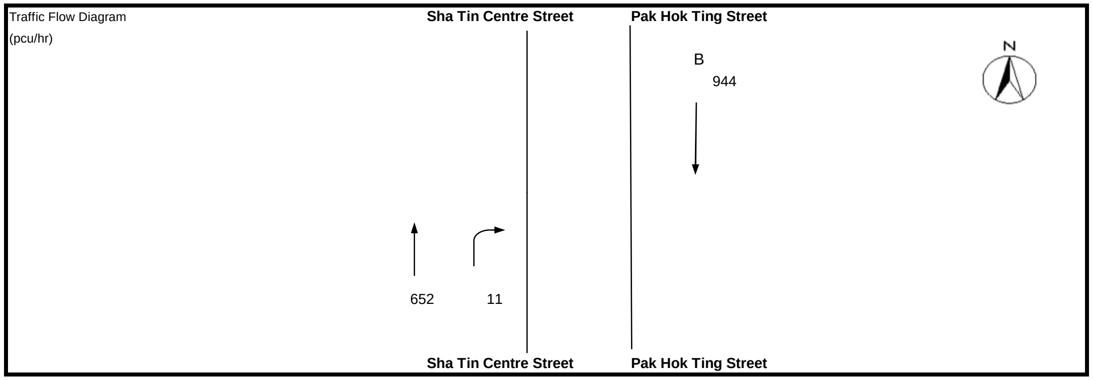
Pedestrain Crossing			GM		FGM		Total		
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

JUNCTION CAPACITY CALCULATION

Junction J24 - Pak Hok Ting Street / Sha Tin Centre Street	2028TTM PM Design Case	DESIGN: JY	CHECK: HY	JOB NO: 60617767	DATE: Dec 20

J24

Traffic Flow Diagram
(pcu/hr)



No. of stages per cycle	N =	2	
Cycle time	C =	82	sec
Sum(y)	Y =	0.153	
Lost time	L =	35	sec
Total Flow	=	12,350	pcu
Optimum Cycle C_o	$= (1.5\times L+5)/(1-Y) =$	68	sec
Min. Cycle Time C_m	$= L/(1-Y) =$	41	sec
Y_{ult}	$= 0.9-0.0075\times L =$	0.638	
$R.C._{ult}$	$= (Y_{ult}-Y)/Y\text{x}100\% =$	317.0	%
Practical Cycle Time C_p	$= 0.9\times L/(0.9-Y) =$	42	sec
Y_{max}	$= 1-L/C =$	0.573	

Stage/Phase Diagrams

Stage 1	Stage 2			

I/G = 5 G = 18 I/G = 13

Critical Case : B,Cp

R.C.(C) $= (0.9\text{x}Y_{max}-Y)/Y\text{x}100\% =$ 237%

MOVEMENT	PHASE	STAGE	LANE WIDTH (m)	NO. OF LANES	RADIUS (m) LEFT	RADIUS (m) RIGHT	OPPOSING TRAFFIC	NEAR SIDE LANE	UPHILL GRADIENT (%)	GRADIENT EFFECT (pcu/hr)	ADDITIONAL CAPACITY (pcu/hr)	STRAIGHT-AHEAD SAT. FLOW (pcu/hr)	FLOW (pcu/hr) LEFT	FLOW (pcu/hr) STRAIGHT AHEAD	FLOW (pcu/hr) RIGHT	TOTAL FLOW (pcu/hr)	PROPORTION OF TURNING VEHICLES (%) LEFT	PROPORTION OF TURNING VEHICLES (%) RIGHT	REVISED SAT. FLOW (pcu/hr)	FLOW FACTOR y	CRITICAL y	EFFECTIVE GREEN g=y/Yx(C-L) (sec)	ACTUAL GREEN G (sec)	DEGREE OF SATURATION X	Average Queue N
	A	1	3.500	3				1		0		6175		652		652			6175	0.106		32		0.000	0
	B	1	3.500	3				1		0		6175		944		944			6175	0.153	0.153	47	46	0.267	0

Pedestrian Crossing			GM		FGM		Total		CRITICAL
Cp	2	min.	18	+	10	=	28	sec	*
Dp	2	min.	18	+	10	=	28	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	
		min.		+		=	0	sec	

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+852 3922 9797 fax

Your Ref.: Application No.: A/ST/1025
Our Ref.: AYFW:BWYM:etly:60674881/13.27-0158 (2024000742W)

25 January 2024

By Hand

Town Planning Board
15/F, North Point Government Offices
333 Java Road
North Point, Hong Kong

Attn.: Secretary of Town Planning Board

Dear Sir/Madam,

Application No.: A/ST/1025
Section 16 Planning Application for Proposed Public Utility Installation (Stormwater Storage Facility) in Government Land at Sha Tin Park near Yi Ching Lane, Sha Tin, New Territories

We are pleased to submit Further Information (Response-to-Comment Table and corresponding amendment pages) for the captioned Section 16 Planning Application.

Should you have any queries, please feel free to contact our Ms. Bella Wong.

Yours faithfully,
For and on behalf of
AECOM Asia Co. Ltd.

Alex Wu
Executive Director
Water, Hong Kong

Encl.

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+852 3922 9797 fax

Your Ref.: Application No.: A/ST/1025
Our Ref.: AYFW:BWYM:etly:60674881/13.27-0158 (2024000742W)

25 January 2024

By Hand

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333 Java Road
North Point, Hong Kong

Attn.: Secretary of Town Planning Board

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Yours faithfully,
For and on behalf of
AECOM Asia Co. Ltd.

Alex Wu
Executive Director
Water, Hong Kong

Encl.

APPLICATION NO. A/ST/1025

Submission of Further Information

A_ST_1025_FI(2)_Response to Comments

25 January 2024

Application No.: A/ST/1025

Proposed Public Utility Installation (Stormwater Storage Facility)

Government Land at Sha Tin Park near Yi Ching Lane, Sha Tin, New Territories

Responses to Comments

Comments Received

1. TD
2. EPD
3. FSD
4. ArchSD
5. FEHD
6. PlanD / Landscape Unit
7. LandsD
8. PlanD / Urban Design Unit

Application No.: A/ST/1025

Proposed Public Utility Installation (Stormwater Storage Facility)

Government Land at Sha Tin Park near Yi Ching Lane, Sha Tin, New Territories

Responses to Comments

Item	Comments	Responses
1.	**Transport Department**	
	As discussed with Mr. Bob YEUNG at 3856 5504 from AECOM, please note that the Traffic Impact Assessment (TIA) Report at Appendix I is not an updated version. Please provide the latest version of TIA report for review.	The latest version of TIA report was submitted as Further Information on 5 January 2024.
2.	**Environmental Protection Department**	
	2. Having reviewed the application, we consider that our previous view provided on 24 Apr 2023 remains valid, i.e. no objection to the proposed public utility installation (stormwater storage facility).	Noted with Thanks.
	3. Nonetheless, based on our record, the proposed stormwater storage facility under the captioned application is part of the PWP item No. 4182CD – "Drainage Improvement Works in Sha Tin and Sai Kung". The applicant has conducted a Preliminary Environmental Review (PER) and a Sewerage Impact Assessment for this PWP item. As the PER is yet to be accepted by us, the applicant and her consultant are reminded to revise the PER to our satisfaction to address the potential environmental impacts and propose necessary mitigation measures.	Revised PER for PWP item No. 4182CD – "Drainage Improvement Works in Sha Tin and Sai Kung" would be submitted to EPD's satisfaction at the detailed design stage of the Project.
3.	**Fire Services Department**	
	1. Please be informed that I have no specific comment on the captioned application.	Noted with Thanks.

Item	Comments	Responses
	2. Detailed fire services requirements will be formulated upon receipt of formal submission of general building plans. 3. The EVA provision shall comply with the standard as stipulated in Section 6, Part D of the Code of Practice for Fire Safety in Buildings 2011, which is administered by the Buildings Department.	Formal submission of general building plans would be submitted at the detailed design stage of the Project. The EVA provision is complied with the standard as stipulated in Section 6, Part D of the Code of Practice for Fire Safety in Buildings 2011.
4.	**Architectural Services Department**	
	2. Based on the information provided, it is noted that the proposed, pumping station consists of a one-storey pump house building with building height of about 10m above ground level and a transformer room building of about 5.65m above ground level. As shown in the photomontages, vertical greening and some variations to the use of materials on the building facades have been incorporated for the pump house building and plantings are shown around the fence wall to soften the visual impact. the applicant may wish to further consider the treatment/articulation of the building facades of the two buildings in the design stage, particularly along the 41m long elevation of the pump house building to reduce the massive scale, and for the back elevations of the transformer room building, including its fence wall.	Design the treatment/articulation of the building facades of the two buildings would be further reviewed in the design stage of the Project.

Item	Comments	Responses
5..	**Food and Environmental Hygiene Department**	
	2. Please be informed that FEHD has no adverse comment on the subject planning application. Our advisory comments are provided as follows: • *To our understanding, the improvements works would be conducted at Sha Tin Park in Sha Tin Town Centre, i.e. No Food and Environmental Hygiene Department's (FEHD) facilities will be affected.* • *In case that FEHD is requested to take up management responsibility of new refuse collection points and other facilities, FEHD should be separately consulted. Prior consent from FEHD must be obtained and sufficient amount of recurrent cost must be provided to us;* • *If provision of cleansing service for new public roads, streets, cycle tracks, footpaths, paved areas, public carpark, footbridge, subway, etc, is required, FEHD should be separately consulted. Prior consent from FEHD must be obtained and sufficient amount of recurrent cost must be provided to us;* • *The associated works and operations shall not cause any environmental nuisance, pest infestation and obstruction to the surrounding. For any waste generated from the operations and works, the project proponent should arrange its proper disposal at their own expenses;*	No FEHD facilities will be affected by the proposed works. Noted, in case the FEHD facilities will be affected, FEHD would be consulted. Noted. Provision of cleaning service by FEHD is not required. Noted. The associated works and operations would not cause any environmental nuisance, pest infestation and obstruction to the surrounding. For waste generated from the operations and works, the project proponent would arrange its proper disposal at own expenses.

Item	Comments	Responses
6.	**Planning Department** **Landscape Unit**	
	Landscape Observations and Comments 2. Based on the aerial photo of 2022, the site is situated in an area of urban park landscape character surrounded by existing residential buildings, government facilities, roads and tree groups. Significant impact on the landscape character arising from the proposed development is not anticipated.	Noted with Thanks.
	3. According to the Planning Application Report, the site is occupied by existing park with leisure facilities. With reference to the tree information provided by the applicant, 83 trees are identified within the application boundary, no Old and Valuable Tree (OVT) is identified and 58 trees are proposed to be felled. Mitigation measures including 9 new trees of native species within application boundary, 49 new trees and transplantation of 16 trees at off-site location, vertical greening, and reinstatement of landscape area are proposed. Significant adverse landscape impact on the existing landscape resource arising from the proposed use is not anticipated. We have no objection to the application from landscape planning perspective.	Noted with Thanks.
	Detailed/ Advisory Comments 4. It is observed that several of our previous comment dated 7.11.2023, 3.10.2023, 27.7.2023, 21.4.2023 and 10.11.2022 via email to DPO regarding the pre-submission have not been fully addressed and are recapped as follow (item i to ix).	

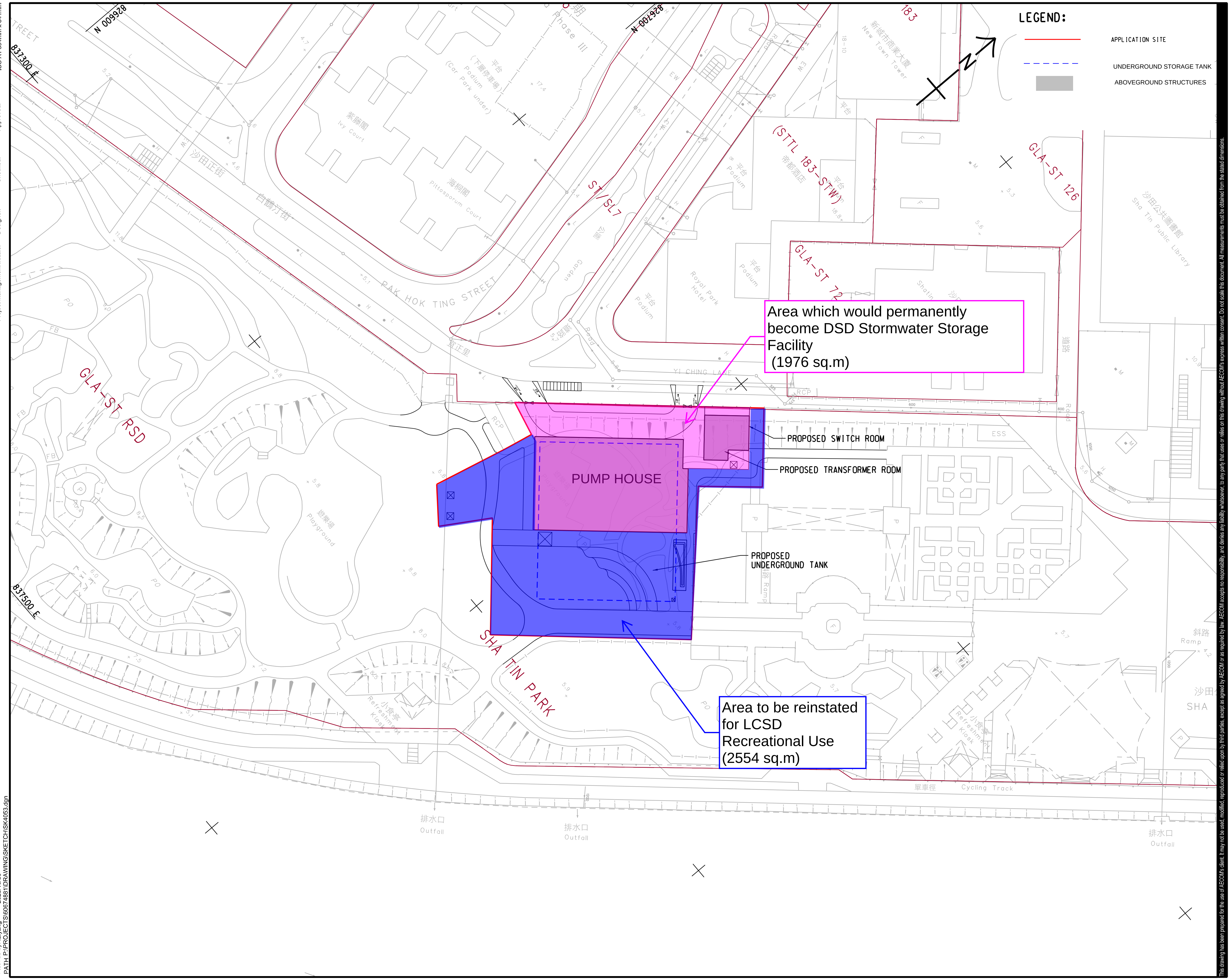
Item	Comments	Responses
	i. Please be advised that sufficient and consistent information on conceptual layout showing the proposed landscape treatments/ mitigation measures should be provided in relevant sections of the planning statement (e.g. para 3,2 & 5.5, etc.). The applicant is advised to make reference to TPB's Guidance Notes "Application for Permission under Section 16 of the Town Planning Ordinance".	Noted.
	ii. It is advised to elaborate more on the mitigation measures (e.g. the number of existing tree to be retained, transplanted, removed, and new tree plantings within and outside the application boundary, re-provision of landscape area) in relevant paragraphs of the Planning Statement (e.g. para. 3.2 and 5.5 etc.).	The detailed elaboration on the mitigation measures (e.g. the number of existing tree to be retained, transplanted, removed, and new tree plantings within and outside the application boundary, re-provision of landscape area) was described in Appendix E of the original submission.
	iii. Self-explanatory information (e.g. scale bar, spot level of key landscape areas) should be provided on the landscape layout plan and all landscape drawings to illustrate the proposed greening and landscape treatments at different levels.	Annotation of spot levels for the proposed greening and landscape treatment are supplemented at Appendix F.
	iv. Appendix B & Appendix G:- Key plans showing view angle of site photos and photomontages should be provided.	Layout plan for view angles for the photomontage is supplemented at Appendix B. Layout plan for view angles for the photomontage is supplemented for Appendix G.
	v. Appendix C & G:- Landscape provision (e.g. location of retain and new trees) are not observed in the photomontages. Please review and revise.	The trees were not shown in photomontages in Appendix C & G of original submission for clarity in order to clearly illustrate the proposed stormwater storage facility.
	vi. Appendix E:- The applicant should clarify the meaning and add a legend for the blue dotted line in the plans under Appendix E.	The blue dotted line were shown at plans Drawing No. at Appendix E of the original submission. – – – – – – UNDERGROUND STORAGE TANK

Item	Comments	Responses
	vii. Appendix E:- For Tree Assessment Schedule (TAS), some trees are recommended to be removed and some are rated to have low suitability for transplanting without justification provided. The TAS should be review as appropriate.	Please refer to the revised Tree Assessment Schedule (TAS) in Appendix E with the justifications added in the "Remarks" under "suitability for transplanting".
	viii. Appendix F:- Landscape sections and elevations with proposed landscape provision and key dimension are advised to be provided to illustrate the indicative landscape quality of the proposed landscape provisions and the relationship of the building associated structures.	Please refer to the landscape sections and elevations supplemented in Appendix F.
	ix. Appendix F:- The layout of green roof as shown on the Landscape Plan (DWG no. 60674881/SK4124) is inconsistent with that indicated in Appendix C. Please rectify all inconsistencies.	The layout of green roof in Appendix C is for illustration only. Exact layout of green roof should refer to Landscape Plan (DWG no. 60674881/SK4124) in Appendix C of the original submission.
	5. Appendix C & F:- According to the tree assessment schedule under appendix E, tree T209 is proposed to be retained but is missing in figure 1a and the landscape plan (DWG no. 60674881/SK4124).	Tree T209 is added in revised DWG no. 60674881/SK4124 in the amended pages and supplement at Appendix F.
	6. Appendix D:- The application boundary in Sha Tin Park Facilities Plan is different from the application boundary in other sections in the report. Please review and revise.	Noted, please refer to the amendment page at Appendix D as supplemented.
	7. Appendix E:- The crown spread of proposed retain trees is advised to be annotated in the tree compensation plan (DWG No.: 60674811/SK4096) to ensure adequate space is provided for proposed planting and demonstrate the new tree planting proposal is practicable.	Please refer to revised DWG No.: 60674811/SK4096 in Appendix E as supplemented.
	8. Appendix F:- Typical landscape details of proposed vertical greening system with key dimensions should be provided.	Landscape details of proposed vertical greening system are supplemented for in Appendix F for reference.

Item	Comments	Responses
	9. Appendix F:- Considering Liriope spicata is a herb species, the legend “shrubs” is advised to be revised as “shrubs & groundcover”.	Noted, please refer to the amendment page at Appendix F as enclosed.
	10. It is observed that there is still space for tree planting at the lawn areas. The applicant is advised to explore opportunity for tree planting within the Site as far as practicable where sufficient growing space can be identified. In situations where compensatory planting ratio of 1:1 in terms of aggregated DBH cannot be achieved, the difficulties should be demonstrated.	Noted. As agreed with LCSD, the lawn areas should not be fully utilized for tree planting in order to reprovide a lawn area for the park visitors. Hence, compensatory planting ratio of 1:1 in terms of aggregated DBH cannot be achieved within the Application Site.
	11. The applicant should be advised that approval of the application does not imply approval of tree works such as pruning, transplanting and felling under lease. The applicant is reminded to seek approval for any proposed tree works from relevant departments prior to commencement of the works.	Noted. Approval for the proposed tree works from relevant departments prior to commencement of the works would be sought.
7.	**Lands Department**	
	2. The Application Site, having an area of about 4,530m^2, for the proposed Stormwater Storage Facility (“Drainage facilities”) falls within **Sha Tin Park** held under the existing GLA-ST 299 (“the GLA”) which was allocated to the then New Territories Services Department on 17.6.1983 and is now responsible by Leisure and Cultural Services Department (LCSD) as allocatee. Under the engineering conditions of the GLA, no structure shall exceed a height of 10.67m above the mean formation level and maximum build over area of 5%. We also note that Sha Tin Park has also been set aside for use as public pleasure grounds under the public Health and Municipal Service Ordinance (Cap. 132).	Noted.

Item	Comments	Responses
	3. According to the Executive Summary of the Planning Submission, the completed drainage improvement facilities and the green open area within the Application Site would be managed and maintained by DSD and LCSD respectively. If the s.16 application is approved by the TPB, LCSD and DSD should liaise with our office for any necessary amendments/arrangement of the GLA (including the boundary) in connection with the aforesaid completed uses.	Noted. DSD would liaise with LCSD and LandsD for any necessary amendments/arrangement of the GLA (including the boundary) in due course.
	4. In addition, we note that the proposed work boundary of the associate drainage pipes outside the Application Site as shown on the drawing nos. *60674881/R13/431 and 60617767/PER/FIGURE 2.5* both of Appendix H at Preliminary' Environmental Review Report are not consistent, The applicant should be advised that the drainage pipes as shown on the drawing no. *60617767/PER/FIGURE 2.5 of* Appendix II together with another drawing no*.60617767/TIA ST/FIGURE 1.9.1* of Appendix I at Traffic Impact Assessment Report should not fall within the areas responsible by the owners of the relevant private developments under lease including (i) the Green Area of STTL 268 (Scenery Court), (ii) the Pink Area and near the Pink Hatched Green Area of STTL 161 (Hilton Plaza) and (iii) the Amenity Area of STTL 361 (New Town Plaza Phase III) to tally with the drawing no. *60674881/R13/431* because the relevant lease conditions have no provision to allow' laying of government drains within the coloured areas as aforesaid.	Proposed work boundary outside the Application Boundary would be separately submitted to LandsD in detailed design stage of the project. The working area outside the Application Site would not encroach (i) the Green Area of STTL 268 (Scenery Court), (ii) the Pink Area and near the Pink Hatched Green Area of STTL 161 (Hilton Plaza) and (iii) the Amenity Area of STTL 361 (New Town Plaza Phase III) under the latest design.
	5. Apart from the above, we have no comment on the s.16 application.	Noted with Thanks

Item	Comments	Responses
8.	**Planning Department** **Urban Design Unit**	
	4. Being situated in the town centre of the Sha Tin New Town, the Site is located in the northwestern portion of the Sha Tin Park, which is sandwiched between Shing Mun River to the southeast, and low- to medium-rise government and commercial buildings (with BHs ranging from about 17mPD to 61mPD) as well as high-rise residential developments to the northwest. Given that the proposed development is low-rise in nature and with reprovisioning of the park amenities, it is considered not incompatible with the surrounding context.	Noted with Thanks.
	5. According to the submission (e.g. Para. 5.5.2 & Appendix C), mitigation measures including aesthetic design of above-ground structures and landscape treatments such as vertical greening are proposed to enhance the visual amenity of the proposed development, and no significant adverse visual impact is anticipated.	Noted with Thanks.
	7. Comments from our Landscape Unit, if any, will be provided under separate cover.	Noted with Thanks.
	Supplementary Departmental Comments from Urban Design Unit of Planning Department 6. Figures 1a & 1b of Appendix C – As observations on the sections, the proposed BH of the transformer and switch room (i.e. 11.35mPD) as indicated on these figures do not tally with that (i.e. 12.5mPD) in the table of Broad Development Parameters on P.1. Also, the BH at main roof level of the pump house has been indicated as 15.7mPD on these figures instead of 18.7mPD in the table of Broad Development Parameters on P.1. Please clarify.	Please be clarified that the building height at the main roof of pump house is +15.7mPD. There is a kiosk which would be installed at the roof of the pump for the operation of PV panel and the top level of that kiosk +18.7mPD. Please be clarified that the building height of Transformer and Switch room is +12.5mPD. Revised Figures 1a & 1b are enclosed at Appendix C as supplemented for reference.



Plot File by: lu.yang 2023/10/30
PATH P:\PROJECTS\60674881\DRAWING\SKETCH\SK4053.dgn

Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm

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PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT 業主

渠務署 Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
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ISSUE/REVISION 修訂

I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

SCALE 比例: A1 1 : 500

DIMENSION UNIT 尺寸單位: METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號: 60674881

CONTRACT NO. 合約編號: CE 44/2021 (DS)

SHEET TITLE 圖紙名稱

ABOVEGROUND USES UPON COMPLETION

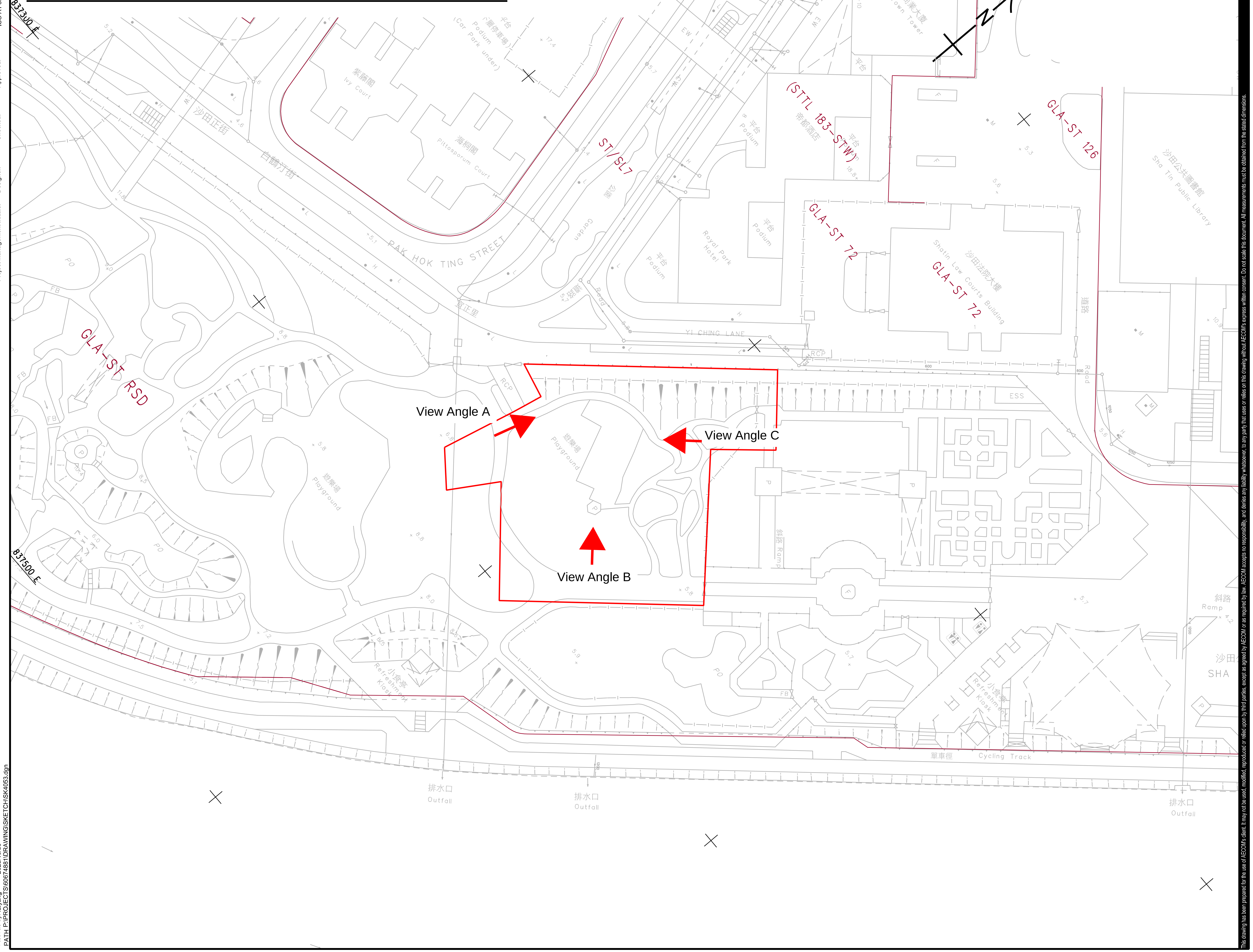
SHEET NUMBER 圖紙編號

60674881/SK9001

Appendix B – Current Condition with Surrounding Environment

Amended Pages only

LAYOUT PLAN FOR VIEW ANGLE



AECOM

PROJECT 項目

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PROJECT NO. 項目編號

60674881

CONTRACT NO. 合約編號

CE 44/2021 (DS)

SHEET TITLE 圖紙名稱

PRELIMINARY LAYOUT PLAN AND SECTIONS OF SHA TIN TOWN CENTRE STORMWATER PUMPING STATION (STTCSPS)

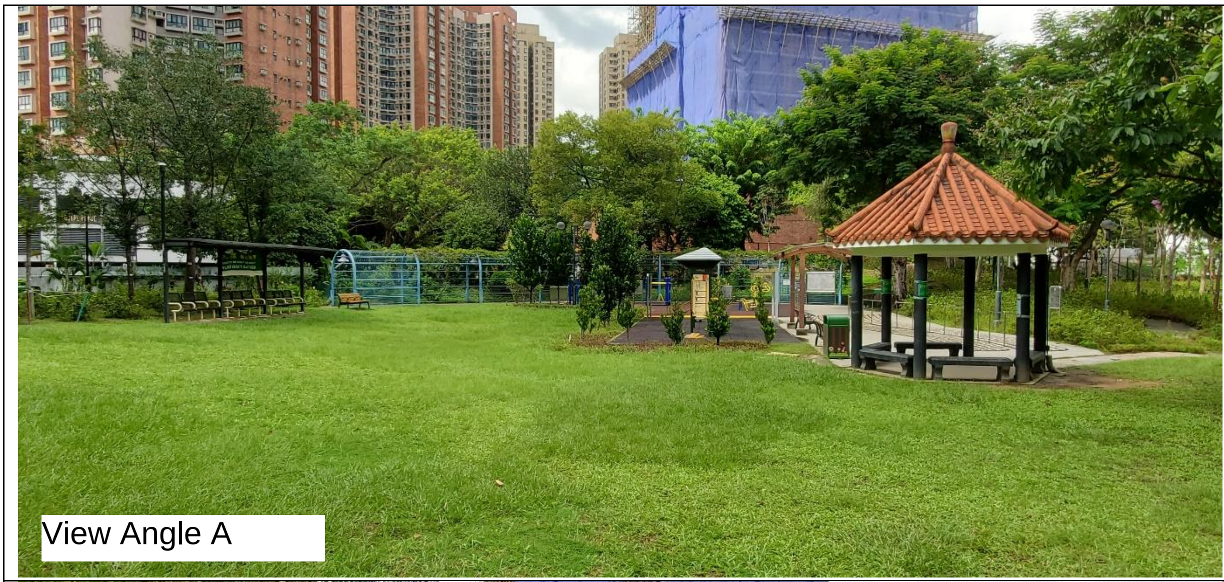
SHEET NUMBER 圖紙編號

60674881/SK4053

ISO A1 594mm x 841mm

Project Management Initials: Designer: Checked: Approved:

Plot File by: lu.yang 2023/10/30
PATH P:\PROJECTS\60674881\DRAWING\SKETCH\SK4053.dgn


View Angle A

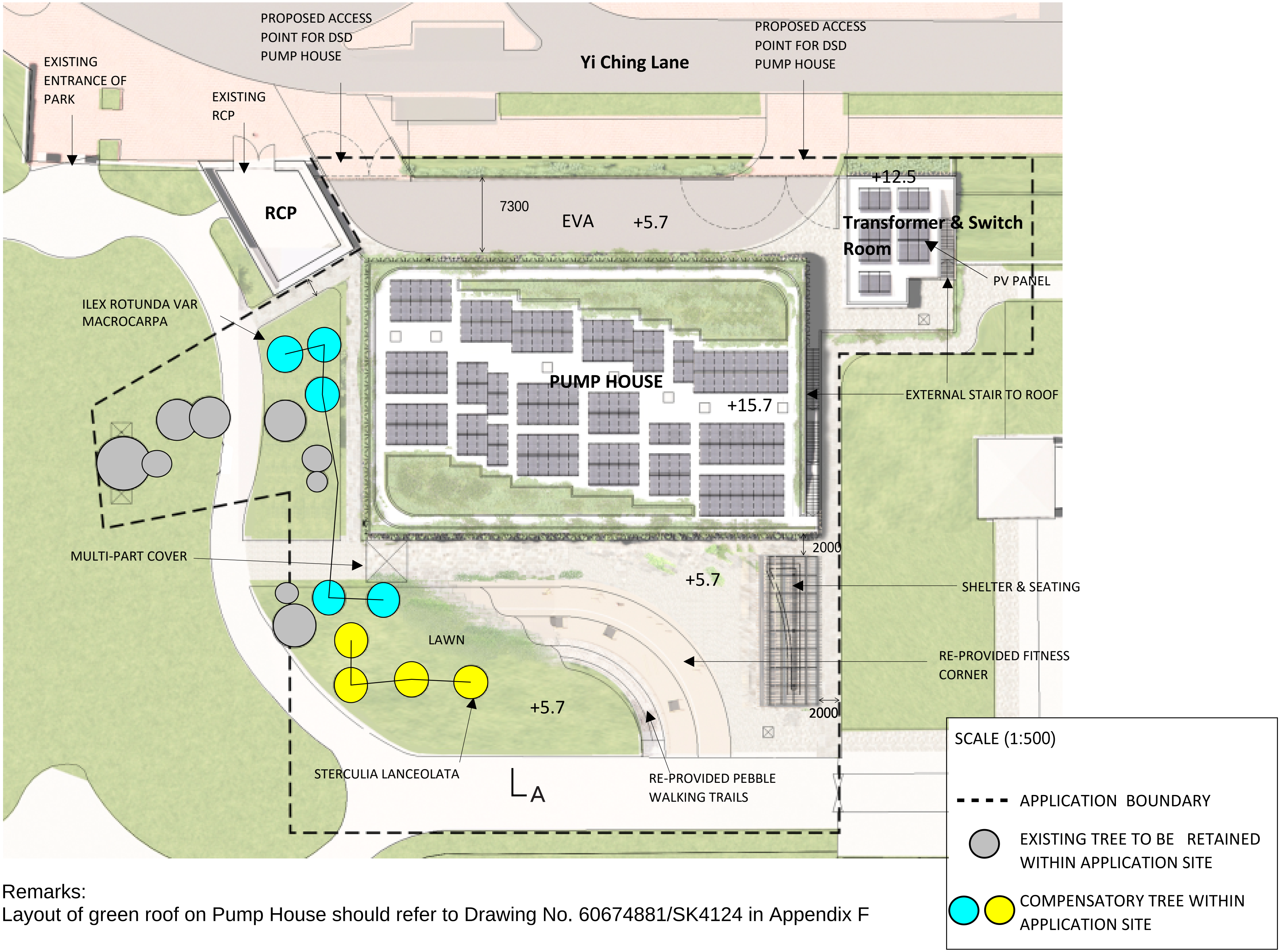

View Angle B


View Angle C

Appendix C – Architectural Design

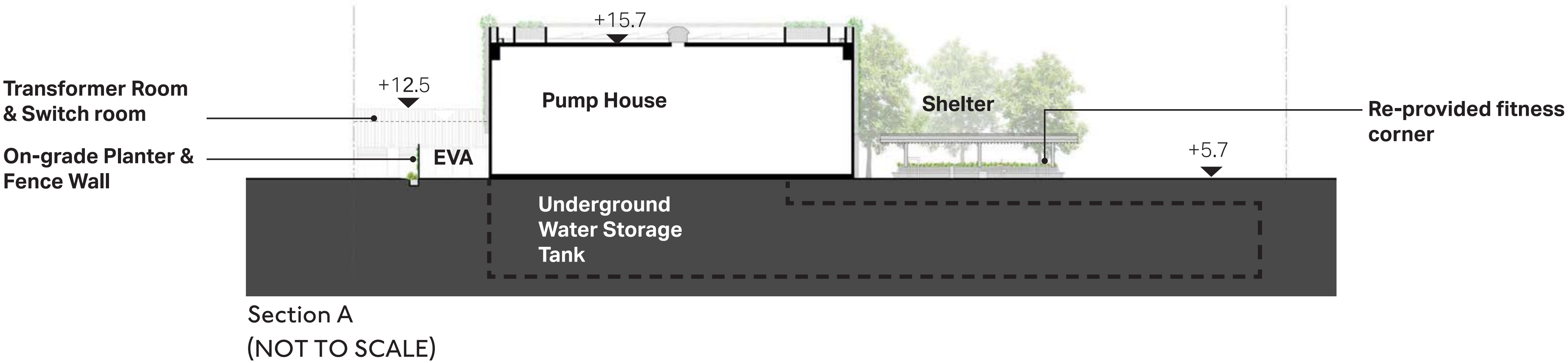
Amended Pages only

Figure 1a – Overview of Architectural Design



Remarks:
Layout of green roof on Pump House should refer to Drawing No. 60674881/SK4124 in Appendix F

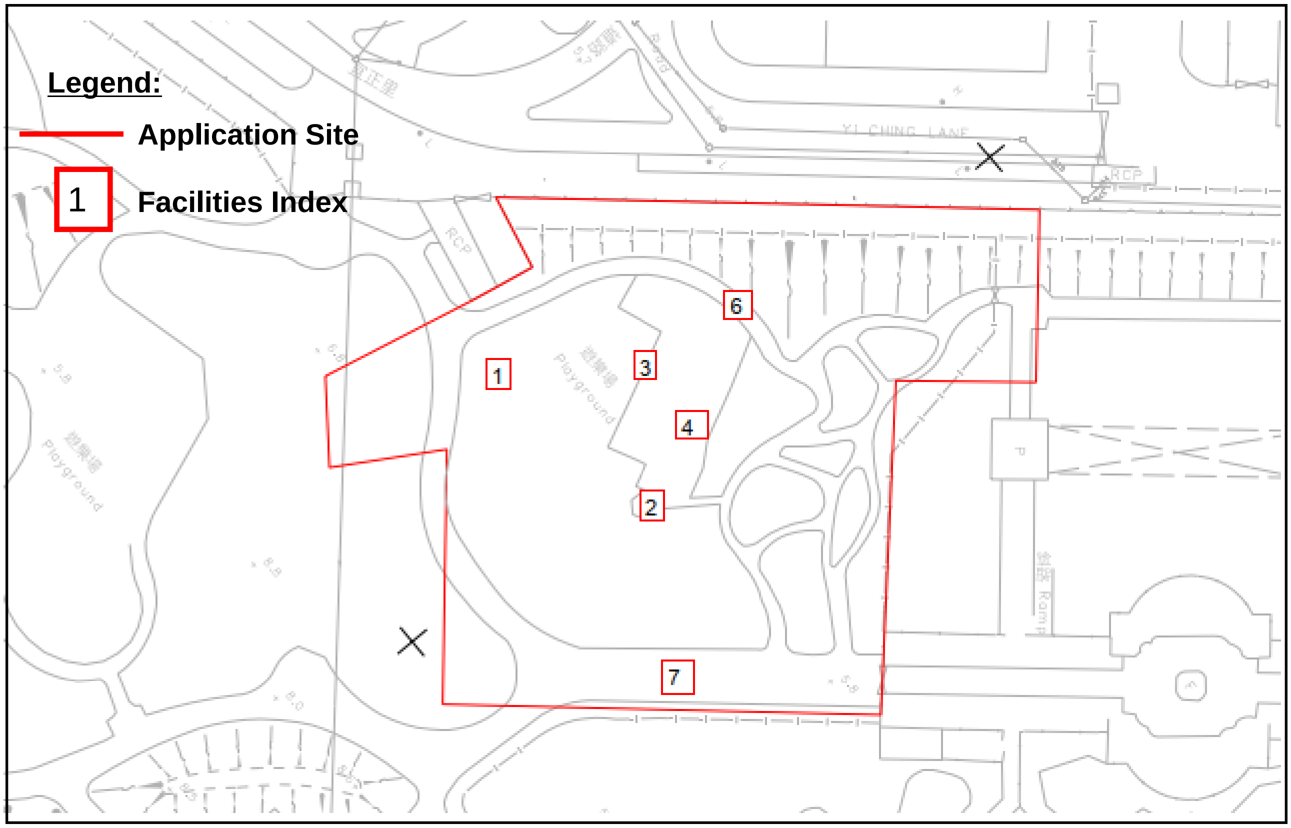
Figure 1b – Overview of Architectural Design



Appendix D – Plan for Existing LCSD Facilities and Plan for Affected Alternative Facilities

Amended Pages only

Sha Tin Park Facilities Plan



Appendix E – Tree Survey Report and Tree Felling / Transplanting Application

Amended Pages only

Appendix II

Tree Assessment Schedule

Tree Assessment Schedule
Contract No. **DP 08/2020**
Topographical and Tree Surveys for Drainage Improvement Works in Sha Tin and Sai Kung
Sha Tin Park

Surveyed by :
Date of Tree Survey : July 2020, July 2022

Drawing No.	Tree ID Number	Tree Photo No.	Tree Species		Measurements			Amenity Value	Top of Soil Level above Root Zone (mPD)	Form	Health	Structural Condition	Suitability for transplanting **		Conservation Status ***	Recommendation	Maintenance department to provide comments on TPRP		Vetting and approving panel of TPRP	Additional Remarks
			*Scientific name	Chinese name	Height (m)	DBH (mm)	Spread (m)	(high(H) /medium (M) /low(L)		(good (G)/average(A)/poor(P)			(high(H)/ medium (M)/low(L)	Remarks*		(retain/transplant /remove)	Before	After		
60674881/SK4095	T101	T101	*Delonix regia*	鳳凰木	12.0	160	6.0	M	5.7	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T102	T102	*Delonix regia*	鳳凰木	11.0	280	10.0	M	5.9	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T103	T103	*Delonix regia*	鳳凰木	10.0	190	8.0	M	5.9	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T105	T105	*Celtis sinensis*	朴樹	10.0	300	11.0	M	6.0	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T106	T106	*Peltophorum pterocarpum*	雙翼豆	21.0	500	12.0	M	6.1	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T107	T107	*Spathodea campanulata*	火焰樹	13.0	380	5.0	M	5.9	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T108	T108	*Spathodea campanulata*	火焰樹	11.0	300	5.0	M	5.9	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T109	T109	*Sapium sebiferum*	烏桕	9.0	320	7.0	M	6.3	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T110	T110	*Sapium sebiferum*	烏桕	9.0	200	6.0	M	5.6	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T111	T111	*Delonix regia*	鳳凰木	10.0	250	10.0	M	5.7	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T112	T112	*Delonix regia*	鳳凰木	7.0	250	9.0	M	5.7	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T118	T118	*Delonix regia*	鳳凰木	7.0	160	6.0	M	5.8	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T119	T119	*Delonix regia*	鳳凰木	7.0	270	12.0	M	5.5	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T122	T122	*Delonix regia*	鳳凰木	9.0	220	6.0	M	6.1	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T123	T123	*Delonix regia*	鳳凰木	6.0	130	5.0	M	6.4	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T124	T124	*Delonix regia*	鳳凰木	6.0	150	4.0	M	6.4	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T125	T125	*Delonix regia*	鳳凰木	7.0	160	4.0	M	5.8	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T126	T126	*Peltophorum pterocarpum*	雙翼豆	13.0	470	9.0	M	6.4	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T127	T127	*Peltophorum pterocarpum*	雙翼豆	13.0	550	9.0	M	6.2	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T128	T128	*Grevillea robusta*	銀樺	9.0	320	3.0	M	6.2	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T129	T129	*Podocarpus macrophyllus*	羅漢松	5.0	190	3.0	M	6.5	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T130	T130	*Podocarpus macrophyllus*	羅漢松	6.0	160	3.0	M	6.7	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T131	T131	*Podocarpus macrophyllus*	羅漢松	6.0	100	3.0	M	6.6	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T132	T132	*Araucaria heterophylla*	異葉南洋杉	21.0	380	5.0	M	6.5	P	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T133	T133	*Thuja orientalis*	扁柏	4.0	140	3.0	M	6.7	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T134	T134	*Podocarpus macrophyllus*	羅漢松	6.0	120	3.0	M	6.4	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T135	T135	*Lagerstroemia speciosa*	大花紫薇	6.0	130	4.0	M	6.1	A	A	A	L	c	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T136	T136	*Lagerstroemia speciosa*	大花紫薇	7.0	130	4.0	M	6.1	A	A	A	L	c	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T137	T137	*Lagerstroemia speciosa*	大花紫薇	7.0	140	4.0	M	6.1	A	A	A	L	c	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T138	T138	*Lagerstroemia speciosa*	大花紫薇	5.0	100	3.0	M	6.3	A	A	A	L	c	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T139	T139	*Lagerstroemia speciosa*	大花紫薇	5.0	120	3.0	M	6.4	A	A	A	L	c	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T140	T140	*Lagerstroemia speciosa*	大花紫薇	5.0	120	4.0	M	6.6	A	A	A	L	c	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T141	T141	*Lagerstroemia speciosa*	大花紫薇	5.0	130	4.0	M	6.8	A	A	A	L	c	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T142	T142	*Lagerstroemia speciosa*	大花紫薇	6.0	130	4.0	M	6.9	A	A	A	L	c	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T143	T143	*Lagerstroemia speciosa*	大花紫薇	5.0	110	3.0	M	7.1	A	A	A	L	c	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T144	T144	*Lagerstroemia speciosa*	大花紫薇	5.0	120	4.0	M	7.1	A	A	A	L	c	Cap 96	remove	LCSD	LCSD	DSD	
60674881/SK4095	T145	T145	*Nageia nagi*	竹柏	6.0	160	5.0	M	7.6	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T146	T146	*Nageia nagi*	竹柏	4.0	100	3.0	M	7.4	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T147	T147	*Nageia nagi*	竹柏	5.0	120	2.0	M	7.1	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T148	T148	*Nageia nagi*	竹柏	5.0	100	3.0	M	6.9	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T149	T149	*Nageia nagi*	竹柏	5.0	110	2.0	M	6.7	A	A	A	L	-	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T150	T150	*Nageia nagi*	竹柏	7.0	150	5.0	M	6.8	A	A	A	L	c	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T151	T151	*Nageia nagi*	竹柏	8.0	140	4.0	M	6.7	A	A	A	L	c	No	transplant	LCSD	LCSD	DSD	wounded bark
60674881/SK4095	T152	T152	*Nageia nagi*	竹柏	10.0	270	5.0	M	6.7	A	A	A	L	c, d	No	transplant	LCSD	LCSD	DSD	wounded bark
60674881/SK4095	T153	T153	*Nageia nagi*	竹柏	7.0	160	4.0	M	6.6	P	A	A	L	c, f	No	remove	LCSD	LCSD	DSD	codominant trunks
60674881/SK4095	T154	T154	*Delonix regia*	鳳凰木	10.0	200	7.0	M	6.0	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T155	T155	*Schefflera heptaphylla*	鴨腳木	6.0	200	5.0	M	8.0	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T156	T156	*Ficus microcarpa*	細葉榕	7.0	300	10.0	M	7.9	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T157	T157	*Celtis sinensis*	朴樹	15.0	550	14.0	M	8.6	A	A	A	L	b, d, h, i	No	remove	LCSD	LCSD	DSD	on slope
60674881/SK4095	T158	T158	*Peltophorum pterocarpum*	雙翼豆	18.0	200	7.0	M	8.3	A	A	A	L	d	No	remove	LCSD	LCSD	DSD	asymmetric crown
60674881/SK4095	T159	T159	*Ficus microcarpa*	細葉榕	9.0	260	9.0	M	8.5	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T160	T160	*Schefflera heptaphylla*	鴨腳木	6.0	100	4.0	L	9.1	A	A	A	L	a	No	remove	LCSD	LCSD	DSD	on slope
60674881/SK4095	T161	T161	*Schefflera heptaphylla*	鴨腳木	6.0	180	5.0	L	8.3	A	A	A	L	a	No	remove	LCSD	LCSD	DSD	on slope
60674881/SK4095	T162	T162	*Cinnamomum camphora*	樟樹	15.0	350	12.0	M	9.2	A	A	A	L	c, h	No	remove	LCSD	LCSD	DSD	on slope
60674881/SK4095	T163	T163	*Albizia lebbeck*	大葉合歡	10.0	230	7.0	L	8.7	P	A	A	L	a, f	No	remove	LCSD	LCSD	DSD	asymmetric crown

Drawing No.	Tree ID Number	Tree Photo No.	Tree Species		Measurements			Amenity Value	Top of Soil Level above Root Zone (mPD)	Form	Health	Structural Condition	Suitability for transplanting **		Conservation Status ***	Recommendation	Maintenance department to provide comments on TPRP		Vetting and approving panel of TPRP	Additional Remarks
			*Scientific name	Chinese name	Height (m)	DBH (mm)	Spread (m)	(high(H) /medium (M) /low(L)		(good (G)/average(A)/poor(P)			(high(H)/ medium (M)/low(L)	Remarks*		(retain/transplant /remove)	Before	After		
60674881/SK4095	T164	T164	*Sterculia lanceolata*	假蘋婆	5.0	170	4.0	M	8.3	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	on slope
60674881/SK4095	T165	T165	*Ficus microcarpa*	細葉榕	6.0	180	8.0	M	8.2	P	A	A	L	f, h	No	remove	LCSD	LCSD	DSD	heavy limb, asymmetric crown
60674881/SK4095	T166	T166	*Delonix regia*	鳳凰木	9.0	120	4.0	M	6.4	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T167	T167	*Delonix regia*	鳳凰木	10.0	200	7.0	M	6.6	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T168	T168	*Delonix regia*	鳳凰木	9.0	150	4.0	M	6.8	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T169	T169	*Delonix regia*	鳳凰木	8.0	140	4.0	M	6.7	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T170	T170	*Delonix regia*	鳳凰木	9.0	180	7.0	M	6.6	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T171	T171	*Delonix regia*	鳳凰木	10.0	130	5.0	M	6.3	A	A	A	L	b, c	No	transplant	LCSD	LCSD	DSD	contorted trunk
60674881/SK4095	T172	T172	*Delonix regia*	鳳凰木	9.0	110	4.0	L	6.5	P	A	A	L	a, f	No	remove	LCSD	LCSD	DSD	sparse crown
60674881/SK4095	T173	T173	*Callistemon viminalis*	串錢柳	6.0	120	4.0	M	7.0	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	leaning, sparse foliage
60674881/SK4095	T174	T174	*Celtis sinensis*	朴樹	9.0	290	6.0	M	6.8	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	crooked trunk
60674881/SK4095	T175	T175	*Schefflera heptaphylla*	鴨腳木	5.0	110	4.0	L	6.9	A	A	A	L	a, f	No	remove	LCSD	LCSD	DSD	forked trunk
60674881/SK4095	T176	T176	*Viburnum odoratissimum*	珊瑚樹	5.0	110	4.0	M	7.1	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	slight crooked trunk
60674881/SK4095	T177	T177	*Schefflera heptaphylla*	鴨腳木	5.0	160	6.0	M	6.9	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	slightly leaning, asymmetric crown
60674881/SK4095	T178	T178	*Viburnum odoratissimum*	珊瑚樹	5.0	200	3.0	L	6.6	P	A	A	L	a	No	remove	LCSD	LCSD	DSD	pruned trunk,
60674881/SK4095	T196	T196	*Eucalyptus exserta*	窿緣桉	20.0	210	6.0	M	7.2	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T197	T197	*Eucalyptus exserta*	窿緣桉	22.0	260	7.0	M	7.6	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T209	T209	*Eucalyptus exserta*	窿緣桉	9.0	160	3.0	M	7.5	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T210	T210	*Eucalyptus torelliana*	毛葉桉	11.0	130	6.0	M	6.8	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	
60674881/SK4095	T217	T217	*Eucalyptus robusta*	大葉桉	16.0	370	5.0	M	7.2	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T218	T218	*Melaleuca cajuputi subsp. Cumingiana*	白千層	11.0	450	5.0	M	6.8	A	A	A	L	-	No	retain	LCSD	LCSD	DSD	
60674881/SK4095	T246	T246	*Sterculia lanceolata*	假蘋婆	5.0	200	3.0	M	7.0	A	A	A	L	-	No	transplant	LCSD	LCSD	DSD	
60674881/SK4095	T247	T247	*Sterculia lanceolata*	假蘋婆	6.0	180	6.0	M	7.3	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	on slope, root system exposed
60674881/SK4095	T248	T248	*Bridelia tomentosa*	土蜜樹	6.0	220	8.0	L	7.2	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	exposed roots
60674881/SK4095	T249	T249	*Schefflera heptaphylla*	鴨腳木	5.0	160	7.0	M	7.1	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	leaning
60674881/SK4095	T250	T250	*Syzygium jambos*	蒲桃	10.0	330	8.0	M	7.2	P	A	A	L	c	No	remove	LCSD	LCSD	DSD	pruned trunk, asymmetric crown
60674881/SK4095	T251	T251	*Schefflera heptaphylla*	鴨腳木	5.0	130	4.0	M	7.1	A	A	P	L	-	No	transplant	LCSD	LCSD	DSD	leaning
60674881/SK4095	T252	T252	*Albizia lebbeck*	大葉合歡	16.0	390	13.0	M	6.9	A	A	A	L	c	No	remove	LCSD	LCSD	DSD	leaning, on slope

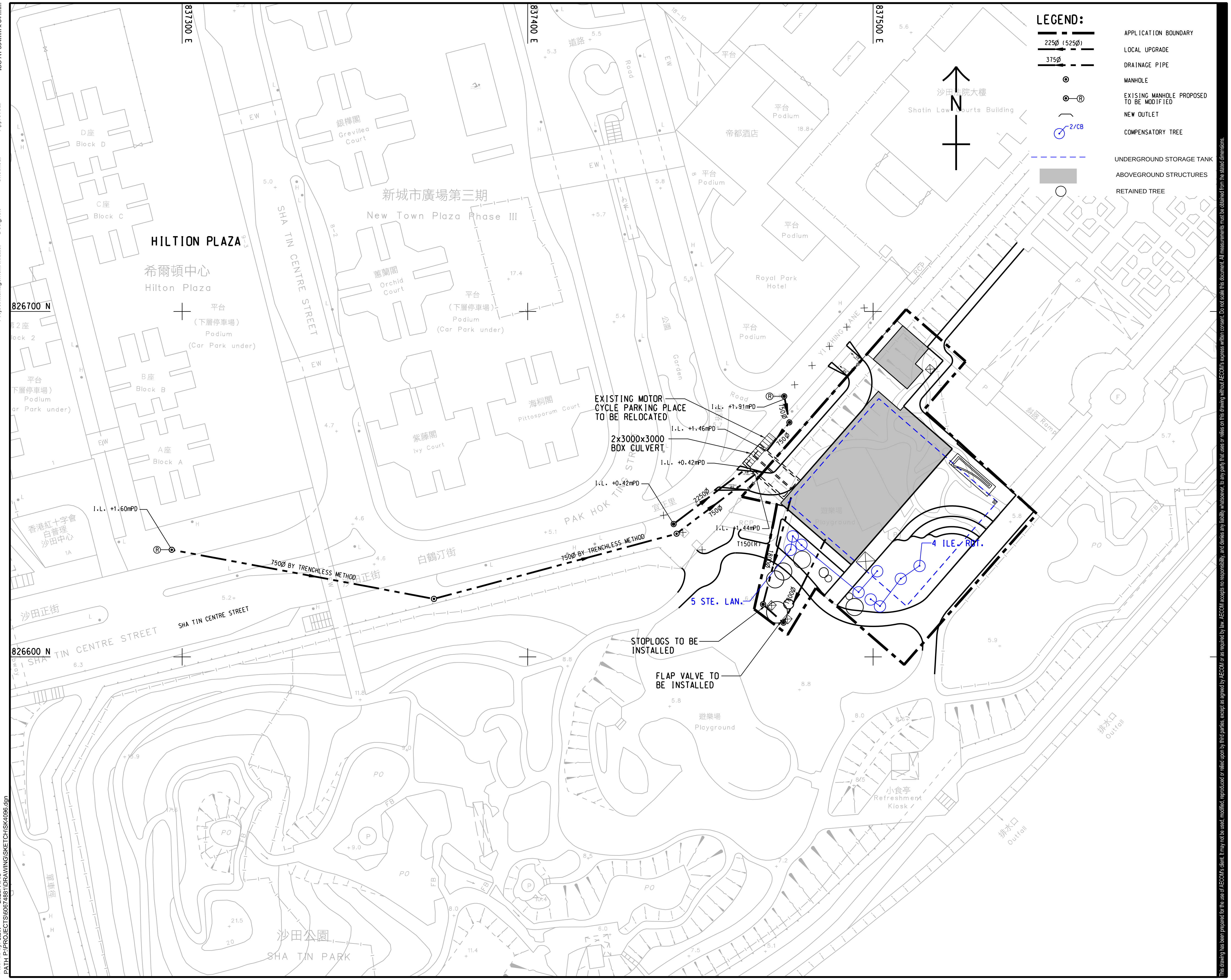
Remarks for Suitability for Transplanting

(a) Low amenity value;
(b) Irrecoverable form after transplanting (e.g. transplanting requires substantial crown and root pruning);
(c) Low chance of survival upon transplanting;
(d) Very large size (unless the feasibility to transplant has been considered financially reasonable and technically feasible during the feasibility stage);
(e) With evidence of over-maturity and onset of senescence;
(f) With poor health, structure or form (e.g. imbalanced form, leaning , with major cavity/cracks/splits); or cavity/cracks/splits); or
(g) Undesirable species (e.g. *Leucaena leucocephala* which is an invasive exotic and self-seeding tree);
(h) On steep slope.
(i) trees grown under poor conditions which have limited the formation of proper root ball necessary for transplanting

Conservation status
Rare tree species listed in "Rare and Precious of Hong Kong"
(http://herbarium.gov.hk/PublicationsPreface.aspx?BookNameId=1) published by Agriculture, Fisheries and Conservation Department
Endangered plant species protected under the Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586)
Tree species listed in the Forestry Regulations (Cap. 96A) under the Forests and Countryside Ordinance (Cap. 96)

Appendix IVa

Compensatory Planting Plan (within Application Boundary)



ISO A1 594mm x 841mm

Approved:

Checked:

Designer:

Project Management Initials:

Plot File by: JiaW 2023/11/15

PATH P:\PROJECTS\60674881\DRAWING\SKETCH\SK4096.dgn

AECOM

PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT 業主

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Drainage Services Department

CONSULTANT 工程顧問公司

AECOM Asia Company Ltd.
www.aecom.com

SUB-CONSULTANTS 分判工程顧問公司

ISSUE/REVISION 修訂

I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

SCALE 比例

A1 1 : 500

DIMENSION UNIT 尺寸單位

METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號

60674881

CONTRACT NO. 合約編號

CE 44/2021 (DS)

SHEET TITLE 圖紙名稱

TREE COMPENSATION PLAN (INSIDE APPLICATION BOUNDARY)

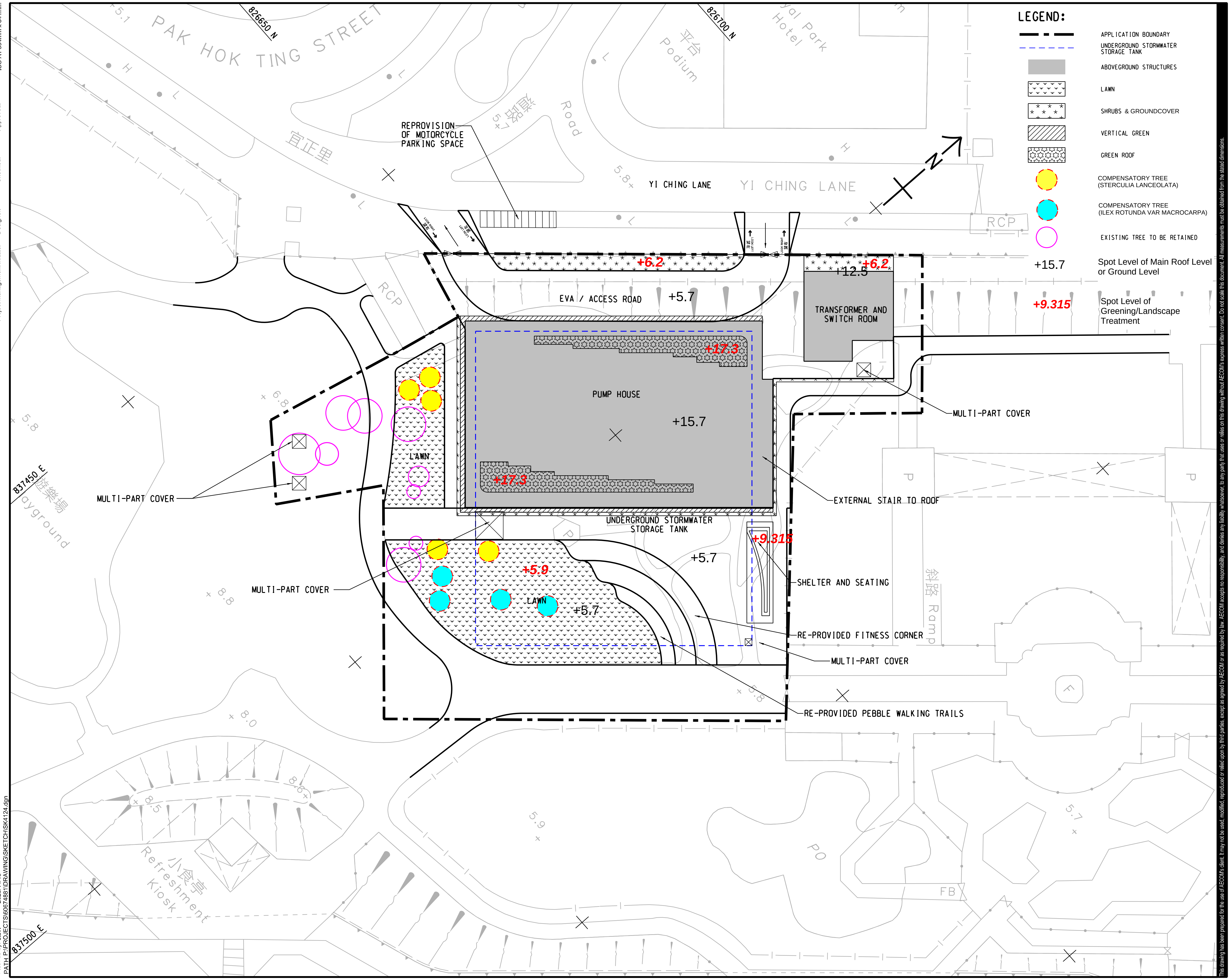
SHEET NUMBER 圖紙編號

60674881/SK4096

Appendix F – Landscape Layout Plan

Amended Pages only

Project Management Initials: Designer: Checked: Approved: ISO A1 594mm x 841mm



AECOM

PROJECT

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT

渠務署 Drainage Services Department

CONSULTANT

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ISSUE/REVISION

I/R	DATE	DESCRIPTION	CHK.

STATUS

SCALE	DIMENSION UNIT
A1 1 : 250	METRES

KEY PLAN

PROJECT NO.	CONTRACT NO.
60674881	CE 44/2021 (DS)

SHEET TITLE

LANDSCAPE PLAN

SHEET NUMBER

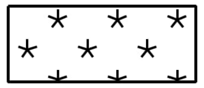
60674881/SK4124

Plot File by: JiaW 2023/11/15
PATH: P:\PROJECTS\60674881\DRAWING\SKETCH\SK4124.dgn

Proposed Shrubs

Subtle colour for a relaxing atmosphere. Refreshing. Cool. Calm.

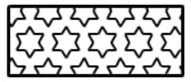
Shrubs & Groundcover



Gardenia jasminoides
梔子

Liriope spicata
山麥冬

Green Roof

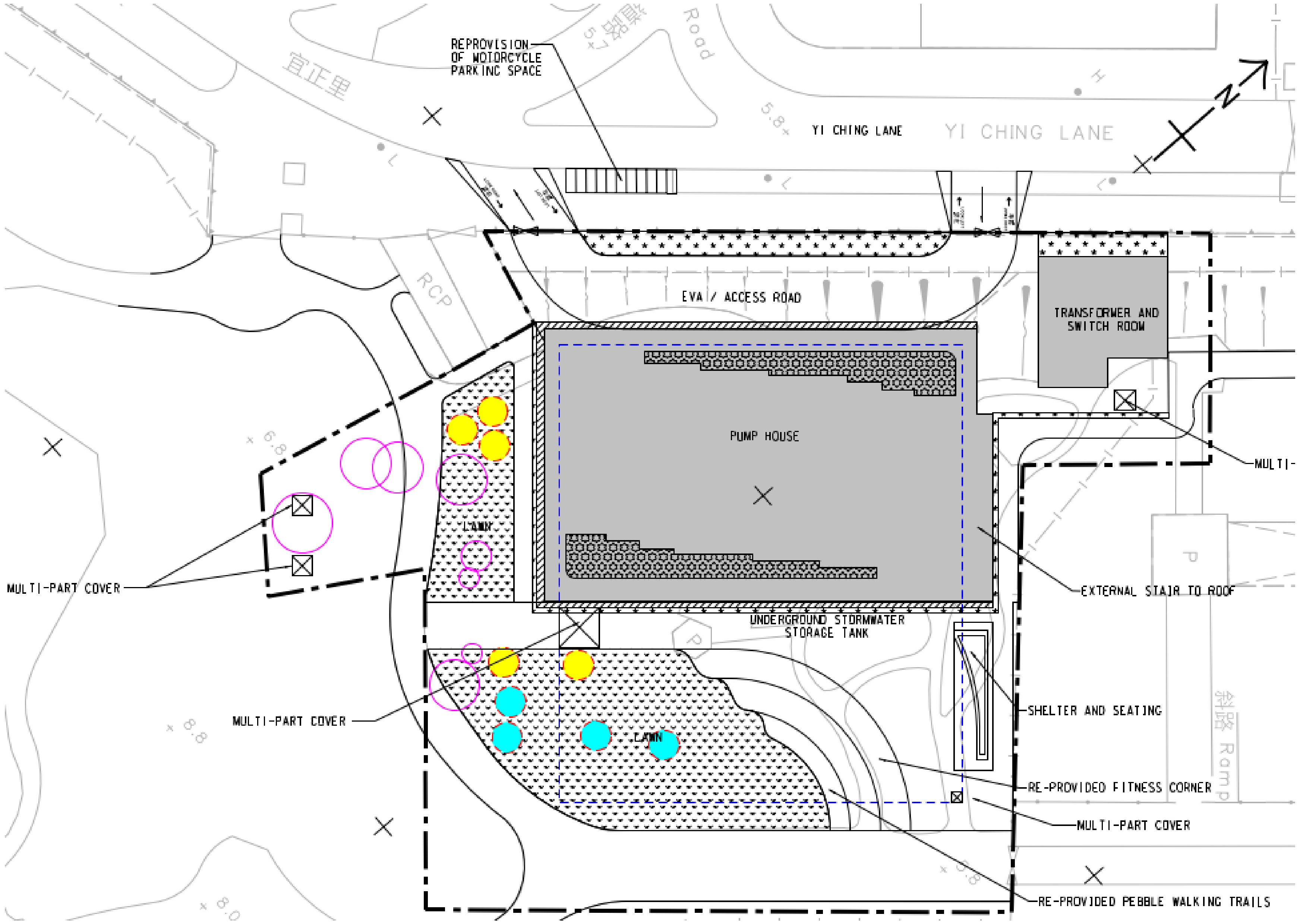


Dietes bicolor
非洲鳶尾

Loropetalum chinense
紅花檵木

Rhododendron mucronatum
錦繡杜鵑

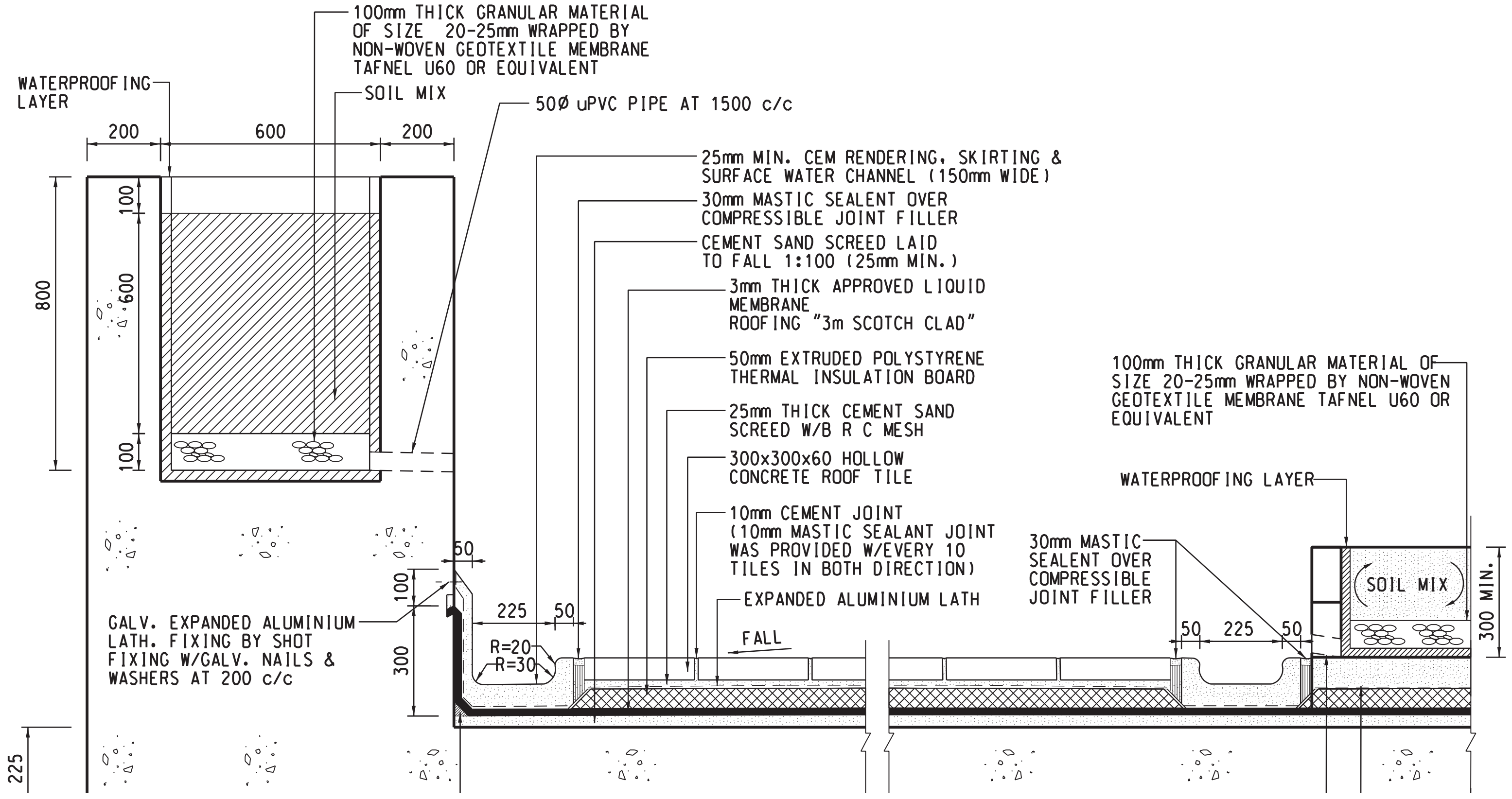
Nephrolepis auriculata
腎蕨



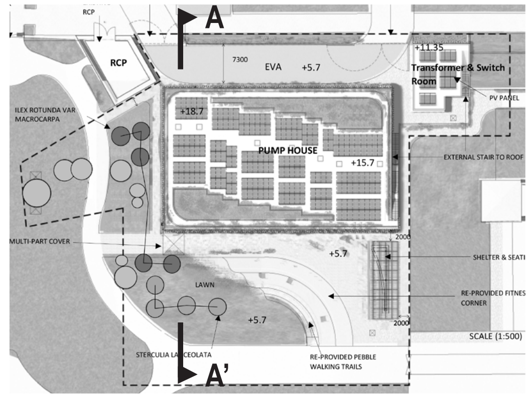
Planting Schedule

Botanical Name	Chinese Name	Size (mm)	Spacing (mm)
Shrubs & Groundcover			
Gardenia jasminoides [1][2]	梔子	600 x 400	500
Liriope spicata [1][2]	山麥冬	150 x 200	150
Green Roof			
Dietes bicolor	非洲鳶尾	500 x 300	300
Loropetalum chinense var 'rubrum'	紅花繼木	600 x 400	500
Rhododendron pulchrum phoeniceum	錦繡杜鵑	500 x 300	400
Nephrolepis auriculata	腎蕨	300 x 300	400

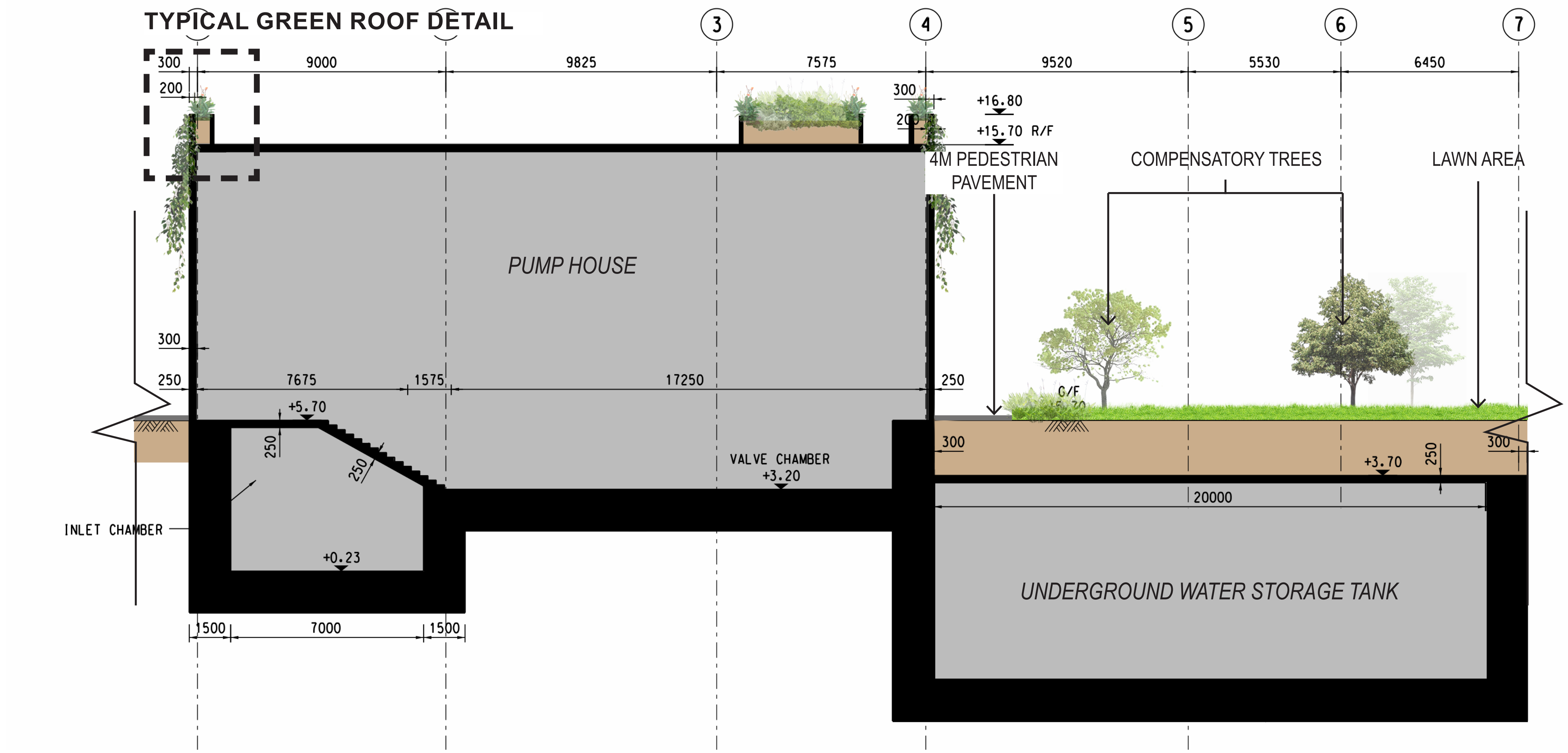
Note:
* The proposed planting species is subject to change and to be agreed with maintenance authorities.
[1] Native species
[2] Recommended species in the Greening Master Plan of Shatin



TYPICAL GREEN ROOF DETAIL



KEY PLAN



LANDSCAPE SECTION A-A'

AECOM

PROJECT
項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT
業主

渠務署
Drainage Services Department

CONSULTANT
工程顧問公司

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ISSUE/REVISION
修訂

I/R	DATE	DESCRIPTION	CHK.

STATUS
階段

SCALE	DIMENSION UNIT
A1 1 : 100	MILLIMETRES

KEY PLAN

PROJECT NO.	CONTRACT NO.
60674881	CE 44/2021 (DS)

SHEET TITLE
圖紙名稱

LANDSCAPE SECTION

SHEET NUMBER
圖紙編號

60674881/SC0001

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:
Plot File by:
PATH P:

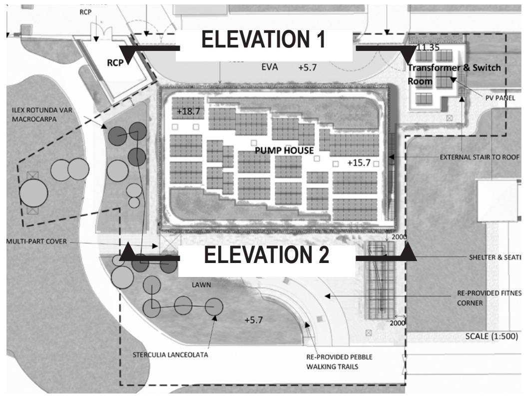
ISO A1 594mm x 841mm

Approved:

Checked:

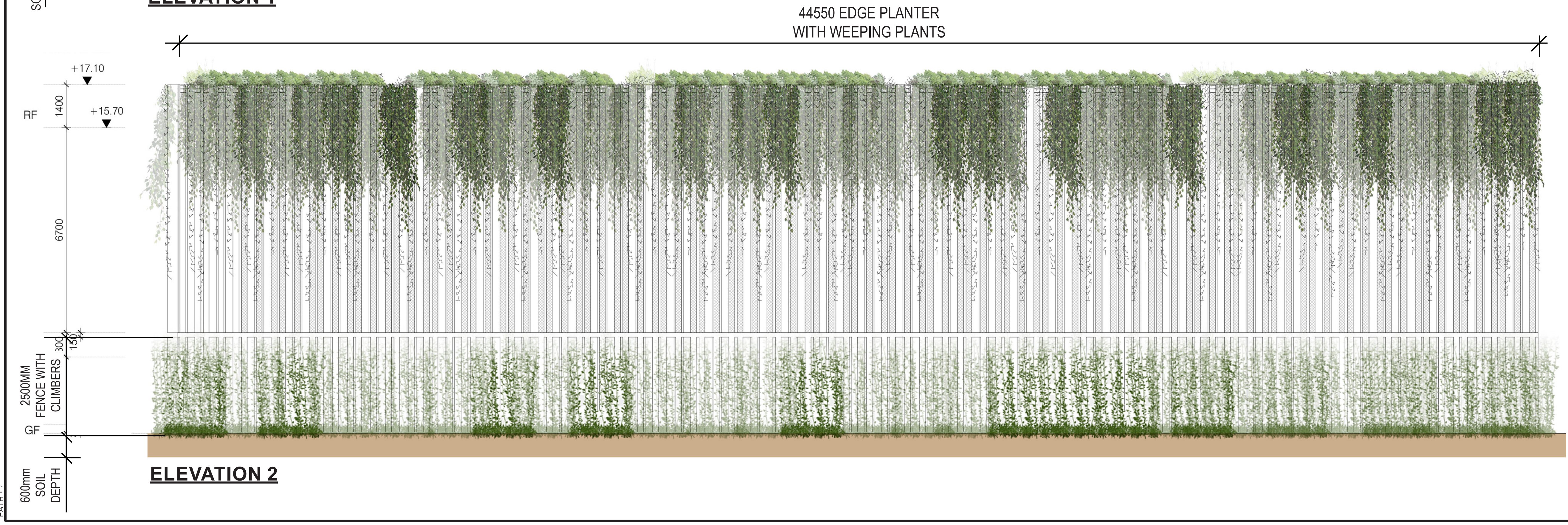
Designer:

Project Management Initials:



KEY PLAN

ELEVATION 1



ELEVATION 2

Plot File by:
PATH P:

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I/R	DATE	DESCRIPTION	CHK.

STATUS

SCALE: A1 1 : 100

DIMENSION UNIT: MILLIMETRES

KEY PLAN

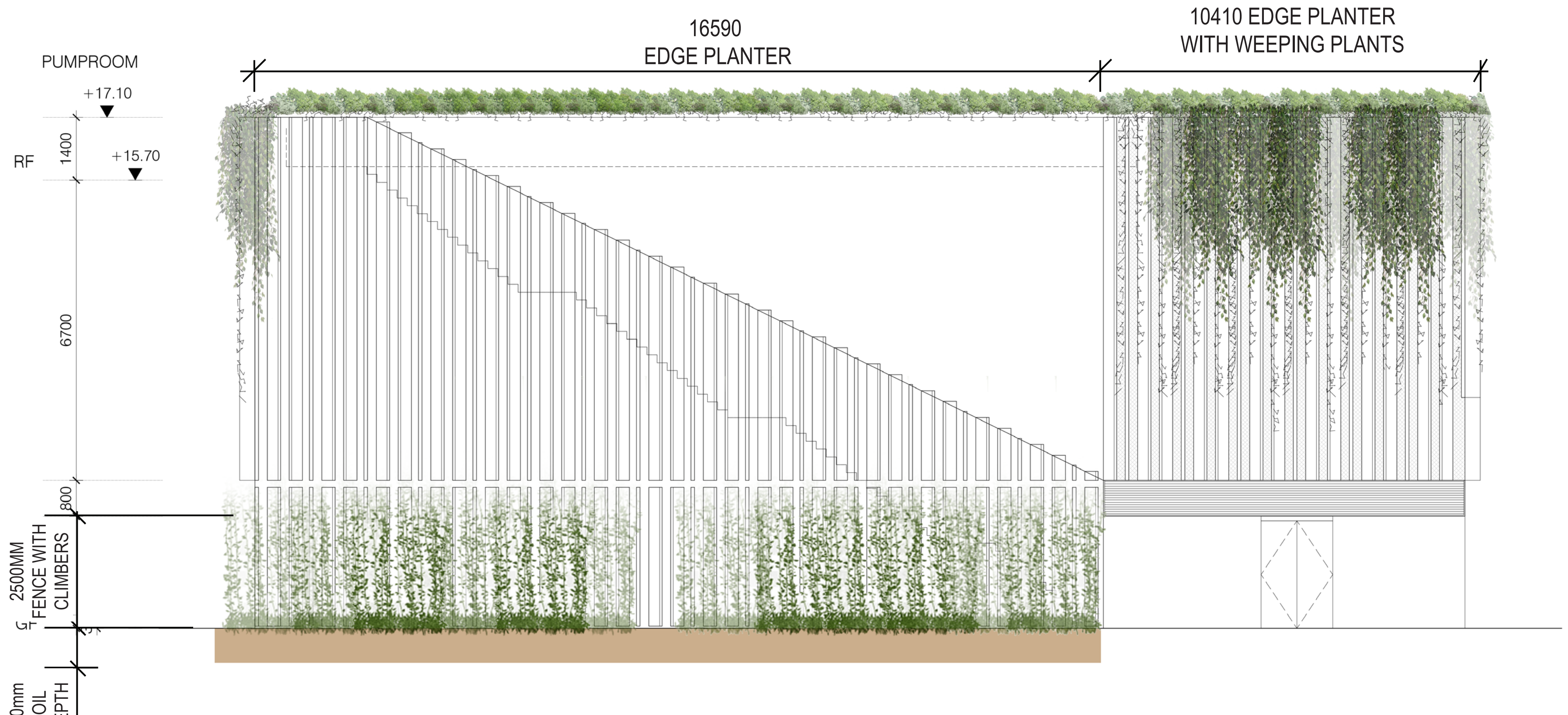
PROJECT NO.: 60674881

CONTRACT NO.: CE 44/2021 (DS)

SHEET TITLE: PUMP HOUSE ELEVATION 01

SHEET NUMBER: 60674881/SC0002

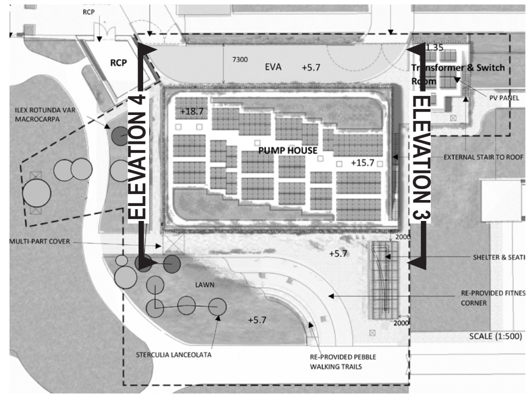
ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:



ELEVATION 3

ELEVATION 4

Plot File by:
PATH P:



KEY PLAN

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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

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I/R	DATE	DESCRIPTION	CHK.

STATUS

SCALE	DIMENSION UNIT
A1 1 : 100	MILLIMETRES

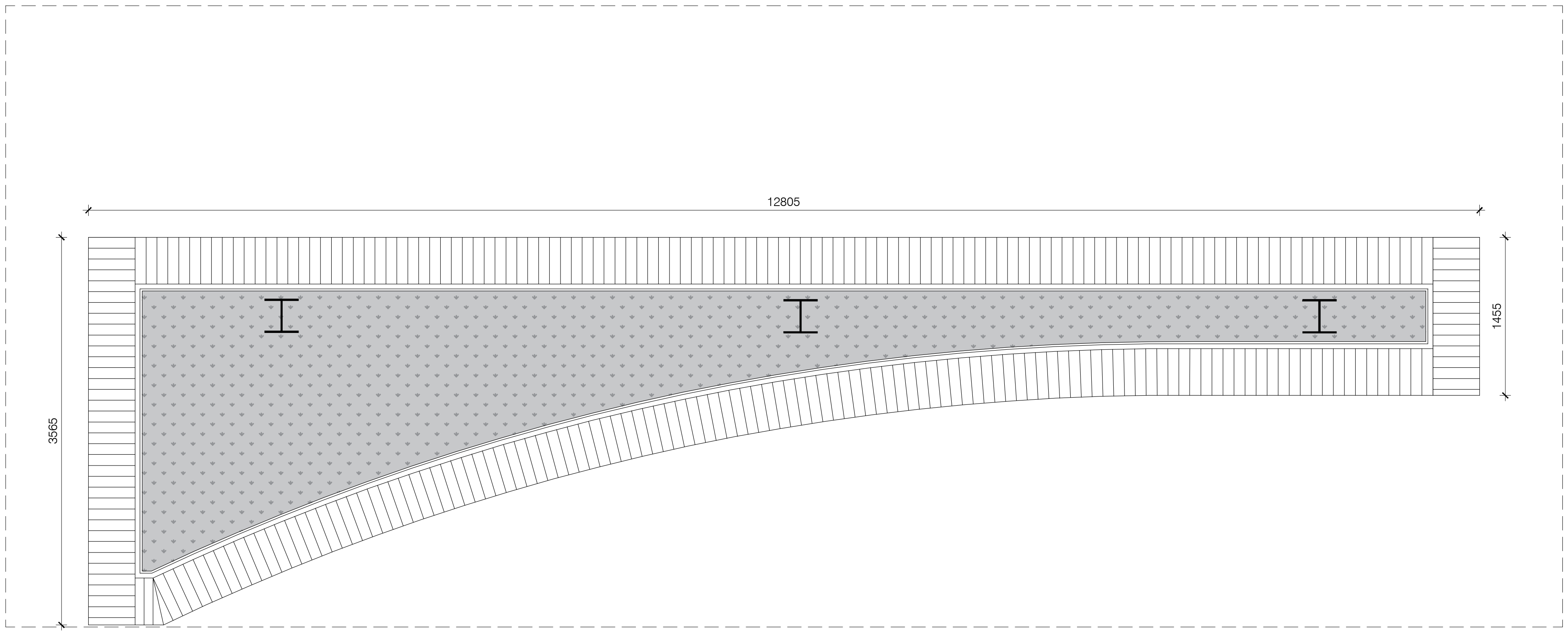
KEY PLAN

PROJECT NO.	CONTRACT NO.
60674881	CE 44/2021 (DS)

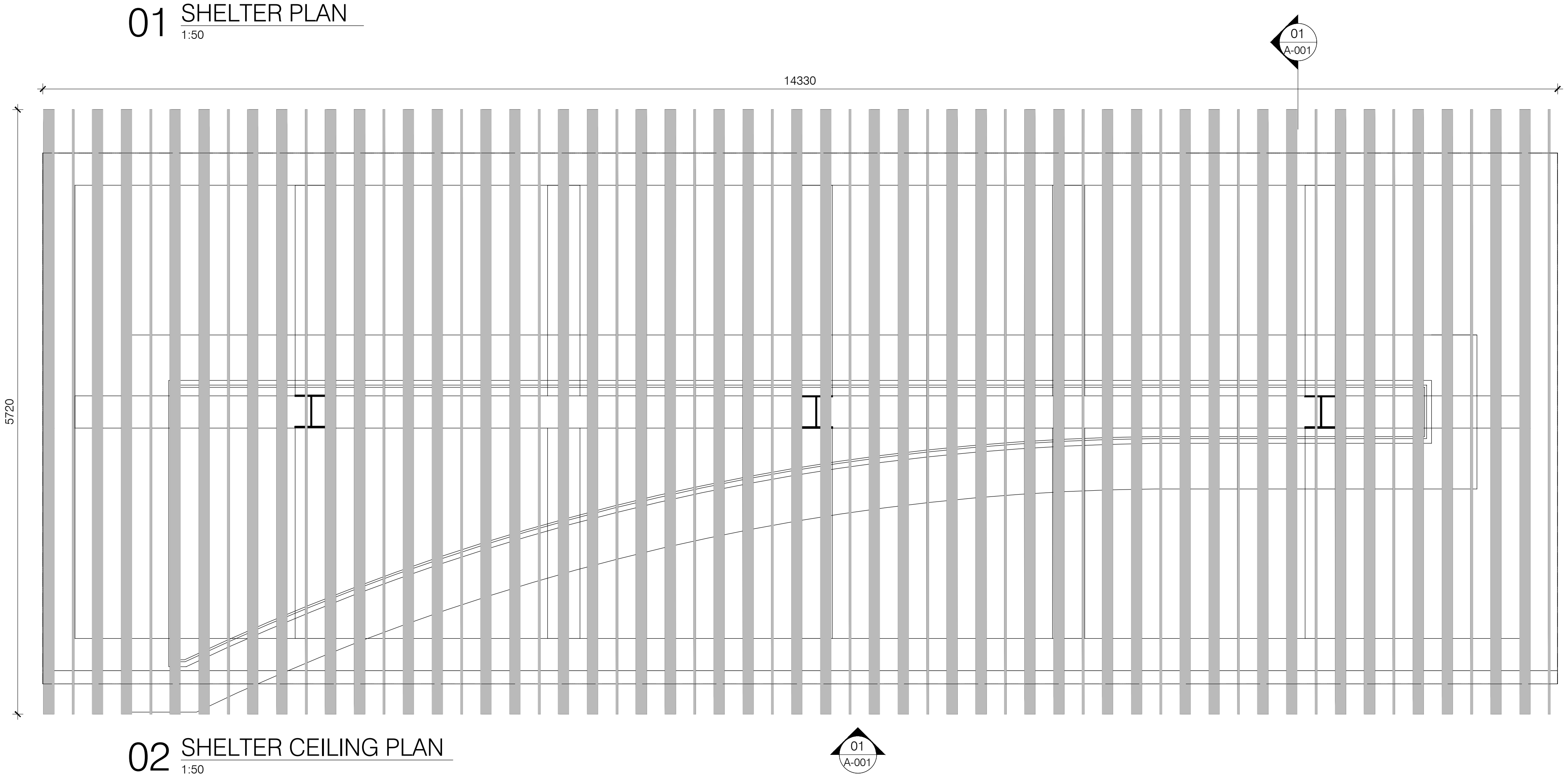
SHEET TITLE
PUMP HOUSE ELEVATION 02

SHEET NUMBER
60674881/SC0003

Sheltered Seat Plan & Ceiling Plan

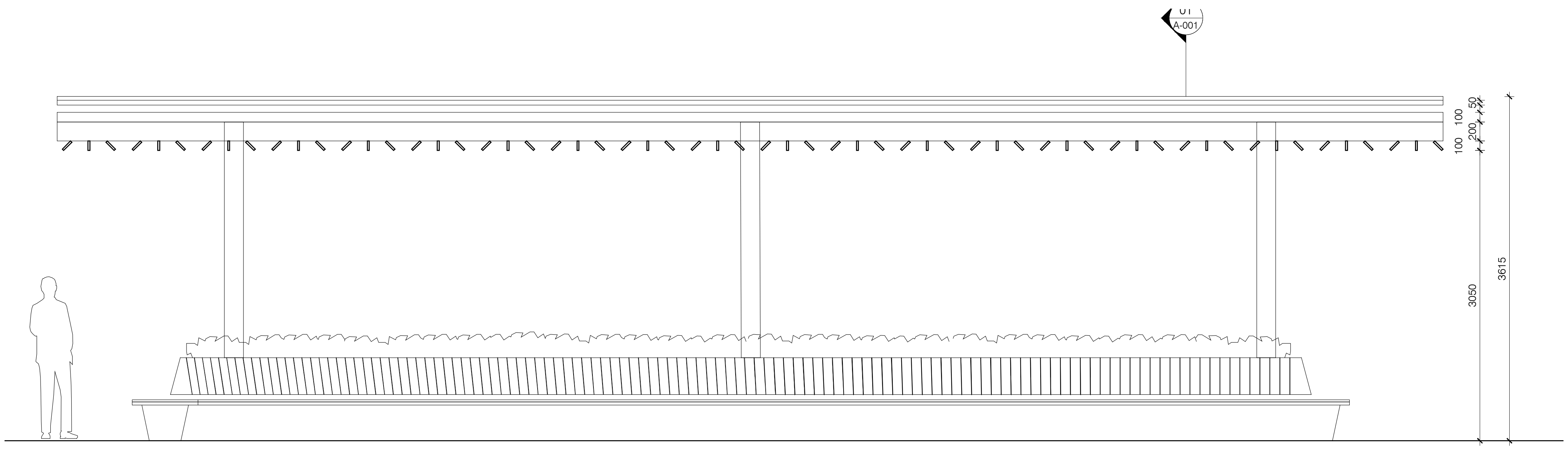


01 SHELTER PLAN
1:50



02 SHELTER CEILING PLAN
1:50

Sheltered Seat Elevation & Section

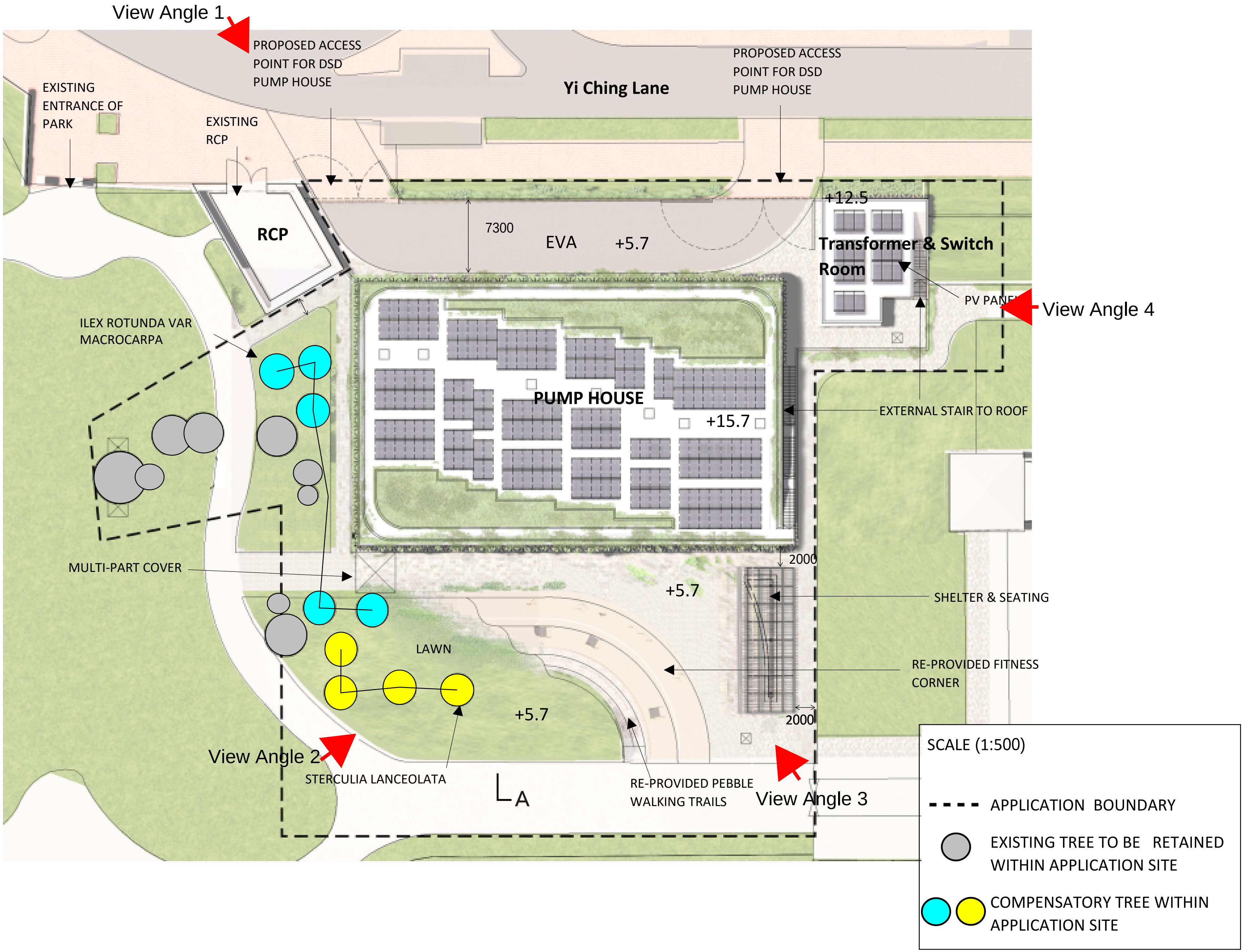


01 SHELTER ELEVATION
1:50

Appendix G – Photomontages

Amended Pages only

View Angle for Photomontage



View from Yi Ching Lane (View Angle 1)

View from Park (1) (View Angle 2)

View from Park (2) (View Angle 3)

View from Park (3) (View Angle 4)

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AECOM
12/F Grand Central Plaza, Tower 2
138 Shatin Rural Committee Road
Shatin, Hong Kong
香港新界沙田鄉事會路 138 號
新城市中央廣場第 2 座 12 樓
www.aecom.com

+852 3922 9000 tel
+852 3922 9797 fax

Your Ref.: Application No.: A/ST/1025
Our Ref.: AYFW:BWYM:etly:60674881/13.27-0160 (2024001034W)

5 February 2024

By Hand

Town Planning Board
15/F, North Point Government Offices
333 Java Road
North Point, Hong Kong

Attn.: Secretary of Town Planning Board

Dear Sir/Madam,

Application No.: A/ST/1025
Section 16 Planning Application for Proposed Public Utility Installation (Stormwater Storage Facility) in Government Land at Sha Tin Park near Yi Ching Lane, Sha Tin, New Territories

We are pleased to submit Further Information (Response-to-Comment Table and corresponding amendment pages) for the captioned Section 16 Planning Application.

Should you have any queries, please feel free to contact our Miss Netté Siu.

Yours faithfully,
For and on behalf of
AECOM Asia Co. Ltd.

Alex Wu
Executive Director
Water, Hong Kong

Encl.

Application No.: A/ST/1025

Proposed Public Utility Installation (Stormwater Storage Facility)

Government Land at Sha Tin Park near Yi Ching Lane, Sha Tin, New Territories

Responses to Comments

	Comments Received	Date Received
1.	PlanD	01 Feb 2024

Application No.: A/ST/1025

Proposed Public Utility Installation (Stormwater Storage Facility)

Government Land at Sha Tin Park near Yi Ching Lane, Sha Tin, New Territories

Responses to Comments

Item	Comments	Responses
1.	**Planning Department**	
	Landscape Observations and Comments 1. Based on the aerial photo of 2022, the site is situated in an area of urban park landscape character surrounded by existing residential buildings, government facilities, roads and tree groups. Significant impact on the landscape character arising from the proposed development is not anticipated.	Noted that significant impact on the landscape character arising from the proposed development is not anticipated.
	2. According to the Planning Application Report, the site is occupied by existing park with leisure facilities. With reference to the tree information provided by the applicant, 83 trees are identified within the application boundary, no Registered Old and Valuable Tree (OVT) is identified, and 58 trees are proposed to be felled. Mitigation measures including 9 new trees of native species within application boundary, 49 new trees and transplantation of 16 trees at off-site location, vertical greening, roof greening, and reinstatement of landscape area are proposed. According to the Response to Comment Table of FI(2), it is acknowledged that the lawn area should not be fully utilized for tree planting as agreed with LCSD and thus the compensatory planting ratio of 1:1 in terms of aggregated DBH cannot be achieved within the application site. Significant adverse landscape impact on the existing landscape resource arising from the proposed use is not anticipated. We have no objection to the application from landscape planning perspective.	Noted that significant adverse landscape impact on the existing landscape resource arising from the proposed use is not anticipated and PlanD has no objection to the application from landscape planning perspective.

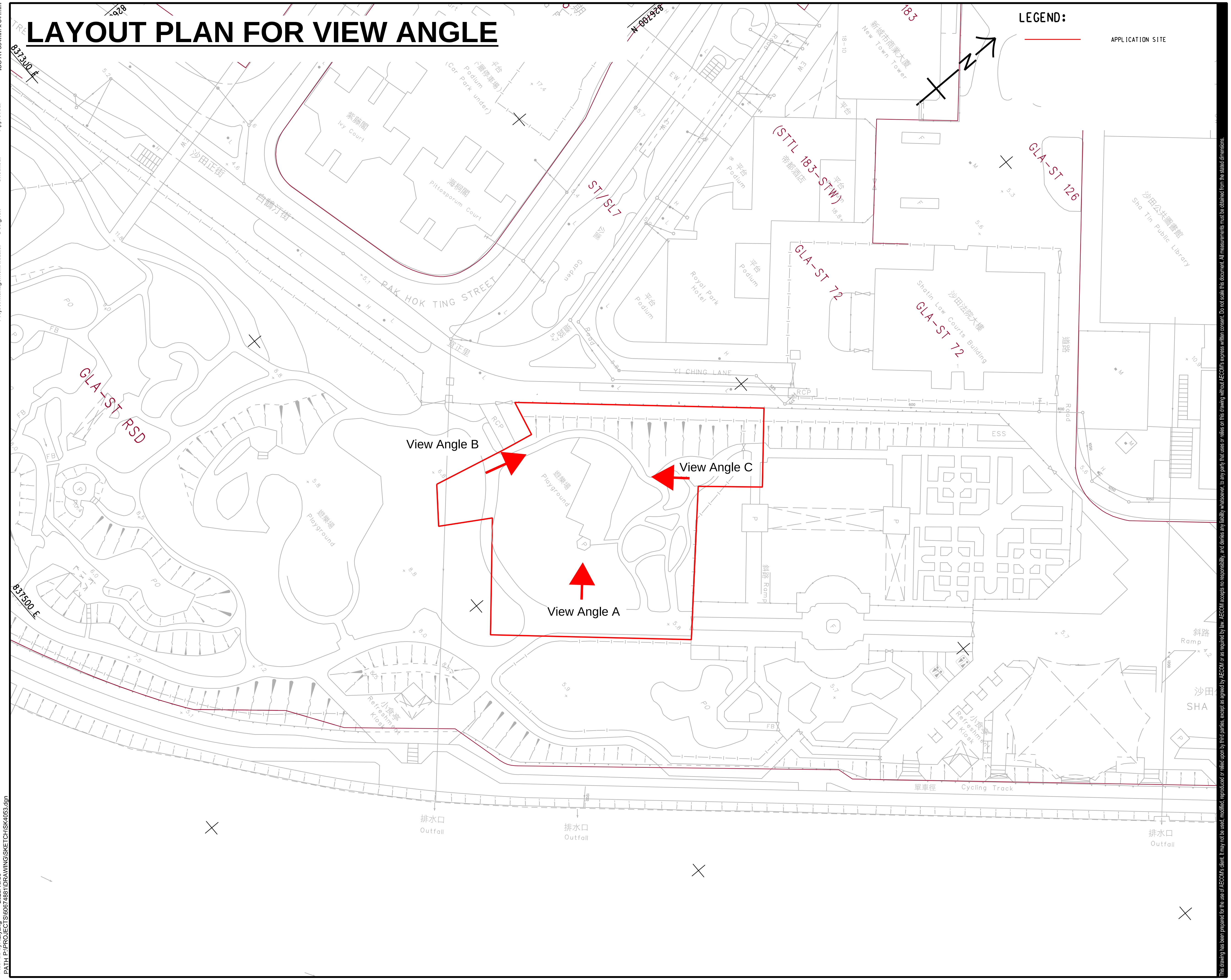
Item	**Comments**	**Responses**
	Detailed/ Advisory Comments 3. A 1.6m and 0.2-0.5m level difference is observed between the planting area and adjacent hard-paved area at R/F and G/F respectively, which is different with the landscape treatment (e.g. 1.1m high planter at R/F and sunken planters at G/F) as shown in the landscape section (DWG no. 60674881/SC0001). Furthermore, discrepancies on height of planters at R/F is observed among the landscape sections (+17.3, +16.8, +17.1).	Noted and updated under Appendix F. Refer to DWG no. 60674881/SK4124, at G/F, the planting area at lawn and the two areas in front of EVA and Transformer and Switch Room are at +5.7mPD. They are tally with the level shown in DWG no. 60674881/SC0001-SC0003. Refer to DWG no. 60674881/SK4124, at R/F, the vertical green at the periphery of the pump house is at level +16.8mPD while the two green roof are at level + 16.4mPD with min. 600mm soil depth. They are tally with the level shown in DWG no. 60674881/SC0001-SC0003.
	4. Site photos (view angle A & B) seems to be different with the annotation as indicated on the layout plan.	Noted and updated, please refer to Appendix B.
	5. It is noted that 5 nos. of Ilex rotunda and 4 no. of Sterculia lanceolata are proposed in this drawing, which does not tally with Compensatory Planting Plan under Appendix E and Landscape Layout Plan under Appendix F.	Noted and updated Appendix C to tally with Compensatory Planting Plan under Appendix E and Landscape Layout Plan under Appendix F.

Item	Comments	Responses
	6. The applicant should be advised that approval of the application does not imply approval of tree works such as pruning, transplanting and felling under lease. The applicant is reminded to seek approval for any proposed tree works from relevant departments prior to commencement of the works.	We have already obtained agreement from LCSD for the proposed tree works both within and outside application boundaries. The tree compensatory planting plan (outside application boundary) has been updated under Appendix E in Appendix IVb. The tree compensation ratio taken is 1:1. There will be 9 number of trees to be compensated within application site, while 65 number of trees will be compensated or transplanted to locations outside application boundary at Sha Tin Park and Tsang Tai Uk Recreation Ground. LCSD has agreed that the specific details of tree compensatory plan will be discussed at later stage.

Appendix B – Current Condition with Surrounding Environment

Amended Pages only

LAYOUT PLAN FOR VIEW ANGLE



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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT

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STATUS

SCALE

A1 1 : 500

DIMENSION UNIT

METRES

KEY PLAN

PROJECT NO.

60674881

CONTRACT NO.

CE 44/2021 (DS)

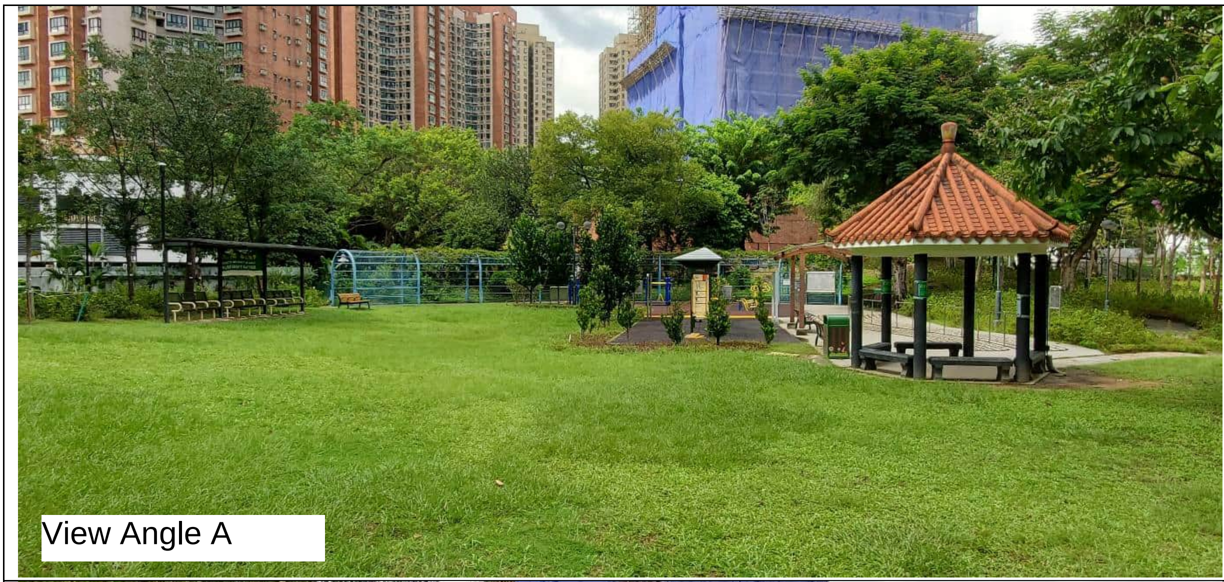
SHEET TITLE

PRELIMINARY LAYOUT PLAN AND SECTIONS OF SHA TIN TOWN CENTRE STORMWATER PUMPING STATION (STTCSPS)

SHEET NUMBER

60674881/SK4053

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:
Plot File by: lu.yang 2023/10/30
PATH P:\PROJECTS\60674881\DRAWING\SKETCH\SK4053.dgn


View Angle A

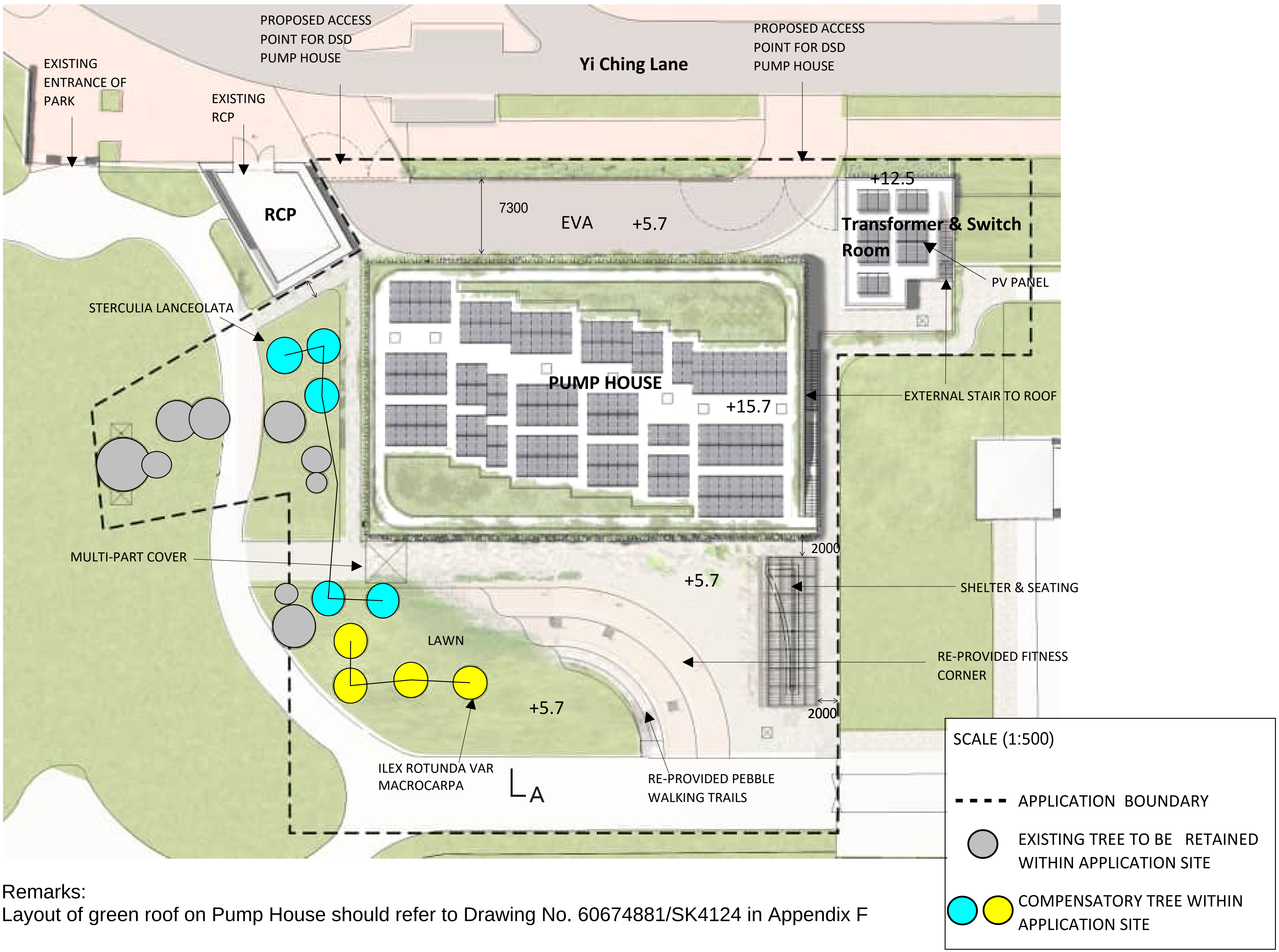

View Angle B


View Angle C

Appendix C – Architectural Design

Amended Pages only

Figure 1a – Overview of Architectural Design



Remarks:
Layout of green roof on Pump House should refer to Drawing No. 60674881/SK4124 in Appendix F

Appendix E – Tree Survey Report and Tree Felling / Transplanting Application

Amended Pages only

Appendix IVb

Compensatory or Transplant Plan (Outside Application Boundary) [Agreed with LCSD]

ISO A1 594mm x 841mm

Approved:

Checked:

Designer:

Project Management Initials:

Plot File by: Zhou23 2024/2/1

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PROJECT 項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT 業主

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I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS 階段

SCALE 比例 A1 1 : 2000

DIMENSION UNIT 尺寸單位 METRES

KEY PLAN 索引圖

PROJECT NO. 項目編號 60674881

CONTRACT NO. 合約編號 CE 44/2021 (DS)

SHEET TITLE 圖紙名稱

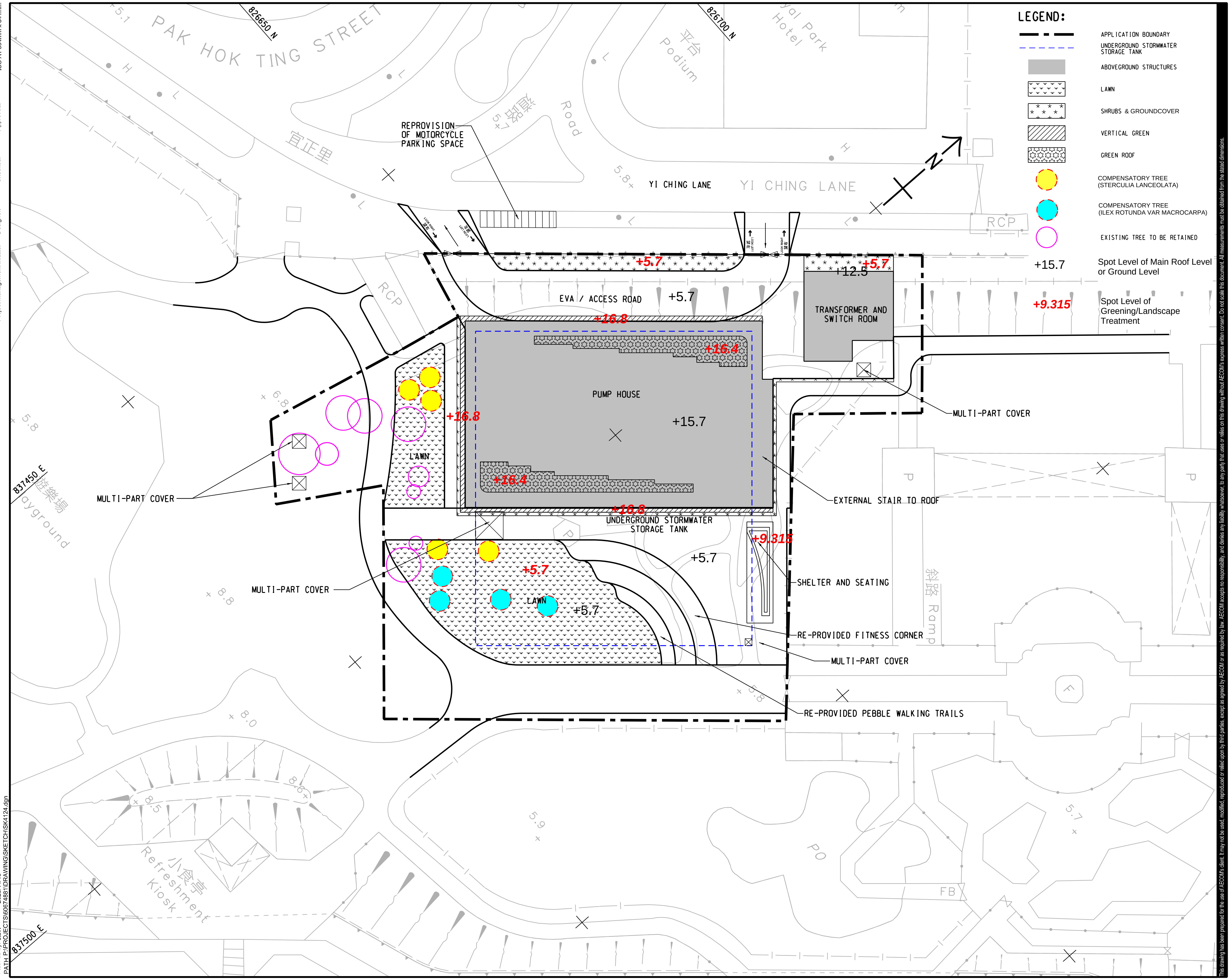
PROPOSED LOCATIONS FOR COMPENSATORY OR TRANSPLANT PLANTING

SHEET NUMBER 圖紙編號

60674881/SK7004

Appendix F – Landscape Layout Plan

Amended Pages only



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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

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I/R	DATE	DESCRIPTION	CHK.

STATUS

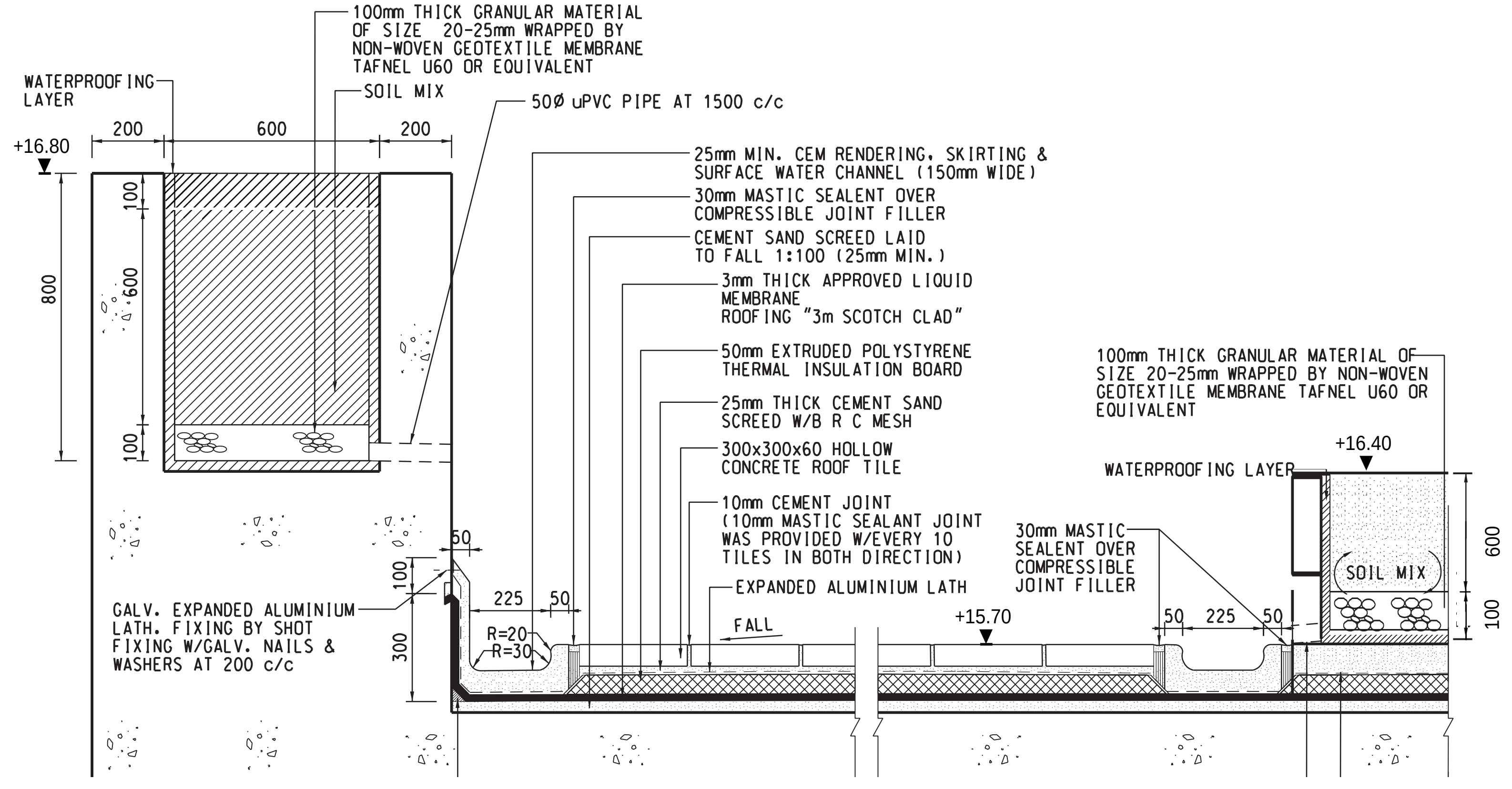
SCALE: A1 1 : 250
DIMENSION UNIT: METRES

KEY PLAN

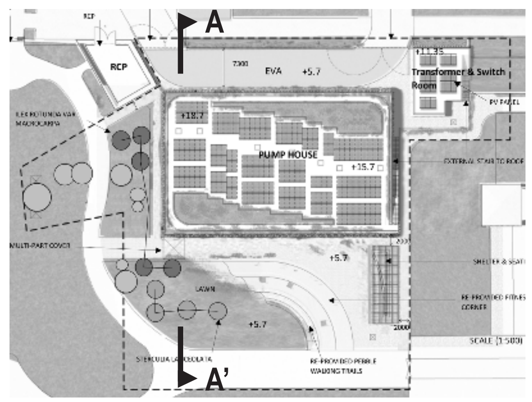
PROJECT NO.: 60674881
CONTRACT NO.: CE 44/2021 (DS)

SHEET TITLE
LANDSCAPE PLAN

SHEET NUMBER
60674881/SK4124

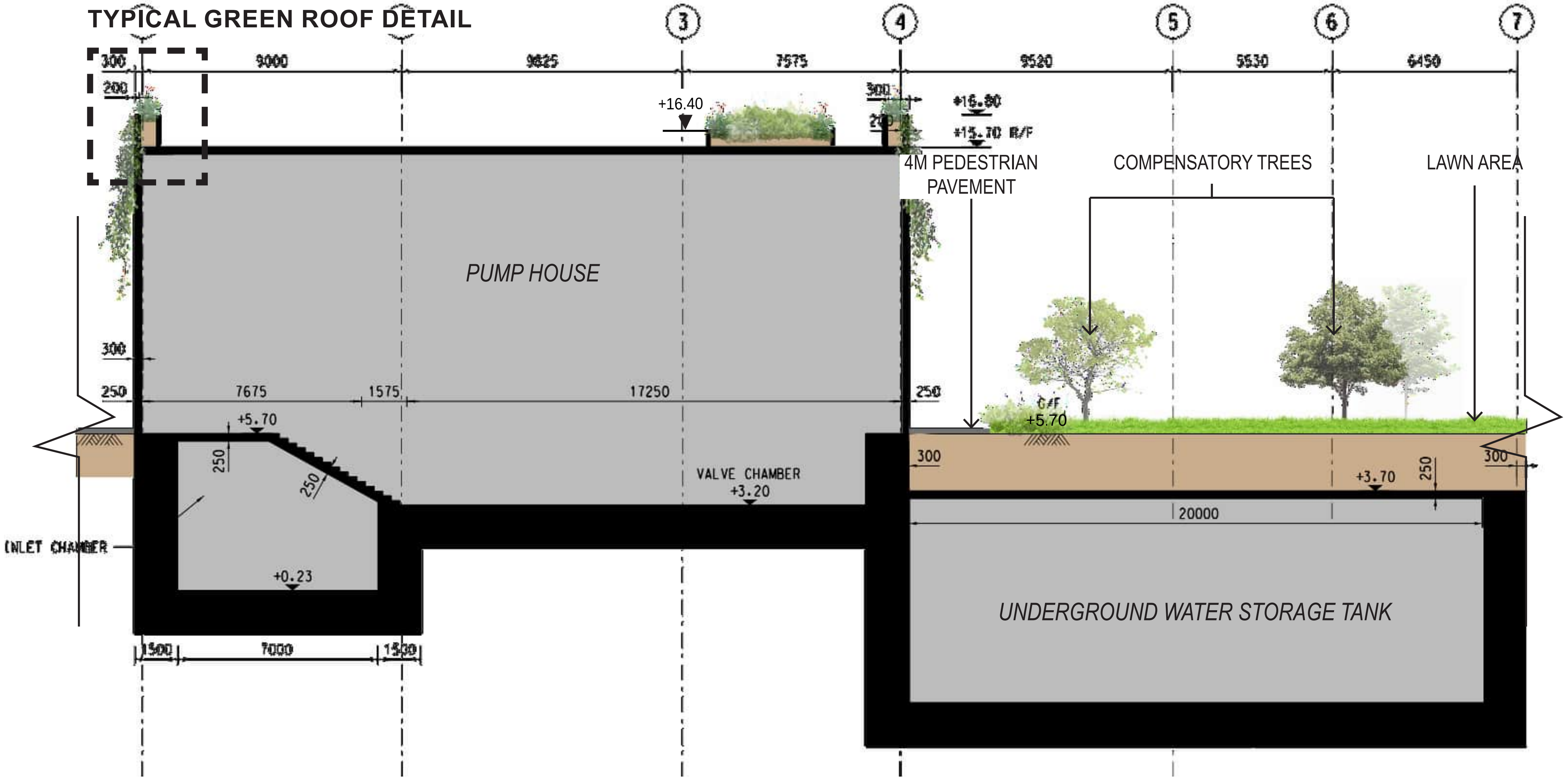


TYPICAL GREEN ROOF DETAIL



KEY PLAN

TYPICAL GREEN ROOF DETAIL



LANDSCAPE SECTION A-A'

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DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT

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ISSUE/REVISION

I/R	DATE	DESCRIPTION	CHK.

STATUS

SCALE A1 1 : 100

DIMENSION UNIT MILLIMETRES

KEY PLAN

PROJECT NO. 60674881

CONTRACT NO. CE 44/2021 (DS)

SHEET TITLE

STTCSPS PUMP HOUSE - SECTION

LANDSCAPE SECTION

SHEET NUMBER

60674881/SC0001

ISO A1 594mm x 841mm
Approved:
Checked:
Designer:
Project Management Initials:
Plot File by:
PATH P:

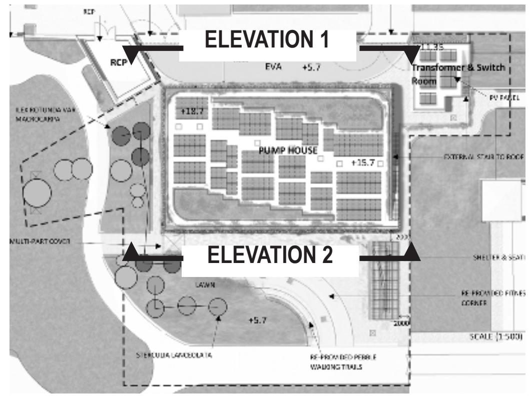
ISO A1 594mm x 841mm

Approved:

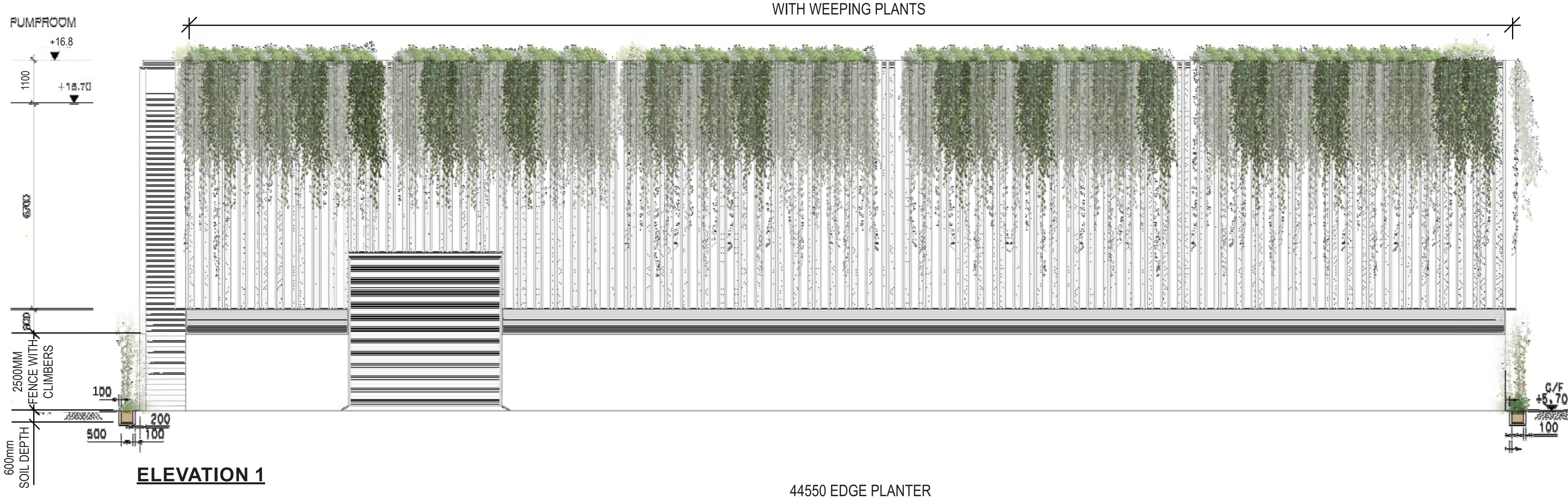
Checked:

Designer:

Project Management Initials:



KEY PLAN



ELEVATION 1

ELEVATION 2

Plot File by:
PATH P:

AECOM

PROJECT
項目

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

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I/R 修訂	DATE 日期	DESCRIPTION 內容摘要	CHK. 複核

STATUS
階段

SCALE 比例	**DIMENSION UNIT** 尺寸單位
A1 1 : 100	MILLIMETRES

KEY PLAN
索引圖

PROJECT NO. 項目編號	**CONTRACT NO.** 合約編號
60674881	CE 44/2021 (DS)

SHEET TITLE
圖紙名稱

PUMP HOUSE ELEVATION 01

SHEET NUMBER
圖紙編號

60674881/SC0002

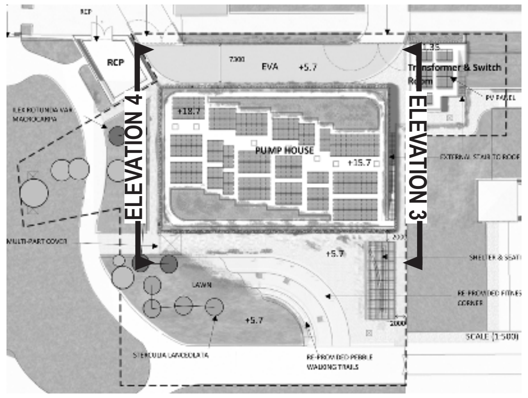
ISO A1 594mm x 841mm

Approved:

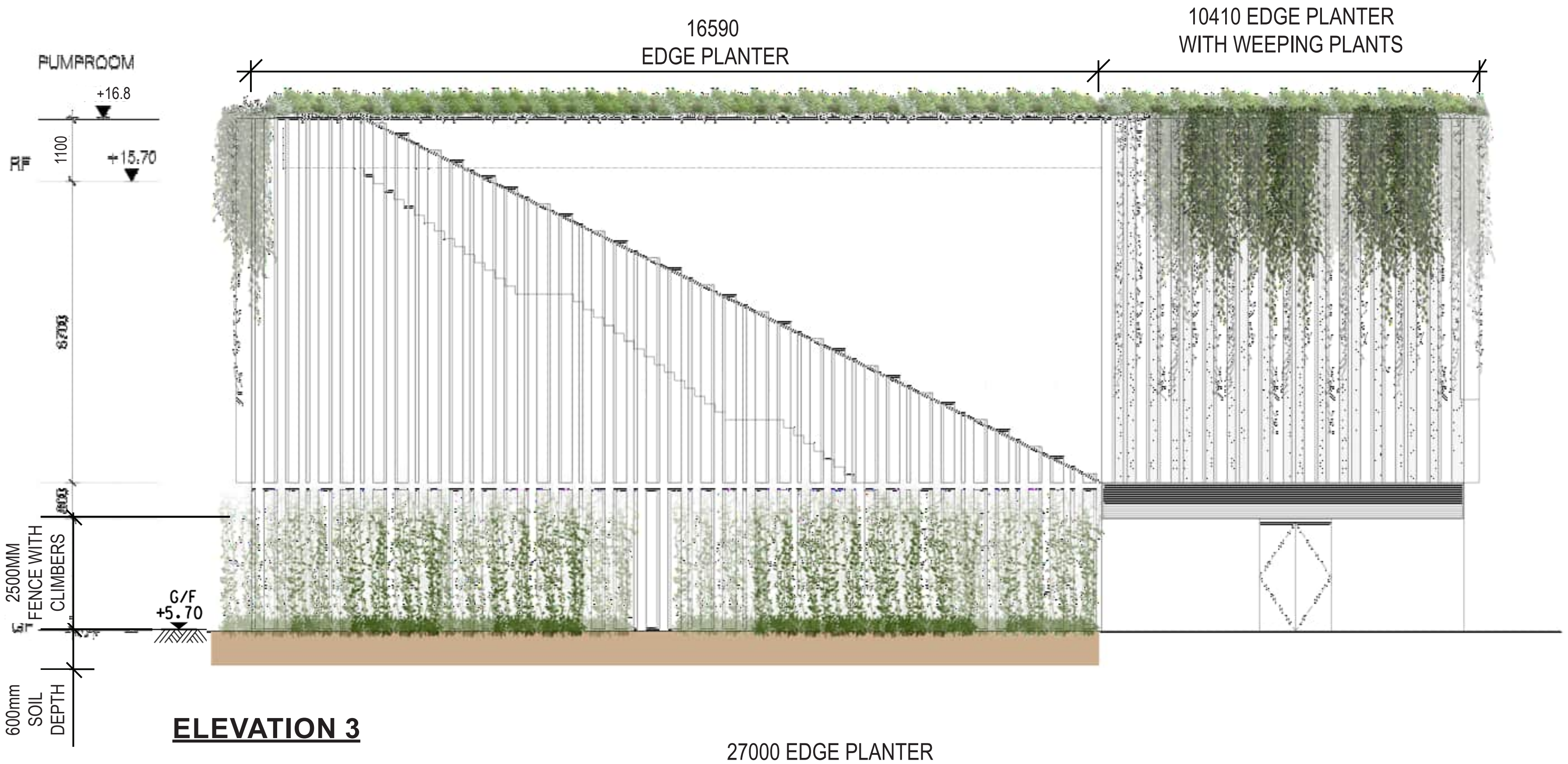
Checked:

Designer:

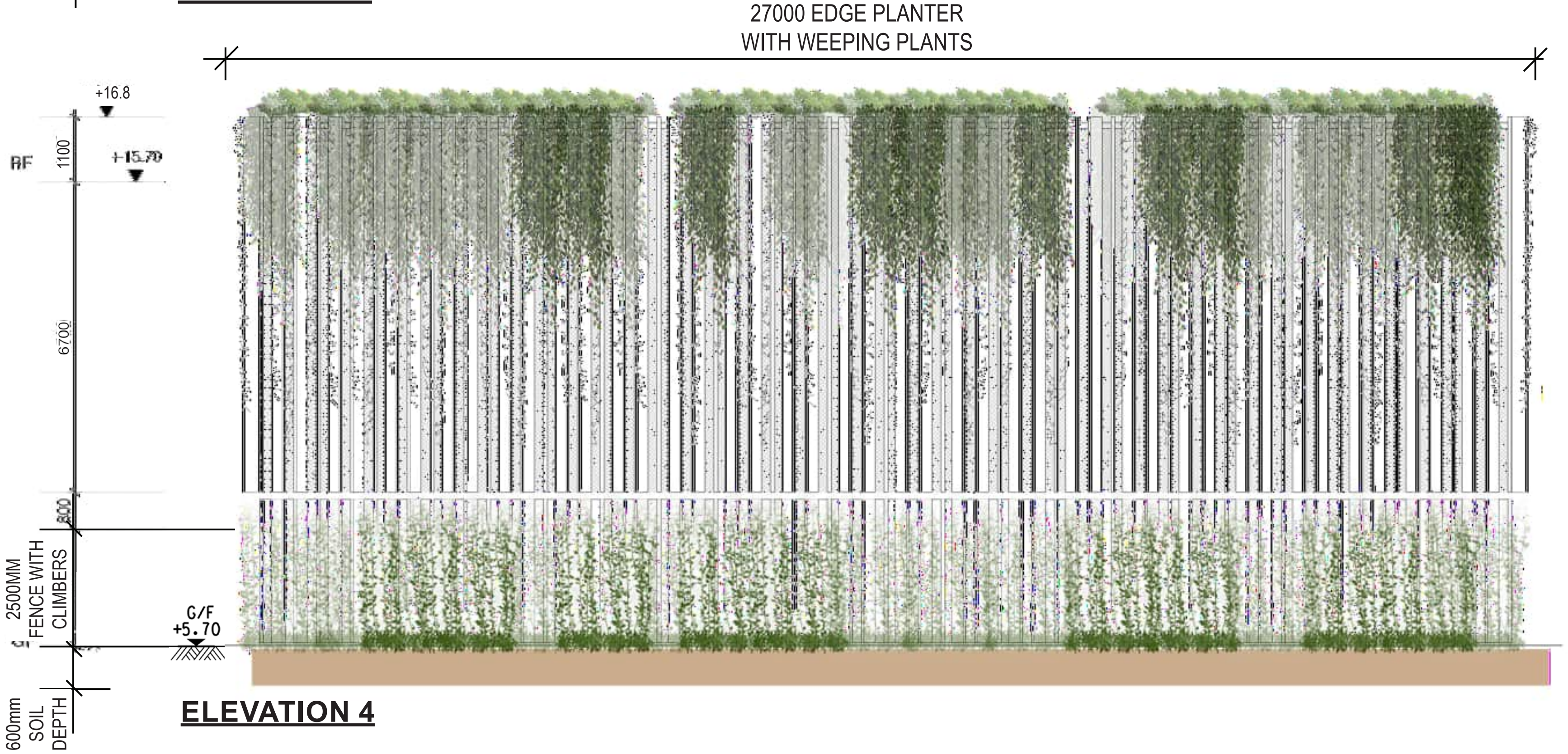
Project Management Initials:



KEY PLAN



ELEVATION 3



ELEVATION 4

Plot File by:
PATH P:

AECOM

PROJECT

DRAINAGE IMPROVEMENT WORKS IN SHA TIN AND SAI KUNG - DESIGN AND CONSTRUCTION

CLIENT

渠務署
Drainage Services Department

CONSULTANT

AECOM Asia Company Ltd.
www.aecom.com

SUB-CONSULTANTS

ISSUE/REVISION

I/R	DATE	DESCRIPTION	CHK.

STATUS

SCALE

A1 1 : 100

DIMENSION UNIT

MILLIMETRES

KEY PLAN

PROJECT NO.

60674881

CONTRACT NO.

CE 44/2021 (DS)

SHEET TITLE

PUMP HOUSE ELEVATION 02

SHEET NUMBER

60674881/SC0003

Appendix G – Photomontages

Amended Pages only

View Angle for Photomontage