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Date : 5th June, 2024
Your Ref : TPB/Y/NE-LYT/16
Our Ref. : ADCL/PLG-10248/L010

The Secretary
Town Planning Board
15/F., North Point Government Offices
333 Java Road, North Point, Hong Kong

Shatin, Tai Po & North District Planning Office
14 JUN 2024
RECEIVED

By Hand and Email

Dear Sir/Madam,

Section 12A Planning Application - Request for Amendment to the Approved Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan No. S/NE-LYT/19 from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A) 2" Zone at Lot Nos. 755, 756, 782 S.A, 789 S.A, 789 RP, 790 S.A ss.1, 790 S.A RP, 791 S.A ss.1, 791 S.A ss.2, 791 S.A ss.3, 791 S.A RP, 791 RP, 792 S.A RP, 792 RP, 793, 794 S.A, 794 RP, 800 S.A RP, 801 S.A, 803 RP, 835 S.B ss.1 S.A, 835 S.B ss.1 RP, 836 S.A, 836 RP, 837, 838 S.A, 838 RP, 839, 840, 841 S.A, 841 S.B, 841 RP, 842 S.A, 842 S.B, 842 RP, 843, 844 S.A, 844 RP and 854 in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau, New Territories

We refer to the comments from Antiquities and Monuments Office (dated 8.3.2024), Drainage Services Department (dated 2.4.2024) and Environmental Protection Department (dated 20.5.2024) regarding the subject application, we submit herewith the Further Information (FI) for the consideration by relevant Government departments or Town Planning Board. Please find the attached the following items for your onward processing:-

i. Response-to-Comments table;
ii. Extract of Revised Planning Statement;
iii. Revised Drainage Impact Assessment;
iv. Revised Environmental Assessment; and
v. Revised Sewerage Impact Assessment.

Considering the significant changes and supplementary information involved, the assessment reports have undergone substantial revisions.

Thank you for your kind attention and should you have any queries, please do not hesitate to contact the undersigned at 3180 7811.

Town Planning Board
13 JUN 2024
RECEIVED

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Nos. 267-275 Des Voeux Road Central, Hong Kong

Yours faithfully,
For and on behalf of
Aikon Development Consultancy Limited

Encl.
cc. DPO/STN, PlanD (Attn: Mr. Ryan HO)
Client

Further Information (7)

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Table | 1

Response-to-Comments

Responses-to-Comments Table

Date	Department	Comments	Responses
8.3.2024	Antiquities and Monuments Office	1. After reviewing the location and scope of works, AMO has no objection in principle to the proposed application. The applicant is reminded to ensure that no disturbance and physical damages would be made to Queen's Hill Site of Archaeological Interest ("SAI") during the course of works. Pursuant to the Antiquities and Monuments Ordinance (Cap. 53), the applicant is required to inform AMO (Ms Amy CHENG, Assistant Curator II (Archaeological Preservation) 5, tel: 2780 8944, email: amyylcheng@amo.gov.hk) immediately of discovery of any antiquities or supposed antiquities during the course of works.	Noted with thanks.
		2. Please delete Sections 5.11.2-5.11.4. The previous archaeological surveys and ground investigation quoted were carried out at the locations that had certain separation distance from the application site. Besides, the archaeological potential of the non-surveyed areas within Queen's Hill SAI could not be ruled out simply by desktop research. The conclusion of "the archaeological potential within the SAI is small" has no scientific proof.	Please refer to the revised Planning Statement (see **Enclosure 1**).
		3. Please revise Section 5.11.5 as "Considering that only a small portion of the proposed development encroaches on the SAI	Please refer to the revised Planning Statement (see **Enclosure 1**).

Date	Department	Comments	Responses
		and no works will take place there since the existing use of the access road will remain unchanged, and the minor works to the EVA is immediately outside the SAI boundary, it is unlikely that the proposed development will significantly affect heritage conservation, and no damage to valuable antiquities is anticipated."	

Date	Department	Comments	Responses
2.4.2024	Drainage Services Department	1. Please be advised that the stormwater drainage manual has been recently updated pursuant to its Corrigendum No. 1/2024. Please review the relevant calculation with view of the latest drainage guideline.	Thanks for the information. We noticed that the storm constants for calculating rainfall intensity have been updated in the latest Corrigendum. The calculation of runoff has been updated accordingly by taking the latest storm constants (see **Enclosure 2**).
		2. 2. Please validate and elaborate on the feasibility of upgrading the SUP1001474 to 1000mm with consideration of the site conditions and existing facilities in the vicinity	We revised the diameter of the proposed channel from 1000mm to 900mm after updating the assumed surface material (see **Enclosure 2**). We here provide justification for its feasibility in different aspects: For assessment purpose, the channel surface is originally assumed to be concrete-lining because bottom lining is commonly adopted in channel design to control the flow velocity under acceptable level. After reviewing the site condition, we find that bottom lining is unnecessary for the proposed channel because the only available source of dry weather flow will be the effluent from the proposed STP. Therefore, we propose to use cement mortar as channel surface and no bottom lining will be required. After the proposed upgrade, when the STP operate at its design capacity 0.05787m^3/s, the corresponding flow velocity at the 900mm channel would be approximately 1.0m/s, which is suitable as self-cleaning velocity. The maximum nominal size of U-channel shown in CEDD Standard Drawing C2409I is 900mm. As there is standard drawing available,

Date	Department	Comments	Responses
			the design of channel section at this planning application is not necessary. The total runoff to be generated from the site area is expected to be deducted by the provision of 35.76% landscape area in the Proposed Development. Even after the consideration of the treated effluent from the proposed STP as well as the added design allowance for newly constructed drains, the estimated peak flow through SUP1001474 during a 50-year returning period rainfall is estimated to reduce from 1.584m^3/s to 1.567m^3/s. As such, no increase in the flow rate is expected. It is therefore not anticipated that the proposed development can cause drainage characteristic change and induce drainage impact to the existing downstream drainage facilities. Even though flooding has been recorded in Lung Yuek Tau area during the recording breaking black rainstorm in September 2023, the acting director of DSD said the flooding was related to the capacity of rivers being overwhelmed by extreme rainfall intensity[1]. In this regard, the overall flooding risk of the site area is a district-wide issue subject to Ng Tung River and not directly related to the

[1] https://www.info.gov.hk/gia/general/202309/08/P2023090800662.htm

Date	Department	Comments	Responses
			Proposed Development and the nearby urban drainage branch systems. On the other hand, the proposed channel upgrade is more likely a measure to improve the drainage performance during the specified 50-year returning period rainfall intensity. During the previous site visits, the surrounding of SUP1001474 was generally cleared and no obvious obstacle was observed. The photos taken are inserted in Appendix D of revised DIA report to present the site condition. In sum, the upgrading of SUP1001474 will not induce any adverse impact to the existing drainage condition.

Date	Department	Comments	Responses
20.5.2024	Environmental Protection Department	<u>Environmental Assessment Report Air Quality Perspective</u> 1. Section 2.4.8 Please clarify for the averaging time of the RSP concentration 100µg/m3. Please explain why only RSP is monitored.	Please refer to **Enclosure 3** for Revised Environmental Assessment. The averaging time of 24 hours will be added to last sentence of Section 2.4.8. We propose only the RSP is monitored because we expect that the health impact associated with RSP will be higher than FSP, and monitoring RSP concentration will be sufficient to control the dust impact from the proposed development. Below is the justification: 1. The FSP/RSP ration in construction dust is usually low, for example, USEPA Compilation of Air Pollutant Emissions Factors from Stationary Sources AP-42 Section 13.2.4 suggests the FSP/RSP ratio of 0.15 for aggregate handling activities. 2. In the calculation of AQHI of Hong Kong, the added health risk factor of RSP is set to be 0.0002821751, which is higher than the added health risk factor of FSP, 0.0002180567. Therefore, RSP is statistically indicated to be more detrimental than FSP in short term exposure.

Date	Department	Comments	Responses
		2. Section 2.4.12 Please supplement the previous discussion "For Hai Wing Road and Dao Yang Road in the vicinity of the Site, they are not classified in ATC 2021. As discussed with TD, both roads are private roads and not managed by TD. Thus, the road types of the two roads could not be classified by TD.".	The 2nd sentence has been revised to include the discussion that the road type cannot be determined from the information provided by Transport Department.
		3. Section 2.4.19 to 2.4.29 Please also discuss the estimated extent of the odour impact from the proposed STW by making reference to the results of the odour impact assessment of the EIA report AEIAR-207/2017.	Section 2.4.29 has been revised to quote the odour assessment result from the AEIAR-207/2017 to discuss the odour impact of the proposed STP.
		<u>Environmental Assessment Report Water Quality Perspective</u> 4. We have no further comment from water quality perspective. Nevertheless, should there be any changes, we reserve our right to offer technical comment from water quality perspective.	Noted with thanks.
		<u>Environmental Assessment Report Noise Perspective</u> 5. We have no further comment from noise perspective. Nevertheless, should there be any changes, we reserve our right to offer technical comment from noise perspective.	Noted with thanks.
		6. To ensure the noise mitigation measures proposed by the Applicant will be incorporated into the future development, and considering there is no mechanism to impose approval condition for S.12A rezoning applications, control should be in place under land mechanism by special conditions under the	After this TPO Section 12A rezoning application, the project will undergo TPO Section 16 planning application to enable the residential development. EPD can request Planning Department to add the requirement of NIA submission as approval condition of the future S.16 planning application.

Date	Department	Comments	Responses
		lease modification to require the developer to submit a Noise Impact Assessment and implement the design and mitigation measures recommended therein.	

Date	Department	Comments	Responses
20.5.2024	Environmental Protection Department	**<u>Environmental Assessment Report Waste Management Perspective</u>** 7. Response-to-Comment (10) – Section 5.3.1 Please be advised that the Consultant may retain the demolition of temporary structures and excavation for the construction of the basement and foundation. The previous comment was issued to correct the misinterpretation of the previous response to Comment (17), "Within the proposed development, the site clearance work is almost equivalent to the demolition of existing buildings. And site formation usually involves excavation and backfilling to form temporary assess and building platform for the later structure construction works. The wording in that section has been modified to suit EPD concern", which was confusing and misleading. The Consultant is also advised to carefully review the quality of the submission and update the relevant wording accordingly.	We apology for the misleading sentences appeared in the previous response to comments. The update report has been fully reviewed in the concern paragraphs and revise accordingly.
		8. Response-to-Comment (11) – Section 5.3.3 The definition of non-inert C&D materials is confusing; please consider adopting the following description, "non-inert construction	The first sentence has been revised by adopting the definition provided by EPD.

Date	Department	Comments	Responses
		and demolition (C&D) materials refer to those materials that are not chemically stable and can undergo physical or chemical changes over time", and replace the initial portion of the first sentence.	
		9. Response-to-Comment (12) – Section 5.3.7 Please revise the first sentence as follows: "Currently, the site is still occupied by ~~under~~ brownfield operation, building survey for the existing structures within site area is not available.	The wording has been revised as suggested.
		10. Response-to-Comment (13) – Figure 5.1 The site boundary on the aerial photo is incomplete; please carefully review and update the scale and extent of the figure.	Figure 5-1 is an aerial photo is taken by drone. We currently cannot obtain another aerial photo with bigger scale and higher resolution. More aerial photos from Land's Department on the site are shown in Appendix F.
		11. Response-to-Comment (14) – Section 5.3.8 (a) The Consultant shall append the extract of the reference study for further vetting and review. Please highlight the relevant parts for easy reference.	(a)The study by Chen is not an open-access article. Due to concern of copyright issue, it is not appropriate to append it in the report or in response. As EPD concerns about the original study by Chen and may have difficult access it, we change the reference source of demolition waste generation index to *Model Development for Estimating the Quantity of A Single Building's Demolition Waste*, which is another study for demolition waste based on statistic from China cities, and can be accessed in http://www.cem.ncu.edu.tw/FileUpload/Thesis/92325010.pdf. The calculation of demolition waste will be updated accordingly. This reference has been also appended as Annex 1 of this response to

Date	Department	Comments	Responses
			comment. The most relevant contents within have been highlighted in green and are summarized at below: The new reference use statistic of demolition sites in Taipei and Taichung to develop a neural network system to estimation generation of demolition waste from multiple factors. After the development of the neural network system, the averaging unit demolition waste generation rate based on the two major factors, structure material and land use, is obtained.
		(b) The previous comment has yet been duly addressed. The Consultant shall carefully review the submission and clarify the difference between the demolition waste index of steel structures and the demolition waste generation rate of steel concrete structures. Please thoroughly proofread the submission and ensure consistency throughout the entire document.	(b) We clarify that the two terms demolition waste index and demolition waste generation rate have the equivalent meaning. For consistency, we have replaced all "index" by "generation rate" in the updated EA report.
		12. Response-to-Comment (17) – Section 5.3.9 and 5.3.10 The terminologies adopted in this Study are very confusing. Given there is no clear definition for "inert construction waste" and "inert demolition waste" throughout the submission, the Consultant shall	As most tables and headings in Section 5 are titled as waste and not material. The definition in Section 5.3.1 will be replaced by "waste" to stay consistent.

Date	Department	Comments	Responses
		consider standardizing those terms as "inert C&D materials" to avoid confusion and ensure consistency with the other parts of Section 5	
		13. Response-to-Comment (18) – Section 5.3.11 and Table 5-2 (a) The Consultant is advised to carefully review the previous comment. Please be advised that structural elements are usually located on the lowest floor of the proposed building. According to Appendix I (Section C-C), part of the B1/F was not the lowest floor of the buildings; please carefully elaborate on the assumption made for estimating inert C&D materials from B1/F and B2/F. The Consultant is also advised to update the calculation as appropriate.	(a) The elements below the lowest floor of building will be the foundation. The excavation volume caused by foundation work could not be estimated at this stage because the geotechnical design has not yet been confirmed, and whether excavation would be required for foundation work depends on the installation method at the detailed design stage. Even if shallow foundation will be used (despite driven piles or bored piles are commonly favoured in Hong Kong to obtain better end bearing resistance from rock layer), the excavation volume for foundation work is expected to be small when compared with the basement construction. Nonetheless, clear information on the excavation design and planning will be provided at the detailed design stage for EPD review. Referring to the Building Department Practice Notes APP-05, the floor height is measured between structural members. Since the transfer plate of residential blocks/shopping arcade is placed below the building and above the basement, and will consist of the upper slab of the B1/F, the depth of structure should be reserved beside the floor height when estimating the floor level of the B1/F. The

Date	Department	Comments	Responses
		(b) The Consultant is advised to incorporate a footnote for Table 5-2 to briefly elaborate on the assumption adopted for the addition of 0.8m for the thickness of structural elements.	calculation of excavation volume is not affected. No update is necessary. (b)A footnote is added as suggested.
		14. Response-to-Comment (20) – Section 5.3.13 and 5.3.14 (a) Although the upstream estimation method could be adopted for the entire portion of C&D materials, the waste volume adopted covers only the non-inert composition. Please provide further information and sound justification showing that 0.60m3/m2 is applicable to all C&D materials rather than only the non-inert portion as per the title of this particular section. (b) The attachment within the RtC table is unreadable. Please incorporate it as an Annex of the RtC for further vetting. (c) Given the mixed amount of variables (i.e., survey time, nature of construction and scale of construction works), an average number does not yield a reasonable ratio of inert and non-inert C&D materials. The Consultant is advised to provide further information or justification to substantiate the current estimation approach. Alternatively, the Consultant shall outline the assumption adopted	(a) The justification is provided as below: Despite the title is about non-inert construction composition, the methodology provided in Report 6 actually covers both the generation of inert and non-inert C&D waste during the superstructure works. For example, the below screenshot is part of the proforma (Appendix A of Report 6 in CIC paper) used to estimate the generation of C&D waste from wastage level and bills of quantity, presenting the calculation of the waste block work and masonry work during the construction of superstructure. The inclusion of these typical inert C&D waste in upstream estimation method can demonstrate that this method is developed for all C&D waste instead of solely inert or non-inert.

<table>
<tr><th>Date</th><th>Department</th><th>Comments</th><th>Responses</th></tr>
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<td></td>
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<td>and clarify the accuracy of the proposed ratio developed by averaging the statistics from three projects with different natures.

(d) Please be advised that the Consultant was not instructed to append the entire CIC Report. Instead, please extract the relevant parts (i.e., assumption, estimation methodology, proposed waste ratio, and waste volume) to facilitate further review and vetting.

(e) Given the doubts and uncertainties on the assumption and reference source adopted, we reserve our right to offer further comments on estimating the quantity of C&D wastes generated from superstructure works.</td>
<td>
<table>
<tr><td>Brickwork</td><td>Wall</td><td></td><td>M²</td><td>15%</td></tr>
<tr><td></td><td>Others</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Blockwork</td><td>Wall</td><td></td><td>M²</td><td>10%</td></tr>
<tr><td></td><td>Others</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Drywall (plaster board)</td><td></td><td></td><td></td><td>4-6%</td></tr>
<tr><td>Masonry and Granite/Marble Work (backing deemed to be included)</td><td>Internal wall</td><td></td><td>M²</td><td>8-12%</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>External wall</td><td></td><td>M²</td><td></td></tr>
</table>
And the inert waste will be reported within the non-inert waste sorting list to contribute the estimation of total quantity:
<table>
<tr><td>Inert</td><td>17</td><td>Inert</td><td>1</td><td>rock, soil, sand, aggregate, rubble, boulder, masonry, concrete, asphalt, brick & tile etc. (i.e. no sub-group)</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>Total weight:</td><td></td></tr>
</table>

(b)The Report 6 describing the upstream method of C&D waste estimation and the Summary Report presenting the waste generation rate and inert/non-inert ratio are appended as Annex 2 and Annex 3 of this response to comment table.

(c)At this planning application stage, the architectural and structural design of the Proposed Development has not yet commenced. As</td>
</tr>
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Date	Department	Comments	Responses
			such, conducting a very accurate estimation on C&D waste is not feasible. Even though the CIC report stated that there were great variances in the component of C&D waste generated from 3 sites due to the sample size and different stage of constructions, indicating their uncertainty within, CIC's investigation is the only available source we can find for site-oriented statistic after sorting and segregation. Therefore, by knowing that the non-inert C&D waste partition can range from 36% to 61%, adopting an averaging statistic should be sufficient to provide a tentative estimation, and would be the most suitable approach at the current stage. For comparison, the recently approved AEIAR-261/2024 for San Tin/ Lok Ma Chau Development Node adopted a 7%/93% of non-inert to inert ratio based on Monitoring of Solid Waste in Hong Kong 2021. The same approach had been previously adopted in this EA report before Rev.3 but was criticized that it may lead to significant errors in the EPD comments dated on 29/12/2024. We then turned on the CIC statistics to try to come up a more reasonable estimation in order to minimize the uncertainty. (d) Part of the CIC Report is appended as Annex 2 and 3 of this response to comment table.

Date	Department	Comments	Responses
			(e) Noted with thanks.
		15. Response-to-Comment (21) – Section 5.3.15 Please clarify whether 30 working days is a reasonable assumption for estimating the quantity of general refuse during the construction phase.	The monthly working days will be rectified to be 26days to align with the referencing AEIAR-221/2019 in Section 5.3.16.
		16. Response-to-Comment (25) and (26) – Table 5-3 Please be advised that the Consultant was not instructed to append the entire USEPA document; instead, please extract the relevant pages to facilitate further review and vetting.	The USEPA paper is appended as Annex 4 of the response to comment table.
		17. Response-to-Comment (26) – Table 5-3 (a) Please be advised that the Consultant was not instructed to append the entire USEPA document; instead, please extract the relevant pages to facilitate further review and vetting. (b) Please review the comments above and appropriately update the quantity estimation accordingly, particularly for those with uncertainties on the assumption, such as the generation of C&D materials from excavated soil and rock and construction of superstructure.	(a) The USEPA document is appended as Annex 4 of the response to comment table. (b)Noted.
		18. Response-to-Comment (26) – Section 5.3.23 Please specify the destination of inert C&D materials is subject to the designation by	A sentence has been added to the end of Section 5.2.23 to mentioned about designation of Public Fill Committee as specified by EPD.

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		the Public Fill Committee according to DEVB TC(W) No.6/2010 in the last sentence.	
		19. Response-to-Comment (26) and (32) – Section 5.3.25 (a) According to Section 5.3.24, 20% of inert C&D material will be on-site reused. Thus, a total of 110,232m3 is anticipated for off-site beneficial use. Such a figure does not tally with the estimated amount of 111,492m3 as presented in Section 5.3.25, please carefully review and update accordingly. (b) Regarding the calculation of the number of dump trucks and the average amount of daily inert C&D materials, the Consultant shall elaborate further on the assumption of the bulk factor and working days. (c) Please revise "inert C&D" to "inert C&D materials" in the second last sentence.	(a)We expect that the opportunity of onsite reusing will mainly concentrate at the site formation stage when back filling/ground enhancement/access construction will be required. Therefore, 20% of the inert construction waste generated from the demolition and excavation is proposed to be reused onsite. The remaining 80% will be transported to public fill reception facilities or other construction site. After the commencement of superstructure construction, there will be not much opportunity for onsite reuse, therefore, we assumed that all the inert construction waste generated at that stage will be transported to public fill reception facilities or other construction sites. There was no inconsistency or confusion. (b)The calculation of dump truck number is added to Section 5.3.25. What the USEPA document provides is the conversion factors between weight and volume, and not absolute density of each material. The factors are developed for directly converting volume of waste collected to weight when data reporting is required. Therefore, bulk factor is not applicable.

Date	Department	Comments	Responses
			The working days was previously taken as 30days/month. In the updated report, the working days will be revised to be 26days/month in response to Comment 19. (c) Revised to "inert C&D waste" as requested in other comments to be consistent.
		20. Response-to-Comment (26) and (33) – Section 5.3.26 Given that part of the Project Site is covered with vegetation, a certain amount of non-inert C&D materials, such as timber and woody materials, are anticipated during site clearance. The Consultant is advised to specify that the delivery of these materials to the Yard Waste Recycling Centre in Y-Park for recycling will be further explored in a subsequent stage prior to disposal at the designated landfill site.	The arrangement about delivering to Y-Park is added back as EPD requested.
		21. Response-to-Comment (26) and (34) – Section 5.3.27 (a) The previous comment has not been duly addressed. Please clarify whether "on a least weekly basis" shall be written as "on at least weekly basis". (b) According to the last sentence of Section 5.3.28, the quantity estimation of dump trucks is based on an assumption of every two days. The Consultant is advised to ensure consistency throughout the submission.	(a) The wording has been revised as "on at least weekly basic". (b) The last sentence is discussing the demand of dump truck to transport the non-inert C&D waste. It is converted to 4 trip/week to keep consistency as advised.

Date	Department	Comments	Responses
		22. Response-to-Comment (26) – Section 5.3.28 (a) The Consultant is advised to share the calculation and assumption for estimating the number of dump trucks. (b) Please review the comments above and appropriately update the quantity estimation accordingly, particularly those with uncertainties on the assumption, such as the generation of C&D materials from excavated soil and rock and the construction of the superstructure.	(a)The calculation of dump truck trip for inert C&D waste transportation is added to Section 5.3.25. The calculation of dump truck trip for non-inert C&D waste transportation is added to Section 5.3.28. (b)Noted.
		23. Response-to-Comment (29) – Section 5.5.4 (a) Please review the comments above and appropriately update the quantity estimation accordingly, particularly those with uncertainties on the assumption, such as the generation of C&D materials from excavated soil and rock and the construction of the superstructure. (b) The last sentence is confusing, "Additional measures to minimize C&D material generation and enhance inert material reuse should be explored when Ground Investigation is completed.". Please consider revising the sentence as follows: "Measures to minimize the generation of C&D materials and enhancement of on-site material reuse will be further explored upon acquiring further information on the subsurface geological profile".	(a)Noted. (b)The sentence has been revised as suggested. (c)The full title of the Vetting Committee in CEDD TC No.11/2019 is exactly Civil Engineering and Development Department Vetting Committee on Construction and Demolition Materials Management.

Date	Department	Comments	Responses
		(c) Please revise "Construction and Demolition Materials Management" to "Construction and Demolition Materials Management Plan" to avoid confusion.	
		24. Response-to-Comment (38) – Section 5.5.20 The Consultant is advised to elaborate further on the mitigation measures to be taken to handle and dispose of ACM.	The handling, transporting, and disposal measures required by LD and EPD have been added after Section 5.5.20.
		25. Response-to-Comment (39) – Section 5.5.22 (a) The Consultant shall elaborate on the preventative measures for chemical spillage and controlling measures after spillage in the first sentence for clarity. (b) Please remove "immediately" from the last sentence to avoid confusion.	(a) The first sentence is for summary. The elaboration of preventative and controlling measures is described after it. (b) The word has been removed as requested.
		26. Response-to-Comment (38) – Section 5.5.23 Please be advised that the transportation of dewatered sludge to T-PARK shall be prioritized over the disposal at the NENT Landfill.	The discussion about prioritizing recycling has been added to the end of Section 5.5.29.
		27. Response-to-Comment (40) – Section 5.5.24 The Consultant shall note that even without the support from EPD through the Pilot Scheme in Food Waste Collection, food waste should still be collected and transported to the food waste treatment facilities. Please refer to the link (https://www.opark.gov.hk/en/deliver.php) for more information. Please carefully review and update the paragraph for clarity.	The description about food waste collection and recycling has been added on top of the EPD pilot scheme in Section 5.5.30.

Date	Department	Comments	Responses
		<u>Environmental Assessment Report Land Contamination Perspective</u> 28. Response-to-Comment (43) – Section 6.2.2 The Consultant seems confused by the previous comment. Please be advised that the required assessment methodology covers the evaluation approach and the site appraisal via desktop review and site walkover, which have already been covered in this Study. Please remove the first two sentences to avoid confusion.	The first two sentences are removed as suggested.
		29. Response-to-Comment (44) – Section 6.3.2 (a) The previous comment remains unaddressed. Please confirm whether all landlords have granted consent for full access within the Project Site. (b) It is noted that several parts of the proposed development sites were inaccessible during the site walkover. Given that consent from all landlords has already been obtained, please elaborate on the challenge of accessing the portions in orange hatches for clarity. The Consultant shall briefly discuss the land use of these concerned areas and clarify whether peripheral inspection has been carried out.	(a)Consent for full access is not available since access to some site portion is still not possible at this moment. (b)Some portion of the site area is still not handed over to the planning applicant, and was locked as warehouse usage and covered under open storage yard during the past site visits. Shun Cheong Electrical Products and Tung Chun Soy Sauce and Cammed Food Company Factory Limited are out of the site and are not open to the public.
		30. Section 6.4.3 Please revise the first sentence as follows: "As observed from the aerial photos, there is potential land contamination issues	The sentence is revised as required.

Date	Department	Comments	Responses
		associated with past land use such as open area storage and possible vehicle maintenance activities" for clarity.	
		31. Appendix F The Consultant is advised to incorporate indicative markup showing the land use mentioned in Table 6-1 for consistency and to facilitate further review and vetting of the accuracy of the finding on historical land uses within the Project Sites, in particular those potential land contamination issues associated with past land use such as open area storage and possible vehicle maintenance activities mentioned in Section 6.4.3.	The markups showing location of open storage and vehicle maintenance activities have been added to Appendix F.
		32. Table 6-1 According to Section 6.4.3, possible vehicle maintenance activities are identified from the historical aerial photographs. For clarity, the Consultant shall further elaborate on this land use in Table 6-1.	The existence of vehicle maintenance activities was actually identified during the site visit because the activities were covered by the temporary structures. Nevertheless, the identification of vehicle activities in aerial photo is added as EPD requested.
		33. Response-to-Comment (45) – Section 6.4.4 and 6.4.5 (a) Please be advised that the Consultant is responsible for identifying suspected contamination areas and operations (if any) during the site appraisal to determine whether a detailed site investigation is required. If affirmative, the Consultant must devise a	(a)The project team has agreed to prepare and submit a CAP in the subsequent stage. During the site appraisal of this Environmental Assessment preparation, we suspected the possibility of potentially land contaminating issues on site due to site activities even though

Date	Department	Comments	Responses
		site investigation plan with the sampling and testing requirements and procedures in a Contamination Assessment Plan (CAP) in the subsequent stage. The Consultant shall review the findings of the site appraisal to conclude whether future site reappraisal is required and whether potential contamination areas are identified from both the desktop review and site walkover. It is frankly unreasonable to determine whether a CAP is required in a sub-section discussing solely the site walkover finding and stating that there is no evidence of potential land contamination issues. The Consultant is advised to carefully go through the Practice Guide to better understand the assessment and evaluation procedures. Please thoroughly review the findings and update the section accordingly. (b) According to the first sentence of Section 6.4.4, several suspected contaminative land uses are identified, including but not limited to warehouses, open storage yards, storage of construction materials and equipment and vehicle maintenance workshops. The Consultant is advised to graphically indicate their locations to facilitate the evaluation of land contamination of each of the areas individually.	no clear evidence on land contamination was recorded. However, existence of suspected activities does not guarantee the existence of the land contamination. Actually, during the site visit in 2023 January, the site was found to be mostly paved and kept clean, and soil experienced contamination was not observed. As EPD previously insisted to request the evidence on land contamination issue in the previous round of comments, and the evidence cannot be provided at this moment, we proposed the preparation and submission of CAP at the subsequent stage to conduct a thorough inspection on the site area as well as the nearby factories in order to infirm the land contamination issues. So, our previous suggestion to conduct a CAP at the further stage is consistent with previous EPD comments. (b) Please be advised that the graphical indication of potentially land contaminating activities can be found at Photo 29 within the Appendix G.

Date	Department	Comments	Responses
		(c) The Consultant is advised to individually and briefly discuss the site walkover findings for each of the concerned land uses (i.e., warehouse, open storage yards, storage of construction materials and equipment and vehicle maintenance workshops), including but not limited to the paving condition, housing keeping condition, identification of chemical storage areas, identified of fuel-driven machinery, nature of materials storage, any distressed vegetation and oil stains, underground tanks, chemical waste and dangerous goods storage, nature of activities and operation and the identification of potential workshop areas (please review to the Practice Guide and site walkover checklist to facilitate a comprehensive site walkover and appraisal). (d) To determine the completeness of the site walkover and representativeness of the conclusion, the Consultant shall discuss the accessibility of the Project Site during the site walkover and refer to Figure 6-1 for clarity. Given that some sites were inaccessible during the site walkover, the Consultant shall clarify whether future site reappraisal will be conducted in subsequent stages or further site walkovers will be carried out in this Study to fill the information gaps about 1.5 years ago.	(c) Actually, overall view and analysis of the site inspection checklist show no evidence for land contamination onsite. As such, individual description and discussion on each inspected portion without potential land contamination is necessary. However, as we have committed previously, further clarification on the land contamination with sampling and laboratory testing (by following CAP procedures) could be provided at the subsequent stage to confirm or infirm the land contamination issues. Further site visit with more access to all portion might be subsequent stage. Thus, we reasonably think that any individual or comprehensive site checklist analysis may not be useful at this stage to confirm or infirm land contamination issues. (d) The discussion on accessibility in reference to Figure 6-1 has been added to Section 6.4.5. We clarify that further site walkover will be conducted in subsequent stage when the CAP is prepared and submitted.

Date	Department	Comments	Responses
		(e) Since crawler cranes and forklifts are fuel-driven machinery, please clarify whether spent fuel and lubrication oils are anticipated. The Consultant shall review whether chemical waste storage areas are within the site. The Consultant is also advised to elaborate on the presence of a fuel storage area (if any). (f) The statement "In general, no obvious land contamination issues are observed during the walkover" is not supported by sufficient information. The Consultant shall comprehensively discuss and evaluate the land contamination potential of the concerned land uses highlighted in the first sentence. We reserve the right to further comments on the findings and procedures of the site walkover. (g) The response to the previous comment (45) is unacceptable. Please be advised that the findings of the site walkover (and site appraisal) must be clearly discussed, and the results shall be further adopted as the baseline information for future site reappraisal and the preparation of the CAP.	(e) During the previous site visit, storage tank of lubricant was observed near the entrance. However, storage of chemical waste was not observed and the location was fully paved. The information about chemical usage on site is limited, and will be supplemented and elaborated in the later CAP stage. (f) Actually, based on the site information on our hand at this stage, no evidence of land contamination issues was noticed onsite. However, as we mentioned previously, further investigation with full open access of all site portions (since some site portions are still not handed over to the planning applicant at this stage) following the CAP procedure shall be carried out at the subsequent stage. (g) From the site walkover, there is no evidence for land contamination issues at this stage. However, some site portions cannot be accessed at this stage because they are not yet handed over to the planning applicant. Thus, so comprehensive on the site walkover may not be possible at this stage. However, as mentioned previously, further investigation with full access to all site portions (after hand over) should be carried out the subsequent stage by following the CAP procedure to confirm or infirm the land contamination issue.

Date	Department	Comments	Responses
		(h) The previous comment (45b), "According to the site photographic records and historical and current land uses within the project sites, (i) the suspected oil stain (e.g. Photos 2 and 20), (ii) contaminative land use (e.g., vehicle maintenance workshop, open storage yard and lubricating oil tank in Photo 29), (iii) chemical/chemical waste storage areas (e.g., for the fuel-driven machinery) and (iv) suspected chemical containers (e.g., Photos 11, 19 and 21) were identified. The Consultant shall individually evaluate their land contamination potential and determine whether detailed site investigation and the submission of CAP are required in the subsequent stage", remains unaddressed. The Consultant is advised to respond to each comment instead of bypassing them.	(h)The contamination potential related to each land use is provided at Table 6-2 as required. Usage of chemical under potentially land contaminating activities does not necessarily cause land contamination. For example, a vehicle maintenance workshop following EMSD guidelines, and statuary regulations like Dangerous Goods (Control) Regulation, Waste Disposal Ordinance will not likely cause land contamination. However, please noted that all observed land use areas were fully paved and cleaned with no potential land contamination evidence. However, some site portions cannot be accessed at this stage because they are not yet handed over to the planning applicant. Thus, so comprehensive on the site walkover may not be possible at this stage. However, as mentioned previously, further investigation with full access to all site portions (after hand over) should be carried out the subsequent stage by following the CAP procedure to confirm or infirm the land contamination issue.
		(i) The previous comment (45c), "It is noticed that some site photographic records were taken on 6 December 2022, which is earlier than the one stated in this paragraph; please review and clarify accordingly" remains unaddressed. The Consultant is advised to respond to each comment instead of bypassing them.	(I)The difference on the date show in the photos previously provided to EPD is due to the fact that several site visits (supplementary site visits) were conducted the first site visit in December 2022.

Date	Department	Comments	Responses
		(j) In case there is no potential chemical spillage or suspected area of land contamination identified during the site appraisal, there would be no need to proceed further with a detailed site investigation plan and the submission of CAP. Based on the findings provided in this submission, it is not hard to say that the site walkover is incomplete and the previous comments (45d, 45f, 45g, 45h and 45i) have not been addressed or responded to. (k) According to the third sentence in Section 6.4.5, "As the village house, temporary structures (i.e., open storage and vehicle maintenance workshops) and warehouses within the Site are still in use, it is inappropriate to conduct a site investigation at the planning stage". Given the need for site investigation, it contradicts the first sentence stating there was no evidence of potential contamination issues. Please carefully review whether potential contamination areas are identified during the site appraisal and graphically indicate their locations to facilitate the devising of sampling and testing plans in the subsequent submission.	(j) Yes. Actually, based on information on our hand at this stage, we could not conclude on any evidence on land contamination issue. However, some site portion will be handed over at the later stage for further investigation. That is why we proposed to follow the CAP procedure at the subsequent stage with full access of all site portions in order to confirm or infirm land contamination issues. (k)Actually, it should be understood that we have no evidence for land contamination issue at this stage. This is consistent with site information we have got on hand now at this stage.
		34. Response-to-Comment (46) – Appendix G (a) All previous comments (i.e., 46a to 46f) remain unaddressed. The Consultant is required to respond to every comment to facilitate our vetting and evaluation of the findings and the proposed way	(a) Noted with thanks. Further clarification on the land contamination issues with consistency to site information at this stage has been provided. There is no confusion on our assessment.

Date	Department	Comments	Responses
		forward for the land contamination assessment in this Project. We request that the Project Proponent and the Consultant address all these comments promptly and implement the necessary improvements. Should the subsequent submission be unsatisfactory and any comments are bypassed in the following revision, we opt only to provide further technical comments or approve the submission once all issues have been duly addressed. This comment applies to the entire submission, particularly the land contamination assessment chapter. (b) Please supplement the locational plan showing the photo-taking locations and directions for further vetting and review. (c) It is observed that there was a lubrication oil storage area; please review whether it may possibly cause land contamination issues within the Project Site.	Only open access area has been inspected at this stage. All inspected areas are observed clean and fully paved with no chemical leakage and no evidences for land contamination issues. Other site portions will be certainly handed over to the planning applicant and further investigation will also be carried out at these portions with full procedure of CAP to confirm or infirm the land contamination issues. There was inconsistency or confusion in our previous descriptions. Everything was only based on site information at this stage. (b)The location layout plan with photos of each area has already been provided as the first figure in Appendix G. (c)Observed lubrication oil storage area was fully paved and clean with no chemical leakage. Thus, no evidence of land contamination issue was observed.
		35. Response-to-Comment (47) – Section 6.4.6 (a) While the title of this sub-section is "Review of Information from Relevant Government Departments", please clarify whether it is appropriate to incorporate "inquiring the planning applicant" in the first sentence", in particular, there is no discussion on the information provided by the planning applicant throughout this sub-section.	(a) The planning applicant verbally informed us that there was no chemical spillage incident happening to the site area and there was no known record of the onsite business owners registering as chemical waste producer. As no written record can be provided, the description about information provided by planning applicant will be deleted in the report.

Date	Department	Comments	Responses
		(b) The previous comment regarding the CWP records of the existing site owner, "The previous comment has not been duly addressed. The finding of no record of valid/invalid chemical waste producers, as enclosed in Appendix I, contradicts the questionnaire taken in the site walkover checklist (item 19) in Appendix G. The Consultant is advised to confirm whether the project proponent has already been registered as a chemical waste producer under the relevant regulation under Cap.354. Please be advised that there might be a potential violation of the WDO in case contractors or construction companies (with the production of chemical wastes) fail to register as chemical waste producers. Please seek further clarification with the relevant section of EPD and supplement the relevant correspondence for the record" has not been duly addressed. If there is currently no available information regarding CWP records, the most practical solution is to reach out to the relevant government authorities for the latest records. (c) The term "chemical issues" is confusing, please review and update the wording as appropriate.	(b) The planning applicant runs only warehouse business in the site area, and is not required to register as chemical waste producer. EPD has already informed in January 2023 that there was no chemical waste producer in the site area. Whatever the other business owners (for other site portions which are not yet handed over at this stage) have registered as chemical waste producers or not, further investigation will be conducted to inspect the corelation between chemical waste production and land contamination. (c) The wording "chemical issues" will be deleted.
		36. Response-to-Comment (48) – Section 6.5.1 (a) If there is no evidence to conclude that land contamination issues are anticipated within the Project Site, then there would be	(a) Noted with thanks. Further clarification on the land contamination issues with consistency to site information at this

Date	Department	Comments	Responses
		no point in carrying out a detailed site investigation and preparing CAP in the subsequent stage. From the findings or all relevant information provided by the Consultant, several potential contamination areas are identified, of which land contamination issues can only be ruled out by comprehensively assessing and evaluating through site investigation. (b) The discussion about the inaccessibility of premises during the site walkover shall be relocated to Section 6.4.4 and Section 6.4.5 under the sub-section of "Site Walkover". (c) Despite no solid evidence showing land contamination potential during the site visit, the Consultant shall review whether land contamination might be anticipated based on the overall findings of the site appraisal. (d) The Consultant shall elaborate further on coverage and requirements of the site –reappraisal.	stage has been provided. There is no confusion on our assessment. Only open access area has been inspected at this stage. All inspected areas are observed clean and fully paved with no chemical leakage and no evidences for land contamination issues. Other site portions will be certainly handed over to the planning applicant and further investigation will also be carried out at these portions with full procedure of CAP to confirm or infirm the land contamination issues. There was no inconsistency or confusion in our previous descriptions. Everything was only based on site information at this stage. (b) The discussion about accessibility has been added to Section 6.4.4. (c) Noted with thanks. Further investigation by following the CAP procedure will be carried out at the subsequent stage. (d)The site reappraisal with full access of sit portions by following the CAP procedures, should be carried out after the handover of other site portions in the subsequent for EPD review.

Date	Department	Comments	Responses
		Sewerage Impact Assessment Report 37. Section 3.1.1 The peaking factor for the proposed STP is based on the Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning (GESF), please revise.	Please refer to **Enclosure 4** for Revised Sewerage Impact Assessment. Section 3.1.1 has been revised by removing description about peaking factor. Table 3-1 and Appendix A has been revised by making reference to GESF
		38. Appendix A (a) The unit of the Estimated flow from the Swimming Pool Shower Facilities should be l/s, not m^3/day. Please revise. (b) Please include the peak flow for the sewer in the Calculation of Sewage Generation.	(a)The unit has been revised in the updated Appendix A. (b)The peak flow has been included as the last row of calculation in updated Appendix A.

Annex 1

國　立　中　央　大　學

營 建 管 理 研 究 所

碩 士 論 文

單一建築物拆除工程混合物產生量推估之研究

研 究 生：林 政 緯

指導教授：黃 榮 堯 博士

中　華　民　國　九　十　四　年　七　月

國立中央大學圖書館
碩博士論文電子檔授權書

(93 年 5 月最新修正版)

本授權書所授權之論文全文電子檔，為本人於國立中央大學，撰寫之碩/博士學位論文。(以下請擇一勾選)

(V)同意 (立即開放)

(　)同意 (一年後開放)，原因是：________________

(　)同意 (二年後開放)，原因是：________________

(　)不同意，原因是：________________

以非專屬、無償授權國立中央大學圖書館與國家圖書館，基於推動讀者間「資源共享、互惠合作」之理念，於回饋社會與學術研究之目的，得不限地域、時間與次數，以紙本、微縮、光碟及其它各種方法將上列論文收錄、重製、公開陳列、與發行，或再授權他人以各種方法重製與利用，並得將數位化之上列論文與論文電子檔以上載網路方式，提供讀者基於個人非營利性質之線上檢索、閱覽、下載或列印。

研究生簽名: 林 政 緯

論文名稱: 單一建築物拆除工程混合物產生量推估之研究

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學號： 92325010

日期：民國 94 年 7 月 20 日

備註：

1. 本授權書請填寫並**親筆**簽名後，裝訂於各紙本論文封面後之次頁（全文電子檔內之授權書簽名，可用電腦打字代替）。
2. 請加印一份單張之授權書，填寫並親筆簽名後，於辦理離校時交圖書館（以統一代轉寄給國家圖書館）。
3. 讀者基於個人非營利性質之線上檢索、閱覽、下載或列印上列論文，應依著作權法相關規定辦理

單一建築物拆除工程混合物產生量推估之研究

中文摘要

台灣地區每年產生大量之建築混合物，據內政部建研所之調查顯示，台灣地區經合法申請新建與拆除之建築混合物數量據估計每年約有 1,100 多萬公噸。順應世界各國永續發展的潮流趨勢下，目前政府正努力朝向著混合物減量與再利用之方向努力。倘若能追溯建築混合物之產生源頭，掌握建築混合物產生量，方能有效管制混合物與減少違規棄置之情事發生。

建築混合物產生量之推估不似開挖土方可做簡易計算，較難有精確之估算標準。目前相關推估研究只考慮將建築面積與用途納入影響因子當中，並未將其他影響因子（如構造種類等）考慮至建築混合物產生量之計算，如此將造成推估數據與實際產生量有所落差。

本研究透過專家訪談及問卷調查方式，彙整現行建築物拆除工程混合物產生量之主要影響因子。並蒐集各縣市政府拆除執照資料與工地現場實際調查紀錄之拆除混合物產生量加以分析篩選，利用近年來解決預測問題有較佳成效之類神經網路，建立單一建築物拆除工程混合物產生量推估之模式。

經上述建立拆除混合物推估系統，測試資料於容許誤差 15％之內時準確率達 91.67％，與現行各界常使用之推估係數相比較，本研究所建立之模式較為接近實際產生量，顯示本研究已改善現行推估係數之準確率。本研究之結果可供政府機關更有效掌握拆除工程時所產生之混合物數量，健全現行拆除混合物總量申報管控作業，避免違規棄置情形發生。

關鍵詞：建築混合物、數量推估、類神經網路

Model Development for Estimating the Quantity of A Single Building's Demolition Waste

ABSTRACT

Under the global development of sustainable construction, the government in Taiwan devotes more and more efforts for the proper treatment and recycling of construction and demolition wastes. In order for controlling those wastes to go into recycling plants or legal dumping sites, more and more local district counties demand construction sites to submit a waste treatment plan before starting the work. In the plan they have to estimate the expected quantity of CD&W wastes, and to state clearly where will they go, how will they treated. Thus the estimated quantity serves as a base for waste monitoring and controlling in the remaining process.

The objective of this research is to study the major factors influencing the waste quantity generated in a building's demolitiom construction, and to develop a model each for the estimation of waste quantity. Literature reviews and expert interviews are conducted to identify the major factors influencing waste quantity. Identified factors include size of the building floors, purpose of the building, the structural type, height of the building, and so on. Totally 47 cases for building demolition are collected for their quantities of waste generated. The Neural Network (NN) method is employed for the development of the estimating model. The developed NN model is about 100％ accurate under permit error rate 15％ in testing , and 91.67% accurate under permit error rate 15％ in testing. A comparison of the developed estimation model and the current most used estimation formula is conducted on 14 test cases. The result shows that the developed models are significantly more accurate than the current ones in estimating the waste quantity of a single building's demolition.

Keyword：Demolition Waste, Quantity, Neural Network

誌 謝

回首過去六年，從一個只會讀書又讀不好，凡事都不太懂的小毛頭，經歷了大學及研究所的洗禮，讓我著實成長不少。在研究所 26 個多月的日子裡，總在無數個與地板和桌面肌膚之親中，匆匆飛逝，隨著論文之完成，意味著學生生涯將畫上句號，在中央營管與中原大學的一切，將成為我生命中最美好的回憶。

本論文得以完成，首先感謝恩師　黃榮堯博士悉心指導與教誨，研究所兩年中在老師的訓練之下，使學生之做事、邏輯觀念、寫作（雖提升不多）等，更為茁壯與成長，使學生受益匪淺。此外，所上　李建中教授、　姚乃嘉教授、　謝定亞教授、　陳介豪教授平日於專業知識與待人處世之傳授與教誨。並對於論文之斧正，學生在此致上由衷之謝忱。而在論文口試期間承蒙口試委員　林志棟教授、　王慶煌教授、　王維志教授、　郭斯傑教授於百忙之中撥冗審視論文與殷切指正，促使論文更加詳盡完整，在此致上誠摯的謝意。其中　林主傑博士及其指導學生柳志民同學指導與幫忙學生有關方法論上之疑問，雖然學生愚昧，但仍感激對於學生之幫助與指導。

在此特別感謝台北縣政府施工科土資組　黃新達組長現服務營建署建築管理課、台北縣政府　陳殊凡先生與大鋼牙　賴啟東先生，提供學生關於本論文相關之資料與協助，在學生不厭其煩刁擾下，對學生論文之幫助，學生難以忘懷，在此特別感謝。

研究所生涯中感謝　黃金田學長、　孫國勛學長、　吳英亮學長、　吳銜桑學長、　蘇世章學長、　古鴻坤學長、　曾文麟學長之指導與教誨，感謝　許維庭學長指導政緯之寫作技術及研究態度。感謝　屏甫學長、　文政學長適時提供場地讓學弟紓解壓力，　大蛇學長之照相功力真是深不可默。至於同窗好友偉宏由衷佩服你的公務員作息及最著名之”呀馬騎(台語)”；婉婷對任何事都表現非常驚訝，有時眞讓我嚇一跳；智遠你的冷氣，我好懷念喔，部隊裡見；大中你到處都有家的精神，我好想學習，加油喔；振翰我會懷念你的喵叫聲的；京翰你的浪漫主義有時眞會吸引到我；國雄不要再自怨自哀了，還有很多春天阿，你答應要辦的聯誼記得實現喔；凡鵬改天去淡水再找你；反應總是慢一拍之羽豐，眞想不

到你練過跆拳道；神龍見首不見尾的士賓，加油喔別再混了；二代掌門人昭惠，新的工作有新的挑戰，加油！有空再回來看妳，妳應該還會在吧？至於同 team 之小黑全與明哲，很珍惜與你們相處這兩年，彼此照應扶持，祝福你們都有美好的未來。

此外，感謝德威學弟及耿禎學弟於研究案上之支援，以後還有的你們忙，加油喔！記得「不讓學弟成長是學長的責任」；俊杰學弟你也要做論文了，加把勁成長喔；其餘研一學弟妹，感謝這段日子來的共同生活與幫忙；最重要的是美麗的徐小姐，祝妳在另一人生跑道順順利利，有好消息記得通知喔。

在大學社團裡結識之學長姐及學弟妹，偉龍、阿法、文裕、小貝、阿君、小新、宥任、小圓、麻吉綱榮、詩穎、阿凱、小圻、佳雯、小妹、澎澎、雨潔、慧敏、柏舜、立庭、小笨、松年、puppy、小舒、小芬、阿緒及更下幾屆的學弟妹們，非常高興認識你們，雖在社團有苦有樂，但跟你們在一起是我最快樂的時光。

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祝福所有認識政緯及政緯認識的人，願大家平安、幸福、順利！

政緯　謹誌
于中大營建管理研究所
中華民國九十四年七月

目錄

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圖目錄

一、緒論

1.1 研究背景與動機

台灣地區每年產生大量之建築混合物，據民國八十七年內政部建築研究所對拆除與新建混合物產生現況作調查顯示，台灣地區經合法申請新建施工與拆除之建築混合物數量據估計每年約有 1,100 多萬公噸【1】、【2】。按重量比例計算，我國的建築混合物產生量有 43%來自建築拆除工程，而 57%來自建築施工工程。每年如此龐大之建築混合物產生，在順應世界各國永續發展的潮流趨勢下，目前政府正努力朝著混合物減量（Reduce）、重覆使用（Reuse）、回收再利用（Recycle）與無法再利用者進行適當之處理（Recovery），期望建築混合物之再利用率能逐年達到預定目標。倘若追溯建築混合物之產生源頭，唯有確實掌握建築混合物產生量，方能有效落實建築混合物流向與處理再利用機制，減少違規棄置之情事發生。

建築物拆除工程混合物產生量之推估不似建築開挖土方可以體積做簡易計算，較難有精確之估算標準，例如建築物之構造形式、樓地板面積大小、使用分區、建築用途、裝修材料、拆除要項等諸多條件均影響拆除混合物之產生量計算。以往相關推估建築混合物數量之研究僅考慮建築面積與用途別等影響因子，並未將其他影響因子（如構造種類等）考慮至建築物拆除工程混合物產生量之計算，且多為較粗略之統計推估。另根據現地施工單位表示，利用現有之推估係數推估所得與實際產生之建築物拆除工程混合物數量常有相當程度落差，造成每年產生之真正數量不易掌握，不利於混合物之流向管理。

1.2 研究目的與方法

本研究之目的整理如下：

- 分析與探討影響單一建築物拆除工程混合物產生數量之因子。
- 建立單一建築物拆除工程時所產生之混合物產生量推估模式。

於拆除工程混合物產生量推估部分，本研究將利用人工智慧中之類神經網路技術進行分析，有關類神經網路方法，將於稍後說明介紹。

1.3 研究範圍

建築物進行拆除工程時會產生各類之建築混合物，本研究單一建築物拆除時所產生之建築混合物定義為建築物整體拆除後所產生之產物總量，但並不包括可移動式家具。茲將本研究範圍整理如下：

- 建築物拆除工程施工時之建築混合物產生量
- 單一建築物產生之混合物產生量

1.4 研究內容與流程

本研究主要針對單一建築物進行拆除工程方面著手，先應用問卷調查出主要影響單一建築物拆除工程混合物產生量之因素，並透過蒐集現場工地實際之拆除混合物產生量與各縣市政府提供之拆除執照資料，再利用營建系統分析方法，嘗試推估單一建築物拆除工程時所產生之混合物總量，以改善目前推估數量方式不夠準確之現況，以便健全現行建築混合物總量申報管控作業程序。本研究之研究流程及內容如圖 1-1 所示，分述如下：

1. 研究動機與目的之確認
2. 文獻蒐集與整理

   利用各大圖書館、國家科學委員會資料中心及網際網路等資源，蒐集整理國內外現有之相關文獻、資料統計及技術報告等，瞭解國內外建

築物拆除工程混合物推估之方式與實施計畫，並整理歸納現有建築物拆除工程混合物之相關公式，以利後續分析建議事項。

3. 混合物產生量推估現況調查與問題分析

一方面透過研究報告回顧,另一方面實地走訪民間各相關處理業者(清運業者、中間處理業者、拆除廠商、施工單位、使用單位等），藉由參觀訪談的方式，了解目前建築物拆除工程混合物實際產生量之估算方式，並蒐集調查有關數據作為後續研究分析使用。

4. 混合物產生量影響因子之專家訪談與問卷調查

經由專家詢問訪談之方式，了解所有會影響拆除混合物產生量之因子，再輔以模糊德菲法篩選重要影響因子，以利後續進行類神經網路架構之建立與設定。

5. 案例蒐集

走訪國內各縣市政府，蒐集各縣市政府拆除執照資料，加上現場工地實際紀錄拆除工程所產生混合物數量。將此些蒐集而來之案例加以整理分析，以利後續建立推估預測模式之用。

6. 拆除混合物產生量推估模式之建立

選擇本研究主要之應用軟體與建立類神經網路之輸入層、中間層與輸出層整體網路。將資料輸入至類神經網路前,對其進行尺度化之工作,以提升類神經網路之效能與收斂速度。經由蒐集之資料進行訓練學習，以訓練範例教導網路，經由重複之學習，將估計之誤差降低，並透過測試範例對訓練完之模式進行驗證之工作，倘若其正確率無法達到較高之水準，則進行其網路修改與調整。經由上述步驟後建立建築物拆除工程混合物產生量推估之模式。

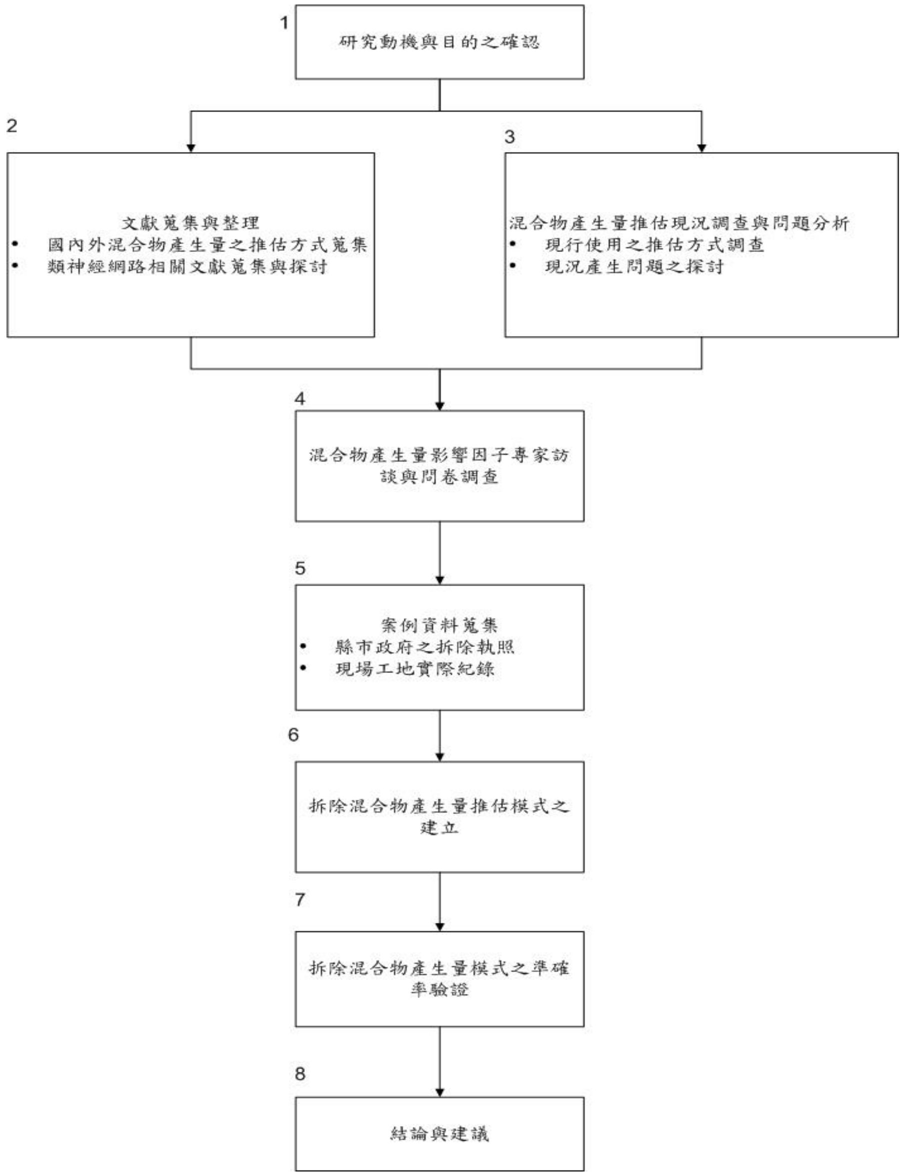


圖 1-1 研究流程圖

7. 拆除混合物產生量模式之準確率驗證

建構之單一建築物拆除工程混合物產生量推估模式，與現行為各界較常使用之經驗係數（0.79 M^3/M^2）做比較，驗證本研究建構之推估預測模式是否已修正現行經驗係數之準確性？

8. 結論與建議

藉由研究過程之廠商訪談方式，了解現行所使用之推估係數與實際產

生量不同之癥結點，提出改良之推估模式，提供政府機關對於建築物拆除工程時產生混合物作正確的估算，並就所產生之混合物總量做控管，避免違規隨意棄置情形發生，同時可結合與強化現行「營建剩餘土石方資訊系統」兩階段作業申報系統，以達建築混合物總量之良好管控。

1.5 預期成果

本研究主要針對建築物拆除工程建立其拆除混合物產生量推估模式，預期完成之工作項目如下：

- 建築物拆除工程混合物產生量推估現況調查與問題分析。
- 分析與探討影響拆除混合物產生數量之因子。
- 建立單一建築物拆除工程時之混合物產生量推估模式。

本研究之結果可供政府機關於建築物拆除工程時所產生之混合物數量作有效之掌握，並可結合與強化現行「營建剩餘土石方資訊系統」作業申報系統，健全現行建築混合物總量申報管控作業，避免違規棄置情形發生，再配合我國所實施之各項再生利用之措施，可促使國內建築混合物減量與再利用之目標得以有效落實，朝永續發展之路邁進。

二、文獻回顧

2.1 國內外建築混合物定義

2.1.1 國內建築混合物種類與定義

國內營建混合物相關名詞之定義不盡相同，常見的一些名詞如建築廢棄物、營建剩餘土石方、營建混合物、營建廢棄物等，其相關定義範圍及內容彙整如下表 2-1 所示。

表 2-1 營建副產物之名詞定義

類別	定義	來源
建築廢棄物	營建、拆除建築物或其他工程所產生之砂、石、土、磚瓦、水泥塊、混凝土塊等性質安定之固體廢棄物。	環保署廢字第一九九八四號解釋函
營建剩餘土石方	建築工程、公共工程及建築物拆除工程施工所產生之剩餘泥、土、砂、石、磚、瓦及混凝土塊，經暫屯、堆置可供回收、分類、加工、轉運、處理、再利用者，屬有用之土壤砂石資源。	內政部營建署「營建剩餘土石方處理方案」
營建廢棄物	施工所附帶產生之金屬屑、玻璃碎片、塑膠類、木屑、竹片、紙屑、瀝青等。	營建剩餘土石方處理方案
	建築工程、公共工程或拆除工程施工所附帶產生之金屬屑、玻璃碎片、塑膠類、木屑、竹片、紙屑、瀝青等。	各地方自治條例及管理辦法
營建混合物	工程施工建造、建築拆除、裝修工程及整地刨除所產生之事業廢棄物。又依各地方之自治條及相關管理法皆將營建混合物定義為：係指營建剩餘土石方(餘土)及營建廢棄物在尚未分離處理前之物狀稱之。	依「營建事業廢棄物再利用種類及管理方式」編號八營建混合廢棄物

資料來源：【3】、本研究整理

2.1.2 國外建築混合物種類與定義

各國於建築混合物之定義皆有所差異，故於敘述各國建築混合物之處理現況時，須先加以釐清。各國建築混合物定義說明如下：

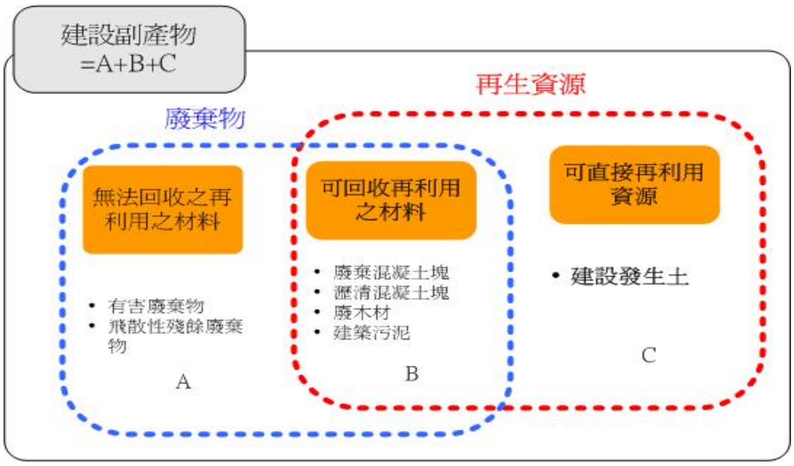
1. 香港

香港將有關營建工程所產生之物質統稱為『拆建物料』（C&D Waste），並區分為惰性和非惰性兩類，其中惰性物料係指不會分解與無臭味之碎石、混凝土、瀝青、拆樓後的瓦礫和挖掘之石頭及泥土，又稱為『公眾填料』；而非惰性拆建物料則包括竹子、塑膠、木材和其他有機物，亦稱為『拆建廢物』【36】、【37】、【38】。

2. 日本

日本將有關營建工程所產生之物質統稱為『建設副產物』如圖 2-1 所示，包括『建設發生土』與『建設廢棄物』兩大類，前者為施工建造階段產生之開挖土方，後者指廢棄混凝土塊、瀝青混凝土塊、建設污泥、建設混合廢棄物、木材等可回收再利用之材料，及有害廢棄物、飛散性殘餘廢棄物等無法回收再利用之廢棄物【1】。而以資源回收之觀點亦可將建設副產物分成以下三種：

1. 按照原樣可當成原材料者：屬於可直接再利用之範圍內，意指該廢棄物可不經再處理之「製造過程」及可再度使用。
2. 有可能當作原材料者：屬再生利用範圍。經一定之處理過程，經物理或化學之改變，方可使用。
3. 不可當作原材料利用者：即有害與具危險之物質。



資料來源：【3】

圖 2-1 日本建設副產物內容

3. 美國

美國主要是依 RCRA、CERCLA 等聯邦法，以嚴格的州法與條例來進行管理。對於營建廢棄物的定義，各州不同，如紐約州環境保護部於 1988 年對 C&DW（建造以及拆除廢棄物）的定義為：「所有新建、修建、改建、拆除、農地清理、公用事業維護、季節性或天災的清理工作所產生之未受污染的固體廢棄物皆屬之。」加州之洛杉磯市對於營建廢棄物或營建棄土並無特別定義，磚瓦及混凝土碎塊等視同一般垃圾來處理。根據所蒐集到的文獻及資訊，美國對於營建廢棄物之定義較為模糊，並不包含營建廢棄物明確之種類項目【1】。

4. 加拿大

加拿大將廢棄物區分「施工建造廢棄物」（Construction Waste）與「拆除廢棄物」（Demolition Waste），施工建造廢棄物係指所有施工建造階段所產生之廢棄物，包含廢木料、開挖土方、金屬、水泥塊、混凝土塊、磚瓦、玻璃、廢電纜、隔熱材料、紙類、塑膠、纖維等。而拆除廢棄物為所有拆除工程所產生之廢棄物，包含廢木料、開挖土方、金屬、水泥塊、混凝土塊、磚瓦、玻璃、廢電纜、隔熱材料、紙類、塑膠、纖維、家電、廢棄設備、傢俱、瀝青、石膏等【27】。

參酌國外所收集之文獻對於建築廢棄物之定義後，茲將其整理如表 2-2 所示：

表 2-2 國外建築混合物之定義

國家	定義			備　註
香港	「拆建物料」(C&D Waste)：分為惰性和非惰性兩類，其中惰性物料係指不會分解與無臭味之碎石、混凝土、瀝青、拆樓後的瓦礫和挖掘之石頭及泥土，又稱為「公眾填料」；而非惰性拆建物料則包括竹子、塑膠、木材和其他有機物，亦稱為「拆建廢物」			香港環保署
加拿大	施工建造廢棄物 (Construction Wastes)：所有施工建造階段所產生之廢棄物。包含廢木料、開挖土方、金屬、水泥塊、混凝土塊、磚瓦、玻璃、廢電纜、隔熱材料、紙類、塑膠、纖維等。			合稱 C&DW Forintek Canada Corp.
加拿大	拆除廢棄物 (Demolition Wastes)：所有拆除工程所產生之廢棄物。包含廢木料、開挖土方、金屬、水泥塊、混凝土塊、磚瓦、玻璃、廢電纜、隔熱材料、紙類、塑膠、纖維、家電、廢棄設備、傢俱、瀝青、石膏等。			
日本	建設副產物	建築發生土	可回收再利用：混凝土塊、瀝青混凝土塊、建設污泥、紙類、金屬、廢木料	戶谷有一、建設副產物現況與課題
日本	建設副產物	建設廢棄物	不可再利用：有害廢棄物、飛散性廢棄物	
美國	施工建造以及拆除廢棄物 (C&DW)：所有新建、修建、改造、拆除、農地清理、公用事業維護、季節性或天災性的清理工作所產生之未受污染的固體廢棄物皆屬之。			美國紐約州環境保護部
美國	施工建造以及拆除殘餘物 (C&D debris) 所有構造物的新建、拆除、修建過程產生之廢棄物。構造物包含了住宅及非住宅建物、道路、橋樑等。廢棄物的組成包括混凝土、瀝青、木材、金屬、石膏、壁板及樓板；有些州的定義尚包含土地清理物如樹木殘株、岩石、土壤等。			美國環保署

資料來源：【1】、本研究整理

2.1.3 小結

本研究所稱建築物拆除工程時所產生之混合物為建築拆除工程所產生不包含土方之營建副產物，如圖 2-2 所示，包括混凝土塊、磚瓦、廢木料、金屬與玻璃等物質。因本研究所調查之數量主要以工地所載運出現場之卡車數為主，拆除地下室時不免會夾雜到少量土石方，仍屬本研究拆除工程混合物之範圍。而開挖工程土方因可簡單由開始體積計算，因此不納入本研究推估數量之範圍。

營建副產物

	種類	建築現場排出之廢棄物內容來源
營建剩餘土石方	土方	新建工程、拆除工程：岩屑、礫石、砂土及沙、石混合物沉泥、黏土、污泥、淤泥
	磚瓦	新建工程：運送過程損毀之磚瓦片 拆除工程：拆除磚牆、屋瓦、水塔等之碎塊
	混凝土塊	新建工程：施工殘餘之廢料、打石修鑿之碎塊 拆除工程：拆除混凝土結構體之碎塊
營建廢棄物	廢木料	新建工程：模板、棧木、木作或裝潢工程廢材 拆除工程、整修工程：拆除木構材、木隔間、木門窗、天花板等產生之廢木屑
	金屬	新建工程：鐵作工程殘餘廢料、鷹架鐵管、金屬防護板廢料、廢油漆罐等 拆除工程、整修工程：拆除之鋁門窗框架、鋼骨、鋼筋、鋼板、銅、製樓梯防滑條、鐵捲門等
	玻璃	新建工程、整修工程：玻璃修邊之廢料 拆除工程、整修工程：拆除玻璃窗之碎玻璃
	有害物	新建工程：噴射石綿粉牆壁剝落碎片、鉻化砷酸銅(CCA)防腐木材屑 拆除工程、整修工程：拆除石綿瓦板碎片、日光燈管
	其他	紙類如紙箱、壁紙屑、水泥袋等；纖維類如絨毯、窗簾、破布、繩等；廢塑膠如水管、電線皮、保特瓶、便當盒；垃圾…

資料來源：【4】、本研究整理

圖 2-2 本研究建築物拆除工程混合物之定義

2.2 國內拆除工程混合物處理現況

國內建築混合物之處理，可分為『產生』、『清運』、『中間處理』與『回收再利用』四個階段，其中產生階段係指建築混合物於工地現場產生之時期；清運階段則為產生階段運送至中間處理階段之運送過程；中間處理階段為建築混合物收容或加以分類處理之過程；而回收再利用階段則為建築混合物經分類處理後再應用於其它工程項目的階段。【3】、【13】

2.2.1 建築混合物之產出問題

營建工程實務上一般如屬開挖行為一般會產出較單純之土石方，在做回收再利用時又以此項目為主要對象，雖營建剩餘土石方是為經暫屯、堆置可供回收、分類、加工、轉運、處理、再生利用，屬有用之土壤砂石資源，於法並不適用「廢棄物清理法」之體系，但「營建剩餘土石方處理方案」中涵括新建及建築拆除後之物質如廢棄混凝土塊、磚、瓦等，這類物質常於工程實務中會因工地分類不易

常挾雜含有營建事業廢棄物體系中之物質，範圍界定並非明確，且沒有一認定標準，常造成執行單位困擾，造成機關權責不清。

以台北市政府為例，其為解決此一問題，於『台北市營建剩餘資源及處理場設置管理自治條例』草案中述及；營建混合物係指挖方餘土、拆方餘土與營建廢棄物任二種混合在尚未分離處前之狀態，營建廢棄物之重量比例應小於百分之十五。前開所述之營建廢棄物係指；建築工程、公共工程及建築拆除工程施工產生之金屬屑、玻璃碎片、塑膠類、木屑、竹片、紙屑等；混合物內營建廢棄物重量超過百分之十五視為廢棄物。雖建立判定比例之原則，但實務上應如何執行並無交待。

2.2.2 建築混合物之清運、申報及流向管理問題

依據現行《廢棄物清理法》第 28 條及第 39 條之規定，事業廢棄物之清除、處理應以（1）自行清除、處理；（2）共同清除、處理；（3）委託清除、處理；（4）其他經中央主管機關許可之方式(5)再利用等五種方式為之，彙整如表 2-3 所示。且依據《廢棄物清理法》第 9 條規定，廢棄物、剩餘土石方清除機具應隨車持有載明廢棄物產生源及處理地點之證明文件，以供查詢。

經由現況了解，承包商對於營建混合物部分多委託清運公司全權處理，通常不會過問運送去處，如依照廢清法之規定清除業者應將營建混合物送往合法之收容處理場(廠)所，由於合法之收容處理場所之收費價格高昂，清除業者因成本的考量而選擇送往收費較低廉之砂石棧場，因砂石棧場尚未合法化，管理單位無法管控其營建混合物之流向。

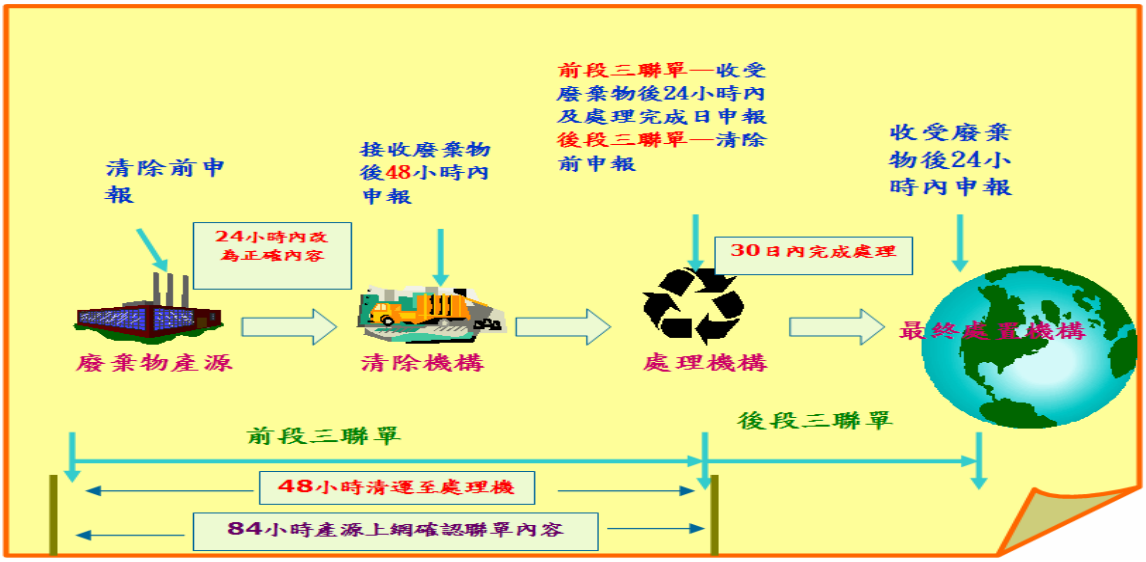
目前營建混合物之清除處理單位或經中央目的事業主管機關核可之再利用許可之事業，需向環保署事業廢棄物管制中心申報，其申報制度彙整如圖 2-3。因各地方自治條例及相關管理辦法各有不同之處，主要差異在於有無將營建混合物納入管理，而有將營建混合物納入管理之縣市皆遭遇一相同問題，即是申報問

題，由上開所述；營建混合物清除處理或再利用機構，如公民營廢棄物清除、處理及清理機構、事業廢棄物共同清除、處理機構需向環保署廢管中心申報，而地方對於管理營建混合物之自治法或管理辦法係屬工務體系，規定需向營建剩餘土石方資訊中心申報，其制度彙整如圖 2-4，兩者申報制度有所不同分屬不同層級法規，處理業者需遵循兩套不同申報制度及系統，而造成處理業者之困擾。

表 2-3 事業廢棄物清理制度

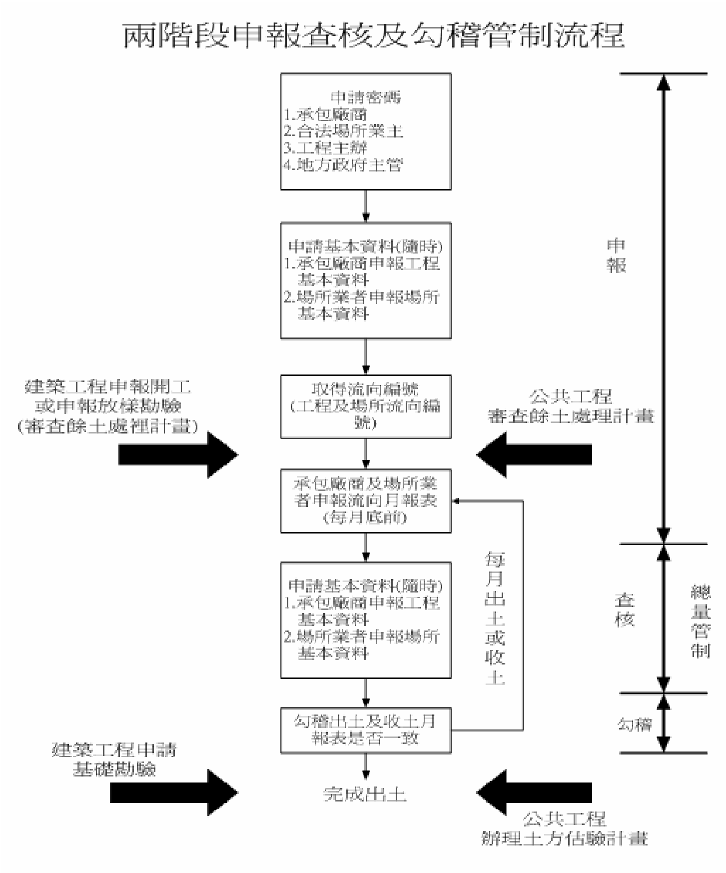
清理方式	法規
自行清理	依據《事業自行清除處理事業廢棄物許可管理辦法》(92.4.30)之規定辦理。
共同清理	依據《營建廢棄物共同清除處理機構管理辦法》(90.12.31)之規定辦理。
委託清理	委託經環保單位許可核備之公民營廢棄物清除、處理機構清除、處理其所產生之事業廢棄物。公民營廢棄物清除處理機構應依《公民營廢棄物清除處理機構許可管理辦法》(90.11.23)之規定辦理。
其他經中央主管機關許可之方式	目前尚無訂定
再利用	依據廢棄物清理法第39 條：『事業廢棄物之再利用，應依中央目的事業主管機關規定辦理，不受第28條、第41條之限制。』

資料來源：【3】、本研究整理



資料來源：【3】、【13】、本研究整理

圖 2-3 我國事業廢棄物申報作業流程現況



資料來源：【3】、本研究整理

圖 2-4 兩階段申報查核及勾稽管制流程

國內因各地政府目前並未全面要求建築工程及拆除工程所產生之混合物將其納入管理，唯基隆市、台北縣市、台中縣市及高雄縣有要求工程單位所產出之營建混合物應至營建剩餘土石方資訊中心申報外，其餘縣市並未有申報制度，故營建資訊系統中屬營建混合物之資料庫統計值僅有統計上開五個縣市之值，故未能有效估計全國營建混合物之產生量。

2.2.3 國內中間處理場（廠）所之類型

目前國內建築混合物處理機構，主要可以區分為以下形式：（1）多元化土資場；（2）營建廢棄物分類處理場；（3）砂石棧場。多元化土資場主要為收受營建剩餘土石方，且因場內具有處理分類機具，故可兼收營建混合物，詳述彙整如表 2-4 所示。

表 2-4 建築混合物處理機構類型

類型	營運功能	營運方式	備註
多元化土資場	營建剩餘土石方收容、暫屯、堆置、破碎、分類、回收、加工處理及轉運	對外營運收費	申設者可依場區特性決定營運項目
砂石棧場	建築廢棄物或混合物資源暫屯、『初步』分類、回收、處理	對外營運收費	➢ **目前多未合法** ➢ 可依各地方管理辦法及自治條例申請合法 ➢ 可依公民營廢棄物清除處理機構申請合法 ➢ 可依營建廢棄物共同清處理機構管理辦法申請合法
分類處理場	開挖土方、建築廢棄物或混合物破碎、分類、混合、加工或回收等處理	對外營運收費	➢ 公民營廢棄物清除處理機構 ➢ 營建廢棄物共同清處理機構管理辦法

資料來源：本研究整理

2.2.4 建築混合物之再利用問題

建築混合物經初步分類後之產物依法規相關規定而需進入不同之中間處理場，同時也會因不同處理單位而收取不同之處理費用，是故成本為清除業者最大的考量點。如 B5 類（磚塊或混凝土塊）及之單純廢棄混凝土，清除業者即會事前聯絡附近工地是否有需要回填，或是需要道路臨時的舖設，或直接進行其它種類之再利用方式，如此清除業者便可省去進土資場之費用。

如無鄰近工程可直接再利用者，依營建剩餘土石方處理方案之土石流向管制規定，B5 類及單純廢棄混凝土即會運至土資場或兼營土資場之砂石場加以處理後再利用。當在都市地區巷道狹窄時而屬小工程者所產出之營建混合廢棄物或 B5 類即會進入砂石棧場（棧仔場），屬小量收容及轉運之功能，目前有關砂石棧場之相關規定，僅有台北縣市有其管理辦法。而第三類之營建混合物即會進入營建廢棄物分類處理場(公民營處理廠)。

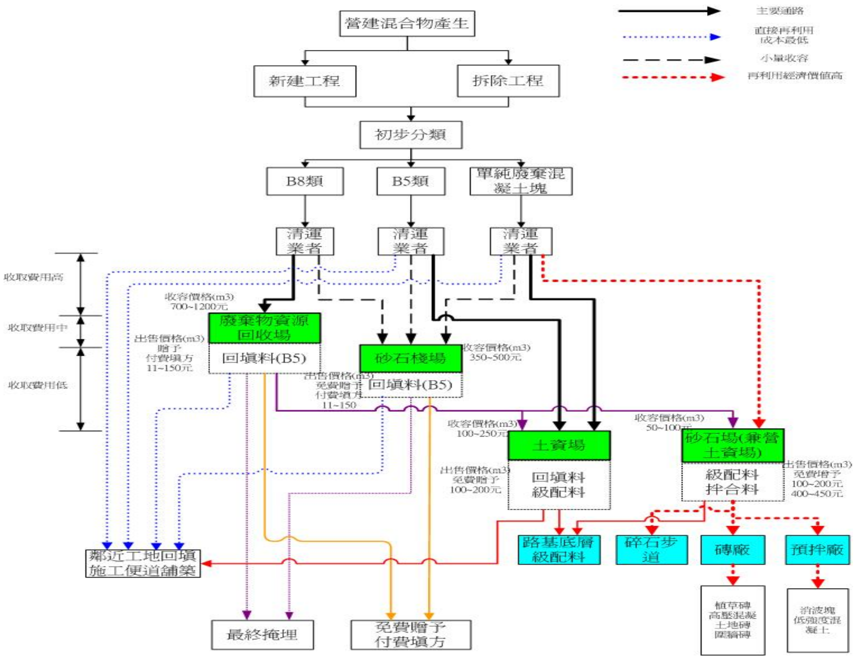
圖 2-5 為國內北部地區營建混合物之流向及處理後再生粒料通路之現況，營建混合物經處理後，仍多侷限於鄰近工地回填、施工便道鋪築及路基底層級配料等經濟效益較低之用途，而廢棄物分類處理場及砂石棧場所產出之再生骨材，因

帶有「廢棄物」之不良印象且品質較差而乏人問津，故處理業者為避免再生料無人使用而囤積場區影響處理場之運作，均面臨免費提供使用甚且須付費予使用者的困境，不但處理業者成本增加，對再利用之通路產生阻礙，甚至有以最終掩埋之方式處理，已失去再利用之意義。將所遭遇課題彙整如下：【6】

1.回收處理業者對於營建混合物產出量無法正確掌握，由於無法獲得穩定且足夠的數量保證，在成本效益考量之下，業者多無意願投入大量資本參與。

2.營建混合物成份複雜且分類不易，資源化困難建築施工或拆除混合物之回收處理方式係將各種不同之廢建材依種類特性先行分類再回收，但因內含成份複雜，且材質不均勻，不易進行分類處理，其再生產品的品質不穩定，導致使用者難以接受，造成資源化工作難以推動。

3.營建混合物再利用之市場性不足，目前尚無再生材料的使用標準與規範，再加上市場對於再生材料認識不夠，在信心不足情況下，工程單位不敢貿然使用，以致市場通路不明，業者投資風險大。



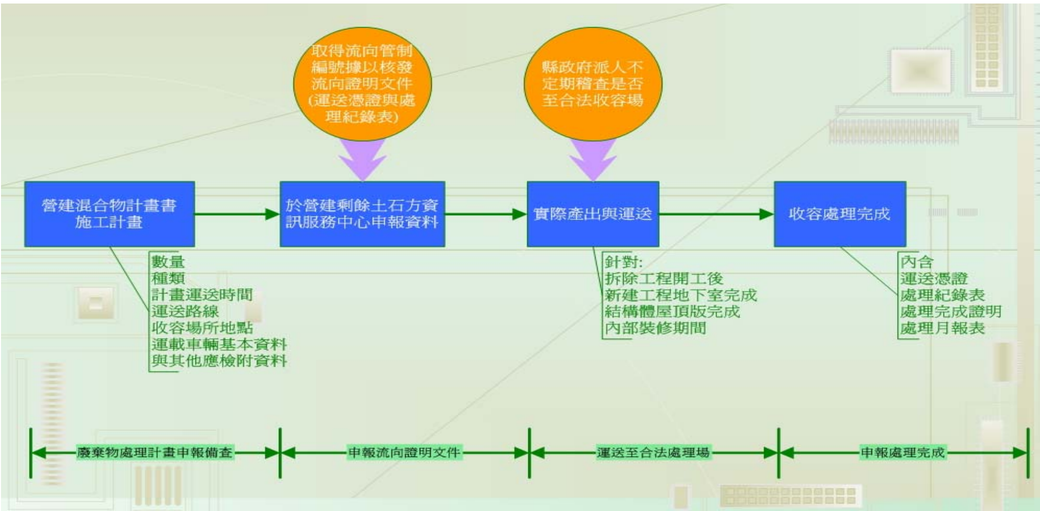
資料來源：【6】、本研究整理

圖 2-5 我國混合物再利用市場之通路

2.2.5 借鏡台北縣之管理制度

現行政府將建築工程施工或舊有建築拆除所產生之營建混合物納入管理，以避免違規棄置之情形產生。以現行管理營建混合物最為完善之縣市台北縣為例，其依建築法第五十四條、建築管理規則第二十七條規定及台北縣建築管理規則第十九條規定，於九十一年四月一日起實行營建混合物申報作業，於工程實際產出營建混合物前，由起造人會同承造人與監造人提報營建廢棄物處理計畫書併施工計畫書送請縣政府備查，並於拆除完成後或申請核發使用執照前送請縣政府備查【5】。

目前台北縣政府營建混合物管理流程，可分為（1）營建廢棄物處理計畫書備查（2）申請運送憑證及處理紀錄表（3）營建混合物產出運送至合法處理場（4）申報處理完成報告書，茲將整體流程繪如圖 2-6 所示：



資料來源：本研究整理、【5】

圖 2-6 現行營建混合物管理流程

（1）營建廢棄物處理計畫書備查

營建混合物申報作業規定適用於已領有建築執照（含拆除執照）但尚未申報施工計畫書者，於工程實際產出營建混合物前，由起造人會同承造人與監造人提

報營建廢棄物處理計畫書併施工計畫書送請縣政府備查。營建廢棄物處理計畫書格式包含建築執照號碼、工地地點、起造人、承造人、監造人、清運業者、營建混合物數量（含計算式）、種類、計畫運送時間、運送路線、合法收容處理場所名稱、地點、運載車輛基本資料與其他應檢附資料。

（2）申請運送憑證及處理紀錄表

營建廢棄物處理計畫書備查後，承造人並至「營建剩餘土石方資訊服務中心」兩階段申報系統申報工程基本資料，取得流向管制編號，再據以核發營建混合物流向證明文件（運送憑證及處理紀錄表），用以管制營建混合物流向。承造人應督促清運業者將工程營建混合物運送往計畫核准之合法收容處理場所。

（3）營建混合物產出運送至合法處理場

建築工程於申報開工後，於施工或拆除過程中即可能開始產出營建混合物，為杜絕違規棄置之情形發生，縣政府不定期派員進行營建混合物流向管制追蹤作業，並針對拆除工程開工後、新建工程地下完成、結構體屋頂板完成與內部裝修期間四個營建混合物產量較大之時間點做流向管制抽查。

（4）申報處理完成報告書

營建混合物處理完成後，承造人應於下列階段檢附已完成簽證之流向證明文件（運送憑證及處理紀錄表）、合法收容處理場所出具之完成處理證明文件及兩階段申報處理月報表等資料，報請縣政府主管機關備查：

1. 僅領有建築執照或拆除執照並建築執照者，於申請核發使用執照前。
2. 僅領有拆除執照者，於拆除完成後。

配合「營建剩餘土石方資訊服務中心」實施兩階段申報作業，規定建築工配合「營建剩餘土石方資訊服務中心」實施兩階段申報作業，規定建築工程及拆除

工程於申請流向證明文件前，應上網申報工程基本資料，縣政府於核發流向證明文件時核對。實際運送營建混合物期間，承造人每月底前申報登陸該工程當月份混合物處理月報表，縣政府於營建混合物申報清運完成報告時列為審查項目【5】、【7】。

2.3 國內外拆除工程混合物數量推估方式

國內外目前對於拆除混合物產生數量之統計資料十分有限，尤其缺乏正確案例資料數據，大多是以平均總樓地板面積之方式推估建築物拆除工程混合物之產生數量。表 2-5 彙整近幾年來建築物拆除工程混合物數量之評估研究資料，各研究對於拆除混合物之定義與資料取得方式皆有所差異，且評估對象與範圍並非完全一致，且僅以蒐集資料統計而得推估計算方式，因此造成彼此估算結果不盡相同。茲將表 2-5 之推估方式敘述於下。

表 2-5 近年來拆除混合物產生數量研究結果

研究個案	說明
Characterization of Building-Related Construction and Demolition Debris in The United States（U.S. EPA，1998）	美國環保署透過研究調查資料顯示住宅類新建之單位樓地板面積廢棄物產生量為 0.021 公噸/平方公尺，非住宅類新建之單位樓地板面積廢棄物產生量為 0.019 公噸/平方公尺。非住宅類拆除之單位樓地板面積廢棄物產生量為 0.757 公噸/平方公尺。
建築拆除污染及廢棄物產生現況與調查架構研究(黃榮堯，1998)	依據構造物之材料使用量(m^3/m^2)加總之後為構造物之整體廢棄物產生係數，高雄市單位樓地板面積拆除廢棄物產生量約為 $1.28t/m^2$（$0.81\ m^3/m^2$）。
建築廢棄物來源、產生總量推估、分佈狀況、清理再利用體系規劃（工研院，2000）	依據「建築拆除污染及廢棄物產生現況與調查架構研究」之研究成果，換算為全國之拆除混合物產生量約為 0.79 m^3/m^2。

資料來源：【1】、【9】、【28】、本研究整理

透過國內外之研究調查蒐集與分析，所蒐集有關拆除混合物產生量之調查與研究共有三個研究個案，顯示出於國內外對於拆除混合物產生量之調查與研究有限，再者根據研究調查個案中顯示，對於營造工程之建築工地所蒐集之工程筆

數，即資料之蒐集而言仍屬困難，故對於營造工程之拆除工程混合物數量之調查顯示其重要與急迫性，乃因於對於工程中所產生之混合物數量能進行完整與真實之紀錄為相當重要之一環，對於拆除混合物之管控亦屬重要。

對於三個研究個案本研究對於其分析方法、資料蒐集與計算結果進行剖析，分析出研究個案之缺點，如表 2-6 所示。本研究分析出三個研究個案均有其共通之缺點，主要為影響拆除混合物產生量之影響因子並未考慮完善，主要以總樓地板面積作為影響拆除混合物產生之因子，但是卻忽略其他影響因子如構造種類、建築用途等，故計算之結果較無法準確推估出實際產生量之情況；再者於三個研究中，對於資料之分析與篩選，並未將極端值刪除，亦即對於資料之篩選並無透過一系統性之分析與比較，此將對於推估混合物產生量造成影響。

本研究將針對上述幾項缺點進行改進，亦將透過工地實際紀錄蒐集拆除混合物產生量之數據資料，並針對所蒐集而來之資料進行更為嚴謹之篩選與選用，以使拆除混合物推估模式能達到完善之功能。

表 2-6 拆除混合物產生數量之推估研究個案比較

研究個案	缺點
Characterization of Building Related Construction and Demolition Debris in The United States（U.S. EPA，1998）	1. 影響因子除樓地板面積外並未考慮其他影響因子。 2. 非住宅類之工程數量過少。 3. 取樣年份與範圍過於分散，故所得資料有待商確。
建築拆除污染及廢棄物產生現況與調查架構研究(黃榮堯，1998)	其假設鋼鐵造之木材類廢棄物單位面積發生量與RC相同，有待商確鋼構案例較少。
建築廢棄物來源、產生總量推估、分佈狀況、清理再利用體系規劃（工研院，2000）	其主要架構，是依據黃榮堯教授等人於 87 年所研究成果加以換算而得全國推估係數，故當年擁有之缺失並無改善。

資料來源：【1】、【9】、【28】、本研究整理

2.4 模糊德菲法之簡介

2.4.1 傳統德菲法

傳統的德菲法(Delphi method)是專家預測法，也是群體決策法的一種，最先是由藍得公司(RAND Corporation)的得爾凱(Dalkey)所發展出來的【10】，主要目的乃在於獲取專家們較一致之意見，尋求專家們對特定預測對象之一致性意見。其進行方式必須要有一位協調者居中籌畫、擬定問卷並將專家們意見加以彙整，直至獲取專家們較一致之意見。若專家們意見未趨一致，則必須反覆進行【11】。

傳統的德菲法具有以下幾種缺點【12】：

1. 蒐集專家意見耗時日久；
2. 成本高；
3. 所謂「專家意見一致」僅為專家意見落於某範圍中，而此範圍隱含了模糊性，但在處理過程中卻未將模糊性納入考慮；
4. 問卷回收率低；
5. 求取專家意見過程中，亦扭曲專家意見；亦即會系統性的削弱對手的意見與抑制不同的想法；
6. 工作小組無法保持中立的角色，往往將自己的期望加在受事者的意見上；
7. 受訪者缺乏面對面的溝通，喪失了解決問題的努力。

2.4.2 模糊德菲法簡介

1993 年 Ishikawa【29】等人，利用累積次數及模糊積分的觀念，整合專家的意見成模糊數，其過程稱為模糊德菲法。模糊德菲法較傳統德菲法具備以下優點：

1. 降低調查次數；

2. 專家個別意見可完整表達；

3. 預測項之語意結構可清楚表達；

4. 可將訪查過程中無可避免的模糊性納入考量。

Klir 與 Folger【35】曾提出一個平均數一般化模式之模糊德菲法，採用幾何平均數計算以克服傳統德菲法之缺失， 其平均數一般化模式如公式 2-1 所示：

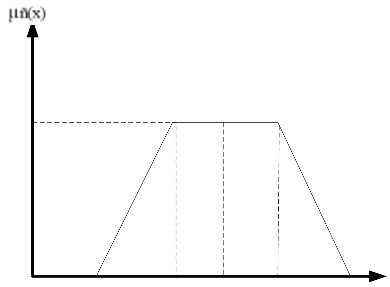
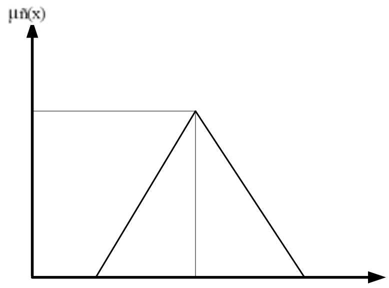
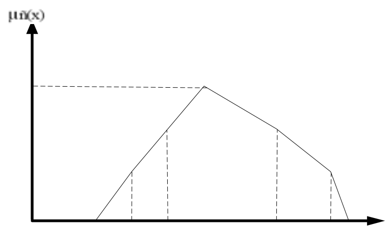
$$h_\alpha(a_1, a_2, \ldots\ldots, a_n) = \left(\frac{a_1^\alpha + a_2^\alpha + \ldots\ldots\ldots + a_n^\alpha}{n} \right)^{\frac{1}{n}}$$

………公式 2-1

其中 a 為不同平均數型態之參數。

極大值與極小值分別是最小與最大的平均數函數型態，即為一般化平均數函數之上下限。而在這一般化平均數函數之上下限之間尚存在許多不知型態的平均數函數。本研究依據相關研究成果【11】、【30】彙整專家隸屬函數圖如下表 2-7 所示。本研究親訪之專家人數少，因此擬以三角模糊函數來涵蓋專家群體之意見。

表 2-7 模糊德菲法專家隸屬函數比較圖

專家共識說明	專家隸屬函數圖	適用情況
1.專家共識分成前 25%及 75%加以排序並描繪 2.以幾何平均數代表大部分專家之共識 3.U 值為專家共識之極大值,L 值為專家共識之極小值，X_0 為幾何平均數，代表部分專家之共識。	 專家共識梯形模糊函數圖	1.詢問的專家達到一定數量或回答問題的情形較極端時。 2.將專家共識分成前 25%及後 75%來描述。 3.其中中間部分為大部分專家的幾何共識值 X_0。
1.以一般化平均數中之極大值、極小值為專家共識之兩端點。 2.以幾何平均數代表大部分專家之共識。 3.U 值為專家共識之極大值，L 值為專家之極小值，X_0 為幾何平均數代表大部分專家之共識。	 專家共識三角模糊函數圖	1.當詢問的專家數量少時，為了涵蓋所有專家的意見，將參加共識的極小值及極大值，予以幾何平均。 2.此法以幾何平均數更能客觀的表達專家的意見。
1.排序專家共識 2.分成前 25%、50%、75%及 100%之專家共識加以描繪。	 專家共識 Piece-wise 模糊函數圖	1.當詢問的專家達一定數量，且專家回答情形為常態分布時。 2.為方便統計分析，將專家共識分成 25%、50%、75%及 100%等四個區間來描述。

資料來源：【11】、【30】

模糊德菲法操作之步驟如下所述：【10】

步驟一：依專家學者問卷所回饋之評估標的即基準評價值加以整理，並利用下列公式建立模糊三角函數。

$$\tilde{N}_A = (L_A, M_A, U_A)$$ ……………………………...…………………公式 2-2

$$L_A = Min(x_{Ai}), i = 1, \ldots, N$$ ……………………………………………...公式 2-3

$$M_A = (x_{Ai} x_{A2} \ldots x_{An})^{1/N}$$ ……………………………………………….公式 2-4

$$U_A = Max(x_{Ai}), i = 1,\ldots,N$$ ………………………...………………….公式 2-5

其中

x_{Ai} ：第 i 個專家徐者對 A 基準之評價值。

L_A：專家學者對 A 評估基準評價之下限

M_A：專家學者對 A 評估基準評價之幾何平均數

U_A：專家學者對 A 評估基準評價之上限

A：建築物拆除工程混合物產生量之影響因子

i：專家學者

$\tilde{N}_A$ ：重要性之模糊數。

經由上述之處理可得各評估基準之三角函數型態，如圖 2-7 所示。

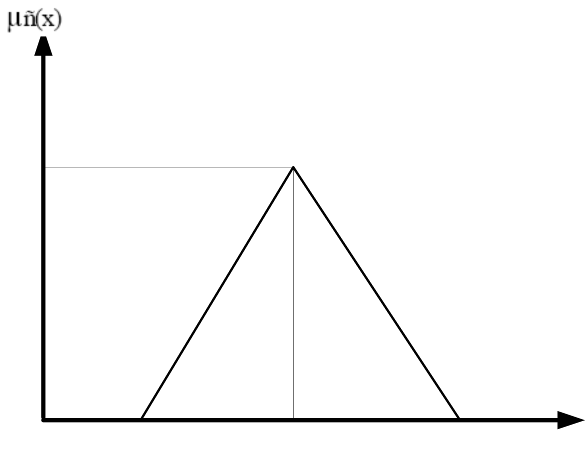


圖 2-7 決策群體共識三角模糊數圖

步驟二：利用步驟一之方式所得之三角模糊函數來篩選評估標的及基準。因

為在此函數中，極大值與極小值皆較極端，幾何平均數可代表專家中大部分之意見。因此本研究以每個評估標的及基準三角模糊函數中之幾何平均數（M_A）為隸屬度，用以代表專家對此評估標的及基準評價值之共識。最後則依研究目的決定門檻值（S），篩選出適當的評估基準。其篩選方式如下：

1. $M_A \geqq S$，接受A影響因素為評估基準。
2. $M_A < S$，刪除A影響因素。

其中，M_A 為專家學者群體對A影響因素之共識值

然而篩選評估基準時，如何決定門檻值則是一個值得深入探討的課題。若門檻值（S）太低，所篩選出的基準較多；而門檻值（S）太高，所篩選出的基準相對較少。因此能否篩選出具代表性、適當的評估標的及基準，端賴門檻值（S）之決定。

考量以上因素，故本研究採用文獻【35】中所提之平均數一般化模式，作為本研究模糊德菲法之理論基礎。利用模糊德菲法進行第一階段影響單一建築物拆除工程混合物產生量因子之篩選，以作為後續利用類神經網路建構預測推估模式輸入層之基礎。

2.5 類神經網路之簡介

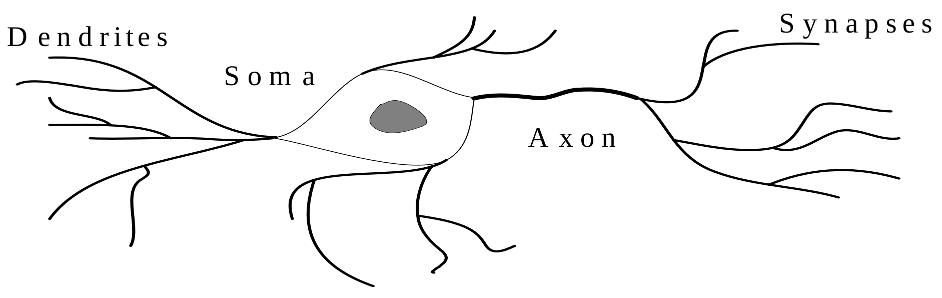
本研究主要建立單一建築物拆除工程混合物產生量之推估模式，主要經由歷史資料與現地實際紀錄資料之蒐集，透過資料轉換與計算後求得產生量。建立此模式之方法眾多，如迴歸分析估算法、案例式推理法、專家系統等；但近十年來，電腦科技發展迅速，電腦對於數值運算的速度提昇，其所得之結果具有相當程度之精確度與可靠性。但是在思維上，電腦能力與人腦相差甚遠，例如樣本識別、專門職業的決策工作等，其主要原因在於人腦具有學習與思考的能力。為解決此一問題，於人工智慧（Artificial Intelligence）的領域中，模擬人腦智慧特點和結

構的類神經網路乃應運而生。類神經網路是一個具有高度非線性的超大型連續時間動力系統，其主要特徵為連續時間非線性動力學、網路的整體作用、大型平行分散式處理及高度的堅韌性和學習聯想力【13】，茲將類神經網路簡介如下。

2.5.1 類神經網路概述

類神經網路系統基本結構為模仿生物神經網路資訊處理系統，眾多文獻均對類神經網路做過不同的定義，其皆大同小異，在此引用葉怡成(1993)之定義：「類神經網路是一種計算系統，包括軟體與硬體，它使用大量簡單的相連神經元來模仿生物神經網路的能力。神經元是生物神經元的簡單模擬，它從外界或者其他類神經元取得資訊，並加以非常簡單的運算，並輸出其結果到外界環境或者其他神經元」。由於其知識儲存於網路架構中，即各神經處理單元連結之權重值(weight)，因此要決定了所有處理單元相互連結的加權值，即完成了整個類神經網路演算系統的結構【14】。

類神經網路模式是一種模仿生物神經網路的知識學習過程，而自然界中高等生物之生物神經網路，是由大量簡單的神經細胞或神經元(neurons)組成，各神經元經由連結構成一個複雜網路，使其能夠從外在環境中學習適應。神經元是人腦組織的基本單元，人類大約有 10^{11} 個神經元組成巨大的腦系統，圖 2-8 表示一個神經細胞的結構【15】。



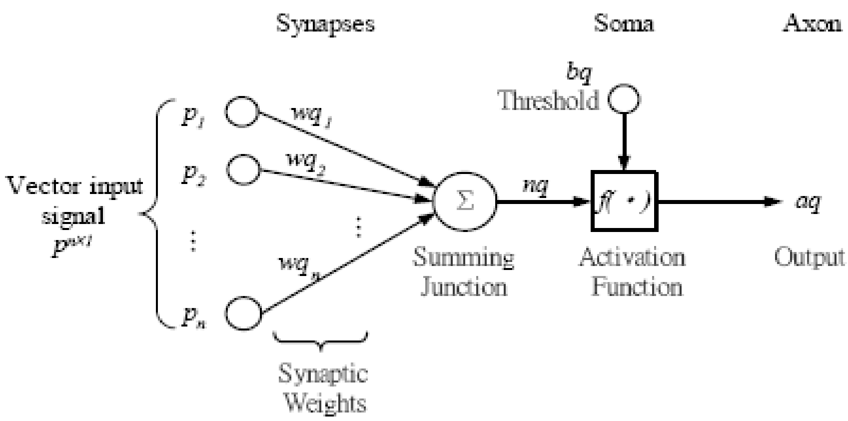
資料來源：【16】

圖 2-8 神經細胞結構圖

1. 神經核(Soma)：神經細胞成核狀的處理機構。
2. 神經軸(Axon)：神經細胞向外伸出的最長一條分支，呈軸索狀的輸送機構，屬於細胞輸出端。
3. 神經樹(Dendrites)：神經細胞向外伸出的其他許多分支，它屬於細胞的輸入節點，接受激發的訊號(或稱神經衝動)。
4. 神經節(Synapse)：神經軸輸出和神經樹輸入相互連結的點狀介面。

類神經網路是由許多的人工神經細胞(Artificial Neurons)所組成，人工神經細胞又稱為類神經元、人工神經元、處理單元(Processing Element，PE)，見圖 2-9。其結構包括：

1. 一組類似突觸的連結：每一個連結擁有一個權重（Synaptic Weight），以表現連結的強度。
2. 集成結點（Summing Junction）：將輸入值與權重的乘積進行加成的動作，此部份的運算是屬於線性的。
3. 轉移函數（Transfer Function）：功用在於限制輸出訊號的強度，並對訊號進行某種轉換後再將訊號送給另一個人工神經元。



資料來源：【16】

圖 2-9 人工神經元模型

2.5.2 類神經網路之分類

目前類神經網路可依學習策略分類與網路架構分類兩種：

（一）依學習策略分類

可將它們分成四個種類，監督式(Supervised Learning Network)、非監督式學習網路(Unsupervised Learning Network)、聯想式學習網路(Associate Learning Network)、最適化應用網路(Optimization Application Network)，並由下表 2-8 中列舉幾種學習策略分類的主要模式。

1. 監督式學習(Supervised Learning Network)：從問題領域中取得訓練範例(有輸入變數值，也有輸出變數值)，並從中學習輸入變數與輸出變數的內在對應規則，以應用於新的範例（只要有輸入變數值，而需推論輸出變數值的應用）。

表 2-8 類神經網路主要模式分類

網路類型	模式
監督式學習網路	感知機網路（Perceptron Network）
	倒傳遞網路（Back propagation Network）
	機率神經網路（Probabilistic Neural Network）
	學習向量化網路（Learning Vector Quantization）
	反傳遞網路（Counter propagation Network）
非監督式學習網路	自組織映射網路（Self Organization Feature Mapping ）
	自適應共振理論（Adaptive Response Theory Network）
聯想式學習網路	霍普菲爾網路（Hopfield Neural Network）
	雙向聯想記憶網路（Bi-directional Associative Memory）
最式化應用網路	霍普菲爾-坦克網路（Hopfield-Tank Neural Network）
	退火神經網路（Annealed Neural Network）

資料來源：本研究整理、【16】

2. 非監督式學習(Unsupervised Learning Network)：從問題領域中取得訓練範例(只有輸入值)，並從中學習範例內在集群規則，以應用於新的範例

（有輸入變數值，需推論它與那些訓練範例屬於同一集群的應用）。

3. 聯想式學習(Associate Learning Network)：從問題領域中取得訓練範例（狀態變數值），並從中學習範例的內在記憶規則，以應用於新的範例(只有不完整的狀態變數值,而需推論其完整的狀態變數值的應用)。

4. 最適化應用網路(Optimization Application Network)

（二）依網路架構分類

1. 前向式架構(Forward)：神經元分層排列，形成輸入層、隱藏層與輸出層；每一層只接受前一層的輸出當作輸入者，稱前向式架構。

2. 回饋式架構(Feedback)：從輸出層回饋到輸入層，或層內各處理單元間有連接者，或者神經元不分層排列，只有一層，各神經元均可相互連接者稱回饋式架構【16】。

2.5.3 類神經網路之基本架構

（一）網路基本架構

類神經網路組成的基本單位為處理單元，經由處理單元組成「層」(Layer)，再經由層組成「網路」(Network)。

（二）輸入與輸出值

類神經網路之輸入與輸出必須要能夠反應問題的特性，通常都會以應變數與自變數間所存在關係來解釋，表示兩者之間所存在的關係，因此在構建網路模式時的第一要件便是確立出目標（輸出值），並且尋找解釋變數(輸入值)，釐清各變數對於輸出值相關的程度，要有效的解釋輸出值則在輸入變數時就必須變數作謹慎的選擇，並且視各問題性質而定。

（三）轉換函數

轉換函數的作用是要模仿神經元在受到刺激之後所產生的反應大小適當的轉換輸入與輸出的關係；一般常用的轉換函數可分為兩種型態，一為離散型轉換函數如線性函數(Linear Function)、階梯函數，一為連續型轉換函數如雙曲線正切函數(Hyperbolic Tangent Function)、雙曲線函數(Sigmoid Function)等。其中最常使用之轉換函數為 S 型雙曲線函數(Sigmoid Function)，如下所示：

$$Sigmoid = f(x) = \frac{1}{1+e^{-x}}$$

（四）學習過程

類神經網路與人腦所具有學習功能，透過不斷的學習調整連結權重，來達到預期的輸出結果。經由網路反覆進行訓練過程達到訓練出來的數值與實際上所期望的數值能相當接近或是在某一可忍受的範圍之內，亦即由能量函數(Energy Function)推導使兩者之間的誤差能最小化。要達到能量最小化乃是透過不斷的訓練從誤差去學習降低輸出值與實際值間之差距，下式便是用來衡量學習誤差的公式（Error Function）。

$$E = \frac{1}{2}\sum (d - o)^2$$

d：期望輸出值(Desired Output)

o：網路輸出值(Real Output)【15】

（五）學習法則

類神經網路透過學習過程來判定網路是否要繼續學習或者已經達到可容忍的誤差範圍而停止學習，若未達到標準而繼續學習則以調整權重值，一般

來說，最常被用來使用之學習法則有兩種：

1. On-line：每學習一個範例，網路權重就更新一次，每次均用修正過後之權重，直至結束為止。
2. Batch：每載入一個訓練範例時即計算權重的變化量，但並無立即更新權重，當訓練結束後再修正權重，下次訓練時則用修正後之權重【16】。

2.5.4 類神經網路之特性

類神經網路具有以下幾點特性：

1. 高速計算能力：由於生物神經網路的神經元皆有獨立處理資料的能力，因此資料在網路中是在同一時段中，以平行的方式被處理。原因在於人腦的計算架構為巨量平行架構，大約有 10^{11} 那麼多的連結，若再加上每根以平行方式連結進行運作，同時可以處理較多資料，加快處理速度。

2. 學習能力：生物神經網路的連結是柔性的，即神經元間的連結是透過神經節，而神經節本身是可調整的，因此生物神經網路具有強大的學習能力，但對使傳統電腦具有學習能力則困難重重。

3. 容錯能力：生物神經網路如果有少數神經元或連結受損，並不損及其正常功能，其原因在於生物神經網路資訊儲存是分散式記憶(Distributed Memory)，也就是資訊散佈在許多連結（神經節）上。因此即使小部份連結受損，並不會道成嚴重的後果，而僅是造成功能略為降低。也因為分散記憶的關係，對於不完整或有雜訊的輸入也能正確的處理，亦即具有模糊推論(Fuzzy Reasoning)的能力。

4. 數學模式簡單化：以類神經網路設計動態決策行為模式時，並不需要

系統之數學模式，只要有足夠之系統輸入輸出對資料即可訓練。該點相較傳統需要仰賴精確數學模式之方法完全不同，故對有極其複雜動態決策行為模式而言，類神經控制有著極其便利的優點。

5. 高容量記憶能力：類神經網路是高度連結的網路，可將高維度的映射以較少的神經元來完成，因此具有驚人的記憶容量【17】。

2.5.5 倒傳遞演算法

在目前類神經網路預測模式的實用中，最普遍使用及最具代表性的學習演算法，為監督式學習中的「倒傳遞網路演算法(Back Propagation)」，或簡稱為 BP 演算法。該演算是一種具有學習能力的多層前饋型網路(Feed-Forward Net)，而所謂前饋型網路，即該網絡神經元乃分層排列，包含輸入層、隱藏層、及輸出層，且每層只接受前一輸出作為輸入，層內之處理單元則互為獨立且不相連結，最常採雙彎曲函數（Sigmoid Function）作為神經元的非線性函數，可處理輸入與輸出之間的非線性映射關係。另該演算法主要將「最陡坡降法（The Gradient Steepest Descent Method）」的原理概念加入隱藏層的處理單元中，並作為模型輸出與目標輸出間之誤差函數（Error Function）最小化的迭代運算法【18】。

倒傳遞演算法為差距法則(Generalized Delta Rule)，以網路輸出值與範例輸出值之差值作為修正網路中各神經元間連結權重的依據。若在輸出層無法得到期望的輸出，則誤差訊號將沿原連接通路返回，透過修改各層神經元的權重，期能使誤差函數值達到容忍誤差容忍範圍之內而停止或達到設定的訓練次數而停止，一般給定一誤差函數(或稱能量函數)表示學習之品質，其誤差函數如 2.5.3 小節所表示之。

類神經網路學習過程通常以一次一個訓練範例的方式來進行，直到學習完所有的訓練範例，稱為一個學習循環(Learning Cycle)，一個網路訓練成功通常需要上百個或上千個訓練範例，將訓練範例反覆學習不斷修正直到收斂為止。

倒傳遞網路中有幾個重要參數，包括隱藏層處理單元數目、隱藏層層數、學習速率與慣性因子，分別說明如下：

1. 隱藏層處理單元數目：

通常隱藏層處理單元之數目越多收斂越慢，但可達到更小的誤差值，特別是「訓練範例」誤差。但超過一定數目後，再增加則對降低「測試範例」誤差幾乎沒幫助，徒然增加執行時間。這可解釋成隱藏層處理單元之數目太少，不足以反映輸入變數間的交互作用，因而有較大的誤差，而數目越多，雖然可達到更小的誤差值，但因網路較複雜，因而收斂較慢。為平衡品質與成本，以取適當的數目為宜。一般而言，隱藏層處理單元數目的選取原則如下：

A. 公式1：隱藏層單元數目=(輸入層單元數＋輸出層單元數)/2

   公式2：隱藏層單元數目=(輸入層單元數＋輸出層單元數)

   公式3：隱藏層單元數目=(輸入層單元數＋輸出層單元數)×2

B. 問題雜訊高，隱藏層單元數目宜少。

C. 問題複雜性高，隱藏層單元數目宜多。

D. 測試範例誤差遠高於訓練範例誤差，隱藏層單元數目宜減少；反之，宜增加。

2. 隱藏層層數

通常隱藏層之數目為一層到二層時有最好的收斂性質，太多層或者太少層其收斂結果均較差。這可解釋成沒有隱藏層不能反應此問題輸入單元間的交互作用，因而有較大的誤差；而有一、二層隱藏層已足以反應此問題的輸入單元間的交互作用，更多的隱藏層反而使網路過度複雜，造成更多局部最小值，使得在修正網路加權值時更易掉入一個誤差函數的局部最小

值，而無法收斂。依據經驗，一般問題可取一層隱藏層，較複雜的問題則取二層隱藏層。但有一點必須注意；在用倒傳遞網路求解問題時，一定要先用無隱藏層架構試作，如果其精確性比有隱藏層者為佳，則此問題必不適合用倒傳遞網路解，其理由為無隱藏層架構的倒傳遞網路其效果接近統計學上一些有「線性」假設的方法，例如線性迴歸、區別分析，因此無理由用一個複雜的網路解答去取代一個有明確公式的統計學解答。

3. 學習速率

通常學習速率太大或太小對網路的收斂性質均不利。這可解釋成較大的學習速率，有較大的網路加權值修正量，可較快逼近函數最小值，但過大的學習速率將導致網路加權值修正過量，造成數值振盪而難以達到收斂的目的，因此學習速率的大小對學習有很大的影響。由經驗顯示，學習速率在相當大的範圍均有很好的收斂性，在此範圍內，學習的結果對學習速率並不敏感。依據經驗取 0.5，或 0.1 到 1.0 間的值作為學習速率的值，大都可得到良好的收斂性。但仍有些問題的適當學習速率可能低到 0.01 以下或高到 10 以上。上述這些參數都有一些經驗值，然而，假使參數的設定一旦變動，學習的效果與精度可能會有很大的差異；因此，本研究將先以經驗值進行實證，然後調整各參數值以比較結果之差異，再決定適合本研究之參數值。

4. 慣性因子

通常慣性因子太大或太小均對網路之收斂不利，通常在學習過程中，慣性因子可採取較大之初始值，在於網路之訓練過程中逐漸減小之方式設定，一般採用在每一學習循環完畢即將慣性因子乘以一小於 1.0 之係數（例如 0.95）之方式，逐漸縮小慣性因子，但不小於預設之慣性因子之下限。依據經驗：初始值=0.5，折減係數=0.95，下限值=0.1【13】。

2.5.6 類神經網路於營建工程之應用

以上針對人工智慧中之類神經網路技術之簡介後，可發現類神經網路具有高速計算及學習能力，可由系統輸入之樣本中擷取其內在規則並建立其間之非線性關係，易於掌握系統之預測、分類等模式，國內外許多研究常用類神經網路於預測工程成本、砂石產生量、營造工程物價指數亦或是於交通流量之預測等，此類之預測或推估研究均有其共通之特性，主要為影響因子或參數均為多數時，而類神經網路技術符合此項要求，適合用於非線性亦或是無法利用數學方程式可求得解之問題上，利用類神經網路內之運算神經元經過高速計算，並透過其學習能力與容錯能力，快速計算出所預測之問題。類神經網路如此之廣泛應用，其領域包含工程應用（如材料之選用、電子電路診斷、排程問題與 VLSI 設計等）、商業與金融之應用（如信用卡盜用判斷、股價、匯率及利率預測與財務分析等）及科學技術之應用（如天氣氣象預測、醫學儀器之映像判斷與指紋辨識系統等）。有關類神經網路應用在營建工程方面之研究包括如下：

1. 余文德、楊智斌、賴建中、鄭正光應用「類神經模糊系統」技術所發展出來之自動化工程估價系統，由案例分析發現應用此系統於橋樑工程成本估測上可達誤差 10％以下之精確度，且可提供估算人員法則式之估價知識，並進行成本影響敏感度分析【19】。
2. 「工業生態學中物質流系統之研究－以台灣地區砂石為例」之研究中【17】指出類神經網路於砂石生產量推估模式方面，其結果與經濟部礦務局所公佈之砂石生產量數據之差距不到 10%。
3. 「公路土石方工程成本估價之研究」【20】利用類神經網路對於公路土石方工程成本進行估價，此研究的重點在於評估運用類神經模糊系統在對於公路土石方工程專案的成本概估的可行性。由類神經模糊系統發現，在公路土石方工程成本估價之誤差能低於 1%，遠比傳統概估方

法好很多。此外當與比率估價法結合應用時，所建議的類神經模糊系統成本概估法能提供即時的成本估價，其誤差能低於 2.5%；且此系統也考慮到營建材料與勞務工資在市場上單價的偏差，故對營建專案的成本概估而言，類神經模糊系統與比率估價法結合應用的成本概估方法是非常有用的。

4. 國內學者郭斯傑、陳信夫於「以類神經網路估算建築工程成本之研究」中利用類神經網路預測建築工程成本，其簡要的介紹類神經網路基本架構，觀念與發展過程，並找出於何種應用狀況下運用最佳類神經網路架構。此研究將九個實際案例分成四種不同狀況，實際測試各種方法的估算表現。結果顯示類神經網路不論在平均誤差平方和、誤差標準差或是誤差比率範圍，其表現均優於迴歸分析、蒙地卡羅估測法、傳統推估法與專家估測法等估算模式。於此研究證實了類神經網路在工程成本估算方面的準確性及適用性，可提供更加準確的成本預測，減少估計的風險【21】。

5. 「台灣地區營造工程物價指數預測之研究---以類神經網路與 ARIMA 模式」【22】為建立一台灣地區營造工程物價指數之預測模式，依據指數之特性，分別以類神經網路與 ARIMA 模式建構指數之預測模式，並將預測結果進行比較，探討其適用性，以作為工程主辦單位編列公共建設預算及營造廠商計算工程投標價格之參考。研究結果顯示，類神經網路模式之預測誤差，無論在均方誤差、均方根誤差、平均絕對誤差及平均絕對百分比誤差均較 ARIMA 模式低;而於 ARIMA 輔助類神經網路之信賴區間建構方面，亦顯示結合模式成功地為類神經網路模式建構預測之信賴區間，使得在應用上更為方便與實用。

6. 陳維東、石進芳、盧順逸、陳盈宏【23】應用 Neuron solutions 類神經網路商用軟體預測國內營造工程物價指數。研究結果顯示，此系統預

測平均經度可達93%水準，與灰色理論及時間數列模式相當，可見類神經網路應用於預測營建物價指數可行性頗佳。

7. 謝獻仁利用類神經網路所具有之平行處裡能力，來處裡各項參數對落石坡危險度之影響，進行對其危險度之分析，研究以中橫谷關-德基水庫之 237 個落石坡為調查對象，其中隨機選取 150 個落石坡為訓練資料，87 個落石坡為預測目標，利用類神經網路程式加以分析預測，分析結果證明類神經網路具有評估落石坡之能力，成功率可達 86%【24】。

8. 楊秉蒼利用二元形本位學習類神經網路解決 N 皇后指派問題，研究結果顯示，該法在解答品質方面較退火神經網路及遺傳演算法佳，雖然該法略遜於運輸特殊解法，但具備較強之通用性，且在多目標山坡地開發決策問題方面亦優於隨機搜尋法【25】。

9. 亦有學者利用迴歸方式與類神經網路兩種方式所尋求之各種營建工程問題，結果均為類神經網路優於利用迴歸分析所做出之結果；如利用類神經網路與迴規分析估測工程直接成本，則利用類神經網路之誤差值遠較利用迴歸分析求得之工程直接成本來的小，如表 2-9 所示【31】、【26】。

表 2-9 類神經網路與迴歸分析之比較表

案例	結果	
估測碳鋼水管之成本（Graza、Rouhana1995）	類神經網路 MSE=3.72	迴歸分析 MSE=11.205
工程直接成本之估測（郭炳煌，2001）	類神經網路 RMS=3.631e06	迴歸分析 RMS=4.979e06

資料來源：【31】、【26】

2.5.7 小結

本研究目的為求得單一建築物拆除工程混合物產生量，往往產生拆除混合物

之因子不單只有建築樓地板面積亦或是構造方式便能決定。綜合以上針對人工智慧中之類神經網路技術之初步探討，檢視本研究之架構，發現本研究屬於多參數型之問題，且所擁有之資料有輸入值與輸出值，故選用類神經網路之監督式學習中最普遍使用及最具代表性，且適合用來解決與處理需要以類比為基礎求解之問題的多層前饋型倒傳遞網路演算法（Feed-Forward Back Propagation）。

本研究之研究方法將參考類神經網路的施行步驟，先逐步釐清本研究進行拆除混合物的目的、理由、對象、所需資料種類及深度等，隨即進行各項資料調查、收集及輸出計算。從拆除混合物申報、處理完成之處理流程與實際影響拆除混合物產生之工地現場進行深入之研究，並客觀分析出影響拆除混合物產生量之因素，透過影響因子輸入至類神經網路中，試推估拆除工程施工中所產生之混合物總量，以改善目前推估數量不夠準確之現況，健全現行拆除混合物總量申報管控作業程序。

三、影響拆除工程混合物產生因子之探討與資料蒐集

3.1 影響拆除工程混合物產生量因子之探討

建築物進行拆除工程時所產生混合物數量之影響因子眾多，如構造種類、建築物用途、建築物高度、樓地板面積、所在區域等諸多因子均會影響拆除混合物產生之數量。本研究係藉由過往工地參訪與專家訪談等方式，整理影響建築物拆除工程混合物產生量之因子，依序分敘如下：

1. 構造種類型式

   構造種類主要影響建築物拆除工程混合物產生量之原因為各構造型式之建築物主要結構體皆有所不同，建築物設計時所考量之梁柱大小、垮距、混凝土用量及隔間等，皆會因構造形式之特性而有不同之設計。例如鋼鐵或鋼骨構造型式之建築物，與 RC 造建築物不論重量或體積皆不相同，故構造種類型式易影響建築物拆除工程混合物之產生量。

2. 建築物總樓地板面積

   建築物總樓地板面積之大小，會影響到此建築物之設計型式。建築師會依樓地板面積大小，對於樑、柱之承載能力與垮距等會有不同之考量，則會造成拆除混合物產生量之差異。

3. 建築用途

   不同建築用途會影響拆除工程混合物產生量之差異，如一般而言學校教室與工廠型建築物，它們相較於住宅型之建築物，其隔間較大裝潢材料較少，拆除工程產生之混合物與住宅型建築物即產生差異，故不同之建築物用途對於建築物拆除工程混合物產生量亦有差異。

4. 建築物總高度

相同樓地板面積之情形下，不同之建築物總高度，由樑、柱之承載設計與高出部分之體積，即可得知拆除混合物產生量不相同，故不同之建築物高度會影響建築物拆除工程混合物產生量。

5. 所在區域別

建築物所處區域不同，如郊區與都會區而言，擁有同樣樓地板面積但購買之房價有所差異。一般而言，都會區所購買房子較貴，一般人會較注重實用性；郊區房子較便宜，購屋者較注重休閒性。因地段特性不同，往後對建築物之裝潢亦有所不同，此即會影響拆除混合物產生量。所在區域別此項因子，本研究以各縣市政府地政課公告之當地地段地價為輸入基準。

經由與多位在拆除工程領域 10 年以上經驗之專家現場訪談後得知上述影響建築物拆除工程混合物產生量之因素，但於訪談過程中，專家們認為有無地下室亦會影響拆除工程進行時所產生之混合物數量，故本研究將樓地板面積與建築物高度區分為地上與地下兩部分，以突顯出地下室此因子之存在。本研究所建置之建築物拆除工程混合物推估模式未能全面性推廣應用，並期望能符合未來新式建築物拆除時所需，另考慮建築物挑高及各樓層樓地俺面積會有所差異之問題，故將建築物高度（包含地上及地下）及樓地板面積（包含地上及地下）此兩項影響因子採用除以樓層數之平均方式來表示，即為建築物平均樓層高度（包含地上及地下）與平均樓層樓板面積（包含地上及地下）。茲將此些影響因子整理如下表 3-1 所示，本研究將利用上述整理之影響建築物拆除工程混合物產生量之因子，做為模糊德菲法問卷之調查因子。

表 3-1 影響拆除工程混合物產生量之因子

<table>
<tr><th colspan="2">項目</th><th>影響原因</th></tr>
<tr><td colspan="2">構造種類</td><td>如鋼構造、RC造、磚造、加強磚造、木造等，各型式之構造物所使用之材料均為不同，易影響混合物之產生量。</td></tr>
<tr><td colspan="2">建築用途</td><td>如工廠、住宅…等，教室或工廠建築設計較為簡單，住宅內部設計就較為複雜，其所產生之混合物亦不同。</td></tr>
<tr><td rowspan="2">平均樓層
樓地板面積</td><td>地上</td><td>平均樓地板面積不同，其所設計之垮距、樑、柱等結構皆有所不同，其混合物數量亦不相同</td></tr>
<tr><td>地下</td><td>平均樓地板面積不同，其所設計之垮距、樑、柱等結構皆有所不同，其混合物數量亦不相同</td></tr>
<tr><td rowspan="2">平均樓層高度</td><td>地上</td><td>平均樓層愈高，所支撐之樑、柱設計及外牆高度會隨之改變，造成混合物數量之增加</td></tr>
<tr><td>地下</td><td>平均樓層愈高，所支撐之樑、柱設計及外牆高度會隨之改變，造成混合物數量之增加</td></tr>
<tr><td colspan="2">所在區域別</td><td>各地段之住戶，多少會因其購買之地段緣故，對其建築物有不同之裝潢，所產生之混合物數量將有差異。</td></tr>
</table>

資料來源：本研究整理

3.2 模糊德菲法問卷

本研究為建立建築物拆除工程混合物產生量推估模式，乃經由專家訪談後獲得如 3.1 節中所顯示之影響因子，藉此使本研究決定之影響因子不至於過於主觀性。以其內容利用模糊德菲問卷，篩選出重要性達一定程度以上之影響因子，納入本研究所採用之類神經網路之輸入層。

本研究採用文獻【Klir and Folger，1988】中所提出之模糊德菲法，評估各因子之重要性。流程說明如下：

步驟一：蒐集專家意見

依訪談獲得之影響建築物拆除工程混合物產生量之因子，進行問卷設計與調查，問卷填寫者被要求評估各評估因子的重要性程度（10 代表最重要，0 代表最不重要）。問卷寄發對象均為拆除工程領域服務至少十年以上經驗之專家，藉由專家們之意見交流，相信可了解國內拆除工程現況。問卷調查方式為現場面談等方式進行，發放問卷共 10 份，回收份數 10 份，相關寄發對象之資訊請詳表 3-2。

表 3-2 訪談專家名單

受訪單位	受訪人員職稱	工程經歷（年）
大鋼牙工程	總經理	20
聲寶營造有限公司	總經理	20
聲寶營造有限公司	主任	20
承羿營造有限公司	主任	15
卓承工程公司	負責人	20
卓承工程公司	工程師	10
任慶工程行	負責人	15
協侑營造有限公司	主任	20
新亞營造有限公司	副主任	20
永竟處理廠	經理	20

資料來源：本研究整理

步驟二：建立模糊三角函數

將本研究蒐集到的專家評估值依公式 2-2 至 2-5，建立每項評估項目之三角模糊函數。經計算後所有評估因子之模糊三角函數整理如下表 3-3 所示。

表 3-3 建築物拆除工程混合物產生量影響因子之模糊三角函數

影響因子	最小值	幾何平均數	最大值
構造種類	7	8.23	10
建築用途	6	8.07	10
地上平均樓層樓地板面積	4	6.84	8
地下平均樓層樓地板面積	5	6.98	8
地上平均樓層高度	5	7.64	10
地下平均樓層深度	5	7.27	10
所在區域別	2	4.89	6

步驟三：篩選評估因子

選擇評估因子模糊三角隸屬函數中之幾何平均數（M_A），乃是代表決策群體對此評估因子評價值之共識，而決策門檻值（S）則可依研究目的設定，據以篩選出適當的評估因子。當評估因子之 M_A＞S 時，則接受該評估因子，否之便篩除該因子。以往模糊德菲法之研究門檻值多以「8」作為因子篩選之門檻，而

本研究若以「8」作為門檻篩選值，則通過篩選之因子僅2個項目，失去篩選之意義，故本研究綜合多位學者之研究【Bass and Kwakernaak，1977】、【Chen，1985】、【Tong and Bonissone，1984】，乃以7.0作為建築物拆除工程混合物產生量影響因子篩選門檻值。經由模糊德菲法篩選出因子後，最後篩選出構造種類、建築用途、地上平均樓層高度及地下平均樓層深度等四個因子，將篩選出之因子運用於後續建構推估模式之類神經網路中之輸入層。

3.3 建築物拆除工程案例蒐集

本研究有關拆除工程之蒐集資料來源，包括現場工地產生之拆除混合物數量、各縣市政府之拆除執照與營建棄填土資訊系統之資料。其中各縣市政府提供之拆除執照資料一年有多達數百筆，但經分析發現大多數縣市政府拆除執照上之混合物數量多為由相關研究公式直接換算而得，且未有實際完工之數量，僅有拆除工程開工前提報至縣市政府廢棄物處理計畫書中之推估數量，因缺乏實際正確產生量之資料，所以可信度並不高。目前，國內僅有台北縣政府、桃園縣政府、台中市政府及高雄市政府有進行開工前預估混合物產生量與實際產生量之兩階段勾稽作業，但經由接洽上述四縣市政府相關單位後，桃園縣政府及高雄市政府因業務上之不便，故無法索取資料，所以本研究採用台北縣政府與台中市政府之拆除執照資料。進一步查看台中市政府與台北縣政府之資料後發現，大多數資料實際產生量與預估數量相當，且預估數量是由相關研究公式計算而得，本研究視此些資料有失真實性，故僅採用實際數量與預估數量有差異之資料。至於營建棄填土資訊系統之資料，因所提供之基本資料為全國混合物（B8）類之統計數量，並非單一工程個案之混合物數量統計，且並無提供任一影響因子，故此方面之資料亦無法採用。

本研究另實際走訪進行拆除工程之工地，經由與現場人員溝通並徵求業者同意後，於現場觀測建築物拆除情況與實際紀錄混合物總產生量。目前全國各縣市

政府對於混合物計量單位均有所不同，一般而言分為體積或重量計量。而若以重量為紀錄單位，則實際紀錄時所有車次均須過磅，現場人員為避免須修改廢棄物處理計畫書等繁雜作業，故僅會將開工前所提報之推估數量過磅，若有超過此數量時，因過磅須額外花費故均無法配合。環保署混合物申報系統是採重量計量，但因目前申報率過低，故不採用，最後本研究計量單位均統一為體積單位。本研究對於蒐集之實際拆除案例從開工至拆除清運完成均於現場實際紀錄，若工期過長，則會與現場人員溝通，於工程完工後將實際載運車輛數告知，所訪談之案例廠商因已事前溝通並告知研究目的，故廠商均配合告知實際產生數量。本研究最後採用台北縣政府、台中市政府所提供之拆除執照資料與實際現場工地紀錄之資料進行分析。

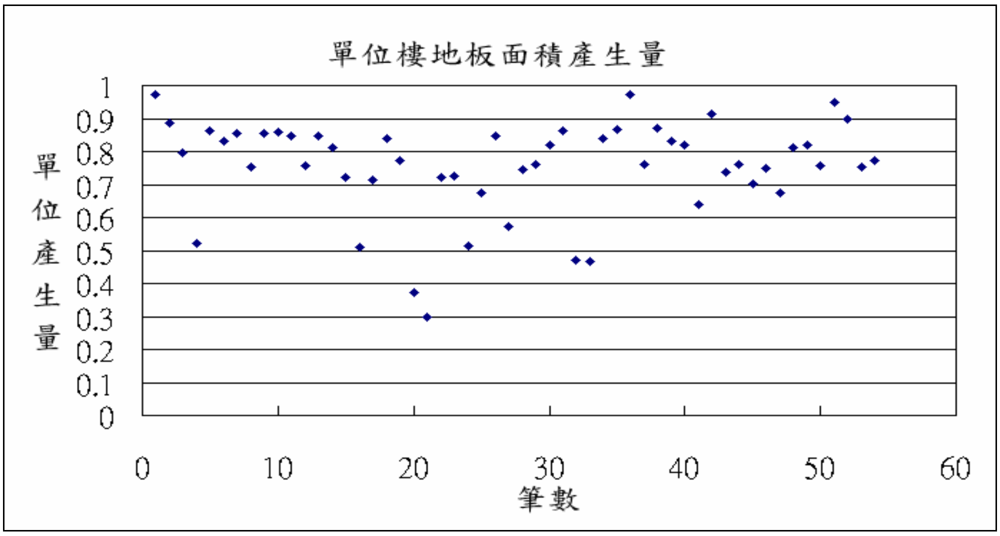
總共蒐集拆除工程案例共有 54 筆，分別為住宅類 36 筆、工廠 8 筆、教室 7 筆與住宅加工廠型複合用途 3 筆，茲將用途別、構造別及區域範圍等整理如表 3-4 所示。

表 3-4 拆除工程蒐集資料之整理

種類	細項	筆數
用途	住宅	36
	工廠	8
	教室	7
	住宅加工廠	3
構造種類	加強磚造	20
	RC造	19
	磚造	8
	鋼鐵造	3
	加強磚加鋼鐵造	2
	RC加鋼架造	1
	RC加鋼鐵造	1
區域範圍	台北縣	38
	台中市	9
	實際紀錄	8

3.4 拆除工程資料分析與篩選

本研究透過台北縣政府、台中市政府與現場工地實際紀錄蒐集拆除工程所產生之建築物拆除工程混合物產生量，並對所蒐集之資料進行篩選，以避免某部分資料偏離蒐集樣本過大，而造成推估數量時之偏差。本研究所蒐集之案例，其單位樓地板面積產生之廢棄物產生量主要分佈範圍在 0.298~0.974 m^3/m^2 之間，如圖 3-1 所示。



資料來源：本研究整理

圖 3-1 拆除工程蒐集案例之單位樓地板面積產生量

本研究分析發現，資料筆數中複合種類之筆數過少，均少於 3 筆如表 3-4 所示，為避免影響建築物拆除工程混合物產生量推估模式之準確度，故先將之排除不用；住宅加工廠型複合用途此項資料，雖有 3 筆資料，但有兩筆資料與複合種類相重複，實剩一筆資料，故也先將之排除。

複合種類與複合用途等資料篩除後剩 49 筆資料，再將資料依構造種類加用途別型式分類，將之繪製成散佈圖，如圖 3-2、3-3、3-4、3-5 所示。經本研究分析後發現，住宅 RC 造型有兩筆資料，相距同組其他資料平均值約 40%以上，如圖 3-2 所示，為避免造成建構推估拆除混合物數量模式時之誤差，本研究將這兩筆資料排除不用。

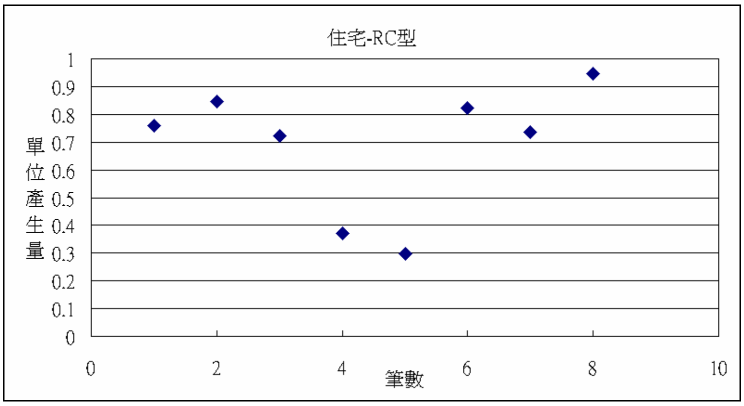


圖 3-2 拆除工程住宅 RC 造型資料散佈圖

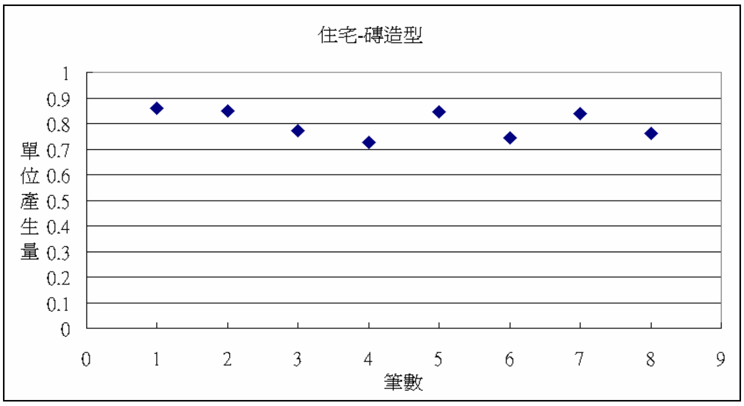


圖 3-3 拆除工程住宅磚造型資料散佈圖

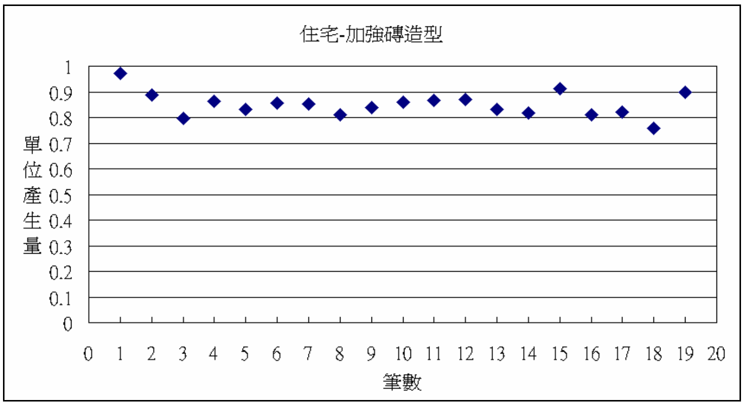


圖 3-4 拆除工程住宅加強磚造型資料散佈圖

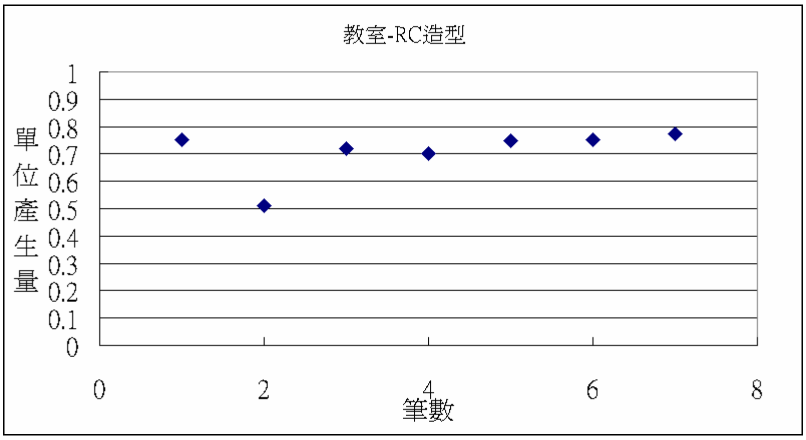
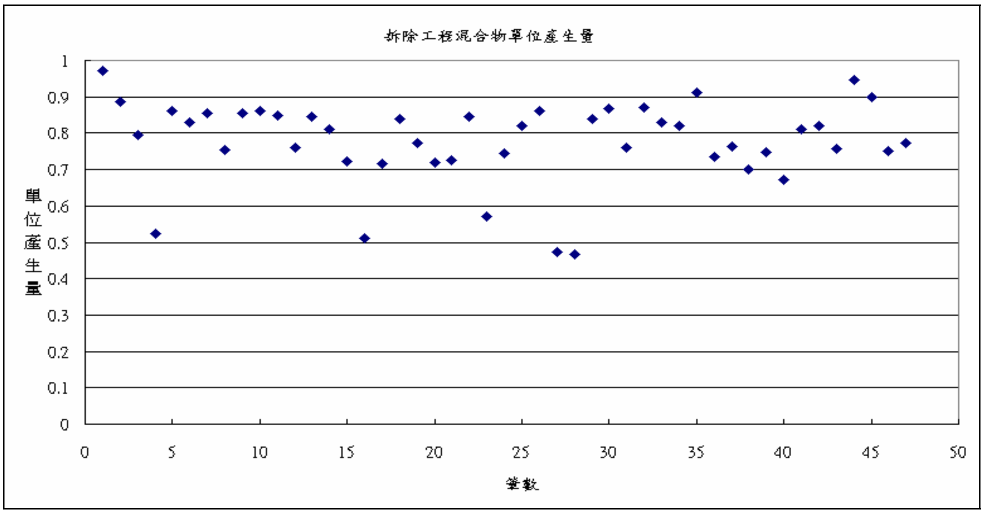


圖 3-5 拆除工程教室 RC 造型資料散佈圖

經篩選後之資料散佈圖，如圖 3-6 所示。篩選後資料筆數共 47 筆，所得資料範圍為 0.468~0.972 m^3/m^2，平均數為 0.777 m^3/m^2，分別為住宅類 34 筆、工廠 6 筆與教室 7 筆；構造種類分為加強磚造 20 筆、RC 造 16 筆、磚造 8 筆與鋼鐵造 3 筆；地上層平均樓層樓地板面積在 40.77~37,197.54m^2，地下層平均樓層樓地板面積在 0~1,339 m^2；地上建築物平均高度在 2.94~9.68m，地下建築物平均身在 0~3.2m；茲將篩選後新資料整理如表 3-5 所示。



資料來源：本研究整理

圖 3-6 拆除工程資料篩選後之散佈圖

表 3-5 拆除工程資料篩選後之整理

種類	細項	筆數
用途	住宅	34
	工廠	6
	教室	7
構造種類	加強磚造	20
	RC 造	16
	磚造	8
	鋼鐵造	3
地上平均樓層樓地板面積	40.77~37,197.54 m^2	—
地下平均樓層樓地板面積	0~1,339 m	—
地上平均建築物高度	2.94~9.68 m	—
地下平均建築物深度	0~3.2 m	—
區域範圍	台北縣	38
	台中市	9
	實際紀錄	8

四、建築物拆除工程混合物產生量推估模式之建構

4.1 資料之尺度化處理

類神經網路之輸入變數為數值資料之組合，本身並不具任何意義，藉由類神經網路訓練過程，找出描述輸入與輸出變數之間對應關係之加權值。資料表現與處理是否適當，對於類神經網路模式發展具有相當重要的影響。所謂資料之尺度化處理是指將原始資料以尺度化方式處理之，主要目的為當用於類神經網路預測系統訓練之資料其變數值域差別過大，將使值域小之變數對於類神經網路之重要性無法突顯，而值域大之變數控制整個類神經網路學習過程，故可能降低類神經網路學習效果。此外，尺度化處理也可使輸入變數間之對應關係更加明確，提高類神經網路預測能力【余昌翰，2004】。一般將資料尺度化之方式有數種，如線性尺度法、對數尺度法等，本研究將採用此二種尺度化之方式，並依研究需求進行改良，分別說明如下：

- 對數尺度法（取 log）：數據差異較大時使用，如平均樓層樓地板面積其數值之範圍較為廣大，故採用此方式尺度化。但因資料數值過大，無法順利將資料縮減至 0~1 之區間內，故本研究另採用改良式之對數尺度法，將資料取對數後再除以 5 之方式將資料縮減至 0~1 之間，同時也可將資料預測範圍擴大。

- 線性尺度法：資料數據差異不大或分類編碼時使用，如構造形式、建築用途、平均建築物高度等，將可使資料縮減至 0~1 之間。

4.2 建築物拆除工程混合物產生量推估模式之建立

本研究建構與訓練類神經網路所採用的軟體為 The MathWorks，Inc.所研製之 MATLAB 中之類神經網路工具箱（Neural Network Toolbox）。將設定好之訓

練範例與測試範例，儲存於 EXCEL 試算表中，再透過 MATLAB 的匯入資料功能將訓練範例與測試範例數據直接匯入 MATLAB 中即可。將問卷調查篩選後之影響建築物拆除工程混合物產生量之因子做為輸入變數，以建築物拆除工程混合物單位樓地板面積產生量作為輸出變數，藉由類神經網路進行演算，預測建築工程中於拆除時所產生之單位建築物拆除工程混合物產生量，以作為將來施工單位與管理單位管理與預算編列之依據。

根據觀察本研究問題之特性，選擇監督式學習網路建構建築物拆除工程混合物單位產生量預測模式之網路模式，所使用之類神經網路架構為倒傳遞類神經網路（Back Propagation Neural Network，BPNN），此網路是目前類神經網路學習模式中最具代表性與應用最為普遍之模式，其適合用來解決與處理需要以類比為基礎求解之問題，並且於非線性問題等求解上以其精確度高、回想速度快等優於其他類型網路，故本研究將透過倒傳遞類神經網路之建置，進行建築物拆除工程混合物產生量推估模式之建立。

4.2.1 建築物拆除工程混合物產生量推估模式之網路架構

倒傳遞類神經網路（Back Propagation Neural Network，BPNN）之基本架構主要分為輸入層、隱藏層與輸出層三層架構。茲分別說明如下：

輸入層：本研究主要以影響建築物拆除工程混合物產生量因子作為主要之輸入變數，共有構造種類、建築物用途、地上平均建築物高度及地下平均建築物深度等四因子。

隱藏層：表示輸入變數間之交互影響，其主要作用為連接反應前一層與後一層之互動關係。

輸出層：本研究主要以每單位樓地板面積產生量作為輸出變數。

類神經網路基本運算原理為利用最陡坡降法（Gradient Steepest Descent

Method）之觀念，將誤差函數予以最小化，藉由誤差函數對網路調整加權值之敏感程度，控制每次最陡坡降法之調整幅度，求得最小之誤差函數。有關倒傳遞類神經網路相關介紹請參照 2.5.5 節中。

其網路架構如下所述：

1. 影響因子之決定

輸入層之變數主要為經由模糊德菲法問卷篩選過後之影響建築物拆除工程混合物產生量因子，分別為地上平均樓層高度、地下平均樓層深度、構造種類與建築用途等四項。

2. 資料前處理

一般而言，運用類神經網路不論是何種型式之網路型態，於訓練前均須將輸入變數進行數值尺度化之處理步驟，方能提高網路表現之績效或求解出正確之解答。尺度化方式有數種，將所有輸入變數轉換成 0 與 1 之間或-1 與 1 之間之方式為多，或是將數值壓縮於數值間最大值與最小值，即為數值轉換，關於資料尺度化方式請參閱 4.1 節介紹。本研究中，輸出值為拆除混合物單位樓地板面積產生量，其數值為 0 至 1 之間，故為配合輸出值將本研究所有資料尺度化為 0 至 1 之間。本研究先將非數值化之影響因子進行編碼，如構造形式與建築用途等，再利用線性尺度化方式將其數值轉換至 0 至 1 之間，此外基於使用線性尺度化較對數尺度化方式數值影響較大，且線性尺度化適用於數值因次差異不大時使用，故地上平均樓層高度與地下平均樓層深度也採用線性尺度化方式進行數值轉換。地上平均樓層樓地板面積、地下平均樓層樓地板面積與所在區域地段地價等因子，因數值因次差異較大故利用 log(數值)/5 尺度化至 0 與 1 之間。

3. 轉換函數

因資料尺度化於 0 與 1 之間，故採用非線性轉換函數之對數雙曲線函數

（Logistic Function），此函數當自變數趨近於正負無窮大時，函數值趨於常數，其值域於[0,1]之間。函數公式如下所示：

$$Sigmoid = f(x) = \frac{1}{1+e^{-x}}$$

4. 隱藏層之選擇

隱藏層主要表示輸入變數間之交互影響作用，其主要作用為連接反應前一層與後一層之互動關係，隱藏層之層數多少為佳，依據 2.5.5 節中，較常使用為一至二層，但二層隱藏層多為解較複雜之問題，故本研究選擇一層隱藏層。

本研究將於下一節對於類神經網路中需輸入之重要參數，如隱藏層神經元數、學習次數、學習速率與慣性因子等參數進行敏感度分析與討論。

5. 輸出層

此預估模式依據上述之影響因子為輸入變數，經由預估模式網路訓練後，產生一數值，主要針對單一建築物所產生之拆除混合物單位產生量為主要輸出值。

4.2.2 類神經網路參數之測試

影響倒傳遞類神經網路運作較為重要之參數為（1）隱藏層神經元（2）學習速率（3）訓練次數（4）慣性因子等四個參數，此四個參數均會影響到網路之收斂性質與準確率，故本研究針對固定其他參數，改變一個參數之方式，是分別測試出較佳之學習速率、隱藏層神經元數、慣性因子，最後觀察訓練次數探討訓練次數之收斂情況，以下將逐步討論上述之各項測試：

1. 學習速率

學習速率可以決定網路加權值修正量之多寡，較大之學習速率，其網路之加權值也較大，但若學習速率過大，將導致網路加權值修正量過多，造成數值震盪

而無法收斂。反之，則易造成網路收斂速度緩慢。本研究為求得較佳的學習速率參數值，將學習速率分為 0.1、0.2、0.3、0.4、0.5、0.6、0.7、0.8、0.9 及 1.0 等十種。測試結果如圖 4-1 所示，可發現學習速率於 0.6 時所得之準確率達 80%為最高，故本研究學習速率選用 0.6。

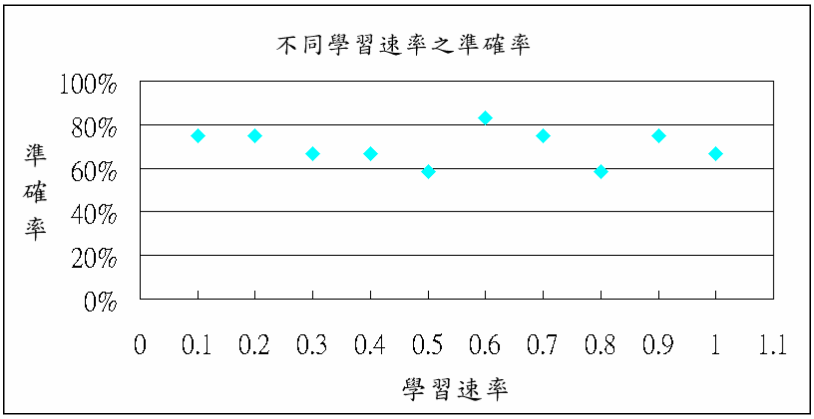


圖 4-1 類神經網路不同學習率之正確率

2. 慣性因子

通常可將類神經網路學習公式加上一個慣性項，即加上某比例的上次加權值改變量，以改善收斂過程中振盪的現象，加速收斂。本研究以慣性因子 0.1、0.2、0.3、0.4、0.5、0.6、0.7、0.8 及 0.9 等九種進行測試，結果如圖 4-2 所示，慣性因子在 0.3 時有最高之準確率。

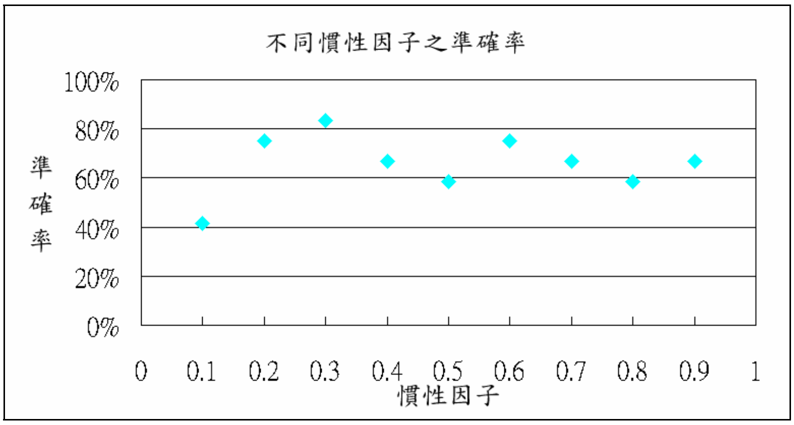


圖 4-2 類神經網路不同慣性因子之正確率

3. 隱藏層神經元

本研究透過經驗公式所得之隱藏層神經元數目為基準加以增減，擬定了不同的神經元數目加上述測試過後之學習速率與慣性因子進行網路學習。本研究所測試之隱藏層神經元個數從 1~30 個分別進行測試，其測試結果如圖 4-3 所示，結果顯示，於測試隱藏層神經元數為 8 時，所得到之準確率為最高，達準確率 80％，故本研究於隱藏層神經元數目以 8 個為準。

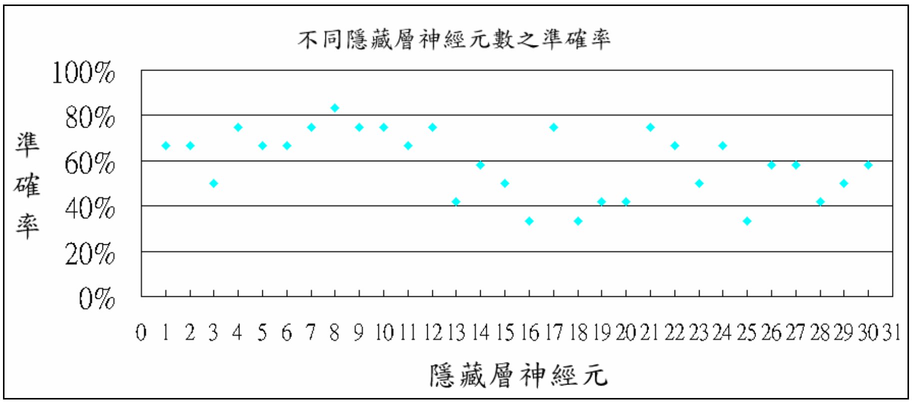


圖 4-3 類神經網路不同隱藏層處理單元之正確率

4. 訓練次數

將上述測試結果當作類神經網路之輸入參數，再測試與探討訓練次數，由圖 4-4 可觀察出，訓練次數於 15,000 次可得較佳之準確率，故本研究採用 15,000 次訓練次數。

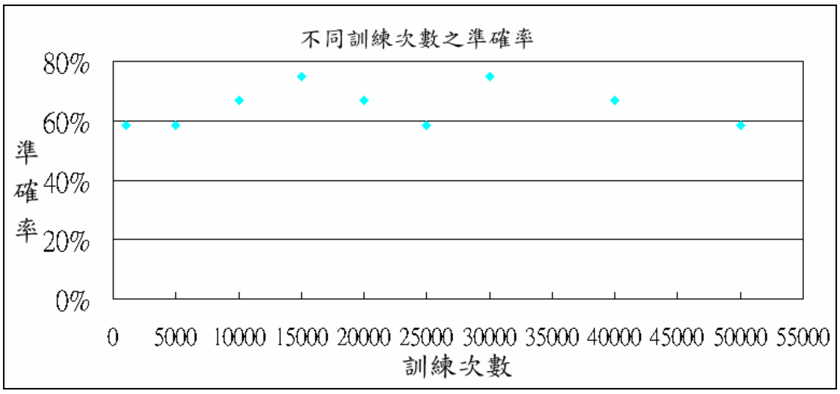


圖 4-4 類神經網路不同訓練次數之正確率

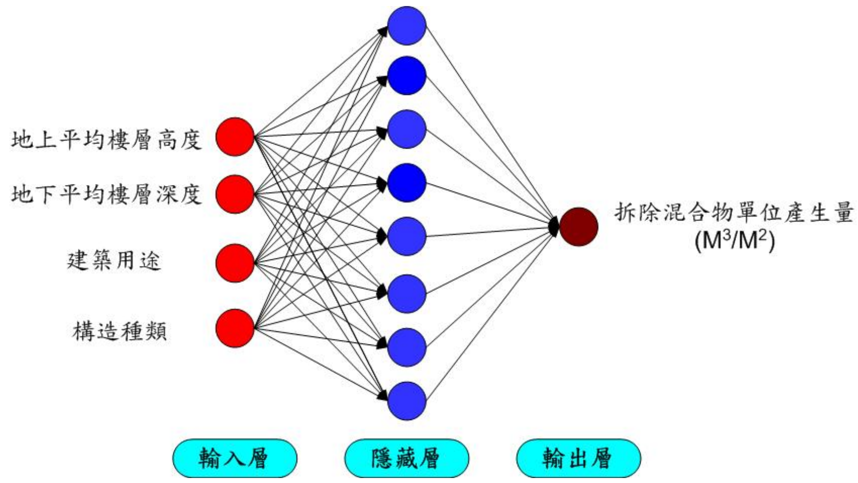
4.2.3 小結

本研究針對類神經網路數個較為重要之參數如（1）隱藏層神經元數（2）學習速率（3）訓練次數（4）慣性因子等四個參數進行測試，試透過測試之方式尋求較佳之參數組合，以使類神經網路於推估建築物拆除工程混合物產生量時有著良好之效能。經測試類神經網路幾個參數後，可從中發現，測試隱藏層神經元數時，若神經元數太多，所得之準確率不高；假若神經元數太少，準確率卻不一定提升。故隱藏層神經元之個數對於類神經網路訓練出來之模型準確率而言，具有相當重要之意義。經由本研究測試結果決定較佳之組合如下所示：

- 拆除工程
    - 隱藏層處理神經元：8 個
    - 學習速率：0.6
    - 慣性因子：0.3
    - 訓練次數：15,000 次

4.3 建築物拆除工程混合物產生量推估模式之架構

本研究所採用之類神經網路為倒傳遞類神經網路，架構為 4 個輸入值，中間層為 1 層之隱藏層，輸出值為 1 個輸出值，網路架構如圖 4-5 所示，各項參數值如表 4-1 所示。



資料來源：本研究整理

圖 4-5 建築物拆除工程混合物數量推估系統網路架構圖

表 4-1 類神經網路之參數表

網路參數項目	參數值（形態）
NN Type	Feed Forward Backpropagation
Transfer Function	Logsigmoid
Training Function	TrainGDM
Learning Function	LearnGDM
Performance Function	MSE
Goal	0
Learning Rate	0.6
Hidden Layer	1
Hidden Node	8
Epochs	15,000
Sample Search	80% 訓練（35 筆）、20%測試（12 筆）

資料來源：本研究整理

4.4 拆除工程混合物產生量推估模式之訓練與驗證

4.4.1 拆除工程混合物產生量推估模式之訓練

經由第三章因子與資料篩選及 4.2 節、4.3 節之類神經網路架構選定後，利用隨機選取 47 筆拆除工程資料之 80%作為類神經網路訓練筆數，共有 35 筆資料進行訓練，透過 EXCEL 建構整體拆除工程之資料庫，再透過匯入 MATLAB

之功能進行類神經網路之操作，而類神經網路各項參數之設定，如表 4-1 所示，進行類神經網路之訓練。

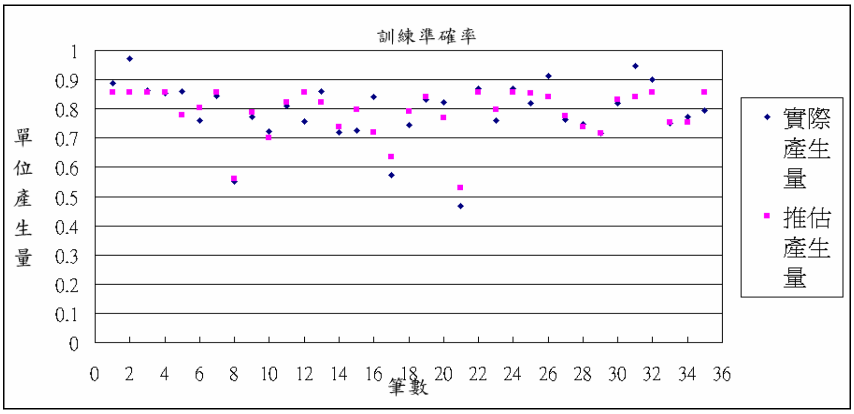


圖 4-6 建築物拆除工程混合物數量推估系統訓練結果

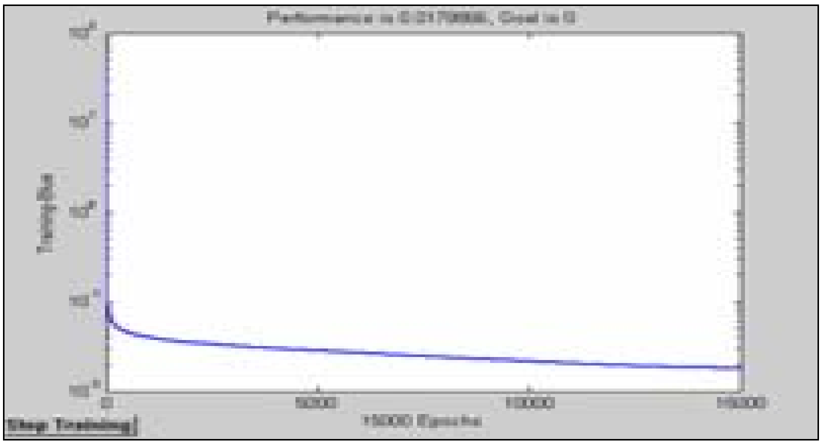


圖 4-7 建築物拆除工程混合物數量推估系統訓練收斂圖

表 4-2 拆除混合物推估模式訓練之準確率

容許誤差（%）	筆數	準確率（%）
5%	23	65.71%
10%	31	88.86%
15%	35	100%

類神經網路之訓練結果及收斂如圖 4-6 及圖 4-7 所示，計算每一筆資料推估數值與實際數值之誤差，發現容許誤差在 5%之內有 23 筆，準確率為 65.71%；

容許誤差在 10%之內有 31 筆，準確率為 88.86%；容許誤差在 15%之內有 35 筆，準確率可達為 100%，整理如表 4-2 所示。進一步查看容許誤差大於 10%之資料，如表 4-3 所示，發現此些資料與經驗公式（0.79 M^3/M^2）相比，雖本研究所建置之推估模式之推估結果誤差大於 10%，但卻較經驗公式更接近實際數量。將所訓練出來之類神經網路推估預測模型進行測試之工作，以驗證本研究利用類神經網路所建構之單一建築物拆除工程混合物產生量推估模式是否準確。

表 4-3 推估模式訓練誤差大於 10%之資料

構造種類	建築用途	實際單位產生量	經驗係數	推估單位產生量
住宅	加強磚	0.9716	0.79	0.85723
工廠	RC	0.5718	0.79	0.655
工廠	鋼鐵	0.4678	0.79	0.536
住宅	RC	0.9472	0.79	0.856

4.4.2 拆除工程混合物產生量推估模式之驗證

本研究選定 47 筆拆除工程資料，利用扣除訓練樣本數之剩餘資料對 4.4.1 節中所建構之類神經網路推估預測模型進行測試，共有 12 筆資料進行測試。測試結果如圖 4-8。容許誤差在 5%之內有 5 筆，準確率達 41.7%；容許誤差在 10%之內有 9 筆，準確率達 75%；容許誤差在 15%之內有 10 筆，準確率可達 83.33%；容許誤差在 20%之內有 12 筆，準確率達 100%；整理如表 4-4 所示。

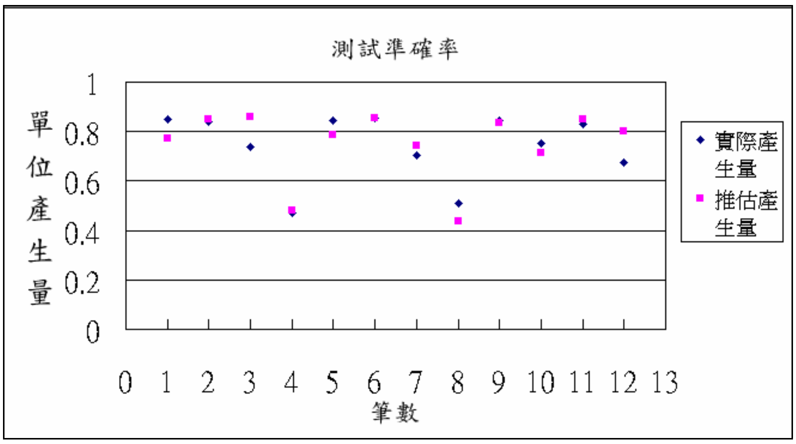


圖 4-8 建築物拆除工程混合物數量推估系統測試結果

表 4-4 拆除混合物推估模式測試之準確率

容許誤差（%）	筆數	準確率（%）
5%	5	41.7%
10%	9	75%
15%	10	83.33%
20%	12	100%

測試資料在容許誤差 15%時，準確度已可達 83.33%，進一步查看誤差大於 15%之資料，如表 4-5 所示，發現此些資料與經驗公式（0.79 M^3/M^2）相比，雖誤差大於 15%，但卻較經驗公式接近實際產生數量。誤差較大之資料多為目前資料庫裡擁有較少筆數之資料，往後若能持續增加筆數，誤差率將縮小。雖本研究建構之推估模式，仍有誤差較大之情況發生，但依測試結果發現，本研究所建構之單一建築物拆除工程混合物產生量推估模式相較於現今常使用之經驗公式，本模式已改善經驗公式之準確度，且較為接近實際產生量。

表 4-5 推估模式測試誤差大於 15%之資料

構造種類	建築用途	實際單位產生量	經驗係數	推估單位產生量
工廠	鋼鐵	0.51	0.79	0.428
工廠	RC	0.673	0.79	0.8

4.4.3 測試推估模式穩定度

本研究將蒐集而來之 47 筆資料，隨機排列出 3 種訓練組與測試組之資料不完全重複之組合，重複進行推估模式之建立，驗證此推估模式若經資料之排列組合改變後，是否會影響推估模式之準確率？目的在於測試此推估模式是否已經趨於穩定。

經重新建構單一建築物拆除工程混合物推估模式後，結果如下表 4-6 所示，可以發現本研究所建構之推估模式，經資料組合改變後，測試容許誤差準確率依然不變，可證實本研究之推估模式已趨於穩定。

表 4-6 不同資料組合之推估模式比較

資料組合＼容許誤差／準確率	5%	10%	15%	20%	25%
組合一	41.67%	75%	83.33%	91.67%	100%
組合二	41.67%	75%	83.33%	91.67%	100%
組合三	41.67%	75%	83.33%	91.67%	100%
組合四	41.67%	75%	83.33%	91.67%	100%

4.5 不同輸入因子數推估模式之比較

由 4.4 節建立四個輸入因子之建築物拆除工程混合物數量推估模式，在容許誤差 15%時，準確率已可達 83.33%。本節將利用專家訪談與問卷調查而得之影響因子，依模糊德菲法決定之重要性程度高低，即是地下平均樓層樓地板面積、地上平均樓層樓地板面積與所在區域別，依序加入輸入層中，比較增加輸入因子後對於推估模式之影響。

當原輸入因子加上地下平均樓層樓地板面積之因子後，其測試結果如圖 4-9 所示，可以發現其各容許誤差之準確率與原四個輸入因子時差異不大。而當再行加入地上平均樓層樓地板面積之因子後，其測試結果如圖 4-10 所示，可以發現在容許誤差 15%之內，準確率已提升至 91.67%，明顯發現加入兩個因子後修正了建築物拆除工程混合物推估模式之準確率。最後加入所在區域別此因子，其測試結果如圖 4-11 所示，從中發現各容許誤差之準確率與六輸入因子差異不大，不同輸入因子之準確率整理如表 4-7 所示。

經由上述之分析後可發現，當輸入因子為四個時，在容許誤差 15%之內準確率達 83.33%，已為本研究可接納之準確率。進一步增加輸入因子數，測試模式之準確率，發現五個輸入因子時各容許誤差準確率與四個輸入因子差異不大，但輸入因子增加為六個時，已把原容許誤差 15%之內準確率修正為 91.67%，可見六個輸入因子比前述輸入因子準確。而七個輸入因子各容許誤差之準確率，與六個輸入因子差異不大。本研究最後為尋求較佳之拆除工程混合物推估模式及方

便使用者使用，故本研究選取六個輸入因子之拆除工程混合物推估模式，當作本研究所建構之推估預測模式。

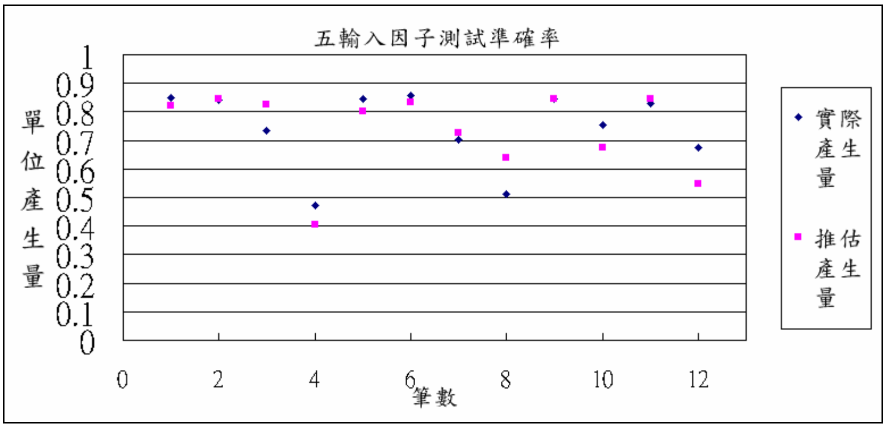


圖 4-9 五輸入因子之測試結果

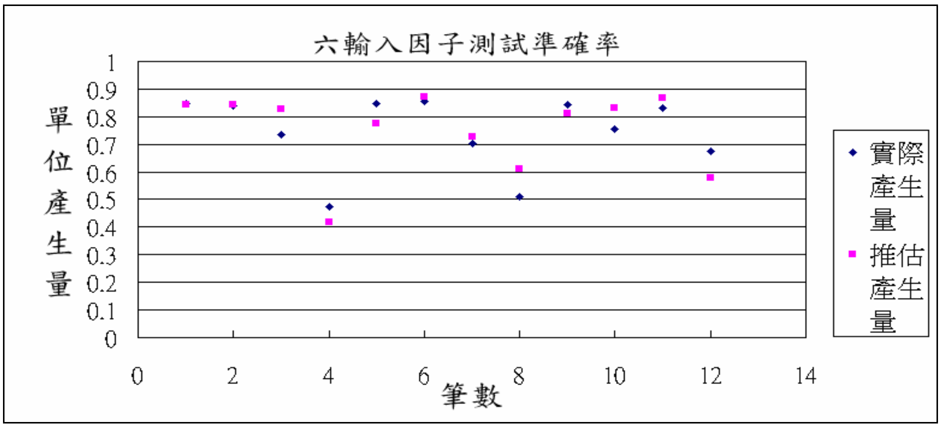


圖 4-10 六輸入因子之測試結果

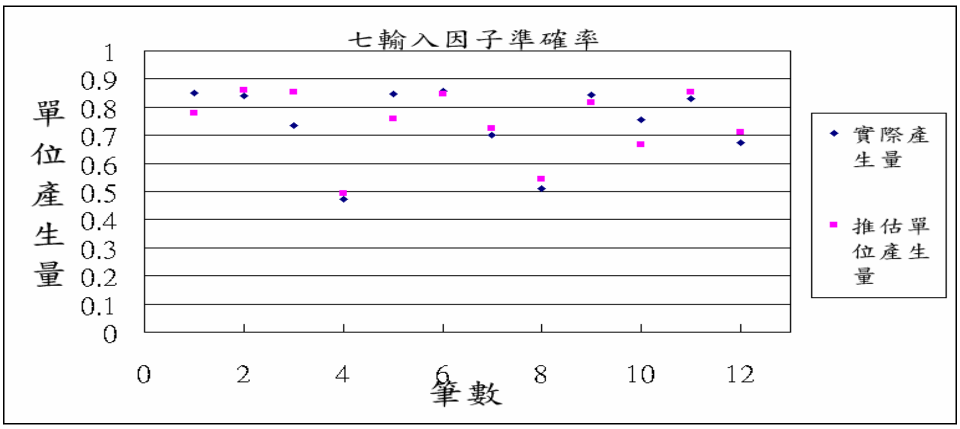


圖 4-11 七輸入因子之測試結果

表 4-7 不同輸入因子數推估模式之比較

輸入因子 \ 容許誤差 準確率	5%	10%	15%	20%	25%
四輸入因子	41.67%	75%	83.33%	91.67%	100%
五輸入因子	41.67%	75%	83.33%	91.67%	100%
六輸入因子	50%	75%	91.67%	100%	100%
七輸入因子	50%	75%	91.67%	100%	100%

4.6 與現行建築物拆除工程混合物推估係數比較

本研究嘗試以單位樓地板面積之混合物產生量作為比較標準，將本研究於上節中所選取出之六個輸入因子之推估模式與現行國內各界常使用之推估係數（0.79 M^3/M^2）進行比較，比較結果如圖 4-12 所示。比較之筆數為類神經網路推估系統中使用於測試之 12 筆資料，其中有 9 筆資料較經驗係數準確，有 3 筆較經驗係數不準確，但進一步檢視較不準確之資料筆數，發現兩者差異並不大，由此可以看出本研究所建構之單一建築物拆除工程混合物產生量推估模式較經驗公式準確。

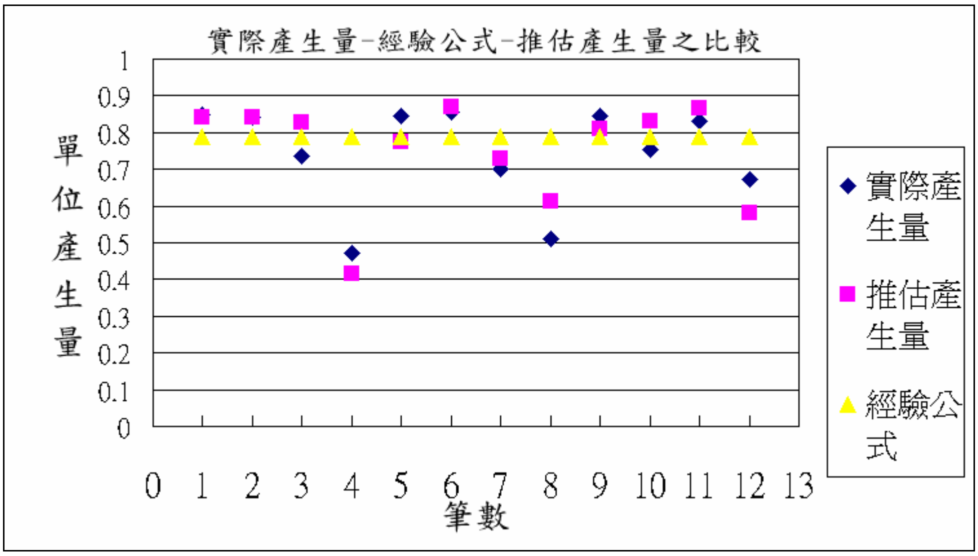


圖 4-12 實際產生量、本研究模式與現行推估之比較圖

本研究將與經驗公式比較之資料詳細列表，如表 4-8、4-9 所示，分析後發

現一般業界認為經驗公式（0.79 M^3/M^2）較適宜推估住宅類之建築物，經本研究所建構之推估模式推估結果平均誤差率約 4.08%，而經驗係數推估結果平均誤差率 7%，由結果顯示本研究推估模式以能有效降低與住宅類型建築物之誤差率，使推估值更能接近實際產生量。

而現今經驗公式推估較為不準確之工廠及教室類別等資料，本研究推估模式推估結果平均誤差率為 11.3%，相較於經驗公式推估平均誤差率 30%，本研究明顯改善了經驗公式之準確度。故本研究所建構之建築物拆除工程混合物產生量推估模式已改善現行推估係數之準確度，利用本研究推估模式推估建築物拆除工程混合物產生量，較能符合實際產生量之情形，且可降低現行推估係數所產生之誤差，拉近與實際產生量之數值。

表 4-8 較經驗公式準確之資料

資料	構造種類	用途	單位樓地板面積實際產生量（m3/m2）	經驗公式推估（0.79）	本研究推估產生	誤差率比較(經驗公式-推估產生量)
一	加強磚	住宅	0.84	5.9%	0.18%（0.841）	+5.72%
二	磚	住宅	0.8487	6.9%	0.8%（0.842）	+6.1%
三	加強磚	住宅	0.856	7.7%	1.7%（0.87）	+6%
四	RC	住宅	0.845	6.5%	3.78%（0.813）	+2.72%
五	RC	教室	0.7	12.86%	4.3%（0.73）	+8.56%
六	加強磚	住宅	0.83	4.8%	4.45%（0.867）	+0.35%
七	RC	工廠	0.673	17.38%	13.82%（0.58）	+3.56%
八	鋼鐵	工廠	0.4722	67.3%	11.88%（0.416）	+55.42%
九	RC	教室	0.51	54.9%	19.8%（0.611）	+35.1%

表 4-9 與經驗公式準確率差異不大之資料

資料	構造種類	用途	單位樓地板面積實際產生量（m3/m2）	經驗公式推估（0.79）	本研究推估產生	誤差率比較(經驗公式-推估產生量)
一	RC	住宅	0.7358	7.4%	9.3%（0.804）	-1.9%
二	磚	住宅	0.846	6.6%	8.4%（0.775）	-1.8%
三	RC	教室	0.754	4.8%	6.7%（0.804）	-1.9%

4.7 建築物拆除工程混合物單位產生量

根據上述各章節之步驟所建構之單一建築物拆除工程混合物產生量推估模式，本研究進一步針對構造用途別與構造型式建立其平均單位樓地板面積混合物產生量（M^3/M^2），如下表 4-10 所示。本研究利用所建構之推估系統，依照如表 4-10 之參數組合，改變其他影響因子之輸入值，求得平均係數。因受限於所蒐集之資料範圍有限，目前僅能先針對用途別加構造別組合建立平均單位產生量，但經由模糊德非問卷調查之結果顯示，該兩因子亦為影響拆除工程混合物產生量最大之主要因子。

表 4-10 建築物單位面積拆除混合物產生量

拆除工程		
構造別	用途別	單位產生量（M^3/M^2）
加強磚造	住宅	0.848
	工廠	0.73
RC 造	住宅	0.8
	工廠	0.66
	教室	0.762
磚造	住宅	0.717
鋼鐵造	工廠	0.65

五、拆除工程混合物產生量推估系統開發與使用

5.1 推估模式系統開發

本研究所建構之單一建築物拆除工程混合物產生量推估模式，主要目的在於透過影響建築物拆除工程混合物產生量之因子輸入至本推估模式後，能推估出拆除混合物之產生量。本研究經由類神經網路之訓練與驗證後，將其訓練後之權重值與偏權值輸出至 EXCEL 試算表中，透過 EXCEL 計算功能將建築物拆除工程混合物產生量推估模式建立於 EXCEL 中。運算模式為透過中間層之權重相乘與加總，再扣除偏權值與雜訊後，經由轉換函數之方式，輸出至各中間層，再透過輸出於輸出層之權重相乘並經轉換函數轉換後，便可計算出單位樓地板面積混合物產生數量。本研究乃利用 EXCEL 功能表中之隱藏功能，將整體類神經網路運算之過程，如輸入值之尺度化、中間層運算過程、尺度化之過程、加總至輸出層與輸出層尺度化之過程等利用隱藏之功能將其簡化如圖 5-1 所示，讓使用者在使用本研究所建置之單一建築物拆除工程混合物推估模式時，可以更為方便操作。

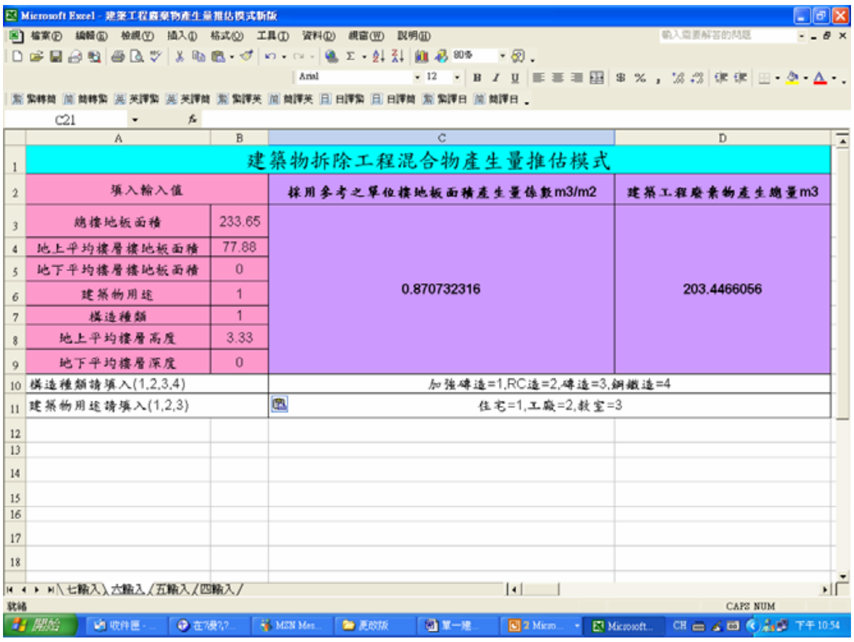


圖 5-1 單一建築物拆除工程混合物產生量推估模式介面

5.2 推估模式系統之操作使用說明

5.2.1 推估模式之適用範圍

本研究所建構之單一建築物拆除工程混合物產生量推估模式，主要透過如圖5-1中左半部區塊使用者輸入影響因子如總樓地板面積、地上平均樓層樓地板面積、地下平均樓層樓地板面積、構造種類、建築用途、地上平均樓層高度與地下平均樓層深度等因子，除可量化之因子如總樓地板面積、地上平均樓層樓地板面積、地下平均樓層樓地板面積、地上平均樓層高度與地下平均樓層深度外，不可量化之因子如構造種類及建築物用途等，其輸入方式均顯示於推估系統下方之區塊。構造種類為加強磚造時輸入1、RC造輸入2、磚造輸入3及鋼鐵造輸入4；建築用途為住宅時輸入1、工廠型式輸入2及學校教室型式輸入3。利用Excel計算功能將結果輸出至中間區塊，可求得單一建築物拆除工程混合物單位產生量。

本研究所建構之數量推估模式所適用之範圍及各項參數輸入時之判別定義如下表5-1、5-2所示：

表5-1 建築物拆除工程混合物數量推估模式之適用範圍

	構造種類	建築物用途	地上平均樓層高度	地下平均樓層深度	地上平均樓層樓地板面積	地下平均樓層樓地板面積
拆除工程	RC、加強磚造、磚造、鋼鐵造、鋼骨造	住宅、工廠、教室	2.9~9.68公尺	0~3.2公尺	40.77~37,197M^2	0~1,339M^2

表 5-2 建築拆除工程混合物數量推估系統輸入值之定義

拆除工程					
建築物用途	構造種類	地上平均樓層高度	地下平均樓層深度	地上平均樓層樓地板面積	地下平均樓層樓地板面積
住宅輸入1 工廠輸入2 教室輸入3	加強磚造輸入1 RC輸入2 磚造輸入3 鋼鐵造輸入4	以地上建築物總高度除以地上樓層數	以地下室總深度除以地下室層數	地上總樓地板面積除以樓層數	地下室總樓地板面積除以樓層數

5.2.2 案例分析

本節將以一個案例介紹如何操作使用本研究所建置之單一建築物拆除工程混合物產生量推估系統。

案例資料：建築物地點位於台北縣三重市市區，為一棟約 30 年之建築物，緊鄰隔壁住戶，且建築物於狹小巷道內，大型拆除機具較難進入，其基本資料如下表 5-3 所示：

表 5-3 建築物基本資料

影響因子	細項
總樓地板面積	233.65
有無地下室	無
建築物高度	9.99
樓層數	3
構造種類	加強磚
建築物用途	住宅

在使用此推估系統前，須先計算出平均地上及地下樓層樓地板面積與平均地上及地下建築物樓層高度。此案例因無地下室故先將總樓地板面積與建築物高度除以 3，即為 3.33 M 平均樓層高度及 77.88 M^2 平均樓層樓地板面積，輸入時建築物為住宅型建築物故用途別輸入 1，而建築物為加強磚造故構造別輸入 1，因無地下室所以地下平均樓層樓地板面積與地下平均樓層深度皆為 0。依照數量推

估模式之輸入項目各自填入資料，經由 Excel 之自動計算功能後，其結果將輸出至中間之區塊，求得單一建築物拆除工程混合物產生量之建議數值 0.871M^3/M^2，而最右邊之區塊會自動計算出拆除混合物之產生總量 203.45 M^3，其操作結果如圖 5-2 所示。

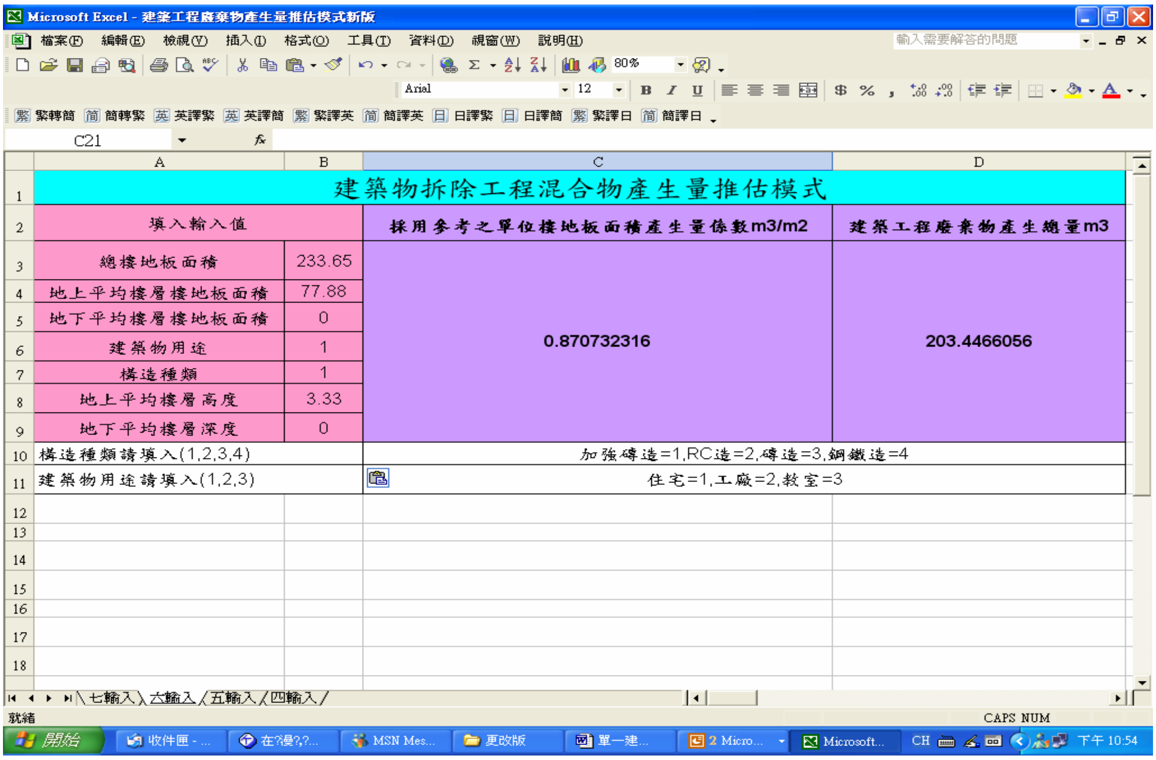


圖 5-2 拆除混合物數量推估系統操作範例圖

六、結論與建議

6.1 結論

為促使政府相關單位能確實掌握建築物拆除工程混合物之產生量,本研究以專家訪談、問卷調查及類神經網路方式去建構單一建築物拆除工程混合物產生量推估模式，經分析研究可歸納下述幾項結論：

1. 現行影響單一建築物拆除工程混合物產生量之主要因子為樓地板面積、構造種類、建築用途、建築物高度與所在區域別等因子，本研究為考量到地下室之問題,將樓地板面積與建築物高度分為地上與地下兩部分；另考慮樓層挑高及各樓層樓地板面積不相同之問題,將樓地板面積與建築物高度分別取與樓層數之平均方式來表示；而所在區域別則以當地地段地價為基準。經模糊德菲法篩選因子後選擇構造種類、建築用途、地上平均樓層高度與地下平均樓層深度等四項因子。

2. 經由試誤過程求得較佳網路架構與輸入參數組合,結果顯示類神經網路以一個隱藏層、隱藏層神經元數 8 個、訓練次數 15,000 次以上、慣性因子 0.3 與學習速率 0.6 左右，可得較佳單一建築物拆除工程混合物產生量。

3. 透過類神經網路之學習,本研究所建構之四輸入因子之單一建築物拆除工程混合物產生量推估模式，於容許誤差 15%時準確率達 83.33%；再經由增加輸入因子後發現，六輸入因子之推估模式已可達容許誤差 15%時準確率 91.67%，故本研究最後採用六個輸入因子之單一建築物拆除工程混合物產生量推估模式。

4. 經由本研究所建構之推估模式與現行國內各界常使用之推估係數與實際產生量相比較結果，本研究所建立之推估模式較接近實際產生量，已改善經驗

係數之不準確性。

5. 本研究重新定義構造別加用途別之單位產生量係數，可提供除了使用本推估系統推估拆除混合物數量外，另一項可較準確推估之工具。

6. 透過類神經網路建構單一建築物拆除工程混合物產生量之推估模式，對於推估模式多參數型之複雜計算，類神經網路已簡化其複雜數學計算，且經由試驗發現本研究所建構之模式有相當程度之可信度。

6.2 建議

本研究有下述幾點建議：

1. 近幾年拆除之建築物多為老舊式建築，大部份均為加強磚造與 RC 造，其他構造種類之建築物資料較少，建議持續擴充案例資料庫，諸如各構造種類、各種不同之建築用途、與裝潢材料等之蒐集，並且可針對北、中、南、東區位進行資料蒐集，透過全面性之資料蒐集，以強化資料庫之資料完整性。

2. 本研究所建構之推估模式主要針對單一建築物，建議可研究建構群體建築物之推估模式，如此可掌握全國每年產生量，對拆除混合物之流向掌控更有幫助。

3. 本研究所建立之模式，倘若能透過系統開發介面化方式，則更能讓使用者易於操作及使用。

4. 建議各縣市政府可在拆除執照上增列本研究所調查之影響參數，不但可讓拆除工程混合物數量推估更為精準，也可讓業者在提報減量措施時有評估依據。

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附件一拆除工程影響因子重要性評估問卷

敬啟者：

「建築物拆除工程混合物產生量推估之研究」為內政部建築研究所委託國立中央大學營建管理研究所進行之研究計畫，其研究目的在於建立建築物拆除工程所產生之建築混合物總量推估預測模式。

素聞　貴公司工程品質優良，希冀經由您的專業知識及實務經驗，提供　貴公司有關建築混合物產生量之相關資訊，以供本研究進行探討分析時，能更符合實際現況。

本問卷主要是調查所有可能影響建築物進行拆除工程時所產生之混合物單位產生量（M^3/M^2）之影響因子，並針對此些影響因子做重要性程度分析研究。

感謝您在百忙之中抽空填答本問卷，您所提供之寶貴意見將對本研究的周延及完整性有重大的幫助。貴公司所提供之資料純屬學術研究將不對外公開，僅作為本研究統計分析之用。感謝您撥冗填寫本問卷。謝謝！耑此

順頌

時祺

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E-Mail：92325010@cc.ncu.edu.tw

一、基本資料

1.公司名稱：______

2.地　　址：______

3.電　　話：______傳　　真：______

4.受訪人員職稱：______

5.受訪人員之經驗年資：______

6.公司營運年數：☐1~3 年　☐3~5 年　☐5~10 年　☐10 年以上

7.公司年營業額：______

8.員工總數：______

二、調查之混合物定義

本研究所調查建築物拆除工程所產生之混合物，主要內容物為**扣除可移動式家具**後之混合物數量，主要包含有混凝土、磚、瓦、木材、鋼筋、其他金屬及非金屬等，皆為本研究調查範圍內。

三、問卷理念之範例說明

本研究主要分析方向為針對各項影響因子，對於拆除工程所產生之建築混合物 **單位樓地板面積產生量（M^3/M^2）** 之影響，以下針對總樓地板面積對於單位樓地板面積產生量做一範例說明：

A 總樓地板面積＝100 M^2　　廢棄物產生量＝80 M^3

B 總樓地板面積＝1000 M^2　　廢棄物產生量＝750 M^3

故 A 單位樓地板面積產生量為 80/100 ＝0.8 M^3/M^2

B 單位樓地板面積產生量為 750/1000 ＝0.75 M^3/M^2

此範例說明**總樓地板面積越大不一定單位樓地板面積產生量就越大**。

希冀專家們填寫此問卷時，能以**各項影響因子對於單位樓地板面積產生量的重要性程度**去填寫，而非以對總產生量的影響填寫，謝謝。

四、影響因子之釋義

以下為本研究調查之各項影響因子釋義：

1. 地上平均樓地板面積

建築物平均樓層樓地板面積之大小，會影響到此建築物之設計型式。建築師會依樓地板面積大小，對於樑、柱之承載能力與垮距等會有不同之考量，則會造成拆除混合物產生量之差異。

1. 地下室平均總樓地板面積

建築物平均樓層樓地板面積之大小，會影響到此建築物之設計型式。建築師會依樓地板面積大小，對於樑、柱之承載能力與垮距等會有不同之考量，則會造成拆除混合物產生量之差異。

2. 構造種類

構造種類主要影響建築物拆除工程混合物產生量之原因為各構造型式之建築物主要結構體皆有所不同，建築物設計時所考量之梁柱大小、垮距、混凝土用量及隔間等，皆會因構造形式之特性而有不同之設計。鋼鐵或鋼骨構造型式之建築物，與 RC 造建築物不論重量或體積皆不相同，故構造種類型式易影響建築物拆除工程混合物之產生量。

3. 建築物用途

不同建築用途會影響拆除工程混合物產生量之差異，如一般而言學校教室與工廠型建築物，它們相較於住宅型之建築物，其隔間較大裝潢材料較少，拆除工程產生之混合物與住宅型建築物即產生差異，故不同之建築物用途對於建築物拆除工程混合物產生量亦有差異。

4. 地上建築物平均樓層高度

相同樓地板面積之情形下，不同之建築物平均樓層高度，由樑、柱之承載設計與高出部分之體積，即可得知拆除混合物產生量不相同，故不同之地上建築物平均樓層高度即會影響建築物拆除工程混合物產生量。

5. 地下室建築物平均樓層深度

相同樓地板面積之情形下，不同之建築物平均樓層深度，由樑、柱之承載設計與高出部分之體積，即可得知拆除混合物產生量不相同，故不同之地下建築物平均樓層高度即會影響建築物拆除工程混合物產生量。

6. 所在區域別

建築物所處區域不同，如郊區與都會區而言，擁有同樣樓地板面積但購買之房價有所差異。一般而言，都會區所購買房子較貴，一般人會較注重實用性；郊區房子較便宜，可能會較注重休閒性。因地段特性不同，往後對建築物之裝潢亦有所不同，此即會影響拆除混合物產生量。

五、德菲法之填寫說明

本問卷之目的在於評定評估表中影響因子之重要次序等級。評定方式採1~10 等級，分數越高表示越重要，請依您個人之專業知識評估影響因子的重要性，並填入整數值，每一評估因子包括兩部分：

1. 重要性程度：請評估此因子對建築混合物產生總量之重要性程度，並請填入對此因子重要性程度之單一評估值。
2. 可接受範圍：請評估此因子對建築混合物產生總量重要性程度之可接受範圍，並請填入可接受範圍之上限與下限。

範例說明：

評估**建造種類**此一要素對於建築混合物產生總量之重要性程度，在相同樓地板面積、用途等其他條件皆相同的情形下，如**同為 100 坪建築物，且同為住宅**，則若它是 RC 造、磚造或鋼構造時，影響產生量程度尚大，可以達到 8 等級；而其他條件相同，不同構造別它的影響程度**最小也有 5 最大可達到 9 等級**。

將上述想法填入表中，如下表所示。其餘影響因子依此類推。

	重要性程度	**可接受之範圍**	
	最有可能之單一值	**可接受之最小值**	**可接受之最大值**
評估因子	（1~10）	（1~10）	
構造種類	（ 8 ）	（ 5 ）	（ 9 ）

- 各項影響因子之重要性程度評估

評估因子	重要性程度 最有可能之單一值 （1~10）	可接受之範圍 可接受之最小值 （1~10）	可接受之範圍 可接受之最大值 （1~10）
地上平均樓地板面積	(　　　)	(　　　)	(　　　)
地下平均樓地板面積	(　　　)	(　　　)	(　　　)
構造種類	(　　　)	(　　　)	(　　　)
建築物用途別	(　　　)	(　　　)	(　　　)
地上平均樓層高度	(　　　)	(　　　)	(　　　)
地下室平均樓層深度	(　　　)	(　　　)	(　　　)
所在區域別	(　　　)	(　　　)	(　　　)

- 其他建議與意見

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本問卷到此結束，再次感謝您的鼎力協助

附件二 拆除工程案例資料

編號	總樓地板面積	地上平均樓地板面積	地下平均樓地板面積	用途別	構造形式	地上平均樓層高度	地下平均樓層深度
1	149.24	74.62	0	住宅	加強磚	3.2	0
2	936.13	468.065	0	住宅	加強磚	3	0
3	144.63	72.315	0	住宅	加強磚	3	0
4	6892.87	3446.435	0	工廠	RC	4.7	0
5	208.86	69.62	0	住宅	加強磚	3	0
6	125.32	62.66	0	住宅	加強磚	3	0
7	233.65	77.88	0	住宅	加強磚	3.33	0
8	2309.01	374.83	60.01	教室	RC	3.442	3.2
9	199.14	99.57	0	住宅	加強磚	3	0
10	37197.54	37197.54	0	住宅	磚	3	0
11	7658.4	7658.4	0	住宅	磚	3	0
12	94.9	94.9	0	住宅	RC	3	0
13	297.99	148.995	0	住宅	RC	3.1	0
14	864.26	432.13	0	住宅	加強磚	3.1	0
15	8037.95	1844.1275	661.44	住宅	RC	3.3	3.2
16	6862.51	2189.5	294	教室	RC	3	3
17	3773.96	608.74	1339	工廠	RC	2.935	2.5
18	315.48	157.74	0	住宅	加強磚	3	0
19	103.5	103.5	0	住宅	磚	4	0
20	1803.78	440.82	0	教室	RC	3.6	0
21	89.42	89.42	0	住宅	磚	3.6	0
22	165.49	82.745	0	住宅	磚	3.3	0
23	104.94	104.94	0	工廠	鋼鐵	4	0
24	215.27	71.76	0	住宅	磚	3.3	0
25	669.85	334.925	0	住宅	RC	3	0
26	85.91	85.91	0	住宅	加強磚	3	0
27	254.13	127.065	0	工廠	鋼鐵	3	0
28	213.78	213.78	0	工廠	鋼鐵	3.5	0
29	607.45	151.8625	0	住宅	磚	3.4	0
30	109.47	54.735	0	住宅	加強磚	3	0
31	89.38	44.69	0	住宅	磚	3.5	0

32	143.56	71.78	0	住宅	加強磚	3.1	0
33	529.45	264.725	0	住宅	加強磚	3.6	0
34	2565.17	855.06	0	住宅	加強磚	3.35	0
35	158.94	79.47	0	住宅	加強磚	3	0
36	163.08	40.77	0	住宅	RC	3.315	0
37	11409	2852.25	0	工廠	加強磚	3.3	0
38	1425.44	712.72	0	教室	RC	3.6	0
39	2275.25	758.42	0	教室	RC	3.6	0
40	2228.77	1114.385	0	工廠	RC	9.68	0
41	240.54	120.27	0	住宅	加強磚	3	0
42	377.89	94.4725	0	住宅	加強磚	3.7	0
43	396	132	0	住宅	加強磚	3	0
44	163.64	40.91	0	住宅	RC	4.05	0
45	144.63	72.315	0	住宅	加強磚	3	0
46	5322.82	1330.7	0	教室	RC	3.225	0
47	1680.52	420.13	0	教室	RC	3.225	0

Annex 2

REPORT 6

PROPOSED METHODOLOGY FOR NON-INERT CONSTURCTION WASTE COMPOSITION

August 2017

Table of Contents

This report introduces the proposed upstream and downstream approaches for non-inert construction waste composition study.

1. Upstream Estimation of Non-Inert Construction Waste

For effective waste management, it is beneficial for project team members to predict the approximate quantities of waste of individual projects (e.g., to comply with trip ticket procedures of the Development Bureau) based on the complete design information, especially when near to the tender stage for the main building contract for a project using the traditional procurement approach.

For a single project, the estimated quantities and types of waste will enable the consultants and contractors to take appropriate waste management action even before the project commences. In the long run, such estimates can form benchmarks when they are related to the scope (say on unit m^2 basis) and nature of the projects. Efforts can then be made to reduce waste as far as practisable during the design stage in the choice of materials and dimensional coordination.

Since the bulk volume of waste is a critical concern for waste management, the conversion of design quantities into waste is based on bulk volume estimate, but if for some justifiable reasons, weight will be of concern, the calculation may be extended to include weights where necessary.

1.1. Approach (A) – Bills of Quantities (BoQs) being available from professional quantity surveyors

Since piling usually forms a separate contract, the extraction of quantities starts from the pile cap (if it is incorporated in the main contract; if not, account for the quantities since pile cap formwork is usually of timber which would eventually be scrapped after use). Excavated spoil for foundations is excluded.

For BoQs presented in elemental format, add similar items appearing in different elements (e.g., screedings in floors and walls).

For waste management purpose, wastes arising from the use of the materials and their containers/packaging materials are included.

A proforma similar to Appendix A may be used to tabulate the summary quantities extracted from BoQs but separate compilation sheets should be attached to show the break-down.

The general principle of arriving at the bulk volume of materials:

(1) Convert materials into absolute volume (in m^3) from their given quantities and dimensions, if any (e.g., areas multiplied by thickness);
(2) Convert weights into absolute volume using absolute densities;
(3) Estimate waste allowances and bulking ratios (for example, by referring to tables as listed in Appendix B);
(4) Estimate bulk volume using absolute volume multiplied by a bulking ratio.

Multiply each bulk volume by the respective suggested waste percentage as shown in Appendix A, which is estimated based on normal urban site conditions (for multi-storey construction with common plant usage on flat ground). Where site conditions differ significantly from the said scenario, suitable adjustments may be made to reflect the envisaged wastage levels.

If timber is envisaged as formwork materials, the no. of re-use for typical floors needs to be differentiated from non-typical floors, depending on the complexity of design. Zero waste may be assumed for metal formwork, if specified, but again this is dependent on the design.

For the following types of materials (not exhaustive), extra allowance shall be made for:

- Timber pellets and crating for materials delivered in them (assuming not returnable to suppliers);
- Cement for plastering, mortar, screeding and the like to be mixed on site: - paper bags;
- Liquid membrane waterproofing/roofing: - metal/plastic containers;
- Joint sealant: - plastic containers and cartons;
- Off-site manufactured doors: - assumed corrugated cardboards as protection;
- Paper boxes for tiles and ironmongery;
- Painting (including sealer): - metal containers;

- Sanitary fittings: - pellets/crating/wrapping;
- Hardwood flooring: - pellets/crating;
- Kitchen cabinet/countertops: - wrapping.

For building services equipment, estimation of waste arising from packaging materials may be based on the number of accommodation units, differentiating into large and small units where applicable. Reference may also be made to the prime cost sums allowed in the main contract as to the relative scale of works. All equipment is assumed to be fully fixed on completion and cause no waste.

1.2. Approach (B) – no BoQ available (e.g., for contracts based on specifications and drawings)

Major quantities as shown in the proforma in Appendix A may be taken off from tender drawings, or the estimation may be deferred until the contract is awarded. The successful contractor's schedule of quantities may be used as a good reference, although errors in measurement need to be mindful of.

A similar process of estimation applies as in Method (A).

1.3. Intended use of the results

Whilst the estimated waste volume may be used in the currently enforced trip ticket system, statistical figures may be built up after a sufficient pool of samples (say more than 30 projects assuming normal distribution) have been processed. A useful benchmarking statistic would be estimated waste volume per m^2 of Construction Floor Area.

Construction Floor Area is defined as the summation of all areas at all floor levels, including basements, mezzanine floors, balconies and enclosed rooftop structures, measured to outer face of external wall. It is measured over all partitions, columns, walls, stair wells, lift wells, escalator openings, etc.

2. Downstream Estimation of Non-Inert Construction Waste

Based on the experience gained from the construction waste sorting of the current study, the methodology for the "*future non-inert construction waste composition study"* is proposed. The methodology includes the following main parts:

(1) Number of lorry/truck load of construction waste to be studied;
(2) Duration and time;
(3) Method of non-inert waste estimation;
(4) Sorting list;
(5) Sorting area and location;
(6) Manpower;
(7) Large equipment;
(8) Small equipment/tools/set-up for operation and safety requirements;
(9) Appropriate contractor and budget.

2.1. Number of lorry/truck load of construction waste to be studied

Table 1 presents the extent of the future study proposed. The study covers three types of building construction site ("residential", "commercial" and "hotel"), and three stages of construction ("superstructure", "immediate after superstructure completion" and "before occupation").

Table 1 Extent of the future study proposed

<table>
<tr><th>Type of Site</th><th>Stage of Construction</th><th>Scale of Site</th><th>Set</th></tr>
<tr><td>• Residential</td><td rowspan="2">• Superstructure
• Immediate after superstructure completion
• Before occupation</td><td>• 1 block
• >1 block</td><td>1</td></tr>
<tr><td>• Commercial
• Hotel</td><td>-</td><td>2</td></tr>
</table>

For the residential building, two scales of construction site ("1 block" and ">1 block") will be studied. For the commercial building and the hotel building, two sets of sites for each type will be included. Hence, the study will include 18 numbers of building construction site. It is suggested that each of the sites provides three lorry/truckloads of construction waste. In total, there will be 54 lorry loads of construction waste for the study.

2.2. Duration and time

With reference to the observation of the construction waste sorting of the current study, it is possible that 3 lorries of construction waste can be sorted in an eight-hour working day. Hence, the estimated time for waste sorting is about 18 working days.

The sorting exercise should avoid the raining season and the typhoon season prevailing in Hong Kong. The best time period for the sorting is, therefore, between November and March of the year.

2.3. Method of non-inert waste estimation

Non-inert wastes are more than likely to be mingled together with inert wastes due to the fact that effective sorting at construction site is difficult to be implemented in most cases. Hand sorting, together with manual weighing, is recommended as the method for non-inert waste estimation.

Construction waste delivered to the sorting ground is to be spread out and divided into four equal parts (as shown in Figure 1). Sorting is then carried out on two of the parts according to a pre-fixed plan.

4	**1**
3	**2**

Figure 1 Construction waste divided into four parts

2.4. Sorting list

Table 2 shows a sample list for sorting non-inert wastes. The table includes two main sections:

(1) General information registration;

(2) Non-inert wastes to be identified (29 types).

The general information registration contains:

- Date;
- Weather;
- Site number;
- Lorry number;
- Lorry arrival time;
- Lorry licence plate number;
- Sorting time (beginning);
- Sorting time (completion);
- Parts sorted;
- Grab mounted lorry arrival time;
- Grab mounted lorry licence plate number;
- Chit ticket number;
- Total load of construction waste stated on chit ticket;
- Person taking the record;
- Remark.

The list of non-inert wastes includes the following items:

- Bamboo;
- Formwork;
- Wooden pallet;
- Packaging timber;
- Iron/copper pipe;
- Rebar;
- Aluminium scrap;
- Metal container;
- Steel scraps;
- Cardboard;
- Packaging paper;

- Plastic wrapping;
- Plastic container;
- PVC duct;
- Cable;
- Plastic traffic barrier;
- Window seal container;
- Rubber;
- WEEE;
- Vegetation;
- Textile;
- Fibreglass;
- Nylon;
- Domestic waste;
- Sanitary ware;
- Styrofoam;
- Gypsum board;
- Glass;
- Others.

Table 2 A sample list for sorting non-inert waste

<table>
<tr><td colspan="2">Date:</td><td>Weather:</td><td></td><td>Site no.:</td><td></td></tr>
<tr><td>Lorry arrival time:</td><td></td><td></td><td></td><td colspan="2">Grab mounted lorry arrival time:</td></tr>
<tr><td colspan="3">Lorry no.:</td><td></td><td colspan="2">Grab mounted lorry licence plate no.:</td></tr>
<tr><td>Lorry licence plate no.:</td><td></td><td></td><td></td><td colspan="2">Chit ticket no.:</td></tr>
<tr><td colspan="3">Sorting time (beginning):</td><td></td><td>Total load of construction waste stated on chit ticket:</td><td></td></tr>
<tr><td colspan="3">Sorting time (completion):</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Parts sorted:</td><td></td><td>Recorded by:</td><td></td></tr>
<tr><td colspan="6">Remark:</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Material	Group No.	Group	Type No.	Type	Weight (kg)
Non-inert	1	Bamboo	1	no sub-group	
	2	Wood & Timber	2a	formwork	
			2b	wooden pallet	
			2c	packaging timber	
			2d	others	
	3	Metal	3a	iron / copper pipe	
			3b	metal sink	
			3c	rebar	
			3d	aluminium scrap	
			3e	metal containers for material packaging	
			3f	steel scrap	
			3g	others	
	4	Paper & Cardboard	4a	cardboard	
			4b	packaging paper	
			4c	others (newspaper, office paper etc.)	
	5	Plastic & Rubber	5a	plastic wrapping	
			5b	plastic container	
			5c	PVC duct	
			5d	cable	
			5e	plastic traffic barrier	
			5f	window seal container	
			5g	rubber	
			5h	others	
	6	WEEE	1	electric appliance, electric socket, lighting, water pump, electric motor, transformer (i.e. no sub-group)	
	7	Vegetation	1	tree trunk etc. (i.e. no sub-group)	
	8	Textile	1	no sub-group	
	9	Fibreglass	1	no sub-group	
	10	Nylon	1	no sub-group	
	11	Domestic Waste	1	food waste etc. (i.e. no sub-group)	
	12	Sanitary Ware	1	porcelain water closet, porcelain wash hand basin, kitchen solid surface material etc. (i.e. no sub-group)	
	13	Styrofoam	1	no sub-group	
	14	Gypsum Board	1	Gypsum drywall etc. (i.e. no sub-group)	
	15	Glass	1	no sub-group	
	16	Others (to be descripted)	1	-	
Inert	17	Inert	1	rock, soil, sand, aggregate, rubble, boulder, masonry, concrete, asphalt, brick & tile etc. (i.e. no sub-group)	
				Total weight:	

2.5. Sorting area and location

The sorting platform should be strong enough to sustain loadings of lorries and movements of backhoe without deterioration that could generate additional waste to the construction waste being sorted. Platform of C40 concrete of 200mm thick with a proper foundation is recommended. The platform should also be large enough for construction waste spreading and sorting. A minimum area of 12m by 8m is suggested.

2.6. Manpower

Apart from the backhoe operator, who is usually supplied by the backhoe hiring company, the construction waste sorting team will include a foreman and six site workers. Based on 18 working days, as suggested in Part 2 of the current document, the total man-days of the foremen and the site worker are 18 and 108 respectively for the sorting operation. The foreman is responsible for all on-site management and communication works – including taking full record of site work and sorting measurements, and communication with different construction sites, grab mounted lorry and the site workers etc. The site workers work on all manual works related to waste sorting and weighing.

2.7. Large equipment

A 6-tonne backhoe or a large backhoe will be used to even and move the construction waste on site. And a grab mounted lorry will be hired to send the construction waste away after completion of the sorting work of each load.

2.8. Small equipment/tools/set-up for operation and safety requirements

The list of small equipment/tools/set-up for operation and safety requirements includes:

- Digital camera with video capturing function;
- Mobile phone;
- 120-150kg balance;
- Containers/buckets of different sizes;
- Hand shovel;
- Small hand tools;
- Site office;
- Temporary electricity supply;
- Temporary water supply;

- Temporary toilet;
- First aid box;
- Insect/mosquito repellent;
- Sunburn lotion;
- Personal Protection Equipment (PPE) for each on-site staff:
  - safety helmet;
  - safety shoes;
  - dust mask;
  - general purpose gloves;
  - blade cut resistance gloves;
  - goggles against flying particles;
  - fluorescent jacket;
  - "Level C" safety equipment for handling chemical waste.

2.9. Appropriate contractor and budget

Any contractors, who have previous experience on waste sorting, are considered appropriate for providing the service.

Major items for budget estimation are shown in the list below. The list covers three main areas – "provisions for works before conducting the actual waste sorting operation", "provisions for works during the sorting operation" and "provision for site clearing and restoration after completion of the sorting operation".

Provisions for works before conducting the waste sorting operation

- Provision of sorting site (including site clearance);
- Provision of temporary water;
- Provision of temporary electricity;
- Provision of temporary toilet;
- Provision of site office;
- Provision of fencing / hoarding for site boundary;
- Provision of concrete slab platform of 12m x 8m x 0.2m with a proper foundation;
- Insurance - contractor all risks and 3rd party liability insurance;
- Insurance - personal accident for the backhoe operator and grab mounted lorry.

Provisions for works during the sorting operation

- Provision of foreman (18 man-days during sorting operation + other man-days as necessary for management and administration tasks before and after the sorting operation);
- Provision of site worker (108 man-days);
- Hiring of backhoe including operator (18 working days);
- Hiring of grab mounted lorry (54 trips);
- Dumping charge to landfills;
- Provision of small equipment, hand tools and personal protection equipment.

Provision for works after completion of the sorting operation

- Site clearing and restoring subsequent to completion of operation.

Appendix A - Proposed Form for the Estimation of Construction Waste Generated from New Building Construction

Proposed Form for the Estimation of Construction Waste Generated from New Building Construction

Project Type: ____ **CFA**: _________m²
Date: __________________________________ **Recorded by:** ___________________________

Substructure (with basement ☐; with pile caps ☐)

Superstructure Structure (including ground floor) ☐ (separate form for standalone clubhouse)

Site activities	**Material/Location**	**B.Q. Qty**	**Unit**	**Wastage Level (%)**	**Remarks**
Formworking (excluding left-in formwork)	Wall/Column		**M²**		Differentiate no. of reuses for non-typical and typical floors. After reuse, timber formwork is scrapped
	Slab & Beam		**M²**		
	Others				
Reinforcement Fixing (all locations)	Steel bars (Y & R)		**Kg**	2-3%	
	Steel fabric mesh		**M²**	5%	
Concreting	Wall (int'l & ext'l)		**M³**	3-5%	
	Column		**M³**		
	Slab & Beam		**M³**		
	Transfer plate/pile cap		**M³**		
Envelope	Precast Façades		**M²**	1%	

Finishing

Site activities	**Material/Location**	**B.Q. Qty**	**Unit**	**Wastage Level (%)**	**Remarks**
Brickwork	Wall		**M²**	15%	Add pellet
	Others				
Blockwork	Wall		**M²**	10%	Add pellet
	Others				
Drywall (plaster board)				4-6%	
Masonry and Granite/Marble Work (backing deemed to be included)	Internal wall		**M²**	8-12%	Add packing
	External wall		**M²**		Add packing
Plastering (wet) (ct/sand backings deemed to	Internal: wall		**M²**	10%	
	Internal: ceiling		**M²**		

Site activities	Material/Location	B.Q. Qty	Unit	Wastage Level (%)	Remarks
be included)	External wall		**M²**	15%	
Roofing, Waterproofing and Expansion Joints	Cement/sand screed		**M³**	10%	
	Roof waterproofing		**M²**	Coating5% Membrane10%	
	Roof tile		**M²**	5%	
	Decorative roof feature (steel or concrete)		**Kg or M³**		
	Expansion joint		**M**		All cans
	Insulation board		**M²**	10%	
Carpentry/Joinery *(convert to m³ of timber content unless otherwise stated*)	Cabinet/wardrobe		**M³**		
	Door (all sizes)		**M²**	0%	Manufactured off-site
	Frame		**M**	3%	Converted into length from BQ door area
Ironmongery	Lockset		**Set**		All boxes
	Hinges		**Pair**		
	Door knob		**Set**		
Staircases Railings and Handrails (assume 1.1m high)	Balustrade		**M**	1%	
	Railing		**M**		
	Handrail		**M**		
Metal Windows and Doors	Window		**M²**	1%	
	Louvre		**M²**	3%	
	Metal Door		**M²**	1%	
Glazing, Curtain Wall and Cladding	Site fixed		**M²**	2%	
	Factory fixed		**M²**		
Floor Finishes (by types: all assumed site-fixed unless otherwise stated)	All types of tiles		**M²**	10%	Add packing
Screeding to be converted into total volume using designed thicknesses	Screeding		**M³**	10%	
Wall tile/cladding (by types: all assumed site-fixed unless otherwise stated)	Internal		**M²**	10%	Add packing
	Pre-fixed (on precast)		**M²**		
	External		**M²**	10%	Add packing
Screeding to be converted	Pre-fixed tiles (on precast)		**M²**	0%	

Site activities	Material/Location	B.Q. Qty	Unit	Wastage Level (%)	Remarks
into total volume using designed thicknesses	Screeding		**M3**	10%	
False ceiling, if applicable (by types)	Gypsum board		**M2**	5%	
	Aluminium board		**M2**	3%	
Painting (by types)	Wall				
	Sealer		**M2**		All cans
	Paint		**M2**		All cans
	Ceiling				
	Sealer		**M2**		All cans
	Paint		**M2**		All cans
Sanitary Fittings	WC		**No**	0-1%	Add packing
	Urinal		**No**		
	Wash basin		**No**		
	Cistern		**No**		
	Bath tub		**No**		
	Mixer		**No**		
External Work and Landscape Work	Paving (insitu, e.g. Grano)		**M2**	10%	
	Paving (preformed, e.g. slab)		**M2**	5%	
	Screeding		**M3**	10%	
	Kerb		**M**	3%	
	Drain pipe		**M**	3%	
	Turfing		**M2**	5%	
Others (pls state): e.g. swimming pool to itemise					

Appendix B - Published Sources for Converting Design Work Quantities into Bulk Wastage Quantities

Based on the waste percentages, several published sources may be used to convert the design work quantities into bulk wastage quantities, including the following:

- Construction Waste Guide, New Zealand, May 1999;
- Volume-to-Weight Conversion Factors, US Environmental Protection Agency, April 2016;
- FEECO International Handbook, FEECO International Inc. May, 2010;
- Conversion factors, UK Waste Classification Scheme, DEFRA;
- Construction and Demolition Waste Management Toolkit, WasteCap Resource Solutions, Inc., 2011.

Annex 3

SUMMARY REPORT

August 2017

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The objectives of the Consultancy are:

1. To conduct literature review on overseas policies and measures for management and reduction of construction waste;
2. To conduct literature review on the current statutory and administrative measures for management and reduction of construction waste in public works and private works projects;
3. To propose strategy and measures for management and reduction of construction waste;
4. To conduct feasibility study of on-site snapshot survey for the non-inert construction waste composition in Hong Kong;
5. To propose an appropriate methodology (upstream or downstream approach) for the non-inert construction waste composition study after the feasibility study;
6. To prepare a service specification for the suggested methodology (upstream or downstream approach) to carry out the snapshot survey for the non-inert construction waste composition.

This summary report aims to provide the main findings of the 8 reports with an overall recommendation for C&D Waste Minimisation in Hong Kong.

1. Literature Review on Overseas C&D Waste Management Policies and Measures

The information of overseas policies and measures was collected from three main sources: a) academic publications; b) official websites of overseas governments; and c) overseas green building rating tools. The investigated overseas countries/regions include United States, European Union, Sweden, the Netherlands, Japan, Singapore, Korea, Australia, and Taiwan. The following green building rating tools were also reviewed: LEED for United States, BREEAM for United Kingdom, Green Globes for Canada, Green Mark for Singapore, and Assessment standard for green building (GB/T50378-2014) for Mainland China.

The policies and measures identified from academic literature review are presented in Table 1.

Table 1 Summary of the identified overseas policies and measures.

Policy/measure	Remarks
Legislation	Legislation on C&D waste management can provide legal basis for implementing C&D waste minimisation. However, most countries have no legislation particularly focusing on C&D waste. The C&D waste related requirements are usually embedded in the regulation of general waste related regulations or solid waste related regulations.
Market-based instruments	The recycling market is a critical factor that influence the stakeholders' waste reuse/recycling intentions, because most of them are benefit-earning oriented. Meanwhile, a certification system is suggested to ensure the quality of recycled materials.
Vehicle impoundment policy	The vehicle impoundment policy is efficient to prevent illegal dumping, especially in developing countries. An effective supervision system should be established to oversee the illegal dumping behaviour.
Proper design	Proper design is an effective measure that can avoid waste before it is generated. However, the awareness of C&D waste minimisation is not optimistic among designers. Publicity should be made to let the designers know their roles in waste reduction.
Use of prefabrication	Prefabrication is an effective strategy for not only minimising C&D waste, but also carbon emissions. It is an emerging strategy that has been encouraged by many studies.
Waste sorting	Waste sorting can be conducted on-site or off-site according project conditions; on-site sorting is highly recommended. Potential limitations of employing on-site sorting include space limitation, time limitation,

Policy/measure	Remarks
	labour limitation, and cost limitation. However, cost limitation is the most important factor concerned by the contractors. A high landfill disposal fee can facilitate the improvement of on-sorting.
Selective demolition	Selective demolition is also named as deconstruction in some literature, it is a reverse process of construction. The separated waste can be reused directly or sold to recyclers. However, selective demolition faces the same limitations as waste sorting; cost is the major consideration factor.
Accurate waste quantification	Accurate waste quantification is essential for good management at both regional and project levels. Regional waste generation can be estimated through forecasting techniques if historical generation data are well collected and stored. At project level, a feasible waste management plan can be made based on the accurate waste estimation. However, the main obstacle is that reliable estimation of C&D waste generation is rare.
Incentive reward program	The incentive reward program can promote the waste reduction intentions of construction workers. However, an efficient system should be established and benchmarks should be set up to monitor how many materials saved by the construction workers.
Online waste exchange	Online waste exchange can increase the C&D waste reuse/recycling rate by avoiding disposal at landfills. A reliable platform is needed for efficient exchanging of waste generation information. Meanwhile, the government should permit such exchange. Thus, the platform is suggested to be established by the government.
GIS (Geographic Information System) technology	GIS technology can be used at a project to monitor the distribution of materials storage. The advantages include visual representation and quantification of the waste flows. However, this technology need comprehensive GIS data.
Building information modeling (BIM)	BIM can be used to minimise C&D waste from many aspects, such as estimation of waste amount, flexible design change, etc. However, this is a comparatively novel technology, more modules should be developed for C&D waste management.
Education and training	The aim of education and training is to increase the construction practitioners' awareness of C&D waste management and enhance their relevant skills. This needs project managers' support and a better C&D waste management culture.

The successful overseas experiences were identified from governmental websites of the investigated countries, as shown in Table 2.

Table 2 Overseas successful experiences on C&D waste management

Country/region	Successful experience
United States	• implementation of source reduction; • implementation of deconstruction; • illustrative manuals and practical cases; • development of mature waste trade market.
European Union	• implementation of Waste Framework Directive; • mature reuse/recycling market; • life-cycle thinking; • support for research projects.
Sweden	• implementation of legislative initiatives; • improved and better controlled quality of C&D waste; • implementation of landfill taxes; • ban on landfilling of combustible waste fractions.
The Netherlands	• implementation of legislative initiatives; • implementation of landfill and incineration taxes; • development of mature secondary material market.
Japan	• implementation of Construction Recycling Law; • mature C&D waste recycling technologies and facilities.
Singapore	• efficient waste sorting; • strict supervision on illegal dumping; • mature waste recycling technologies and facilities.
Korea	• implementation of Construction Waste Recycling Promotion Act; • quality certification system for recycled aggregates; • construction waste information management system for waste exchange.
Australia	• implementation of legislative initiatives; • implementation of landfill tax; • supply chain management.
Taiwan	• implementation of legislative initiatives; • effective sorting.

The waste management requirements identified from the investigated green building rating tools were presented in the overseas report in detail. The results showed that LEED and BREEAM have very detailed requirements and specifications for C&D waste management. However, Green Globes and Green Mark do not have too much emphasis on C&D waste management. Although GB/T50378-2014 gives emphasis on C&D waste management, the detailed specifications are not adequate.

2. Literature Review on Current Statutory and Administrative C&D Waste Management Measures in Hong Kong

The current statutory and administrative measures in Hong Kong were reviewed from academic papers, governmental and industrial association websites, and BEAM Plus. The main findings are shown in Table 3.

Table 3 Advantages and potential limitations of the identified policies and measures in Hong Kong

Policy/measure	Advantages	Potential limitations
Regulations, codes, and initiatives	C&D waste management has been emphasised in regulations (i.e. Waste Disposal Ordinance) since 1980; Particular regulations have been published by Hong Kong government, such as the Trip Ticket System.	No more initiatives since the implementation of the Construction Waste Disposal Charging Scheme.
Construction waste disposal charging scheme	The charging scheme has been established since 2005; C&D waste are classified into inert and non-inert categories in order to encourage sorting.	The current disposal charges are low compared with other countries limiting the incentives for better waste management.
Waste management plan	Waste management plans are generally required before the commencement of construction projects.	Enforcement of implementation of the waste management plan is lacking.
Development of a mature waste recycling market	A mature recycling market will increase the willingness of construction stakeholders to sort, reuse or recycle materials.	Potential worries about the quality of recycled materials; Lack of quality specifications; Lack of sufficient support from government to the recycling industry.
Proper design	Several C&D waste minimisation measures have been recommended by government and BEAM Plus for proper design.	No minimum requirement on MA Credits in BEAM Plus and credits for C&D waste management BEAM Plus are not compulsory.
Use of	The technology has been	Higher initial and transportation costs;

Policy/measure	Advantages	Potential limitations
prefabrication	mature; Hong Kong government has promoted the implementation of this technology.	Last minutes design changes limit its use.
On-site sorting	Benefit-earning from selling sorted valuable materials; Cost-saving from disposal at public fills rather than landfilling; Recommendations from government and green building rating tools.	Space demanding; Time demanding; Cost demanding; Labour demanding; Lack of a mature recycling market to absorb the sorted materials.
Off-site sorting	Lower cost than landfilling disposal.	Double handling as a high percentage of waste received need to go the landfills eventually; Need proper locations of the off-site sorting facilities in order to reduce transportation cost; Potential generation of noise and dust at the off-site sorting facilities.
Selective demolition	Benefit-earning from selling sorted valuable materials; Cost-saving from disposal at public fills rather than landfilling; Recommendations from government and green building rating tools.	Space demanding; Time demanding; Cost demanding; Labour demanding; Lack of a mature recycling market; Lack of coordination in contract arrangement limits its use.
Accurate waste quantification	Continuous recording of waste disposal data by EPD and CEDD; Computer-aided data mining techniques.	Lack of detailed waste generation classification records at project levels.
Incentive reward program	Waste reduction intentions of construction workers can be stimulated.	Lack of benchmarks to evaluate material savings; Lack of awareness from project managers or developers.
Online waste exchange	Techniques for developing an online waste platform are mature.	Lack of promotion from the government and related organisations.
Integrated GPS	The GPS and GIS technologies	Lack of GIS information;

Policy/measure	Advantages	Potential limitations
and GIS technology	are mature.	Lack of successful practices; Increase of cost.
RFID technology	The RFID technology is mature.	Increase of cost; More staff need to be assigned for using this technology.
Building information modeling (BIM)	The BIM technology has been used in Hong Kong.	More modules need to be developed for C&D waste management; Increase of cost for establishment.
Education and training	Hong Kong government has held workshops and trainings for increasing safety awareness.	Lack of emphasis from government and other construction stakeholders; Increase of cost.
Waste Minimisation: Provision of Fitments and Fittings in New Buildings	Requirements for the provision of fitments and fittings prior to issue of an occupation permit for a new building should not be insisted upon to reduce waste.	Construction waste generated from fitting out works carried out by individual contractors; Chaotic condition arising from individual owners engaging their own contractor to carry out the fitting out works; The practicality of testing plumbing and drainage system without fitments for compliance with regulation; Mostly applicable to restaurants and hotels for which extensive renovation and fitting out will be carried out by a restaurant or hotel operator after the issue of occupation permit; and in the process any sanitary fitting installed prior to the issue of an occupation permit would be dismantled in the course of such renovation work.

3. Report of Interviews & Focus Group Meetings

In order to propose appropriate strategies and measures for construction waste management and reduction in Hong Kong, 11 face-to-face interviews and two focus group meetings were implemented with construction stakeholders including client, designer, contractor, and government officer. The face-to-face interviews were conducted in August 2016, and the two focus group meetings were conducted on 15 and 22 of September 2016 respectively. The proposed strategies and measures for managing and reducing C&D waste are summarised in Table 4. A summary of proposed actions for government to reduce C&D waste is tabulated in Table 5.

Table 4 Proposed strategies and measures for C&D waste minimisation

Strategies & Measures	**Client**	**Designer**	**Contractor**
Design Stage			
• No-Frills Design	X	X	
• Adaptive design	X	X	
• Integrated Project Design		X	X
• Consider waste reduction and management	X	X	
• Use Design and Build contract for infrastructure projects	X	X	X
• Use low-waste technologies	X	X	X
• Use precast concrete/prefabricated building components	X	X	
• Reuse existing foundation/structures	X	X	
• Use reusable temporary work		X	
• Use dry wall system and external painting	X	X	
• Use durable/recycled building materials	X	X	
• Minimise design change	X	X	
• Apply BIM to review construction sequences		X	
Tender Stage			
• List Management of contractors	X	X	X
• Introduce “Award and Penalty” scheme	X	X	X
• Contractors propose innovative waste management scheme	X	X	X

Strategies & Measures	Client	Designer	Contractor
• Introduce waste reduction procurement for nominated subcontracts	X	X	X
• Allow recycle rates in BQ	X	X	X
Construction Stage			
• Set up contractor communication platform for reuse and recycling			X
• Allow longer construction period	X		
• Review Method Statement for Construction		X	X
• Phasing construction period		X	X
• On-site sorting			X
• Consider off-site sorting when on-site sorting is not feasible			X
• Reuse excavated soil in other projects			X
• Reuse demolished concrete for paving bicycling tracks			X

Table 5 Proposed actions for government to reduce C&D waste

Proposed Actions: C&D waste reduction should become a government policy	Term
Interim Measures	
• Use T-Park to burn timber waste for energy recovery	Short
Promote Green Technologies & Materials	
• Setup a central coordinating team for approving alternative recyclable/reusable material	Medium
• Simplify and streamline the approval process of innovative waste reducing technologies	Medium
• BD to work with CIC and HKGBC to streamline approving process of low-waste technologies and reusable materials	Medium
Encourage Reuse/Recycling of C&D waste	
• Significant increase in dumping charge	Short
• Revitalisation of buildings to be classified under “New Buildings”	Medium
• Mandatory selective onsite sorting for timber & plastic wastes	Medium
• Mandatory use of reusable formwork	Medium
• Introduce interim percentages to the 60% requirement of recycling C&D waste in BEAM Plus	Medium
• Set up C&D waste reduction policy and monitor implementation	Long
• CIC to set up recycle standards and study implementation method	Long
• Line up with Mainland’s demand on recyclable materials	Long

Proposed Actions: C&D waste reduction should become a government policy	**Term**
• HKGBC to review and revise the scoring system based on comments from construction industry	Long
Facilitate the Development of Recycling Industry	
• Set up a central coordination team to streamline and simplify the approving process of recycle subsidise	Medium
• Provide more public sorting sites	Medium
• Privatise the sorting facilities to let market decide the appropriate development patterns	Long
• Publicise the potential of lining up with recycling factories in Mainland	Long
Facilitate the Development of Local Prefabrication Industry	
• Award GFA concession for precast/prefabricated facade	Medium
• Provide low-rent sites for manufacturing	Medium
Research and Education	
• Set up research funding for C&D waste reduction and management	Long
• Educate clients and contractor on social responsibility of reducing C&D waste	Long
• Educate the general public the importance and necessity to minimise C&D waste	Long

4. Report of Site Visits

In order to conduct the feasibility study of on-site snapshot survey, three sites in different construction stages were visited and 10 trucks of construction waste were sorted.

Site observations were arranged to three different building sites at different stages of construction, such as end stage of construction (Site A), mid-stage of construction (Site B), and initial to mid-stage of construction (Site C). Prior to site observations, meetings were held with Environmental Officers of each project to get an overview of the waste management situation. Then, the work trades, waste types, and waste management measures of each site were observed by our team members. Photos 1-3 show the pictures taken during the site visits.

Photo 1 Site visit at Site A

Photo 2 Site visit at Site B

Photo 3 Site visit at Site C

5. Report of Construction Waste Sorting

A total of 10 trucks of waste from the three observed residential building sites were collected for sorting. Waste composition analysis was carried out from 29 July 2016 to 10 August 2016 (29/7, 30/7, 8/8, 9/8, 10/8). Upon receiving each lorry of the construction waste, the material was unloaded on a concrete platform, spread out and divided into four equal parts. Two of each set of four parts were selected for measuring and recording corresponding weights. Photos 4-6 show the activities during construction waste sorting.

Photo 4 Using backhoe to even the debris

Photo 5 Sorting process

Photo 6 Quantifying of each type of materials

The sorting results are presented in Figure 1-4. It can be seen that the percentages of non-inert waste in the construction waste were 38% in Site A, 61% in Site B, 40% in Site C and 47% overall. Wood & Timber was the major non-inert waste: 19% in Site A, 53% in Site B, 32% in Site C and 36% overall. Comparison between the three sites suggests that Site B, at its middle construction stage, generated the highest percentage of “Wood & Timber” waste (53%). Site C, at its initial to middle construction stage also produced relatively high amount of “Wood & Timber” waste (32%). In both cases, the high “Wood & Timber” waste generation was due to the use of timber formwork.

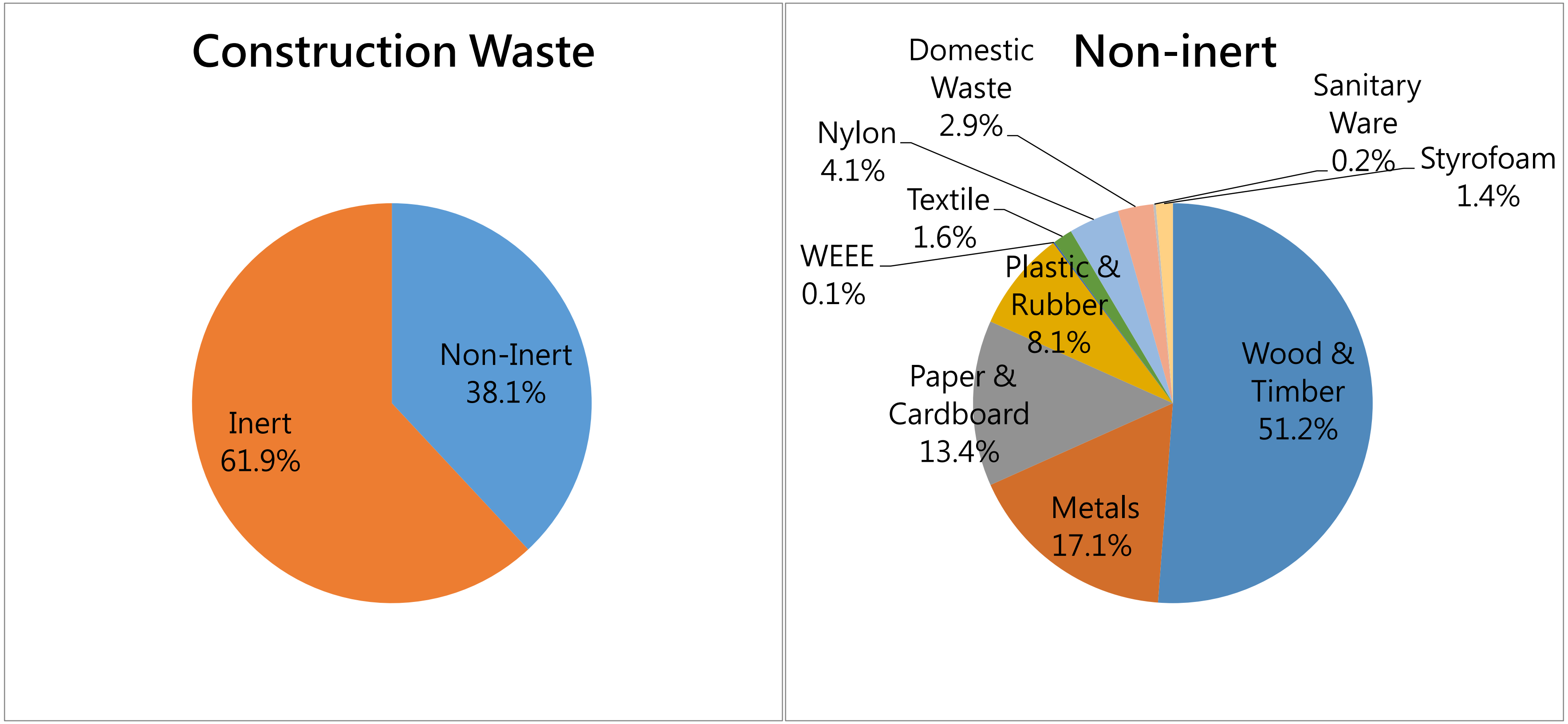

Figure 1 Sorting results of Site A

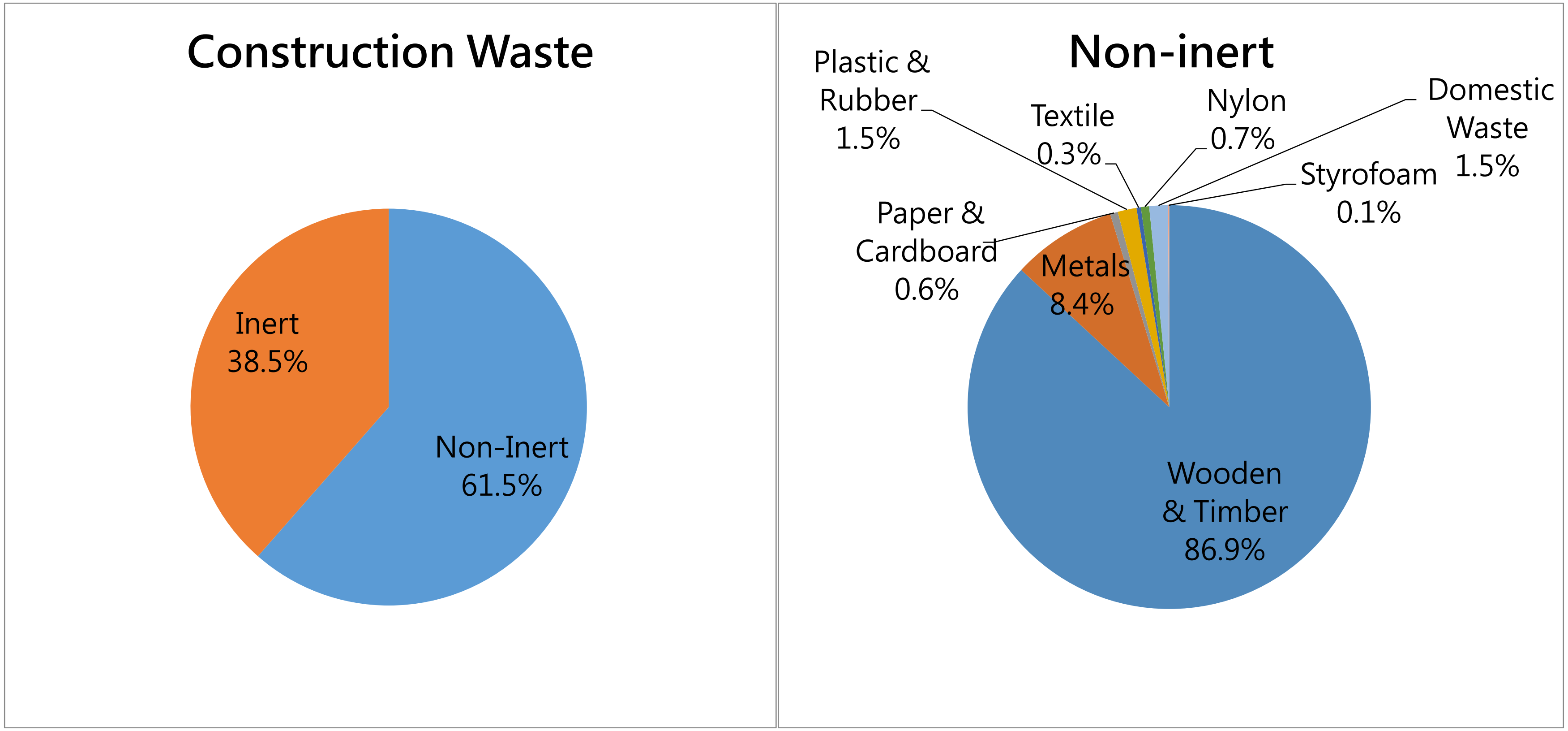

Figure 2 Sorting results of Site B

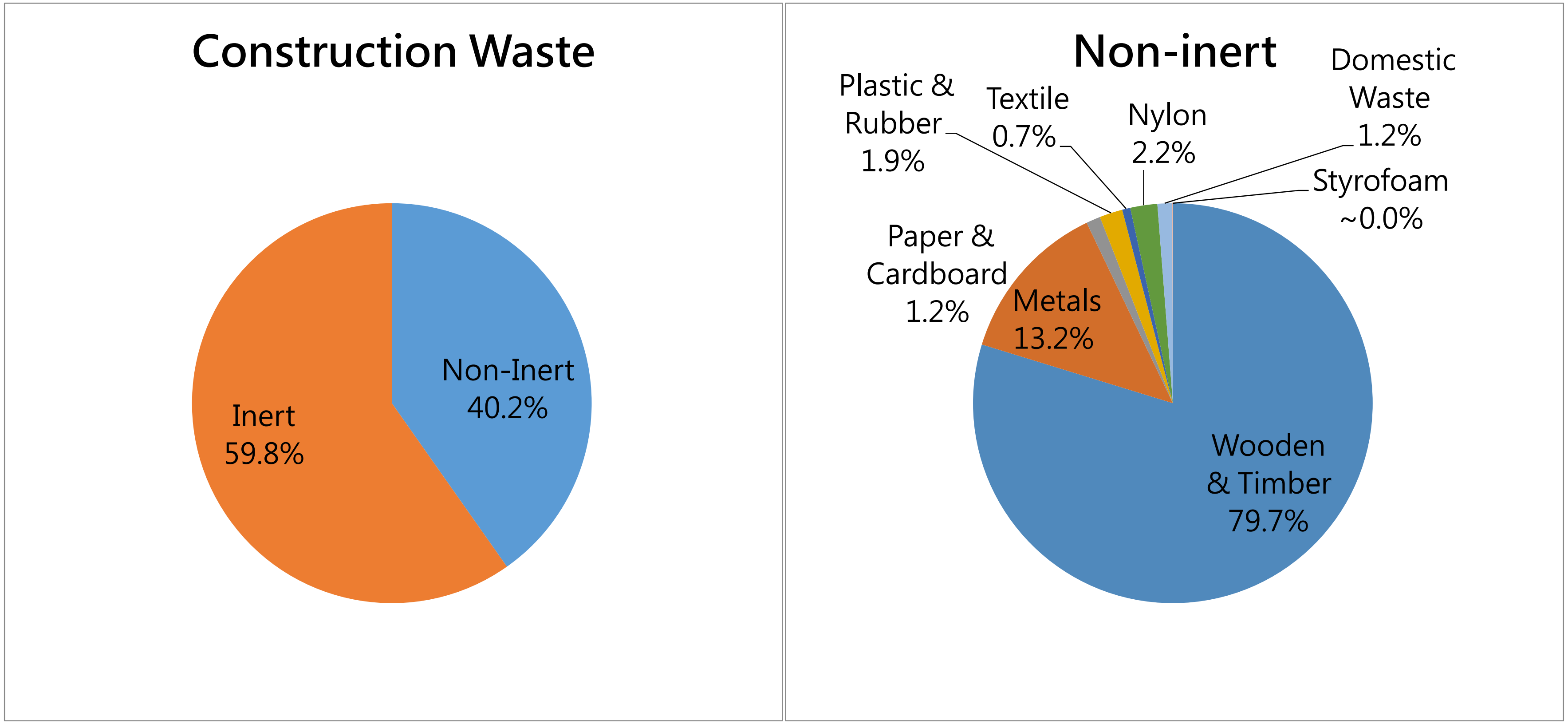

Figure 3 Sorting results of Site C

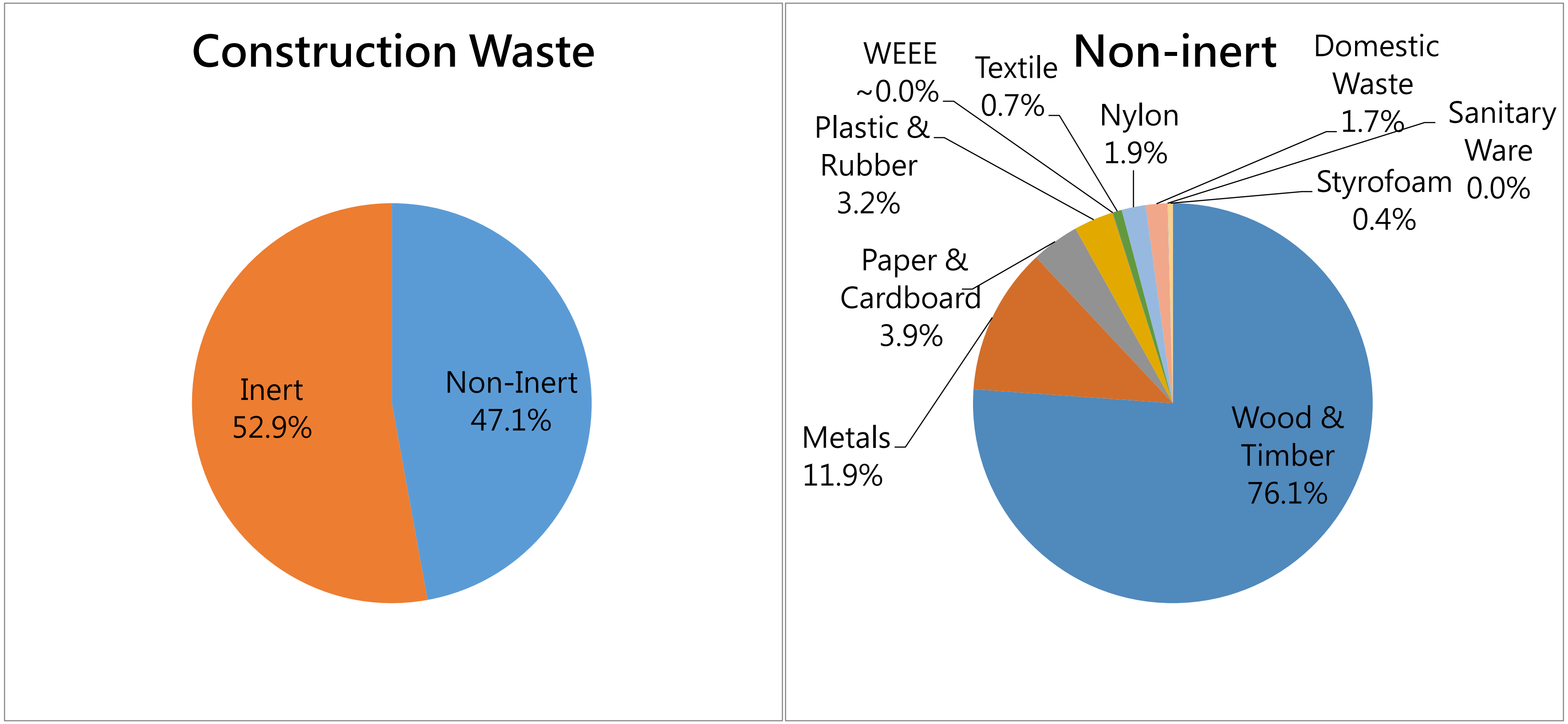

Figure 4 Sorting results of All Sites

6. Proposed Methodology for Non-Inert Construction Waste Composition

Two approaches have been proposed for non-inert construction waste composition study: upstream approach and downstream approach.

In terms of the upstream approach, Bills of Quantities should be considered for the estimation. A useful benchmarking statistic of waste volume would be estimated per m^2 of Construction Floor Area.

When conducting downstream approach, the following nine parts should be included:

(1) Number of lorry/truck load of construction waste to be studied;

(2) Duration and time;

(3) Method of non-inert waste estimation;

(4) Sorting list;

(5) Sorting area and location;

(6) Manpower;

(7) Large equipment;

(8) Small equipment/tools/set-up for operation and safety requirements;

(9) Appropriate contractor and budget.

7. Specification for Upstream Estimation of Non-Inert Construction Waste Composition

For effective waste management, it is beneficial for individual project team members to predict the approximate quantities of waste based on the complete design information (including Bills of Quantities). The general principle of arriving at the bulk volume of waste is given as follows:

(1) Convert materials into absolute volume (in m^3) from their given quantities and dimensions (e.g., areas multiplied by thicknesses);

(2) Convert weights into absolute volume using absolute densities;

(3) Estimate waste allowances and bulking ratios;

(4) Estimate bulk volume using absolute volume multiplied by the waste allowance and a bulking ratio.

According to the above method, the tender document samples of five selected building projects (i.e., three residential projects, one commercial project, and one hotel project) were studied to estimate the bulk volume of waste and the formwork proportion therein. The results are listed in Table 6.

Table 6 Estimated waste volume from document review (as calculated from samples)

No.	**Project Sample** **(superstructure only unless otherwise stated)**	**Waste (m^3/m^2)**	**Timber formwork (%)**
1	Multi-storey residential towers with basement carparks & club house	0.60	37.5
2	Multi-storey residential towers with 6-storey podium carparks*	0.56	33.7
3	Multi-storey residential towers with 7-storey podium carparks*	0.54	35.9
4	Multi-storey commercial building	0.56	49
5	Multi-storey 3-star economy hotel	0.48	47

Note: * represents projects with about half of their formwork using aluminium in tower construction. All residential projects have part of their facades using precast concrete.

CFA stands for Construction Floor Area.

8. Specification for Downstream Estimation of Non-Inert Construction Waste Composition

Based on the experience gained from the construction waste sorting of the current study, the methodology for the "future non-inert construction waste composition study" is proposed. The methodology includes the following main parts:

(1) Number of Lorry/Truck Load of Construction Waste to be Studied;

(2) Duration and Time;

(3) Method of Non-Inert Waste Estimation;

(4) Sorting List;

(5) Sorting Area and Location;

(6) Manpower;

(7) Large Equipment;

(8) Small Equipment/Tools/Set-up for Operation and Safety Requirements;

(9) Appropriate Contractor and Budget.

Table 7 shows a sample of sorting list for non-inert waste.

Table 7 A sample list for sorting non-inert waste

Date:		**Weather:**		**Site no.:**	
Lorry arrival time:				**Grab mounted lorry arrival time:**	
				Grab mounted lorry licence plate no.:	
Lorry licence plate no.:				**Chit ticket no.:**	
Sorting time (beginning):				**Total load of construction waste stated on chit ticket:**	
Sorting time (completion):					
Parts sorted:				**Recorded by:**	
Remark:					

Material	**Group No.**	**Group**	**Type No.**	**Type**	**Weight (kg)**
Non-inert	1	Bamboo	1	no sub-group	
	2	Wood & Timber	2a	formwork	
			2b	wooden pallet	
			2c	packaging timber	
			2d	others	
	3	Metal	3a	iron / copper pipe	
			3b	metal sink	
			3c	rebar	
			3d	aluminium scrap	
			3e	metal containers for material packaging	
			3f	steel scrap	
			3g	others	
	4	Paper & Cardboard	4a	cardboard	
			4b	packaging paper	
			4c	others (newspaper, office paper etc.)	
	5	Plastic & Rubber	5a	plastic wrapping	
			5b	plastic container	
			5c	PVC duct	
			5d	cable	
			5e	plastic traffic barrier	
			5f	window seal container	
			5g	rubber	
			5h	others	
	6	WEEE	1	electric appliance, electric socket, lighting, water pump, electric motor, transformer (i.e. no sub-group)	
	7	Vegetation	1	tree trunk etc. (i.e. no sub-group)	
	8	Textile	1	no sub-group	
	9	Fibreglass	1	no sub-group	
	10	Nylon	1	no sub-group	
	11	Domestic Waste	1	food waste etc. (i.e. no sub-group)	
	12	Sanitary Ware	1	porcelain water closet, porcelain wash hand basin, kitchen solid surface material etc. (i.e. no sub-group)	
	13	Styrofoam	1	no sub-group	
	14	Gypsum Board	1	Gypsum drywall etc. (i.e. no sub-group)	
	15	Glass	1	no sub-group	
	16	Others (to be descripted)	1	-	
Inert	17	Inert	1	rock, soil, sand, aggregate, rubble, boulder, masonry, concrete, asphalt, brick & tile etc. (i.e. no sub-group)	
				Total weight:	

9. Overall Recommendations for C&D Waste Minimisation in Hong Kong

Based on the literature review, site visits, waste sorting results, interviews with professionals and focus group meetings, the current sustaining good practices to reduce C&D waste are identified and listed in Table 8. New recommendations to reduce and manage C&D waste are proposed in Table 9.

9.1. Current good practices

Currently, the Government and building industry are working together to reduce C&D waste. Various measures and strategies of waste reduction and management are practising in both the public and private sectors. Existing good practices should be further reinforced particularly on the following measures as listed in Table 8.

Table 8 Enhancement of existing good practices

Existing good practices	**Reference**	**Enhancement**
Minimise design change	Poon (2007)	• Consider "Integrated Project Design" approach
Construction Waste Disposal Charging Scheme	Poon et al. (2013); Yu et al. (2013); Lu et al. (2015)	• Effective in first 2 years but not sustaining as the charge is insignificant comparing with project sum • Consider to revise charge
Prefabrication	Chiang et al. (2006); Tam et al. (2007); Jaillon and Poon (2008); Jaillon et al. (2009)	• Successfully implemented by Housing Department but not so common in the private sector • More incentives should be provided
Waste Management Plan	Poon et al. (2004b); Tam and Tam (2008)	• Can enhance on-site reuse of materials • Require further study on reduction of overhead cost
On-site Sorting	Poon et al. (2001); Lu et al. (2006)	• Not commonly practised, especially in the private sector due to space, time and labour issues • Should identify more outlets for sorted waste

Existing good practices	Reference	Enhancement
		• Government can explore measures to promote on-site sorting in the private sector
Selective demolition	Poon et al. (2004a)	• Effective in improving waste recycling rate • Requires more outlets for recovered waste
Waste recycling	Poon (1997); Ling et al. (2013)	• Reduce and revitalise C&D waste • Demand various types of recycling outlets

9.2. New recommendations

Success in implementing C&D waste reduction measures requires participation and cooperation of clients, designers, contractors, and government. Government plays a dual role acting as a policy maker and a facilitator. Construction waste generation can be regulated by laying down appropriate policies and legislations which target at waste reduction and reuse/recycling. Government can also facilitate the development of green technologies and the recycling industry by creating favorable conditions for growth of the industries. Implementation of reducing C&D waste can be enhanced by design and contract management. Fourteen new recommendations are proposed and summarised in Table 9 below:

Table 9 New recommendations for management and reduction of C&D waste

New Recommendations	Implementations
Government Initiatives	
Promote the use of timber & bamboo waste as biofuel	• Encourage industrial users to using timber & bamboo waste to recover energy as an interim measure *please see remarks below • Develop waste to energy facilities for burning timber & bamboo waste in the long run
Appointment of Environmental Officer	• Mandatory requirement of appointing Environmental Officers on construction sites to supervise the implementation of Waste Management Plan (WMP)

New Recommendations	Implementations
Mandatory auditing of Waste Management Plan	• To formulate (e.g. through BEAM-Plus) a system for mandatory auditing of WMP by qualified persons to ensure compliance and satisfactory implementation. The eligibility of the qualified persons need to further consult with the industry.
Concession of Gross Floor Area	• When awarding GFA concession, Buildings Department should incorporate the use of precast/prefabrication as one of the additional requirements to effectively reduce construction waste. The exact details will need to discuss and consult with the industry.
Revise construction waste disposal charge	• Review and revise the charge to a level similar to other countries which have good performance in C&D waste reduction and management and at a shorter regular timeframe (e.g., 2 or 3 years)
Facilitate development of local recycling and prefabrication industries and sorting facilities	• Provide low-rent sites for recycling and prefabrication industry • Purposely design and build multi-storey mega factory buildings to maximum land use • Propose to set up central recycling construction material centre for trade-in & out of recycled materials
Improving the efficiency of the existing C&D waste sorting facilities	• Government should carry out studies to review the current operation of the existing C&D waste sorting facilities to improve efficiency
Promote incentive to use non-timber and no-bamboo temporary work	• Provide incentives to use of reusable temporary work (e.g. Al or metal formworks and steel scaffolding)
Facilitate R&D	• Setup a research unit on robotic construction methods
Provide optional “Bare-shell” housing for public housing	• Develop policies for optional housing for "Bare-Shell" standard for public and private residential buildings to save unnecessary demolition due to renovation/interior design of individual owners
Clients/Building Designers	
Encourage minimising design changes	• Encourage the use of BIM to review crashes in tentative construction sequences to avoid abortive works

New Recommendations	Implementations
Hong Kong Green Building Council (HKGBC) and Construction Industry Council (CIC)	
Revise BEAM Plus to encourage waste reduction and recycling	• HKGBC to introduce "category threshold" in Materials and other related Aspects through BEAM-Plus to encourage C&D waste minimisation and recycling.
Setup communication platform for reusing C&D waste	• CIC to consider to take lead to set up website for encouraging C&D waste exchange among building contractors, and study implementation method to be posted on website for reference and provide links to other websites • CIC to consider to take lead to carry out research to specify "recycling standard" of recycled materials.
Education	• CIC to consider to take lead to introduce C&D waste management as a CPD course for technical supervisors

<u>Remarks:</u>

***Biofuel from wood waste to energy**

Wood waste is an inherently renewable resource that can be recycled and utilised for the production of renewable energy. A feasibility study was conducted in Hong Kong to assess the environmental sustainability of converting recycled wood wastes (generated from construction and demolition activities and other wood product waste) to produce wood pellets for direct energy generation. The chemical and physical characteristics of wood wastes were tested. A life cycle assessment (LCA) approach was used to assess and compare the environmental impacts for energy generation from the pelletised bio-fuel and coal. The test results showed that the energy content, chemical compositions and the trace metal concentrations of the waste wood all met the relevant standards. The LCA results also showed that significant environmental impacts can be potentially avoided by using wood pellets instead of coal for energy generation. The study concluded that the proposed "energy recovery" approach for using wood pellets as a bio-fuel in Hong Kong is environmentally sustainable, which can provide an alternative route for managing wood product wastes with the added benefits of energy recovery.

For more information

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Poon, C.S., Yu, A.T.W., See, S.C., Cheung, E., 2004a. Minimizing demolition wastes in Hong Kong public housing projects. Construction Management and Economics 22 (8), 799-805.

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Annex 4

Volume-to-Weight Conversion Factors
U.S. Environmental Protection Agency
Office of Resource Conservation and Recovery
April 2016

EPA's 1997 report, "Measuring Recycling: A Guide for State and Local Governments", was a guide to facilitate standardization of MSW data collection at the local level, which included volume-to-weight conversion factors for comparing recovery efforts between municipalities, regions and states. The factors are also valuable when planners work with the national recovery data presented in EPA's sustainable materials management report series.

This document provides updates to the volume-to-weight conversion factors found in the 1997 report Appendix B.

The goal of this update is to identify more current secondary data measurements of the various products. Of particular interest are products known to have been source reduced through light weighting since the early nineties such as plastic, glass and metal packaging. Some factors included on the original table are excluded from the revised table due to lack of updated data. Primary data collection was not performed.

The original Appendix B table included 12 materials categories; the updated table provides factors for 15 material categories, including the following.

- Appliances
- Automotive
- Carpeting
- Commingled Recyclables
- Electronics
- Food
- Glass
- Metals
- Municipal Solid Waste
- Paper
- Plastic
- Textiles
- Wood
- Yard Trimmings
- Construction & Demolition Debris (C&D)

All of the categories include multiple products and/or density measurements. Four product categories—carpeting, commingled recyclable material, electronics and construction and demolition debris—are new. Previously lead-acid batteries and scrap tires were separate categories but are combined into the single category "Automotive" in the updated table.

Other differences include the removal/addition of products within some of the categories to better reflect the current recycling industry. For example, eliminating "Tab Card" and adding "Mixed Paper" to the paper category reflects the move toward commingled recyclables collection. The addition of "Electronics" reflects the growth in these products since the original table was published.

The updated factors are shown in the table below.

Standard Volume-to-Weight Conversion Factors

Category	Recyclable Materials	Volume	Estimated Weight (lbs)	Source
Appliances	Major Appliances			
	Dishwasher	1 unit	125	1
	Clothes Dryer	1 unit	125	1
	Stove	1 unit	150	1
	Refrigerator	1 unit	250	1
	Clothes Washer	1 unit	150	1
Automotive	Lead-Acid Battery			
	Auto	one	36	3
	Truck	one	47	3
	Scrap Tire			
	Light Duty Tires (passenger, light truck)	one	22.5	5
	Commercial Tires	one	120	5
	Fluids			
	Used Motor Oil	gallon	7.4	2
	Antifreeze	gallon	8.42	2
	Other Automotive			
	Oil Filters not crushed	drum	175	1
	Oil Filters crushed	drum	700	1
	Oil Filters	gallon	5	1
Carpeting	Carpet			
	Carpet	cubic yard	147	6
	Carpet Padding	cubic yard	62	6
Commingled Recyclable Material	Containers (Plastic bottles, Aluminum cans, Steel cans, Glass bottles) and Paper			
	Commingled Recyclables	cubic yard	262	4
	Containers (Plastic bottles, Aluminum cans, Steel cans, Glass bottles), Corrugated Containers and Paper			
	Campus Recyclables	cubic yard	92	7
	Commingled Recyclables	cubic yard	111	4
	Containers (Plastic bottles, Aluminum cans, Steel cans, Glass bottles) – No paper			
	Campus Recyclables	cubic yard	70	7
	Commingled Recyclables	cubic yard	67	4
	Commercial Recyclables	cubic yard	113	8
	Containers (Cans, Plastic) - No glass			
	Campus Recyclables	cubic yard	32	7
	Containers (Cans, Plastic) and Paper - No glass			
	Residential Recyclables	cubic yard	260	2
	Containers (Food/beverage, Glass) Corrugated Containers and Paper			
	Commercial Recyclables	cubic yard	88	2
	Commercial Recyclables	cubic yard	58	21
	Multifamily Recyclables	cubic yard	96	2
	Multifamily Recyclables	cubic yard	51	21

Category	Recyclable Materials	Volume	Estimated Weight (lbs)	Source
Commingled	*Single family Recyclables*	cubic yard	126	2
Recyclable	Containers (Food/beverage, Glass) Corrugated Containers and Paper- No glass			
Material	*Campus Recyclables*	cubic yard	139	2
	Commercial Recyclables	cubic yard	155	2
Electronics	Computer Equipment			
	Desktop	one	27	24
	Laptop	one	9.8	24
	Monitor			
	CRT	one	40	1
	15"	one	30	2
	17"	one	45	2
	21"	one	60	2
	Flat Panel	one	24	1
	Mixed Monitors	one	29.4	24
	Televisions			
	CRT < 19 inch	one	41	1
	CRT ≥ 19 inch	one	73	1
	Flat Panel	one	29	1
	Mixed TVs	one	67.3	24
	Peripheral Devices			
	Printers	one	16.1	24
	Mice	one	0.2	9
	Keyboards	one	2.9	9
	Mobile Devices			
	Cellular Phone	one	0.22	9
	Mixed Electronics			
	Brown Goods	cubic yard	343	6
	Computer-related Electronics	cubic yard	354	6
	Other Small Consumer Electronics	cubic yard	438	6
Food				
	Fats, Oils, Grease	55-gallon	412	2
	Organics - commercial	cubic yard	135	21
	Source Separated Organics - commercial	cubic yard	1,000	15
	Food Waste - restaurants	cubic yard	396	21
	Food Waste	cubic yard	463	4
	Food Waste	cubic foot	22-45	4
	Food waste - university	gallon	3.8	22
	Food Waste	64 gallon toter	150	4
	Food waste	2 cubic yard full towable	2,736	4
Glass	Bottles			
	Loose	cubic yard	380	4

Category	Recyclable Materials	Volume	Estimated Weight (lbs)	Source
Metals	Aluminum Cans			
	Uncompacted	cubic yard	46	4
	Uncompacted	case = 24 cans	0.7	11
	Baled	cubic yard	250-500	10
	Steel Cans			
	Whole	cubic yard	50-175	10
	Baled	cubic yard	700-1,000	10
	Steel Cans - Institution			
	Whole	can	0.09	7
	Whole	cubic yard	136	7
Paper	Newsprint			
	Loose	cubic yard	360-800	1
	Baled	cubic yard	750-1,000	10
	Books - paperback, loose	cubic yard	428	23
	Old Corrugated Containers			
	Flattened	cubic yard	106	4
	Baled	cubic yard	700-1,100	10
	Old Corrugated Containers and Chip Board			
	Uncompacted	cubic yard	74.54	4
	Office Paper			
	Computer Paper			
	Loose	cubic yard	375-465	1
	Compacted/Baled	cubic yard	755-925	1
	Mixed			
	Loose	cubic yard	110-380	1
	Loose	cubic yard	323	4
	Compacted	cubic yard	610-755	1
	Shredded	cubic yard	128	4
	Mixed Baled	cubic yard	1,000-1,200	10
	Miscellaneous			
	Cartons (milk and juice) uncrushed	cubic yard	50	7
Plastic	PET			
	PET Bottles - baled	30"x42"x 48"	525-630	12
	PET Thermoform - baled	30"x42"x 48"	525-595	12
	HDPE			
	HDPE Dairy - baled	30"x42"x 48"	525-700	12
	HDPE Mixed - baled	30"x42"x 48"	525-700	12
	Mixed PET and HDPE			
	Loose	cubic yard	32	7
	Mixed Bottles/Containers #1 - #7			
	Loose	cubic yard	40.4	4
	Mixed Bottles/Containers #3 - #7			

Category	Recyclable Materials	Volume	Estimated Weight (lbs)	Source
Plastic	*Loose*	cubic yard	25.7	4
	Film			
	LDPE, loose	cubic yard	35	13
	LDPE, compacted	cubic yard	150	13
	LDPE, baled	30" x 42" x 48"	1,100	13
	Miscellaneous			
	Trash Bags	cubic yard	35	6
	Grocery/Merchandise Bags	cubic yard	35	6
	Expanded Polystyrene Packaging/Insulation	cubic yard	32	6
Textiles	Mixed Textiles			
	Loose	cubic yard	125-175	10
	Baled	cubic yard	600-750	10
Wood	Wood			
	Wood Chips, green	cubic yard	473	1
	Wood Chips, dry	cubic yard	243	1
	Saw Dust, wet	cubic yard	530	1
	Saw Dust, dry	cubic yard	275	1
	Pallets	one	25	1
	Pallets and Crates	cubic yard	169	18
	Christmas Trees, loose	cubic yard	30	1
Yard Trimmings	Yard Trimmings			
	Leaves	cubic yard	250-500	1
	Leaves (Minnesota)	cubic yard	300 - 383	15
	Mixed Yard Waste			
	Uncompacted	cubic yard	250	1
	Compacted	cubic yard	640	1
	Prunings & Trimmings	cubic yard	127	6
	Branches & Stumps	cubic yard	127	6
Municipal Solid Waste	MSW - Commercial			
	Commercial - dry waste	cubic yard	56-73	16, 8
	Commercial - all waste, uncompacted	cubic yard	138	21
	Mixed MSW - Residential, Institutional, Commercial			
	Uncompacted	cubic yard	250-300	14
	Compacted	cubic yard	400-700	14
	Mixed MSW - Multifamily uncompacted	cubic yard	95	21
	MSW - Landfill			
	Compacted - MSW Small Landfill with Best Management Practices	cubic yard	1,200-1,700	17
	Compacted - MSW Large Landfill with Best Management Practices	cubic yard	1,700-2,000	17

Category	Recyclable Materials	Volume	Estimated Weight (lbs)	Source
Municipal Solid Waste	*Compacted - MSW Very Large Landfill with Best Management and Cover Practices, Combined MMSW/Industrial/and other solid waste, or/and Leachate Recirculation*	cubic yard	>2,000	17
C &D	Concrete			
	Large Concrete with Re-bar	cubic yard	860	18
	Large Concrete without Re-bar	cubic yard	860	18
	Small Concrete with Re-bar	cubic yard	860	18
	Small Concrete without Re-bar	cubic yard	860	18
	Asphalt Paving			
	Large Asphalt Paving with Re-bar	cubic yard	773	19
	Large Asphalt Paving without Re-bar	cubic yard	773	19
	Small Asphalt Paving with Re-bar	cubic yard	773	19
	Small Asphalt Paving without Re-Bar	cubic yard	773	19
	Roofing			
	Composition Roofing	cubic yard	731	18
	Other Asphalt Roofing	cubic yard	731	18
	Other Aggregates	cubic yard	860	18
	Wood			
	Clean Dimensional Lumber	cubic yard	169	18
	Clean Engineered Wood	cubic yard	268	18
	Other Recyclable Wood	cubic yard	169	18
	Painted/Stained Wood	cubic yard	169	18
	Treated Wood	cubic yard	169	18
	Gypsum Board			
	Clean Gypsum Board	cubic yard	467	18
	Painted/Demolition Gypsum	cubic yard	467	18
	Aggregate			
	Large Rock	cubic yard	999	18
	Small Rock/Gravel	cubic yard	999	18
	Dirt and Sand	cubic yard	929	18
	Remainder/Composite Construction and Demolition	cubic yard	417	18
	Construction & Demolition Bulk	cubic yard	484	20
	Metal			
	Major Appliances	cubic yard	145	18
	Other Ferrous	cubic yard	225	18
	Other Non-Ferrous	cubic yard	225	18
	Remainder/Composite Metal (avg of metals, without used oil filters)	cubic yard	143	18
	HVAC Ducting	cubic yard	47	18

1 Oregon Department of Environmental Quality. 2007 Oregon Material Recovery and Waste Generation Rates Report September 2008 08-LQ-092. Attachment B: Measurement Standards and Reporting Guidelines 07-LQ-134. http://www.deq.state.or.us/lq/pubs/docs/sw/MRAttachmentB.pdf

2 Department of Ecology, State of Washington. Coordinated Prevention Grant Conversion Sheet. March, 2014. www.ecy.wa.gov/pubs/1107016.pdf

3 Factor developed using lead per battery data from Battery Council International. Recycling Rates 2009 to 2013. April 2014. http://c.ymcdn.com/sites/batterycouncil.org/resource/resmgr/BCI_Recycling_Rate_Study_200.pdf applied to battery composition data from Sulllivan, JL and Gaines, L. 2010. A Review of Battery Life Cycle Analysis: State of Knowledge and Critical Needs. October 2010. Center for Transportation Research, Energy Systems Division, Argonne National Laboratory ANL/ESD/10-7.

4 Keep America Beautiful. Volume-to-Weight Recycling and Trash Conversion Factors Report. December 2013.

5 Rubber Manufacturers Association (RMA). 2013 U.S. Scrap Tire Management Summary. November 2014. http://www.rma.org/download/scrap-tires/market-reports/US STMarket2013.pdf

6 California Integrated Waste Management Board. Targeted Statewide Waste Characterization Study: Detailed Characterization of Construction and Demolition Waste. June 2006. http://www.calrecycle.ca.gov/publications/Documents/Disposal%5C34106007.pdf

Brown Goods: larger, non-portable electronic goods that have some circuitry. Examples include microwaves, stereos, VCRs, DVD players, radios, audio/visual equipment, and non-CRT televisions (such as LCD televisions).

Computer-related Electronics: electronics with large circuitry that is computer-related. Examples include processors, mice, keyboards, laptops, disk drives, printers, modems, and fax machines.

Other Small Consumer Electronics: portable non-computer-related electronics with large circuitry. Examples include personal digital assistants (PDAs), cell phones, phone systems, phone answering machines, computer games and other electronic toys, portable CD players, camcorders, and digital cameras.

7 Keep America Beautiful, Recycle-Bowl Competition. Accessed February 2015. http://recycle-bowl.org/wp-content/uploads/Recycle-Bowl-Estimating-Data-Fact-Sheet.pdf

8 Great Forest. Volume to Weight Conversion Ratios for Commercial Office Waste in New York City. January 2013. Primary data; Commingled; large commercial properties (500,000 sq. ft – 1m sq. ft) in the New York metropolitan area. http://www.greatforest.com/files/FileUpload/files/Great%20Forest%20-%20Waste%20Conversion%20Paper%20-

9 US EPA Electronics Waste Management in the United States Through 2009 . May 2011.

10 WasteCare Corporation. Some Typical Loose and Baled Weights of Various Materials. Accessed April 2015. http://www.wastecare.com/Products-Services/Balers/aboutbalers.htm.

11 The Aluminum Association. U.S. Aluminum Beverage Can Recycling. http://www.aluminum.org/sites/default/files/section images/UBCRecyclingRate2013.pdf

12 The Association of Postconsumer Plastic Recyclers (APR). Model Bale Specifications. http://www.plasticsrecycling.org

13 Caldwell, Maggie. Recycling Plastic Film and Shrink Wrap. May 16, 2014. http://www.federalinternational.com/blog/recy

14 Caterpillar Performance Handbook. 40th Edition. January 2010.

15 Minnesota Pollution Control Agency. Data provided by professional composter. 2015. Source separated organics - food scraps, non-recyclable paper (paper plates/towels/etc) and compostable plastics.

16 Minnesota Department of Administration 2015 hauler records (excludes organics).

17 Minnesota Pollution Control Agency. 2013 MPCA MSW Landfill Annual Report Data.

18 California Integrated Waste Management Board. Targeted Statewide Waste Characterization Study: Detailed Characterization of Construction and Demolition Waste. June 2006

19 Tellus scaled down by factor from Florida C&D study -- Converting C&D Debris from Volume to Weight: A Fact Sheet for C&D Debris Facility Operators, University of Florida, 2000.

20 Florida Dept of Environmental Protection http://www.dep.state.fl.us/waste/categories/recycling/cd/canddmain.htm

21 CalRecycle. 2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California. September 10, 2015. http://www.calrecycle.ca.gov/Publications/Documents/1543/20151543.pdf

Organics - putrescible material hauled by a contracted third party to a permitted facility mainly engaged in producing compost or mulch, or in anaerobic digestion of organics. Minor mechanical separation of contaminants or recyclable materials may occur at the facility prior to composting or digestion.

22 Goldstein, Nora. "Food Scraps Composting Laboratory". *BioCycle.* January 2013, Vol. 54, No. 1, p. 33. https: //www .biocycle.net/2013/01/22/food-scraps-composting-laboratory/

23 U.S. EPA. Standard Volume-to-Weight Conversion Factors. Last updated: February 28, 2006. https://www.epa.gov/smm/metrics-waste-reduction

24 National Center for Electronics Recycling (NCER). http://www.electronicsrecycling.org/

Mixed monitors and TVs: total pounds collected divided by total units collected.

Enclosure | 1

Extract of Revised Planning Statement

5.6.2 All the residential buildings will be located more than 20m from Sha Tau Kok Road – Lung Yeuk Tau (Primary Distributor in accordance with Traffic Census 2021) and 5m from the local private roads Dao Yang Road and Hai Wing Road, the minimum setback distances for roads recommended in Table 3.1 of Chapter 9 Environment of the HKPSG will be complied with. As referred to **Section 2** of **Appendix 6**, no adverse air quality impact on the proposed development from industrial emission and vehicular emissions is anticipated with the implementation of the proposed mitigation measures during the operation phase. Meanwhile, the operation of the proposed development will not cause any adverse air quality impact on the surrounding air sensitive uses.

Noise Impact

5.6.3 As referred to **Section 3** of **Appendix 6**, no adverse noise impact is anticipated during the construction phase of the proposed development with the implementation of the recommended noise mitigation measures. Buildings of the surrounding environment would provide effective acoustic linings and shields for the proposed development. No adverse fixed source noise impact on the proposed development is anticipated.

5.6.4 Moreover, adverse fixed noise impact from the operation of the proposed development is not anticipated with the provision of good practices. For road traffic noise, the noise impact on the Proposed Development is predicted to comply with the standards as recommended in Chapter 9 Environment of the HKPSG with the building setback of about 130m to Sha Tau Kok Road (Lung Yeuk Tau). Therefore, no adverse noise impact is anticipated during the construction and operation phases of the proposed development.

Water Quality

5.6.5 As referred to **Section 4** of **Appendix 6**, the potential water quality impacts have been evaluated in construction and operation phases. With the implementation of the recommended measures including the provision of portable toilets for construction workers on-site, no adverse water quality impact site is anticipated from the construction phases of the proposed development. The contractor shall apply for a Discharge Licence from EPD under the WPCO. All site discharges shall be treated in accordance with the terms and conditions of the Discharge Licence.

5.6.6 The sewage generated from the proposed development will be treated in an on-site sewerage treatment plant before discharging into Ng Tung River. During operation, no adverse water quality impact is anticipated from sewage generated by the proposed development in view of the adoption of tertiary treatment and the appropriate emergency discharge arrangement. As such, no adverse water quality impacts to the nearby watercourses are anticipated during the construction or operational phases of the proposed development.

Waste Management

5.6.7 As referred to **Section 5** of **Appendix 6**, with the development of Waste Management Plan and to implement the good site practices recommended therein, the waste generated during construction phase can be greatly reduced. Provided that good site practices recommended are followed, there should be no adverse impacts related to the management, handling and transportation of waste during the construction phase. With the implementation of recommended mitigation measures, adverse waste impacts generated during the construction and operation phase of the Proposed Development are not anticipated.

Land Contamination

5.6.8 As referred to **Section 6** of **Appendix 6**, a detailed investigation of the past and present land-use of the project site was carried out. Despite vehicle maintenance workshop and open storage yard were identified on site, evidence on site contamination was not found because the site portions under potentially contaminating activities were clean and fully paved with concrete. A separated contamination assessment plan will be prepared for EPD's endorsement during the detailed design stage.

5.7 Water Supplies

5.7.1 A Water Supply Impact Assessment (**Appendix 7** refers) has been conducted to evaluate the possible impacts on the existing water supply during the operation of the proposed development. The results indicate that the capacity of the existing water supply system would be sufficient to handle the water demand from the operation of the application site and from the nearby residential uses. Therefore, there should be no adverse impact on the existing water supply system due to the proposed development.

5.8 Drainage Aspect

5.8.1 With reference to Drainage Services Department's Advice Note No. 1 - Application of the Drainage Impact Assessment Process to Private Sector Projects, a Project Profile of Drainage (**Appendix 8** refers) has been prepared. Based on the review of **Sections 3 and 4** of **Appendix 8**, no adverse drainage impact on the municipal drainage system is anticipated due to the proposed development.

5.9 Sewerage Aspect

5.9.1 A Sewerage Impact Assessment (**Appendix 9** refers) has been conducted to assess the potential sewerage impact arising from the proposed development. With the provision of the on-site sewage treatment plant (STP), the treated effluent from the STP will be discharged to nearby stormwater drainage system and eventually reach Ng Tung River after tertiary treatment. And one additional discharge system will be connected to the public sewerage system serving as optional route for emergency discharge. Therefore, the sewerage analysis indicates that no unacceptable sewerage impact is anticipated with the provision of on-site STP and the proposed discharge arrangement.

5.10 Air Ventilation Considerations

5.10.1 Air ventilation considerations of the application site and the proposed development are evaluated. As reference to the Regional Atmospheric Modelling System (RAMS) wind facilitate the movement of air and allow air flows to reach crucial downstream areas, thereby mitigating potential impacts from wind. In the case of S winds, the air streams would continue to flow towards the north through the building separations. On the other hand, E winds would flow towards the western regions through the building separations.

5.10.16 Compared to the current performance, the proposed development may slightly reduce wind flow to some extent due to the increased development intensity, which is similar to the nearby Queen's Hill developments. However, considering that the proposed development has a smaller scale and less bulky morphology, along with the proposed mitigation measures, it is anticipated that there will be **no significant air ventilation issues within the application site and its surroundings arising from the proposed development.**

5.11 Archaeological Interest Considerations

5.11.1 Heritage conservation has been given due consideration. While a small portion of the application site on Lot 854 partially falls within Queen's Hill Site of Archaeological Interest ("SAI") (hereinafter referred to as the "encroached area") (**Illustration 6-I** and **Illustration 6-II** refer), it is important to note that the encroached area is occupied by an existing road, namely Dao Yang Road. The current proposal does not involve any works on or underneath this road (also the encroached area), and its use will remain unchanged as it serves as a major access road for local residents in the vicinity. To further minimize potential impacts on the SAI, a buffer zone of approximately 10m between Dao Yang Road and the proposed development is proposed as an emergency vehicular access (EVA), landscape area, loading and unloading bay, and bicycle parking area. Only minor furnishing works are required for constructing the proposed EVA, landscaping, parking and L/UL area. The construction works will ensure no disturbance to the adjacent SAI.

5.11.2 "Considering that only a small portion of the proposed development encroaches on the SAI and no works will take place there since the existing use of the access road will remain unchanged, and the minor works to the EVA is immediately outside the SAI boundary, it is unlikely that the proposed development will significantly affect heritage conservation, and no damage to valuable antiquities is anticipated.

5.11.3 Nonetheless, the applicant is committed to maintaining the encroached area to preserve its existing use. Furthermore, the applicant is willing to allow access to staff from the Antiquities and Monuments Office (AMO) at any time for investigation and inspection purposes. Any necessary follow-up actions as determined by the AMO will be undertaken.

5.11.4 The current application aims to strike a balance between development and heritage conservation. The applicant is reminded to ensure that no disturbance and physical damages would be made to Queen's Hill Site of Archaeological Interest ("SAI") during the course of works. Pursuant to the Antiquities and Monuments Ordinance (Cap. 53), the applicant is required to inform AMO immediately of discovery of any antiquities or supposed antiquities during the course of works. Furthermore, if any antiquities are found, construction activities will be paused to allow the AMO to assess their heritage value before determining the next course of action.

Enclosure | 2

Revised Drainage Impact Assessment

SMEC

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D03 – Project Profile of Drainage

S12A Rezoning Application – Request for Amendment to the Lung Yeuk Tau and Kwan Tei South OZP from “Residential (Group C)” Zone and “Agriculture” Zone to “Residential (Group A)2” Zone at Various Lots in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau, N.T.

Reference No. 7076933
Prepared for Carlton Woodcraft Manufacturing Ltd
4 June 2024

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Important Notice

This report is confidential and is provided solely for the purposes of supporting S12A Rezoning Application – Request for Amendment to the Lung Yeuk Tau and Kwan Tei South OZP from “Residential (Group C)” Zone and “Agriculture” Zone to “Residential (Group A)2” Zone at Various Lots in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau, N.T.. This report is provided pursuant to a Consultancy Agreement between SMEC Asia Limited (“SMEC”) and Carlton Woodcraft Manufacturing Ltd, under which SMEC undertook to perform specific and limited tasks for Carlton Woodcraft Manufacturing Ltd. This report is strictly limited to the matters stated in it and subject to the various assumptions, qualifications and limitations in it and does not apply by implication to other matters. SMEC makes no representation that the scope, assumptions, qualifications and exclusions set out in this report will be suitable or sufficient for other purposes nor that the content of the report covers all matters which you may regard as material for your purposes.

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1 PROJECT BACKGROUND

1.1 Introduction

1.1.1 The title of the Project is S12A Rezoning Application – Request for Amendment to the Lung Yeuk Tau and Kwan Tei South OZP from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A)2" Zone at Various Lots in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau, N.T.

1.2 Project Proponent

1.2.1 The Applicant of the Section 12A Rezoning Application, i.e., On Billion International Ltd, is the Project Proponent.

1.3 Contact Person

1.3.1 The Contact Person's details are as follows:

Name:	Ms Isa YUEN
Company:	Aikon Development Consultancy Ltd
Email:	Iyuen@aikon.hk
Telephone:	3180 7811
Address:	Unit 1310, Level 13, Tower 2, Metroplaza, No.223 Hing Fong Road, Kwai Fong, N.T.

1.4 Project Background

1.4.1 With reference to the latest policy address in developing the Northern Metropolis, it is aimed to optimize the use of land resources, adopt a higher development intensity and increase high-quality housing supply. In order to address the aforementioned needs, it is planned to redevelop a land with an area of approximately 22,445m^2 comprising various lots in D.D. 83, and the adjoining government land of about 1,358m^2, Lung Yeuk Tau, New Territories, into proposed flat, shop and services and eating place ("the Site" or "the Proposed Development").

1.4.2 The Site is currently zoned "Residential (Group C)" ("R(C)") and "Agriculture" ("AGR") under the Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan ("OZP"). It was planned to develop a commercial complex for shop and services and eating place, and Residential Development comprising 5 blocks for domestic use.

1.4.3 In this regard, a rezoning application under Section 12A of the *Town Planning Ordinance* ("TPO") to rezone the Site from "R(C)" and "AGR" zones to "Residential (Group A)2 ("R(A)2") zone under Column 1 shall be required. SMEC Asia Ltd ("SMEC") has been commissioned by Carlton Woodcraft Manufacturing Ltd ("the Applicant") to conduct this Project Profile of Drainage to support the application.

1.5 Site Description

1.5.1 The Site is located in a developed area in Lung Yeuk Tau, New Territories, which is a flat land used for workshop, storage and warehouses. Its northern part is currently occupied by a permanent domestic structure, temporary structures for open storage yards, storage of construction materials and workshops, open carparks and vacant land. The southern part is currently occupied by the Applicant for warehouse storage.

1.5.2 As shown on ***Figure 1-1***, Sha Tau Kok Road (Lung Yeuk Tau) Section is located to the immediate north of the Site that runs along the northeast-southwest direction. Across the opposite site of Sha Tau Kok Road (Lung Yeuk Tau) Section, there are San Wai Barracks, a recycling centre and some warehouses. The Site is mainly surrounded by Tung Chun Soy Sauce factory place and some vegetated land to the east, Queen's Hill Estate to the south, village houses and warehouses to the west, intermixed with temporary structures, scattered vegetated and abandoned land.

1.6 Project Description

1.6.1 The Proposed Development will tentatively comprise a commercial complex and a Residential Development with the following components:

- Five Residential Blocks
- One Clubhouse
- One Swimming Pool
- One Shopping Arcade

1.7 Objectives of this PP

1.7.1 The objectives of this PP are to:

- Assess the potential drainage impacts arising from the Site; and
- Recommend the necessary mitigation measures to alleviate the impacts.

1.7.2 This Project Profile comprises the following Sections, in accordance with DSD Advice Note No. 1 - Application of the Drainage Impact Assessment Process to Private Sector Projects:

- Assess the potential drainage impacts arising from the Site; and
- Recommend the necessary mitigation measures to alleviate the impacts.

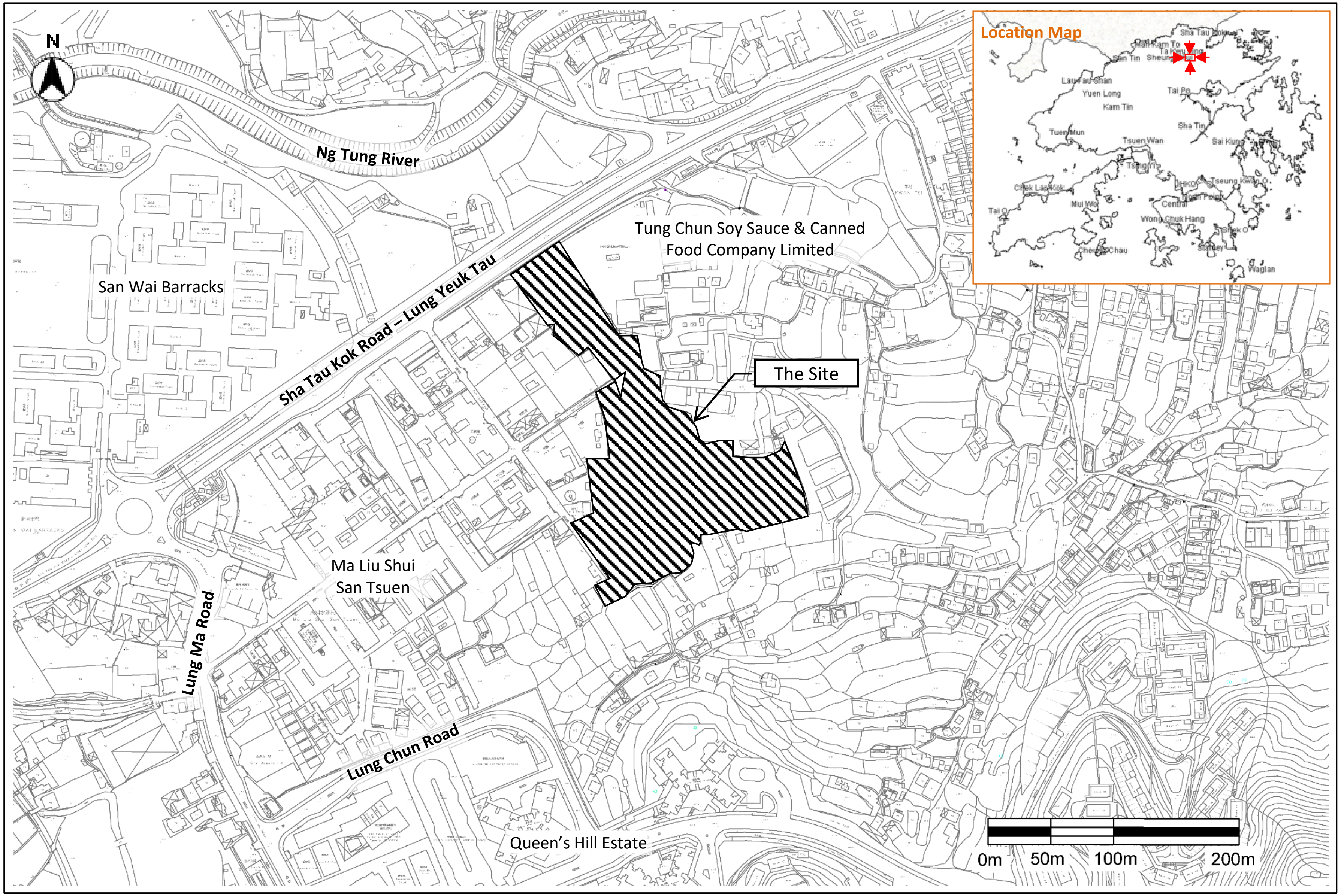
1.8 Reference Materials

1.8.1 In evaluating the drainage impact arising from the Proposed Development, the following materials have been referred to:

1.8.2 In evaluating the potential drainage impact arising from the Proposed Development, the following documents have been referred to:

- Drainage Services Department ("DSD") Publication Stormwater Drainage Manual (with Eurocodes incorporated) – Planning, Design and Management (2018 Edition).
- DSD Publication Stormwater Drainage Manual – Corrigendum No. 1/2022.
- DSD Publication Stormwater Drainage Manual – Corrigendum No.1/2024.
- DSD Advice Note No. 1 – Application of the Drainage Impact Assessment Process to Private Sector Projects.
- Survey maps downloaded from Hong Kong Map Service ("HKMS") 2.0.
- GeoInfo Map (https://www.map.gov.hk/gm/) reviewed on 10 May 2024.

Figure 1-1 Site Location and its Environs



2 DESCRIPTION OF EXISTING ENVIRONMENT AND DRAINAGE CONDITIONS

2.1 Project Implementation

2.1.1 As mentioned in ***paragraph 1.4.3,*** SMEC has been commissioned by the Project Proponent to prepare this PP to study the changes to the drainage characteristics and the potential drainage impacts arising from the Project.

2.1.2 The Project Proponent, subject to the final recommendation of this PP, will be responsible for implementing the proposed works together with all the environmental and drainage mitigation measures.

2.1.3 Construction of the Project will be carried out by the Contractor(s) to be appointed by the Project Proponent at a later stage.

2.2 Project Timetable

2.2.1 The tentative operation of the Proposed Development will be in 2031.

2.2.2 No detailed design including the drainage system is available at this rezoning application stage. The actual drainage construction works will be designed by the drainage engineer to be engaged by the Authorised Person ("AP") of the Proposed Development subject to the approval from the Building Authority and the relevant government departments. The drainage connection proposal will be submitted by the AP at the detailed design stage.

2.2.3 The indicative milestones of the Proposed Development subject to change during the detailed design stage are as follows:

Table 2-1 Indicative Milestones of the Proposed Development

ID	ITEM	ANTICIPATED TIME
1.	Appointing AP	2023
2.	Preliminary Designs	2023 to 2024
3.	Preparation of DIA Study (if required)	2023
4.	Detailed / Finalised Designs	2024
5.	Construction / Implementation	2026 to 2031
6.	Completion / Commencing Operation	2031

2.3 Interaction with Other Projects

2.3.1 With reference to the construction programme of the Project, the concurrent works in the vicinity of the Proposed Development are identified as the Public Housing Development at Queen's Hill Extension and Y/NE-LYT/15, another TPO Section 12A rezoning application at Lots 926, 934, 936 S.B, 937 RP, 947 RP, 948 RP, 949, 950, 951, 952, 955 S.A and 2435 in D.D. 83 and Adjoining Government Land. The status of the identified construction project is summarized as below in Table 2-2. Because of the relatively long horizontal distant and lack of shared drainage facilities between other concurrent construction projects to the site boundary, it is unlikely that the proposed development will be affected by the runoff generated from other projects.

Table 2-2 Concurrent Construction Project at the Vicinity of Proposed Development

Concurrent Construction Project	Status	Construction Period	Horizontal Distant to Proposed Development

Public Housing Development at Queen's Hill Extension, Fanling	commenced	2023 - 2030/2031	357m
Y/NE-LYT/15	under planning application	unknown	233m
Y/NE-LYT/16 (Proposed Development)	under planning application	completed in 2031 (tentatively)	-

3 DESCRIPTION OF CONDITIONS

3.1 Introduction

3.1.1 This section describes the existing and future conditions of the environment at and in the vicinity of the Site.

3.2 Site Location and Topography

3.2.1 As mentioned in paragraph 2.1.2 of the Planning Statement, part of the Site is used for workshop, storage and warehouses. Its northern part is currently occupied by a permanent domestic structure, temporary structures for open storage yards, storage of construction materials and workshops, open carparks and vacant land. The southern part is currently occupied by the Applicant for warehouse storage. The Site is relatively flat with the existing ground elevations of +12.2mPD to +13.3mPD. The Site area is approximately 22,445m^2.

3.3 Statutory Land Use Zoning

3.3.1 As mentioned in ***paragraph 1.1.1***, the Site is currently zoned R(C) and AGR under the Lung Yeuk Tau and Kwan Tei South OZP.

3.4 Existing and Future Conditions

Paved and Unpaved Area of the Site

3.4.1 The total Site area is about is approximately 22,445m^2. In order to understand the existing conditions of the Site and the surrounding area, Site visits were conducted on 6 December 2022 and 18 January 2023. Most of the Site area is hard paved as summarised in ***Table 3-1***.

Table 3-1 Percentage of Paved and Unpaved Areas of the Existing Site

SITE AREA, m^2	PAVED AREA, m^2	UNPAVED AREA, m^2
~22,445	~21,323 (~95%)	~1,122 (~5 %)

3.4.2 As mentioned in paragraph 5.3.1 of the Tree Preservation and Landscape Proposal for the Proposed Development, greenery [note 1] will be provided and the common greenery is calculated in accordance with PNAP APP-152 Sustainable Building Design Guideline [note 2]. As mentioned in Table 2 of PNAP App-152, the minimum overall site coverage of greenery for site area between 1,000m^2 and 20,000m^2 should be 20% and that for site area for equal to or larger than 20,000m^2 should be 30% respectively.

3.4.3 As mentioned in ***paragraph 3.4.1***, the Site area of the Proposed Development is approximately 22,445m^2. The total greenery area is proposed to be about 8,026.5m^2 as mentioned in paragraph 5.3.2 of the aforementioned Tree Preservation and Landscape Proposal. The coverage of greenery will be approximately 35.76% for the Proposed Development in accordance with PNAP APP-152.

[1] "Greenery" or "Greenery Area" is area with live plant and soil or similar base defined in BD's PNAP APP-152.

[2] Practice Notes for Authorised Persons, Registered Structural Engineers and Registered Geotechnical Engineers ("PNAP") APP-152 *Sustainable Building Design Guidelines* published by the Building Department ("BD") in January 2016.

Table 3-2 Percentage of Paved and Unpaved Areas of the Proposed Development

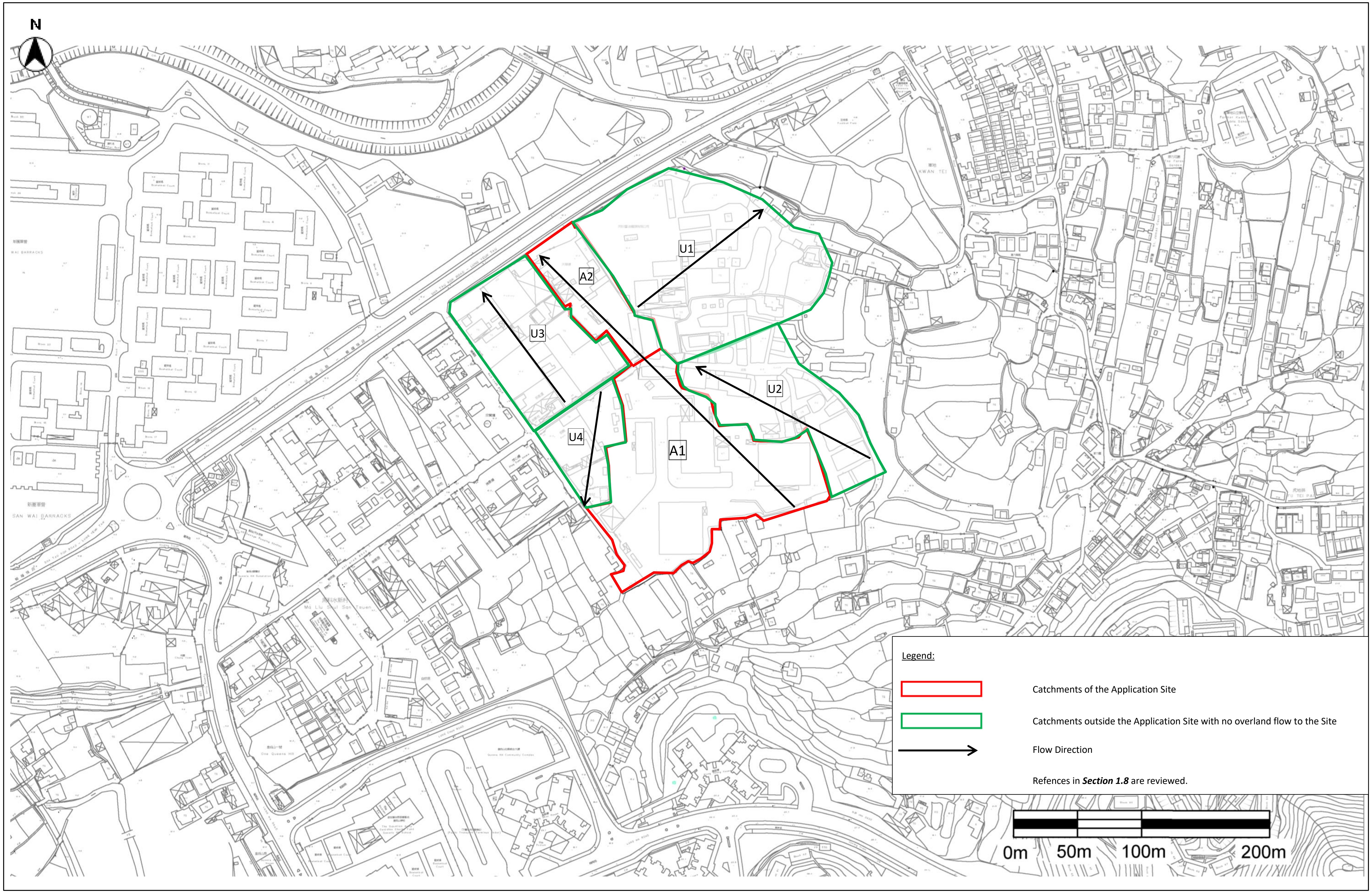
SITE AREA, m^2	PAVED AREA, m^2	UNPAVED AREA, m^2
~22,445	14,418.5 64.24%	8,026.5 35.76%

Catchment Areas

3.4.4 Based on the Site observations and desktop study of the elevations shown on the topographical maps, the identified catchments and anticipated flow directions are shown on ***Figure 3-1***. The catchments are identified as follows:

1. The Site comprises two sub-catchments, Sub-Catchments A1 and A2, with elevations between 12.7mPD and 13.3mPD within A1 and 12.2mPD within A2 respectively.
2. Public roads such as Sha Tau Kok Road – Lung Yeuk Tau, etc. are provided with road drains. Therefore, overland flow from public roads to the Site is unlikely.
3. Other catchments, Catchments U1 to U4 adjacent to the Site, are identified that:
   (a) Since U1 to U4 are outside the Application Boundary, the payment conditions and flow patterns of U1 to U4 will not be changed due to the Proposed Development.
   (b) U1 is an industrial use adjacent to A1 of the Site with elevations between 11.6mPD and 12.2mPD. Most of its site is hard paved and provided with fence walls. The runoff from U1 should be flowed to the northeastern stream. Overland flow from U1 to the Site is unlikely.
   (c) U2 is a rural area adjacent to A2 of the Site with approximately 90% of the area to be vegetated area or bare land while the other 10% of the area to be village houses/paved areas with elevations between 12.5mPD and 13.9mPD. Some runoff from U2 should overland flow onto the Site which can be currently intercepted by the perimeter drains located to the eastern boundary of A2 of the Site.
   (d) There are warehouses and workshops located within U3. Most of its site is hard paved and provided with fence walls with elevations between 12.2mPD and 12.4mPD. U4 is a house development adjacent to A2 of the Site. It is approximately 70% hard paved with elevations between 12.5mPD and 12.6mPD lower than A2 with elevations between 12.7mPD and 13.3mPD. Suggested by DSD comments, the runoff from U3 and U4 have been taken into account for the hydraulic performance check of U-shape surface channel at Sha Tau Kok Road – Lung Yeuk Tau because no existing drainage can be identified for U3 and U4 at Geoinfo Map.

Figure 3-1 Identified Catchments



4 DRAINAGE ANALYSIS

4.1 Assumptions and Methodology

4.1.1 Peak instantaneous runoff before and after development of the Project was calculated based on the Rational Method. The recommended physical parameters, including runoff coefficient (C) and storm constants for different return periods, are as per the *Stormwater Drainage Manual* ("SDM").

4.1.2 The Rational Method has been adopted for hydraulic analysis and the peak runoff is given by the following expression:

$Q_p = 0.278\ C\ i\ A$ --- ***Equation 1***

where Q_p = Peak Runoff in m^3/s

C = Runoff Coefficient

i = Rainfall Intensity in mm/hr

A = Catchment Area in km^2

4.1.3 Rainfall intensity is calculated using the following expression:

$\boldsymbol{i = a/(t_d+b)^c}$ --- ***Equation 2***

where i = Rainfall Intensity in mm/hr

t_d = Duration in minutes ($t_d \leq 240$)

a, b, c = Storm constants (Table 3 of SDM)

4.1.4 For a single catchment, duration (t_d) can be assumed equal to the time of concentration (t_c) which is calculated as follows:

$t_c = t_0 + t_f$ --- *Equation 3*

where t_c = time of concentration

t_0 = Inlet time (time taken for flow from the remotest point to reach the most upstream point of the urban drainage system).

t_f = Flow time.

4.1.5 Generally, t_0 is much larger than t_f. As shown in the equation of paragraph 3.1.3, t_d is the divisor. Therefore, larger t_d will result in smaller rainfall intensity (i) as well as smaller Q_p. For the worst-case scenario, t_f is assumed to be negligible and so:

$\boldsymbol{t_d = t_c = t_o}$

$\boldsymbol{t_o = 0.14465\ L/\ (H^{0.2}A^{0.1})}$ ---- ***Equation 4***

where A = catchment area (m^2)

H = average slope (m per 100m), 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)

4.1.6 On the other hand, capacity of the open channel has been calculated using Manning's Equation:

$$V = \frac{R^{1/6}}{n} \times \sqrt{Rs}$$

--- *Equation 6*

where V = mean velocity (m/s)
R = hydraulic radius (m)
n = Manning coefficient ($s/m^{1/3}$)
s = hydraulic gradient (energy loss per unit length due to friction)

4.2 Assessment Assumptions

4.2.1 As mentioned in ***Section 3.4***, the Site is currently 95% paved area and 5% soft landscape area. After the Proposed Development, the greenery area would be 35.76% of the total site area. The plans showing the existing and proposed pavement condition and site survey photos are provided in ***Appendix A.***

4.2.2 Before the proposed development, the highest ground elevation within the site area is 13.1mPD, the lowest is 12.2mPD. The site currently comprises for various lots owning by different landlords, and the land use within the site is complex. After the proposed development, the site will undergo site clearance and site formation, the highest elevation become 13.0mPD, and the lowest become 12.0mPD, resulting in change of overall averaging slope.

4.2.3 In addition to Catchment A, i.e. the Site, 4 other catchments, U1 to U4 were identified in the surrounding of the Site. As concluded in ***Paragraph 3.4.4***, runoff from U2 may overflow and be intercepted by perimeter drains of the Site while runoff from U3 and U4 will be counted as being collected by the U-shape surface channel, forming the upstream runoff of the site.

4.2.4 With reference to the *Stormwater Drainage Manual*, the runoff coefficients of 0.95 for paved surface and 0.25 for flat grassland were adopted in the runoff calculation as summarised ***Table 4-1.***

Table 4-1 Catchment Surface Characteristics and Runoff Coefficient

CATCHMENTS	SCENARIO OF PROJECT	AREA	SURFACE CHARACTERISTICS	RUNOFF COEFFICIENT
A	Before Development	22,445m^2	95% paved+5% grassland	0.92
	After Development		64.24% paved+35.76% grassland	0.70
U2	N/A	9,041m^2	10% paved+90% grassland	0.32
U3	N/A	9,374m^2	10% paved+90% grassland	0.32
U4	N/A	3,415m^2	70% paved+30% grassland	0.74

4.3 Estimated Existing and Future Runoff

4.3.1 The cumulative runoff from Catchment A, U2, U3 and U4 would be calculated using rational method. The runoff was estimated based on the return periods of 2, 10 and 50 years. The runoff calculation is detailed in ***Appendix B.***

4.3.2 With consideration of the climate change effect of 16% for the end of 21st Century mentioned in *Stormwater Drainage Manual Corrigendum No. 1/2022*, the estimated peak runoff generated from the Site before development is 1.032m^3/s and that after development is 0.795m^3/s under 50-year return period.

4.3.3 As shown in ***Table 4-2***, there will be around 23% reduction in the estimated peak runoff from Catchment A (i.e. the Site), after the Proposed Development. Moreover, as mentioned in ***Section 3.4.4***, runoff from Catchments U2 has also been assumed to overflow into the Site and estimated for a conservative approach. Runoff from Catchment U3 and U4 is assumed to share the capacity with the site as upstream flow. The estimated peak runoff from all considered catchment is estimated and summarised in ***Table 4-2***. It shows approximately 15% reduction in the estimated peak runoff after the Proposed Development for the conservative approach considering a rainfall with 50 years returning period.

Table 4-2 Estimated Peak Runoff of the Cumulative Catchments A, U2, U3 and U4

RETURN PERIOD	ESTIMATED PEAK RUNOFF (m^3/s)		% CHANGE
	BEFORE DEVELOPMENT	AFTER DEVELOPMENT	
Catchment A			
2 Years	0.661	0.510	-22.9%
10 Years	0.865	0.666	-23.0%
50 Years	1.032	0.795	-23.0%
Catchments A, U2, U3, and U4			
2 Years	1.034	0.883	-14.6%
10 Years	1.336	1.137	-14.9%
50 Years	1.584	1.346	-15.0%

4.4 Drainage Impact Review

4.4.1 As shown in ***Figure 4-1***, surface runoff generated from the Catchment A (i.e. the Site) and Catchment U2 will be collected by the perimeter drains and then be discharged into a 750 U-Channel SUP1001474 via catchpit SCH1010789, which is eventually connecting to northeastern stream. The capacity check of Channel SUP1001474 will also take Catchment U3 and U4 into consideration because of the absence of record of other drainage facilities in the vicinity.

4.4.2 Portion of the upstream 600 U-channel, SUP1001473, falls within the site boundary of proposed development. It is expected that SUP1001473 will no longer be affected by the runoff from the site area because the provision of perimeter drains system will convey the runoff and sewage treatment plant (STP) effluent into the downstream SUP1001474.

4.4.3 In the sewage impact assessment of the Proposed Development, the average dry weather flow has been estimated to be 3,005.4m^3/day, and the treatment capacity of the proposed STP is designed to be 5,000m^3/day, which is equivalent to 0.05787m^3/s. Therefore, the total peak flow to be conveyed by SUP1001474 after proposed development would be added up to 1.404m^3/s, which is still lower than the peak runoff under the no development scenario. Considering the design allowance as required at Storm Water Drainage Manual Corrigendum 1/2022, the peak flow on SUP1001474 will be 1.567m^3/s. The hydraulic calculation for SUP1001474, can be referred to ***Appendix C***. The result shows that the existing 750 U-channel does not have sufficient capacity to handle the peak flow from the cumulative catchments.

4.4.4 Even though the Proposed Development will not cause increment in the peak flow and therefore will not induce drainage impact to the existing downstream drainage facilities, the insufficient capacity of existing SUP1001474 might cause potential flooding risk to the proposed development. In this regard, channel upgrading is proposed for SUP1001474 to increase its capacity. The channel diameter will be expanded from 750mm to 900mm, and cement mortar surface will be adopted to enhance the bottom smoothness. The channel section design shall make reference to Civil Engineering and Development Department (CEDD) Standard Drawing C2409I. After taking the 10% sedimentation into consideration, the utilisation rate of the 900mm U-channel with cement mortar bottom surface will be 96.1% under the rainfall intensity of 50-year returning period at the end of the 21st Century, showing that SUP1001474 would acquire sufficient capacity to handle both the runoff and the STP effluent after the proposed channel upgrade. The justification for the feasibility of proposed channel upgrade is explained in the below sections.

4.4.5 As shown in Figure 4-1, there is no other upstream for SUP1001474 beside the adjacent SUP1001473 which is another channel along Sha Tau Kok Road. Available source of dry weather flow for the existing drainage system is not found. After the proposed development, the effluent from the proposed STP will contribute as only source of dry weather flow for SUP1001474. When the proposed STP operate at its design capacity $0.05787m^3/s$, the corresponding flow velocity at the upgraded 900mm cement mortar surface channel will be approximately 1.0m/s during the dry weather. As this dry weather flow velocity is within the normally used range, the adoption of cement mortar surface and no bottom lining for the proposed channel upgrade should be acceptable.

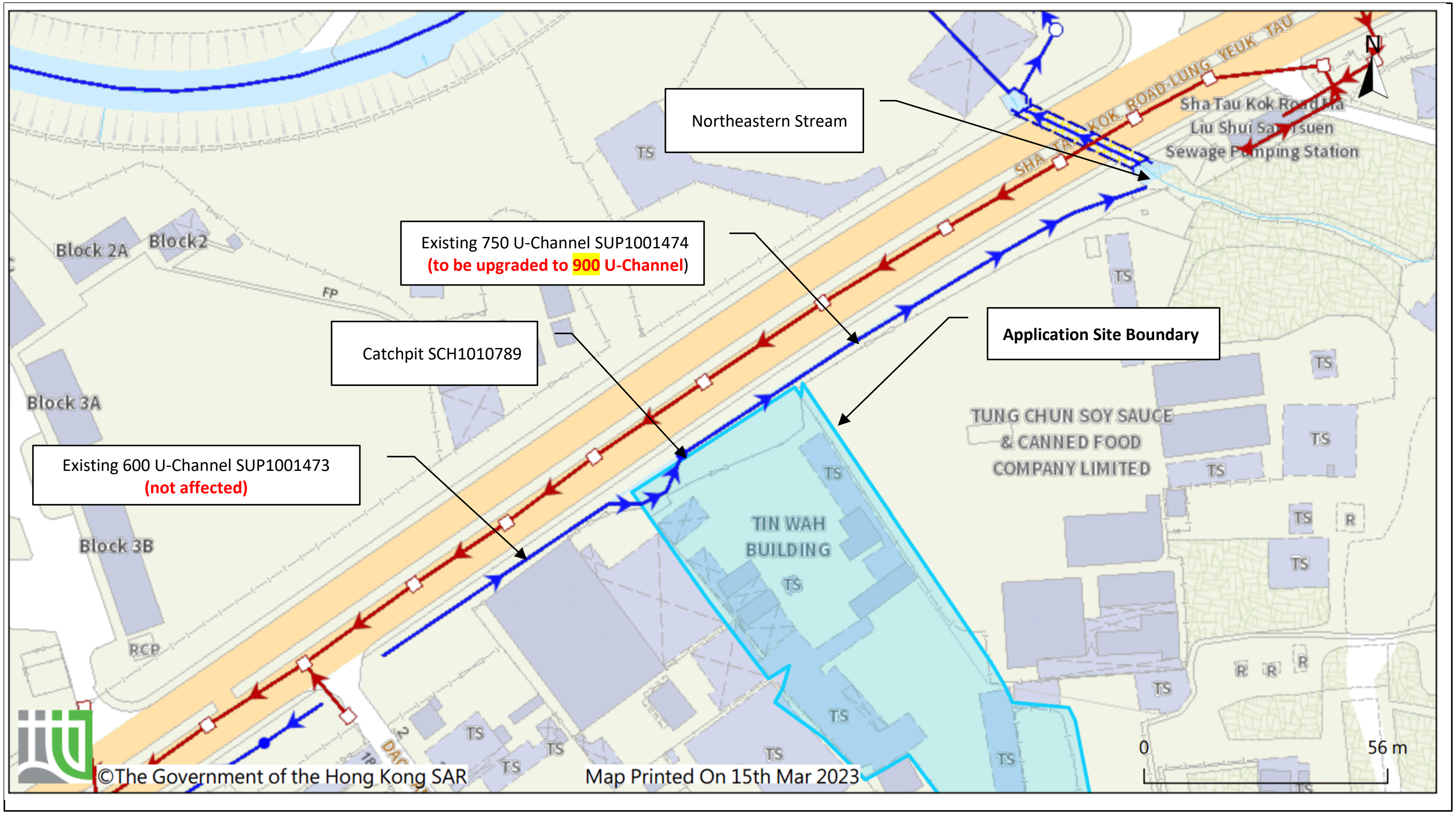
4.4.6 Even though flooding has been recorded at the Lung Yuek Tau area during the black rainstorm in September 2023, DSD stated that the flooding was related to the capacity of rivers being overwhelmed by the extreme rainfall intensity[3]. In this regard, the overall flooding risk of the site area is more likely a district-wide issue subject to the Ng Tung River, and is not directly related to the Proposed Development and the nearby urban drainage branch systems. On the other hand, the proposed upgrade for SUP1001474 is a measure to improve the drainage performance against the specified 50-year returning period rainfall intensity, rather than the remedial action to cater the drainage impact from Proposed Development (of which no adverse impact is anticipated).

4.4.7 The photos taken at the vicinity of the SUP1001474 during site visits in June 2023 and December 2022 are presented in Appendix D, which indicates that there is no obvious obstacle for the channel upgrade work.

4.4.8 In summary, the existing SUP1001474 is proposed to be upgraded to mitigate the potential flooding risk against the 50-year returning period rainfall intensity, and the feasibility of the proposed channel upgrade can be justified by the conditions of the site area and the nearby facilities.

[3] https://www.info.gov.hk/gia/general/202309/08/P2023090800662.htm

Figure 4-1 Proposed Drainage Connection



Notes:

1. The drainage plan was printed on 15 March 2023 from GeoInfo Map.
2. Red lines are foul sewerage system and blue lines are stormwater drainage system.
3. Sufficient areas within the Application Site shall be reserved and provided for the barrier-free maintenance access of the stormwater drainage system adjacent to and within the Application Boundary for the government.

5 CONCLUSION

5.1.1 The drainage impact from the Site before the Proposed Development and after the Proposed Development has been assessed in this report.

5.1.2 The existing Site is 95% paved which is mainly flat concrete surface. The surface characteristics of the Proposed Development will be changed, in which approximately 64.24% of the Site will be paved while at least 35.76% will be landscape area.

5.1.3 The estimated peak runoff generated from the Site before development is 1.032m^3/s and that after development is 0.795m^3/s under a 50-year return period. There will be around 23% reduction in the estimated peak runoff from Catchment A (i.e. the Site), after the Proposed Development.

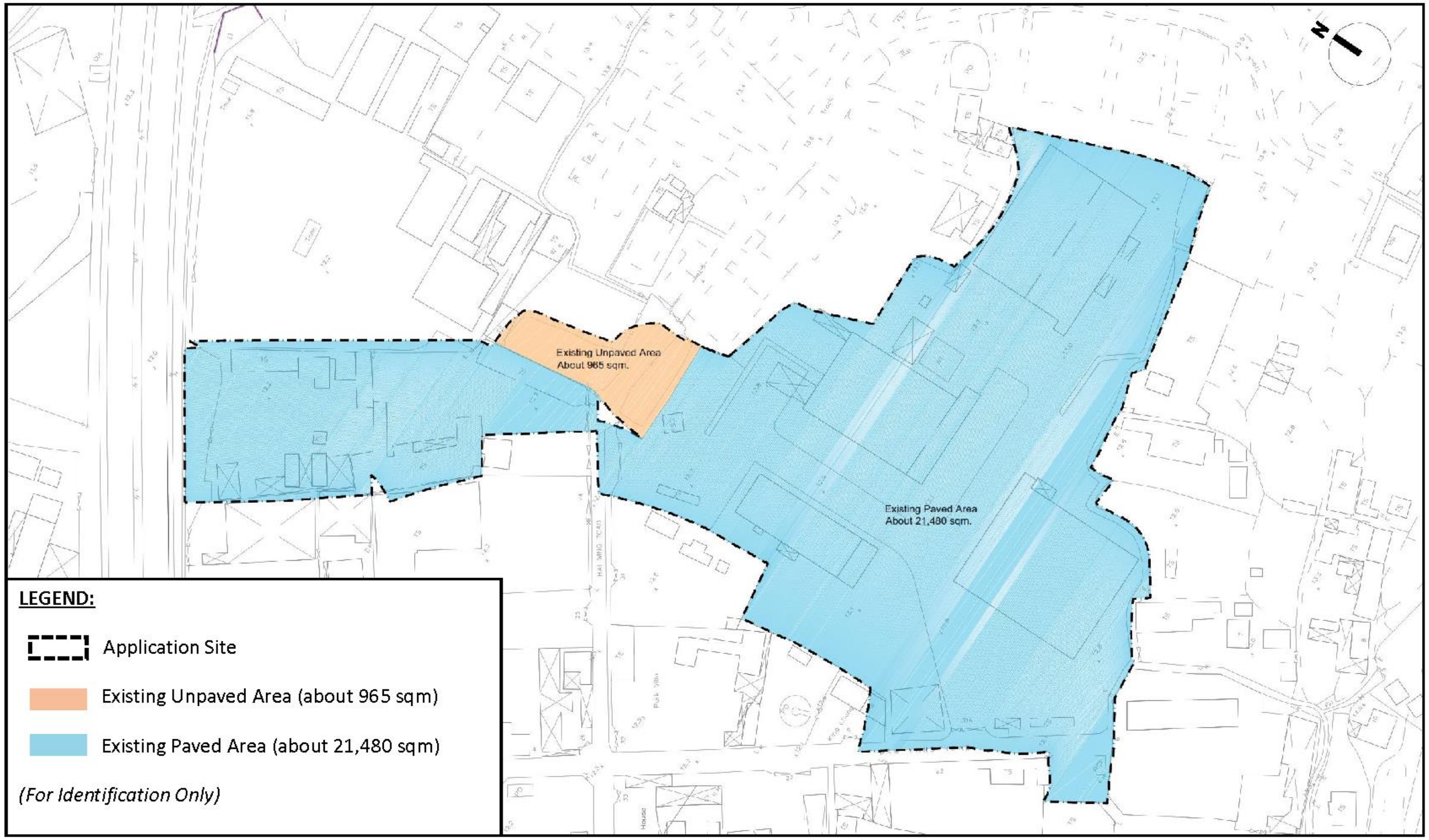
5.1.4 The runoff generated from the Catchment A and effluent from the proposed STP will be discharged to the adjacent SUP1001474. In addition to Catchment A, 4 other catchments, U1 to U4 were identified in the surrounding of the Site. The runoff from U2 may overflow and be intercepted by perimeter drains of the Site. Even though U1, U3 and U4 would not have obvious drainage connection with the Site, runoff from U3 and U4 has been considered in the hydraulic performance check as the upstream of site.

5.1.5 In order to mitigate the potential flooding risk associated the insufficient capacity of existing channel SUP1001474, channel upgrade is proposed. The existing 750 U-channel shall be expanded to 900mm diameter, and cement mortar will be adopted as bottom surface, the channel section design shall make reference to CEDD Standard Drawing C2409I. After the implementation of the upgrading works, the hydraulic calculation shows SUP1001474 would acquire enough capacity to handle the peak flow under the rainfall intensity of 50 years returning period, with a utilisation rate of 96.1%.

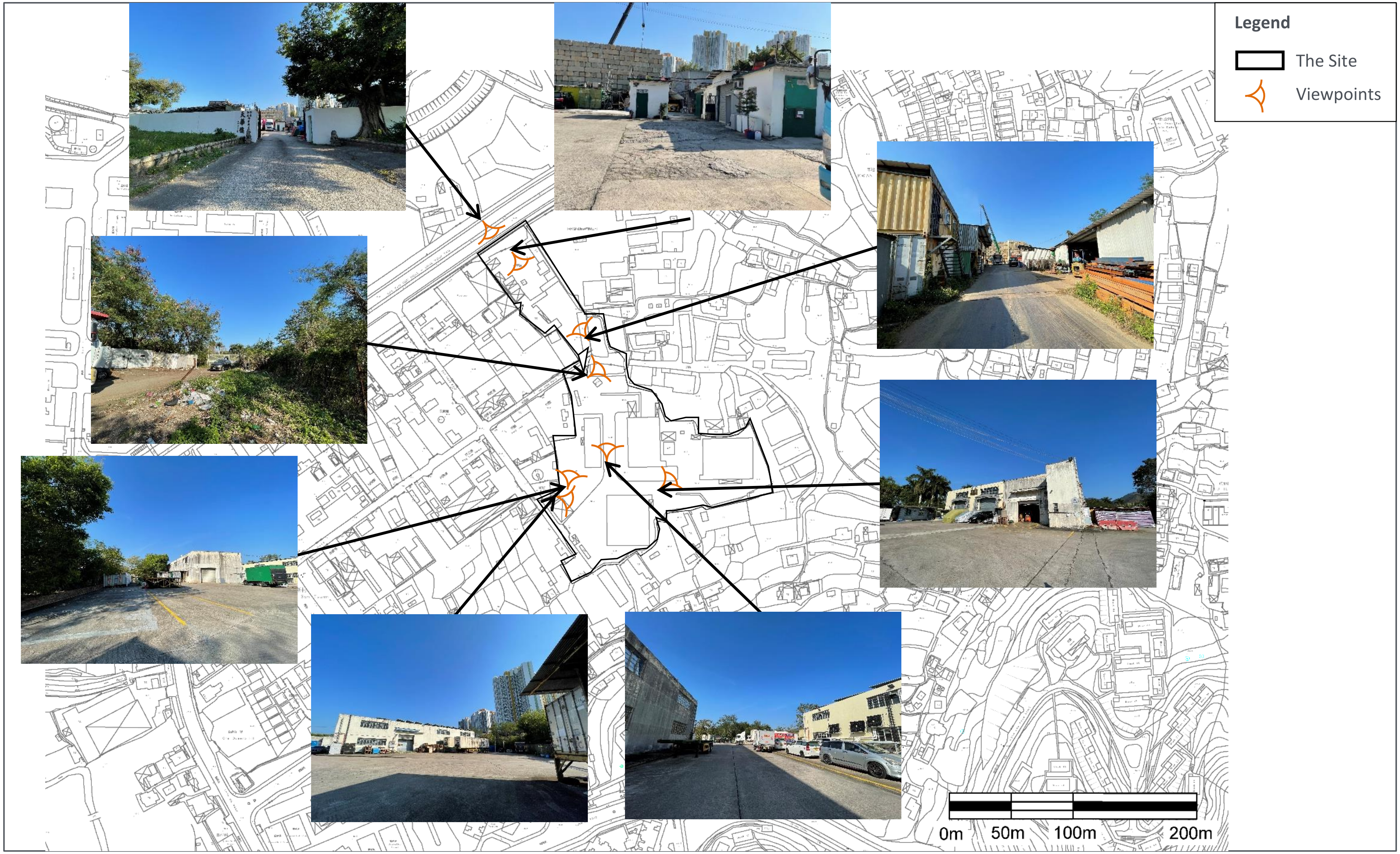
5.1.6 In summary, drainage impact associated with the Proposed Development is not anticipated, and it is expected that the flooding risk under the 50-year returning period rainfall intensity can be mitigated by the proposed channel upgrade.

Appendix A EXISTING AND PROPOSED PAVEMENT CONDITION

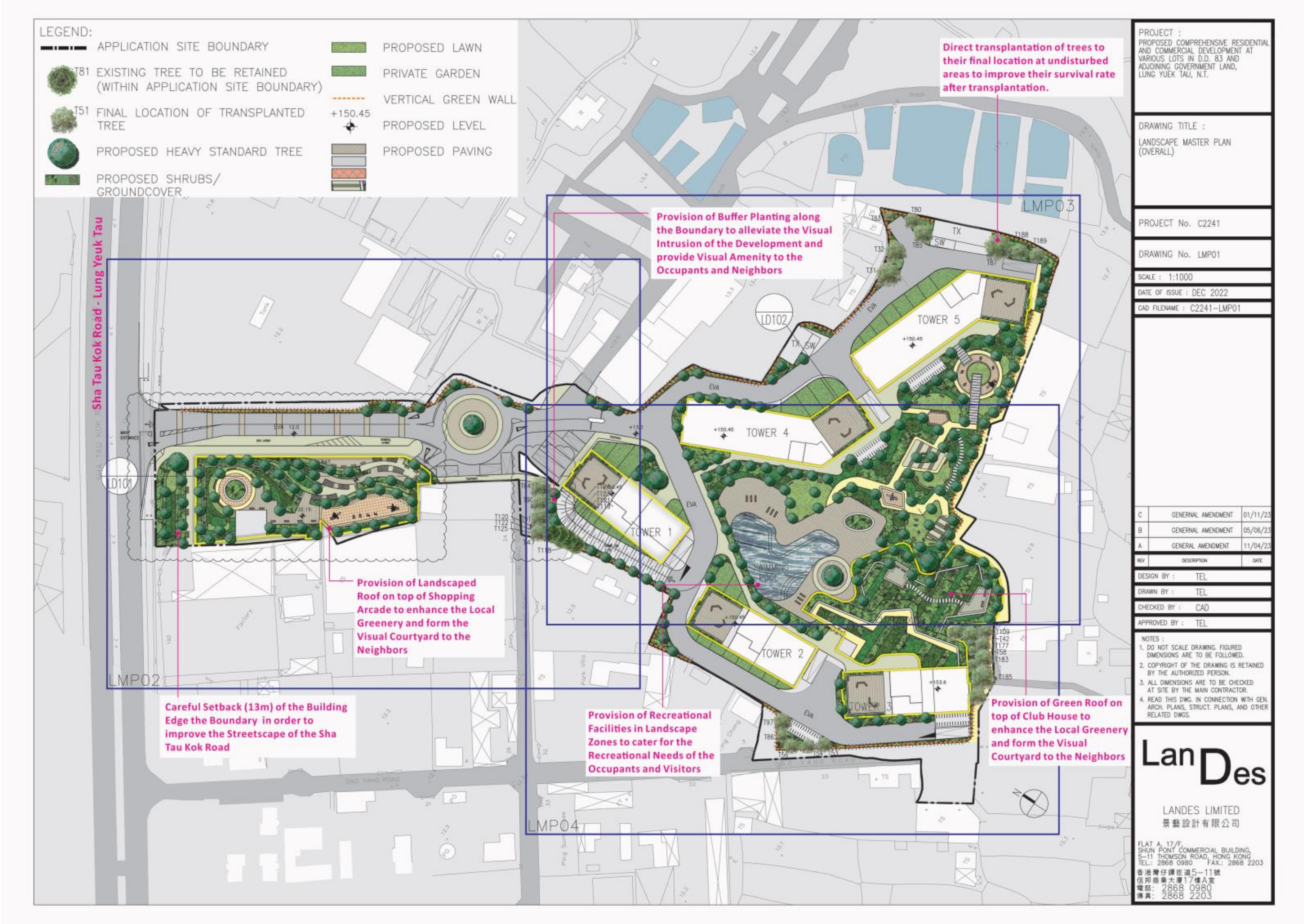
Existing Pavement Condition



Project:	Title:	Illustration:	
Section 12A Planning Application for Proposed Amendment to the Draft Lung Yeuk Tau And Kwan Tei South Outline Zoning Plan No. S/NE-LYT/18 from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A)2" Zone at Lot Nos. 755, 756, 782 S.A, 789 S.A, 789 RP, 790 S.A ss.1, 790 S.A RP, 791 S.A ss.1, 791 S.A ss.2, 791 S.A ss.3, 791 S.A RP, 791 RP, 792 S.A RP, 792 RP, 793, 794 S.A, 794 RP, 800 S.A RP, 801 S.A, 803 RP, 835 S.B ss.1 S.A, 835 S.B ss.1 RP, 836 S.A, 836 RP, 837, 838 S.A, 838 RP, 839, 840, 841 S.A, 841 S.B, 841 RP, 842 S.A, 842 S.B, 842 RP, 843, 844 S.A, 844 RP and 854 in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau, New Territories	Existing Site Condition – Paved and Unpaved Area Ref.: ADCL/PLG-10248-L006/I001	1 **Scale:** 1:1000 (A3) **Date:** Jul 2023	AikoN AIKON DEVELOPMENT CONSULTANCY LTD.


Legend
The Site
Viewpoints
0m
50m
100m
200m

Proposed Pavement Condition



Appendix B RUNOFF CALCULATIONS

Calculation of Runoff for Return Period of 2 Years

Catchment ID	Catchment Area (A), km^2	Average slope (H), m/100m	Flow Path Length (L), m	Inlet time (t_0), min [note 2]	Duration (t_d), min [note 2]	Storm Constants a	b	c	Runoff intensity (i), mm/hr	Runoff coefficient (C) [note 3]	C x i x A	Peak runoff (Q_p), m^3/s	Peak runoff with Climate Change (Q'_p), m^3/s [note 4]
Before Proposed Development													
Catchment A	0.0224	0.3	262.0	17.23	17.23	439.1	4.1	0.484	99.84	0.92	2.050	**0.570**	**0.661**
Catchment U2	0.0090	0.8	124.0	7.53	7.53	439.1	4.1	0.484	133.91	0.32	0.387	**0.108**	**0.125**
Catchment U3	0.0094	0.2	101.2	8.12	8.12	439.1	4.1	0.484	130.76	0.32	0.392	**0.109**	**0.126**
Catchment U4	0.0034	0.2	57.7	5.25	5.25	439.1	4.1	0.484	148.82	0.74	0.376	**0.105**	**0.121**
After Proposed Development													
Catchment A	0.0224	0.4	262.0	16.87	16.87	439.1	4.1	0.484	100.67	0.70	1.581	**0.439**	**0.510**
Catchment U2	0.0090	0.8	124.0	7.53	7.53	439.1	4.1	0.484	133.91	0.32	0.387	**0.108**	**0.125**
Catchmnet U3	0.0094	0.2	101.2	8.12	8.12	439.1	4.1	0.484	130.76	0.32	0.392	**0.109**	**0.126**
Catchment U4	0.0034	0.2	57.7	5.25	5.25	439.1	4.1	0.484	148.82	0.74	0.376	**0.105**	**0.121**

Calculation of Runoff for Return Period of 10 Years

Catchment ID	Catchment Area (A), km^2	Average slope (H), m/100m	Flow Path Length (L), m	Inlet time (t_0), min [note 2]	Duration (t_d), min [note 2]	Storm Constants a	b	c	Runoff intensity (i), mm/hr	Runoff coefficient (C) [note 3]	C x i x A	Peak runoff (Q_p), m^3/s	Peak runoff with Climate Change (Q'_p), m^3/s [note 4]
Before Proposed Development													
Catchment A	0.0224	0.3	262.0	17.23	17.23	454.9	3.44	0.412	130.61	0.92	2.682	**0.746**	**0.865**
Catchment U2	0.0090	0.8	124.0	7.53	7.53	454.9	3.44	0.412	169.57	0.32	0.491	**0.136**	**0.158**
Catchment U3	0.0094	0.2	101.2	8.12	8.12	454.9	3.44	0.412	165.97	0.32	0.498	**0.138**	**0.161**
Catchment U4	0.0034	0.2	57.7	5.25	5.25	454.9	3.44	0.412	186.65	0.74	0.472	**0.131**	**0.152**
After Proposed Development													
Catchment A	0.0224	0.4	262.0	16.87	16.87	454.9	3.44	0.412	131.56	0.70	2.066	**0.574**	**0.666**
Catchment U2	0.0090	0.8	124.0	7.53	7.53	454.9	3.44	0.412	169.57	0.32	0.491	**0.136**	**0.158**
Catchmnet U3	0.0094	0.2	101.2	8.12	8.12	454.9	3.44	0.412	165.97	0.32	0.498	**0.138**	**0.161**
Catchment U4	0.0034	0.2	57.7	5.25	5.25	454.9	3.44	0.412	186.65	0.74	0.472	**0.131**	**0.152**

Calculation of Runoff for Return Period of 50 Years

Catchment ID	Catchment Area (A), km^2	Average slope (H), m/100m	Flow Path Length (L), m	Inlet time (t_0), min [note 2]	Duration (t_d), min [note 2]	Storm Constants a	b	c	Runoff intensity (i),	Runoff coefficient (C)	C x i x A	Peak runoff (Q_p), m^3/s	Peak runoff with Climate Change
Before Proposed Development													
Catchment A	0.0224	0.3	262.0	17.23	17.23	474.6	2.9	0.371	155.81	0.92	3.200	**0.890**	**1.032**
Catchment U2	0.0090	0.8	124.0	7.53	7.53	474.6	2.9	0.371	198.86	0.32	0.575	**0.160**	**0.186**
Catchment U3	0.0094	0.2	101.2	8.12	8.12	474.6	2.9	0.371	194.86	0.32	0.585	**0.162**	**0.188**
Catchment U4	0.0034	0.2	57.7	5.25	5.25	474.6	2.9	0.371	217.91	0.74	0.551	**0.153**	**0.178**
After Proposed Development													
Catchment A	0.0224	0.4	262.0	16.87	16.87	474.6	2.9	0.371	156.85	0.70	2.463	**0.685**	**0.794**
Catchment U2	0.0090	0.8	124.0	7.53	7.53	474.6	2.9	0.371	198.86	0.32	0.575	**0.160**	**0.186**
Catchmnet U3	0.0094	0.2	101.2	8.12	8.12	474.6	2.9	0.371	194.86	0.32	0.585	**0.162**	**0.188**
Catchment U4	0.0034	0.2	57.7	5.25	5.25	474.6	2.9	0.371	217.91	0.74	0.551	**0.153**	**0.178**

Notes:

1. Runoff is calculated in accordance with DSD's "*Stormwater Drainage Manual (with Eurocodes incorporated) - Planning, Design and Management* " (SDM), fifth edition, January 2018; DSD's Stormwater Drainage Manual - Corrigendum No. 1/2022, and DSD's Stormwater Drainage Manual Corrigendum No.1/2024.
2. As mentioned in the DIA Report, Time of Concentration (tc) is assumed to be the same as Inlet Time (t0) and Duration (td) for the worst-case scenario. With reference to *Guidance Notes on Road Pavement Drainage Design* published by the Highways
3. Before the Proposed Development, the Site is approximately 95% paved. After the Proposed Development, 35.76% of the Site will be soft landscape area. Runoff coefficients 0.95 and 0.25 are therefore adopted for paved andunpaved surface respectively in accordance with DSD's SDM.
4. Table 28 Rainfall Increase due to Climate Change of DSD's *Corrigendum No. 1/2022* of 16% for end of 21^{st} Century is adopted.

Appendix C CALCULATION OF FLOW CAPACITY

Calculations of Drainage Capacity for the Existing U-Channel and Proposed U-Channel

Stormwater Drain	D, m	A_w, m^2	P_w, m	R, m	Gradient, 1 in	s	n	v, m/s	Q_c, m^3/s	Q'_p, m^3/s	Catchments	% of Capacity	Acceptable?
750 U-Channel	0.750	0.502	1.928	0.260	200	0.005	0.016	1.802	0.815	1.404	A, U2, U3, U4	172.4%	No
Proposed 900 U-Channel	0.900	0.723	2.314	0.313	200	0.005	0.013	2.505	1.630	1.567	A, U2, U3, U4	96.1%	Yes

Legends:

D = diameter, m

A_w = Cross Section Area of Flow, m^2

P_w = Wetted Perimeter, m

R = Hydraulic Radius = A_w/P_w, m

s = Hydraulic Gradient

n = Manning's roughness coefficient

V = Mean Velocity, m/s

Q_c = Flow Capacity (10% sedimentation inclusive), m^3/s

Q'_p = Estimated Total Peak Flow with Climate Change Effect for 50-year Returning Period after the Proposed Development, m^3/s

% of capacity = Q'_p / Q_c

Notes:

1. The $0.0578 m^3/s$ design capacity of proposed Sewerage Treatment Plant has been included in the peak flow.
2. Concrete-lined surface is assumed for the exisitng channel. Cement mortar surface without lining is designed for the proposed upgraded channel.
3. In reference to SDM Corrigendum No.1/2022, a 12.1% increment of collected runoff is added to the peak flow of the proposed channel as design allowance.

Appendix D PHOTO TAKEN AT THE VICINITY OF SUP1001474


6/12/2022

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E n c l o s u r e | 3

Revised Environmental Assessment

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D01 Environmental Assessment

S12A Rezoning Application – Request for Amendment to the Lung Yeuk Tau and Kwan Tei South OZP from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A)2" Zone at Various Lots in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau

Reference No. 7076933
Prepared for Carlton Woodcraft Manufacturing Ltd
4 June 2024

Document Control

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3	26 January 2024	LUO, KAICHAO	Alex GBAGUIDI	Alex GBAGUIDI
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This report is confidential and is provided solely for the purposes of supporting S12A Rezoning Application – Request for Amendment to the Lung Yeuk Tau and Kwan Tei South OZP from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A)2" Zone at Various Lots in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau. This report is provided pursuant to a Consultancy Agreement between SMEC Asia Limited ("SMEC") and Carlton Woodcraft Manufacturing Ltd, under which SMEC undertook to perform specific and limited tasks for Carlton Woodcraft Manufacturing Ltd. This report is strictly limited to the matters stated in it and subject to the various assumptions, qualifications and limitations in it and does not apply by implication to other matters. SMEC makes no representation that the scope, assumptions, qualifications and exclusions set out in this report will be suitable or sufficient for other purposes nor that the content of the report covers all matters which you may regard as material for your purposes.

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1 PROJECT BACKGROUND

1.1 Introduction

1.1.1 With reference to the latest policy address in developing the Northern Metropolis, it is aimed to optimise the use of land resources, adopt a higher development intensity and increase high-quality housing supply. In order to address the aforementioned needs, it is planned to redevelop a land comprising various lots in D.D. 83, and the 1,358m^2 adjoining government land, Lung Yeuk Tau, New Territories, into proposed flat, shop and services and eating place ("the Site" or "the Proposed Development"). The total site area is 22,445m^2.

1.1.2 The Site is currently zoned "Residential (Group C)" ("R(C)") and "Agriculture" ("AGR") under the Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan ("OZP") No. S/NE-LYT/19. It is planned to develop a commercial complex for shop and services and eating place, and Residential Development comprising five blocks for domestic use.

1.1.3 In this regard, a rezoning application under Section 12A of the *Town Planning Ordinance* ("TPO") to rezone the Site from "R(C)" and "AGR" zones to "Residential (Group A)2 ("R(A)2") zone under Column 1 shall be required. SMEC Asia Ltd ("SMEC") has been commissioned to conduct this Environmental Assessment ("EA") to support the application.

1.2 Site Description

1.2.1 The Site is located in a developed area in Lung Yeuk Tau, New Territories, which is a flat land used for workshop, storage and warehouses. Its northern part is currently occupied by a permanent domestic structure, temporary structures for open storage yards, storage of construction materials and workshops, open carparks and vacant land. The southern part is currently occupied by the Applicant for warehouse storage.

1.2.2 As shown on ***Figure 1-1***, Sha Tau Kok Road (Lung Yeuk Tau) Section is located to the immediate north of the Site that runs along the northeast-southwest direction. Across the opposite site of Sha Tau Kok Road (Lung Yeuk Tau) Section, there are San Wai Barracks, a recycling centre and some warehouses. The Site is mainly surrounded by Tung Chun Soy Sauce factory place and some vegetated land to the east, Queen's Hill Estate to the south, village houses and warehouses to the west, intermixed with temporary structures, scattered vegetated and abandoned land.

1.3 Project Description

1.3.1 The Proposed Development will tentatively comprise a commercial complex and a Residential Development with the following components:

- Five Residential Blocks
- One Clubhouse
- One Swimming Pool
- One Commercial Complex
- One Sewage Treatment Plant ("STP")

1.3.2 The tentative intake year of the Proposed Development is 2031.

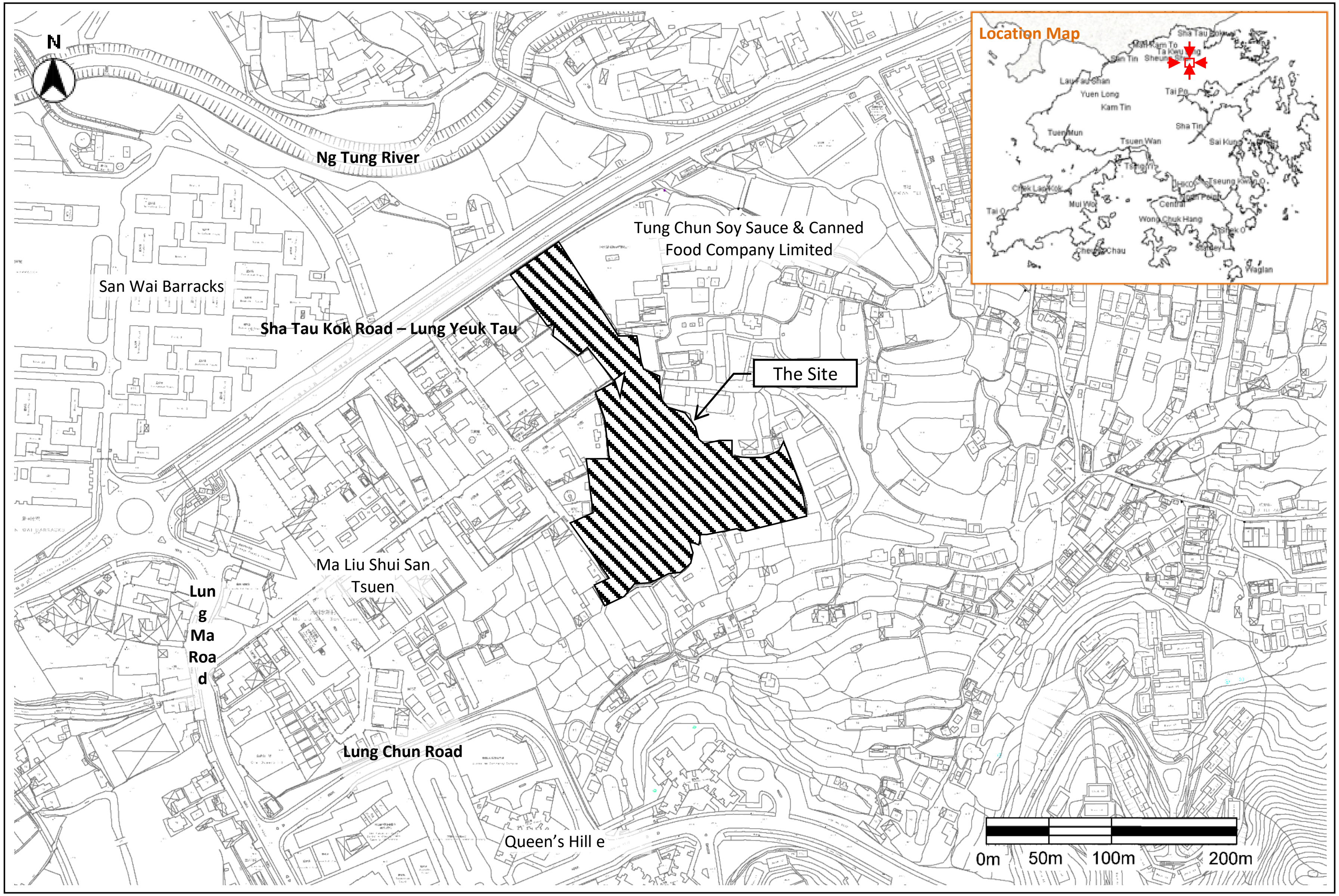
1.4 Objective of this Report

1.4.1 The objectives of this EA are to:

- Identify and qualitatively assess potential environmental impacts arising from surrounding emissions to the Site, as well as that arising from the operation of the Project Site to the nearby sensitive uses, in terms of air quality, noise, water quality and waste management.

- Mitigation measures have been recommended, where appropriate, to alleviate any identified environmental impacts or constraints during the operation of the Project. Potential environmental impacts during construction phase, thought transient, have also been reviewed and mitigation measures have been recommended to reduce any identified environmental impacts to acceptable levels.

Figure 1-1: Site Location and its Environs



2 AIR QUALITY

2.1 Introduction

2.1.1 This section assesses the potential air quality impacts that will be generated by the Project during the construction and its operation. On the other hand, potential air pollution problem arising from the surrounding of the Site is also evaluated. Mitigation measures are recommended, where necessary, as part of the assessment.

2.2 Environmental Legislation and Standards

Air Quality Objectives

2.2.1 The Air Quality Objectives ("AQOs") established under the *Air Pollution Control Ordinance* ("APCO") (Cap. 3.11) enacted from 1 January 2022 are given in ***Table 2-1***.

Table 2-1: Hong Kong Air Quality Objectives

POLLUTANT	AVERAGING TIME	PREVAILING AQOs	
		CONCENTRATION LIMIT [1] (µg/m^3)	NO. OF EXCEEDANCE ALLOWED
Sulphur Dioxide ("SO_2")	10-minutes	500	3
	24-hour	50	3
Respirable Suspended Particulates ("RSP" or "PM_{10}") [2]	24-hour	100	9
	Annual	50	N/A
Fine Suspended Particulates ("FSP" or "$PM_{2.5}$") [3]	24-hour	50	35
	Annual	25	N/A
Nitrogen Dioxide (NO_2)	1-hour	200	18
	Annual	40	N/A
Ozone ("O_3")	8-Hour	160	9
Carbon Monoxide ("CO") [4]	1-hour	30,000	0
	8-Hour	10,000	0
Lead ("Pb")	Annual	0.5	N/A

Notes:
1. All measurements of the concentration of gaseous air pollutants, i.e., sulphur dioxide, nitrogen dioxide, ozone and carbon monoxide, are to be adjusted to a reference temperature of 293 Kelvin and a reference pressure of 101.325 kilopascal.
2. RSP or PM10 means suspended particles in air with a nominal aerodynamic diameter of 10 µm or less.
3. FSP or PM2.5 means suspended particles in air with a nominal aerodynamic diameter of 2.5 µm or less.
4. The 8-hour mean of CO concentration is calculated based on Item 9 of Schedule 5 of APCO. The maximum daily 8-hour mean concentration of CO in air is selected by examining 8-hour running averages, calculated from CO hourly data and updated each hour, that is:
   (a) the first calculation period for a day is the period from 5pm on previous day to 1am on that day.
   (b) the last calculation period for a day is the period from 4pm to 12 midnight on that day.

Air Pollution Control (Construction Dust) Regulation

2.2.2 Enacted under Section 43 of the APCO, the *Air Pollution Control (Construction Dust) Regulation* defines notifiable and regulatory works to ensure effective dust abatement measures have been properly implemented to reduce dust emissions for a number of construction activities.

2.2.3 The Regulation requires that any notifiable work [Ref. #1] shall give advance notice to the Environmental Protection Department ("EPD"), and the contractor shall ensure that the notifiable and regulatory works are carried out in accordance with the Schedule of the Regulation. Dust control and suppression measures are also provided in the Schedule.

Air Pollution Control (Furnaces, Ovens and Chimneys) (Installation and Alteration) Regulations

2.2.4 Enacted under Section 43 of the APCO, the *Air Pollution Control (Furnaces, Ovens and Chimneys) (Installation and Alteration) Regulations* stipulate that a prior approval from EPD will be required if the total fuel consumption capacity of any fuel-burning equipment or its chimney on premises to be installed or altered exceeds (a) 25 litres ("L") of conventional liquid fuel per hour; or (b) 35 kilograms (kg) of conventional solid fuel per hour; or (c) 1,150 megajoules ("MJ") of any gaseous fuel per hour.

Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation

2.2.5 This Regulation requires Non-road Mobile Machinery ("NRMM"), except those exempted, to comply with the prescribed emission standards. 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. Only approved or exempted NRMMs with a proper label are allowed to be used in specified activities and locations including construction sites, container terminals and back up facilities, restricted areas of the airport, designated waste disposal facilities and specified processes.

Hong Kong Planning Standards and Guidelines (HKPSG)

2.2.6 The minimum buffer distances required between different types of roads and active open spaces are recommended in Chapter 9 Environment of *Hong Kong Planning Standards and Guidelines* ("HKPSG") and are summarised in ***Table 2-2*** for ease of reference.

Table 2-2: HKPSG Minimum Setback Distances

POLLUTANT	TYPE OF ROAD	BUFFER DISTANCE	PERMITTED USES
Road and Highways	Trunk Road and Primary Distributor	>20m	Active and passive recreation use
		3 – 20m	Passive recreational use
		<3m	Amenity areas
	District Distributor	>10m	Active and passive recreational use
		<10m	Passive recreational uses
	Local Distributor	>5m	Active and passive recreational use
		<5m	Passive recreational use
	Under Flyovers	-	Passive recreational use

Source: Adapted from Table 3.1 of Chapter 9 Environment of HKPSG.

2.2.7 The minimum buffer distances required between industrial chimneys and active open spaces are recommended in HKPSG as well. The relevant buffer distances of HKPSG are summarised in ***Table 2-3*** for ease of reference.

[1] Notifiable works include site formation, reclamation, demolition of a building, work carried out in any part of a tunnel that is within 100m of any exit to the open air, construction of the foundation of a building, construction of the superstructure of a building and road construction work.

Table 2-3: HKPSG Recommended Setback Distances from Industrial Chimneys

Pollution Source	Difference in Height between Industrial Chimney Exit and the Site	Buffer Distance	Permitted Uses
Industrial Chimneys	< 20m	> 200m	Active and passive recreation use
		5 – 200m	Passive recreational use
	20 – 30m	> 100m	Active and passive recreational use
		5 – 100m	Passive recreational uses
	30 – 40m	> 50m	Active and passive recreational use
		5 – 50m	Passive recreational use
	> 40m	> 10m	Active and passive recreational use

Source: Adapted from Table 3.1 of Chapter 9 Environment of HKPSG.

2.2.8 Minimum buffer distance of 200m is required between odour sources and sensitive use, as recommended in HKPSG.

2.3 Background Air Quality

2.3.1 The surrounding areas of the Site is generally located at a developed area in Lung Yeuk Tau, which are surrounded by warehouses, open storages, factories, a number of low-rise residential blocks located at its west and high-rise public estates to the south of the Site.

2.3.2 The major road networks at the surrounding of the Site include Sha Tau Kok Road (Lung Yeuk Tau) Section located to its north, Dao Yang Road and Hai Wing Road to the west of the Site.

2.3.3 To evaluate the background air quality of the Site, EPD air quality monitoring data from air quality monitoring station ("AQMS") at Northern District between 2021 and 2022, and air quality data from PATH v3.0 model (year 2025 at Level 1 of Grid cells (38,54) and (39,54)) were reviewed.

2.3.4 For the reviewed air quality monitoring data from monitoring station at Northern District, all the pollutant concentrations were compiled with the AQOs except ozone, as shown in ***Table 2-4***. For the air quality data from PATH model, all pollutant data are lower than the AQOs except ozone with the number of exceedances more than that allowed, as shown in ***Table 2-5***. *Annual Air Quality Monitoring Results Air Quality in Hong Kong 2022* states that ozone is a complex regional air pollution issue. Nevertheless, it is considered that the Site is not located in a severely polluted urban centre.

Table 2-4: Air Quality Monitoring Data from AQMS at Northern District [2]

POLLUTANT	PARAMETER	CONCENTRATIONS ($\mu g/m^3$)		PREVAILING AQOs ($\mu g/m^3$) [1]
		2021	2022	
SO_2	4th highest 10-minute	18	27	500 (3)
	4th highest 24-hour	7	7	50 (3)
RSP	10th highest 24-hour	62	50	100 (9)
	Annual	25	23	50
FSP	36th highest 24-hour	25	25	50 (35)

POLLUTANT	PARAMETER	CONCENTRATIONS (µg/m³)		PREVAILING
	Annual	15	14	25
NO_2	19th highest 1-hour	135	115	200 (18)
	Annual	36	31	40
O_3	10th highest 8-hour[3]	<u>**187**</u>	<u>**197**</u>	160 (9)

Notes:
1. Values in () indicate the number of exceedances allowed per year.
2. Data extracted from EPD Website (https://www.aqhi.gov.hk/en/download/air-quality-reportse469.html?showall=&start=1).
3. Bolded and underlined values represent exceedances of the AQOs.

Table 2-5: Air Quality Data from PATH v3.0 model at Level 1

POLLUTANT	PARAMETER	CONCENTRATIONS IN PATH GRIDS (µg/m³)		PREVAILING AQOs (µg/m³) [1]
		38,54	39,54	
SO_2	1st highest 10-minute	59	55	500 (3)
	4th highest 24-hour	11	11	50 (3)
RSP	10th highest 24-hour	66	64	100 (9)
	Annual	27	27	50
FSP	19th highest 24-hour	37	37	50 (35)
	36th highest 24-hour	24	23	50 (35)
	Annual	15	16	25
NO_2	19th highest 1-hour	99	88	200 (18)
	Annual	12	11	40
O_3	10th highest 8-hour[2]	<u>**206**</u>	<u>**206**</u>	160 (9)

Notes:
1. Values in () indicate the number of exceedances allowed under the AQOs.
2. Bolded and underlined values represent exceedances of the AQOs.

2.4 Assessment and Mitigation

Identification of Air Sensitive Receivers ("ASRs") and Impact

2.4.1 Based on the site visits conducted on 6 December 2022 and 18 January 2023, and the information on the survey map, several representative ASRs in the vicinity of the Site are identified, which are listed in ***Table 2-6*** and shown on ***Figure 2-1***. In addition, the Proposed Development itself is also identified as an ASR during the operation phase.

Table 2-6: Representative ASRs surrounding/ within the Site

ASR ID	DESCRIPTION	LAND USE	APPROX. SHORTEST DISTANCE TO SITE BOUNDARY (m)	ASSESSMENT HEIGHT (m)
A1	Tung Chun Soy Sauce & Canned Food Company Limited	Industrial	2	3
A2	Shun Cheong Electrical Products Factory Limited	Industrial	17	6
A3	No. 4 Dao Yang Road (恩基廬)	Residential	61	6
A4	No. 26 Hai Wing Road (英豪苑)	Residential	61	6
A5	Park Villa	Residential	3	6
A6	No. 31 Hai Wing Road (竹園)	Residential	1	6
A7	King Chong	Residential	1	6
A8	Domestic blocks within the Proposed Development	Residential	-	150
A9	Fresh air intakes of shopping arcade within the Proposed Development	Commercial	-	32
A10	Fresh air intakes of club house within the Proposed Development	Recreational	-	23

Construction Phase

2.4.2 Fugitive dust is the major impact that will be generated during construction activities, such as excavation, stockpiling, earth moving, transferring or handling of dusty materials, site formation, foundation and superstructure of the Proposed Development. Two-storey basement carpark and plant rooms will be constructed. Therefore, excavation works and stockpiling are expected in the construction stage. On the other hand, dust emission may raise from the demolition activity. In terms of mitigation, the detailed assessment of demolition and excavation extent can be found in the later Section 5.3. The total construction floor area (CFA) of existing structures on site is 5,484.2m^2. The excavation area is 15,810m^2. The volume of excavation material is 111,895m^3. The estimated maximum dump truck frequency during construction period is 8 trip per day.

2.4.3 With the implementation of mitigation measures that are recommended in the *Air Pollution Control (Construction Dust) Regulation*, dust generation can be controlled and significant fugitive dust impact is therefore not anticipated.

2.4.4 To avoid adverse dust impact on the air sensitive uses nearby, good practice and dust control measures to be implemented during the construction phase are as follows:

- Provide hard paving on open area, regular watering to reduce dust emissions from exposed site surfaces and unpaved roads, particularly during dry weather.
- The working area of any excavation or earth moving operation shall be sprayed with water immediately before, during and immediately after the operation so as to maintain the entire surface wet.
- Unpaved surface should be minimized. Exposed earth should be covered or paved as soon as the works have been completed.
- Frequent watering for particularly dusty areas and areas close to ASRs.
- Any stockpile of dusty materials shall be either covered entirely by impervious sheeting, placed in an area sheltered on the top and the 3 sides, or sprayed with water so as to maintain the entire surface wet.
- Dusty works and stockpiling near ASRs should be avoided.
- Where possible, dusty materials shall be sprayed with water immediately prior to any loading, unloading or transfer operation so as to maintain the dusty materials wet.

- The working area for the uprooting of trees, shrubs, or vegetation or for the removal of boulders, poles, pillars or temporary or permanent structures shall be sprayed with water immediately before, during and immediately after the operation so as to maintain the entire surface wet.
- All demolished items (including trees, shrubs, vegetation, boulders, poles, pillars, structures, debris, rubbish and other items arising from site clearance) that may dislodge dust particles shall be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides within a day of demolition.
- Tarpaulin covering of all dusty vehicle loads transported to, from and between site locations.
- Vehicle washing facilities including a high-pressure water jet shall be provided at every discernible or designated vehicle exit point. The area where vehicle washing takes place and the section of the road between the washing facilities and the exit point shall be paved with concrete, bituminous materials or hardcore.
- Provision of not less than 2.4m high hoarding from ground level along site boundary where adjoins a road, streets or other accessible to the public except for a site entrance or exit.
- Spray water on the surface of façade before and during grinding work.
- Site hoarding with sufficient height should be installed at the site boundary closed to the ASRs.
- Equip vacuum cleaner on grinder for façade grinding work as far as practicable.
- Main haul road shall be sprayed with water so as to maintain the entire road surface wet. Imposition of speed controls for vehicles on site haul roads and confine haulage and delivery vehicles to designated roadways inside the site.
- The portion of any road leading only to a construction site that is within 30m of a discernible or designated vehicle entrance or exit shall be kept clear of dusty materials.
- Where possible, routing of vehicles and positioning of construction plant should be at the maximum possible distance from ASRs.
- Haul road should be located away from ASRs.
- Every stock of more than 20 bags of cement or dry Pulverised Fuel Ash (“PFA”) should be covered entirely by impervious sheeting or placed in an area sheltered on the top and three sides.
- Plan the site layout to locate machinery and dust causing activities, including haul roads and stockpiling areas away from receptor as far as possible.
- Erect solid screens or barriers around dusty activities as far as practicable.
- Where possible, connect the construction plant and equipment to mains electricity supply and avoid use of diesel generator and diesel-powered equipment to minimize air quality impact arising from the equipment.

2.4.5 The construction contractors shall also provide regular maintenance of any plant and equipment so as to minimise gaseous emissions.

Concurrent Construction Project

2.4.6 Referring to North Committees Meetings Discussion Paper PWP Item No. B838CL – Site Formation Works for Public Housing Development at Queen’s Hill Extension, Fanling, the site formation of the public housing development at Queen’s Hill Extension has already commenced in 2023, and the construction of the public housing development is expected to be completed in 2030/2031. Besides, referring to Town Planning Board, there is another ongoing TPO Section 12A “Agriculture” and “Residential (Group C)” to “Residential (Group A)” rezoning application, Y/NE-LYT/15, other than the proposed development, Y/NE-LYT/16, at the Sha Tau Kok Road, Lung Yeuk Tau area. The status of the identified concurrent construction project is summarized in ***Table 2-7***.

Table 2-7: Concurrent Construction Project at Sha Tau Kok Road, Lung Yeuk Tau

Concurrent Construction Project	Status	Construction Period	Horizontal Distant to Proposed Development
Public Housing Development at Queen's Hill Extension, Fanling	commenced	2023 - 2030/2031	357m
Y/NE-LYT/15	under planning application	unknown	233m
Y/NE-LYT/16 (Proposed Development)	under planning application	completed in 2031 (tentatively)	-

2.4.7 The fugitive dust emission from the concurrent construction activities of multiple projects may cause cumulative air quality to the air sensitive receivers at Lung Yuek Tau area, inducing excessive health risk to the surrounding residents. Dust reduction measures should therefore be emphasized. The mitigation measures discussed in Section 2.4.6 shall be strictly implemented in the proposed development to supress the dust generation. Referring to Legislative Council PWSC (2022-23)34, mitigation measures, in terms of frequent cleaning, watering and provision of wheel-washing, would also be implemented for the Queen's Hill Extension Public Housing Project to control the environmental impact caused by the construction works in compliance to established standards and guidelines. Assuming the similar measures will be adopted on the construction stage of Y/NE-LYT/15 (which is unknown) as standard practice in Hong Kong, the dust emission of those concurrent construction sites is expected to be minimized.

2.4.8 To ensure the compliance of air quality objective, an Environmental Monitoring and Auditing (EM&A) program associated with event action plan should be implemented to monitor the dust impact arising from the construction activities associated with the proposed development at the construction stage. The concentration of respirable suspended particulate shall be measured at the site boundary right after the commencement of construction of proposed project. Remedial action should be immediately taken if the 24-hour averaging RSP concentration exceeds 100µg/m^3.

2.4.9 With proper dust control measures and monitoring program as described above, significant fugitive dust impacts during the construction phase are not anticipated.

Operation Phase

Industrial Emissions

2.4.10 A site visit was conducted on 18 January 2023 and 12 June 2023 to identify the potential air pollution sources in the vicinity of the Site. Based on the site visit, no active chimney or dusty use was identified within 200m from the Site. Therefore, the buffer distance between industrial chimneys and air sensitive uses recommended in Table 3.1 of Chapter 9 in HKPSG has been satisfied. No adverse air quality impact from industrial emissions is therefore anticipated.

Vehicular Emission from Open Road

2.4.11 Sha Tau Kok Road (Lung Yeuk Tau), Lung Ma Road, Lung Chun Road, Hai Wing Road, Dao Yang Road have been identified as the major open roads within the 500m assessment area.

2.4.12 The Annual Traffic Census 2022 (ATC 2022) has classified Sha Tau Kok Road (Lung Yeuk Tau) as Rural Road, and Lung Ma Road as Local Distributor. For the roads that are not mentioned in ATC 2022, their road types could not be classified by the Transport Department. As an alternative method, reference is made to Transport Planning and Design Manual (TPDM) Version 2021 Volume 2 Chapter 3 – Road Characteristics to determine their road types. Lung Chun Road should be classified as Local Distributor as it is enclosed by Lung Ma Road. Hai Wing Road and Dao Yang Road is classified as Feeder Roads as they connect the low rising industrial or residential blocks at the vicinity of the Site to Sha Tau Kok Road.

2.4.13 As shown in Table 2-2, HKPSG Chapter 9 has provide guidelines for the minimum buffer distance required between roads and active open spaces. A buffering distance of 5m will be adopted for Lung Ma Road and Lung Chun Road because they are local distributor. Since HKPSG Chapter 9 does not cover the buffering distance requirement for Feeder Road and Rural Road, the adoption of buffering distance should take vehicle flow into consideration as air pollution is directly associated with traffic. 5m buffering distance as conservative approach will be adopted for Hai Wing Road, and Dao Yang Road because the traffic flow at Hai Wing Road and Dao Yang Road is expected to decrease significantly after being intercepted by Proposed Development. 20m buffering distance will be adopted to Sha Tau Kok Road because the forecasted traffic flow there has reached 2,500 vehicle/hour as shown in Appendix D and there is planned upgrade for Sha Tau Kok Road.

2.4.14 The buffer distance requirements between air sensitive uses and the major roads in the vicinity of the Site are summarised in ***Table 2-8***, and the buffering distance of the identified major open roads are drawn in Figure 2-2.

Table 2-8: The Buffer Distance Requirements between Air Sensitive Uses and Roads in the Vicinity of the Site

ROAD NAME	ROAD TYPE	BUFFER DISTANCE REQUIREMENTS (m)	COMPLY WITH BUFFER DISTANCE REQUIREMENTS?
Hai Wing Road	Feeder Road	5	Yes
Dao Yang Road	Feeder Road	5	Yes
Lung Ma Road	Local Distributor	5	Yes
Lung Chun Road	Local Distributor	5	Yes
Sha Tau Kok Road	Rural Road	20	Yes

2.4.15 As illustrated on ***Figure 2-3***, the entire site area could satisfy the buffer distance summarised in ***Table 2-8***. As such, no adverse air quality impact arising from vehicle emissions on the air sensitive uses of the proposed development is anticipated.

Odour Impact from Surrounding Uses

2.4.16 Tung Chun Soy Sauce & Canned Food Company Limited ("Tung Chun Soy Sauce Factory") is located to the adjacent north-east of the Site, at approximately 57m to the nearest residential block of the Proposed Development. Site visits conducted on 6 December 2022 and 18 January 2023 confirmed that no odour is noticeable at the boundary of the Site. To further identify any potential odour impact, another site visit was made on 12 June 2023 (i.e. during hot and humid season). According to the weather monitoring data on 12 June 2023 at the nearby Ta Kwu Ling station, the daytime temperature was above 30 degrees Celsius, the relative humidity during daytime ranged from 60 to 75 percent, wind direction was east. Even though the weather condition on that day should be favourable for odour generation and diffusion from the soy sauce factory to the site, no odour nuisance was identified inside Site area and at the entrance of the soy sauce factory. In addition, regional office of EPD was contacted to review if any complaint record for the odour impact from the factory. Email reply confirmed that no complaint was made on the factory. Information request letter and reply from EPD are attached in ***Appendix A***. No active chimney was identified at the factory. As such, odour impact from the Tung Chun Soy Sauce Factory upon the Proposed Development is not anticipated.

2.4.17 Nevertheless, the fresh air intake for the ventilation system of the proposed Shopping Arcade shall be located away from the Tung Chun Soy Sauce Factory, and they shall also be located at high elevation to enhance quality of the air to be extracted for indoor air flushing. Activated carbon filters are recommended to be installed at fresh air intakes of the mechanical ventilation system to alleviate any potential odour impact at the Proposed Development.

2.4.18 The Sha Tau Kok Road Ma Liu Shui San Tsuen Sewage Pumping Station is located at over 180m to the nearest residential block of the Proposed Development. As observed during site visit, the sewage pumping station is fully enclosed with concrete and no odour is noticeable at the pumping station. Therefore, no adverse odour impact arising from the sewage pumping station on the Proposed Development is anticipated.

Odour Impact from the Proposed On-site STP

2.4.19 A sewage treatment plant (STP) with 5,000m^3/day design capacity is proposed to treat the sewage discharge of the Proposed Development, which may result in potential odour impact to the existing ASRs and the operation of the Proposed Development. The preliminary design of the STP is shown in the Sewage Impact Assessment.

2.4.20 Sewage smells naturally and under septic condition generates obnoxious hydrogen sulphide gas characterized by its rotten egg smell. Even though fresh water will be used for flushing in the proposed development for the lack of seawater supply, and the generation of hydrogen sulphide (H_2S) is expected to be lower than other sewerage treatment works in Hong Kong, the control on odour deserves emphasized in the proposed development because of the close distance between STP and the planned air sensitive receivers. In reference to Environmental Impact Assessment Ordinance Technical Memorandum (EIAO-TM) Annex 4 Criteria for Evaluating Air Quality Impact and Hazard to Life, the predicted odour nuisance at air sensitive receivers should not be greater than the guideline of 5 odour units based on an average time of 5 seconds. Despite this project is not classified as EIA designated project, the proposed STP shall be designed to satisfy the odour criteria within the EIAO-TM to prevent nuisance. At this stage, the key odour sources of the STP include the sewage treatment sludge, chemical input for the treatment, and the treatment process, with probably the potential impact on nearby air sensitive receivers (ASRs).

2.4.21 Three types of mitigation measures in reducing odour nuisance from the sewage treatment works are commonly implemented. These include:

- Dosing of chemicals, like calcium nitrate, ferric chloride, sodium chlorite and other deodourising agents, and injection of oxygen into sewage / sludge to control the generation of odour;
- Covering up of channels, chambers and tanks which are likely to emit odour;
- Installing deodourisation units like activated carbon system, chemical scrubbers and biofilters at appropriate locations to clean up the collected foul gases from odour sources in the plants.
- Activated sludge recycling and oxidized nitrogen recycling could be combined to prevent the emissions of H_2S and acetic acid from the primary settler during the sewage treatment could also be adopted as cost-effective strategies for the control of malodorous emissions.

2.4.22 Depending on the type of treatment operation in a sewage treatment works, and the characteristics of its surrounding and the incoming sewage flow, one or a set of combinations of the above three types of measures in the sewage treatment works could be adopted with a view to meeting the odour standard. Based on the common practice in Hong Kong, the odour removal efficiency of the deodourizing unit is proposed to be at least 99.5% to avoid nuisance to the public. The treated air discharge points will be located away from the nearby ASRs as far as practicable.

2.4.23 To ensure that all odour control systems are in proper working condition, their performance is closely monitoring and proper maintained, like timely replacement of odour absorption media such as activated carbon in the deodourisers is ensured. The provision of odour mitigation measures together with good operational practices have been proven to be very effective in controlling odour nuisance from sewage treatment facilities.

2.4.24 Sewage treatment works occasionally experience shock odour load arising from the fluctuating composition of incoming sewage. This may result in short term strong odour emission. The source of such shock load is very difficult to trace. If the sources can be identified, appropriate actions to avoid reoccurrence will be taken.

2.4.25 As the indication of odour level, H_2S concentration should be regularly measured in sewage treatment works to monitor the performance of the odour control measures. Referring to AEIAR-207/2017, regular removal of the sludge cake and cleaning of sludge holding tank should be adopted by the project team.

2.4.26 Operational adjustment, like adding more chemical or increasing the air changing rate of the deodorisers, would be done in the sewage treatment works to tackle any variations in operating environment. In case there are or will be major variations which could not be handled by operational adjustments alone, upgrading works will be considered. Exhaust air flow rate, temperature of exhaust, odour emission rate of the deodorization systems should be monitored during the commissioning test.

2.4.27 The project team will put strong emphasis at the detailed design stage on mitigating odour nuisance. The STP operation management system will be design to ensure allow to identify operational abnormality as far as odour nuisance is concerned, so that prompt operational adjustment or enhancement works could be put in place.

2.4.28 In addition, odour monitoring system should be set up to minimize the odour impact during the operation of the STP. Especially, exhaust air flow rate, temperature of exhaust, odour emission rate of the deodorization systems should be monitored. Weekly monitoring of odour emission at the exhausts by taking odour samples is recommended to be conducted in the first two months of the first year of the operation in reference to AEIAER-207/2017. Frequency of odour monitoring should not be reduced unless long term full compliance is observed.

2.4.29 According to the odour assessment result in the AEIAR-207/2017, the maximum 5-second averaged odour concentration around the 10,000m^3/day design capacity Sha Tau Kok Sewage Treatment Work Phase 2 (STKSTW Phase 2) will cap at 0.13OU/m^3, which is well below the detection threshold criterion 1 OU/m^3. Since the design capacity of the onsite STP in this project is half of the design capacity of STKSTW Phase 2, the demands on equipment sizing of the proposed STP is expected to be lower, and the odour generation from the proposed STP is also expected to be lower than STKSTW Phase 2. Since the odour assessment result in AEIAR-207/2017 indicates that the odour impact from sewage treatment plants can be effectively mitigated to acceptable level, it is very likely that the odour impact from the proposed STP in this project will not be adverse with implementation of similar mitigation measures.

Underground Carpark

2.4.30 The *Environmental Protection Department Practice Note for Professional Persons - Control of Air Pollution in Car Parks* (ProPECC PN 2/96) provides guidance on the control of air pollution in car parks including air quality guidelines required for the protection of public health; and factors that should be considered in the design and operation of car parks in order to achieve the required air quality.

2.4.31 The proposed 2-storey carpark of the Proposed Development with 485 spaces for private car will be located at basement. To minimize the air quality impact on the nearby ASRs, the exhaust/opening/ingress/egress of the carpark will be faced and located away from the nearby ASRs as far as practicable. The proposed carpark will be designed and built in accordance with the requirements and appropriate mitigation measures stipulated in ProPECC PN 2/96. No major air quality impact from the Proposed Development on nearby sensitive uses during operational phase is expected.

2.5 Conclusion

2.5.1 With the implementation of the recommended mitigation measures and good site practice, adverse air quality impacts during the construction phases are not anticipated.

2.5.2 No adverse air quality impact on the Proposed Development from industrial emission and vehicular emissions is anticipated with the implementation of the proposed mitigation measures during the operation phase. Meanwhile, the operation of the Proposed Development will not cause any adverse air quality impact on the surrounding air sensitive uses.

2.5.3 Overall, therefore, no adverse air quality impacts are anticipated during the construction and operation phases of the Site.

Figure 2-1: Locations of Representative Air Sensitive Receivers

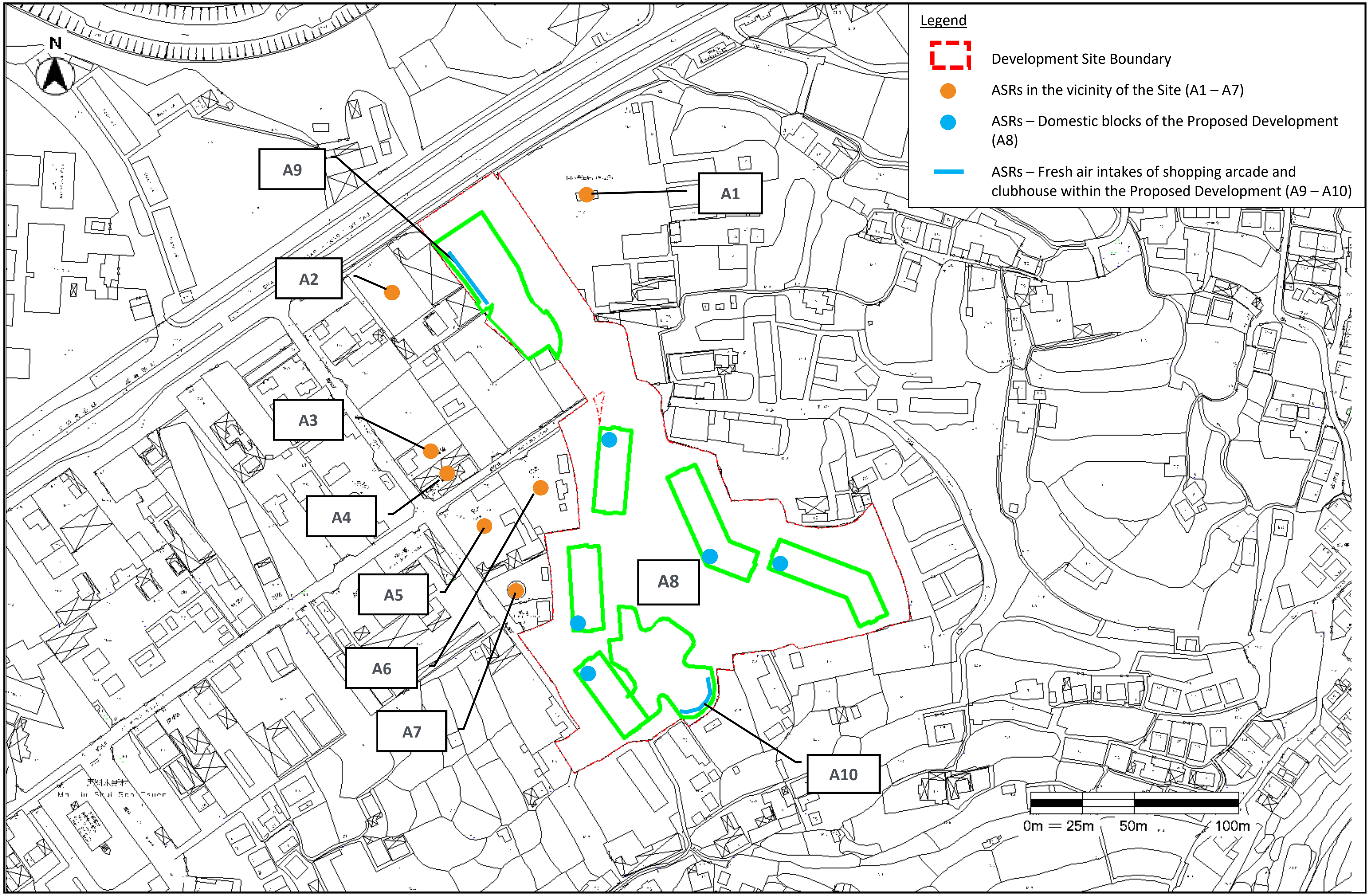


Figure 2-2: Buffering Distance of Identified Major Road

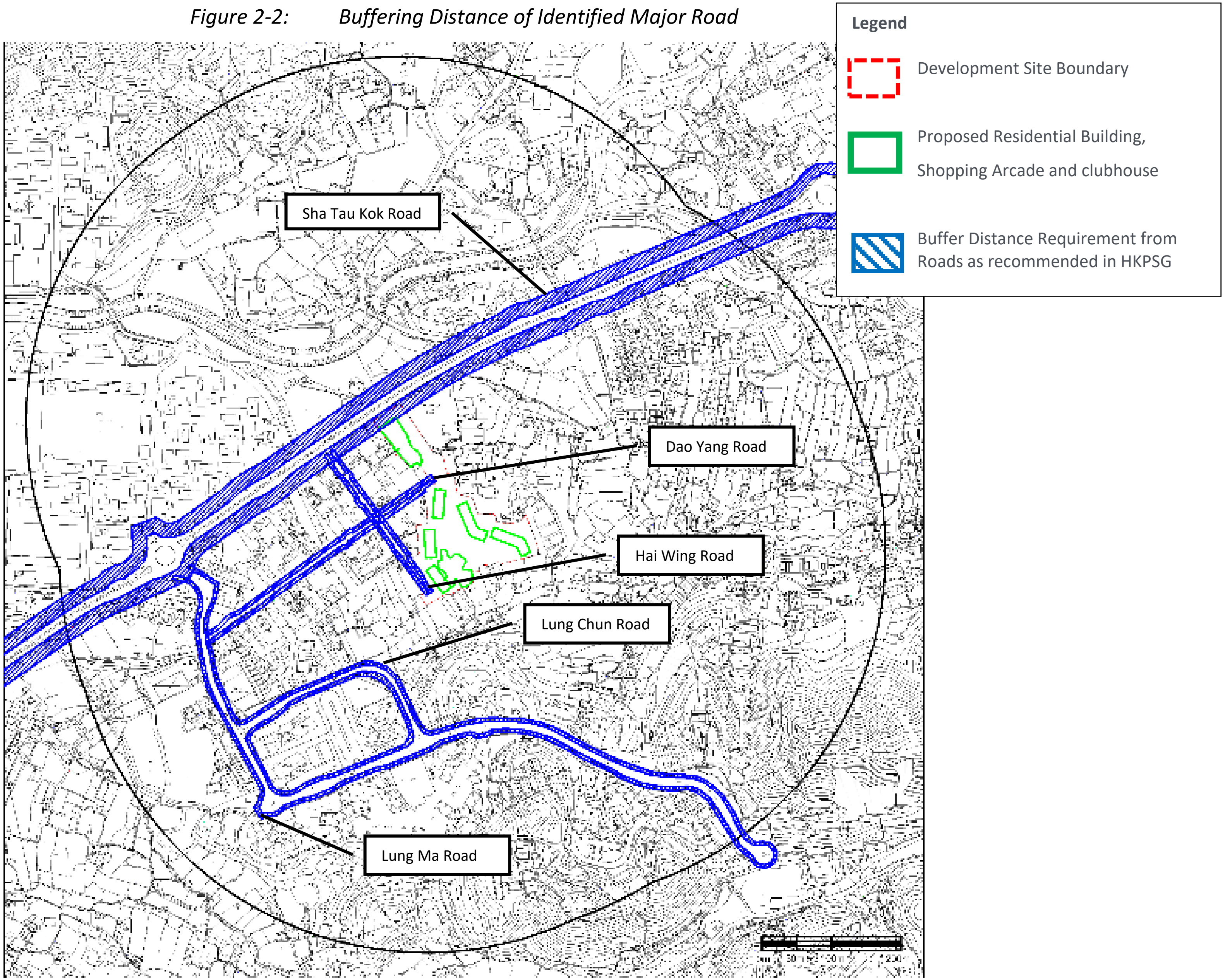
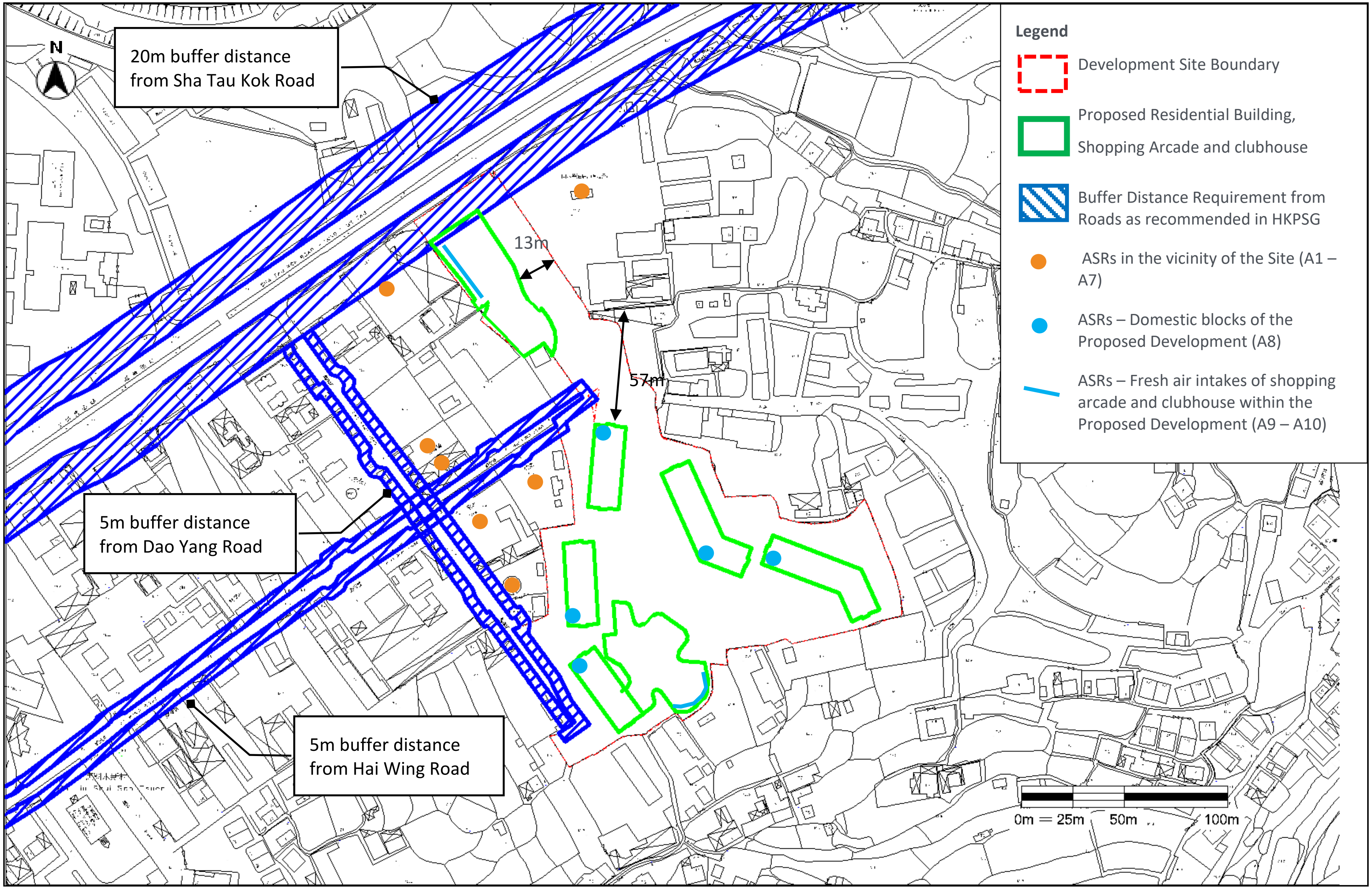


Figure 2-3: Shortest Horizontal Distances Between Nearby Roads and Site Boundary



3 NOISE IMPACT

3.1 Introduction

3.1.1 The potential noise impacts in associated with the Project during the construction and operation phases are assessed in the section. Mitigation measures are recommended where required.

3.1.2 Construction noise is considered to be the major source of potential noise impact during the construction stage of the Project and is assessed in the following sections with relevant standard and criteria.

3.1.3 The Proposed Development is a potential noise sensitive receiver of traffic noise impact during operational phase. Road traffic noise impact on the Proposed Development has been quantitatively assessed with a study area of 300m from the Proposed Development. Mitigation measures are proposed to mitigate any adverse noise impact.

3.1.4 Apart from traffic noise impact, potential fixed plant noise during the operation phase has also been assessed in the following sections with relevant standard and criteria.

3.1.5 Within this Environmental Assessment, as the proposed residential buildings (Tower 1, 2, 3, 4, 5) are all located around the site boundary, they will be selected as the Noise Sensitive Receivers (NSRs) in the following noise assessment.

3.2 Environmental Legislation and Standards

Noise Control Ordinance (Cap. 400)

3.2.1 The main piece of legislation controlling environmental noise nuisance is the *Noise Control Ordinance* ("NCO"). The NCO enables regulations and Technical Memoranda ("TMs") to be made, which introduce detailed control criteria, measurement procedures and other technical matters. The relevant TMs include:

- Technical Memorandum on Noise from Percussive Piling ("PP-TM")
- Technical Memorandum on Noise from Construction Work other than Percussive Piling ("GW-TM")
- Technical Memorandum on Noise from Construction Work in Designated Areas ("DA-TM")
- Technical Memorandum for the Assessment of Noise from Places Other Than Domestic Premises, Public Places or Construction Sites ("IND-TM")

3.2.2 According to EPD's Plan No. EPD/AN/NT-02 for Tai Po, Fanling, Sheung Shui and Sha Tau Kok, the Site is entirely located within a Designated Area (DA) and so the DA-TM is applicable.

3.2.3 A Construction Noise Permit ("CNP") must be obtained by the contractor for any percussive piling at any time. CNP must also be obtained for the use of any Powered Mechanical Equipment ("PME") within restricted hours as defined in the NCO (for all days 7pm to 7am the next day and at all times on general holidays or Sundays).

3.2.4 In addition to a CNP, hand-held breakers having a mass of above 10kg and any air compressor capable of supplying compressed air at 500kPa or above for carrying out construction work must be fitted with a Noise Emission Label ("NEL") issued under the *Noise Control (Hand Held Percussive Breakers) Regulations and the Noise Control (Air Compressors) Regulations* of the NCO.

3.2.5 There is no statutory control for noise arising from construction activities (other than percussive piling) during normal working hours (7am to 7pm from Monday to Saturday, not including general holidays). Nevertheless, *Professional Persons Environmental Consultative Committee* ("ProPECC") *Practice Note PN1/23 Minimizing Noise from Construction Activities* ("ProPECC

PN1/24") recommends the noise criteria as shown in ***Table 3-1*** and guideline to minimise the potential construction noise impact during normal working hours.

Table 3-1: Construction Noise Criteria for Non-Restricted Hours

NOISE SENSITIVE RECEIVERS	L_{eq}(30min)* dB(A)
All domestic premises Temporary housing accommodation Hotels Convalescences homes Home for the aged	75
Places of public worship Courts of law Hospitals and medical clinics	70
Educational institutions (including kindergartens and nurseries)	70 (65 during examination)

3.2.6 Referring to the Table 4.1 of HKPSG Chapter, the criteria for fixed noised sources should be taken as 5 dB(A) below the appropriate Acceptable Noise Levels shown in Table 2 of the Technical Memorandum of Noise from Places Other than Domestic Premises, Public Places or Construction Sites or as the prevailing background noise levels. Table 2 of IND-TM stipulates the day, evening and night time Acceptable Noise Levels ("ANLs") for Noise Sensitive Receivers ("NSRs") according to the corresponding Area Sensitive Rating ("ASR"), which is determined by Influencing Factors ("IFs") in accordance with the IND-TM. These are summarized in ***Table 3-2*** and ***Table 3-3*** .

Table 3-2: Area Sensitivity Ratings

TYPE OF AREA CONTAINING NSR	DEGREE TO WHICH NSR IS AFFECTED BY IF		
	NOT AFFECTED	INDIRECTLY AFFECTED	DIRECTLY AFFECTED
i) Rural area, including country parks or village type developments	A	B	B
ii) Low density residential area consisting of low-rise or isolated high-rise developments	A	B	C
iii) Urban Area	B	C	C
iv) Area other than those above	B	B	C

Table 3-3: Acceptable Noise Levels for Fixed Noise Source

TIME PERIOD	ANL, dB(A)		
	ASR "A"	ASR "B"	ASR "C"
Day (0700 to 1900 hours) Evening (1900 to 2300 hours)	60	65	70
Night (2300 to 0700 hours)	50	55	60

3.2.7 The Site is located in a low-density residential area consisting of some low-density residential developments in the vicinity, the site should be classified as "Type (ii) Low density residential area" according to the IND-TM. The Site is not affected by any IFs, ASR "A" shall be considered.

Hong Kong Planning Standards & Guidelines ("HKPSG")

Planned Fixed Noise Source

3.2.8 The noise criteria for planned fixed noise source shall follow the requirements of Table 4.1 of Chapter 9 of HKPSG:

(a) 5dB(A) below the appropriate ANLs shown in Table 2 of IND-TM, or

(b) the prevailing background noise levels.

3.2.9 To identify prevailing background noise levels during day/evening time and night time at the site, noise measurements were conducted on 20 and 23 June 2023. Two measurement locations namely B1 and B2, as shown on ***Figure 3-1***, were selected to represent the prevailing noise environment. The measured background noise levels are summarised in ***Table 3-4***.

Table 3-4: Noise Criteria for Planned Fixed Noise Sources

TIME PERIOD	BACKGROUND NOISE LEVEL, $L_{Aeq30min}$ dB(A)		HKPSG NOISE CRITERIA [i.e. ANL – 5 dB(A)], dB(A)	NOISE CRITERIA, dB(A)
	B1	B2		
Day (0700 to 1900 hours)	50	55	55	50
Evening (1900 to 2300 hours)	48	49	55	48
Night (2300 to 0700 hours)	47	46	45	45

Noted: Façade correction of +3dB(A) has been applied to the measured background noise level.

3.2.10 Referring to ***Table 3-4***, the prevailing background noise during day/evening time is lower than the HKPSG noise criteria, while prevailing background noise during night time is higher than HKPSG noise criteria. Therefore, the noise criteria for planned fixed noise sources as presented in ***Table 3-4*** should be followed.

Road Traffic Noise

3.2.11 As recommended in Table 4.1 of Chapter 9 Environment of HKPSG, standards for road traffic noise in terms of $L_{10(1\text{-}hr)}$ for the following uses relying on opened windows for ventilation are shown in ***Table 3-5***.

Table 3-5: Summary of Road Traffic Noise Standards

USES	NOISE CRITERIA $L_{10(1\text{-}hr)}$, dB(A)
All domestic premises including temporary housing accommodation	70
Hotels and hostels	70
Offices	70
Educational institutions including kindergartens, child care centres and all others where unaided voice communication is required	65
Places of public worship and courts of law	65
Diagnostic rooms and wards of hospitals, clinics, convalescences and residential care homes for the elderly	55

3.2.12 All the office uses of the Proposed Development will not rely on prescribed window for natural ventilation and so the above traffic noise standard of 70dB(A) does not apply to the office uses.

3.3 Construction Noise Impact

3.3.1 Various construction activities will be the key noise sources generated during the construction phase. In particular, the use of PME and the vehicle movement within the Site are the major potential noise sources.

3.3.2 Construction shall be carried out during non-restricted hours as far as practicable. The mitigation measures recommended in ProPECC PN1/24 should be implemented where applicable. In addition, the following measures and on-site practice are recommended in order to minimise the potential construction noise impacts during daytime:

- Quiet PME and construction method should be adopted if possible.
- The Contractor shall devise and execute working methods to minimise the noise impacts on the surrounding sensitive uses, and provide experienced personnel with suitable training to ensure that those methods are implemented.
- Switch off idling equipment.
- Regular maintenance of equipment.
- Fit muffler or silencer for equipment.
- Noisy equipment and noisy activities should be located as far away from the NSRs as is practical.
- Use quiet construction method, e.g. use saw-cut or hydraulic crusher instead of excavator-mounted percussive breaker.
- PME should be kept to a minimum and the parallel use of noisy equipment / machineries should be avoided.
- Erect noise barriers or noise enclosure for the PME if appropriate.
- Implement good house-keeping and provide regular maintenance to the PME.
- Spot check resultant noise levels at nearby NSRs.

3.3.3 If construction work involving use of PME will be required during restricted hours, a CNP shall be applied for under the NCO. The noise criteria and assessment procedures for obtaining a CNP are specified in GW-TM.

3.3.4 With the implementation of the abovementioned mitigation measures, adverse construction noise impact is not anticipated.

3.4 Fixed Noise Impacts during Operation

Existing Fixed Noise Sources Impact

3.4.1 According to the desktop study and site surveys conducted in January and June 2023, some fixed noise sources were identified near the Site. Description of the identified noise sources are summarized in ***Table 3-6***. The locations are shown on ***Figure 3-2***.

Table 3-6: Identified Fixed Noise Sources

ID	FIXED NOISE SOURCES	DESCRIPTIONS
S1	Shun Cheong Electrical Products Factory Ltd	According to the site surveys, loading/unloading activities were observed during day time. No night-time operation was observed. On-Site noise measurement was conducted to estimate the sound power level from the noisy activities. The corrected sound power level of 102dB(A) was adopted in the assessment. Detailed calculation is provided in ***Appendix B***.

ID	FIXED NOISE SOURCES	DESCRIPTIONS
S2	Fanling Environmental Recycling Limited	According to the site surveys, sorting and loading/unloading activities were observed during day time. No night-time operation was observed. On-Site noise measurement was conducted to estimate the sound power level from the noisy activities. The corrected sound power level of 109dB(A) was adopted in the assessment. Detailed calculation is provided in ***Appendix B***.
S3	Tung Chun Soy Sauce and Canned Food Company Limited	During the site surveys, no any mechanical equipment was observed. And no auditable noise from this source was noticed. Therefore, the noise impact from Tung Chun Soy Sauce and Canned Food Company Limited is not anticipated.
S4	Riches Profit Logistics (HK) Limited	The logistics company is enclosed by steel structure. And no auditable noise was noticed. Therefore, the noise impact from Riches Profit Logistics (HK) Limited is not anticipated.

Assessment Methodology

3.4.2 Several assumptions were adopted in the calculation as follows:

- All identified fixed noise sources operate simultaneously.
- As a conservative approach, the shortest horizontal distance between identified fixed noise source and representative NSRs was adopted in the Corrected Noise Level ("CNL") calculation.
- As a conservative approach, it is assumed that there is no screening effect between the fixed noise sources and NSRs.
- Site visit confirmed that all the fixed noise sources are in operation continually, so no intermittency for all fixed noise sources is adopted in the noise calculation.
- Site visit also confirmed that noise from the identified fixed noise sources rise and fall gradually but not impulsive in nature, therefore impulsiveness is not adopted in the noise calculation.

3.4.3 The CNL from identified fixed noise sources have been assessed based on the following formula:

$$CNL = SWL + DC + FC$$

Where:

CNL = Corrected Noise Level at NSR, in dB(A)

SWL = Calculated sound power level of fixed noise sources, in dB(A)

DC = Distance correction, -(20 log (distance between source and NSR)+8) dB(A)

FC = Façade correction, +3 dB(A)

Assessment Result

3.4.4 As shown on ***Figure 3-3***, three representative NSRs (R1 to R3) were identified for fixed noise impact assessment arising from existing fixed noise sources. The results are summarized in the table below. Detailed calculation is provided in ***Appendix B***.

Table 3-7: Predicted Cumulative Fixed Noise Levels at the NSRs

NSR ID	PREDICTED NOISE LEVELS, dB(A)	NOISE CRITERIA, dB(A)
R1	57	60
R2	60	
R3	59	

3.4.5 The predicted cumulative noise level is not greater than the noise criteria. Therefore, no adverse noise impact from the surrounding fixed noise sources on the proposed development is anticipated.

Planned Fixed Noise Sources Impact

3.4.6 For the fixed plant noise impacts that will be generated within the Proposed development, most of Electrical and Mechanical ("E&M") equipment such as emergency generators, water pumps including Fire Services ("FS") pumps and transformer of the Proposed Development will be enclosed or located within the building structures. It is anticipated that the noise impacts from these noise sources to the off-site NSRs will be relatively low and insignificant.

3.4.7 For the Heating, Ventilation and Air Conditioning ("HVAC") system, split-type air conditioners and/or window-type air conditioners will be selected and installed at the residential units. The power ratings of these systems are considered as small and the potential noise impact to the offsite NSRs shall be minimal.

3.4.8 The proposed sewage treatment plant (STP) will be located at the basement 1st floor of the shopping arcade. The enclosed indoor environment is expected to confine the noise emitted from the STP during its operation phase. As the shopping arcade itself is not identified as a Noise Sensitive Receiver, the noise impact from the proposed STP can be neglected.

3.4.9 Besides, central air conditioning will be provided for the club house and shopping arcade of the Proposed Development. The chillers for central air conditioning will be installed at roof tops of the buildings in the Site. The indicative locations of proposed outdoor units and the representative NSRs are shown on ***Figure 3-4***.

3.4.10 As the sound power level of the proposed outdoor units is not available in this stage, therefore, the noise impact from concerned outdoor units upon the NSRs cannot be assessed in this stage. Instead, the maximum allowable sound power level ("SWL") of the outdoor units is determined in order to ensure the compliance of statutory requirements and HKPSG.

3.4.11 In general, the outdoor units would start and stop gradually. The effect of impulsiveness would be unlikely be occurred. As there will be no sporadic or intermittent events during operation of the ventilation system, the correction for intermittency would not be applied. In addition, the outdoor units will be properly maintained by the operator of the proposed development. Therefore, the effect of tonality, impulsiveness and intermittency is unlikely to be occurred.

3.4.12 With the assumption of placing the outdoor units on the roof of the club house and shopping arcade, same noise levels for two assessed outdoor units, the detailed calculation for the potential NSR has been carried out and presented in ***Appendix C*** and summarized in ***Table 3-8***. Tower 1 of the proposed residential building (denoted as F1), No. 31 Hai Wing Road (denoted as F2) and Tower 3 of the proposed residential building (denoted as F3) have been selected as the representative Noise Sensitive Receiver for the planned noise source evaluation because they are the closest NSRs to the proposed shopping arcade or clubhouse.

Table 3-8: Maximum Allowable Sound Power Level of the Proposed Outdoor Units

TIME PERIOD	NOISE CRITERIA, dB(A)	MAXIMUM ALLOWABLE SWL, dB(A)
Day Time	50	84
Evening Time	48	82
Night Time	45	79

3.4.13 The above calculation shows that the maximum allowable sound power level is 84dB(A) during day time, 82 dB(A) during evening time and 79dB(A) during night-time for each proposed outdoor units and should be followed in order to avoid adverse operational noise impact upon the surrounding NSR. In reference IND-TM, if the noise emitted by the proposed outdoor units is tonal or intermittent, the allowable sound level requirements shown in Table 3-8 shall be further tightened accordingly. As the design layouts have not been finalized at this stage, the maximum allowable SWL is subject to change. To reduce the noise nuisance to the residents, the opening of the noise source shall be oriented away from the nearby NSRs, and any practicable mitigation measure to reduce the residual noise impact should be considered.

3.4.14 Nevertheless, the actual noise impact from the fixed noise sources shall be subject to the selected model, brand of the equipment and the locations to be placed. The design consultant/ E&M consultant/ contractor should ensure the compliance of planning and statutory standards for operational noise impacts in the detailed design stage. The requirements for compliance of the HKPSG criteria can make reference to the above calculation.

3.5 Traffic Noise Impacts during Operation

3.5.1 A quantitative road traffic noise impact assessment has been carried out to demonstrate the feasibility of the proposed design of the Project in terms of road traffic noise impact.

Assessment Methodology

Noise Prediction Methodology

3.5.2 The peak hour road traffic noise levels have been predicted using a computer noise model, RoadNoise, which mainly follows the prediction procedures of the UK Department of Transport's *Calculation of Road Traffic Noise* ("CRTN"), as recommended in Chapter 9 Environment of HKPSG.

Noise Source

3.5.3 The assessment was carried out based on the projected peak hourly traffic flows in 2046, which corresponds to the maximum projected traffic conditions within 15 years of occupancy of the Proposed Development, anticipated to be commenced in 2031. All road sections with free flow traffic situated within 300m of the Proposed Development have been considered. Traffic forecasts provided by the Project Traffic Consultant were adopted to assess the traffic noise impact at the Site. Detailed peak hour traffic forecasts for the assessment year of 2046, TD's endorsement letter and traffic consultant's confirmation letter are provided in ***Appendix D***.

3.5.4 The proposed development is expected to introduce additional traffic flow the existing condition. Referring to the Traffic Impact Assessment within the planning statement, the daytime averaging hourly traffic flow at Sha Tau Kok Road - Lung Yeuk Tau will be increased to 1733 PCU. This value will replace the original Sha Tau Kok Road traffic flows in the mentioned Traffic Forecast as the input of Traffic noise impact assessment. Sha Tau Kok Road will be the major entrance of the vehicle enter and exit the proposed development project upon its completion. By taking the increased traffic flow in Sha Tau Kok Road into consideration, the traffic noised impact induced by the proposed development has been quantitively included.

Noise Sensitive Receivers ("NSRs")

3.5.5 The noise sensitive uses e.g. living rooms and bedrooms of the residential blocks are considered to be NSRs of road traffic noise impact. All noise sensitive uses other than the residential units (e.g. management office) will be equipped with air conditioning system and will not rely on opened window for ventilation.

3.5.6 These NSRs will be provided with prescribed windows for natural ventilation complying with the *Building (Planning) Regulations, Cap 123* ("B(P)R"). The noise standards stipulated in the HKPSG are applicable to noise sensitive uses which rely on opened windows for ventilation. Thus, assessment points ("APs") for NSRs are assigned to these prescribed windows.

3.5.7 The APs were all taken to be 1m from the exterior façade of opened windows and 1.2m above the floor of the APs as shown on ***Figure 3-5*** to ***Figure 3-7***.

3.5.8 In order to alleviate traffic noise impact, traffic noise mitigation measures recommended in Section 4.3 of Chapter 9 of HKPSG have been referred to. The traffic noise mitigation measures in terms of self-protecting building design and arrangement have been considered and incorporated into the layouts as follows:

i. For the domestic blocks, building setback of about 130m from Sha Tau Kok Road (Lung Yeuk Tau) has been made to minimize the potential noise impact.

ii. For the commercial complex, which is classified as noise tolerant use, has been arranged and located near the Sha Tau Kok Road (Lung Yeuk Tau) to shield noise sources.

Assessment Results

3.5.9 The predicted road traffic noise levels are detailed in ***Appendix E*** and summarised in ***Table 3-9***. With the mitigation measures proposed in **Section 3.5.8**, the traffic noise levels at all APs of the Proposed Development are predicted to comply with the criterion of 70 dB(A) recommended in Chapter 9 of HKPSG.

Table 3-9: Summary of Traffic Noise Assessment Results

PROPOSED DEVELOPMENT	NO. OF UNITS WITH NOISE EXCEEDANCE	NOISE LEVEL ($L_{10\ (1\text{-hr})}$, dB(A))	NOISE CRITERIA ($L_{10\ (1\text{-hr})}$, dB(A))	NOISE COMPLIANCE (%)
Domestic Blocks	0	44-69	70	100

3.6 Conclusion

3.6.1 During the construction phase of the Proposed Development, with the implementation of the noise mitigation measures recommended in ***Section 3.3,*** no adverse noise impact is anticipated.

3.6.1 The Proposed Development is located at a low-density residential area, which is surrounded by village houses, such as Park Villa and King Chong, and some temporary dwellings, etc. These buildings provided effective acoustic shielding for the Proposed Development with buildings up to three storeys. Moreover, quantitative fixed noise impact assessment has been conducted to evaluate the fixed noise impact from the existing fixed noise sources. The predicted cumulative noise level is not greater than the noise criteria. Therefore, no adverse noise impact from the surrounding fixed noise sources on the proposed development is anticipated.

3.6.2 Most of the E&M equipment of the Proposed Development will be installed inside plant rooms. Potential noise sources have been identified as fixed mechanical equipment, such as chillers for central air conditioning. The chillers will be installed at roof top, which provided greatest separation from the identified NSRs and they will be shielded by the on-site building structure itself.

3.6.3 The maximum allowable sound power level of the proposed outdoor units has been determined in order to ensure the compliance of statutory requirements and guidelines, which is subject to be changed in the detailed design stage.

3.6.4 For road traffic noise, the noise impact on the Proposed Development is predicted to comply with the standards as recommended in Chapter 9 Environment of the HKPSG with the building setback of about 130m to Sha Tau Kok Road (Lung Yeuk Tau).

3.6.5 Overall, therefore, no adverse noise impact during the construction and operation phases of the Proposed Development is expected.

Figure 3-1: Location of Background Noise Measurement

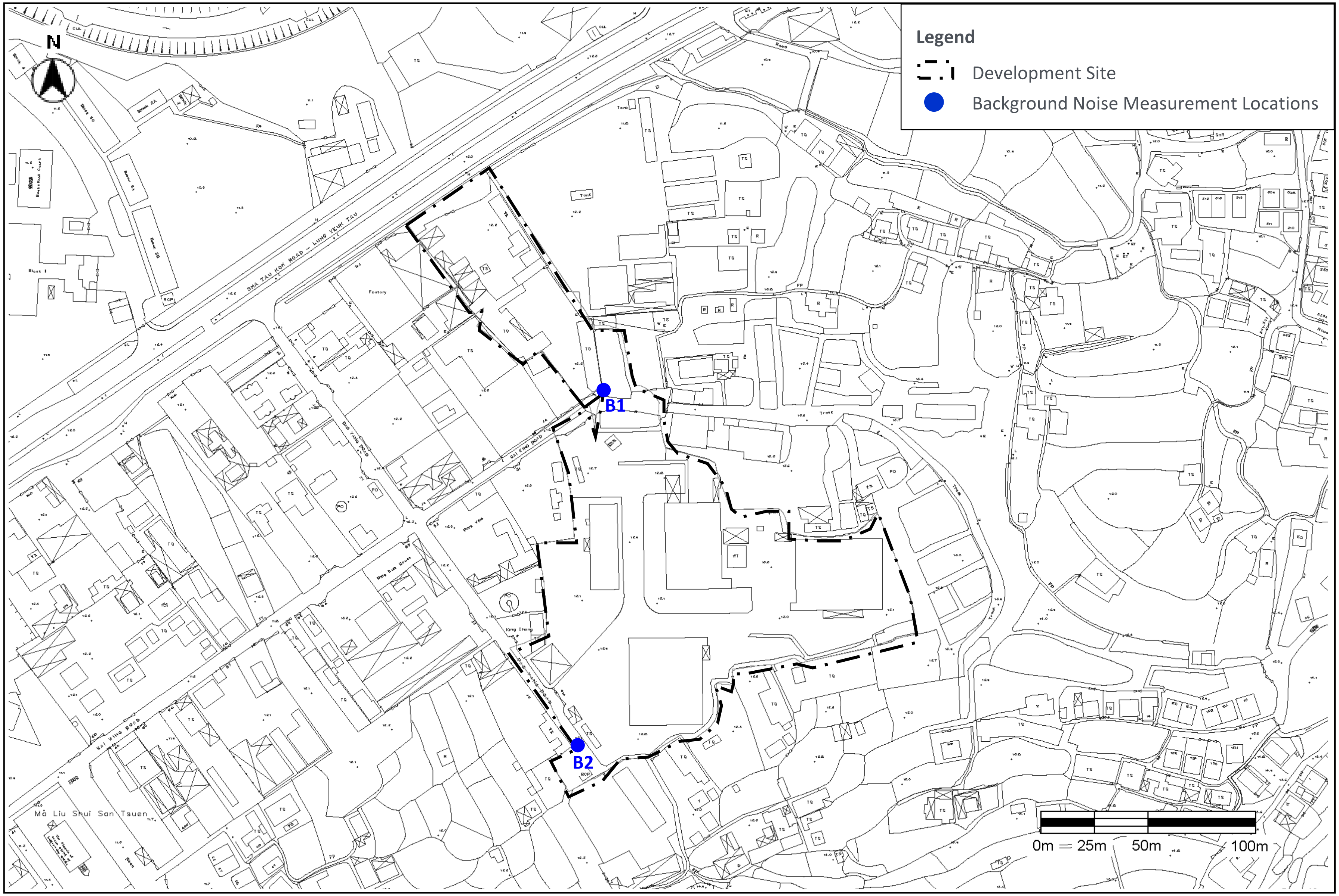


Figure 3-2: Location of Identified Fixed noise Sources

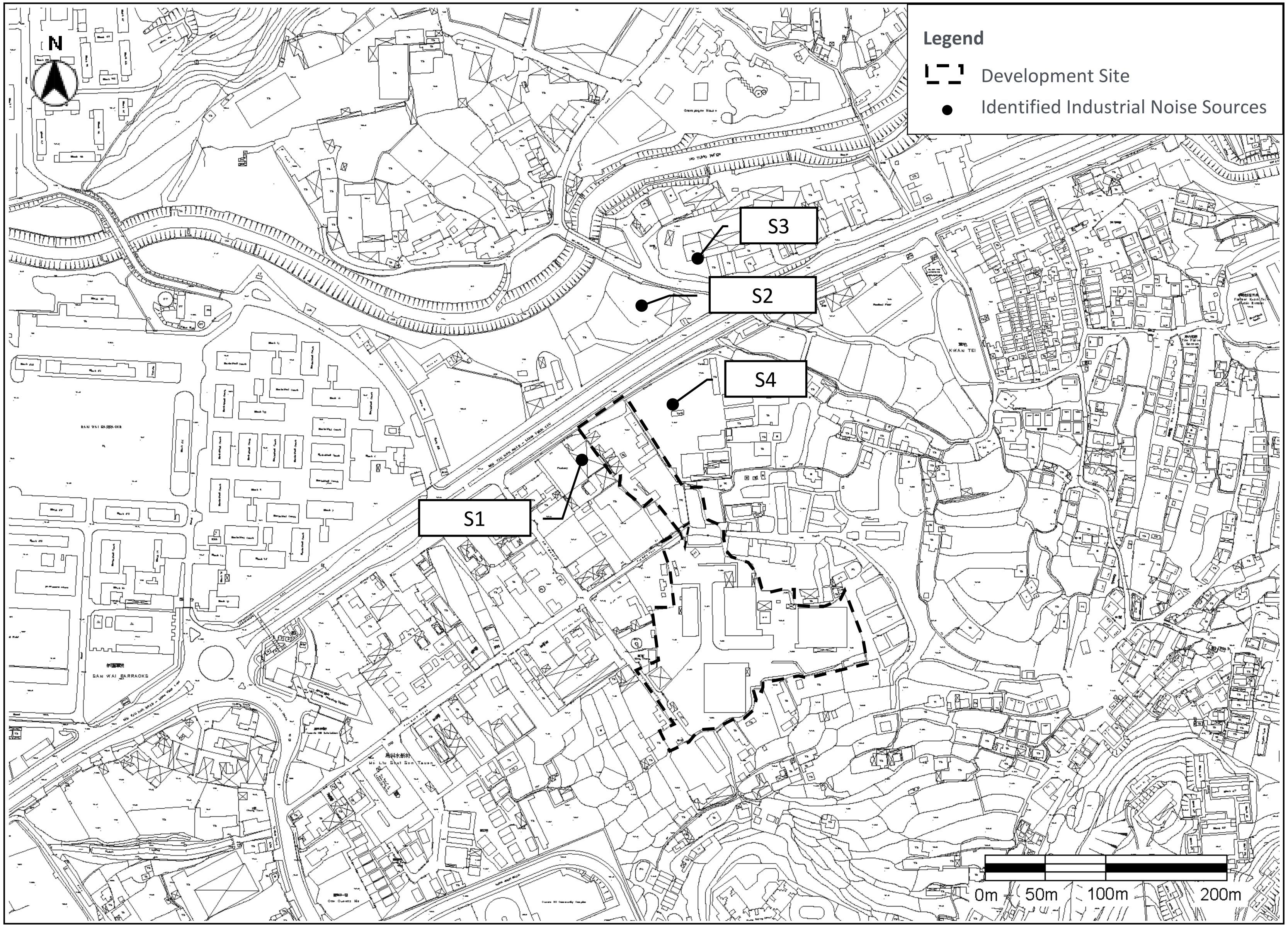


Figure 3-3: Location of Representative NSRs for Existing Fixed noise Impact

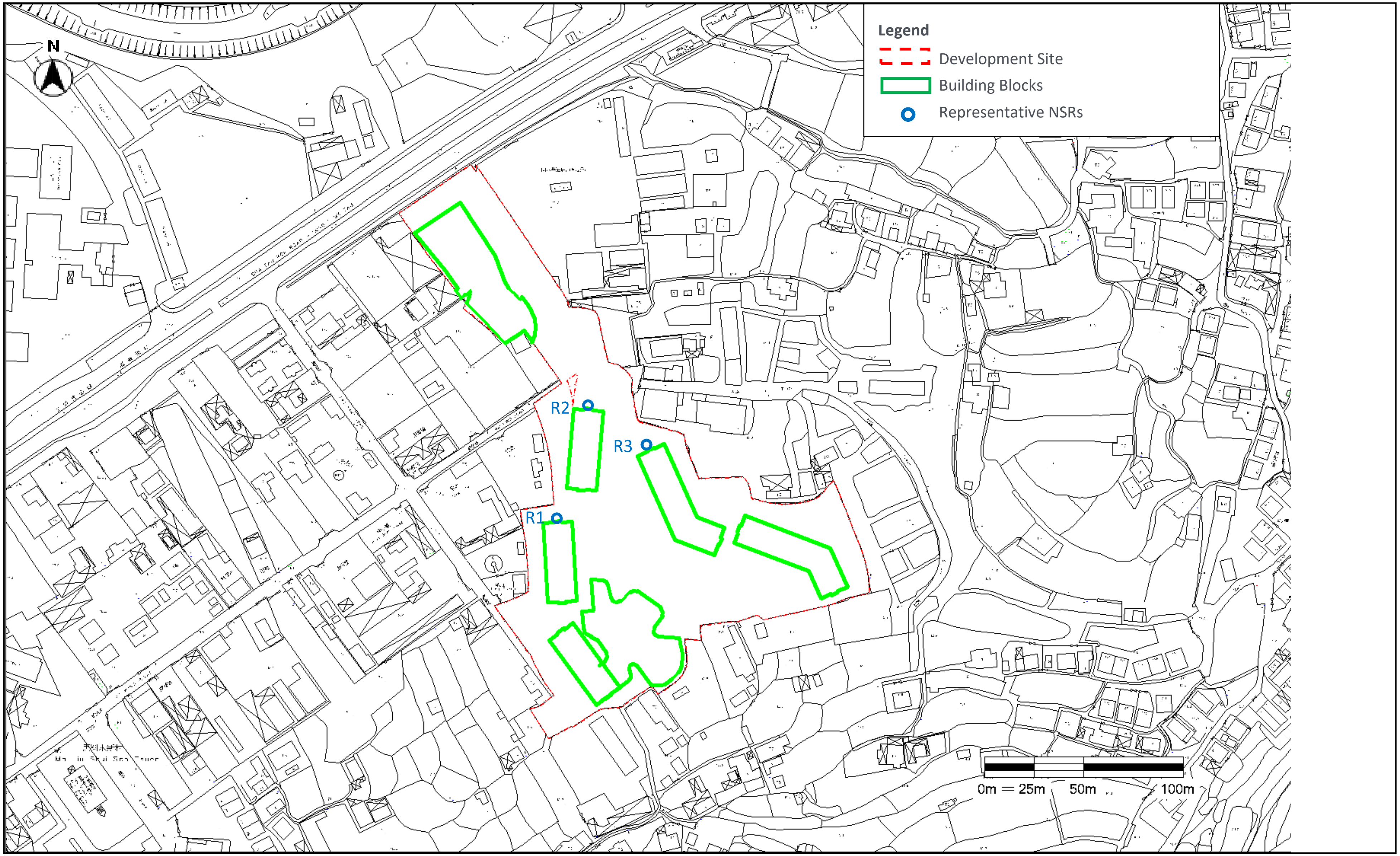


Figure 3-4: Indicative Locations of Proposed Outdoor Units and Representative NSRs

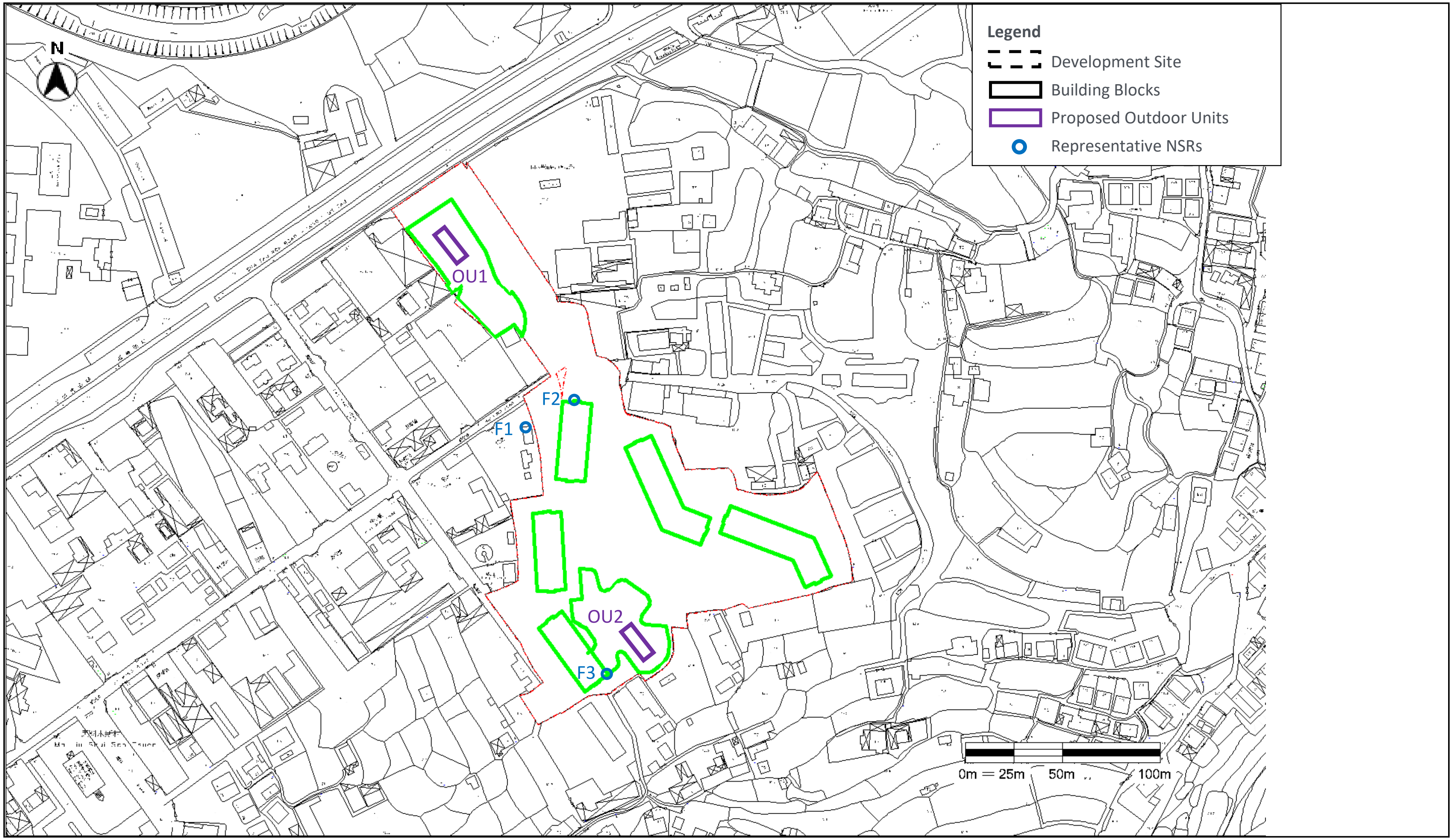


Figure 3-5: Location of Assessment Points for Road Traffic Noise on G/F

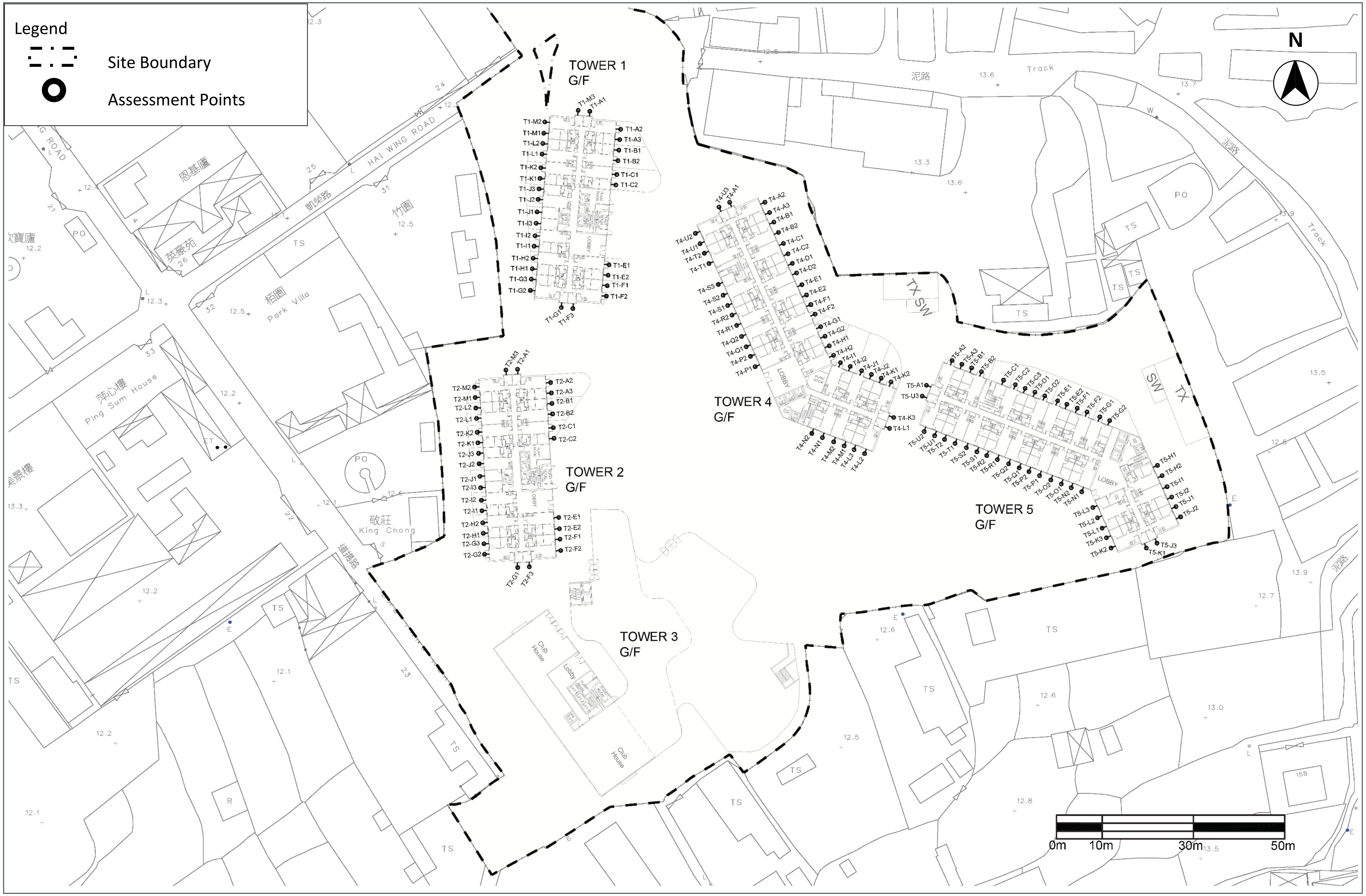


Figure 3-6: Location of Assessment Points for Noise Sensitive Receivers on Typical Floor A

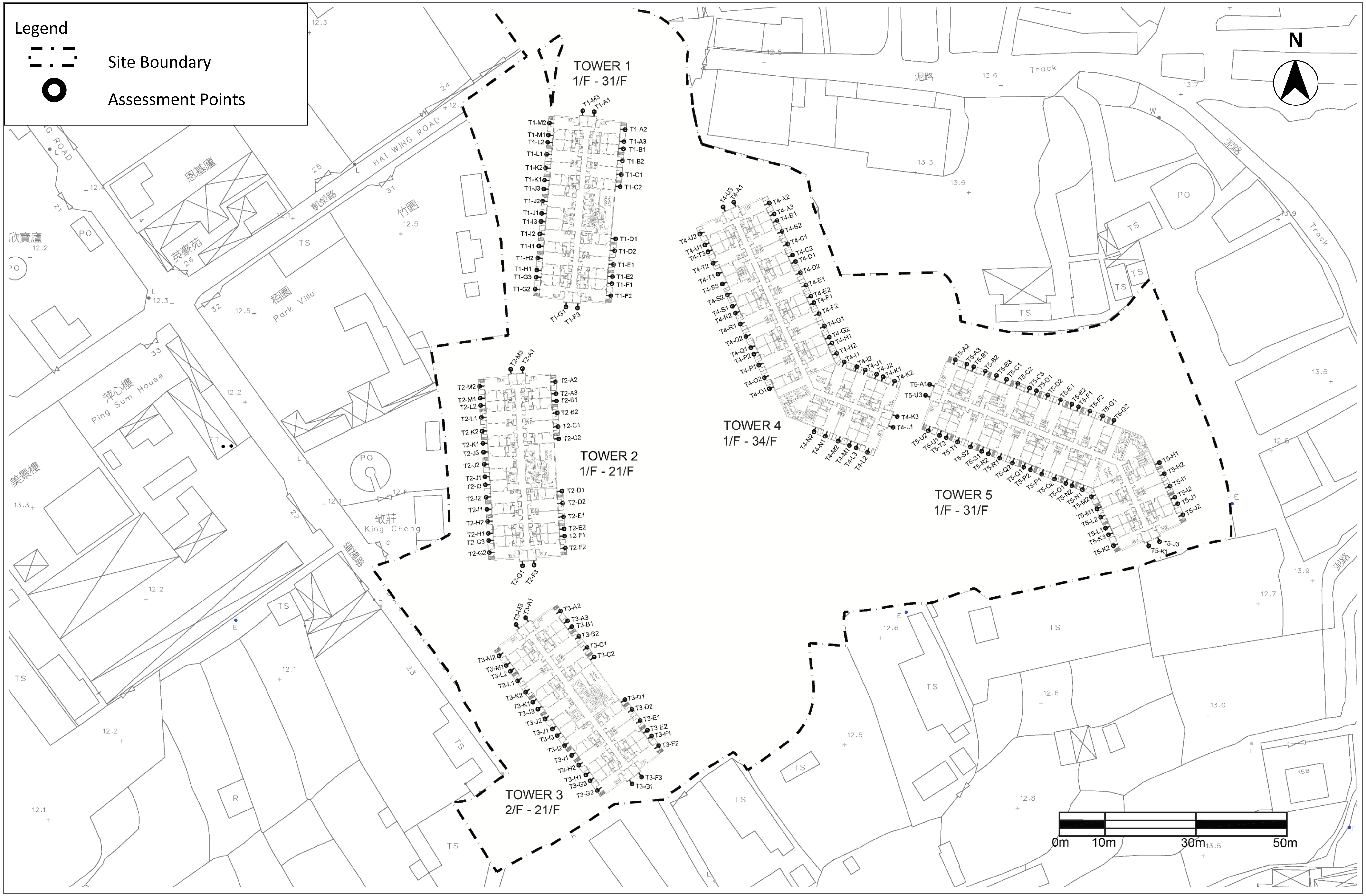
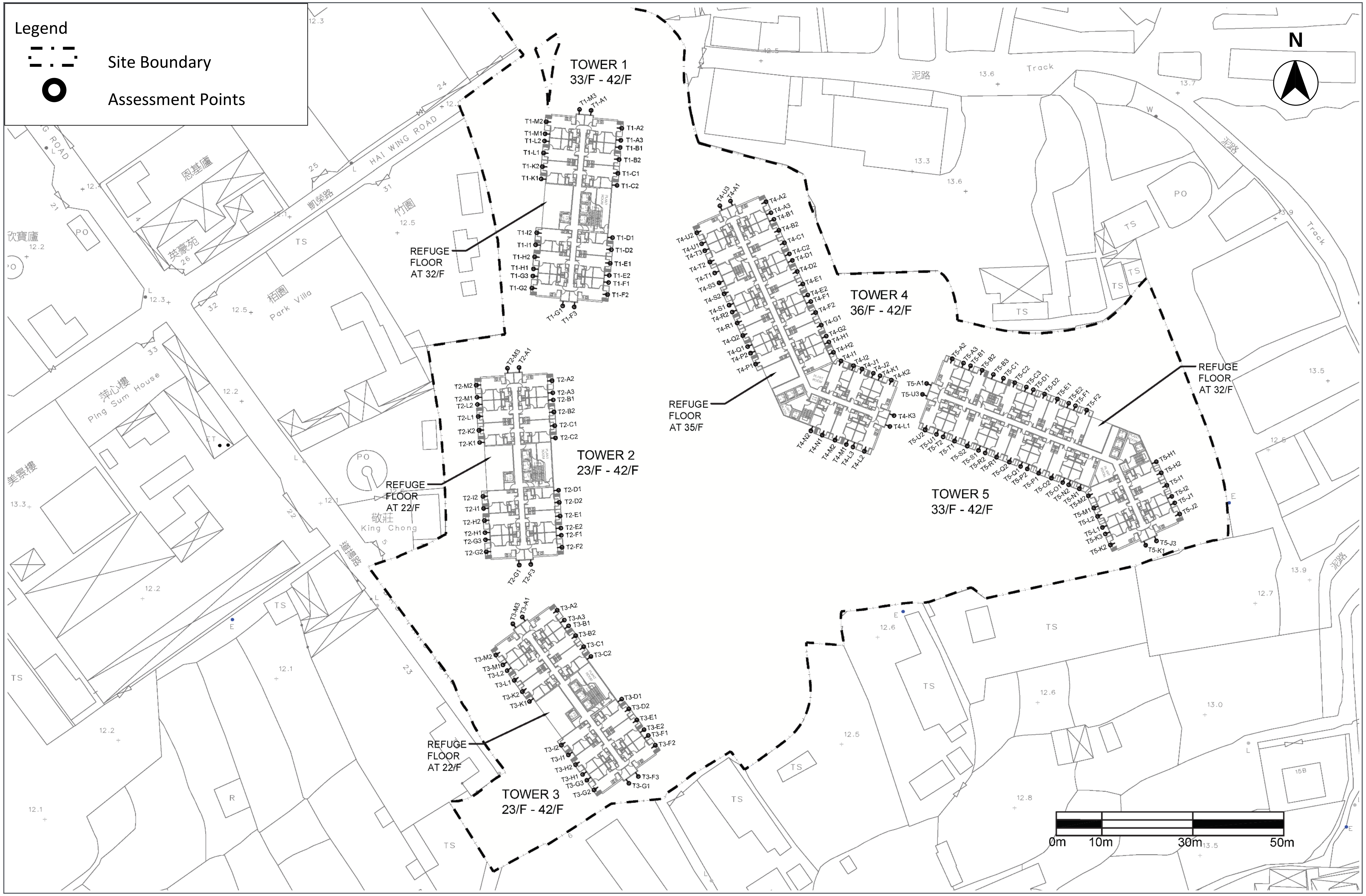


Figure 3-7: Location of Assessment Points for Noise Sensitive Receivers on Typical Floor B



4 WATER QUALITY

4.1 Introduction

4.1.1 This section assesses the potential water quality impact arising from the Proposed Development during construction and operation phases. Mitigation measures are recommended, where necessary, as part of the assessment.

4.2 Environmental Legislation, Standards and Guidelines

Water Pollution Control Ordinance (Cap. 358)

4.2.1 An amendment to the *Water Pollution Control Ordinance* ("WPCO") was enacted in 1990 and provides a mechanism for setting effluent standards. These are included in the *Technical Memorandum Standards for Effluents Discharged in to Drainage and Sewerage Systems, Inland and Coastal Waters* (WPCO Cap 358, S.21). All discharges into government sewerage systems, marine and inland waters are required to comply with the standards stipulated in the Technical Memorandum.

4.2.2 Water Control Zone and the corresponding Water Quality Objectives have been set up under WPCO. Referring to the Statement of Water Quality Objectives (Deep Bay Water Control Zone), the site is located within Indus Subzone. The water quality objectives for Deep Bay Water Control Zone Indus Subzone have been shown in Table 4-1.

Table 4-1: Water Quality Objectives for Deep Bay Water Control Zone Indus Subzone

WATER QUALITY OBJECTIVES (DEEP BAY WATER CONTROL ZONE INDUS SUBZONE)	
A. Appearance	(a) Waste discharges shall cause no objectionable odours or discolouration of the water.
	(b) Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.
	(c) Mineral oil should not be visible on the surface. Surfactants should not give rise to a lasting foam.
	(d) There should be no recognisable sewage-derived debris.
	(e) Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.
	(f) Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.
B. Bacteria	(b) The level of Escherichia coli should be zero per 100 mL, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days. (E.R. 6 of 2019)
C. Colour	(a) Waste discharges shall not cause the colour of water to exceed 30 Hazen units.
D. Dissolved Oxygen	(d) Waste discharges shall not cause the level of dissolved oxygen to be less than 4 milligrams per litre.
E. pH	(b) Waste discharges shall not cause the pH of the water to exceed the range of 6.5–8.5 units.
F. Temperature	Waste discharges shall not cause the natural daily temperature range to change by more than 2.0 degree Celsius.
G. Salinity	Waste discharges shall not cause the natural ambient salinity level to change by more than 10%.
H. Suspended Solids	(b) Waste discharges shall not cause the annual median of suspended solids to exceed 20 milligrams per litre.
I. Ammonia	The un-ionized ammoniacal nitrogen level should not be more than 0.021 milligram per litre, calculated as the annual average (arithmetic mean).
K. 5-Day Biochemical Oxygen Demand	(a) Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 3 milligrams per litre.
L. Chemical Oxygen Demand	(a) Waste discharges shall not cause the chemical oxygen demand to exceed 15 milligrams per litre.
M. Toxins	(a) Waste discharges shall not cause the toxins in water to attain such levels as to produce significant toxic carcinogenic, mutagenic or teratogenic 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.
	(b) Waste discharges shall not cause a risk to any beneficial uses of the aquatic environment.

Construction Site Drainage, ProPECC PN2/23

4.2.3 Under ProPECC Practice Note PN2/23 Construction Site Drainage (ProPECC PN2/23), various guidelines for the handling and disposal of construction site discharges are included. The guidelines include the use of sediment traps, wheel washing facilities for vehicles leaving the Site, adequate maintenance of drainage systems to prevent flooding and overflow, sewage collection and treatment, and comprehensive waste management (collection, handling, transportation, and disposal) procedures.

Drainage Plans subject to Comment by the Environmental Protection Department, ProPECC PN1/23

4.2.4 Under ProPECC Practice Note PN1/23, drainage plans submitted to the Building Authority are referred to the Environmental Protection Department ("EPD") for comment whenever there is a concern for pollution control. The EPD has, based on the experience of the common problems found in the drainage submissions, prepared this practice note for reference by Authorised Persons ("APs") in preparing drainage plans. Although the guidelines contained in this practice note are not meant to be exhaustive, it is hoped that they will help secure early approval of drainage plans.

Protection of Natural Streams/Rivers from Adverse Impact Arising from Construction Works, ETWB TCW No.5/2005

4.2.5 Under Environment, Transport and Works Bureau ("ETWB") Technical Circular (Works) No. 5/2005 *Protection of Natural Streams/Rivers from Adverse Impact Arising from Construction Works* ("ETWB TCW No. 5/2005"), an administrative framework for the protection of all natural streams/rivers from the impacts of construction works is provided. It also introduces existing measures and provides guidelines on planning for construction works and on developing precautionary measures during construction stage.

4.3 Potential Water Quality Impacts

Water Sensitive Receiver ("WSR")

4.3.1 In accordance with the *Technical Memorandum on Environmental Impact Assessment Ordinance* ("EIAO-TM"), WSR is defined as existing or potential beneficial uses that are sensitive to water pollution, which include, but are not limited to, the following:

- Areas of ecological or conservation values including marine conservation areas, existing or gazetted proposed marine parks and marine reserves, Sites of Special Scientific Interest ("SSSI"), existing or gazetted proposed country parks and special areas, wetlands, mangroves and important freshwater habitats;
- Area for abstraction of water for potable water supply;
- Water abstraction for irrigation and aquaculture;
- Fish spawning grounds, fish culture zones, shellfish harvesting/culture site and brackish/freshwater fish ponds;
- Beaches or other recreational areas;
- Water abstraction for cooling, flushing and other industrial purposes;
- Areas for navigation/shipping including typhoon shelters, marinas and boat parks.

4.3.2 In order to identify the WSRs, a desktop study on the OZP, topographic map and aerial photographs has been conducted together with site visits. The WSRs in the vicinity of the Site are summarised in ***Table 4-2*** and shown on ***Figure 4-1***.

Table 4-2: Water Sensitive Receivers

WSR ID	Description	Type	Distant to Site Boundary (m)

WSR ID	Description	Type	Distant to Site Boundary (m)
W1	Ng Tung River	Natural river	104.9
W2	Kwan Tei River	Natural river	496.6
W3	Fish Pond in Kwan Tei	Freshwater fish pond	235.2
W4	Watercourse to the northeast of the Site	Nullah	94.9
W5	Watercourse to the southwest of the Site	Nullah	362.6
W6	Another Watercourse to the southwest of the Site	Nullah	415.0

Construction Phase

4.3.3 Muddy runoff from the Site may be generated during the construction phase, especially during the rainy season. If the muddy water is not properly controlled, it would lead to increased amounts of suspended solids in the drainage system.

4.3.4 Wash water from vehicles and equipment; silt from any on-site stockpiles of soil, cement and grouting materials; and spillage of fuels, oil and lubricants from construction vehicles and plant may generate water quality impacts. If these pollution sources are not properly controlled, it would lead to increased amounts of suspended solids, grease and oil, pH, Biochemical Oxygen Demand (“BOD”), etc. in the drainage system.

4.3.5 There is also the issue of sewage generated by construction workers on-site. The sewage may result in high levels of NH_3-N, BOD and *E. coli* if it is not disposed of properly before discharging into drainage system.

4.3.6 Accidental spillage of chemicals during construction may leak into the nearby watercourses, causing sediment contamination or water quality degradation. The spilled chemical may also flow into the drainage system, blocking or corrupting the drainage pipe.

Operation Phase

4.3.7 Surface runoff is mainly discussed in a separate Drainage Impact Assessment Report (“DIA”) supporting this planning application. It is concerned that the surface runoff from the site may carry the residual fertilisers and pesticides applied to landscape area, introducing toxins, nutrients, and suspended solid to the watercourses.

4.3.8 During the operation phase, sewage will be generated from toilets flushing, and grey water. It will contribute to the major sources of wastewater generation arising from the Proposed development. The assessment of sewerage impact from the proposed development is included in a separate Sewerage Impact Assessment (“SIA”) Report supporting this planning application. All the wastewater generated in the proposed development will be treated on site by a proposed tertiary Sewage Treatment Plant before discharging to the stormwater drain in Sha Tau Kok Road, and eventually to Ng Tung River. The average dry weather flow of the proposed development has been calculated to be 3005.4m^3/day. The design capacity of the proposed STP is set to be 5000m^3/day. Combination of membrane bioreactor and ultrafiltration is tentatively adopted as the treatment process design to meet the WPCO private sewerage treatment plant discharge standard as shown in Table 4-3.

Table 4-3: Discharge Standards of the Effluent from Proposed STP

PARAMETER	UNIT	Tertiary Effluent Standards (Upper Limit)

PARAMETER	UNIT	Tertiary Effluent Standards (Upper Limit)
BOD_5	mg/L	10
TSS	mg/L	10
TN	mg/L	20
TP	mg/L	2
Ammonia-N	mg/L	5
E.Coli	Counts/100 ml	100

4.4 Mitigation Measures

4.4.1 During the Site visits on 6 December 2022 and 18 January 2023, no watercourse was observed within the Site boundary. In order to avoid muddy surface runoff from entering the existing watercourse/storm water drainage system outside the Site, channels along the site boundary shall be provided to collect and direct the muddy runoff to the wastewater treatment facilities for treatment prior to being discharged. The design of the construction site drainage system shall be independent from the existing watercourse. The details of wastewater treatment arrangement shall be submitted to EPD for review during the application of the wastewater discharge licence before commencement of the construction activities.

4.4.2 During construction, it is recommended that portable toilets should be provided for construction workers. These will be supplied, maintained and emptied (at a sewage treatment facility) by a licenced contractor.

4.4.3 The construction contractor shall also follow good site practice and be responsible for the design construction, operation and maintenance of all the mitigation measures as specified in ProPECC PN 2/23 for construction site drainage:

- Surface run-off from construction sites shall be discharged into storm drains via adequately designed sand/silt removal facilities such as sand traps, silt traps and sediment basins. Channels or earth bunds or sand bag barriers shall be provided on site to properly direct storm water to such silt removal facilities. Perimeter channels at site boundaries shall be provided 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 shall be maintained and the deposited silt and grit should be removed regularly, at the onset of and after each rainstorm to ensure that these facilities are functioning properly at all times.
- For the purpose of preventing soil erosion, temporarily exposed slope surfaces should be covered e.g. by tarpaulin, and temporary access roads should be protected by crushed stone or gravel, as excavation proceeds. Intercepting channels should be provided (e.g. along the crest/edge of 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.
- Earthworks final surfaces shall be well compacted and the subsequent permanent work or surface protection shall be carried out immediately after the final surfaces are formed to prevent erosion caused by rainstorms. Appropriate drainage like intercepting channels shall be provided where necessary.
- Measures shall be taken to minimise the ingress of rainwater into trenches. If excavation of trenches in wet seasons is necessary, they shall be dug and backfilled in short sections.

Rainwater pumped out from trenches or foundation excavations shall be discharged into storm drains via silt removal facilities.

- Open stockpiles of construction materials (e.g. aggregates, sand and fill material) on sites shall be covered with tarpaulin or similar fabric during rainstorms. Measures shall be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.
- Manholes 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.
- Discharge of surface run-off into foul sewers shall always be prevented in order not to unduly overload the foul sewerage system.
- Regulated by Pesticides Ordinance, the utilisation of pesticide should be carried by a permit holder. Overdosing should be carefully avoided. The soil in the landscape area should be confined by enclosed planter so that surface runoff will not flow out. Minimum drainage system should be provided on the landscape area and directed to the proposed sewerage treatment plant in case the soil fully saturates and cannot precipitate excessive rainfall.

4.4.4 Besides registering as a chemical waste producer, the contractor shall prepare an emergency cleanse plan to respond the accidentally spillage of chemicals. The contractor will need to prepare sufficient absorbent material to control the spread of spilled chemical, enabling the later collection and decontamination works. The detailed management scheme of chemicals utilisation in construction phase is discussed in Section 5.5.13 to Section 5.5.18.

4.4.5 During operation phase, sewage arising from the Proposed Development will be treated in the proposed STP before discharging, no adverse water quality impact due to the Proposed Development is therefore anticipated during the normal operation of the STP. Nevertheless, as specified in ProPECC PN 1/23, mitigation measures/recommendations for effluent discharge to storm drains and foul sewers shall be followed:

- Drainage outlets provided in open areas and areas subjected to a substantial amount of wind-blown rain, including balconies and podiums, should be discharged to stormwater drains.
- Drainage outlets provided in covered areas, including covered podiums and other roofed areas, should be discharged to foul sewers.
- Drainage outlets of verandahs next to kitchens and utilities rooms where a substantial amount of wind-blown rain is not expected should, as far as possible, be connected to foul sewers because of the concern that dwellers might discharge laundry or dishwater wastewater through these drainage outlets.
- Swimming pool main drain, footbath main drain and swimming pool make-up tank drain should be connected to stormwater drains while the filtration plant backwash should be discharged to foul sewers. Swimming pool drainage layout, filtration plant room drainage layout and filtration plant schematic line diagrams are required to be included in drainage plans.
- Drainage in covered carparks should be connected to foul sewers via petrol interceptors.
- All wastewater collected from a restaurant kitchen, including that from basins, sinks and floor drains, should be discharged via a grease trap capable of providing at least 20 minutes retention during peak flow.

4.4.6 In case the STP equipment experiences failure or malfunction, the Emergency Response Plan and Efficient Handling Management System should be developed during the detailed design of the STP, and submitted to EPD and DSD for approval prior to the commission of the STP.

4.4.7 Preventative measures against emergency discharge should be emphasized. The STP should be equipped with sewage reception/storage facilities for the temporary storage of 6-hour average dry weather flow (752m^3) to provide sufficient response time for the potential equipment failure. The design capacity of the STP is proposed to be 5000m^3, around 66% over the average dry weather flow of the proposed development, to provide adequate buffer against the capacity loss from potential equipment damages.

4.4.8 Since the treated effluent will be discharged through the public drainage channel along Sha Tau Kok Road, an alternative discharge route should be proposed for the emergency discharge to minimize the water quality impact to the surrounding. Even though the available capacity of the sewer system along Sha Tau Kok has been estimated to be insufficient to sustain the peak flow from the proposed development, it can serve as an option as the emergency bypass of the STP. During the emergency discharge, the sewage in the sewage reception/storage tank to be pumped out and discharged to sewer manhole FWD1004186 on Sha Tau Kok Road after agreeing with DSD about the discharge quantity and flow rate. And the remaining portion that could not be covered by the available capacity of public sewer system will be collected by sewage suction truck. The arrangement of effluent discharge and emergency discharge of the proposed STP has been drawn in Figure 4-2.

4.5 Conclusion

4.5.1 During construction, water quality impacts can be properly controlled with the implementation of good site practice, as stated in ***paragraph 4.4.3***. Portable toilets will be provided for constructions workers on-site. Provided these measures are implemented, it is unlikely that any adverse water quality impacts from the Site will be generated during the construction phase.

4.5.2 The contractor shall apply for a Discharge Licence from EPD under the WPCO. All site discharges shall be treated in accordance with the terms and conditions of the Discharge Licence.

4.5.3 The sewage generated from the Proposed Development will be treated in an on-site sewerage treatment plant before discharging into Ng Tung River. During operation, no adverse water quality impact is anticipated from sewage generated by the proposed development in view of the adoption of tertiary treatment and the appropriate emergency discharge arrangement.

4.5.4 Overall, therefore, no adverse water quality impacts to the nearby watercourses are anticipated during the construction or operational phases of the Proposed Development.

Figure 4-1: Location of Identified Water Sensitive Receiver (WSR)

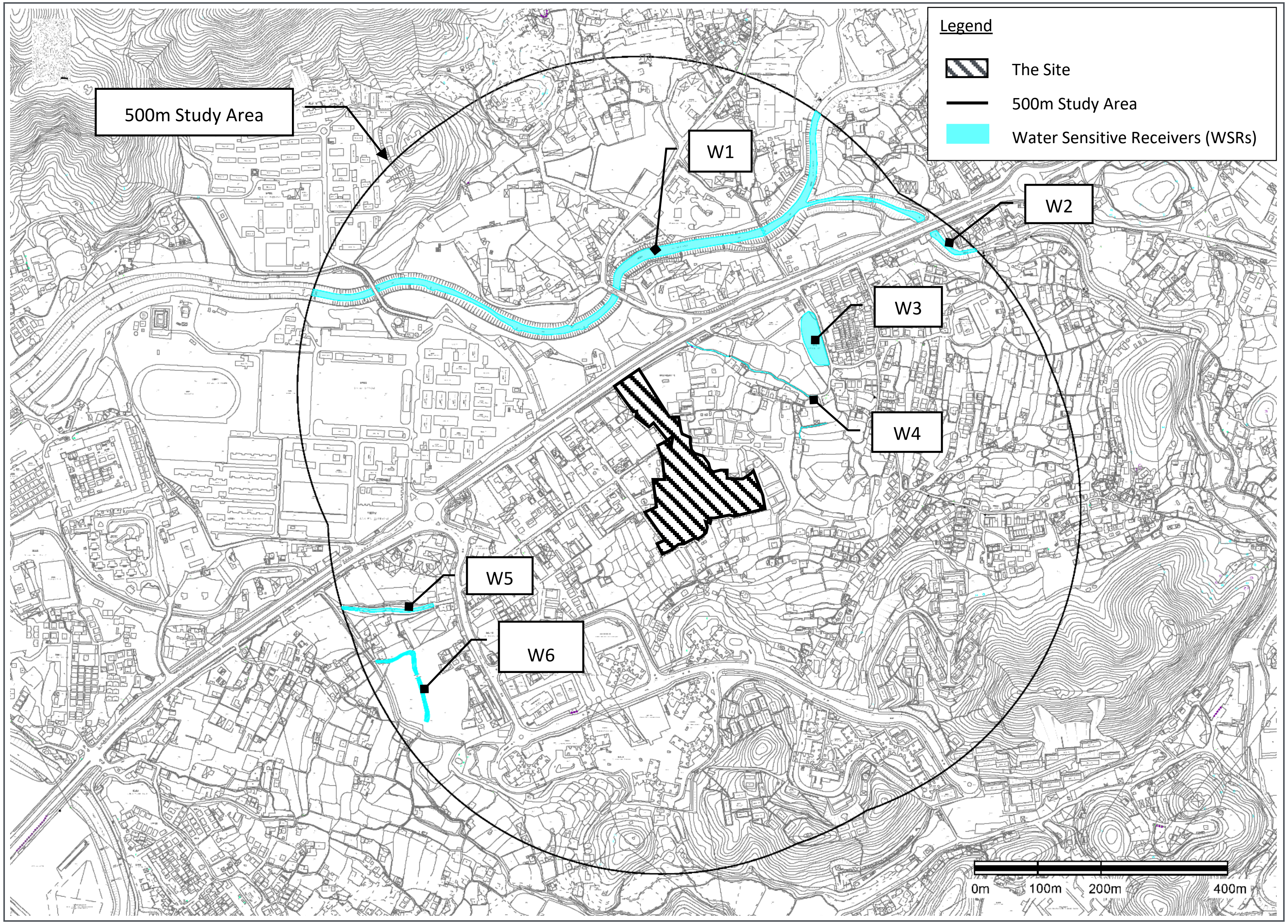
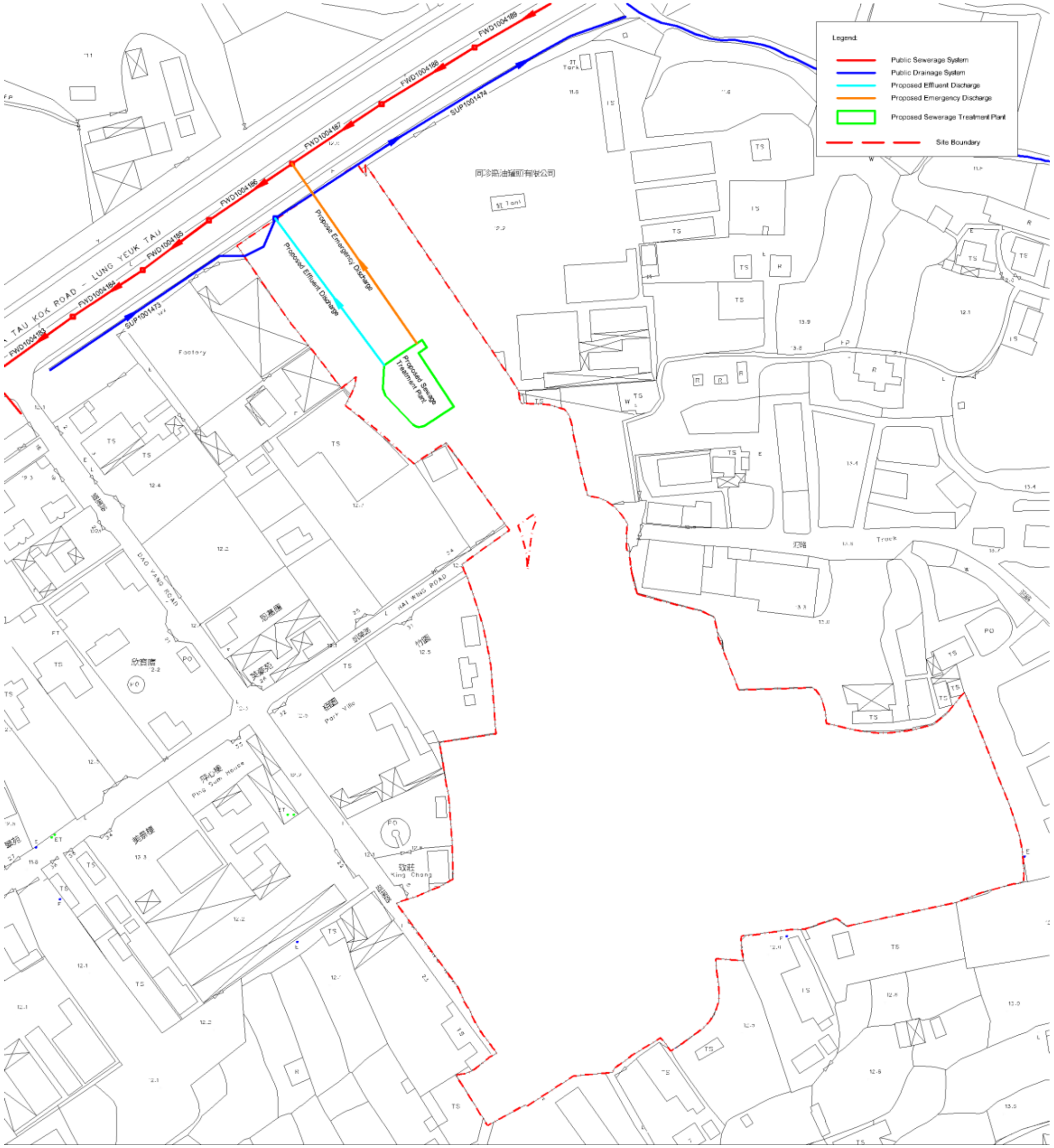


Figure 4-2: Tentative Location of Proposed STP and Discharge Arrangement



5 WASTE MANAGEMENT

5.1 Environmental Legislation and Standards

5.1.1 In carrying out the assessment, references have been made to the following relevant legislation, documents and guidelines that are applicable to waste management and disposal in Hong Kong:

- The *Waste Disposal Ordinance* (Cap. 354) ("WDO") setting out requirements for storage, handling and transportation of all types of wastes, and subsidiary legislation such as the Waste Disposal (Charges for Disposal of Construction Waste) Regulation (Cap. 354N), the Waste Disposal (Charges for Disposal of Chemical Waste) Regulation (Cap. 354J) and the Waste Disposal (Chemical Waste) (General) Regulation (Cap. 354C).
- Land (Miscellaneous Provisions) Ordinance (Cap. 28).
- Air Pollution Control Ordinance ("APCO") (Cap. 3.11)
- Factories and Industrial Undertakings (Asbestos) Ordinance (Cap. 59AD)
- Public Health and Municipal Services Ordinance – Public Cleansing and Prevention of Nuisances Regulation (Cap.132BK)
- Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes.
- Code of Practice on the Handling, Transportation and Disposal of Asbestos Wastes
- Code of Practices and Guidelines for Asbestos Control and Handling.
- Code of Practice on Safety and Health at Work with Asbestos.
- Environmental, Transport and Works Bureau ("ETWB") Technical Circular (Works) No. 19/2005, Environmental Management on Construction Sites.
- ETWB Technical Circular (Works) No. 22/2003A, Additional Measures to improve Site Cleanliness and Control Mosquito Breeding on Construction Sites.
- Development Bureau ("DevB") Technical Circular (Works) No. 6/2010, Trip Ticket System for Disposal of Construction & Demolition Materials.
- DevB Technical Circular (Works) No. 9/2011, Enhanced Control Measures for Management of Public Fill.
- Civil Engineering and Development Department ("CEDD") Technical Circular No. 11/2019, Management of Construction and Demolition Materials.
- Building Department Practice Notes for Registered Contractors (PNRC 17), Control of Environmental Nuisance from Construction.
- Building Department Practice Notes for Authorized Persons and Registered Structural Engineers – Construction and Demolition Waste (PNAP ADV – 19).
- CEDD Project Administration Handbook for Civil Engineering Works, 2022 Edition ("PAH").
- Monitoring of Solid Waste in Hong Kong 2022.
- Work Branch Technical Circular No. 2/93 Public Dumps
- Work Branch Technical Circular No. 2/93B Public Filling Facilities
- Work Branch Technical Circular No. 12/2000 Fill Management
- Hong Kong Planning Standards and Guidelines (2021)

5.2 Assessment Methodology

5.2.1 The assessment methodology for waste management will include the followings:

- Identification/estimation of the types and quantities of waste arising from the Proposed Development;
- Addressing impacts caused by handling (including stockpiling, labelling, packaging and storage), collection, transportation and reuse/disposal of wastes in detail and propose appropriate mitigation measures;
- Adoption of waste management hierarchy with priorities towards waste reduction, on-site or off-site reuse and recycling;
- Estimation of the types and quantities of wastes required to be disposed of and their disposal method; and
- Assessment of the impacts on the capacity of waste collection, transfer and disposal facilities.

5.3 Waste Management Impact in Construction Phase

5.3.1 The construction activities of the proposed development will include site clearance, site formation, site construction, superstructure works, etc. The key potential waste sources during the construction phase are:

- Inert Construction and Demolition ("C&D") waste (e.g. waste concrete, surplus soil, waste asphalt etc.)
- Non-inert C&D waste (wood and plastics)
- Chemical wastes (e.g. waste battery, waste lubricating oil from vehicles / plant maintenance)
- General refuse, i.e. Municipal Solid Waste ("MSW"), generated by site workers.

5.3.2 Inert C&D waste are those which do not decompose, such as debris, rubble, earth and concrete, and which are suitable for land reclamation and site formation. Illegal disposal of inert C&D material may damp landfill capacity, and has the potential of damaging local environment.

5.3.3 Non-inert C&D waste refers to those material that are not chemically stable and can undergo physical or chemical changes over time, such as bamboo, timber, vegetation, metal, packaging waste and other organic material, and therefore are unsuitable for land reclamation. Inappropriate handling of non-inert C&D materials may lead to loss and waste of resource.

5.3.4 Accumulation of general refuse can cause hygiene problem and generate nuisance to the neighbour community.

5.3.5 Spillage or leakage of chemical waste will cause land contamination and pollute groundwater or nearby watercourse. Improper handling of chemical waste will increase the health risk of workers.

5.3.6 The quantitative assessment of waste generation during construction phase is given in the following section.

Demolition Waste

5.3.7 Currently, the site is still occupied by brownfield operation, building survey for the existing structures within site area is not available. The floor areas of the existing structures on site are obtained from topographic map to estimate the generation of demolition waste. The location of each existing structure is shown in Figure 5-1.

5.3.8 There is no local floor-area-based demolition waste generation rate typically for Hong Kong. The demolition waste generation rates developed from statistic in Taipei and Taichung are adopted in this project as substitution, making reference to *Model Development for Estimating the Quantity of A Single Building's Demolition Waste* [accessed from http://www.cem.ncu.edu.tw/FileUpload/Thesis/92325010.pdf]. The referencing study suggests the demolition waste generation rate of 0.8m^3/m^2 for reinforced concrete residential buildings, 0.66m^3/m^2 for reinforced concrete industrial buildings, and 0.65m^3/m^2 for steel industrial buildings. These generation rates will be adopted to estimate the demolition waste generation from the demolition works of existing structure under Proposed Development. In this regard, the quantity of waste generated from demolition of existing structure on site will be 3,627.4m^3. The breakdown calculation is presented in Table 5-1.

Table 5-1: Estimation of Demolition Waste Generation

Structure	Type	Building Characteristic	Occupy Area (m^2)	CFA (m^2)	Generation Rate (m^3/m^2)	waste quantity (m^3)
Tin Wah House	Residential	Two Floors Reinforced Concrete Structure	64.5	129.1	0.80	103.3
Vehicle Repair Workshop	Industrial	Single Floor Metal Plate Structure	631.3	631.3	0.65	410.4
Warehouse 1	Industrial	Single Floor Reinforced Concrete Structure	1396.3	1396.3	0.66	921.6
Warehouse 2	Industrial	Single Floor Reinforced Concrete Structure	1067.2	1067.2	0.66	704.3
Warehouse 3	Industrial	Single Floor Reinforced Concrete Structure	1341.2	1341.2	0.66	885.2
Warehouse 4	Industrial	Single Floor Reinforced Concrete Structure	523.2	523.2	0.66	345.3
Warehouse 5	Industrial	Single Floor Metal Plate Structure	178.8	178.8	0.65	116.2
Warehouse 6	Industrial	Single Floor Metal Plate Structure	217.1	217.1	0.65	141.1
					Total	3627.4

5.3.9 Within the 3627.4m^3 demolition waste, the 667.7m^3 generated from the demolition of metal plate structure is expected to be mainly steel plates and steel frames, which should be categorised as non-inert C&D waste. The residual 2,959.7m^3 is expected to be mainly broken concrete which should be categorised as inert-demolition waste.

5.3.10 The site area of the proposed development is 22,445m^2. Assuming the 95% of the Site area i.e. about 21,323m^2 is paved with 200mm concrete layer, about 4,264.6m^3 of concrete slab will be removed from site area during the site clearance stage, contributing generation of inert C&D waste.

Excavation Material

5.3.11 The current elevation of the Site ranges from 12.2mPD to 13.3mPD of the ground level. After the Proposed Development, the ground level will maintain at around 13mPD. Shown in Appendix I, the 1,950m^2 basement of for shopping arcade carpark and sewage treatment plant and will be constructed by excavating to 8.15mPD. There are two basement floors for the residential buildings. Basement 1/F is at 7.4mPD with an area of 13,860m^2, and Basement 2/F is at 3.9mPD with an area of 4,035m^2. The total area and total volume of excavation will be about 15,810m^2 and 111,895 m^3 respectively. The breakdown of calculation is presented in Table 5-2.

Table 5-2: Estimation of Excavation Volume

Basement floor	Floor Level	Floor Height + Thickness of Structural Elements	below ground level	Area of Excavation	Excavation Volume
B1/F (Retail)	8.15mPD	3.85m + 0.8m	4.65mbgl	1,950m^2	9,068m^3
B1/F (Residential)	7.40mPD	5.6m + 0.8m	6.4mbgl	13,860m^2	88,704m^3
B2/F (Residential)	3.90mPD	3.5m	9.9mbgl	4,035m^2	14,123m^3

total	NA	NA	NA	15,810m^2	111,895m^3

Notes: The thickness of structural elements refers to the space reserved for beams, columns, slabs/transfer plate etc. The excavation volume from foundation work is not considered because geotechnical design is yet to be confirmed.

Construction Waste from Superstructure

5.3.12 In addition to demolition waste from site clearance works and excavation material from site formation works, construction waste will also be generated during the superstructure work. This includes inert materials, such as concrete waste, waste from blockwork and brickwork, waste from screening and plastering; and non-inert C&D materials from timber formwork, packaging waste and other wastes.

5.3.13 *The Report on Strategy for Management and Reduction of Construction and Demolition Waste in Hong Kong*[accessed from https://www.cic.hk/files/page/56/C%26D%20Report_E.pdf] published by Construction Industry Council (CIC) proposes a waste generation rate of 0.60m^3/m^2 CFA for superstructure work of multi-storey residential towers with basement carparks & club after reviewing the tender documents of several selected building projects. This CIC report also reveals that the portion of inert C&D waste within construction waste can range around 61.9%, 38.5%, and 59.8% after studying the waste segregating and sorting statistics from three residential development projects respectively, and the weighted averaging inert portion is 52.9%. The waste generation rate and averaging inert/non-inert ratio from the CIC report will be adopted to provide a tentative calculation on the generation of construction waste from the superstructure work of proposed development.

5.3.14 Informed by the project team, the total CFA of the proposed development will be around 19,845 m^2. Therefore, the construction waste generated from the construction of superstructure of the proposed project can be estimated by 19,845m^2 × 0.6m^3/m^2 = 11,907m^3, at which 6,299m^3 would be inert construction waste and 5,608m^3 would be non-inert construction waste.

General Refuse

5.3.15 The master program and construction plan of the proposed development has not yet been formularized. The total construction period is estimate to be 60 months, the average number of workers on site is assumed to be 60 persons.

5.3.16 The previously approved Environmental Assessment Report (AEIAR-221/2019 - Shuen Wan Golf Course) adopted a generation rate of 0.65kg/person/day and monthly working day of 26day/month to estimate the generation of general refuse from construction worker. The same generation rate and working day assumption will be adopted in this report. Therefore, the daily general refuse generation from the proposed development during construction phase can be estimated by 0.65kg/person/day × 60persons = 39kg/day. The total quantity of general refuse generated on construction in the 60 months construction period would be 39kg/day × 26days/month × 60months = 60,840kg = 61 tonne.

Asbestos Containing Materials ("ACMs")

5.3.17 Currently, there is no evidence to justify the presence of ACMs on site. However, further investigation is needed from the project team at detailed design stage to thoroughly check whether any ACMs could be found on site. Under the APCO, asbestos investigation shall be conducted by Registered Asbestos Consultant ("RAC") before demolition work potentially involving ACMs. If any ACMs is identified, an Asbestos Investigation Report ("AIR") and an Asbestos Abatement Plan ("AAP") shall be submitted to EPD. A Registered Asbestos Contractor ("RACont") shall be engaged to carry out asbestos abatement work according to the approved AIR and AAP before demolition. The owner of the premises must notify the Labour Department and the EPD at least 28 days before the commencement of the asbestos abatement works in accordance with the regulatory requirement.

5.3.18 The RAC shall be requested to conduct a visual inspection upon the completion of asbestos removal for each working area identified in the AAP. If additional ACMs is discovered during the work, demolition shall be suspended and inform the RAC immediately, the RAC shall submit the modified AAP to the EPD after the investigation. An air sampling test shall be conducted by a Registered Asbestos Laboratory ("RAL") at the working area when all ACMs has been removed, in order to verify there is no asbestos fibre left suspended in the air.

5.3.19 Under the Waste Disposal (Chemical Waste) (General) Regulation, asbestos waste should not be mixed with household waste, nor delivered to the refuse collection points nor public dumping areas. Registered asbestos contractor shall remove the asbestos waste in accordance with the Regulation for disposal to Landfill upon agreement with EPD.

5.3.20 The asbestos waste labelling, handling and packaging depends on the type of ACMs. All the handling, collection and transportation and disposal of asbestos waste shall be carried out according to EPD's Code of Practice on the Handling, Transportation and Disposal of Asbestos Waste and Labor Department's Code of Practice on Safety and Health at Work with Asbestos. The quantity of the asbestos to be generated depends on the investigation and asbestos abatement plan carried out by RAC.

Chemical Waste

5.3.21 The generation of chemical waste during construction phase is usually hard to estimate as it subject to the practice of the contractor and the specified project condition. Given the site scale and the complexity of the proposed development, the generation of chemical waste is expected to be lower than 1 tonne. The amount of chemical waste to be generated shall be quantified in the Waste Management Plan (WMP) as part of the Environmental Management Plan (EMP) to be prepared by the Contractor.

Summary of Waste Generation During Construction Phase

5.3.22 Based on the above assessment, Table 5-3 summarises the generation of waste during the construction phase.

Table 5-3: Summary of Waste Generation During Construction Phase

estimated waste generation		estimated quantity		volume-to-weight conversion factor	
source	type	volume (m3)	weight (tonne)	material type	factor (kg/m3)
demolition of existing structure	non-inert C&D waste	667.7	903.0	Other Ferrous	225.0
	inert C&D waste	2959.7	7822.0	Large Concrete with Re-bar	860.0
removal of existing concrete pavement	inert C&D waste	4264.6	2175.9	Large concrete without Re-bar	860.0
excavated soil and rock	inert C&D waste	111895.0	66318.3	Small Rock/Gravel	999.0
construction of superstructure	inert C&D waste	6299.0	1808.7	Construction and Demolition Bulk	484.0
	non-inert C&D waste	5608.0	562.3	Other Recyclable Wood	169.0
summary of inert C&D waste		125418.3	78124.9	-	-
summary of non-inert C&D waste		6275.7	1465.3	-	-
summary of C&D waste		131694.0	79590.2	-	-
activity of construction worker	general refuse	341.8	60.8	Uncompacted Mixed MSW	300.0
spent lubricants, waste batteries and etc.	chemical waste	expect to be less than 1 tonne		-	-

Notes: The conversation between volume and weight is in reference to *Volume-to-Weight Conversion Factors for Solid Waste* [accessed from https://www.epa.gov/smm/volume-weight-conversion-factors-solid-waste] published by United State Environmental Protection Agency (USEPA) in April 2016.

Reusing and Transportation Arrangement of Inert C&D Waste

5.3.23 The generation of inert C&D waste during each stage of the construction period has been estimated as shown in Table 5-3. Inert C&D waste should be reused on-site as far as practicable and efforts should be made to optimise cut and fill requirements during the detailed design. Good site practice and mitigation measures should be implemented. Possibility of reuse on other construction site should be explored. Surplus inert C&D waste should be sent to public fill reception facilities as the last resort after agreed with relevant authorities. The destination of inert C&D waste is subject to the designation by the Public Fill Committee according to DEVB TC(W) No.6/2010.

5.3.24 The portion of the generated inert C&D materials that could be reused on site is tentatively targeted as 20% (essentially from excavation and demolition waste) for backfilling and temporary site access road reinforcement activities, which is equivalent to 23,824m^3 of inert C&D waste.

5.3.25 After deducting the reused proportion from the total excavation and demolition waste, the remaining quantity of inert C&D material that might be transported to public fill reception facilities is assumed to be 101,594m^3. As such, the tentative average daily inert C&D waste to be transported to public fill reception facilities would be estimated by $\frac{101584\ m^3}{60\ month \times 26\ day/month} = 65.12\ m^3/day$. Assuming a dump truck capacity of 7.5m^3 per trip, the tentative average number of dump truck trips per day could therefore be estimated as $\frac{65.12\ m^3/day}{7.5\ m^3/trip} = 9\ trip/day$. Nonetheless, the above estimations of inert C&D waste and dump truck trip are tentatively only. Detailed information on the waste generation activity in terms of procedures, time, and specific quantity will be provided at detailed design stage.

Recycling and Transportation Arrangement of Non-inert C&D Waste

5.3.26 For the proposed development, non-inert C&D waste will be generated at the site clearance stage and superstructure construction stage, at which the composition is expected to be mostly demolished metal and waste wood and timber respectively. The contractor should reserve a space on site to sort and segregate non-inert C&D waste in different types to enable the later recycling. If yard waste like timber and woody materials are anticipated during site clearance, the project team should further explore to deliver the yard waste to the Yard Waste Recycling Centre for recycling prior to disposal.

5.3.27 After maximized waste sorting, segregation and recycling, the residual non-inert C&D waste should be transported to and disposed at North East New Territories Landfill (NENT) on at least weekly basis.

5.3.28 The total non-inert C&D waste generated from the proposed development is tentatively estimated to be 6,276m^3. The tentative average daily generation rate is estimated as $\frac{6276\ m^3}{60\ month \times 26\ day/month} = 4.02\ m^3/day$. In terms of dump truck trips to NENT and recycle facilities, the weekly dump trip demand can be estimated as $\frac{4.02\ m^3/day \times 7\ day/week}{7.5\ m^3/trip} = 4\ trip/week$.

5.4 Waste Management Impact in Operation Phase

5.4.1 The key potential waste sources during the operation phase are:

- Domestic waste, generated from residents and staffs.
- Chemical wastes, generated from maintenance of sewage treatment plant.
- Dewatered sludge cake, generated from operation of sewage treatment plant.

5.4.2 During the operation phase, the major type of waste will be domestic waste from the residents. According to the EPD's *Waste Statistics for 2022* published in December 2023, the most recent per capital domestic waste disposal rate is 0.93 kg/person/day, and per capital commercial and industrial waste disposal rate is 0.59 kg/person/day.

5.4.3 As advised by Project Applicant, the estimated maximum number of the Domestic (Flat) is 3,305 and it is estimated to accommodate a residential population of 9,915 persons. The total number of staffs from the club house and commercial complex is estimated to be 354. On this basis, it is estimated that the daily domestic waste generation rate would be 9.2tonne and daily commercial waste generation rate would be 0.2tonne from the proposed development. The total municipal solid waste generation would be 9.4tonne per day.

5.4.4 During the operation phase of the proposed STP, treatment input (coagulant, flocculant, and others) will be applied, and sludge cake will be generated after the sludge thickening and dewatering process. Even though the dosing of chemical will not be counted as chemical waste generation, the maintenance of STP might potentially generate small amount of chemical waste due to application of lubrication for equipment repair and corrosive chemical for cleaning.

5.4.5 Within the SIA, the average dry weather flow of the proposed development has been calculated as 3005.4m^3/day. Assuming a suspended solid concentration of 220 mg/L for medium domestic wastewater, and the dry content of 30% for sludge cake, the daily sludge cake generation rate can be estimated by $\frac{3005.4\ m^3/day \times 1000\ L/m^3 \times 220\ mg/L \times 0.000001\ kg/mg \times 100\%}{30\%} = 2203.96\ kg/day = 2.2\ tonne/day$.

5.5 Mitigation Measures

Construction Phase

5.5.1 Waste management shall be controlled through contractual requirements as well as through statutory requirements.

5.5.2 A Waste Management Plan ("WMP") should be prepared and implemented in accordance with *Practice Note for Authorized Persons and Registered Structural Engineers – Construction and Demolition Waste* (PNAP ADV – 19) issued by the Buildings Department and submitted to the Engineer/Architect for approval before the commencement of any construction works. The objectives of the WMP will be to identify any potential environmental impact from the generation of waste at the Site; to recommend appropriate waste handling, collection, sorting, disposal and recycling measures in accordance with requirements of the current regulations; and to categorize and permit segregation of C&D materials where practicable (i.e. inert material / non-inert material) for disposal considerations i.e. public fill reception facilities/ landfill.

5.5.3 The Contractors should adopt good housekeeping practices with reference to the WMP such as waste segregation prior to disposal. Besides the provision of stockpiling and segregating areas at site, effective collection of site wastes is required to prevent waste materials being blown around by wind, flushed or leached into nearby waters, or creating odour nuisance or pest and vermin problems. Waste storage areas should be well maintained and cleaned regularly.

5.5.4 According to Section 4.1.3 of the Project Administrative Handbook for Civil Engineering Works (2022 Edition) ("PAH") and CEDD TC No. 11/2019, the project office is required to draw up a Construction and Demolition Materials Management Plan (C&DMMP) at the feasibility study or preliminary design stage of each Project, which generates more than 50,000m^3 of C&D materials. For projects which are not classified as "designated projects" under Schedule 2 of the EIAO but generating surplus C&D material in excess of 300,000m^3 or requiring imported fill exceeding 300,000m^3, the C&DMMP should be submitted to Public Fill Committee ("PFC") for in-principle approval prior to commencement of the detailed design in accordance with PAH Clause 4.1.3 and DEVB TCW No. 9/2011. As the estimated total C&D waste generation from the proposed development has reached 131,694m^3, a C&DMMP should be prepared by the project team and submitted to Civil Engineering and Development Department Vetting Committee on Construction and Demolition Materials Management. Measures to minimize the generation of C&D materials and enhancement of on-site material reuse will be further explored upon acquiring further information on the subsurface geological profile.

5.5.5 However, as the C&DMMP requires detailed procedure of each step of construction stage, mitigation, construction methodology, and detailed waste management plan. This plan will be provided at the detailed design stage or before the detailed design stage (if the captioned detailed procedures are available).

5.5.6 A trip-ticket system should be established in accordance with DevB TC(W) No. 6/2010 and the *Waste Disposal (Charges for Disposal of Construction Waste) Regulation* to monitor the disposal of public fill and solid wastes at public filing facilities and landfills, and to control fly-tipping. A trip-ticket system should be included as one of the contractual requirements for the contractor to strictly implement.

5.5.7 In addition, the EPD's Recommended Pollution Control Clauses for Construction Contract should be incorporated in the relevant works contract. The RPCC are generally good engineering practice to minimize inconvenience and environmental nuisance to nearby residents and other sensitive receivers. The general requirements as summarised as follows:

- The Contractor shall observe and comply with WDO and its subsidiary.
- The Contractor shall submit the Engineer for approval a waste management plan with appropriate mitigation measures including allocation of an area for waste segregation and shall ensure that the day-to-day site operations comply with the approved waste management plan.
- The Contractor shall minimise the generation of waste from his work. Avoidance and minimisation of waste generation can be achieved through changing or improving design and practices, careful planning and good site management.
- The Contractor shall ensure that different types of wastes are segregated on-site and stored in different containers, skips or stockpiles to facilitate reuse / recycling of waste and, as the last resort, disposal at different outlets as appropriate.
- The reuse and recycling of waste shall be practised as far as possible. The recycled materials shall include paper / cardboard, timber and metal etc.
- The Contractor shall ensure that Construction and Demolition ("C&D") materials are sorted into public fill (inert portion) and C&D waste (non-inert portion). The public fill which comprises soil, rock, concrete, brick, cement plaster/mortar, inert building debris, aggregates and asphalt shall be reused in earth filling, reclamation or site formation works, The C&D waste which comprises metal, timber, paper, glass, junk and general refuse shall be reused and recycled and, as the last resort, disposed of at landfills.
- The Contractor shall record the amount of waste generated, recycled and disposed of (including the disposal sites).
- The Contractor shall use a trip-ticket system for the disposal of C&D materials to any designated public fill reception facility and/or landfill.
- Training shall be provided for workers about the concepts of site cleanliness and appropriate waste management procedure, including waste reduction, reuse and recycling.
- The Contractor shall observe and comply with the *Waste Disposal (Chemical Waste) (General) Regulation*.
- The Contractor shall register as chemical waste producer under the *Waste Disposal (Chemical Waste) (General) Regulation* if chemical waste is anticipated. All chemical waste shall be properly stored, labelled, packaged, collected and disposed of in accordance with the Regulation.

5.5.8 When inclement weather (e.g. heavy rain, typhoon, etc.) is forecast, additional control measures should be adopted as follows:

- Construction material, stockpiles, chemical and waste storage / recycling facilities should be immediately moved to secured area.
- Construction material, stockpiles and waste storage / recycling facilities should be covered by an impermeable sheeting, if necessary.
- Intercepting channels will be provided at the edge of the excavated area to prevent storm runoff from washing across the exposed surface.
- Silt removal facilities, channels and manholes will be maintained and the deposited silt and grit will be removed regularly.

5.5.9 The specified mitigation measures for general refuse, chemical waste generated during the construction phase are discussed as below.

Mitigation Measure for General Refuse

5.5.10 General refuse should be stored in enclosed bins or compaction units separate from C&D material. A reputable waste collector should be employed by the construction contractor to remove general refuse from the Site at the minimum frequency of once a day, separately from C&D materials. Preferably an enclosed and covered area should be provided to reduce the occurrence of “wind-blown” materials.

5.5.11 In order to minimize the final disposal quantities of general refuse, provisions of recycle bins for different types of recyclable waste should be provided together with general refuse bins. Arrangements should be made with recycling companies to collect recycled waste as required.

5.5.12 With the proper implementation of the good site practice and recommended mitigation measures as discussed in this section, no adverse waste impact from the handling, transportation or disposal of general refuse is anticipated during construction of the Proposed Development.

Mitigation Measure for Chemical Waste

5.5.13 The contractor is required to register with the Environmental Protection Department (EPD) as chemical waste producer at the construction stage. The Cradle to Grave approach should be used to control chemical waste. This approach consists of assessing the chemical waste reduction based on life cycle assessment, oil and lubrification materials with proactive maintenance of construction machine and equipment. The Cradle to Grave approach applied to chemical waste aims to maximize the reduction of chemical waste at all stage of the project to prevent disposal of chemical waste. The same approach should be applied to all kinds of waste related to the project to maximize the waste reduction. Further elaboration in this aspect is expected at the detailed design stage.

5.5.14 **Chemical Waste Minimization**: quantities of chemical waste produced can be reduced by careful site management. The contractor can use up leftover chemicals within the site or from other sites according to their originally intended purposes as far as possible. Good practice can avoid contamination of chemicals with other substances; thus, enhancing the possibility to minimising any surplus of the original chemicals; thus, avoiding wastage.

5.5.15 **Chemical Waste Storage**: chemical waste should be packed and held in containers of suitable design and construction so as to:

- Prevent leakage
- Prevent spillage or escape of contents under normal conditions of handling, storage and transport

- The chemical waste producer should provide a suitable area for temporary storage of chemical waste.
- The storage area should be used for chemical waste storage only. It is strictly forbidden to store chemical waste with either chemicals or dangerous good substances in the same storage facility.
- The storage area should be located close to the source of waste generation.
- The storage area should be enclosed on at least three sides by a wall, partition or fence with a height of not less than two metres or at least the total height of containers in the stack.
- Suitable materials for enclosures: Concrete, Brick, Steel with protective coating or treatment
- Enclosures should be rigidly erected and fixed to the area.
- Adequate space should be allowed within the storage area for container handling by workers.
- Containers of incompatible chemical waste must not be stored together where potentially dangerous consequence may result in the event of contact between the wastes.
- A warning sign that indicates the English words and Chinese characters "CHEMICAL WASTE" and "化學廢物" clearly and boldly in red on a white background with a letter/character size of not less than 60mm high should be displayed at or near the entrance or opening of the storage area for chemical waste other than asbestos and PCB wastes.

5.5.16 **Chemical Waste Labelling:**

- Every container of chemical waste should be labelled clearly, in both Chinese and English.
- The waste producer should ensure that the information contained on the label is accurate and sufficient so as to enable proper and safe handling, storage and transport of the chemical waste.
- The label should be securely attached to a suitable part of the container (to the sides of drum and not on the top), which allows the information on the label to be easily read.
- Remove old labels from the containers if you decide to reuse or recondition containers.

5.5.17 **Good Practices to Reduce the Risk of Chemical Spillage**:

- Reduce the amount of chemical waste generated during activities by careful planning and usage.
- Reduce the amount of chemical waste stored on site, regular collection of chemical waste by licensed Waste Collector.
- Chemical waste should be stored within designated enclosure, away from direct sunlight or heat generating / propagating activities. Always close the door of enclosure.
- Ensure ventilation is adequate within enclosure, prevent the building up of gaseous substances.
- Separate incompatible chemical waste from each other.
- Use a pump instead of simple pouring to transfer liquid waste.
- Ensure caps and lids are tightly fitted to seal containers.
- Ensure drip trays are placed under each chemical waste container, so that any spillage can be retained.
- Check conditions of containers regularly.
- Avoid the use of large size containers, as they are hard to handle and transport.
- Clearly label all the chemical waste.
- Use suitable carriers to transfer containers between locations.
- Provide training to staff on chemical waste handling.

- Ensure the shelves are secure, and easily accessible to collect or handle chemical waste containers.
- Use absorbent materials to absorb spillage of chemicals or chemical wastes.
- Regular drills on handling of chemical spills should be conducted.

5.5.18 **Collection and disposal of chemical waste**: the chemical waste should be regularly collected from site by licensed chemical waste collectors to Chemical Waste Treatment Centre or other equivalent facilities.

5.5.19 With the proper implementation of the good site practice and recommended mitigation measures as discussed above, no adverse waste impact from the handling, transportation or disposal of chemical waste during the construction of the Proposed Development is anticipated.

Asbestos Containing Materials

5.5.20 If any ACMs is identified, the project proponent would strictly follow the Waste Disposal (Chemical Waste) (General) Regulation, Factories and Industrial Undertakings (Asbestos) Ordinance, Air Pollution Control Ordinance, Code of Practice on the Handing, Transporting and Disposal of Asbestos Waste, and Code of Practice on Safety and Health at Work with Asbestos to mitigate the environmental impact associated with ACMs.

5.5.21 Control measures and suitable systems of work stipulated in Code of Practice on Safety and Health at Work with Asbestos should be implemented during the handling of ACMs when applicable as follow:

- removing materials containing asbestos before any other work begins
- adopting work methods that minimize breakage, abrasion, sanding, grinding or cutting of materials containing asbestos
- suppressing dust by wetting where appropriate
- avoiding carrying out asbestos work together with other work in the same place at the same time.
- segregating the asbestos work area from other areas
- keeping the work area clean by promptly removing off-cuts, waste and debris.

5.5.22 Besides, the spread of asbestos should be prevented by the following measures:

- adopting appropriate system of work which aims to minimize workman's contact with asbestos, to minimize the possibility of spillage or accumulation of debris and to discourage careless, unduly hurried or untidy work
- taking appropriate control measures such as carrying out work with asbestos under HEPA filter-equipped local exhaust ventilation
- restricting access to the asbestos work area by the designation of a protective equipment zone, and ensuring that contaminated protective clothing and RPE are not worn outside the protective equipment zone
- ensuring asbestos wastes, contaminated protective clothing and filters of RPE are suitably packed and labelled, and outside surfaces of the packages are adequately cleaned before being removed from asbestos work area for disposal
- isolating air conditioning and ventilation systems serving the asbestos work area from all other such systems
- constructing the appropriate work area enclosure to confine the asbestos work in an enclosed region, and maintaining the enclosure under negative pressure so that any leakage will result in clean air being drawn into the work area from outside
- ensuring any piece of tools and equipment contaminated by asbestos is adequately cleaned or sealed inside polythene bags before being removed from asbestos work area for maintenance or servicing or other treatments
- providing appropriate washing and changing facilities for decontamination of the workmen

5.5.23 ACMS should be properly transported and disposed in accordance to Code of Practice on the Handling, Transportation and Disposal of Asbestos Waste. ACMS should be transported to the disposal sites by enclosed skips, open lorries or enclosed vehicles according to the requirement for each type of asbestos waste: Type 1 asbestos are bonded asbestos product free from dust, and in good condition. Type 2 asbestos contain loose asbestos fibres which are potentially hazardous if the waste is allowed to disperse into the air, even in small quantity. Type 3 asbestos waste is hazardous in very small quantities.

5.5.24 Drummed waste and Type 1 asbestos waste are not required to be transported by skips and may be transported by open lorries or enclosed vehicles subject to the following requirements:

- Vehicles should not be loaded above the free edge of the sideboards.
- The waste should be secured on the vehicles.
- Plastic sheets should be used for covering waste on an open type lorry and for lining the vehicles when loaded with Type 1 waste. The used sheets should be disposed of as contaminated waste at the landfill.
- Proper warning panels must be placed on vehicles to indicate the carriage of asbestos waste.
- Wash down asbestos contaminated vehicles with water at the disposal sites where the wash water may be drained into reception trenches.

5.5.25 Type 2 and Type 3 asbestos waste contained in plastic bags must be transported in enclosed skips which meet the following specifications:

- Dedicated skips must be exclusively used to transport asbestos waste.
- Skips must be constructed of steel and possess sealable drain outlet.
- Skips must be fully enclosed and be of the walk-in type with double lockable door at the rear end. The doors and joints of the skips must be rubber sealed, and the doors must be locked during transport.
- The capacity of the skips will normally be 9 or 15m^3, and the skips must not be overloaded.
- Skips must be capable of being hydraulically loaded on and off the transport vehicles.
- Loading and unloading of the bagged waste must be conducted by hand whilst the skip is in the lowered position (on the ground).
- The bagged asbestos waste should not be stacked indiscriminately resulting in damage to the bottom bag due to the weight at top.
- Proper warning panels must be placed on the skips to indicate the carriage of asbestos waste.
- Pallets of Types 2 and 3 asbestos waste may be carried together within the skips.
- Contaminated skips must be washed down at the disposal sites where wash water may be drained into reception trenches.

5.5.26 Prior to the disposal of ACMs to landfill, the registered asbestos contractor should notify EPD to obtain the specific instruction and direction for disposal of waste. Similar to the arrangement of inert C&D waste and chemical waste, a trip ticket system should be adopted to keep track of the movement of ACMS from the point of arising to the final place disposal.

Operation Phase

5.5.27 The property management team shall encourage proper waste management in line with the government policy. The waste management hierarchy shall be adopted by the building management to manage waste in a sustainable manner. The waste management hierarchy is a concept which shows the desirability of various waste management methods and comprises the following in order of descending preference:

- Avoidance
- Minimisation

- Recycling / reuse

5.5.28 During the operation phase of the proposed STP, the preventative measure for chemical spillage and controlling measures after spillage should be prioritized. Similar approach of mitigating chemical waste impact during construction stage described in Section 5.5.15 to Section 5.5.18 should be adopted. The chemical storage and dosing equipment shall be inspected regularly and maintained at good condition. The chemical should be labelled and stored in a suitable area before dosing in treatment process in accordance with Waste Disposal (Chemical Waste) (General) Regulation and the Code of Practice on Packaging, Labelling and Storage of Chemical Wastes. Emergency cleanse plan and proper handheld equipment and sufficient absorption material to confine spilled chemical should be prepared. The maintenance of STP should be handled by experienced technicians. Even though dosing of chemical is not considered as generation of chemical waste, the property management team is suggested to register as a chemical waste producer in EPD because of the potential chemical waste generation from STP during its maintenance. The property management team should contact a licenced chemical waste collector to collect the chemical waste from the STP to Chemical Waste Treatment Centre or equivalent facilities if chemical waste is generated from maintenance of STP or spillage incident.

5.5.29 The sludge cake should be dewatered to achieve the requirement of 30% dryness before being transported to and disposed at NENT. The property management team can also transport the sludge cake to Sludge Treatment Facilities at T. Park for recycling if consent from T. Park can be obtained. Whenever feasible, the sludge recycling option at T. Park should be prioritized over the disposal option at NENT.

5.5.30 The waste generated during the operation of the commercial complex and residential blocks will mainly be municipal solid waste comprising recyclable waste, such as paper, aluminium cans, plastic bottles, food waste etc. Sufficient recycle bins should be provided for the convenience of maximizing waste sorting and segregation. Waste shall be collected and stored in appropriate waste receptacles, each with a proper cover to minimize odour and hygiene issues. Different kinds of waste shall be regularly collected by private waste collectors on the minimal frequency of once per day and taken off-site for proper recycling or disposal, respectively. The property management team should attempt to collect the food waste from the restaurant and residents and transport to O-Park or equivalent food waste treatment facilities. The property management team can also attempt to liaise with EPD to set up a food waste recycling spot and install food waste smart recycling bins within the Proposed Development to collect the food waste from restaurants and residents respectively. The detailed waste transportation, recycling and disposal during operation phase of Proposed Development shall be elaborated in detailed design stage.

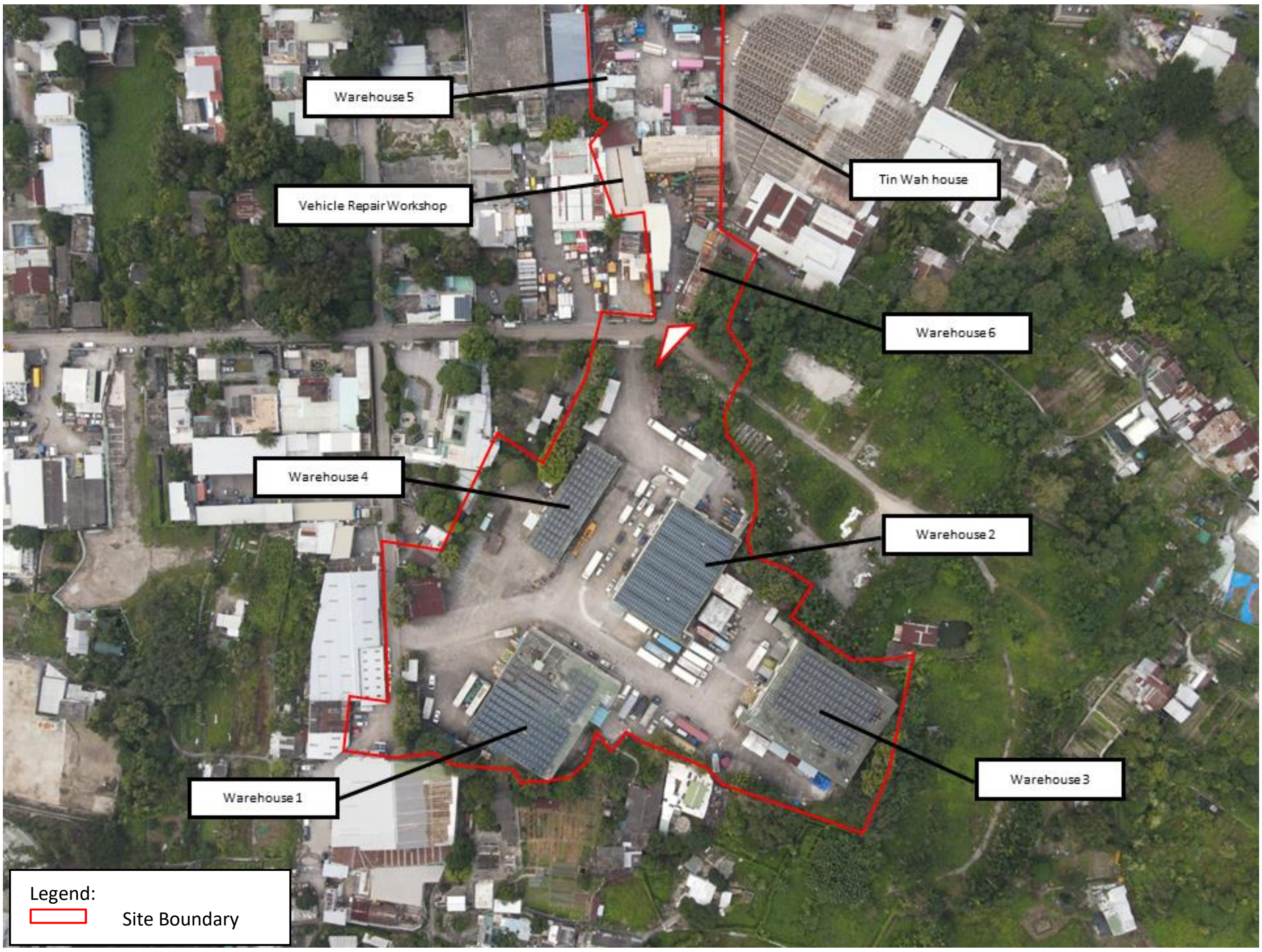
5.6 Conclusions

5.6.1 Generation of inert and non-inert C&D waste, chemical waste and general refuse is expected during the construction phase of proposed development. With the development of WMP and to implement the good site practices recommended therein, the waste generated during construction phase can be greatly reduced. Provided that good site practices recommended are followed, there should be no adverse impacts related to the management, handling and transportation of waste during the construction phase.

5.6.2 During the operation phase, the major type of waste generated will be municipal solid wastes from the residential blocks and commercial complex, dewatered sludge cake from the STP, as well as chemical waste generated from maintenance of STP or chemical spillage incident. Since municipal solid waste and sludge cake will be collected on a regular basis by waste collectors and will be disposed of at SENT, no adverse waste impacts from handling, transportation or disposal are anticipated during operation.

5.6.3 With the implementation of recommended mitigation measures, adverse waste impacts generated during the construction and operation phase of the Proposed Development are not anticipated.

Figure 5-1: Aerial Photo of Existing Structure in Site



6 LAND CONTAMINATION

6.1 Environmental Legislation and Standards

6.1.1 The land contamination assessment has been conducted in accordance with the following legislation, standard and guidelines:

- EPD Guidance Note for Contaminated Land Assessment and Remediation.
- EPD Practice Guide for Investigation and Remediation of Contaminated Land.
- Guidance Manual for Use of Risk-Based Remediation Goals for Contaminated Land Management

6.2 Assessment Methodology

6.2.1 The assessment for land contamination of the Site was carried out with reference to EPD's Practice Guide.

6.2.2 At this stage of preliminary design, the assessment methodology will consist of documentary justification and supplemental information from the past and present land use activities through desktop study, site survey (in terms of site's land use history, aerial photos, site visit photos, spillage records, potential contamination sources, etc) consolidated in a separated contamination assessment plan (CAP) to be submitted to EPD for review at further stage. The CAP will therefore show evidence or infirm the presence of land contamination within the development area. Specifically, following steps should be strictly adopted for the land contamination study separately at the further stage:

(a) Carry out site appraisal, including background information collection
(b) Design site investigation ("SI") strategy and prepare a Contamination Assessment Plan ("CAP") for EPD's approval
(c) Conduct SI according to the approved CAP
(d) Interpret SI results and prepare a Contamination Assessment Report ("CAR") for EPD's approval if evidence of contamination is demonstrated at the CAP stage
(e) Plan and design remediation strategy and prepare a Remediation Assessment Plan ("RAP") for EPD's approval
(f) Carrying out the remediation works
(g) Preparing the Remediation Report ("RR") for EPD's endorsement

6.3 Site Environment

6.3.1 Referring to the Draft Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan No. S/NE-LYT/18, the zoning of the project site area is "Residential (Group C)" and "Agriculture". The project site area is currently a flat land, being occupied for the use of workshop, storage and warehouses. The northern portion of the application site is currently occupied by one permanent domestic structure, some temporary structures for open storage yards, storage of construction materials and workshops, open carparks and vacant land with little vegetation cover. The southern portion of the application site is currently occupied by the Applicant using as warehouse purposes. There is a total of 4 warehouses currently in operation. Overall, the application site is featured by warehouses and brownfield undertakings and observed with little vegetation cover.

6.3.2 Referring to the Land Registry record, the project site area is owned by multiple landlords, and the planning applicant, Carlton Woodcraft Manufacturing Limited, is the major owner of the southern portion. The planning applicant has already obtained the consent from all landlords on the project site for the Town Planning Ordinance Section 12A rezoning application. The site boundary includes 1,358 m^2 government land.

6.4 Site Appraisal Findings

6.4.1 Site appraisal was conducted in order to identify any potential contamination sources generated by the past and present land-use activities within the Site and the associated causes for land contamination.

Historical Use of the Site

6.4.2 Aerial photographic records obtained from the Survey and Mapping Office ("SMO") of Lands Department between Year 1963 and Year 2022 were reviewed. These photographic records revealed that the Site was an agricultural land on or before Year 1963. In Year 1973, it is found that much of the previous farmlands were abandoned and became vacant with vegetations, while small part of farmland remained in the middle and southeast of the Site. Small temporary structures were also identified at the northwest of the Site. In Year 1982, the aerial photo indicated more farmlands were abandoned and became vacant, while only the middle part of the Site remained as agricultural land. Building structures were identified at the north of the Site. In Year 1993, the Site was partly paved and four building structures were identified at the southern part of the Site, several temporary structures and possible open car park were also found at the northern part of the Site. In Year 2002, the Site was almost entirely paved, while open car park, temporary structures and the four building structures still existed. A village house was also found at the north of the Site. Between Year 2013 and Year 2022, similar site conditions could be observed. The northern part of the Site was further paved and building structures within the Site remained the same. Activities such as parking of heavy trucks and open storage of construction materials could be identified. As advised by the Applicant, there were no underground contamination sources such as storage tanks and pipework in previous land uses.

6.4.3 As observed from the aerial photos, there is potential land contamination issues associated with past land uses such as open area storage and possible vehicle maintenance activities. Land contamination issue from the warehouse usage is not likely as the stored goods are mainly construction materials like metal plates and formworks. Therefore, investigation on potential land contamination issues is further discussed in ***paragraphs 6.4.4*** to ***6.4.7.*** The historical land uses of the Site based on the aerial photographic records is summarized ***Table 6-1*** and aerial photographs are provided in ***Appendix F.***

Table 6-1: Historical Land Uses of the Site based on the Aerial Photographical Records

Photo Date	Reference No.	Land Use
1963	1963-0148	Entirely covered by agricultural land.
1973	05591	Mainly abandoned farmland / vacant land covered with vegetations, with scattered farmland found at middle and southeast of the Site. Small temporary structures were identified at the northwest of the Site.
1982	46797	Mainly abandoned farmland / vacant land covered with vegetations, small part of agricultural land could be found in the middle of the Site. Building structures observed at the northwest of the Site.
1993	CN05044	The Site was mainly paved with small part of vegetated land at the middle of the Site. Four building structures were found at the south of the Site. At the north of the Site, temporary structures and possible open carpark were identified.
2002	CW41443	The Site was almost entirely paved. Possible open carpark, temporary structures and four building structures identified in 1993 were also found in aerial photo of 2002. Besides, a village house was

Photo Date	Reference No.	Land Use
		also identified at the north of the Site.
2013, 2020, 2022	CW102122, E093906C, E152970C	The Site was almost entirely paved with similar conditions since 2002. Parking of heavy trucks, open storage of construction materials, and vehicle maintenance activities could be identified.

Site Walkover

6.4.4 Site walks was carried out on 6 December 2022 and 18 January 2023. The Site was currently used as village house, warehouses, open storage yards, and vehicle maintenance workshops. The land contamination potential of each land use is described as below Table 6-2 in reference to Practice Guide while the actual relation between the suspected activities to land contamination should be determined by site condition.

Table 6-2: Land Contamination Potential related to Identified Land Uses

Land Use Types	Potentially Polluting Activities	Key Chemicals of Concern
warehouse	Spillages and accidents related to storage of chemicals, manufacturing process, equipment maintenance and cleaning, storage, treatment and disposal of wastes.	Dependent on the materials handled, stored, used and produced on site.
open area storage	Loading, unloading and storage of goods, fuel storage and transfer, maintenance of equipment and vehicles.	Metals, PCRs, VOCs and SVOCs.
vehicle maintenance workshop	Release of oils and fuels and lubricants from vehicles, vehicle and equipment maintenance and refuelling. Use of chemicals and solvents in maintenance activities. Motor vehicle painting and storage and disposal of wastes.	Metals (e.g. chromium, copper, lead, manganese, nickel, zinc), PCRs, VOCs (e.g. acetone, BTEX, MTBE, and trichloroethene) and PAHs.

6.4.5 Because of the occupying business activities onsite, some portion of the site area was not accessible as shown in Figure 6-1. Even though potentially land contaminating activities could be observed, no obvious land contamination issue was observed during the walkover as the area was maintained cleaned and the site portion under potentially contaminating land use are fully paved with concrete. The photos of the existing site and the site walkover checklist are shown on ***Appendix G.*** There is concern that the periphery of the project site may cause off-site contamination. Shun Cheong Electrical Products and Tung Chun Soy Sauce and Canned Food Company Factory Limited is at the nearby of the site. During the previous site visit, all the windows and doors of Shun Cheong Electrical Products Factory Limited was closed. The business nature was unknown. It was observed to be a two-story reinforced concrete structure. Tung Chun Soy Sauce and Canned Food Company was entirely paved and maintained overall clean. Further investigation should be done at these two factories to see whether there is any possible land contamination connection.

6.4.6 Even though there was no evidence of potential land contamination issue during the previous site walkover, further investigation should be provided by the project team at the detailed design stage to provide better insight on land contamination issue. In case any evidence could be established on the land contamination, steps (b) to (g) of ***paragraph 6.2.1*** shall be required. As the village house, temporary structures (i.e. open storage and vehicle maintenance workshops) and warehouses within the Site are still in use, it is not appropriate to carry out site investigation at this planning stage. A separated CAP with updated site information will be prepared for EPD's review during the detailed design stage of the Proposed Development. The CAR should be prepared for EPD's review after site investigation. If land contamination is confirmed, RAP should be prepared for EPD's review and remediation works should be carried out according to the approved RAP. No commencement of the construction work will be allowed prior to completing remediation works. A RR should also be prepared for EPD's endorsement to demonstrate that the clean-up of the contaminated land is completed.

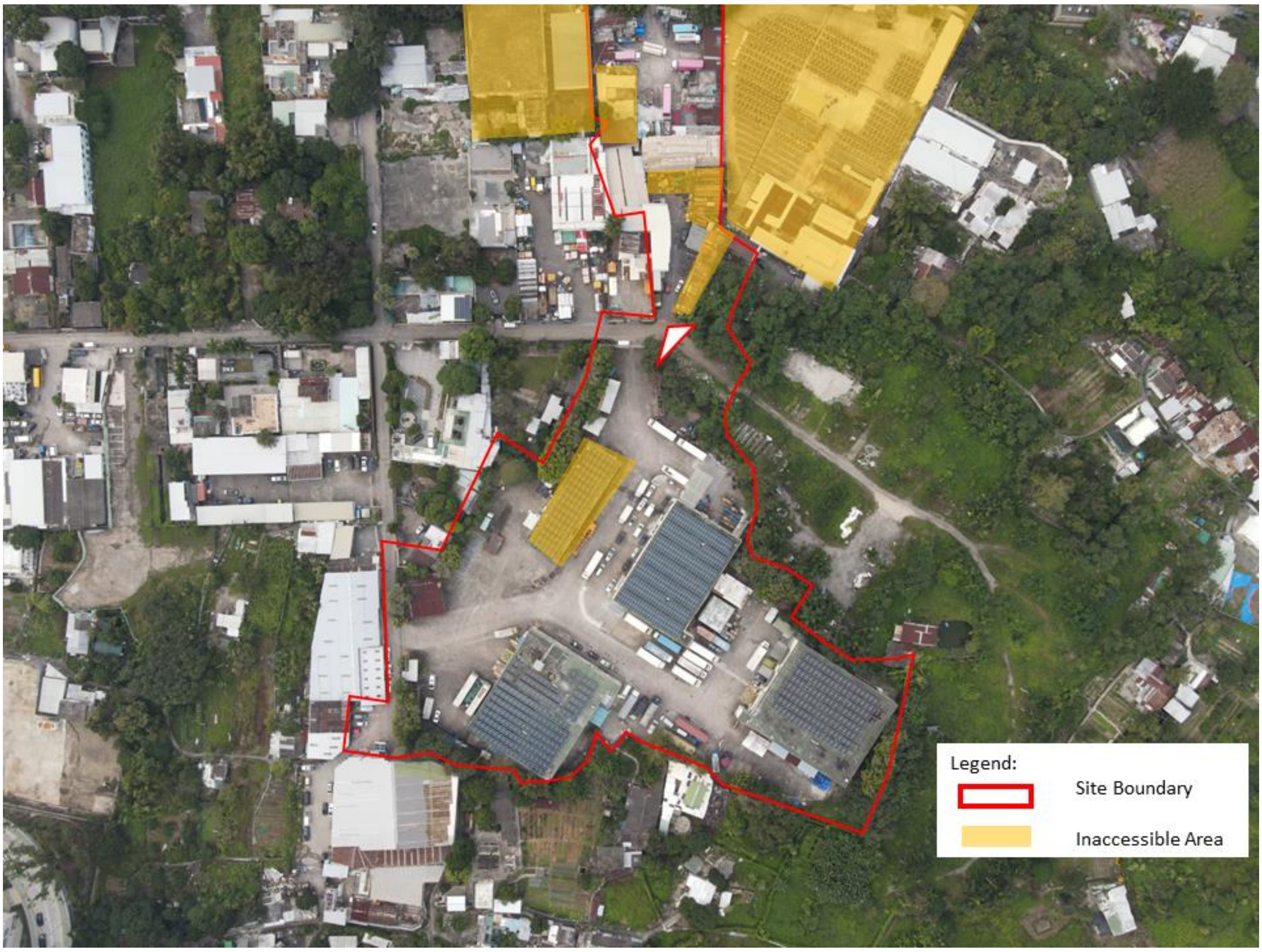
Review of Information from Relevant Government Departments

6.4.7 Based on the background research on this project area by inquiring the related governmental departments, there is no chemical spillage incident, fire incident, and dangerous goods storage record. The information request letters and replies from EPD and FSD are attached in ***Appendix H***. EPD confirmed that there was no incident of chemical spillage/leakage and no registered chemical waste producer in the site area, and FSD confirmed that there is neither record of dangerous goods license, fire incident nor incidents of spillage/leakage were found in connection with the site area.

6.5 Conclusion

6.5.1 A detailed investigation of the past and present land-use of the Project Site was carried out. Even though there are open storage yard and vehicle maintenance workshop within the Site, evidence of land contamination was not found during the site visit. In addition, the current site activities will not be change before the demolition for the construction related to the development target. Currently, some small portion within the site area is obstructed by the open storage yard and warehouse operation and the two adjacent factories have not yet been given permission for inspection. Emphasis should be given for these inaccessible area as shown in Figure 6-1 during the site appraisal in subsequent stage while other already accessible area should also undergo thorough inspection. A CAP will be prepared for EPD's endorsement during the detailed design stage. The CAR shall be prepared for EPD's approval after further site investigation. If land contamination is confirmed, RAP shall be prepared for EPD's approval and remediation works shall be carried out according to the approved RAP. No commencement of the construction work will be allowed prior to the completion of the remediation works. A RR shall also be prepared for EPD's endorsement to demonstrate that the clean-up of the contaminated land is completed. Updated CAP, CAR, RAP (if contamination is identified) and RR (if contamination is identified) shall also be provided.

Figure 6-1: Inaccessible Location within Development Area and Surrounding Area



7 CONCLUSION

7.1.1 The potential environmental impacts arising from the Proposed Development on the nearby sensitive uses, have been assessed. Mitigation measures have been recommended, where appropriate, to alleviate any identified adverse environmental impacts during the construction and operation of the Project. This EA has indicated that the Proposed Development will not generate any unacceptable environmental impacts during construction and operation phases, provided that all the recommended mitigation measures and good site practice are strictly implemented.

7.1.2 The conclusions of the different aspects of environmental impact assessments are as follows:

Air Quality

7.1.3 With the implementation of the recommended mitigation measures and good site practice, adverse impacts during the construction phases are not anticipated.

7.1.4 No existing chimney was identified within 200m from the Site. Therefore, no adverse air quality impact from industrial emissions on the Proposed Development is anticipated.

7.1.5 No adverse air quality impact on the Proposed Development from the vehicular emissions is anticipated with the sufficient buffer distance provided between these air pollution sources and the Proposed Development. Deodorizing unit with 99.5% efficiency will be installed for the proposed STP. Concentration of H_2S will be monitored to guarantee the compliance of 5 odour units based on an average time of 5 seconds. No adverse air quality from the Proposed Development on the surrounding air sensitive uses is also anticipated.

7.1.6 Overall, therefore, no adverse air quality impact is anticipated during the construction or operation phases of the Proposed Development.

Noise

7.1.7 During the construction phase of the Proposed Development, with the implementation of the noise mitigation measures recommended in ***Section 3.3***, no adverse noise impact is anticipated.

7.1.8 The Proposed Development is located at a low-density residential area, which is surrounded by village houses, such as Park Villa and King Chong, and some temporary dwellings, etc. These buildings provided effective acoustic shielding for the Proposed Development with buildings up to three storeys. Moreover, quantitative fixed noise impact assessment has been conducted to evaluate the fixed noise impact from the existing fixed noise sources. The predicted cumulative noise level is not greater than the noise criteria. Therefore, no adverse noise impact from the surrounding fixed noise sources on the proposed development is anticipated.

7.1.9 Most of the E&M equipment of the Proposed Development will be installed inside plant rooms. Potential noise sources have been identified as fixed mechanical equipment, such as chillers for central air conditioning. The chillers will be installed at roof top, which provided greatest separation from the identified NSRs and they will be shielded by the on-site building structure itself.

7.1.10 The maximum allowable sound power level (SWL) of the proposed outdoor units has been determined in order to ensure the compliance of statutory requirements and guidelines, which is subject to be changed in the detailed design stage.

7.1.11 For road traffic noise, the noise impact on the Proposed Development is predicted to comply with the standards as recommended in Chapter 9 Environment of the HKPSG with the building setback of about 130m to Sha Tau Kok Road (Lung Yeuk Tau).

7.1.12 Overall, therefore, no adverse noise impact during the construction and operation phases of the Proposed Development is expected.

Water Quality

7.1.13 During construction, water quality impacts will be properly controlled with the implementation of good site practice. Portable or Container toilets, when necessary, will be provided for constructions workers on-site. Provided these measures are implemented, adverse water quality impact is not anticipated during the construction phase. The Contractor shall apply for a Discharge Licence under the WPCO and the effluent discharged from the construction site shall comply with the terms and conditions of the Discharge Licence.

7.1.14 During operation, no adverse water quality impact is anticipated from the wastewater / sewage generated by the Proposed Development. The separate SIA Report has concluded that there will be no adverse sewerage impact from the Proposed Development.

7.1.15 Overall, therefore, no adverse water quality impacts are anticipated during the construction or operational phases of the Proposed Development.

Waste Management

7.1.16 With the development of WMP and to implement the good site practices recommended therein, the waste generated during construction phase can be greatly reduced. Provided that good site practices recommended are followed, there should be no adverse impacts related to the management, handling and transportation of waste during the construction phase.

7.1.17 During the operation phase, the major type of waste generated will be municipal solid wastes from the residential blocks and commercial complex, as well as dewatered sludge cake from the STP. Since municipal solid waste will be collected on a regular basis by waste collectors and will be disposed of at SENT managed by EPD, dewatered sludge cake will be attempted to deliver to Y-Park for recycling, and food waste will be explored to be recycled offsite or through EPD food waste recycling scheme, no adverse waste impacts from handling, transportation or disposal are anticipated during operation.

7.1.18 With the implementation of recommended mitigation measures, adverse waste impacts generated during the construction and operation phase of the Proposed Development are not anticipated.

Land Contamination

7.1.19 A detailed investigation of the past and present land-use of the Project Site was carried out. Despite vehicle maintenance workshop and open storage yard were identified on site, evidence on site contamination was not found because the site portions under potentially contaminating activities were clean and fully paved with concrete. Nonetheless, further investigation will be needed to confirm or infirm the land contamination issue after the entire site area is handed over and open for access. A separated CAP will be prepared for EPD's endorsement during the detailed design stage. The CAR shall be prepared for EPD's approval after site investigation. If land contamination is confirmed, RAP shall be prepared for EPD's approval and remediation works shall be carried out according to the approved RAP. No commencement of the construction work will be allowed prior to the completion of the remediation works. A RR shall also be prepared for EPD's endorsement to demonstrate that the clean-up of the contaminated land is completed. Updated CAP, CAR, RAP (if contamination is identified) and RR (if contamination is identified) shall also be provided.

Appendix A ODOUR COMPLAINT RECORDS OF CONCERNED SOURCES NEAR THE SITE

Pinky LAM

From: shchu@epd.gov.hk
Sent: 2023年6月16日星期五 11:00
To: Pinky LAM
Subject: Re: 7076933 Section 12A Rezoning Application at Lung Yeuk Tau - Odour and Noise Impact Review

This message Is From an External Sender

Please do not click the links or attachments and do not respond to this message if you are unsure of its origin.

Dear Pinky,

I refer to your email below.

There is no odour complaint records on (1) Tung Chun Soy Sauce & Canned Food Company Limited and Sha Tau Kok Road Ma Liu Shui San Tsuen Sewage Pumping Station in the past two years whilst one noise complaint was lodged against the recycling site (known as 天晴環保廢料回收有限公司) located at Point 3 marked in the map in Nov 2022, regarding a noise nuisance from construction waste handling.

Thanks.

Regards,
CHU Shun-hang
AE(RN)33 / EPD
2158 5832

From: Pinky LAM <Pinky.Lam@smec.com>
To: "shchu@epd.gov.hk" <shchu@epd.gov.hk>
Cc: Charls LIANG <Charls.Liang@smec.com>, Fred NG <Fred.Ng@smec.com>
Date: 15/06/2023 14:08
Subject: 7076933 Section 12A Rezoning Application at Lung Yeuk Tau - Odour and Noise Impact Review

---

Dear Mr. CHU,

Section 12A Rezoning Application – Request for Amendment to the approved Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan No. S/NE-LYT/19 from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A) 2" Zone
Request for Information – Odour and Noise Impact Review

We have been appointed by Carlton Woodcraft Manufacturing Ltd as the Environmental Consultant to undertake an Environmental Assessment ("EA") for the captioned project. In order to review potential odour and noise impact, we would be most grateful if you could provide us with the following information, if any:

1. Odour complaint record on (1) Tung Chun Soy Sauce & Canned Food Company Limited and (2) Sha Tau Kok Road Ma Liu Shui San Tsuen Sewage Pumping Station
2. Noise complaint record on (3) 粉嶺環保回收有限公司

1

Please refer to the attached plan for the locations of the project site and the listed items. Should you have any enquiries regarding the above, please do not hesitate to contact the undersigned. Thank you.

Regards,

Pinky LAM
Assistant Environmental Consultant
D +852 3995 8135 **T** +852 3995 8100 **F** +852 3995 8101 **E** pinky.lam@smec.com

SMEC Hong Kong – We're redefining exceptional
27/F Ford Glory Plaza, 37-39 Wing Hong Street, Cheung Sha Wan, Kowloon, Hong Kong

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[attachment "7076933_Location Plan.pdf" deleted by SH CHU/EPD/HKSARG]

Appendix B CALCULATION OF NOISE IMPACT FROM EXISTING FIXED NOISE SOURCES

Calculation of Sound Power Level of Existing Fixed Noise Sources

Fixed Noise Sources	Measured SPL, dB(A)	Distance from the Noise Source, m	distance Correction, dB(A)	Corrected SWL, dB(A)
S1 Shun Cheong Electrical Products Factory Ltd	74.5	9	27.1	101.6
S2 Fanling Environmental Recycling Limited	71.1	31	37.8	108.9

Calculation of Fixed Source Noise Impact from Existing Sources

NSR ID	Sources	Corrected SWL, dB(A)	Distance, m	Distance Attenuation, dB(A)	Façade Correction, dB(A)	Predicted SPL, dB(A)	Total SPL, dB(A)
R1	S1	102	167	-52.4	3	52.1	57
	S2	109	251	-56.0	3	55.9	
R2	S1	102	131	-50.4	3	54.2	60
	S2	109	197	-53.9	3	58.0	
R3	S1	102	169	-52.6	3	52.0	59
	S2	109	197	-53.9	3	58.0	

Appendix C CALCULATION OF MAXIMUM ALLOWABLE SOUND POWER LEVEL OF PROPOSED OUTDOOR UNITS

Predicted Noise Level at F1

Fixed Noise Source ID	Maximum SWL, dB(A)			Distance, m	Correction, dB(A)		Predicted Noise Level, dB(A)			Overall Noise Level, dB(A)		
	Day Time	Evening Time	Night Time		Distance	Façade	Day Time	Evening Time	Night Time	Day Time	Evening Time	Night Time
OU1	84	82	79	102	-48	3	39	37	34	41	39	36
OU2	84	82	79	129	-50	3	37	35	32			
								Criteria, dB(A)		50	48	45

Predicted Noise Level at F2

Fixed Noise Source ID	Maximum SWL, dB(A)			Distance, m	Correction, dB(A)		Predicted Noise Level, dB(A)			Overall Noise Level, dB(A)		
	Day Time	Evening Time	Night Time		Distance	Façade	Day Time	Evening Time	Night Time	Day Time	Evening Time	Night Time
OU1	84	82	79	103	-48	3	39	37	34	41	39	36
OU2	84	82	79	132	-50	3	37	35	32			
								Criteria, dB(A)		50	48	45

Predicted Noise Level at F3

Fixed Noise Source ID	Maximum SWL, dB(A)			Distance, m	Correction, dB(A)		Predicted Noise Level, dB(A)			Overall Noise Level, dB(A)		
	Day Time	Evening Time	Night Time		Distance	Façade	Day Time	Evening Time	Night Time	Day Time	Evening Time	Night Time
OU1	84	82	79	229	-55	3	32	30	27	50	48	45
OU2	84	82	79	28	-37	3	50	48	45			
								Criteria, dB(A)		50	48	45

Appendix D TRAFFIC FORECAST FOR YEAR 2046

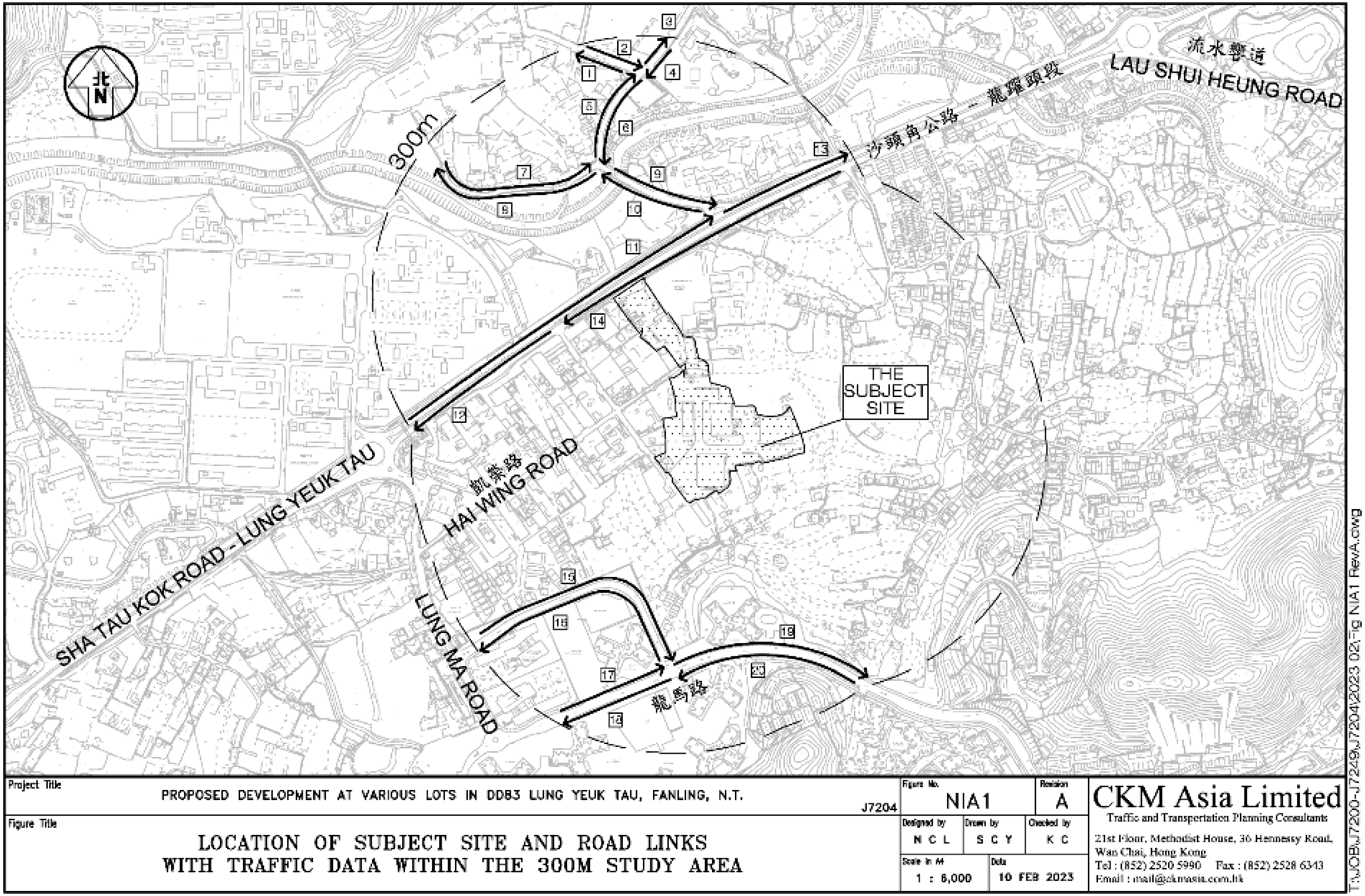
Traffic Forecast – Year 2046

TABLE 1 – PEAK HOUR TRAFFIC FLOW AND VEHICLE COMPOSITION

YEAR 2046 TRAFFIC FORECAST **Date: 10 February 2023** **Job No.: J7204**

Link ID	Road Section	From Road	To Road	Peak Hour Traffic Flows (veh/hr)	Peak Hour Vehicle Composition LV	Peak Hour Vehicle Composition HV
L001	Unnamed Access Road (L001/L002)	Access Road to Kwai Tei (North)	Unnamed Site Access	50	42.9%	57.1%
L002	Unnamed Access Road (L001/L002)	Unnamed Site Access	Access Road to Kwai Tei (North)	50	42.9%	57.1%
L003	Access Road to Kwai Tei (North)	Unnamed Access Road (L001/L002)	Kwan Tei North	100	47.7%	52.3%
L004	Access Road to Kwai Tei (North)	Kwan Tei North	Unnamed Access Road (L001/L002)	200	66.0%	34.0%
L005	Access Road to Kwai Tei (North)	Unnamed Access Road (L007/L008)	Unnamed Access Road (L001/L002)	100	47.4%	52.6%
L006	Access Road to Kwai Tei (North)	Unnamed Access Road (L001/L002)	Unnamed Access Road (L007/L008)	200	65.4%	34.6%
L007	Unnamed Access Road (L007/L008)	Cul-de-sac	Unnamed Access Road (L001/L002)	50	40.0%	60.0%
L008	Unnamed Access Road (L007/L008)	Unnamed Access Road (L001/L002)	Cul-de-sac	50	40.0%	60.0%
L009	Access Road to Kwai Tei (North)	Unnamed Access Road (L007/L008)	Sha Tau Kok Road - Lung Yeuk Tau	200	63.6%	36.4%
L010	Access Road to Kwai Tei (North)	Sha Tau Kok Road - Lung Yeuk Tau	Unnamed Access Road (L007/L008)	150	46.2%	53.8%
L011	Sha Tau Kok Road - Lung Yeuk Tau	Lung Ma Road	Unnamed Access Road (L001/L002)	1,150	69.6%	30.4%
L012	Sha Tau Kok Road - Lung Yeuk Tau	Dao Yang Road	Lung Ma Road	1,300	71.1%	28.9%
L013	Sha Tau Kok Road - Lung Yeuk Tau	Unnamed Access Road (L001/L002)	Lau Shui Heung Road	1,200	70.8%	29.2%
L014	Sha Tau Kok Road - Lung Yeuk Tau	Lau Shui Heung Road	Dao Yang Road	1,250	70.4%	29.6%
L015	Lung Chun Road	Lung Ma Road	Lung Ma Road	150	75.5%	24.5%
L016	Lung Chun Road	Lung Ma Road	Lung Ma Road	100	63.4%	36.6%
L017	Lung Ma Road	Mini Roundabout at Lung Ma Road	Lung Chun Road	400	73.2%	26.8%
L018	Lung Ma Road	Lung Chun Road	Mini Roundabout at Lung Ma Road	350	73.0%	27.0%
L019	Lung Ma Road	Lung Chun Road	Access Road (Shan Lai Court)	400	74.7%	25.3%
L020	Lung Ma Road	Access Road (Shan Lai Court)	Lung Chun Road	300	72.5%	27.5%

Note: "LV" includes motorcycle, private car and taxi
"HV" includes light / medium / heavy goods vehicle, public / private light bus, non-franchised bus and franchised bus


北
N
300m
LAU SHUI HEUNG ROAD
流水響道
沙頭角公路 — 龍躍頭段
THE SUBJECT SITE
凱業路
HAI WING ROAD
SHA TAU KOK ROAD - LUNG YEUK TAU
LUNG MA ROAD
龍馬路
1
2
3
4
5
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20
Project Title
PROPOSED DEVELOPMENT AT VARIOUS LOTS IN DD83 LUNG YEUK TAU, FANLING, N.T.
J7204
Figure Title
LOCATION OF SUBJECT SITE AND ROAD LINKS WITH TRAFFIC DATA WITHIN THE 300M STUDY AREA
Figure No.
NIA1
Revision
A
Designed by
N C L
Drawn by
S C Y
Checked by
K C
Scale in A4
1 : 6,000
Date
10 FEB 2023
CKM Asia Limited
Traffic and Transportation Planning Consultants
21st Floor, Methodist House, 36 Hennessy Road, Wan Chai, Hong Kong
Tel : (852) 2520 5990 Fax : (852) 2528 6343
Email : mail@ckmasia.com.hk
T:\JOB\J7200-J7249\J7204\2023 02\Fig NIA1 RevA.dwg

TD's Endorsement

By Fax
2528 6343

運輸署
Transport Department

本署檔案 Our Ref. : (NNK0Z) in TD NR146/194-S19
來函檔號 Your Ref. : J7204/5
電 話 Tel. : 2399 6933
圖文傳真 Fax : 2381 3799
電 郵 Email : homanchu@td.gov.hk

28 July 2023

CKM Asia Limited
21st Floor, Methodist House,
36 Hennessy Road,
Wan Chai,
Hong Kong
(Attn: Mr. CHIN Kim Meng)

Dear Sir,

S12A Rezoning Application from Residential (Group C) Zone & Agriculture Zone to Residential (Group A)2
Proposed Development at Various Lots in DD83
Lung Yeuk Tau, Fanling
Traffic Forecast for Noise Impact Assessment ("NIA")

I refer to your letter ref. J7204/5 dated 30 June 2023 providing the response to our previous comments.

Please be informed that we have no further comments on the proposed methodology on the traffic forecast for NIA from traffic engineering point of view.

Yours faithfully,

(Hoffman CHU Ho-man)
for Commissioner for Transport

c.c.
PlanD (Attn: Ms. CHEUNG Chui Ying, Carman fax: 2691 2806)

新界分區辦事處
NT Regional Office
九龍聯運街三十號旺角政府合署七樓
7th Floor, Mong Kok Government Offices, 30 Luen Wan Street, Kowloon.
圖文傳真 Fax No.: 2381 3799 (新界區) (NTRO)
網址 Web Site: http://www.td.gov.hk

TOTAL P.001

Traffic Consultant's Confirmation Letter

CKM ASIA LIMITED 陳錦敏亞洲有限公司

Traffic and Transportation Planning Consultants 交通及運輸策劃顧問

Our Ref: J7204/6

2nd August, 2023

SMEC Hong Kong
27/F Ford Glory Plaza
37-39 Wing Hong Street
Cheung Sha Wan, Kowloon
Hong Kong

Attn: Mr. Alex GBAGUIDI

(By E-mail: alex.gbaguidi@smec.com)

Dear Mr. Gbaguidi,

S12A Rezoning Application from
Residential (Group C) Zone & Agriculture Zone to Residential (Group A) 2
Proposed Development at Various Lots in DD83
Lung Yeuk Tau, Fanling (Y/FL-LYT/16)

2046 Traffic Forecast for Traffic Noise Impact Assessment ("TNIA")

This is to confirm that the traffic forecast methodology for the captioned project submitted to Transport Department ("TD") on 17th March 2023 (CKM Ref: J7204/3) and 30th June 2023 (CKM Ref: J7204/5), were produced in accordance to the relevant guideline issued by the TD.

Subsequent to our submission, TD replied with *"no further comments on the proposed methodology on the traffic forecast for NIA from traffic engineering point of view"* as stated in the TD letter dated 28th July 2023 (TD Ref: (NNK0Z) in TD NR146/194-S19). The relevant correspondences mentioned are attached herewith for your reference.

The peak hour traffic flows produced for Year 2046 are the highest within 15 years after occupation of the captioned project, which is assumed to be Year 2031.

Should you have any queries, please do not hesitate to contact us.

Thank you very much for your attention.

Yours sincerely,

CHIN Kim Meng
Director

Encl.

cc: Client

KM/WO

21st Floor, Methodist House, 36 Hennessy Road, Wanchai, Hong Kong
香港灣仔軒尼詩道36號循道衛理大廈21樓

Tel 電話 : (852) 2520 5990 Fax 傳真 : (852) 2528 6343
Email 電郵 : mail@ckmasia.com.hk Website 網址 : http://www.ckmasia.com.hk

Appendix E PREDICTED ROAD TRAFFIC NOISE LEVELS

Predicted Road Traffic Noise Levels for Tower 1

Tower 1

Floor	mPD	T1-A1	T1-A2	T1-A3	T1-B1	T1-B2	T1-C1	T1-C2	T1-D1	T1-D2	T1-E1	T1-E2	T1-F1	T1-F2	T1-F3	T1-G1	T1-G2	T1-G3	T1-H1	T1-H2	T1-I1	T1-I2	T1-I3	T1-J1	T1-J2	T1-J3	T1-K1	T1-K2	T1-L1	T1-L2	T1-M1	T1-M2	T1-M3
G	**13.2**	63	60	56	56	56	55	55	-	-	54	54	54	54	47	47	60	60	60	60	61	62	62	62	62	62	62	62	63	63	63	63	60
1	**18.2**	64	63	60	60	59	59	59	58	58	58	58	58	58	52	52	61	61	62	62	62	62	62	63	63	63	63	63	63	62	64	64	64
2	**21.3**	66	64	62	62	61	61	60	60	60	60	59	59	59	53	53	62	62	62	62	63	63	63	63	63	63	64	64	64	62	64	65	66
3	**24.5**	66	65	63	63	62	62	62	61	61	61	61	61	60	53	54	62	63	63	63	63	63	63	63	64	64	64	64	64	62	65	66	66
4	**27.6**	67	66	64	63	63	62	62	62	62	61	61	61	61	54	55	63	63	63	63	63	64	64	64	64	64	64	64	65	63	65	66	67
5	**30.8**	67	66	64	64	63	63	63	62	62	62	62	62	62	54	55	63	63	63	64	64	64	64	64	64	65	65	65	65	63	66	67	67
6	**33.9**	67	66	64	64	63	63	63	62	62	62	62	62	62	55	56	64	64	64	64	64	64	64	65	65	65	65	65	65	63	66	67	67
7	**37.1**	67	66	64	64	63	63	63	62	62	62	62	62	62	56	57	64	64	64	64	65	65	65	65	65	65	65	66	66	64	66	67	68
8	**40.2**	68	66	64	64	64	63	63	62	62	62	62	62	62	56	58	64	65	65	65	65	65	65	65	66	66	66	66	66	64	67	68	68
9	**43.4**	68	66	64	64	64	63	63	62	62	62	62	62	62	57	58	65	65	65	65	65	65	66	66	66	66	66	66	67	65	67	68	68
10	**46.5**	68	66	64	64	64	63	63	62	62	62	62	62	62	57	59	65	65	65	65	66	66	66	66	66	66	66	67	67	65	67	68	68
11	**49.7**	68	66	65	64	64	63	63	62	62	62	62	62	62	58	59	66	66	66	66	66	66	66	66	66	67	67	67	67	65	68	68	68
12	**52.8**	68	66	65	64	64	63	63	63	62	62	62	62	62	58	60	66	66	66	66	66	66	66	66	67	67	67	67	67	66	68	68	68
13	**56**	68	66	65	64	64	63	63	62	62	62	62	62	62	59	60	66	66	66	66	66	67	67	67	67	67	67	67	67	66	68	69	69
14	**59.1**	68	66	64	64	64	63	63	62	62	62	62	62	62	59	60	66	66	66	66	67	67	67	67	67	67	67	67	67	67	68	69	69
15	**62.3**	69	66	64	64	64	63	63	62	62	62	62	62	62	59	60	66	66	66	67	67	67	67	67	67	67	67	67	68	67	68	69	69
16	**65.4**	69	66	64	64	64	63	63	62	62	62	62	62	62	59	60	66	66	67	67	67	67	67	67	67	67	67	68	68	67	68	69	69
17	**68.6**	69	66	64	64	64	63	63	62	62	62	62	62	62	59	60	67	67	67	67	67	67	67	67	67	67	67	68	68	67	68	69	69
18	**71.7**	69	66	64	64	64	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	68	68	67	68	69	69
19	**74.9**	69	66	64	64	64	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	68	68	68	68	69	69
20	**78**	69	66	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	68	68	68	68	69	69
21	**81.2**	69	66	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	68	68	68	68	69	69
22	**84.3**	69	66	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	68	68	68	68	69	69
23	**87.5**	69	66	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	68	68	68	68	69	69
24	**90.6**	69	66	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	68	68	68	68	69	69
25	**93.8**	68	66	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	68	68	68	68	69	69
26	**96.9**	68	66	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	68	68	68	68	69	69
27	**100.1**	68	66	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	68	68	68	68	69	69
28	**103.2**	68	66	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	68	68	68	68	69	69
29	**106.4**	68	65	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	67	68	68	68	69	69
30	**109.5**	68	65	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	67	68	68	68	69	69
31	**112.7**	68	65	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	67	67	67	67	67	67	68	68	68	69	69
32	**115.8**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	**119**	68	65	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	-	-	-	-	67	67	68	68	68	69	69
34	**122.1**	68	65	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	-	-	-	-	67	67	67	68	68	69	68
35	**125.3**	68	65	64	64	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	-	-	-	-	67	67	67	68	68	68	68
36	**128.4**	68	65	64	63	63	63	63	62	62	62	62	62	62	60	61	67	67	67	67	67	67	-	-	-	-	67	67	67	68	68	68	68
37	**131.6**	68	65	64	63	63	63	62	62	62	62	62	62	62	60	61	67	67	67	67	67	67	-	-	-	-	67	67	67	68	68	68	68
38	**134.7**	68	65	64	63	63	63	62	62	62	62	62	62	62	60	61	67	67	67	67	67	67	-	-	-	-	67	67	67	68	68	68	68
39	**137.9**	68	65	64	63	63	63	62	62	62	62	62	62	62	60	61	67	67	67	67	67	67	-	-	-	-	67	67	67	68	68	68	68
40	**141**	68	65	64	63	63	63	62	62	62	62	62	62	61	60	61	67	67	67	67	67	67	-	-	-	-	67	67	67	68	68	68	68
41	**144**	68	65	64	63	63	63	62	62	62	62	62	62	61	60	61	66	67	67	67	67	67	-	-	-	-	67	67	67	68	68	68	68
42	**147.3**	68	65	64	63	63	63	62	62	62	62	62	62	61	60	60	66	66	67	67	67	67	-	-	-	-	67	67	67	68	68	68	68

Predicted Road Traffic Noise Levels for Tower 2

Tower 2

Floor	mPD	T2-A1	T2-A2	T2-A3	T2-B1	T2-B2	T2-C1	T2-C2	T2-D1	T2-D2	T2-E1	T2-E2	T2-F1	T2-F2	T2-F3	T2-G1	T2-G2	T2-G3	T2-H1	T2-H2	T2-I1	T2-I2	T2-I3	T2-J1	T2-J2	T2-J3	T2-K1	T2-K2	T2-L1	T2-L2	T2-M1	T2-M2	T2-M3
G	**13.2**	59	48	47	50	51	48	49	-	-	49	49	49	49	45	47	53	53	53	53	54	55	55	55	55	55	56	56	57	58	58	58	56
1	**18.2**	60	53	51	53	54	55	55	55	55	55	54	54	54	53	52	54	59	59	59	59	59	59	59	59	60	60	60	61	61	62	62	62
2	**21.3**	61	54	53	55	56	57	57	57	57	57	57	57	57	56	54	55	59	59	59	60	60	60	60	60	60	61	61	61	62	62	62	63
3	**24.5**	62	55	55	55	56	57	58	58	58	58	58	58	57	57	54	55	60	60	60	60	60	60	60	61	61	61	61	62	62	62	63	63
4	**27.6**	62	55	55	56	57	58	58	58	59	58	58	58	58	58	54	55	61	61	61	61	61	61	61	61	61	62	62	62	63	63	63	64
5	**30.8**	63	56	56	56	57	58	58	59	59	59	58	58	58	58	54	55	61	61	61	61	62	61	62	62	62	62	62	63	63	63	64	64
6	**33.9**	63	56	56	56	57	58	58	59	59	59	58	58	58	58	54	56	62	62	62	62	62	62	62	62	62	63	63	63	64	64	64	65
7	**37.1**	63	56	56	56	57	58	58	59	59	59	59	58	58	58	54	56	62	62	62	62	62	62	62	63	63	63	63	64	64	64	64	65
8	**40.2**	64	56	56	56	57	58	58	59	59	59	59	59	58	58	54	56	62	63	63	63	63	63	63	63	63	63	64	64	64	64	65	65
9	**43.4**	64	56	56	56	57	58	58	59	59	59	59	59	59	58	54	56	63	63	63	63	63	63	63	63	64	64	64	64	65	65	65	66
10	**46.5**	64	56	56	56	57	58	58	59	59	59	59	59	59	58	54	56	63	63	63	63	63	63	64	64	64	64	64	64	65	65	65	66
11	**49.7**	65	57	56	57	57	58	58	59	59	59	59	59	59	58	54	56	63	64	64	64	64	64	64	64	64	64	64	65	65	65	66	66
12	**52.8**	65	57	57	57	57	58	58	59	59	59	59	59	59	58	55	56	64	64	64	64	64	64	64	64	65	65	65	65	65	66	66	66
13	**56**	65	57	57	57	57	58	58	59	59	59	59	59	59	59	55	57	64	64	64	64	64	64	65	65	65	65	65	65	66	66	66	66
14	**59.1**	66	57	57	57	57	58	58	59	59	59	59	59	59	59	55	57	64	64	64	65	65	65	65	65	65	65	65	66	66	66	66	67
15	**62.3**	66	57	57	57	58	58	58	59	59	59	59	59	59	59	55	57	65	65	65	65	65	65	65	65	65	65	65	66	66	66	66	67
16	**65.4**	66	58	57	58	58	58	58	59	59	59	59	59	59	59	55	57	65	65	65	65	65	65	65	65	65	65	65	66	66	66	66	67
17	**68.6**	66	58	58	58	58	58	58	59	59	59	59	59	59	59	55	57	65	65	65	65	65	65	65	65	65	66	66	66	66	66	66	67
18	**71.7**	66	58	58	58	58	58	58	59	59	59	59	59	59	59	55	57	65	65	65	65	65	65	65	66	66	66	66	66	66	66	67	67
19	**74.9**	66	58	58	58	58	58	58	59	59	59	59	59	59	58	55	57	65	65	65	65	65	65	65	66	66	66	66	66	66	66	67	67
20	**78**	66	58	58	58	58	58	58	59	59	59	59	59	59	58	55	57	65	65	65	65	65	65	66	66	66	66	66	59	60	60	60	60
21	**81.2**	66	59	58	53	53	52	53	52	52	52	52	52	51	50	52	57	57	57	57	58	58	58	58	58	59	59	59	60	61	61	62	61
22	**84.3**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	**87.5**	66	59	58	58	58	58	58	59	59	59	59	58	58	55	57	65	65	65	66	66	66	-	-	-	-	66	66	66	67	67	67	66
24	**90.6**	66	59	58	58	58	58	58	59	59	59	59	58	58	55	57	65	65	66	66	66	66	-	-	-	-	66	66	66	66	67	67	66
25	**93.8**	66	59	58	58	58	58	58	59	59	59	58	58	58	55	57	65	66	66	66	66	66	-	-	-	-	66	66	66	66	67	67	66
26	**96.9**	66	59	58	58	58	58	58	59	59	59	58	58	58	55	57	65	65	66	66	66	66	-	-	-	-	66	66	66	67	67	67	66
27	**100.1**	66	59	58	58	58	58	58	59	59	59	58	58	58	55	57	65	66	66	66	66	66	-	-	-	-	66	66	66	66	67	67	66
28	**103.2**	66	59	58	58	58	58	58	59	59	58	58	58	58	55	57	65	66	66	66	66	66	-	-	-	-	66	66	66	66	67	67	66
29	**106.4**	66	59	58	58	58	58	58	59	59	58	58	58	58	55	57	65	65	65	66	66	66	-	-	-	-	66	66	66	66	67	67	66
30	**109.5**	66	59	58	58	58	58	58	59	59	58	58	58	58	55	57	65	65	65	66	66	66	-	-	-	-	66	66	66	66	67	67	66
31	**112.7**	66	59	58	58	58	58	58	59	59	58	58	58	58	55	57	65	65	65	66	66	66	-	-	-	-	66	66	66	66	67	67	66
32	**115.8**	66	59	58	58	58	58	58	59	58	58	58	58	58	55	57	65	65	66	66	66	66	-	-	-	-	66	66	66	66	67	67	66
33	**119**	66	59	58	58	58	58	58	59	58	58	58	58	58	55	57	65	65	65	66	66	66	-	-	-	-	66	66	66	66	67	67	66
34	**122.1**	66	59	58	57	58	58	58	59	58	58	58	58	58	54	57	65	65	65	65	66	66	-	-	-	-	66	66	66	66	67	67	66
35	**125.3**	66	59	58	57	58	58	58	58	58	58	58	58	58	54	57	65	65	65	66	66	66	-	-	-	-	66	66	66	66	67	67	66
36	**128.4**	66	59	58	57	58	58	58	58	58	58	58	58	58	54	57	65	65	65	65	66	66	-	-	-	-	66	66	66	66	67	67	66
37	**131.6**	66	59	58	57	57	58	58	58	58	58	58	58	58	54	57	65	65	65	65	66	66	-	-	-	-	66	66	66	66	67	67	66
38	**134.7**	66	59	58	57	57	58	58	58	58	58	58	58	58	54	56	65	65	65	65	66	66	-	-	-	-	66	66	66	66	67	67	66
39	**137.9**	66	59	58	57	57	58	58	58	58	58	58	58	58	54	56	65	65	65	65	66	66	-	-	-	-	66	66	66	66	66	67	66
40	**141**	66	60	58	57	57	58	58	58	58	58	58	58	58	54	56	65	65	65	65	66	66	-	-	-	-	66	66	66	66	66	67	66
41	**144**	66	60	58	57	57	58	58	58	58	58	58	58	58	54	56	65	65	65	65	65	66	-	-	-	-	66	66	66	66	66	67	66
42	**147.3**	66	60	58	58	58	58	58	58	58	58	58	58	58	54	56	65	65	65	65	65	66	-	-	-	-	66	66	66	66	66	67	66

Predicted Road Traffic Noise Levels for Tower 3

Floor	mPD	T3-A1	T3-A2	T3-A3	T3-B1	T3-B2	T3-C1	T3-C2	T3-D1	T3-D2	T3-E1	T3-E2	T3-F1	T3-F2	T3-F3	T3-G1	T3-G2	T3-G3	T3-H1	T3-H2	T3-I1	T3-I2	T3-I3	T3-J1	T3-J2	T3-J3	T3-K1	T3-K2	T3-L1	T3-L2	T3-M1	T3-M2	T3-M3
G	**13.2**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	**18.2**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	**21.3**	55	56	55	55	54	54	54	54	55	55	56	56	56	60	60	61	61	61	61	61	61	61	61	61	60	61	60	61	60	61	61	56
3	**24.5**	56	57	55	55	55	55	55	55	55	55	56	56	56	56	60	60	62	62	62	61	61	61	61	61	61	61	61	61	61	61	61	57
4	**27.6**	58	58	56	56	56	56	56	56	56	56	56	57	57	60	60	62	62	62	62	62	61	61	61	61	61	61	61	61	61	61	62	58
5	**30.8**	59	58	56	56	56	56	56	56	56	56	57	57	57	60	60	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	59
6	**33.9**	59	59	57	57	57	56	56	56	56	57	57	57	57	60	60	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	60
7	**37.1**	60	59	57	57	57	57	57	56	56	57	57	57	57	60	60	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	63	60
8	**40.2**	60	59	57	57	57	57	57	57	57	57	57	57	57	60	60	62	62	62	62	62	62	62	62	62	62	62	62	62	63	63	63	61
9	**43.4**	60	60	57	57	57	57	57	57	57	57	57	57	57	60	60	63	63	63	62	62	62	62	62	62	62	62	62	63	63	63	63	61
10	**46.5**	61	60	57	57	57	57	57	57	57	57	57	57	57	60	60	63	63	63	63	63	62	62	62	62	62	63	63	63	63	63	63	61
11	**49.7**	61	60	57	57	57	57	57	57	57	57	57	57	57	60	60	63	63	63	63	63	63	63	63	62	63	63	63	63	63	63	63	62
12	**52.8**	61	60	57	57	57	57	57	57	57	57	58	58	58	60	60	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	64	62
13	**56**	62	60	57	57	57	57	57	57	57	57	58	58	58	60	60	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	64	62
14	**59.1**	62	61	57	57	57	57	57	57	57	57	58	58	58	60	60	63	63	63	63	63	63	63	63	63	63	63	63	63	63	63	64	62
15	**62.3**	62	61	57	57	57	57	57	57	57	57	58	58	58	60	60	63	63	63	63	63	63	63	63	63	63	63	63	63	64	64	64	63
16	**65.4**	62	61	57	57	57	57	57	57	57	57	58	58	58	60	60	63	63	63	63	63	63	63	63	63	63	63	63	64	64	64	64	63
17	**68.6**	62	61	57	57	57	57	57	57	57	57	58	58	58	60	60	63	63	63	63	63	63	63	63	63	63	63	64	64	64	64	65	63
18	**71.7**	63	61	57	57	57	57	57	57	57	57	58	58	58	60	60	63	63	63	63	63	63	63	63	63	63	64	64	64	64	64	65	63
19	**74.9**	63	61	57	57	57	57	57	57	57	57	58	58	58	60	60	63	63	63	63	63	63	63	63	63	64	64	64	64	64	64	65	63
20	**78**	63	62	57	57	57	57	57	57	57	57	58	58	58	60	60	63	63	63	63	63	63	63	64	64	64	64	64	64	64	64	65	63
21	**81.2**	63	62	57	57	57	57	57	57	57	57	58	58	58	60	60	63	63	63	63	64	64	64	64	64	64	64	64	64	64	64	65	64
22	**84.3**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	**87.5**	63	61	57	57	57	57	57	57	57	57	58	58	58	60	60	63	64	64	64	64	64	64	-	-	-	-	64	64	64	64	65	64
24	**90.6**	63	61	57	57	57	57	57	57	57	58	58	58	58	60	60	63	64	64	64	64	64	64	-	-	-	-	64	64	64	65	65	64
25	**93.8**	63	61	57	57	57	57	57	57	57	58	58	58	58	60	60	63	64	64	64	64	64	64	-	-	-	-	64	64	64	65	65	64
26	**96.9**	63	61	57	57	57	57	57	57	57	58	58	58	58	60	60	64	64	64	64	64	64	64	-	-	-	-	64	64	64	65	65	64
27	**100.1**	63	61	57	57	57	57	57	57	57	58	58	58	58	60	60	63	64	64	64	64	64	64	-	-	-	-	64	64	64	65	65	64
28	**103.2**	63	61	57	57	57	57	57	57	57	58	58	58	58	60	60	63	64	64	64	64	64	64	-	-	-	-	64	64	64	65	65	64
29	**106.4**	63	61	57	57	57	57	57	57	57	58	58	58	58	60	60	63	64	64	64	64	64	64	-	-	-	-	64	64	64	65	65	64
30	**109.5**	63	61	57	57	57	57	57	57	57	58	58	58	58	60	60	63	64	64	64	64	64	64	-	-	-	-	64	64	64	65	65	64
31	**112.7**	63	61	57	57	57	57	57	57	57	58	58	58	58	59	60	63	64	64	64	64	64	64	-	-	-	-	64	64	64	65	65	64
32	**115.8**	63	61	57	57	57	57	57	57	57	57	58	58	58	59	59	63	63	64	64	64	64	64	-	-	-	-	64	64	64	65	65	64
33	**119**	63	61	57	57	57	57	57	57	57	57	58	58	58	59	59	63	63	64	63	64	64	64	-	-	-	-	64	64	64	65	65	64
34	**122.1**	63	61	57	57	57	57	57	57	57	57	58	58	58	59	59	63	63	63	64	64	63	64	-	-	-	-	64	64	64	65	65	64
35	**125.3**	63	61	57	57	57	57	57	57	57	57	58	58	57	59	59	63	63	63	63	64	63	64	-	-	-	-	64	64	64	64	65	64
36	**128.4**	63	61	57	57	57	57	57	57	57	57	58	58	57	59	59	63	63	63	63	63	63	64	-	-	-	-	64	64	64	64	65	64
37	**131.6**	63	61	57	57	57	57	57	57	57	57	58	57	57	59	59	63	63	63	63	63	63	64	-	-	-	-	64	64	64	64	65	64
38	**134.7**	63	61	57	57	57	57	57	57	57	57	57	57	57	59	59	63	63	63	63	63	63	64	-	-	-	-	64	64	64	64	65	64
39	**137.9**	63	61	57	57	57	57	57	57	57	57	57	57	57	59	59	63	63	63	63	63	63	64	-	-	-	-	64	64	64	64	65	64
40	**141**	63	61	57	57	57	57	57	57	57	57	57	57	57	59	59	63	63	63	63	63	63	64	-	-	-	-	64	64	64	64	65	64
41	**144**	63	61	57	57	57	57	57	57	57	57	57	57	57	59	59	63	63	63	63	63	63	64	-	-	-	-	64	64	64	64	65	64
42	**147.3**	63	61	57	57	57	57	57	57	57	57	57	57	57	59	59	63	63	63	63	63	63	64	-	-	-	-	64	64	64	64	65	64

Predicted Road Traffic Noise Levels for Tower 4

Floor	mPD	T4-A1	T4-A2	T4-A3	T4-B1	T4-B2	T4-C1	T4-C2	T4-D1	T4-D2	T4-E1	T4-E2	T4-F1	T4-F2	T4-G1	T4-G2	T4-H1	T4-H2	T4-I1	T4-I2	T4-J1	T4-J2	T4-K1	T4-K2	T4-K3	T4-L1	T4-L2	T4-L3	T4-M1	T4-M2	T4-N1	T4-N2	T4-O1	T4-O2	T4-P1	T4-P2	T4-Q1	T4-Q2	T4-R1	T4-R2	T4-S1	T4-S2	T4-S3	T4-T1	T4-T2	T4-T3	T4-U1	T4-U2	T4-U3
G	**13.2**	60	60	60	58	58	58	58	58	58	58	59	59	59	59	59	58	58	58	58	57	56	55	56	54	54	53	53	53	53	53	53	-	-	57	57	57	57	57	58	58	58	58	58	59	-	59	60	60
1	**18.2**	62	62	62	61	61	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	58	58	55	55	55	55	55	56	58	58	58	58	58	58	58	58	58	58	59	59	59	59	60	61	62
2	**21.3**	64	64	63	63	62	62	62	62	62	62	61	61	61	61	61	61	61	61	61	61	61	61	61	59	59	56	56	56	56	56	57	58	58	58	58	58	58	58	58	58	59	59	59	59	60	61	62	64
3	**24.5**	65	65	64	64	64	63	63	63	63	63	62	62	62	62	62	62	62	62	62	62	62	62	62	60	59	57	57	57	56	56	57	58	58	58	58	58	58	59	59	59	59	59	59	60	60	61	63	65
4	**27.6**	65	65	65	64	64	64	64	64	63	63	63	63	63	63	63	63	62	63	63	63	63	63	63	60	59	57	57	57	57	57	57	59	59	59	59	59	59	59	59	59	59	59	60	60	61	62	63	65
5	**30.8**	65	65	65	65	65	64	64	64	64	64	64	63	63	63	63	63	63	63	63	63	63	63	63	60	60	57	57	57	57	57	58	59	59	59	59	59	59	59	59	59	59	60	60	60	61	62	64	65
6	**33.9**	66	66	65	65	65	65	64	64	64	64	64	64	64	63	63	63	63	63	63	63	64	64	64	60	60	57	57	57	57	57	58	59	59	59	59	59	59	59	59	59	59	60	60	60	61	62	64	66
7	**37.1**	66	66	66	65	65	65	65	64	64	64	64	64	64	64	64	63	63	63	64	64	64	64	64	60	60	57	57	57	57	57	58	59	59	59	59	59	59	59	59	59	59	60	60	60	61	62	64	66
8	**40.2**	66	66	66	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	58	58	58	58	58	59	59	59	59	59	59	59	59	59	59	59	60	60	60	61	62	64	66
9	**43.4**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	58	58	58	58	58	59	60	60	60	59	59	59	59	59	59	59	60	60	60	61	62	64	66
10	**46.5**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	58	58	58	58	58	59	60	60	60	60	60	59	59	59	59	59	60	60	60	61	62	64	66
11	**49.7**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	58	58	58	58	59	59	60	60	60	60	60	59	59	59	59	59	60	60	60	61	62	64	66
12	**52.8**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	58	58	58	59	59	60	60	60	60	60	60	60	59	59	59	59	60	60	60	61	62	64	66
13	**56**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	59	59	59	60	60	60	60	60	60	60	59	59	59	59	60	60	60	61	62	64	66
14	**59.1**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	59	59	59	60	61	61	61	60	60	60	60	59	59	59	60	60	60	61	62	64	66
15	**62.3**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	59	59	59	60	61	61	61	60	60	60	60	59	59	59	59	60	60	61	62	64	66
16	**65.4**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	59	59	59	60	61	61	61	61	60	60	60	60	59	59	59	60	60	61	62	64	66
17	**68.6**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	59	59	60	60	61	61	61	61	61	60	60	60	59	59	59	60	60	61	62	64	66
18	**71.7**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	59	59	60	61	61	61	61	61	61	60	60	60	59	59	59	60	60	61	62	64	66
19	**74.9**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	59	60	60	61	61	61	61	61	61	60	60	60	59	59	59	60	60	61	62	64	66
20	**78**	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	59	60	60	61	61	61	61	61	61	60	60	60	59	59	59	60	60	61	62	64	66
21	**81.2**	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	59	60	60	61	61	61	61	61	61	60	60	60	59	59	59	60	60	61	62	64	66
22	**84.3**	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	59	60	60	61	61	61	61	61	61	60	60	60	59	59	59	60	60	61	62	64	66
23	**87.5**	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	60	60	60	61	61	61	61	61	61	61	60	60	59	59	59	60	60	61	62	64	66
24	**90.6**	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	60	60	60	61	61	61	61	61	61	61	60	60	59	59	59	60	60	61	62	64	66
25	**93.8**	66	66	65	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	60	59	59	60	60	60	61	61	61	61	61	61	61	60	60	59	59	59	60	60	61	62	64	66
26	**96.9**	66	66	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	59	59	59	60	60	60	61	61	61	61	61	61	61	60	60	59	59	59	59	60	61	62	64	66
27	**100.1**	66	66	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	59	59	60	60	60	60	61	61	61	61	61	61	61	60	60	59	59	59	59	60	61	62	64	66
28	**103.2**	66	66	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	59	59	59	60	60	60	61	61	61	61	61	61	61	60	60	59	59	59	59	60	61	62	64	66
29	**106.4**	66	66	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	59	59	59	59	60	60	61	61	61	61	61	61	61	60	60	59	59	59	59	60	61	62	64	66
30	**109.5**	66	66	65	65	65	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	60	59	59	59	60	60	60	61	61	61	61	61	61	61	60	60	59	59	59	59	60	61	61	64	66
31	**112.7**	66	66	65	65	65	64	64	64	64	64	64	64	64	64	64	64	63	64	64	64	64	64	64	60	59	59	59	59	60	60	61	61	61	61	61	61	61	60	60	59	59	59	59	60	61	61	64	66
32	**115.8**	66	66	65	65	65	64	64	64	64	64	64	64	64	64	64	64	63	63	64	64	64	64	64	60	59	59	59	59	60	60	61	61	61	61	61	61	61	60	60	59	59	59	59	60	60	61	64	66
33	**119**	66	66	65	65	65	64	64	64	64	64	64	64	64	64	64	64	63	63	64	64	64	64	64	60	59	59	59	59	60	60	61	61	61	61	61	61	61	60	60	59	59	59	59	60	60	61	64	66
34	**122.1**	66	66	65	0	65	64	64	64	64	64	64	64	64	64	64	63	63	63	64	64	64	64	64	60	59	59	59	59	60	60	61	61	61	61	61	61	61	60	60	59	59	59	59	60	60	61	63	65
35	**125.3**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	**128.4**	66	66	65	65	65	64	64	64	64	64	64	64	64	64	63	63	63	63	64	64	64	64	64	60	59	59	59	59	60	60	61	-	-	61	61	61	61	60	60	59	59	59	59	60	60	61	63	65
37	**131.6**	66	66	65	65	65	64	64	64	64	64	64	64	64	64	63	63	63	63	64	64	64	64	64	60	59	59	59	59	60	60	61	-	-	61	61	61	61	60	59	59	59	59	59	60	60	61	63	65
38	**134.7**	66	66	65	65	65	64	64	64	64	64	64	64	64	64	63	63	63	63	64	64	64	64	64	60	59	59	59	59	60	60	61	-	-	61	61	61	60	60	59	59	58	59	59	60	60	61	63	65
39	**137.9**	66	66	65	65	65	64	64	64	64	64	64	64	64	63	63	63	63	63	64	64	64	64	64	60	59	59	59	59	60	60	61	-	-	61	61	61	60	60	59	59	58	59	59	60	60	61	63	65
40	**141**	66	65	65	65	64	64	64	64	64	64	64	64	64	63	63	63	63	63	64	64	64	64	64	60	59	59	59	59	60	60	60	-	-	61	61	61	60	60	59	59	58	59	59	60	60	61	63	65
41	**144**	66	65	65	65	64	64	64	64	64	64	64	64	64	63	63	63	63	63	63	64	64	64	64	60	59	59	59	59	59	60	60	-	-	61	61	61	60	60	59	59	58	59	59	60	60	61	63	65
42	**147.3**	66	65	65	65	64	64	64	64	64	64	64	64	63	63	63	63	63	63	63	64	64	64	64	60	59	59	59	59	59	60	60	-	-	61	61	61	60	60	59	59	58	59	59	60	60	61	63	65

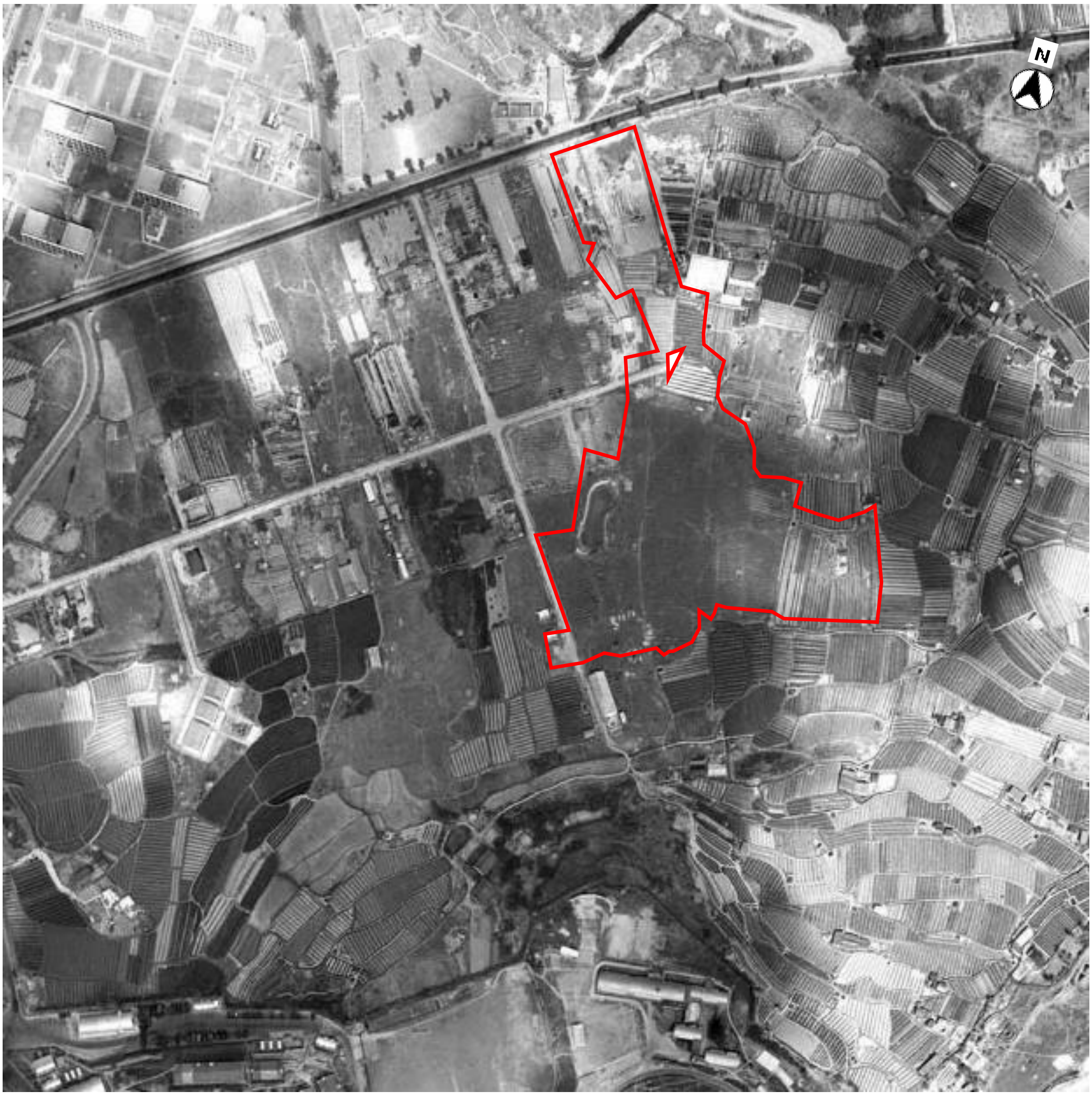
Predicted Road Traffic Noise Levels for Tower 5

Tower 5

Floor	mPD	T5-A1	T5-A2	T5-A3	T5-B1	T5-B2	T5-B3	T5-C1	T5-C2	T5-C3	T5-D1	T5-D2	T5-E1	T5-E2	T5-F1	T5-F2	T5-G1	T5-G2	T5-H1	T5-H2	T5-I1	T5-I2	T5-J1	T5-J2	T5-J3	T5-K1	T5-K2	T5-K3	T5-L1	T5-L2	T5-M1	T5-M2	T5-N1	T5-N2	T5-O1	T5-O2	T5-P1	T5-P2	T5-Q1	T5-Q2	T5-R1	T5-R2	T5-S1	T5-S2	T5-T1	T5-T2	T5-U1	T5-U2	T5-U3
G	**13.2**	58	59	59	59	57	-	54	54	54	56	57	57	58	57	57	57	56	53	53	52	52	53	56	56	56	56	56	55	57	-	-	55	55	54	54	54	54	53	54	53	54	53	54	55	53	53	53	58
1	**18.2**	62	61	62	61	61	61	61	61	61	61	61	61	60	60	60	60	60	59	59	58	58	58	59	57	57	57	57	57	58	58	57	57	57	57	57	57	56	57	56	56	56	56	57	56	56	56	56	61
2	**21.3**	62	62	62	62	62	62	62	62	62	62	62	62	61	61	61	61	61	60	60	59	59	59	60	57	57	58	58	57	59	58	58	57	57	57	57	57	57	57	57	57	57	57	57	56	56	56	56	62
3	**24.5**	63	63	63	63	63	63	63	63	63	62	62	62	62	62	62	62	62	61	60	60	60	60	61	58	58	58	58	58	59	59	58	58	58	58	58	58	57	57	57	57	57	57	58	57	57	57	57	63
4	**27.6**	64	63	64	63	63	63	63	63	63	63	63	63	63	63	63	63	63	61	61	60	60	60	61	58	58	58	58	58	59	59	58	58	58	58	58	58	57	58	57	57	57	57	58	57	57	57	57	64
5	**30.8**	64	64	64	64	64	64	63	63	63	63	63	63	63	63	63	63	63	62	61	61	61	61	61	58	58	58	58	58	59	59	58	58	58	58	58	58	58	58	57	57	57	58	58	57	57	57	57	64
6	**33.9**	64	64	64	64	64	64	64	64	64	64	64	63	63	63	63	63	63	62	61	61	61	61	61	58	58	58	58	58	59	59	58	58	58	58	58	58	58	58	57	57	57	58	58	57	57	57	57	64
7	**37.1**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	63	63	63	62	62	61	61	61	62	58	58	58	58	58	59	59	58	58	58	58	58	58	58	58	57	57	57	58	58	57	57	57	57	64
8	**40.2**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	63	62	62	61	61	61	62	58	58	58	58	58	59	59	59	58	58	58	58	58	58	58	57	57	57	58	59	57	57	57	57	64
9	**43.4**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	61	61	61	62	58	58	58	58	58	60	59	59	58	58	58	58	58	58	58	57	57	57	58	59	57	57	57	57	64
10	**46.5**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	61	62	61	62	58	58	59	58	58	60	59	59	58	58	58	58	58	58	58	57	57	57	58	59	57	57	57	57	64
11	**49.7**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	58	58	60	59	59	58	58	58	58	58	58	58	57	57	57	59	59	57	57	57	57	64
12	**52.8**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	58	60	59	59	59	59	59	59	59	58	59	57	57	57	59	59	57	57	57	57	64
13	**56**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	58	60	60	59	59	59	59	59	59	58	59	57	57	57	59	59	57	57	57	57	64
14	**59.1**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	59	60	60	59	59	59	59	59	59	58	59	57	57	57	59	60	57	57	57	57	64
15	**62.3**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	59	60	60	59	59	59	59	59	59	58	59	57	57	57	59	60	57	57	57	57	64
16	**65.4**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	59	60	60	59	59	59	59	59	59	58	59	57	57	57	59	60	57	57	57	57	64
17	**68.6**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	59	60	60	60	59	59	59	59	59	58	59	57	57	57	59	60	57	57	57	57	64
18	**71.7**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	63	62	62	62	62	62	58	58	59	59	59	60	60	60	59	59	59	59	59	58	59	58	57	57	59	60	57	57	57	57	64
19	**74.9**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	63	62	62	62	62	62	58	58	59	59	59	60	60	60	59	59	59	59	59	58	59	58	57	57	60	60	57	57	57	57	64
20	**78**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	63	62	62	62	62	62	58	58	59	59	59	60	60	60	59	59	59	59	59	58	59	58	57	57	60	60	57	57	57	57	64
21	**81.2**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	59	60	60	60	59	59	59	59	59	58	59	58	57	57	60	60	57	57	57	57	64
22	**84.3**	65	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	59	60	60	60	59	59	59	59	59	58	59	58	57	57	60	60	57	57	57	57	64
23	**87.5**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	59	60	60	60	59	59	59	59	59	58	59	58	57	57	60	60	57	57	57	57	64
24	**90.6**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	59	60	60	60	59	59	59	59	59	58	59	58	57	57	60	60	57	57	57	57	64
25	**93.8**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	59	60	60	60	59	59	59	59	60	58	59	58	57	57	60	60	57	57	57	57	64
26	**96.9**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	58	58	59	59	59	60	60	60	59	60	59	59	60	58	59	58	57	57	60	60	57	57	57	57	64
27	**100.1**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	57	58	59	59	59	60	60	60	59	60	59	59	59	58	59	58	57	57	60	60	57	57	57	57	64
28	**103.2**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	57	58	59	59	59	60	60	60	59	59	59	59	60	58	59	58	57	57	60	60	57	57	57	57	64
29	**106.4**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	57	57	59	59	59	60	60	60	59	59	59	59	59	58	59	58	57	57	60	60	57	57	57	57	64
30	**109.5**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	57	57	59	59	59	60	60	60	59	59	59	59	59	58	59	58	57	57	60	60	57	57	57	57	64
31	**112.7**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	64	64	62	62	62	62	62	62	57	57	59	59	59	60	60	60	59	59	59	0	59	58	59	57	57	57	60	60	57	57	57	57	64
32	**115.8**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	**119**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	-	-	62	62	62	62	61	62	57	57	59	59	59	60	60	60	59	59	59	58	58	58	59	57	57	57	60	57	57	57	57	57	64
34	**122.1**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	-	-	62	62	62	62	61	62	57	57	59	59	59	60	60	60	59	59	59	58	58	58	59	57	57	57	60	57	57	57	57	57	64
35	**125.3**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	-	-	62	62	62	62	61	62	57	57	59	59	59	60	60	60	59	59	59	58	58	58	59	57	57	57	60	57	57	57	57	57	64
36	**128.4**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	-	-	62	62	62	62	61	62	57	57	59	59	59	60	60	60	59	59	59	58	58	58	59	57	57	57	59	57	57	57	57	57	64
37	**131.6**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	-	-	62	62	62	62	61	62	57	57	59	59	59	60	60	60	59	59	59	58	58	58	59	57	57	57	59	57	57	57	57	56	64
38	**134.7**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	-	-	62	62	61	62	61	62	57	57	59	59	59	60	60	60	59	59	59	58	58	58	59	57	57	57	59	57	57	57	57	56	64
39	**137.9**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	-	-	62	62	61	62	61	62	57	57	59	59	59	60	60	60	59	59	59	58	58	58	59	57	57	57	59	57	57	57	56	56	64
40	**141**	64	64	65	64	64	64	64	64	64	64	64	64	64	64	64	-	-	62	62	61	62	61	62	57	57	59	59	59	60	60	60	59	59	59	58	58	58	59	57	57	57	59	57	57	57	56	56	64
41	**144**	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	-	-	62	62	61	61	61	62	57	57	59	59	59	60	60	60	59	59	59	58	58	58	59	57	57	57	59	57	57	57	56	56	64
42	**147.3**	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64	-	-	62	62	61	61	61	62	57	57	59	59	59	60	60	60	59	59	59	58	58	58	59	57	57	57	59	57	57	56	56	56	64

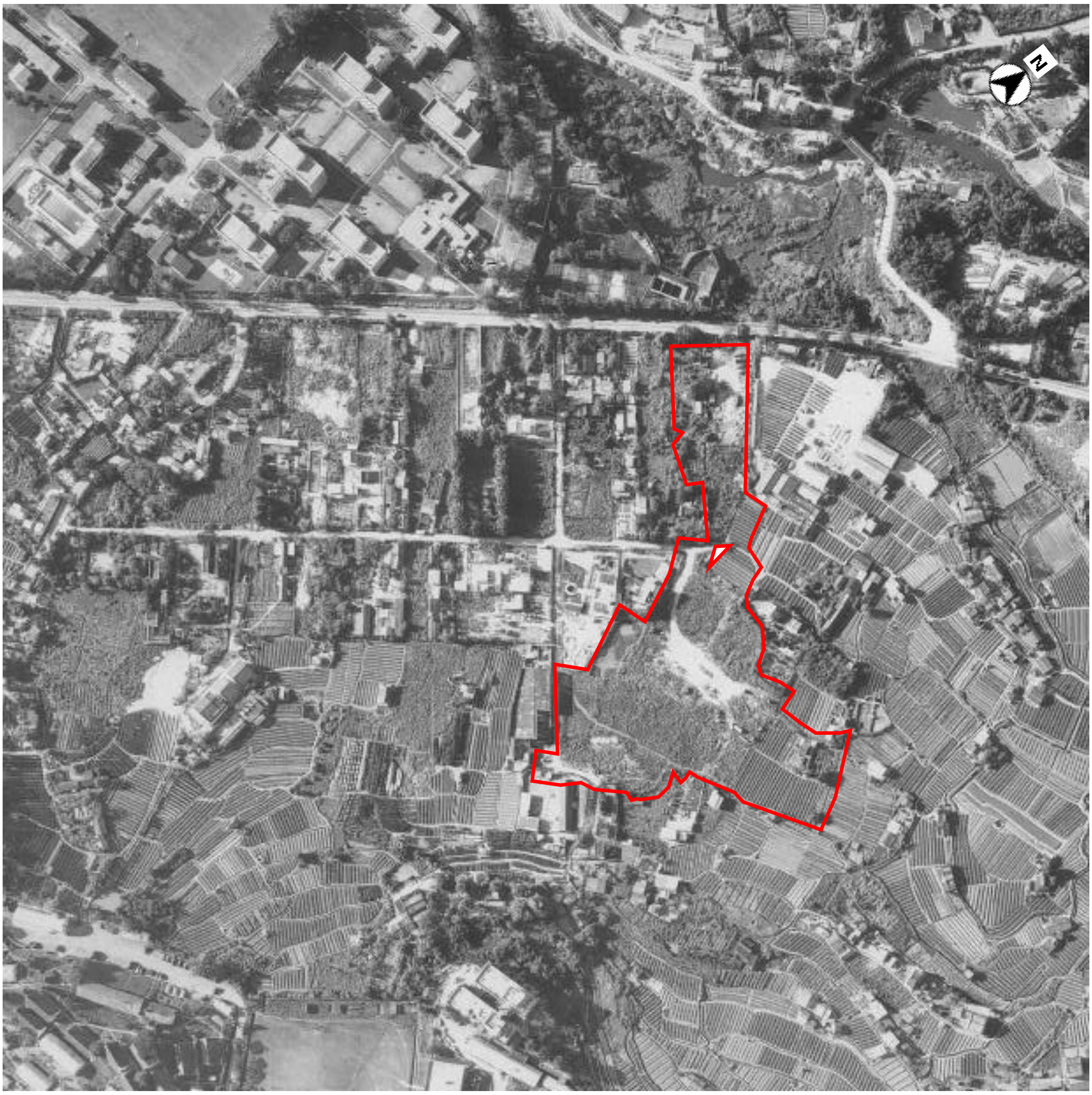
Appendix F AERIAL PHOTOS

Figure F-1: Aerial Photo in Year 1963



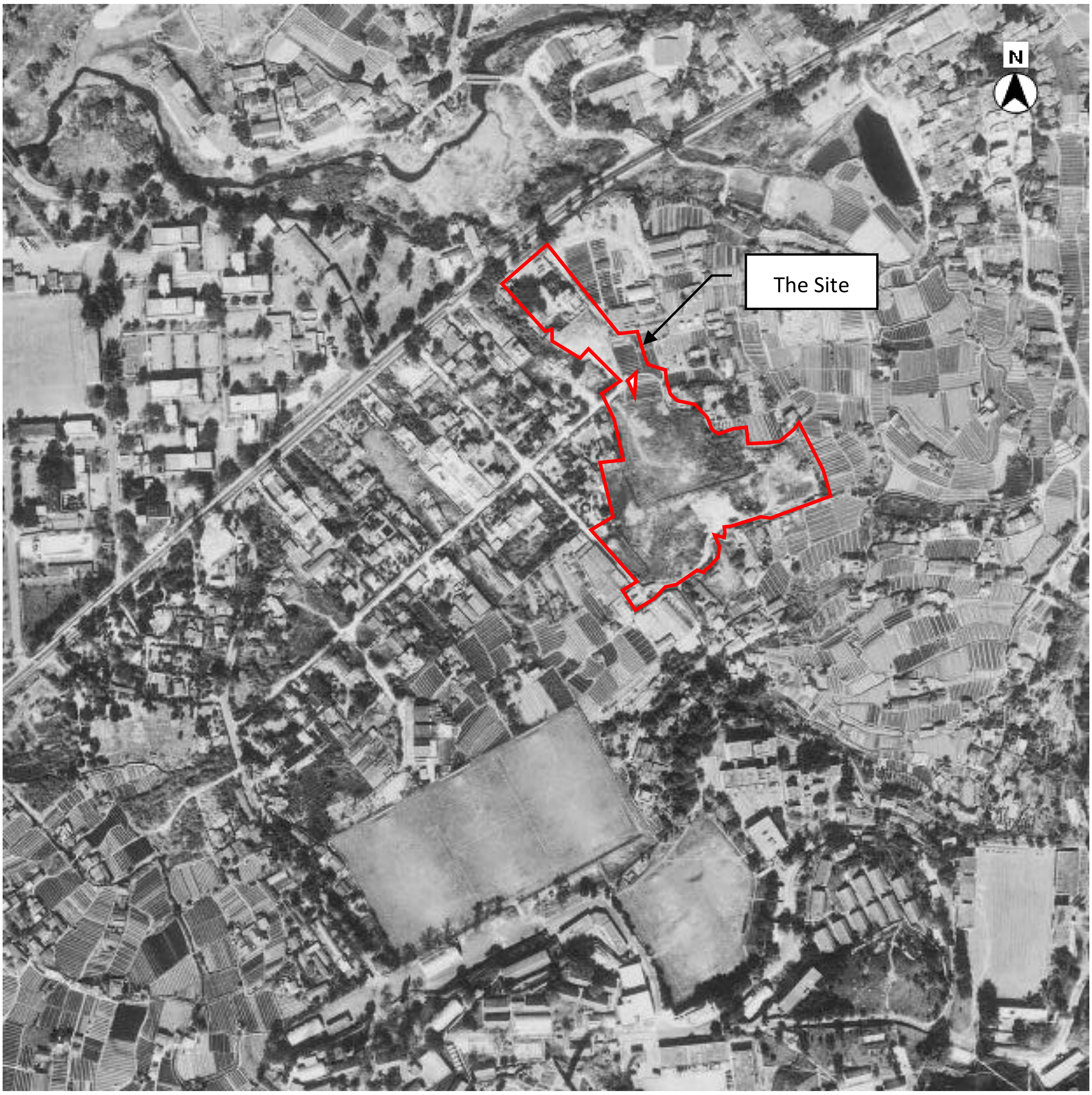
Source: Lands Department

Figure F-2: Aerial Photo in Year 1973



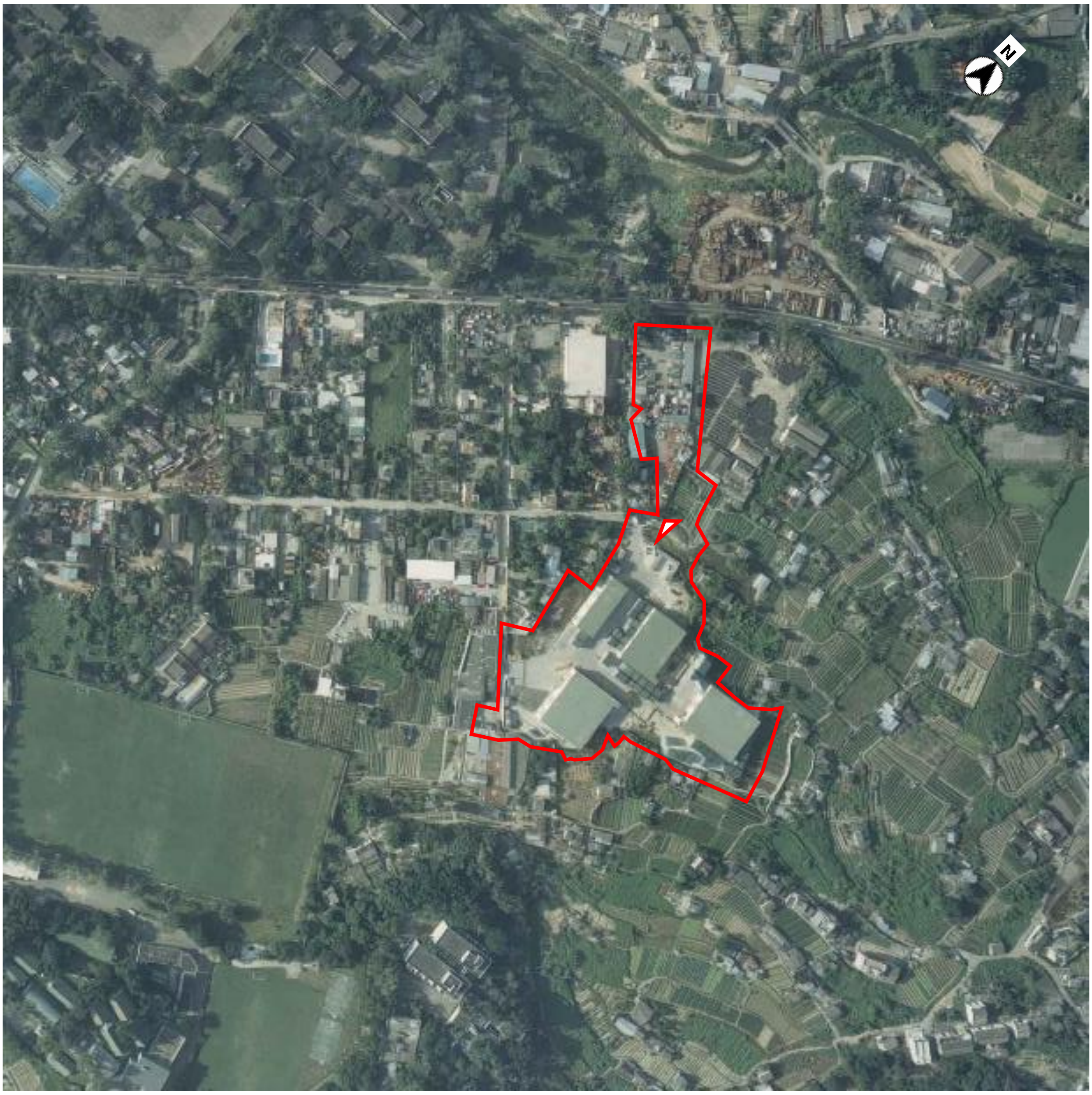
Source: Lands Department

Figure F-3: Aerial Photo in Year 1982



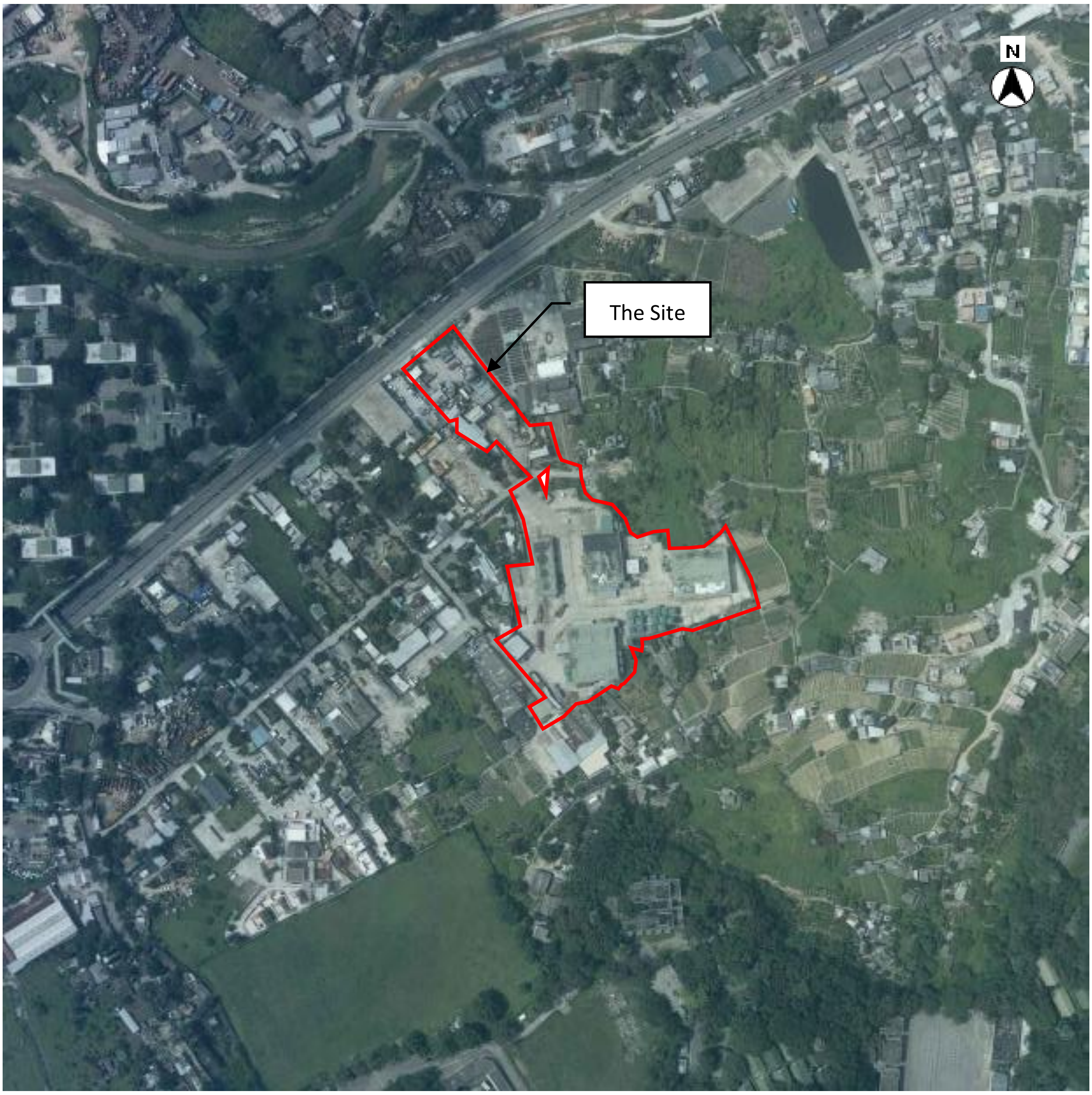
Source: Lands Department

Figure F-4: Aerial Photo in Year 1993



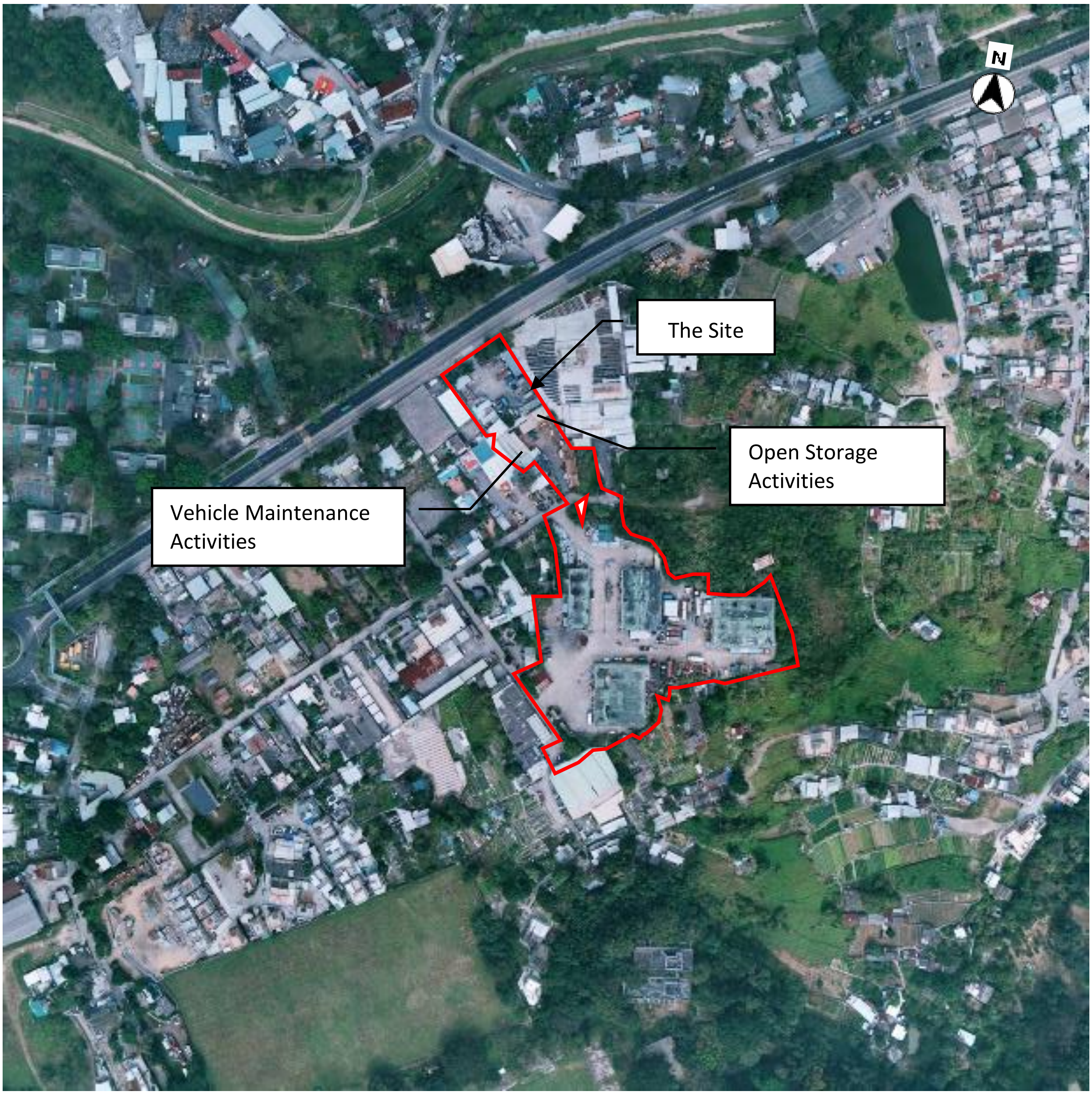
Source: Lands Department

Figure G-5: Aerial Photo in Year 2002



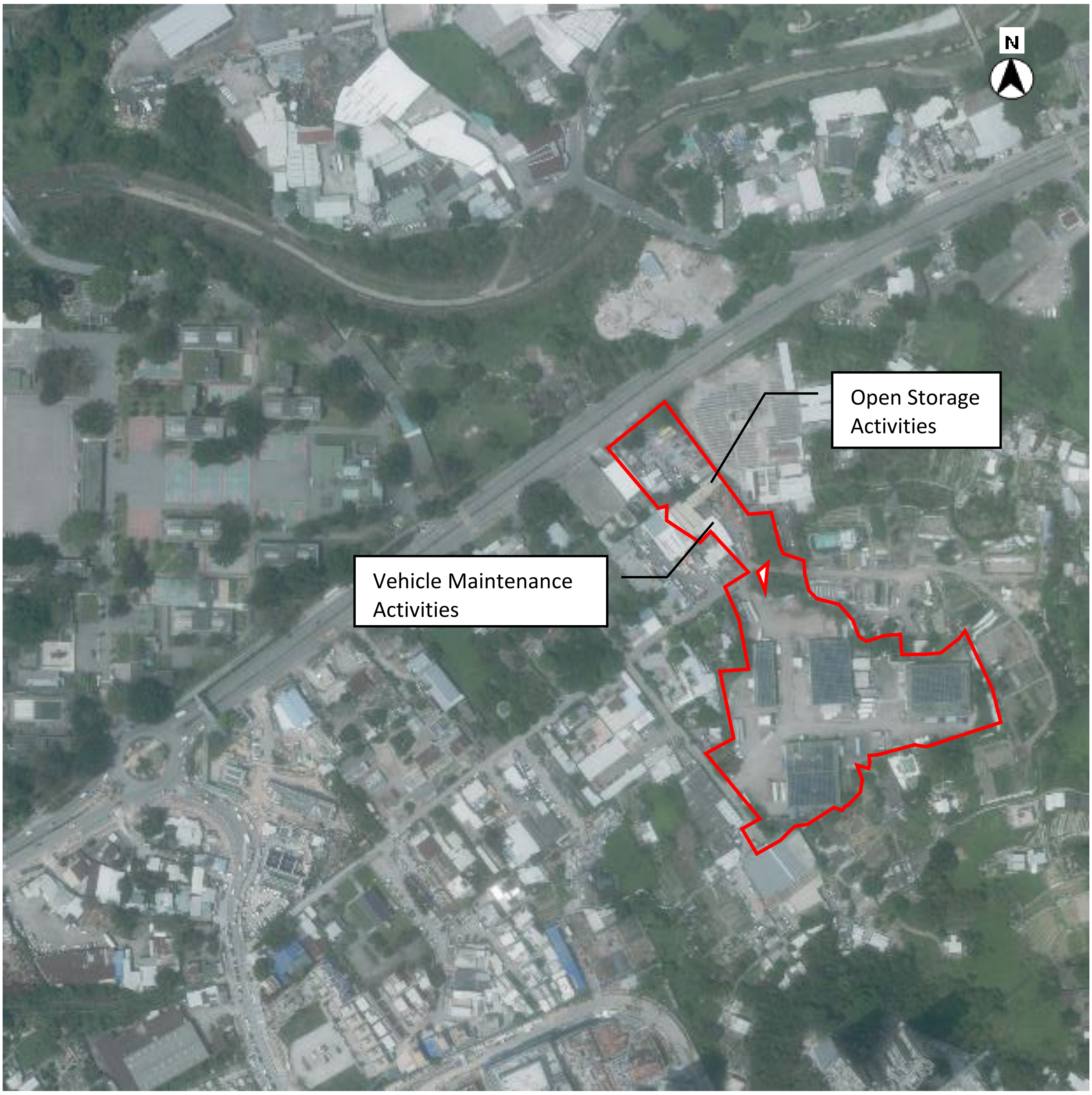
Source: Lands Department

Figure G-6: Aerial Photo in Year 2013



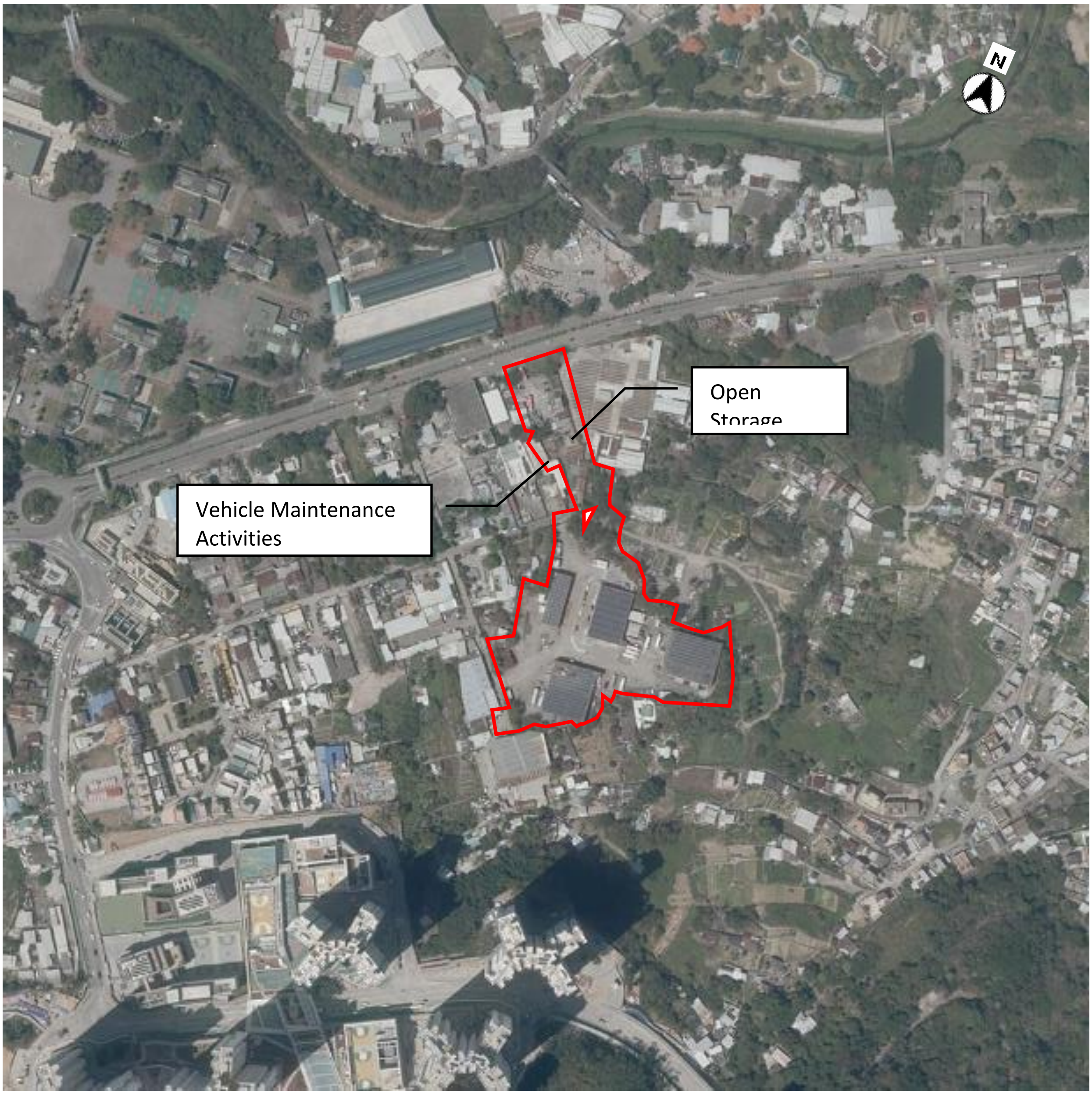
Source: Lands Department

Figure G-7: Aerial Photo in Year 2020



Source: Lands Department

Figure G-8: Aerial Photo in Year 2022



Source: Lands Department

Appendix G SITE SURVEY PHOTOS AND SITE WALKOVER CHECKLIST

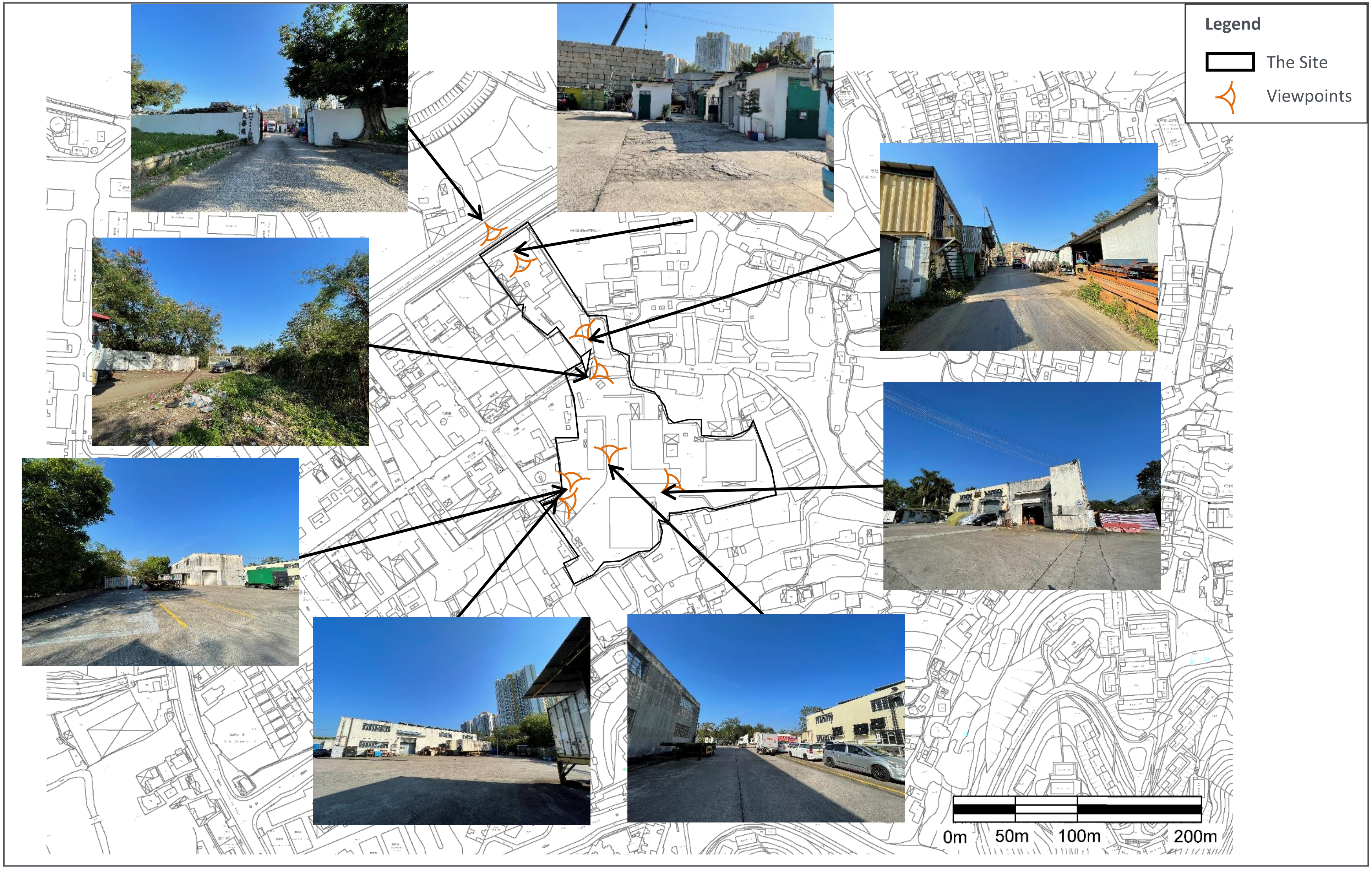

Legend
The Site
Viewpoints
0m
50m
100m
200m

Photo 1: Warehouse

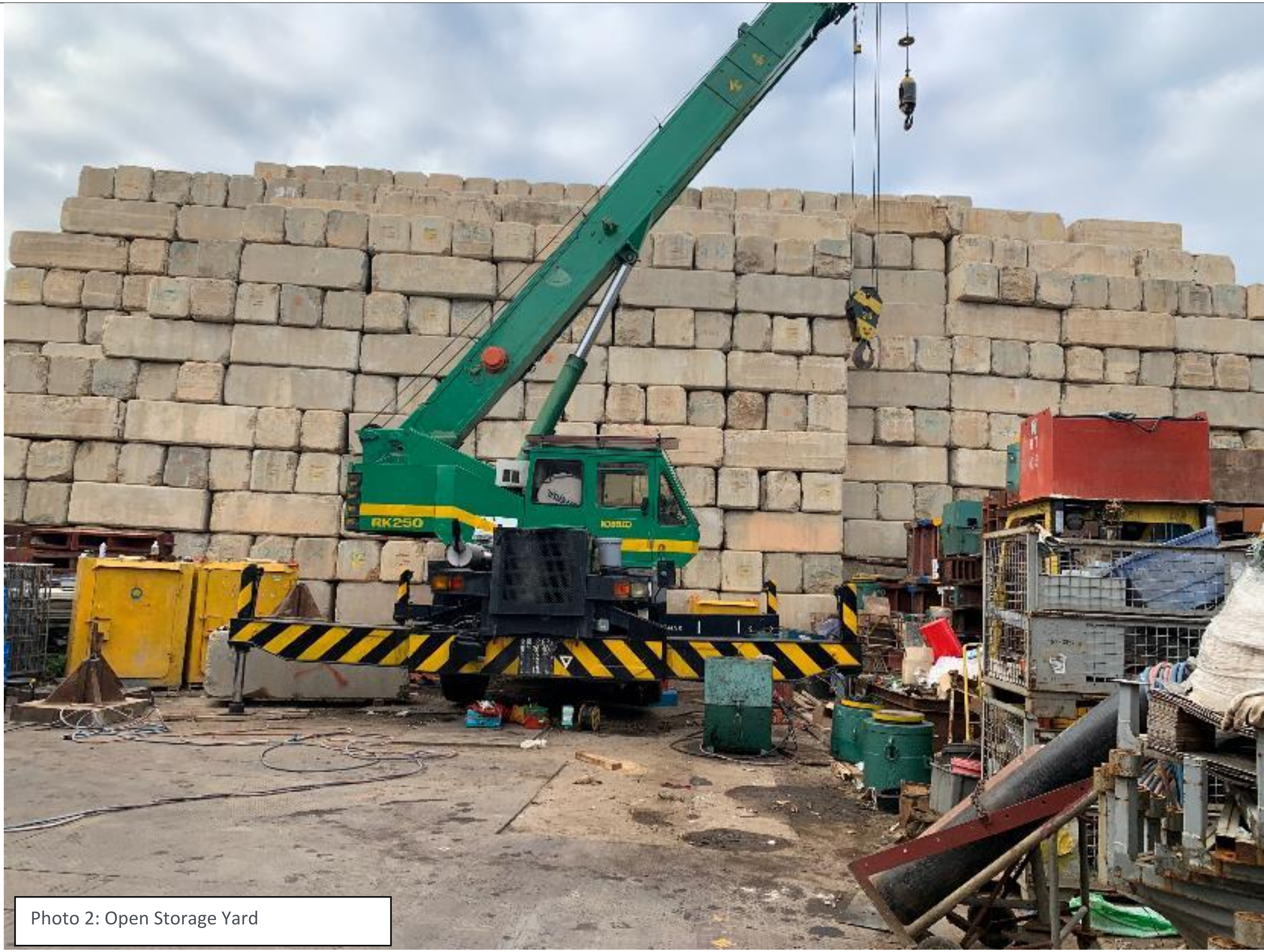


Photo 2: Open Storage Yard

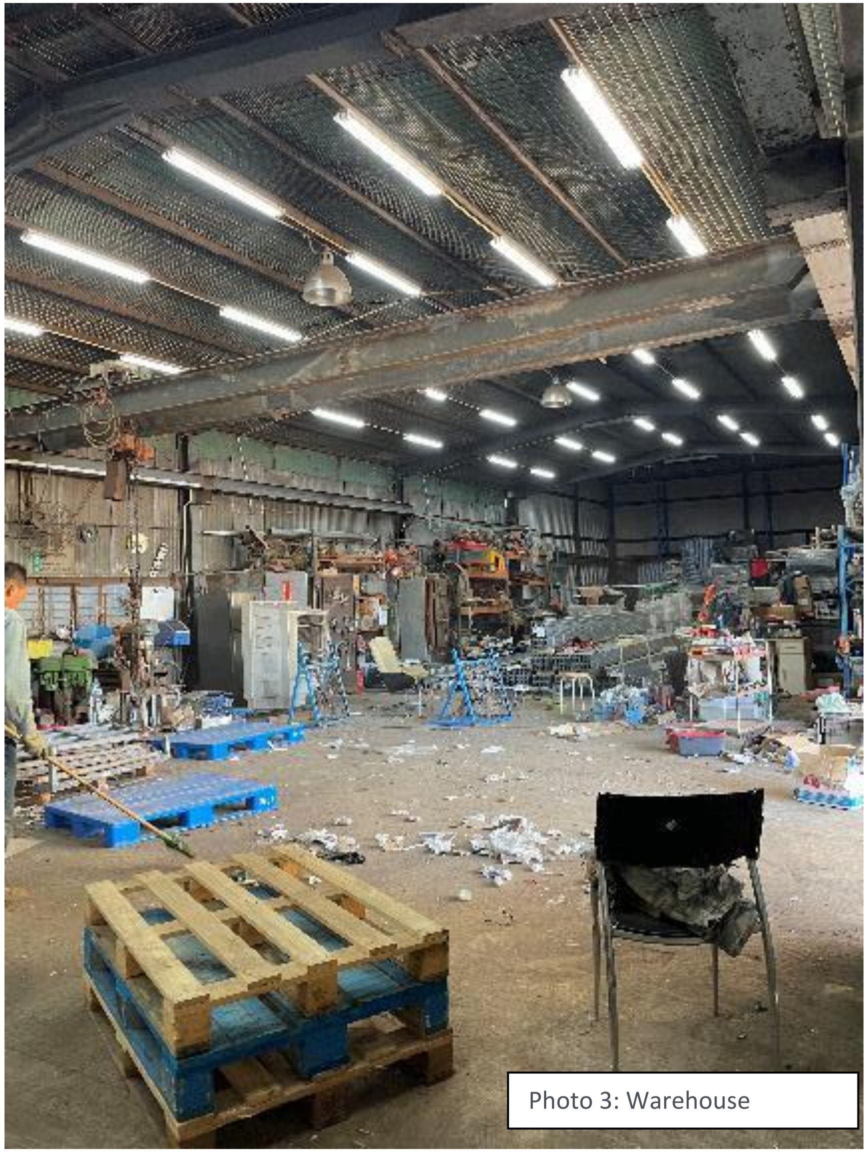


Photo 3: Warehouse

Photo 4: Warehouse

Photo 5: Shun Cheong Electrical Products Factory Limited

Photo 6: Shun Cheong Electrical Product Factory

Photo 7: Site Entrance

Photo 8: open storage yard and warehouse

Photo 9: warehouse

Photo 10: warehouse

Photo 11: warehouse

Photo 12: pavement

Photo 13: warehouse

Photo 14: warehouse

Photo 15: pavement

Photo 16: site entrance

Photo 17: site entrance

Photo 18: open storage yard

Photo 19: warehouse

Photo 20: vehicle maintenance workshop

Photo 21: vehicle maintenance workshop

Photo 22: pavement

Photo 23: open storage yard

Photo 24: Tin Wah House

Photo 25: warehouse

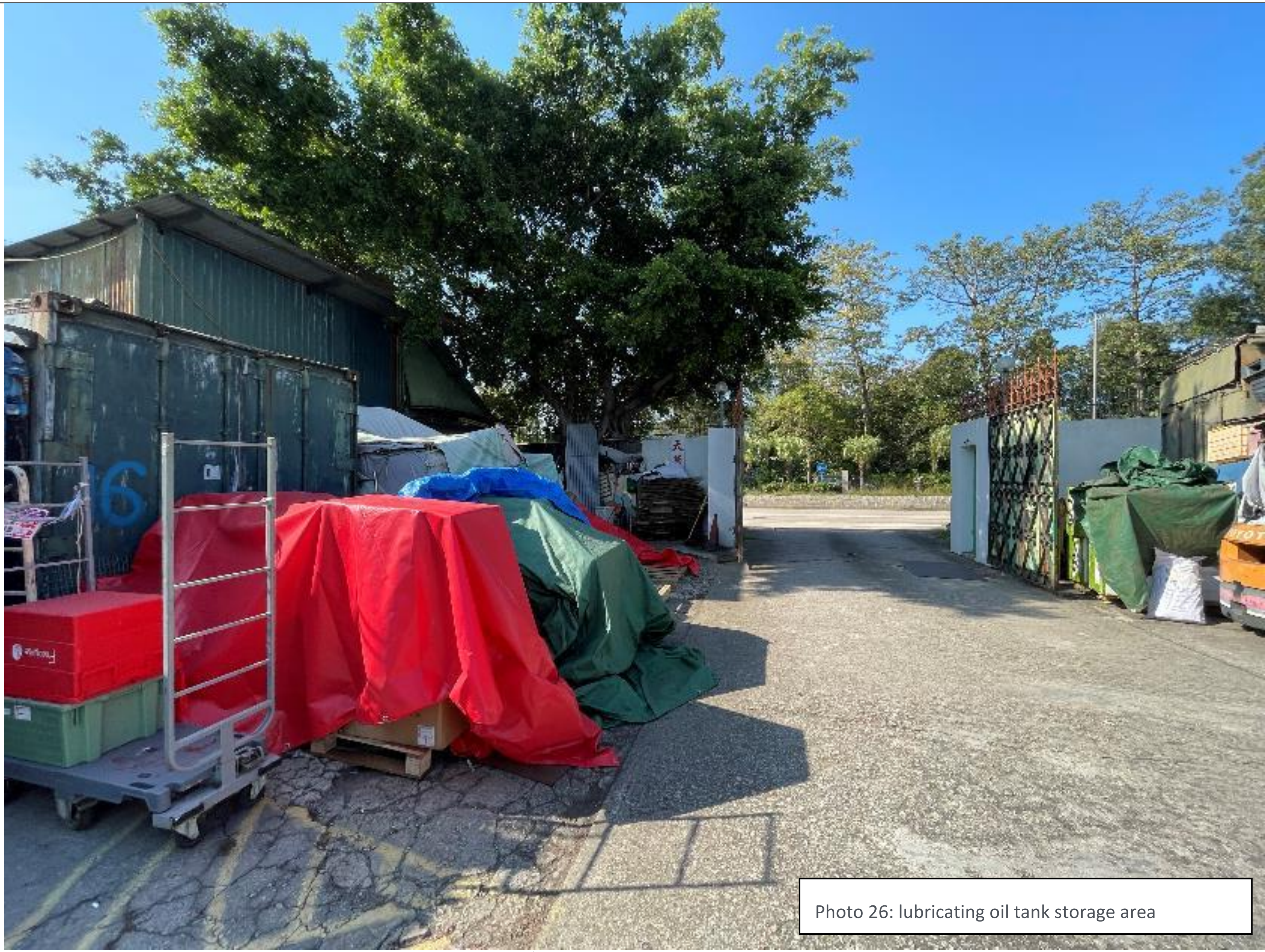


Photo 26: lubricating oil tank storage area

Photo 27: Tung Chun Soy Sauce and Canned Food Limited

Photo 28: Tung Chun Soy Sauce and Canned Food Limited

Photo 29: observed lubricating oil tank stock piling area outlined in purple, vehicle maintenance workshop outlined in green and open storage yard outlined in blue

Photo 30: southern portion of site

Annex C1

Site Walkover Checklist

GENERAL SITE DETAILS

SITE OWNER/CLIENT Carlton Woodcraft Manufacturing Ltd

PROPERTY ADDRESS Various Lots in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau, N.T.

PERSON CONDUCTING THE QUESTIONNAIRE

NAME Charls LIANG

POSITION Assistant Environmental Engineer

~~AUTHORIZED OWNER/CLIENT REPRESENTATIVE (IF APPLICABLE)~~

NAME

POSITION

TELEPHONE

SITE ACTIVITIES

Briefly describe activities carried out on site, including types of products/chemicals/materials handled. **Obtain a flow schematic if possible.**

N/A

Number of employees: Full-time:

Part-time:

Temporary/Seasonal:

Maximum no. of people on site at any time:

Typical hours of operation:

Number of shifts:

Days per week:

Weeks per year:

Scheduled plant shut-down:

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: 22,445m^2

What area of the site is covered by buildings (%): 60%

Please list all current and previous owners/occupiers if possible. N/A

Is a site plan available? If yes, please attach. ~~Yes~~/No

Are there any other parties on site as tenants or sub-tenants? Yes/~~No~~

If yes, identify those parties: N/A

Describe surrounding land use (residential, industrial, rural, etc.) and identify neighbouring facilities and types of industry.

North: Industrial Use (Fanling Environmental Recycling Limited)

South: Argricultural Use (Farmland)

Residential Uses (Village Houses and Queen's Hill Estate)

East: Argricultural Use (Farmland)

Industrial Use (Tung Chun Soy Sauce and Canned Food Company Limited)

West: Industrial Use (Shun Cheong Electrical Products Factory Ltd)

Residential Use (Village Houses)

Annex C1

Site Walkover Checklist

Describe the topography of the area (flat terrain, rolling hills, mountains, by a large body of water, vegetation, etc.).

Flat paved areas with small part of vegetations

State the size and location of the nearest residential communities.

Some separate village houses are identified near the Site. And a public housing development is located to the south of the Site.

Are there any sensitive habitats nearby, such as nature reserves, parks, wetlands or sites of special scientific interest?

N/A

Questionnaire with Existing/Previous Site Owner or Occupier

		Yes/No	Notes
1.	What are the main activities/operations at the above address?	N/A	Storage/Residential
2.	How long have you been occupying the site?	N/A	More than 40 years
3.	Were you the first occupant on site? (If yes, what was the usage of the site prior to occupancy.)	Yes	Farmland
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?	No	
7.	Have any polluting activities been carried out in the vicinity of the site in the past?	No	
8.	To the best of your knowledge, has the site ever been used as a petrol filling station/car service garage?	No	
9.	Are there any boreholes/wells or natural springs either on the site or in the surrounding area?	No	
10.	Do you have any registered hazardous installations as defined under relevant ordinances? (If yes, please provide details.)	No	
11.	Are any chemicals used in your daily operations? (If yes, please provide details.)	Yes	Lubricating oil for PME maintenance
	• Where do you store these chemicals?		Drum with secondary containment
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?	No	
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.)	No	

		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	Drums
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?	Yes	Water tank for fire services
18.	Do you have regular check for any spillage and monitoring of chemicals handled? (If yes, please provide details.)	No	
19.	How are the wastes disposed of?		Chemical waste would be collected by licensed collector
20.	Have you ever received any notices of violation of environmental regulations or received public complaints? (If yes, please provide details.)	No	
21.	Have any spills occurred on site? (If yes, please provide details.)	No	
	• 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.)	No	
23.	Have disused underground tanks been removed or otherwise secured (e.g. concrete, sand, etc.)?	No	
24.	Are there any known contaminations on site? (If yes, please provide details.)	No	
25.	Has the site ever been remediated? (If yes, please provide details.)	No	

Annex C1
Site Walkover Checklist

Observations

		Yes/No	Notes
1.	Are chemical storage areas provided with secondary containment (i.e. bund walls and floors)?	Yes	
2.	What are the conditions of the bund walls and floors?		Paved with concrete in good conditions
3.	Are any surface water drains located near to drum storage and unloading areas?	N/A	
4.	Are any solid or liquid waste (other than wastewater) generated at the site? (If yes, please provide details.)	Yes	General refuse; Lubricating oils
5.	Is there a storage site for the wastes?	Yes	
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?	Yes	Shun Cheong Electrical Products Factory Ltd Tung Chun Soy Sauce and Canned Food Company Limited
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?	Yes	Lubricating oils

Appendix H INFORMATION REQUEST LETTERS AND REPLIES FROM EPD AND FSD

Information Request Letter to EPD

SMEC

Member of the Surbana Jurong Group

local people
global experience

Our ref: 7076933/L29461/AW/TSC/CL/rw

20 January 2023

Environmental Protection Department
Environmental Compliance Division
Regional Office (North)
10/F Shatin Government Offices
No.1 Sheung Wo Che Road, Sha Tin
N.T., Hong Kong

By Email (shchu@epd.gov.hk)
& Fax (2685 1133)

Attention: Mr. CHU Shun Hang

Dear Sir

Section 12A Rezoning Application – Request for Amendment to the approved Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan No. S/NE-LYT/19 from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A) 2" Zone
Request for Information - Land Contamination Review

We have been appointed by Carlton Woodcraft Manufacturing Ltd as the Environmental Consultant to undertake an Environmental Assessment ("EA") for the captioned project. A copy of appointment letter (ref: 17601076-0785/L29290/AB/AW/FN/rw) dated 7 December 2022 regarding the appointment of the captioned Agreement is enclosed for your information. The Subject Site is in Lung Yeuk Tau, Fanling, and its location is shown on the attached figure.

In order to review potential land contamination issue, we would be most grateful if you could provide us with a list of records of Chemical Waste Producers Registration or incidents of chemical spillage/leakage, etc. relating to the Site, if any.

Should you have any enquiries regarding the above, please do not hesitate to contact the undersigned on tel. 3995 8124 or to cindy.chung@smec.com or our Mr. Charls LIANG on tel. 3995 8128 or to charls.liang@smec.com.

Yours faithfully

Cindy CHUNG
Senior Environmental Consultant

Encl.

SMEC ASIA LIMITED
27/F Ford Glory Plaza, 37-39 Wing Hong Street
Cheung Sha Wan, Kowloon, Hong Kong
T +852 3995 8100
F +852 3995 8101
E hongkong@smec.com
W www.smec.com

Information Request Letter to EPD

Appointment Letter

SMEC
Member of the Surbana Jurong Group

local people
global experience

Our ref: 17601076-0785/L29290/AB/AW/FN/rw

7 December 2022

Carlton Woodcraft Manufacturing Ltd
15/F VIP Commercial Centre
116-120 Canton Road
Tsim Sha Tsui
Kowloon
Hong Kong

By Hand

Attn: Mr Joseph S.P. FU

Dear Sir

12A Rezoning Application from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A)2" Zone under the Draft Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan No. S/NE-LYT/18
Technical and Fee Proposal

Thank you for your invitation. We are pleased to provide this Scope of Works and Fee Proposal including our scope of services and the fees, as appended to this letter, for your consideration.

We look forward to receiving your formal instruction to proceed by providing a signed copy of this letter, a works order/purchase order, or a letter confirming your acceptance of the attached proposal.

Should you have any queries regarding this proposal, please do not hesitate to contact our Mr Antony WONG, on 3995 8120 or at antony.wong@smec.com.

Yours faithfully
for and on behalf of
SMEC Asia Ltd

Ir Alexi BHANJA
Managing Director

Encl.

Signed and Agreed
for and on behalf of the Client

Name: Joseph S.P. Fu

Position: Chairman

SMEC ASIA LIMITED
22/F Ford Glory Plaza, 37-39 Wing Hong Street
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F +852 3995 8101
E hongkong@smec.com
W www.smec.com

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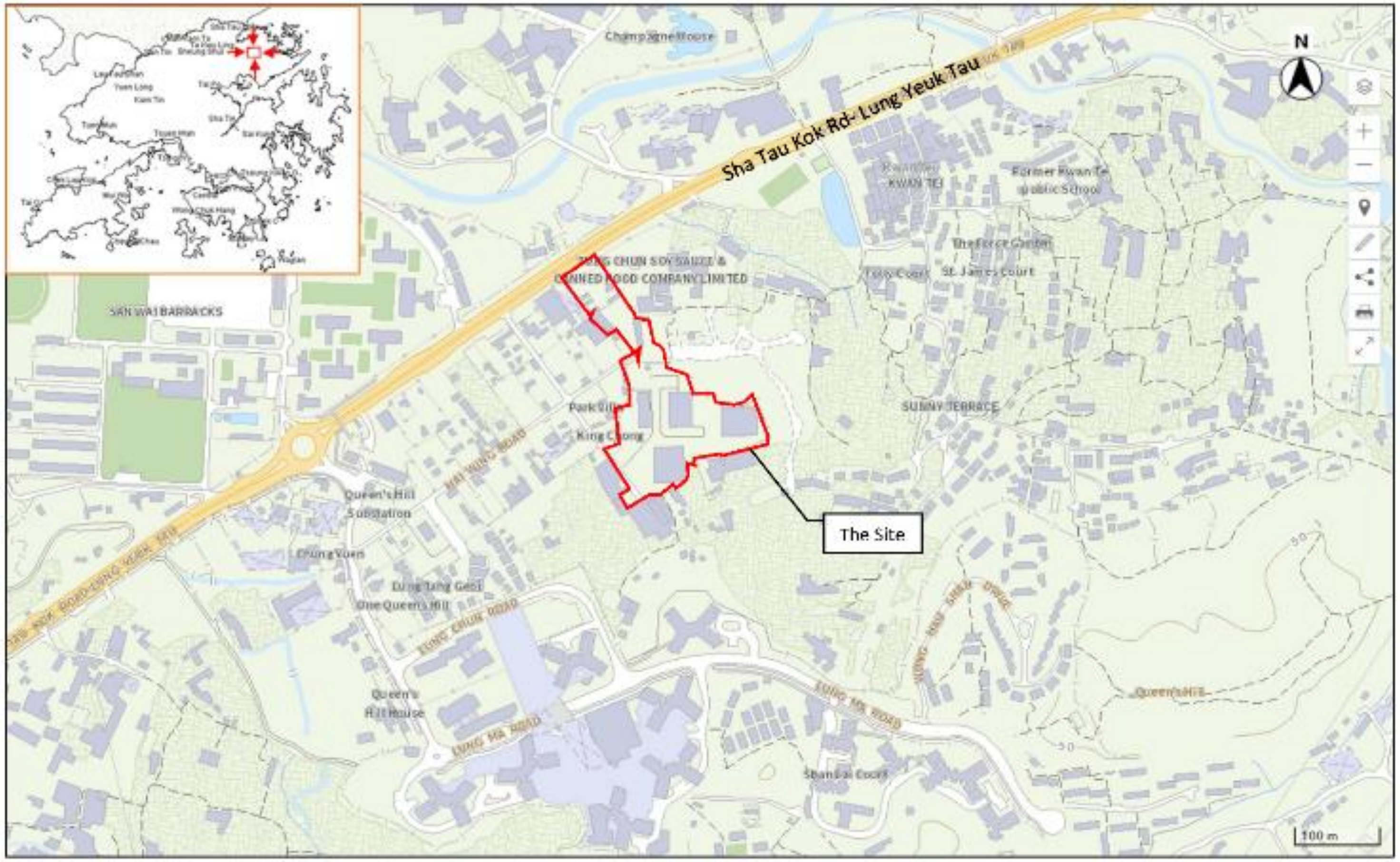
[illegible]
Attachment Page 1 of 2

Information Request Letter to EPD

Site Location Plan



(Source: Processed from GeoInfo Map)

Attachment Page 2 of 2

Email Reply from EPD

Charls LIANG

From:	herrickho@epd.gov.hk
Sent:	Friday, 17 February 2023 5:22 pm
To:	Charls LIANG
Cc:	Cindy CHUNG
Subject:	Re: FW: 7076933 Section 12A Rezoning Application at Lung Yeuk Tau - Land Contamination Review
Attachments:	230120 EPD Info Request 29461.pdf

This message Is From an External Sender

Please do not click the links or attachments and do not respond to this message if you are unsure of its origin.

Dear Charls,

There is no registered Chemical waste producer in concerned area.

Thanks & Regards,
Herrick HO / CI(RN)32
2158 5831

From: Charls LIANG <Charls.Liang@smec.com>
To: "herrickho@epd.gov.hk" <herrickho@epd.gov.hk>
Cc: Cindy CHUNG <Cindy.Chung@smec.com>
Date: 31/01/2023 15:48
Subject: FW: 7076933 Section 12A Rezoning Application at Lung Yeuk Tau - Land Contamination Review

Dear Herrick,

We just spoke. In addition to the incident of chemical spillage/leakage record in the last 5 years, could you please also advise whether there is any registered Chemical Waste Producer related to the Project Site? Please feel free to contact me should there be any queries.

Thanks.
Regards,
Charls LIANG
Graduate Engineer
D +852 3995 8128 T +852 3995 8100 F +852 3995 8101 E charls.liang@smec.com

SMEC Hong Kong

1

Charls LIANG

From:	Cindy CHUNG
Sent:	Monday, 30 January 2023 12:31 pm
To:	Charls LIANG
Subject:	FW: 7076933 Section 12A Rezoning Application at Lung Yeuk Tau - Land Contamination Review
Attachments:	230120_EPD_Info Request_29461.pdf

From: herrickho@epd.gov.hk <herrickho@epd.gov.hk>
Sent: Thursday, January 26, 2023 10:17 AM
To: Cindy CHUNG <Cindy.Chung@smec.com>
Cc: shchu@epd.gov.hk
Subject: Re: 7076933 Section 12A Rezoning Application at Lung Yeuk Tau - Land Contamination Review

Dear Cindy,

According to our records, there is no incident of chemical spillage/leakage in relevant location in last 5 years .

Thanks & Regards,
Herrick HO / EPD
2158 5831

From: SH CHU/EPD/HKSARG
To: CI[RN]32
Cc: SI[RN]34, DPI[RN]1, I[RN]34
Date: 20/01/2023 17:18
Subject: 7076933 Section 12A Rezoning Application at Lung Yeuk Tau - Land Contamination Review

---

Dear Herrick,

Would you please provide the records as requested and reply to the Cindy Chung.

Regards,
CHU Shun-hang
AE(RN)33 / EPD
2158 5832

----- Forwarded by SH CHU/EPD/HKSARG on 20/01/2023 17:11 -----

From: Cindy CHUNG <Cindy.Chung@smec.com>
To: "shchu@epd.gov.hk" <shchu@epd.gov.hk>
Cc: Antony WONG <Antony.Wong@smec.com>, Charls LIANG <Charls.Liang@smec.com>, Isa Yuen <iyuen@aikon.hk>, Thomas Luk <tluk@aikon.hk>, "jlee@carltonwood.com.hk" <jlee@carltonwood.com.hk>
Date: 20/01/2023 17:06
Subject: 7076933 Section 12A Rezoning Application at Lung Yeuk Tau - Land Contamination Review

---

Dear Mr. CHU,

1

Email Reply from EPD

Section 12A Rezoning Application – Request for Amendment to the approved Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan No. S/NE-LYT/19 from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A) 2" Zone
Request for Information - Land Contamination Review

We have been appointed by Carlton Woodcraft Manufacturing Ltd as the Environmental Consultant to undertake an Environmental Assessment ("EA") for the captioned project. In order to review potential land contamination issue, we would be most grateful if you could provide us with a list of records of Chemical Waste Producers Registration or incidents of chemical spillage/leakage, etc. relating to the Site, if any. Please refer to the attached letter for details of the project and requested information.

Should you have any enquiries regarding the above, please do not hesitate to contact the undersigned. Thank you.

Regards,

Cindy CHUNG
Senior Environmental Consultant
D +852 3995 8124 T +852 3995 8100 F +852 3995 8101 E cindy.chung@smec.com

SMEC Hong Kong – We're redefining exceptional
27/F Ford Glory Plaza, 37-39 Wing Hong Street, Cheung Sha Wan, Kowloon, Hong Kong

www.smec.com LinkedIn YouTube Instagram Subscribe

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2

Information Request Letter to FSD

SMEC

Member of the Surbana Jurong Group

local people
global experience

Our ref: 7076933/L29462/AW/TSC/CL/rw

20 January 2023

Fire Services Department
Corporate Strategy Command
Management Group
9/F, Fire Services Headquarters Building
1 Hong Chong Road, Tsim Sha Tsui East
Kowloon, Hong Kong

By Email (hkfsdenq@hkfsd.gov.hk)
& Fax (2739 5879)

Attention: Mr. NG Wing Chit

Dear Sir

Section 12A Rezoning Application – Request for Amendment to the approved Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan No. S/NE-LYT/19 from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A) 2" Zone
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In order to review potential land contamination issue, we would be most grateful if you could provide us with a list of records of fire incidents or incidents of spillage/leakage of dangerous goods, etc. relating to the Site, if any.

Should you have any enquiries regarding the above, please do not hesitate to contact the undersigned on tel. 3995 8124 or to cindy.chung@smec.com or our Mr. Charls LIANG on tel. 3995 8128 or to charls.liang@smec.com.

Yours faithfully

Cindy CHUNG
Senior Environmental Consultant

Encl.

SMEC ASIA LIMITED
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W www.smec.com

Z:\Jobs\7076933 - Carlton - S12A Lung Yeuk Tau\02 Out\230120_FSD_Info Request_L29462.docx

Information Request Letter to FSD

Appointment Letter

SMEC

Member of the Surbana Jurong Group

local people
global experience

Our ref: 17601076-0785/L29290/AB/AW/FN/rw

7 December 2022

Carlton Woodcraft Manufacturing Ltd
15/F VIP Commercial Centre
116-120 Canton Road
Tsim Sha Tsui
Kowloon
Hong Kong

By Hand

Attn: Mr Joseph S.P. FU

Dear Sir

12A Rezoning Application from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A)2" Zone under the Draft Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan No. S/NE-LYT/18
Technical and Fee Proposal

Thank you for your invitation. We are pleased to provide this Scope of Works and Fee Proposal including our scope of services and the fees, as appended to this letter, for your consideration.

We look forward to receiving your formal instruction to proceed by providing a signed copy of this letter, a works order/purchase order, or a letter confirming your acceptance of the attached proposal.

Should you have any queries regarding this proposal, please do not hesitate to contact our Mr Antony WONG, on 3995 8120 or at antony.wong@smec.com.

Yours faithfully
for and on behalf of
SMEC Asia Ltd

Ir Alexi BHANJA
Managing Director

Signed and Agreed
for and on behalf of the Client

Name: Joseph S. P. Fu
Position: Chairman

Encl.

SMEC ASIA LIMITED
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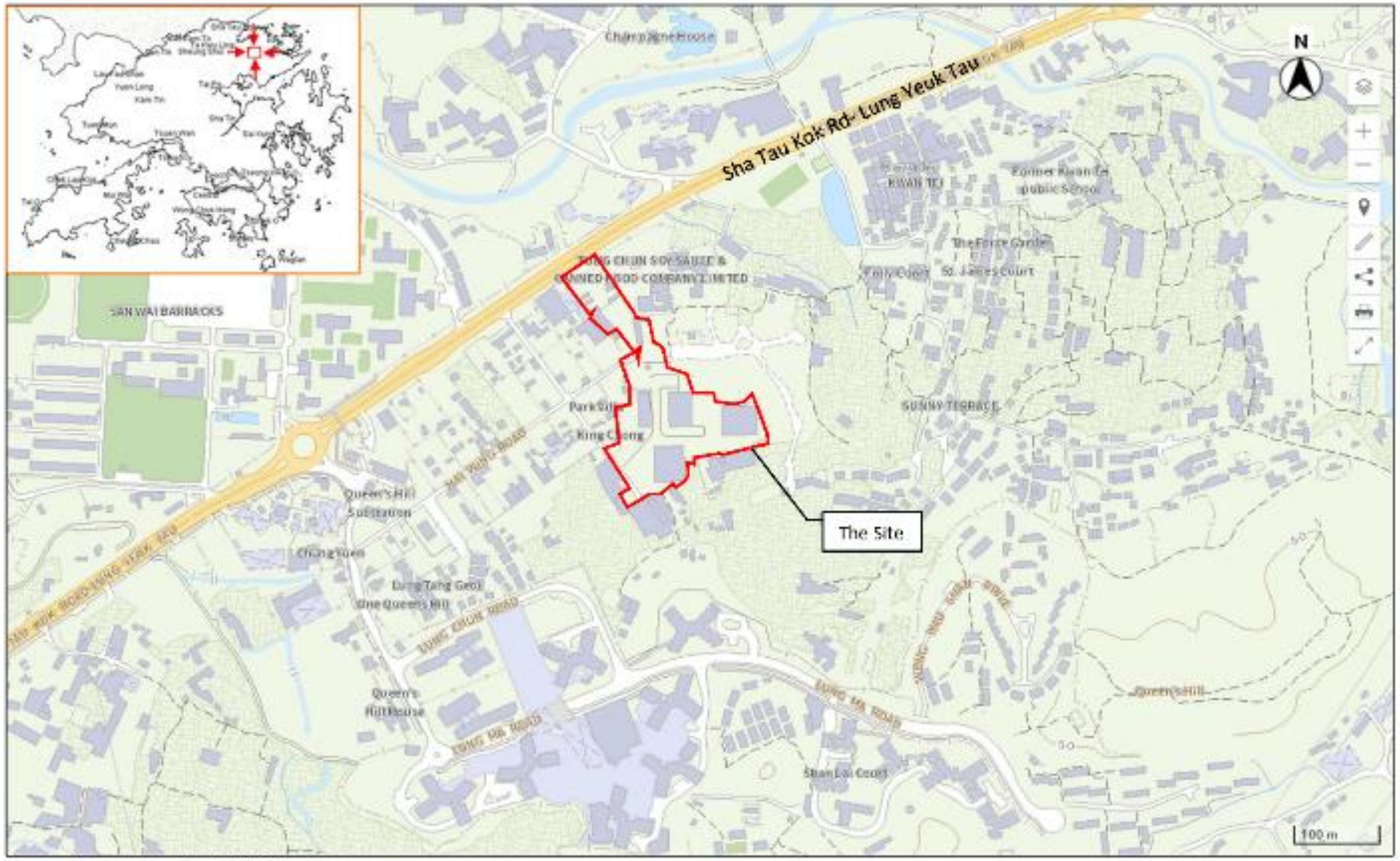
W www.smec.com

Attachment, Page 1 of 2

Information Request Letter to FSD

Site Location Plan



(Source: Processed from GeoInfo Map)

Reply from FSD

消 防 處
香港九龍尖沙咀東部康莊道1號
消防處總部大廈

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.	:	(91) in FSD GR 6-5/4 R Pt. 45
來函檔號 YOUR REF.	:	7076933/L29462/AW/TSC/CL/rw
電子郵件 E-mail	:	hkfsdenq@hkfsd.gov.hk
圖文傳真 FAX NO.	:	2739 5879
電 話 TEL NO.	:	2733 7741

24 February 2023

SMEC Asia Limited
27/F Ford Glory Plaza,
37-39 Wing Hong Street,
Cheung Sha Wan, Kowloon, Hong Kong.
(Attn: Ms. Cindy CHUNG, Senior Environmental Consultant)

Dear Ms. CHUNG,

Section 12A Rezoning Application – Request for Amendment to the approved Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan No. S/NE-LYT/19 from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A) 2" Zone
Request for Information of Dangerous Goods & Incident Records

I refer to your letter of 20.1.2023 regarding the captioned request and reply below in response to your questions:-

Please be advised that neither records of dangerous goods license, fire incidents nor incidents of spillage / leakage of dangerous goods were found in connection with the given conditions of your request at the subject location.

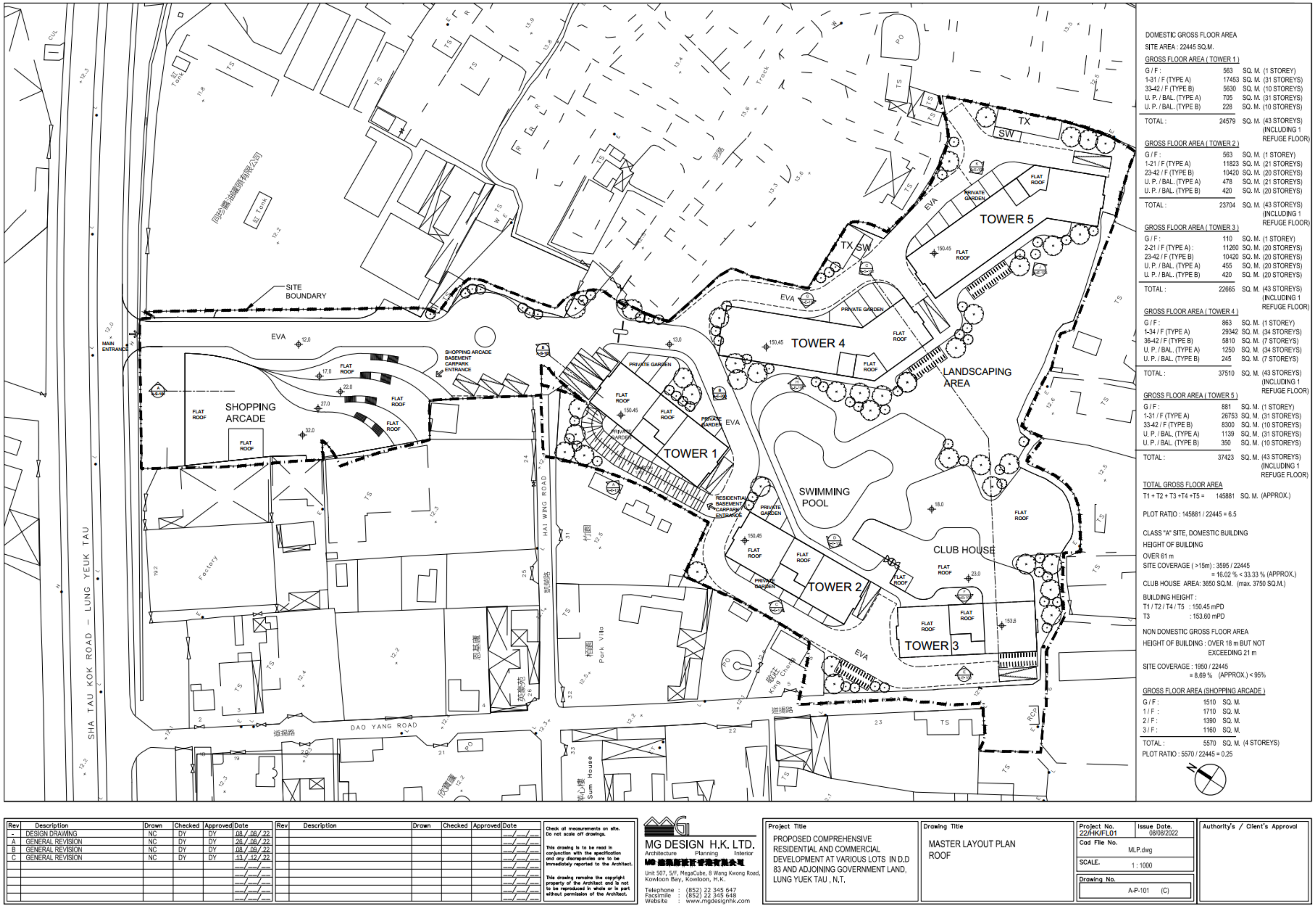
If you have further questions, please feel free to contact the undersigned.

Yours sincerely,

(NG Wing-chit)
for Director of Fire Services

Ref. number and date should be quoted in reference to this letter
凡 提 及 本 信 時 請 引 述 編 號 及 日 期

Appendix I **LAYOUT PLAN AND SECTION PLAN OF PROPOSED DEVELOPMENT**



SITE BOUNDARY
MAIN ENTRANCE
EVA
SHOPPING ARCADE
SHOPPING ARCADE BASEMENT CARPARK ENTRANCE
FLAT ROOF
TOWER 1
TOWER 2
TOWER 3
TOWER 4
TOWER 5
PRIVATE GARDEN
RESIDENTIAL BASEMENT CARPARK ENTRANCE
SWIMMING POOL
CLUB HOUSE
LANDSCAPING AREA
SHA TAU KOK ROAD – LUNG YEUK TAU
HAI WING ROAD
DAO YANG ROAD
Park Villa
King Chalet
Sum House
Factory
DOMESTIC GROSS FLOOR AREA
SITE AREA : 22445 SQ.M.
GROSS FLOOR AREA (TOWER 1)
G / F : 563 SQ. M. (1 STOREY)
1-31 / F (TYPE A) 17453 SQ. M. (31 STOREYS)
33-42 / F (TYPE B) 5630 SQ. M. (10 STOREYS)
U. P. / BAL. (TYPE A) 705 SQ. M. (31 STOREYS)
U. P. / BAL. (TYPE B) 228 SQ. M. (10 STOREYS)
TOTAL : 24579 SQ. M. (43 STOREYS) (INCLUDING 1 REFUGE FLOOR)
GROSS FLOOR AREA (TOWER 2)
G / F : 563 SQ. M. (1 STOREY)
1-21 / F (TYPE A) 11823 SQ. M. (21 STOREYS)
23-42 / F (TYPE B) 10420 SQ. M. (20 STOREYS)
U. P. / BAL. (TYPE A) 478 SQ. M. (21 STOREYS)
U. P. / BAL. (TYPE B) 420 SQ. M. (20 STOREYS)
TOTAL : 23704 SQ. M. (43 STOREYS) (INCLUDING 1 REFUGE FLOOR)
GROSS FLOOR AREA (TOWER 3)
G / F : 110 SQ. M. (1 STOREY)
2-21 / F (TYPE A) : 11260 SQ. M. (20 STOREYS)
23-42 / F (TYPE B) 10420 SQ. M. (20 STOREYS)
U. P. / BAL. (TYPE A) 455 SQ. M. (20 STOREYS)
U. P. / BAL. (TYPE B) 420 SQ. M. (20 STOREYS)
TOTAL : 22665 SQ. M. (43 STOREYS) (INCLUDING 1 REFUGE FLOOR)
GROSS FLOOR AREA (TOWER 4)
G / F : 863 SQ. M. (1 STOREY)
1-34 / F (TYPE A) 29342 SQ. M. (34 STOREYS)
36-42 / F (TYPE B) 5810 SQ. M. (7 STOREYS)
U. P. / BAL. (TYPE A) 1250 SQ. M. (34 STOREYS)
U. P. / BAL. (TYPE B) 245 SQ. M. (7 STOREYS)
TOTAL : 37510 SQ. M. (43 STOREYS) (INCLUDING 1 REFUGE FLOOR)
GROSS FLOOR AREA (TOWER 5)
G / F : 881 SQ. M. (1 STOREY)
1-31 / F (TYPE A) 26753 SQ. M. (31 STOREYS)
33-42 / F (TYPE B) 8300 SQ. M. (10 STOREYS)
U. P. / BAL. (TYPE A) 1139 SQ. M. (31 STOREYS)
U. P. / BAL. (TYPE B) 350 SQ. M. (10 STOREYS)
TOTAL : 37423 SQ. M. (43 STOREYS) (INCLUDING 1 REFUGE FLOOR)
TOTAL GROSS FLOOR AREA
T1 + T2 + T3 +T4 +T5 = 145881 SQ. M. (APPROX.)
PLOT RATIO : 145881 / 22445 = 6.5
CLASS "A" SITE, DOMESTIC BUILDING
HEIGHT OF BUILDING
OVER 61 m
SITE COVERAGE (>15m) : 3595 / 22445 = 16.02 % < 33.33 % (APPROX.)
CLUB HOUSE AREA: 3650 SQ.M. (max. 3750 SQ.M.)
BUILDING HEIGHT :
T1 / T2 / T4 / T5 : 150.45 mPD
T3 : 153.60 mPD
NON DOMESTIC GROSS FLOOR AREA
HEIGHT OF BUILDING : OVER 18 m BUT NOT EXCEEDING 21 m
SITE COVERAGE : 1950 / 22445 = 8.69 % (APPROX.) < 95%
GROSS FLOOR AREA (SHOPPING ARCADE)
G / F : 1510 SQ. M.
1 / F : 1710 SQ. M.
2 / F : 1390 SQ. M.
3 / F : 1160 SQ. M.
TOTAL : 5570 SQ. M. (4 STOREYS)
PLOT RATIO : 5570 / 22445 = 0.25
N
Rev | Description | Drawn | Checked | Approved | Date
- | DESIGN DRAWING | NC | DY | DY | 08/08/22
A | GENERAL REVISION | NC | DY | DY | 26/08/22
B | GENERAL REVISION | NC | DY | DY | 26/09/22
C | GENERAL REVISION | NC | DY | DY | 13/12/22
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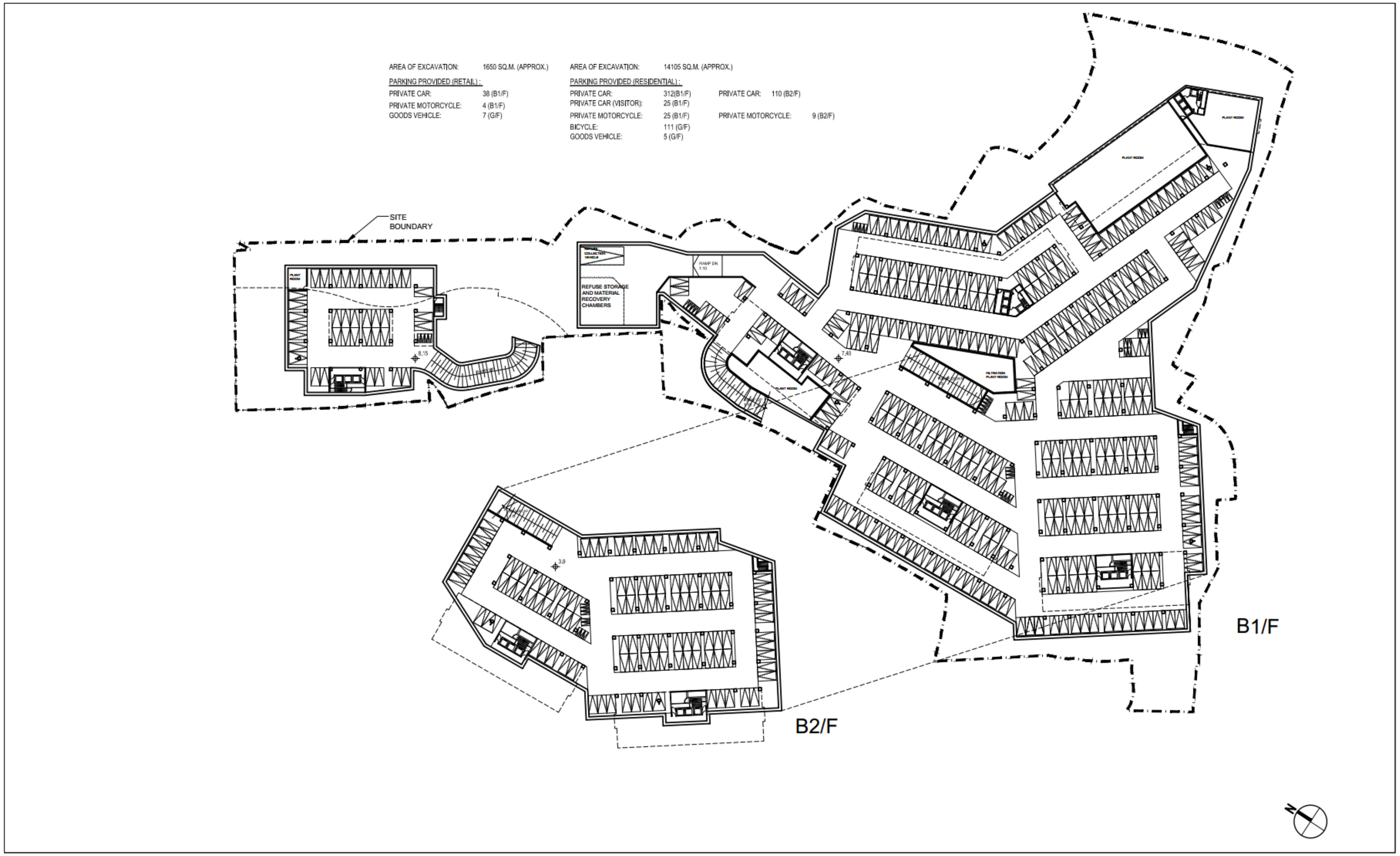
Facsimile : (852) 22 345 648
Website : www.mgdesignhk.com
Project Title
PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.
Drawing Title
MASTER LAYOUT PLAN
ROOF
Project No. 22/HK/FL01
Issue Date. 08/08/2022
Cad File No. MLP.dwg
SCALE. 1 : 1000
Drawing No. A-P-101 (C)
Authority's / Client's Approval



Rev	Description	Drawn	Checked	Approved	Date
-	DESIGN DRAWING	NC	DY	DY	08 / 08 / 22
A	GENERAL REVISION	NC	DY	DY	26 / 08 / 22
B	GENERAL REVISION	NC	DY	DY	08 / 09 / 22
C	GENERAL REVISION	CM	DY	DY	29 / 09 / 22
D	GENERAL REVISION	NC	DY	DY	13 / 12 / 22

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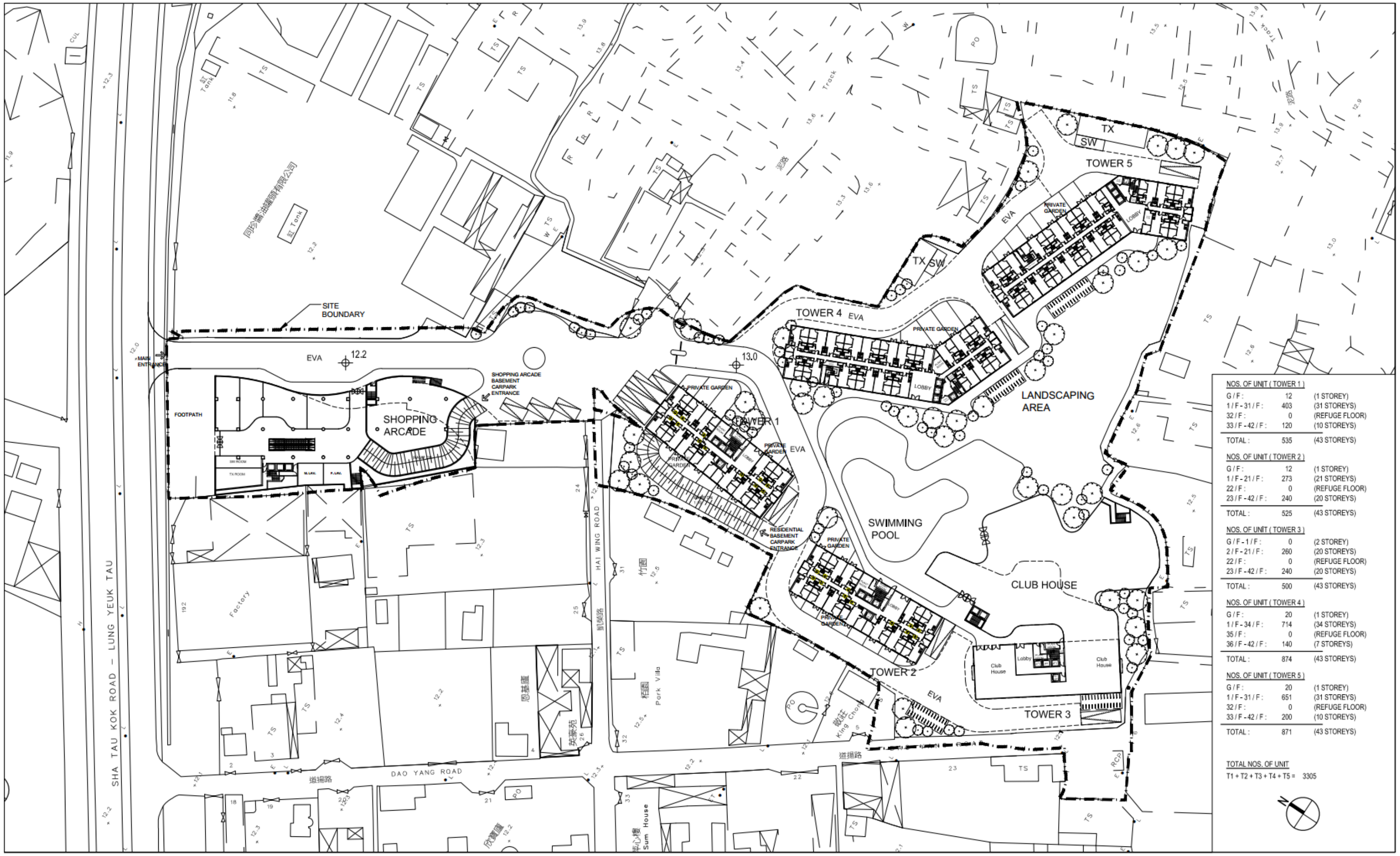
Project Title	Drawing Title	Project No.	Issue Date.	Authority's / Client's Approval
PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.	MASTER LAYOUT PLAN BASEMENT B1/F & B2/F	22/HK/FL01	08/08/2022	
		Cad File No. MLP.dwg		
		SCALE. 1 : 1000		
		Drawing No. A-P-102 (D)		



Rev	Description	Drawn	Checked	Approved	Date
-	DESIGN DRAWING	NC	DY	DY	08 / 08 / 22
A	GENERAL REVISION	NC	DY	DY	26 / 08 / 22
B	GENERAL REVISION	NC	DY	DY	08 / 09 / 22
C	GENERAL REVISION	NC	DY	DY	13 / 12 / 22

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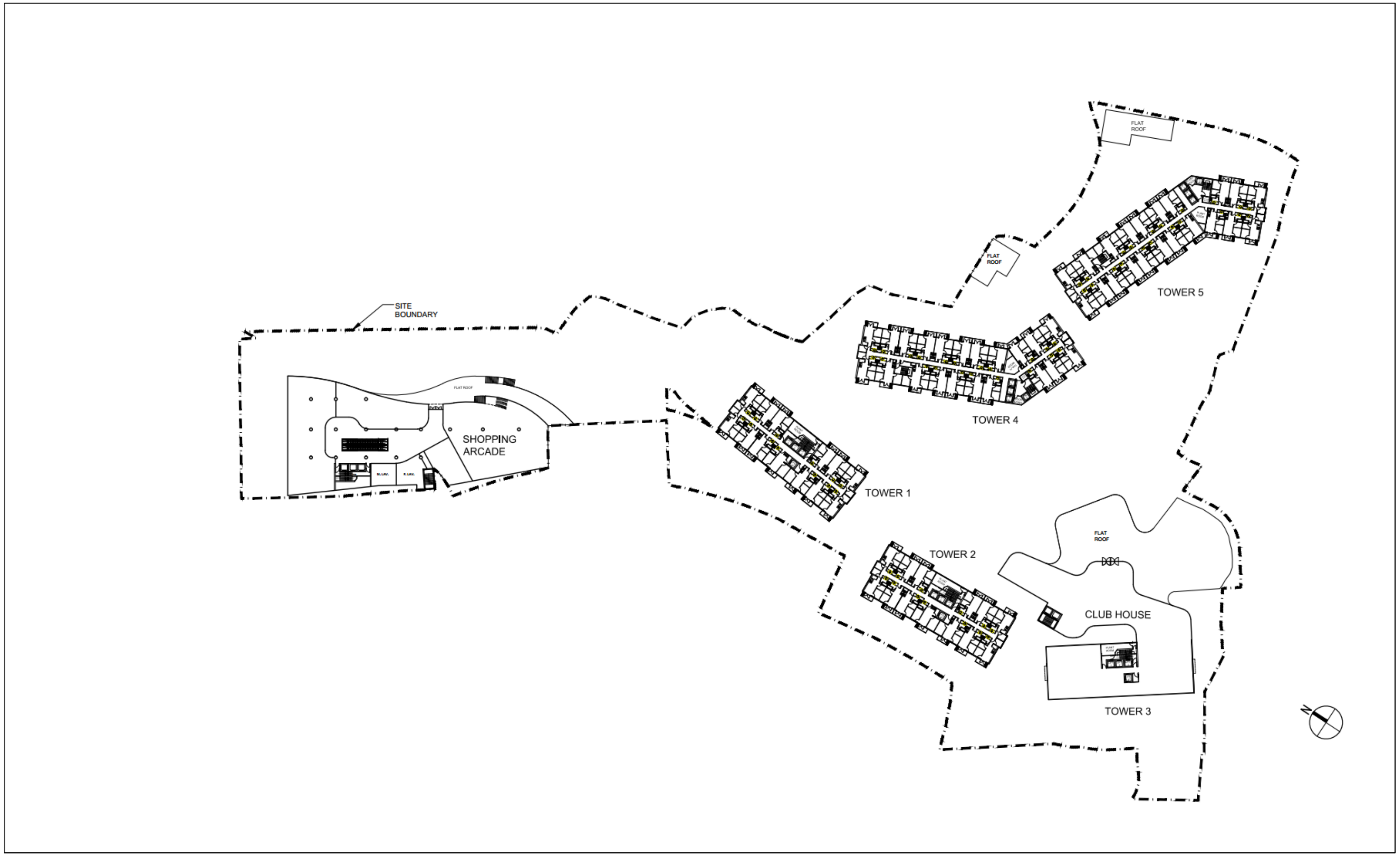
Facsimile : (852) 22 345 648
Website : www.mgdesignhk.com

Project Title: PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.

Drawing Title: MASTER LAYOUT PLAN G/F

Project No. 22/HK/FL01
Issue Date. 08/08/2022
Cad File No. MLP.dwg
SCALE. 1 : 1000
Drawing No. A-P-103 (C)

Authority's / Client's Approval



Rev	Description	Drawn	Checked	Approved	Date
-	DESIGN DRAWING	NC	DY	DY	08 / 08 / 22
A	GENERAL REVISION	NC	DY	DY	26 / 08 / 22
B	GENERAL REVISION	NC	DY	DY	13 / 12 / 22

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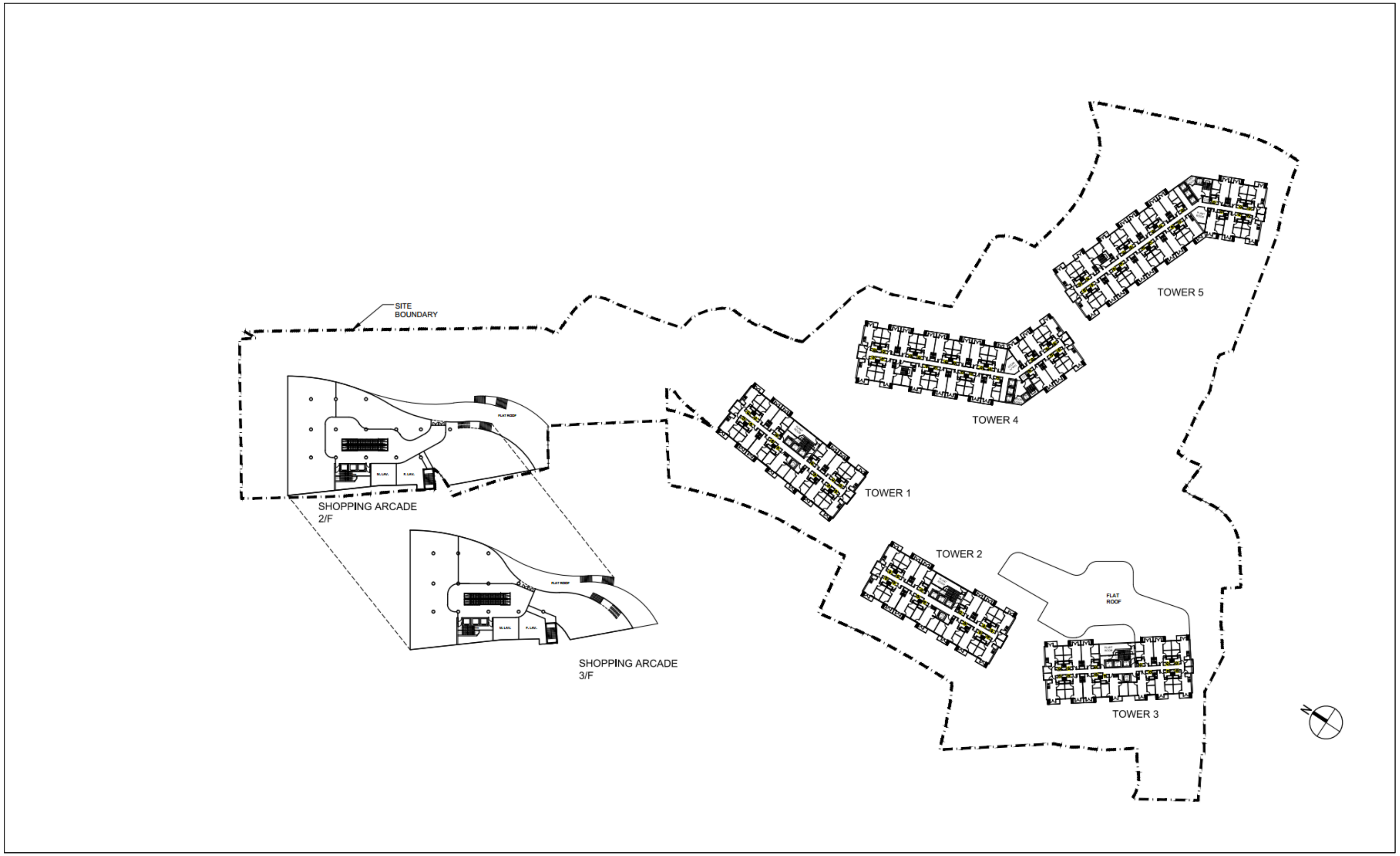
Project Title
PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.

Drawing Title
MASTER LAYOUT PLAN
1/F

Project No. 22/HK/FL01
Issue Date. 08/08/2022
Cad File No. MLP.dwg
SCALE. 1 : 1000
Drawing No. A-P-104 (B)

Authority's / Client's Approval



Rev	Description	Drawn	Checked	Approved	Date
-	DESIGN DRAWING	NC	DY	DY	08 / 08 / 22
A	GENERAL REVISION	NC	DY	DY	26 / 08 / 22
B	GENERAL REVISION	NC	DY	DY	13 / 12 / 22

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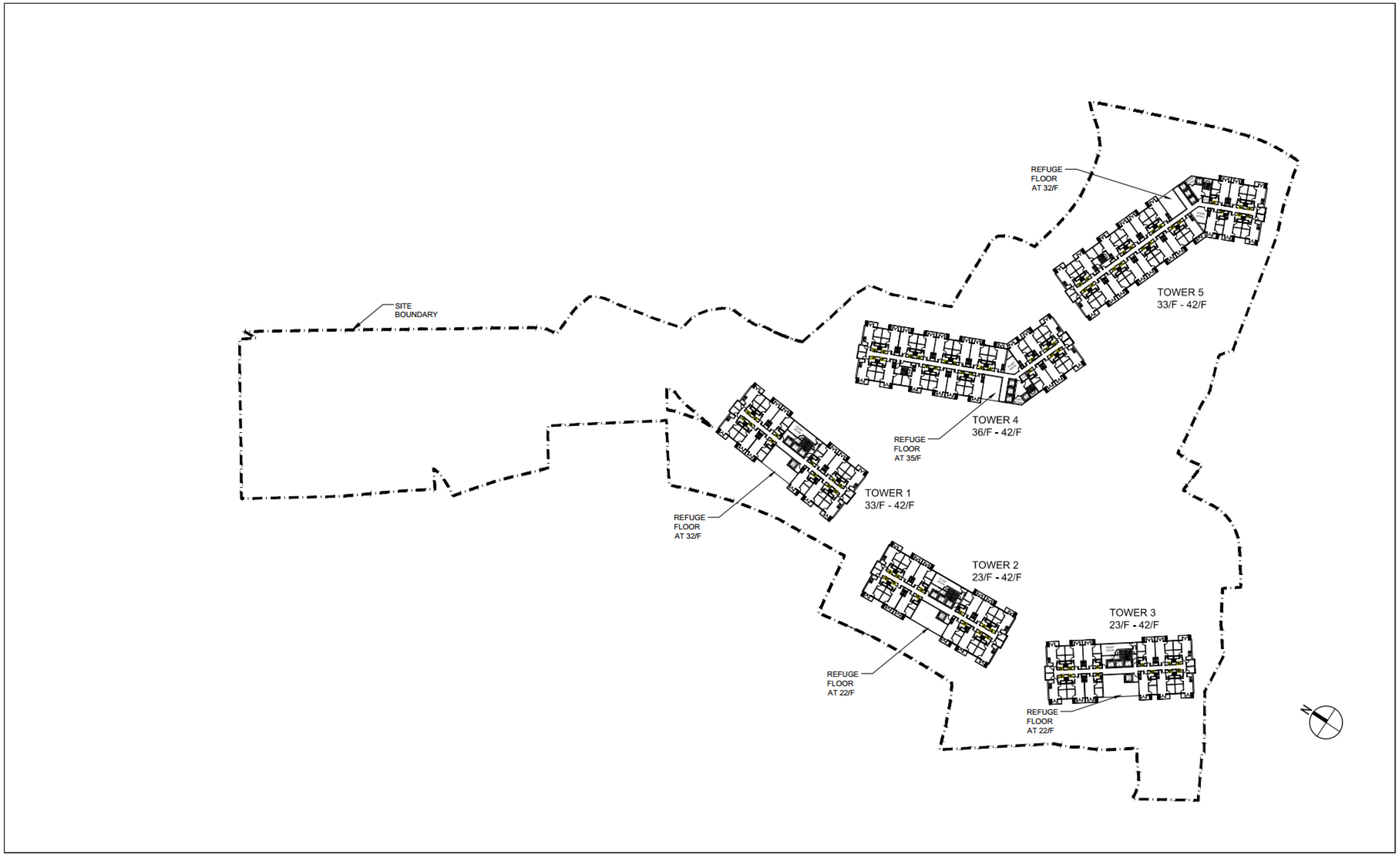
Website : www.mgdesignhk.com

Project Title
PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.

Drawing Title
MASTER LAYOUT PLAN
2/F

Project No. 22/HK/FL01
Issue Date. 08/08/2022
Cad File No. MLP.dwg
SCALE. 1 : 1000
Drawing No. A-P-105 (B)

Authority's / Client's Approval



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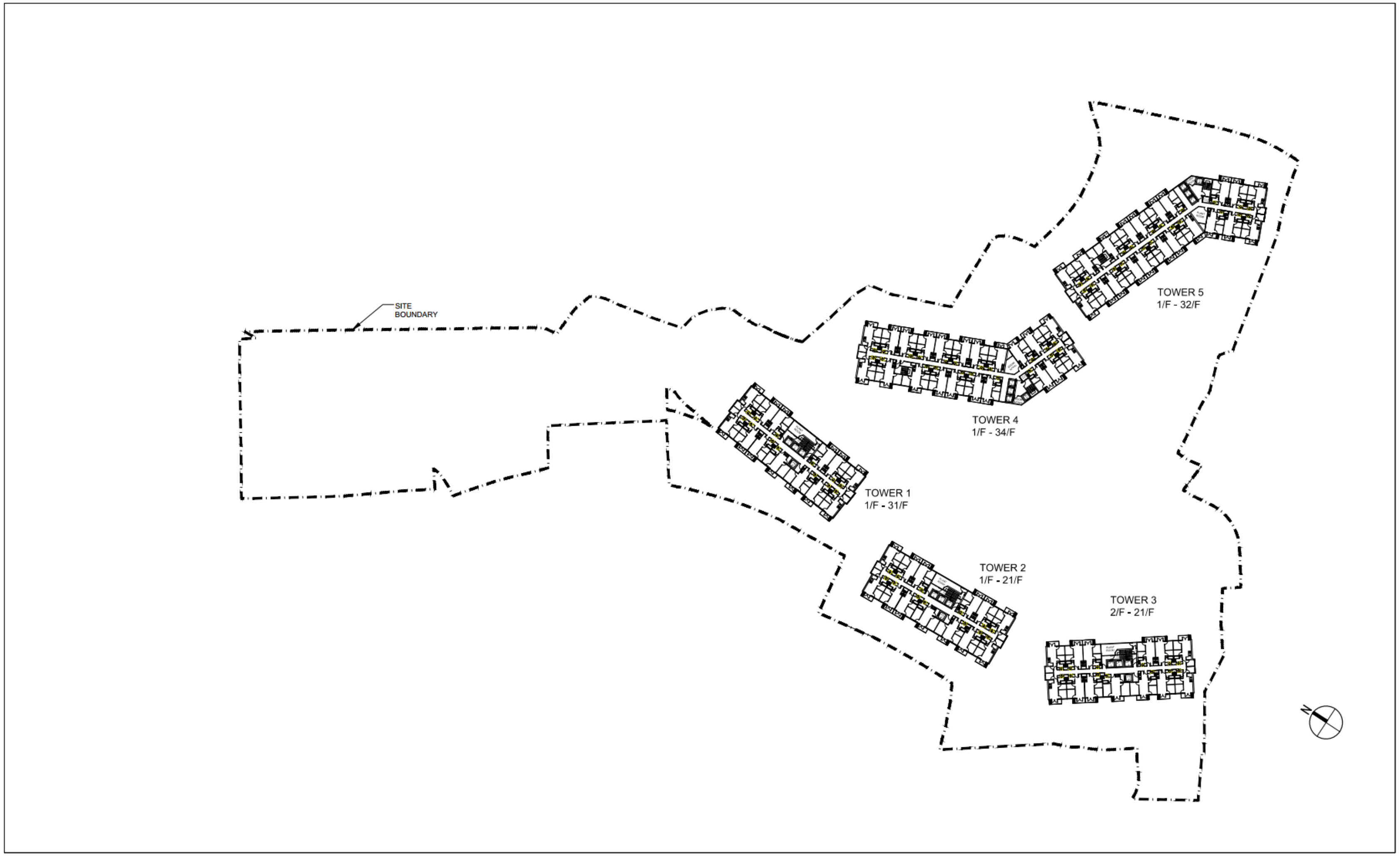
Website : www.mgdesignhk.com

Project Title: PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.

Drawing Title: MASTER LAYOUT PLAN TYPICAL FLOOR TYPE B

Project No. 22/HK/FL01
Issue Date. 13/12/2022
Cad File No. MLP.dwg
SCALE. 1 : 1000
Drawing No. A-P-107 (-)

Authority's / Client's Approval



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A	GENERAL REVISION	NC	DY	DY	26 / 08 / 22
B	GENERAL REVISION	NC	DY	DY	13 / 12 / 22

Rev	Description	Drawn	Checked	Approved	Date

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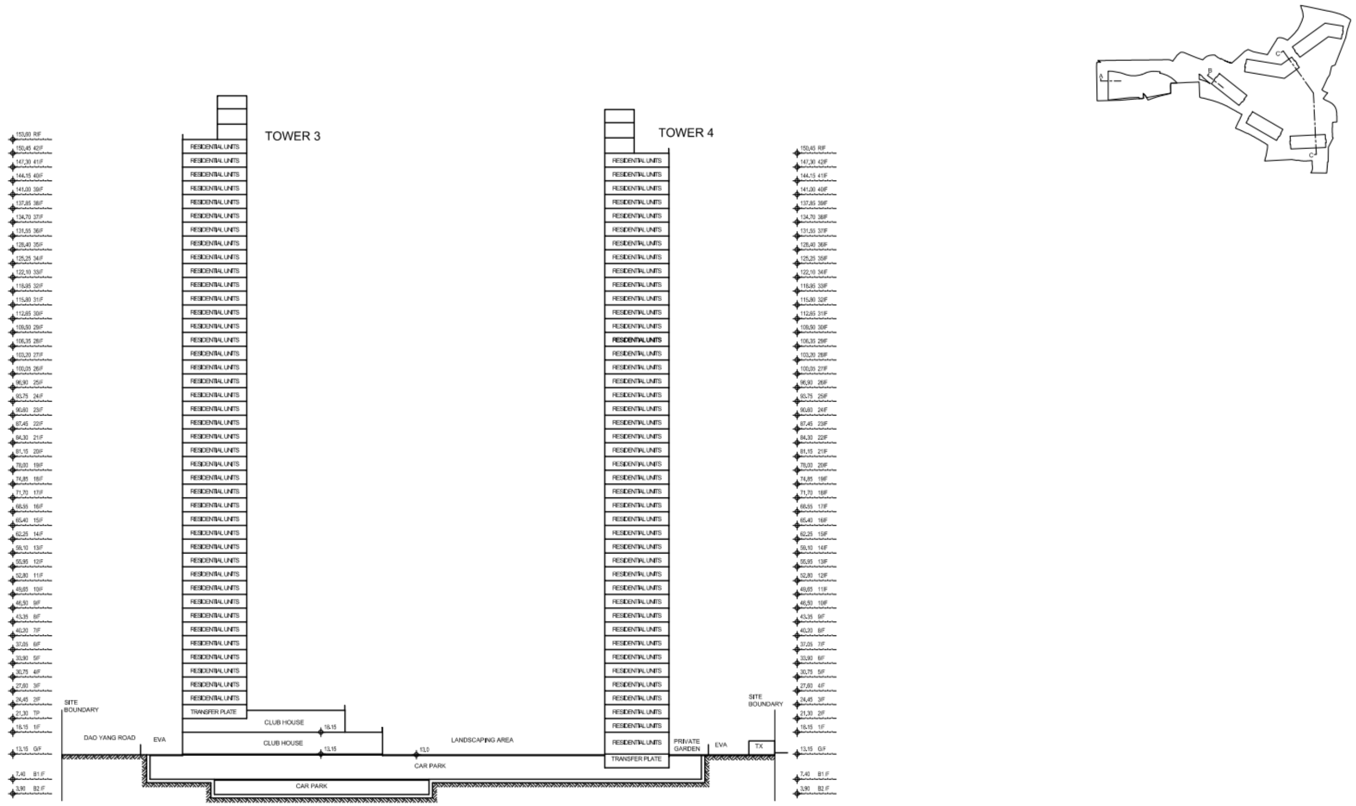
Project Title
PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.

Drawing Title
MASTER LAYOUT PLAN
TYPICAL FLOOR TYPE A

Project No.	Issue Date.
22/HK/FL01	08/08/2022
Cad File No.	MLP.dwg
SCALE.	1 : 1000
Drawing No.	A-P-106 (B)

Authority's / Client's Approval



SECTION C-C

Rev	Description	Drawn	Checked	Approved	Date
-	DESIGN DRAWING	NC	DY	DY	13/12/22

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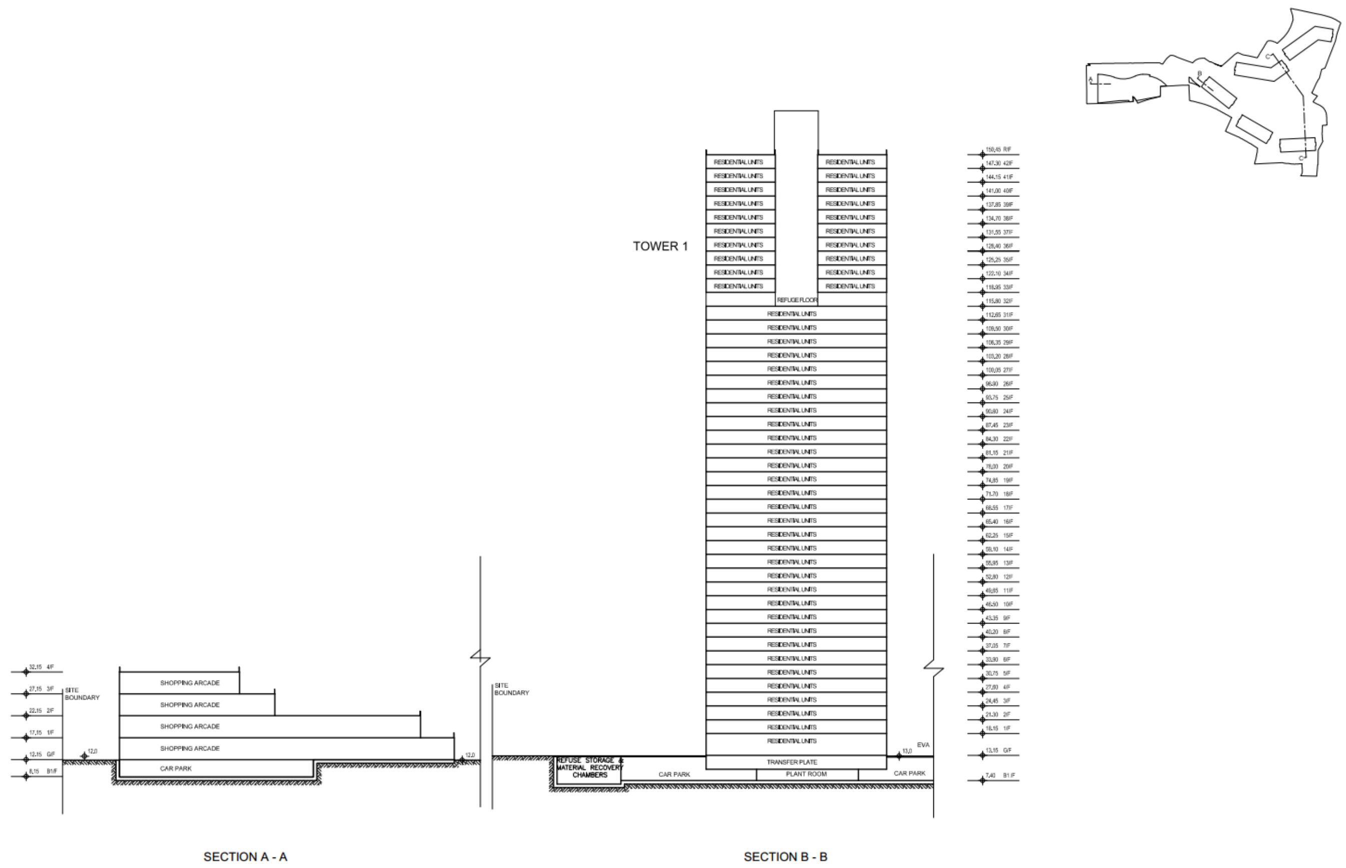
Project Title: PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.

Drawing Title: SECTION

Project No.: 22/HK/FL01
Issue Date: 13/12/2022
Cad File No.: section.dwg
SCALE: 1 : 1000
Drawing No.: A-S-102 (-)

Authority's / Client's Approval



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-	DESIGN DRAWING	NC	DY	DY	13/12/22						

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Project Title	Drawing Title	Project No.	Issue Date.	Authority's / Client's Approval
PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.	SECTIONS	22/HK/FL01	13/12/2022	
		Cad File No.	section.dwg	
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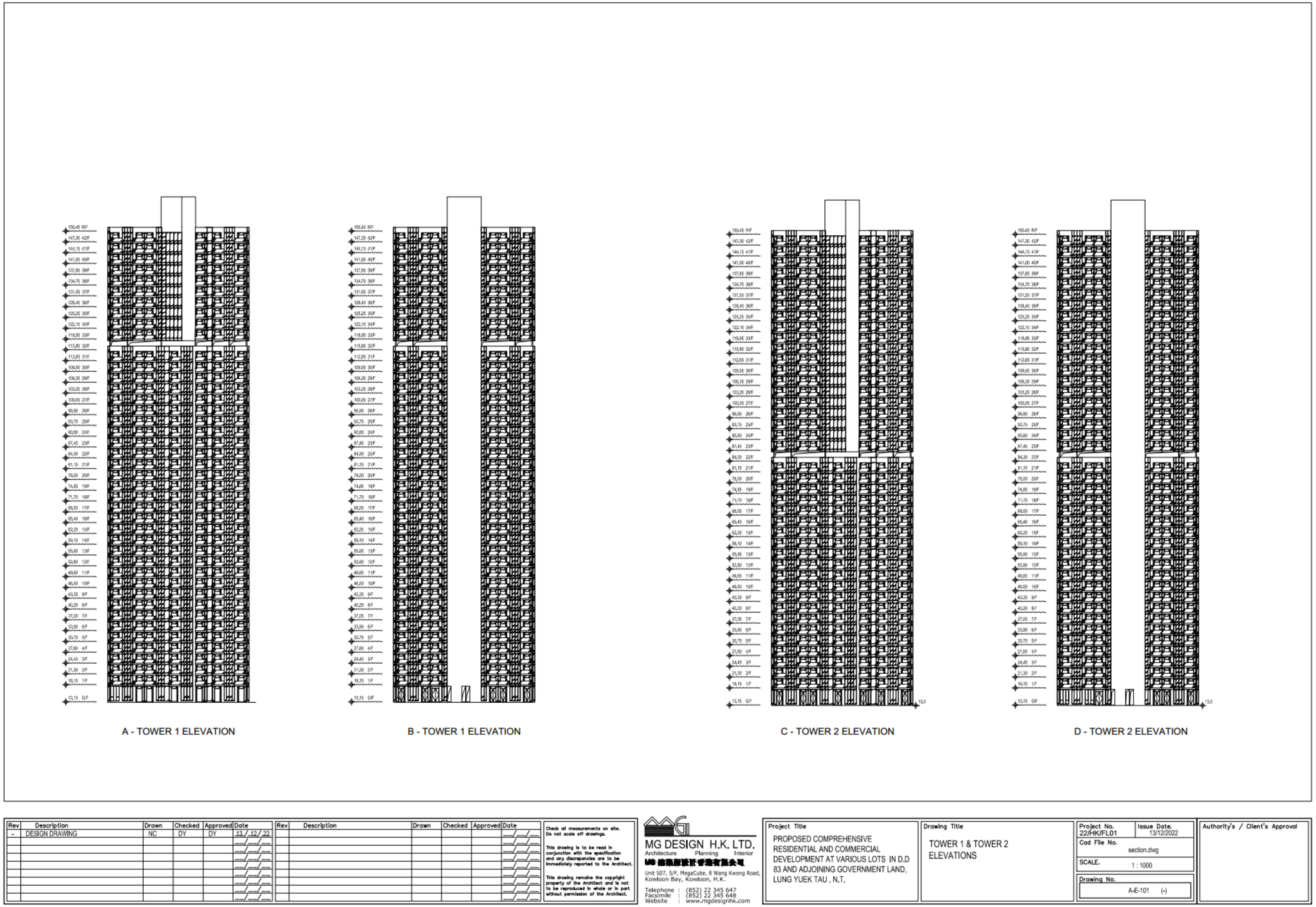
		Drawing No.	A-S-101 (-)	


A - TOWER 1 ELEVATION
B - TOWER 1 ELEVATION
C - TOWER 2 ELEVATION
D - TOWER 2 ELEVATION
Rev Description Drawn Checked Approved Date
- DESIGN DRAWING NC DY DY 13/12/22
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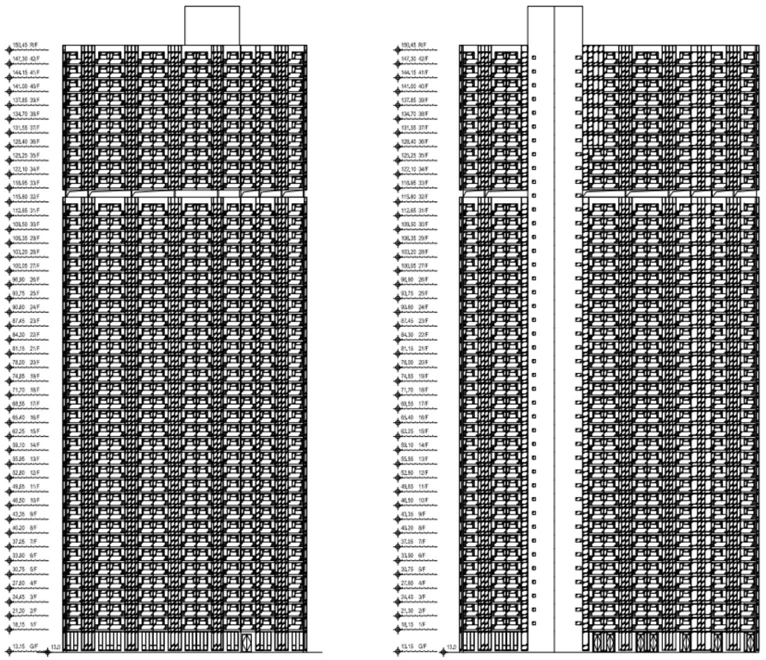
Website : www.mgdesignhk.com
Project Title
PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.
Drawing Title
TOWER 1 & TOWER 2 ELEVATIONS
Project No. 22/HK/FL01
Issue Date. 13/12/2022
Cad File No. section.dwg
SCALE. 1 : 1000
Drawing No. A-E-101 (-)
Authority's / Client's Approval



J - TOWER 5 ELEVATION

K - TOWER 5 ELEVATION

Rev	Description	Drawn	Checked	Approved	Date
-	DESIGN DRAWING	NC	DY	DY	13/12/22

Rev	Description	Drawn	Checked	Approved	Date

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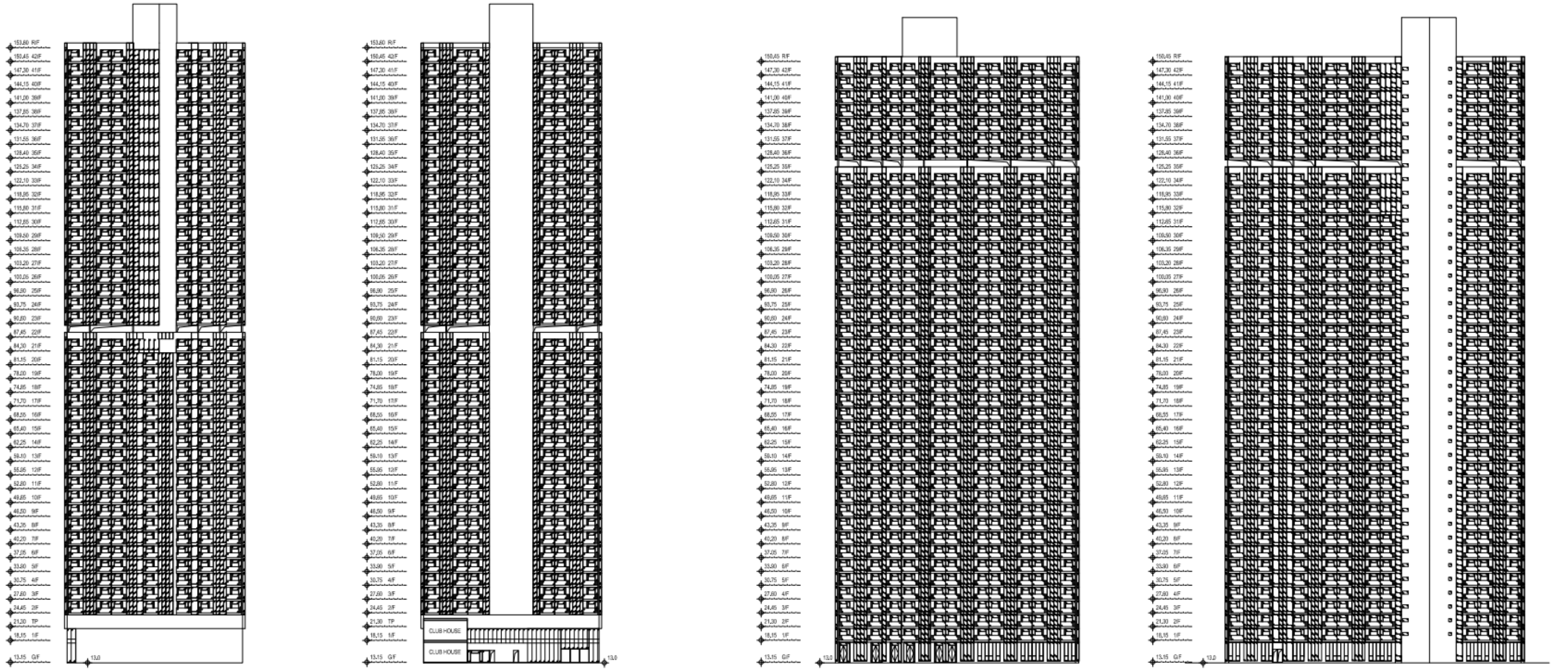
Project Title: PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.

Drawing Title: TOWER 5 ELEVATIONS

Project No.: 22/HK/FL01
Issue Date: 13/12/2022
Cad File No.: section.dwg
SCALE: 1 : 1000
Drawing No.: A-E-103 (-)

Authority's / Client's Approval



E - TOWER 3 ELEVATION

F - TOWER 3 ELEVATION

G - TOWER 4 ELEVATION

H - TOWER 4 ELEVATION

Rev	Description	Drawn	Checked	Approved	Date	Rev	Description	Drawn	Checked	Approved	Date
-	DESIGN DRAWING	NC	DY	DY	13/12/22						

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Project Title: PROPOSED COMPREHENSIVE RESIDENTIAL AND COMMERCIAL DEVELOPMENT AT VARIOUS LOTS IN D.D 83 AND ADJOINING GOVERNMENT LAND, LUNG YUEK TAU , N.T.

Drawing Title: TOWER 3 & TOWER 4 ELEVATIONS

Project No. 22/HK/FL01
Issue Date. 13/12/2022
Cad File No. section.dwg
SCALE. 1 : 1000
Drawing No. A-E-102 (-)

Authority's / Client's Approval

local people
global experience

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Enclosure | 4

Revised Sewerage Impact Assessment

SMEC
Member of the Surbana Jurong Group

local people
global experience

D02 Sewerage Impact Assessment

S12A Rezoning Application – Request for Amendment to the Lung Yeuk Tau and Kwan Tei South OZP from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A)2" Zone at Various Lots in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau, N.T.

Reference No. 7076933
Prepared for Carlton Woodcraft Manufacturing Ltd
4 June 2024

Document Control

Document:	D02 Sewerage Impact Assessment
Project Name:	S12A Rezoning Application – Request for Amendment to the Lung Yeuk Tau and Kwan Tei South OZP from “Residential (Group C)” Zone and “Agriculture” Zone to “Residential (Group A)2” Zone at Various Lots in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau, N.T.
Project Number:	7076933 | D02/01
Revision Number:	4

Revision History

REVISION NO.	DATE	PREPARED BY	REVIEWED BY	APPROVED BY
0	10 March 2023	Pinky LAM	Charls LIANG	Antony WONG
1	18 July 2023	Pinky LAM	Fred NG	Fred NG
2	2 November 2023	LUO, KAICHAO	Alex GBAGUIDI	Alex GBAGUIDI
3	3 April 2024	LUO, KAICHAO	Alex GBAGUIDI	Alex GBAGUIDI
4	4 June 2024	LUO, KAICHAO	Alex GBAGUIDI	Alex GBAGUIDI

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Important Notice

This report is confidential and is provided solely for the purposes of supporting S12A Rezoning Application – Request for Amendment to the Lung Yeuk Tau and Kwan Tei South OZP from "Residential (Group C)" Zone and "Agriculture" Zone to "Residential (Group A)2" Zone at Various Lots in D.D. 83 and Adjoining Government Land, Lung Yeuk Tau, N.T.. This report is provided pursuant to a Consultancy Agreement between SMEC Asia Limited ("SMEC") and Carlton Woodcraft Manufacturing Ltd, under which SMEC undertook to perform specific and limited tasks for Carlton Woodcraft Manufacturing Ltd. This report is strictly limited to the matters stated in it and subject to the various assumptions, qualifications and limitations in it and does not apply by implication to other matters. SMEC makes no representation that the scope, assumptions, qualifications and exclusions set out in this report will be suitable or sufficient for other purposes nor that the content of the report covers all matters which you may regard as material for your purposes.

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1 INTRODUCTION

1.1 Project Background

1.1.1 With reference to the latest policy address in developing the Northern Metropolis, it is aimed to optimise the use of land resources, adopt a higher development intensity and increase high-quality housing supply. In order to address the aforementioned needs, it is planned to redevelop a land with an area of approximately 22,445m^2 comprising various lots in D.D. 83, and the adjoining government land with an area of about 1,358m^2, Lung Yeuk Tau, New Territories, into proposed flat, shop and services and eating place ("the Site" or "the Proposed Development").

1.1.2 The Site is currently zoned "Residential (Group C)" ("R(C)") and "Agriculture" ("AGR") under the Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan ("OZP") No. S/NE-LYT/19. It is planned to develop a commercial complex for shop and services and eating place, and Residential Development comprising five blocks for domestic use. For the Proposed Development, it is proposed to amend the Site to "Residential (Group A)2" ("R(A)2") by submitting an application under Section 12A of the *Town Planning Ordinance* ("TPO").

1.1.3 In order to support the rezoning application, SMEC Asia Ltd ("SMEC") has been commissioned to prepare this Sewerage Impact Assessment ("SIA") Report to evaluate and assess impacts from the Proposed Development on the downstream public sewerage system. Effective mitigation measures to reduce any adverse sewerage issues identified will be recommended.

1.2 Site Description

1.2.1 The Site is located in a developed area in Lung Yeuk Tau, New Territories, which is a flat land used for workshop, storage and warehouses. Its northern part is currently occupied by a permanent domestic structure, temporary structures for open storage yards, storage of construction materials and workshops, open carparks and vacant land. The southern part is currently occupied for warehouse storage.

1.2.2 As shown on ***Figure 1-1***:, Sha Tau Kok Road (Lung Yeuk Tau) Section is located to the immediate north of the Site that runs along the northeast-southwest direction. Across the opposite site of Sha Tau Kok Road (Lung Yeuk Tau) Section, there are San Wai Barracks, a recycling centre and some warehouses. The Site is mainly surrounded by Tung Chun Soy Sauce factory place and some vegetated land to the east, Queen's Hill Estate to the south, village houses and warehouses to the west, intermixed with temporary structures, scattered vegetated and abandoned land.

1.3 Project Description

1.3.1 The Proposed Development will tentatively comprise a commercial complex and a Residential Development with the following components:

- Five Residential Blocks
- One Clubhouse
- One Swimming Pool
- One Commercial Complex
- One Sewage Treatment Plant ("STP")

1.3.2 The tentative intake year of the Proposed Development is 2031.

1.4 Objective of the Report

1.4.1 The objectives of this SIA are to:

- Assess the potential sewerage impacts arising from the Proposed Development.

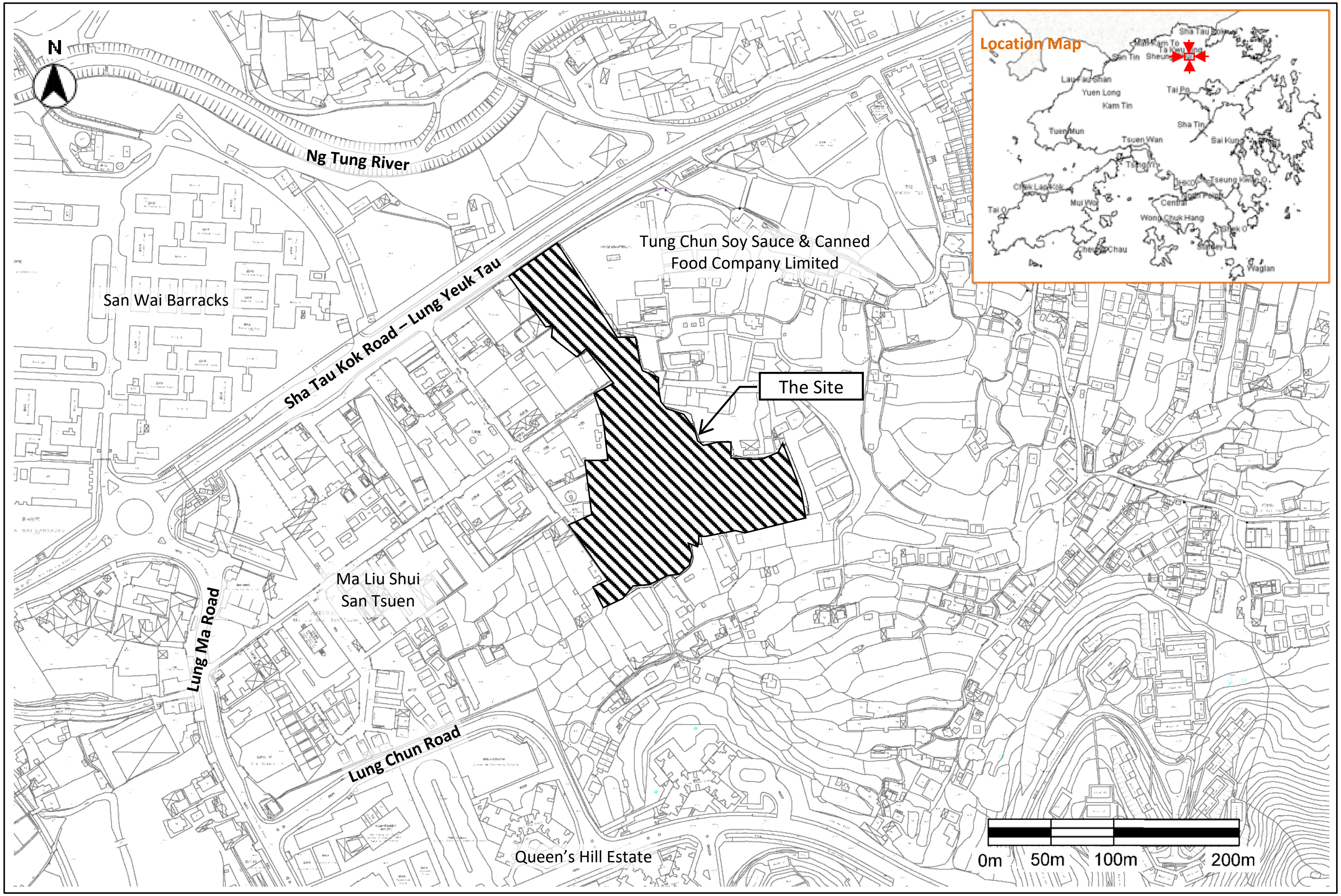
- Recommend the necessary mitigation measures to alleviate the impacts.

1.5 Reference Materials

1.5.1 In evaluating the sewerage impact arising from the Project, the following documents have been referred to:

- Drainage Services Department ("DSD") publication *Sewerage Manual (with Eurocodes incorporated) (Part 1) Key Planning Issues and Gravity Collection System, 3rd Edition, May 2013*
- Environmental Protection Department ("EPD") publication *Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Version 1.0, March 2005* ("GESF")
- GeoInfo Map (https://www.map.gov.hk/gm/) reviewed on 7 February 2023
- Water Pollution Control Ordinance (WPCO) Technical Memorandum Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters

Figure 1-1: Site Location and its Environs



2 EXISTING ENVIRONMENT AND BASELINE CONDITIONS

2.1 Existing Baseline Conditions

2.1.1 Based on the sewerage data of GeoInfo Map checked on 7 February 2023 and the sewerage layout plan shown on ***Figure 2-1***:, there is existing municipal sewerage system running along Sha Tau Kok Road (Lung Yeuk Tau) Section from the north of the Site and then to the northwest of it. Informed by EPD, the available spare flow capacity of sewage treatment system at Sha Tau Kok Road has been reserved for other planning purposes, and alternative sewage disposal scheme instead of discharging sewage into the sewerage system along Sha Tau Kok Road.

2.2 Sewerage Discharge for the Proposed Development

2.2.1 During the operation of the Proposed Development, the major sources of sewage will be the sewage generated by the staff and visitors of the commercial complex, the sewage generated by the residents and staff of the Residential Development, as well as the wastewater generated from the swimming pool of the club house.

2.2.2 Due to insufficient capacity of the existing public sewerage system, an on-site STP is proposed to treat the sewage generation from the Proposed Development. Two separated discharge system will be constructed for the proposed STP. One is for discharging the treated effluent from STP to the drainage channel along Sha Tau Kok Road, which will convey to Ng Tung River and eventually flow to Deep Bay. The other serve as an emergency discharge system to discharge the untreated sewage into the public sewer system under Sha Tau Kok Road in case the STP equipment experiences failure or malfunction. The estimated total daily sewage generation from the Proposed Development and capacities of the STP as well as the proposed discharge system are discussed in the subsequent sections.

Figure 2-1: Existing Sewerage Layout Plan

3 SEWERAGE ANALYSIS

3.1 Assumptions and Methodology

3.1.1 In order to assess the acceptability of the sewerage impact arising from the Proposed Development, the anticipated sewage generation has been estimated based on Environmental Protection Department ("EPD")'s *Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning* ("GESF") shown in ***Table 3-1***.

Table 3-1: Parameters for Estimating Wastewater Generation from the Proposed Development

PARAMETER	VALUE	REMARK
Generation from Residents of Residential Development		
No. of Residents	9,915	As advised by the Applicant.
Unit Flow Factor of Residents	0.270m^3/day/person	The unit flow factor for "Private R2" given in Table T-1 of GESF.
Generation from Staff of Residential Development		
Total Area	3,650m^2	Non-domestic GFA as advised by the Applicant.
No. of Staff	121	Worker density by All Type for "Community, Social & Personal Services" is 3.3 staff in 100m^2 as stated in Table 8 of Commercial and Industrial Floor Space Utilization Survey.
Unit Flow Factor of Staff	0.280m^3/day/staff	The unit flow factor for employees of "J11 Community, Social & Personal Services" + that for commercial employee given in Table T-2 of GESF. For J11, the "per-employee" unit flow factor takes into account the flows of customers and/or tenants.
Generation from Retail Staff of Commercial Complex		
Total Area	3,220m^2	As advised by the Applicant.
No. of Staff	113	Worker density by All Type for "Retail Trade" is 3.5 staff in 100m^2 as stated in Table 8 of Commercial and Industrial Floor Space Utilization Survey.
Unit Flow Factor of Staff	0.280m^3/day/staff	The unit flow factor for employees of "J4 Wholesale & Retail" given in Table T-2 of GESF + that for commercial employee.
Generation from Restaurant Staff of Commercial Complex		
Total Area	2,390m^2	As advised by the Applicant.
No. of Staff	120	Worker density by All Type for "Restaurants" is 5.1 staff in 100m^2 as stated in Table 8 of Commercial and Industrial Floor Space Utilization Survey.
Unit Flow Factor of Staff	1.580m^3/day/staff	The unit flow factor for employees of "J10 Restaurants & Hotels" + that for commercial employee given in Table T-2 of GESF. For J10, the "per-employee" unit flow factor takes into account the flows of customers and/or tenants.

PARAMETER	VALUE	REMARK
Generation from Swimming Pool of Clubhouse		
Total Area	$525m^2$	The tentative design of the swimming pool is provided by the Applicant.
Water Depth of Swimming Pool	1.25 m	As advised by the Applicant.
Time for Completely Changing Water	6 hours	CAP 132CA Swimming Pools Regulation.
Filtration Rate	40 m^3/m^2-hour	The average high-rate filtration for domestic pool [Note 1]
Backwash Rate	0.81 m^3/m^2-min	The maximum typical backwash rate for combined air-water backwash [Note 2]
Maximum capacity of Swimming Pool	175 persons	Determined from the rate of 1 person for every 3 square meters of water surface.
No. of shower heads	7 showers	One water closet shall be provided for every 25 persons in reference to Swimming Pool Licence Application Guideline. Client states one shower will be provided for each water closet.
Average maximum flow rate of shower heads	10 L/min	Based on Water Supply Department Domestic Water Consumption Survey 2015.
Sewage Generation per Shower Head	7.8 m3/day	The daily operation time of clubhouse is tentative assumed to be 13 hours.
Total Sewage Generation by the shower facilities in Clubhouse	54.6 m3/day	Divided from assuming shower under usage all the time in operation hours of Clubhouse
Others		
Catchment Inflow Factor	1.0	Catchment inflow factor for North District is adopted as stated in Table T-4 of GESF.
Peaking Factor	3 for contributing population below 10,000 2.5 for contributing population from 10,000 to 25,000 2 for contributing population from 25,000 to 50,000	Peaking Factor (excluding stormwater allowance) for Sewage Treatment Works, Preliminary Treatment Works and Pumping Stations with new upstream sewerage

Note:

1. The average high-rate filtration for domestic pool in Plumbing Engineering Services Design Guide - Domestic Swimming Pool
2. Wastewater Engineering - Treatment, Disposal, Reuse, 4th ed., Metcalf and Eddy

3.2 Proposed Sewage Treatment Plant and Discharge Arrangement

3.2.1 The calculation of the estimated sewage generation is provided in ***Appendix A***. The average dry weather flow from the Proposed Development is calculated to be 3005.4m^3/day during its commission stage. As the contributing population would reach 1,1131, and the peaking factor should be taken as 2.5 in accordance to GESF, the peak flow is estimated to be 7,513.6m^3/day.

3.2.2 Because of the constrain of the existing public sewer system mentioned in ***Section 2.1.1***, an on-site STP is proposed to handle the sewage from the Proposed Development. The STP is located at the B1/F of the shopping arcade of the proposed development. As the effluent will be discharged through the public drainage system, the treatment level of the proposed STP will be set to be tertiary treatment. The treatment process is tentatively proposed to be membrane bioreactor and ultrafiltration. The WPCO license standards for private tertiary sewage treatment plant (for discharge into Deep Bay) will be adopted as the effluent discharge standard for the proposed STP as shown in Table 3-2.

Table 3-2: Discharge Standards of the Effluent from Proposed STP

PARAMETER	UNIT	Tertiary Effluent Standards (Upper Limit)
BOD_5	mg/L	10
TSS	mg/L	10
TN	mg/L	20
TP	mg/L	2
Ammonia-N	mg/L	5
E.Coli	Counts/100 ml	100

3.2.3 The tentative schematic diagram of the proposed STP is presented in ***Figure 3-1***. The sewage generated from the residential buildings and shopping arcade will be collected in sewage storage tank. After the pre-treatment process in fine screen and grit separator, primary treatment process in dissolved air floatation system, secondary treatment process in membrane bioreactor and lastly tertiary treatment process in ultrafiltration system, the sewage will be treated into effluent that can satisfy the discharge standards mentioned above. Whenever it is necessary, the effluent will undergo chlorine dosage in the effluent tank as additional disinfection measure to suppress the bacteria count before discharging.

3.2.4 The design capacity of the proposed STP is 5,000m^3/day, which is 66% higher than the ADWF. The treatment demand between the design capacity and the peak flow will be covered by the 752m^3 sewerage storage tank, which can sustain 6 hours of ADWF and provide sufficient retention for the surplus sewage flow during the peak hours. The 66% excessive partition of design capacity over the ADWF will enable the rapid evacuation of the sewage storage tank during the non-peak hours and provide buffer to sustain the capacity loss due to the potential equipment damage.

3.2.5 As mentioned in Section 2.2.2, two separated discharge system will be constructed to connected the proposed STP to the public sewer system and drainage channel respectively. The location of the proposed STP and the alignment of the discharge system is shown in ***Figure 3-2***. During the normal operation, the treated effluent will be pumped through the effluent discharge system from the effluent tank of the proposed STP to the drainage channel SUP1001474 along Sha Tau Kok Road at the site boundary. If the STP experience equipment failure and malfunction, the sewage storage tank can provide a 6-hour retention time for emergency response. If emergency discharge is found necessary, the untreated raw sewage in the sewage storage tank will be pumped through the emergency discharge system to sewer manhole FMH1003633 on Sha Tau Kok Road, and discharge to the public sewerage system after agreeing with DSD about the discharge quantity and discharge flow rate. The remaining portion of sewage that could not be covered by the available capacity of public sewerage system will be collected by sewage suction truck.

3.2.6 Extensive effort will be expedited to avoid the occurrence for emergency discharge. In order to achieve this, the design of STP and associated pumping system will be cautiously reviewed to include additional provisions including as follows:

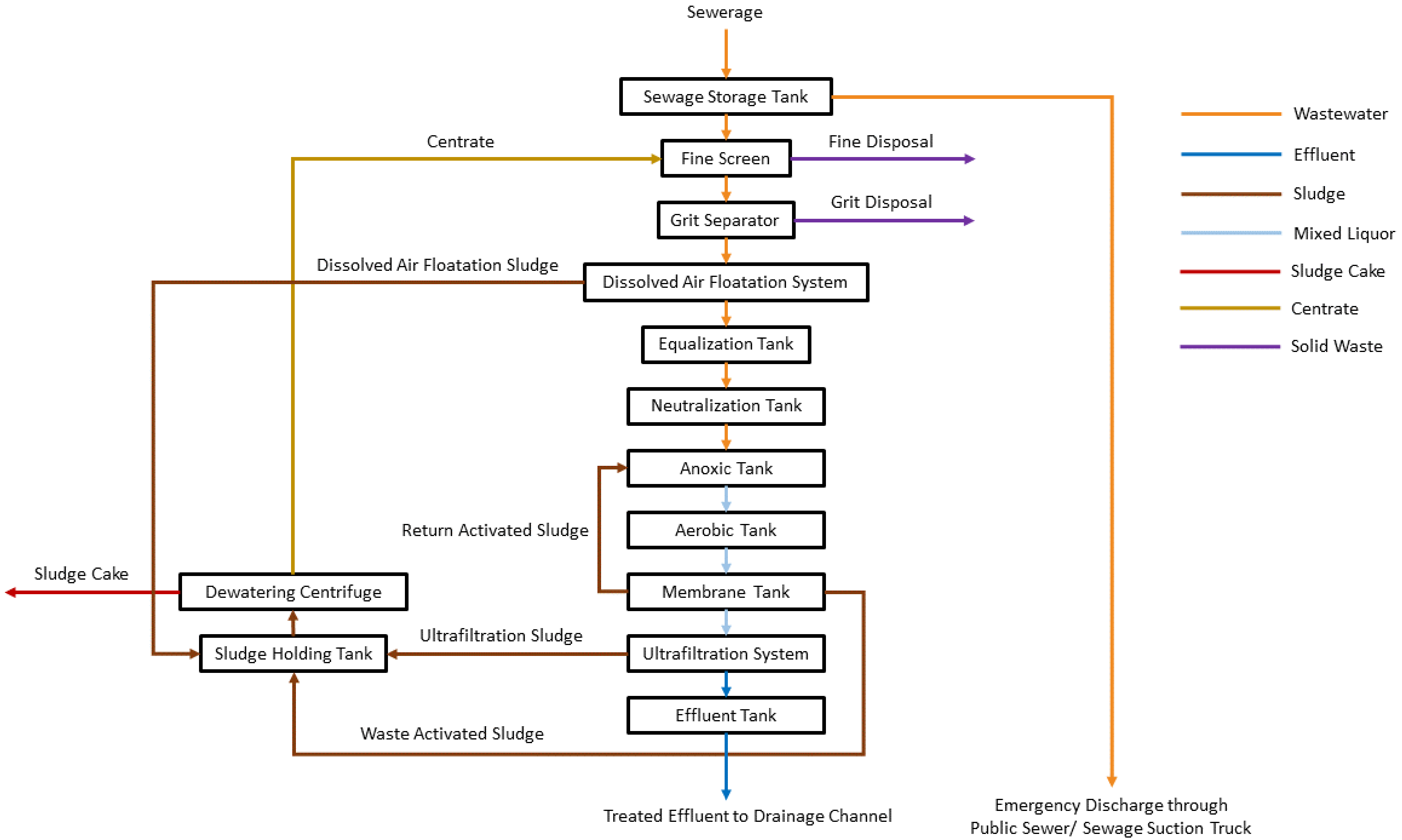
- Design capacity of proposed STP has been set to be 5,000m^3/day, which is 66% over the ADWF to sustain capacity loss due to potential equipment failure.
- Sewage Storage tank or equivalent facility with capacity of 752m^3 storage volume will be equipped to the proposed STP to provide sufficient retention time for the emergency response action.
- Standby pumps and treatment facilities would be provided in case of unexpected breakdown of pumping and treatment facilities such that the standby pumps and treatment facilities could take over and function to replace the broken pumps and treatment facilities;
- Uninterruptible power supply system will be installed to protect the proposed STP from power shutdown.
- Flow meter for pumps, level sensors for tanks, and gate valves for pipes shall be installed and connected with alarm signalizing system to keep monitoring on flow rate of each treatment system to avoid overflow.

3.2.7 To provide a mechanism to minimize the impact of emergency discharges and facilitate subsequent management of any emergency, Emergency Response Plan and Efficient Handling Management System will be formulated prior to commissioning of STP during the detailed design stage to set out the emergency response procedures and actions to be followed in case of equipment or sewage treatment failure or malfunction. The quantity percentage of sewage that will be discharged through the emergency discharge system should also be estimated and achieved consent with DSD before the commissioning of STP. The Developer will be responsible for the operation of the STP and the mitigation measures to be carried out inside the STP per the contingency plan to be prepared and agreed with EPD, DSD and relevant parties. Regular maintenances and inspections to all treatment system, mechanical works and dosing system are necessary to maintain a good operation condition.

3.2.8 Referring to the Outline Zoning Plan No. S/NE-LYT/19 Section 7, the on-site sewage treatment facilities should preferably be connected back to public sewerage network once completion of the full upgrade of Shek Wu Hui Sewerage Treatment Works and with sufficient capacity to accommodate the additional flow. Once the public sewerage system underneath Sha Tau Kok Road is updated and sufficient available capacity can be provided for the direct discharge from the proposed development, the project team can explore the opportunity of turning the emergency discharge system into a conventional sewerage connection system to convey the sewage from the proposed development to sewer manhole FMH1003633.

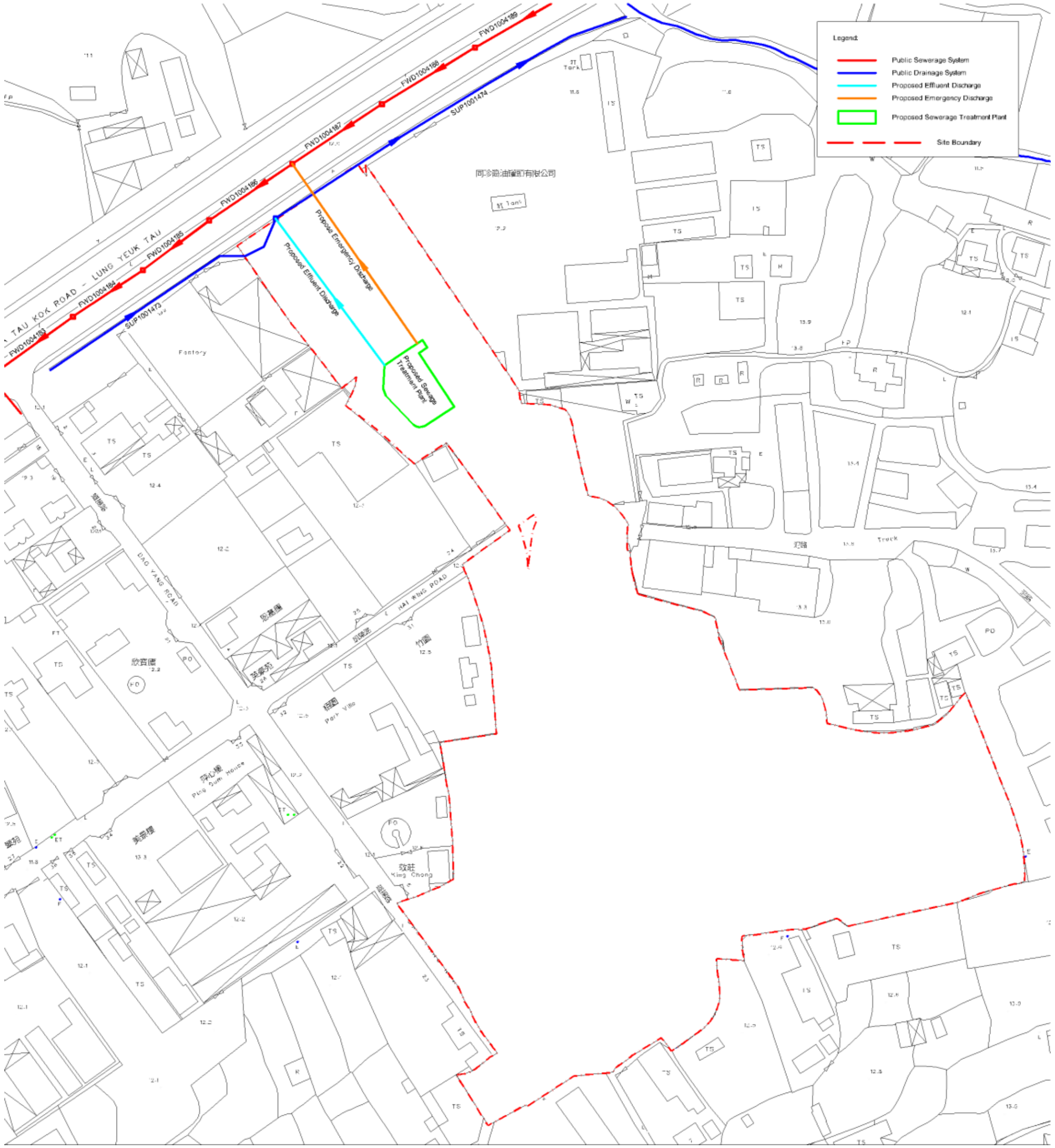
3.2.9 With the provision of the tertiary level on-site STP, the treated effluent from the STP will be treated to satisfy the WPCO license standards for private tertiary sewage treatment plant (for discharge into Deep Bay) before discharging into the stormwater drainage system while the emergency discharge is through the existing public sewerage system and sewage suction truck. No adverse sewerage impact from the Proposed Development is anticipated.

Figure 3-1: Tentative Schematic Diagram of Proposed Sewage Treatment Plant



Note: The chemical dosing system and mechanical works are omitted in this tentative schematic diagram.

Figure 3-2: Tentative Location of Proposed Sewerage Treatment Plant and Discharge Arrangement



4 CONCLUSION

4.1.1 It is proposed to develop the Site at various lots in D.D. 83, and the adjoining government land, Lung Yeuk Tau, New Territories, into proposed flat, shop and services and eating place. The Site is currently zoned “Residential (Group C)” (“R(C)”) and “Agriculture” (“AGR”) under the Lung Yeuk Tau and Kwan Tei South Outline Zoning Plan No. S/NE-LYT/19. This Sewerage Impact Assessment is carried out in order to support the Section 12A planning application for the Proposed Development.

4.1.2 The total estimated Average Daily Dry Weather (ADWF) flow from the Proposed Development is about 3,005.4 m^3/day. An on-site Sewage Treatment Plant (“STP”) with the capacity of 5,000m^3/day is proposed to handle the sewage arising from the Site. The effluent from the STP will be discharged to nearby stormwater drainage system and eventually reach Ng Tung River after tertiary treatment. And one additional discharge system will be connected to the public sewerage system serving as optional route for emergency discharge.

4.1.3 Overall, the sewerage analysis indicates that no unacceptable sewerage impact is anticipated with the provision of on-site STP and the proposed discharge arrangement.

Appendix A CALCULATION OF SEWAGE GENERATION DURING OPERATION OF THE PROPOSED DEVLOPMENT

Appendix A - Calculation of Sewage Generation

Calculation of Sewage Generation from the Proposed Development, Upstream and Downstream Catchments				Remarks/ Justification
Catchment 1 - Proposed Development				
2a) Sewage generated by the Residential Development				
i. Sewage generated by Residents of the Residential Development				
No. of Flats	=	3305	flats	As advised by the Applicant.
Total population in Proposed Residential Development	=	9915	persons	As advised by the Applicant.
Unit Flow Factor (UFF) per resident	=	0.27	m^3/day/person	Unit flow factor for Private R2 type in Table T-1 of Ref. 2.
Total Sewage Generation by the Residents of the Residential Development	=	2677.1	m^3/day	
ii. Sewage generated by Staff of the Residential Development				
Total Gross Floor Area (GFA) of non-domestic portion of Residential Development	=	3650	m^2	As advised by the Applicant.
Staff occupancy density	=	30.3	m^2/staff	Worker density Industry Group (All Type) for "Community, Social & Personal Services" is 3.3 staff in 100m^2 as stated in Table 8 of ref. 1.
No. of Onsite Staff (e.g. security, management office, clubhouse etc.)	=	121	staff	
Unit Flow Factor (UFF) per staff	=	0.28	m^3/day/staff	Refer to "Commercial Employee" + J11 "Commerical, Social & Personal Services" of Table T-2 of Ref 2.
Total Sewage Generation by the Staff of the Residential Development	=	33.88	m^3/day	
Total Sewage Generation by Residents and Staff for the Proposed Residential Development	**=**	**2710.9**	**m^3/day**	
2b) Sewage generated by the Commercial Complex				
i. Sewage generated by Staff of Retail Shops of the Commercical Complex				
Total Gross Floor Area (GFA) of Retail Shops of the Commercial Complex	=	3220	m^2	As advised by the Applicant.
Staff occupancy density	=	28.6	m^2/staff	Worker density Industry Group (All Type) for "Retail Trade" is 3.5 staff in 100m^2 as stated in Table 8 of ref. 1.
No. of Staff of Retail Shops	=	113	staff	
Unit Flow Factor (UFF) per staff	=	0.28	m^3/day/staff	Unit flow factor for "Commercial Employee + J4 Wholesale & Retail" in Table T-2 of ref. 2.
Total Sewage Generation by the Staff of Retail Shops of the Commercial Complex	=	31.6	m^3/day	
ii. Sewage generated by Staff of Restaurants of the Commercical Complex				
Total Gross Floor Area (GFA) of Restaurants of the Commercial Complex	=	2390	m^2	As advised by the Applicant.
Staff occupancy density	=	19.6	m^2/staff	Worker density Industry Group (All Type) for "Restaurants" is 5.1 staff in 100m^2 as stated in Table 8 of ref. 1.
No. of Staff of Retail Shops	=	122	staff	
Unit Flow Factor (UFF) per staff	=	1.58	m^3/day/staff	Unit flow factor for "Commercial Employee + J10 Restaurants & Hotels" in Table T-2 of ref. 2.
Total Sewage Generation by the Staff of Restaurants of the Commercial Complex	=	192.76	m^3/day	
Total Sewage Generation by Staff of the Commercial Complex	**=**	**224.4**	**m^3/day**	
2c) Sewage generated by the Clubhouse				
i. Sewage generated by Staff of Clubhouse				
Total Gross Floor Area (GFA) of the Clubhouse	=	3650	m^2	
Staff occupancy density	=	2.3	staff/100m^2	Worker density Industry Group (Private Commercials) for "Community, Social & Personal Services" is 3.3 staff in
No. of Staff of Clubhouse	=	84	staff	
Unit Flow Factor (UEF) per staff	=	0.28	m^3/day/staff	Unit flow factor for "Commercial Employee + J11 Community, Social & Personal Services" in Table T-2 of ref. 2.
Total Sewage Generation by the Staff at Clubhouse	=	23.52	m^3/day	
2d) Wastewater generated from Swimming Pool in the Clubhouse				
Approximate Area of Swimming Pool	=	525.4	m^2	Based on estimation from survey map.
Average Water Depth of Swimming Pool	=	1.25	m	As advised by the Applicant.
Approximate Size of Swimming Pool	=	656.7	m^3	
Time for Completely Changing Water	=	6	hours	The minimum turnover time in ref. 3.
Turnover Rate	=	109.5	m^3/hour	
Filtration Rate	=	40	m^3/m^2-hour	The average high rate filtration for domestic pool in ref. 4.
Filter Area	=	2.7	m^2	
No. of Filters used for Filtration	=	1		
Backwash Rate	=	0.81	m^3/m^2-min	The maximum typical backwash rate for combined air-water backwash in Table 11-12 of ref. 5.
Estimated flow from the Swimming Pool	**=**	**15.5**	**m^3/day**	7 minutes for cleaning the filter by backwashing water excluding the air scouring time is recommended in B8.5.5 of
	=	**0.18**	**l/s**	
Maximum Capacity of Swimming Pool	=	175	person	Determined from the rate of 1 person for every 3 square meters of water surface.
No. of shower heads	=	7	shower	One water closet shall be provided for every 25 persons in reference to Swimming Pool Licence Application
Average maximum flow rate of shower heads	=	10	L/min	Based on Water Supply Department Domestic Water Consumption Survey 2015.
Sewage Generation per Shower Head	=	7.8	m^3/day	The daily operation time of clubhouse is tentative assumed to be 13 hours.
Total Sewage Generation by the shower facilities in Clubhouse	=	54.6	m^3/day	Divided from assuming shower under usage all the time in operation hours of Clubhouse
Estimated flow from the Swimming Pool Shower Facilities	**=**	**54.6**	m^3/day	
	=	**0.63**	**l^3/s**	
Catchment Inflow Factor	=	1.0		Catchment inflow factor of North District, ref.1.
Average flow sewage generated from Catchment 1 (Proposed Development)	**=**	**3005.4**	**m^3/day**	
Contributing population	**=**	11131.3		
Peaking factor	=	2.5		Peaking factor for new sewage treatment work with contributing population from 10,000 to 25,000.
Peak flow of sewage generated from Catchment 1 (Proposed Development)	=	**7513.6**	**m^3/day**	

Note:

1 Commercial and Industrial Floor Space Utilization Survey, Planning Department, 2005
2 Environmental Protection Department (EPD) publication Guidelines for Estimating Sewage Flows (GESF) for Sewage Infrastructure Planning Version 1.0, March 2005.
3 CAP 132CA Swimming Pools Regulation
4 Plumbing Engineering Services Design Guide - Domestic Swimming Pool
5 Wastewater Engineering - Treatment, Disposal, Reuse, 4th ed., Metcalf and Eddy
6 General Specification for Swimming Pool Water Treatment Installation in Government Buildings of HKSAR, 2012 ed., Architectural Services Department

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