Geotechnical Control on Developments in Area Numbers 2 and 4 of the Scheduled Areas

North-western part of the New Territories and part of Ma On Shan area are designated as Area Numbers 2 and 4 of the Scheduled Areas in Schedule 5 to the Buildings Ordinance (BO) respectively. The plans delineated such areas are on display in the Buildings Department (BD) [1] and in the Geotechnical Information Unit of the Civil Engineering Library of the Civil Engineering and Development Department (CEDD). Location maps of these areas are shown in Figures 1 and 2 respectively at Appendix A.

2. This practice note describes geotechnical control measures in respect of building works in Area Numbers 2 and 4 of the Scheduled Areas (these Areas). It applies to submissions relating to ground investigation (GI), foundation design and construction, and any groundwater pumping proposed in these Areas. These measures are the industry's good practice developed since the discovery of the cavity problems. They are complementary to the Code of Practice for Foundations 2017 (Foundation Code) and Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers (PNAP) APP-18.

Ground Investigation

3. By virtue of section 41(3) of the BO, GI in these Areas require approval from the Building Authority (BA). Plans of any proposed GI in these Areas prescribed under regulation 8(1)(l) of the Building (Administration) Regulations (B(A)R) should therefore be submitted to BA for approval and consent from BA should be obtained before the commencement of the GI.

4. Authorized persons (AP), registered structural engineers (RSE) and registered geotechnical engineers (RGE) are advised to ensure that GI works are carried out to a high standard and are properly supervised. Guidance on GI may be obtained from Geoguide 2 - Guide to Site Investigation [2] issued by the Geotechnical Engineering Office (GEO) of CEDD. It is advisable to employ competent registered specialist contractors with sufficient relevant experience who are capable of producing high quality work.

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[1] Available for inspection in BD's Building Information Centre and viewing in BD website https://www.bd.gov.hk/en/resources/codes-and-references/scheduled-areas/index.html.

[2] Available in CEDD website www.cedd.gov.hk.

5. The site supervision requirements and the minimum qualifications and experience of the supervisory personnel and the Competent Person (Logging) for GI field works are given in Code of Practice for Site Supervision 2009. The cores recovered should be examined and properly logged by a Competent Person (Logging). Guidance on this aspect can be found in Geoguide 3 - Guide to Rock and Soil Descriptions [2] issued by GEO. Attention should be given to logging the location and size of the cavities, the nature of the cavity wall and the infill, together with rock discontinuities. Fracture indices including total core recovery, solid core recovery, rock quality designation and fracture index should be shown on the drill logs.

6. Considering the special ground conditions in these Areas, GI is best carried out in stages. It should be adequate to ascertain whether marble with cavities exists beneath the site, and allow an assessment of whether the cavities will affect the proposed development. Some deep drillholes will be required for this purpose. Cavities in marble, and related geological structures, may follow certain trends, and inclined boreholes may provide useful information if the dominant trend is vertical or near vertical. Geophysical survey may also provide additional information between drillholes. All drillholes should be grouted on completion of the GI works.

7. It is advisable to carry out the initial stages of GI prior to the finalisation of general building plans for the site because, in certain circumstances, adjustments to the locations of certain structures may be the most economical means of dealing with serious geological problems posed by cavities.

8. The depths of drillholes should be determined by considering the depth of marble bedrock and the magnitude of the load to be applied by the structure. If marble is encountered, a minimum penetration of 20 m into sound marble rock is recommended in order to reduce the risk of existing cavities not being identified. Where cavities are encountered in the hole being drilled or in adjacent drillholes, increasing the depth of penetration is necessary. The use of water as a flushing medium should be carefully controlled as there have been cases where sinkholes were induced by excessive use of flushing water. High quality core samples of the cavity infill can be obtained by using triple-tube core-barrels with air foam as the flushing medium. The intensity and depth of drillholes for each site will be governed by the nature of the structures proposed, the foundation loading and the ground conditions encountered.

9. Further investigation will normally be required once the layout of the development and the locations of piles have been decided. Some drillholes at the edges of the main pile foundation area may be required, since cavities at the edges are likely to be more detrimental than cavities at the inner part of the foundation area itself.

10. Discussion with the relevant district Chief Geotechnical Engineer of GEO before a ground investigation proposal is finalised may allow the optimum drillhole layout to be adopted and could expedite approval of foundation plans. With regard to the requirements of regulation 20 of the B(A)R, at least two weeks prior notification of the intention to commence GI works in these Areas should be given to the relevant district Chief Geotechnical Engineer.

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11. Prior to substantial completion of all building works of the development project, all cores and samples should be retained on site in good condition for inspection by the officers of BD and GEO.

Foundation Design

12. For the design of foundation, the guidelines and requirements provided in the Foundation Code should be followed.

13. Driven or machine-bored piles will usually provide the most suitable foundation for heavily loaded structures on sites underlain by marble. Hand-dug caissons require dewatering, which might be difficult and could induce the formation of sinkholes. PNAP APP-59 also restricts the use of hand-dug caissons.

14. When driven piles are to be used, these should be of a suitably heavy section to withstand hard driving and with modified or strengthened tips. The modified section should allow the piles to be driven through and beyond any cover or rock bridging over shallow cavities or thin overhangs, and to prevent the piles deflecting where the marble surface is inclined. Pre-drilling may be necessary when very deep rock surfaces are expected or when piles have to penetrate thick karst zones. As it is not possible to determine the exact extent and configuration of subsurface cavities or overhang under each pile, the pile layout cannot be adjusted to suit all these features. It is, therefore, necessary to increase the number of piles used above the minimum so that, where cavities may lead to local lack of support, the surplus piles can then carry the redistributed load without being overstressed. It is necessary to consider this in the pile cap design.

15. When high capacity bored piles or barrettes are proposed, the effect of cavities below both the plan position of each pile or barrette and the surrounding area should be considered in the choice of founding level and allowable bearing capacity. Adequate drillholes should be sunk and, where appropriate, probing should be carried out to detect the presence of cavities, if any, within the zone significantly stressed by the piles.

Supporting Documentation to Accompany Foundation Plans

16. The supporting documentation prescribed under regulation 8(1)(d)(ii) of the B(A)R should accompany foundation plans for building works in these Areas to be submitted to BA for approval, and submissions not in compliance with this requirement may be refused under section 16(1)(a) and 16(1)(i) of the BO.

Foundation Construction

17. Where driven piles are used as foundations, the piling reports submitted to BD should include the complete blow count records throughout pile driving. These should be presented in the form of blows per 500 mm where driving is easy, reducing to blows per 100 mm where driving is hard. The blow count should also be plotted against depth of penetration for each pile, in terms of blows per 100 mm. It is suggested that the dividing point between ‘easy’ and ‘hard’ driving should be at 10 blows per 100 mm.

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18. The deviation of each driven pile from its initial position should also be surveyed.

19. In karst areas, there is always the risk despite conservative design, that foundation problems might arise, e.g. buckling of piles during driving, and reactivation of sinkholes or collapse of cavities during piling or foundation construction. The RSE and RGE should therefore review the ground conditions experienced during foundation construction. Pile driving and other foundation construction records should be assessed at close intervals and the necessity or otherwise of modifying the design should be considered.

20. Trial piling and instrumentation of piles may be necessary in karst areas. General requirements on proof tests on piles are given in the Foundation Code. Other non-destructive tests may have to be carried out on piles which are suspected to have deflected or have defects or there are anomalies in the pile driving records.

Submission of a Performance Review

21. Consent to commence superstructure works may be refused under section 16(3)(ba) of the BO if any required performance review as mentioned in clause 7.8 of the Foundation Code fails to demonstrate that the foundation works have been adequately inspected and the construction records adequately assessed in the course of construction, or that any necessary changes in the design have been undertaken and plans suitably amended and approved.

Monitoring

22. When settlement monitoring of the foundation works is required by BA, AP/RSE/RGE should also submit the proposed monitoring scheme, including the type, installation and location of the monitoring points and the survey method including the choice of datum point, to BA for agreement prior to the completion of the foundation works.

23. The results, together with an assessment of the monitoring mentioned in clause 7.8 of the Foundation Code and paragraph 22 above should be submitted to BD on a monthly basis. Any unusual or significant settlement or impact should be brought to the attention of BD immediately.

24. It should be noted that, where appropriate, GEO will take over and continue the monitoring for a period following the granting of an occupation permit.

25. AP/RSE/RGE should note that buildings founded in weathered siltstones and sandstones above marble may also encounter difficulties. They are encouraged to monitor the settlements and impacts during the construction of these buildings and to bring any unusual settlements to the attention of BD immediately.

Wells

26. Where any well is proposed within these Areas, application to BA for approval should be accompanied by a submission prepared by an RGE demonstrating that groundwater extraction will not adversely affect the site and the surrounding areas.

27. As mentioned in paragraph 10 of PNAP APP-4, the Water Authority has agreed that flushing water will normally be supplied whenever possible within these Areas, which at present include Yuen Long Town in Area Number 2 and Ma On Shan in Area Number 4 of the Scheduled Areas.

Reference Information

28. A considerable amount of information exists on the geology of these Areas. For Area Number 2 of the Scheduled Areas, twenty 1:5000 Geological Map sheets are available, together with an account of the geology as Hong Kong Geological Survey Sheet Report No. 1 - Geology of Yuen Long. For Area Number 4 of the Scheduled Areas, a 1:5000 Geological Map sheet is available, together with an account of the geology as Hong Kong Geological Survey Sheet Report No. 5 - Geology of Ma On Shan. A copy of the Sheet Reports can be obtained free of charge from the Planning Division of GEO. A copy of the 1:5000 Geological Map sheets can be purchased from Map Publications Centre, Survey and Mapping Office of the Lands Department.

29. Supplementary guidelines for foundation design in areas underlain by marble and marble-bearing rocks are given in GEO Technical Guidance Note No. 26 [2]. The updated sources of information on site investigation are given in GEO Technical Guidance Note No. 5 [2]. Furthermore, a review of the principles and practices related to the design and construction of piles in Hong Kong is provided in GEO Publication No. 1/2006 [2].

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Appendix A
(PNAP APP-61)

Scheduled Area for Northwestern Part of New Territories

(The area is designated as Area Number 2 of the Scheduled Areas in Schedule 5 to the BO)

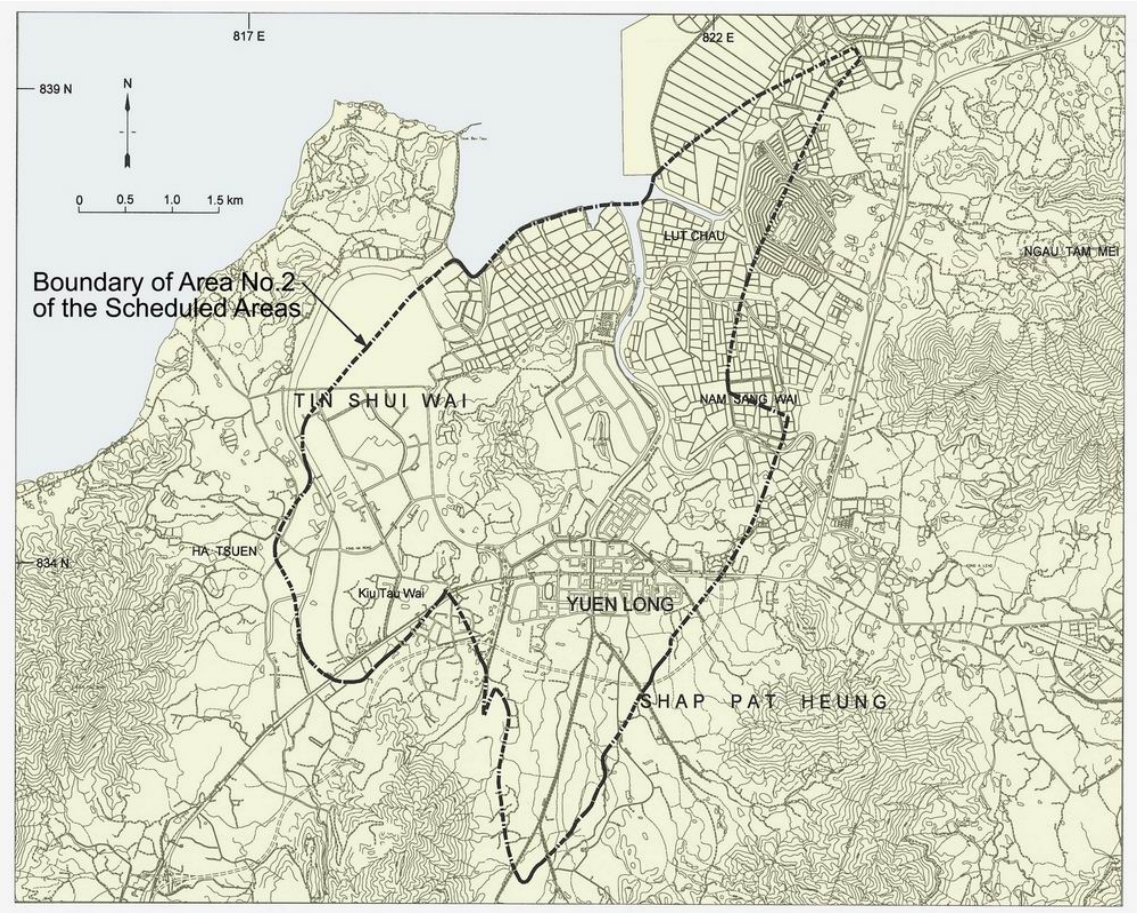

Figure 1

Scheduled Area for Ma On Shan

(The area is designated as Area Number 4 of the Scheduled Areas in Schedule 5 to the BO)

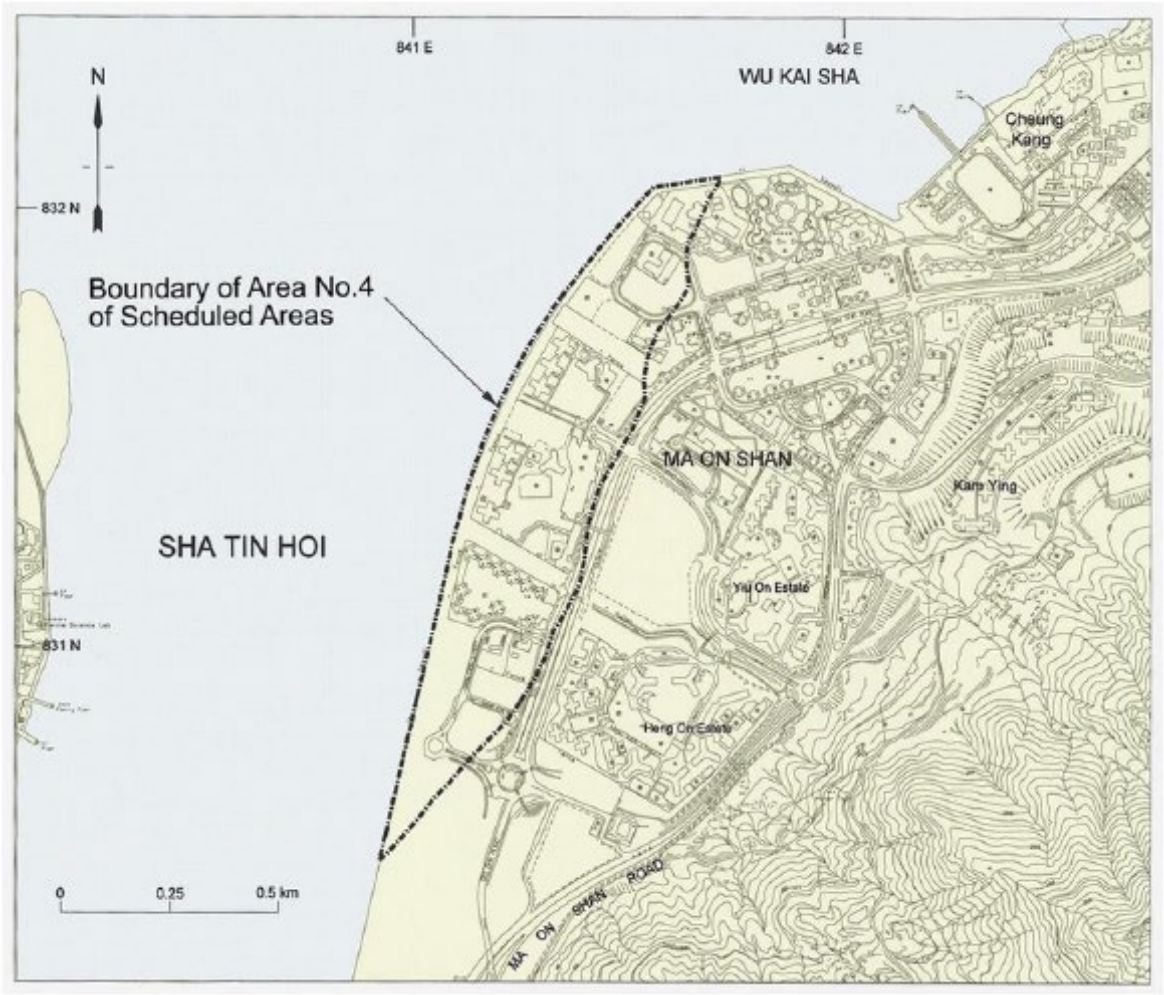

Figure 2

(Rev. 2/2021)