

MTR Announces Phased Opening of Tuen Ma Line Covering Hin Keng, Diamond Hill and Kai Tak stations

After completing a detailed feasibility study, the MTR Corporation recommends and the Hong Kong Special Administrative Region Government (“Government”) accepts that phased opening of the Tuen Ma Line (“TML”) under the Shatin to Central Link (“SCL”) project, covering three new stations at Hin Keng, Diamond Hill and Kai Tak is feasible with a target opening in the 1st quarter of 2020.

The Corporation has also submitted to Government today (18 July 2019) the report on the holistic assessment study for Hung Hom Station Extension, and the report on the verification study on as-constructed conditions of the North Approach Tunnels (“NAT”), South Approach Tunnels (“SAT”) and Hung Hom Stabling Sidings (“HHS”), all being parts of the SCL project.

“There has been much public concern over the construction issues relating to the SCL, which have delayed the opening of this project so eagerly awaited by the local communities. Under the proposed arrangements, three new stations along the TML are planned to open for passenger service in the 1st quarter of 2020 while continued efforts will be made to complete the rest of the TML as soon as possible,” said Dr Jacob Kam, Chief Executive Officer of MTR Corporation.

The Corporation is now undertaking necessary system modifications works, including adjustment of the signalling system, some re-cabling works, and modifications to some of the signage, which will allow the opening of the first phase of TML covering Hin Keng, Diamond Hill and Kai Tak stations, once all statutory processes have been completed.

Upon opening of this first phase of the TML, passengers travelling on the Ma On Shan Line will be able to travel directly to Kai Tak Station in East Kowloon district via Hin Keng Station and Diamond Hill Station. The expanded Diamond Hill Station will become a new interchange between the TML and the Kwun Tong Line, allowing passengers from New Territories North and East districts to interchange for rail services to the East Kowloon district and Hong Kong Island East district. This will reduce train travelling time and also relieve the current peak link on the East Rail Line between Tai Wai and Kowloon Tong stations.

As regards the two final reports prepared by the Corporation on verification and assurance of the platform slabs and diaphragm walls of the Hung Hom Station Extension as well as the as-constructed conditions of NAT, SAT and HHS, they have been carefully reviewed and the conclusions therein have been accepted by Government and its Expert Advisor Team. The reports conclude that the structures are safe for the purpose of the ongoing construction activities, but suitable measures should be implemented to address deficiencies and achieve code compliance. Subsequently, a long-term monitoring scheme will be developed to monitor the on-going structural integrity of the structures. Since it would take time to complete the suitable measures, the Corporation recommends and Government agrees that phased opening of Tuen Ma Line should be implemented.

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“Safety and quality of railway projects are of top priority to the MTR Corporation. We have completed a detailed verification of the Hung Hom Station Extension and related works based on methodologies agreed with Government. Given we have agreed the conclusions of the two reports with Government we will now proceed with the implementation of the suitable measures. I believe this is a pragmatic way to take forward the project and restore public confidence in our railway projects,” said Mr Roger Bayliss, Projects Director of MTR Corporation.

Details of the suitable measures at the platform slabs and tunnel structures under the Hung Hom Station Extension as well as HHS are subjected to detailed design and acceptance from Government, which is expected to take 4 to 6 months to complete. Subsequent to obtaining the necessary acceptance from Government, the suitable measures are expected to take 9 to 12 months to complete on site.

“The Corporation is disappointed with the workmanship issues that have been uncovered at the Hung Hom Station Extension and adjacent structures. We reserve our rights to take action against the contractor of the relevant works in accordance with the terms of the contract,” said Mr Bayliss.

The Corporation has also completed an audit of key documentation for the other five TML new stations. Audit results, which have been reviewed by Government, show that 90% of the structure related Request for Inspection and Survey Check forms are available; while supplementary evidence, such as photographs and site diaries, fill the gaps.

“On the basis that the Corporation is in the process of negotiating an overall settlement with Government on the SCL project (including the Hung Hom related incidents, costs and other issues) and to facilitate the phased opening of the TML, we will fund the costs associated with the verification and assurance exercises and implementation of the suitable measures at the Hung Hom Station Extension and adjacent structures, as well as the costs for the preparation and implementation of phased opening, which are estimated to be around HK\$2 billion. MTR will continue discussions with Government with a view to reaching an overall settlement in relation to the Hung Hom related incidents, phased opening, related costs as well as the overall cost to complete,” said Dr Kam. “We will continue to use our best endeavours to bring SCL to fruition to serve the public.”

The executive summary of the Final Report on Holistic Assessment Strategy for the Hung Hom Station Extension and the Final Verification Study Report on As-Constructed Conditions of the NAT, SAT and HHS are attached. The two full final reports (English version only) can be found at SCL project website (www.mtr-shatincentrallink.hk). Please also see details in the Corporation’s Stock Exchange announcement.

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Every day, MTR connects people and communities. As a recognised world-class operator of sustainable rail transport services, we are a leader in safety, reliability, customer service and efficiency.

MTR has extensive end-to-end railway expertise with more than 40 years of railway projects experience from design to planning and construction through to commissioning, maintenance and operations. Going beyond railway delivery and operation, MTR also creates and manages dynamic communities around its network through seamless integration of rail, commercial and property development.

With more than 40,000 dedicated staff*, MTR carries over 12 million passenger journeys worldwide every weekday in Hong Kong, the United Kingdom, Sweden, Australia and the Mainland of China. MTR strives to grow and connect communities for a better future.

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Final Report on Holistic Assessment Strategy for the Hung Hom Station Extension

Executive Summary

1. In May 2018, there were allegations in the media about threaded steel bars being cut during the steel fixing works and workmanship in the connection of threaded steel bars and couplers at the East West Line (“**EWL**”) slab connection with the diaphragm walls (“**D-walls**”) at the Hung Hom Station (“**HUH**”) Extension works under Contract No. 1112. The overall layout plan of the HUH Extension is shown in **Appendix A1**.

2. In addition, there have been concerns that Leighton Contractors (Asia) Limited (“**Leighton**”), the main contractor, has adopted revised slab to D-wall connection details which were different from the design drawings accepted by the Building Authority (“**BA**”). In light of these allegations, the MTR Corporation Limited (“**MTRCL**”) prepared and submitted a Holistic Proposal to the Railway Development Office (“**RDO**”) in December 2018 to verify the as-constructed conditions and workmanship quality of the HUH Extension and to provide assurance on the structural integrity of the works. The Holistic Proposal consists of three stages.

Stage 1 - Desktop Exercise

3. Stage 1 involves the collation of construction records and the verification of the as-constructed details of EWL slab and D-wall connections. Where there are gaps identified in the objective evidence or review process indicating uncertainties in the as-constructed details, site examinations and tests would be conducted to verify the as-constructed conditions.

4. In December 2018, after reviewing all the information and construction records available in comparison with the amendment drawings (as-constructed) prepared by Leighton, a total of 24 locations of EWL slab to D-wall connections were required to be opened up for further verification of the available records or evidence to demonstrate the accuracy of the as-constructed conditions shown in the contractor’s amendment drawings (as-constructed).

Stage 2 – Physical Investigation

5. Stage 2 comprises four parts as described below.

Stage 2a

6. Stage 2a involves the opening-up works (i.e. Purpose (i)) to verify the as-constructed conditions of EWL slab and D-wall connections against the relevant contractor's amendment drawings (as-constructed). The physical works commenced in December 2018 and were completed in April 2019. Through the verification process, eight out of 24 D-wall panel locations were found to be inconsistent with the contractor's amendment drawings (as-constructed). The results revealed that there were some inaccuracies in the drawings which suggest deficiencies in the drawing amendment process during construction. Some site changes were not properly recorded and/or updated in the contractor's amendment drawings (as-constructed). These Stage 2a findings will be incorporated in the amendment drawings for onward submission to the Government.

7. The engagement of the couplers exposed in the Stage 2a opening-up works has been checked by physical inspection and/or the Phased Array Ultrasonic Test ("**PAUT**"), which is a Non-Destructive Test ("**NDT**").

Stage 2b

8. Stage 2b involves the opening-up (i.e. Purpose (ii)) of randomly selected steel bar/coupler connections at the EWL and North South Line ("**NSL**") slabs for further physical inspection and/or examination using PAUT, and assessment of the possible defective rate of coupler connections based on statistical principles. In line with the statistical sampling requirements, not less than 84 randomly selected steel bar/coupler connections each for the EWL and NSL slabs had to be examined to assess the defective rates with a 95% confidence level. The Holistic Proposal proposed using binomial statistics to analyse the overall impact of the observed coupler connections. Binomial statistics allow results to be either a "fail" or a "pass" against the agreed criteria. As set out in Section 6.4 of the Holistic Proposal, samples which do not meet the agreed criteria are treated as failures and described as defective (see Clause 6.4.21 of the Holistic Proposal). The question of whether the works should be regarded as defective under the contract will be determined in accordance with the terms of such contract.

9. For this purpose, 28 locations with a minimum of 84 samples at each of the EWL and NSL slabs were randomly selected. The opening-up works commenced in December 2018 and all the PAUT were completed in April 2019.

10. A total of 102 and 99 samples at EWL and NSL slabs respectively have eventually been examined. Among these, 90 and 93 samples at the EWL and NSL slabs respectively yielded valid results for statistical analysis. For the purpose of Stage 2b, engagement lengths found to be less than 37 mm by PAUT or 40 mm by direct measurement are treated as not complying with the manufacturer's installation requirements and are considered as defective. 25 out of 90 samples at the EWL slab and 23 out of 93 samples at the NSL slab were defective. Based on the binomial analysis, it is estimated that, with a 95% confidence level, not more than 36.6% and 33.2% of couplers at the EWL and NSL slabs respectively are considered defective.

11. As couplers exposed in Stage 2a are not randomly selected samples, their PAUT results are not included in the statistical analysis.

12. The 48 defective samples include eight cases where the main reinforcement bars were not connected to the couplers, and five cases where the bars would appear to have been cut. These findings indicate that the cutting of the threaded ends of rebar is real although not extensive, but other deficiencies in coupler connections are more widespread.

13. The EWL slab in Areas A and Hong Kong Coliseum (“**HKC**”) was mainly connected to the D-walls via capping beams. The opening-up works revealed that two out of 11 main rebar from the capping beams at the top of D-walls were not properly connected with the couplers linking the rebar from the EWL slab and capping beams in Areas A and HKC. Therefore, the defective rate of the coupler connection in these locations will need to take into account the condition on both sides of these couplers.

14. The likely causes of deficiencies in coupler connections include poor workmanship in rebar fixing which was not identified during inspection of the construction works.

15. The above findings in respect of coupler connections are addressed in the Stage 3 assessment.

Stage 2c

16. Stage 2c involves the review of the available construction records to check whether or not there are irregularities in the D-wall construction. All the 243 D-wall panels within the Holistic Assessment areas were reviewed.

17. Request for Inspection/Survey Check Forms (“**RISCFS**”) and coupler inspection records were used as the primary evidence. Although the RISCFS submitted by Leighton were found to be substantially available for cage installation and pre-pour checking, late submission and endorsement of RISCFS and unavailability of some coupler inspection records have been identified.

18. Other relevant information, including in particular, the signed shop drawings of the fabricated reinforcement cages and relevant photographs were then reviewed. These indicate that site supervision and inspection had generally been conducted during D-wall construction, and no obvious workmanship issues have been identified. Hence, the opening-up of D-walls for further investigation is considered not necessary and the D-wall structure is regarded as intact for the purpose of the Stage 3 assessment.

Stage 2d

19. Stage 2d involves the investigation of honeycombing and gaps between the wall/column/hanger wall and EWL slab soffit, verification of shear link workmanship and horizontal construction joints, all at the EWL slab. NDT and visual inspections have been deployed to investigate the works, thereby minimising further opening-up of the structure.

Honeycombing at EWL Slab Soffit

20. Honeycombed concrete at the EWL soffit was observed in July 2018. Automatic hammer and tapping hammer were used to identify the suspect areas at the soffit and the suspect areas were then opened up to verify the actual condition.

21. The investigation has identified approximately 12% of the inspected area with shallow honeycombing (i.e. less than 50mm deep) and approximately another 7% of the inspected area with deeper honeycombing (i.e. 50mm to 350mm deep). The honeycombing was likely related to unsatisfactory workmanship of the concreting works.

Gaps Between Wall/Column/Hanger Wall and EWL Slab Soffit

22. 31 gaps between the wall/column/hanger wall and EWL slab soffit were identified which were either unfilled or filled with improper materials. Reinforcement and coupler connection issues were identified in some of these gaps. The likely cause of these gaps is unsatisfactory concreting workmanship, which was not identified during supervision of construction works.

Shear Links Investigation

23. Investigation of the honeycombing also identified irregularities in the shear links. 18 localised areas at the EWL slab soffit were therefore selected for further investigation, taking into account site accessibility and shear stress concentration. They were opened up in April 2019 to investigate the workmanship and as-constructed condition of the shear link installation.

24. The opening-up works revealed shear link irregularities at all 18 locations. These included missing shear links, smaller bar sizes and insufficient anchorage lengths. These irregularities did not conform to the design and also reflected construction and supervision issues. They may exist in other parts of the platform slabs.

Horizontal Construction Joints in Connections between EWL Slab and D-wall

25. Video Rigid ("**VR**") Scope investigation was carried out in Stage 2d to check the condition of the concrete at the EWL and NSL slabs as part of the honeycombing investigation. At four VR Scope locations, the condition of the concrete interface at the construction joint, where the EWL slab is connected to the D-wall, was examined using the VR Scope.

26. Irregularities were found at two of the four VR Scope locations. A gap was observed at the interface area between slab and D-wall at one location. Remnants of a hessian sheet were found in the concrete sample taken at another location.

27. External consultants were engaged to review the core samples and results from the VR Scope survey. It was concluded that the irregularities were related to workmanship issues during construction of the joints.

28. The irregularities identified in the investigation on honeycombing, shear links and horizontal construction joint will be taken into account in the Stage 3 assessment.

Other Findings in Stage 2

Corrosion

29. During the Stage 2 investigation, some of the exposed coupler connections were cut and unscrewed. Signs of rusting were observed on most of the unscrewed threaded bars. After detailed investigation by the MTRCL's expert, including inspection of additional samples retrieved from the NSL slab, it

was concluded that the rusting was superficial and likely resulted from moisture trapped in the couplers when the rebar was first installed. The rusting in general has not caused any dimensional change to the threaded portion of the rebar and hence there is no significant effect on the overall strength of the coupler connections. The rusting process is considered to have ceased in most samples examined. To ensure that no further rusting would take place in the future, grouting or other water seepage prevention measures will be conducted to minimise seepage of water into the connection between the platform slabs and D-walls.

Water Seepage

30. In the course of the Stage 2 investigation, water seepage/ponding was observed at some opening-up locations at the platform slabs. It was probably due to the water seepage through the construction joints between the D-wall panels and those between the NSL slabs and D-walls. The infiltrated water was saline, implying sea water. To minimise water seepage into the concrete slabs, grouting will be conducted to seal possible pathways of water seepage.

Non-conformance Report (“NCR”) 157 Investigation

31. Due to the allegations of threaded bar cutting issues at D-wall panel EM100 under NCR 157, seven couplers at locations between the soffit of the EWL slab and the D-wall were exposed by opening-up works. PAUT was conducted to investigate the engagement lengths on five of the seven coupler connections that were connected with rebar at platform slab side.

32. Of these seven coupler connections, one sample was discarded due to the limitation of test. Of the remaining six, three were found to be unconnected and/or cut, while the remaining three met the manufacturer’s installation requirements.

33. NCR 157 was issued on non-conforming coupler connections observed at the top rebar layers of the bottom mat for the EWL slab. Due to site constraints, this investigation could not reach the exact layers of the rebar on which NCR 157 was issued. The likely cause of the identified issues is unsatisfactory workmanship which was not identified during inspection of the construction works. As the findings indicate a higher percentage of non-conforming coupler connections at this location, this will be taken into account in analysing the structural integrity at this location in the Stage 3 assessment.

Stage 3 - Structural Assessment

34. The Stage 3 Structural Assessment (“**the Assessment**”) assesses the HUH Extension box structure taking into account the findings from the Stages 1 and 2 investigations. External consultants have been engaged for the Assessment.

35. Before the external consultants commenced the Assessment, consideration was given to the design requirements to be used for the analysis. At the early design stage, a number of factors were unknown to the designer, in particular the final architectural layout and the detailed construction methodology. The original design was thus built up with extra provisions and flexibilities in order to cater for the range of uncertainties that might be realised during the subsequent design and construction stages. However, with the completion of the detailed design and construction of the station structure, it is considered that these extra provisions and flexibilities can be reviewed. Furthermore, it is acceptable to also adopt some other changes to the original design assumptions for this structure provided that suitable restrictions and precautionary arrangements are put in place for the future use of the station. Therefore, two scenarios were considered in the Assessment, namely the *Original Design* and the *Updated Design*.

36. Under the *Original Design* scenario, the structural integrity was assessed based on the original design assumptions and models with consideration of the findings of as-constructed conditions from Stages 1 and 2 Investigations. It was based on these original design assumptions and models that the proposed works were accepted as achieving the safety level required in the Code of Practice for Structural Use of Concrete (“**Code**”) for meeting established good practice of engineering design.

37. The Assessment based on the *Original Design* indicates that, in the event the structure was required to meet the original design requirements, works would be required in the EWL and NSL slabs to cater for the irregularities in the coupler assemblies, including those directly connecting the slabs with the D-walls and connections via the capping beam. Works would also be generally required to cater for irregularities in the shear links in the EWL and NSL slabs. Works would also be required to strengthen the horizontal construction joints in the connections between the D-walls and EWL slab.

38. After reviewing the original design assumptions, MTRCL and the external consultants have recommended a set of revised design assumptions for the *Updated Design* to be used in the Assessment. MTRCL and the external consultants consider that the adoption of these revised criteria together with the findings of the Stages 1 and 2 investigations into the as-constructed conditions

and the relevant material/strength reductions generally complies with the MTRCL's New Works Design Standard Manual ("**NWDSM**") and achieves the safety level required in the then prevailing Code.

39. MTRCL considers the *Updated Design* to be an appropriate approach for assessing the extent to which further works are required to the structures. It reflects more accurately the actual situation. It also incorporates changes that have been selected to strike a suitable balance between the extent of further works proposed to be undertaken and the cost and time effectiveness of these works, whilst ensuring that the functionality and performance of the structure are not compromised.

40. Based on the *Updated Design*, and after consideration of the as-constructed conditions and the inspections carried out, MTRCL considers that for the purpose of the ongoing construction activities, the station is structurally safe.

41. It is proposed that suitable measures are carried out to cater for the poor workmanship issues found and to achieve the safety level required in the Code for meeting the requirements of the Buildings Ordinance ("**BO**") and the established good practice of engineering design. The NWDSM should also be complied with. Furthermore, in view of the updated design requirements adopted in the Assessment, some restrictions and precautionary arrangements will be imposed on the future use of the site but these will neither hamper the operation of the structure nor usage of the site.

42. Where specific actions or repair works have been identified and submitted to the Government, these are stated in the Report. The phrase "suitable measures" has been used elsewhere when the precise scope of measures to be taken is still subject to formal consultation with the Government. "Suitable measures" means actions which are deemed necessary to address the issues identified in this Report and achieve the safety level required in the Code for meeting the requirements of the BO and the established good practice of engineering design. The NWDSM should also be complied with. The term covers a wide range of actions and may include structural modifications, remedial works, long-term monitoring of the structure and the surrounding areas, and the restrictions/precautionary arrangements on future modifications to the structure, and future usage of the site and development in its vicinity.

43. Based on the *Updated Design*, the suitable measures including drilled-in bars, local thickening of slabs, reinstating shear links, adding columns, grouting, etc. are proposed to address the workmanship issues of coupler connections, shear links, horizontal construction joints, seepage, etc. It is estimated that it will take 4 to 6 months to design the suitable measures and obtain acceptance from

the Government. The implementation will then take 9 to 12 months to complete. As part of the suitable measures, a long-term structural monitoring scheme including instrumentation and inspection will be developed to monitor the ongoing structural integrity of the structure.

Conclusion

44. Stage 1 and Stage 2 works were completed in December 2018 and June 2019 respectively. A number of defects were identified. Taking into consideration the as-constructed conditions and findings from Stage 1 and Stage 2, the assessment of Stage 3 was completed in early July 2019.

45. The opened up areas will be reinstated. Suitable measures are proposed to address the deficiencies identified in this Holistic Assessment. It is estimated that implementation of the suitable measures will take 9 to 12 months to complete upon acceptance of the design.

46. It is considered that, given the findings of the Holistic Assessment and with the implementation of the proposed suitable measures, the concerns about the structural integrity of the HUH Extension arising from the various reported issues would be adequately addressed. Based on the Updated Design, and after consideration of the as-constructed conditions and the inspections carried out, MTRCL considers that for the purpose of the ongoing construction activities, the station is structurally safe.

47. MTRCL will also explore options for providing the Government with additional quality assurance and/or an undertaking in respect of the structures of the HUH Extension.

Final Verification Study Report on As-Constructed Conditions of the North Approach Tunnels, South Approach Tunnels and Hung Hom Stabling Sidings

Executive Summary

1. In April 2018, MTR Corporation Limited (“**MTRCL**”) issued Non-Conformance Reports (“**NCR**”) to Leighton Contractors (Asia) Limited (“**Leighton**”) because Leighton had not submitted the required “Request for Inspection and Survey Check Forms” (“**RISCFs**”) for certain structural works of the North Approach Tunnels (“**NAT**”) and the South Approach Tunnels (“**SAT**”) of Hung Hom Station (“**HUH**”) Extension in the Shatin to Central Link in accordance with the Inspection and Test Plan and General Specification of the Contract Documents.
2. On 20 December 2018, MTRCL informed the Highways Department (“**HyD**”) that, in addition to the lack of RISCFs, there were insufficient construction records for couplers installation, changes of steel reinforcement lapped bars into coupler connections and insufficient materials testing for NAT structures. Subsequently, similar situations for SAT and Hung Hom Stabling Sidings (“**HHS**”) were identified.
3. After deliberations with the Government, MTRCL submitted on 15 May 2019 to HyD a “Verification Proposal of As-constructed Conditions of the NAT, SAT and HHS” (“**Proposal**”) to verify the as-constructed conditions, ascertain the structural integrity and ensure the quality assurance of the structures in NAT, SAT and HHS. The Proposal was accepted by the Government on the same day. The Proposal consists of 2 parts.

Part 1a Consolidation and verification of available construction records

4. This part consolidates and verifies all available construction records with a view to identifying any gaps in site inspection records, material testing records and design change records.
5. Availability of RISCFs for two Hold Points inspections at NAT, SAT and HHS structures was identified to be about 28%, 58% and 50% respectively.
6. Material testing records, including concrete cube test, rebar sampling tests and sand replacement tests (“**SRT**”) are generally complete. A small number of concrete cube tests and some rebar test records were found missing and the issues are addressed in Part 1b and Part 2. Leighton

contended in the Commission of Inquiry (“COI”)’s Extended Inquiry that approximately 7% of the rebar delivered to site under Contract No. 1112 was not sampled for testing (“**untested rebar**”) by a Hong Kong Laboratory Accreditation Scheme (“**HOKLAS**”) accredited laboratory. MTRCL is continuing to seek clarification from Leighton in this regard.

Part 1b Review and ascertain the as-constructed conditions of the structures

7. This part reviews and ascertains the as-constructed conditions, including design changes, and the quality and workmanship of the structures to close the gaps identified in Part 1a. For the gaps that cannot be closed under Part 1b which may affect the structural integrity of the structure, they will be addressed in Part 2. In this context, “gaps” refer to the irregularities in the RISCs and other known issues that have potential structural implications and need to be accounted for in the structural review in Part 2.

8. Available objective evidence, such as site photographs, site diaries and other construction records, were used to supplement the RISCs and facilitate the assessment of the as-constructed conditions of NAT, SAT and HHS structures under Part 1b.

9. For checking concrete cover to rebar and rebar spacing, cover meter tests were conducted at selected locations at the NAT, SAT and HHS structures, where RISCs are not available or where couplers were used to replace lapped bars. Test results of cover meter scans indicate appropriate rebar spacing and about 9% of scan locations without sufficient concrete cover.

10. Additional concrete coring and Schmidt Hammer tests were conducted to check the concrete strength at the locations without sufficient concrete cube test results. The results complied with the required design strength.

11. The findings under Part 1b have provided useful information for evaluating the key workmanship issues that may have implications on structural integrity. The recommended provisions to cater for the issues were identified and incorporated in the structural review under Part 2.

Part 2 Structural Review

12. This part conducts a structural review of the structures and devises schematic suitable measures to address gaps that cannot be closed out in Part 1. At the early design stage of NAT and SAT, a number of factors were unknown to the Detailed Design Consultants (“**DDC**”), in particular the detailed construction methodology. The original design was thus built up with extra provisions and flexibilities in order to cater for a wide range of

uncertainties that might be realised during subsequent design and construction stages. However, with the completion of the detailed design and construction of the structures, these extra provisions/flexibilities can be reviewed and rationalised as some of the uncertainties at the early design stage are either more certain or no longer need to be accommodated. Furthermore, it is acceptable to also adopt some other changes to the original design assumptions for this structure provided that suitable restrictions and precautionary arrangements are put in place.

13. In the light of this, a set of updated design assumptions are adopted in the structural review. MTRCL considers the adoption of these updates to be an appropriate approach for assessing the integrity of the structure and the extent to which further works are required to the structure. It reflects more accurately the actual situation. It also incorporates changes that have been selected to strike a suitable balance between the extent of further works to be carried out and the cost and time effectiveness of the works required, whilst ensuring that the functionality and performance of the structure are not compromised.

14. Based on the results of the structural review, some suitable measures have been identified and proposed at certain locations at the NSL tunnel of the SAT and trough walls of the HHS to ensure the structural integrity. These measures will be further developed for submission to the Government for acceptance. It is expected that the required works identified in this Final Report will be implemented concurrently with those for the HUH Extension.

15. The term “suitable measures” covers a wide range of actions and may include structural modifications, remedial works, long-term monitoring of the structure and surrounding areas, and the imposition of constraints on potential future modifications to the structure and its use. These measures serve to address the gaps and related workmanship/quality issues so as to achieve the safety level required in the then prevailing Code of Practice for Structural Use of Concrete (“**Code**”) for meeting the requirements of the Buildings Ordinance (“**BO**”) and the established good practice of engineering design. The MTRCL’s New Works Design Standard Manual (“**NWDSM**”) should also be complied with.

16. As part of the suitable measures, a long-term monitoring scheme including instrumentation monitoring and inspection will be developed to monitor the structural integrity of the NAT, SAT and HHS structures.

17. Based on the Part 2 structural review and inspections carried out, MTRCL considers that for the purpose of the ongoing construction activities, the NAT, SAT and HHS are structurally safe.

18. Formal design amendment submissions (as-constructed) will be made to the Government.

19. MTRCL will also explore options for providing the Government with additional quality assurance and/or an undertaking in respect of the structures where gaps are identified in Part 1a.