inter.noise 2014
MELBOURNE AUSTRALIA
16-19 NOVEMBER

Challenge on Environmental Mitigation Measures on Site Formation Work to Achieve Win-Win-Win Situation for Project Proponent, Contractors and Stakeholders

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ABSTRACT

The construction of South Island Line (East) is a designated project under the Environmental Impact Assessment Ordinance (EIAO) in Hong Kong. An Environmental Impact Assessment (EIA) tool has been developed for the project and was approved in 2010 during the design stage. An amendment of noise mitigation was further enhanced to suit and optimize their methodology in order to achieve a win-win-win situation for the Project Proponent, the Contractors and the Stakeholders. The EIA defined two main activities for the South Horizons Plant Building works, namely "Slope Stabilization and Rock Slope Excavation". The excavation work was presumed to last for over 2 years by mechanical means involving intensive breaking and drilling with hydraulic breakers and drilling rigs respectively which could potentially generate excessive noise impacts to the nearby high density of residents with nearest 30m away from the work site. This paper gives an overview of challenges on the amendment of EIA which included the technical aspects of blasting operation and noise impact from the proposed alternative construction methodology by using opencast blasting in comparison to the mechanical method presumed, where pros and cons are also examined.

Keywords: Construction Noise, Noise Mitigations, Stakeholder Engagement, Permit
I-INCE Classification of Subjects Number(s): 52.6

1. INTRODUCTION

The South Island Line (East) (SIL(E)) is a ~7km long and is a medium capacity railway with stations at populated districts in South Horizons (SOH), Lei Tung (LET), Wong Chuk Hang (WCH), Ocean Park (OCP) and Admiralty (ADM), comprising underground and elevated structures. The SIL(E) alignment is illustrated in Figure 1. The integrated ADM station provides a convenient interchange amongst SIL(E), Shatin to Central Link (SCL), the existing Tsuen Wan Line (TWL) and the Island Line (ISL). A depot is required at Wong Chuk Hang to provide maintenance support for the SIL(E) with property development above. The strategic project commenced construction in 2011 and construction is still ongoing in 2014.

The operation of the SIL(E) will provide a fast, convenient, environmentally friendly and reliable mode of public transport between South Horizons and the central business district of Hong Kong. The new railway line serves not only the resident population in the Southern District but also tourists visiting the major existing tourist attractions in the District. Operation of the new railway will help to relieve existing traffic congestion at critical bottlenecks at Aberdeen Tunnel and local traffic in Hong Kong Island.

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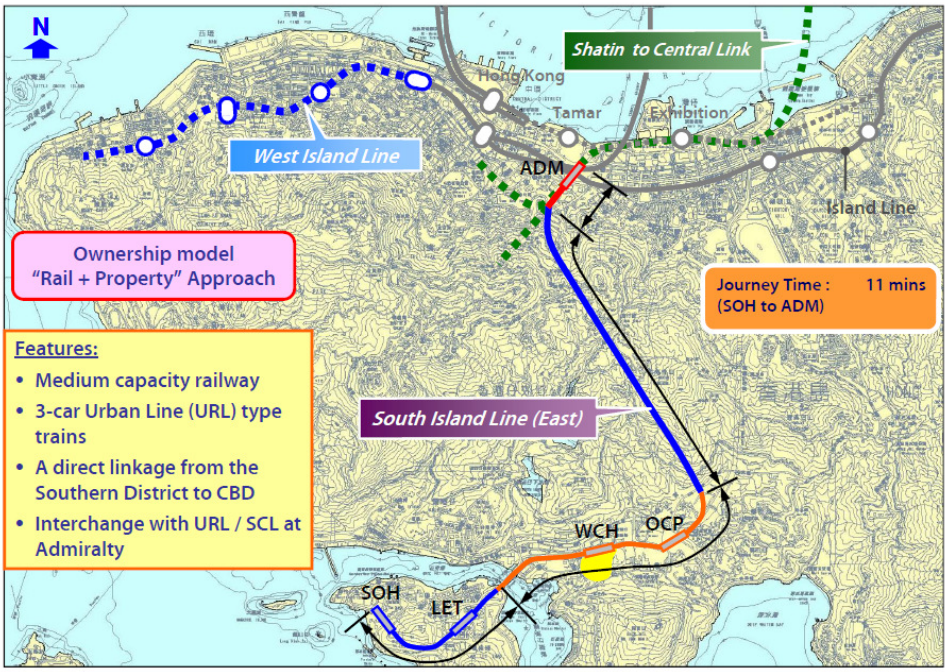

Figure 1 - SIL(E) alignment in urban Hong Kong Island

One of the major challenges associated with the construction activities in the urban Hong Kong Island was the minimization of environmental noise impact. Apart from the use of quieter construction equipment and methods during design stage, an amendment of noise mitigation was further enhanced to suit and optimize the construction methodology in order to achieve a win-win-win situation for the project proponent MTR, the Contractors and the Stakeholders. The paper seeks to examine the pros and cons from the optimized construction methodology.

2. LEGISLATIVE CONTROLS

2.1 Environmental Legislations

The SIL(E) project was subject to the controls under various environmental legislations in Hong Kong, including the Air Pollution Control Ordinance, Environmental Impact Assessment Ordinance (EIAO), Waste Disposal Ordinance, and Water Pollution Control Ordinance.

Under the EIAO, the project proponent is required to obtain an Environmental Permit (EP) for both construction and operation phases of SIL(E) and to adopt proper environmental mitigation measures to address potential impacts. Under the EP, the project proponent is required to prepare a Construction Noise Mitigation Measures Plan (CNMMP) to further reduce construction noise impacts on the 12 identified Noise Sensitive Receivers (NSRs), including South Horizons with predicted exceedance in air borne construction noise. The CNMMP for SIL(E) was approved in Feb 2012 where it was planned to use mechanical means to undertake the site formation work of South Horizons (SOH) Station plant building.

2.2 Noise Standards

Noise impacts arising from general construction activities other than percussive piling during the daytime period (07:00-19:00 hours of any day not being a Sunday or general holiday) shall be assessed against the noise standards tabulated in Table 2.1.

Table 2.1 – Noise Standards for Daytime Construction Activities

Noise Sensitive Uses	Noise Limits 0700 to 1900 hours on any day not being a Sunday or general holiday, Leq (30 min), dB(A)
All domestic premises including temporary housing accommodation	75
Hotels and hostel	
Educational institutions including kindergarten, nurseries and all others where unaided voice communication is required	70 (65 during examination)

There are no statutory procedures and criteria under the NCO and EIAO for assessing the airborne noise impacts from blasting, hence the airborne noise impact generated by this specific activity is beyond the scope of the EIA. However, the administrative and procedural control of all blasting operations in Hong Kong is vested in the Mines Division of the Civil Engineering and Development Department (CEDD). The Dangerous Goods (General) Regulations, Chapter 295 also stipulates that no person shall carry out blasting unless he/she possesses a valid mine blasting certificate to be issued by the Mines Division of CEDD.

2.3 Hazard Assessment Standards

In accordance to the SIL(E) EIA Study Brief, a hazard assessment is required for the SIL(E) project for the blasting activities. Particularly, for the storage and transport of explosives, the requirements are as follow:

(i) Identify hazardous scenarios associated with the storage and transport of explosives and then determine a set of relevant scenarios to be included in a Quantitative Risk Assessment (QRA);

(ii)Execute a QRA of the set of hazardous scenarios determined in (i), expressing population risks in both individual and societal terms;

(iii) Compare individual and societal risks with the criteria for evaluating hazard to life stipulated in Annex 4 of the TM; and

(iv) Identify and assess practicable and cost-effective risk mitigation measure.

According to risk guideline, maximum level of offsite individual risk should not exceed 1 in 100000 per year (i.e. 1x10-5/year), while the societal risk should not fall into the unacceptable region. The methodology to be used in the hazard assessment should be consistent with previous studies having similar issues.

3. ALTERNATIVE METHOD

3.1 Construction Methodology

An alternative drill & blast construction method for the site formation work of South Horizons (SOH) Station Plant Building with improvement in noise performance was submitted to the Environmental Protection Department in May 2012.

The previous approved method during planning stage in 2010 assumed that site formation would be undertaken by mechanical drill and spilt method.

The closest public road and habitation is Lee Nam Road which is circa 30 metres to the north east of the nearest blasting area. The proposed site formation excavation volume is approximately 47,000 cu m.

The topography at the Plant Building location consists of natural terrain with a slope angle of approximately 30^{o}. The low point of the slope is on the north western side where the Plant Building runs parallel with Lee Nam Road. At this location the elevation level is approximately +26 mPD. The slope rises

to the south east to an elevation of approximately +44 mPD. The site formation arrangement is shown in Figure 2.

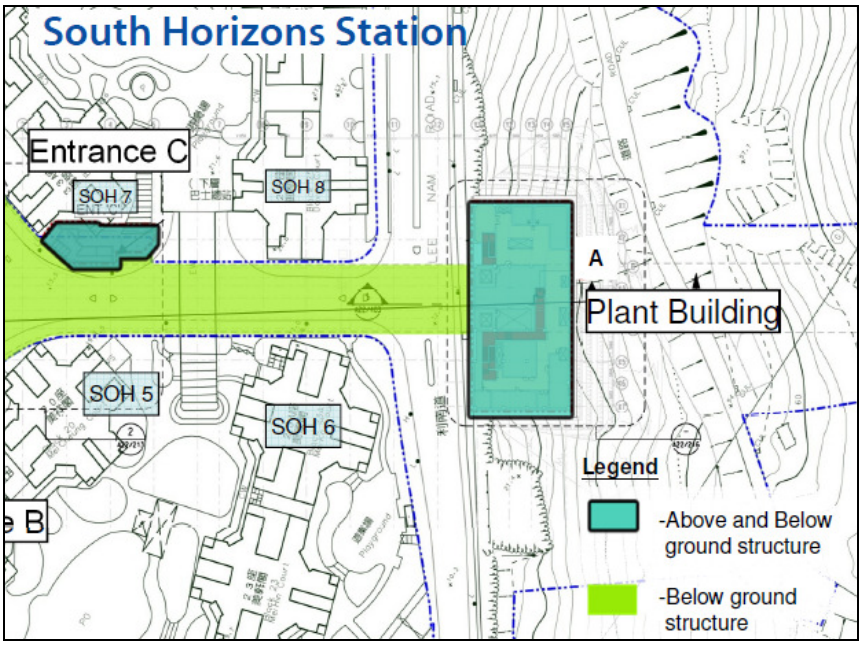

Figure 2 - The site formation work of South Horizons (SOH) Station Plant Building

3.2 Blasting Works

Based on the geological information, mechanical excavation is only required up to the first blasting excavation level of +31.5mPD. The final excavation level assessed in the BMS is +11.5mPD. The blasting at Plant Building will be carried out in two stages. Stage 1 is when the WSD water main is in the current position. Stage 2 is when the WSD water main has been diverted to the permanent position.

The MIC's to be used for blasting of the SOH Plant Building site should only revert from the Stage 1 – MIC's to the Stage 2 – MIC's, when the WSD watermains are diverted and the soil nail slope underneath the WSD watermains is completed. The MIS calculated for Plant Building ranges from <0.2kg to 2.9kg. A 'Non-Blast' zone of at least 6 and 8m from the crest of slope away from Lee Nam Road is proposed to enhance the public safety during the blasting works.

Drill hole depths will be up to maximum 5m, The depth of blasts will be up to maximum 5m. The depth of blasts will generally be between maintenance berms.

3.3 Blast Firing Time and Public Relations

The blasting time frame was between 09:30-11:30. No blasting will be permitted on Sundays and Public Holidays. Public Relations (PR) notices were dispatched to the surrounding residents/occupants and Stakeholders, inside the 13mms contour, advising them of the blasting activity at Plant Building. The PR notices will clearly state the dates and times of blasts, information which will also be shown on the signage surrounding the site.

3.4 Delivery of Explosives

After the Contractor placed their orders of explosives for CHS Magazine, the nominated Supplier will apply the Removal Permit with Mines Division for delivery of the ordered explosives to the Magazine. The Registered Shotfirer will unload the Mines delivery truck, check the order and arrange for the explosives to be stored in the Magazine with monitoring by the RES.

Before blasting works, the Contractor will apply the Removal Permit with Mines Division. After the withdrawal of explosives from the Magazine, under supervision of the RES, the Removal Permit will be signed by the Registered Shotfirer and countersigned by the Contractor Representatives and the MTRC Resident Explosives Supervisor (RES). The Contractor will deliver the explosives from the CHS Magazine to the blast site. Ordering of explosives will be scheduled and planned such that upon arrival at the blast

face, the drilling operations will have been completed and blasthole charging can commence immediately. No explosives will leave the CHS magazine store unless the placement of all the cages are completed and checked on site and certified in writing by Blasting Engineer and BCS.

Explosives will be placed in specific wooden boxes and transported by hand to the blasting area. The detonators will be kept safe in a special wooden box and transport separately from the explosives to the blast area by the Registered Shotfirer.

3.5 Effect of Mitigation Measures on AOP and Flyrock

3.5.1 Blast Cages & Nissen Huts

To ensure that no rock will be ejected from the blast face and to help to mitigate the effects of AOP and potential flyrock, blast cages will be employed for every blast. Wire mesh matting will also be placed directly over the blast area to enhance the effectiveness of the mitigation measure.

3.5.2 Stemming

The quality, length and types of stemming have a significant effect on the AOP generated by a blast. Where the mitigation of AOP is considered necessary, the blasthole will be stemmed to an appropriate length, usually 2,000 to 2,500mm. Good quality (10mm) crushed rock aggregate is the preferred stemming material when mitigating AOP. The Registered Shotfirer will follow the blast design and provide the correct length of stemming required.

3.5.3 Evacuation Zone

For every blast in the Plant Building, all personnel will be evacuated to a safe zone located outside the Works Area. The site clearance and evacuation procedures were implemented by the Registered Shotfirer, the Superintendent and the Blasting Engineer.

3.6 Control of Flyrock

The Contractor's Blasting Assessment Report, CBAR outlines the general principles for avoiding problems with flyrock and these principles will be followed.

The four aspects of flyrock management are prevention, interception, protection and monitoring. In accordance with best blasting practice, emphasis is placed on flyrock prevention rather than relying upon interception devices.

3.6.1 Blast Design

Blast design principles are compatible with best practice in flyrock prevention namely, adequate powder factor, appropriate pattern geometry, suitable inter-row delay timings, proper burden control, the correct initiation sequences and adequate bench height.

The blast firing direction will be towards south so as to throw the muckpile away from areas where the public may be present. The direction of rock throw is shown in Figure 3.

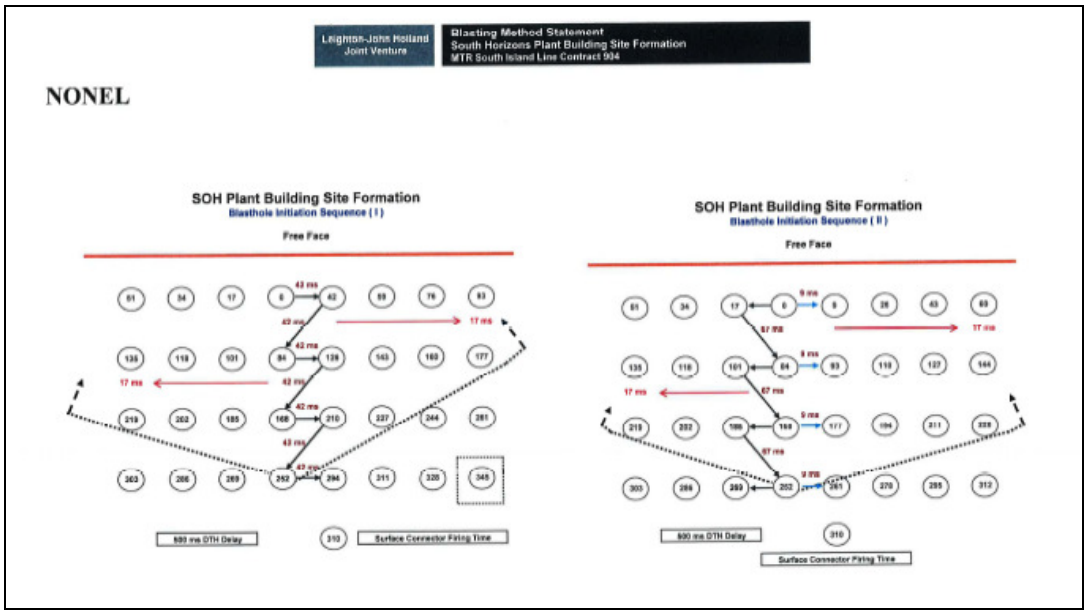

Figure 3 - The site formation Blast Hole Installation Sequence

3.6.2 Stemming

The Blast Design indicates that a 2.0m stemming column was used for cartridge and bulk emulsions, equivalent to 40 times the blasthole diameter. The stemming column between loaded decks should be equivalent to 12 times the blasthole diameter. Stemming material will be 10mm crushed aggregate from a quarry.

3.6.3 Protective Measures Required Prior to Blasting Works

A number of protective measures were implemented for the blasting works at SOH Plant Buildings, as shown in the Figure 4, 5 & 6.

All protective measures including the blast cages, Nissen Huts, top screens, or roof over blast mats, hanging mesh and so on, will be installed in place prior to the loading of the explosives. For the bulk emulsion loading part of the safety measures may be left open to provide an access for the emulsion pump and pumping operation. All safety measures shall be in place after the completion of the pumping operation.

Rubber Blast Mats

These blast mats are used to enhance the safety protective measures during blasting, and they will be placed over the top of the blast cages and extended to cover the vertical free face side of the cages.

Nissen Huts

Two steel frame screens making up the outer blast cage will be placed to cover the standard blast cage to further prevent the ejection of any vertical flyrock.

Figure 4 - Blasting Mat

Figure 5 - Nissen Hut (with Blast cages inside)

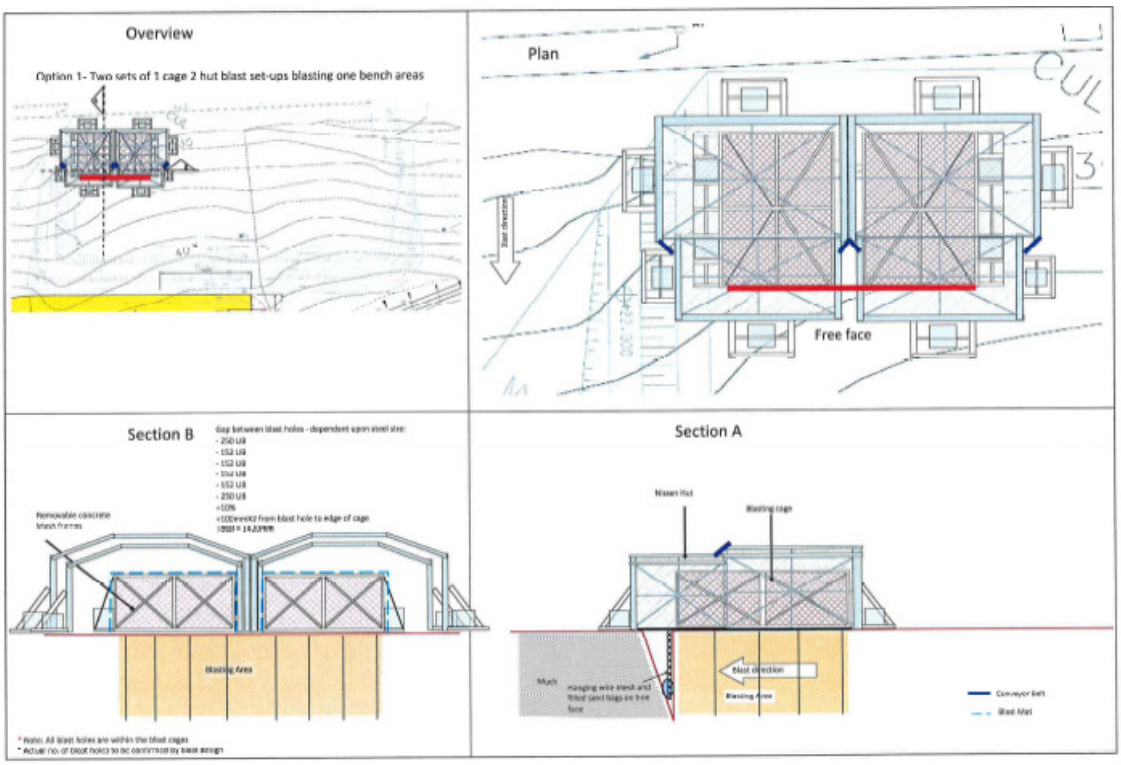

Figure 6 – Layout Plan of the Blast cages

4. Environmental Assessment

4.1 Construction Noise Assessment

The proposed change of construction method will shorten the rock excavation for site formation of SOH Station plant building by around 6 months from the original 24 months. The air-borne construction noise impacts in the nearby NSRs could be reduced by 1-3 dB(A).

In consideration of the proposed drill & blast construction method for SOH Station Plant Building, a table summarizing the 4 NSRs under both EIA scenario and the revised scenario is shown in Table 4.1.

Table 4.1 – Summary of Results

NSR	Maximum Predicted Noise Impact from SIL(E) Site Formation Works					
	Revised Scenario			EIA Assessed Scenario		
	Max Noise Level	Exceedance and Duration		Max Noise Level	Exceedance and Duration	
SOH5	76	1-4dB(A) (8 months)	≥5dB(A) (- -)	82	1-4dB(A) (0.5 month)	≥5dB(A) (2.5 months)
SOH6	78	1-4dB(A) (4.5 months)	≥5dB(A) (- -)	81	1-4dB(A) (5.5 months)	≥5dB(A) (2.5 months)
SOH7	75	No exceedance		76	1-4dB(A) (2.5 months)	≥5dB(A) (- -)
SOH8	77	1-4dB(A) (4.5 months)	≥5dB(A) (- -)	78	1-4dB(A) (3 months)	≥5dB(A) (- -)

4.2 Noise Assessment and Proposed Mitigation Measures

The noise assessment adopted was the same as the approved SIL(E) EIA. Notional source distances have been measured for the construction of SOH Station and associated plant building.

The percentage on-time for all powered mechanical equipment (PME) has been estimated for each construction activity and works area to ensure practicality and reference has been made to the SIL(E) EIA. Assumptions have been made for some PMEs located in the zones closest to the NSRs under worst case scenario.

All proposed mitigation measures in the CNMMP and their effectiveness have been adopted in the SIL(E) EIA and silent plant, noise barriers, including movable barriers and enclosure/sheds, and acoustic fabric have been considered. In general, the use of movable noise barrier for certain PME can alleviate 5dB(A) for movable PME and 10dB(A) for stationary PME depending on the actual design of the movable noise barrier. Barrier material with surface mass in excess of 7 kg/m2 is required to achieve the screening effect. Due to site constraints, noise barriers have been evaluated for each PME and applied where feasible. The noise enclosures are used to cover stationary PME such as air compressor. The adoption of the noise enclosure with the PME completely screened can achieve a noise reduction of 15dB(A).

4.3 Quantitative Risk Assessment (QRA) on Explosives

As described in previous sections, the work required additional explosive delivery to the SOH Station Plant Building works area. However, such delivery point was not accounted in the Hazard Assessment during the EIA stage, thus a review on the QRA was required.

Same as the QRA in approved SIL(E) EIA report, the reassessment covered the storage and transport of explosives for the SIL(E) project. It was assured that the blasting at SOH Station Plant Building would not affect the storage of explosives, as such that part of the QRA remained unchanged from the original assessment.

The explosives delivery route to the SOH Station Plant Building works area share a common route as the explosives delivery to Lee Wing Street delivery point. In other words, there would be no new delivery route, and the additional delivery point at SOH Station Plant Building works area would share similar information, such as affected population, etc., as the explosive delivery route to Lee Wing Street delivery point.

The QRA in the approved SIL(E) EIA report had considered a worst case scenario to account for uncertainty and changes during construction stage. After considering the additional delivery to the

SOH Station Plant Building works area and the explosives delivery to other delivery points for the SIL(E) project, the updated explosives delivery arrangement was found to be within the number of trips assessed in the worst case scenario.

The methodology and computational model used in this reassessment were the same as the QRA in the approved SIL(E) EIA report. The Societal Risk and the Individual Risk of the revised case were found to be within the risk level of the worst case assessed in approved SIL(E) EIA report.

Comparing against the statutory criteria, the criterion of the Individual Risk was met, while the societal risk was within the As Low As Reasonably Practicable (ALARP) region of the criteria. The ALARP assessment of the QRA in approved SIL(E) EIA report and the respective recommendations remained valid for the revised case, since there is no change to the explosive delivery route.

It was concluded that, from the hazard assessment perspective, the additional delivery point at SOH Station Plant Building works area would not constitute a material change to the SIL(E) project in the context of EIAO.

5. Community Liaison

MTR have established Community Liaison Groups (CLGs) for different localities which were well represented by concerned memebers from the respective District Councils, local residents and businesses, as well as government departments, e.g. Highways Department, Transport Department, etc. The CLG meetings provide a good platform for hearing views from different stakeholders and for introducing to those people directly affected by construction works the relevant mitigation measures for addressing environmental impacts.

Regular meetings with the stakeholders at SOH were held and no objections were received to the proposed changes of using the drill and blast construction methodology for the drill & blast works.

6. CONCLUSIONS

The proposed change of construction method has shortened the rock excavation for site formation of SOH Station plant building by around 6 months. The air-borne construction noise impacts in the nearby NSRs reduced by 1-3 dB(A). Despite the construction site is in close vicinity to the NSRs, all the relevant licenses and permits were obtained from the Governments and consent obtained from the CLG members. It is truly a challenge to the project team to enhance the environmental mitigation measures on site formation work at SOH Plant Building in order to achieve a win-win-win situation for the project proponent MTR, contractors and the stakeholders.

On the other hand, the introduction of the explosives created new risks to the project. The Project Proponent & Contractors were very mindful to ensure the new explosive delivery arrangement would be acceptable when compared to the approved SIL(E) EIA. The safety provisions for managing risks from blasting were carefully planned and managed by qualified blasting professionals. In a world where we place high values on timely project delivery and good environmental performance, the new risks associated with the alternative method were carefully managed.

ACKNOWLEDGEMENTS

The authors would like to express their thanks to the stakeholders, the community and the MTR for enabling the successful completion of the site formation works at South Horizons Station Plant Building.

Acknowledgement to Richard Kwan, Environment Manager of MTR Corporation, Ken Wong, Project Manager of MTR Corporation, and Mark Cuzner, General Manager of MTR Corporation on supporting this paper to be published.

The presentation of this paper is supported by the Hong Kong Institute of Acoustics.

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