AECOM

Highways Department

Agreement No. CE 20/2009 (EP)

Environmental Team for the Widening of Tolo Highway / Fanling Highway between Island House Interchange and Fanling

(Stage 1) Between Island House Interchange and Tai Hang - Investigation

First Operational Phase Noise Monitoring Report

[11/2016]

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Reviewed & Approved:	Y T Tang	

Version:	Rev. 3	Date: 8 November 2016

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Attn.: Mr. James Penny

Widening of Tolo Highway between Island House Interchange and Tai Hang

First Operational Phase Noise Monitoring Report (Rev 3)

Our Reference
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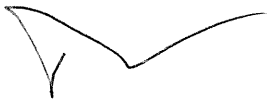
8 November 2016

By Fax (2805 5028) and Post

Dear Sir,

Regarding the captioned Project, we refer to the receipt from Environmental Team (ET) on 28 October and 8 November 2016 via email of the First Operational Phase Noise Monitoring Report (Rev 3) during the first year of operation, as required under Section 9 of the Updated EM&A Manual. We confirm that we have no comment on the captioned report.

Yours faithfully
for MOTT MACDONALD HONG KONG LIMITED



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ETL, AECOM – Mr. Y T Tang (Fax: 3922 9797)

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1 INTRODUCTION

1.1 Background

1.1.1 Tolo Highway and Fanling Highway are expressways in the North East New Territories connecting Sha Tin, Tai Po and Fanling. These highways form a vital part of the strategic Route 9, which links other major strategic routes to Shenzhen. At present, this section of Route 9 is dual 3-lane carriageway. However, at several major interchanges along this section of Route 9, the highway is only dual-2 lane. Severe congestion is a frequent occurrence during peak periods, particularly in the Kowloon bound direction.

1.1.2 The objective of the Project "Widening of Tolo Highway / Fanling Highway between Island House Interchange and Fanling" is to widen Tolo Highway and Fanling Highway to dual 4-lane carriageway in order to alleviate the current traffic congestion problems and to cope with the increasing transport demands to and from the urban areas and also cross boundary traffic.

1.1.3 The Project is a Designated Project under the Environmental Impact Assessment Ordinance (Cap. 499) (EIAO) and is governed by an Environmental Permit (EP-324/2008) (EP) issued by EPD on 23 December 2008. Subsequently, the EPD issued Variation of Environmental Permits of EP-324/2008/A, EP-324/2008/B and EP-324/2008/C on 31 January 2012, 17 March 2014 and 27 March 2015 respectively. The current valid VEP was applied on 19 August 2015 and the VEP (EP-324/2008/D) was subsequently granted on 27 August 2015. The most recent variation of the EP does not cover Stage 1 (between Island House Interchange and Tai Hang) of the Project.

1.1.4 The construction works for Stage 1 of the Project are implemented under 2 works contracts (Contract 1 and Contract 2). Contract 1 covers the section of Tolo Highway between Island House Interchange and Ma Wo, Contract 2 covers the section of Tolo Highway between Ma Wo and Tai Hang.

1.1.5 Hyder-Arup-Black and Veatch Joint Venture (HABVJV) are appointed by Highways Department (HyD) as the consultants for the design and construction assignment for the Tolo project under Agreement No. CE 58/2000 Supplementary Agreement No. 3 (SA3) (i.e. the Engineer for the Contracts).

1.1.6 China State Construction Engineering (Hong Kong) Ltd. (CSHK) was commissioned as the Contractor of Contract 1 of Stage 1 of the Project, while Gammon Construction Limited (GCL) was commissioned as the Contractor of Contract 2 of Stage 1 of the Project.

1.1.7 AECOM Asia Co. Ltd. was employed by HyD as the Environmental Team (ET) to undertake the Environmental Monitoring and Audit (EM&A) works for Stage 1 of the Project and Mott MacDonald Hong Kong Ltd. acts as the Independent Environmental Checker (IEC) for the Contracts.

1.1.8 This report summarises the findings of the First Operational Phase Noise Monitoring for the Project "Widening of Tolo Highway / Fanling Highway between Island House Interchange and Fanling" (the "Project").

2 OPERATIONAL PHASE NOISE MONITORING

2.1 Monitoring Requirement

2.1.1 According to the Updated EM&A Manual (August 2009), operational phase noise monitoring was recommended during the first year of operation of the Project. The operational phase noise monitoring shall be conducted once the relevant road section is in fully operation. The measured noise levels should be compared with the predicted noise levels in the Environmental Review Report (ERR) using the counted traffic data at the time of measurement.

2.1.2 According to the traffic notice released by the Transport Department, the speed limit of Tolo Highway was increased to 100km/h with effect from 11:00 a.m. on 7 August 2015. Therefore, the operational phase noise monitoring shall be performed upon 7 August 2015.

2.1.3 The purpose of this monitoring is to verify the traffic noise prediction and effectiveness of the proposed noise mitigation measures.

2.2 Monitoring Frequency, Parameter and Duration

2.2.1 The noise measurements were conducted to obtain an A-weighted $L_{10\ (1\text{-}hr)}$ sound pressure level during the AM and PM traffic peak hour in a period of one and half hours at each designated monitoring station. Noise measurement was paused during periods of high intrusive noise if possible. Any non-project related noise sources in the vicinity of the monitoring stations during the monitoring were also recorded when intrusive noise was unavoidable. Intrusive noise from sources (e.g. railway noise, aircraft noise, etc.) was edited out.

2.2.2 Traffic survey was conducted concurrently with the noise measurements for the road sections in the vicinity of the monitoring stations. The traffic survey included traffic flow, percentage of heavy vehicle and estimate of average operating speeds for both north-bound and south-bound carriageways.

2.3 Monitoring Equipment

2.3.1 Integrating Sound Level Meters were used for noise monitoring. They are Type 1 sound level meters capable of giving a continuous readout of the noise level readings including equivalent continuous sound pressure level (L_{eq}) and percentile sound pressure level (L_x). They comply with International Electrotechnical Commission Publications 651:1979 (Type 1) and 804:1985 (Type 1). Also, a portable electronic wind speed indicator was used to measure the wind speed in m/s. **Table 2.1** shows the equipment used for the noise monitoring. Calibration certificates of the sound level meters and acoustic calibrator are provided in **Appendix A**.

Table 2.1 Noise Monitoring Equipment

Equipment	Model
Integrating Sound Level Meter	B&K 2238
Calibrator	B&K 4231

2.3.2 The sound level meter was calibrated using a Bruel and Kjaer Sound Level Calibrator Type 4231 for 94dB at 1kHz, prior to and after each set of measurements. The results of the calibration were recorded on the field data sheet. Measurement results was discarded if the calibration before and after does not agree to within 1dB(A) and measurement was taken until this condition is fulfilled.

2.4 Monitoring Date and Time

2.4.1 As stipulated in the EM&A manual, noise level shall be measured at morning and evening traffic peak hour on normal weekdays. As confirmed by the Transport Department, the current morning traffic peak hour and evening traffic peak hour are 08:00 to 09:30 and 18:00 to 19:30 respectively.

2.4.2 The first set of monitoring was performed on 7 January 2016 and 16 August 2016 at the evening traffic peak hour, i.e. 18:00 to 19:30.

2.5 Monitoring Location

2.5.1 Noise measurements were carried out at three locations according to the EM&A manual as shown in **Table 2.2** below.

Table 2.2 Noise Monitoring Locations

Monitoring Station	Location	Uses	Monitoring Floor
SR57(1)	King Yuet House 2, King Nga Court	Residential	36/F
SR20	House No. 10A, 18th Street, Hong Lok Yuen	Residential	2/F(2)
SR39	Block 9, The Paragon	Residential	1/F

Note:
(1) A lift shaft was found to be located near SR58 (originally proposed monitoring station for King Nga Court in the Updated EM&A Manual) during the site visit. To avoid the influence of noise from the lift shaft, SR57 which is located at the same block as SR58 and is exposed to similar noise impact from the project roads has been chosen to replace SR58 as the monitoring station for King Ng Court.

(2) According to the Updated EM&A manual, the noise monitoring at SR20 was proposed to be conducted at the second floor. However, the management staff of Hong Lok Yuen only allowed the ET to conduct the monitoring at the periphery of Hong Lok Yuen (outside the boundary wall). As such, the monitoring was conducted outside the boundary wall of SR20 with the sound level meter installed at a height of 6 meters from ground level.

2.6 Noise Monitoring Methodology

2.6.1 The first set of noise measurements were conducted to obtain three sets of A-weighted $L_{10\ (30\ mins)}$ sound pressure level during the evening peak traffic hour in one and half hour monitoring period at each designated monitoring station.

2.6.2 Noise measurements were made in accordance with Section III of the "Calculation of Road Traffic Noise (CRTN), 1998". Statistical results such as L_{eq} and L_{90} were also obtained for reference.

2.6.3 For SR57 and SR39, noise measurements were conducted at a point 1m from exterior of the sensitive receiver building façade and at least 1.2m above ground of the sensitive receiver level.

2.6.4 For SR20, the noise measurement was conducted in a free-field condition. A façade effect correction factor of 2.5 dB(A) was added to the measured noise level according to the CRTN.

2.6.5 The wind speed was frequently checked with a portable wind meter. Observations were recorded when intrusive noise was unavoidable. Noise monitoring was cancelled in the presence of fog, rain, wind with a steady speed exceeding 5 m/s, or wind with gusts exceeding 10 m/s.

2.7 Traffic Survey

2.7.1 Road traffic data including vehicle speeds, number of vehicles per hour and percentage of heavy vehicles for both north-bound and south-bound were recorded at the time of noise measurement for the three monitoring stations. The road traffic count details are summarized in **Table 2.3**.

Table 2.3 Road Traffic Count Details

Monitoring Station	Location	Location of Road Traffic Count
SR57	King Yuet House 2, King Nga Court	Roof top of King Yuet House
SR20	House No. 10A, 18th Street, Hong Lok Yuen	Footbridge near Tai Hang Fui Sha Wai
SR39	Block 9, The Paragon	Roof top of King Yuet House

3 RESULTS AND OBSERVATIONS

3.1 General

3.1.1 During the course of noise monitoring, road traffic along Tolo Highway was the major noise source. Noise data were continuously recorded by sound level meters at an interval of 1 second. Other extraneous noise sources including community noise, railway noise etc. recorded during the monitoring events were not taken into calculation of the traffic noise level.

3.2 Traffic Noise Monitoring Results

3.2.1 The first operational phase noise monitoring was conducted on a weekday during PM peak traffic hour from 18:00 to 19:30 on 7 January 2016 and 16 August 2016. The weather condition during the monitoring days were fine. Random check of wind speed at the monitoring station showed that it was below 5 m/s.

3.2.2 There were some activities, which generated extraneous noises, and these activities were recorded during the monitoring events. The noise data was recorded by the sound level meters. Based on the site records, non-traffic related data was neglected, in order to indicate the traffic noise level only.

3.2.3 Due to site constraint, the monitoring location for SR20 was adjusted. A distance correction was hence applied to the measured noise level.

3.2.4 The distances between the line source and the measuring point and original reception point were about 148m and 156m respectively. Hence, the relationship between the Sound Pressure Level (SPL) at the original reception point and the SPL at the measuring point can be expressed as follow:

$$SPL_{original\ reception\ point} = SPL_{measuring\ point} + 10\log\left(\frac{148}{156}\right)$$
$$\approx SPL_{measuring\ point} - 0.2$$

3.2.5 The noise level measured during 18:15 – 19:15 were taken as the representative PM peak hour noise level. **Table 3.1** summarises the traffic noise measurement results during the PM peak hour.

Table 3.1 Noise Measurement Results

Monitoring Date	Monitoring Station	Period	Measured Noise Level (Mitigated), $L_{10\ (1\text{-}hr)}$ dB(A)
7 January 2016	SR 57	PM Traffic Peak hour	68.3
16 August 2016	SR 20		59.9*
7 January 2016	SR 39		56.9

Note:
* A distance correction for the relocation of measuring point and 2.5 dB(A) correction for free-field condition were applied.

3.2.6 A ventilation system was identified at the rooftop of the King Yuet House (SR57). The distance between the traffic noise monitoring point and the ventilation louver was about 14 m. Noise measurement for the ventilation system was conducted to investigate the effect of the ventilation system on the noise monitoring. The results indicate that the noise generated by the ventilation system is about 59 dB(A) at 7m from the ventilation louver. Based on standard acoustical principles, the projected SPL, due to the noise of the ventilation system, would be 53 dB(A) at the traffic noise monitoring point. As the projected SPL is about 15 dB below the measured road traffic noise level, the noise contribution from the ventilation system to the traffic noise monitoring result is minimal (less than 1dB(A)).

3.3 Road Condition and Traffic Survey

3.3.1 The traffic conditions along the concerned road sections were normal and there was no traffic congestion during the monitoring periods.

3.3.2 Details of the traffic flow, percentage of heavy vehicle and estimated traffic speed collected during the survey are presented in **Appendix B**. **Table 3.2** shows a summary of the traffic data obtained in the peak hour.

Table 3.2 Traffic Survey Results

Monitoring Station		Referred Road Segment in the ERR Predicted Traffic Data	No. of Vehicles	Percentage of Heavy Vehicles	Estimated Speed (km/hr)
SR57	North Bound	1m1	3855	17	79
	South Bound	1m2	3837	17	95
SR20	North Bound	1w1	3809	18	85
	South Bound	1w2	3708	18	80
	North Bound	1v1*	2914	18	85
	South Bound	1v2*	2896	19	80
	North Bound	1x1*	896	17	50
	South Bound	1x2*	812	16	50
SR39	North Bound	1i1	3855	17	79
	South Bound	1i2	3837	17	95

Note:
* The traffic data for the road segments 1v1, 1v2, 1x1 and 1x2 were estimated based on the counted traffic data at 1w1 and 1w2 and the traffic data predicted in the ERR.

4 DISCUSSION

4.1 Predicted Noise Levels under the Traffic Flow Condition in 2028

4.1.1 According to the ERR for the Project, "Widening of Tolo Highway / Fanling Highway between Island House Interchange and Fanling", for the worst case scenario, the traffic noise level was predicted to occur in year 2028.

4.1.2 The traffic noise levels at the identified NSRs were predicted using the computer model "RoadNoise" which implements the calculation method as prescribed in "Calculation of Road Traffic Noise (CRTN)" developed by the UK Department of Transport, Welsh Office in 1988. The assumptions of speed limits and low noise road surfacing as stated in the approved EIA Report were generally adopted in the ERR.

4.1.3 In the ERR, the traffic data of year 2028, which was agreed by the Transport Department, shows that the predicted traffic flows of the morning peak are higher than those of the afternoon peak. Therefore, the morning peak traffic data were used in the assessment to represent the worst-case scenario. In this report, the measured noise levels and predicted noise level in current situation at the afternoon peak were also compared with the ERR prediction although the predicted values were obtained using the morning peak traffic data.

4.2 Predicted Noise Levels in Current Situation

4.2.1 According to the Updated EM&A Manual, the measured noise levels should be compared with the noise modeling result obtained with the counted traffic data.

4.2.2 The traffic flow, vehicular speed and percentage of heavy vehicle obtained during the course of traffic noise measurements were applied to the same noise model as adopted in the ERR to obtain the predicted traffic noise levels for the purpose of the comparison. Apart from the counted traffic data, some adjustments to the noise model were made based on current on-site observations and actual conditions of the monitoring locations.

4.2.3 According to the Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM), for domestic premises, the statutory noise standard of $L_{10\ (1\text{-}hr)}$ is 70 dB(A). **Table 4.1** shows the measured noise level, predicted noise level in current situation and the ERR predicted noise level in year 2028 in comparison with the noise standard.

Table 4.1 Comparison of the Measured noise level and the Predicted noise level in Current Situation

Monitoring Station	Noise Level, $L_{10\ (1\text{-}hr)}$ dB(A)			
	Measured Noise Level	Predicted Noise Level in Current Situation	ERR Predicted Noise Level in Year 2028 (AM Peak Hour)	Noise Standard
SR57	68.3	66.2	67.3	70
SR20	59.9	63.2	68.5	70
SR39	56.9	57.6	64.0	70

4.2.4 As shown in **Table 4.1**, all of the measured noise level and predicted noise level in current situation are within the criterion of 70 dB(A). The measured noise level and the predicted noise level for each of the monitoring station are considered comparable with a reasonable deviation. Hence, the noise mitigation measures implemented are considered effective.

5 CONCLUSION

5.1.1 The First Operational Phase Noise Monitoring was conducted on weekdays during PM peak traffic hour from 18:00 to 19:30 on 7 January 2016 and 16 August 2016. The weather condition during the monitoring days were fine. The traffic conditions along the concerned road sections were normal and there was no traffic congestion during the monitoring periods. Activities which generated extraneous noise were recorded, and these irrelevant noise data were not taken into the evaluation of traffic noise levels.

5.1.2 The traffic flow, speed and percentage of heavy vehicles were recorded during the monitoring period. The traffic data obtained were applied to the noise model used in the ERR to obtain a predicted traffic noise level in current situation.

5.1.3 The measured noise levels were compared with the noise modeling result obtained based on the counted traffic data. All of the measured noise level and predicted noise level in current situation are within the criterion of 70 dB(A). The measured noise level and the predicted noise level for each of the NSRs are considered comparable with a reasonable deviation. In conclusion, the noise mitigation measures implemented are considered effective.

APPENDIX A

Calibration Certificates of Noise Monitoring Equipments

綜合試驗有限公司
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E-mail: smec@cigismec.com Website: www.cigismec.com
Tel : (852) 2873 6860
Fax : (852) 2555 7533

HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

Certificate No.: 15CA0317 03 **Page** 1 **of** 2

Item tested

Description:	Sound Level Meter (Type 1)	,	Microphone
Manufacturer:	B & K	,	B & K
Type/Model No.:	2238	,	4188
Serial/Equipment No.:	2285692	,	2791211
Adaptors used:	-	,	-

Item submitted by

Customer Name:	AECOM ASIA CO., LTD.
Address of Customer:	-
Request No.:	-
Date of receipt:	17-Mar-2015

Date of test: 18-Mar-2015

Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	20-Jun-2015	CIGISMEC
Signal generator	DS 360	33873	09-Apr-2015	CEPREI
Signal generator	DS 360	61227	09-Apr-2015	CEPREI

Ambient conditions

Temperature:	21 ± 1 °C
Relative humidity:	60 ± 10 %
Air pressure:	1010 ± 5 hPa

Test specifications

1, The Sound Level Meter has been calibrated in accordance with the requirements as specified in BS 7580: Part 1: 1997 and the lab calibration procedure SMTP004-CA-152.

2, The electrical tests were performed using an electrical signal substituted for the microphone which was removed and replaced by an equivalent capacitance within a tolerance of ±20%.

3, The acoustic calibration was performed using an B&K 4226 sound calibrator and corrections was applied for the difference between the free-field and pressure responsess of the Sound Level Meter.

Test results

This is to certify that the Sound Level Meter conforms to BS 7580: Part 1: 1997 for the conditions under which the test was performed.

Details of the performed measurements are presented on page 2 of this certificate.

Actual Measurement data are documented on worksheets.

Approved Signatory: Huang Jian Min/Feng Jun Qi **Date:** 19-Mar-2015 **Company Chop:** SOILS AND MATERIALS ENGINEERING COMPANY LTD. 綜合試驗有限公司

Comments: The results reported in this certificate refer to the condition of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument.

綜合試驗有限公司
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Tel : (852) 2873 6860
Fax : (852) 2555 7533

CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 15CA0317 03 **Page** 2 **of** 2

1, Electrical Tests

The electrical tests were perfomed using an equivalent capacitance substituted for the microphone. The results are given in below with test status and the estimated uncertainties. The "Pass" means the result of the test is inside the tolerances stated in the test specifications. The "-" means the result of test is outside these tolerances.

Test:	Subtest:	Status:	Expanded Uncertainty (dB)	Coverage Factor
Self-generated noise	A	Pass	0.3	
	C	Pass	1.0	2.1
	Lin	Pass	2.0	2.2
Linearity range for Leq	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
	Reference SPL on all other ranges	Pass	0.3	
	2 dB below upper limit of each range	Pass	0.3	
	2 dB above lower limit of each range	Pass	0.3	
Linearity range for SPL	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
Frequency weightings	A	Pass	0.3	
	C	Pass	0.3	
	Lin	Pass	0.3	
Time weightings	Single Burst Fast	Pass	0.3	
	Single Burst Slow	Pass	0.3	
Peak response	Single 100μs rectangular pulse	Pass	0.3	
R.M.S. accuracy	Crest factor of 3	Pass	0.3	
Time weighting I	Single burst 5 ms at 2000 Hz	Pass	0.3	
	Repeated at frequency of 100 Hz	Pass	0.3	
Time averaging	1 ms burst duty factor $1/10^3$ at 4kHz	Pass	0.3	
	1 ms burst duty factor $1/10^4$ at 4kHz	Pass	0.3	
Pulse range	Single burst 10 ms at 4 kHz	Pass	0.4	
Sound exposure level	Single burst 10 ms at 4 kHz	Pass	0.4	
Overload indication	SPL	Pass	0.3	
	Leq	Pass	0.4	

2, Acoustic tests

The complete sound level meter was calibrated on the reference range using a B&K 4226 acoustic calibrator with 1000Hz and SPL 94 dB. The sensitivity of the sound level meter was adjusted. The test result at 125 Hz and 8000 Hz are given in below with test status and the estimated uncertainties.

Test:	Subtest	Status	Expanded Uncertainty (dB)	Coverage Factor
Acoustic response	Weighting A at 125 Hz	Pass	0.3	
	Weighting A at 8000 Hz	Pass	0.5	

3, Response to associated sound calibrator

N/A

The expanded uncertainties have been calculated in accordance with the ISO Publication "Guide to the expression of uncertainty in measurement", and gives an interval estimated to have a level of confidence of 95%. A coverage factor of 2 is assumed unless explicitly stated.

- End -

Calibrated by: Fung Chi Yip **Date:** 18-Mar-2015

Checked by: Lam Tze Wai **Date:** 19-Mar-2015

The standard(s) and equipment used in the calibration are traceable to national or international recognised standards and are calibrated on a schedule to maintain the required accuracy level.

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Fax : (852) 2555 7533
HOKLAS 028
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CERTIFICATE OF CALIBRATION

Certificate No.: 15CA0703 02-02 **Page** 1 **of** 2

Item tested

Description:	Sound Level Meter (Type 1)	,	Microphone
Manufacturer:	B & K	,	B & K
Type/Model No.:	2238	,	4188
Serial/Equipment No.:	2800927	,	2791214
Adaptors used:	-	,	-

Item submitted by

N.009 06

Customer Name:	AECOM ASIA CO., LTD.
Address of Customer:	-
Request No.:	-
Date of receipt:	03-Jul-2015

Date of test: 04-Jul-2015

Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	19-Jun-2016	CIGISMEC
Signal generator	DS 360	33873	16-Apr-2016	CEPREI
Signal generator	DS 360	61227	16-Apr-2016	CEPREI

Ambient conditions

Temperature:	21 ± 1 °C
Relative humidity:	60 ± 10 %
Air pressure:	1000 ± 5 hPa

Test specifications

1, The Sound Level Meter has been calibrated in accordance with the requirements as specified in BS 7580: Part 1: 1997 and the lab calibration procedure SMTP004-CA-152.

2, The electrical tests were performed using an electrical signal substituted for the microphone which was removed and replaced by an equivalent capacitance within a tolerance of ±20%.

3, The acoustic calibration was performed using an B&K 4226 sound calibrator and corrections was applied for the difference between the free-field and pressure responsess of the Sound Level Meter.

Test results

This is to certify that the Sound Level Meter conforms to BS 7580: Part 1: 1997 for the conditions under which the test was performed.

Details of the performed measurements are presented on page 2 of this certificate.

Actual Measurement data are documented on worksheets.

Approved Signatory: Huang Jian Min/Feng Jun Qi **Date:** 06-Jul-2015 **Company Chop:** SOILS AND MATERIALS ENGINEERING COMPANY LTD. 綜合試驗有限公司

Comments: The results reported in this certificate refer to the condition of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument.

綜合試驗有限公司
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Tel : (852) 2873 6860
Fax : (852) 2555 7533

CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 15CA0703 02-02 **Page** 2 **of** 2

1, Electrical Tests

The electrical tests were perfomed using an equivalent capacitance substituted for the microphone. The results are given in below with test status and the estimated uncertainties. The "Pass" means the result of the test is inside the tolerances stated in the test specifications. The "-" means the result of test is outside these tolerances.

Test:	Subtest:	Status:	Expanded Uncertainty (dB)	Coverage Factor
Self-generated noise	A	Pass	0.3	
	C	Pass	1.0	2.1
	Lin	Pass	2.0	2.2
Linearity range for Leq	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
	Reference SPL on all other ranges	Pass	0.3	
	2 dB below upper limit of each range	Pass	0.3	
	2 dB above lower limit of each range	Pass	0.3	
Linearity range for SPL	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
Frequency weightings	A	Pass	0.3	
	C	Pass	0.3	
	Lin	Pass	0.3	
Time weightings	Single Burst Fast	Pass	0.3	
	Single Burst Slow	Pass	0.3	
Peak response	Single 100μs rectangular pulse	Pass	0.3	
R.M.S. accuracy	Crest factor of 3	Pass	0.3	
Time weighting I	Single burst 5 ms at 2000 Hz	Pass	0.3	
	Repeated at frequency of 100 Hz	Pass	0.3	
Time averaging	1 ms burst duty factor $1/10^3$ at 4kHz	Pass	0.3	
	1 ms burst duty factor $1/10^4$ at 4kHz	Pass	0.3	
Pulse range	Single burst 10 ms at 4 kHz	Pass	0.4	
Sound exposure level	Single burst 10 ms at 4 kHz	Pass	0.4	
Overload indication	SPL	Pass	0.3	
	Leq	Pass	0.4	

2, Acoustic tests

The complete sound level meter was calibrated on the reference range using a B&K 4226 acoustic calibrator with 1000Hz and SPL 94 dB. The sensitivity of the sound level meter was adjusted. The test result at 125 Hz and 8000 Hz are given in below with test status and the estimated uncertainties.

Test:	Subtest	Status	Expanded Uncertainty (dB)	Coverage Factor
Acoustic response	Weighting A at 125 Hz	Pass	0.3	
	Weighting A at 8000 Hz	Pass	0.5	

3, Response to associated sound calibrator

N/A

The expanded uncertainties have been calculated in accordance with the ISO Publication "Guide to the expression of uncertainty in measurement", and gives an interval estimated to have a level of confidence of 95%. A coverage factor of 2 is assumed unless explicitly stated.

- End -

Calibrated by: Fung Chi Yip **Date:** 04-Jul-2015

Checked by: Lam Tze Wai **Date:** 06-Jul-2015

The standard(s) and equipment used in the calibration are traceable to national or international recognised standards and are calibrated on a schedule to maintain the required accuracy level.

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HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

Certificate No.: 15CA0703 02-01 **Page** 1 **of** 2

Item tested

Description:	Sound Level Meter (Type 1)	,	Microphone
Manufacturer:	B & K	,	B & K
Type/Model No.:	2238	,	4188
Serial/Equipment No.:	2800930	,	2250455
Adaptors used:	-	,	-

Item submitted by

N-009-07

Customer Name: AECOM ASIA CO., LTD.
Address of Customer: -
Request No.: -
Date of receipt: 03-Jul-2015

Date of test: 04-Jul-2015

Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	19-Jun-2016	CIGISMEC
Signal generator	DS 360	33873	16-Apr-2016	CEPREI
Signal generator	DS 360	61227	16-Apr-2016	CEPREI

Ambient conditions

Temperature: 21 ± 1 °C
Relative humidity: 60 ± 10 %
Air pressure: 1000 ± 5 hPa

Test specifications

1, The Sound Level Meter has been calibrated in accordance with the requirements as specified in BS 7580: Part 1: 1997 and the lab calibration procedure SMTP004-CA-152.
2, The electrical tests were performed using an electrical signal substituted for the microphone which was removed and replaced by an equivalent capacitance within a tolerance of ±20%.
3, The acoustic calibration was performed using an B&K 4226 sound calibrator and corrections was applied for the difference between the free-field and pressure responsess of the Sound Level Meter.

Test results

This is to certify that the Sound Level Meter conforms to BS 7580: Part 1: 1997 for the conditions under which the test was performed.

Details of the performed measurements are presented on page 2 of this certificate.

Actual Measurement data are documented on worksheets.

Approved Signatory: Huang Jian Min/Feng Jun Qi **Date:** 06-Jul-2015 **Company Chop:** SOILS & MATERIALS ENGINEERING COMPANY LTD. 綜合試驗有限公司

Comments: The results reported in this certificate refer to the condition of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument.

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HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 15CA0703 02-01 **Page** 2 **of** 2

1, Electrical Tests

The electrical tests were perfomed using an equivalent capacitance substituted for the microphone. The results are given in below with test status and the estimated uncertainties. The "Pass" means the result of the test is inside the tolerances stated in the test specifications. The "-" means the result of test is outside these tolerances.

Test:	Subtest:	Status:	Expanded Uncertainty (dB)	Coverage Factor
Self-generated noise	A	Pass	0.3	
	C	Pass	1.0	2.1
	Lin	Pass	2.0	2.2
Linearity range for Leq	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
	Reference SPL on all other ranges	Pass	0.3	
	2 dB below upper limit of each range	Pass	0.3	
	2 dB above lower limit of each range	Pass	0.3	
Linearity range for SPL	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
Frequency weightings	A	Pass	0.3	
	C	Pass	0.3	
	Lin	Pass	0.3	
Time weightings	Single Burst Fast	Pass	0.3	
	Single Burst Slow	Pass	0.3	
Peak response	Single 100μs rectangular pulse	Pass	0.3	
R.M.S. accuracy	Crest factor of 3	Pass	0.3	
Time weighting I	Single burst 5 ms at 2000 Hz	Pass	0.3	
	Repeated at frequency of 100 Hz	Pass	0.3	
Time averaging	1 ms burst duty factor $1/10^3$ at 4kHz	Pass	0.3	
	1 ms burst duty factor $1/10^4$ at 4kHz	Pass	0.3	
Pulse range	Single burst 10 ms at 4 kHz	Pass	0.4	
Sound exposure level	Single burst 10 ms at 4 kHz	Pass	0.4	
Overload indication	SPL	Pass	0.3	
	Leq	Pass	0.4	

2, Acoustic tests

The complete sound level meter was calibrated on the reference range using a B&K 4226 acoustic calibrator with 1000Hz and SPL 94 dB. The sensitivity of the sound level meter was adjusted. The test result at 125 Hz and 8000 Hz are given in below with test status and the estimated uncertainties.

Test:	Subtest	Status	Expanded Uncertainty (dB)	Coverage Factor
Acoustic response	Weighting A at 125 Hz	Pass	0.3	
	Weighting A at 8000 Hz	Pass	0.5	

3, Response to associated sound calibrator

N/A

The expanded uncertainties have been calculated in accordance with the ISO Publication "Guide to the expression of uncertainty in measurement", and gives an interval estimated to have a level of confidence of 95%. A coverage factor of 2 is assumed unless explicitly stated.

- End -

Calibrated by: Fung Chi Yip **Date:** 04-Jul-2015

Checked by: Lam Tze Wai **Date:** 06-Jul-2015

The standard(s) and equipment used in the calibration are traceable to national or international recognised standards and are calibrated on a schedule to maintain the required accuracy level.

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HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

Certificate No.: 15CA0303 01-02 **Page:** 1 **of** 2

Item tested

Description:	Acoustical Calibrator (Class 1)
Manufacturer:	B & K
Type/Model No.:	4231
Serial/Equipment No.:	3006428
Adaptors used:	-

Item submitted by

Curstomer:	AECOM ASIA CO LIMITED
Address of Customer:	-
Request No.:	-
Date of receipt:	03-Mar-2015

Date of test: 03-Mar-2015

Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Lab standard microphone	B&K 4180	2412857	13-May-2015	SCL
Preamplifier	B&K 2673	2743150	10-Apr-2015	CEPREI
Measuring amplifier	B&K 2610	2346941	08-Apr-2015	CEPREI
Signal generator	DS 360	61227	09-Apr-2015	CEPREI
Digital multi-meter	34401A	US36087050	01-Dec-2015	CEPREI
Audio analyzer	8903B	GB41300350	07-Apr-2015	CEPREI
Universal counter	53132A	MY40003662	11-Apr-2015	CEPREI

Ambient conditions

Temperature:	21 ± 1 °C
Relative humidity:	60 ± 10 %
Air pressure:	1010 ± 5 hPa

Test specifications

1, The Sound Calibrator has been calibrated in accordance with the requirements as specified in IEC 60942 1997 Annex B and the lab calibration procedure SMTP004-CA-156.

2, The calibrator was tested with its axis vertical facing downwards at the specific frequency using insert voltage technique.

3, The results are rounded to the nearest 0.01 dB and 0.1 Hz and have not been corrected for variations from a reference pressure of 1013.25 hectoPascals as the maker's information indicates that the instrument is insensitive to pressure changes.

Test results

This is to certify that the sound calibrator conforms to the requirements of annex B of IEC 60942: 1997 for the conditions under which the test was performed. This does not imply that the sound calibrator meets IEC 60942 under any other conditions.

Details of the performed measurements are presented on **page 2** of this certificate.

Approved Signatory: **Date:** 04-Mar-2015 **Company Chop:**

Huang Jian Min/Feng Jun Qi

SOILS AND MATERIALS ENGINEERING COMPANY LTD. 綜合試驗有限公司

Comments: The results reported in this certificate refer to the conditon of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument.

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CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 15CA0303 01-02 **Page:** 2 **of** 2

1, Measured Sound Pressure Level

The output Sound Pressure Level in the calibrator head was measured at the setting and frequency shown using a calibrated laboratory standard microphone and insert voltage technique. The results are given in below with the estimated uncertainties.

(Output level in dB re 20 μPa)

Frequency Shown Hz	Output Sound Pressure Level Setting dB	Measured Output Sound Pressure Level dB	Estimated Expanded Uncertainty dB
1000	94.00	94.23	0.10

2, Sound Pressure Level Stability - Short Term Fluctuations

The Short Term Fluctuations was determined by measuring the maximum and minimum of the fast weighted DC output of the B&K 2610 measuring amplifier over a 20 second time interval as required in the standard. The Short Term Fluctuation was found to be:

At 1000 Hz **STF = 0.002 dB**

Estimated expanded uncertainty 0.005 dB

3, Actual Output Frequency

The determination of actual output frequency was made using a B&K 4180 microphone together with a B&K 2673 preamplifier connected to a B&K 2610 measuring amplifier. The AC output of the B&K 2610 was taken to an universal counter which was used to determine the frequency averaged over 20 second of operation as required by the standard. The actual output frequency at 1 KHz was:

At 1000 Hz **Actual Frequency = 1000.0 Hz**

Estimated expanded uncertainty 0.1 Hz Coverage factor k = 2.2

4, Total Noise and Distortion

For the Total Noise and Distortion measurement, the unfiltered AC output of the B&K 2610 measuring amplifier was connected to an Agilent Type 8903 B distortion analyser. The TND result at 1 KHz was:

At 1000 Hz **TND = 0.3 %**

Estimated expanded uncertainty 0.7 %

The expanded uncertainties have been calculated in accordance with the ISO Publication "Guide to the expression of uncertainty in measurement", and gives an interval estimated to have a level of confidence of 95%. A coverage factor of 2 is assumed unless explicitly stated.

- End -

Calibrated by: Fung Chi Yip **Checked by:** Lam Tze Wai

Date: 03-Mar-2015 **Date:** 04-Mar-2015

The standard(s) and equipment used in the calibration are traceable to national or international recognised standards and are calibrated on a schedule to maintain the required accuracy level.

綜合試驗有限公司
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CERTIFICATE OF CALIBRATION

Certificate No.: 16CA0304 02 **Page** 1 **of** 2

Item tested

Description:	Sound Level Meter (Type 1)	Microphone	Preamp
Manufacturer:	B & K	B & K	B & K
Type/Model No.:	2250-L	4950	ZC0032
Serial/Equipment No.:	2681366	2879980	19428
Adaptors used:	- (N-0001.01)	-	-

Item submitted by

Customer Name:	AECOM ASIA CO LIMITED
Address of Customer:	-
Request No.:	-
Date of receipt:	04-Mar-2016

Date of test: 05-Mar-2016

Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Multi function sound calibrator	B&K 4226	2288444	19-Jun-2016	CIGISMEC
Signal generator	DS 360	33873	16-Apr-2016	CEPREI
Signal generator	DS 360	61227	16-Apr-2016	CEPREI

Ambient conditions

Temperature:	21 ± 1 °C
Relative humidity:	60 ± 10 %
Air pressure:	1010 ± 5 hPa

Test specifications

1, The Sound Level Meter has been calibrated in accordance with the requirements as specified in BS 7580: Part 1: 1997 and the lab calibration procedure SMTP004-CA-152.

2, The electrical tests were performed using an electrical signal substituted for the microphone which was removed and replaced by an equivalent capacitance within a tolerance of ±20%.

3, The acoustic calibration was performed using an B&K 4226 sound calibrator and corrections was applied for the difference between the free-field and pressure responsess of the Sound Level Meter.

Test results

This is to certify that the Sound Level Meter conforms to BS 7580: Part 1: 1997 for the conditions under which the test was performed.

Details of the performed measurements are presented on page 2 of this certificate.

Actual Measurement data are documented on worksheets.

Approved Signatory: Huang Jian Min/Feng Jun Qi **Date:** 08-Mar-2016 **Company Chop:** SOILS AND MATERIALS ENGINEERING COMPANY LTD. 綜合試驗有限公司

Comments: The results reported in this certificate refer to the condition of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument.

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HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

(Continuation Page)

1, Electrical Tests

The electrical tests were perfomed using an equivalent capacitance substituted for the microphone. The results are given in below with test status and the estimated uncertainties. The "Pass" means the result of the test is inside the tolerances stated in the test specifications. The "-" means the result of test is outside these tolerances.

Test:	Subtest:	Status:	Expanded Uncertainty (dB)	Coverage Factor
Self-generated noise	A	Pass	0.3	
	C	Pass	0.8	
	Lin	Pass	1.6	
Linearity range for Leq	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
	Reference SPL on all other ranges	Pass	0.3	
	2 dB below upper limit of each range	Pass	0.3	
	2 dB above lower limit of each range	Pass	0.3	
Linearity range for SPL	At reference range , Step 5 dB at 4 kHz	Pass	0.3	
Frequency weightings	A	Pass	0.3	
	C	Pass	0.3	
	Lin	Pass	0.3	
Time weightings	Single Burst Fast	Pass	0.3	
	Single Burst Slow	Pass	0.3	
Peak response	Single 100μs rectangular pulse	Pass	0.3	
R.M.S. accuracy	Crest factor of 3	Pass	0.3	
Time weighting I	Single burst 5 ms at 2000 Hz	Pass	0.3	
	Repeated at frequency of 100 Hz	Pass	0.3	
Time averaging	1 ms burst duty factor $1/10^3$ at 4kHz	Pass	0.3	
	1 ms burst duty factor $1/10^4$ at 4kHz	Pass	0.3	
Pulse range	Single burst 10 ms at 4 kHz	Pass	0.4	
Sound exposure level	Single burst 10 ms at 4 kHz	Pass	0.4	
Overload indication	SPL	Pass	0.3	
	Leq	Pass	0.4	

2, Acoustic tests

The complete sound level meter was calibrated on the reference range using a B&K 4226 acoustic calibrator with 1000Hz and SPL 94 dB. The sensitivity of the sound level meter was adjusted. The test result at 125 Hz and 8000 Hz are given in below with test status and the estimated uncertainties.

Test:	Subtest	Status	Expanded Uncertainty (dB)	Coverage Factor
Acoustic response	Weighting A at 125 Hz	Pass	0.3	
	Weighting A at 8000 Hz	Pass	0.5	

3, Response to associated sound calibrator

N/A

The expanded uncertainties have been calculated in accordance with the ISO Publication "Guide to the expression of uncertainty in measurement", and gives an interval estimated to have a level of confidence of 95%. A coverage factor of 2 is assumed unless explicitly stated.

- End -

Calibrated by: Fung Chi Yip Date: 05-Mar-2016

Checked by: Lam Tze Wai Date: 08-Mar-2016

The standard(s) and equipment used in the calibration are traceable to national or international recognised standards and are calibrated on a schedule to maintain the required accuracy level.

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HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

Certificate No.: 16CA0428 02 **Page:** 1 **of** 2

Item tested

Description:	Acoustical Calibrator (Class 1)
Manufacturer:	Rion Co., Ltd.
Type/Model No.:	NC-74
Serial/Equipment No.:	34246490
Adaptors used:	Yes

Item submitted by

Curstomer:	AECOM ASIA CO., LTD.
Address of Customer:	-
Request No.:	-
Date of receipt:	28-Apr-2016

Date of test: 10-May-2016

Reference equipment used in the calibration

Description:	Model:	Serial No.	Expiry Date:	Traceable to:
Lab standard microphone	B&K 4180	2412857	14-Apr-2017	SCL
Preamplifier	B&K 2673	2239857	28-Apr-2017	CEPREI
Measuring amplifier	B&K 2610	2346941	26-Apr-2017	CEPREI
Signal generator	DS 360	61227	18-Apr-2017	CEPREI
Digital multi-meter	34401A	US36087050	18-Apr-2017	CEPREI
Audio analyzer	8903B	GB41300350	19-Apr-2017	CEPREI
Universal counter	53132A	MY40003662	19-Apr-2017	CEPREI

Ambient conditions

Temperature:	21 ± 1 °C
Relative humidity:	50 ± 10 %
Air pressure:	1005 ± 5 hPa

Test specifications

1, The Sound Calibrator has been calibrated in accordance with the requirements as specified in IEC 60942 1997 Annex B and the lab calibration procedure SMTP004-CA-156.

2, The calibrator was tested with its axis vertical facing downwards at the specific frequency using insert voltage technique.

3, The results are rounded to the nearest 0.01 dB and 0.1 Hz and have not been corrected for variations from a reference pressure of 1013.25 hectoPascals as the maker's information indicates that the instrument is insensitive to pressure changes.

Test results

This is to certify that the sound calibrator conforms to the requirements of annex B of IEC 60942: 1997 for the conditions under which the test was performed. This does not imply that the sound calibrator meets IEC 60942 under any other conditions.

Details of the performed measurements are presented on **page 2** of this certificate.

Approved Signatory: Huang Jian Min/Feng Jun Qi **Date:** 11-May-2016 **Company Chop:**

SOILS & MATERIALS ENGINEERING COMPANY LTD. 綜合試驗有限公司

Comments: The results reported in this certificate refer to the conditon of the instrument on the date of calibration and carry no implication regarding the long-term stability of the instrument.

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HOKLAS 028 CAL

CERTIFICATE OF CALIBRATION

(Continuation Page)

Certificate No.: 16CA0428 02 **Page:** 2 **of** 2

1, Measured Sound Pressure Level

The output Sound Pressure Level in the calibrator head was measured at the setting and frequency shown using a calibrated laboratory standard microphone and insert voltage technique. The results are given in below with the estimated uncertainties.

(Output level in dB re 20 μPa)

Frequency Shown Hz	Output Sound Pressure Level Setting dB	Measured Output Sound Pressure Level dB	Estimated Expanded Uncertainty dB
1000	94.00	94.07	0.10

2, Sound Pressure Level Stability - Short Term Fluctuations

The Short Term Fluctuations was determined by measuring the maximum and minimum of the fast weighted DC output of the B&K 2610 measuring amplifier over a 20 second time interval as required in the standard. The Short Term Fluctuation was found to be:

At 1000 Hz **STF = 0.002 dB**

Estimated expanded uncertainty 0.005 dB

3, Actual Output Frequency

The determination of actual output frequency was made using a B&K 4180 microphone together with a B&K 2673 preamplifier connected to a B&K 2610 measuring amplifier. The AC output of the B&K 2610 was taken to an universal counter which was used to determine the frequency averaged over 20 second of operation as required by the standard. The actual output frequency at 1 KHz was:

At 1000 Hz **Actual Frequency = 1001.9 Hz**

Estimated expanded uncertainty 0.1 Hz Coverage factor k = 2.2

4, Total Noise and Distortion

For the Total Noise and Distortion measurement, the unfiltered AC output of the B&K 2610 measuring amplifier was connected to an Agilent Type 8903 B distortion analyser. The TND result at 1 KHz was:

At 1000 Hz **TND = 1.2 %**

Estimated expanded uncertainty 0.7 %

The expanded uncertainties have been calculated in accordance with the ISO Publication "Guide to the expression of uncertainty in measurement", and gives an interval estimated to have a level of confidence of 95%. A coverage factor of 2 is assumed unless explicitly stated.

- End -

Calibrated by: Fung Chi Yip **Date:** 10-May-2016

Checked by: J. Q. Feng **Date:** 11-May-2016

The standard(s) and equipment used in the calibration are traceable to national or international recognised standards and are calibrated on a schedule to maintain the required accuracy level.

APPENDIX B

Details Traffic Data

Appendix B - Details Traffic Data

Counted Traffic Data Obtained on 7 January 2016 and 16 August 2016 during PM Traffic Peak Hour

Sensitive Receivers		No. of Vehicles	No. of Vehicles in Peak Hour (veh/hr)	Percentage of Heavy Vehicle in Peak Hour	Estimated Speed in Peak Hour (km/hr)	No. of Vehicles	No. of Vehicles in Peak Hour (veh/hr)	Percentage of Heavy Vehicle in Peak Hour	Estimated Speed in Peak Hour (km/hr)
		North Bound				South Bound			
SR20 (16 August 2016)	18:00-18:30	2046	3809	18%	90	1930	3708	18%	85
	18:30-19:00	1930				2072			
	19:00-19:30	1738				1560			
		North Bound				South Bound			
SR57 & SR39 (7 January 2016)	18:00-18:30	1902	3855	17%	79	1944	3837	17%	95
	18:30-19:00	1994				2002			
	19:00-19:30	1886				1810			