

1 LSR Measurements and the Results

1.1 Measurement Methodology

1.1.1.1 Borehole impact tests were conducted to investigate the transfer mobility from track level to the ground surface and building structure. Force excitation by hammer impact was performed at the bottom of the borehole having similar depth as the track level. In view of there being no major sources of background vibration near the borehole impact sites (e.g. busy road traffics, fixed plants, construction activities, etc.), the measurements were conducted during daytime.

1.1.1.2 According to the Transit Noise and Vibration Impact Assessment, two methods are recommended to determine the LSR from the PSR data collected from measurements: (A) lines of transducers and (B) line of impacts. The former refers to the setting up of one or more lines of transducers corresponding to a single impact location at each site, while the latter refers to the setting up of multiple impact locations along the rail alignment with transducers at specific vibration paths and/or specific buildings at each specific site. For practical reasons, the number of borehole locations is limited. Thus, the lines of transducers method has been adopted.

1.1.1.3 The measurement setup of borehole impact test is illustrated in **Annex 4.5.1**. The impact hammer is mounted at the top of the connecting pipe. The bottom side of the connecting pipe is installed with an impact head for the transmission of the hammer impact to the bottom of the borehole. Instantaneous impact forces transmitted are measured by the load cell of the impact hammer. Lines of accelerometers are installed at the ground surface to detect the vibration transmission from each borehole.

1.2 Selection of Measurement Locations

1.2.1.1 It should be noted that the trackform of TUE at TCE would be at-graded ballast track except the TCE station section which is non-ballast track. In addition, the nearest distance between the NSR and the track at TCE is approximately 120m. Considering that the TUE trackform is at-grade with sufficient separation distance between the NSRs and the track, adverse groundborne noise impact for this part of the alignment are not anticipated. Hence, LSR measurements were not considered of TCE.

1.2.1.2 For TCW however, the alignment runs in tunnel from Tung Chung Crescent, through Ma Wan Chung until it reaches the TCW Station to the west of Yat Tung Estate. NSRs in close proximity of the tunnel alignment include the village houses in Ma Wan Chung, high-rise residential buildings in Yat Tung Estate, etc. According to the latest design, the tunnel track level is approximately 20m below ground at near Yat Tung Estate. In order to establish the LSR as specific to the alignment and NSRs as possible, 2 borehole locations representing the village houses in Ma Wang Chung and Yat Tung Estate have been selected. Their locations are shown in **Figure 1** and details are listed in the following table. The LSR measurements were conducted when the borehole depths reached about the proposed track levels.

Table 1 Borehole impact test sites

No.	Borehole Impact Test Site	Borehole Depth	Geological Condition
1	Tung Chung Road North	30.0 m (bottom level at -14.8 mPD)	Rock
2	Yat Tung Estate	17.8 m (bottom level at -13.8 mPD)	Soil

1.2.1.3 Accelerometer locations of the vibration measurement conducted at each borehole impact test site were set at horizontal distances from 5 m to 50 m, as shown in **Table 2** and **Annex Figure 4.5.1**.

Table 2 Distances between accelerometers and the borehole impact location at each test site

Borehole Impact Test Site 1				Borehole Impact Test Site 2			
ID	Horizontal Distance (m)	Vertical Distance (m)	Slant Distance (m)	ID	Horizontal Distance (m)	Vertical Distance (m)	Slant Distance (m)
1A	9.9	28.8	30.5	2A	5.0	17.8	18.5
1B	19.9	27.8	34.2	2B	12.5	21.0	24.4
1C	29.9	27.8	40.8	2C	21.5	21.0	30.1
1D	38.9	27.9	47.9	2D	32.0	21.0	38.3
1E	50.0	28.1	57.3	2E	42.0	21.0	47.0
1F	10.0	30.8	32.4	2F	50.0	21.0	54.2
1G	19.9	31.8	37.5	2G	19.0	21.0	28.3
1H	29.8	33.8	45.0	2H	37.0	21.0	42.5
1I	39.6	35.8	53.4	2I	44.0	21.0	48.8
1J	49.4	37.8	62.2	-	-	-	-

1.3 Data Analysis

1.3.1.1 PSR from borehole impact location to accelerometer locations is determined by the standard signal-processing techniques of frequency response function of the measured groundborne vibration velocities reference to the excitation force, averaged for 20 to 30 hammer impacts.

1.3.1.2 LSR is then evaluated by numerical regression of the measured PSR and numerical integration along the train length.

$$LSR(s, d, f) = 10 \log \left\{ \int_{-\frac{L}{2}}^{\frac{L}{2}} \left[10^{\frac{PSR(\sqrt{d^2+s^2+y^2}, f)}{20}} \right]^2 dy \right\}$$

where s , d and L represents the perpendicular setback distance, the depth of track level and the train length respectively.

1.4 Measurement Results

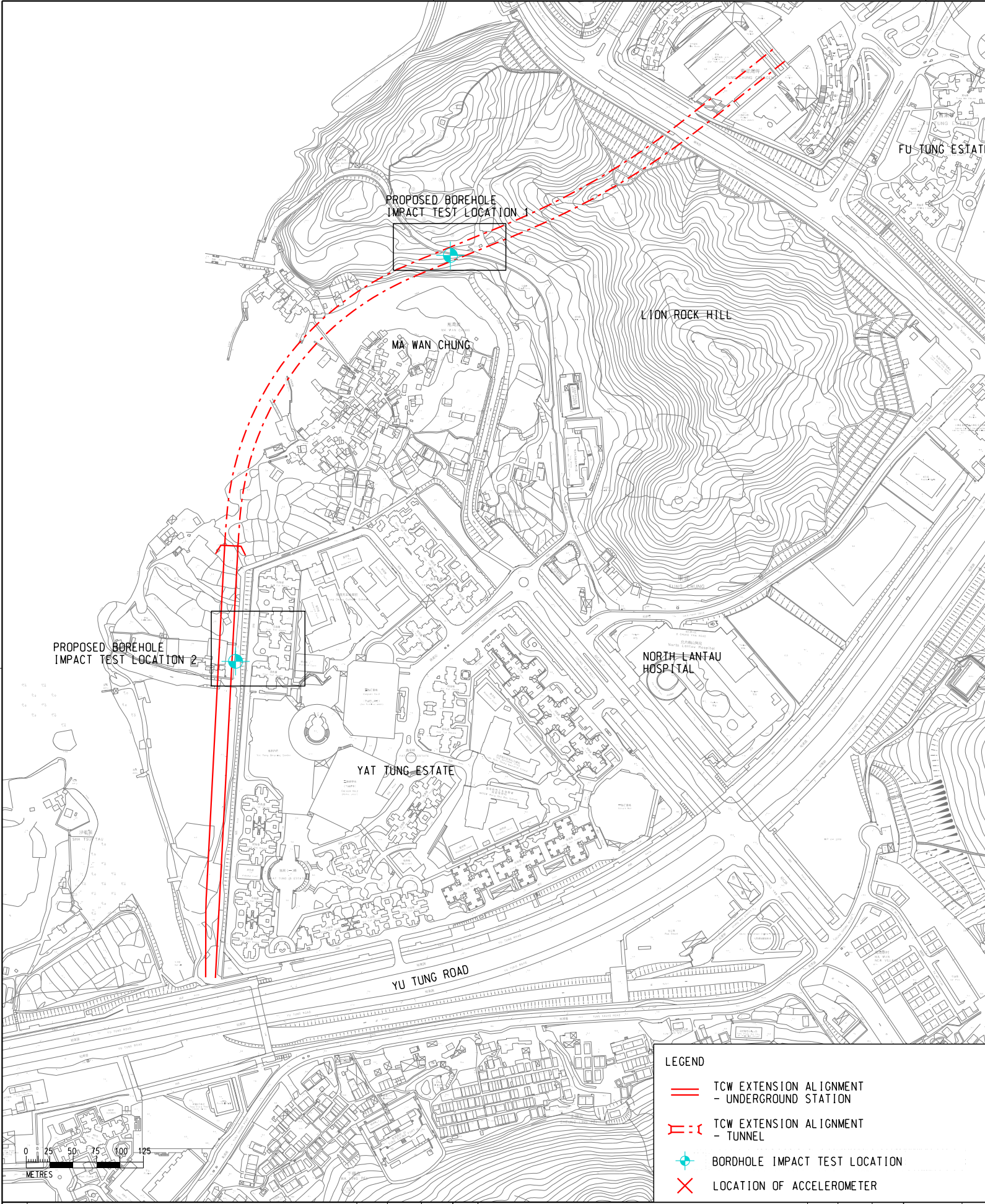
1.4.1.1 PSR and LSR results are shown in **Annex 4.5.2**. All the measured spectra cover from 3.15Hz up to 500Hz.

Annex Figure

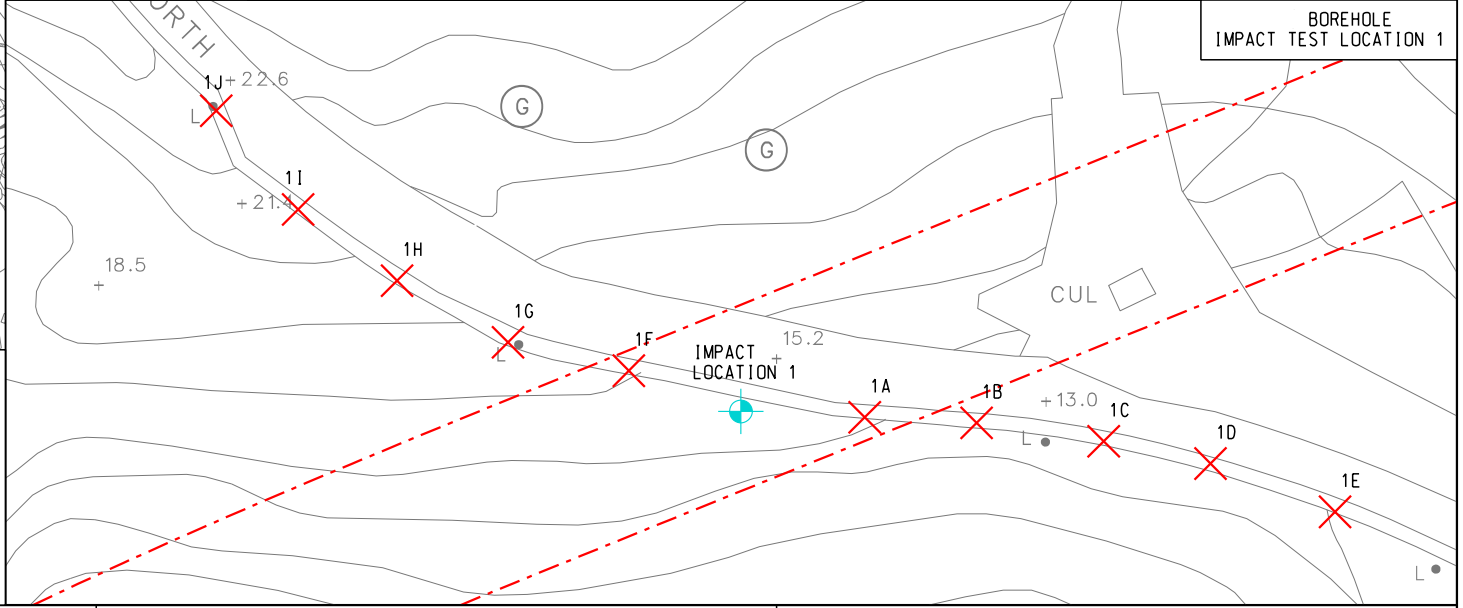
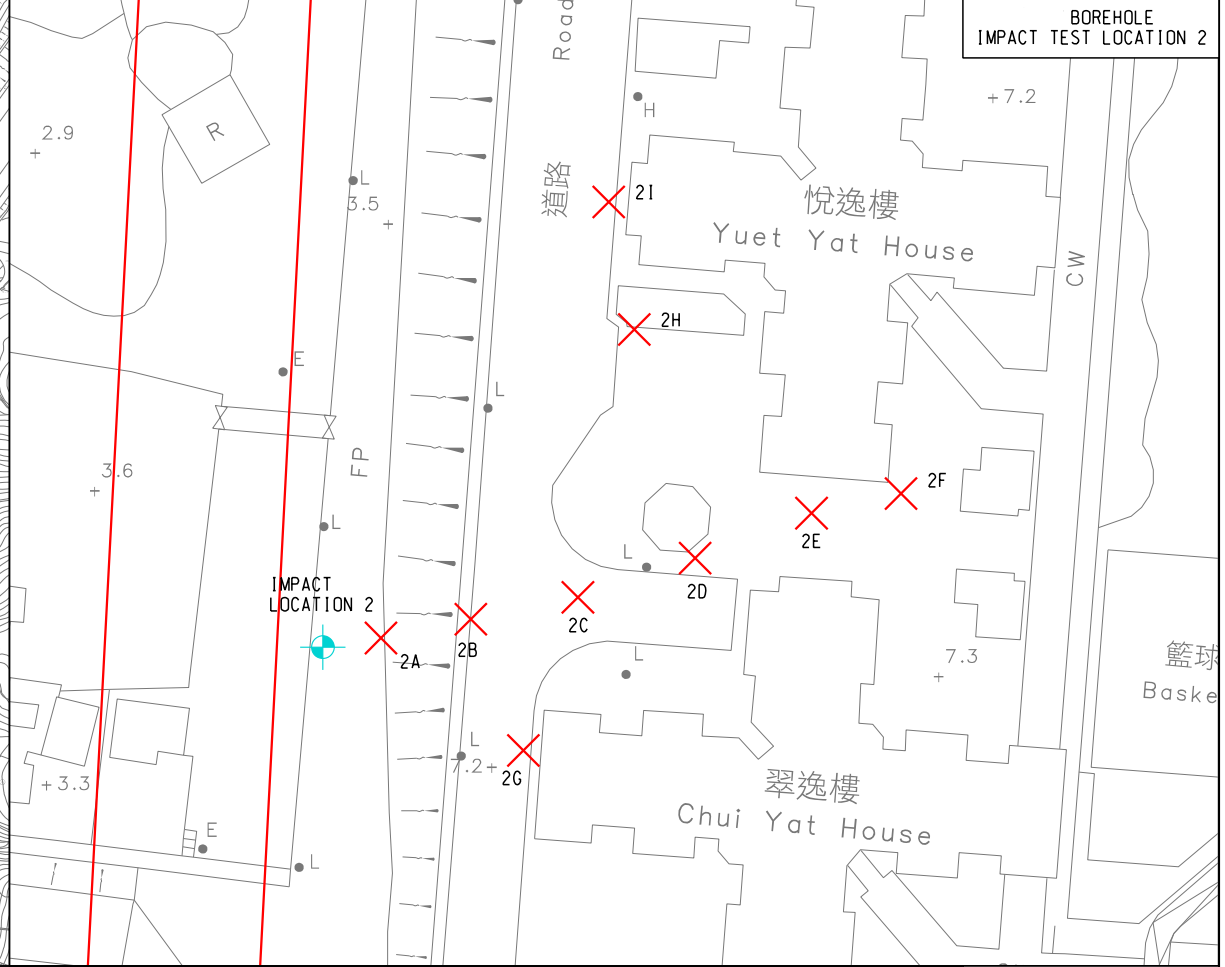


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\\hkmg1s2\c\env\project\271613 Drawing Deliverables\report_016 Working Paper on LSR Measurement Methodology\FIGURE 3.L.F.dgn

PLOT DRW:
MODELNAME:
FILENAME:



- LEGEND
- TCW EXTENSION ALIGNMENT - UNDERGROUND STATION
 - TCW EXTENSION ALIGNMENT - TUNNEL
 - BORDHOLE IMPACT TEST LOCATION
 - LOCATION OF ACCELEROMETER



REV	DESCRIPTION	BY	DATE	APPROVED	REV	DESCRIPTION	BY	DATE	APPROVED
					F	SIXTH ISSUE	GL	230821	FC
					E	FIFTH ISSUE	GL	091220	FC
					D	FOURTH ISSUE	GL	150920	FC
					C	THIRD ISSUE	GL	080920	FC
					B	SECOND ISSUE	GL	070920	FC
					A	FIRST ISSUE	GL	040920	FC

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ORIGINATOR

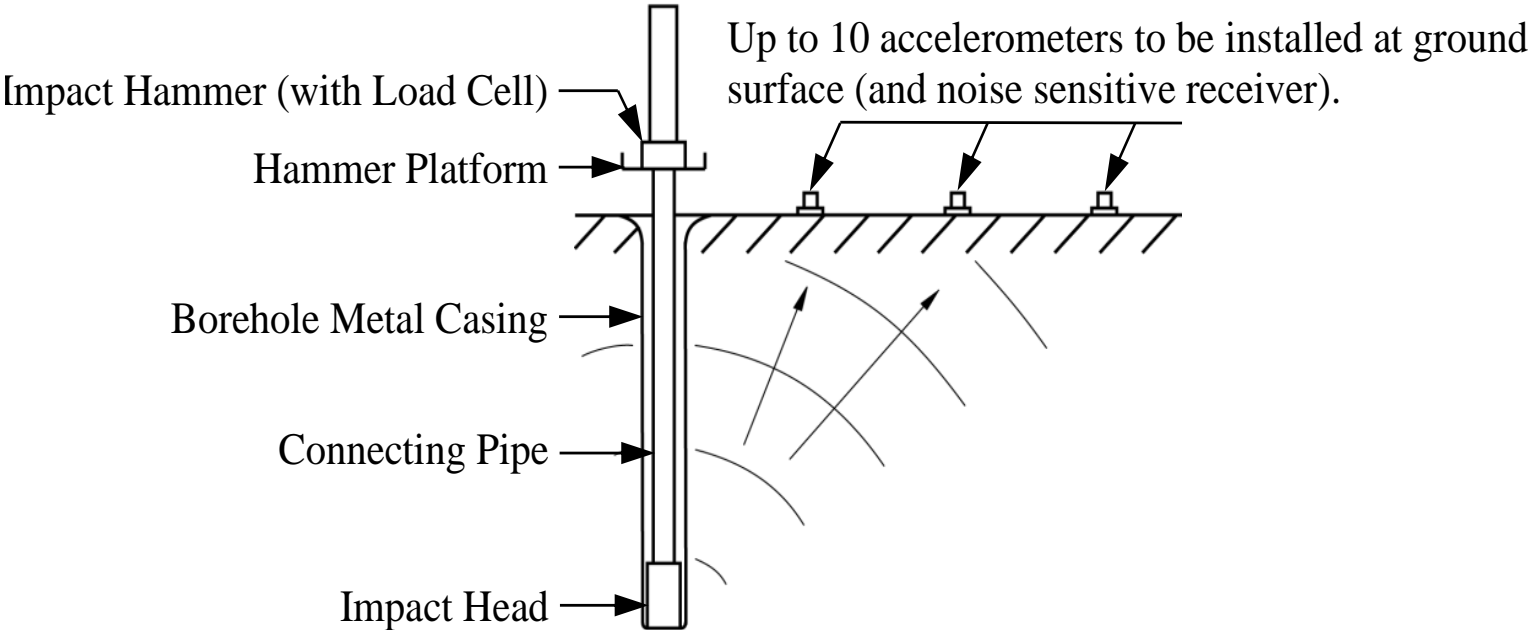
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TITLE			SCALE		DRAWING NO.		REV.
BOREHOLE IMPACT TEST LOCATION 1 AND 2 FOR THE TENTATIVE ALIGNMENT			1: 5000 (A3)		ANNEX FIGURE 4.5.1		F

Annex 4.5.1

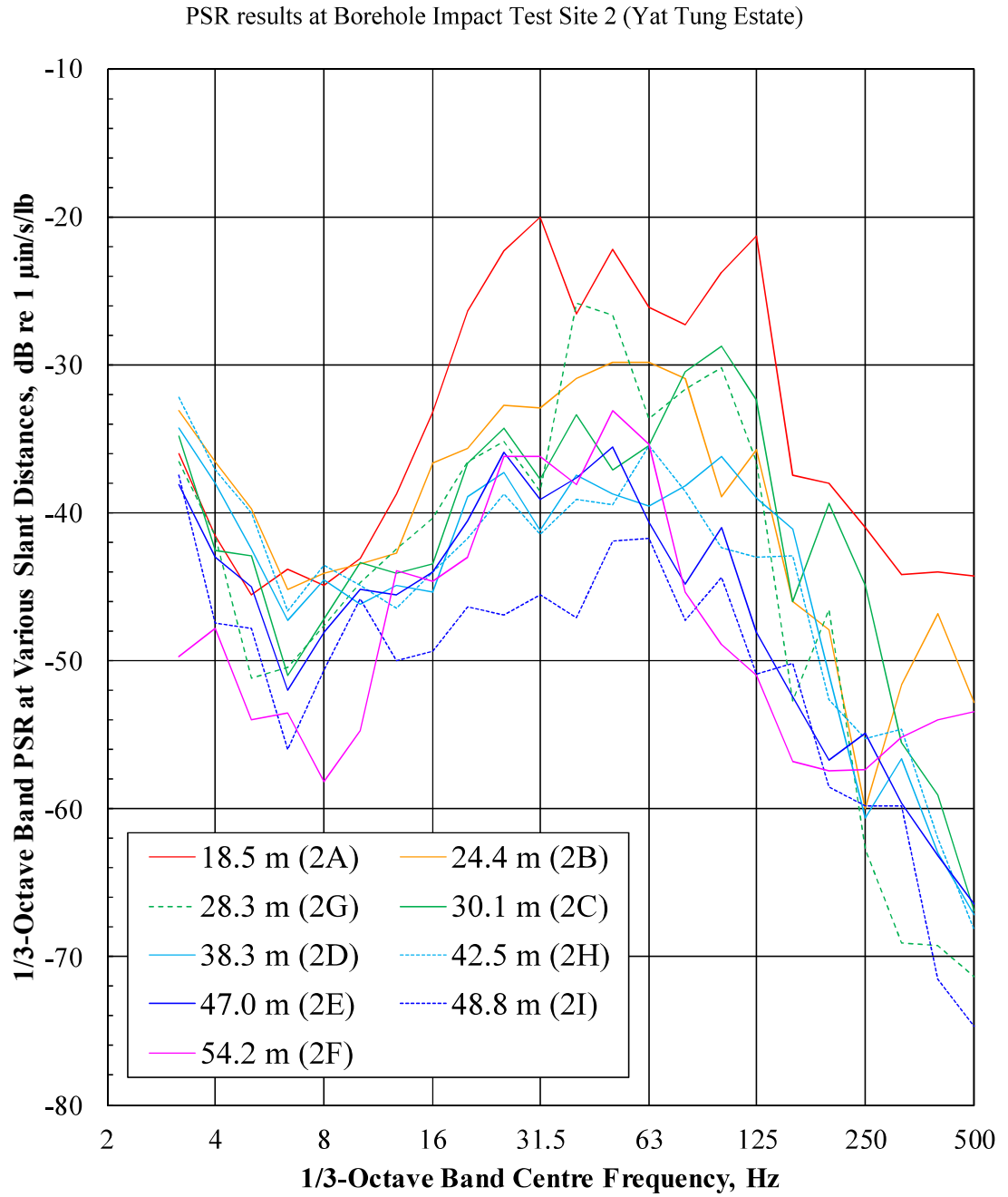
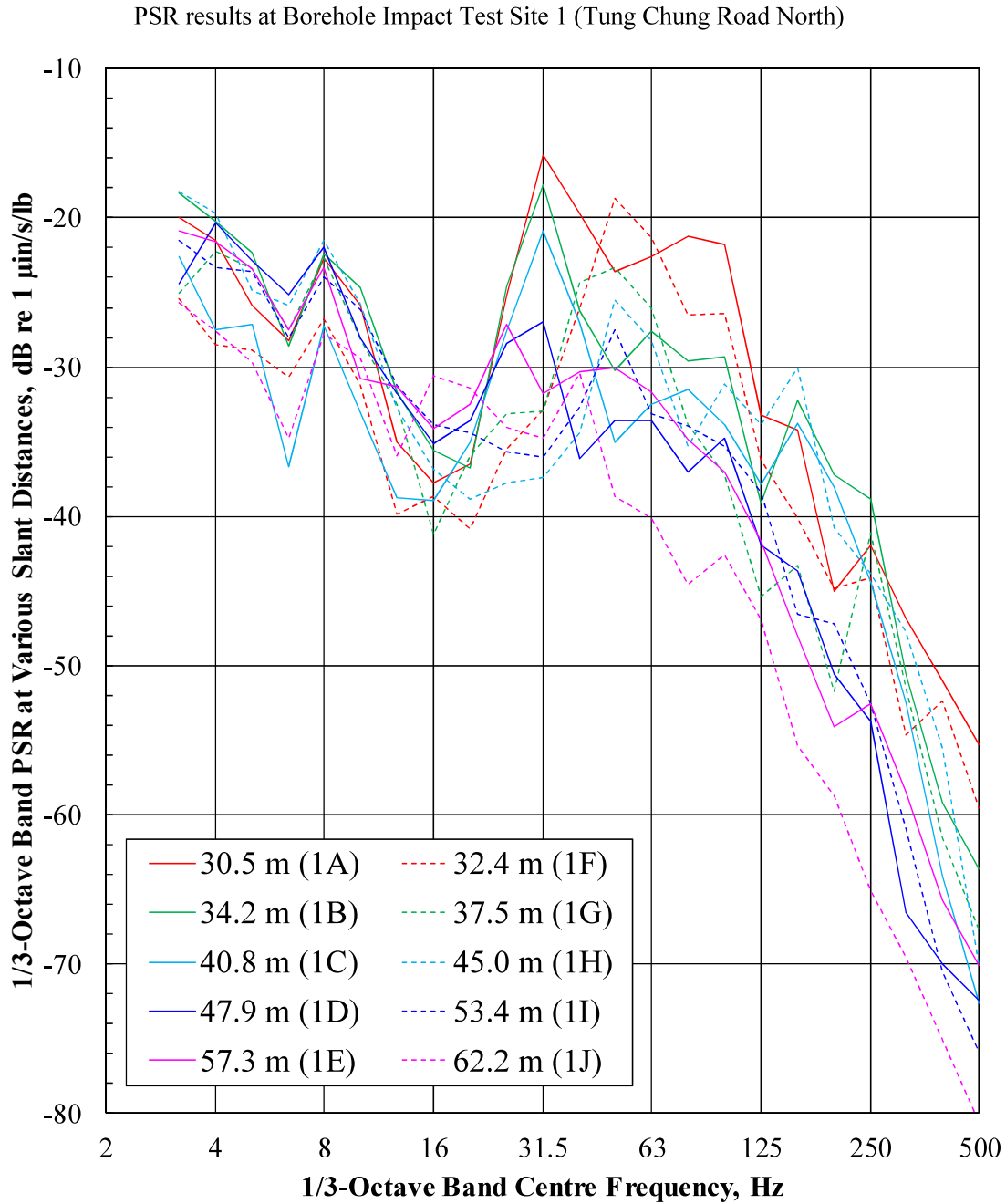
Measurement setup of
borehole impact test



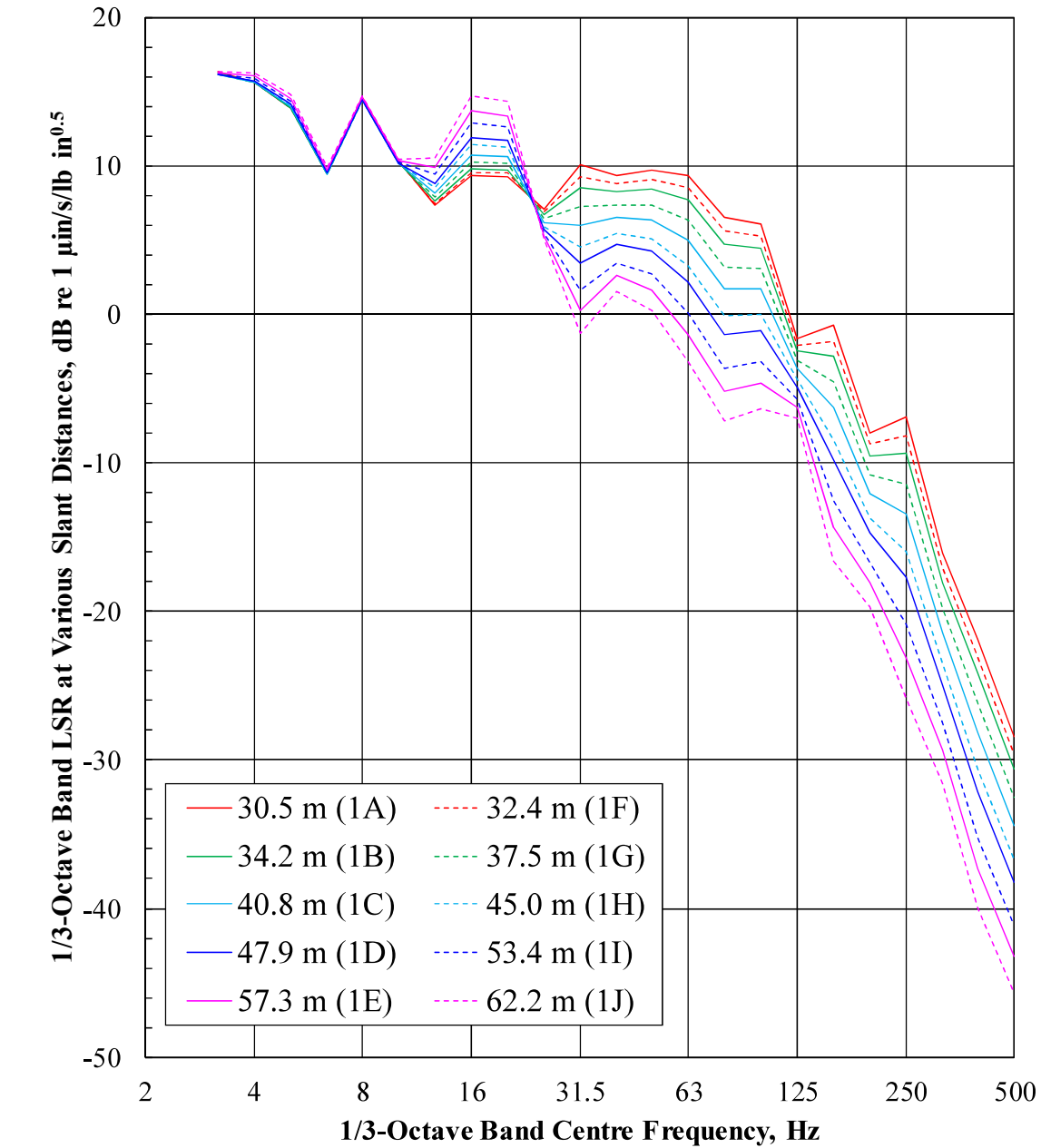
Annex 4.5.2

PSR and LSR

measurement result



LSR results at Borehole Impact Test Site 1 (Tung Chung Road North)



LSR results at Borehole Impact Test Site 2 (Yat Tung Estate)

