Section 7
Potentially Significant Impacts and Mitigation Measures During The Operation Stage

SECTION 7 : POTENTIALLY SIGNIFICANT IMPACTS AND MITIGATION MEASURES DURING THE OPERATIONAL STAGE

7.1 INTRODUCTION

This section of the report examines the potentially significant impacts that could arise during the operational phase of the Project. The impacts are assessed in terms of magnitude, prevalence, duration and frequency of occurrence whichever is applicable, and their consequences. This section also discusses the mitigation measures which can be implemented to ensure the adverse impacts are kept to a minimum.

7.2 SENSITIVE RECEPTORS

The receptors of the potential impacts from the Project would include all the various communities and land uses located along the alignment, which have been identified and described in **Section 4.4** of this report.

7.3 POTENTIALLY SIGNIFICANT IMPACTS

The main potentially significant impacts expected during the operational stage are as follows:

Noise – from the operation of the trains, especially for premises located close to the station and at bends

Vibration – from the operation of the trains, particularly along the underground section

Traffic – the Project is expected to contribute the overall traffic improvement, particularly at Klang areas

Visual impacts – the elevated structures may affect the existing landscape along certain stretch of the alignment, particularly at residential areas

Air quality – the Project is expected to contribute to overall air quality improvement in the Klang Valley in terms of avoided emissions

Social impacts – people in Klang, Shah Alam and Petaling Jaya are expected to benefit in terms of better public transport system as well as enhanced economic activities, especially those located within the certain radius of the stations. However, at local level, adverse impacts in terms of traffic congestion, increased noise level and loss of privacy could occur.

7.4 NOISE IMPACTS

Noise is a concern during the operational phase, particularly for the sensitive receptors located near to the track. Noise sensitive receptors which include schools, hospitals and houses have been identified and assessment of the noise impacts carried out. The methodology for the noise modeling as well as the noise limits that need to be complied to are discussed in the following sections.

7.4.1 Acceptable Noise Limits

The recommended environmental noise limits are given in the DOE's Planning Guidelines for Environmental Noise Limits and Control (2007). The recommended absolute numerical limits are given based on the receiving land use, as well as limits based on the existing environment (in terms of L_{max}, $L_{eq\ day}$ and $L_{eq\ night}$). Recommended maximum permissible sound levels assessed at the real property boundary of the receptors for different land use for railways development are given in Annex A, Schedule 5 of the Guidelines (**Table 7-1**).

Table 7-1 Limiting Sound Level for Railways Including Transits (For New Development and Re-alignments)

Receiving Land Use Category	Day Time 7.00 am - 10.00 pm	Night Time 10.00 pm - 7.00 am	L_{max} (Day & Night)
Noise Sensitive Areas Low Density Residential Areas	60 dBA	50 dBA	75 dBA
Suburban and Urban Residential Areas	65 dBA	60 dBA	80 dBA
Commercial, Business	70 dBA	65 dBA	80 dBA
Industrial	75 dBA	65 dBA	NA

Source: DOE Guidelines for Environmental Noise Limits & Control (2007)

Limits in Schedule 5 are absolute numerical limits for continuous A-weighted equivalent noise L_{Aeq} for daytime and night time, and trains pass-by instantaneous L_{max} noise level. In practical situations where projects are undertaken in areas with existing high noise levels where existing noise levels are higher than the limits stated in Schedule 5, recommend limits shall be based on the existing noise climate (L_{Aeq}). An acceptance criterion at receptors based on the existing noise levels as extracted from Schedule 3 of the Guidelines are tabulated in **Table 7-2**.

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Table 7-2 Recommended Limits based on Existing Noise Levels

Existing Levels	Desirable Levels	Maximum Permissible
L_{Aeq}	L_{Aeq}	L_{Aeq}+3 dBA

Source: DOE Guidelines for Environmental Noise Limits & Control (2007)

Annex C of the DOE Guidelines (**Table 7-3**) also provides guidance in determining community response and impact classification with respect to any increase in noise levels above the existing ambient.

Table 7-3 Anticipated Community Response to Noise

Amount in dBA of sound level exceeding noise criterion	Anticipated community response	
	Impact	Description
0	None	No observed reaction
5	Little	Sporadic complaints
10	Medium	Widespread complaints
15	Strong	Threats of community action
20	Very Strong	Vigorous community action

Source: DOE Guidelines for Environmental Noise Limits & Control (2007)

Based on the different methods suggested in the Guidelines, the acceptance noise limits are proposed as follows:

At noise sensitive receptors where the existing noise climate is below 65 dBA L_{eq} day and 60 dBA L_{eq} night, the permissible noise limits are:

L_{eq} Day = 65 dBA
L_{eq} Night = 60 dBA

At noise sensitive receptors with baseline noise levels exceeding the above criteria, the permissible noise limits:

New L_{eq} Day = Existing L_{eq} Day + 3 dBA
New L_{eq} Night= Existing L_{eq} Night + 3 dBA

The above limits are based on a permissible increase of 3 dBA ($L_{eq\ current}$ + 3 dBA) of the existing continuous A-weighted equivalent noise limit.

For single events train pass-by noise at sensitive receptors, the permissible instantaneous pass L_{max} noise level shall be :

Permissible L_{max} = 75 dBA for trains pass-by events averaged over one (1) hour.

There shall therefore be two noise limits criteria (L_{Aeq} and L_{max}) to ensure minimal noise impact affecting sensitive receptors located along the proposed alignment.

The above recommended noise limits are consistent with the limits stipulated in the EIA approvals for the Kelana and Ampang LRT Extension projects and MRT1.

7.4.2 Methodology

Noise propagation is primarily governed by sound power levels of the noise source (primarily from wheels rail rolling and traction noise), elevation of the railway viaducts, distance of the receiver from the viaducts, relative elevation of the receiver, angle of view between a receiver and the track, ground absorption, reflection (from building and other reflectors), acoustic screening (from natural or manmade barriers, embankment, etc) and atmospheric absorption.

Environmental noise modelling requires the noise source (train pass-by) to be quantified. As manufacturer's noise data is not yet available, the most accurate manner upon which LRT train noise could be established were from actual measurements of similar installations. Noise measurements were undertaken at the existing LRT lines (Kelana and Ampang Lines) since the LRT3 trains would be similar. Measurements were undertaken in two locations with direct line of sight to LRT trains: on grade at the Plaza Rakyat/Jalan Hang Jebat area and at Wisma Bumi Raya and Bangunan DBKL Jalan Raja Laut (**Plate 7-1**).

The noise measurements showed typical L_{max} transient peaks corresponding to trains pass-bys. One third octave band sound pressure levels for short term L_{Aeq20s} and L_{max} were also determined for LRT pass-bys (with repeat measurements over several hours monitoring) (**Chart 7-1**). The measurements also showed variations in noise levels for different trains (which confirmed dependency on train wheels conditions). Maximum measured levels were used for the sound power levels assumed in the noise modeling.

Environmental noise modelling was undertaken using the *Cadna-A Noise Modelling Software* Version 3.7.123*.* The noise calculation algorithms in the software are based on the ISO 961302: "*Acoustics- Attenuation of sound propagation outdoors- Part 2 General method of calculation*". Computations were undertaken in octave band centre frequencies from 63 Hz to 8000 Hz. Resulting total sound pressure level from the line source of the trains at receiver locations were determined.

Sound pressure levels propagated to the environment are basically governed by the following relationship

$$L_p = L_w - D_c - A$$

where L_p = *Sound pressure level, dBA (ref 20 micro Pascals)*
L_w = *Sound power level, dBA*
D_c = *Directivity constant (dependent on orientation & location of noise source)*
A = *Attenuation factor, dBA*

The attenuation factor (A) is the cumulative attenuation due to distance loss (A_{div}) i.e. distance, r of a receiver from the noise source, atmospheric absorption (A_{atm}), ground effects (A_{gr}) and other miscellaneous loss (A_{misc}). In addition to the above, barrier shielding effects (from screens and firewalls) offers further sound attenuation ($A_{barrier}$). The attenuation factors are as follows:

$$A_{div} = 20 \log (r/r_o) + 11 \text{ dB}$$
$$A_{atm} = \alpha_r / 1000 \text{ dB per km}$$

where r = *is the distance from source to receiver (m)*
r_o = *is a reference distance (1 m)*
α_r = *atmospheric absorption constant, dB*

Plate 7-1 LRT pass-by noise measurements at Jalan Hang Jebat and Raja Laut



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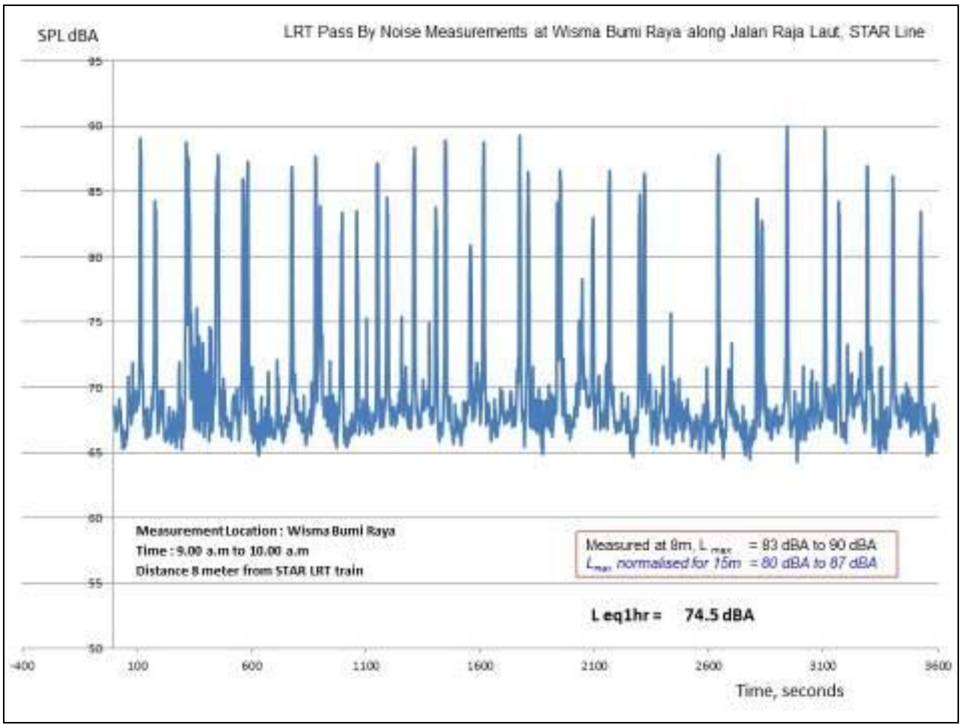
Chart 7-1 Typical LRT Pass Noise Levels Versus Time for Ampang Line



The constant α_r is dependent on atmospheric conditions as defined in ISO 9613 Part 1. The ground effects (A_{gr}) are given in Equation 8.5 of ISO 9613 – Part 2, and barriers loss ($A_{barrier}$) are given in Equation 8.6 to 8.11 in ISO 9613 – Part 2 Calculations.

The LRT3 alignment was modelled as a line source in a 3-dimensional spatial model with buildings and receptors of interest represented in the geometric model. Noise propagation from the rail alignment throughout the alignment was then undertaken using the modelling software. Computational noise models developed for transient pass-by instantaneous noise L_{max} and short term (1 hour) equivalent $L_{Aeq\ 1hr}$ to determine noise propagation (and contours) for L_{max} and $L_{Aeq\ 1\ hr}$.

The modelling was based on the following assumptions:

- Sound emission level for LRT3 pass-by was assumed to be 87 dBA measured at 15m from track side (at train speed of 80 km/hr) without noise shielding from parapets.

- Noise modelling was undertaken for an assumed constant train speed (80 km/hr being the maximum speed along the alignment) since speed profile are yet to be finalised (typically available only during detailed design). Train L_{max} is governed by a semi-empirical relationship of *30 x log (speed ratio referenced to 80 km/hr).* This implies that train noise level would reduce by 2 dBA for every 10km/hr speed reduction. (Source: *Recent developments in operational rail noise and vibration in New South Wales, Australia Rail Corp. Anderson. 2008).*

- Rail noise is also influenced by wheels and rail tracks conditions and in particular during braking (wheels and brake squeals) and rails corrugations. The noise data as used in the noise modelling were based on measured worst case noise levels; and as such had embedded within the assumed sound power levels some degree of wheels and rails degradation typical of existing LRT operations.

- Due to limited information available at this stage, noise modelling of the LRT3 was based on an assumed average guide-way height of 15m above ground. At Persiaran Dato' Menteri Shah Alam area where the alignment goes underground, the descent and ascent to and from the tunnel section was represented accordingly. There is no airborne noise emission from the alignment in the underground section.

- Noise modelling was on the basis of a standard viaduct guideway design (without additional noise barriers for example) but with parapet wall included on the viaduct guideway.

- Noise modeling was undertaken for the entire alignment. For ease of data processing and reporting, the modeling was undertaken in 11 separate sections of the alignment.

- Outdoor noise propagation was undertaken in the absence of wind. Ground effects and reflections from ground and large building surfaces were included in the modelling. Wind effects are relatively minimal and sensitivity analysis done with and without wind showed differences in noise levels of less than 1 dBA downside of the wind. Thermal effects are also not significant in Malaysia (unlike countries with winter and summer) and effects on noise propagation due to variations in temperature between day and night time for example are typically an order of magnitude less than wind effects.

- Noise maps presented are without highway and roads represented in the LRT3 noise propagation models. The total noise (cumulative effect) of LRT3 train noise (and other existing noise prevailing at the respective receptors) was nevertheless considered in the summation of the LRT3 trains noise with the measured ambient baseline noise that inherently is dictated by the prevailing noise climate.

7.4.3 Predicted Noise Levels

Noise contours were generated and presented as a continuous noise map (instead of presenting actual train noise at a particular instant in time travelling along the alignment). Noise levels at all locations along the track alignment are visually represented as colour contours.

For purpose of reporting and assessment, noise maps were generated for receivers located 4m above grade (i.e. on 1st floor of residential houses, etc.) consistent with noise monitoring done at microphone locations 4m above grade in accordance to ISO acoustic measurements and assessment procedures. Noise maps at other heights / elevations can be produced where required.

Noise levels at specific locations and receptors heights were obtained numerically from the resulting noise contour maps. Noise levels from LRT trains pass-bys at all the noise sensitive receptors locations (noise monitoring locations) are reported for single event L_{max} and. L_{Aeq} day and night.

Examples of a typical 3-D noise model is shown in **Chart 7-2** for the receptors at Kelana Jaya (Kelana D'Putera Condo, etc).

Chart 7-2 3-D Noise Model at Kelana Jaya (Kelana D'Putera Condo)

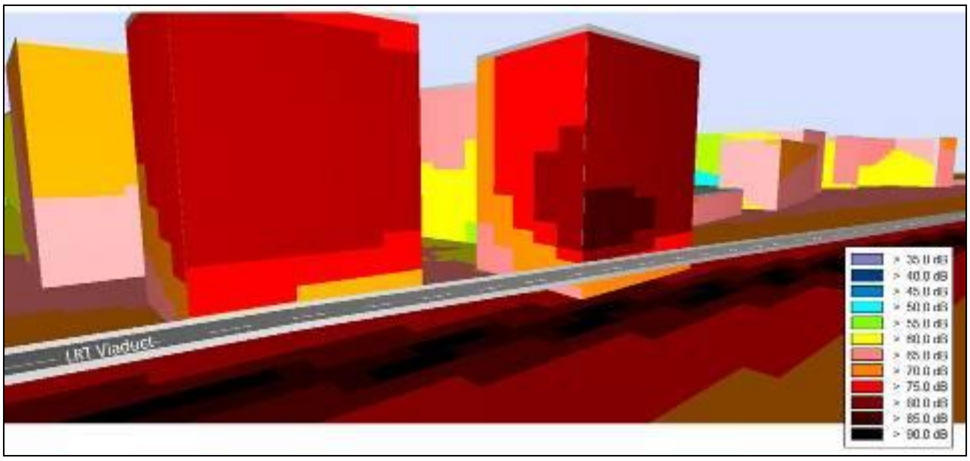


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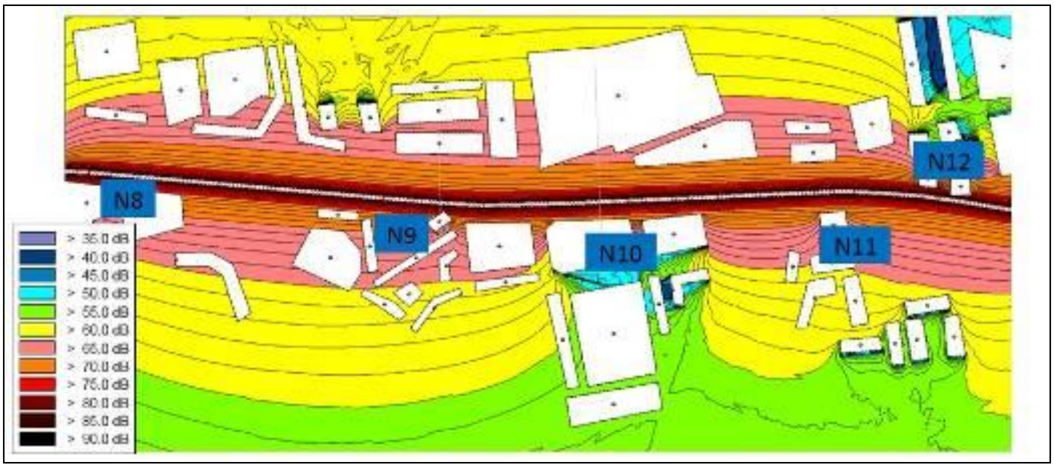
Chart 7-3 Noise Contours in Plan View at Kelana Jaya Area

Examples of the corresponding noise contours plotted in plan is given in **Chart 7-3** and typical cross sections at selected receptors' buildings given in **Chart 7-4**.

Chart 7-4 Cross Sections of Noise Model at Kelana Jaya (Kelana D'Putera Condo)



Results of the noise modelling in the form of noise contours along the entire alignment from Damansara Utama to Klang are given in **Charts 7-5 to 7-18**. These noise maps show LRT3 noise propagation to all areas along the entire railway corridor for transient trains pass-by L_{max} noise. Noise levels are represented as color bands of 5 dBA within demarcation lines 1 dBA increment shown within each color band.

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Chart 7-5 Noise Maps L_{max} for LRT3 Trains Pass-By. Damansara Utama Area

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Chart 7-6 **Noise Maps L_{max} for LRT3 Trains Pass-By. Puncak Damansara & Jalan Tropicana Selatan Area**

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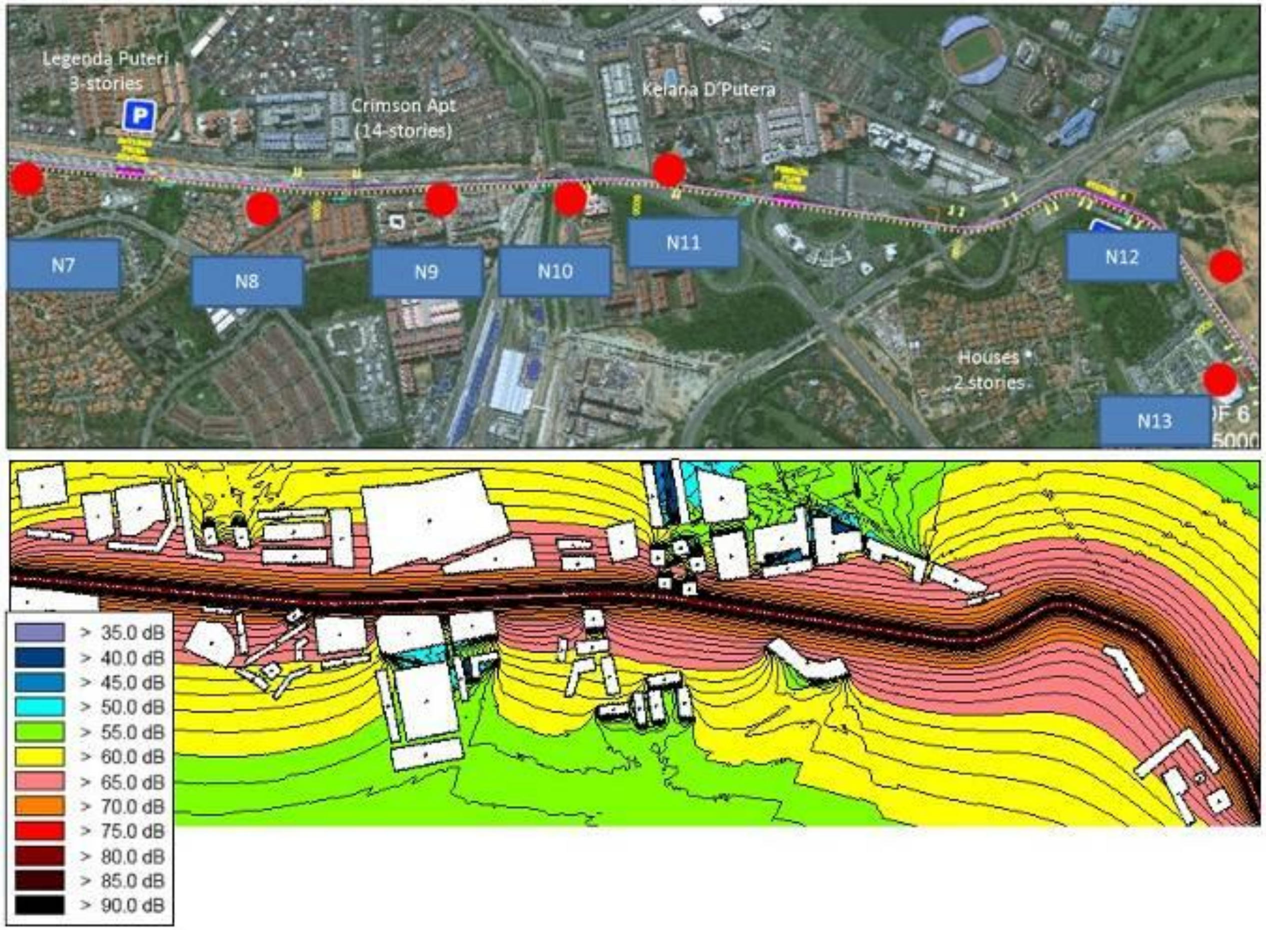

Chart 7-7 Noise Maps L_{max} for LRT3 Trains Pass-By. Puncak Damansara & Jalan Tropicana Selatan

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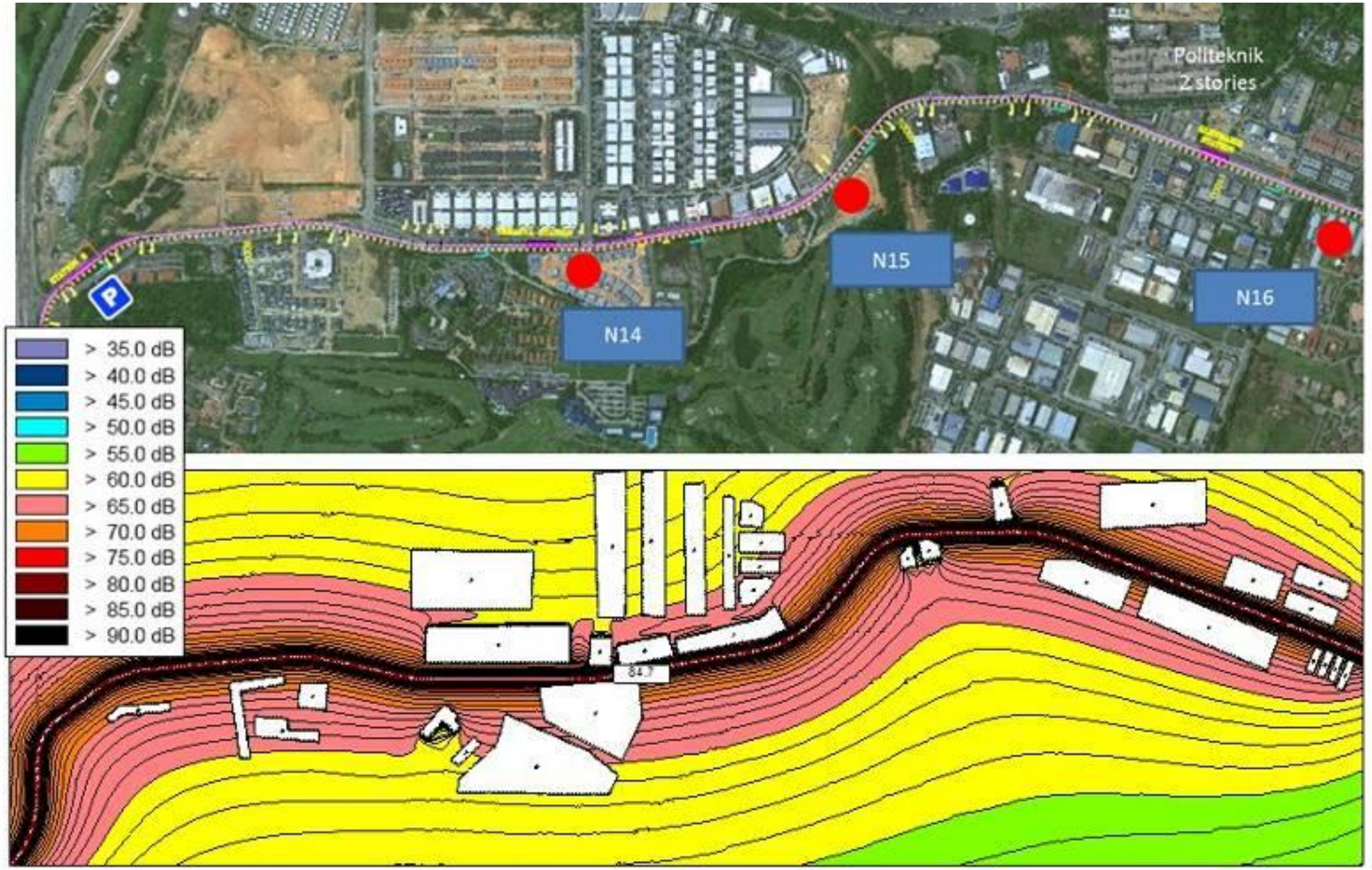

Chart 7-8 Noise Maps L_{max} for LRT3 Trains Pass-By. Glenmarie / Persiaran Kerjaya Area

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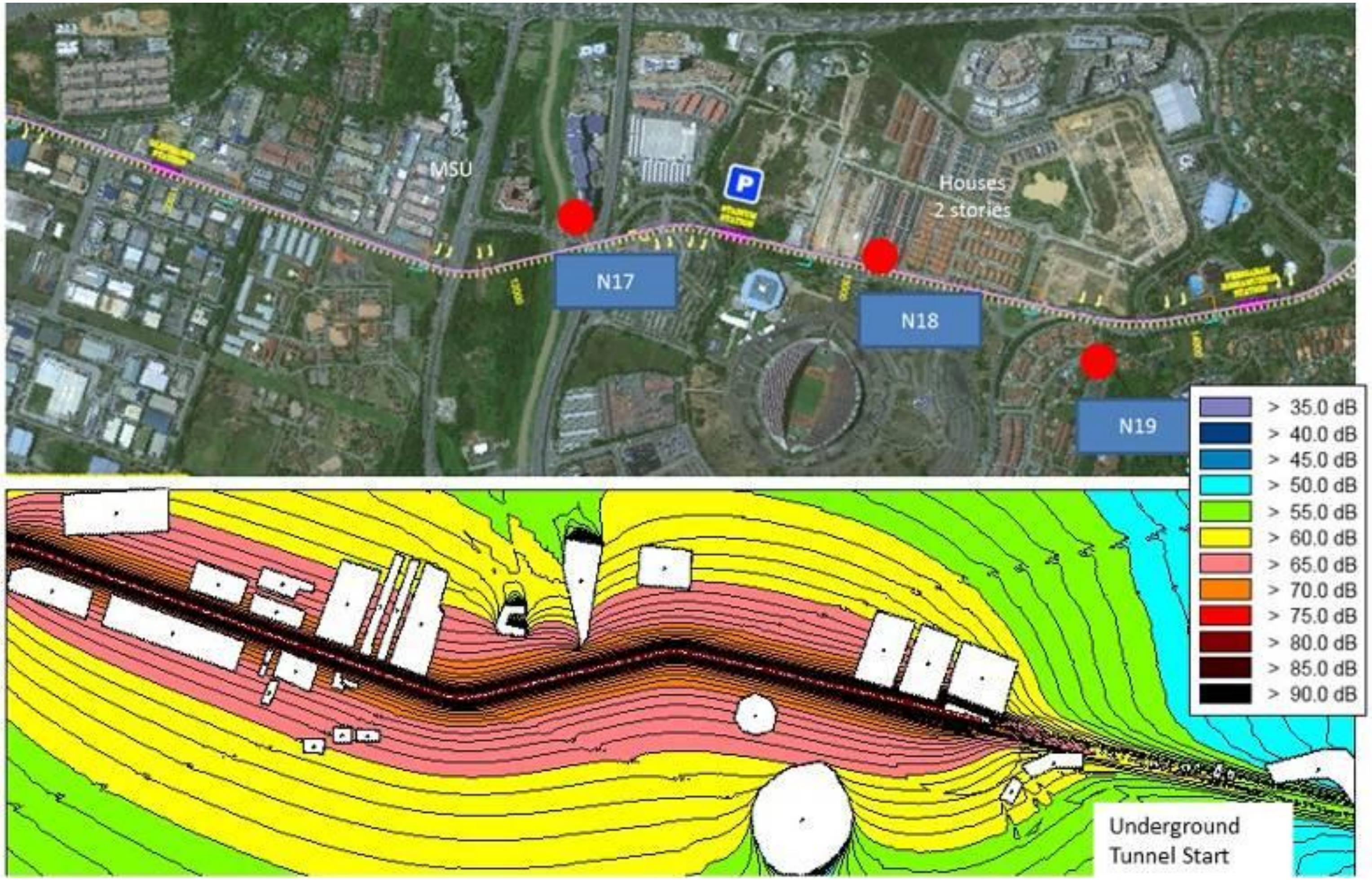

Chart 7-9 Noise Maps L_{max} for LRT3 Trains Pass-By. Shah Alam Stadium Area

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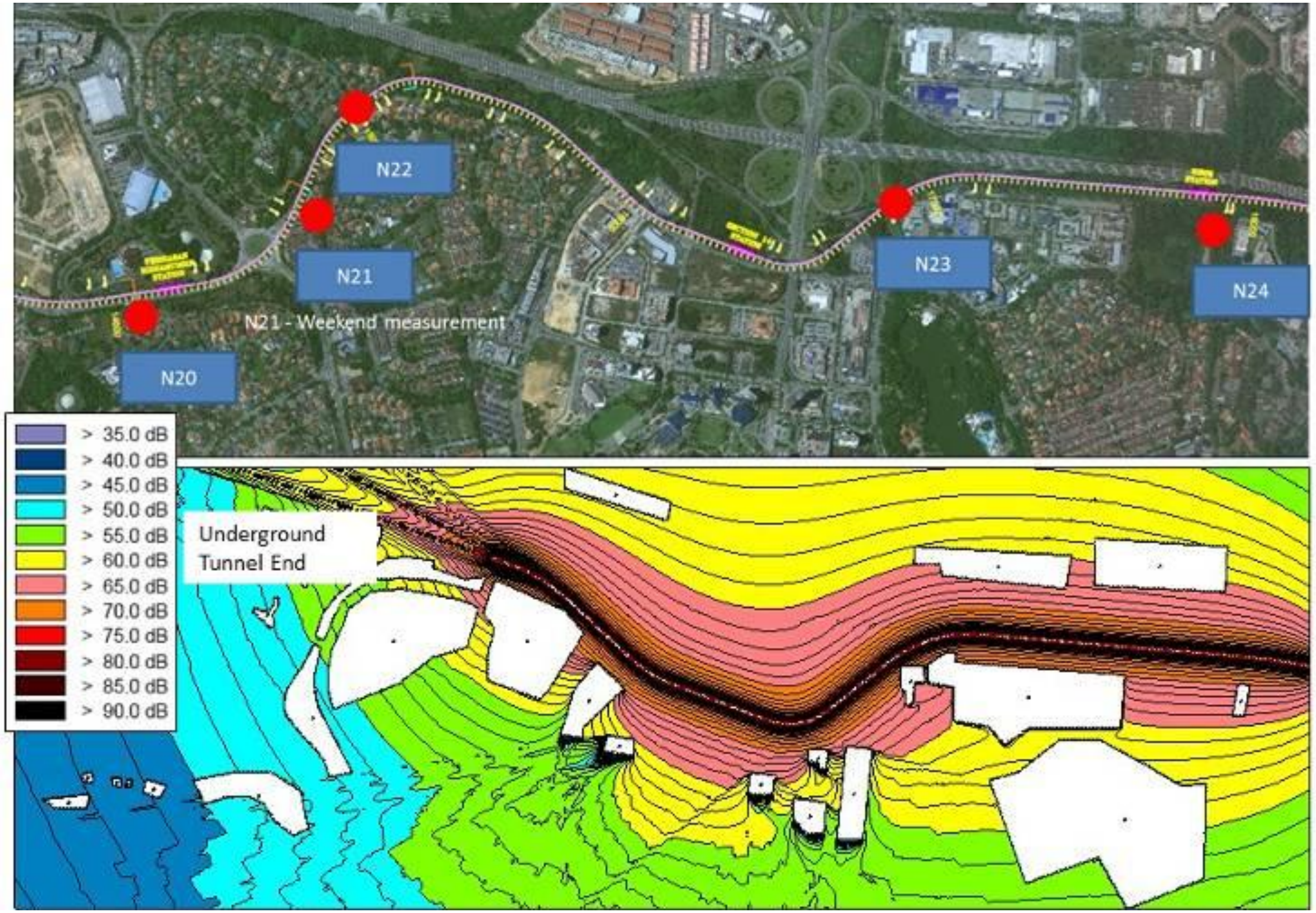

Chart 7-10 Noise Maps L_{max} for LRT3 Trains Pass-By. Seksyen 14 Area

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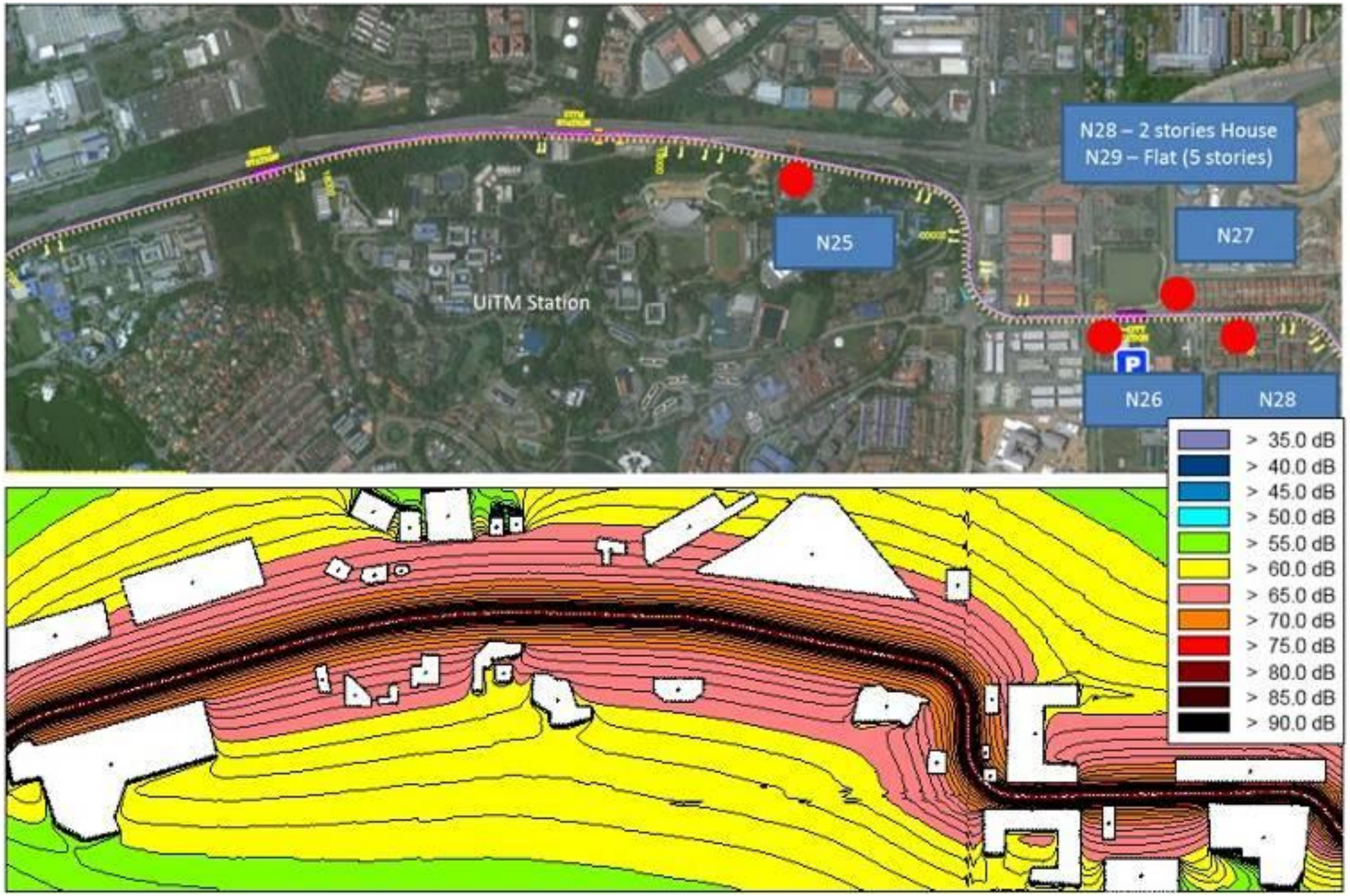

Chart 7-11 Noise Maps L_{max} for LRT3 Trains Pass-By. UiTM / Jalan Plumbum Area

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Chart 7-12 Noise Maps L_{max} for LRT3 Trains Pass-By. Jalan Plumbum / Persiaran Permai/Keluli Area

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Chart 7-13 Noise Maps L_{max} for LRT3 Trains Pass-By. Bukit Raja & Bandar Baru Kelang Area

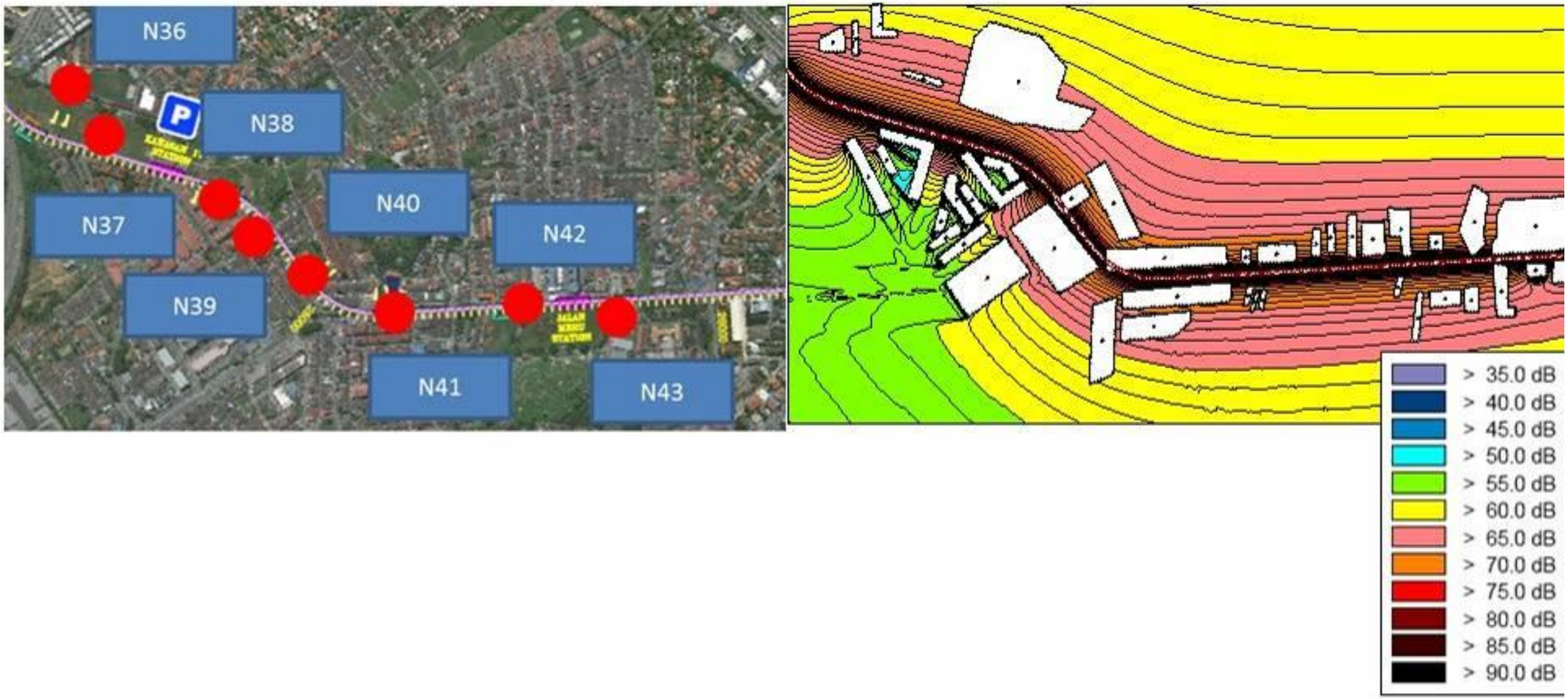

Chart 7-14 Noise Maps L_{max} for LRT3 Trains Pass-By. Pekan Baru / Jalan Kelicap / Meru Areas

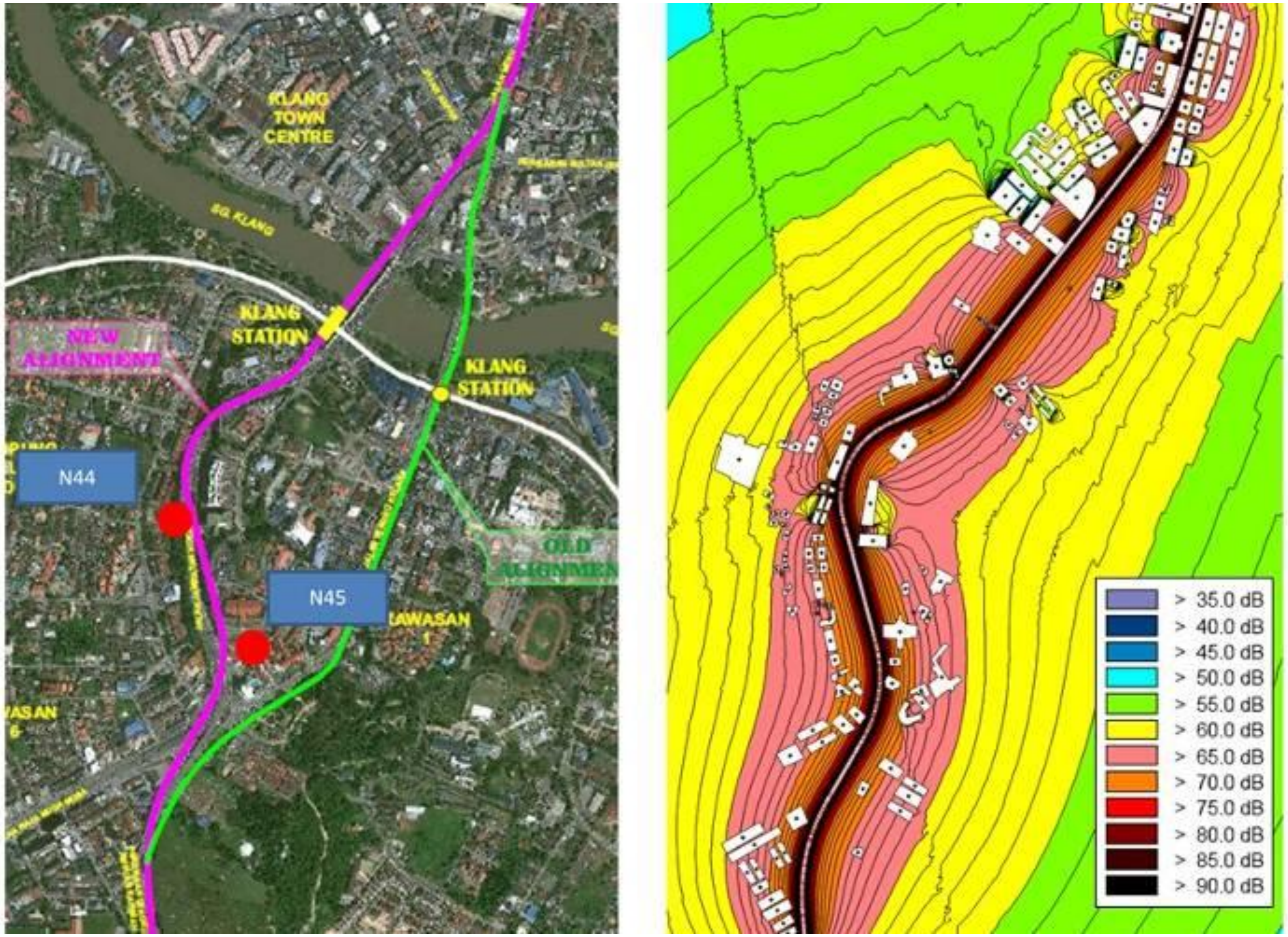

Chart 7-15 **Noise Maps L_{max} for LRT3 Trains Pass-By. Kawasan 1 / Klang Town Centre**

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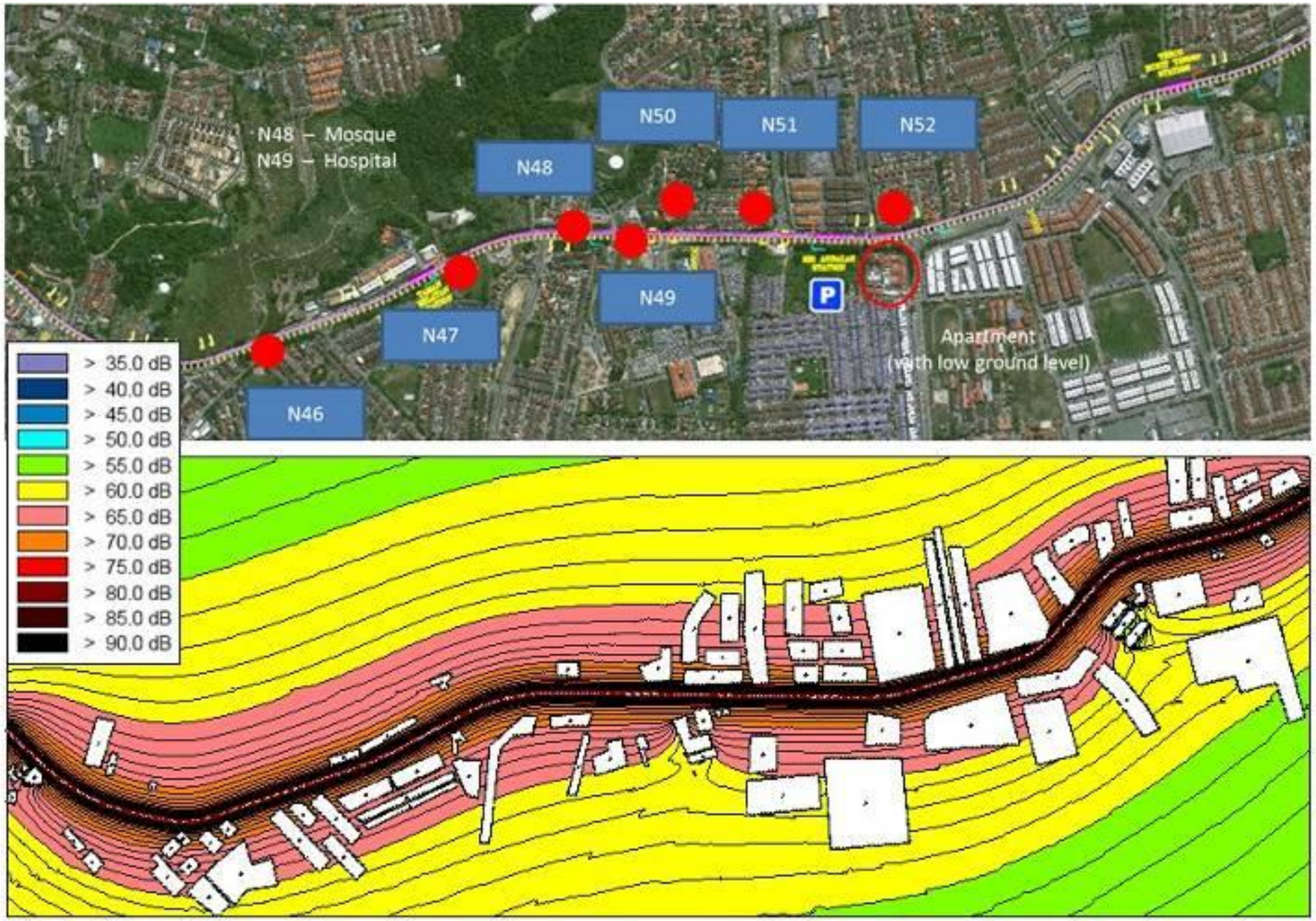

Chart 7-16 Noise Maps L_{max} for LRT3 Trains Pass-By. Jalan Langat Klang Area

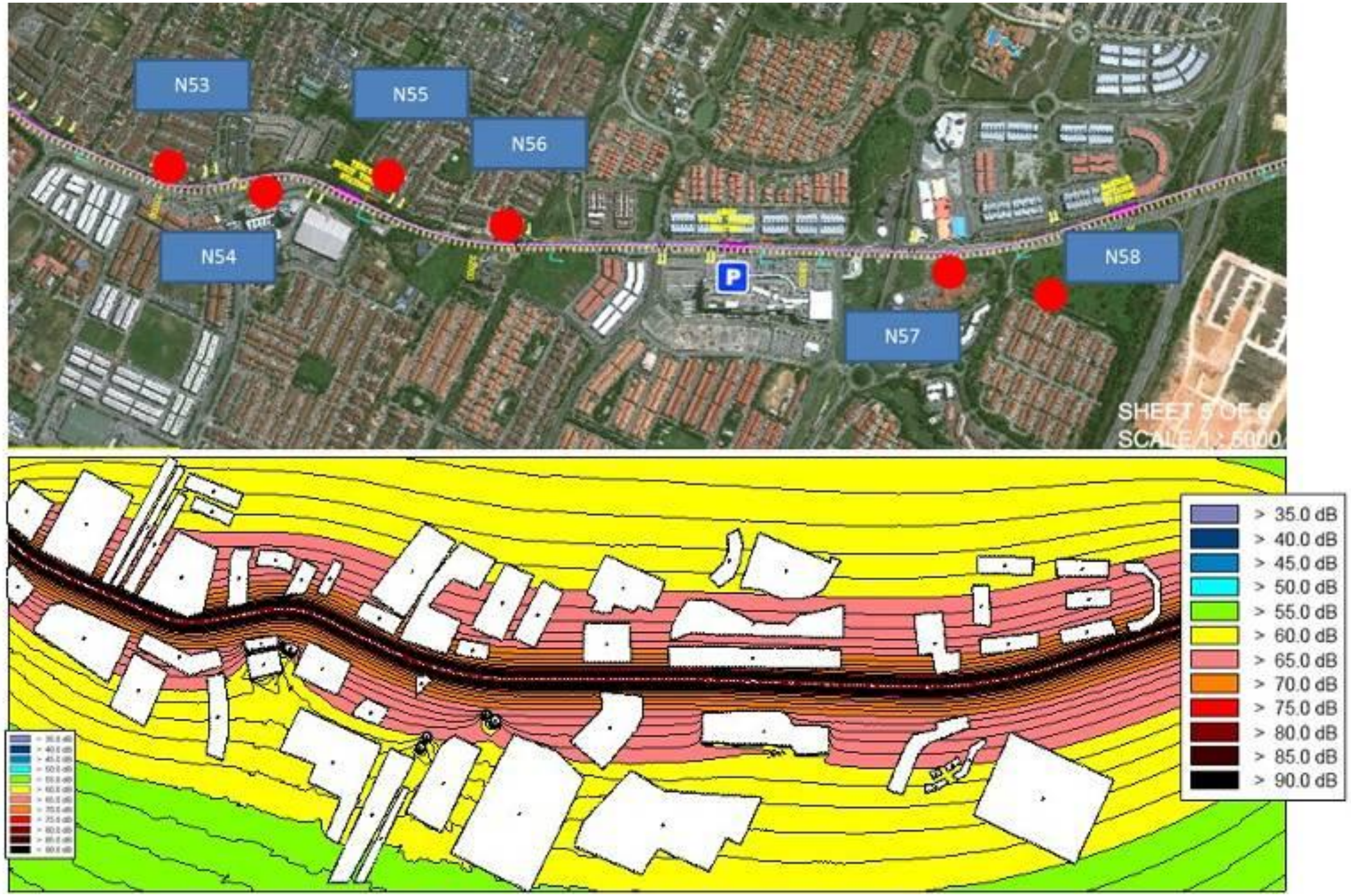

Chart 7-17 Noise Maps L_{max} for LRT3 Trains Pass-By. Gambus / Bandar Botanik Area

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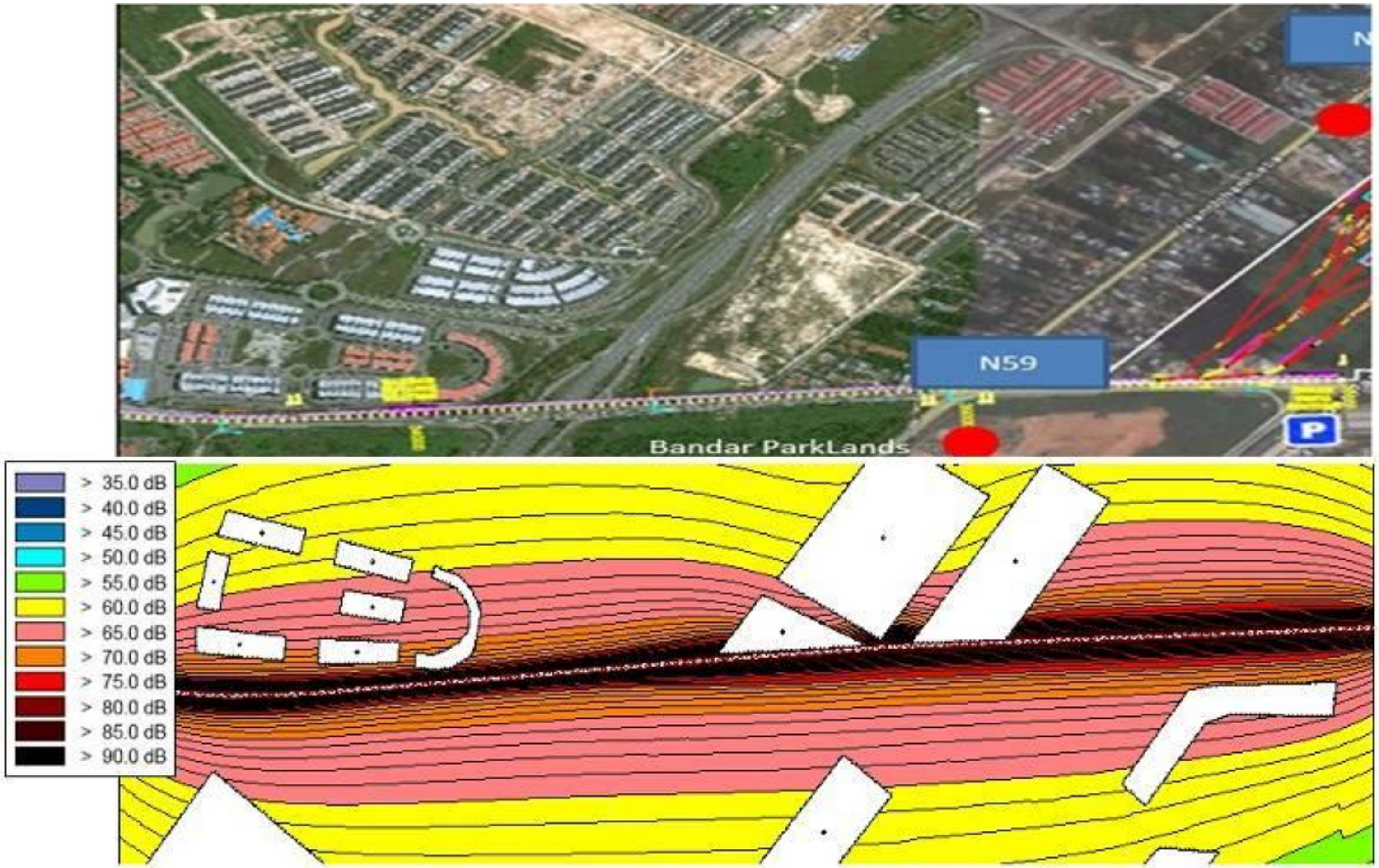

Chart 7-18 Noise Maps L_{max} for LRT3 Trains Pass-By. Bandar Parkland Area

To obtain the noise levels with the cumulative addition of the trains, the train noise levels at the respective receptor locations were added to the existing baseline day time and night time L_{Aeq} levels. The computations basically involved the addition of the train's pass-by $L_{Aeq\ 1\ hr}$ and summed for the number of trains per hour.

Predicted noise level from train pass-by at sensitive receptors and at the respective noise monitoring locations along the alignment are examined. **Table 7-4** shows the baseline noise levels (day and night L_{eq}), the recommended acceptance limits used for assessment, the predicted LRT noise (pass-by L_{max}) and L_{eq} noise) and the cumulative noise from the LRT trains combined with the existing ambient noise. The final column shows whether the resulting noise levels exceed the allowable limits.

Table 7-5 shows the baseline noise levels and the LRT equivalent continuous noise for LRT only and the cumulative levels added to the existing baseline levels.

Assessment for residual impact, and the descriptors with respect to the impact are based on Annex C of the DOE Guidelines for Environmental Noise Limits & Control (2007) (**Table 7-6**).

Table 7-4 Measured and Predicted Noise Levels and L_{max} Pass-By

Ref.	Location	Measured Existing Noise		Recommended Acceptance Limits*		Predicted Train Noise		Cumulative Pass-by Noise		L_{max} > 75 dBA Limit	
		L_{eq} Day	L_{eq} Night	L_{eq} Day	L_{eq} Night	Pass-by L_{max}	L_{eq}	L_{max} Day	L_{max} Night	Day	Night
N1	Jalan SS 21/42	58.9	54.3	65	60	73	63	73.2	73.1		
N2	Jalan SS 21/28	54.7	47.1	65	60	74	64	74.1	74.0		
N3	Jalan SS 21/13	58.6	52.0	65	60	73	63	73.2	73.0		
N4	Puncak Damansara Apartments	62.5	58.3	65	60	79	69	79.1	79.0	4.1	4.0
N5	Jln Tropicana Selatan 1	66.6	65.0	70	68	71	61	72.3	72.0		
N6	Persiaran Tropicana	71.6	66.9	75	70	71	61	74.3	72.4		
N7	Lagenda Puteri 1, Damansara Idaman	75.2	73.9	78	77	75	65	78.1	77.5	3.1	2.5
N8	Jalan PJU 1a/ 43 Damansara Idaman	70.6	68.1	74	71	83	73	83.2	83.1	8.2	8.1
N9	D'Aman Crimson Apartments	71.0	68.5	74	72	81	71	81.4	81.2	6.4	6.2
N10	Suria Damansara Condo	68.5	67.5	72	71	80	70	80.3	80.2	5.3	5.2
N11	Kelana D'Putera Condo	61.3	56.8	65	60	88	78	88.0	88.0	13.0	13.0
N12	Persiaran Kerjaya 1	69.0	66.5	72	70	72	62	73.8	73.1		
N13	Persiaran Kerjaya 2	70.3	65.9	73	69	74	64	75.5	74.6	0.5	
N14	Jalan Kerjaya	73.3	67.2	76	70	79	69	80.0	79.3	5.0	4.3
N15	Persiaran Kerjaya 3	73.5	66.5	77	70	77	67	78.6	77.4	3.6	2.4
N16	Politeknik Sultan Sallehuddin	73.4	66.6	76	70	75	65	77.3	75.6	2.3	0.6
N17	Section 13, Education Institution	70.6	63.6	74	67	77	67	77.9	77.2	2.9	2.2
N18	Jalan Akuatik 13/77	74.7	70.1	78	73	78	68	79.7	78.7	4.7	3.7
N19	Jalan Bola Sepak Lima ,13/11E	68.9	64.7	72	68	63	53	69.9	66.9		
N20	Jalan Opu Daeng Chelak 9/2	64.4	61.5	65	60	55	45	64.9	62.4		

*Note: Limits as highlighted are based on L_{eq} + 3 criteria. The last two columns show locations of anticipated areas with L_{max} > 75 dBA criteria which shall require mitigation measures.

Table 7-4 Measured and Predicted Noise Levels and L_{max} Pass-By (Cont'd)

Ref.	Location	Measured Existing Noise		Recommended Acceptance Limits*		Predicted Train Noise		Cumulative Pass-by Noise		L_{max} > 75 dBA Limit	
		L_{eq} Day	L_{eq} Night	L_{eq} Day	L_{eq} Night	Pass-by L_{max}	L_{eq}	L_{max} Day	L_{max} Night	Day	Night
N21	Persiaran Dato' Menteri 1	71.9	64.9	75	68	64	54	72.6	67.5		
N21a	Jalan Kelewang 11/4b	71.9	64.9	75	68	73	63	75.5	73.6	0.5	
N22	Persiaran Dato' Menteri 2	65.4	60.1	68	63	75	65	75.5	75.1	0.5	0.1
N23	SIRIM	73.3	67.2	76	70	69	59	74.7	71.2		
N24	Persiaran Raja Muda	61.3	60.2	65	60	71	61	71.4	71.3		
N25	Jalan Sarjana 1/2 -2	70.0	67.1	73	70	71	61	73.5	72.5		
N26	SJK (T)- I-City station	70.2	67.6	73	71	73	63	74.8	74.1		
N27	Persiaran Permai	67.1	63.3	70	66	74	64	74.8	74.4		
N28	Jalan Plumbum 7/97	67.9	64.0	71	67	83	73	83.1	83.1	8.1	8.1
N29	Jalan Plumbum 7/101	67.4	64.1	70	67	84	74	84.1	84.0	9.1	9.0
N30	Persiaran Permai/Keluli	71.0	68.0	74	71	74	64	75.8	75.0	0.8	
N31	Bukit Raja Station	68.1	64.0	71	67	76	66	76.7	76.3		
N32	Kawasan 17 Bungalows	68.4	64.5	71	68	74	64	75.1	74.5	0.1	
N33	Hospital KPJ Klang	63.3	60.3	65	60	77	67	77.2	77.1	2.2	2.1
N34	Lorong Mahkota 2d	62.4	57.6	65	60	73	63	73.4	73.1		
N35	Flat Mawar	63.9	61.0	65	60	86	76	86.0	86.0	11.0	11.0
N36	SMK Hwa Kua	62.1	55.3	65	60	69	59	69.8	69.2		
N37	Apartment Pelangi	58.6	55.3	65	60	85	75	85.0	85.0	10.0	10.0
N38	JalanPekan Baru 38	56.3	53.6	65	60	87	77	87.0	87.0	12.0	12.0
N39	Jalan Kelicap 41	55.2	55.3	65	60	75	65	75.0	75.0		
N40	Jalan Kelicap 45	64.1	58.6	65	60	76	66	76.3	76.1	1.3	1.1

*Note: Limits as highlighted are based on L_{eq} + 3 criteria. The last two columns show locations of anticipated areas with L_{max} > 75 dBA criteria which shall require mitigation measures.

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Table 7-4 Measured and Predicted Noise Levels and L_{max} Pass-By (Cont'd)

Ref.	Location	Measured Existing Noise		Recommended Acceptance Limits*		Predicted Train Noise		Cumulative Pass-by Noise		Lmax > 75 dBA Limit	
		L_{eq} Day	L_{eq} Night	L_{eq} Day	L_{eq} Night	Pass-by L_{max}	L_{eq}	L_{max} Day	L_{max} Night	Day	Night
N41	Jalan Meru - 1	56.6	53.6	65	60	78	68	78.0	78.0	3.0	3.0
N42	SMK Meru/ Gereja	64.1	58.6	65	60	75	65	75.3	75.1	0.3	0.1
N43	SK Jalan Meru	71.9	68.0	75	71	75	65	76.7	75.8	1.7	0.8
N44	Perumahan MPK	64.1	60.9	65	60	85	75	85.0	85.0	10.0	10.0
N45	Sekolah Kebangsaan Convent	62.0	58.6	65	60	68	58	69.0	68.5		
N46	Jalan Jelutong	54.7	55.9	65	60	72	62	72.1	72.1		
N47	Sekolah Khas Klang	73.0	70.0	76	73	73	63	76.0	74.8	1.0	
N48	Masjid Ar-Rahimah	66.5	64.2	70	67	73	63	73.9	73.5		
N49	Hospital Besar Tengku Rahimah	66.5	64.2	70	67	75	65	75.6	75.3	0.6	0.3
N50	Jalan Sri Siantan 43	67.1	64.5	70	68	74	64	74.8	74.5		
N51	Jalan Langat	68.1	66.4	71	69	74	64	75.0	74.7		
N52	Jalan Sri Sarawak 1	69.5	66.6	73	70	73	63	74.6	73.9		
N53	Jalan Serunai 3	63.5	58.4	65	60	75	65	75.3	75.1	0.3	0.1
N54	BB Hotel	71.5	68.4	75	71	75	65	76.6	75.9	1.6	0.9
N55	Jalan Gambus 2	66.2	61.1	69	64	72	62	73.0	72.3		
N56	Jalan Gambus 3	57.2	54.1	65	60	72	62	72.1	72.1		
N57	Klinik Kesihatan Bandar Botanik	64.3	59.3	65	60	69	59	70.3	69.4		
N58	Jalan Cassia houses, Bdr Botanik	57.3	55.1	65	60	74	64	74.1	74.1		
N59	Bandar Park Land	54.7	55.9	65	60	72	62	72.1	72.1		
N60	Taman Johan Setia Permai	52.8	53.0	65	60	65	55	65.3	65.3		

*Note: Limits as highlighted are based on L_{eq} + 3 criteria. The last two columns show locations of anticipated areas with L_{max} > 75 dBA criteria which shall require mitigation measures.

Table 7-5 Measured and Predicted Noise Levels Noise Levels and L_{eq}

Ref.	Location	Measured Existing Noise		Recommended Acceptance Limits*		Predicted Train Noise		Cumulative Noise		L_{eq} Noise Increase above Baseline		Exceed Acceptance Limits		Residual Impact	
		L_{eq} Day	L_{eq} Night	L_{eq} Day	L_{eq} Night	Pass-by L_{max}	L_{eq}	L_{eq} Day	L_{eq} Night	Day	Night	L_{eq} Day	L_{eq} Night	Day	Night
N1	Jalan SS 21/42	58.9	54.3	65	60	73	63	64	64	6	9	No	Yes	Little	Medium
N2	Jalan SS 21/28	54.7	47.1	65	60	74	64	64	64	10	17	No	Yes	Medium	Strong
N3	Jalan SS 21/13	58.6	52.0	65	60	73	63	64	63	6	11	No	Yes	Little	Medium
N4	Puncak Damansara Apartments	62.5	58.3	65	60	79	69	70	69	7	11	Yes	Yes	Little	Medium
N5	Jln Tropicana Selatan 1	66.6	65.0	70	68	71	61	68	66	1	1	No	No	None	None
N6	Persiaran Tropicana	71.6	66.9	75	70	71	61	72	68	0	1	No	No	None	None
N7	Lagenda Puteri 1, Damansara Idaman	75.2	73.9	78	77	75	65	76	74	0	1	No	No	None	None
N8	Jalan PJU 1a/ 43 Damansara Idaman	70.6	68.1	74	71	83	73	75	74	4	6	Yes	Yes	Little	Little
N9	D'Aman Crimson Apartments	71.0	68.5	74	72	81	71	74	73	3	4	Yes	Yes	Little	Little
N10	Suria Damansara Condo	68.5	67.5	72	71	80	70	72	72	4	4	Yes	Yes	Little	Little
N11	Kelana D'Putera Condo	61.3	56.8	65	60	88	78	78	78	17	21	Yes	Yes	Strong	Very strong
N12	Persiaran Kerjaya 1	69.0	66.5	72	70	72	62	70	68	1	1	No	No	None	None
N13	Persiaran Kerjaya 2	70.3	65.9	73	69	74	64	71	68	1	2	No	No	None	None
N14	Jalan Kerjaya	73.3	67.2	76	70	79	69	75	71	1	4	No	Yes	None	Little
N15	Persiaran Kerjaya 3	73.5	66.5	77	70	77	67	74	70	1	3	No	Yes	None	Little
N16	Politeknik Sultan Sallehuddin	73.4	66.6	76	70	75	65	74	69	1	2	No	No	None	None
N17	Section 13, Education Institution	70.6	63.6	74	67	77	67	72	69	2	5	No	Yes	None	Little
N18	Jalan Akuatik 13/77	74.7	70.1	78	73	78	68	76	72	1	2	No	No	None	None
N19	Jalan Bola Sepak Lima ,13/11E	68.9	64.7	72	68	63	53	69	65	0	0	No	No	None	None
N20	Jalan Opu Daeng Chelak 9/2	64.4	61.5	65	60	55	45	64	62	0	0	No	Yes	None	None

*Note: Limits highlighted are based on L_{eq} + 3 criteria. Locations anticipated to exceed recommended limits from LRT operations are highlighted.

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Table 7-5 Measured and Predicted Noise Levels Noise Levels and L_{eq} (Cont'd)

Ref.	Location	Measured Existing Noise		Recommended Acceptance Limits*		Predicted Train Noise		Cumulative Noise		L_{eq} Noise Increase above Baseline		Exceed Acceptance Limits		Residual Impact	
		L_{eq} Day	L_{eq} Night	L_{eq} Day	L_{eq} Night	Pass-by L_{max}	L_{eq}	L_{eq} Day	L_{eq} Night	Day	Night	L_{eq} Day	L_{eq} Night	Day	Night
N21	Persiaran Dato' Menteri 1	71.9	64.9	75	68	64	54	72	65	0	0	No	No	None	None
N21a	Jalan Kelewang 11/4b	71.9	64.9	75	68	73	63	72	67	1	2	No	No	None	None
N22	Persiaran Dato' Menteri 2	65.4	60.1	68	63	75	65	68	66	3	6	No	Yes	None	Little
N23	SIRIM	73.3	67.2	76	70	69	59	73	68	0	1	No	No	None	None
N24	Persiaran Raja Muda	61.3	60.2	65	60	71	61	64	64	3	3	No	Yes	None	Little
N25	Jalan Sarjana 1/2 -2	70.0	67.1	73	70	71	61	71	68	1	1	No	No	None	None
N26	SJK (T)- I-City station	70.2	67.6	73	71	73	63	71	69	1	1	No	No	None	None
N27	Persiaran Permai	67.1	63.3	70	66	74	64	69	67	2	3	No	Yes	None	Little
N28	Jalan Plumbum 7/97	67.9	64.0	71	67	83	73	74	74	6	10	Yes	Yes	Little	Medium
N29	Jalan Plumbum 7/101	67.4	64.1	70	67	84	74	75	74	7	10	Yes	Yes	Little	Medium
N30	Persiaran Permai/Keluli	71.0	68.0	74	71	74	64	72	69	1	1	No	No	None	None
N31	Bukit Raja Station	68.1	64.0	71	67	76	66	70	68	2	4	No	Yes	None	Little
N32	Kawasan 17 Bungalows	68.4	64.5	71	68	74	64	70	67	1	3	No	No	None	None
N33	Hospital KPJ Klang	63.3	60.3	65	60	77	67	69	68	5	8	Yes	Yes	Little	Little
N34	Lorong Mahkota 2d	62.4	57.6	65	60	73	63	66	64	3	6	Yes	Yes	Little	Little
N35	Flat Mawar	63.9	61.0	65	60	86	76	76	76	12	15	Yes	Yes	Medium	Strong
N36	SMK Hwa Kua	62.1	55.3	65	60	69	59	64	61	2	5	No	Yes	None	Little
N37	Apartment Pelangi	58.6	55.3	65	60	85	75	75	75	16	20	Yes	Yes	Strong	Very strong
N38	JalanPekan Baru 38	56.3	53.6	65	60	87	77	77	77	21	23	Yes	Yes	Very strong	Very strong
N39	Jalan Kelicap 41	55.2	55.3	65	60	75	65	65	65	10	10	Yes	Yes	Medium	Medium

*Note: Limits highlighted are based on L_{eq} + 3 criteria. Locations anticipated to exceed recommended limits from LRT operations are highlighted.

SECTION 7 : POTENTIALLY SIGNIFICANT IMPACTS AND MITIGATION MEASURES DURING THE OPERATIONAL STAGE

Table 7-5 Measured and Predicted Noise Levels Noise Levels and L_{eq} (Cont'd)

Ref.	Location	Measured Existing Noise		Recommended Acceptance Limits*		Predicted Train Noise		Cumulative Noise		L_{eq} Noise Increase above Baseline		Exceed Acceptance Limits		Residual Impact	
		L_{eq} Day	L_{eq} Night	L_{eq} Day	L_{eq} Night	Pass-by L_{max}	L_{eq}	L_{eq} Day	L_{eq} Night	Day	Night	L_{eq} Day	L_{eq} Night	Day	Night
N40	Jalan Kelicap 45	64.1	58.6	65	60	76	66	68	67	4	8	Yes	Yes	Little	Medium
N41	Jalan Meru - 1	56.6	53.6	65	60	78	68	68	68	12	15	Yes	Yes	Medium	Strong
N42	SMK Meru/ Gereja	64.1	58.6	65	60	75	65	68	66	3	7	Yes	Yes	Little	Little
N43	SK Jalan Meru	71.9	68.0	75	71	75	65	73	70	1	2	No	No	None	None
N44	Perumahan MPK	64.1	60.9	65	60	85	75	75	75	11	14	Yes	Yes	Medium	Strong
N45	Sekolah Kebangsaan Convent	62.0	58.6	65	60	68	58	63	61	1	3	No	Yes	None	None
N46	Jalan Jelutong	54.7	55.9	65	60	72	62	63	63	8	7	No	Yes	Medium	Little
N47	Sekolah Khas Klang	73.0	70.0	76	73	73	63	73	71	0	1	No	No	None	None
N48	Masjid Ar-Rahimah	66.5	64.2	70	67	73	63	68	67	2	2	No	No	None	None
N49	Hospital Besar Tengku Rahimah	66.5	64.2	70	67	75	65	69	68	2	3	No	Yes	None	Little
N50	Jalan Sri Siantan 43	67.1	64.5	70	68	74	64	69	67	2	3	No	No	None	None
N51	Jalan Langat	68.1	66.4	71	69	74	64	70	68	1	2	No	No	None	None
N52	Jalan Sri Sarawak 1	69.5	66.6	73	70	73	63	70	68	1	2	No	No	None	None
N53	Jalan Serunai 3	63.5	58.4	65	60	75	65	67	66	4	7	Yes	Yes	Little	Little
N54	BB Hotel	71.5	68.4	75	71	75	65	72	70	1	2	No	No	None	None
N55	Jalan Gambus 2	66.2	61.1	69	64	72	62	68	65	1	3	No	Yes	None	Little
N56	Jalan Gambus 3	57.2	54.1	65	60	72	62	63	63	6	9	No	Yes	Little	Medium
N57	Klinik Kesihatan Bandar Botanik	64.3	59.3	65	60	69	59	65	62	1	3	Yes	Yes	None	None
N58	Jalan Cassia houses, Bdr Botanik	57.3	55.1	65	60	74	64	65	65	8	9	No	Yes	Little	Medium
N59	Bandar Park Land	54.7	55.9	65	60	72	62	63	63	8	7	No	Yes	Medium	Little
N60	Taman Johan Setia Permai	52.8	53.0	65	60	65	55	57	57	4	4	No	No	Little	Little

*Note: Limits highlighted are based on L_{eq} + 3 criteria. Locations anticipated to exceed recommended limits from LRT operations are highlighted.

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Table 7-6 Summary of Predicted Noise Levels with LRT3 Operations (Without Mitigation Measures)

Ref.	Location	Measured Existing Noise		Cumulative Noise		L_{eq} Noise Increase above Baseline		Residual Impact	
		L_{eq} Day	L_{eq} Night	L_{eq} Day	L_{eq} Night	Day	Night	Day	Night
N1	Jalan SS 21/42	58.9	54.3	64	64	6	9	Little	Medium
N2	Jalan SS 21/28	54.7	47.1	64	64	10	17	Medium	Strong
N3	Jalan SS 21/13	58.6	52.0	64	63	6	11	Little	Medium
N4	Puncak Damansara Apartment	62.5	58.3	70	69	7	11	Little	Medium
N5	Jln Tropicana Selatan 1	66.6	65.0	68	66	1	1	None	None
N6	Persiaran Tropicana	71.6	66.9	72	68	0	1	None	None
N7	Lagenda Puteri 1, Damansara Idaman	75.2	73.9	76	74	0	1	None	None
N8	Jalan PJU 1a/ 43 Damansara Idaman	70.6	68.1	75	74	4	6	Little	Little
N9	D'Aman Crimson Apartments	71.0	68.5	74	73	3	4	Little	Little
N10	Suria Damansara Condo	68.5	67.5	72	72	4	4	Little	Little
N11	Kelana D'Putera Condo	61.3	56.8	78	78	17	21	Strong	Very strong
N12	Persiaran Kerjaya 1	69.0	66.5	70	68	1	1	None	None
N13	Persiaran Kerjaya 2	70.3	65.9	71	68	1	2	None	None
N14	Jalan Kerjaya	73.3	67.2	75	71	1	4	None	Little
N15	Persiaran Kerjaya 3	73.5	66.5	74	70	1	3	None	Little
N16	Politeknik Sultan Sallehuddin	73.4	66.6	74	69	1	2	None	None
N17	Section 13, Education Institution	70.6	63.6	72	69	2	5	None	Little
N18	Jalan Akuatik 13/77	74.7	70.1	76	72	1	2	None	None
N19	Jalan Bola Sepak Lima ,13/11E	68.9	64.7	69	65	0	0	None	None
N20	Jalan Opu Daeng Chelak 9/2	64.4	61.5	64	62	0	0	None	None
N21	Persiaran Dato' Menteri 1	71.9	64.9	72	65	0	0	None	None
N21a	Jalan Kelewang 11/4b	71.9	64.9	72	67	1	2	None	None
N22	Persiaran Dato' Menteri 2	65.4	60.1	68	66	3	6	None	Little
N23	SIRIM	73.3	67.2	73	68	0	1	None	None
N24	Persiaran Raja Muda	61.3	60.2	64	64	3	3	None	Little
N25	Jalan Sarjana 1/2 -2	70.0	67.1	71	68	1	1	None	None
N26	SJK (T)- I-City station	70.2	67.6	71	69	1	1	None	None
N27	Persiaran Permai	67.1	63.3	69	67	2	3	None	Little
N28	Jalan Plumbum 7/97	67.9	64.0	74	74	6	10	Little	Medium
N29	Jalan Plumbum 7/101	67.4	64.1	75	74	7	10	Little	Medium
N30	Persiaran Permai/Keluli	71.0	68.0	72	69	1	1	None	None

Table 7-6 Summary of Predicted Noise Levels with LRT3 Operations (Without Mitigation Measures) (Cont'd)

Ref.	Location	Measured Existing Noise		Cumulative Noise		L_{eq} Noise Increase above Baseline		Residual Impact	
		L_{eq} Day	L_{eq} Night	L_{eq} Day	L_{eq} Night	Day	Night	Day	Night
N31	Bukit Raja Station	68.1	64.0	70	68	2	4	None	Little
N32	Kawasan 17 Bungalows	68.4	64.5	70	67	1	3	None	None
N33	Hospital KPJ Klang	63.3	60.3	69	68	5	8	Little	Little
N34	Lorong Mahkota 2d	62.4	57.6	66	64	3	6	Little	Little
N35	Flat Mawar	63.9	61.0	76	76	12	15	Medium	Strong
N36	SMK Hwa Kua	62.1	55.3	64	61	2	5	None	Little
N37	Apartment Pelangi	58.6	55.3	75	75	16	20	Strong	Very strong
N38	JalanPekan Baru 38	56.3	53.6	77	77	21	23	Very strong	Very strong
N39	Jalan Kelicap 41	55.2	55.3	65	65	10	10	Medium	Medium
N40	Jalan Kelicap 45	64.1	58.6	68	67	4	8	Little	Medium
N41	Jalan Meru - 1	56.6	53.6	68	68	12	15	Medium	Strong
N42	SMK Meru/ Gereja	64.1	58.6	68	66	3	7	Little	Little
N43	SK Jalan Meru	71.9	68.0	73	70	1	2	None	None
N44	Perumahan MPK	64.1	60.9	75	75	11	14	Medium	Strong
N45	Sekolah Kebangsaan Convent	62.0	58.6	63	61	1	3	None	None
N46	Jalan Jelutong	54.7	55.9	63	63	8	7	Medium	Little
N47	Sekolah Khas Klang	73.0	70.0	73	71	0	1	None	None
N48	Masjid Ar-Rahimah	66.5	64.2	68	67	2	2	None	None
N49	Hospital Besar Tengku Rahimah	66.5	64.2	69	68	2	3	None	Little
N50	Jalan Sri Siantan 43	67.1	64.5	69	67	2	3	None	None
N51	Jalan Langat	68.1	66.4	70	68	1	2	None	None
N52	Jalan Sri Sarawak 1	69.5	66.6	70	68	1	2	None	None
N53	Jalan Serunai 3	63.5	58.4	67	66	4	7	Little	Little
N54	BB Hotel	71.5	68.4	72	70	1	2	None	None
N55	Jalan Gambus 2	66.2	61.1	68	65	1	3	None	Little
N56	Jalan Gambus 3	57.2	54.1	63	63	6	9	Little	Medium
N57	Klinik Kesihatan Bandar Botanik	64.3	59.3	65	62	1	3	None	None
N58	Jalan Cassia houses, Bdr Botanik	57.3	55.1	65	65	8	9	Little	Medium
N59	Bandar Park Land	54.7	55.9	63	63	8	7	Medium	Little
N60	Taman Johan Setia Permai	52.8	53.0	57	57	4	4	Little	Little

Train pass-by noise exceed 75 dBA L_{max} criteria at receptor areas near the LRT viaducts (**Table 7-4**). Based on the predicted results, potential noise impact areas are areas where the L_{max} limit is exceeded by more than 5 dBA and at some areas more than 10 dBA. The areas where train pass-by noise is expected to exceed the L_{max} 75 dBA limit are listed in **Table 7-7(a)**.

Table 7-7(a) Locations With Trains Pass-By Noise L_{max} >75 dBA (Without Mitigation Measures)

#	Receptors
1	Puncak Damansara Apartments
2	Residential units at Jalan Lagenda Puteri 1, Damansara Idaman
3	Houses at Jalan PJU 1a/43, Damansara Idaman
4	D'Aman Crimson Apartments
5	Suria Damansara Condominium
6	Kelana D'Putera Condominium and thereabout
7	Jalan Kerjaya / Persiaran Kerjaya 3
8	Politeknik Sultan Sallehuddin
9	Section 13 Education Institution
10	Jalan Akuatik 13/77
11	Jalan Plumbum areas (Plumbum7/97, 7/101) Seksyen 7 Shah Alam
12	Flat Mawar
13	Apartment Pelangi
14	Houses along Jalan Pekan Baru areas
15	Jalan Meru 1
16	Perumahan MPK

Steady state equivalent L_{Aeq} noise levels perceived at receptors locations are dependent on the train noise and the existing noise (from road traffic and other prevailing activity noise). Noise contribution from "trains only" are tabulated in **Table 7-5** and **Table 7-6**. Cumulative noise (i.e. train noise added onto existing noise) are also tabulated in the respective tables.

Receptors where the cumulative noise levels are anticipated to exceed the acceptance limits are identified in **Table 7-5** (items as highlighted) and the residual impact assessed accordingly. Receptors where noise levels are anticipated to exceed recommended acceptance limits from LRT train operations (without mitigation measures) by more than 5 dBA deemed to have residual impact were identified are listed in **Table 7-7(b)**.

Table 7-7b Areas Identified With Residual Impact From LRT3 Operations (Without Mitigation Measures)

#	Monitoring Ref.	Location
1	N1 to N3	Jalan SS 21/42, Jalan SS 21/28, Jalan SS 21/13
2	N4	Puncak Damansara Apartments
3	N9 to N11	Jalan PJU 1a/43, D'Aman Crimson Apartments, Suria Damansara Condominium, Kelana D'Putera Condominium
4	N28 and N29	Jalan Plumbum 7/97, 7/101 and adjoining areas
5	N37 and N38	Apartment Pelangi, Jalan Pekan Baru 38
6	N38 to N40	Jalan Kelicap 41, Jalan Kelicap 45
7	N41	Jalan Meru -1
8	N44	Perumahan MPK
9	N46	Jalan Jelutong
10	N53	Jalan Serunai 3
11	N55 and N56	Jalan Gambus 2, Jalan Gambus 3
12	N58 and N59	Bandar Botanik (Jalan Cassia, Bandar Parkland)

Receptors with "*strong*" and "*very strong*" residual impact are at the residential areas of Damansara Utama (Jalan SS 21/28, Jalan SS 21/13), Kelana D'Putera Condominium areas, Klang Mawar Flat, Pelangi Apartment and Jalan Pekan Baru 38 areas, Jalan Meru-1 and Perumahan MPK areas. "*Strong" / "very strong*" residential impacts occur when the disturbing noise is substantially higher (>15 dBA) than the existing ambient noise – either due to a relatively low baseline noise or high levels disturbing noise, and combination thereof. The relatively higher residual impact at the Damasara Utama areas, Jalan Pekan Baru 38 and Jalan Kelicap areas is in a major part attributed to low existing noise levels at these locations (L_{eq} day typically below 60 dBA, and night time L_{eq} below 55 dBA). Noise from train operations would subjectively be perceived as more intrusive. At the Kelana D'Putera Condominium areas, the higher residual impact is attributed to high trains pass by noise to the receptors due to proximity of the trains to the receptors.

Although the analysis showed that residual impact for LRT operations at the Damansara Idaman areas (rear and side facades of houses along Jalan Lagenda Puteri 1 and Jalan PJU 1a/43, etc. facing the NKVE and LRT alignment) are anticipated to *"little" to "none"* due to the existing high road traffic noise from NKVE, potential concerns are anticipated in these areas due to proximity of the viaducts which are at similar elevation to the high end residential units located here.

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Trains pass by noise was also calculated to exceed the 75 dBA criteria at these locations.

In addition to train pass-by noise, there is potential concern of noise disturbance in the vicinity of the stations. The severity of the potential disturbance depends very much on the road access to and from the station fronting noise sensitive receptors.

Since details of the stations are not available until detailed design, potential impact for noise disturbance was considered based on typical scenarios of traffic flow for two selected stations (where traffic impact assessment are similarly considered in this EIA).

Noise modeling and assessment of the traffic circulation in the vicinity of Temasya Station was undertaken (**Chart 7-19**).

Chart 7-19 Aerial Map of Temasya Station Showing Traffic Flow

Road traffic on the existing main roads were modelled for an assumed existing condition. The resulting noise map in the vicinity of the station was obtained (**Chart 7-20**). Repeat analysis with an assumed doubling of road traffic (100% increase in traffic volume) was also undertaken (**Chart 7-21**).

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Chart 7-20 Noise Contours around Temasya Station (Baseline)

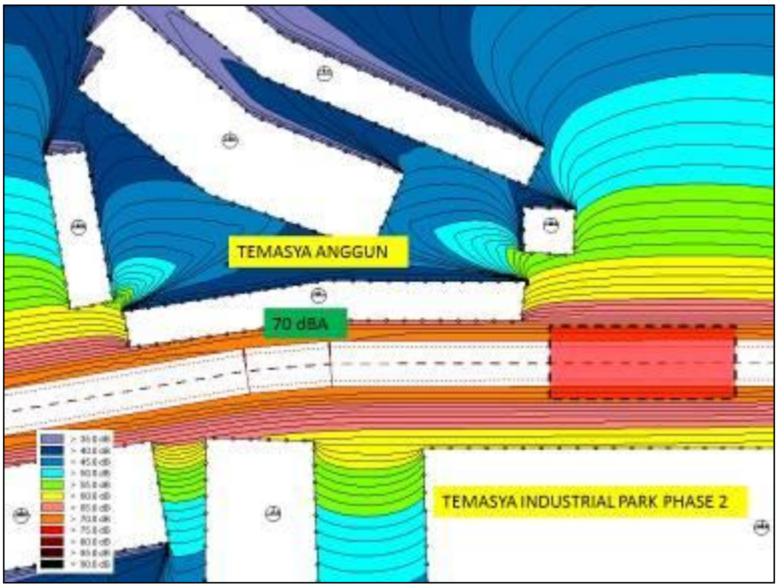
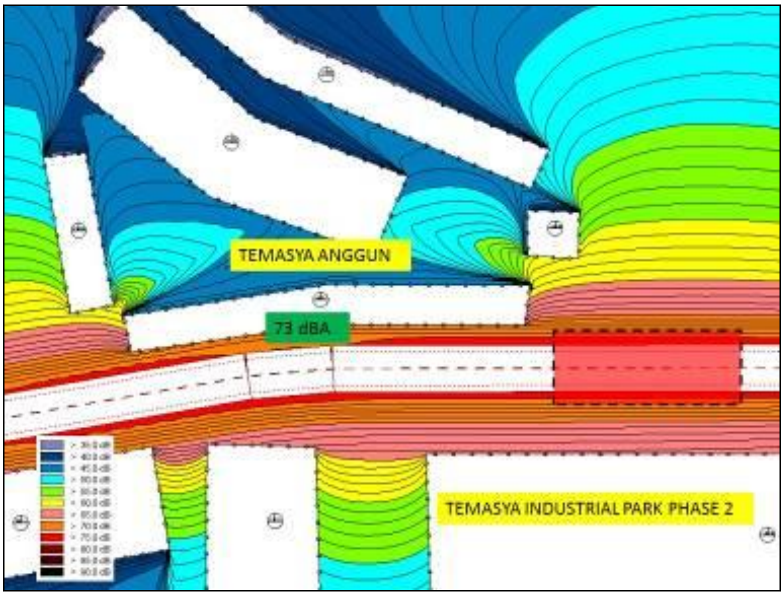


Chart 7-21 Noise Contours around Temasya Station (100% Increase Traffic Volume)



A similar exercise was undertaken for the Kawasan 17 Station in the vicinity of the Jalan Pekan Baru and Taman Eng Ann residential areas (**Chart 7-22)**.

Chart 7-22 Aerial Map of Kawasan 17 Station Showing Traffic Flow

Road traffic is primarily along Jalan Pekan Baru and the access roads into and out of Taman Eng Ann. The noise contours for existing baseline conditions are shown in **Chart 7-23**, and with 100% increase in traffic volume shown in **Chart 7-24**.

For both stations, the L_{eq} is expected to increase by 3 to 4 dBA (due to the doubling of traffic volume). This is usually deemed acceptable. Notwithstanding this increase, potential issues relate to the intrusion of transient noise above the ambient instead of the overall equivalent continuous noise levels (L_{eq}).

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Chart 7-23 Noise Contours around Kawasan 17 Station (Baseline)

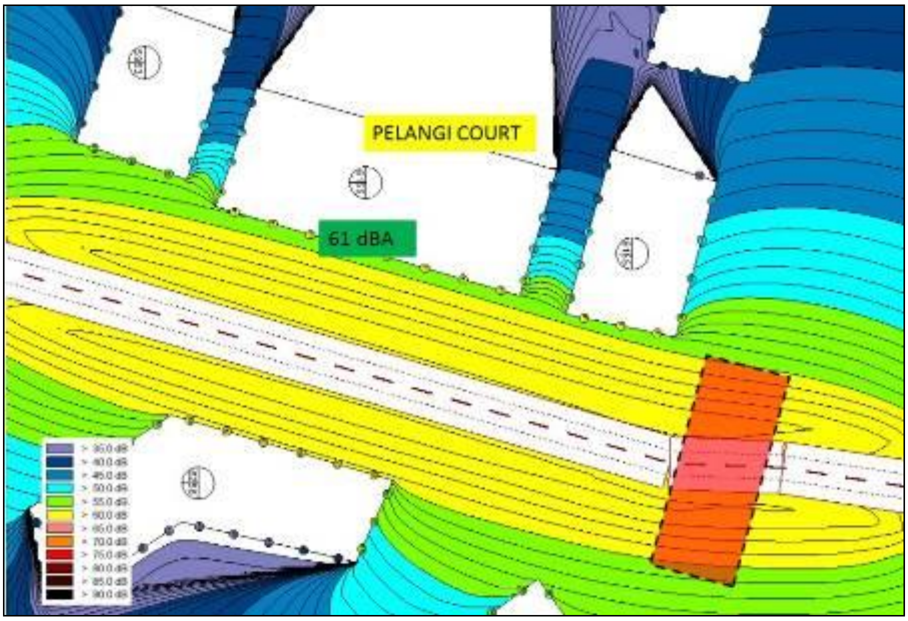
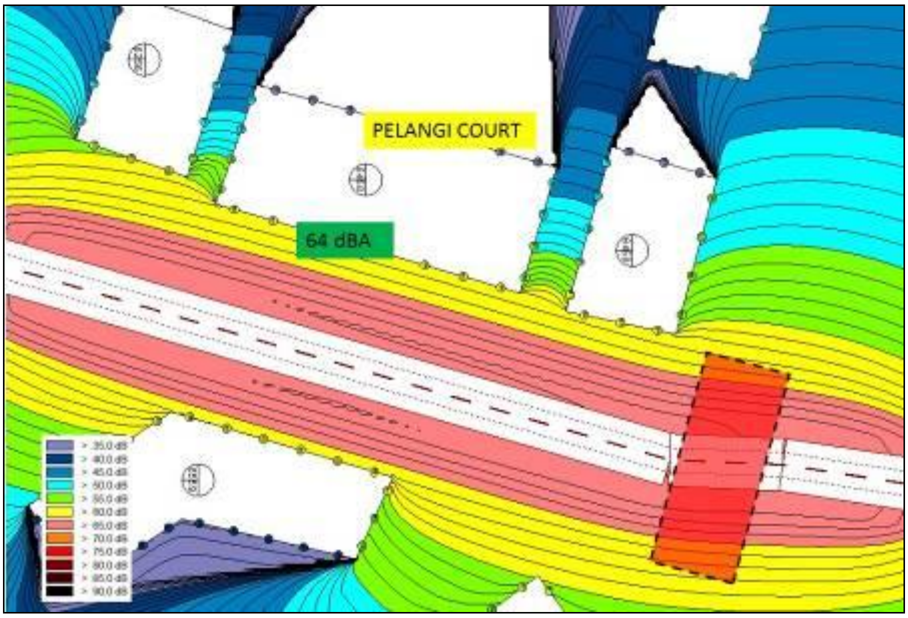


Chart 7-24 Noise Contours around Kawasan 17 Station (100% Increase Traffic Volume)



7.4.4 Management Measurese For Noise

The noise modelling along the proposed alignment has identified locations with potential concerns of noise from future LRT operations. While the change in L_{Aeq} are generally not significant due to the short term nature of train pass-bys (i.e. trains pass-by noise combined with ambient without trains) a noise disturbance are anticipated in most residential areas close to the tracks (typically up to 50m corridor depending on relative heights, distance and natural shielding of the receiver to the tracks). This short term noise disturbance was evident at locations where the instantaneous peak maximum noise of the trains pass-bys (L_{max}) were found exceeding 75 dBA noise limits (Schedule 5 of DOE Guidelines for Environmental Noise Limits and Control, 2007 for railways development).

Potential noise disturbance are therefore anticipated for residential dwellings with a line of sight to the tracks (including high rise apartments) within this 50m corridor, and also dwellings even without a direct line of sight but in closer proximity to the alignment. These areas have been identified (**Table 7-4**, **Table 7-5** and **Table 7-6**). The locations typically have L_{max} contour lines exceeding 75 dBA in the noise maps.

The affected areas shall require noise mitigation measures to address potential noise disturbance from trains pass-bys. There is also potential concern of LRT trains generated noise from wheels and brake squeals at tracks curvature (typically less than 250m radius). At the stations there is also potential noise disturbance from local road traffic and human activities.

British Standards EN ISO 3095: 2005 Railway applications: Acoustics – Measurement of noise emitted by rail bound vehicles, amongst the recommendations for noise measurement procedures provides information on the major influence parameters on railway track noise including track dynamics. **Table 7-8** (as extracted from ISO 3095: 2005) tabulates a summary of major parameters on track noise.

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Table 7-8 Major Influence Parameters on Railways Track Noise

Parameter	Parameter value for minimum noise level	Parameter value for maximum noise level	Level difference for min. and max. parameter value
Rail Type	UIC 54 E1	UIC 60 E1	0.7 dB
Pad Stiffness	5000 MN/m	100 MN/m	5.9 dB
Pad Loss Factor	0.5	0.1	2.6 dB
Sleeper Type	Bi-bloc	Wooden	3.1 dB
Sleeper Distance	0.4 m	0.8 m	1.2 dB
Ballast Stiffness	100 MN/m	30 MN/m	0.2 dB
Ballast Lost Factor	2	0.5	0.2 dB
Wheel Offset	0 m	0.01 m	0.2dB
Rail Offset	0 m	0.01 m	0.2 dB
Wheel Roughness	Smoothest	Roughest	8.5 dB
Roughness of Un-corrugated Rails	Smoothest	Roughest	0.7 dB to 3.9 dB
Train Speed	80 km/h	160 km/h	9.4 dB
Axle Load	25 t	10 t	1.1 dB
Air Temperature	10 ^{o}C	30 ^{o}C	0.2 dB

Source: BS EN ISO 3095- 2005, Annex D

It is evident that noise generated at the wheel/rail interface (rolling noise) due to wheel roughness, rail roughness and traction (train speed) are the most dominant parameters followed by tracks fasteners (pad stiffness and pad damping (loss factor).

In addition to the above, there is also noise associated with wheel and brake squeal. Wheel squeal is a high-pitched piercing noise that can occur as trains travel on curved track due to friction between the steel wheel and the top of the steel rail. Squeal is caused by lateral stick-slip behaviour of the contact between the wheel and rail exciting high frequency resonances in the rail and wheel. Wheel squeal is usually louder than other types of train noise. Brake squeal is a similar high pitch noise generated during braking. When the brake is applied, the brake shoe scrubs the wheels and causes wear and tear, which often causes a squeal.

Noise (and vibration) control in principle involves measures taken to address the following elements:

- Source
- Path
- Receiver.

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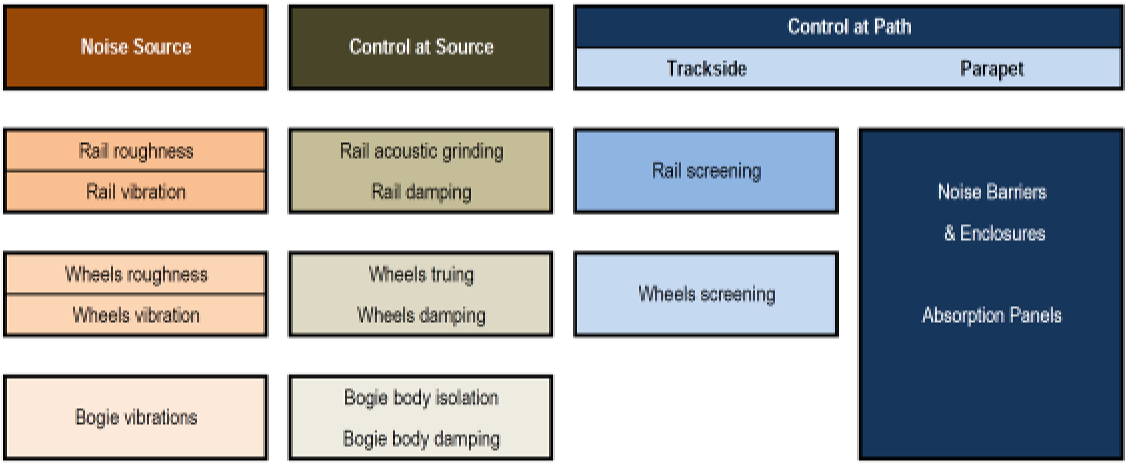
Effectiveness of a noise reduction measure or device will depend on the wheel and track contributions (depending e.g. on the stiffness of the rails system, construction of the viaduct structure, vehicle type, etc.) to the total noise emissions.

Chart 7-25 Reduction Measures to Address Trains Pass-By Noise



Source: Federal Environmental Agency Germany, 2013

Reduction measures that can be undertaken to address the source and path of the different noise and vibration sources contributing to the pass-by noise are indicated in **Chart 7-25** (adapted from a guideline of the Federal Environmental Agency Germany, 2013).

The recommended noise mitigation strategy shall be based on the following best practice:

- Trains noise emission specifications required on the rolling stock and track works (control at source);
- Noise barriers & enclosures (control at path).

Noise reduction at source is usually undertaken by the rail systems manufacturer and track works contractor. In this respect the Rail Systems Designer of this LRT Project should stipulate a maximum allowable train pass-by emission levels for procurement. Trains noise emission specifications shall be based in on ISO 3095:2013 "*Acoustics – Railway applications- Measurement of noise emitted by rail-bound vehicles*".

When a maximum allowable trains' emission noise limit is specified, there is an element of design, manufacture and installation responsibility imposed on the rolling stock manufacturer and track works contractor to implement some degree of noise and vibration control on the traction system, wheels and rails.

Options available for noise reduction at source include:

i. Reducing wheel excitation (low roughness of rails by rail grinding and wheels by wheel truing);
ii. Reducing wheel / rail vibration (by damping of rails with rail dampers / constrained layer damping*, and damping of wheels with damping devices);
iii. Reducing bogie body vibrations by damping (constrained layer damping*).

Note: *"constrained layer damping" is a layer of adhesive viscous material which is stuck onto the base metal.

Squeal noise is often mitigated with wheel and rail damper solutions stated above. Friction modifiers can also be used to change the interaction of wheel and rail to prevent squeal.

There is however a limit as to how much noise can be reduced at source, upon which the most common practice is for noise reduction in the sound propagation path. Options available for sound propagation path are:

i. Noise barrier and enclosures;
ii. EMU absorptive skirt;
iii. Near track noise barrier;
iv. Track bed absorption;
v. Viaduct multi-plenum.

Noise barrier and enclosures (partial and fully enclosed) are the most commonly used measures for noise mitigation that addresses all noise sources (rolling noise, squeals and auxiliary equipment). Noise mitigation options and effectiveness are summarised in **Chart 7-9**.

It is evident that noise barrier is one of the most effective mitigation measure to address trains pass-by noise. For squeal noise (which are maintenance related) localised measures in additional to noise barriers are usually required.

For the barriers to be effective, there must be no line of sight between the receptors and the noise source. This is often a problem for receptors in high rise buildings that overlook the viaducts and tracks. Even if there is no line of sight, sound propagation by means of diffraction (sound waves “bending” over the barrier) would still result in noise propagation to the receiver in the “shadow” zone. The quantum of noise reduction depends on the “path difference” governed by relative heights and distances between the noise sources, receptors and top of barrier.

A full enclosure is obtained when a barrier forms a complete envelope enclosing the viaduct. A partial enclosure is when the barrier forms a vertical wall with a partial roof covering overhead the viaduct.

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Typical noise reduction as listed in **Table 7-9**, and in particular noise barriers ranging from 10 dBA to 15 dBA, showed that the areas with high residual impact form LRT train operations (without mitigation measures) as listed in **Table 7-7** could be adequately addressed to result in minimal residual impact.

Types and design of noise barriers that are suitable for trains' noise mitigation are examined below.

Table 7-9 Comparison of Noise Mitigation Measures and Effectiveness

#	Measures	Mitigation of	Abatement Effect	Overall Noise Reduction Potential
1	K-blocks	Rolling noise	network wide	Up to 8 dBA –10 dBA
2	LL-blocks	Rolling noise	network wide	Up to 8 dBA –10 dBA
3	General grinding of bad track	Rolling noise	local	10 – 12 dBA (up to 20 dBA at very bad tracks)
4	Special acoustic grinding	Rolling noise	local	1 – 4 dBA (depending on local rail roughness), typical 2dBA
5	Disc brakes	Rolling noise	network wide	10 dBA
6	Wheel-tuned absorbers	Wheel noise	network wide	2 – 7 dBA
7	Bogie shrouds with low height barriers	Wheel noise	local	8 – 10 dBA
8	Rail dampers	Rail Noise	local	3 – 7 dBA (most typical 3 dBA)
9	Slab tracks	Rail noise	local	5 dBA
10	Rail pads	Rail Noise	local	3 – 4 dBA
11	Different measures to lower squeal noise	Squeal noise	local	Up to 20 dBA depending on local conditions
12	Shielding of pantographs	High speed train only	Global, >200 km/h	5 – 10 dBA
13	Barriers 2 meter high	All sources	local	**10 dBA**
14	Barriers 4 meter high	All sources	local	**15 dBA**
15	Insulated windows	All sources	Inside house only	10 – 30 dBA

Source: Directorate-General for Internal Policies, European Parliament on "Reducing Railway Noise Pollution". 2012

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Materials used in the barrier construction shall have sufficient sound insulation properties so that sound does not transmit through the material. Noise reduction would then be governed by sound diffraction instead - dictated by path difference and barrier heights. This therefore requires the barrier and enclosure panels to have a minimum construction and acoustics performance in addition to other physical properties. While the controlling mechanism for noise barrier reduction is from noise shielding dictated by diffraction and bending of sound waves over an impervious occluding element (physical barrier panels), there are other additional barrier properties that inherently determine the net realisable noise reduction.

Noise barrier design and constructions can either be of the following types:
- Absorptive,
- Diffusive; or
- Reflective

Absorption occurs when sound energy impinging onto the panels is substantially absorbed (typically more than 50% sound absorption) (**Chart 7-26**).

Reflection occurs when the sound waves are reflected back towards the noise source (when sound absorption is generally less than 20%). In practical situations, the reflected sound waves would be directed back onto the train coaches and other side of the guide way (parapet and reflective noise barrier) as well as any nearby buildings. Diffusive barriers are when the barriers surfaces are not flat - rendered with modulations on the surface so that sound is “scattered” and not reflected back (like a mirror).

Barrier designs are thus based on one or combination of the above, which then dictate the choice of materials to be used, its design and construction.

Chart 7-26 Typical Absorptive Metal Noise Barriers

(a) High performance absorption panel
Source: Samjung Muhibbah SV Samjung JV, MRT1 Project

(b) Conventional absorption panel
Source: http://alphacoustic.com/wp-content /uploads/2013/09/Metal-Noise-Barriers-MB-2.jpg

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Chart 7-27 Metal Absorptive Noise Barriers Used For Railways Noise Mitigation

Source: http://www.forster.at/uploads/tx_chimgslider/Wien2.jpg

Chart 7-28 Absorptive Noise Barriers With Clear Panels

Source: Muhibbah SV Samjung JV Sdn Bhd

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Chart 7-29 Diffusive and Reflective Transparent Noise Barrier
(Diffusive panels on lower half with upper clear panels)

Source: http://www.whisper-wall.com/images/860_korea.jpg

An acoustically absorptive barrier is often recommended so that noise emitted from the train and rails are absorbed with minimal lateral reflections (slap back between barrier side walls and train body). In an acoustically reflective barrier lateral reflections would occur that results in noise reduction inferior to acoustically absorptive barriers. An example of diffusive and reflective noise barrier is shown in **Chart 7-29**. Reflective panels can either be transparent panels, or ordinary masonry (brickwalls, pre-cast concrete panels, timber planks, etc.) that are more often used on grade and not on elevated viaducts (due to loading constraints).

Barriers which are acoustically absorptive inherently mean that the barriers are impervious to light (visual) which then makes such barriers visually imposing. This is evident from **Chart 7-27** for typical railway lines.

While transparent barriers are acoustically reflective it is visually more appealing and less intrusive as a visual impact perspective.

Noise barriers and enclosures can be totally or partially transparent except that lateral sound reflections (short falls in noise reduction from the sound reflections) need to be addressed. This usually requires the noise barriers to be of higher heights, or preferably be semi or fully enclosed to contain the reflections (semi or full enclosures). An example of combined absorptive and transparent noise barrier is shown in **Chart 7-28**.

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Examples of noise barrier installations in Hong Kong (West Rail project, etc.) are shown in **Chart 7-30** and **Chart 7-31**. These are absorptive metal noise barrier and full acoustics enclosure respectively.

Examples of transparent noise barriers installed for highways are given in **Chart 7-32** and **Chart 7-33**. These include transparent panels using relatively new generation polymethlmenthacrylate (PPMA acrylic) sheets (**Chart 7-32**) as compared to older generation polycarbonate sheets (**Chart 7-33**). Potential issues with transparent panels are weathering and discoloration of the panels (especially with older generation polycarbonate sheets as evident in **Chart 7-33** and in locally in the SPRINT Kerinchi Link highway noise barrier).

Chart 7-30 Absorptive Metal Noise Barrier (West Rail Hong Kong)

Source: Sontoc Far East Ltd

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Chart 7-31 Full Enclosure for Noise Mitigation Adjacent High Rise Buildings (West Rail Hong Kong)

Source: Sontoc Far East Ltd

Chart 7-32 Acoustically Reflective Transparent (PMMA) Noise Barrier (Germany)

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Chart 7-33 Transparent Polycarbonate Noise Barrier

Source: http://www.struktonciviel.com/serveimage.ashx

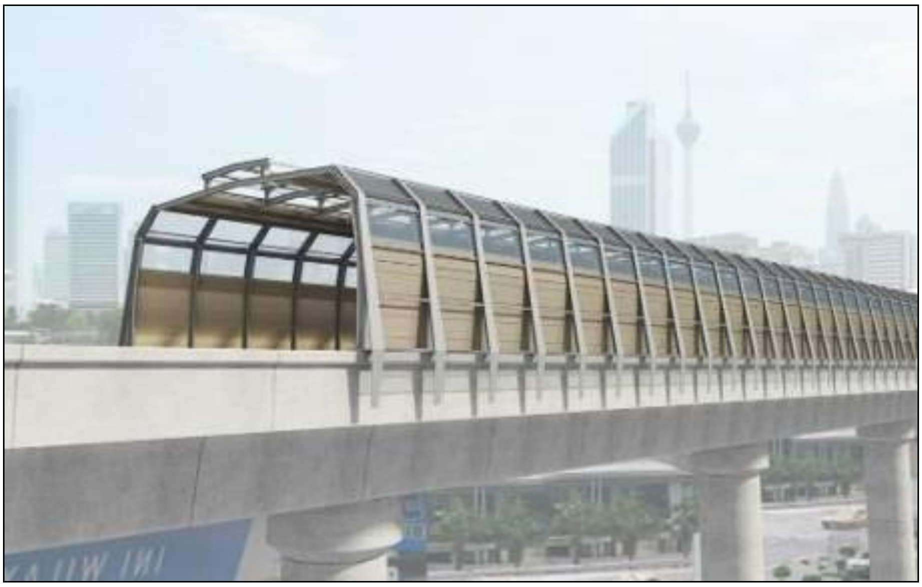
Once the acoustic and physical properties requirements of noise barriers and enclosure are addressed, there is a need to address visual impact of the barriers and enclosures. It is therefore necessary that aesthetics design and requirements to be considered in the noise mitigation.

Chart 7-34 and **Chart 7-35** show example of architectural aesthetics screens to be installed on typical noise barrier types used for the MRT1 project. The basic design consists of acoustically absorptive panels combined with transparent panels barriers visually screened with aesthetically designed feature elements on the exposed sides of the viaducts. Noise barriers can therefore be to visually more pleasing while maintaining acoustics performance.

Chart 7-34 Noise Barrier with Architectural Aesthetic Screen

Source: MMC Gamuda MRT1 (PDP)

Chart 7-35 Full Enclosure with Architectural Aesthetic Screen



Source: Muhibbah SV Samjung JV Sdn Bhd

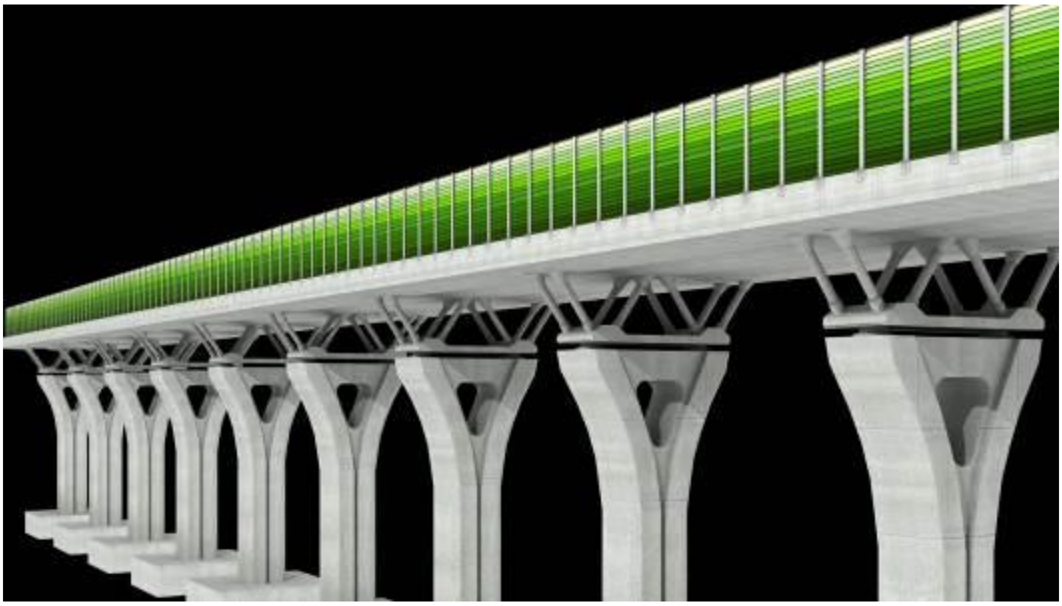
An example of a simple screening element as used in the Singapore MRT Jurong Line is given in **Chart 7-36**.

Chart 7-36 Perforated Mesh Screen Used in Singapore MRT Jurong Line

Source: M Salman Leong

It is also possible to introduce colour schemes and patterns to minimise the visual impact of barriers and enclosure (**Chart 7-37** and **Chart 7-38)**.

Chart 7-37 Metal Acoustics Noise Barrier with Colour Scheme



Source: Samjung

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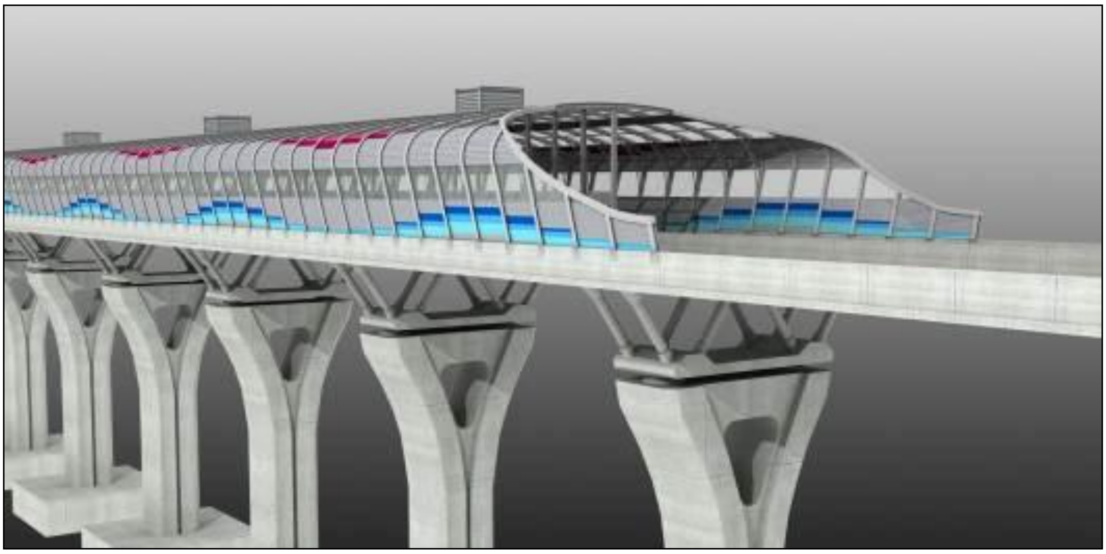
Chart 7-38 Full Enclosure - Metal and Clear Panels with Colour Scheme



Source: Samjung

Design alternatives for visually imposing acoustics enclosures (as seen in the Hong Kong West Rail Line, **Chart 7-33**) are shown in **Chart 7-39** below (used with permission from Samjung).

Chart 7-39 New Generation Low Visual Impact Full Enclosure

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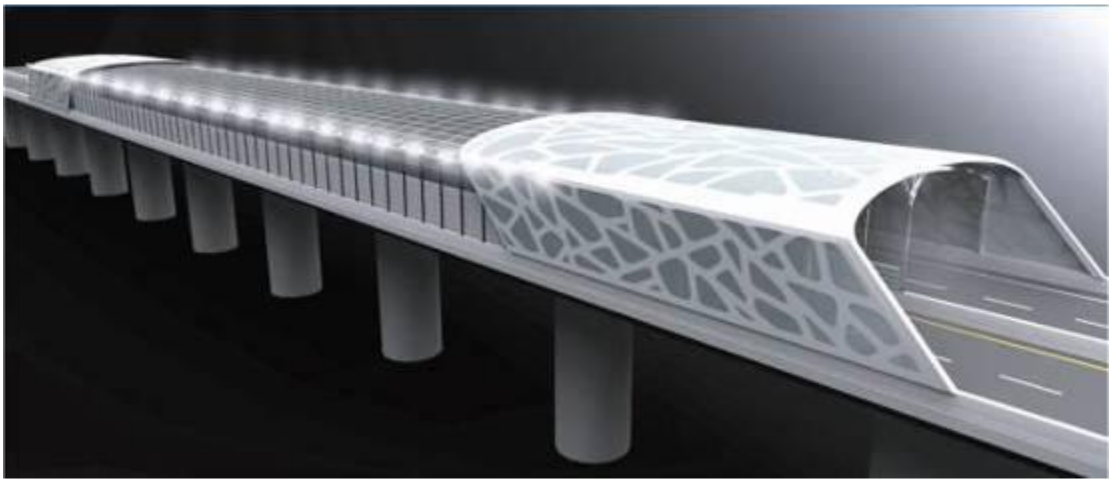

Source: Samjung

Locations tentatively identified in this EIA that shall require noise mitigation (noise barriers) are given in **Table 7-10**. These locations are not necessarily exhaustive. Determination of actual requirements on heights, extent (linear run along the alignment) and types of noise barriers requires comprehensive noise analysis considering all governing parameters of the track alignments and receivers physical (geometrical) relationships of the affected sensitive locations with respect to the tracks alignment (Right-of-Way).

Table 7-10 Tentative Locations to be Installed with Noise Barriers*

#	**Locations**
1	Damansara Utama Jln SS 21/42, Jln SS 21/28, Jln SS 21/13
2	Puncak Damansara Condominium
3	Jalan PJU 1a/43, D'Aman Crimson Apartments, etc.
4	Suria Damansara Condo, Kelana D'Putera Condo
5	Persiaran Permai/Keluli (Residential Area)
6	Bandar Baru Klang Condomimium
7	The Palm Garden(Under Construction)
8	Flat Cempaka Mawar
9	Apartment Pelangi
10	Jalan Kelicap 44, Kelicap 46, etc.
11	Saujana Damai Apartment
12	Perumahan MPK, Jalan Jelutong
13	Jalan Gambus
14	Hospital Besar Tengku Rahimah
15	Jalan Cassia, Bandra Botanik

** Locations as listed above are not necessarily exhaustive. Barrier locations and design are subject to detailed noise analysis based on final alignment (viaducts RoW) to comply with EIA Approval noise limits.

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The proposed locations identified above and noise barriers design are therefore subject to further analysis and detailed design based on final alignments to comply with the EIA Approval noise limits.

Determination of actual requirements on heights, extent (linear run along the alignment) and types of noise barriers requires comprehensive noise analysis considering all governing parameters of the track alignments and receivers physical (geometrical) relationships of the affected sensitive locations with respect to the tracks alignment. The proposed locations identified above and noise barriers design are therefore subject to further analysis and detailed design.

Examples of the detailed acoustic analysis are illustrated below for a typical case of elevated viaducts located in vicinity of terrace houses and low rise buildings along existing local roads median are shown in **Charts 7-40** to **7-42**. These examples are representative of residential houses at Jalan SS 21/42, Jalan SS 21/28, Jalan SS 21/13 and Jalan Plumbum for example.

During detailed design of the noise barriers, the analysis and modeling shall include cumulative effects of noise propagation from existing highways and road traffic.

Chart 7-40 Noise Propagation (L_{max}) Without Mitigation

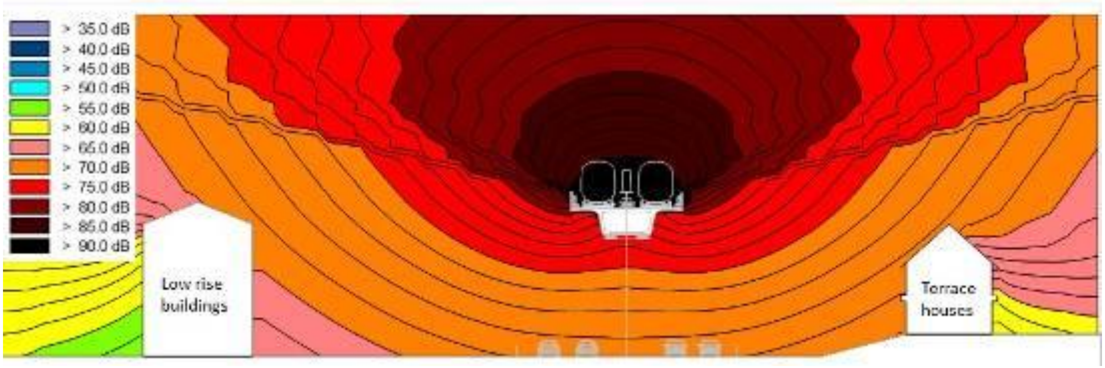

Chart 7-41 Noise Propagation (L_{max}) with 3.5m Noise Barrier

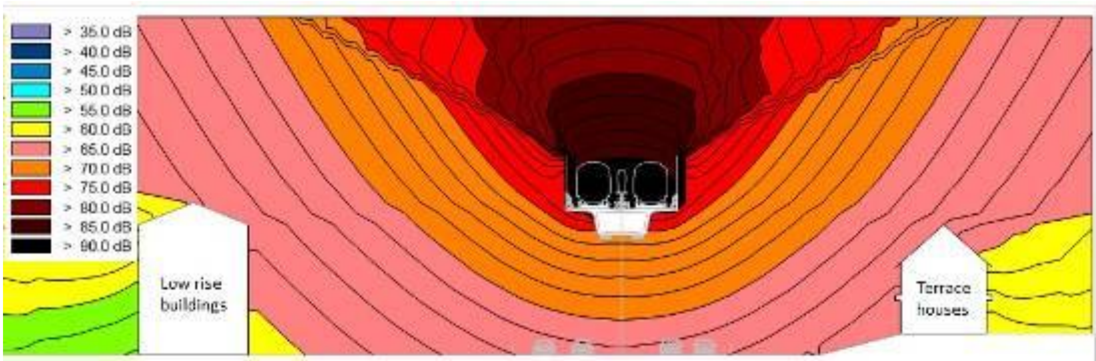

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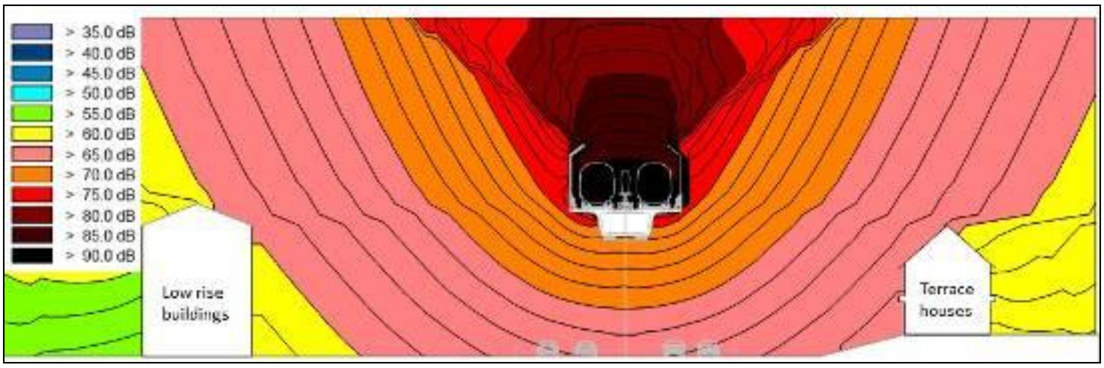
Chart 7-42 Noise Propagation (L_{max}) with 4.5m Noise Barrier



Additional examples of elevated viaducts in close proximity to receptors in high rise buildings (Kelana D'Putera Condo at Kelana Jaya, etc. as used in this example) are shown in **Charts 7-43** to **7-46**.

Chart 7-43 Noise Propagation (L_{max}) Without Mitigation

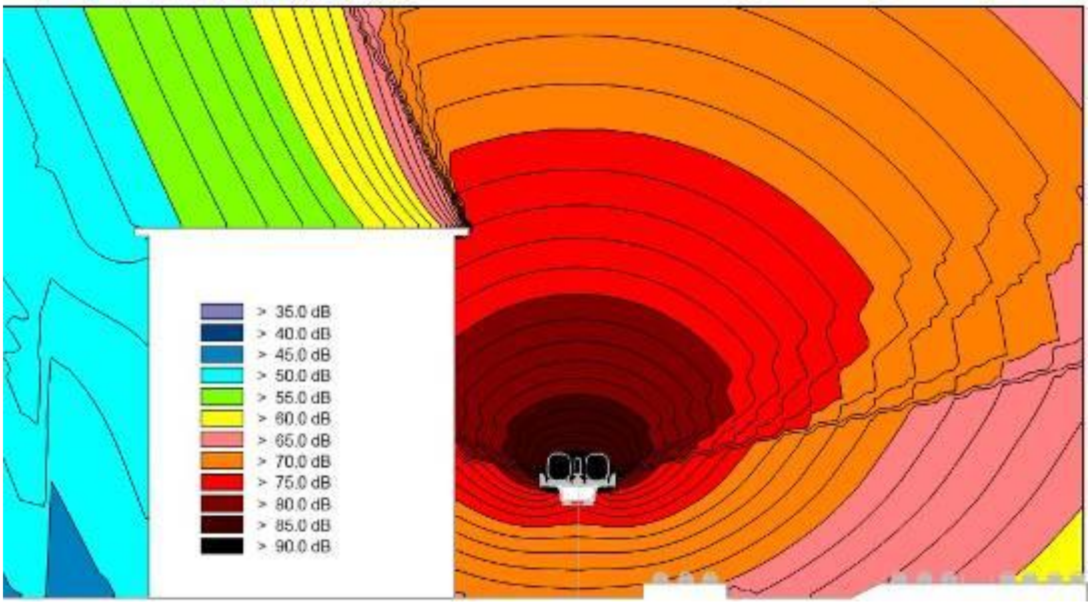


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Chart 7-44 Noise Propagation (L_{max}) with 3.5m Noise Barrier

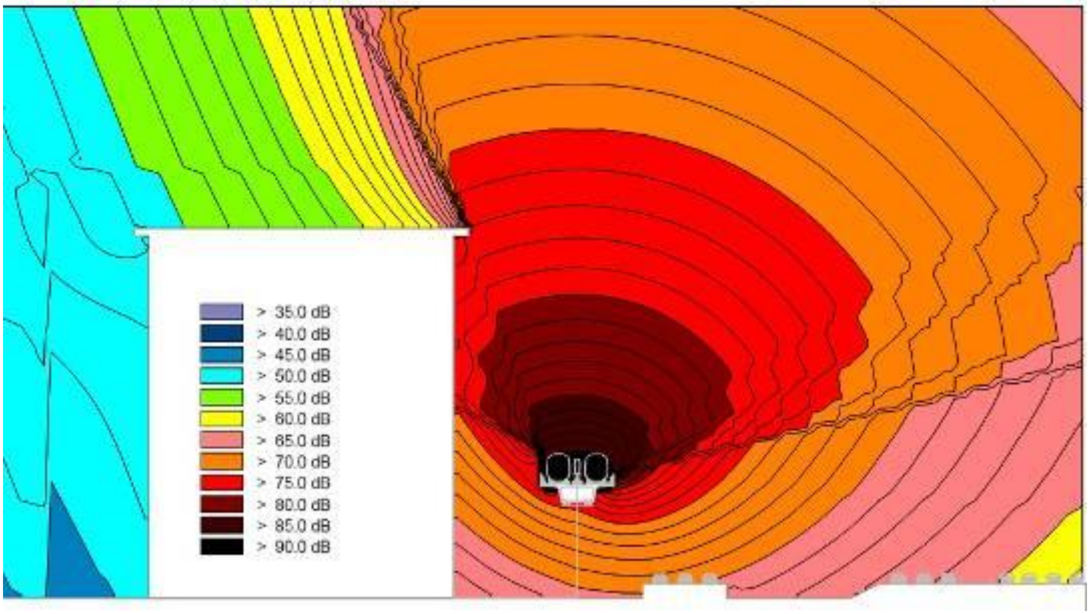

Chart 7-45 Noise Popagation (L_{max}) with 4.2m Noise Barrier

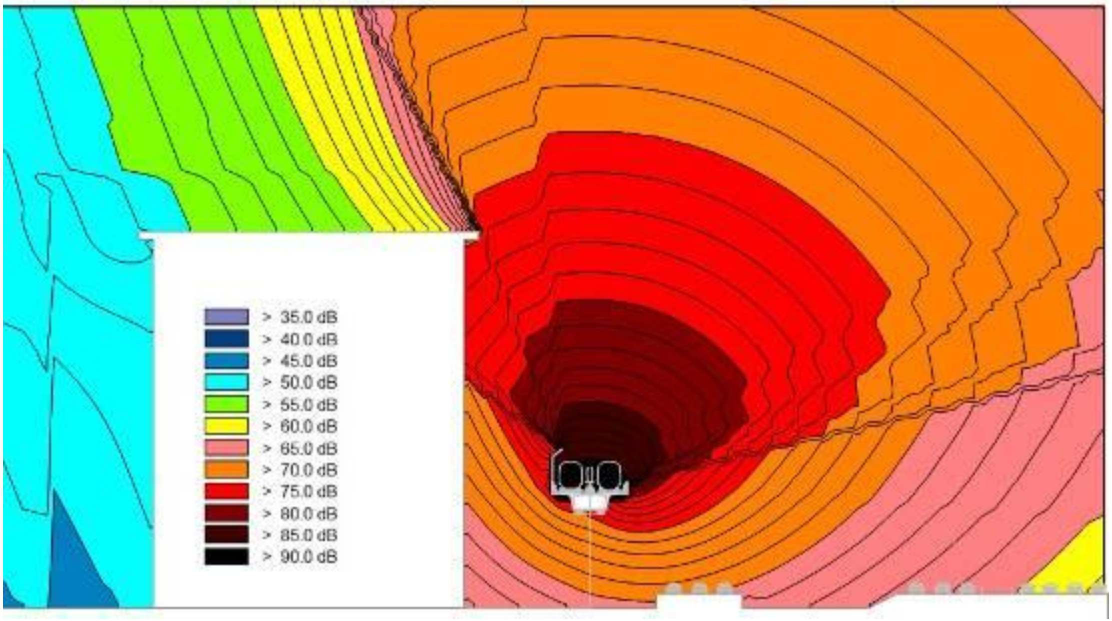

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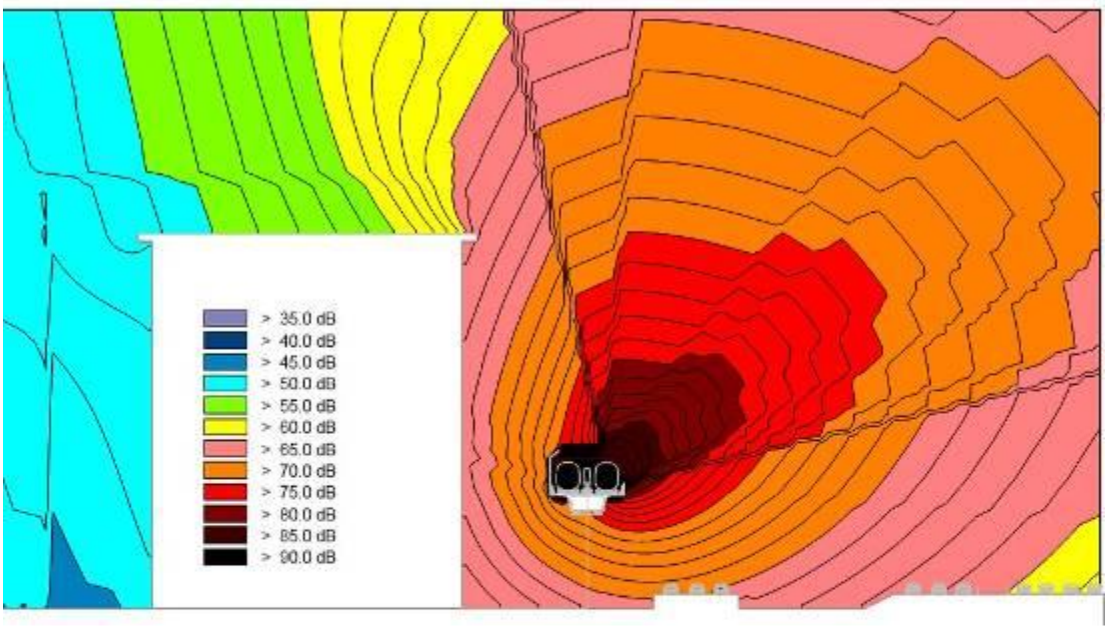
Chart 7-46 Noise Propagation from LRT3 Pass-By (L_{max}) with Semi-Enclosure



It is also to be noted that there are structural loadings (including wind loadings) and public safety requirements in noise barriers affecting the viaduct design. Design solutions incorporating the noise mitigation measures shall therefore be addressed in the detailed engineering of the Project.

Reduction of noise propagation via the ground (ground-borne noise and vibration) requires mitigation to trains vibrations and is addressed in **Section 7.5**.

In addition to railway operation noise, noise from ventilation air fans (fresh air supply and exhaust of the underground tunnel and Station) at the Persiaran Menteri LRT underground alignment shall also be addressed.

Mitigation of ventilation air fans are conventionally with the use of sound attenuators/ silencers placed along the air ducts or at the air intakes and exhaust discharge. Additional measures include acoustics lining of the air ducts and use of acoustically line air plenum at the air intakes and discharge. The use of low noise fan type with high air flow capacities is also recommended to minimise noise generation at source. Self-regenerated noise from air flow via louvers of the fresh air openings is also an additional issue of concern. This can be addressed with correct sizing of fresh air opening and louvers to minimise air flow noise. The design and selections of sound attenuators/ fans silencing, and air intake/discharge plenum shall be undertaken as part of the ventilation fan design.

At the LRT stations, increased road traffic is anticipated along local roads leading or passing the stations. There are also provisions for car park and ride facilities at some stations. Noise from local traffic to and from the stations and from the feeder buses is anticipated to be an issue of concern that requires mitigation. This includes vehicle noise at the car parks located adjacent residential houses in early mornings and late evening.

Mitigation of the local traffic noise along the approach roads and at the car park perimeter with the adjacent neighbors will be addressed with noise barriers (which can be masonry acoustics type to be rendered aesthetically acceptable to minimise visual impact). The station planning and design and all ingress and departure roads to the station shall be include due consideration to potential noise disturbance and avoidance of inconvenience including addressing likely road traffic congestions. This includes the use of noise screening barriers, soft and hard landscape.

7.5 VIBRATION

When a train travels through along the viaduct (or underground), the interaction between the wheels and the rails generates vibration. This vibration will transmit from the track into the viaduct box girder (or underground tunnel wall) and from there propagate ground-borne to the surrounding area.

Vibration impact to receptors located along the alignment relates to human response in buildings to ground borne propagation from passing trains. The severity depends on the properties of the ground, building type and sensitivity of the receptors.

Hospitals with vibration sensitive facilities (e.g. MRI and imaging equipment) are most at risk. There is also perception of rumbling noise (structure-borne noise) in low noise environment (for example, hotel or condominium located close to the railway corridor).

7.5.1 Acceptable Limits for Vibration

Vibration limits for train operation shall be based on continuous vibrations (although the train events are short term in nature but repeated in regular time intervals over an hour depending on the LRT3 operations frequency).

Recommended limits from steady state vibrations for human response as prescribed in Schedule 5 of the DOE Planning Vibration Guidelines (**Table 7-11)**.

Table 7-11 Recommended Limits for Human Response and Annoyance from Steady State Vibrations

Receiving Land Use Category	Day Time 7.00 am - 10.00 pm	Night Time 10.00 pm - 7.00 am
Vibration Sensitive Areas	Curve 1	Curve 1
Residential	Curve 2 to Curve 4	Curve 2
Commercial, Business	Curve 4 to Curve 8	Curve 4
Industrial	Curve 8 to Curve 16	Curve 8 to Curve 16

Source: DOE Guidelines for Vibration Limits & Control in the Environment (2007)

In vibration sensitive areas and receptors (typically hospitals, and schools), the recommended limit is Curve 1 (0.1mm/s RMS) day and night time. For residential buildings, the recommended limits are Curve 2 night time and Curve 2 to Curve 4 in the daytime.

7.5.2 Predicted Vibration Levels

Train and road traffic induced vibration is dependent on the severity of the vibration at source, transmission through the ground and interaction with the building (vibration response). The vibration generation is function of the force density (trains axle loading); whereas vibration transmission in the ground are function of the soil condition between the rails and roads to the building (transfer mobility). The transfer mobility is dependent on soil dynamic properties and damping which varies for soil types (typically limestone, granite and Kenny Hill formation typically prevalent in the Klang Valley). These dynamic soil properties are best determined from tests done on site. Vibration propagated through the ground is then amplified (modulated) by the dynamic response of the building.

The impact of ground-borne vibration is in principle dependent on the ground conditions and receptor in order to quantify the human response at each receptor location. Accurate assessment for ground borne vibrations requires soil tests of the entire alignment to determine damping properties of the underlying soil and considerations of vibration propagation to receptors and the likely response to ground excitation. Such assessment is usually done during detailed design stage when details of the underground tunnel and soil test data are available.

The Federal Transit Administration (FTA), United States of America in its Technical Manual FTA-VA-90-1003-06, “Transit Noise and Vibration Impact Assessment” recommends that buildings for *residences where people normally sleep* (Category 2) shall require vibration assessment for transit trains located within 70m (~200 ft). Extracts of the table from FTA is given below.

Table 7-12 Distances for Buildings to be Screened for Vibrations from Trains

Type of Project	Critical Distance for Land Use Categories* Distance from Right of Way or Property Boundary		
	Category 1	Category 2	Category 3
Conventional Commuter Rail	200m	70m	40m
Rail Rapid Transit	200m	70m	40m
Light Rail Transit	150m	50m	35m
Intermediate Capacity Transit	70m	35m	18m
*Definition of land use	Buildings where vibration would interfere with interior usage	Residences and buildings where people normally sleep	Commercial land uses with primarily daytime use

Source: Federal Transit Administration USA, Technical Manual FTA-VA-90-1003-06

The vibration from LRT3 was quantified on a generalised basis for residential dwellings at different distances between the receptors and track. The analysis undertaken were based on typical properties of soil damping (transfer mobility) based on published literature and actual test data.

For the ground borne vibration propagation analysis, published values for a range of transfer mobility were checked against results of an actual site soil tests conducted for controlled vibration tests undertaken for the MRT1 project. The tests involved vibration impact from a dropped weight of known impact forcing with simultaneous measurements using seismic accelerometers. The data were analysed to validate transfer mobility (vibration reduction over distances) based on published literature. Typical force densities were obtained from measurements of trains ground-borne vibrations from other rail projects.

It is difficult using theoretical techniques to predict the propagation of vibration through the ground and into buildings since multiple propagation paths are numerous (**Chart 7-47)**.

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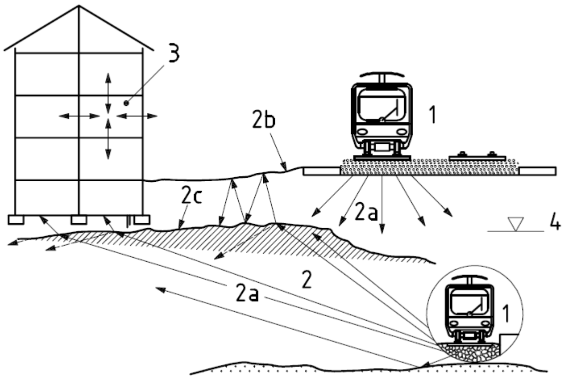
Chart 7-47 Ground-Borne Vibration Propagation from Railways



Key

1 source

2 propagation:
2 a body waves (compression, shear)
2 b surface waves (e.g. Rayleigh, Love)
2 c interface waves (e.g. Stoneley)

3 receiver (vibration, re-radiated noise)

4 water table

Source: BS ISO 14837-1:2005

Calculation procedures for ground borne vibrations from trains (and road traffic) based on semi-empirical relationships and measured data are published by the FTA's Technical Manual FTA-VA-90-1003-06, Transit Noise and Vibration Impact Assessment, (pages 11-1 to 11-24). Similar procedures are recommended in BS ISO 14837-1:2005 "*Mechanical vibration - Ground-borne noise and vibration arising from rail systems- Part 1: General guidance*".

In brief, the prediction requires computations of the dependent parameters in one-third octave band spectral levels (in vibration decibels referenced to a reference values) are given by the following relationship:

$$L_v = L_F + TM_{line} + C_{build}$$

where L_v rms vibration velocity level;
L_F force density for a line vibration source;
TM_{line} line source transfer mobility from the tracks to a receiver site;
C_{build} constant to account for ground-building foundation interaction and attenuation.

All of the quantities given above are functions of frequency and referenced to a reference velocity (10^{-6} inch per second). Typical ranges of values are as follows.

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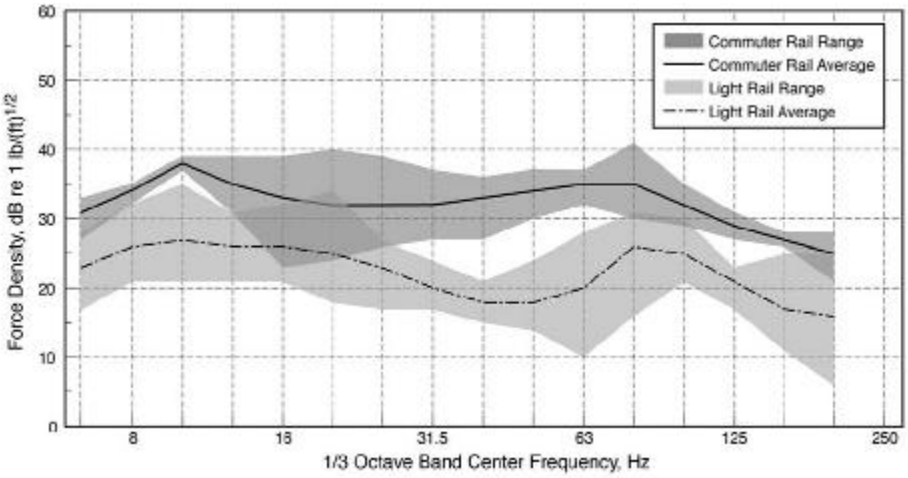
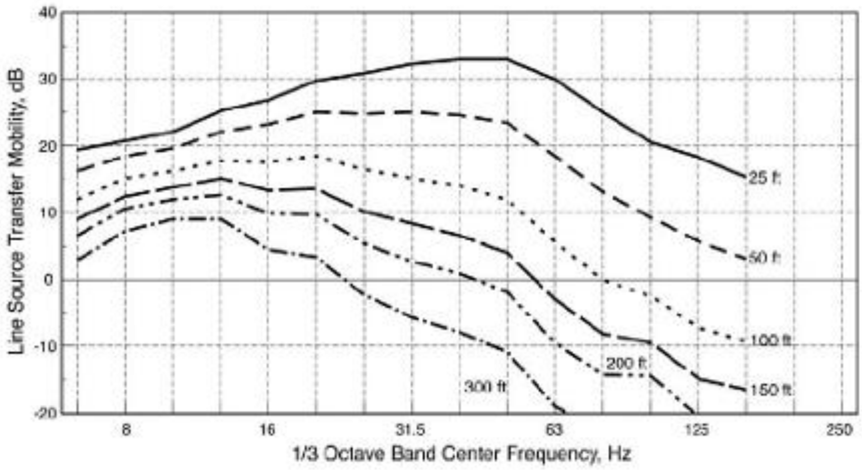
Chart 7-48 Typical Force Densities for Rail Transit Vehicles, 65 km/hr



Source: Federal Transit Administration USA

Chart 7-49 Typical Line Source Transfer Mobility



Source: Federal Transit Administration USA

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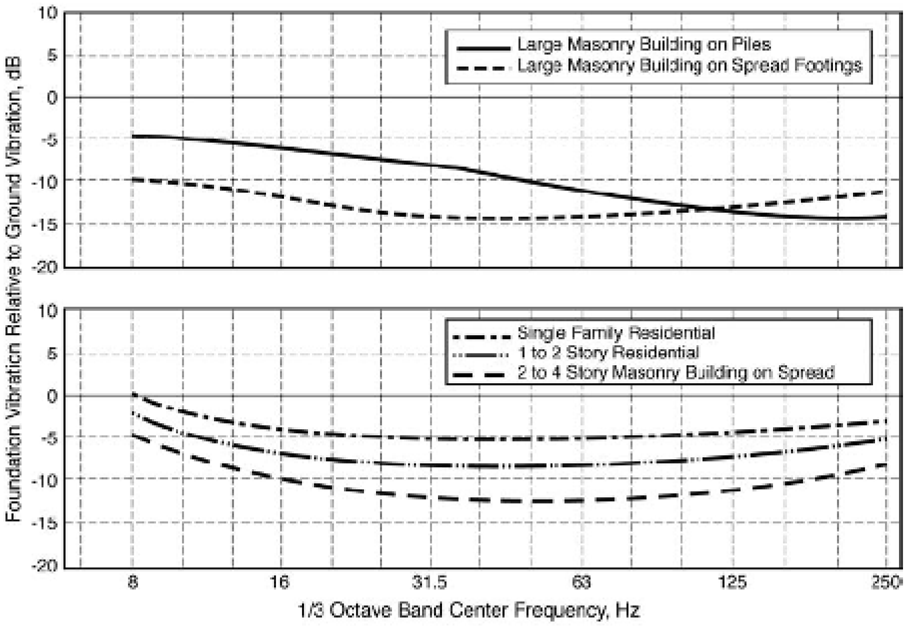
Chart 7-50 Foundation Response for Various Types of Buildings



Source: Federal Transit Administration USA

The FTA algorithms and values for force densities and transfer mobility had been used and validated in several railway projects in Malaysia including groundborne vibration and noise assessment and design for the MRT1 Line.

Assumptions used for the vibration analysis are.

- A train speed of 80 km/hr (being the LRT3 maximum speed). Vibrations reduce by 1.1 dBV (ref. with speed 10^{-6} inch per sec velocity) for a 10 km/hr speed reduction.
- Ground-borne vibration propagation analysis from the rails median with consideration to distances to receptors were undertaken based on two range of railway force intensity (good wheel/track condition, and worn wheels/tracks).
- Calculations were undertaken for receptors in typical landed residential dwelling and high rise buildings (1st floor, as there shall be 2 dBV per floor). Values used for ground-building foundation interaction (C_{build}) were based on recommendations of the FTA manual.

Results of the ground-borne vibrations were then plotted against human response curves for two selected distances (15 m and 30 m). These human response curves were assessed against acceptable limits as per the DOE Guidelines for Vibration Limits and Control in the Environment (2007) and BS 6472-1:2008.

7.5.3 Vibration Assessement

The DOE Vibration Guidelines recommend an acceptance limit (for steady state vibrations, not necessarily trains induced vibrations) of Curve 2 in the night and Curve 2 to Curve 4 in the day for residential receivers, and Curve 1 day and night for vibration sensitive receivers.

The FTA Technical Manual FTA-VA-90-1003-06, "Transit Noise and Vibration Impact Assessment" recommends an acceptance limit of Curve 1 (0.1 mm/s, 72VdB ref. 10^{-6} inch per sec velocity) for hospitals and residential receivers night time, and Curve 2 for residential receivers day time. The BS 6472-1:2008 "*Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration source other than blasting*", Section 6 Table 1 states that there is a "*low probability of adverse comments"* for vibrations of 0.1 mm/s to 0.2 mm/s (Curve 1 to Curve 2).

Table 7-13 shows the predicted vibration levels (without and with mitigation) for two selected critical distances (15m and 30m) from the tracks for typical terrace houses and high rise buildings (at 1st floor),

Plots of the vibration response anticipated in buildings by receptors for two selected distances without and with vibration mitigation measures on the railways are given in **Charts 7-51 to Chart 7-54** (good track and wheel conditions).

Table 7-13 Summary of Predicted Vibrations to Receptors from LRT3 Operations

No.	Receptor distance to LRT	Building Type	Wheels Rail Condition	Mitigation Measure	Human Response Curve
1.1	15m	1 - 2 storey house	Good	None	VC-A
1.2	15m	1 - 2 storey house	Worn	None	Curve 1 to Curve 2
2.1	30m	1 - 2 storey house	Good	Resilient baseplate	VC-B
2.2	30m	1 - 2 storey house	Worn	Resilient baseplate	Curve 1 to Curve 2
3.1	15m	High rise with piles	Good	None	>VC-A
3.2	15m	High rise with piles	Worn	None	>Curve 2
4.1	30m	High rise with piles	Good	Resilient baseplate	VC-A to VC-B
4.2	30m	High rise with piles	Worn	Resilient baseplate	Curve 1 to Curve 2

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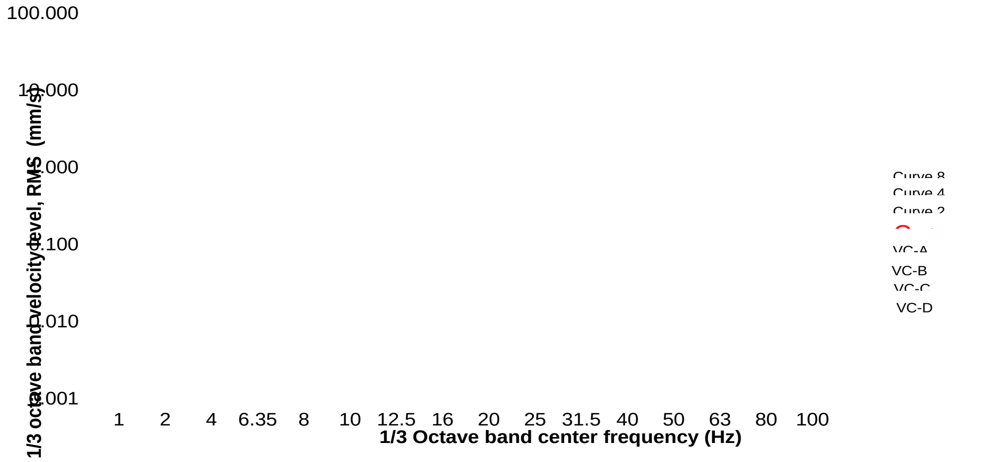

Chart 7-51 Predicted Vibrations in 2 Stories Houses 15m from Viaduct Pier (Good Wheels and Track Conditions)

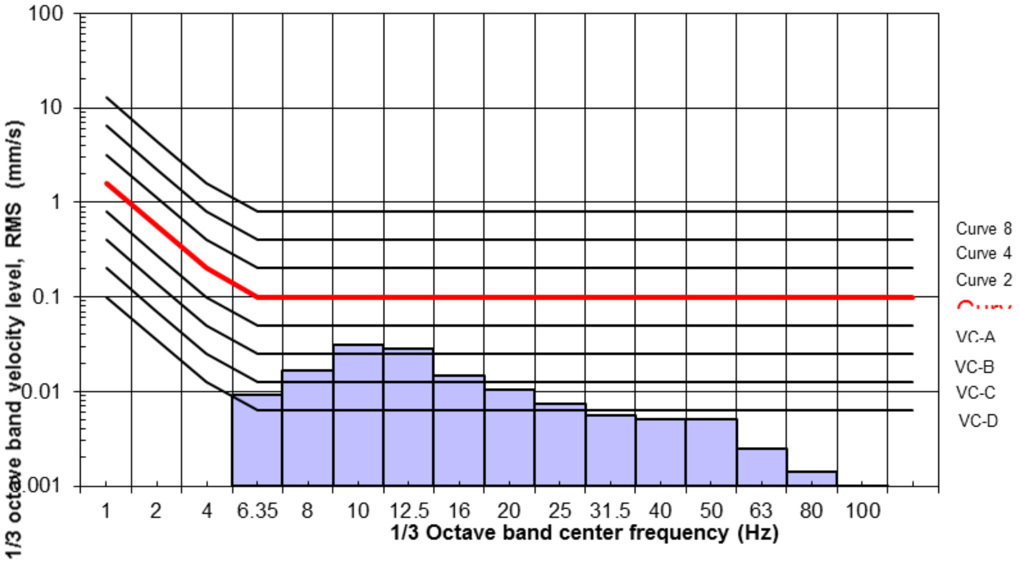

Chart 7-52 Predicted Vibrations in 2 Stories Houses 30m from Viaduct Pier (Good Wheels and Track Conditions)

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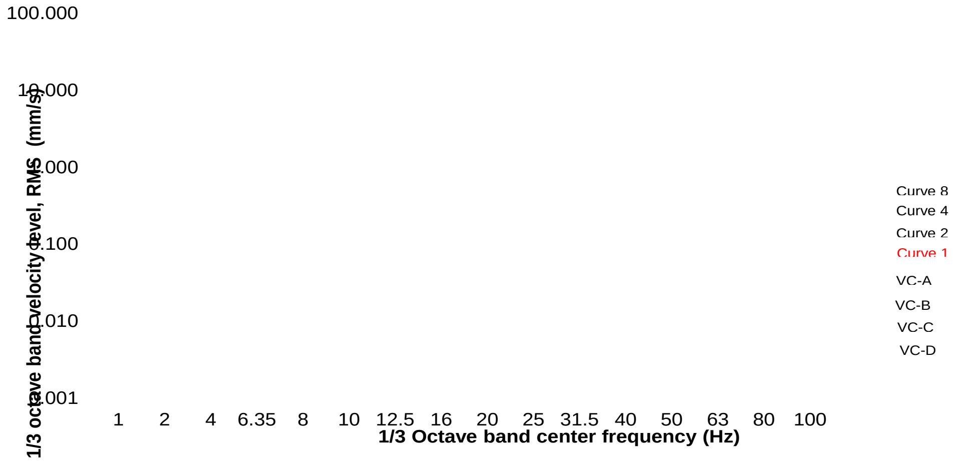

Chart 7-53 Predicted Vibrations in 1st Floor High Rise 15m from Viaduct Pier (Good Wheels and Track Conditions)

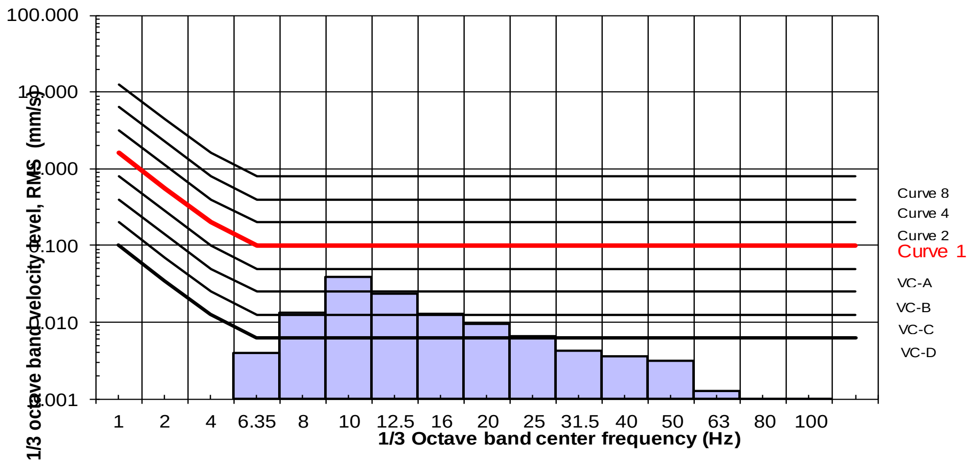

Chart 7-54 Predicted Vibrations in 1st Floor High Rise Condo 30m from Viaduct Pier (Good Wheels and Track Conditions)

The ground-borne vibration propagation analysis showed that receptors in houses (1 to 2 storey buildings) at 15m away were estimated to have vibrations below Curve 1 with good condition wheels/tracks, but exceed Curve 2 with worn wheels/tracks without railways vibration mitigation. For a receptor (at 1st floor) in a high rise building on piles (at 1st floor) at 15m away vibration levels were estimated to below Curve 1 good condition wheels/tracks but exceed Curve 2 with worn wheels/tracks without vibration mitigation. At 30m distances, vibration in houses were estimated to be well below perceptible levels with good condition wheels/tracks and marginally above curve 1 but below curve 2 with worn wheels/tracks without mitigation.

With vibration mitigation on the railway tracks (typically using resilient baseplate fasteners) vibration levels were shown to be within recommended limits (Curve 1) even with worn wheels/rails conditions at 15m distance from the railway tracks for typical residential buildings.

It is noted that the above calculations and predictions were based on specific assumptions of ground damping (line source transfer mobility) which may be different at specific sites. A lower transfer mobility (ground damping loss) or/and higher force densities from the trains would require a higher reduction from the tracks isolation assumed in this exercise to ensure compliance to the vibration acceptance limits at a specific receiver location. Detailed vibration analysis for ground borne vibrations to specific users at distances less than 30 m from the LRT track will be undertaken during design to confirm actual requirements of the tracks isolation works required for trains induced vibration mitigation.

Receptors of potential concern within distances of concern with regards of proximity of viaduct piers are at Idaman Villa and Damansara Lagenda in situations when worn wheels and tracks occur over time resulting in increased vibrations. The use of resilient baseplate fasteners is recommended as a pre-cautionary measure. Notwithstanding this recommendation, extent and locations where resilient baseplates to be used shall be subject to detailed design of the track works.

7.5.4 Vibration Mitigation Measures

Impact of ground-borne vibrations is site and receiver specific. In this EIA, the impact was quantified on a generalised basis rather than a specific receiver and building basis. Accurate assessment for ground borne vibrations requires soil tests of the entire alignment to determine damping properties of the underlying soil, vibration propagation to receivers and the likely response to ground excitation.

Vibration mitigations similar to noise in principle are addressed with respect to:

- Source;
- Path; and
- Receiver.

Mitigation at source typically involves the use of continuous welded tracks which is often a standard design in modern railway lines. Issues related to brake squeals and impacts between wheels and track from out of roundness wheels are maintenance related issues and shall be addressed with proper maintenance and upkeep by the trains (wheels in particular) and tracks (undulations/corrugations in the rails which shall require rail grinding).

Mitigation of LRT ground borne vibrations requires the control of vibration transmission from the tracks to the ground. This involves a vibration isolation medium introduced between the tracks and supporting structure. Several methods/devices with varying degree of effectiveness are available. The choice of vibration isolation method/solutions is dependent on the quantum of vibration reduction in addition to the complexity and economics of the solution.

Rail tracks without a vibration problem are conventionally fitted directly onto the underlying structure and have a simple rail pad to sit directly between the rail foot and structure or ballast. It is more intended for levelling (shimming) purpose and not vibration reduction. Vibration reductions from rail pads are typically in the order of 3 dBV, and no more than 6 dBV depending on rail pad stiffness. For tracks supported on a slab track, a standard rail strip is designed to sit directly between the rail foot and the supporting slab. It has the benefit of continuously supporting the rail thereby minimising rail corrugations. Vibration reductions from standard rail strips are similar to rail pads are typically in the order of 3 dBV, and no more than 6 dBV depending on rail pad stiffness.

An improvement to standard rail pads is a highly resilient rail pads where an improvement to vibration reduction is obtained from the resilient (isolation) nature of the resilient pads. Vibration reductions from resilient rail pads can be up to 8 dBV depending on rail pad stiffness.

An improvement to the above is a under base plate designed to sit directly between the base plate and the supporting slab. Vibration reductions of between 10 dBV and 12 dBV are possible depending on rail pad stiffness. In track systems that use sleepers, under-sleeper pads that sit beneath the sleeper and the track slab can be used. Vibration reductions of between 10 dBV and 15 dBV are possible depending on under-sleeper pad stiffness.

While floating slab track is available for railways vibration isolation (mainly used only in underground tunnels beneath buildings), vibrations from railways on elevated viaducts generally do not require the use of floating slab tracks.

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Vibration mitigation devices (fasteners) are usually proprietary products. Examples of a resilient fastener to be used in lieu of rigid baseplate being considered for use in the MRT1 project are shown in **Plate 7-2** (*Pandrol Vanguard*) and **Plate 7-3** (*Delkor* egg type baseplate). Selections of the required vibration mitigation option are subject to design of the trackworks and track fasteners to be undertaken during detailed design.

Plate 7-2 Typical Resilient Fastening System (Pandrol Vanguard)

Source: Pandrol.com/product/vanguard

Plate 7-3 Typical Egg Type Resilient Rail Fastener (Delkor Egg)

Source: www.delkorail.com/products/rail-products/egg.html

7.6 TRAFFIC IMPACTS

LRT is a popular mode of public transportation in the Klang Valley because the service reliability is high and it offers a comfortable ride. In many countries, LRT or MRT is the backbone of the public transport services that connects sub-urban areas with the Central Business District (CBD). It is then supported by other modes of public transport such as feeder buses that complement rail services.

The proposed LRT3 will provide connectivity to Shah Alam and Klang areas that are experiencing a development boom, predominantly with residential and commercial development. It is thus important to provide alternative modes (besides private vehicles) to travel into the CBD. This would reduce traffic demand on the existing road network that could alleviate traffic congestion problems.

Proposed linkages from the LRT3 to the existing train or MRT stations have been carried out in a strategic manner. The proposed LRT3 could integrate well into the existing public transport services, eventually serving as an added advantage to further attract higher ridership. In terms of ensuring smooth vehicular traffic flow, new junctions and upgrade of road capacity are proposed to improve traffic flow.

The main traffic impacts from the LRT3 during the operational stage are :

- Alleviation of traffic congestion in the Klang Valley, particularly in the western corridor from Petaling Jaya to Klang.
- Localised traffic congestion in the vicinity of stations

7.6.1 Alleviation of Traffic Congestion

The main and the biggest beneficial impact of the LRT3 is to alleviate traffic congestion in the Klang Valley, particularly in the western corridor from Petaling Jaya to Klang. An efficient rail system serves as the pull factor to encourage mode shift that reduces private vehicles usage. Thus, it could reduce private vehicle trips especially on the western corridor of Klang Valley.

(a) Klang Valley

The LRT3 improves rail connectivity in Klang Valley region as it serves as a pull factor to increase public transport ridership. According to the Feasibility Study of the LRT3, it is anticipated that the future traffic volume on the roads will be reduced by about 13% after implementation of the LRT3 system. This would ease the congestion problem especially along the LRT3 corridor. LRT is attractive as it provides reliable and comfort services to passengers. LRT3 in particular enhance the rail network as it increases network coverage along the western corridor of Klang Valley.

In addition, it is planned strategically to integrate with existing rail network as it has several interchanges with existing LRT and KTM Komuter. It is also linked to the MRT SBK Line (which is currently under construction). The LRT3 interchanges with MRT SBK Line at One Utama station and with LRT Kelana Jaya Line at Station 3 station.

(b) Petaling Jaya – Shah Alam – Klang corridor

The western corridor of Klang Valley particularly Petaling Jaya – Shah Alam – Klang corridor is a busy corridor with many residential, industrial, and commercial developments. For the past few decades, Petaling Jaya has developed rapidly and serves as one of the financial and commercial centre in the region. Shah Alam and Klang has been developed as sub-urban towns to support the City Centre and Petaling Jaya. Urban sprawl occurs in which people choose to stay at the sub-urban towns and commute daily to Petaling Jaya/City Centre to work. As a result, huge number of trips are found commuting between these areas especially during morning and evening peak hours. Traffic congestion and long delay is observed on the arterial roads and highways connecting these areas. As such, an efficient LRT system is needed to reduce private vehicle usage on this corridor which ease the traffic congestion.

(c) One Utama Station to Persada PLUS Station in Petaling Jaya Area

This segment of LRT3 passes through Damansara Utama and Tropicana of Petaling Jaya. It passes through several arterial/collector roads, such as Jalan Tropicana Selatan 1, Persiaran Tropicana, NKVE, and SPRINT Highway. Currently, although these roads/highways are performing at LOS of A to D, but significant delays and queues are observed during peak hours. With LRT3 implemented, it is anticipated that the road performance could be improved. For example, the NKVE has most of the sections performing at LOS F during both AM and PM peak hours in future year if LRT3 is not available. However, the road performance is improved and has less failure segments with LRT3 services. This shows that LRT3 is anticipated to improve road performance and traffic flow condition. This would benefit the daily commuters and residents within the captive area of the alignment, i.e. Damansara Utama, Kelana Jaya, and Tropicana areas.

(d) Station 3 to Bukit Raja Station in Shah Alam Area

The alignment passes through major/distributor roads such as Persiaran Kerjaya, Persiaran Hishamuddin, Persiaran Dato' Menteri and Persiaran Permai and Federal Highway. Currently, these roads are performing at acceptable level but would deteriorate in the future as more developments are coming up at the areas in the along the roadway.

Particularly Federal Highway is performing at LOS F at current. It is expected to deteriorate further if LRT3 is not implemented. With LRT3, the highway performance could be improved to LOS C (depended on sections). Persiaran Kerjaya is another example in which with no LRT3, it will have LOS F in Year 2030, but its performance will improve to LOS D if LRT3 is implemented. This shows that LRT3 Line would benefit the daily commuters and residents within the captive area of the alignment, i.e. Glenmarie, Seksyens of Shah Alam, I-City and Uitm.

(e) Klang area

This segment of LRT3 passes through the heart of Klang district. It passes through several major/arterial roads such as Lebuh Keluli, Persiaran Bukit Raja, Jalan Meru, Jalan Jambatan Kota, Persiaran Tengku Ampuan Rahimah, and Jalan Langat. Currently, these roads are performing at acceptable level but would deteriorate in the future as more developments are coming up at the areas along the alignment. The construction of LRT3 Line would benefit the road users and the residents residing within the captive areas, such as Bandar Bukit Tinggi, Taman Bayu Perdana, Bandar Botanik, Taman Meru, and Taman Summit.

7.6.2 Localised Congestion In the Vicinity of Stations

During operation, localised traffic congestion may occur at certain stations due to their locations. Therefore, it is important to have proper station access plans as many of the proposed LRT3 stations are situated along the arterial roads and near residential areas. Proper access plans are beneficial to ensure smooth flow of traffic and minimise traffic congestion around the stations. It could also ensure proper integration of the proposed LRT3 services in the multi-modal transportation context. In addition other facilities for pedestrians and vulnerable road users to access the stations are also important.

One of the factors that could encourage higher ridership is the accessibility to the proposed station. Due consideration has been given due station access planning, especially for pedestrian flow. Bus and taxi bays are provided at almost all of the stations, and park-and-ride facilities are provided wherever suitable.

The proposed LRT3 stations access management plan addresses:

a) Planning of feeder bus services to complement the LRT services. Considering that many of the stations do not have park and ride services, feeder bus services are necessary to facilitate passengers' access to the stations. For each of the stations, two bus routes are planned, with the maximum distance of not more than 15km and travel time of not more than 40 minutes. Feeder bus service is preferred over park and ride service as it covers larger area, and could reduce localised traffic congestion at stations due to induced traffic.

b) Proposed transit oriented design at several stations give an advantage of seamless connection between residential/commercial developments with train services. This could encourage more ridership and higher public transport mode share in the future.
c) The planning of pedestrian facilities, such as covered walkways and pedestrian bridges, are proper to allow pedestrian access to the station.

7.6.3 Management Measures

Apart from the strengths, there are several concerns on the access management plan that the Project Proponent shall address to improve the situation, including:

a) Access via minor roads creates noise and air pollution to the residential areas. Traffic safety is a concern for those stations in the vicinity of schools.
b) Access via arterial roads might disrupt through traffic and cause unnecessary bottleneck.
c) Some junctions have insufficient capacity to cater for future traffic conditions.
d) Roads have insufficient capacity to cater for future traffic conditions.

Traffic issues and management measures specific to each station are listed in **Table 7-14**.

Table 7-14 Traffic Issues and Management Measures at Selected Stations

No.	Station	Critical Issue	Management Measures
Segment of One Utama Station to Persada PLUS Station			
1	One Utama	• Proposed access is located along Persiaran Bandar Utama via LDP or Lebuh Bandar Utama. • Persiaran Bandar Utama is the major access to the surrounding development such as Sri Pentas, SMK Bandar Utama, etc. • With the proposed station along Persiaran Bandar Utama, surrounding junctions might have insufficient capacity to cater for the traffic growth.	• Junctions reconfiguration is necessary to provide smooth internal and external traffic circulation. • Traffic calming strategy, such as road hump installation, is applied to reduce travel speed. • Pedestrian crossing along Persiaran Bandar Utama. • 2 feeder bus routes are planned, with the maximum route distance of 10 km and average travel time of 30 minutes
2	Damansara Utama	• The station can be accessed from Jalan 5 via Jalan SS 21/34 or Lorong Masjid. • Surrounding are mainly residential development such as Pelangi Utama Condominium and Apartment, etc. • New proposed road is required to connect the proposed station for a better traffic circulation.	• New proposed road is required to have better traffic circulation. • Junction improvement is necessary to provide smooth internal and external traffic circulation. • Traffic calming strategy, such as road hump installation, is applied to reduce travel speed.
3	Tropicana	• Access via local street Jalan Tropicana Selatan 1 and Jalan Tropicana Selatan which are the major access for the residential apartments and schools. With the increase of traffic on these roads, it poses some safety risk to the road users. Junctions might have insufficient capacity to accommodate traffic growth.	• Pedestrian bridge to Riana Green Condominium and Genting Awana Building • Proposed TOD • 2 feeder bus routes are planned, with the maximum route distance of 7.8 km and average travel time of 24 minutes • Traffic calming strategy, such as road hump installation, is applied to reduce travel speed. • Junctions upgrading and reconfiguration is necessary to provide smooth internal and external traffic circulation.

Source: Traffic Impact Assesment Reports

Table 7-14 Traffic Issues and Management Measures at Selected Stations (Cont'd)

No.	Station	Critical Issue	Management Measures
Segment of One Utama Station to Persada PLUS Station (Cont'd)			
4	Persada PLUS	• There is no direct vehicular access to the station. It is accessible only by walking through the elevated bridge which is about 300 m in length. Security might be an issue especially during night time. • Taxi and bus bay are proposed along Jalan SS 7/26 which is currently used as the roadside parking.	• Road expansion is necessary to increase road capacity • Covered walkway to the nearest building • Pedestrian bridge to buildings on the opposite site of the station • 2 feeder bus routes are planned, with the maximum route distance of 6.8 km and average travel time of 22 minutes • Provide dedicated area for taxi and bus bay as well as drop off/pick up traffic
Segment of Station 3 Station to Bukit Raja Station			
5	Station 3	• Persiaran Kerjaya has insufficient capacity to accommodate future traffic condition. • Junction of Persiaran Kerjaya/Jalan Presiden U1/1 has insufficient capacity to accommodate future traffic condition	• To upgrade Persiaran kerjaya from dual carriageway with 3-lane to Eastbound and 4-lane to the Westbound to cater for future traffic • Junction of Persiaran Kerjaya/Jalan Presiden U1/1 will be upgraded and operated as four arm-signalised junctions with better ane markings and channelisation. • Covered walk path from station to park and ride of about 125 m • Covered drop-off and pick-up area of about 200 m • A pedestrian bridge crossing Persiaran Kerjaya is proposed to directly connect the platform level to the other side of the road • Proposed TOD development • Link to Kelana Jaya LRT extension • 2 feeder bus routes are planned, with the maximum route distance of 7.8 km and average travel time of 23 minutes

Source: Traffic Impact Assesment Reports

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Table 7-14 Traffic Issues and Management Measures at Selected Stations (Cont'd)

No.	Station	Critical Issue	Management Measures
Segment of Station 3 Station to Bukit Raja Station			
6	Section 14	• Junction of Persiaran Dato' Menteri/Persiaran Bandar Raya have not sufficient capacity to accommodate for future traffic condition. • Junction of Persiaran Dato' Menteri/Persiaran Tasik have not sufficient capacity to accommodate for future traffic condition	• To upgrade and reconfigure junctions layout as follow: ○ Junction of Persiaran Dato' Menteri/Persiaran Bandar Raya to have a u-turn movement to LRT station ○ Reduce number of traffic signal phasing and junction reconfiguration for junction of Persiaran Dato' Menteri/Persiaran Tasik ○ To provide a u-turn from LRT station at junction Persiaran Dato' Menteri/Persiaran Damai station • Covered walkway to the nearest building • Pedestrian bridge to buildings on the opposite site of the station • Proposed TOD development • 2 feeder bus routes are planned, with the maximum route distance of 7.5 km and average travel time of 22 minutes
7	UiTM	• Taxi and bus lay-by as well as drop-off/pick up bay at the roadside. The waiting traffic might obstruct smooth flow on Federal Highway.	• To install proper curb and railing to separate the station access traffic with through traffic • Covered walkway to the nearest building • Pedestrian bridge to buildings on the opposite site of the station • Proposed TOD development • 2 feeder bus routes are planned, with the maximum route distance of 28.5 km and average travel time of 25 minutes

Source: Traffic Impact Assesment Reports

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Table 7-14 Traffic Issues and Management Measures at Selected Stations (Cont'd)

No.	Station	Critical Issue	Management Measures
Segment of Kawasan 17 Station to Johan Setia Station			
8	Kawasan 17	• No existing access to park and ride area.	• To upgrade Pesiaran Bukit Raja/Persiaran Rajawali junction from a 3 arm junction to a 4-arm signalised junction. This junction will provide access to park and area. • 2 feeder bus routes are planned, with maximum route distance of 9km and average travel time of 27 minutes.
9	Klang	• No existing traffic access to the proposed Park & Ride. • Access via local roads, Jalan Sg Bertih, Jalan Lembaga Bandaran and Jalan Bukit Jati which also provide access for Taman Teluk Pulai Indah to south of Klang Town.	• New road linking the local roads and Park & Ride. • To upgrade priority junction to signalised junction. • To add a storage lane for right turn and movement and at Jalan Sg Bertih. • To provide a left slip from Jalan Bukit Jati to Jalan Sg Bertih. • 2 feeder bus routes are planned, with maximum route distance of 9.4km and average travel time of 28 minutes.
10	Taman Selatan	• Junction of Persiaran Seraya/Persiaran Tengku Ampuan have insufficient capacity to accommodate future traffic condition	• To add 1 lane for the through movements at the northern and southern arm of junction of Persiaran Seraya/Persiaran Tengku Ampuan • Pedestrian bridge is proposed • Covered walkway to nearby buildings • 2 feeder bus routes are planned, with the maximum route distance of 9.3 km and average travel time of 28 minutes
11	Sri Andalas	• Interchange has insufficient capacity to accommodate future traffic condition	• Proposing upgrade of Pandamaran Interchange by having additional one lane on the Banting approach towards Klang • Covered walkway to nearby building • Proposed pedestrian bridge from TOD to existing development • Proposed TOD development • 2 feeder bus routes are planned, with the maximum route distance of 9.7 km and average travel time of 30 minutes

Source: Traffic Impact Assesment Reports

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Table 7-14 Traffic Issues and Management Measures at Selected Stations (Cont'd)

No.	Station	Critical Issue	Management Measures
Segment of Kawasan 17 Station to Johan Setia Station			
12	Bandar Botanik	• Interchange has insufficient capacity to accommodate future traffic condition	• Proposing upgrade of Pandamaran Interchange by having additional one lane on the Banting approach towards Klang • Covered walkway to the nearest building • Pedestrian bridge to buildings on the opposite site of the station • Proposed TOD development • 2 feeder bus routes are planned, with the maximum route distance of 7.8 km and average travel time of 23 minutes
13	Johan Setia	• Junction have insufficient capacity to accommodate future traffic condition • Interchange has insufficient capacity to accommodate future traffic condition	• Proposing upgrade of Pandamaran Interchange by having additional one lane on the Banting approach towards Klang • Upgrading of junction (from 3-arm to 4-arm signalised junction) to accommodate new access to the station and depot. The upgrading consist of providing an additional lane on the main line. • Covered walkway to the nearest building • Pedestrian bridge to buildings on the opposite site of the station • Proposed TOD development • 2 feeder bus routes are planned, with the maximum route distance of 12.6 km and average travel time of 38 minutes

Source: Traffic Impact Assesment Reports

7.7 VISUAL IMPACTS

Given the scale of the project, visual changes caused by the development to its surroundings; improvement (positive) and deterioration (negative), temporary or permanent – are inevitable, and mitigations can be made to address these changes. As the alignment traverses a variety of land use, significant visual impact is expected especially in urban areas (FHA Office of Environmental Policy, 1981). Therefore, consideration of visual component of the Project is important to integrate the structure of the Project structure to the surrounding environment.

7.7.1 Methodology

Visual assessment is more qualitative than quantitative, the assessment is not guided by a formula or a crunch system, but rather it is just a simple evaluation exercise steered mainly by theoretical interpretation of visual integrity. Meaning to say here, a good visual quality is defined by the "level of pleasantness" and how appealing a surrounding is to the eyes – and nothing more than that. Since the exercise is highly conjectural, a structured and well-defined procedure is important to ensure that the findings do not lack accuracy. In achieving this, four basic steps were adopted as follows:

Step 1 : Defining the context

Defining the context is the most important step prior to the implementation of the assessment. This can be achieved by employing the following exercises:

a) Defining the definitions and categories of receptors.

Receptors of the visual impacts can be divided into two categories which are **static receptors** and **mobile receptors**. Technically, static receptors consists of those people who are "permanently or temporarily based" at the affected points. Examples include housing residents, shop keepers and even security guards. While mobile receptors consist of those people who are just "briefly passing through" such as road users, cyclists and joggers. These two groups of receptors will be the most affected as their visual assets such as green sceneries, landmarks, recreational and cultural spaces will be heavily affected by the intrusion of the LRT stuctures.

It also important to highlight that, amongst these receptors (both static and mobile), there are several that can be ranked above the others when it comes to their "sensitiveness" to visual deterioration. Examples of these sensitive receptors include:

- Residents living along the route.
- Teachers and pupils of schools along the route.
- Hospital staffs and patients.

- Visitors to parks and recreational areas
- Occupants of commercial establishments along the route.
- Buildings or an area with cultural importance.

b) Defining the categories of impacts

As the line traverses a mosaic of land uses, valuing the aesthetics is therefore subjected to varied perceptions of different groups. Sentiments that are largely attached to diverse socio-economic and ownerships have been identified as some of the main drivers that contribute to the differences in the way people perceive aesthetic.

In total, three categories of aesthetics have been identified. These categories and their explanations are as follow:

<u>Perfect View</u> – locations of some of the buildings may have the best positioning for good scenery. The best example is a house located facing a park or an open space. This provides the house members a feast of visual tranquillity with images of green trees and people committing to less-hectic urban activities. Additionally, public facilities and infrastructure such as roads which are situated or oriented facing aesthetically pleasant view (such as a clear view of the sky) can also be grouped under this category.

<u>Important View</u> – view of areas or places that are important for not just individuals, but also for the whole community (including visitors). This may exist in various forms (i.e. building, landscape, statue etc.). The best example is the view of a community centre or government offices. View towards this area need to be ensured unobstructed to ensure high visibility level at all time. If unavoidable, then suitable mitigation measures need to be implemented - such as the installing of effective signage and inclusion of lighting elements.

<u>Sentimental View</u> – growing up in a particular area and has been framing the image of the surroundings as part of childhood memories, a person as a result might have a certain level of fondness against the changing of the scenery. This is however is very subjective and may not be appropriate to be used to oppose project implementation.

c) Defining the magnitude of impacts

The magnitude of impacts can be measured through an estimation of visibility level of the receptors. Here, two major characters which are (1) the location and (2) the distance between the receptors and the proposed project structures (i.e. LRT stations) are being used to estimate the level of impact.

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Based on this, a foreground, mid-ground and background comparison concept is adopted to compare the categories of visibility. “Foreground” implies to the scenario where the proposed LRT station or track is located close to receptors, contributing to “HIGH” visual impact as the view of most areas located at the back is obstructed by the proposed LRT structures. While “mid-ground” translates to “MODERATE” visual impact as the surrounding is only visible half-way through. And lastly, “background” translates to “LOW” visual impact as the structure is located further behind (where in the case of urban areas, the proposed structure might not be visible at all due to the high concentration of buildings located in foreground). These analogies are further explained through diagrams in **Plate 7-1, Plate 7-2 and Plate 7-3**:

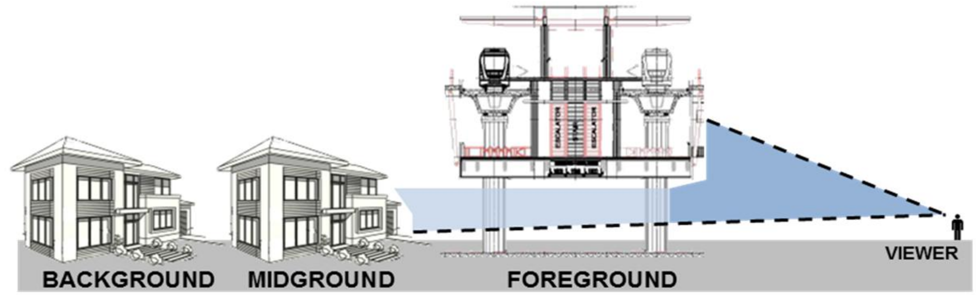


Plate 7-1: HIGH Visual Impact.
The viewshed (highlighted in blue) with structure located at the “foreground”, relative to the viewer. The pillars are placed at intervals, forming an intermittent and uncontinous line which allows limited view.

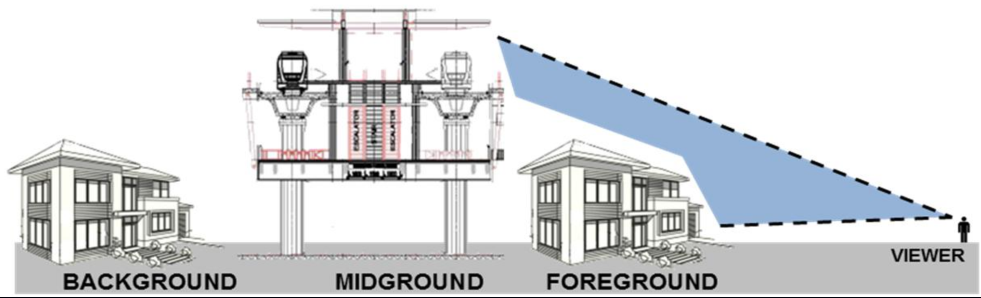


Plate 7-2: MODERATE Visual Impact.

The viewshed (highlighted in blue) with structure located at the “mid-ground”. The current view has been limited by existing features and addition of the project structure may block part of the viewer’s limited view.

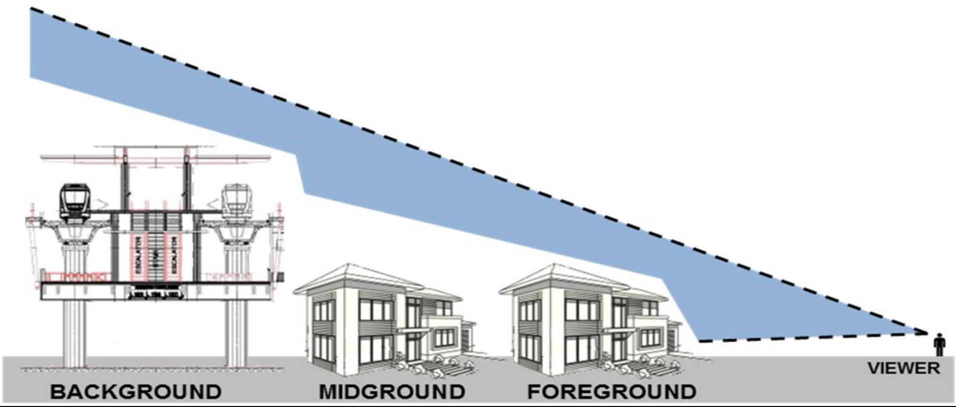


Plate 7-3: LOW Visual Impact.

The viewshed (highlighted in blue) with structure located at the "background". Project structure can be hardly seen as it has been shielded by existing features.

Neverthless, it is important to note that there are several variables that need to be factored in when the diagrams above are used for assessing the level of visual impacts. These variables include:

- Difference of the level (elevation) between receptors and the line
- Temporal exposure to the viewers (permanent vs temporary)
- Ownership and land use around the receptors
- Traveller variables; motivations, speed and frequency

Step 2 : Locating the affected areas

Step 2 focuses on how to locate and evaluate the affected areas. For this purpose, maps and satellite images were reviewed, and on-the-ground reconnaissance carried out to identify and profile visual quality and receptor sensitivity in the area.

This exercise includes the following:

- Categorising the existing landscape and visual setting along the LRT3 Line
- Characterising the potential views of project features, identifying visual sensitivity
- Determining the expected visibility of the project facilities at specific locations (key viewpoints)
- Identifying the overall degree of visual change (contrast) introduced by the project
- Assign visual management objectives (preserve, allow visual change of low contrast, allow visual change of high contrast) to each visual assessment area by evaluating representative views
- Assess the impact for each visual assessment area by comparing representative views of existing conditions to simulated views with the LRT3 Line

Step 3 : Assessment of impacts

In this step, the surrounding landscape then need to be assessed to evaluate the extent to which the LRT3 alignment (stations and viaducts) would potentially be visible from the surrounding areas. This exercise takes into account the context of the view, the importance of the view, the relative number of receptors, duration of the view and distance of the view. Based on the combination of all these factors, an overall ranking of visibility then can be applied based on the following categories of visibility – LOW, MODERATE or HIGH.

A “LOW” visual impact ranking indicates that the area is able to absorb the development without losing its scenic quality, while “HIGH” impact ranking indicates the area is vulnerable to the Project and may lose its existing scenic quality.

In order to show the potential changes to the current landscape, the proposed viaduct structure and stations were overlay on photos taken at specific locations. However, please take not the the photos shown are limited in terms of scale, exact location of the piers and stations as well as land use along the ROW.

7.7.2 Visual Impact Assessment

The assessment will assess the surrounding receptors as the alignment travels from One Utama Station to Johan Setia Station. For this purpose, the alignment is divided into five different sections as follows.

- **Section 1**: One Utama Station to Persada PLUS Station,
- **Section 2**: Station 3 Station to Persiaran Hishamuddin Station,
- **Section 3**: Section 14 Station to Bukit Raja Station,
- **Section 4**: Kawasan 17 Station to Sri Andalas Station,
- **Section 5**: Tesco Bukit Tinggi Station to Johan Setia Station/Depot.

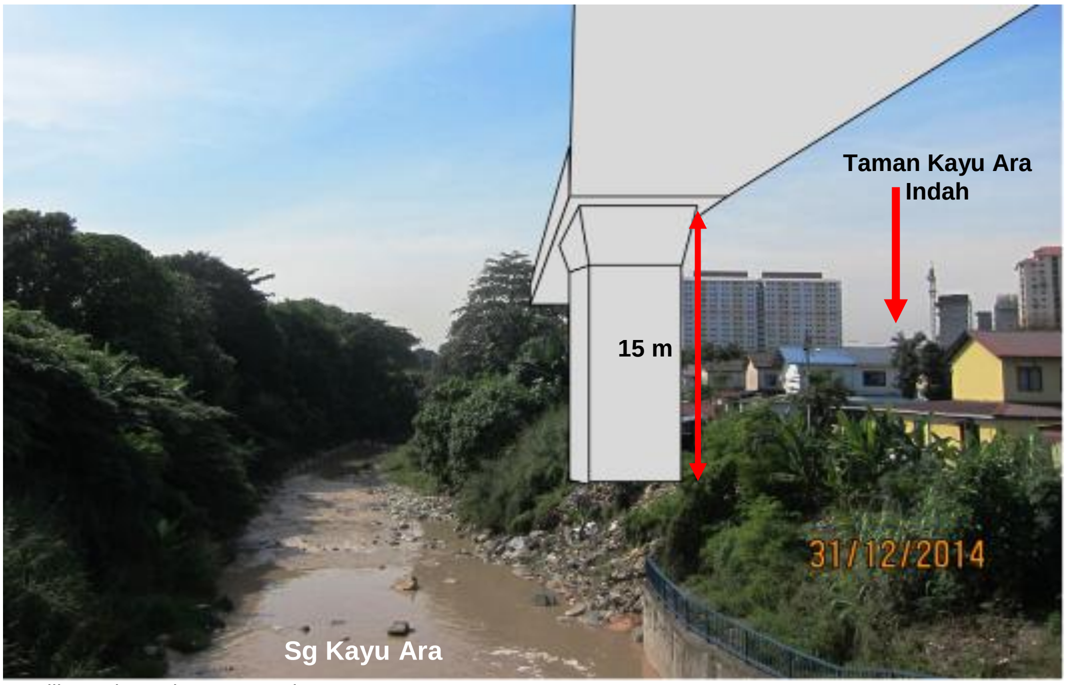
7.7.2.1 Section 1 – One Utama Station to Persada PLUS Station

Section 1 is consists of six stations – of which all are located within the MBPJ administrative boundary. The elevated alignment will pass through several high-density urban zones, affecting several residential areas.

One Utama Station to Damansara Utama Station

Within the earlier section of this particular stretch, the line will be running parallel to Sg Kayu Ara, and through several residential areas such as Damansara Utama, Taman Kayu Ara Indah and Kg Sg Kayu Ara. Presently, Sg Damansara and the landscapes along the river reserve provide green scenery to the surrounding residential areas. This is especially for the immediate receptors – of which here refer to the houses located the nearest to the reserve.

Nevertheless, despite the intrusion of the LRT3 Line into (or near to) the residential areas, visual impact is anticipated to be low. The river reserve will help to establish a buffer that can cushion visual impact from the presence of the proposed LRT3 Line to the surrounding receptors. There are however some exceptions, this is especially when the line is running too near to houses as highlighted in **Plate 7-4**.



For illustration only, not to scale.

Plate 7-4
This photo was photographed from a bridge along Jalan SS 21/34. Prior to reaching the Damansara Utama Station, the line will travel along the river reserve, and at certain points, will be running extremely near to sensitive visual receptors. One of the best examples is the presence of the line near Taman Kayu Ara Indah (as shown in this photo). At this point, visual impact is expected to be high, especially with the viaduct located less than 15 meters from the houses.

Visual Impact: **HIGH**

For illustration only, not to scale.

Plate 7-5
As the LRT3 Line approaches the SPRINT highway; the line will continue travelling along the river reserve, elevated above Sg Damansara, and surrounded by a mixture of landed and high rise residential on both sides of the river.

Even though landed houses along the river reserve is situated close to the alignment, visual impact is expected to be low as the reserve is presently lined and buffered with mature trees and vegetation. It is therefore important for these landscapes to be protected. If disturbed during construction, measures must be taken to restore the landscapes.

Visual Impact: **LOW**

Lien Hoe Station

After leaving Damansara Utama Station, the line will then enter the NKVE – before making a stop at Lien Hoe Station. This station will be located along the NKVE's road reserve. It is sited near to several prominent landmarks such as Luxor, Ambank and 3M office buildings. Damansara Lagenda residential area is also located near to the station (**Plate 7-6**).

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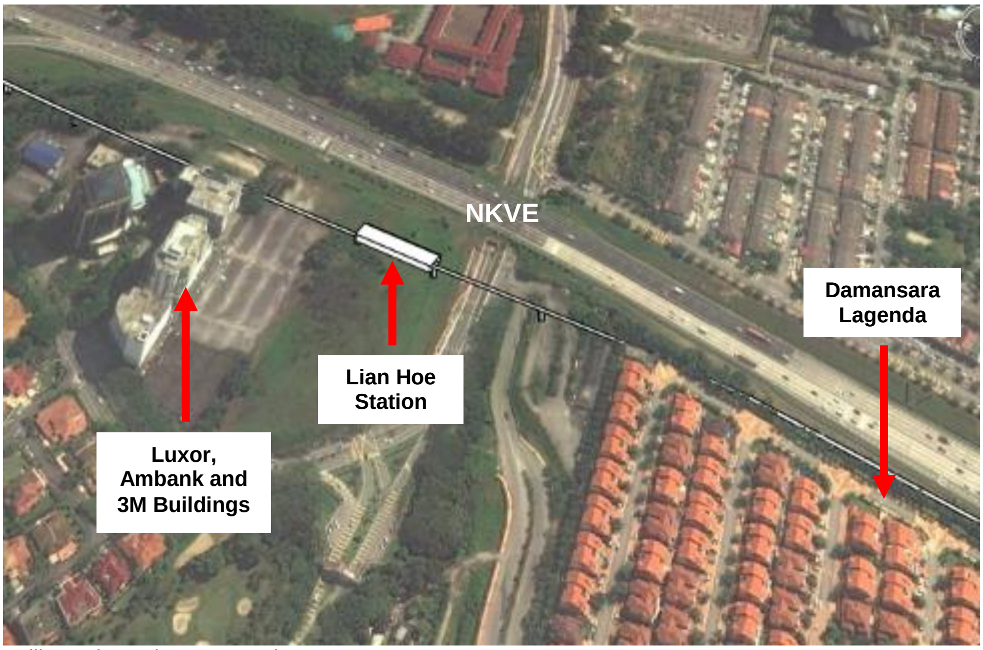


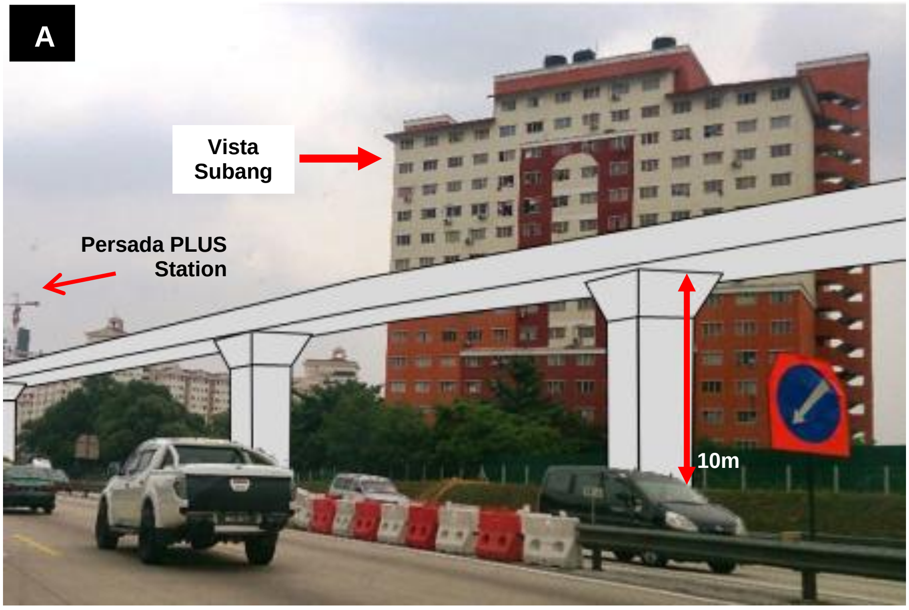
For illustration only, not to scale.

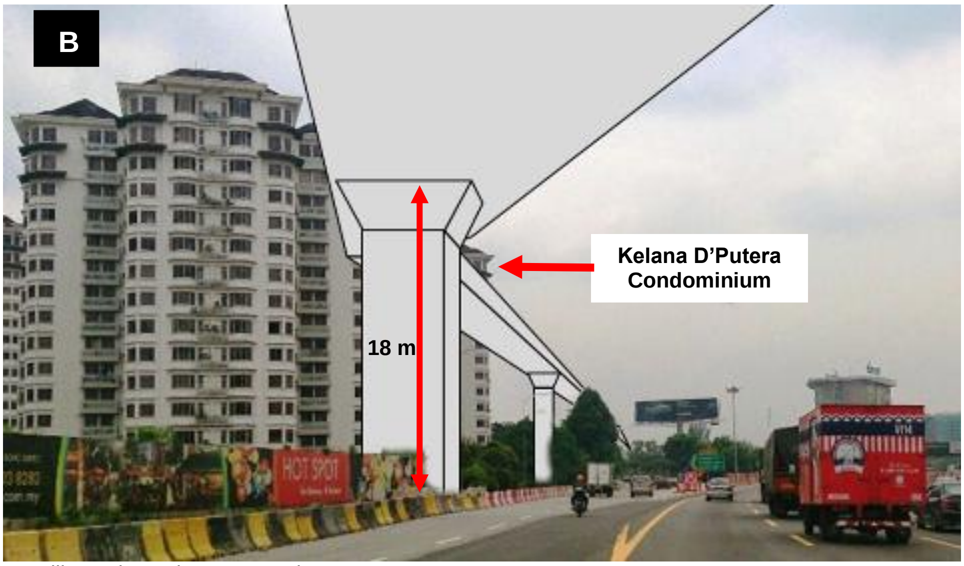
Plate 7-6

Lien Hoe Station is located just next to the NKVE. The station is also situated near to a business complex – of which houses several office buildings for companies like Luxor, Ambank and 3M. It is anticipated that visual integrity will not be affected by the presence of the LRT3 Line here since visual quality is already deteriorated by the presence of the highway.

Visual Impact: **LOW**

<u>Note</u>: Damansara Lagenda residential area which is located near to the proposed Lien Hoe Station too will not be significantly affected. This is primarily due to the orientation of its houses and the availability of buffer zone that separates its northern compound boundary with the NKVE.





For illustration only, not to scale.

Plate 7-7

As the line approaches Persada PLUS Station, it will be running near to two apartment buildings, namely – Vista Subang (about 18m apart) (see Photo A) and Kelana D'Putera Condominium (15 m apart) (see Photo B). Although, the alignment is located relatively close to these buildings, visual impact to the residents is expected to be moderate as the quality of the surrounding views (especially for the units located facing the LRT3 track) is already deteriorated by the presence of the NKVE.

Visual Impact: **MODERAT*E***

7.7.2.2 Section 2 – Station 3 Station to Persiaran Hishamuddin Station

Section 2 is located within the management boundary of MBSA. This segment is comprises of five stations – namely, Station 3, Temasya, Glenmarie, Stadium and Persiaran Hishamuddin Station. Overall, the land use along this section is dominated by residential areas, except at Station 3 Station and Glenmarie Station where the major land uses are commercial and industrial although there are pockets of residential development at Glenmarie area. Please take note that visual impact assessment will not be carried out for the underground stretch between Persiaran Hishamuddin and Persiaran Dato' Menteri.

Station 3 Station to Temasya Station

From Station 3 Station, the alignment will travel along the road median of Persiaran Kerjaya. Both sides of Persiaran Kerjaya are lined with trees. The primary receptors here are the commercial and industrial buildings or premises with pockets of residential areas. Similar to the earlier section, visual impacts are expected to be low due to the sufficient buffer in terms of vegetation or trees and road reserves along Persiaran Kerjaya. Mobile receptors or motorist along Persiaran Kerjaya are not likely to be visually affected as the viaduct height is about 10 m high.

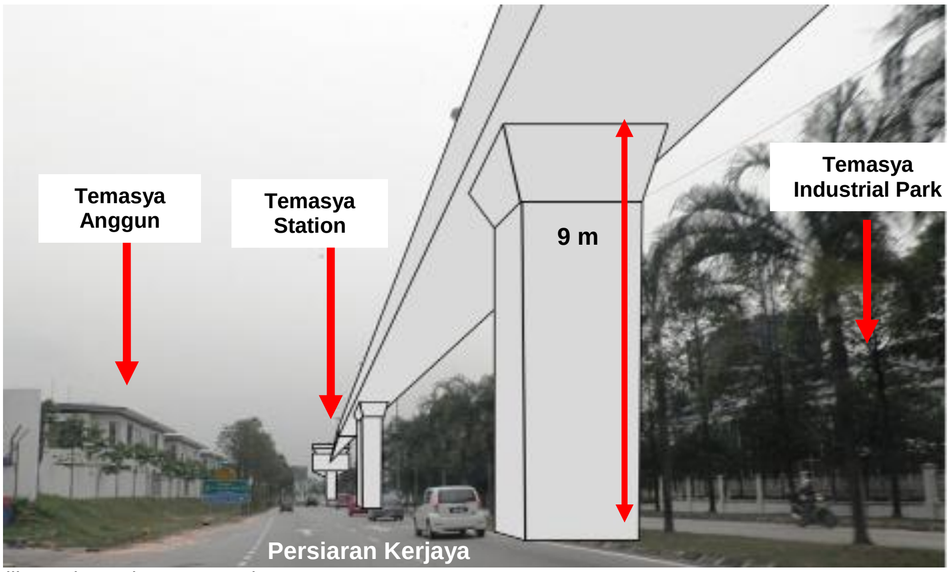
For illustration only, not to scale.

Plate 7-8
This photo shows the view of the viaduct along Persiaran Kerjaya where Glenmarie Garden residential area is located. Visual impact towards Glenmarie Garden is anticipated to be low due to the sufficient existing buffer size and landscapes that are expected to shield the view of the viaduct (especially for those houses located the closest to the proposed LRT3 Line).

Visual Impact: **LOW**

Temasya Station to Glenmarie Station

From Station 3, the line will then make its stop at the Temasya Station. Here, the station will be located next to a new residential area called Temasya Anggun (**Plate 7-9**). It is also important to highlight that as the line travels to the following Glenmarie Station, the line will pass by another new residential area called Temasya Kasih (**Plate 7-10**).



For illustration only, not to scale.

Plate 7-9

LRT3 travels along the road median of Persiaran Kerjaya. The closest houses from Temasya Anggun to Persiaran Kerjaya (and also with house fronting facing the LRT3 structure) are expected to be slightly affected by the intrusion of the LRT3 Line.

Visual Impact: **MODERATE**

For illustration only, not to scale.

Plate 7-10
View of the LRT3 track from Persiaran Kerjaya (towards Shah Alam). For this particular area, the proposed track will be situated on the opposite of Temasya Kasih apartments (currently under construction). It is anticipated that the level of visibility particularly for those units sharing the same elevation as the track will be visually affected once they are occupied.

Visual Impact: **MODERATE**

The line then continues to travel along Persiaran Kerjaya, passing several car dealerships and warehouses until it reaches Glenmarie Station – an area surrounded by primarily commercial and industrial buildings. There will be no significant visual impacts along this area.

Stadium (Grand Central) Station to Persiaran Hishamuddin Station

After the Stadium (Grand Central) Station, the line will run parallel to the Persiaran Sukan. At this point, the line is aligned relatively close to the D'Kayangan residential area (**Plate 7-11**).

For illustration only, not to scale.

Plate 7-11

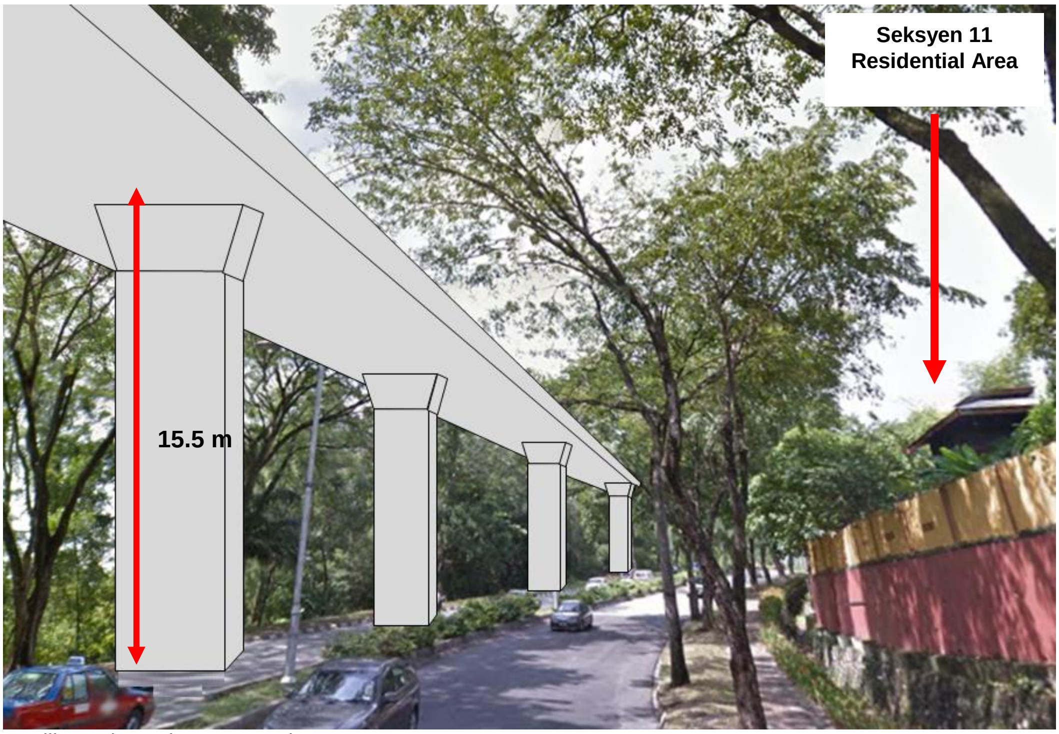
As the line approaches Persiaran Hishamuddin Station, visual impacts become greater as the LRT3 Line descends and runs parallel to Jalan Akuatik 13/77 before going underground. At this point, the houses at the outer row (the closest to the line, along Jalan Akuatik 13/77) will be the most affected as they will be separated by only a small road, with a distance between them and the track around 10 meters.

Visual Impact: **HIGH**

The line will run underground for at least 2 km after leaving D'Kayangan Residential Area. Therefore, there will be no expected visual impacts for this stretch. Nevertheless, some construction works might take place on the surface. It needs to be ensured that once the works are over, all of the affected areas (especially the landscapes) are to be returned to its original state. This is particularly for the nicely landscaped areas along Persiaran Hishamuddin and Bulatan Kayangan.

7.7.2.3 Section 3 – Section 14 Station to Bukit Raja Station

Section 3 is also located within the management boundary of MBSA. This section comprises of five stations – which are Section 14, SIRIM, UiTM, I-City and Bukit Raja Stations. After leaving Persiaran Hishamuddin station (underground station), the line will resurface along the green belt located along to Persiaran Dato' Menteri (just next to Seksyen 11 residential area). The visual integrity for the houses located along this particular stretch will not be affected as they are not oriented facing the proposed LRT3 structures, and they are adequately buffered with vegetation and mature trees (**Plate 7-12**).



For illustration only, not to scale.

Plate 7-12
View of the LRT3 track along Persiaran Dato' Menteri (heading towards Seksyen 14 station).

Visual Impact: **LOW**

Section 14 Station to SIRIM Station

After leaving Persiaran Hishamuddin Station, the line will be travelling along Persiaran Dato' Menteri before making its first stop at the Section 14 Station. Here, the station is sited in front of an empty lot next to Vista Alam Apartment (which is being constructed at the time of writing). The closest landmark is Shah Alam Convention Centre, which is located right after the elevated Persiaran Sultan crossing (**Plate 7-13**).

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For

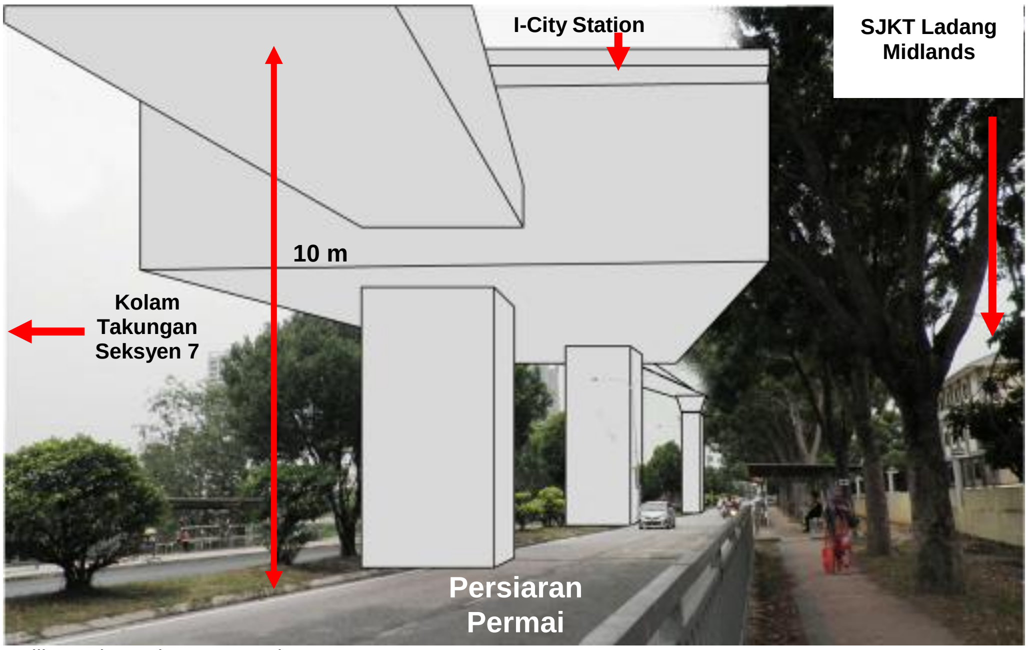
For illustration only, not to scale.

Plate 7-13
View of the LRT3 track along Persiaran Dato' Menteri. There are no significant sensitive receptors found along this road at this particular stretch. It is anticipated that Vista Alam Apartment (the nearest residential area, currently under construction), will not be visually affected once occupied as the nearest blocks are located at least 100 m away from the proposed LRT3 alignment, and the units are not oriented facing the track.

Visual Impact: **LOW**

I-City Station to Bukit Raja Station

I-City Station is located along Persiaran Permai, just on the opposite of SJK(T) Seksyen 7. Other than the school, the proposed station is surrounded by shophouses, residential areas (Kejiranan Plumbum 7/101) and a detention pond. There will be no significant visual impacts from the establishment of this station to its surroundings (**Plate 7-14**).



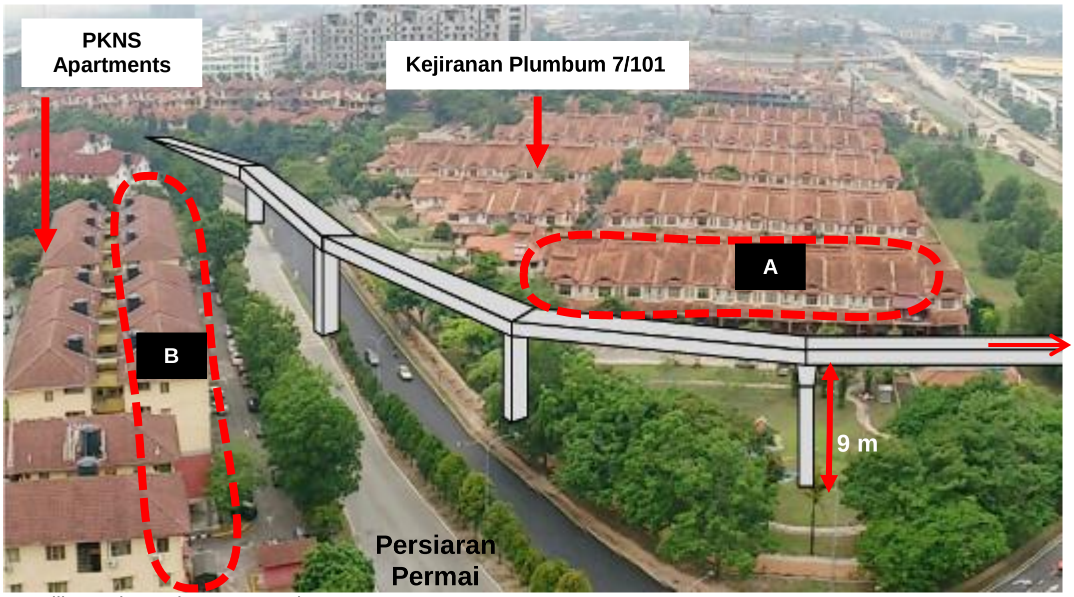
For illustration only, not to scale.

Plate 7-14

This photo shows the view of the I-City Station seen from Persiaran Permai (towards Lebuh Keluli). Here, the nearest receptor to the station and viaduct is one of the school blocks from SJK(T) Ladang Midlands (within 20 meters radius). However, with the presence of existing buffers and mature trees located between the school and Persiaran Permai, visual impact is expected to be less significant.

Additonally, a retention pond (Kolam Takungan Seksyen 7) which is currently utilised as a recreational space (with jogging tracks and gazebos) is located on the other side of the station. Since the pond is presently surrounded by commercial areas, the addition of the LRT3 structures will therefore not significantly deteriorate visual integrity of its surroundings.

Visual Impact: **MODERATE**



For illustration only, not to scale.

Plate 7-15

The most outer row of the terrace houses from Kejiranan Plumbum 7/101 (located facing Persiaran Permai, as indicated with A) will be significantly affected by the presence of the LRT3 structures.

While on the other side of Persiaran Permai (as indicated with B), several blocks from the PKNS Apartments (at least 9 blocks, only 3 blocks can be seen in the photo above) will be affected as the LRT3 track will be aligned very near (between 10 – 15 m) into their compounds. It is anticipated that despite the availability of some vegetation, the size of the road buffer is relatively too narrow to absorb visual impacts from the presence of the LRT3 structures in the area.

Visual Impact: **HIGH**

7.7.2.4 Section 4 – Kawasan 17 Station to Sri Andalas Station

Section 4 is located within the MPK administrative boundary. Throughout the stretch, the line will primarily traverse across residential and commercial areas. The visual impact from the project is expected to be high at several areas as the alignment travels through dense residential areas and public parks especially near Kawasan 17 Station and Taman Bandar Diraja Klang.

Kawasan 17 to Jalan Meru Station

After leaving Bukit Raja Station, the line will travel to Kawasan 17 Station. Here, the station will be sited in a mixed residential and commercial area, with its viaduct running above Persiaran Bukit Raja. Since most of the residential areas along the road are lined by trees, visual impacts from the presence of the LRT3 structures are therefore minimised.

For illustration only, not to scale.

Plate 7-16

After leaving Kawasan 17 Station, the line will travel along the median of Persiaran Bukit Raja before it reaches the following station. Despites the fact that several houses in BBK Heights are situated next to the road (as shown in the photo), visual impact is expected to be minimal. As highlighted earlier, this is primarily caused by the presence of the landscaped pavement outside BBK Heights that helps to serve as visual buffer.

Visual Impact: **LOW**

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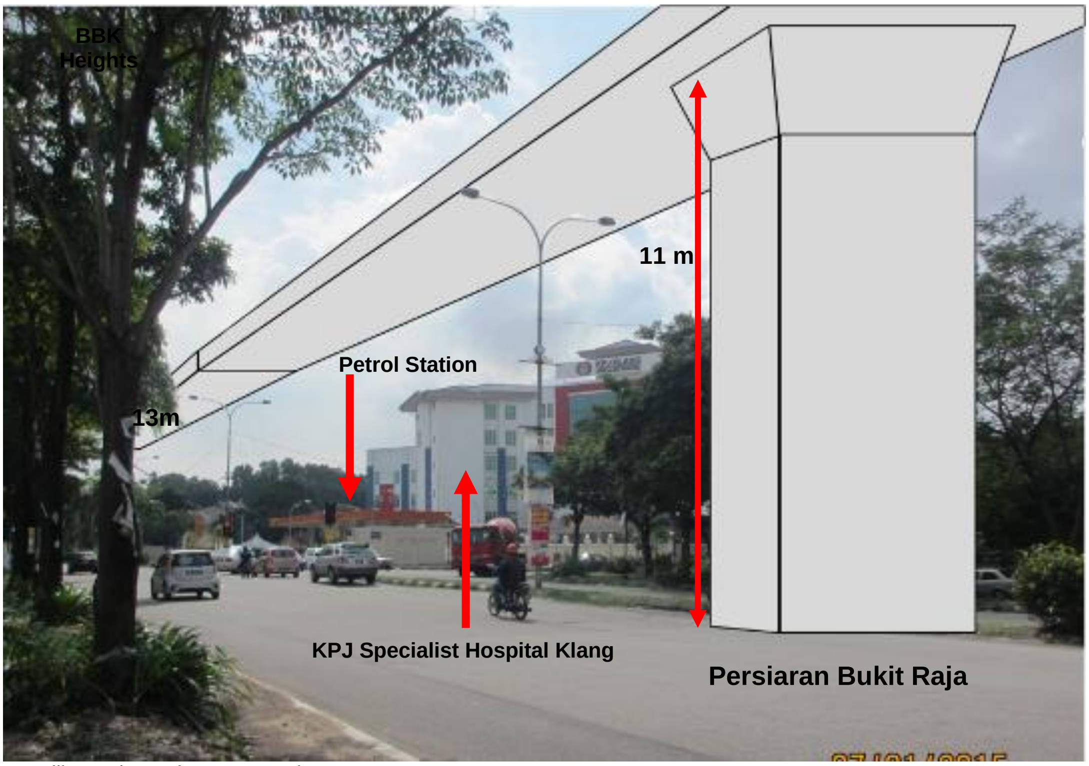

For illustration only, not to scale.

Plate 7-17

View of the KPJ Specialist Hospital Klang from Persiaran Bukit Raja. Visual impact to the hospital is expected to be minimal as it will be buffered by a BH Petrol Station. The line too will be sited relatively far from the hospital, thus contributing to the reduction of visual impacts.

Visual Impact: **LOW**

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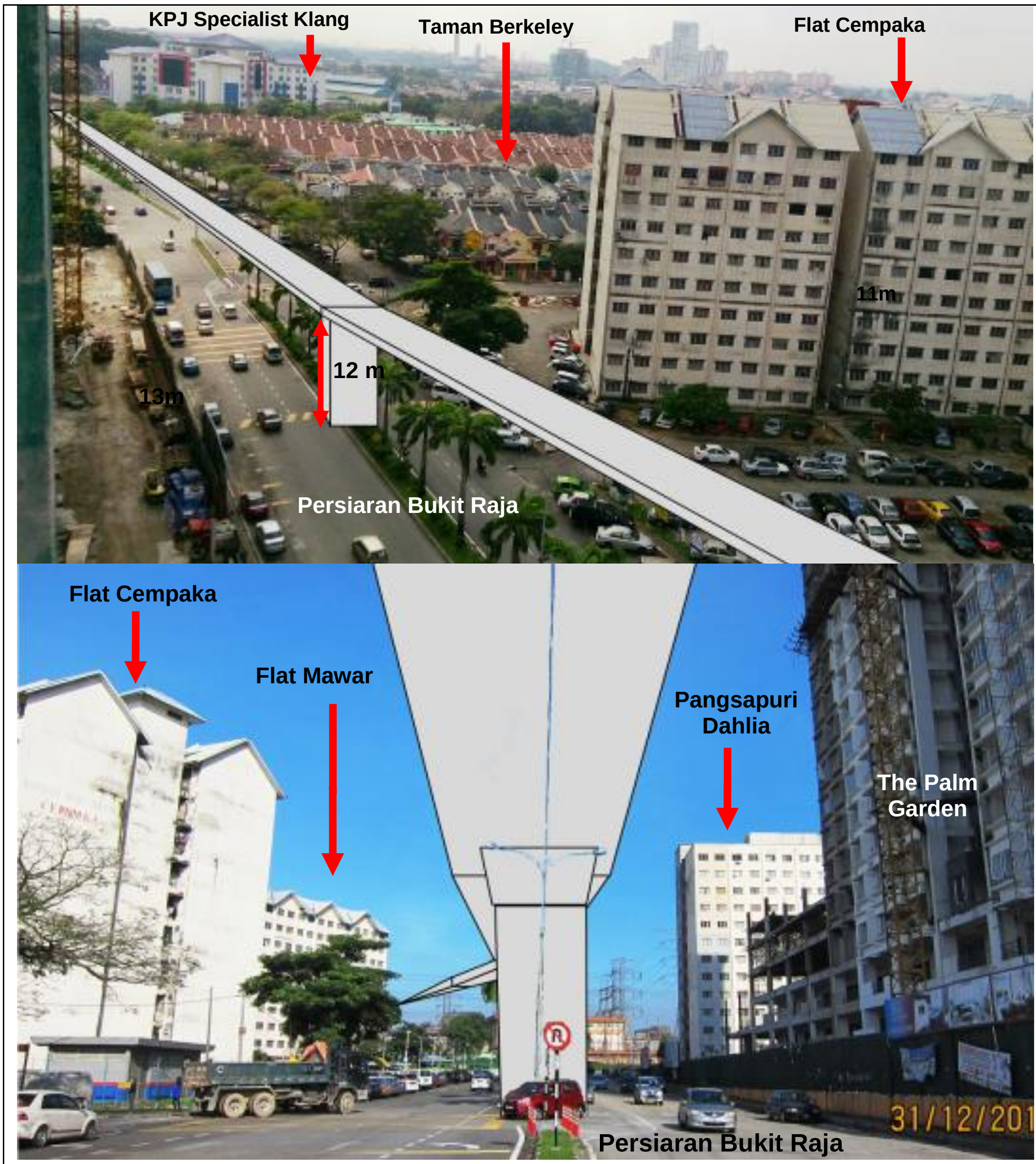

For illustration only, not to scale.

Plate 7-18

The alignment follows the road median and passes through several residential areas such as Taman Berkeley, Flat Cempaka / Mawar, Pangsapuri Dahlia and The Palm Garden (under construction). Visual impact is anticipated to be moderate, as some of the houses will be located relatively near, and directly facing the LRT3 Line.

Visual Impact: **MODERATE**

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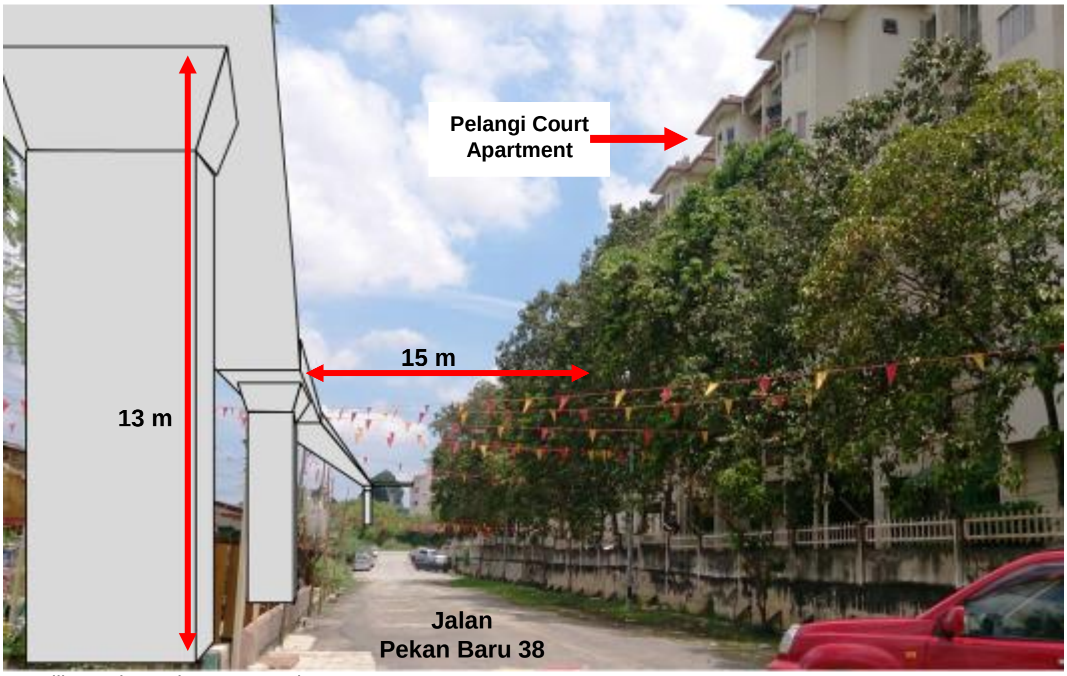

For illustration only, not to scale.

Plate 7-19

Kawasan 17 Station is located relatively near to the Pelangi Court Apartment (15 m apart). Due to their close proximity, visual impact is expected to be high. This is especially for those units located directly facing the Kawasan 17 LRT3 station and its track structures.

Visual Impact: **HIGH**

Note: It is important to highlight that despite located within 15m radius - which is similar to apartments from the earlier sections such as Kelana D'Putera Condominium and Temasya Kasih (that were both given **MODERATE** impact level), the level of visual impact is expected to be different for Pelangi Court Apartment. This is primarily influenced by the setting of Pelangi Court Apartment as the units located nearest to the LRT3 station and viaduct are sited along a cul-de-sac, and the area are generally very quiet and not surrounded by busy roads and highways. These differences have therefore warranted Pelangi Court Apartment a higher level of visual impact compared to the earlier examples.

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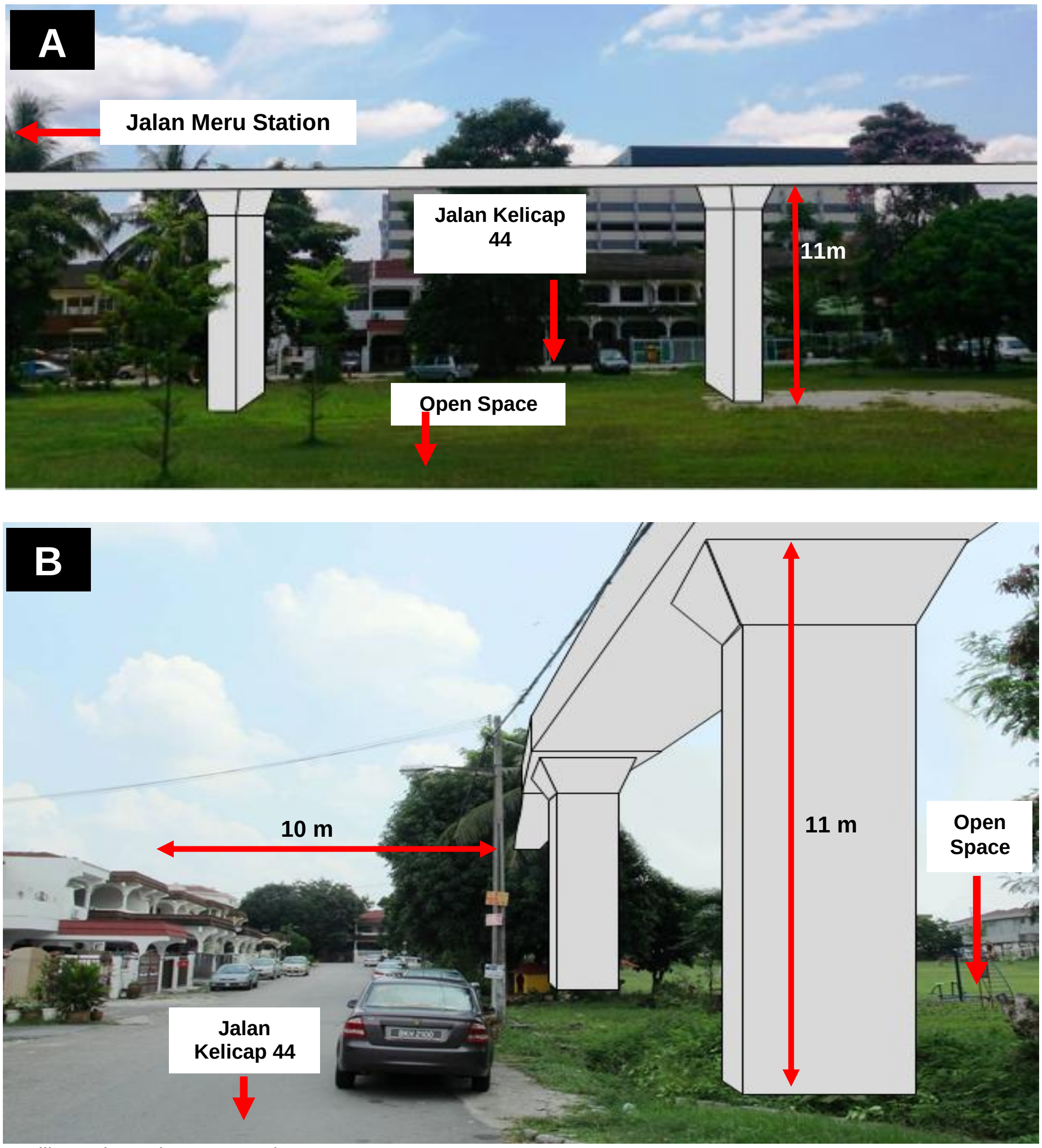


For illustration only, not to scale.

Plate 7-20

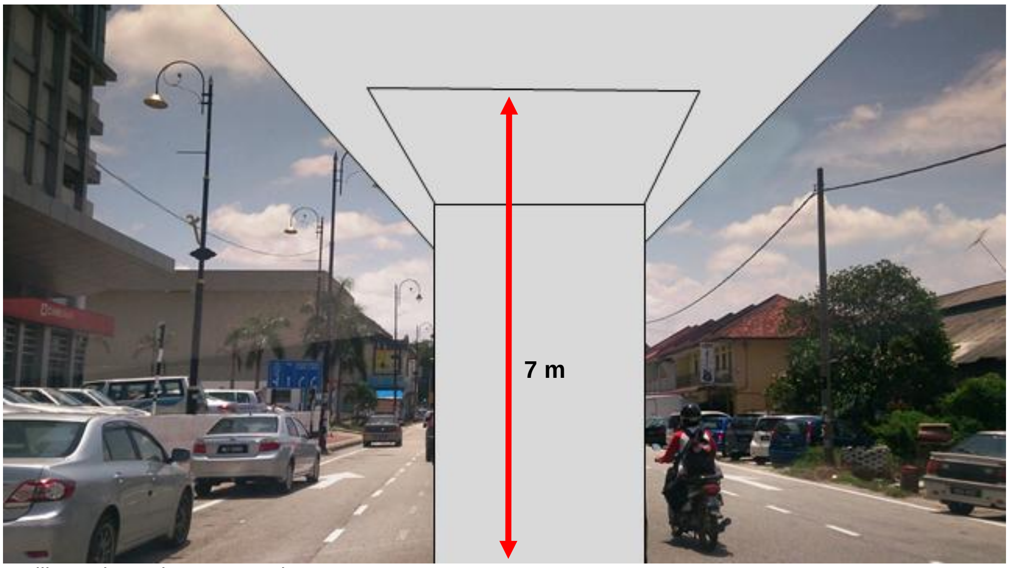
Shortly after leaving Kawasan 17 station, the alignment will pass along several rows of two-storey houses along Jalan Kelicap 44, Jalan Kelicap 45 and Jalan Kelicap 46. Visual impact is expected to be high here due to direct exposure and the close proximity between houses and the LRT3 structures (10m for houses located along Jalan Kelicap 44). Additionally, the track too will be aligned through the neighbourhood’s open space hence making visual impacts even greater.

Visual Impact: **HIGH**

Note: Photo A and B above were taken from the same area, but from different angles.

Jalan Meru to Klang Station

After leaving Jalan Meru Station, the alignment travels towards the Klang town where there are many commercial buildings, government buildings and schools located along Jalan Meru (**Plate 7-21**).



For illustration only, not to scale.

Plate 7-21
View of the proposed LRT3 track along Jalan Meru towards Klang town (before Jambatan Kota). Visual impact is expected to be low as it passes mainly commercial buildings and not expected to obstruct any views for both the static and mobile receptors.

Visual Impact: **LOW**

As the line goes deeper into the city, the alignment will passes several commercial buildings and some level of impacts will be generated towards the integrity of visual quality at certain spots.

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For illustration only, not to scale.

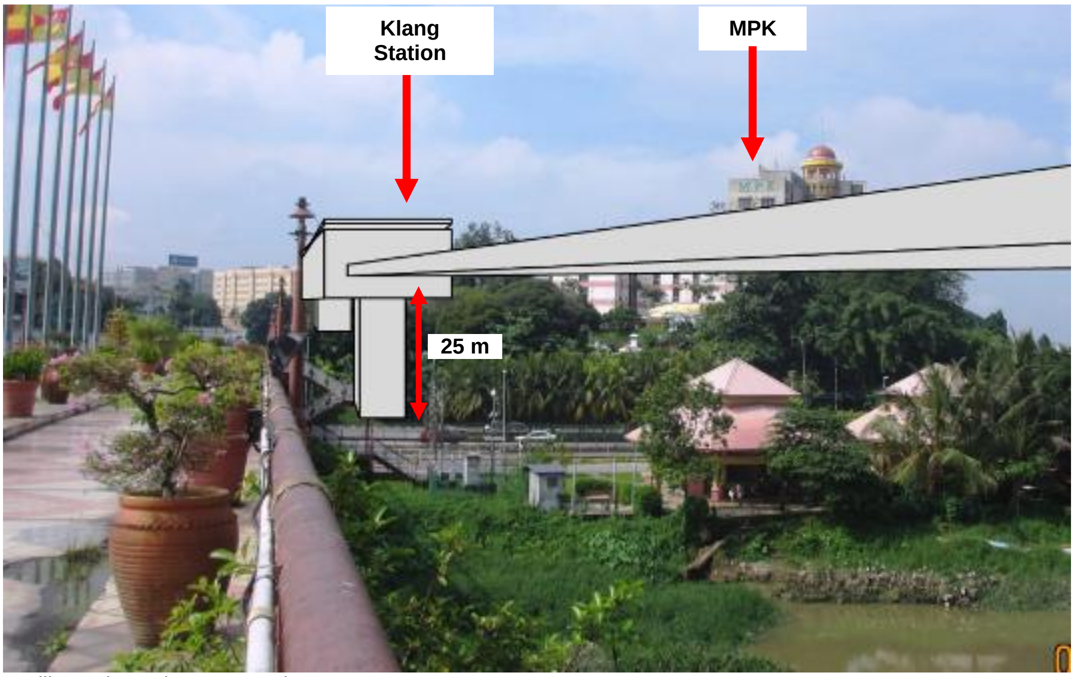
Plate 7-22
The viaduct will continue to travel through several commercial buildings after leaving Jalan Meru Station. Overall, visual impact towards these commercial buildings is expected to be low. As an example, at Shaw Centrepoint (as shown in the photo), the alignment will be aligned just above Jalan Raja Hassan and will run parallel to Jalan Jambatan Kota as it crosses the Klang River.

Visual impact is low here since the LRT3 Line is aligned along several existing major roads and far from any sensitive receptors.

Visual Impact: **LOW**

Klang to Taman Selatan Station

After the alignment crosses the Klang River, it will cross the KTM line and Jalan Tepi Sungai as it reaches the proposed Klang Station.



For illustration only, not to scale.

Plate 7-23
The Klang Station will be sited above a car park just outside the MPK complex. Since this area presently houses a small pocket park (green area), the view of the surroundings will therefore be slightly affected.

Visual Impact: **MODERATE**

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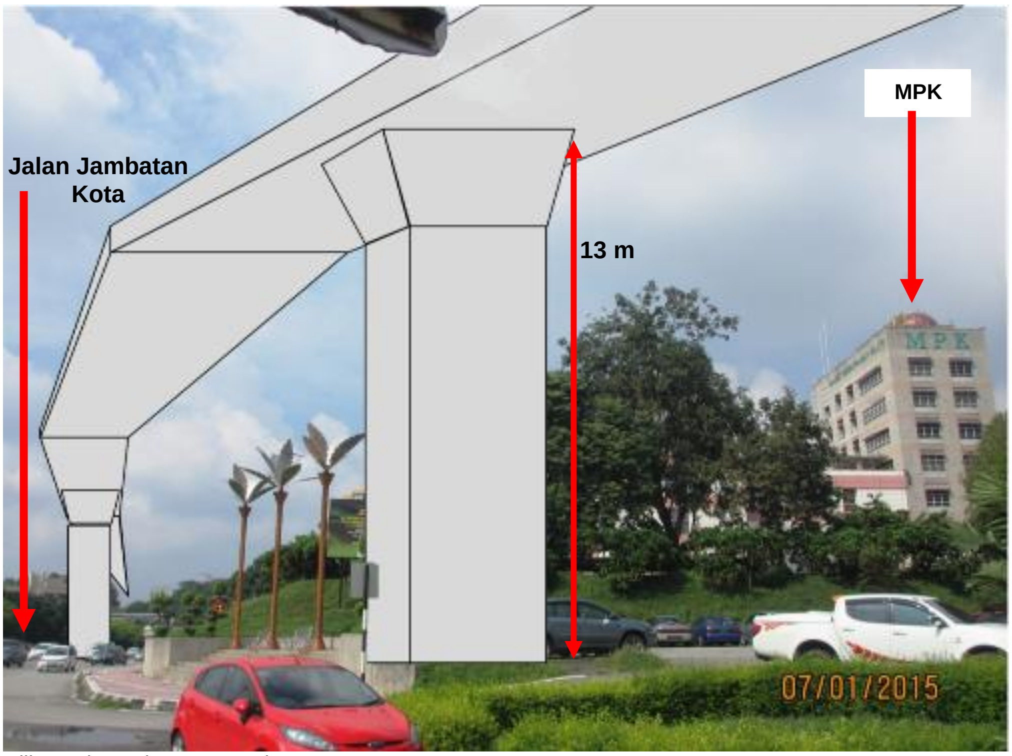

For illustration only, not to scale.

Plate 7-24

This is the view of the LRT3 Line as it travels near the MPK's office (right after leaving the Klang Station). Visual impact will be low here as the line will be travelling along an existing road (Jalan Jambatan Kota). Moreover, the nearest receptor, which is the MPK's tower, is located relatively far from the proposed line.

Visual Impact: **LOW**

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For illustration only, not to scale.

Plate 7-25

This is the view of the LRT3 Line from Prima Klang Avenue's parking area. Visual impact here will be low as the line will be located relatively far from the receptors (on the other side of Jalan Jambatan Kota). Additionally, the availability of landscapes along this road too will help to buffer the impacts from the presence of the LRT3 Line in the area.

Visual Impact: **LOW**

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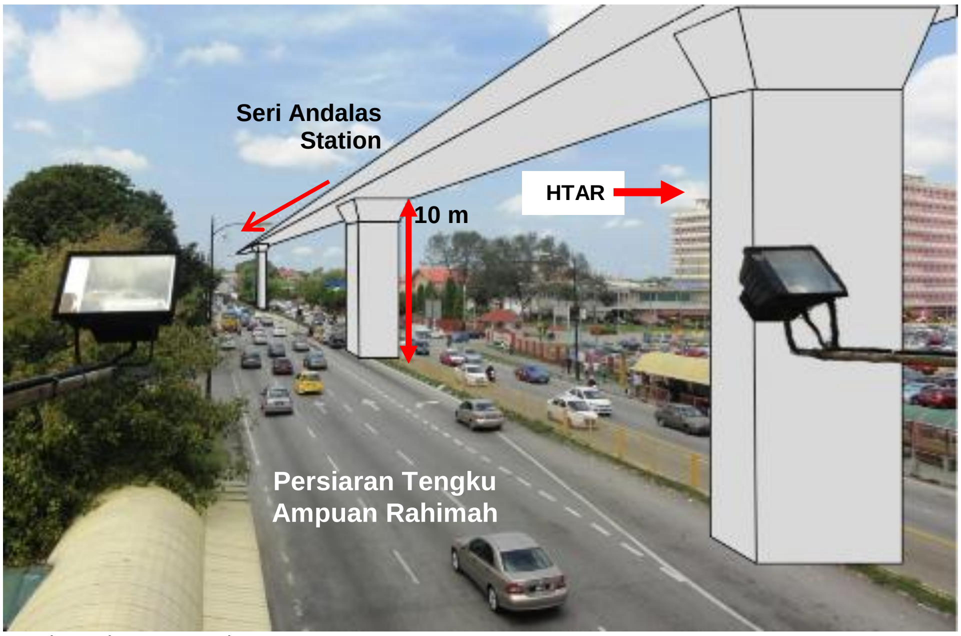

For illustration only, not to scale.

Plate 7-26
View of Hospital Tengku Ampuan Rahimah (HTAR) from Persiaran Tengku Ampuan Rahimah. It is anticipated that there will be no visual impacts for the hospital as the hospital's main buildings are located at least 100m away from the proposed LRT3 track. There will be no significant visual impacts for the mobile receptors too as the track will be elevated 10m from the ground level.

Visual Impact: **LOW**

7.7.2.5 Section 5 – Tesco Bukit Tinggi Station to Johan Setia Station

Along this stretch, the alignment passes through residential and commercial areas. After Sri Andalas Station, the alignment will be running parallel to Jalan Langat, beginning from Tesco Bukit Tinggi Station, and continues further south into Jalan Banting before reaching its final station at Johan Setia.

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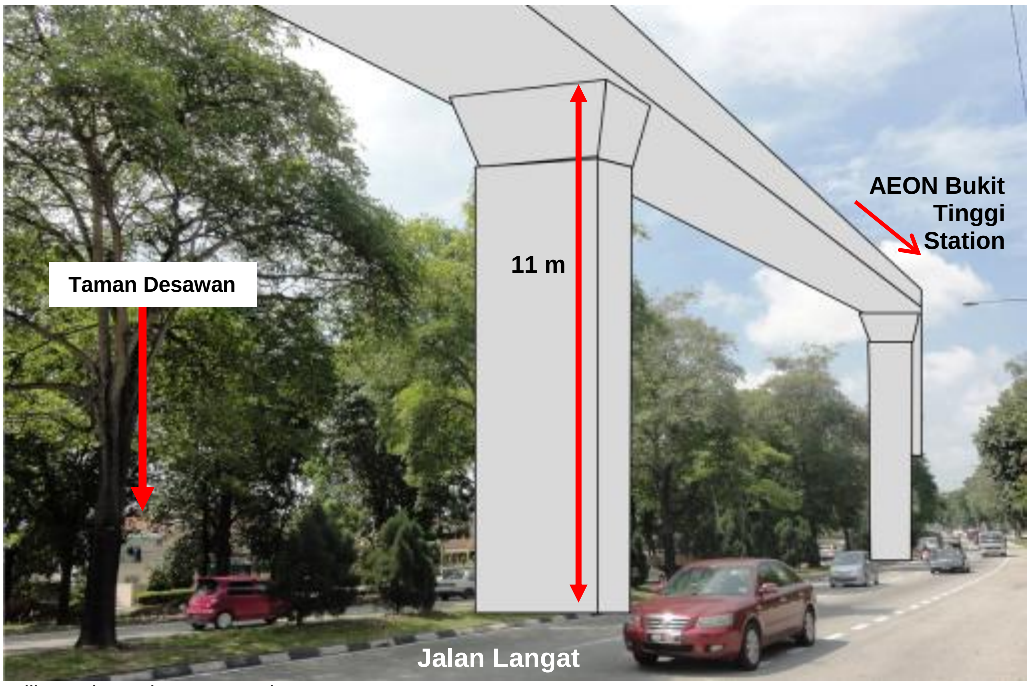
Tesco Bukit Tinggi Station to AEON Bukit Tinggi Station

Taman Desawan is located along Jalan Langat. This residential area is located close to the Tesco Bukit Tinggi Station (**Plate 7-27**).



For illustration only, not to scale.

Plate 7-27
View of Taman Desawan from Jalan Langat. Although the residential area is located along Jalan Langat, the visual impacts are anticipated to be low as there are tall and mature trees along the road and sufficient distance between the structure and the houses

Visual Impact: **LOW**

The alignment continues to travel along Jalan Langat towards AEON Bukit Tinggi Station. The station will be located on the road median of Jalan Langat, in front of AEON Bukit Tinggi Shopping Centre and Bandar Botanic commercial areas (**Plate 7-28**).

For illustration only, not to scale.

Plate 7-28

View of LRT3 along Jalan Langat where AEON Bukit Tinggi and Bandar Botanik commercial areas are located. The visual impact is expected to be low since the road is wide enough and sufficient distance to the buildings along the road.

Visual Impact: **LOW**

7.7.3 Management Measures for Visual Impacts

Finally, based on the level of impacts, suitable recommendations are formulated to if not solve, mitigate visual deterioration. The recommendations are designed in such a way that it will accommodate the needs for the LRT3 Line to function effectively, while at the same time reconstructing, maintaining or improving, and guarding aesthetic and visual integrity along the affected corridors.

The hierarchy for mitigating visual impact based on the level of effectiveness starts with avoidance, then if it is unavoidable, minimisation is engaged – and finally when both avoidance and minimisation cannot be employed, the compensation of impacts will be used. The focuses for measures that will be taken to help minimise visual impacts from the LRT3 structures are divided into three categories, which are: (1) development and enhancement of buffers and landscapes, (2) restoration of aesthetic through physical readjustments and creative designs, and (3) accommodating the needs of mobile receptors.

7.7.3.1 Maintenance, Development and Enhancement of Buffer and Landscapes

The buffer plays an important role in regulating the level of visual impacts along the LRT3 Line. The two most important factors that contribute to the effectiveness of buffer and landscape's functions are; first, the width and size of the buffer; and second, the characters and contents of the buffer.

The first factor is the "width and size of the buffer" – the wider and bigger the buffer between the track and the receptors, the better it is for visual integrity. It is impossible to quantify the most appropriate width, as visual integrity is often characterised by its surroundings. Nevertheless, the right logic should be – if the track is traversing across an open area, the buffer should be wider, while if the track is traversing across areas dominated by buildings, the buffer could be slightly narrower. Nevertheless, with the presence of vegetation and good landscapes, these distances can be reduced significantly.

The second factor is the "characters and contents of the buffer" – the richer the buffer is, the more effective it is in mitigating visual impacts. The presence of vegetation especially, will help to minimise visual impacts as it is natural (instead of man-made structures i.e. hoardings), and is more appealing to the eyes. Other than the denseness of the vegetation (refer **Plate 7-29**), another important element in ensuring effective visual treatment is the manipulation of vegetation height (refer **Plate 7-30**). The implementation of these measures is particularly important for residential areas, schools, hospitals and recreational parks.

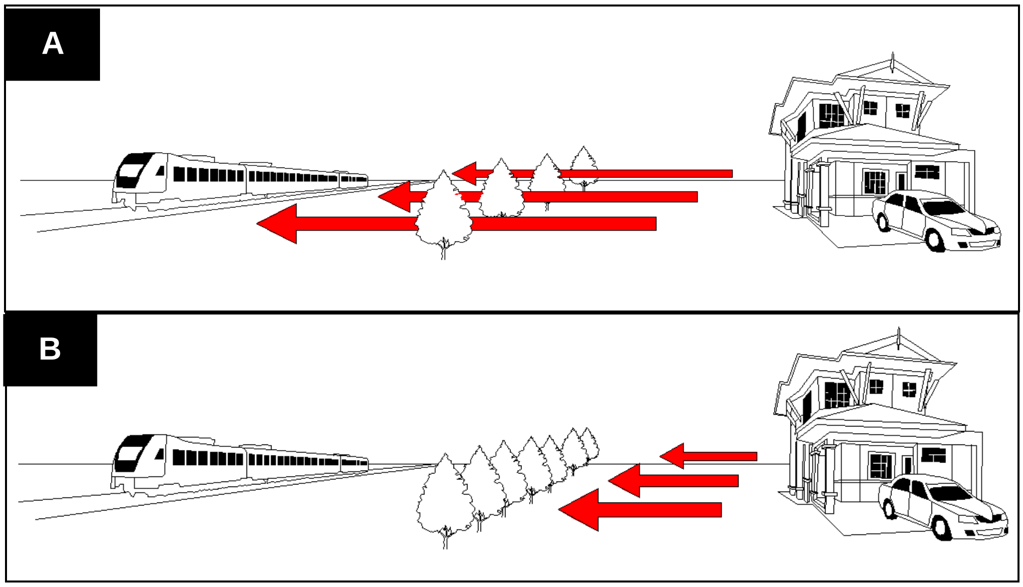


Plate 7-29
Diagram (A) shows visual penetration when vegetation is scarce, while diagram (B) shows how visual integrity can be protected through the manipulation of vegetation density.

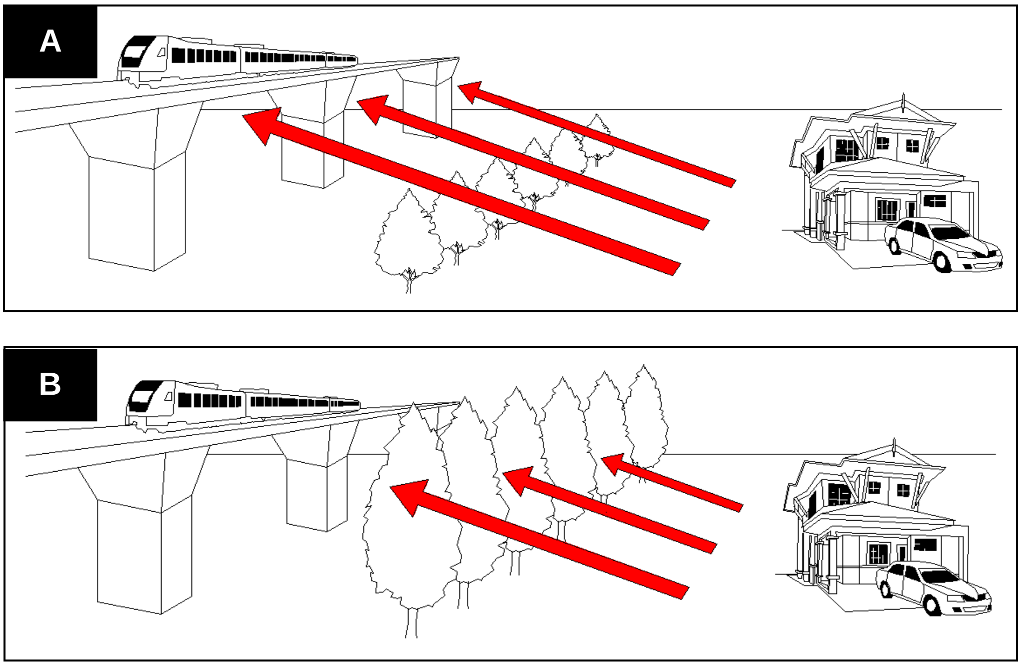


Plate 7-30
Diagram (A) shows visual penetration when vegetation is insufficient in height, while diagram (B) shows how visual integrity can be protected through the manipulation of vegetation height.

Among the areas along the proposed LRT3 alignment where the maintenance, development and enhancement of buffer and landscapes are deemed necessary include:

- The NKVE – particularly along Vista Subang and Kelana D'Putera Condominium.
- Persiaran Kerjaya – particularly opposite Temasya Anggun and Temasya Kasih residential areas.
- Between Persiaran Sukan and Jalan Akuatik 13/77 (along D'Kayangan Residential Area).
- Persiaran Permai (especially those areas located along Kawasan Kejiranan Plumbum 7/101 and PKNS Apartments).
- Along the the cul-de-sac that separates Pelangi Court Apartments and the proposed Kawasan 17 Station.
- Jalan Kelicap 44, Jalan Kelicap 45 and Jalan Kelicap 46.

7.7.3.2 Restoration of Aesthetics through Physical Readjustments and Creative Designs

Structural and physical readjustments focus on the height, width, and positioning of the LRT3 structures. Whenever readjusting and changing the height, width and location of the structures is possible, it should be implemented to accommodate the preservation of visual integrity and the aesthetic of the surrounding areas. The ultimate target is to blend, integrate and absorb the structures into the surroundings.

Creative designs here refer to the good design of the LRT3 structures (which include the station, track and pillars/columns). This means, if the view of the surrounding is somewhat deteriorated by the presence of the structures, a good design is needed to restore the aesthetical attractiveness of the area. The application of creative "architectural designs" (including landscape architecture) is an example, of how the establishment of the LRT3 structures can be balanced in creating a harmonious establishment between the structures and the surroundings. Some of the examples include the application of congruous building façade (for the station), the manipulation of pillars and viaducts for gateways and entry points, or even the exploitation of areas underneath the viaducts for recreational purposes.

Cycle path under the DLR viaduct…, ©Stephen Craven, Wikipedia[11], CC-BY-SA 2.0

Plate 7-31
Docklands Light Railway (DLR) in London, the UK. The space underneath the track is utilised as cycle path.

[11] http://commons.wikimedia.org/wiki/File:Cycle_path_under_the_DLR_viaduct_-_geograph.org.uk_-_1496078.jpg

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Source: http://www.alexblock.net/blog/?p=3231

Plate 7-32
Skytrain Canada Line (SCL) in Vancouver, Canada. The space underneath the viaduct is utilised as sidewalk and resting area (with benches).

Source: https://voony.wordpress.com/2010/02/

Plate 7-33
Canada Line in Richmond, Canada. Spaces underneath the viaduct are landscaped to improve overall visual quality around the area.

The selection of colours is also one of the important components in establishing good design. Colours play an important role in improving visual integrity and aesthetic of the affected areas. As an example, the usage of earth tones[12] is important when the line passes through green or natural landscapes. While the usage of slightly mainstream colours is appropriate when the line passes through the more urbanised areas.

[12] Refer http://www.creativecolorschemes.com/resources/free-color-schemes/earth-tone-color-scheme.shtml

HéPíng East Rd - FùXìng South Rd Intersection, ©Lord Koxinga, Wikipedia[13], CC-BY-SA 3.0

Plate 7-34
Taipei Metro in Taipei, Taiwan. The application of suitable colour and design helps the railway track to blend in with its surroundings.

Source: http://milwaukeejunction.org/tag/art/

Plate 7-35
Amtrak Rail Line in Detroit, the US. The pillars underneath the viaduct were painted and decorated with murals to improve its visual attractiveness.

Among the areas along the LRT3 alignments where the restoration of aesthetics (through physical adjustments and creative designs) can be applied include:

[13] http://commons.wikimedia.org/wiki/File:2010_07_21570_6839_Da%27an_District,_Taipei,_Heping_Road,_Fuxing_Road,_Taipei_Metro_Muzha_Line,_Viaducts,_Composite_bridges,_Taiwan.JPG

- LRT3 viaduct near the Persiaran Permai and Lebuh Keluli intersection
- LRT3 viaduct as it passes through Jalan Kelicap 44, Jalan Kelicap 45 and Jalan Kelicap 46.

7.7.3.3 Accommodating the Needs of Mobile Receptors

As discussed earlier, as far as the mobile receptors are concerned, the greater problem with regards to the establishment of the LRT3 Line is the obstruction of landmarks and reduction of visibility level. Some of the steps that can be taken to address this issue include reviewing the height of the track at areas that are being heavily affected, and providing sufficient signage to ensure mobile receptors are sufficiently navigated. The inclusion of lighting elements, especially at road junctions or corners beneath the track structures need to be given priority. Increasing the luminance level at this spots is not just vital for road users at night, but also when visibility level is low due to rain or fog.

Source: https://voony.wordpress.com/2010/02/

Plate 7-36
Canada Line in Richmond, Canada. The elevated track is lit with lightings to improve visibility level around the area.

Several junctions and road intersections underneath the viaduct need to be installed with sufficient lightings. This is especially important for navigational and safety purposes. The areas that have been identified along the proposed LRT3 Line include:

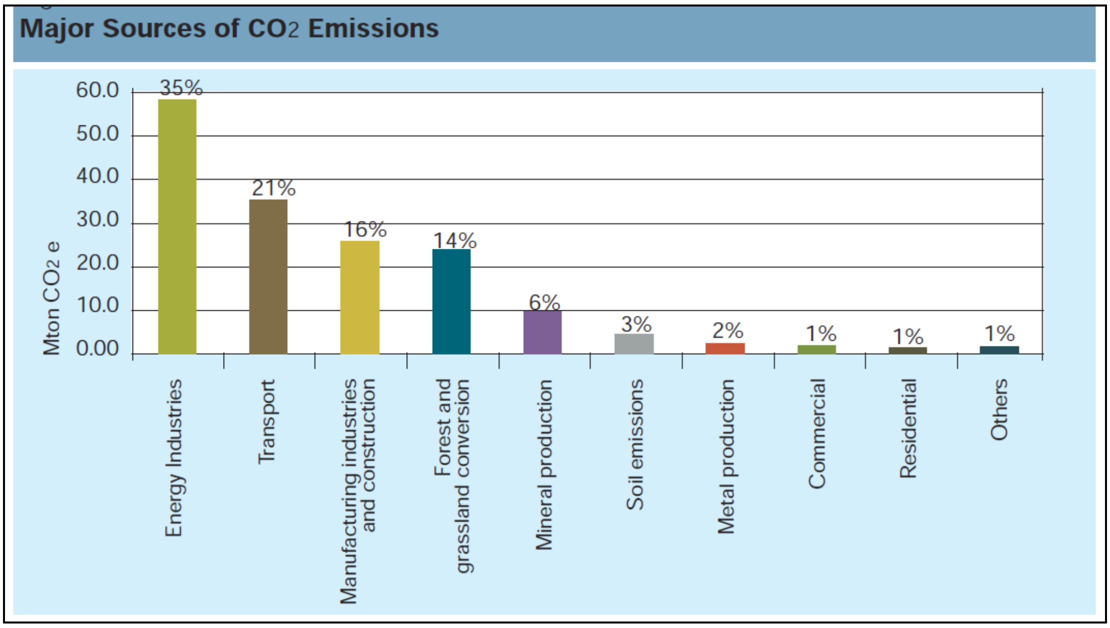
- Persiaran Kerjaya
- Persiaran Permai
- Jalan Meru and Persiaran Tengku Ampuan Rahimah
- Jalan Langat and Jalan Klang-Banting

7.8 AIR QUALITY

The transport sector is the fastest growing sector in terms of greenhouse gas (GHG) emissions in developing countries. As transportation is the fastest growing source of GHG emissions, it is critical that cities development focus on improving public transport to reduce its environmental footprint. Increased usage of public transport complemented with improved pedestrian facility, smart traffic management and pricing will be able to cut future GHG emissions.

Based on the ***Malaysia: Second National Communication to the UNFCCC***, in 2000, Carbon Dioxide (CO_2) emissions from transport sector was estimated to be about 21% (35.16 MT CO_2e) of the total 167.44 Mt CO_2e emitted which was the second highest among all sources (**Chart 7-55**).

Chart 7-55 Major Sources of CO_2 Emissions



Source: Ministry of Natural Resources and Environment Malaysia. Malaysia: Second National Communication to the UNFCCC.

Note: CO_2e is a measurement to express the relative effect to CO_2 a specific amount of greenhouse gases has. It is calculated by multiplying the amount of tonnes of the greenhouse gas by its global warming potential (GWP).

With LRT3 Line, it is anticipated that there will be a positive impact to the overall air quality within the Klang Valley. The reduction of vehicular emission (i.e. mobile combustion gases mainly CO_2 due to modal shift from private vehicle to public transport and reduced traffic congestion is expected result in improved air quality at local levels as well as in Klang Valley in general.

7.8.1 Emission Avoidance

The emission avoidance calculation due to the LRT3 Line was guided by the following equation:

Nett CO_2 Equivalent (CO_2e) Emission Avoided with LRT3 Line in Operation (MT/Annum)	**=**	**Calculated CO_2e Avoided with LRT3 Line in Operation (MT/Annum)**	**-**	**Calculated CO_2e due to Electricity Consumption by LRT3 Line Operation (MT/Annum)**

In order to calculate of the GHG emission, a carbon emission calculator, ***Mobile Combustion: GHG Emissions Calculation Tool Version 2*** developed by World Resources Institute (WRI) was used. This tool was developed by WRI as part of its Greenhouse Gas Protocol Initiative. The emission factors used in this tool come from the United Kingdom Department for Environment, Food and Rural Affairs (UK DEFRA), the US EPA and the Intergovernmental Panel on Climate Change's (IPCC) 2006 Guidelines for National Greenhouse Gas Inventories. It is to be noted that the calculated net emission avoided is only to demonstrate the potential reduction of GHG to the atmosphere for this Project.

Emission Avoided

The amount of emission avoided due to the shift of 142,389 vehicle/trips from private transport to rail was calculated to be about 94,535 MT/annum (**Table 7-14**). This is a conservative estimate as it was assumed that the average vehicle trip is only 10 km.

Table 7-14 CO_2e Emission Avoided with LRT3

Type of Vehicle	Estimated Percentage (%)	Calculated Vehicle Trip/Day	Calculated CO_2e Emission Avoided per Trip (MT/Day/Trip)	Calculated CO_2e Emission Avoided (MT/Day)	Calculated CO_2e Emission Avoided (MT/Annum)
Car	66	93,977	0.002	188	68,620
Bus	1	1,424	0.017	24	8,760
Motorcycle	33	46,988	0.001	47	17,155
Total		**142,389**		**259**	**94,535**

Assumptions:

- Total calculated vehicle trip/day = Traffic Volume in 2 hours (Two way)Difference = Future Year 2020 (without LRT) – Future Year 2020 (with LRT) x 9
- Passenger Car using Gasoline as Fuel for Car Model of 2005 to present;
- Bus using Diesel as Fuel;
- Motorcycle with Catalytic Convertor as Control; and
- Distance covered for 1 vehicle trip equals 10km

In addition to the shift from private to public transport, there will also be emissions avoided to the reduced congestion on the roads. As the traffic flow improves, the fuel consumption will be more efficient and vehicles will emit less emission. It is not possible in this EIA to estimate the potential emission avoidance as a result of reduced congestion but the amount is expected to be substantial. The calculated 94,535 MT/annum is therefore a very conservative figure and the actual emission avoided is expected to be much higher.

Emission Generated

In order to estimate the net emission avoided, it is necessary to offset the amount of emissions that will be generated by the LRT3 Line. The main source of emission will be the power stations which are the main source of electricity to power the trains and the stations.

Table 7-15 CO_2e Emission due to Electricity Consumption

Calculated CO_2e Emission due to Electricity Consumption (MT/Day)*	Calculated CO_2e Emission due to Electricity Consumption (MT/Annum)
200.349	73,127

Assumptions: Note:

- Total passenger per day = 328,281 (As forecasted in 2050)
- LRT passenger distance of 6 km is equivalent to 10 km vehicle trip distance of road
- Emission factor based on average Light Rail and Tram
- GHG include CO_2, methane (CH_4) and Nitrous Oxide (N_2O)

It is not possible at this stage to estimate the amount of electricity that will be consumed at stations.

Nett Emission Avoided

Nett CO_2e Emission Avoided (MT/Annum)	=	Calculated CO_2e Avoided with LRT3 Line in Operation (MT/Annum)	-	Calculated CO_2e due to Electricity Consumption by LRT3 Line Operation (MT/Annum)
	=	94,535	-	73,127
	=	**21,408**		

Using the equation above, the nett CO_2e emission avoided was calculated at approximately 21,408 MT/annum which represent an avoidance of 23% of the total GHG avoided to the atmosphere to the atmosphere with operation of the LRT3 Line. It is reasonable to assume that the actual emission avoided will be higher as the emission reduction due to reduce traffic congestion is expected to be substantial.

With the shift from private transport to rail and the reduction in traffic congestion, air pollution related to vehicular emission such as Nitrogen Oxides (NOx), CO, Sulphur Oxides (SO_2) and Volatile Organic Compounds (VOCs) will also be reduced accordingly.

7.8.2 Air Pollution at Stations

There may be localised deterioration in air quality at the vicinity of stations if the traffic circulation is not planned and designed properly. The problem may be aggravated by buses and cars with engine idling waiting to pick up passengers. Proper traffic circulation system, well-designed car parks and stringent supervision are necessary to minimise this problem.

7.9 PUBLIC SAFETY

The LRT3 will be designed similar to many other transit systems in Malaysia and around the world to ensure a safe and comfortable environment for passengers and surroundings public. Some safety features adopted are exclusive track route, ATO driverless operation or with driver, Automatic Train Protection, Automatic Train Supervision, installation of Closed-Circuit Television, public announcement system, door warning, door obstruction detection, and provisions of stanchions and hold bars.

In comparison with the other transportation modes, rail rapid transit enjoys a higher degree of safety as it is designed with the exclusive right of way and the automatic train control and monitoring systems. Nevertheless, rail rapid transit systems are not free from serious accidents, which often led to human injuries and facility damages. The planning of accident prevention and emergency measures, therefore, are still important issues of the rail rapid transit operations.

7.9.1 Hazard and Risk Identification

Railway operation often involves hazards and risks especially to passengers and surroundings public. Risks may not only attribute from human error, however environmental conditions may contribute to the occurrence of incidents or accidents or both that could lead to following undesired outcomes: fatality, injuries, environmental damage, disruption of traffic and damage to assets.

A general overview of the likely hazardous events is generated through review and references from incident information from other countries. Based on past occurrences and experiences involving rail system from other countries, serious incidents involving collision, derailment, fire, arson, sabotage, suicide have occurred which leads to serious injuries and fatalities. The past transit accidents types and possible causes are presented in **Table 7-16**.

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Table 7-16 Major Rapid Rail Transit Accident Types and Possible Causes

Types	Possible Causes
Fire	Arson, failure of electrical equipment, brakes failure, storage of inflammable material, derailing, and strike of lightning
Flood	Poor design or failure of the drainage system
Collisions	i. Violation of stop signs by the driver (intrusion) ii. Failure of the ATC system iii. Signal errors iv. Breakdown or mishandling of the split switch.
Derailment	i. Inadequate geometric design ii. Excessive rocking of the trains iii. Speeding at the turn iv. Damage of the bearing and wheel v. Rail deformation vi. Foreign objects on track
Door Accident	Jammed by the door or uncontrolled opening of the door
Breakdown of Power	Failure of the power supply or emergency power supply facilities, overload, supply system mishandling, or struck by lightning
Intrusion	Animals or people could be found intruding the track on the level ground or the station
Gap fall	Inadequate design of the platform or station
Scraped by train	Mindless passenger of lack of proper sign on the platform
Natural disaster	Earthquakes, lightning, storms, of heat waves
Others	Terrorist, criminal acts, suicide, crowding, etc.

Source: Hazard Identification Model for Rail Rapid Transit Accidents, L.C. Wang (2004)

Based on past and present incidents and accidents record occurred either locally or intentionally, likely hazardous events can be developed for the operation of LRT. The safety issues identified during operation of LRT3 are as follows:

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i. Accidents involving passenger and other trains

Collisions represent the most serious safety concern for the rail transit as the consequences may affect many peoples' lives and cause damage to property as well. Many factors can influence the occurrence of collisions such as human error, defects of rolling stock, collisions with obstacles on the track, sabotages, trespass, weather conditions, etc, or a contribution of all of the above. The occurrences of LRT collisions are rare, however the safety issues associated with LRT collisions may be severe and often result in death.

Actions of driver is known as possible cause of accidents and collisions involving passenger and other trains as driver is the one who control the operation of a train in terms of direction and speed of travel; signaling and warning; use of head lights and tail lights, or horns; and maneuvers being executed at time of impact; and fatigue during driving.

Apart from that, rail conditions play an important factor because this will influence the surface friction especially during execution of brake at time of impact. For an instance, presence of leaves, debris and water are some environmental conditions that might reduce surface friction and contribute to a collision.

Rolling stock defects such as defects in wheel profile where the tyre is loose, broken or cracked; reduced tire thickness or flange thickness, worn tread profile causing hollow tyre and deep flange reduction may lead to unsafe conditions, thus contribute to accidents or collisions. Poor maintenance of rolling stock will increased the risk of collision.

In addition, collision might occur from the act of human trespass or taking short cuts to the lower railway track that usually result in death due to high speed and velocity of the approaching train. There are some cases where passengers are likely to retrieve belongings that fell onto the lower railway track however they could not return back to the platform before the incoming train approached, resulting in fatal accident. The recent attempt by a man to kill himself by lying on railway track at Cheras LRT Station is an example that there is potential people will used LRT as a place to commit suicide.

ii. Safety Risk to Train Passengers

Train passengers are exposed to safety risks while waiting at the station platform and inside the train. Slips, trips and fall may occur at the station platform when passengers are embarking or disembarking a train due to overcrowding especially when some of the passengers keep pushing others to able them to embark or disembark a train.

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Apart from that, passengers are also exposed to the risk of falling into the railway tracks while waiting for the arrival of incoming train due to lack of focus, use of mobile phone and horseplay near the edge of platform. Possible of accidental falls off the platform onto the lower track area, suicide attempts, and homicides by pushing, or litter build up on the track if the area is not provided with proper platform screen doors or half height platform screen doors.

Safety of passengers is at risk if there is lack of security management during operation. Passengers are exposed to crimes such as pickpocket, murder, abduction, harassment, etc. due to easy escape route as LRT travels fast from one point to another point.

iii. <u>Railway infrastructure</u>

Degradation of infrastructure may cause accidents and casualties in rail operations. Railway infrastructure requires long life operation, corrosion and wear are potential failure mechanisms, but are rare. Nowadays, modern electrified systems are used as the signaling method for the railways. These systems generally rely on an overhead wire for electricity supply and the wire requires delicate control in order to ensure good contact conditions between the wire and the electric current collecting device on the train. Lack of maintenance of wires and supporting structures will lead to wear and fatigue and cause collapse of the supply system.

Defects in track geometry is also a complicated problem because safe running of vehicles on particular track geometry is dependent upon a number of factors for instances, speed of vehicle; type of vehicle; vehicle position in train composition; nature of defect in track geometry and frequency of their occurrence on the approach track; and possibility of the vehicle oscillation in any mode, with the track defect exciting the oscillation at particular speed. Any failures of these are extremely costly in terms of lost revenue, operational delays and human injuries.

iv. <u>Railway tunnels</u>

Railway tunnel constitute safety risks that can lead to a catastrophe accidents and affecting human lives' of the train passengers. Incident scenarios that might occur at railway tunnel are collision; derailment; fire; explosion and toxic gas release.

Fire can only occur with the presence of heat, flames and smoke. Any source of fire such as cigarette and flammable liquids may be brought by train passengers or debris present on railway tracks. Fire can start on a train and detected whether by on-board fire detectors, or by persons on-board. Late detection of small flame will lead to quick spread of fire due to the centralised ventilation system in the train and low air pressure in the tunnel. Inadequate of fire fighting system will speed up the spread of fire due to failure to control the amount of fire spread.

As the fire spread, train passengers will suffocate and lead to panic resulting in uncontrolled evacuation. This might exposes train passengers to dangers present in a tunnel environment. Apart from that, explosions might also occur when there is a sabotage or terrorist activity, where explosives are hidden at the rolling stocks or placed on the railway track.

v. Natural Hazards

Rainy season in Malaysia could lead to flash flood due to short-term, high-intensity rainfall that occurs in flood-prone areas. Storm drains must be designed and constructed to cater the volume of storm water during the event of heavy rainfall especially in the rainy season. Apart from that, the receiving channels towards the storm drains must be clear from any obstruction that will prevent the flow of storm water to the designated storm drains. Poor drainage system will also flood the streets, buildings and infrastructures nearby or even the tunnel area.

vi. Construction or maintenance near operational railway

Construction or maintenance near operational railway may poses risk of accident. Maintenance work usually involves checking and maintaining the rail network and repair in case of any defects on the tracks. Working on the operational railway pose hazards to the maintenance workers such as collision due to improper enclosure of the maintenance work area with the tracks where the trains use to travel. Accident can happen when there are no proper safety procedures or working procedures carried out by personnel such as no provision of lookout stands, inadequate safety alert and signboard or negligence on safety.

7.9.2 Risk and Safety Management Measures

The hazard and risk were identified in earlier section. The worst case from any rail incident is potential to cause fatality and major injuries to passenger and public. The LRT3 shall be operated in conformance with the relevant Safety & Health regulations and other legal requirements such as Occupational Safety & Health Act 1994, Land Public Transport Act 2010, Factories & Machinery Act 1967 and relevant local councils By Laws. In order to safeguard public safety and user safety, mitigation measures as tabulated in **Table 7-17**.

SECTION 7 : POTENTIALLY SIGNIFICANT IMPACTS AND MITIGATION MEASURES DURING THE OPERATIONAL STAGE

Table 7-17 Mitigation Measures for Risk and Safety Management

Item	Proposed Mitigation Measures
Stations	• Platform at stations shall be constructed to be at the same level as the floor of train sets with minimum gap between platform edge and the coach • Pavement marking and texturing to ensure train passengers stand behind the marking and prepared for the arrival or passing of LRV. The marking and texturing need to be maintained and repaint if the marks and textures are defects and in fade color. • Installation of CCTV systems to monitor activity at stations or intersections through a network of video cameras act for security purposes. CCTV system will help to reduce risky behavior by the train passengers such as suicide, pickpocketing, and harassment. • Adequate security guard shall be hired in order to monitor stations and observe any suspicious activities. • Provision of Passenger Information Display System. Train passengers shall be educated with safety procedures during embarking; disembarking and ride in the train. Safety posters and videos shall be located at strategic places to instill safe practices among passengers. • Sufficient safety signage, warnings and instructions shall be provided at strategic locations to advise the passengers on dangers of electrification system and approaching trains. • Provision of barriers at the end of the platform to prevent access to the tracks • Emergency Stop Plunger shall be provided to stop any approaching train upon activation under emergency situation. • Provision of adequate rubbish bins in the rail transit environment with regular disposal to reduce or eliminate fire risk • Regular cleaning of the station floor shall be carried out to remove oil, grime and impurities that stick on the floor thus, reducing the risk of slip, trip and fall due to slippery floor. • Anti-slip flooring shall be provided.

SECTION 7 : POTENTIALLY SIGNIFICANT IMPACTS AND MITIGATION MEASURES DURING THE OPERATIONAL STAGE

Table 7-17 Mitigation Measures for Risk and Safety Management (Cont'd)

Item	Proposed Mitigation Measures
Rolling Stocks	• Schedule of maintenance and inspection of the rolling stocks shall be developed and comply with the schedule. • Teams comprises of competent person shall be established and to be responsible of rolling stocks and ensuring the rolling stocks are safe to continue its service. • Sufficient safety features such as door warning, door obstruction detection, hold bars and stanchions shall be installed to ensure the safety of train passengers. • Emergency stop button shall be installed, maintain and tested to ensure it is in good condition and working. • Standard operating procedures shall be established to ensure all the standard requirement for rolling stocks to operate in good condition is comply during maintenance works and inspection. • Any defects identified on the rolling stocks must be notified to the railway administration and the service of rolling stocks must be stopped until the defects and problems have been addressed and remedied. • Adopt Automatic Train Operation driverless system or with driver that is competent to operate the LRV.
Railway Operator	• LRV operator should be given special, intensive and location-specific training in order to familiarise the operator with the real situation and understand hazards and risk present during operating LRV. • Fatigue management should be applied to all LRV operators in order to reduce human error caused by fatigue during operation. Lack of focus and awareness to the surroundings can contribute to undesired events due to wrong judgment in terms of speed and direction. • Railway administration shall conduct a regular hands-on test to all LRV operators to ensure they do not violate rules and procedures set during operation and comply with the standard operating procedures. Any LRV operator that do not achieve the benchmark need to undergo more intensive training.
Railway Track	• Regular maintenance and inspection shall be carried out to identify any defects on the railway tracks such as rail corrugation, pitting, scabbing, and other surface defects like cracks and corrosions. • Railway personnel to remove any obstacles such as debris and garbage on the railway tracks during periodic inspection.

SECTION 7 : POTENTIALLY SIGNIFICANT IMPACTS AND MITIGATION MEASURES DURING THE OPERATIONAL STAGE

Table 7-17 Mitigation Measures for Risk and Safety Management (Cont'd)

Item	Proposed Mitigation Measures
Emergency Response Preparedness	Emergency preparedness comprised of all of the following: • Written System Security and Emergency Management Plans shall be established. • Roles and responsibilities shall be defined for security and emergency management. • Development of manual "Book of Operating Rules" which details the responsibility of each segment of workforce in the event of any types of emergency. This manual shall be distributed to every employee and is required reading for all job assignments. • Emergency training programs and security are established and maintained. • Public security and emergency awareness program shall be implemented and reinforced. • Conduct functional drills to the possible events that might occur during operation such as fire, flash flood, etc. • Reporting process for any suspicious activity shall be established to facilitate investigations. • Conduct physical security inspections. • Conduct security program audits
Fire Protection	• Install early fire detection in order to detect early signs of fire. • Switch cabinets can be the source of fire because of defects or short circuits; hence switch cabinets shall be inspected periodically to prevent fire. • Fire-fighting system shall be installed in the LRV to control the spread of fire. • Prohibition of smoking at all area to prevent the occurrence of fire • Ensure fire detection signals are working in good condition.

7.10 WATER POLLUTION

A depot will be located at the Johan Setia, mainly to carry out the operation and maintenance of the train. The operation of depot is expected to casue the water pollution from the repair works, workshop activities and cleaning works if not properly managed.

Water pollution in the water courses may occur due to waste oils, fuels and lubricants from machineries that are used in the event of breakdowns, repairs and maintenance flowing into the drainage system. Any spillages such as spillage of diesel may also potentially reach the nearby rivers and result in water pollution.

SECTION 7 : POTENTIALLY SIGNIFICANT IMPACTS AND MITIGATION MEASURES DURING THE OPERATIONAL STAGE

The nearest watercourses to the depot area is Parit Johan Setia located along the Jalan Johan Setia (northern boundary of the site). The runoff will eventually flow into Sg. Langat, about 3km away from the depot.

The types of wastes is expected to be generated from the operation of depot are classified as follows:

SW 305 Spent lubricating oil
SW 306 Spent hydraulic oil
SW 309 Oil-water mixture such as ballast water
SW 312 Oily residue from automotive workshop
SW 408 Contaminated soil, debris or matter resulting from cleaning-up of a spill of chemical, mineral oil or scheduled wastes
SW 409 Disposed containers, bags or equipment contaminated with chemicals, pesticides, mineral oil or scheduled wastes
SW 410 Rags, plastics, papers or filters contaminated with scheduled wastes

Management measures to minimise water pollution

- Maintenance of train will be carried out on at the designated area. The area shall be impervious platform, ideally concrete to prevent oil leakage into the ground.

- Fuel spillage seeping into the ground will be prevented by the construction of a containment wall around the fuel tank. The wall will be made out of either concrete or bricks, and the tank must be sited on an impervious platform, ideally concrete.

- The fuel containment bund around the storage tanks should have a capacity to contain the worst spillage condition, or **110%** of the capacity of the largest container. For a **16,000 L** tank, a containment wall area of **6m x 3m with 1 m height** is required.

- Any spillages inside the containment area will be removed by using sand to soak and remove the spill. The sand will be placed in a fuel drum and will be disposed as scheduled waste. For diesel spillage, the use of sawdust will be more effective than sand.

- Management and disposal of the scheduled waste will be carried out in accordance to the Environmental Quality (Scheduled Wastes) Regulations, 2005.

- Used oils will be stored in proper drums and kept in a shed or store designated for the storage of such waste. The used oils or oil filter will then be transported away for recycling by contractors with the appropriate licenses from DOE.

- Signs indicating “Danger” and “Hazard” will be clearly visible outside the shed.

- All scheduled wastes shall be labeled properly in accordance with the Environmental Quality (Scheduled Wastes) Regulations, 2005.

- The strict documentation of the chain of custody with regards to the storage, transportation and ultimate disposal of the scheduled waste in accordance with the Environmental Quality (Scheduled Wastes) Regulations, 2005.

7.11 SOCIO- ECONOMIC IMPACTS

7.11.1 Impacts to Communities Located Close to the Alignment and Station

For the communities located within the vicinity of the alignment (e.g. within 30 m), the main impacts are expected from the noise and vibration impact from the train operation. These concerns were expressed by some of the communities located along the alignment during the engagement sessions. Taking account such concerns, adequate noise and vibration mitigation measures must be incorporated in the detailed design stage to reduce the impacts to the acceptable limits. It is expected that with proper noise barriers, the noise level can be maintained below the limits stipulated by the DOE.

Another potential impact is traffic congestion for residents or communities located very close to the alignment and within the vicinity of the stations. Traffic congestions are expected at stations such as at One Utama, Kawasan 17, Meru and Klang.

On the other hand, being located close to the LRT3 will also benefit them due to easier and better access to the Project. This is particularly beneficial to those living close to station (within walking distances) and those without their own transport.

For communities located further than 30 m from the track but within walking distance (400 m), they are expected to benefit significantly. The various groups of people such as the residents, workers, students and shoppers are expected to benefit from being within walking distance to the Project, thereby increasing accessibility and mobility of the community. The benefits include:

- Appreciation of their property prices particularly the commercial establishments
- Accessibility to the LRT3 services and facilities such as feeder buses and park and ride facilities
- Enhanced business opportunities and job prospects

Measures are needed to minimise impacts to communities located close to the alignment. Measures proposed include:

- Provide sufficient car parking facilities to avoid negative impacts on local communities;
- Develop proper feeder bus systems that takes into account the specific needs of the communities around the stations;
- Ensure that the design of each stations incorporate universal design and to make sure that it is accessible, safe, clean and properly lighted up;
- Maintain the cleanliness and physical conditions of stations during operations;
- Provide on-line feedback mechanism and establish a communications channel in order to facilitate dialogue.

Improved communications between the Project Proponent, Local Authorities and the communities along the LRT3 are vital.

- The Project Proponent and SPAD shall establish a policy on communications in order to keep the public informed at all times, and to promote the use of public transport system, emphasising its benefits and advantages for its use
- Engagement with public and social institutions for continual dialogue with local communities
- Provide and improve the integrated public transport network that would contribute towards greater connectivity and seamless travel, more information about transport services and networks.

7.11.2 Social and Economic Benefits for the Wider Conurbation

The LRT3, once operational, will provide greater connectivity for Kuala Lumpur and its conurbation via integration with other rail lines such as, Ampang LRT Line, Kelana Jaya LRT Line and MRT 1 Line. This will enable efficient travel which would reduce social cost of travel and enhance overall productivity. Additionally, it will substantially contribute towards achieving the top 20 most liveable city.

The LRT3 is expected to bring considerable benefits to the communities within Klang and Shah Alam areas since these areas are not well served by public transportation network as compared to residents in Petaling Jaya area which is currently served by Kelana Jaya LRT and its extension. Currently, Shah Alam residents depend on the buses while Klang residents rely on both buses and KTM commuter as the main public transport.

The proposed LRT3 is expected to bring positive impacts to these areas by:-

- improving connectivity and mobility of the people
- providing a more reliable and safe mode of transport

- increasing productivity due to travel time saving
- enhancing land and property values within the vicinity of the Project

Improving Connectivity and Mobility of the People

Connectivity and mobility of the people will be significantly improved between Klang and Shah Alam to Petaling Jaya and Kuala Lumpur. The survey findings support this observation where more than 80% agreed that having the proposed LRT3 would improve connectivity. The ability to move large number of people in a relatively short time makes travelling so much easier, faster and less stressful is among the LRT's key benefits to society.

Providing More Reliable and Safe Mode of Transport

Another benefit is the reliability and safety of the trains. In a highly urbanised environment, large crowds of people move within and between urban centres to carry out their economic functions. Punctuality underpins these movements because delays are unproductive and push costs higher. The speed and reliability of the LRT minimise delays and ensure schedules are observed, contributing to cost management of economic activities in cities.

Road safety is important to society at large. Nationwide, road accidents have been rising since 2007. Recent 2012 figures show a total of 462,000 road accidents of which 5% leads to injuries and death. Out of the 5%, nearly 30% were deaths from road accidents. Annually, considerable lives are lost because of road accidents.

The proposed LRT3 alone is not expected to bring this number down but in the urban areas where it operates, it gives people optional mode of transport. For people who are concerned over road safety, it provides them with a safer mode of transport as compared to motorcycles and cars. From the survey results, 88% of the people interviewed believe that LRT helps to reduce road accidents and deaths.

Increasing Productivity due to Travel Time Saving

There are economic benefits from having the LRT3 in the neighbourhood. One major benefit is enhancement in productivity. This stems from less time spent on congested roads in motor vehicles. A worker is able to plan his or her commuting time from home to work and vice versa. In fact, any user should be able to plan his or her travel time well by using the LRT, and thus have more time available not only for productive activity but also for leisure. This is especially important for cities aiming to be competitive and attract investors and workers as well. This economic benefit leads to a social benefit by letting people have access to more leisure hours because they are no longer caught in road congestion.

This economic benefit is not confined to individuals in society. There are indirect benefits for employers' and the business community because they gain from improved productivity. In addition, improved connectivity tends to open up job opportunities so both employers and workers gain. With connectivity, commuting becomes easier and employers can tap into a larger pool of workers that have access to the LRT. In the case of Klang Valley, the proposed LRT3 could enable industrialists from Shah Alam and Klang to reach out to potential employees living in the north and north eastern parts of the Klang Valley. Similarly, workers staying in these areas are not restricted to a job market confined to their neighbourhood and Kuala Lumpur but could access jobs in Shah Alam and Klang as well.

<u>Other Economic Benefits or Spin-offs</u>

The business community operating near stations is expected to also reap economic benefits. These are long-term benefits, not likely to be visible during planning and construction. LRT stations are expected to generate a high degree of pedestrian movements and these, in turn, create demand for other businesses such as retail trade, food, and general services. Again, there are economic repercussions across a whole spectrum of groups comprising traders, business operators, service providers and the property owners. These operations open up job opportunities which would have a multiplier effect on the local economy where the LRT3 Line runs through.

7.11.3 Land Use Changes

It is expected that the LRT3 will lead to the increase of land demands (which mainly either to serve the needs to accommodate urban expansion or to provide premises for business activities) along the proposed alignment. Changes in land use and/or development densities can be expected although these are mainly beyond the control of the Project Proponent.

Land and property values, especially in areas that are near and accessible to proposed stations, are expected to be enhanced. The locations of stations are vital to the success of the LRT3 as well as to the surrounding areas. Owners of residential and commercial properties are likely to see an upward movement in the values of their properties from the announcement of the Project until its completion. The extent of upward movement in values would, of course, vary with proximity to stations and accessibility via walking or feeder buses. The rise in values comes from an increase in demand for saleable and rentable properties, both residential and commercial, with good access to proposed stations. Aside from these, the increase in values is expected to permeate across many types of properties with accessibility to stations, including vacant, developable land and industrial properties.

(a) Conversion of Land Use

Based on previous LRT projects, the demand for properties and land within certain radius of these two projects has increased rather substantially. Numerous developments have sprung up and mainly concentrated around areas surrounding the proposed stations, especially within the 500 m radius.

Based on the current land use distributions and the proposed alignment of the LRT3 Line, areas that may potentially be affected are the agricultural land in Kg Johan Setia. With the areas surrounding the agricultural land have mostly been developed into multiple integrated townships, there would be a huge demand for this land to be converted into new residential and commercial properties as a result of the upcoming presence of a few LRT stations and a proposed depot at this area. The future developments at this area would likely result in the increase of transit ridership and help create a more compact urban area.

(b) Development Intensification and Increase in Plot Ratio

It is expected that developments within urban and suburban areas in Petaling Jaya and Shah Alam to intensify and at some areas particularly surrounding the station there may be a need to increase the plot ratio for development. There will be a tendency among the land and property owners to increase or maximise their lands with the presence of the LRT3 Line near their properties or land. This is expected to be well spread around the surrounding of the LRT3 stations, with the areas surrounding the proposed Stadium (Grand Central) Station and I-City Station expected to be the most affected.

This is in-line with the concept of transit oriented development (TOD) for developments within the vicinity of the stations. Such developments have already taken place or expected to be implemented as observed from the MRT and LRT projects.

(c) Transfer or Dispersal of Economic Centre

1. Seksyen 7 (Shah Alam)

I-City is planned to be developed as a tourism centre and cyber hub according to the Local Plan 2020 by MBSA. Due to the rapid development going on in I-City, it is anticipated that this area would become a major economic centre in Shah Alam as prove that the development has already attracted foreign investors to participate in this grand project. Meanwhile, the I-City station is expected to be a catalyst for future development as well as further boosting the commercial activities in this area.

The placement of LRT station in Seksyen 7 is strategically ideal as it is sited at close proximity to public facilities and institutions such as Hospital Shah Alam, UiTM and UNiSEL. Seksyen 7 can be accessed through Federal Highway, North Klang Straits Bypass and NKVE. The future I-City Station would provide another alternative and better connection for the public to access this area.

2. Seksyen 13 (Shah Alam)

Currently, new land developments are gathering pace around the area of Stadium Shah Alam and D'Kayangan in Seksyen 13. These are all part of the TODs which aimed to harness the improved transport network in this area. The LRT station is touted to be integrated with the BRT station. It is anticipated that this area will transform into a much vibrant city centre due to future mixed developments including residential and commercial properties within this area.

Seksyen 13 is accessible via a few major highways in Klang Valley including the Federal Highway, Guthrie Corridor Expressway (GCE), ELITE and NKVE. Besides that, the LRT line will provide a better access and connection between jobs and housing as well as revitalising the industrial corridors especially around the area of HICOM Glenmarie Industrial Park and Subang Hi-Tech Industrial Park.

3. Seksyen 14 (Shah Alam)

Seksyen 14 is regarded as the Shah Alam's city centre. The proposed Seksyen 14 Station is located close to some notable commercial buildings such as the SACC Convention Centre, Kompleks PKNS and Anggerik Mall. There should be an increase of business activities and opportunities at this area once the LRT starts its operation. A few of TODs are being planned around the LRT station area which would see a new development of commercial buildings which is in tandem with the MBSA Local Plan 2020. This area has the potential to grow further in terms of becoming a main centre of business and commerce.

4. Areas along Jalan Langat, Klang

At the moment, the land uses along Jalan Langat are mainly comprised of various townships such as Bandar Bukit Tinggi 1 and 2, Bandar Botanic, Kota Bayuemas and Bandar Parklands. These townships are mostly built as an integrated development which consists of residential and commercial properties. The placement of LRT stations (Tesco Bukit Tinggi, AEON Bukit Tinggi, Bandar Botanic and Johan Setia) along this road would tremendously boost the commercial value of this area while enhancing the economic activities within this corridor. This area is accessible via Shah Alam Expressway (KESAS), Pulau Indah Expressway, Federal Highway Route 2 and Jalan Klang – Banting.

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P1	LOW	
P2	MEDIUM	BENEFICIAL IMPACTS
P3	HIGH	

N1	LOW	
N2	MEDIUM	ADVERSE IMPACTS
N3	HIGH	

				PROJECT ACTIVITIES – OPERATIONAL STAGE											
				TRAIN MOVEMENT	Accidents	Presence of Piers & Elevated Station	Traffic								
ENVIRONMENTAL COMPONENTS	PHYSICO-CHEMICAL	LAND	Soil profile												
			Soil stability												
			Subsidence and Compaction												
			Land use												
			Buffer zones												
		SURFACE WATER	Drainage pattern												
			Water quality												
			Existing use												
		GROUND WATER	Water table												
			Flow regime												
			Water quality												
			Existing use												
		AIR	Air quality	P1											
			Visibility												
		NOISE	Intensity	N2											
			Duration	N2											
			Frequency	N2											
	BIOLOGICAL	SPECIES & POPULATAION	Terrestrial vegetation												
			Terrestrical wildlife												
			Aquatic flora												
			Aquatic fauna												
		HABITATS & COMMUNITIES	Terrestrial habitat												
			Terrestrical communities												
			Aquatic habitat												
			Aquatic communities												
	HUMAN	HEALTH & SAFETY	Physical safety/health	N1	N1										
			Physical well-being												
			Communicable disease												
		SOCIAL & ECONOMIC	Employment	P1											
			Utilities/Amenities	P3											
			Transportation/Traffic flow	P3			N1								
			Commerce	P3											
		AESTHETIC & CULTURAL	Landform			N1									
			Atmospheric quality	P1											
			Tranquility												
			Sense of community												
			Landscape			N1									
			Odour												

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Figure 7-1

EIA Matrix for the Operational Stage

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