

APPENDIX A1

Technical Paper No. 2 - Traffic Noise Impact Assessment

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Traffic Noise Impact Assessment

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1. INTRODUCTION

1.1 Background

In response to the pressure that is mounting both within the government and from the public in recent years for a policy to implement noise mitigation measures for a large number of existing flyovers which align very close to NSRs, a Scoping Study has been carried out to identify flyovers which may be provided with retroactive measures to reduce noise impacts on the existing receivers. In the Scoping Study on Flyovers, a total of 188 existing flyovers were examined. Taking into account the location of flyovers, government constraints, special requirements and acoustic effectiveness of the direct noise mitigation measures, 11 flyovers were recommended for further investigation. As a pilot study, three existing flyovers have been selected from these recommended flyovers for a feasibility study for providing retroactive noise mitigation measures. The three flyovers include Ap Lei Chau Bridge, Tsing Tsuen Road, and Kwai Chung Road, of which Kwai Chung Road had been included in the 'Feasibility Study for Providing Retroactive Road Traffic Noise Mitigation Measures.' Key objectives will be to establish the engineering feasibility and priority, eventually leading to a policy, if any, for implementing noise mitigation on "noisy" flyovers in Hong Kong.

1.2 Study Objectives

The objectives of this paper are as follows :

- to advise Director's Representative the acoustical effectiveness of provision of direct mitigation measures on the two existing flyovers namely the Apleichau Bridge and the Tsing Tsuen Road near Riviera Gardens and Cheung On Estate; and
- to carry out a review of the findings in the *Scoping Study for Providing Direct Technical Remedies on Existing Flyovers* and to recommend alterations to the proposed measures therein, if necessary, in light of the changes subsequent to the completion of the Scoping Study.

1.3 Technical Paper Structure

This Technical Paper consists of 4 sections, as follows :

1. Introduction
2. Review of Scoping Study
3. Traffic Noise Impact Assessment
4. Conclusion & Recommendation

2. REVIEW OF SCOPING STUDY

2.1 Apleichau Bridge

Apleichau Bridge was identified in the *Scoping Study for Providing Direct Technical Remedies on Existing Flyovers* as a major noise source for the residents in Shan Ming Street, Ping Lam Street and San Shi Street. A concrete noise barrier from 1 m to 2 m high has already been installed at the back of footpath along a length of Apleichau Bridge Road during the construction of the Second Ap Lei Chau Bridge approach road. A 3 m high barrier is expected to reduce the noise from the flyover by 10 dB(A), and an overall noise reduction by approximately 5 dB(A).

As other forms of mitigation measures, e.g. 5 m high cantilever barrier or semi-enclosures do not produce any significant further noise reduction, the Scoping Study on Flyover recommended a 3 m high barrier to be installed for the Apleichau Bridge. One of the key issues in the implementation mitigation measures for this bridge will be how to make good use of the existing provisions along this length of flyover to help to reduce the traffic noise impacts.

2.2 Tsing Tsuen Road

Tsing Tsuen Road was identified as the top priority site in the implementation program and was found to be the dominant traffic noise source to the residents in Riviera Gardens, Tsing On THA and Cheung On Estate. A semi-enclosure is expected to reduce the noise from the bridge by more than 10 dB(A) and an overall noise reduction by approximately 5 dB(A).

One of the key issues in the implementation of mitigation measure for this bridge will be to examine whether a cantilevered barrier is sufficient to protect the exposed dwellings, although such barrier will not be effective for the upper-floor receivers. On this basis, the provision of a semi-enclosure will need to be further examined and justified. This will be one of the issues needed to be carefully addressed. Alternative forms of barrier may be justified from the noise perspective.

3. TRAFFIC NOISE IMPACT ASSESSMENT

3.1 Noise Standards and Regulations

At present, the current policy does not require protection of NSRs to redress the traffic noise problem arising from existing roads. Whilst road traffic noise problem is more amenable through planning process, for the purpose of analysing noise from existing roads, it is considered appropriate to adopt similar criteria for planning new roads or designating new Noise Sensitive Receivers. These criteria according to the Hong Kong Planning Standards and Guidelines (HKPSG) require that the noise level L10 (1-hr) at the external façade due to road traffic should not exceed 70 dB(A) for domestic premises.

3.2 Noise Sensitive Receivers

Based on site surveys, existing representative noise sensitive receivers (NSRs) have been identified along the alignment of the two study flyovers namely Ap Lei Chau Bridge and Tsing Tsuen Road, and they are shown in Figures 3.1 and 3.2, respectively. Table 1 provides further details of these NSRs. As for the planned receivers including the proposed HOS development in Ap Lei Chau as well as Villa Esplanada and Tierra Verde on both sides of Tsing Tsuen Road, they are not identified as NSRs in this study and the noise impacts have been/would be addressed in their respective noise impact assessments.

NSRs WF HL, SO and CO are facing away and/or distanced from the selected flyovers. Results of noise impact assessment indicate that noise levels at these NSRs are dominated by traffic noise arising from other existing roads and hence these NSRs are excluded from further evaluation in the Study.

Table 1 Description of NSRs

NSR ID	Name of Building	No. of Storey	No. of Dwellings per Floor
TC	Toho Court	22	2
RH	Rousseau Heights	10	3
SM	Sun Ming Building	7	6
NT	Nam Tack Mansion	5	2
NF	Ning Fung Mansion	22	6
OM	On Mei House	34	24
OP	On Pak House	34	24
OC	On Chiu House	34	24
SP	St. Paul's Village	3	1
A	Hoi Nga Mansion	40	8
B	Hoi Kwu Mansion	40	8
C	Hoi Sing Mansion	40	8
D	Hoi Fung Mansion	40	8
E	Hoi Wai Mansion	40	8
F	Hoi Yat Mansion	40	8
G	Hoi Kwai Mansion	40	8
H	Hoi Yin Mansion	40	8
J	Hoi Yue Mansion	40	8

3.3 Assessment Methodology

Noise Model

Road traffic noise levels will be predicted using the in-house noise model which is a computerised model developed on the basis of the UK's Department of the Transport procedures described in "Calculation of Road Traffic Noise" published by the Welsh Office, HMSO 1988 (CRTN).

Traffic Figures

The existing AM peak hour traffic flows, i.e. traffic flows in 1998, have been counted and used for this noise impact assessment. The speed limit of the study flyovers and local roads is 50kmh. Traffic flow diagrams for the two study flyovers are shown in Figures 3.3 and 3.4.

Development of Mitigation Measures

For each or clusters of representative NSRs, a number of noise mitigation scenarios have been considered and tested individually for acoustical effectiveness by iterative calculations using the computer model described previously. The noise barriers tested include all practical forms (i.e. vertical barrier, cantilevered barrier, semi-enclosure, or full enclosure).

Evaluation of Noise Mitigation Measures

The noise model is run iteratively for various heights and lengths of a hypothetical barrier system positioned at the edge of the structure. Alternative configurations are examined and the mitigation option that can achieve higher noise protection is identified for further evaluation.

3.4 Traffic Noise Impact Assessment

Ap Lei Chau Bridge

The prevailing road traffic noise levels at the representative NSRs along Ap Lei Chau Bridge in year 1998 are shown in Table 2. About 77 dwellings are predicted to be exposed to noise levels exceeding the HKPSG by upto 9 dB(A). The highest overall noise level of 79 dB(A) is predicted to be at the top floor of SM-2, a sensitive facade overlooking the heavy trafficked bridge and road (i.e. Ap Lei Chau Bridge and Ap Lei Chau Bridge Road), of which the traffic noise contributed by Ap Lei Chau Bridge Road is 78.3 dB(A). The noise levels at the rest of the facades range between 62 to 77 dB(A).

Table 2 Noise Levels at Representative NSRs in Do-Nothing Scenario
(Ap Lei Chau Bridge)

NSRs	Floor	Breakdown and Overall Noise Levels at Various Level in dB(A)		
		Flyover	Other Roads	Overall
TC-1	1	62.1	60.7	65
	5	67.4	65.6	70
	10	69.8	68.5	72
	15	71.7	68.8	74
	20	71.6	68.9	74
	22	71.4	68.8	73
RH-1	1	62.9	44.5	63
	5	70.5	57.0	71
	10	74.2	60.4	74
SM-1	1	61.8	43.3	62
	5	70.7	61.1	71
	7	76.7	63.0	77
SM-2	1	62.3	59.5	64
	5	72.9	69.7	75
	7	78.3	70.9	79
NT-1	1	64.3	61.4	66
	5	73.0	70.6	75
NF-1	1	62.6	65.8	68
	5	70.4	68.4	73
	10	72.9	70.2	75
	15	72.4	69.8	74
	20	71.9	69.4	74
	22	71.6	69.3	74

Tsing Tsuen Road

The prevailing road traffic noise levels at the representative NSRs at both ends of Tsing Tsuen Road in year 1998 are shown in Table 3. About 2606 dwellings are predicted to be exposed to noise levels exceeding the HKPSG by upto 11 dB(A). The highest overall noise level of 81 dB(A) is predicted to be around the fifth floor of C-2, a sensitive facade overlooking the heavy trafficked flyover. The noise levels at the rest of the facades range between 62 to 80 dB(A). Noise levels at NSR SP are within the 70 dB(A) criterion and therefore noise mitigation measures are not required.

3.5 Proposed Mitigation Scenarios

Ap Lei Chau Bridge (ALCB)

In order to mitigate the noise impact at the upper-floor receivers along ALCB, two options as described below have been investigated.

Option I: Two 5m plain barriers, separated by a subway entrance, of a total length of 130m long, are to be erected along the northbound carriageway at the edge of structure to protect the receivers at various heights along ALCB. The location of these barriers is shown in Figure 3.5.

Option II: Instead of two 5m plain barriers, two 4.5m Inverted L-shaped barriers with 1.5m canopy at 45° are to be erected along the exact same extent

and location as *Option I*. The typical configuration of the Inverted L-shaped barrier is shown in Figure 3.6.

In the case of barriers to be supported on independent structure, Option I and/or Option II can simply be modified by adding or increasing the length of canopy to provide an equal level of noise protection to the receivers.

A summary of the predicted road traffic noise levels at representative NSRs after the implementation of these proposed mitigation options are shown in Table 4.

Evaluation of Effectiveness

The options for each road section have been compared in terms of the percentage of protection for affected dwellings. The results are shown in Table 5. In general, the mitigation option with a higher percentage of population protected is considered to be the most effective option in terms of noise attenuation.

As shown in Table 5, noise protection provided by Option I and Option II is 77% and 82%, respectively. Therefore, Mitigation Option II is likely to be a more effective option in terms of noise abatement performance.

Table 3 Noise Levels at Representative NSRs in Do-Nothing Scenario
(Tsing Yi)

NSRs	Floor	Breakdown and Overall Noise Levels at Various Level in dB(A)		
		Flyover	Other Roads	Overall
OM1	1	62.2	65.5	67
	5	66.8	65.4	69
	10	70.4	65.2	72
	15	70.3	65.0	71
	20	70.2	65.6	72
	25	70.0	67.0	72
	30	69.8	66.9	72
	34	69.6	66.6	71
OM2	1	58.6	68.4	69
	5	61.1	68.0	69
	10	69.0	67.3	71
	15	68.9	66.6	71
	20	68.9	67.2	71
	25	68.8	67.0	71
	30	68.6	66.5	71
	34	68.5	66.1	71
OP1	1	68.7	66.0	71
	5	77.2	65.9	78
	10	77.0	65.9	77
	15	76.5	65.5	77
	20	75.9	64.8	76
	25	75.3	64.6	76
	30	74.8	64.2	75
	34	74.4	63.8	75
OP2	1	67.3	70.0	72
	5	77.9	68.4	78
	10	77.4	68.1	78
	15	76.6	67.1	77
	20	75.8	66.3	76
	25	75.1	65.6	76
	30	74.5	65.0	75
	34	74.0	64.6	75

Table 3 (Cont.) Noise Levels at Representative NSRs in Do-Nothing Scenario (Tsing Yi)

NSRs	Floor	Breakdown and Overall Noise Levels at Various Level in dB(A)		
		Flyover	Other Roads	Overall
OP3	1	68.0	75.3	76
	5	78.0	73.9	79
	10	77.5	72.1	79
	15	76.7	70.7	78
	20	76.0	69.6	77
	25	75.3	68.7	76
	30	74.6	68.0	76
	34	74.2	67.5	75
OP4	1	65.0	72.4	73
	5	72.9	71.6	75
	10	72.7	70.2	75
	15	72.2	68.9	74
	20	71.6	68.0	73
	25	71.0	67.4	73
	30	70.5	66.8	72
	34	70.1	66.4	72
OP5	1	66.0	67.6	70
	5	70.5	67.5	72
	10	71.1	67.0	73
	15	71.0	66.6	72
	20	70.7	66.3	72
	25	70.5	66.0	72
	30	70.2	66.6	72
	34	69.9	66.2	71
OC1	1	75.2	71.8	77
	5	79.0	71.7	80
	10	78.1	71.4	79
	15	77.1	71.0	78
	20	76.2	70.7	77
	25	75.4	70.3	77
	30	74.7	69.9	76
	34	74.2	69.6	76
OC2	1	71.9	61.5	72
	5	78.8	61.2	79
	10	78.0	60.9	78
	15	77.1	60.7	77
	20	76.2	60.9	76
	25	75.4	60.6	76
	30	74.8	60.3	75
	34	74.3	60.0	75

- Background noise level

Table 3 (Cont.) Noise Levels at Representative NSRs in Do-Nothing Scenario (Tsing Yi)

NSRs	Floor	Breakdown and Overall Noise Levels at Various Level in dB(A)		
		Flyover	Other Roads	Overall
OC3	1	69.5	63.3	70
	5	77.5	61.7	78
	10	77.3	62.1	77
	15	76.7	62.7	77
	20	76.1	62.4	76
	25	75.5	61.5	76
	30	74.9	61.6	75
	34	74.5	61.3	75
SP1	1	59.2	57.7	62
	3	64.0	60.3	66
SP2	1	65.3	64.7	68
	3	68.3	65.5	70
SP3	1	66.3	65.3	69
	3	68.4	65.9	70
SP4	1	65.8	62.8	68
	3	67.4	63.3	69
A-1	1	63.6	-	64
	5	66.5	-	67
	10	70.9	-	71
	15	71.1	-	71
	20	70.9	-	71
	25	70.6	-	71
	30	70.4	-	70
	35	70.0	-	70
B-1	1	65.0	-	65
	5	70.5	-	71
	10	73.8	-	74
	15	73.6	-	74
	20	73.3	-	73
	25	72.8	-	73
	30	72.4	-	72
	35	72.0	-	72
B-2	1	67.3	34.1	67
	5	75.0	43.0	75
	10	76.9	48.1	77
	15	76.5	48.1	77
	20	76.0	48.1	76
	25	75.5	48.0	76
	30	74.9	48.0	75
	35	74.4	47.9	74
40	73.9	47.8	74	

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Background noise level

Table 3 (Cont.) Noise Levels at Representative NSRs in Do-Nothing Scenario (Tsing Yi)

NSRs	Floor	Breakdown and Overall Noise Levels at Various Level in dB(A)		
		Flyover	Other Roads	Overall
C-1	1	66.9	-	67
	5	76.3	-	76
	10	76.1	-	76
	15	75.6	-	76
	20	74.9	-	75
	25	74.2	-	74
	30	73.6	-	74
	35	73.0	-	73
	40	72.5	-	73
C-2	1	69.0	39.6	69
	5	80.7	53.8	81
	10	80.1	53.8	80
	15	79.0	53.8	79
	20	78.0	53.7	78
	25	77.2	53.6	77
	30	76.4	53.6	76
	35	75.7	53.5	76
	40	75.1	53.4	75
C-3	1	69.5	52.2	70
	5	80.3	57.4	80
	10	79.8	57.5	80
	15	78.8	59.4	79
	20	77.9	60.0	78
	25	77.0	60.0	77
	30	76.3	60.0	76
	35	75.7	59.9	76
	40	75.1	60.0	75
D-1	1	67.3	-	67
	5	74.6	-	75
	10	74.3	-	74
	15	73.8	-	74
	20	73.2	-	73
	25	72.6	-	73
	30	72.0	-	72
	35	71.5	-	72
	40	71.0	-	71
D-2	1	71.9	42.9	72
	5	79.7	55.6	80
	10	79.0	55.5	79
	15	78.1	55.5	78
	20	77.3	55.4	77
	25	76.5	55.2	77
	30	75.8	55.1	76
	35	75.1	55.0	75
	40	74.6	54.8	75

- Background noise level

Table 3 (Cont.) Noise Levels at Representative NSRs in Do-Nothing Scenario (Tsing Yi)

NSRs	Floor	Breakdown and Overall Noise Levels at Various Level in dB(A)		
		Flyover	Other Roads	Overall
D-3	1	72.0	58.8	72
	5	80.2	62.5	80
	10	79.4	63.7	80
	15	78.5	64.9	79
	20	77.6	65.1	78
	25	76.7	65.1	77
	30	76.0	65.1	76
	35	75.4	65.0	76
	40	74.9	65.1	75
E-1	1	69.9	54.2	70
	5	74.0	58.3	74
	10	73.8	59.8	74
	15	73.5	60.5	74
	20	73.1	60.4	73
	25	72.6	60.4	73
	30	72.2	60.3	73
	35	71.8	60.4	72
	40	71.4	60.3	72
F-1	1	74.3	53.6	74
	5	75.4	58.4	76
	10	75.1	58.4	75
	15	74.7	59.4	75
	20	74.3	59.3	74
	25	73.8	59.2	74
	30	73.3	59.0	74
	35	72.9	58.9	73
	40	72.4	58.7	73
G-1	1	78.6	61.3	79
	5	78.1	62.2	78
	10	77.3	63.3	78
	15	76.5	63.2	77
	20	75.7	63.1	76
	25	75.1	63.1	75
	30	74.5	63.0	75
	35	74.0	62.9	74
	40	73.5	62.7	74
G-2	1	78.9	67.0	79
	5	78.3	69.3	79
	10	77.4	69.8	78
	15	76.6	69.7	77
	20	75.8	69.6	77
	25	75.1	69.6	76
	30	74.5	69.4	76
	35	74.0	69.3	75
	40	73.5	69.3	75

Table 3 (Cont.) Noise Levels at Representative NSRs in Do-Nothing Scenario (Tsing Yi)

NSRs	Floor	Breakdown and Overall Noise Levels at Various Level in dB(A)		
		Flyover	Other Roads	Overall
G-3	1	74.3	67.2	75
	5	74.0	68.9	75
	10	73.4	69.3	75
	15	72.7	69.3	74
	20	72.0	69.1	74
	25	71.4	69.1	73
	30	70.9	68.9	73
	35	70.4	68.8	73
	40	69.9	68.7	72
H-1	1	75.6	69.8	77
	5	75.3	71.5	77
	10	74.8	71.3	76
	15	74.3	71.1	76
	20	73.8	71.0	76
	25	73.2	70.8	75
	30	72.7	70.6	75
	35	72.3	70.5	75
	40	71.8	70.4	74
J-1	1	72.9	69.7	75
	5	72.8	70.5	75
	10	72.6	70.3	75
	15	72.3	70.0	74
	20	72.0	69.7	74
	25	71.6	69.4	74
	30	71.2	69.2	73
	35	70.8	69.1	73
	40	70.4	68.9	73
J-2	1	73.5	71.9	76
	5	73.3	73.5	76
	10	73.1	73.3	76
	15	72.8	73.0	76
	20	72.5	72.8	76
	25	72.1	72.5	75
	30	71.7	72.4	75
	35	71.3	72.2	75
	40	71.0	72.0	75

Table 4 Comparison of Mitigation Options for Ap Lei Chau Bridge

NSR	Floor	Noise Levels, dB(A)		
		Unmitigated	Option I	Option II
TC-1	1	65	63	63
	5	70	68	68
	10	72	70	70
	15	74	70	70
	20	74	71	70
	22	73	71	70
RH-1	1	63	59	58
	5	71	65	60
	10	74	67	67
SM-2	1	62	57	56
	5	71	64	64
	7	77	66	65
SM-1	1	64	60	60
	5	75	67	67
	7	79	70	70
NT-1	1	66	62	62
	5	75	68	68
NF-1	1	68	65	65
	5	73	69	69
	10	75	72	71
	15	74	72	72
	20	74	73	72
	22	74	73	73

Table 5 Effectiveness Comparison of Mitigation Options for Ap Lei Chau Bridge

NSR	Number of Dwellings Exceeding the HKPSG criterion		
	Without Mitigation	With Mitigation	
		Option I	Option II
Toho Court	14	4	0
Rousseau Heights	18	0	0
Sun Ming Building	20	0	0
Nam Tack Mansion	6	0	0
Ning Fung Mansion	19	14	14

Tsing Tsuen Road

As stated in the *Tsing Yi North Coastal Road EIA*, the Structure Division of Highways Department confirmed that it was infeasible to erect a noise barrier over the existing structure of the western end of Tsing Tsuen Road due to both strength capacity and space constraints. The feasibility of erecting a noise enclosure on separate foundation was also refuted due to its physical proximity to Cheung On Estate in the north and the Airport Railway in the south. Moreover, any kind of massive structure was not recommended as it would have a huge visual impact on the surrounding environment.

Having considered the above-mentioned constraints, a partial enclosure on the eastbound carriageway outside the Tsing Yi North Coastal Road EIA study area as well as a partial enclosure covering the entire width of the flyover on the same extent, have been tested. As for the eastern end of Tsing Tsuen Road near Riviera Gardens, similar options have also been investigated taking into account the existing terrain and topography. The location and extent of the enclosures are described below and shown schematically in Figure 3.7.

Plain barriers and inverted L-shaped barriers are not considered on this flyover because they would be ineffective to protect the 30-40 storey high-rise buildings located adjacent to the flyover.

Option I: Two 5.5m high partial enclosures to be located along the eastbound carriageway in front of Riviera Gardens and Cheung On Estate as shown in Figure 3.7. A typical cross-section is depicted in Figure 3.8.

Option II: Instead of two partial enclosures covering the eastbound carriageway, two partial enclosures covering the entire flyover to be located along the same extent and location as *Option I*. The typical configuration of this type of partial enclosure is shown in Figure 3.9.

In the case of enclosures supported on independent structures, Option I and/or II can simply be modified by adding or increasing the span of canopy to provide an equal level of noise protection to the receivers.

A summary of predicted road traffic noise levels at representative NSRs after the implementation of these proposed mitigation options are shown in Table 6.

Table 6 Comparison of Mitigation Options for Tsing Tsuen Road

NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Unmitigated	Option I	Option II
OM1	1	67	66	66
	5	69	66	66
	10	72	68	68
	15	71	69	68
	20	72	69	69
	25	72	70	69
	30	72	70	69
	34	71	70	69
OM2	1	69	69	69
	5	69	68	68
	10	71	69	69
	15	71	69	69
	20	71	70	69
	25	71	70	69
	30	71	69	69
	34	71	69	69
OP1	1	71	66	66
	5	78	67	66
	10	77	72	68
	15	77	72	68
	20	76	73	69
	25	76	72	69
	30	75	72	68
	34	75	71	68
OP2	1	72	70	70
	5	78	69	69
	10	78	73	69
	15	77	73	69
	20	76	73	69
	25	76	72	68
	30	75	71	67
	34	75	71	67

Table 6 (Cont.) Comparison of Mitigation Options for Tsing Tsuen Road

NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Unmitigated	Option I	Option II
OP3	1	76	76	75
	5	79	74	74
	10	79	75	73
	15	78	75	72
	20	77	74	71
	25	76	73	70
	30	76	73	69
	34	75	72	69
OP4	1	73	73	73
	5	75	72	72
	10	75	72	71
	15	74	72	71
	20	73	71	70
	25	73	71	69
	30	72	70	69
	34	72	70	68
OP5	1	70	69	69
	5	72	69	69
	10	73	70	69
	15	72	70	69
	20	72	70	69
	25	72	70	69
	30	72	70	69
	34	71	70	69
OC1	1	77	72	72
	5	80	75	75
	10	79	78	78
	15	78	77	77
	20	77	77	76
	25	77	76	76
	30	76	75	75
	34	76	75	75
OC2	1	72	63	63
	5	79	70	70
	10	78	75	75
	15	77	75	74
	20	76	74	73
	25	76	73	72
	30	75	73	71
	34	75	72	71

Table 6 (Cont.) Comparison of Mitigation Options for Tsing Tsuen Road

NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Unmitigated	Option I	Option II
OC3	1	70	64	64
	5	78	65	64
	10	77	72	67
	15	77	73	70
	20	76	73	70
	25	76	72	69
	30	75	72	69
	34	75	71	68
A-1	1	64	63	63
	5	67	66	66
	10	71	70	70
	15	71	70	70
	20	71	70	70
	25	71	70	70
	30	70	70	70
	35	70	69	69
40	70	69	69	
B-1	1	65	60	60
	5	71	66	66
	10	74	69	69
	15	74	69	69
	20	73	69	69
	25	73	68	68
	30	72	68	68
	35	72	68	67
40	72	69	67	
B-2	1	67	59	59
	5	75	66	66
	10	77	69	69
	15	77	68	68
	20	76	68	68
	25	76	68	67
	30	75	69	67
	35	74	71	66
40	74	71	66	
C-1	1	67	57	57
	5	76	65	65
	10	76	66	66
	15	76	65	65
	20	75	65	65
	25	74	67	64
	30	74	70	63
	35	73	69	63
40	73	69	62	

Table 6 (Cont.) Comparison of Mitigation Options for Tsing Tsuen Road

NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Unmitigated	Option I	Option II
C-2	1	69	51	49
	5	81	60	60
	10	80	61	60
	15	79	63	60
	20	78	74	60
	25	77	73	60
	30	76	73	60
	35	76	72	63
	40	75	72	62
C-3	1	70	47	41
	5	80	50	50
	10	80	56	54
	15	79	63	59
	20	78	73	60
	25	77	73	61
	30	76	73	61
	35	76	72	61
	40	75	72	61
D-1	1	67	40	-
	5	75	45	-
	10	74	47	-
	15	74	51	-
	20	73	55	-
	25	73	60	-
	30	72	68	-
	35	72	68	-
	40	71	67	-
D-2	1	72	45	42
	5	80	50	50
	10	79	54	49
	15	78	61	56
	20	77	71	56
	25	77	73	55
	30	76	72	56
	35	75	71	56
	40	75	71	56
D-3	1	72	57	57
	5	80	59	59
	10	80	63	62
	15	79	67	65
	20	78	74	66
	25	77	73	66
	30	76	73	66
	35	76	73	66
	40	75	72	66

- Background noise level

Table 6 (Cont.) Comparison of Mitigation Options for Tsing Tsuen Road

NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Unmitigated	Option I	Option II
E-1	1	70	54	54
	5	74	56	55
	10	74	59	59
	15	74	61	61
	20	73	63	62
	25	73	64	63
	30	73	68	63
	35	72	69	63
F-1	40	72	69	63
	1	74	54	54
	5	76	55	54
	10	75	57	56
	15	75	61	60
	20	74	63	61
	25	74	69	63
	30	74	70	63
G-1	35	73	70	63
	40	73	69	63
	1	79	67	67
	5	78	68	68
	10	78	71	69
	15	77	73	70
	20	76	73	69
	25	75	72	69
G-2	30	75	72	69
	35	74	72	68
	40	74	71	68
	1	79	73	73
	5	79	73	73
	10	78	75	74
	15	77	75	73
	20	77	75	73
G-3	25	76	74	73
	30	76	74	72
	35	75	74	72
	40	75	73	72
	1	75	74	74
	5	75	74	74
	10	75	74	74
	15	74	74	73
	20	74	73	73
	25	73	73	73
	30	73	73	72
	35	73	72	72
	40	72	72	72

Table 6 (Cont.) Comparison of Mitigation Options for Tsing Tsuen Road

NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Unmitigated	Option I	Option II
H-1	1	77	75	75
	5	77	76	75
	10	76	75	75
	15	76	75	75
	20	76	75	74
	25	75	75	74
	30	75	74	74
	35	75	74	73
	40	74	74	73
J-1	1	75	74	74
	5	75	74	74
	10	75	74	74
	15	74	74	74
	20	74	74	73
	25	74	73	73
	30	73	73	73
	35	73	73	72
	40	73	72	72
J-2	1	76	75	75
	5	76	76	76
	10	76	76	76
	15	76	75	75
	20	76	75	75
	25	75	75	75
	30	75	75	74
	35	75	74	74
	40	75	74	74

Evaluation of Effectiveness

The identified options for Tsing Tsuen Road have been compared in terms of the percentage of protection for the affected dwellings, and the results are shown in Table 7. For the eastern end of Tsing Tsuen Road near Riviera Gardens, the noise protection provided by the implementation of Mitigation Option I and Mitigation Option II is 58% and 80%, respectively. As such, Mitigation Option II is considered to be a more effective option in terms of noise abatement performance.

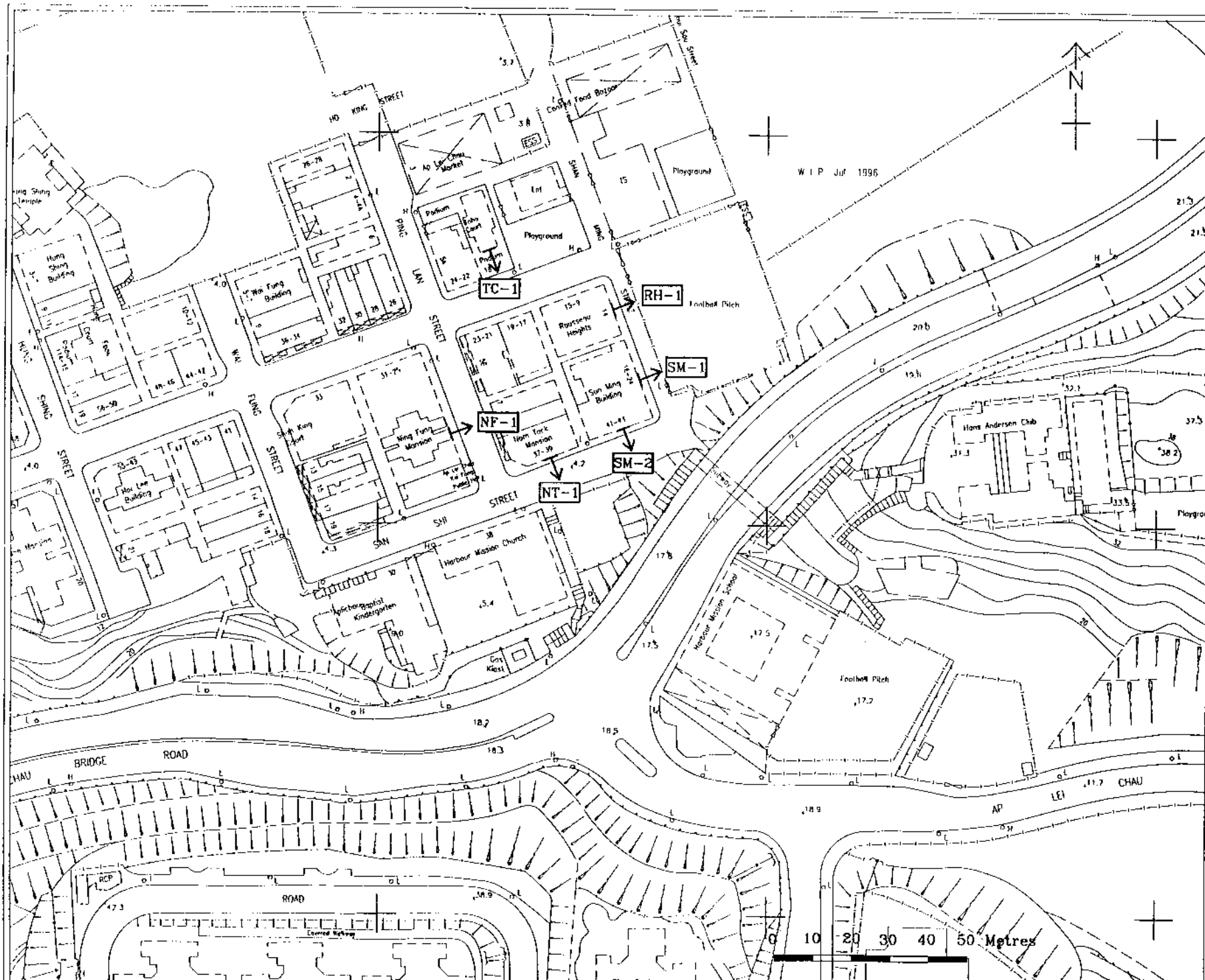
As for the western end of Tsing Tsuen Road near Cheung On Estate, the noise protection provided by the implementation of Mitigation Option I and Mitigation Option II is 53% and 86%, respectively. As such, mitigation Option II is also considered to be a more effective option in terms of noise abatement performance.

Table 7 Effectiveness Comparison of Mitigation Options for Tsing Tsuen Road

NSR	Number of Dwellings Exceeding the HKPSG criterion		
	Without Mitigation	With Mitigation	
		Option I	Option II
Cheung On Estate			
On Mei House	201	0	0
On Pak House	556	268	62
On Chiu House	304	228	82
Riviera Gardens			
Hoi Nga Mansion	142	30	25
Hoi Kwu Mansion	167	21	0
Hoi Sing Mansion	190	67	0
Hoi Fung Mansion	261	81	0
Hoi Wai Mansion	152	0	0
Hoi Yat Mansion	165	0	0
Hoi Kwai Mansion	258	207	160
Hoi Yin Mansion	148	125	125
Hoi Yue Mansion	62	58	58

4. CONCLUSION & RECOMMENDATION

Upon examining the acoustical effectiveness of barriers of different height and configurations, Option II, a 4.5m inverted L-shaped barrier is recommended for Ap Lei Chau Bridge, and two 5.5m partial enclosures on the eastbound carriageway are recommended for Tsing Tsuen Road on noise grounds. The final recommendation of these measures will be subject to the satisfactorily resolution of structural design requirement, land requirement, existing loading of the structure, costs, visual, landscape and air quality assessment, ...etc. Possible side-effects of the recommended noise mitigation option will be investigated and addressed in the Final Report and Technical Paper No. 3 on Air Quality Assessment.

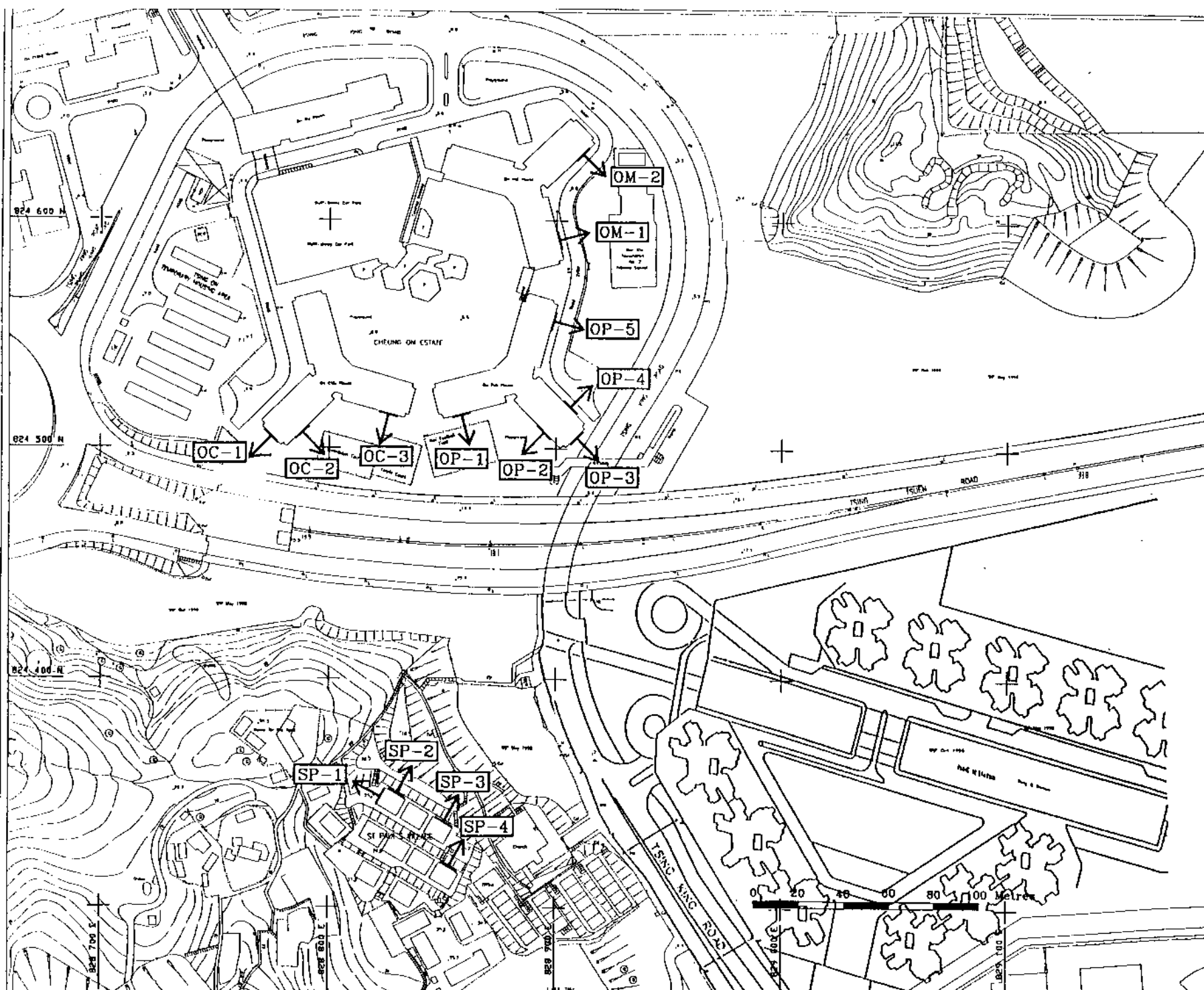


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LEGEND
 → **SM-1** LOCATION OF REPRESENTATIVE NSR

	ENVIRONMENTAL PROTECTION DEPARTMENT
	FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS
LOCATIONS OF REPRESENTATIVE NSR ALONG AP LEI CHAU BRIDGE	
MAUNSELL CONSULTANTS ASIA LTD 茂德亞細亞工程顧問有限公司	
FIGURE NO. 圖紙編號	FIGURE 3-1
SCALE 比例尺	AS SHOWN

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LEGEND
 → OM-1 LOCATION OF REPRESENTATIVE NSR

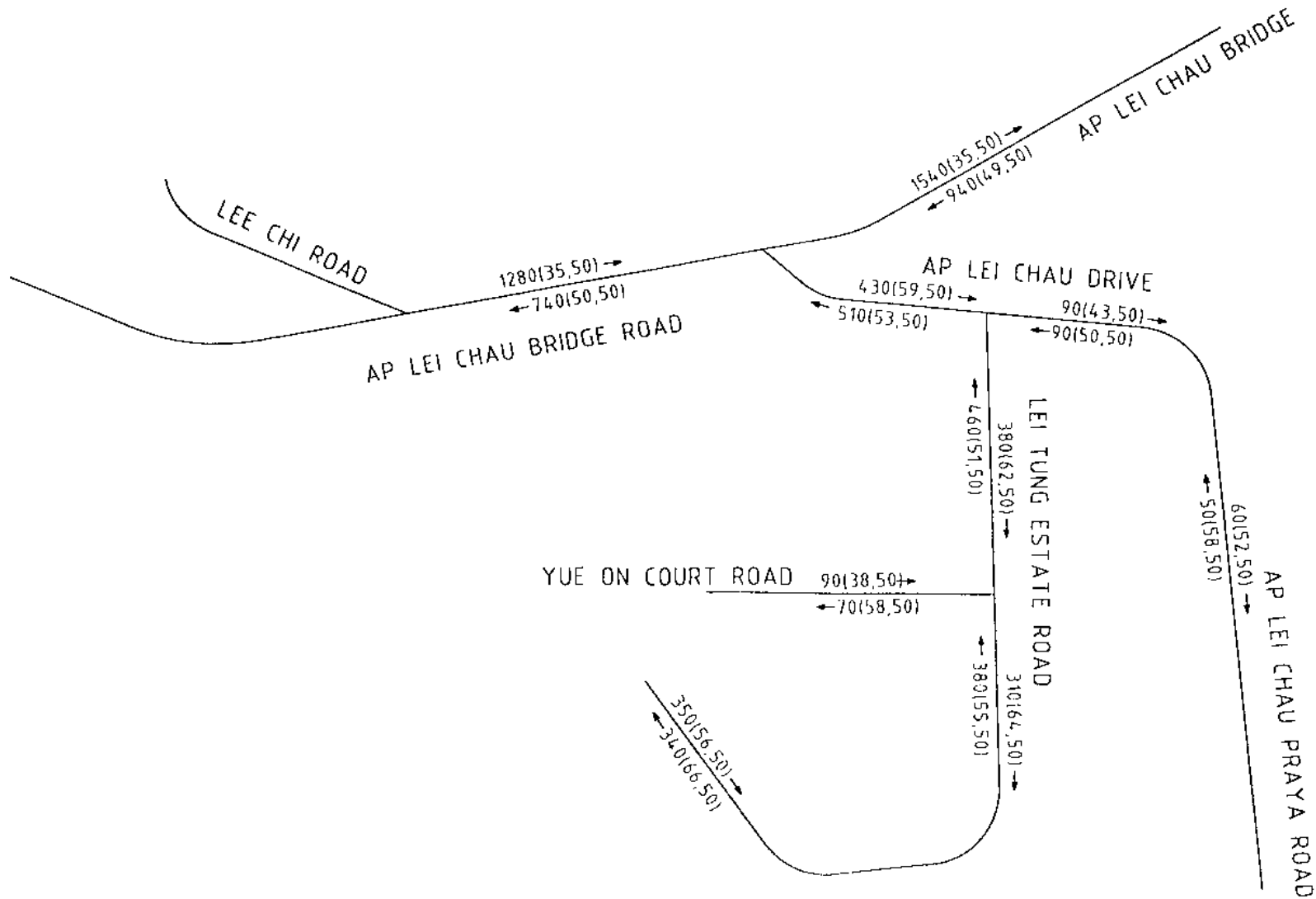
 ENVIRONMENTAL PROTECTION DEPARTMENT	
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS	
LOCATIONS OF REPRESENTATIVE NSR ALONG TSING TSUEN ROAD (SHEET 1 OF 2)	
HAUNSELL CONSULTANTS ASIA LTD. 漢星經理工程師有限公司	
FIGURE NO. 圖號編號	FIGURE 3-2
SCALE 比例	AS SHOWN

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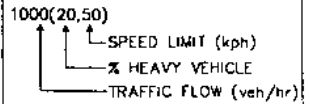


LEGEND
 ↳ 1-2 LOCATION OF REPRESENTATIVE NSR

 ENVIRONMENTAL PROTECTION DEPARTMENT	
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS	
LOCATIONS OF REPRESENTATIVE NSR ALONG TSING TSUEN ROAD (SHEET 2 OF 2)	
HAINSELL CONSULTANTS ASIA LTD. 漢申顧問工程顧問有限公司	
FIGURE NO.	FIGURE 3-2
SCALE	AS SHOWN



LEGEND



NO.	DATE	REVISION

ENVIRONMENTAL PROTECTION DEPARTMENT
 FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

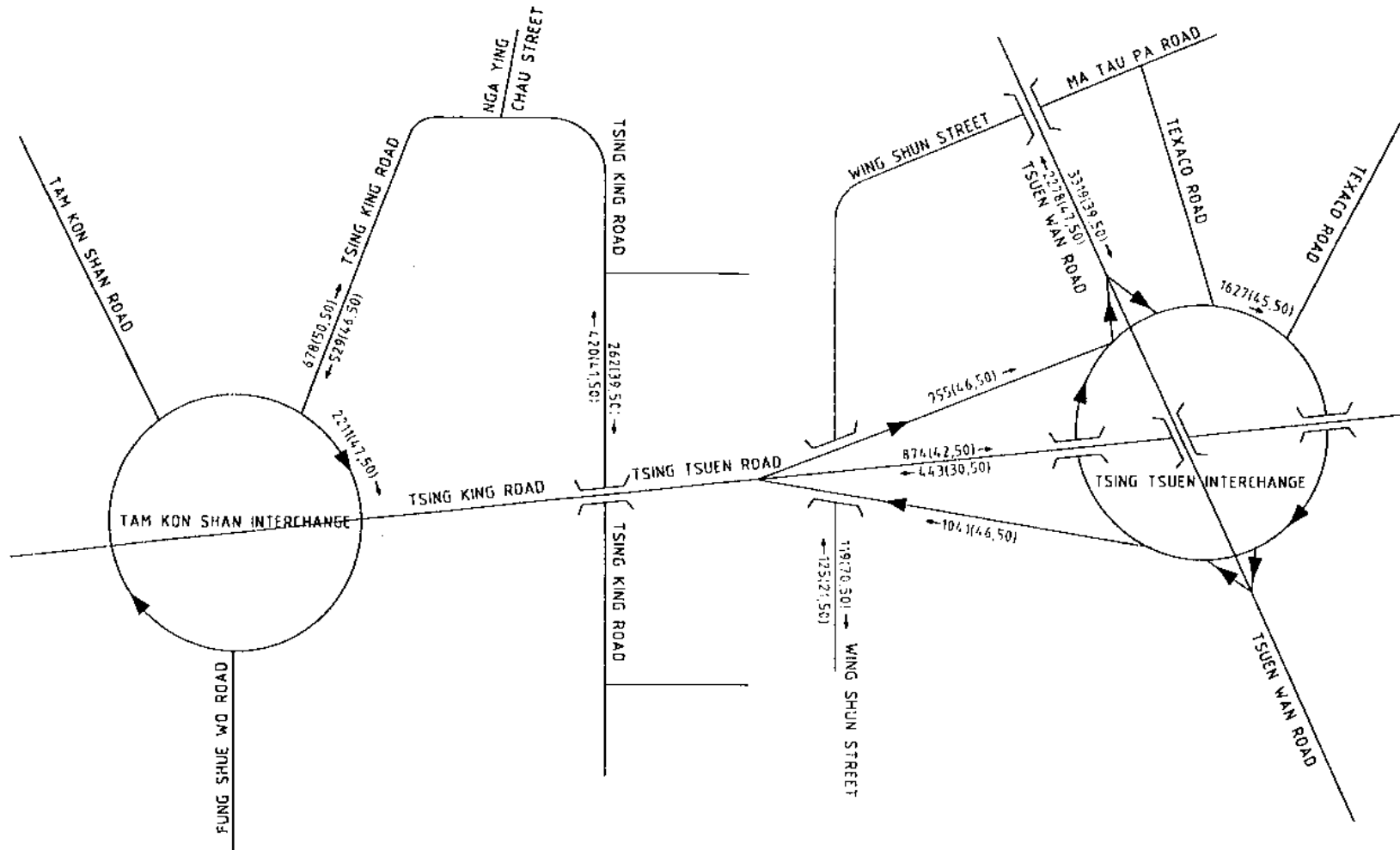
TRAFFIC FLOW DIAGRAM FOR AP LEI CHAU BRIDGE IN 1998

MAUNSELL CONSULTANTS ASIA LTD.
 茂華亞洲工程顧問有限公司

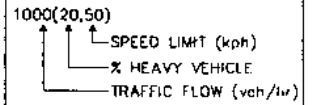
FIGURE NO. 圖號
 FIGURE 3-3

SCALE 比例
 N. T. S.





LEGEND



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ENVIRONMENTAL PROTECTION DEPARTMENT
 FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

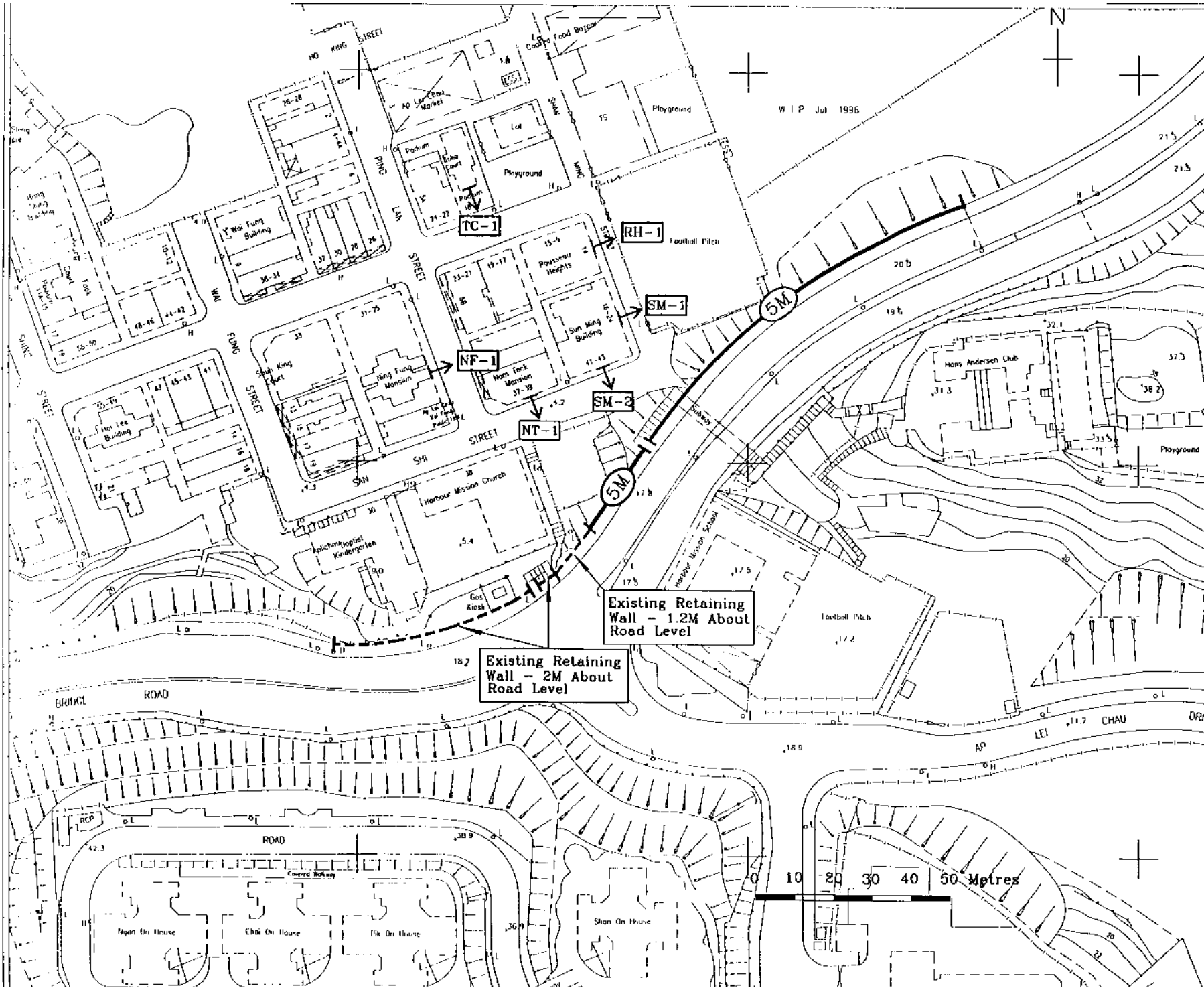
TRAFFIC FLOW DIAGRAM FOR TSING TSUEN ROAD IN 1998

MAUNSELL CONSULTANTS ASIA LTD.
 茂業諮詢工程顧問有限公司

FIGURE NO. 圖號
 3-4


SCALE 比例
 N. T. S.

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LEGEND


PROPOSED 5M PLAIN BARRIER

Existing Retaining Wall - 1.2M About Road Level

Existing Retaining Wall - 2M About Road Level

0 10 20 30 40 50 Metres

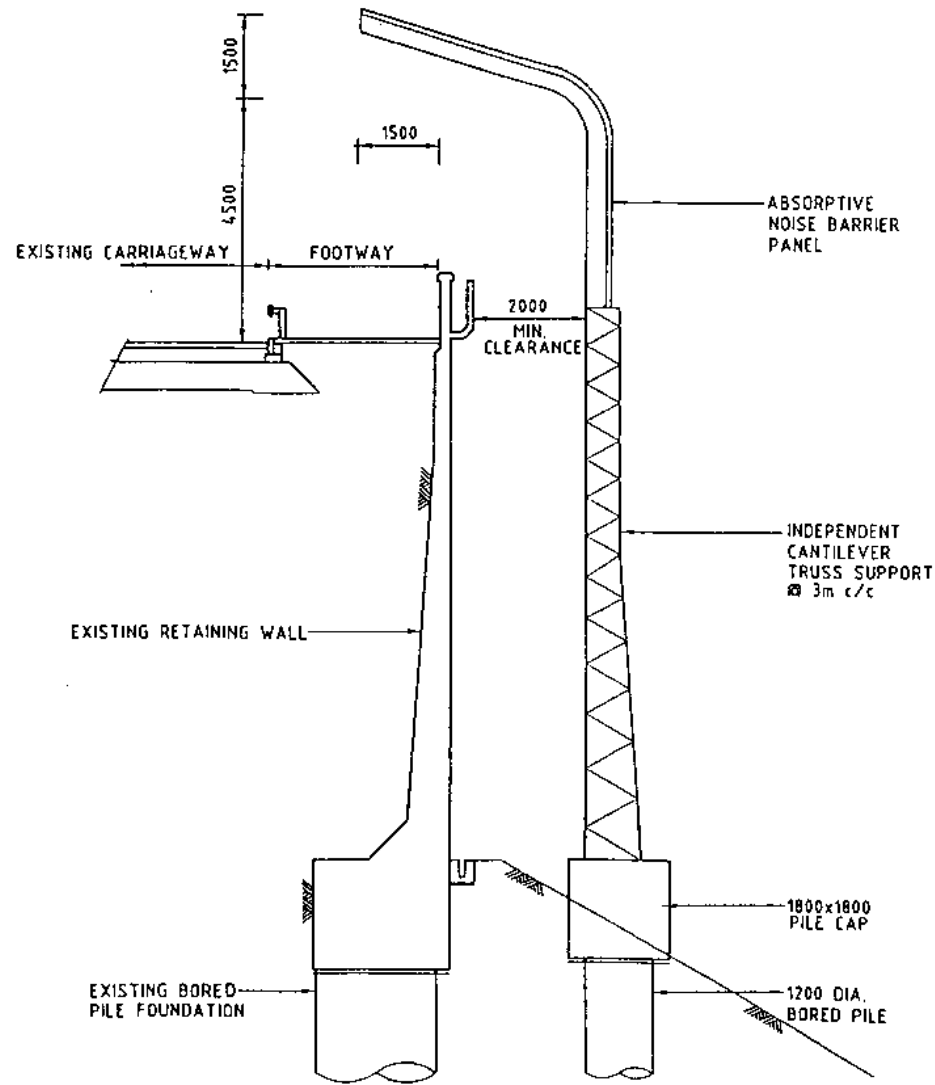

ENVIRONMENTAL PROTECTION DEPARTMENT
 FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATION OF PROPOSED NOISE BARRIER

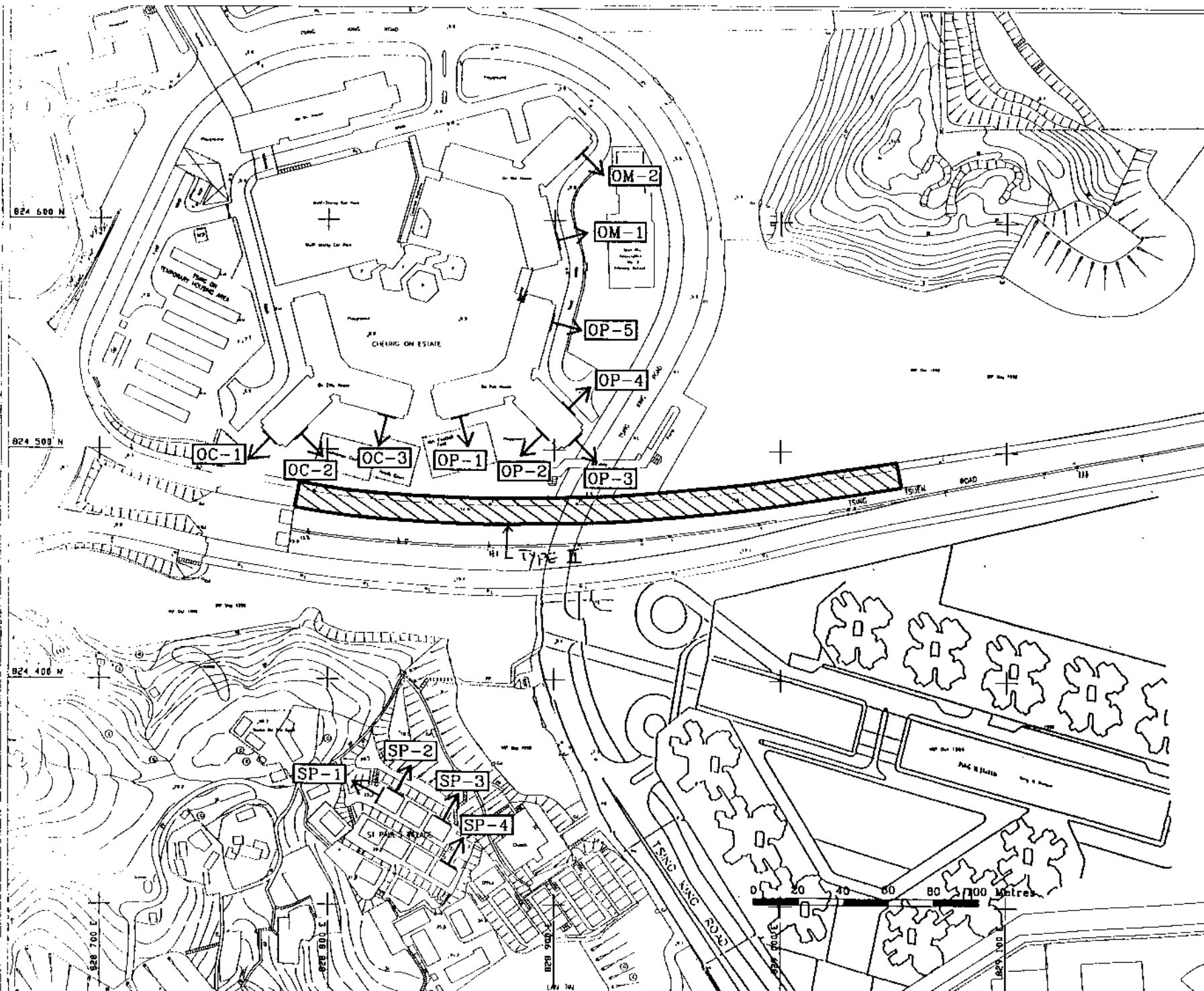
MAUNSELL CONSULTANTS ASIA LTD
 茂德亞洲工程顧問有限公司

FIGURE NO. 圖號
 SCALE 比例
 AS SHOWN

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ENVIRONMENTAL PROTECTION DEPARTMENT	
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS	
CROSS-SECTION OF INVERTED-L SHAPED NOISE BARRIER	
HAUNSELL CONSULTANTS ASIA LTD 漢遜諮詢工程師有限公司	
FIGURE NO.	圖樣號
	FIGURE 3-6
SCALE	

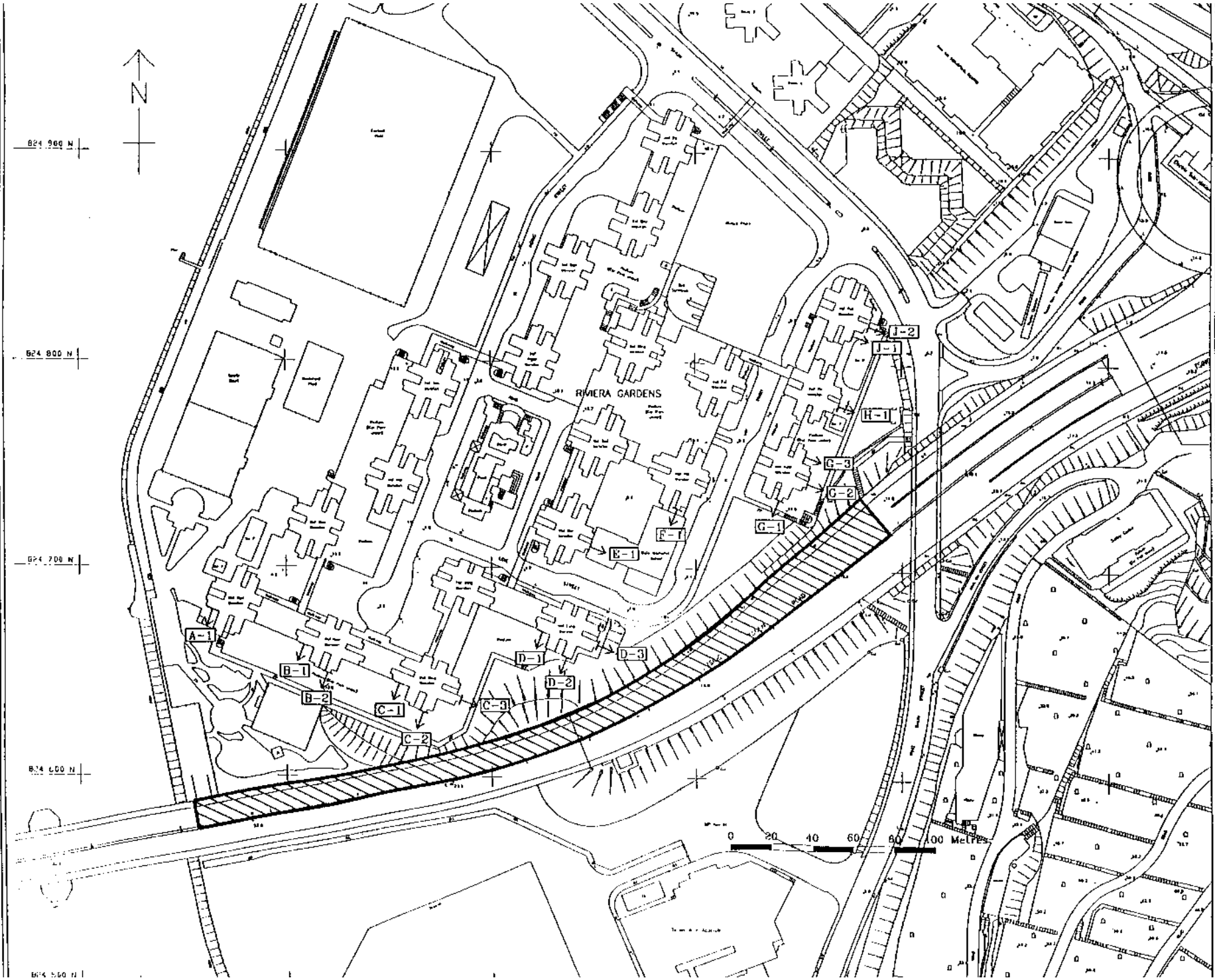


LEGEND


 PARTIAL ENCLOSURE

 ENVIRONMENTAL PROTECTION DEPARTMENT	
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS	
LOCATION OF PROPOSED PARTIAL ENCLOSURE (SHEET 1 OF 2)	
MAUNSELL CONSULTANTS ASIA LTD. 馬敏誠工程師有限公司	
FIGURE NO. 圖則編號	FIGURE 3-7
SCALE 比例	AS SHOWN

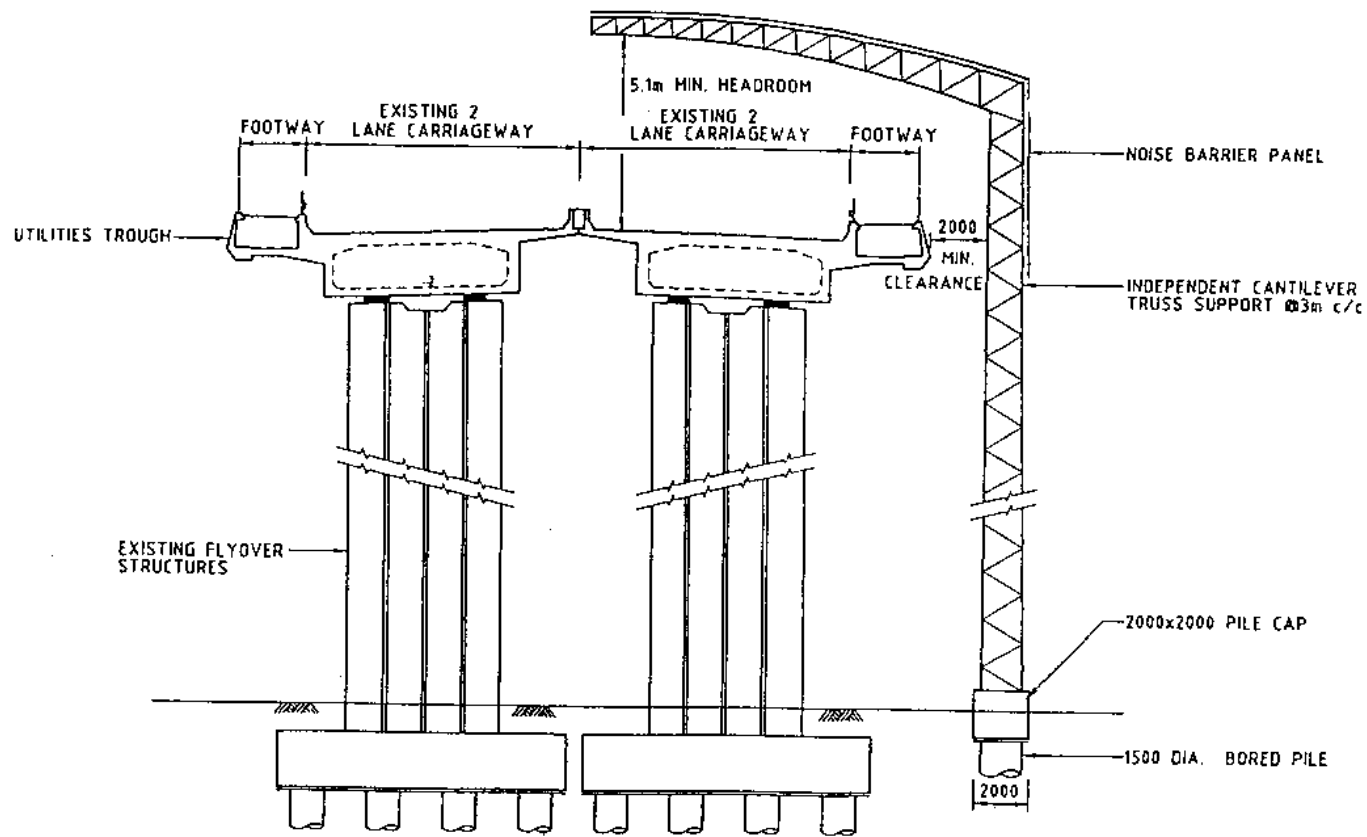
MAUNSELL




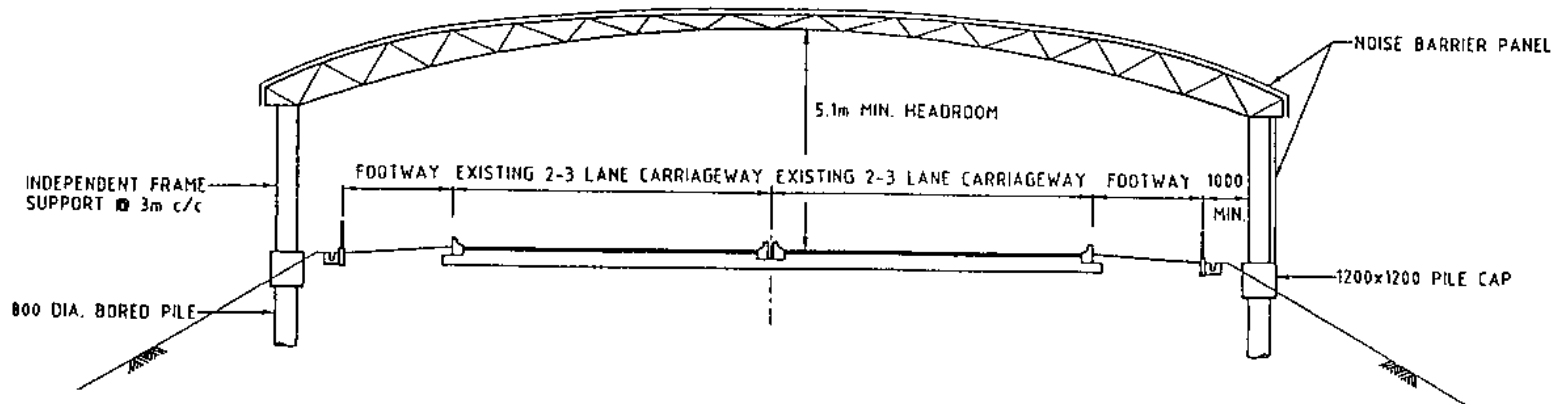
LEGEND
 PARTIAL ENCLOSURE


 ENVIRONMENTAL PROTECTION DEPARTMENT	
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS	
LOCATION OF PROPOSED PARTIAL ENCLOSURE (SHEET 2 OF 2)	
MAUNSELL CONSULTANTS ASIA LTD. 茂源(亞洲)工程顧問有限公司	
FIGURE NO. 圖號編碼	FIGURE 3-7
SCALE 比例尺	AS SHOWN

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NO.	REVISION	DATE	BY
 ENVIRONMENTAL PROTECTION DEPARTMENT			
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS			
CROSS-SECTION OF PARTIAL ENCLOSURE (TYPE I)			
MAHSELL CONSULTANTS ASIA LTD 馬塞爾工程顧問有限公司			
FIGURE NO. 圖號		FIGURE 3-8	
SCALE			



NO.	DATE	BY	CHECKED	DATE
 ENVIRONMENTAL PROTECTION DEPARTMENT				
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS				
CROSS-SECTION OF PARTIAL ENCLOSURE (TYPE 1)				
HAINSELL CONSULTANTS ASIA LTD 茂盛(亞洲)工程有限公司				
FIGURE NO 圖號 3-9				
SCALE				