Agreement No. CE 8/96

Retroactive Road Traffic Noise Mitigation Measures
Feasibility Study

Revised Final Report

August 1998

MAUNSELL CONSULTANTS ASIA LTD
in associated with
ENPAC Limited
HASSELL Limited
Consolidated Consulting Engineers Limited

Issue 1
August 1998

DOCUMENT DISTRIBUTION REGISTER

CLIENT NAME	Environmental Protection Department - Noise Management Policy Group	
PROJECT NAME	Feasibility Study for Providing Retroactive Road Traffic Noise	PROJECT No
SECTION		95796
DOCUMENT	Revised Final Report	DOCUMENT No
		95796/RFR
SUBJECT		DATE OF FIRST ISSUE
		24 August 1998

COPY No	ISSUE No	REGISTERED HOLDER	LOCATION
1 to 2	1	Mr K.S. Chan	EPD(NMP)
3	1	Mr W.H. She	EPD(AP)
4	1	Mr S.K. Leung	BD
5	1	Mr P.G.D. Whiteside	CED
6	1	Mr C.M. Chan	DSD, Mainland South
7	1	Mr W.Y. Tsoi	DSD, Mainland North
8	1	Mr K.K. Sin	TD/NTE
9	1	Mr W.M. Tang	TD/NTW
10	1	Mr Fan Chan	EMSD
11	1	Mr Y.W. Ng	FSD
12	1	Mr W.M. Chan	HyD, HK
13	1	Mr Felix Leung	HyD, NT/East
14	1	Mr Y.M. Lee	HyD, NT/West
15	1	Ms Judy Chung	HAD
16	1	Mr K.K. Cheung	HD
17	1	Miss Stella Ho	LD
18	1	Mr Edwin Young	Plan D
19	1	Mr O.S. Osbourn	HKPF, CSP Traffic
20	1	Mr P.M. Tse	TDD
21	1	Mr B.R. Edwards	TD, RSSD
22	1	Mr Freeman Lui	WSD, Mainland SE
23	1	Mr H.C. Cheung	WSD, Mainland NE
24	1	Mr K.O. Tsui	WSD, Mainland SW
25	1	Mr T.Y. Leung	WSD, Mainland NW
26	1	Mr C.W. Tse	USD
27	1	Mr C.Y. Choi	RSD
28	1	Mr Michael Lai	MCAL
29	1	Mr N.C. Cheung	MCAL
30	1	Mr Stephen Lai	MCAL

= Uncontrolled Copy

DOCUMENT DISTRIBUTION REGISTER

CLIENT NAME	Environmental Protection Department - Noise Management Policy Group	
PROJECT NAME	Feasibility Study for Providing Retroactive Road Traffic Noise	PROJECT No
SECTION		95796
DOCUMENT	Revised Final Report	DOCUMENT No
		95796/RFR
SUBJECT		DATE OF FIRST ISSUE
		24 August 1998

COPY No	ISSUE No	REGISTERED HOLDER	LOCATION
31	1	MCAL Library	MCAL
32	1	Dr H.F. Chan	ENPAC
33	1	Mr Peter Duncan	HASSELL

= Uncontrolled Copy

Agreement No. CE 8/96
Feasibility Study for Providing Retroactive Road Traffic Noise Mitigation Measures

CONTENTS

List of Tables

List of Figures

Figure 8.8 Chart 7 - Acoustic Effectiveness

List of Appendices

1

INTRODUCTION

1. INTRODUCTION

1.1. Background

1.1.1. The Second Review of the 1989 "White Paper: Pollution in Hong Kong -A time to act" has identified the need for a study to review the practicability of reducing the adverse effects of noise impacts due to traffic on existing roads in Hong Kong. A "Scoping Study for Providing Retroactive Road Traffic Noise Measures" study was commissioned in 1994 to define the scale of the traffic noise problems in the territory and to identify roads with potential for retroactive noise mitigation. The initial study is referred to in this Report as the " Scoping Study".

1.1.2. The "Scoping Study" was completed in 1995 and identified 22 road sections of 18 roads for stage 2 investigation (hereinafter called "study"). Subsequently Tolo Highway (Ma Liu Shui and Tai Po Kau) was included in its respective widening study and therefore was excluded for further investigation. The remaining 21 sections of road were consolidated into 16 study areas for further investigation.

1.2. The Assignment

1.2.1. Maunsell Consultants Asia Ltd. in association with Enpac Ltd and Hassell Ltd. were commissioned by the Environmental Protection Department (EPD) to perform the Study under Agreement No. CE 8/96 on 15th October 1996. The study is managed by the Noise Management and Policy Group (NMPG) within EPD.

1.2.2. An Inception Report (IR) which includes the approach, methodology, task definition, liaison and programme for the Study was issued in December 1996. The IR defines the scope of investigation, which is to provide a viable and sound engineering solution to the provision of direct technical remedies (DTR), such as barriers, enclosures etc., on existing roads in Hong Kong.

1.2.3. The engineering and design aspects of the recommended direct technical measures identified in the Scoping Study were reviewed. The costing and programming for the implementation of the proposed measures were also examined.

1.2.4. Sixteen sites were identified for investigation in this Study. Three of them including Island Eastern Corridor at Tai Koo Shing, Hiram's Highway at Sai Kung and Ting Kok Road at Tai Po were excluded from this Study because the noise in these three sites would be addressed in the major works projects currently programmed for implementation in the near future. These 13 sites are shown in Figure 7.1 and the respective road sections are listed as follows:-

Working Paper No.	Road Section	Location
2	Cheung Pei Shan Road	Tsuen Wan
2	Fung Shue Wo Road	Tsing Yi

Working Paper No.	Road Section	Location
2	Tung Tau Tsuen Road	Kowloon City
3	Yuen Wo Road	Sha Tin
3	Tai Chung Kui Road	Sha Tin
3	Che Kung Miu Road	Sha Tin
3	Che Kung Miu Road J/O Hung Mui Kuk Road	Sha Tin
3	Tin Sam Street	Sha Tin
3	Ma On Shan Road	Ma On Shan
4	Tseung Kwan O Road	Kwun Tong
4	Po Lam Road North and Po Hong Road	Tseun Kwan O
5	Tuen Mun Road (Tsuen Wan)	Tsuen Wan
5	Tuen Mun Road (Tsing Lung Tau)	Tsing Lung Tau
5	Tuen Mun Road (Tuen Mun)	Tuen Mun
5	Castle Peak Road (Ping Shan)	Ping Shan
5	Castle Peak Road (Hung Shui Kiu)	Hung Shui Kiu

1.2.5. The findings of this Study will form the basis for consideration of traffic noise mitigation on existing roads in different urban environments and for the formulation of strategies to tackle traffic noise from existing roads in Hong Kong.

1.3. Structure of the Report

1.3.1. Prior to the submission of this Report, six Working Papers have been issued.

Working Paper No. 1 reviews the recommendations of Scoping Study with particular attention to the 16 selected locations included in this Study.

Working Paper No. 2 describes the investigation for Cheung Pei Shan Road, Tung Tau Tsuen Road and Fung Shue Wo Road.

Working Paper No. 3 describes the investigation for Yuen Wo Road, Tai Chung Kiu Road, Che Kung Miu Road, Tin Sam Street, Hung Miu Kuk Road and Ma On Shan Road.

Working Paper No. 4 describes the noise impact from Tsung Kwan O Tunnel Road in East Kowloon and Po Lam Road North and Po Hong Road within Tseung Kwan O New Town. Possible direct noise mitigation measures were also addressed.

Working Paper No.5 studies sections of road along Tuen Mun Road and Castle Peak Road. The assessed locations include Sam Shing Hui, Tsuen Wan, Tsing Lung Tau, Hung Shui Kiu, and Ping Shan

Working Paper No. 6 studies the air quality impacts on identified road sections covered by working paper nos. 2 to 5 of this study.

1.3.2. This Report summarises, concludes and generalises the findings in the above Working Papers in four sections. Chapter 1 is an introduction of the Study. The contents included in the different sections are highlighted below:

1.3.3. Section I describes the formulation of Road Assessment Scheme in four chapters as below:

Chapter 2 highlights the general approach to retroactive noise mitigation

Chapter 3 summarises the development of screening criteria for providing retroactive mitigation measures.

Chapter 4 describes the scheme evaluation system.

Chapter 5 summarises the priority ranking system.

1.3.4. Section II focuses on the application of the road assessment scheme in two chapters:

Chapter 6 illustrates the application of screening criteria

Chapter 7 summarises the findings from the sections of road being investigated in this Study.

1.3.5. Section III includes Chapter 8, which proposes a set of simplified road assessment procedures to assist in addressing impact of traffic noise generated from existing roads.

1.3.6. Section IV includes Chapter 9, which concludes the findings from the Study and recommends ways to address existing road noise impact from ground level roads on affected developments.

2

GENERAL APPROACH TO RETROACTIVE NOISE MITIGATION

2. GENERAL APPROACH TO RETROACTIVE NOISE MITIGATION

2.1. Strategy

2.1.1. Given the thousands of existing roads in Hong Kong, it is necessary to establish a scheme for assessing the applicability of a particular road or road section for retroactive road traffic noise mitigation. Based on the Scoping Study of all existing roads in Hong Kong and the various constraints with mitigating the noise, the proposed mitigation strategy is:

(a) that the road must be "noisy" by reference to 70 dB(A) at the facade of a nominal or typical facade along the road.

(b) that the road must not interfere with or adversely affect street level commercial activities, fire fighting, emergency access, road safety, and structural integrity of the existing highway infrastructure

(c) that the proposed mitigation scheme must be acoustically effective and engineering sound, and this should be subject to a detailed engineering feasibility study

(d) that the mitigation scheme is in the form of (See Figures 2.3 to 2.17):
- plain barrier with a height up to 6m
- bend-top barrier with a vertical height up to 5m and a cantilever extending up to about 2m into the carriageway
- partial enclosure covering half of the carriageway.
- full enclosure covering both bounds of the carriageway

Figure 2.1 shows a flow chart for the consideration of road/road sections with potential for retroactive noise mitigation.

2.2. Engineering Feasibility

2.2.1. The engineering feasibility study comprises assessment of different mitigation options in terms of the:

- compliance with road safety requirements as stipulated in the Traffic Planning & Design Manual (TPDM)
- compliance with fire fighting and emergency access requirements of the Fire Services Department and other government departments
- conflict with pedestrian access
- conflict with existing utilities and services,
- conflict with existing structure
- acoustic effectiveness
- side effects, e.g. air quality, visual impact, fung shui, etc.

A ranking system has been established to weigh the various factors and the mitigation scheme with the highest score is recommended for implementation. In order to propose a program to the Government for implementation of similar mitigation schemes, a priority ranking system has also been established whereby these recommended schemes are assessed. The progress of the works is subject to the availability of funds and other government resources.

2.2.2. Figure 2.2 shows a flow chart for the establishment of a mitigation scheme and the priority of the scheme for implementation by the Government. Further details are described in Chapter 3.

3

DEVELOPMENT OF SCREENING CRITERIA

3. DEVELOPMENT OF SCREENING CRITERIA

3.1. Identification of the Problem

3.1.1. In order that a road is eligible for consideration for retroactive noise mitigation, it is necessary that the following criterion is met:

- Peak-hour noise level L_{10}(1-hour) at a nominal facade from the edge of the carriageway exceeds the HKPSG noise criteria, i.e. 70 dB(A) for domestic premises; and the above criteria follow directly from an analogy of the HKPSG criteria since currently no noise standard applies to existing sensitive receivers affected by road traffic noise.

3.2. Identification of Traffic Engineering and Road Safety Constraints

3.2.1. Noise barriers and enclosures should not be installed where they will present a hazard to road safety or reduce the degree of road safety in any respect. Wherever existing conditions allow, it is desirable to locate a noise barrier behind the footpath, verge, hard strip or hard shoulder of a carriageway. The actual position will vary with the width of verge, medium strip and/or hard shoulder.

3.2.2. Setback requirement of noise mitigation measures should be evaluated against road safety considerations. Special emphases on road alignment, sight stopping distance and visibility splays, are in turn functions of vehicle speed, acceleration and deceleration rates, horizontal and vertical alignments of road and driver behaviour. Due considerations should be given to situations like on and off-ramps, intersections, and intersecting roadways.

3.2.3. In general, barriers and partial enclosures may be placed at the back of footpath or verge along a straight section of road without impairment of the visibility. However, for a curved section with a speed limit of 70 kph, it is a requirement of the Transport Department that the barriers/partial enclosures must be so located to give a clear minimum visibility of 125m ahead. Similarly, a minimum sight distance of 70m must be maintained for a curve with a speed limit of 50kph. Therefore, additional setback would be required to maintain the required visibility

3.2.4. In addition, the proposed barrier structure should avoid conflict with existing street furniture, e.g. footbridge, fire hydrants, road signs, etc. If this is unavoidable, consideration should be given to either modifying the scheme to accommodate this furniture or relocating the existing furniture or a combination of both.

3.2.5. Proper selection of barrier and enclosure materials constitutes another important safety aspect. Metallic and transparent materials can produce headlight glare at certain incident angles. Materials that have low fire rating or produce toxic fumes in a fire should be avoided. Additionally, the screening structure should be carefully designed such that it will not be easily broken into splinters in a crash situation. Under certain circumstances, addition of a safety barrier may be desirable.

3.3. Identification of Fire Fighting and Emergency Access Constraints

3.3.1. In densely developed areas, maintenance of adequate emergency access becomes a crucial safety factor. The proposed mitigation scheme should not obstruct the egress of public vehicles in crises, and operation of fire engines, ambulances, police vehicles, cranes and other emergency vehicles, equipment or plant.

3.3.2. The Fire Services Department requires that no noise screening structures should be erected at positions such that:

(1) external rescue and fire fighting operation by means of ladders is rendered impossible;

(2) vehicular access to areas on both sides of a road is blocked; or

(3) emergency crossing to the opposite lane of a road is blocked,

(4) operation and maintenance of waterworks installation such as valves and fire hydrants

In this respect, restrictions on the setting out and dimensions of noise barriers or enclosures should be observed to minimise the safety implications.

3.4. Identification of Conflict with Existing Pedestrian Access and Street-Level Commercial Activities

3.4.1. The location of noise screening structures should not obstruct pedestrian flows or interfere with street-level business activities e.g. disruptions to kerbside parking, bus stopping, loading/unloading, vehicular access to buildings and commercial activities.

3.5. Identification of Conflict with Existing Utilities and Services

3.5.1. As the underground utilities (including sewers, and water pipes) and services (including power cables, telecommunication cables, and gas pipes) are usually very congested especially in some old districts, e.g. Tung Tau Tsuen Road, consideration should be given to diversion or re-provision of these existing utilities and services without significant impact on the livelihood of the surrounding developments.

3.5.2. The relevant authorities should be consulted for the likely impact, time and costs involved for the necessary diversion or re-provisioning of these utilities. In the event that diversion of these utilities becomes difficult, the scheme should be modified or abandoned as impractical.

3.5.3. In addition, the location of the barrier structure should avoid interfering with the existing road lighting and drainages. If this is unavoidable, these services may be relocated and/or diverted subject to satisfactory arrangement with Highways Department and Drainage Services Department.

3.6. Identification of Conflict with Existing Highway Structure

3.6.1. The foundation of a noise screening structure should be kept clear from the underground infrastructure. The foundation should be wholly outside any box culverts, major pipelines and lot boundaries. The clearance varies from 1m to 3m. This space requirement may not be met for roads running through urban areas because of the limited road space. It is also not often practical to anchor any barriers or enclosures on current highway structures, unless separate or independent structures could be provided.

3.7. Evaluation of Side-Effects

3.7.1 The proposed mitigation scheme should minimise side effects arising from the installation of the scheme. Possible side effects include:

- local air quality impact
- visual impact
- fung shui

3.8. Evaluation of Acoustic Effectiveness

3.8.1. In order to achieve a viable scheme, the proposed mitigation scheme should result in compliance with the HKPSG noise criteria at 50% or more of the exposed population. For high rise buildings, the scheme should ensure that the road traffic noise levels at over 50% of the exposed facades on any vertical section are reduced to below 70dB(A), L_{10} (1-hr). This is based on the understanding that the scheme may not be able to protect the upper floor receivers. On the other hand, for low-rise receivers, scattering or spreading out over a long stretch of the road, it is necessary that the proposed scheme should be able to reduce the overall traffic noise levels at over 50% of the exposed facades along the road section. This is based on the understand that while the upper floor receivers for low-rise buildings can be readily protected by relatively short barriers, the horizontal extent of the barriers should be able to protect at least half the buildings along the road. A noise impact assessment should be conducted to evaluate the acoustic effectiveness of the identified scheme for a particular road section considered for mitigation.

3.9. Evaluation of Social Impact

3.9.1 The proposed mitigation scheme should minimise social impacts on the community arising from the implementation of the scheme. Possible social impacts include:

- severance of two housing areas by the proposed measures
- creation of black spot for crime
- accumulation of debris and the associated odour and vermin problems

3.10. Public Consultation

3.10.1 The recommended scheme should be presented first to the relevant District Board(s) from deliberation. This is an important channel for communication with public and relevant comments from District Board(s) should be incorporated, where appropriate for the proposed scheme. The next stage is to gazette the mitigation measures and the associated utilities/drainage work and respond any objections from the public on the proposed scheme.

3.11. Assessment of Engineering Feasibility

3.11.1. Apart from the various aspects considered above, engineering feasibility for the provision of noise barrier proposals should aim to produce a safe and economical structure that requires minimal maintenance. In the restricted area, large spread footings may pose difficulties in many urban areas. Piling foundation often requires supporting the proposed barrier. Wind pressure is the determining factor in the design criteria for noise barriers. Minimising the foundation as far as possible is a realistic approach to many cases being examined in this study.

3.11.2. Structure form and the landscaping treatments are an important part of the consideration in the engineering feasibility.

4

DEVELOPMENT OF SCHEME EVALUATION SYSTEM

4. DEVELOPMENT OF SCHEME EVALUATION SYSTEM

4.1. Overview

4.1.1. Each identified mitigation option is subject to a comparative evaluation whereby the most optimum option for an identified road section is recommended for implementation, subject to the availability of funds and government resources. The analysis comprises evaluation of three main categories of attributes of the scheme as below:

4.2. Engineering Category

- Traffic engineering considerations
- Traffic management during construction
- Buildability
- Safety

4.3. Environmental Category

- Noise Impact
- Air Quality Impact
- Landscape Impact
- Visual Impact

4.4. Cost Category

- Cost-effectiveness

4.5. Weighting for Comparison of Schemes

4.5.1. Each attribute of the proposed mitigation scheme is given a weighting factor ranging from 0 to 10. This factor is multiplied by the score allotted to it based on professional judgement of a number of assessment criteria as described in Table 1 below. The total score is the sum of the scores allotted for individual attribute in three categories. The higher the score, the higher is the ranking of the scheme. In general, the scheme with the highest ranking is recommended for implementation. Details of the scoring system has been described in Working Paper No. 1.

Table 1 Weighting Factors and Assessment Criteria for Identified Attributes

Category	Attribute	Weighting Factor	Assessment Criteria	Number of Scores
Engineering	Traffic Engineering Consideration	8	No restriction	10
			Desirable minimum	8
			Absolute minimum	4
			Below absolute minimum	2
	Traffic Management During Construction	5	Require full road closure	2
			Require partial closure	4
			Require diversion of traffic but maintain original number of lanes	6
			Simple signing scheme without minor reduction in road width	8
			No traffic diversion required	10
	Buildability	7	Without diversion of utilities	10
			With minor diversion of utilities and simple foundation	8
			With minor utilities diversion and piling	6
			With major utilities diversion	4
			With major utilities diversion and complicated foundation	2
	Safety	7	Pedestrian safety	Two marks for each criterion
			Accessibility to emergency access	
			Fire fighting & rescue operation	
			Load/unloading activities	
			Bus stopping operation	
Environmental	Noise impact	10	Weigh in accordance with percentage of protected exposed facades after the installation of each option.	0 to 10
	Air Quality impact	6	Localized effects on air quality at pedestrian on ready dwellings:	
			• no effect	10
			• mild effect	6
			• adverse effect	2

Category	Attribute	Weighting Factor	Assessment Criteria	Number of Scores
	Landscape and Visual impact	6	Any potential impacts upon existing landscape or streetscape, and impacts to existing views from residential/public properties, or from footpaths and roads are classified as: • slight impact • moderate impact • severe impact	7 to 10 4 to 7 1 to 4
Cost	Cost-effectiveness	8	Weigh in accordance with the cost per dwellings protected by each option.	0 to 10
Total Score			Summation of score of each category	
Ranking			Based on the total score of each mitigation option	

5

DEVELOPMENT OF PRIORITY RANKING SYSTEM

5. DEVELOPMENT OF PRIORITY RANKING SYSTEM

5.1. Ranking based on Population Exposure

5.1.1. In order to optimise the utilisation of resources available and to implement the recommended mitigation schemes for the identified road sections in a manageable and efficient manner, it is necessary that the works should be prioritised. One possible ranking system is to prioritise the works in terms of the population exposure which may be defined as:

(a) Population Exposure = Σ (dB Exceedance of 70 dB(A) x No. of Dwellings), or

(b) Population Exposure = Total no. of dwellings where noise level exceed 70 dB(A)

Higher priority is given to the mitigation scheme which aims to protect more dwellings affected by road traffic noise according to definition (b) or to protect more dwellings adversely affected by road traffic noise according to definition (a).

The method described in (a) would provide a more rational result, as the top prioritised mitigation schemes would tend to protect more population and sites to achieve a higher reduction.

5.2. Ranking based on Cost-effectiveness

5.2.1. Alternatively, the recommended mitigation schemes for the identified road sections may be ranked in terms of cost-effectiveness of the schemes. Higher priority is given to the scheme with lower cost of construction per dwelling protected. In this assessment, the cost of construction should include all direct and indirect costs, i.e.

(a) costs of construction,

(b) costs for diversion of any affected utilities and services, road signs, and other street level furniture, and

(c) costs for land resumption

(d) costs of maintenance which is assumed to be a percentage of the capital cost.

The total number of dwellings protected by each scheme should include those where there would be at least a one dB(A) reduction of noise level as a result of implementing the scheme.

5.3. Recommended Ranking System

5.3.1. The first ranking system, i.e. based on population exposure, prioritises the mitigation schemes according to the severity and extent of the noise problem. Both noise levels and the number of dwellings being exposed to the noise are duly considered in such prioritisation. From the prospective of the District Boards and the public at large, this system is a more logical choice. From a technical prospective, it is also a right choice.

5.3.2. As an example, the programme for 'Noise Abatement in Schools' being implemented by the Education Department adopts this system to prioritise the noise insulation works for various schools being exposed to aircraft noise and road traffic noise. However, this system does not consider the cost effectiveness factor, and one may argue whether the money is well spent on a mitigation scheme although the scheme must be acoustically effective according to Section 3.8.

5.3.3. On the other hand, the second ranking system prioritises the mitigation scheme according to the cost of construction per dwelling protected. For a given funding arrangement, the above system has an obvious advantage because more dwellings would be protected and benefited by the mitigation schemes. However, this system ignores the severity of the problem and therefore may not address the concerns of those who are adversely affected by the road traffic noise. It may also give a wrong impression to the public that government is only concerned about the money in implementing the schemes.

5.3.4. The ultimate objective of the retroactive noise mitigation measures is to reduce the adverse effects of noise impacts due to traffic on existing roads. In due consideration of the pros and cons of the two systems, it is recommended that the first ranking system should be adopted.

6

APPLICATION OF SCREENING CRITERIA

6. APPLICATION OF SCREENING CRITERIA

6.1. Identification of "Noisy Roads"

6.1.1. The Scoping Study has examined over 740 existing at-grade roads across the territory. Over 90% of the roads are considered to be "noisy" and therefore are eligible for consideration for retroactive road traffic noise mitigation based on the definition in Section 2.1. A comprehensive list of these roads is contained in the Final Report of the Scoping Study.

6.2. Identification of Roads with Potential for Mitigation

6.2.1 Upon examination of the various engineering, environmental and safety factors, and taking into account the constraints and considerations likely to be encountered, 34 roads, mainly in New Towns are considered appropriate or with the potential for mitigation. A comprehensive list of these roads is contained again in the Final Report of the Scoping Study.

6.3. Identification of Road Sections with Potential for Noise Mitigation

6.3.1. Amongst these 34 identified roads, only 18 road sections have the potential for retroactive noise mitigation because of various constraints and factors, which are likely to limit the practical and effective application of direct technical remedies to these roads. All these factors are related to safety, structural integrity or public disruption. They are:

(1) obstruction to access for fire fighting or rescue operations;
(2) inadequacy of installation space;
(3) severe disturbance to public or business activities;
(4) significant structural impacts on existing road infrastructure;
(5) presence of multiple vehicular or pedestrian access; and
(6) problems association with visibility and road safety issues.

7

PRELIMINARY FEASIBILITY STUDY OF IDENTIFIED ROAD SECTIONS

7. PRELIMINARY FEASIBILITY STUDY OF IDENTIFIED ROAD SECTIONS

7.1. Cheung Pei Shan Road

7.1.1. Characteristics of Study Area

7.1.1.1. Cheung Pei Shan Road is a dual 2-lane carriageway linking Tsuen Kam Interchange and Wo Yi Hop Interchange. The land uses on both sides of the road are mainly residential development, which is sensitive to road traffic noise.

7.1.1.2. The residential developments include Cheung Shan and Shek Wai Kok Estate along the westbound carriageway. On the opposite side, the affected developments include villages of Sam Tung Uk, Hoi Pa Village on the elevated platforms.

7.1.1.3. The estate tower blocks vary from 22 to 28 storeys while the villages comprise 2- and 3-storey standard village houses.

7.1.2. Major Consideration and Constraints

7.1.2.1. In identifying noise mitigation measures, the following major underground structures have been taken into account. They include:

- a 17m (approx.) wide Tai Lek Ho Culvert running underneath Cheung Pei Shan Road fronting Shek Wai Kok Estate
- a 3.4m x 1.8m box culvert running underneath the middle-lane of westbound carriageway.
- Shek Wai Kok Road Underpass

7.1.2.2. Westbound footpath (2m to 2.5m wide) is fully occupied by existing utilities and underground services such as telephone cables, public lighting cable, CLP cables, etc.

7.1.2.3. Since Cheung Pei Shan Road is a heavily trafficked road, impacts on the existing traffic during the erection of mitigation measures will become a major constraint.

7.1.2.4. The westbound carriageway of Cheung Pei Shan Road fronting Tsui Shan House at Cheung Shan Estate is designated as EVA over a section of approximately 120 metres for both an Electric Sub-station and this estate block. This is based on the advice from Fire Services Department given in their letter with ref. (29) in FSD 4/130/94, dated 4th April 1997.

7.1.3. Recommendation

7.1.3.1. After undergoing a scheme evaluation analysis of two identified options the recommended mitigation measures for Cheung Pei Shan Road are:

- Combination of 3m plain barrier and cantilevered barrier - type A along the eastbound carriageway
- Partial enclosures - type G & A along westbound carriageway (See para. 7.1.3.3 and 7.1.3.4)

7.1.3.2. Further to comments given by Hong Kong Police Force (letter ref. (36) in LM(1/96) in CP/T/TMB 216/61 Pt.2 dated 16th March 1998 on Draft Final Report and the meeting held on 17th April 1998 in the presence of HKPF, EPD and the consultants, the recommended mitigation measures along the westbound carriageway (i.e. partial enclosures) have been further revised to provide sufficient access for operation of cranes from the opposite carriageway in the case of road accidents.

7.1.3.3 The recommended partial enclosures fronting Shek Lan House and Shek Kuk House of Shek Wai Kok Estate and Lok Shan House and Sau Shan House of Chung Shan Estate have been amended to cover the hard shoulder and slow lane of westbound carriageway only. Two additional emergency vehicle crush gates have also been proposed at the central divider along the down hill section of the westbound carriageway to provide access for emergency vehicles to enclosed section from the opposite carriageway in case of road accidents.

7.1.3.4 Confirmation has been given by Traffic Management Bureau in mid June 1998 that they have no further comments on the above amended noise mitigation measures at Cheung Pei Shan Road.

7.1.3.5 The number of dwellings to be protected and the direct construction cost for the recommended option are 1,171 and $121M respectively. This option provides 53% protection of the exposed facades and the estimated direct cost per dwelling for the implementation of this option is $103,000.

7.1.3.6 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 115-172 $\mu g/m^3$ and 129-192 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.2. Tung Tau Tsuen Road

7.2.1. Characteristics of Study Area

7.2.1.1. Tung Tau Tsuen Road is a dual 2-lane carriageway linking Sha Tin Pass Road and Junction Road. The land use on both sides of the road is a mix of residential, institutional and district open space in a typical urban setting. The noise sensitive receivers, which are directly exposed to road traffic noise are mainly residential blocks and a secondary school alongside the road.

7.2.1.2. Tung Tau Estate is located on the eastern side of the road. This is a medium-rise public housing estate of five 12-storey housing blocks situated along the road.

7.2.1.3. On the western side of the road, towards the end of Junction Road is Mei Tung Estate, which is a linear housing block of 12 storeys. To the north of the estate, situated on an elevated platform, is Pui Man Village, which comprises rows of single storey village houses. Also on the western side of the road is Lower Wong Tai Sin Estate. This is situated between Sha Tin Pass Road and Tai Shing Road and has housing blocks of 26 storeys.

7.2.2. Major Consideration and Constraints

7.2.2.1. The existing underground utilities and services along the footpath adjacent to both sides of the carriageway, include public light cables, telephone cables, salt water mains, CLP cables and gas mains. Most of the fresh water mains, a few of the salt water mains and the high tension CLP cables are laid underneath the carriageway. A number of cross road ducts exist for telephone cables, CLP cables and public light cables along the road. There are also storm water drains up to 1425ϕ and sewers up to 900ϕ underneath the carriageway and footpaths throughout the study area.

7.2.2.2. The existing utilities underneath the footpath along both carriageways are so congested that it is difficult to accommodate the foundations of the identified barriers along the footpath. Subsequently, substantial diversions of these utilities would be required.

7.2.2.3. The road runs through an old district with a typical urban setting (i.e. surrounded by high rise blocks). Many road junctions are found along the study area of Tung Tau Tsuen Road. The road itself is a busy bus route and consists of bus stops together with loading/unloading activities. The visibility of road users and highway clearance as stipulated in TPDM are the major constraints.

7.2.2.4. The impact on the existing traffic ducting from the construction of the noise mitigation measures along this heavily trafficked road is also another major consideration that must be taken into account in the identification of appropriate noise mitigation measures.

7.2.3. Recommendation

7.2.3.1. In terms of total score of the selection process, the identified option for Tung Tau Tuen Road are:

- Combination of cantilevered barrier - type A and B along northbound carriageway
- Cantilevered barrier - type B along southbound carriageway.

The number of dwellings to be protected and the direct construction costs for the recommended option are 752 and $45.8M respectively. This option provides 39% protection to the exposed façade. It is estimated to cost $61,000 per dwelling.

7.2.3.2. As pointed out by AC for T/Kowloon's letter ref. ( ) in KR 183/161-4 dated 14 May 1997, the identified barriers along the affected section of Tung Tau Tsuen Road would actually impose constraints on road safety for road users. Beside such low percentage of protection (less than 50%) for the exposed dwellings, a "Do Nothing Solution" is considered more appropriate for this section of road.

7.2.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 81-156 $\mu g/m^3$ and 86-145 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.3. Fung Shue Wo Road

7.3.1. Characteristics of the Study Area

7.3.1.1. Fung Shue Wo Road is a dual 2-lane carriageway linking Tam Kon Shan Interchange and Tsing Yi Heung Sze Wui Road Interchange. The land use on both sides of the road is mainly residential which is sensitive to road traffic noise from the road. A primary school, which is also noise sensitive, is situated adjacent to the road.

7.3.1.2. Tsing Yi Estate, located on the eastern side of the road, nearer to the Tam Kon Shan Interchange, is a high rise rental housing estate with housing blocks of 35 storeys high. Further to the south was Tsing Kin temporary housing area, which was cleared in 1997. Behind this area is Tsing Yi Garden, which has 25-storey tower blocks overlooking the road. To the western side of the road, there are three-storey village houses at San UK Tsuen, Tai Wong Ha Resite Village and Chung Mei Lo Uk Tsuen.

7.3.2. Major Consideration and Constraints

7.3.2.1. The existing underground utilities and services run along the adjacent footpath leading to Greenfield Garden. The affected utilities and services include telephone cables, a salt water main, a fresh water main, a high-tension CLP cable, a medium pressure gas main and a Cable TV cable. The utilities underneath the footpath adjacent to the opposite carriageway include a telephone cable, a fresh water main, a salt water main and high-tension CLP cables.

7.3.2.2. In spite of the above, the existing footpath together with the amenity strip is considered adequate to accommodate a noise barrier. However, diversion of utilities and underground services would be required, especially along the footpath adjacent to the near side carriageway.

7.3.2.3. Three existing footbridges are found across Fung Shue Wo Road and these will impose another constraint for the erection of barriers.

7.3.2.4. The visibility approaching the junction with Fung Shue Wo Road and for passengers and bus drivers at the existing bus bay is another major constraint for the erection of barriers.

7.3.3. Recommendation

7.3.3.1. After carrying out a scheme evaluation analysis of two identified options, the recommended mitigation measures are:

- Combination of 3m and 4m plain barrier alongside the far edge of northbound amenity strip
- Combination of cantilevered barrier - type A and type B alongside the far edge of southbound amenity strip and/or far edge of southbound footpath.

7.3.3.2. The number of dwellings to be protected and the direct construction costs for the recommended option are 787 and $25M. This option provides 84% protection to the exposed facades and it is estimated to cost $32,000 per dwelling.

7.3.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 78-134 $\mu g/m^3$ and 75-109 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.4. Yuen Wo Road

7.4.1. Characteristics of the Study Area

7.4.1.1. Yuen Wo Road is a dual 3-lane carriageway linking Sha Tin Rural Committee Road and Fo Tan Road. It is a major corridor to link Lek Yuen Estate and Wo Che Estate to the other parts of Sha Tin area. The road separates the recreational facilities such as the sports complex, swimming pool, sports ground etc. from high rise blocks at Lek Yuen/Wo Che Estates, which are sensitive to road traffic noise from Yuen Wo Road.

7.4.1.2. The residential developments include Hong Wo House and Hip Wo House of Wo Che Estate alongside the northbound carriageway.

7.4.2. Major Consideration and Constraints

7.4.2.1. The eastbound footpath fronting Hip Wo House is congested with underground services and utilities which make erection of foundation for any barrier structure along this footpath difficult.

7.4.2.2. The existing bus bay in front of Hip Wo House could be another major constraint since the sight line of passengers and bus drivers at bus bay would be much degraded after the erection of a barrier structure.

7.4.2.3. Existing pedestrian access such as ramp and stairs to Yuen Wo Road in front of Hip Wo House should not be blocked after the implementation of noise mitigation measures.

7.4.3. Recommendation

7.4.3.1. After carrying out a scheme evaluation analysis of three identified options, the recommended mitigation measures for Yuen Wo Road are:

- Cantilevered barrier - type B for protecting both Hong Wo House and Hip Wo House.

7.4.3.2. The number of dwellings to be protected and the direct construction costs for the recommended option are 261 and $10M, respectively. This option provides 73% protection to the exposed facades and it is estimated to cost $38,000 per dwelling.

7.4.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 83-158 $\mu g/m^3$ and 82-178 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.5. Tai Chung Kiu Road

7.5.1. Characteristics of the Study Area

7.5.1.1. Tai Chung Kiu Road is a dual 3-lane carriageway running along Shing Mun River and linking Shek Mun Interchange at Siu Lik Yuen and Lion Rock Tunnel Road. It also forms a major corridor to link both private and public residential estates such as City One Sha Tin, Belair Garden, Sha Kok Estate and Jat Min Cheun to other major distributors.

7.5.1.2. Noise sensitive receivers are mainly the high rise residential developments along the westbound footpath, which are directly exposed to road traffic noise from the road. The sections of Tai Chung Kui Road under investigation are in front of Yue Shing Court and also Ming Shun Lau and Ming Yiu Lau, both in Jat Min Chuen.

7.5.2. Major Consideration and Constraints

7.5.2.1. The westbound amenity strip fronting Yue Shing Court is occupied by a 1.8m drainage pipe together with few underground cables. Whilst the footpath fronting Jat Min Chuen is also occupied by underground services.

7.5.2.2. The major constraints that affect the erection of a noise barrier structure include,

- the existing subway together with its ramp across Tai Chung Kiu Road in front of Ming Yiu Lau,
- the existing pedestrian access to Jat Miu Chuen fronting Ming Yiu Lau and
- the existing 2.9m x 2.75m box culvert across Tai Chung Kiu Road adjacent Shing Yan House.

7.5.2.3. The visibility splays at the existing bus bay in front of Ming Yiu Lau should be taken into account in the erection of any noise barrier structure.

7.5.3. Recommendation

7.5.3.1. After carrying out a scheme evaluation of three identified options, the recommended mitigation measures for Tai Chung Kiu Road are:

- Cantilevered barrier - type B for protecting Ming Shun Lau, Ming Yiu Lau of Jat Min Chuen and Yue Shing Court along the eastbound carriageway.

7.5.3.2. The number of dwellings to be protected and the direct construction costs for the recommended option are 670 and $26M respectively. This option provides 50% protection to the exposed facades and it is estimated to cost $39,000 per dwelling.

7.5.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 83-158 $\mu g/m^3$ and 95-166 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.6. Ma On Shan Road

7.6.1. Characteristics of Study Area

7.6.1.1. Ma On Shan Road is a dual 2-lane carriageway with cycle tracks and amenities on both sides of the road. It forms a major corridor to link private and public residential estates such as Yiu On Estate, Heng On Estate, Sunshine City etc. to Shatin and Sai Kung. Noise sensitive receivers are mainly high rise blocks at Heng On and Yiu On Estate, along the eastbound footpath, which are directly exposed to road traffic noise.

7.6.1.2. The sections of Ma On Shan Road under investigation are in front of Heng Fung House, Heng Shan House, Heng Kong House, Yiu Shun House, Yiu Chung House, Yiu Yan House and Yiu Wing House.

7.6.2. Major Consideration and Constraints

7.6.2.1. Although the existing utilities and underground services are along the amenity strip fronting Yiu Wing House and alongside the slope in front of Heng On Estate, it is unlikely to create an insurmountable obstacle. The presence of the existing storm water drains, box culvert and drainage in the reserve zone could create problems and make it difficult to erect a noise barrier structure.

7.6.2.2. The existing 5m (approx.) wide EVA located in front of Heng Shun Road, subway with 7m (approx.) width across Ma On Shan Road are other major constraints for the development of noise mitigation measures.

7.6.2.3. The visibility splays at the junction of Ma On Shan Road and On Shan Lane would be affected in the event that one of the identified mitigation options is implemented. Changing the control to a signalised T-junction would be more appropriate if the scheme were adopted.

7.6.3. Recommendation

7.6.3.1. After carrying out a scheme evaluation analysis of three identified options, the recommended mitigation measures for Ma On Shan Road are:

- combination of 6m plain barrier and cantilevered barrier - type A and B along the eastbound carriageway.

7.6.3.2. The number of dwellings to be protected and the direct construction costs for the recommended option are 963 and $33M, respectively. This option provides 71% protection to the exposed facades and it is estimated to cost $34,000 per dwelling.

7.6.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 64-158 $\mu g/m^3$ and 73-137 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.7. Che Kung Miu Road

7.7.1. Characteristics of Study Area

7.7.1.1. Che Kung Miu Road is a dual three-lane road linking Hin Keng Estate and Tai Chung Kiu Road. There are trees planted along the amenity strips with bus bays provided at approximately 200 metre intervals. The land uses on both sides of the road are mainly high rise residential developments

7.7.1.2. The sections of Che Kung Miu Road under investigation are in front of Shek Yuk House and Shek Fai House of Chun Shek Estate. The estate is situated by the westbound carriageway.

7.7.2. Major Consideration and Constraints

7.7.2.1. These sections of Che Kung Miu Road have high quality landscape treatments on both sides of the dual carriageways, comprising tall avenue tree planting and a low ground cover verge.

7.7.2.2. The existing amenity strip and footpath along the westbound carriageway are fully occupied by utilities and underground services. Details include CLP 132KV cables together with the existing 3m x 2.5m twin box culvert running across Che Kung Miu Road adjacent to Shek Yuk House. These utilities and services are a crucial constraint for the erection of noise barrier structure.

7.7.2.3. The pedestrian access to Chun Shek Estate on the westbound footpath near Shek Yuk House should not be blocked after the implementation of noise mitigation measures. Moreover, the noise mitigation measures should not reduce the degree of road safety, by reducing the visibility and turning radius of the signalised T-junction of Che Kung Miu Road with Sha Tin Tau Road.

7.7.3. Recommendation

7.7.3.1. After carrying out a scheme evaluation analysis of two identified options, the ranking of cantilever barrier- type B along the westbound carriageway is higher than that of partial enclosure - type B. However, by considering the low noise attenuation of cantilevered barrier - type B (14%), option II (i.e. partial enclosure - type B) is recommended.

7.7.3.2. The number of dwellings to be protected and the cost for the recommended option are 228 and $30M, respectively. This option provides 53% protection of the exposed facades and the estimated direct cost per dwelling for the implementation of this option is $132,000.

7.7.3.3. An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 83-158 $\mu g/m^3$ and 102-168 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.8. Tin Sam Street

7.8.1. Characteristics of Study Area

7.8.1.1. Tin Sam Street is a dual 2-lane carriageway linking Tin Sam Village, Carado Garden and Lung Hang Estate to Che Kung Miu Road and Hung Mui Kuk Road with a cycle track and trees by the roadside. The land uses on both sides of the road are mainly residential developments, which are sensitive to road traffic noise. A primary and a secondary school, which are also sensitive to road traffic noise, are situated alongside the westbound carriageway of Tin Sam Street.

7.8.1.2. Lung Hang Estate, which is located to the south of Tin Sam Street is a high rise rental housing estate overlooking the road. To the north of Tin Sam Street there are low-rise village houses, Tin Sam Village and a high-rise building estate, Carado Garden.

7.8.2. Major Consideration and Constraints

7.8.2.1. A 2 x 1.6m and 2.5 x 1.8m box culvert and a twin 2.5 x 2m box culvert have been identified next to a block in Caradon Garden across Tin Sam Street.

7.8.2.2. A number of signalised road junctions are located within the Study area and they are Tin Sam Street J/O Hung Mui Kuk Road, Fu Kin Street, non-signalised junction and the main vehicle entrance of Lung Hang Estate. The identified barriers and enclosure should consider this constraint so that the visibility at these junctions can be maintained.

7.8.2.3. There is a subway across Tin Sam Street in front of block 6 at Carado Garden. It is in close proximity to the existing vehicular entrance of Lung Hang Estate from Tin Sam Street. These facilities are a constraint which must be considered in the development of noise mitigation measures.

7.8.3. Recommendation

7.8.3.1. After undergoing a scheme evaluation analysis of two identified options, the recommended mitigation measures for Tin Sam Street are:

- cantilevered barrier - type B along westbound carriageway
- partial enclosure - type A and B along eastbound carriageway

7.8.3.2. The number of dwellings to be protected and the direct construction cost for the identified option and 446 and $58M, respectively. This option provides 78% protection of the exposed facades and the estimated direct cost per dwelling for the implementation of this option is 130,500.

7.8.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 83-120 $\mu g/m^3$ and 77-122 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.9. Junction of Che Kung Miu Road and Hung Mui Kuk Road

7.9.1. Characteristics of Study Area

7.9.1.1. At this corner of Che Kung Miu Road, only the southern edges of the route are under assessment. This section runs through a landscape of urban/village character, with low-rise buildings and small shops set back from the road behind a wide footpath and a roadside amenity strip.

7.9.1.2. The signalised road junction was upgraded to a roundabout in 1997 and a footbridge system was constructed. The adjacent sites will be affected by a future flyover across the junction along Che Kung Miu Road and the Route 16 connections by 2005.

7.9.1.3. The traffic moving through this junction affects the residential developments at Tin Sam Village, south of the junction, and Sun Chui Estate, east of the junction.

7.9.2. Major Consideration and Constraints

7.9.2.1. The southbound footpath of Hung Mui Kuk Road is fully occupied by public light cables, telephone cables and gas mains.

7.9.2.2. A 3.5m x 3.5m 6 cell box culvert is running underneath Che Kung Miu Road fronting Tin Sam Village and this culvert is connected to branch culverts. A 1050mm diameter sewer also runs next to this culvert and adjacent to the westbound amenity strip of Che Kung Miu Road.

7.9.2.3. The existing signalised junction is being modified to a roundabout with a footbridge system. The alignment of the footbridges, realigned carriageway and bus bays dictate the choice and erection of noise barrier structure. As advised by Director of Territory Development (letter ref. ( ) in TDD 2/1/234 Pt. dated 15th May 1997, possible conflicts between the identified mitigation measures with the proposed road widening of Che Kung Miu Road under Che Kung Miu Road Flyover Project fronting Tin Sam Village would be resulted. Moreover, TIA and EIA for this project will be carried out separately, thus, no identified barrier for protecting Tin Sam Village along Che Kung Miu Road has been proposed.

7.9.3. Recommendation

7.9.3.1. After carrying out a scheme evaluation analysis for two identified options, the recommended mitigation measures for Che Kung Miu Road J/O Hung Mui Kuk Road are:

- combination of 3 to 6m plain barrier to shield the gaps between the ground level and the soffit of the east ramp;
- cantilevered barrier-type B and partial enclosure - type B alongside, southbound of Hung Mui Kuk Road to protect Sun Chui Estates;
- combination of 3 to 6m plain barrier to shield the gaps between the ground level and the soffit of the south ramp;
- 5m plain barrier alongside northbound of Hung Mui Kuk Road to protect Tin Sam Village.

7.9.3.2. The number of dwellings to be protected and the cost for the recommended option are 581 and $47M, respectively. This option provides 64% protection of the exposed facades and the estimated direct cost per dwelling for the implementation of this option is $81,000

7.9.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 101-139 $\mu g/m^3$ and 105-145 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.10. Tseung Kwan O Road

7.10.1. Characteristics of Study Area

7.10.1.1. Tseung Kwan O Road is a dual 3-lane carriageway linking Kwun Tong Bypass and Tseung Kwan O Tunnel. It is a heavily trafficked highway with high rise residential blocks overlooking the road from both sides.

7.10.1.2. The sensitive developments include Tsui Ping Estate (Blocks A to F), public rental housing at Lam Tin Estate (Blocks 4, 5, 7, 8 and 10), Hing Tin Estate (Yan Tin House, Mei Tin House and Choi Tin House) and Chung Hong House and Yee Hong House of Hong Wah Court.

7.10.2. Major Consideration and Constraints

7.10.2.1. The westbound (2-3m wide) footpath is fully occupied with utilities and underground services such as 10 nos. 11KV, 2 nos. 33KB CLP cables, telephone cables, public light cables, etc.

7.10.2.2. Two numbers of large diameter fresh water mains at 1400ϕ have been identified running along the central profile barrier, while 600ϕ water mains together with 5 nos. 11KV and 4 nos. 33KV CLP cables and public light cable have also been found running along the eastbound footpath. Since 2 nos. 1400ϕ fresh watermains are found running along the existing central profile barrier of the road section in question and these mains are essential for providing fresh water supply to Kowloon East area as Hong Kong Island as advised by CE/MSE, WSD's letter ref. (3) in WSD/MSE 1744/2003/96 Pt.3 dated 13th October 1997, thus, diversion of these mains for the accommodation of barrier foundation along the central profile barrier is highly undesirable.

7.10.2.3. A left-in-left-out junction with Kai Tin Road is located at westbound carriageway opposite Block A of Tsui Ping Estate. An EVA which is currently blocked by a crash barrier is also identified at eastbound carriageway adjacent to Block A of Tsui Ping Estate.

7.10.2.4. A sign gantry is located at the westbound carriageway fronting Hing Tin Commercial Centre.

7.10.2.5. About 15m of the westbound slow lane carriageway of Tseung Kwan O Road fronting Ma Yau Tong Salt Water Service Reservoir was designed for maintenance of this reservoir (i.e. loading/unloading activities).

7.10.3. Recommendation

7.10.3.1. After carrying out a scheme evaluation analysis for two identified options, the recommended mitigation measures for sections of Tseung Kwan O Road under investigation are:

- combination of partial enclosure and full enclosure spanning across both bounds of Tseung Kwan O Road for protecting Tsui Ping Estate and Lam Tin Estate; and
- Partial enclosure spanning across both bounds of Tseung Kwan O Road and covering the westbound carriageway of Tseung Kwan O Road with sufficient height to accommodate the existing sign gantry in front of Hing Tin Estate for protecting Hing Tin Estate and Hong Wah Court.

7.10.3.2. The number of dwellings to be protected and the direct construction cost for the identified option are 2,538 and $288M, respectively. This option provides 65% protection of the exposed facades and the estimated direct cost per dwelling for the implementation of this option is $114,000.

7.10.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 103-234 mg/m^3 and 124-272 mg/m^3, respectively. The recommended measures may have localized effects on the air quality. For a basketball field close to the eastern portal with the proposed full enclosure in place, the predicted 24-hour average RSP concentration may increase about 45%. As there is a substantial increase in RSP concentration due to the full enclosure further detailed assessment will be carried out in the detailed EIA Study. Nevertheless, under the current emission controls, the emission rates of the pollutants and hence the future RSP concentrations would be reduced with time in spite of the future increase in traffic flow.

7.10.3.4 Recommendations would also be made in the EIA Study for changing the basketball field to passive recreational uses or some other non-air sensitive uses to avoid any excessive air quality impact.

7.10.3.5 With regard to the air quality inside the proposed full enclosure, the maximum concentration of NO_2 under the worst case scenario is estimated to be 724 mg/m^3. The concentration has taken into account the contributions from vehicles inside the full enclosure of 210m long as well as the boundary concentrations. Against the EPD's guideline of maximum NO_2 concentration (i.e. 1,800 mg/m^3) inside the vehicle tunnel, the impact on the drivers inside the proposed full enclosure along Tseung Kwan O Road is considered minimal.

7.11. Po Lam Road North and Po Hong Road

7.11.1. Characteristics of Study Area

7.11.1.1. Po Lam Road North is a dual 2-lane carriageway adjacent to Po Lam Estate, Ying Ming Court, Yan Ming Court and King Lam Estate. It is a main distributor connecting these residential estates to other parts of Tseung Kwan O. Po Hong Road, which is a dual 2-lane carriageway running adjacent to Well On Garden and Finery Park, Links Po Lam Road North and Po Fung Road.

7.11.1.2. The sensitive developments include Po Lam Estate (Po Tak House and Po Yan House), Ying Ming Court (Ming Tat House, Ming Chi House and Ming On House), Yan Ming Court (Yan Kuk House, Yan Chung House and Yan Lan House), King Lam Estate (King Yu House, King Lui House, King Min House and King Nam House), Well On Garden and Finery Garden.

7.11.1.3. Po Chi House of Po Lam Estate is protected from the traffic noise along Po Lam Road North by Lok Sin Tong Lau Tak Primary School. Similarly Yan Mui House of Yan Ming Court is also protected by the existing commercial complex from the traffic noise along Po Lam Road North. King Yung House of King Lam Estate is located close to an existing roundabout where the sightline will be adversely affected by erection of barrier fronting this building, if any. In view of the above, they are excluded from the list of sensitive development in this Study.

7.11.1.4. The properties such as Well On Garden and Finery Garden along Po Hong Road are newly developed. The assessment has identified that these properties are all experiencing traffic noise level below 70 dB(A) L_{10}(1hour). No extra mitigation measures are therefore needed to be included on the existing Po Hong Road. With reference to Housing Department (letter ref. HD(P) 8/1/4/1 dated 28th January 1997) and Planning Department (letter ref. (9) in SS S/ENV/6II dated 3rd February 1997), Tseung Kwan O Temporary Housing Area (THA) has been planned for village type development. Temporary 4m plain barriers along the back of footpath adjacent to Po Lam Roads was identified for the protection of this THA. Should there be a need to extend the present THA for a long period, temporary plain barrier may be included as part of the measures proposed for Po Lam Road during the detailed design stage. Measures for the planned village type development should be excluded in this Study.

7.11.2. Major Consideration and Constraints

7.11.2.1. This section of road consists of three signalised junctions (i.e. Po Lam Road North J/O Po Hong Road; Po Lam Road North J/O Po Fung Road and Po Lam Road North J/O Yan King Road) and 4 nos. priority junctions (i.e. Po Lam Road North J/O entrance of Fire Station: Po Lam Road North J/O entrance to Po Lam Estate; Po Lam Road North J/O entrance to Ying Ming Court) and one left-in-left-out junction to King Lam Estate. Bus bays and loading/unloading bays have been identified along this road section.

7.11.2.2. This section of road lies within a suburban/rural fringe environment of good landscape and scenic value. Good quality avenue tree and shrub planting borders the roadside while a further shrub amenity strip separates the footpath and cycle-track creating a visually pleasing and high quality streetscape. The existing amenity strip (3-3.5m wide) is considered appropriate for erection of a noise barrier structure.

7.11.2.3. A 4m wide box culvert has been identified running underneath the westbound carriageway fronting Yan Kuk House and two numbers of 3.5m wide box culvert are running across Po Lam Road North to join the big box culvert running underneath Po Hong Road fronting Tseung Kwan O THA.

7.11.2.4. Subways are located across Po Lam Road together with an elevated walkway running across Po Lam Road North fronting Po Tak House.

7.11.3. Recommendation

7.11.3.1. After undergoing a scheme evaluation analysis of two identified options, the recommended mitigation measures for the section of Po Lam Road North and Po Hong Road North under investigation are:

- Combination of partial enclosures - type A and B for protecting Po Lam Estate;
- Cantilevered barrier - type B for protecting Yan Ming Court and King Lam Court
- Cantilevered barrier - type B for protecting Ying Ming Court

7.11.3.2. The number of dwelling to be protected and the direct construction cost for the identified option, 706, and $75M, respectively. This option provides 53% protection of the exposed facades and the estimated direct cost per dwelling for the implementation of this option is $106,000. Moreover, no mitigation along Po Hong Road is considered necessary as the unmitigated noise level of NSRs at Well On Garden and Finery Park Garden are found within noise requirement.

7.11.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 84-159 $\mu g/m^3$ and 83-149$\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.12. Tuen Mun Road (Tsuen Wan)

7.12.1. Characteristics of Study Area

7.12.1.1. Tuen Mun Road is a dual three lane expressway linking Tsuen Wan and Tuen Mun. It is a heavily trafficked highway with several high-rise residential blocks overlooking both sides of the expressway

7.12.1.2. The section of Tuen Mun Road under consideration is adjacent to Belvedere Garden and Greenview Court near Yau Kom Tau Village and is elevated above the coastal edge of Tsuen Wan. Sensitive developments include Belvedere Garden (Phase I and II), GreenView Court and Yau Kom Tau Village.

7.12.2. Major Consideration and Constraints

7.12.2.1. Two numbers of 900ϕ and three numbers of 1500ϕ culvert have been identified running across both directions of carriageway together with sized 250ϕ to 550ϕ U-channels and 250 J-channels running within the study area.

7.12.2.2. An elevated walkway spans Tuen Mun Road in front of Belvedere Garden Phase II area and laybys are located at Tuen Mun bound carriageway in front of Greenview Court.

7.12.2.3. An vehicular underpass runs across both bounds of Tuen Mun road next to Block 2 of Greenview Court. A sign gantry is located at Tsuen Wan bound of Tuen Mun Road fronting Yau Kom Tau Village.

7.12.2.4. This section of road consists of a large 'S-curve' in front of Yau Kom Tau Village, followed by a 420m straight road. Thus, sight stopping distance has been identified to be one of the major constraints in providing the noise mitigation works.

7.12.2.5. It was advised by Highways Department's letters ref. ( ) in HNT 602/TM/20, (63) in HYD MWPMO 52TH/GEN XV and (5) in HYD MWPMO 7052TH/GEN II dated 15th November 1996, 27th December 1996 and 5th August 1997, respectively that concrete profile barriers had been proposed to be erected alongside the slow lane of Tsuen Wan bound of Tuen Mun Road fronting Yau Kom Tau Village.

7.12.2.6. Since Tuen Mun Road is one of the most heavily trafficked expressways in Hong Kong, due consideration should be given to all likely impacts arising from the implementation of noise mitigation measures on this site.

7.12.2.7 Comments given by Hong Kong Police Force, Traffic Management Bureau (letter ref. (36) in LM (1/96) in CP/T/TMB 216/61 Pt.2 dated 16th March 1998 on the Draft Final Report stated they have serious reservations and strong objection to the reduced line of vision caused by the proposed erection of cantilevered and plain barriers on the dangerous downhill/uphill curved sections of Tuen Mun Road. Concerns at the safety of operation over this section of road during the emergency have also been expressed.

7.12.3. Recommendation

7.12.3.1. After undergoing a scheme evaluation analysis of two identified options and taking account of Hong Kong Police Force's comment, the recommended mitigation measures for Tuen Mun Road (Tuen Wan) excluding Yau Kom Tau Village as one of NSRs are:

- cantilevered barrier - type B for protecting Belvedere Garden, Greenview Court

7.12.3.2. The number of dwellings to be protected and the direct construction cost for the identified option are 1,540 and $55M, respectively. This option provides 77% protection of the exposed facades and the estimated direct cost per dwelling for the implementation of this option is $35,600.

7.12.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 134-285 $\mu g/m^3$ and 161-345 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.13. Tuen Mun Road (Tsing Lung Tau)

7.13.1. Characteristics of Study Area

7.13.1.1. Tuen Mun Road at Tsing Lung Tau is an expressway with dual three-lane carriageways linking Tsuen Wan and Tuen Mun. It is a heavily trafficked expressway with a few high-rise residential blocks, such as Hong Kong Garden, overlooking the road from the Tuen Mun bound side of the expressway.

7.13.1.2. The section of Tuen Mun Road under consideration is adjacent to Hong Kong Garden and is elevated above the coastal edge of Dragon Beach. Sensitive developments include Carmel Heights, Dominion Heights, Estoril Heights, Grenville Heights, Hoover Heights, Kingston Heights, Lincoln Heights, Manhattan Heights, Nelly Heights, Orchid Heights, Fontana Heights and Peony Heights of Hong Kong Garden.

7.13.2. Major Consideration and Constraints

7.13.2.1. Three culverts run across both bounds of carriageway within the study section. They are a 900ϕ culvert, a 2.0m x 2.0m box culvert and a 2.5m x 2.5m box culvert. Also running across the carriageway are 150mm to 550mm U-channels and 250mm J-channels and a drainage layer has been identified within the study area.

7.13.2.2. A subway which runs across both bounds of Tuen Mun Road is located in front of Peony Heights of Hong Kong Garden.

7.13.2.3. This section of road consists of a gentle bend in front of Fontana Heights of Hong Kong Garden, followed by a 433m straight road. Sufficient sight distance should be provided in the development of the proposed noise mitigation measures along this section of the road.

7.13.3. Recommendation

7.13.3.1. After carrying out a scheme evaluation analysis of two identified options, the recommended mitigation measures for Tuen Mun Road (Tsing Lung Tau) are:

- combination of 3m plain barrier and cantilevered barrier - type A for protecting Hong Kong Garden

7.13.3.2. The number of dwellings to be protected and the direct construction cost for the identified option are 339 and $17M, respectively. This option provides 90% protection of the exposed facades and the estimated direct cost per dwelling for the implementation of this option is $50,800.

7.13.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 97-209 $\mu g/m^3$ and 120-253 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.14. Tuen Mun Road (Sam Shing Hui)

7.14.1. Characteristics of Study Area

7.14.1.1. Tuen Mun Road at Sam Shing Hui is initially an expressway with dual three lanes carriageway linking Tsuen Wan and Tuen Mun. It is a heavily trafficked highway with a few high rise residential blocks such as Kam Fai Garden overlooking the road from the Tuen Mun bound side of the expressway.

7.14.1.2. As advised by Highways Department in their letter ref. () in HNT 602/TM/20 dated 15th November 1996, road widening works would be implemented along the Tsuen Wan bound of Yuen Mun Road fronting Kam Fai Garden. At the time of preparing this report, the improvement works have been completed and the street furniture such as public lighting and drains have been diverted along the new verge. The new Tsuen Wan bound carriageway consists of 4 traffic lanes

7.14.1.3. The section of Tuen Mun Road under consideration is fronting Kam Fai Garden. Sensitive developments include Block 1, Block 2 and Block 3 of Kam Fai Garden.

7.14.2. Major Consideration and Constraints

7.14.2.1. Apart from a sign gantry located at the Tuen Mun bound carriageway, no major constraints such as existing utilities and physical constraints are identified along this section of the road.

7.14.3. Recommendation

7.14.3.1. After undergoing a scheme evaluation analysis of two identified options, the recommended mitigation measures for Tuen Mun Road (Sam Shing Hui) are:-

- cantilevered barrier - type B for protecting Kam Fai Garden

7.14.3.2. The number of dwellings to be protected and the direct construction cost for the identified option area 100 and $14M, respectively. This option provides 56% protection of the exposed facades and the estimated direct cost per dwelling for the implementation of this option is $140,000.

7.14.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 90-146 $\mu g/m^3$ and 136-208 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.15. Castle Peak Road (Hung Shui Kiu)

7.15.1. Characteristics of Study Area

7.15.1.1. Castle Peak Road at Hung Shui Kiu is a dual three lane carriageway with Light Rail Transit (LRT) tracks running parallel to the road. Castle Peak Road is a busy distributor road running through an area of predominantly urban landscape with low to medium rise housing, small shops and commercial buildings on either side of the road.

7.15.1.2. The section of Castle Peak Road under consideration is fronting Parkview Garden.

7.15.1.3. It has been advised that an LRT reserve exists along this section of the road so that no mitigation measures should be proposed within this area.

7.15.2. Major Consideration and Constraints

7.15.2.1. The eastbound footpath fronting Parkview Garden is fully occupied with utilities and underground services such as water mains, CLP cable, telephone cables, etc.

7.15.2.2. The existing LRT reserve zone adjusted to the cycle-track fronting Parkview Garden should not be used for erection of any noise barrier structure.

7.15.2.3. Besides, drainage pipes of size 300ϕ, 375ϕ and 900ϕ, together with manholes have been identified running along the existing cycle track.

7.15.3. Recommendation

7.15.3.1. After undergoing a scheme evaluation analysis of two identified options, the recommended mitigation measures for Castle Peak Road (Hung Shui Kiu) are:

- 4m plain barrier for protecting Parkview Garden

7.15.3.2. The number of dwellings to be protected and direct construction cost for the identified option are 22 and 3.3M, respectively. This option provides 73% protection of the exposed facades and the estimated direct cost per dwelling for the implementation of this option is $150,000.

7.15.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 71-146 $\mu g/m^3$ and 91-138 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.16. Castle Peak Road (Ping Shan)

7.16.1. Characteristics of Study Area

7.16.1.1. Castle Peak Road at Ping Shan is similar to that at Hung Shui Kiu and is a dual three lane carriageway with Light Rail Transit (LRT) running parallel to the road. This section of Castle Peak Road is a distributor road with a medium to heavy traffic flow and runs through an area of predominantly suburban landscape, with low to medium rise housing on either sides of the road.

7.16.1.2. The section of Castle Peak Road under consideration is fronting Fui Sha Wai Village and houses adjacent to Ping Tong Street West and Ping Shan Lane.

7.16.2. Major Consideration and Constraints

7.16.2.1. As mentioned above, there is an LRT reserve along the road in which no mitigation measures should be proposed.

7.16.2.2. The westbound footpath fronting Fui Sha Wai Village and houses adjacent to Ping Tong Street West and Ping Shan Lane is fully occupied with utilities and underground services.

7.16.2.3. A 1 metre wide kerb separates the cycle track from the westbound carriageway of Castle Peak Road fronting Fui Sha Wai Village. The existing cycle track running next to the kerb separator is 4m wide.

7.16.2.4. The raising kerb running in front of the facades at Ping Shan Lane is 2m wide with no utilities and services underground.

7.16.2.5. The cycle track is occupied by a gas main and a water main of 300ϕ and 700ϕ/800ϕ, respectively underneath.

7.16.2.6. A minor road junction with the existing cycle track and footpath is situated adjacent to the facades of Fui Sha Wai Village. In addition, an elevated walkway runs across Castle Peak Road fronting Ping Shan Lane. In particular, comments given by AC for T/NT's letter ref. NR 182/160-1 dated 21st October 1997 advised that no sightline obstruction to motorists coming out from the access road of Fui Sha Wai should be imposed by the proposed mitigation measures.

7.16.3. Recommendation

7.16.3.1. After undergoing a scheme evaluation analysis of two identified options and taking account of comments given by AC for T/NT on the Draft Final report, the recommended mitigation measures for Castle Peak Road (Ping Shan) are:

- combination of 2m and cantilevered barrier - type C for protecting the residents at Fui Sha Wai, Ping Tong Street West and Ping Shan Lane

7.16.3.2. The number of dwellings to be protected and the direct construction cost for the identified option are 64 and $10M, respectively. This option provides 91% protection of the exposed facades and the estimated direct cost per dwelling for the implementation of this option is $162,600.

7.16.3.3 An air quality study of the road shows that prior to the implementation of the scheme, the average hourly NO_2 and RSP concentrations at the most exposed facades of the dwellings and schools would be in the range of 71-127 $\mu g/m^3$ and 88-133 $\mu g/m^3$, respectively. The recommended measures may have localized effects on the air quality. However, no significant degradation of the air quality at the exposed facades can be determined as a result of implementing the measures.

7.17. Environmental Gains and Losses Account

7.17.1 The recommended noise mitigation measures as stated above may generate either positive or negative effects on the environment in vicinity of the affected road section. Table 2 summarize the environmental gains and losses account of the study road sections in respect of its recommend noise mitigation scheme.

Table 2 Environmental Gains and Losses Account

Location	Environmental Loss	Environmental Gain	Mitigation Measures
Cheung Pei Shan Road	° visual intrusion to pedestrians ° creation of enclosed landscape character ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 53% of exposed facades can be protected in terms of noise attenuation ° screening of poor views for village and high-rise housing ° visual strengthening of route ° unifying landscape element within poor existing urban environment	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context
Fung Shue Wo Road	° visual intrusion due to replacement of streetscape and trees with noise barrier ° visual confinement of pedestrians and vehicles ° loss of good views to vegetated hillsides, Chung Mei Lo Uk and parkland ° landscape loss of trees and streetscape ° introduction of irregular landscape features ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 84% of exposed facades can be protected in terms of noise attenuation	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting
Yuen Wo Road	° screens views of lower level residents and users ° screens trees from pedestrians and vehicles ° introduction of irregular landscape feature ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 73% of exposed facades can be protected in terms of noise attenuation	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting
Tai Chung Kiu Road	° screening of estate boundary trees from pedestrians and vehicles ° replacement of soft roadside edge with hard urban elements ° conflict of barrier with other streetscape elements, e.g. bus stops ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 50% of exposed facades can be protected in terms of noise attenuation	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting

Location	Environmental Loss	Environmental Gain	Mitigation Measures
Ma On Shan Road	° major visual intrusion to pedestrians, cyclists and vehicular passengers adjacent to Yiu On Estate due to loss of trees and planting ° introduction of visually irregular elements along Yiu On Estate ° visual screening of trees to vehicular passengers adjacent to Heng On Estate ° landscape loss of trees and planting adjacent to Yiu On Estate ° introduction of hard landscape element along road ° may have localized effects on the air quality both with no significant degradation of air quality at the exposed facades	° 71% of exposed facades can be protected in terms of noise attenuation ° screening of traffic for high-rise residents	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting
Che Kung Miu Road	° minor visual impacts due to screening of vegetation to pedestrians ° may have localized effects on the air quality both with no significant degradation of air quality at the exposed facades	° 53% of exposed facades can be protected in terms of noise attenuation	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting
Tin Sam Street	° minor visual impacts due to screening of Carado Garden vegetation ° visual intrusion due to screening of vegetation introduction of hard edge to views of pedestrian and vehicular passengers adjacent to Lok Sam House and Wing Sam House ° landscape loss of trees and shrub planting adjacent to Lok Sam and Wing Sam Houses ° may have localized effects on the air quality both with no significant degradation of air quality at the exposed facades	° 78% of exposed facades can be protected in terms of noise attenuation	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting

Location	Environmental Loss	Environmental Gain	Mitigation Measures
Che Kung Miu Road J/O Hung Mui Kuk Road	° minor visual impacts due to loss of open views at lower levels for pedestrians residents and vehicular passengers ° minor landscape intrusion due to restriction of open nature of site ° introduction of hard element within amenity planting ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 64% of the exposed facades can be protected in terms of noise attenuation ° screening of traffic flows	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting
Tseung Kwan O Road	° visual intrusion to vehicular and pedestrians passengers due to enclosure ° landscape effect of introduction of hard urban enclosure elements along the roadside ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 65% of the exposed facades can be protected in terms of noise attenuation	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting ° change the basketball field to passive recreational uses or other non-air sensitive uses
Po Lam Road North	° visual intrusion due to tunnelling of views to pedestrians and vehicular passengers ° introduction of irregular landscape element to the open nature of study area and at base of vegetated slopes ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 53% of the exposed facades can be protected in terms of noise attenuation	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context
Tuen Mun Road, Sam Shing Hui	° intrusion due to shading of lower level apartments ° visual intrusion due to enclosure of views of vehicular passengers ° introduction of harsh vertical element to road ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 56% of the exposed facades can be protected in terms of noise attenuation ° screening of traffic flow ° physical boundary between housing and road	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting

Location	Environmental Loss	Environmental Gain	Mitigation Measures
Tuen Mun Road, Tsuen Wan	° visual intrusion due to screening of views up hillside of Ha Fa Shan from vehicular passengers and residents ° landscape loss of substantial roadside trees and vegetation ° introduction of major hard elements within transport corridor ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 77% of the exposed facades can be protected in terms of noise attenuation ° partial screening of traffic flows	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting
Tuen Mun Road, Tsing Lung Tau	° introduction of strong linear visual element screening views up the local hillside ° visual intrusion to vehicular passengers due to screening of vegetation ° landscape loss of substantial tree and shrub vegetation ° introduction of landscape barrier increasing segregation of upper and lower hillslopes ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 90% of the exposed facades can be protected in terms of noise attenuation ° screening of traffic flow for lower and middle level apartment	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting
Castle Peak Road, Hung Shui Kiu	° minor visual intrusion due to relatively short section of barrier ° introduction of additional hard element within the already harsh environment ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 73% of the exposed facades can be protected in terms of noise attenuation ° screen views of transport corridor from Parkview Garden ° introduction of landscape barrier between Parkview Garden and transport corridor	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context

Location	Environmental Loss	Environmental Gain	Mitigation Measures
Castle Peak Road , Ping Shan	° visual intrusion to pedestrians and cyclists due to enclosure on one side ° minor visual intrusion to housing due to remoteness and intermediate vegetative screening ° loss of visual interest to vehicular passengers ° introduction of dominant landscape elements along the roadside ° may have localized effects on the air quality but with no significant degradation of air quality at the exposed facades	° 91% of the exposed facades can be protected in terms of noise attenuation	° sensitive design of noise mitigation to integrate it within the existing visual and landscape context ° screen and amenity planting

Note: All the 13 study sites have an overall environmental gains after the implementation of these identified noise mitigation measures in terms of noise attenuation, air quality impact, visual and landscape impact, etc.

7.18 Preliminary Landscape and Townscape Design suitable for Submission to ACABAS

7.18.1 Preliminary landscape / townscape proposals have been outlined within the individual working papers and set out appropriate landscape measures to mitigate the visual and landscape impacts of the proposed noise barriers as identified in the Landscape and Visual Impact Assessments.

7.18.2 The working papers identify the fact that the major impacts, on the existing visual and landscape context will be from the introduction of the proposed noise barriers along each of the road sections. It is therefore important that the design of the noise barriers, together with the selection of the materials used in their construction, be considered carefully in order to reduce their visual impact.

7.18.3 As stated in the Inception Report it is proposed that a generic design for the noise mitigation measures be established for site-wide use throughout Hong Kong. This generic design would not only ensure the quality of all future noise barriers, but also reduce the visual clutter associated with individual schemes pursuing their own design solutions. Furthermore, the generic design would standardise all retroactive noise barriers ensuring a cost effective, easily maintainable and visual sensitive barrier which would provide continuity to Hong Kong road edges.

7.18.4 Based on this concept it is proposed that the ACABAS submissions be progressed in two stages. Firstly, to present and gain approval for the generic design approach for each of the barrier types. Secondly, to make separate individual submissions for each of the road sections. These individual submissions will be carried out during the detailed design stage to identify the exact alignment and type of noise barrier to be implemented along with any additional mitigation proposals, e.g. planting.

7.18.5 Generic Design Approach

7.18.5.1 As outlined above the generic design approach for the noise barriers proposes a standardised approach in the selection of finishes. The types of noise barriers which will be employed for noise mitigation purposes can be classified as follows, vertical (from 1m to 6m height), cantilevered, partial enclosure and full enclosure. The design finishes for each of these types are discussed below.

Vertical Noise Barriers (See Figures 7-19 and 7-20)

7.18.5.2 Two separate finishes, either absorptive or reflective are proposed for these barriers. Absorptive barriers will consist of a proprietary brand perforated anodised aluminium clad absorption panel system. All supports and frames will be painted with an anodised aluminium paint finish.

7.18.5.3 Reflective noise barriers will consist of a propriety brand transparent module units in an anodised aluminium frame. All supports will be painted with an anodised aluminium paint finish.

Cantilevered Noise Barrier (See Figures 7-21 and 7-22)

7.18.5.4 The finishing treatments for these noise barriers will be consistent with those identified for the vertical noise barriers above.

Partial Enclosure Noise Barriers (See Figure 7-23)

7.18.5.5 The finishing treatments for these noise barriers will be consistent with those identified for the vertical noise barriers above.

Full Enclosure Noise Barriers (See Figure 7-24)

7.18.5.6 The finishing treatments for these noise barriers will be consistent with those identified for the vertical noise barriers above.

7.19 Priority Ranking of the Recommended Schemes

7.19.1. Based on the priority ranking system as described in Chapter 5 of this report, the recommended schemes have been prioritised and summarized in terms of recommended noise mitigation measures and cost of these options. Table 3.1 presents the summary of these mitigation options, Table 3.2 presents the cost summary of these options and Table 3.3 shows priority ranking based on population exposure (ie. Z (dB exceedance of 70 dB(A) x no. of dwelling), has been proposed for implementation.

7.19.2 Apart from the capital cost estimation for the implementation of these recommended options, the recurrent consequence in terms of financial and staffing implication were also estimated based on the latest information such as annual unit maintenance and annual unit staff cost for noise barriers/enclosures obtained from Chief Highway Engineer/Structures, Highways Department. They are summarized in Table 2.1.

Table 2.1 Recurrent Financial and Staffing Implication

Location	Annual Maintenance Cost ($M/year)	Annual Staff Cost ($M/year)
Cheung Pei Shan Road	3.81	1.14
Fung Shue Wo Road	0.83	0.25
Yuen Wo Road	0.30	0.09
Tai Chung Kiu Road	0.73	0.22
Ma On Shan Road	1.03	0.31
Che Kung Miu Road	0.10	0.03
Tin Sam Street	1.84	0.55
Che Kung Miu Road J/O Hung Mui Kuk Road	1.40	0.42
Tseung Kwan O Road	7.41	2.22
Po Lam Road North	2.46	0.74
Tuen Mun Road, Tsuen Wan	1.59	0.48
Tuen Mun Road, Tsing Lung Tau	0.63	0.19
Tuen Mun Road, Sam Shing Hui	0.40	0.12
Castle Peak Road, Hung Shui Kiu	0.09	0.03
Castle Peak Road, Ping Shan	0.30	0.09

Table 3.1 Mitigation Summary Table

Location	Protected NSRS	No. of exposed dwellings	No. of dwelling protected	No. of dwelling benefited	Recommended noise mitigation measures	% of Protection
Cheung Pei Shan Road	a) Cheung Shan Estate- Sau Shan House and Lok Shan House b) Shek Wai Kok Estate- Shek Tsui House, Shek Kuk House, Shek Lan House and Shek To House c) Hoi Pa Village South d) Hoi Pa Resite Village e) Sam Tung Uk Resite Vilalge	2, 200	1, 171	1, 996	3M on footing - 127m 4.5C on footing- 607m PE(A) - 103m PE(G) - 555m	53
Fung Shue Wo Road	a) Tsing Yi Estate - Yee Yat House, Yee Yip House and Yee Kui House b) Tsing Yi Garden - Block 1 to 5 c) Chung Mei Lo Uk Village d) Tai Wong Ha Resite Village	936	787	812	3M on footing- 68m 4M on footing- 51m 4.5C on footing - 202m 4.5C on pile - 86m 5.5C on footing - 151m 5.5C on pile - 65m	84
Yuen Wo Road	a) Wo Che Estate - Hong Wo House and Hip Wo House	357	261	305	5.5C on pile - 110m 5.5C on footing - 75m	73
Tai Chung Kiu Road	a) Jat Min Chuen - Ming Shun Lau and Ming Yiu Lau b) Yue Shing Court	1, 340	670	793	5.5C on pile - 447m	50
Ma On Shan Road	a) Heng On Estate - Heng Fung House, Heng Shan House and Heng Kong House b) Yiu On Estate - Yiu Shun House, Yiu Chung House, Yiu Yee House and Yiu Wing House	1,355	963	1,143	6M on footing - 96m 4.5C on footing - 340m 5.5C on footing - 264m	71

Location	Protected NSRS	No. of exposed dwellings	No. of dwelling protected	No. of dwelling benefited	Recommended noise mitigation measures	% of Protection
Che Kung Miu Road	a) Chun Shek Estate - Shek Yuk House and Shek Fai House	428	228	408	PE(B) - 134m	53
Tin Sam Street	a) Lung Hang Estate - Wing Sam House and Lok Sam House b) Carado Garden - Block 4 to 6	573	446	514	5.5C on pile - 255m PE(A) - 80m PE(B) - 138m	78
Che Kung Miu Road J/O Hung Mui Kuk Road	a) Sun Chui Estate - Sun Ming House, Sun Yuet House and Sun Yee House b) Tin Sam Village	907	581	859	3M on footing - 20m 4M on footing - 28m 5M on footing - 28m 5M on pile - 45m 6M on footing - 35m 5.5C on pile - 60m PE(B) - 155m	64
Tseung Kwan O Road	a) Hong Wah Court - Chung Hong House and Yee Hong House b) Lam Tin Estate - Block 4,5,7,8 and 10 c) Tsui Ping Estate - Block A to F	3, 903	2,538	3,730	PE(C) - 96m PE(D) - 133m PE(E) - 311m PE(F) - 70m FE - 210m	65
Po Lam Road North	a) Po Lam Estate - Po Tak House and Po Yau House b) Ying Ming Court - Ming On House, Ming Chi House and Ming Tat House c) Yan Ming Court - Yan Chung House, Yan Kuk House and Yan Lan House d) King Lam Estate - King Yu House, King Lui House, King Min House and King Nam House	1, 334	706	746	5.5C on pile - 662m PE(A) - 142m PE(B) - 112m	53

Location	Protected NSRS	No. of exposed dwellings	No. of dwelling protected	No. of dwelling benefited	Recommended noise mitigation measures	% of Protection
Tuen Mun Road (Tsuen Wan)	a) Belvedere Garden- Block 1 to 3 and 5 to 9 b) Greenview Court - Block 2 and 3	2,006	1,540	1,879	5.5C on footing - 1,153m	77
Tuen Mun Road (Tsing Lung Tau)	a) Hong Kong Garden - Carmel Height, Dominion Height, Estoril Height, Fontana Height, Greenville Height, Hoover Height, Kingston Height, Lincoln Height, Manhattan Height, Welling Height, Orchid Height and Peony Height	377	339	373	3M on footing - 416.5m 3M on pile - 3.5m 4.5C on footing - 270m	90
Tuen Mun Road (Sam Shing Hui)	Kam Fai Garden - Block 1 to 3	180	100	180	5.5C on footing - 292m	56
Castle Peak Road (Hung Shui Kiu)	Parkview Garden	30	22	22	4M on pile - 110m	73
Castle Peak Road (Ping Shan)	a) Fui Sha Wai - village houses b) Ping Tong Street West - village houses c) Ping Shan Lane - village houses	70	64	70	2M on footing - 241m 4.5C on pile - 150m	91

Note 1:

2M - 2m plain barrier
3M - 3m plain barrier
4M - 4m plain barrier
5M - 5m plain barrier
6M - 6m plain barrier
4.5C - cantilevered barrier - type A
5.5C - cantilevered barrier - type B
PE(A) - partial enclosure - type A
PE(B) - partial enclosure - type B
PE(C) - partial enclosure - type C
PE(D) - partial enclosure - type D
PE(E) - partial enclosure - type E
PE(F) - partial enclosure - type F
PE(G) - partial enclosure - type G
FE - full enclosure

Table 3.2 Summary of Cost Estimates

Location	Direct Construction Cost	Indirect Construction Cost	Total Construction Cost	Total Cost/dwelling protected	Total Cost/dwelling Benefited
Cheung Pei Shan Road	$121M	$36.3M	$157.3M	$0.13M	$0.08M
Fung Shue Wo Road	$25M	$5M	$30M	$0.04M	$0.04M
Yuen Wo Road	$10M	$2M	$12M	$0.05M	$0.04M
Tai Chung Kiu Road	$26M	$5.2M	$31.2M	$0.05M	$0.04M
Ma On Shan Road	$33M	$6.6M	$39.6M	$0.04M	$0.03M
Che Kung Miu Road	$30M	$6M	$36M	$0.16M	$0.09M
Tin Sam Street	$58M	$11.6M	$69.6M	$0.16M	$0.14M
J/O Che Kung Miu Road and Hung Mui Kuk Road	$47M	$9.4M	$56.4M	$0.10M	$0.07M
Tseung Kwan O Road	$288M	$57.6M	$345.6M	$0.14M	$0.09M
Po Lam Road North	$75M	$15M	$90M	$0.13M	$0.12M
Tuen Mun Road (Tsuen Wan)	$55M	$16.5M	$71.5M	$0.05M	$0.04M
Tuen Mun Road (Tsing Lung Tau)	$17M	$5.1M	$22.1M	$0.07M	$0.06M
Tuen Mun Road (Sam Shing Hui)	$14M	$4.2M	$18.2M	$0.18M	$0.10M
Castle Peak Road (Hung Shui Kiu)	$3.3M	$0.7M	$4M	$0.18M	$0.18M
Castle Peak Road (Ping Shan)	$10M	$2M	$12M	$0.19M	$0.17M

Note 1: Cost of construction includes the followings:

(a) direct construction cost (capital cost);
(b) indirect construction cost includes cost for utilities, street furniture and traffic diversion (assuming 30% of the capital cost for major diversion, 20% of the capital cost for medium diversion, 10% of the capital cost for minor diversion); and
(c) unit construction cost at December 96 prices for each type of barriers/enclosures per metre are :

2m plain barrier on footing - $12,300
3m plain barrier on footing - $16,700
4m plain barrier on footing - $23,600
4m plain barrier on pile - $29,700
5m plain barrier on footing - $31,000
5m plain barrier on pile - $39,200
6m plain barrier on footing - $42,000
cantilevered barrier - type A on footing - $37,000
cantilevered barrier - type A on pile - $49,600
cantilevered barrier - type B on footing - $47,500
cantilevered barrier - type B on pile - $59,200
partial enclosure - type A on pile - $150,200
partial enclosure - type B on pile - $225,200
partial enclosure - type C on pile - $185,900
partial enclosure - type D on pile - $266,100

partial enclosure - type E on pile - $ 345,100
partial enclosure - type F on pile - $401,600
partial enclosure - type G on pile - $142,700
full enclosure on pile - $474,000

Note 2: No resumption on private land is considered necessary for the implementation of the recommended option at each study site.

Note 3: Land resumption on "semi-government land" for erection of the recommended option fronting Jat Min Chuen at Tai Chung Kiu Road is considered necessary.

Table 3.3 Priority of Mitigation

Priority Ranking	Location	Total No. of dwellings exposed	Sum of Exposure Levels (priority criterion)	Recommended noise mitigation measures	Total Cost
1	Cheung Pei Shan Road	2,200	19,094	3M, 4.5C, PE(A) & PE(G)	$157.3M
2	Tseung Kwan O Road	3,903	18,228.5	PE(C), PE(D), PE(E), PE(F) & FE	$345.6M
3	Tuen Mun Road (Tsuen Wan)	2,006	9,839	5.5C	$71.5M
4	Tai Chung Kiu Road	1,340	4,338.6	5.5C	$31.2M
5	Po Lam Road North	1,334	3,243	5.5C, PE(A) & PE(B)	$90M
6	J/O Che Kung Miu Road and Hung Mui Kuk Road	907	2,972.5	3M, 4M, 5M, 6M, 5.5C & PE(B)	$56.4M
7	Ma On Shan Road	1,355	2,732.5	6M, 4.5C & 5.5C	$39.6M
8	Che Kung Miu Road	428	2,156	PE(B)	$36M
9	Fung Shue Wo Road	936	1,976	3M, 4M, 4.5C & 5.5C	$30M
10	Tuen Mun Road (Sam Shing Hui)	180	1,698	5.5C	$18.2M
11	Tin Sam Street	573	1,677.5	5.5C, PE(A) & PE(B)	$69.6M
12	Yuen Wo Road	357	1,283.5	5.5C	$12M
13	Tuen Mun Road (Tsing Lung Tau)	377	1,249.5	3M & 4.5C	$22.1M
14	Castle Peak Road (Ping Shan)	70	213	2M & 4.5C	$12M
15	Castle Peak Road (Hung Shui Kiu)	30	141	4M	$4M

Note 1:

2M - 2m plain barrier
3M - 3m plain barrier
4M - 4m plain barrier
5M - 5m plain barrier
6M - 6m plain barrier
4.5C - cantilevered barrier - type A
5.5C - cantilevered barrier - type B
PE(A) - partial enclosure - type A
PE(B) - partial enclosure - type B
PE(C) - partial enclosure - type C
PE(D) - partial enclosure - type D
PE(E) - partial enclosure - type E
PE(F) - partial enclosure - type F
PE(G) - partial enclosure - type G
FE - full enclosure

Note 2: Exposure Level = Σ(Mean Exceedance x No. of Dwellings)

8

DEVELOPMENT OF WORKING TOOLS FOR ROAD ASSESSMENT

8. DEVELOPMENT OF WORKING TOOLS FOR ROAD ASSESSMENT

8.1. Overview

8.1.1. On completion of a detailed investigation of "13 sites of noisy road" over the territory, it becomes clear that the feasibility of mitigating noise from existing roads is critically dependent on the local site constraints and the type of sensitive developments to be protected. While it is desirable to undertake a detailed feasibility study as outlined in Section II to identify all these site constraints for direct noise mitigation of an existing at-grade it is useful to adopt simplified procedures for initial assessment, since the study usually takes time to complete. To this end, a working tool has been developed to enable an assessor such as the EPD to carry out a desk-top study to assess if the required mitigation is at all feasible before the mitigation is subject to a detailed feasibility study.

8.1.2. This working tool involves a set of simple assessment procedures, which require no complicated modelling and lengthy calculations. The assessor is guided systematically through these procedures to identify and classify the problem and, where appropriate, to recommend further investigation.

8.1.3. The simplified assessment procedures are illustrated in seven flow charts which cover the following aspects of the investigation :

- identification of problems at the subject site,
- selection of a barrier form for the identified problems,
- implication of the identified barrier form on the provision of existing emergency access and fire fighting requirements,
- implication of the identified barrier form on road safety, pedestrian and vehicular movements,
- social implication and severance to commercial activities,
- availability of space, amenity and land for the likely barrier provision,
- checking of the acoustic effectiveness and possible engineering feasibility.

The procedures are summarised in the form of flow charts and the basis for the procedures are described in subsequent sections.

8.1.4. This set of assessment procedures is not meant to replace the formal procedures as outlined in Section II but as a quick working tool to identify whether the existing noise problem can be mitigated by means of noise barriers or not. If the assessment is positive, a preliminary engineering feasibility study should then be carried out to confirm the viability of the proposal. An overview of the simplified procedures is shown in Figure 8.1. Figures 8.2 to 8.8 show the details of Chart 1 to Chart 7. The applicability of these procedures to the "13 sites of noisy road" is illustrated in Appendix A.

8.2. Identification of Problems

8.2.1. Problem identification procedures are given in Chart 1. The identification is based on the number of lanes (L) and the distance of the subject road from the affected facade (D). Appendix B gives the technical basis for the formulation of Chart 1.

8.2.2. The number of lanes in a road gives an indication of the likely volume of traffic using the road. In general, a single two-lane carriageway carries 800 vehicles per hour in two directions while a four-lane single carriageway or a dual two-lane carriageway carries 2,400 to 2,800 vehicles per hour in one direction. This is a simplified approach to define the range of basic noise level generated from the subject road, although the vehicle composition, geometry of the road and speed of traffic also determine the noise level.

8.2.3. As a quick screening process, these factors can be ignored. Distance is also a useful parameter to assist the identification. If the road is identified as a possible noisy road, the next step should be to identify the form of noise barrier for the particular site conditions and the type of sensitive receivers and, furthermore, the chance of providing such barrier in an effective manner. If the subject road is not found to be a noisy road, no immediate noise mitigation measures should be applied.

8.3. Selection of Barrier Form

8.3.1. When a road has been identified as noisy, the next step is to review the site conditions and determine the form of noise barrier to mitigate the noise impact on the affected buildings. Plain vertical noise barriers would be effective to protect receivers up to about 5th floor. For receivers in the mid floor range, i.e. from 5th to 10th floor, a bend top barrier would normally be required. The receivers at floors above 10th would need semi-enclosures to be installed on the subject road. Chart 2 provides a quick procedure to assist the assessor to identify the likely form of barrier on the subject site. Appendix C gives the technical basis for formulation of Chart 2.

8.4. Emergency Access Consideration

8.4.1. Provision of noise barriers may often create an obstruction between the carriageway and the affected development. No provision is made for any noise barrier at the emergency vehicle access (EVA) for fire fighting and emergency vehicles.

8.4.2. For fire fighting, it is essential that the affected facades should be within reach of the fire engines. As a rule of thumb, the maximum unobstructed distance between the fire engine and the farther-most facade should be less than 10 meters. If this is not achievable, the barrier option should be considered as not practical unless alternative arrangement can be identified. Alternatively, the scheme should be modified to comply with the emergency access requirement.

8.5. Road Safety Considerations

8.5.1. Chart 4 focuses on the road safety aspects, which cover the basic traffic engineering requirements, stipulated in the TPDM. A detailed investigation would involve the measurements of visibility splays and speed of traffic. As a quick assessment, Chart 4 has been designed to provide a step-by-step procedure to identify a suitable scheme which duly considers all likely implication of the scheme to road safety and pedestrian and vehicle access.

8.5.2. Provision of a noise barrier close to an existing junction could obstruct the visibility splays of the junction and would violate the principle of "Seeing and be seen". Installation of a barrier along a bend on road could also obstruct the sight line for safe stopping should there be a stationary object on the carriageway.

8.5.3. The proposed noise barrier may often intercept existing pedestrian and vehicular access at the carriageway. Junction visibility requirements would need to be observed and the scheme would need to be modified accordingly.

8.6. Socio-Economic Considerations

8.6.1. Apart from the above road safety requirements, the provision of a noise barrier may interfere with street level commercial activities, and cause social severance, e.g. severing two housing areas or obstructing pedestrian flows/crossings. Street level commercial activities include all shops, restaurants, cinemas etc. There is no way to determine the level of interference from a given barrier in an objective manner. Where a barrier obstructs totally a commercial entity from the right of way on the opposite side of the road is considered objectionable unless some form of compensation is provided to the owner of the entity. Chart 5 provides quick checking on whether the proposed barrier scheme would cause any of the above social problems. If this is the case, the scheme should be modified before adopting it for the identified problem.

8.7. Land Availability

8.7.1. Having established the possibility of providing a barrier to mitigate the noise impact, the available space on site for construction of the proposed noise barrier should be identified prior to carrying out a preliminary engineering feasibility study. This is to confirm the land requirements for the installation of the proposed barrier. Chart 6 provides a quick process to identify the minimum space required for installation of the proposed barrier.

8.8. Acoustic Effectiveness

8.8.1. When no insurmountable obstacle appears to exist in the first six rounds of quick assessment, the next and the final step should be the checking of the acoustic effectiveness of the noise barrier. In order that the scheme is effective and viable, the proposed scheme should achieve more than 50% of protection in terms of meeting the HKPSG noise guideline for the affected properties. If the proposed scheme satisfies this criterion, it should be recommended for a preliminary engineering feasibility study.

8.8.2. Table 4 gives the minimum distance required for a particular form of noise barrier to provide a shadow zone for at least 50% of the exposed facades.

Table 4 Minimum Distance between Road Kerb and Receiver to Achieve 50% Noise Protection

Form of Barrier	Vertical Height of Barrier (m)	Max. No. of Floors (1)	Minimum Distance, (m) (2)
Plain Barrier	3	5	20
		10	39
		15	57
	4	5	14
		10	27
		15	40
	5	5	9
		10	20
		15	30
Canti levered Barrier	5.6 (Type A)	10	14
		15	20
		20	29
	6.4 (Type B)	10	11
		15	17
		20	23

Note:
1. Refers to the height of buildings that can be protected.
2. Distance is measured from road kerb to facade.

8.8.3. In order to achieve the required effectiveness, the proposed extent of the horizontal noise mitigation measures must aim to reduce the angle of view to those exposed facades by 70% or more. At least 50% of the exposed facades would be protected from the proposed mitigation measures and thus noise levels at the protected facades will at least be reduced by 5 dB(A).

8.8.4. The above simplified procedures can only be used to estimate compliance with the HKPSG noise limit subject to the volume of traffic, percentage of heavy vehicles, speed and other geometric factors are required in order to determine the noise level and therefore the compliance.

8.8.5. The items that need to be addressed in the preliminary engineering feasibility are listed in Chart 7.

9

IMPLEMENTATION STRATEGY

9. IMPLEMENTATION STRATEGY

9.1. Overview

9.1.1. The identified retroactive noise mitigation measures can be grouped into a number of packages for implementation purposes. The grouping may be based on the priority ranking as identified in the study. Works within the same jurisdiction with similar priority ranking should be grouped in the same package for administrative convenience. Based on the above consideration and according to resources/timing requirements, these identified retroactive noise mitigation measures are further prioritised into various phases as shown on Table 5.

9.1.2. The key statutory, administrative and consultative steps, staffing and process for the implementation of the identified measures are briefly highlighted in this section.

9.2. Key Statutory, Administrative and Consultative Steps

9.2.1. Status Process

9.2.1.1. The project needs to be gazette under the Roads (Works, Use and Compensation) Ordinance. The timing for the gazette procedures is shown in the project programme that includes allowance for ExCo papers submission under the Ordinance.

9.2.2. Administrative Steps

9.2.2.1. The project will be subdivided into packages based on the priority rating and jurisdiction. (See Table 5) The key administrative steps for each of the packages are highlighted as follows,

- Approval of Preliminary Project Feasibility Study (PPFS) Report
- Public Works Programme upgrading procedures including the earmarking of funds for the projects in the **Central Works Reserve Fund Resources Allocation Exercise (CWRF RAE)** and subsequent upgrading of projects to Category A for construction to proceed,
- Submission to District Lands Conference, as required for transplantation and felling of trees,
- Submission of Clearance Application Form to Land Department,
- Gazette for tender.

9.2.3. Consultation

9.2.3.1. The parties need to be consulted for the proposed packages include:

- The relevant District Boards,
- Advisory Council for Environment,
- Advisory Committee on Appearance of Bridges and Associated Structures,
- Various relevant government departments and offices.

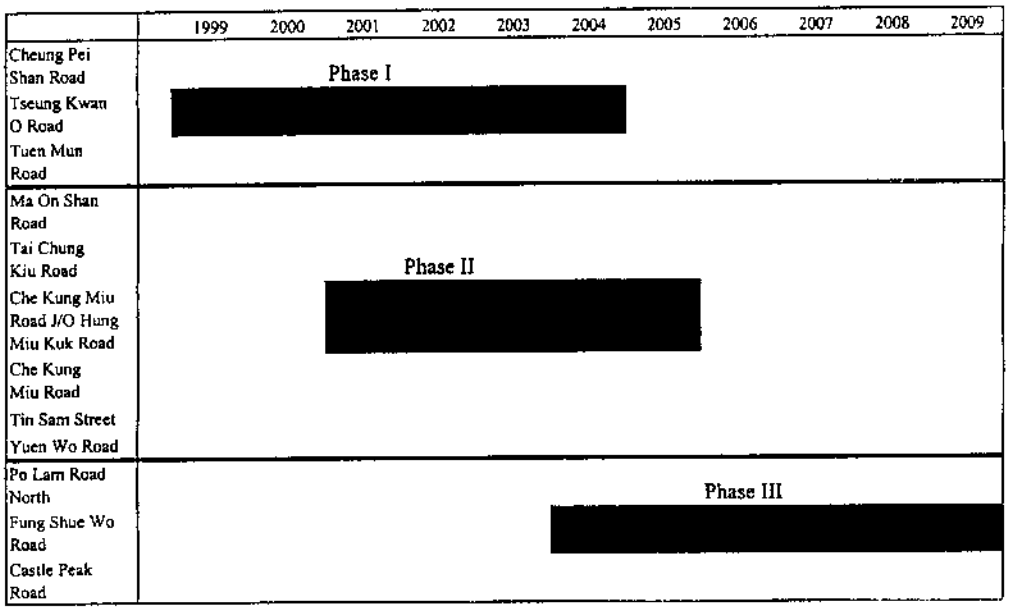
9.3. Staffing

9.3.1. Government In-house Staff verse Consultants

9.3.1.1. The provision of identified mitigation measures is a multidisciplinary project that input from civil, traffic, structural, geo-technical, environmental engineering disciplines, and landscaping.

9.3.1.2. The desirable target for completion of all the identified measures would be within a 10 year period which takes account of the process for resources allocation exercises, design and construction of the various packages. An outlined implementation programme of the proposed measures for the various section of roads are indicated in the following programme.

Proposed Outlined Implementation Programme



9.3.1.3. The engagement of consultants to carry out the detailed design for the various packages and the subsequent supervision of construction works would be desirable. The reasons are:

- provide specialist expertise in a multidisciplinary approach for delivery of the packages,
- provide extra staff to supplement the existing government in-house staff resources for the delivery of packages within the target period.

9.3.1.4. The Environmental Protection Department would monitor the functional design of the mitigation measures. The works department, Highways Department, would manage the consultants for supervising the works.

9.4. Funding for Consultants

9.4.1. Detailed design and supervision of the construction for the defined packages would be via an agreement with the selected consultants. The fees for site investigation, design and contract stage would be funded under a Block Vote. At the construction stage, the consultants fees and the resident site staff costs would be paid under the Project Vote.

9.5. Process

9.5.1. Contract Options

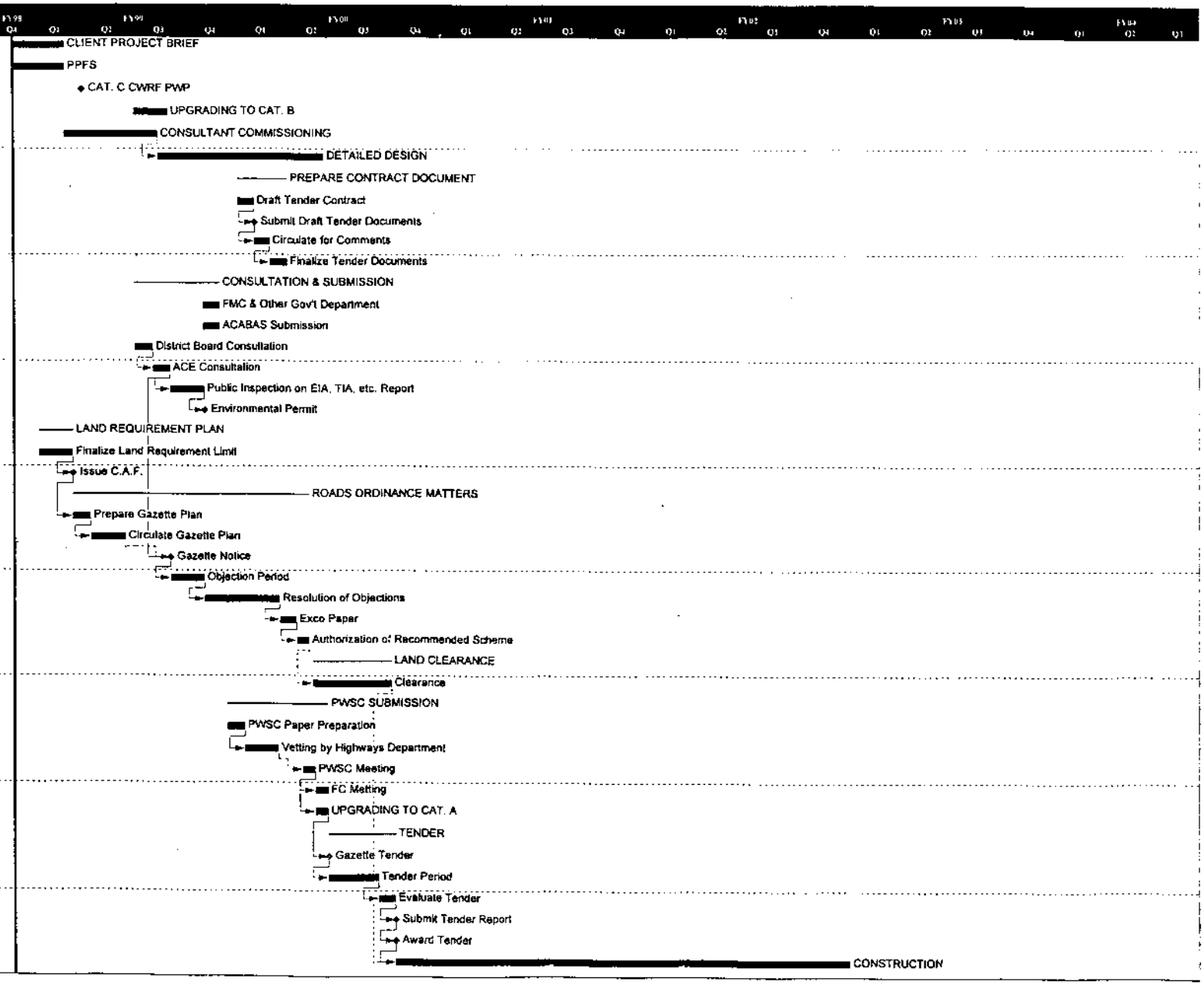
9.5.1.1. There is no need to take advantage of the design and build contracts because there would be adequate lead time for detailed design and tender documentation. Lump sum contract with bills of quantities should be adopted in line with the current government policy.

9.5.1.2. Contractual provision for extension of time due to inclement weather should be included. The contract options should be further reviewed at the detailed design stage to take account of any possible changes to the conditions that may arise.

FEASIBILITY STUDY FOR ROAD TRAFFIC NOISE MITIGATION MEASURES

TYPICAL PROJECT PROGRAMME

Act ID	Description	Orig Dur
1000	CLIENT PROJECT BRIEF	90d
1010	PPFS	90d
1020	CAT. C CWRF PWP	0
1030	UPGRADING TO CAT. B	62d
1040	CONSULTANT COMMISSIONING	163d
1050	DETAILED DESIGN	295d
1060	PREPARE CONTRACT DOCUMENT	90d *
1070	Draft Tender Contract	31d
1080	Submit Draft Tender Documents	0
1090	Circulate for Comments	28d
1100	Finalize Tender Documents	31d
1110	CONSULTATION & SUBMISSION	151d *
1120	FMC & Other Gov't Department	30d
1130	ACABAS Submission	30d
1140	District Board Consultation	31d
1150	ACE Consultation	31d
1160	Public Inspection on EIA, TIA, etc. Report	61d
1170	Environmental Permit	0
1180	LAND REQUIREMENT PLAN	59d *
1190	Finalize Land Requirement Limit	59d
1200	Issue C.A.F.	0
1210	ROADS ORDINANCE MATTERS	417d *
1220	Prepare Gazette Plan	31d
1230	Circulate Gazette Plan	61d
1240	Gazette Notice	0
1250	Objection Period	61d
1255	Resolution of Objections	134d
1260	Exco Paper	30d
1270	Authorization of Recommended Scheme	22d
1280	LAND CLEARANCE	139d *
1290	Clearance	139d
1300	PWSC SUBMISSION	179d *
1310	PWSC Paper Preparation	30d
1320	Vetting by Highways Department	61d
1330	PWSC Meeting	22d
1340	FC Metting	23d
1350	UPGRADING TO CAT. A	23d
1360	TENDER	118d *
1370	Gazette Tender	0
1380	Tender Period	88d
1390	Evaluate Tender	30d
1400	Submit Tender Report	0
1410	Award Tender	0
1420	CONSTRUCTION	807d



Early bar
Progress bar
Summary bar
Progress point
Summary point
Start milestone point

Table 5 **Project Implementation Table**

Phasing	Location		Protected NSRs	No. of exposed dwelling	No. of dwelling protected	No. of dwelling benefited	% of Protection	Total Cost	Total Cost/dwelling protected	Total Cost/dwelling benefited	Sum of Exposure Level 1 (priority Criterion)	Recommend noise mitigation measure
	Cheung Pei Shan Road		a) Cheung Shan Estate - Sau Shan House and Lok Shan House b) Shek Wai Kok Estate - Shek Tsui House, Shek Kuk House, Shek Lan House and Shek To House c) Hoi Pa Village South d) Hoi Pa Resite Village e) Sam Tung Uk Resite Vilalge	2,200	1,171	1,996	53	$157.3M	$0.13M	$0.08M	19,094	3M on footing- 127m 4.5C on footing - 607m PE(A) - 103m PE(G) - 555m
	Tseung Kwan O Road		a) Hong Wah Court - Chung Hong House and Yee Hong House b) Lam Tin Estate - Block 4,5,7,8 and 10 c) Tsui Ping Estate - Block A to F	3, 903	2,538	3,730	65	$345.6M	$0.14M	$0.09M	18,228.5	PE(C) - 96m PE(D) - 133m PE(E) - 311m PE(F) - 70m FE - 210m
I	Tuen Mun Road	Tsuen Wan	a) Belvedere Garden - Block 1 to 3 and 5 to 9 b) Greenview Court - Block 2 and 3	2,006	1,540	1,879	77	$71.5M	$0.05M	$0.04M	9,839	5.5C on footing - 1,153m
		Tsing Lung Tau	a) Hong Kong Garden - Carmel Height, Dominion Height, Estoril Height, Fontana Height, Greenville Height, Hoover Height, Kingston Height, Lincoln Height, Manhattan Height, Welling Height, Orchid Height and Peony Height	377	339	373	90	$22.1M	$0.07M	$0.06M	1,249.5	3M on footing - 416.5m 3M on pile - 3.5m 4.5C on footing - 270m
		Sam Shing Hui	a) Kam Fai Garden - Block 1 to 3	180	100	180	56	$18.2M	$0.18M	$0.10M	1,698	5.5C on footing - 292m
II	Ma On Shan Road		a) Heng On Estate - Heng Fung House, Heng Shan House and Heng Kong House b) Yiu On Estate - Yiu Shun House, Yiu Chung House, Yiu Yee House and Yiu Wing House	1,355	963	1,143	71	$39.6M	$0.04M	$0.03M	2,732.5	6M on footing - 96m 4.5C on footing - 340m 5.5C on footing - 264m
	Tai Chung Kiu Road		a) Jat Miu Chuen - Ming Shun Lau and Ming Yiu Lau b) Yue Shing Court	1, 340	670	793	50	$31.2M	$0.05M	$0.04M	4,338.6	5.5C on pile - 447m
	Che Kung Miu Road J/O Hung Mui Kuk Road		a) Sun Chui Estate - Sun Ming House, Sun Yuet House and Sun Yee House b) Tin Sam Village	907	581	859	64	$56.4M	$0.10M	$0.07M	2,972.5	3M on footing - 20m 4M on footing - 28m 5M on footing - 28m 5M on pile - 45m 6M on footing - 35m 5.5C on pile - 60m PE(B) - 155m

Phasing		Location	Protected NSRs	No. of exposed dwelling	No. of dwelling protected	No. of dwelling benefited	% of Protection	Total Cost	Total Cost/dwelling protected	Total Cost/dwelling benefited	Sum of Exposure Level 1 (priority Criterion)	Recommend noise mitigation measure
II	Che Kung Miu Road		a) Chun Shek Estate - Shek Yuk House and Shek Fai House	428	228	408	53	$36M	$0.16M	$0.09M	2,156	PE(B) - 134m
	Tin Sam Street		a) Lung Hang Estate - Wing Sam house and Lok Sam House b) Carado Garden - Block 4 to 6	573	446	514	78	$69.6M	$0.16M	$0.14M	1,677.5	5.5C on pile - 255m PE(A) - 80m PE(B) - 138m
	Yuen Wo Road		a) Wo Che Estate - Hong Wo House and Hip Wo House	357	261	305	73	$12M	$0.05M	$0.04M	1,283.5	5.5C on pile - 110m 5.5C on footing - 7.5
III	Po Lam Road North		a) Po Lam Estate - Po Tak House and Po Yau House b) Ying Ming Court - Ming On House, Ming Chi House and Ming Tat House c) Yan Ming Court - Yan Chung House, Yan Kuk House and Yan Lan House d) King Lam Estate - King Yu House, King Lui House, King Min House and King Nam House	1,334	706	746	53	$90M	$0.13M	$0.12M	3,243	5.5C on pile - 662m PE(A) - 142m PE(B) - 112m
	Fung Shue Wo Road		a) Tsing Yi Estate - Yee Yat House, Yee Yip House and Yee Kui House b) Tsing Yi Garden - Block 1 to 5 c) Chung Mei Lo Uk Village d) Tai Wong Ha Resite Village	936	787	812	84	$30M	$0.04M	$0.04M	1,976	3M on footing - 68 4M on footing - 51 4.5C on footing - 20 5.5C on footing - 15 5.5C on pile - 65m
	Castle Peak Road	Ping Shan	a) Fui Sha Wai - village houses b) Ping Tong Street West - village houses c) Ping Shan Lane - village houses	70	64	70	91	$12M	$0.19M	$0.17M	213	2M on footing - 241 4.5C on pile - 150m
	Castle Peak Road	Hung Shui Kiu	a) Parkview Garden	30	22	22	73	$4M	$0.18M	$0.18M	141	4M on pile - 110m

10

CONCLUSIONS AND RECOMMENDATIONS

10. CONCLUSIONS AND RECOMMENDATIONS

10.1. Summary of Findings

The above study has shown that the sixteen identified roads under investigation may be classified into four main categories: (a) expressway/trunk roads, (b) primary distributors in rural environment, (c) roads in new town environment and (d) roads in old district environment, in accordance with their characteristic and the local environment.

10.1.1. Expressway/Trunk Road Environment

10.1.1.1. The study sections of Tuen Mun Road, Cheung Pei Shan Road and Tseung Kwan O Road are subject to a limit of 70kph and possess the following characteristic:

- almost no conflict with existing utilities along expressway
- almost no conflict with existing EVA, road junction along expressway
- no conflict with pedestrian movement along expressway
- high quality requirement for visibility along expressway and truck road
- severe constraints in traffic diversion during the construction of noise mitigation measures.

10.1.2. Rural Primary Distribution

10.1.2.1. The study sections of Castle Peak Road at Hung Shui Kiu and Ping Shan are typical primary distributors in rural environment with site specific features such as adjacent LRT reserve. These road sections are subject to a limit of 50kph and possess the following characteristic:

- heavy traffic with fairly good alignment
- always with many minor road junctions
- with suburban environment in the vicinity
- mainly with low-rise developments such as villages and small houses

10.1.3. Roads in new town environment

10.1.3.1. The study sections of Yuen Wo Road, Tai Chung Kiu Road, Ma On Shan Road, Tin Sam Street, Che Kung Miu Road, Che Kung Miu Road J/O Hung Mui Kuk Road, Fung Shue Wo Road, Po Lam Road and Po Hong Road are typical roads in new town environment and possess the following characteristic and features:

- always with a combination of fairly wide amenity area, footpath and cycle track adjacent to the carriageway
- almost with proper planned road layout and less noise sensitive developments nearby
- almost with no severe constraints on land availability
- comparatively less road side commercial activities

10.1.4. Roads in Old District Environment

10.1.4.1. The study section of Tung Tau Tsuen Road is a typical road in old district environment possessing the following features and characteristic :

- severe land constraint
- always with poor sightline and sub-standard traffic arrangement
- existence of EVA to the affected facades, road junctions, pedestrian crossing, bus stopping, loading/unloading activities and road side commercial activities

10.2. Conclusions

10.2.1. The Study has examined 13 selected locations recommended by the "Scoping Study". A preliminary engineering feasibility study together with a detailed Noise Impact Assessment has been carried out for each of these locations, representing four categories of roads, namely expressway, primary distributors, roads in new towns and in existing old urban area.

10.2.2. Each location has different environment setting and different traffic noise problems. Likewise, the approach to the proposed mitigation measures is also different. The major differences are briefly summarized in the following:

- **Expressway/trunk roads environment** is represented by Tuen Mun Road(Route 2), Cheung Pei Shan Road(Route 5) and Tseung Kwan O Road(Route 6). Major characteristics are no major conflicts with kerb side activities, EVA or junctions, higher standards for road safety requirements in terms of visibility but with severe constraints traffic diversion for construction and maintaining the proposed barriers. The noise impact can usually be mitigated by plain vertical barriers, bend top barriers and enclosures.

- **Rural primary distributors environment** is represented by the sections of Castle Peak Road at Hung Shui Kiu, and Ping Shan. The road alignments are generally with higher standards. Traffic volumes are relatively high and heavy conflicts with side roads at junctions. With the suburban environment, the adjacent developments are generally low or medium rise buildings. Most of the problems could be overcome by simple vertical noise barrier.

- **New Town environment** is represented by those roads in Sha Tin, Ma On Shan, Tsing Yi and Tseung Kwan O. The towns are generally well planned. Retroactive measures mainly focus on areas where there was no planning for road traffic noise in the early years. In general, there is more space available or opportunity for the installation of vertical noise barriers by making use of amenity strips, footpaths and cycle tracks. Roadside activities are less than most of the urban areas.

- **Existing old urban environment** is represented by the road section of Tung Tau Tsuen Road. Limited land is available for possible noise barrier installation and conflicts with underground utilities are common. As a result, there is limit scope for providing any noise barriers to mitigate the affected properties. The other characteristics of the old urban areas are the high levels of roadside activities and ground level commercial developments, which would prohibit the provision of noise barriers along the road side.

10.2.3. The Study has developed detailed assessment procedures to investigate any roads which may be considered as noisy. These procedures cover aspects of engineering feasibility, environmental impact and visual impact. A detailed assessment should only be conducted after a preliminary screening of the road. A set of simplified working tools has been developed to assist the government in identifying potential for retroactive mitigation measures.

10.2.4. Based on the proposed ranking system and the recommended options for the 13 sites, a priority ranking has been established for consideration by the government.

10.3. Recommendations

10.3.1. A set of simplified assessment procedures is recommended for use as a working tool to enable an assessor such as EPD to perform a desk-top study without going through lengthy calculations to determine whether the required mitigation is at all feasible before committing to a detailed feasibility study.

10.3.2. Should there be a need to proceed with the detailed feasibility study, the procedures detailed in the flow chart in Section I provide appropriate guidelines for conducting the assessment.

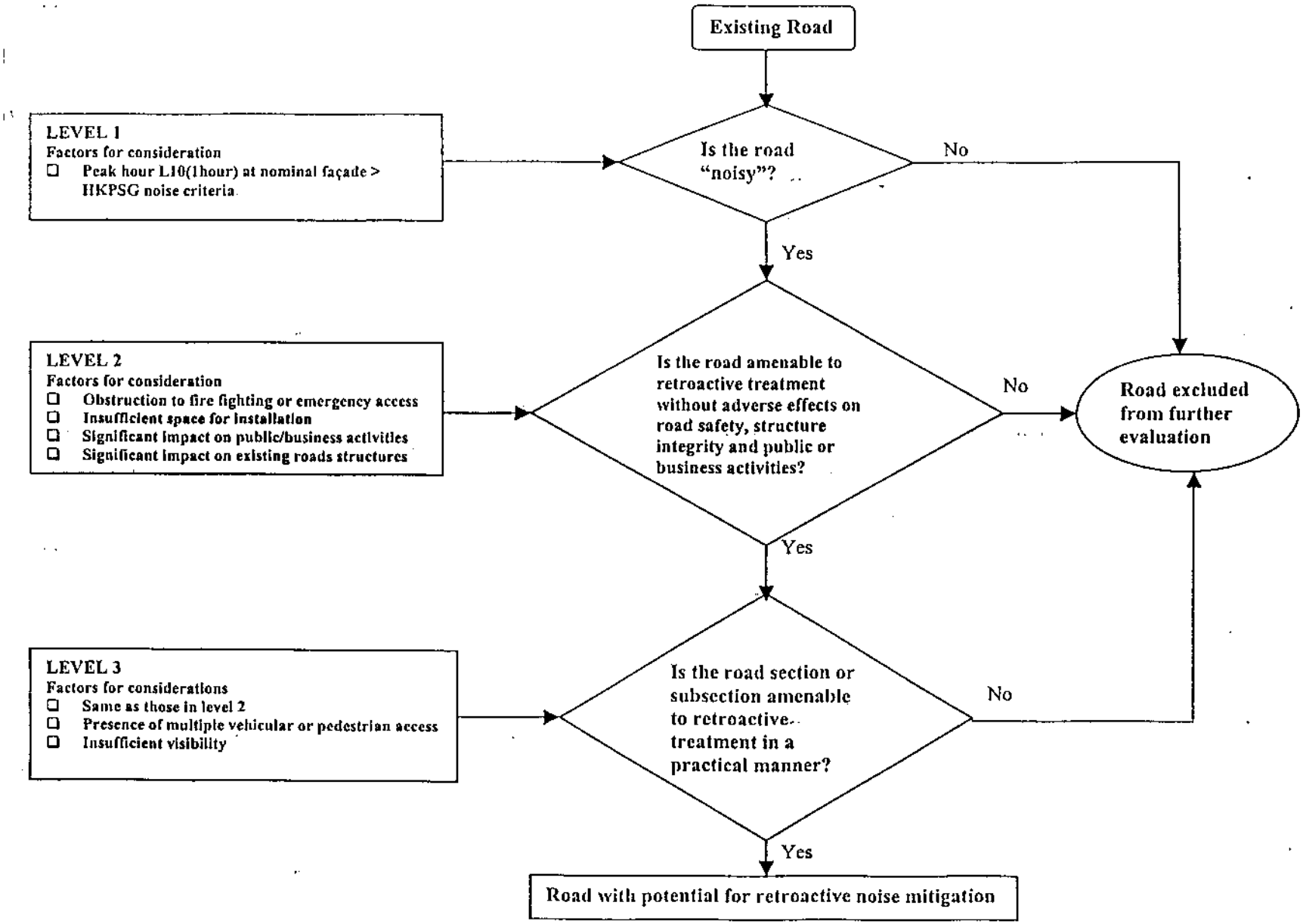
10.3.3. A priority ranking has been established for consideration by the government for the implementation of the proposed direct noise mitigation measures at the 12 selected groups of roads. The ranking is based on population exposure but may be changed if other considerations, e.g. political issues, take priority.

10.3.4. During the detailed design stage, relevant authorities should be consulted for the likely impact, time and costs involved for the necessary diversion or re-provisioning of affected utilities. In particular the following requirements given by Drainage Services Department should be considered while preparing the detailed design of the noise barriers:

(a) no stress shall be induced to the drains from the foundation of the barrier;
(b) minimum horizontal and vertical clearance of 1.0m must be provided;
(c) the noise barriers shall in no case cause any obstruction to the future maintenance and reconstruction of the drains; and
(d) detailed layout of the barriers at such locations must be forwarded for comments.

10.3.5. For tunnel-like enclosure with length exceeding 230 metres, Fire Services Department must be consulted for the provision of fire safety requirements.

FIGURES



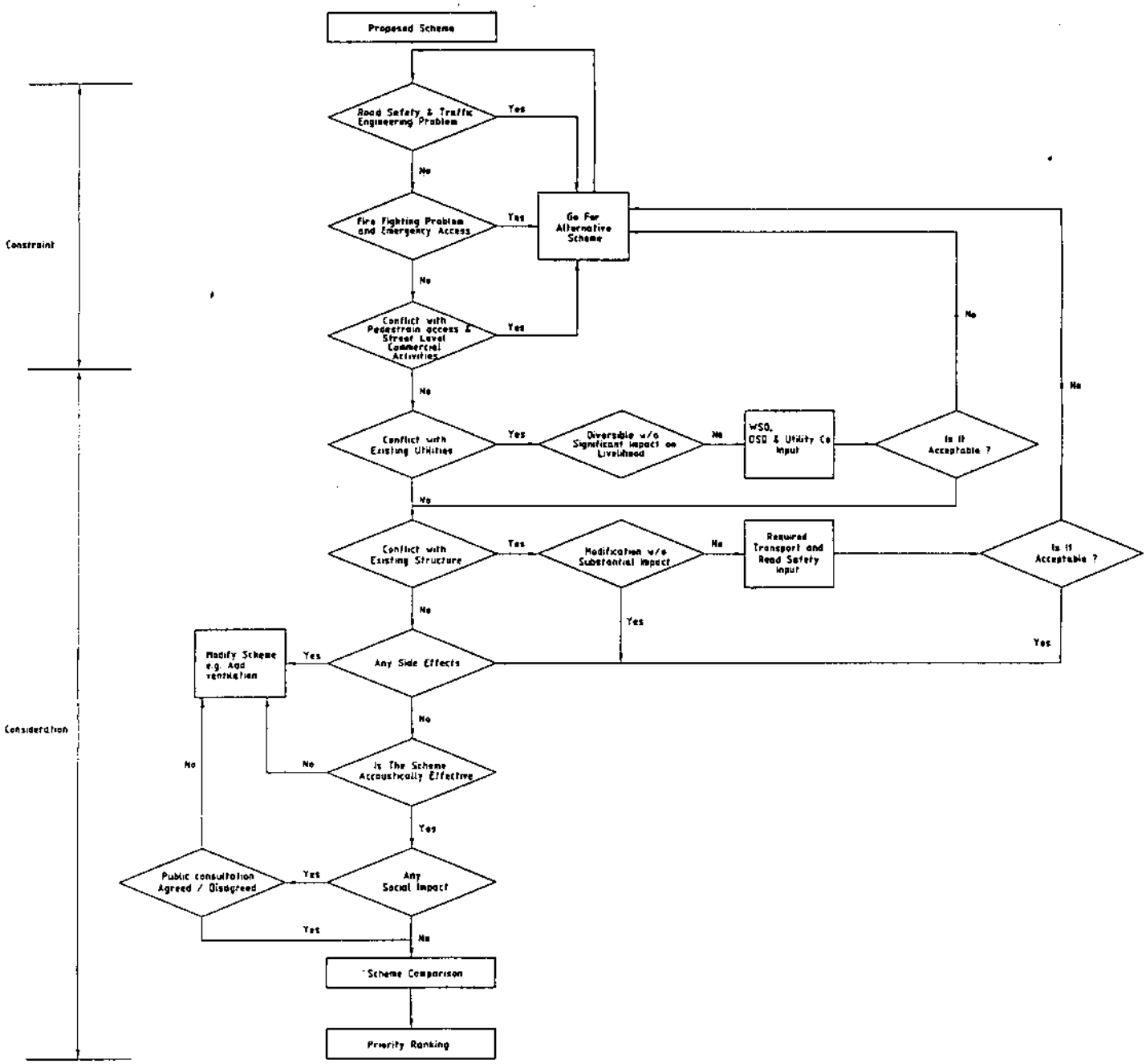
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

FLOW CHART FOR SELECTION OF NOISY ROADS WITH POTENTIAL FOR RETROACTIVE NOISE MITIGATION

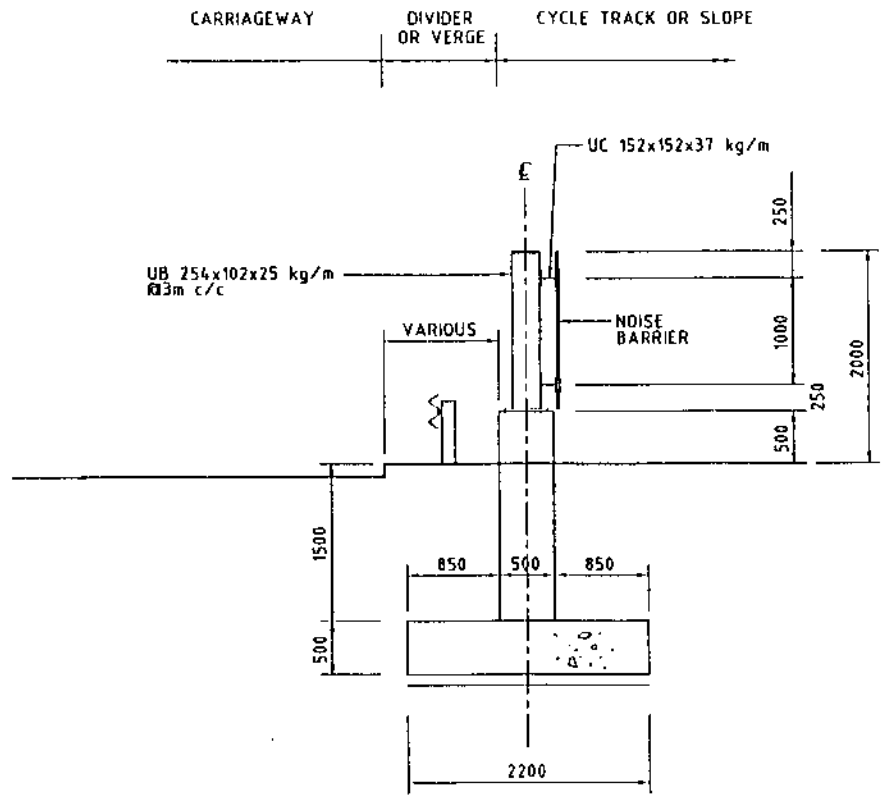
Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO. 95796

FIGURE: FIG 2-1

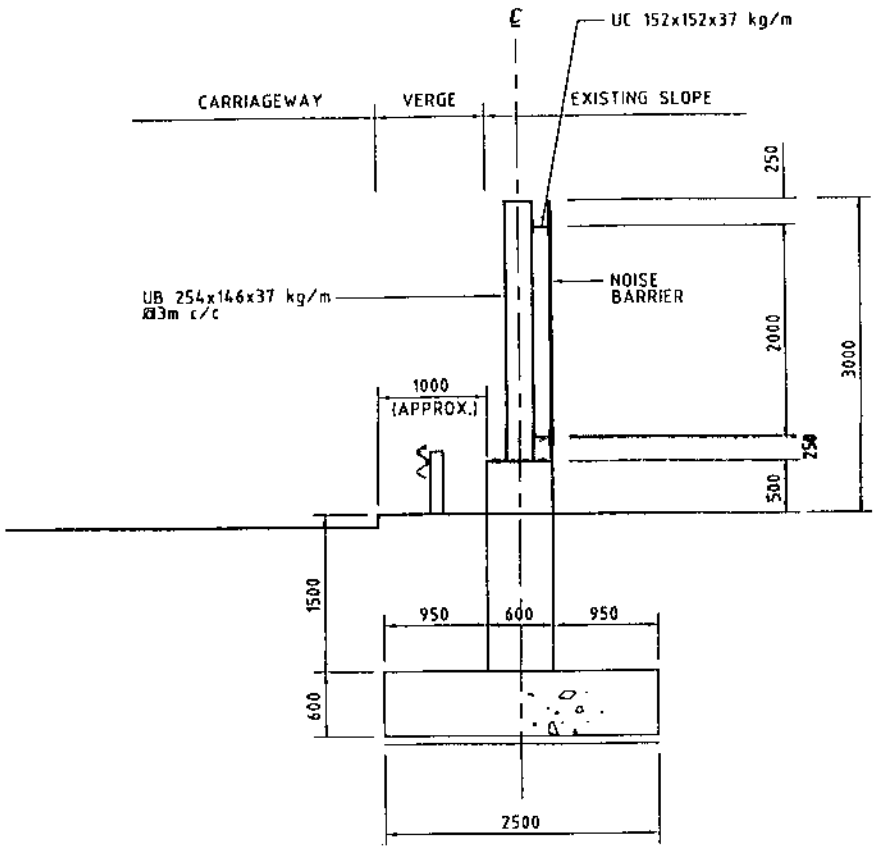


FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES SCHEME ESTABLISHMENT FLOW CHART	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO. 95796	FIGURE: FIG 2-2

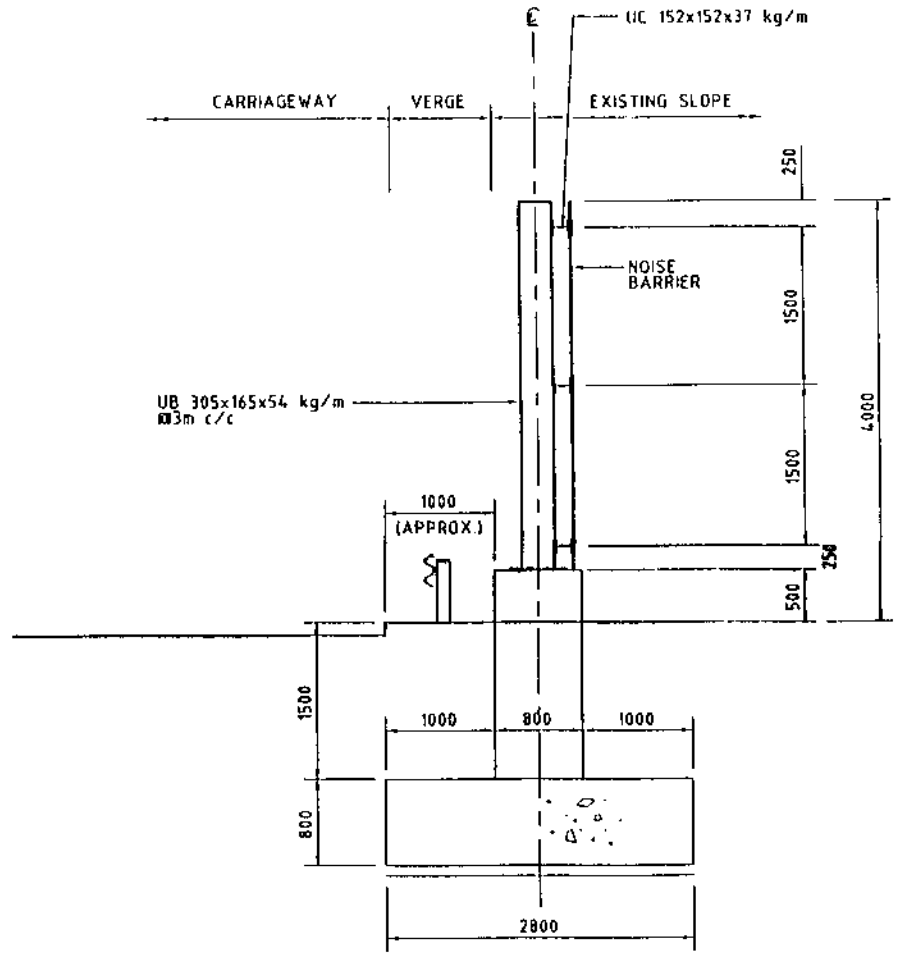


2-METRE PLAIN BARRIER
ON SPREAD FOOTING

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES TYPICAL NOISE BARRIER SECTIONS N.T.S	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO.: 95796	FIGURE: FIG 2-3

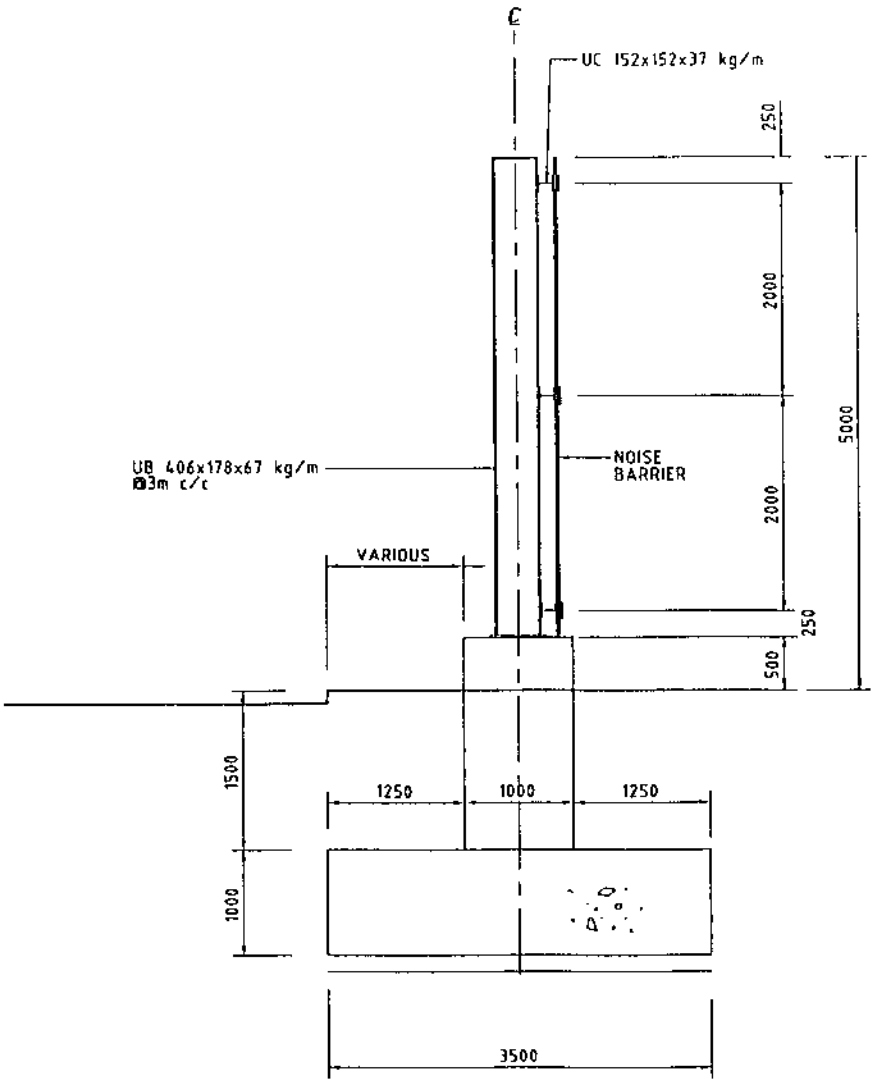


3-METRE PLAIN BARRIER
ON SPREAD FOOTING

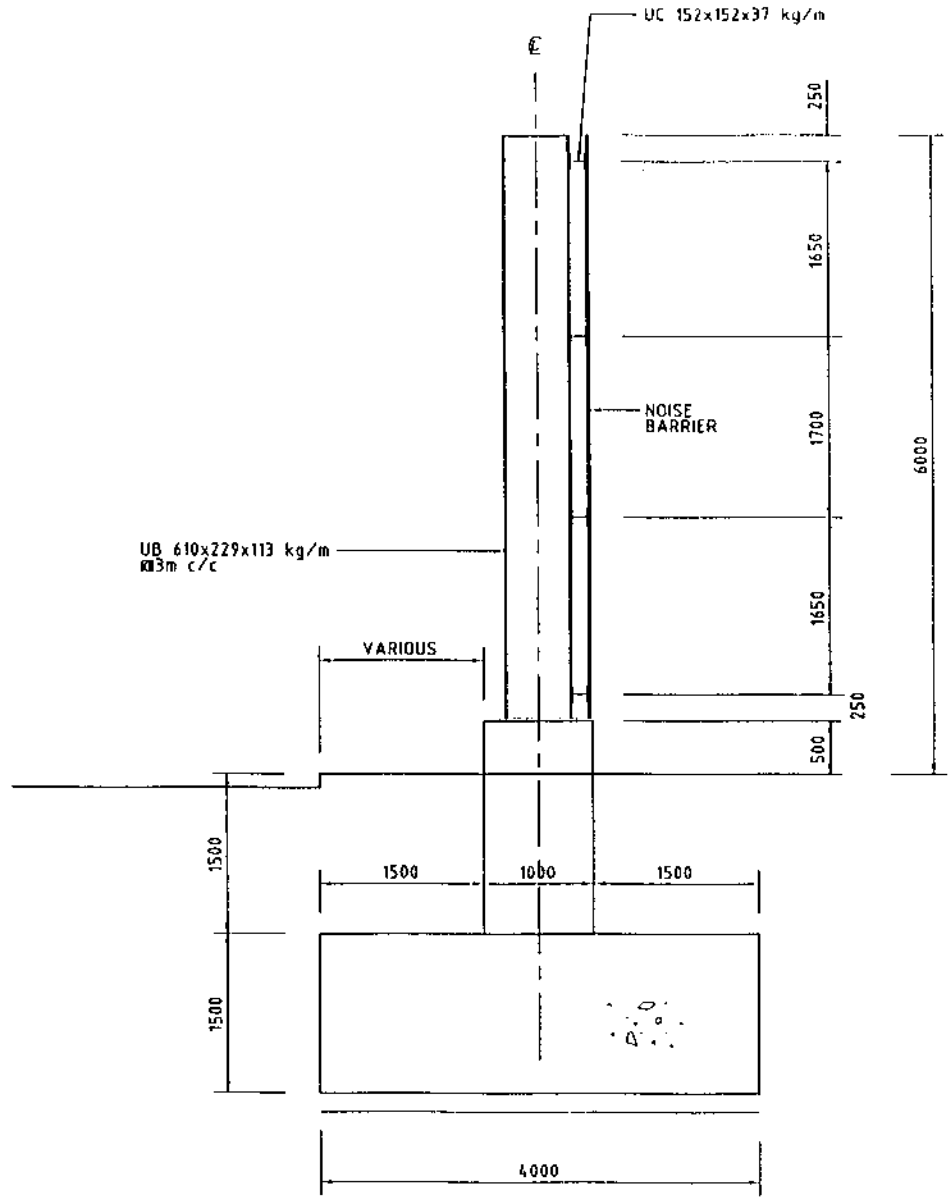


4-METRE PLAIN BARRIER
ON SPREAD FOOTING

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES TYPICAL NOISE BARRIER SECTIONS N.T.S	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO.: 95796	FIGURE: FIG 2-4



5-METRE PLAIN BARRIER
ON SPREAD FOOTING



6-METRE PLAIN BARRIER
ON SPREAD FOOTING

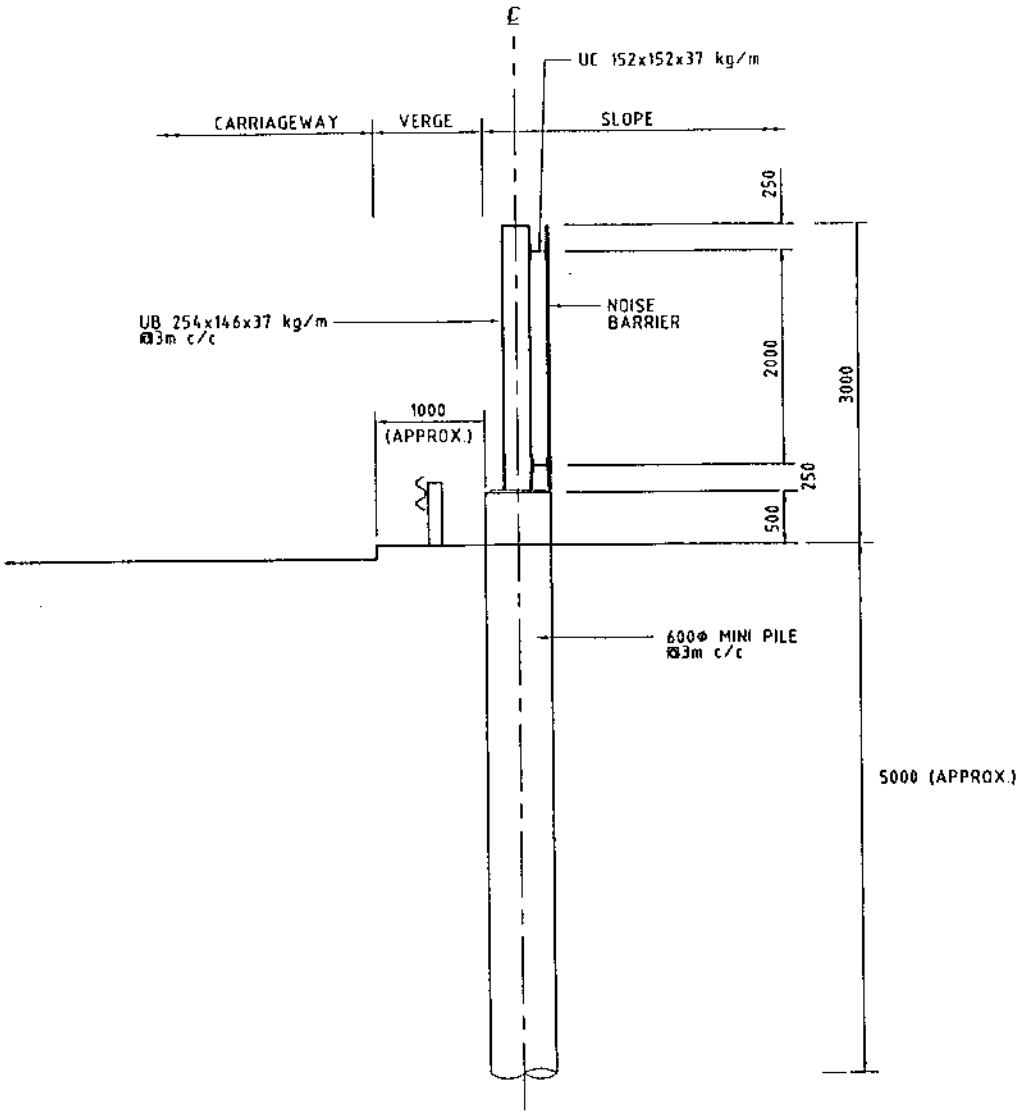
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

TYPICAL NOISE BARRIER SECTIONS

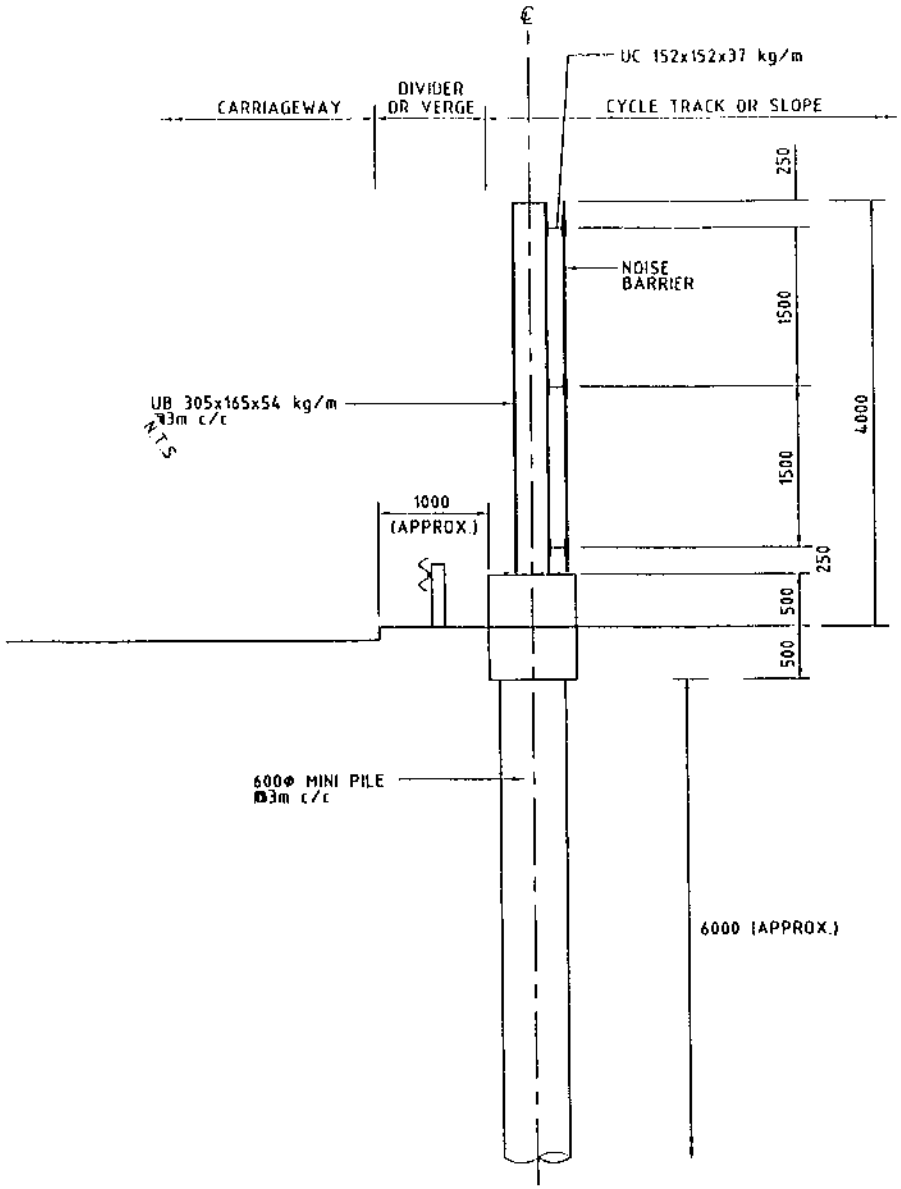
Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 2-5

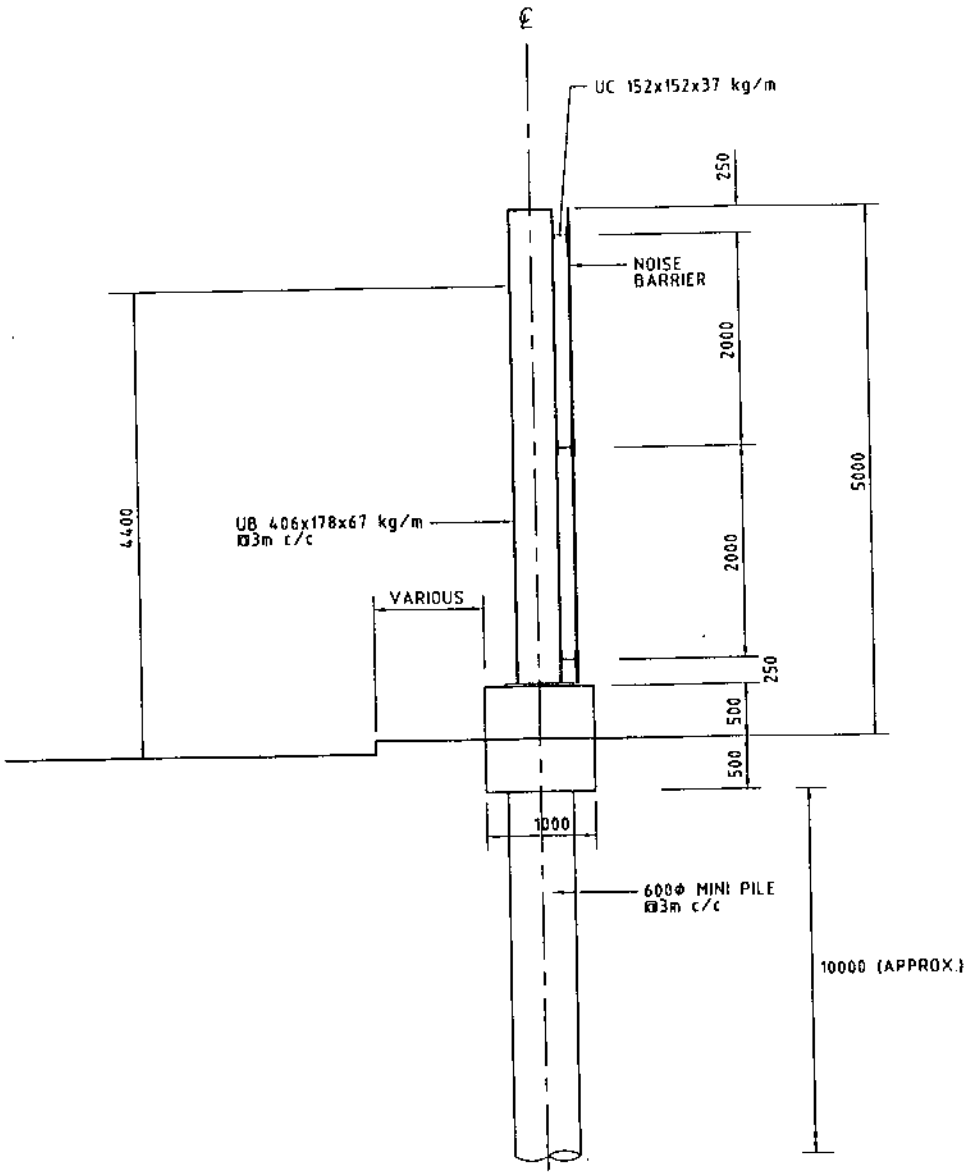


3-METRE PLAIN BARRIER ON PILE

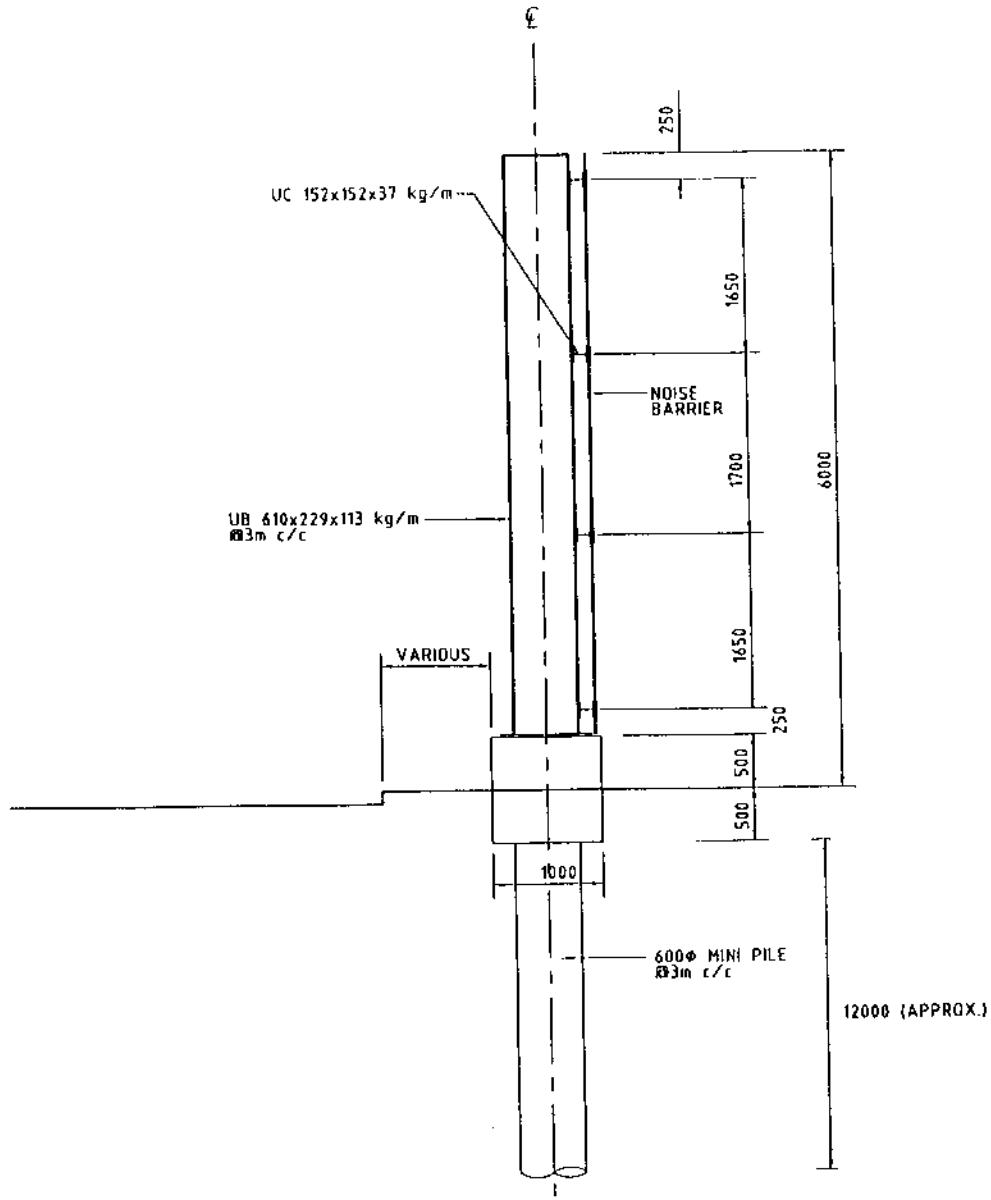


4-METRE PLAIN BARRIER ON PILE

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC MITIGATION MEASURES TYPICAL NOISE BARRIER SECTIONS	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO.: 95796	FIGURE: FIG 2-6



5-METRE PLAIN BARRIER
ON PILE



6-METRE PLAIN BARRIER
ON PILE

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

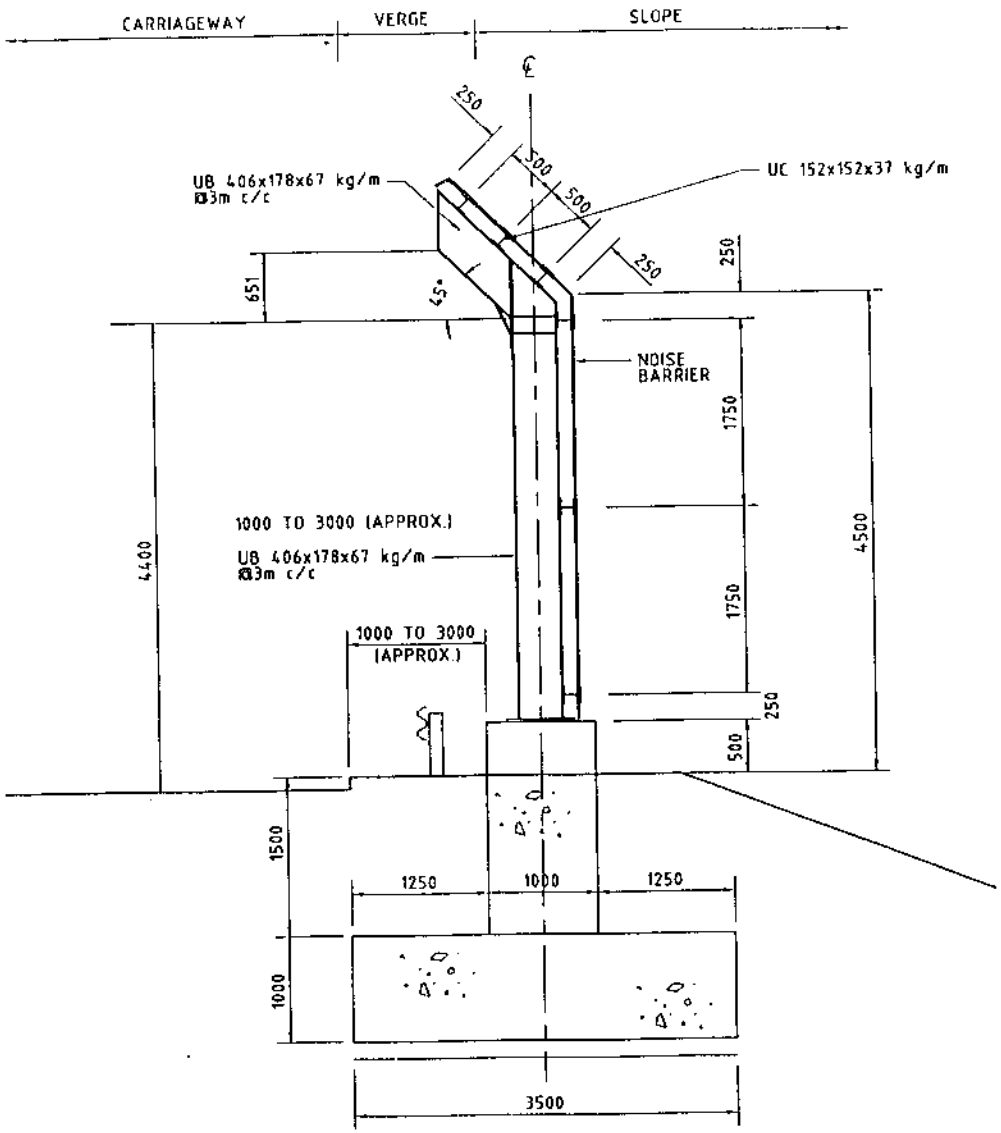
TYPICAL NOISE BARRIER SECTIONS

NTS

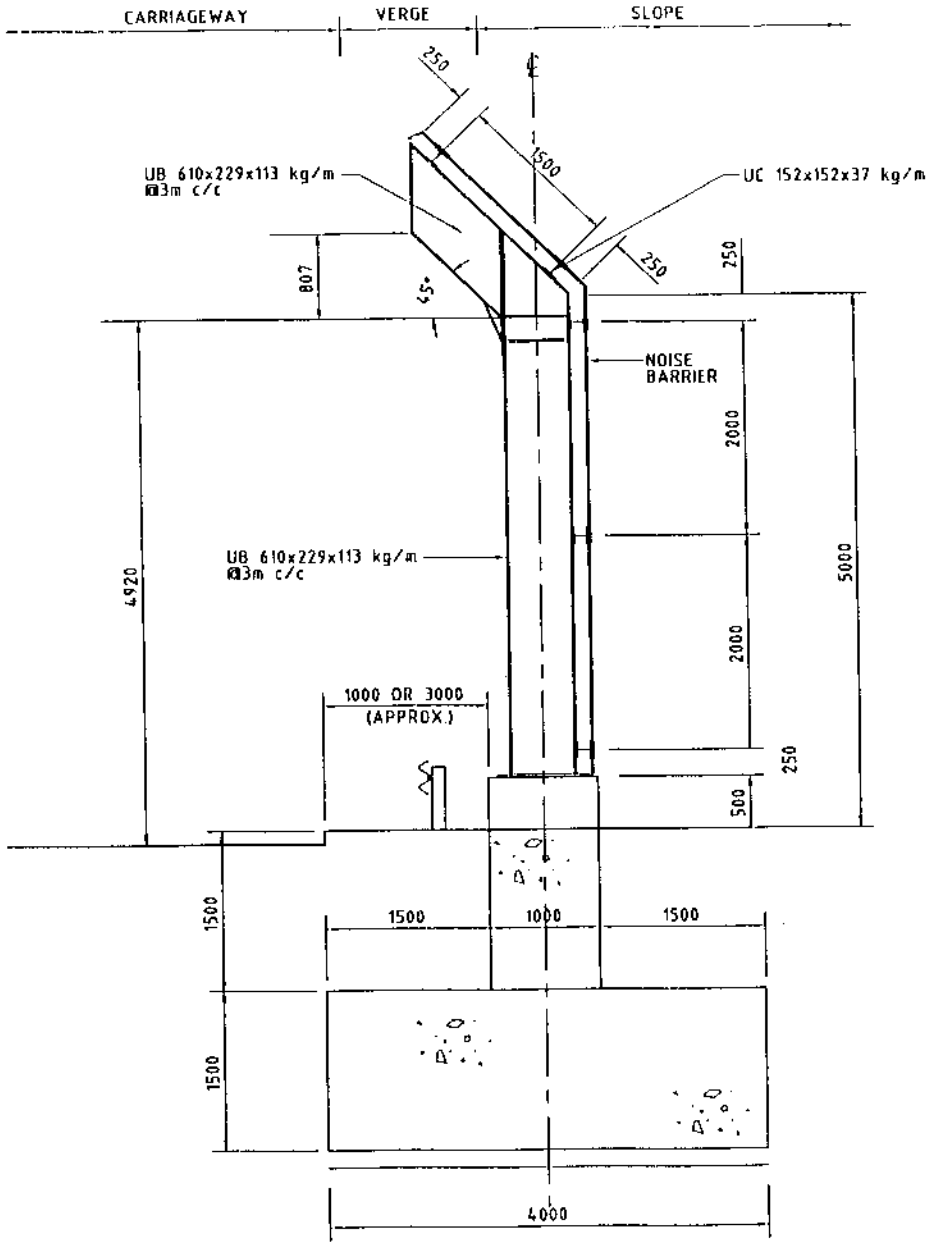
Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 2-7



CANTILEVERED BARRIER (TYPE A) (5.6m)
ON SPREAD FOOTING



CANTILEVERED BARRIER (TYPE B) (6.4m)
ON SPREAD FOOTING

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

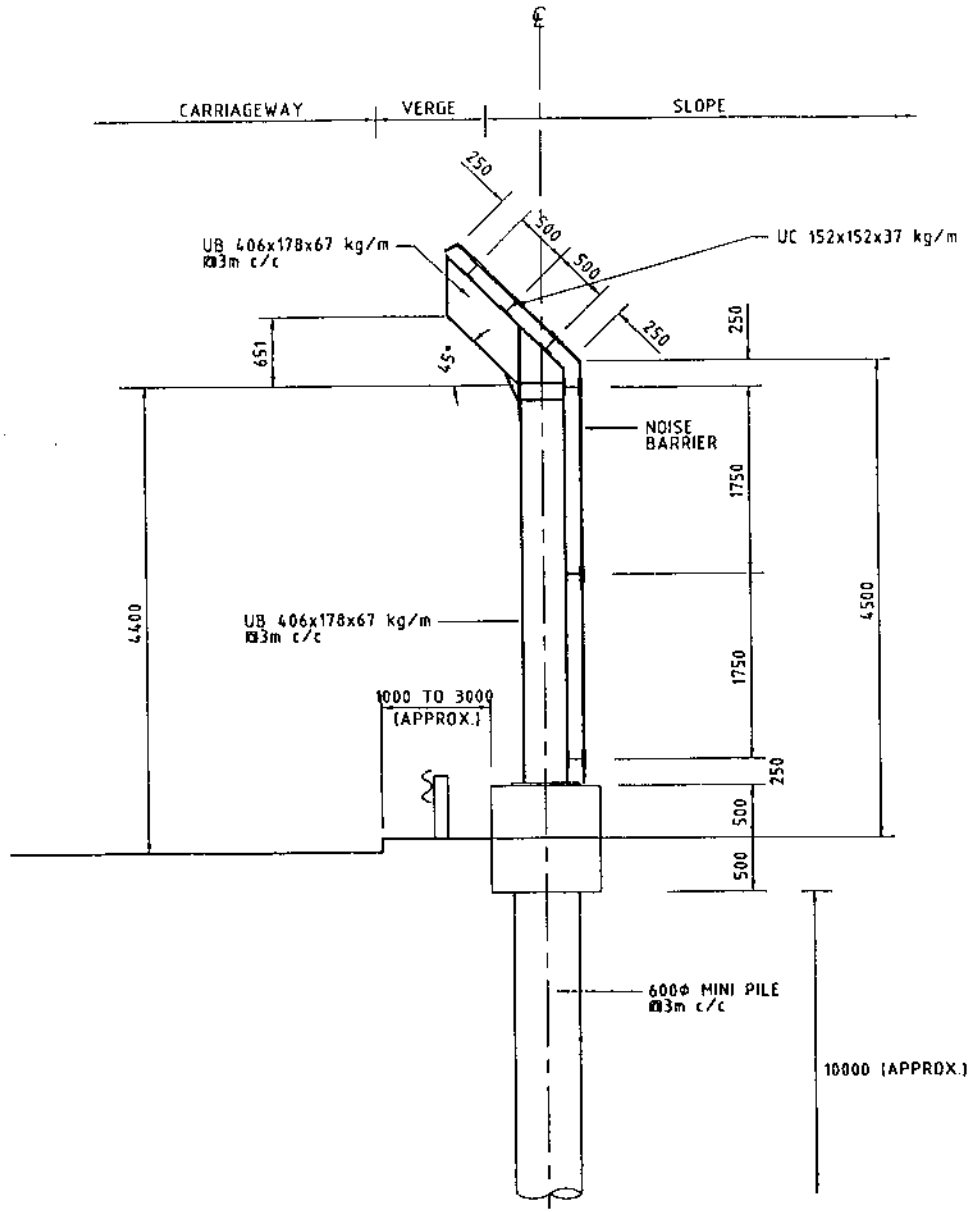
TYPICAL NOISE BARRIER SECTIONS

N.T.S

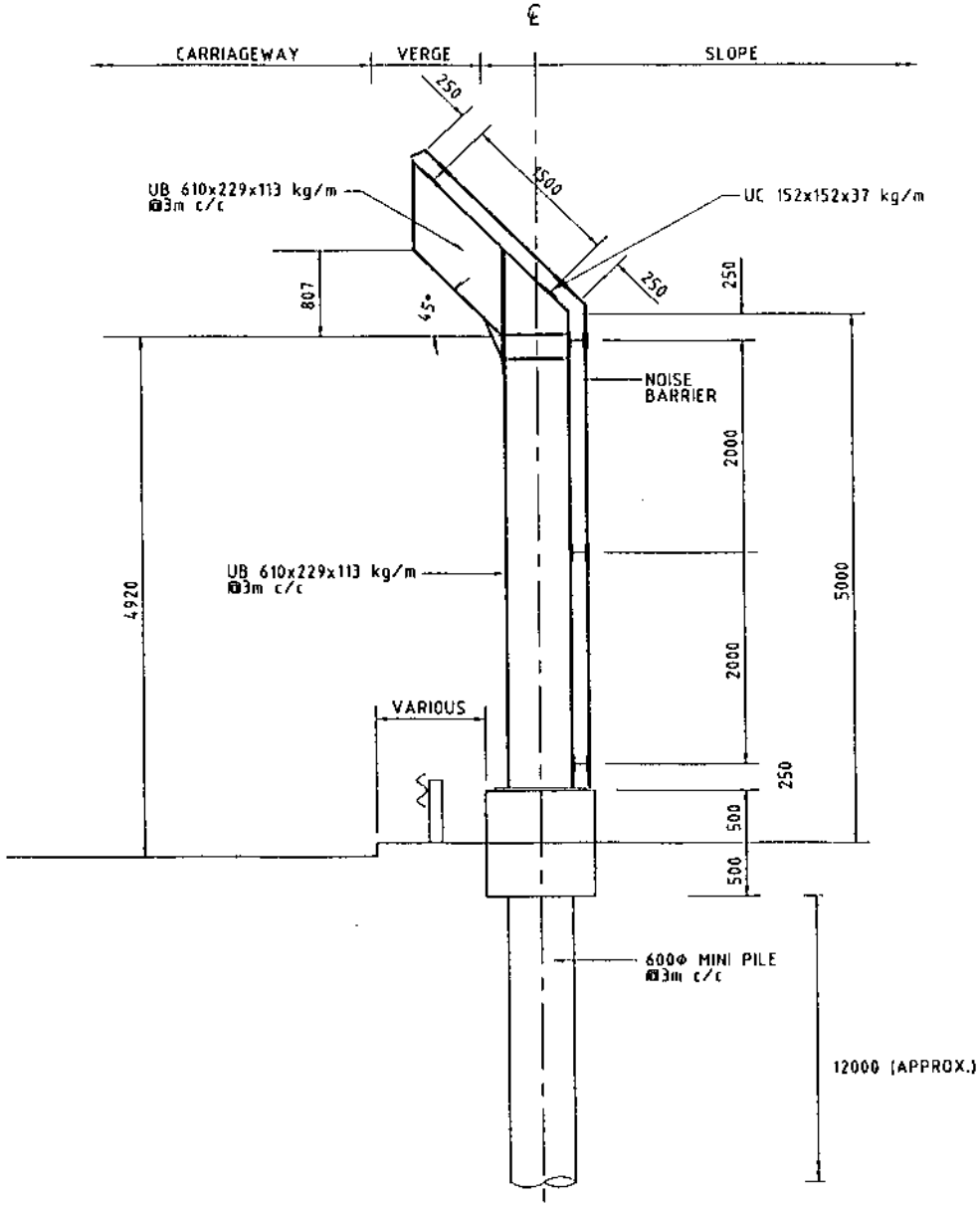
Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 2-8



CANTILEVERED BARRIER (TYPE A) (5.6m)
ON PILE



CANTILEVERED BARRIER (TYPE B) (6.4m)
ON PILE

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC MITIGATION MEASURES

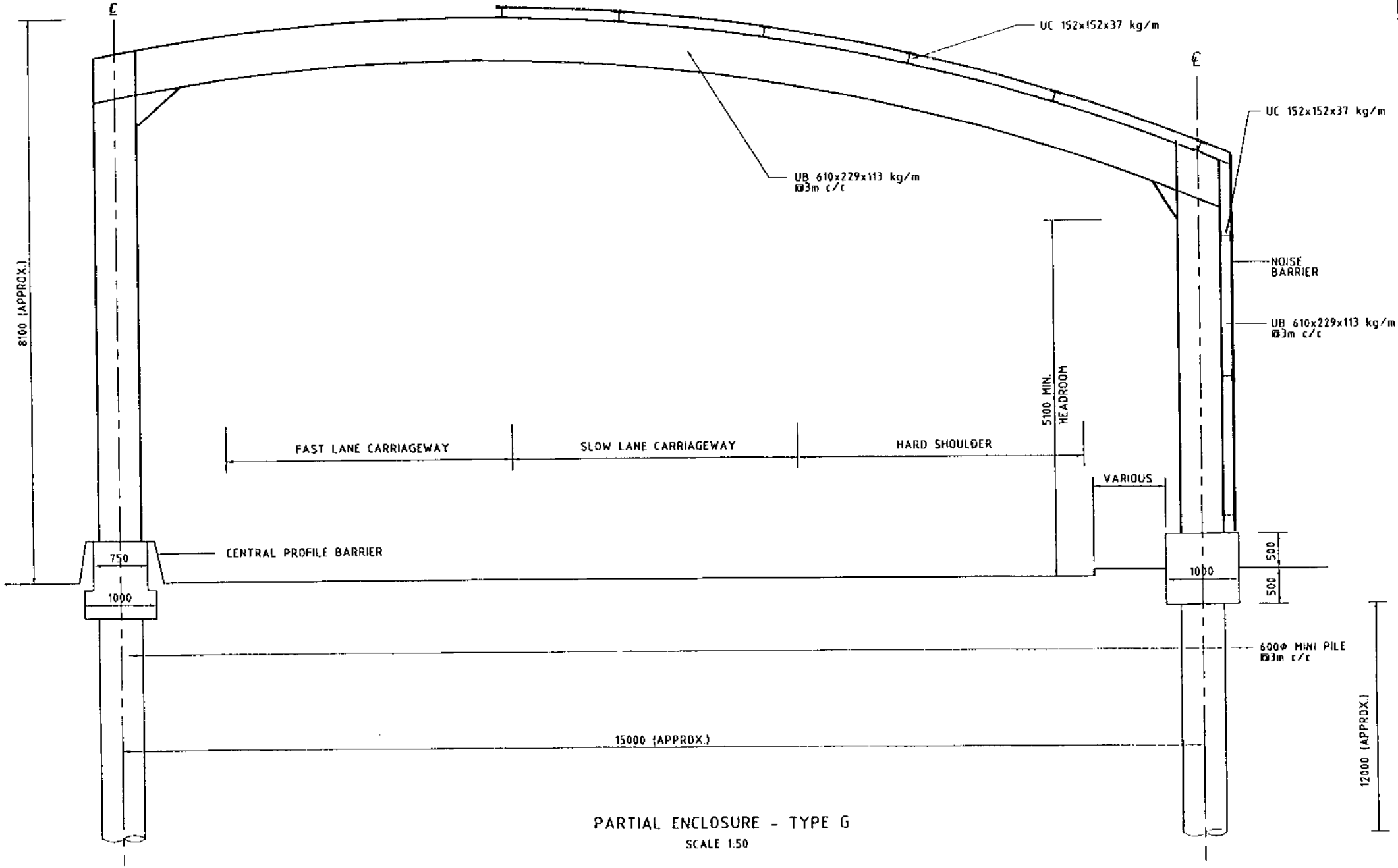
TYPICAL NOISE BARRIER SECTIONS

N.T.S

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 2-9



PARTIAL ENCLOSURE - TYPE G

SCALE 1:50

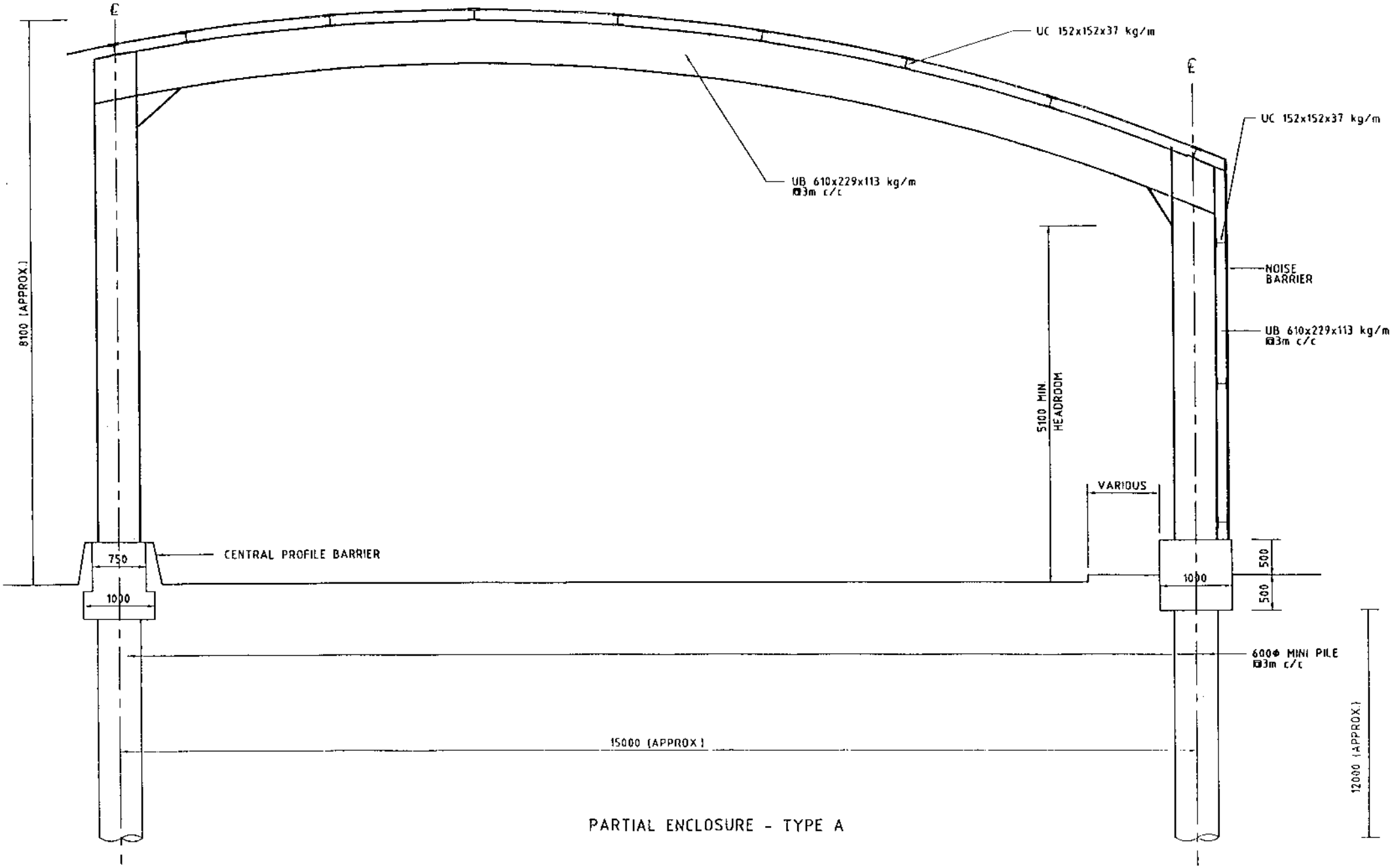
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

TYPICAL NOISE BARRIER SECTIONS

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 2-10A



PARTIAL ENCLOSURE - TYPE A

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

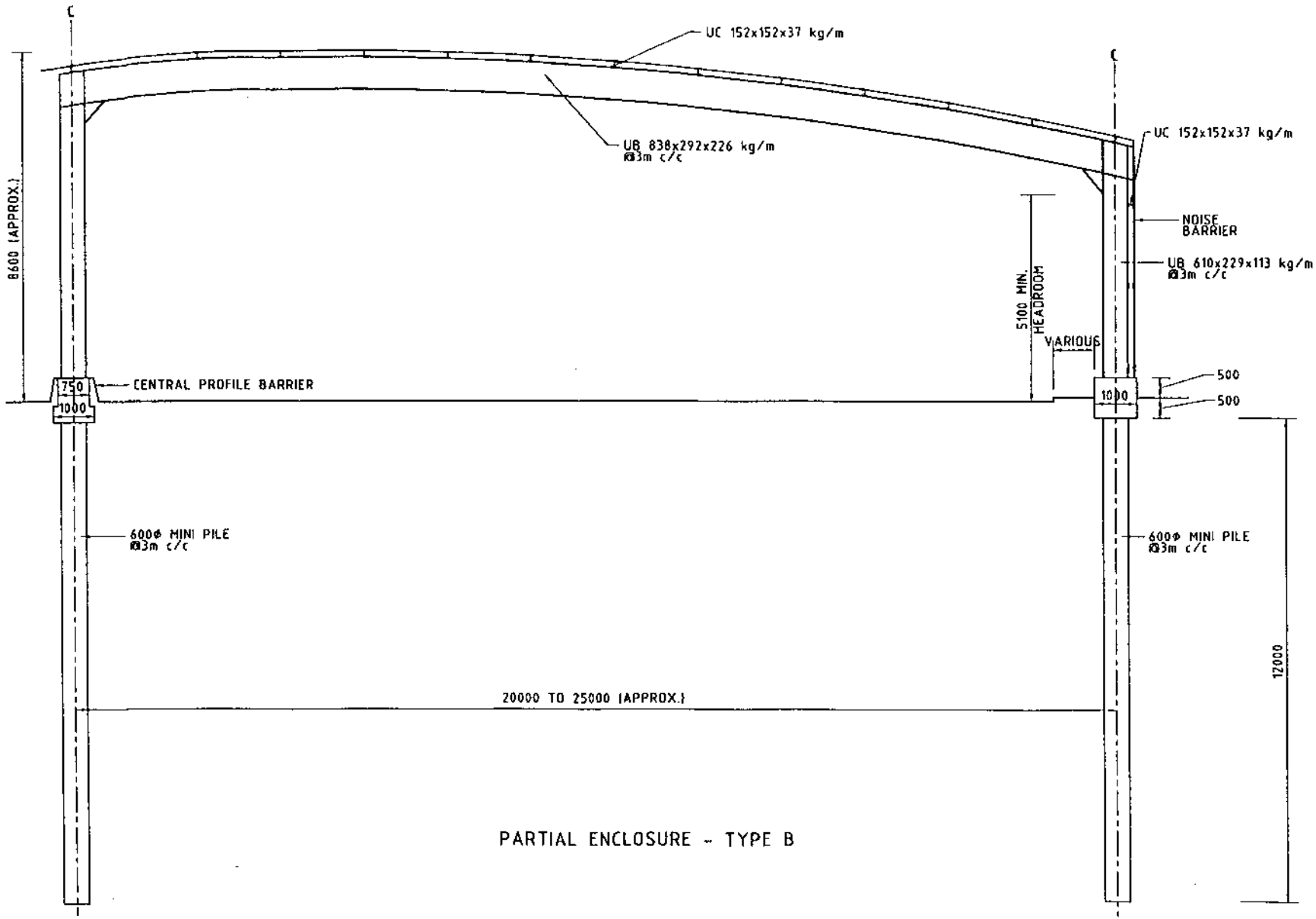
TYPICAL NOISE BARRIER SECTIONS

N.T.S

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 2-11



PARTIAL ENCLOSURE - TYPE B

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

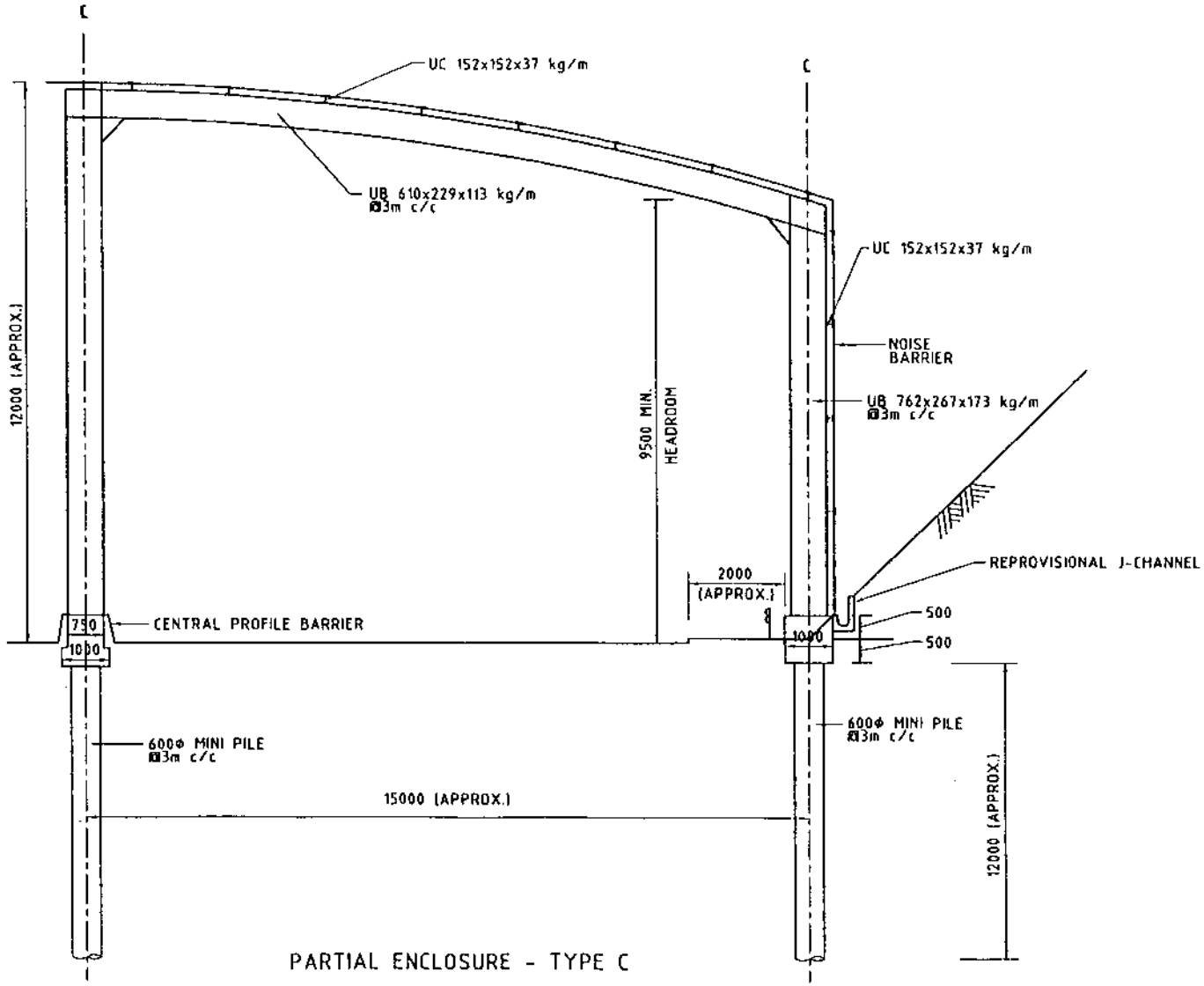
TYPICAL NOISE BARRIER SECTIONS

N.T.S

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 2-12



PARTIAL ENCLOSURE - TYPE C

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

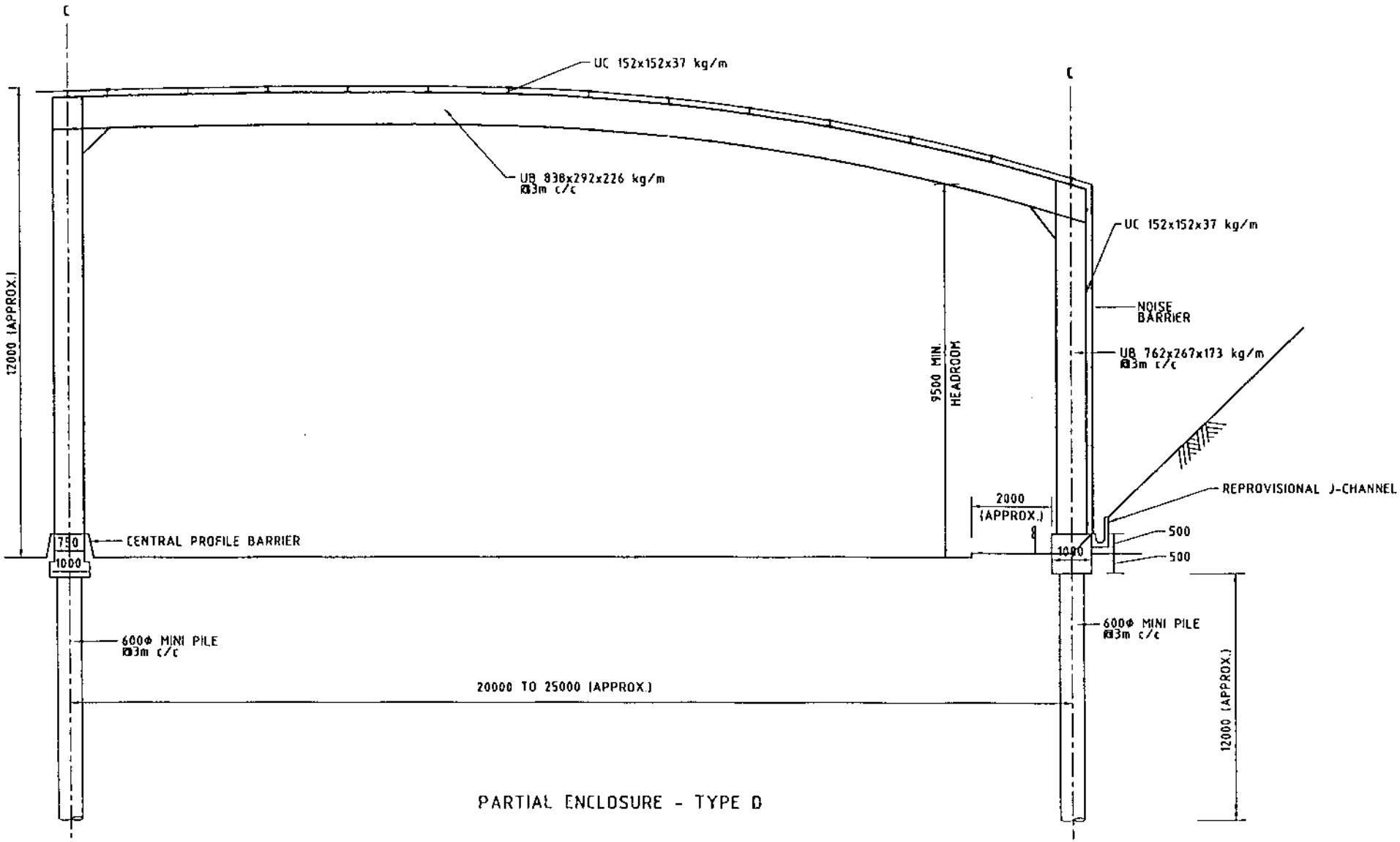
TYPICAL NOISE BARRIER SECTIONS

NTS

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 2-13



PARTIAL ENCLOSURE - TYPE D

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

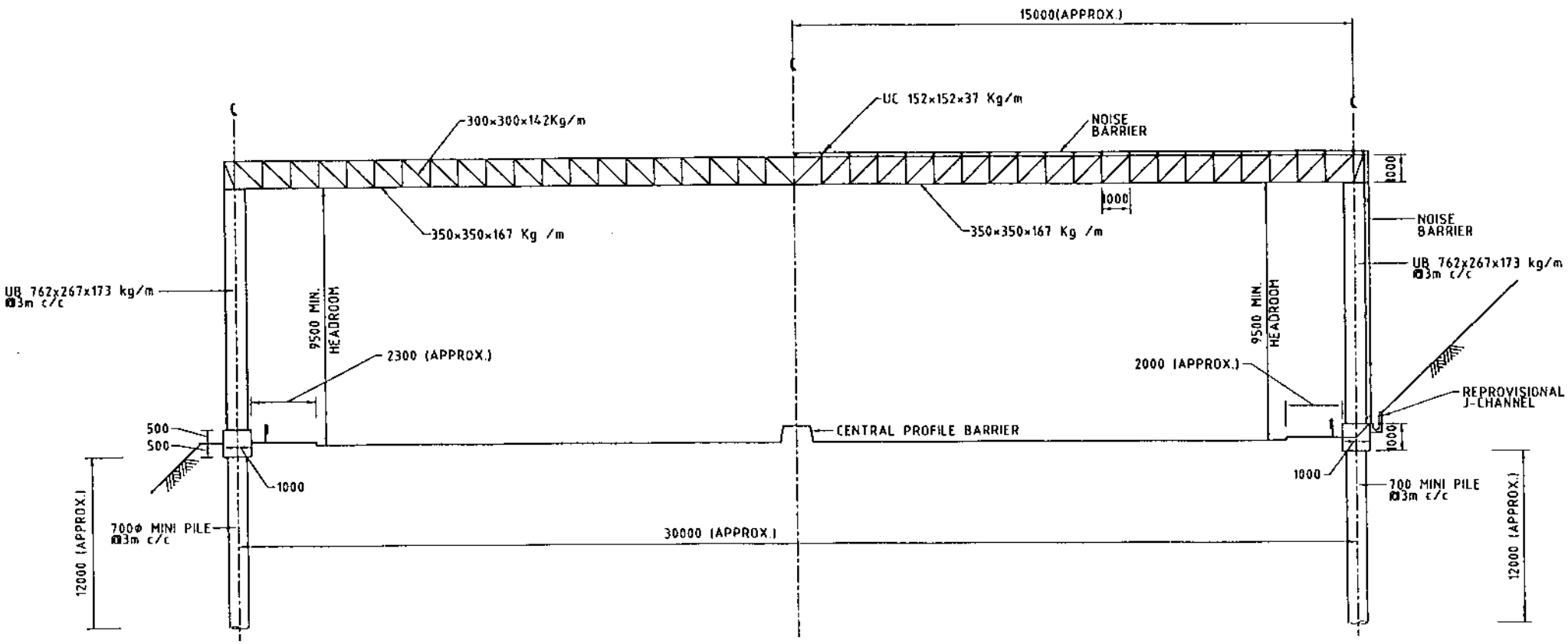
TYPICAL NOISE BARRIER SECTIONS

N.T.S

Maunsell
茂盛(亞洲)工程顧問有限公司

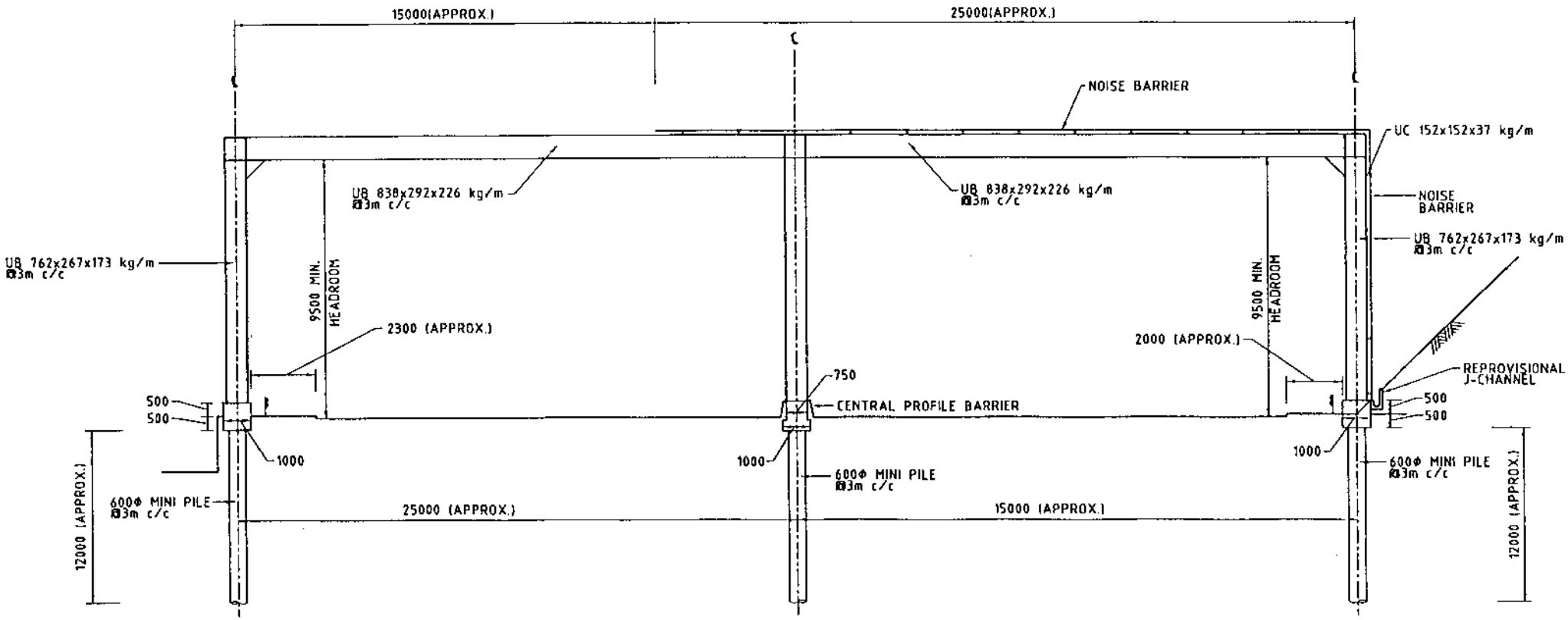
JOB NO.: 95796

FIGURE: FIG 2-14



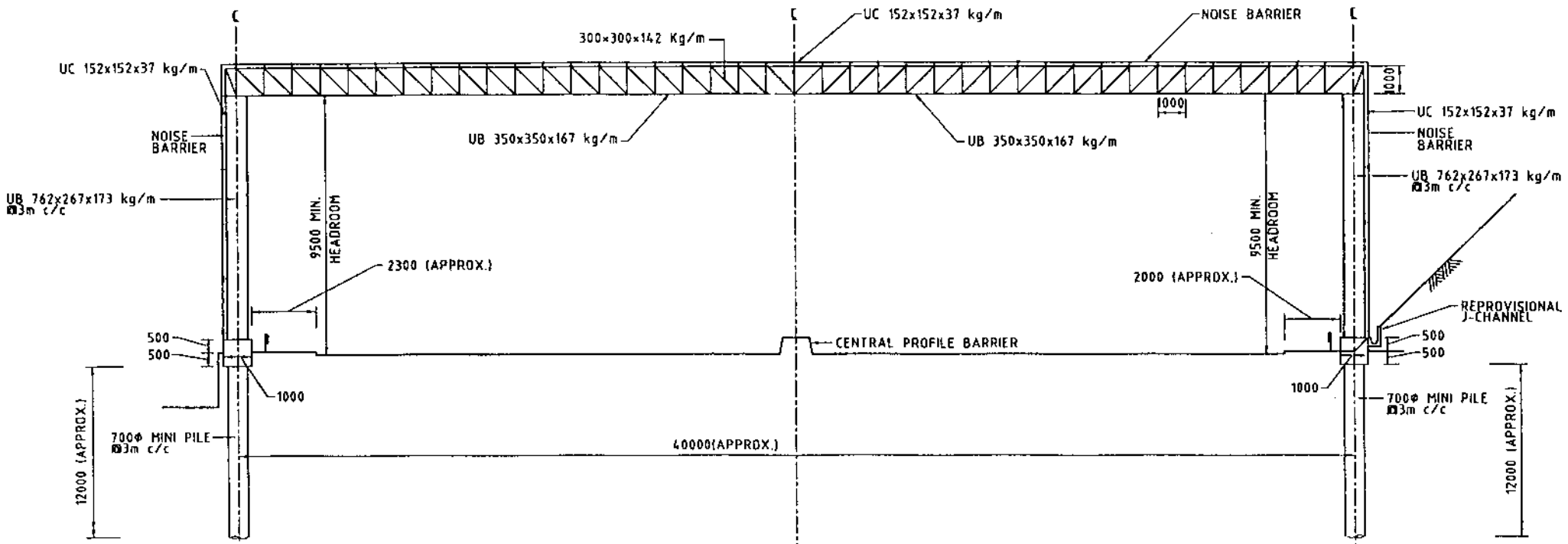
PARTIAL ENCLOUSURE - TYPE E

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES TYPICAL NOISE BARRIER SECTIONS N.T.S.	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO.: 95796	FIGURE: FIG 2-15



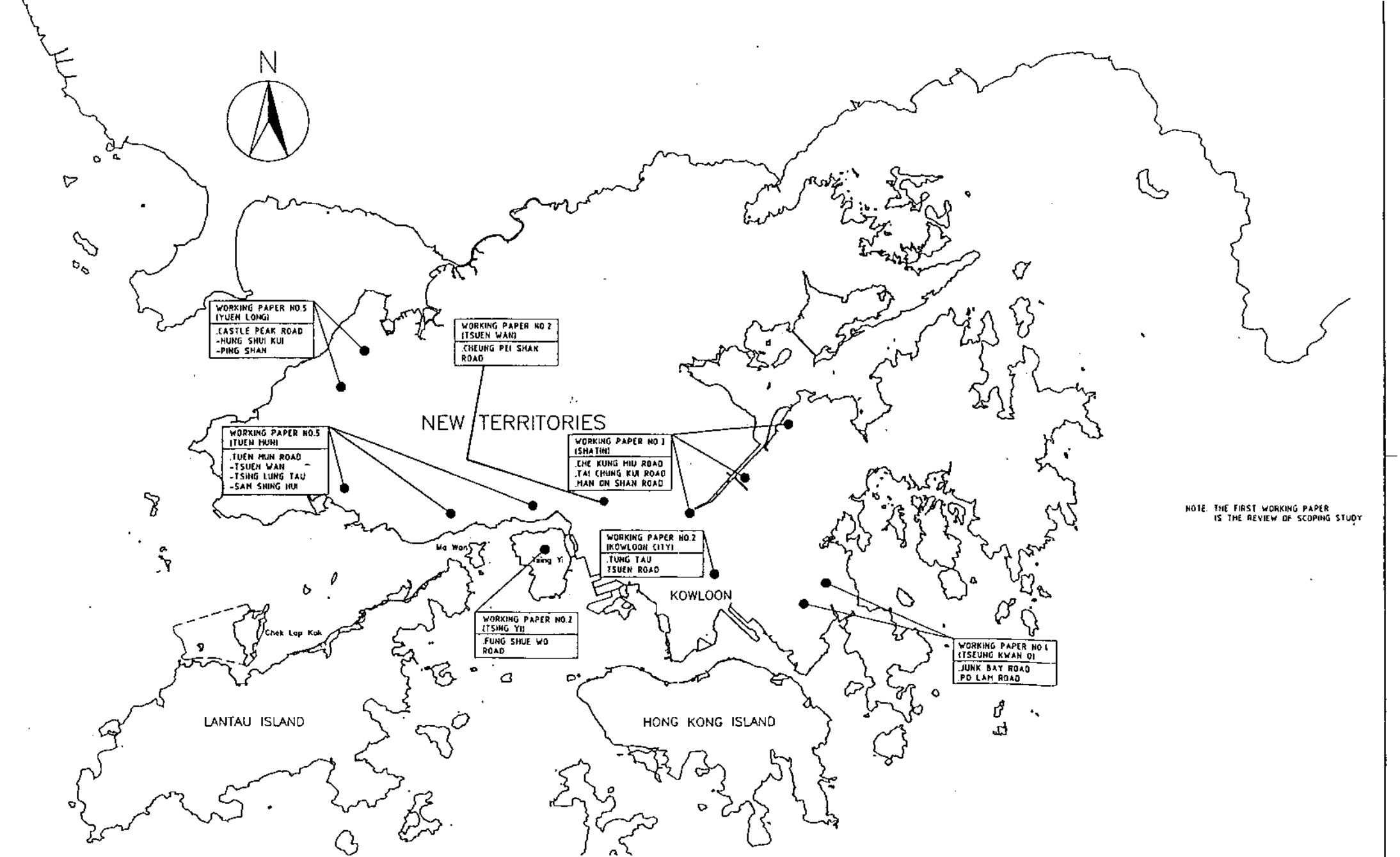
PARTIAL ENCLOUSURE - TYPE F

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES TYPICAL NOISE BARRIER SECTIONS N.T.S.	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO.: 95796	FIGURE: FIG 2-16



FULL ENCLOUSURE

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES TYPICAL NOISE BARRIER SECTIONS N.T.S.	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO.: 95796	FIGURE: FIG 2-17



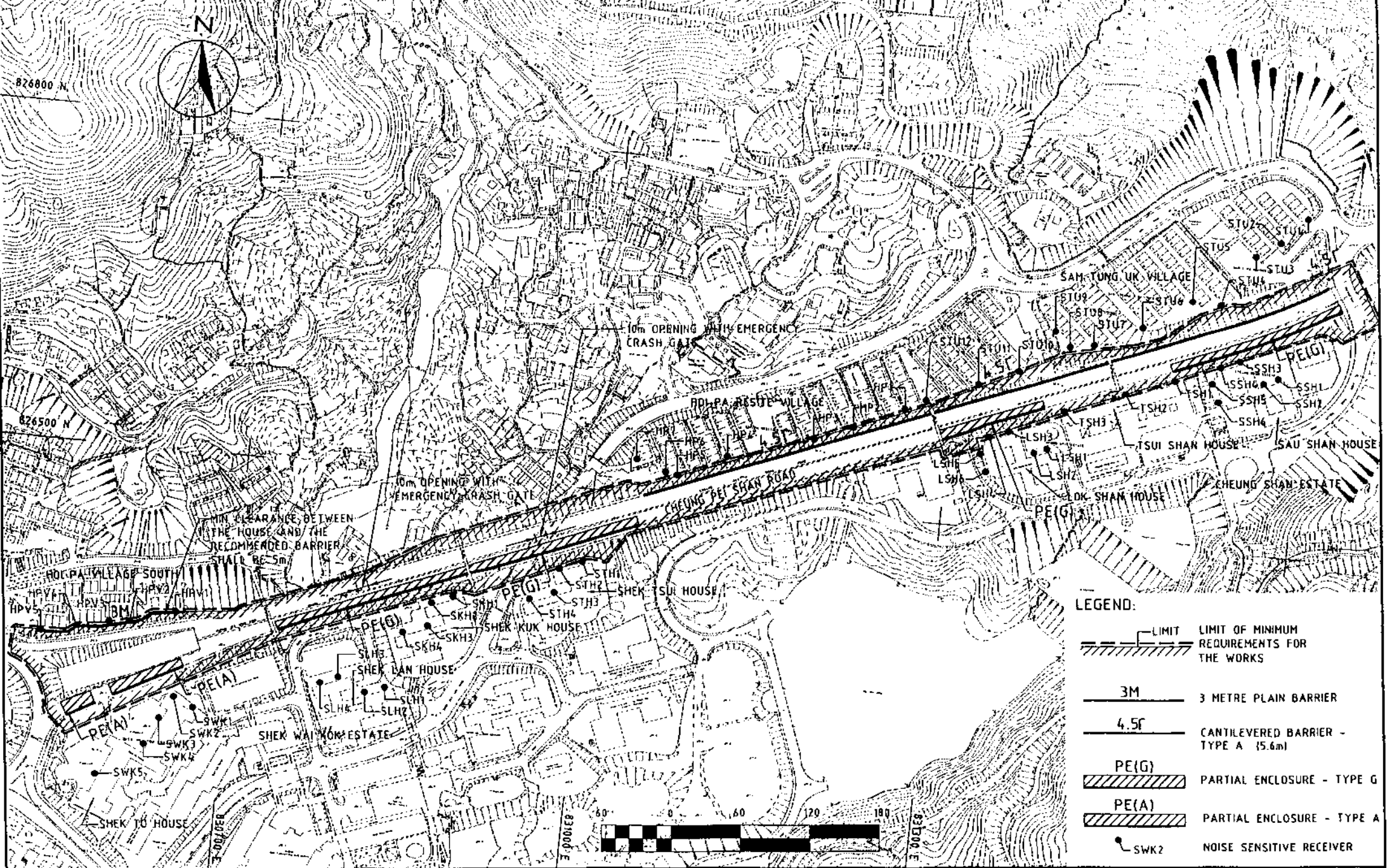
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

KEY PLAN FOR THE SELECTED LOCATIONS

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-1



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC MITIGATION MEASURES

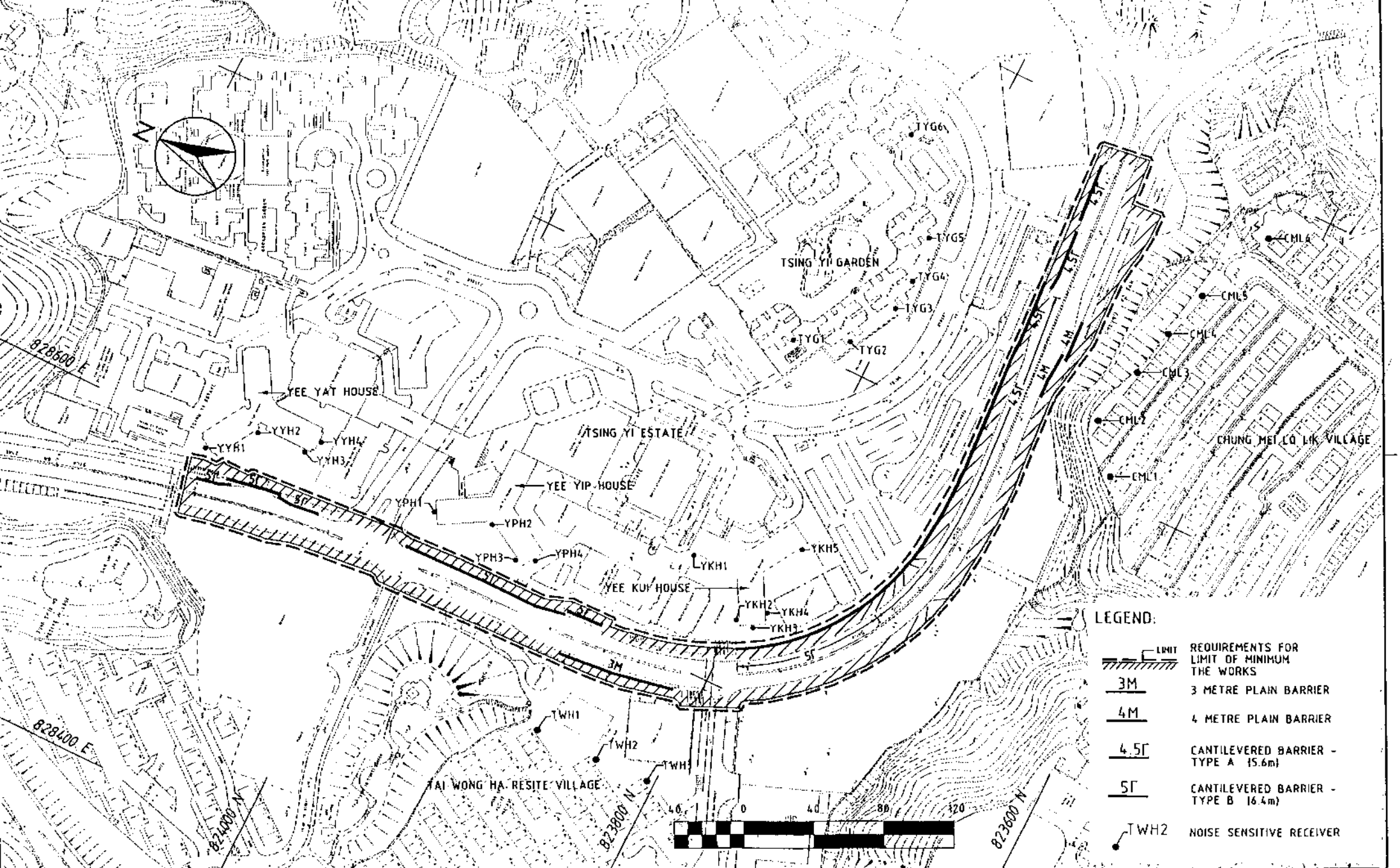
MITIGATION MEASURES FOR CHEUNG PEI SHAN ROAD - RECOMMENDED OPTION

N.T.S

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-2A



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

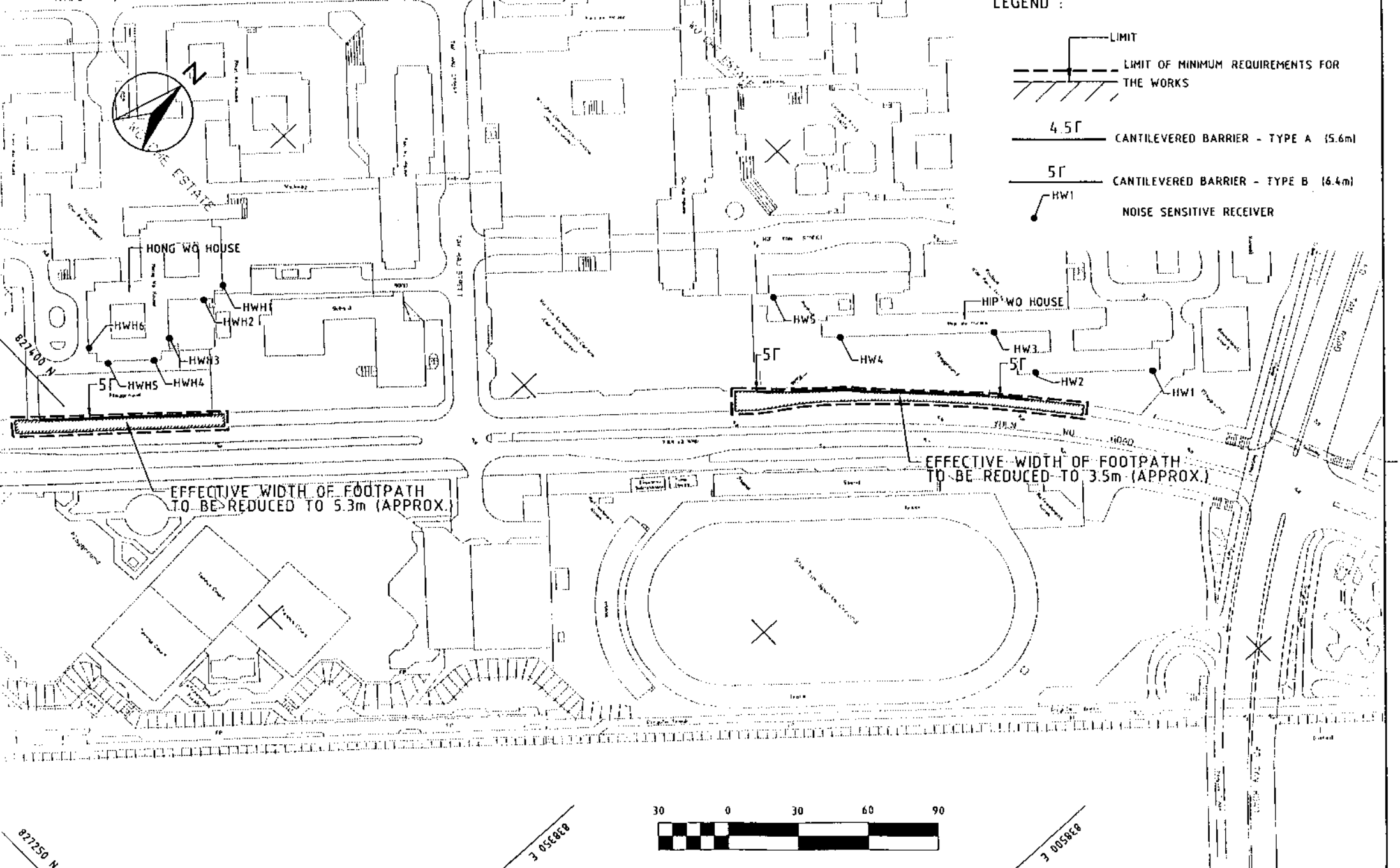
MITIGATION MEASURES FOR FUNG SHUE WO ROAD - RECOMMENDED OPTION

N.T.S

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-3



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

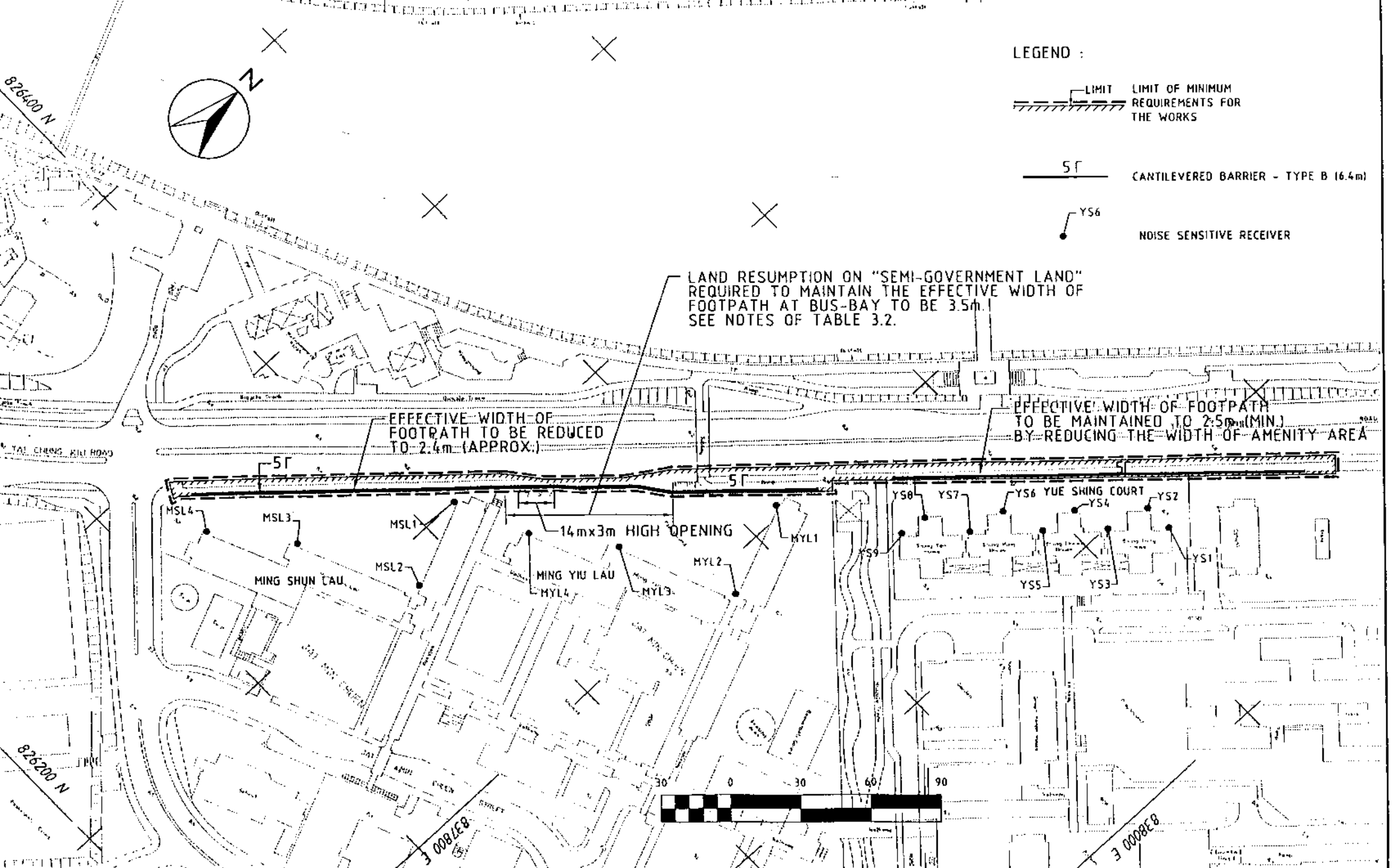
MITIGATION MEASURES FOR YUEN WO ROAD - RECOMMENDED OPTION

N.T.S

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-4A



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

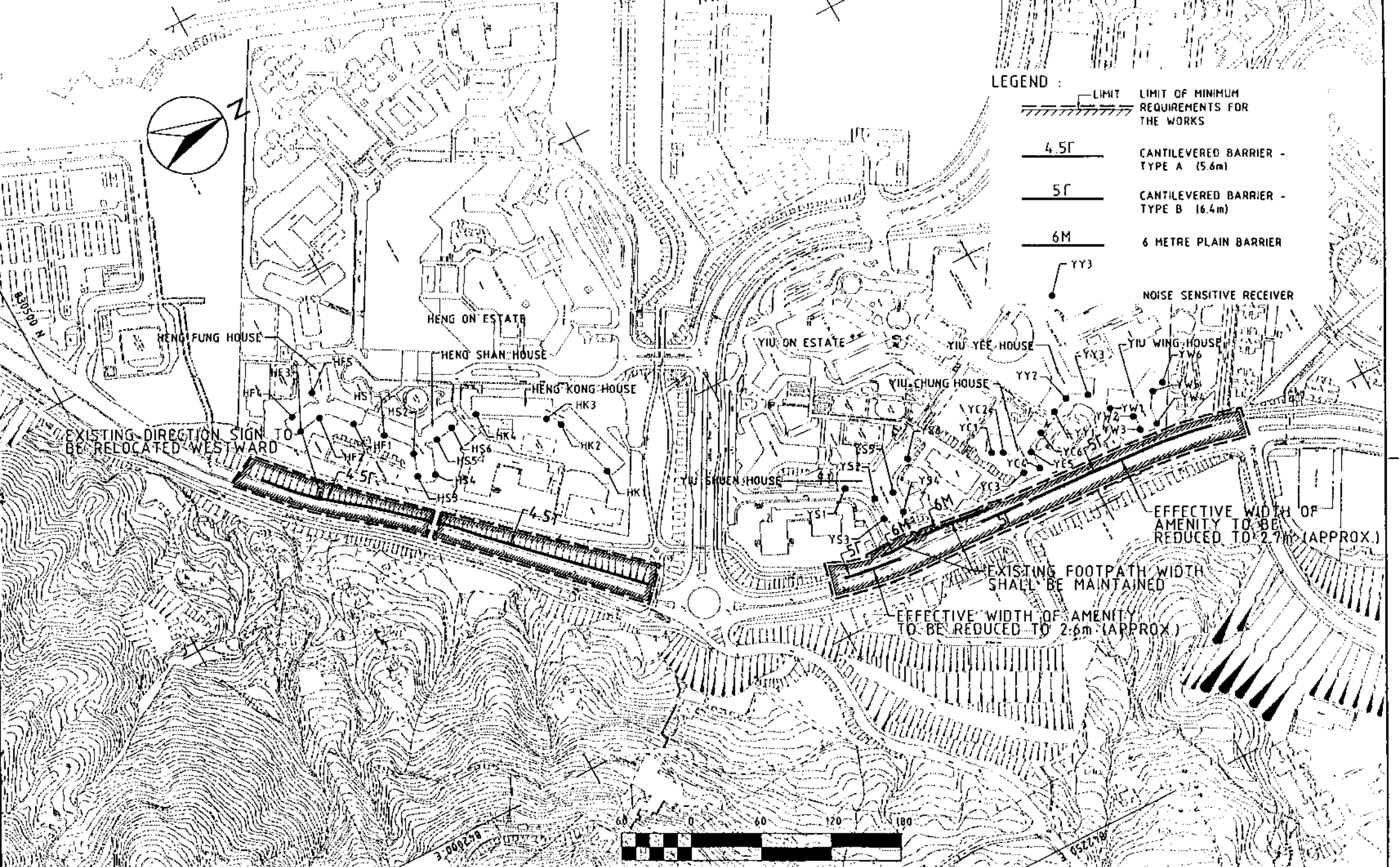
MITIGATION MEASURES FOR TAI CHUNG KIU ROAD - RECOMMENDED OPTION

N.T.S

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-5A



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

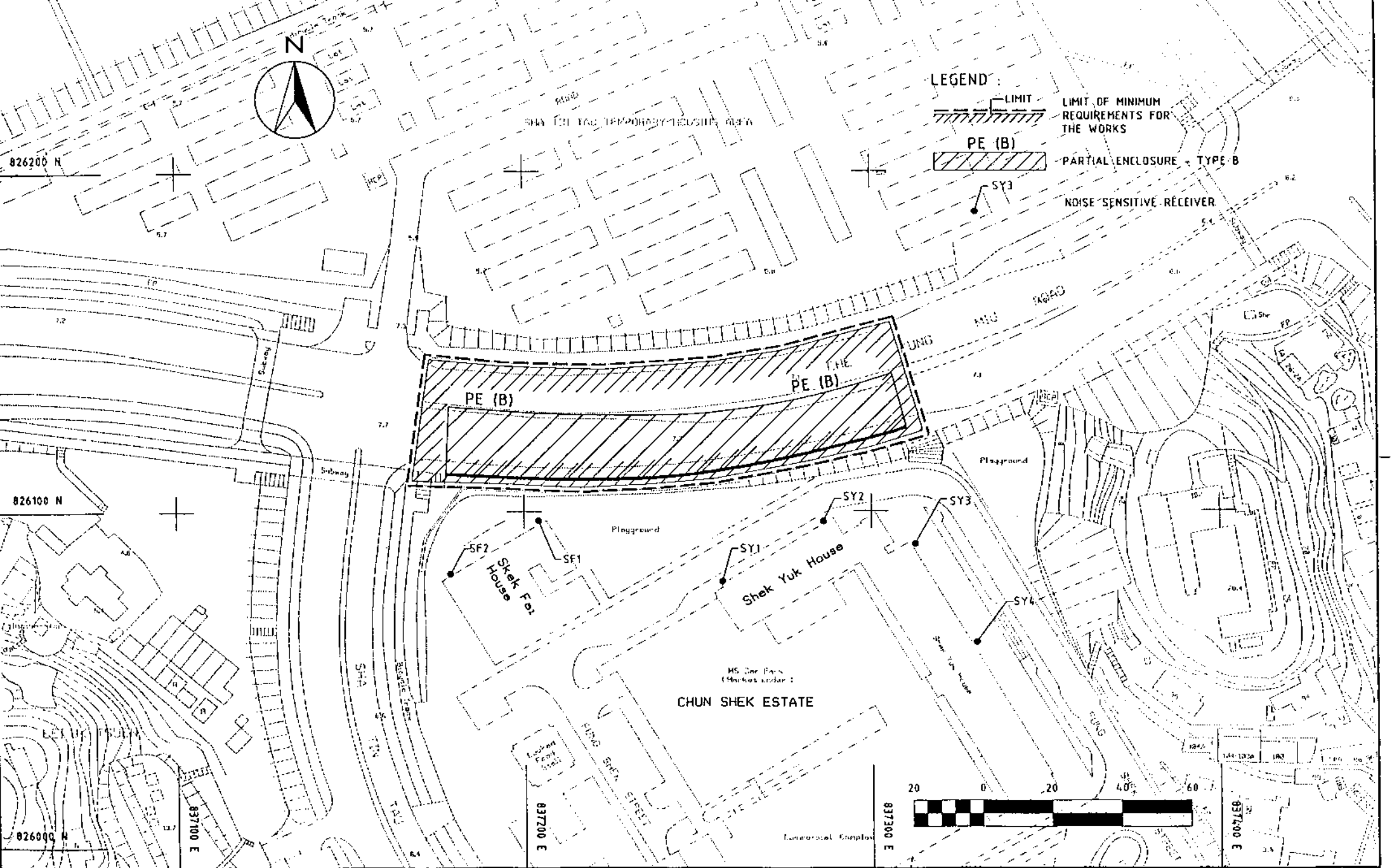
MITIGATION MEASURES FOR MA ON SHAN ROAD - RECOMMENDED OPTION

N.T.S

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-6A



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

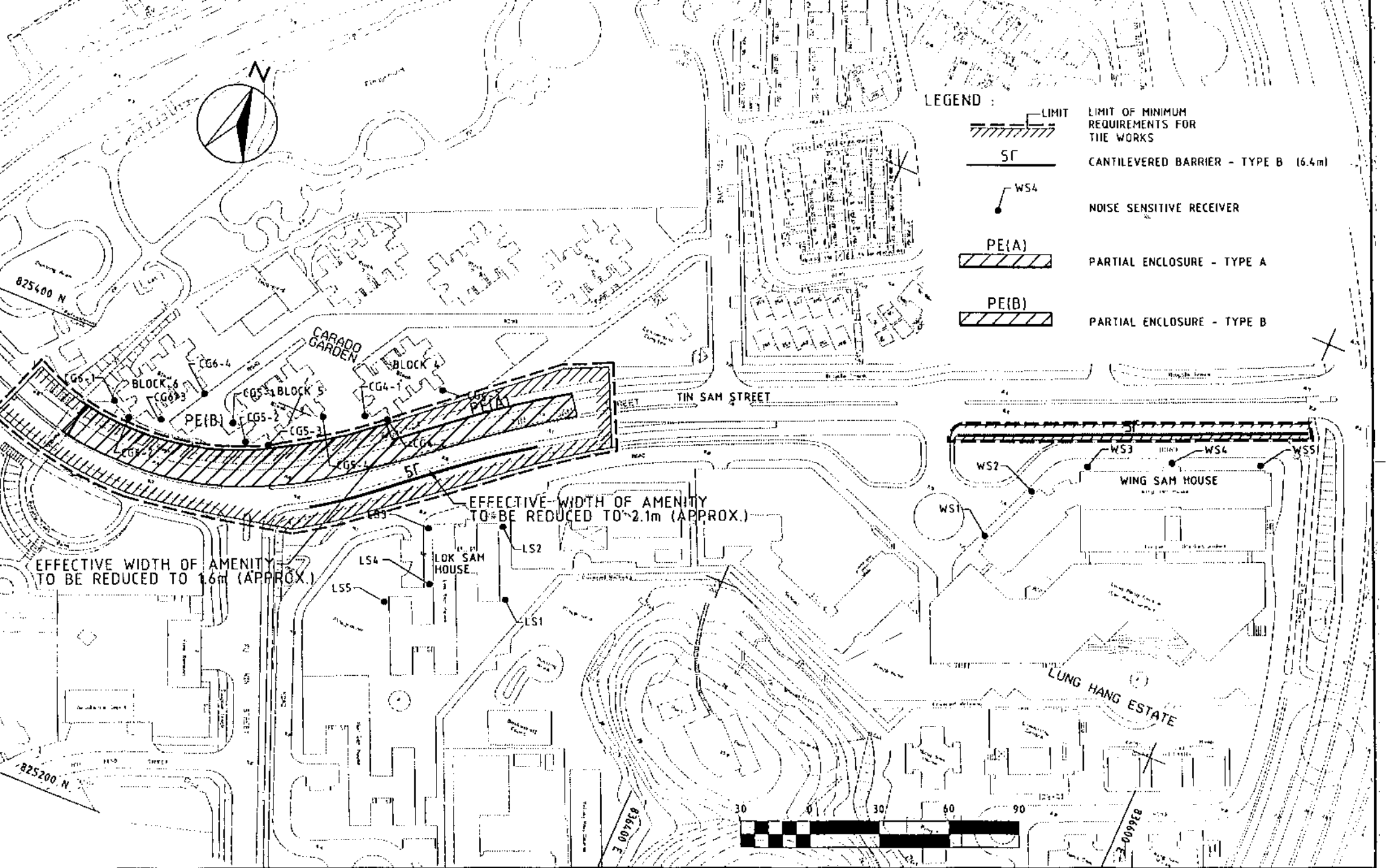
MITIGATION MEASURES FOR CHE KUNG MIU ROAD - RECOMMENDED OPTION

N.T.S

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-7



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

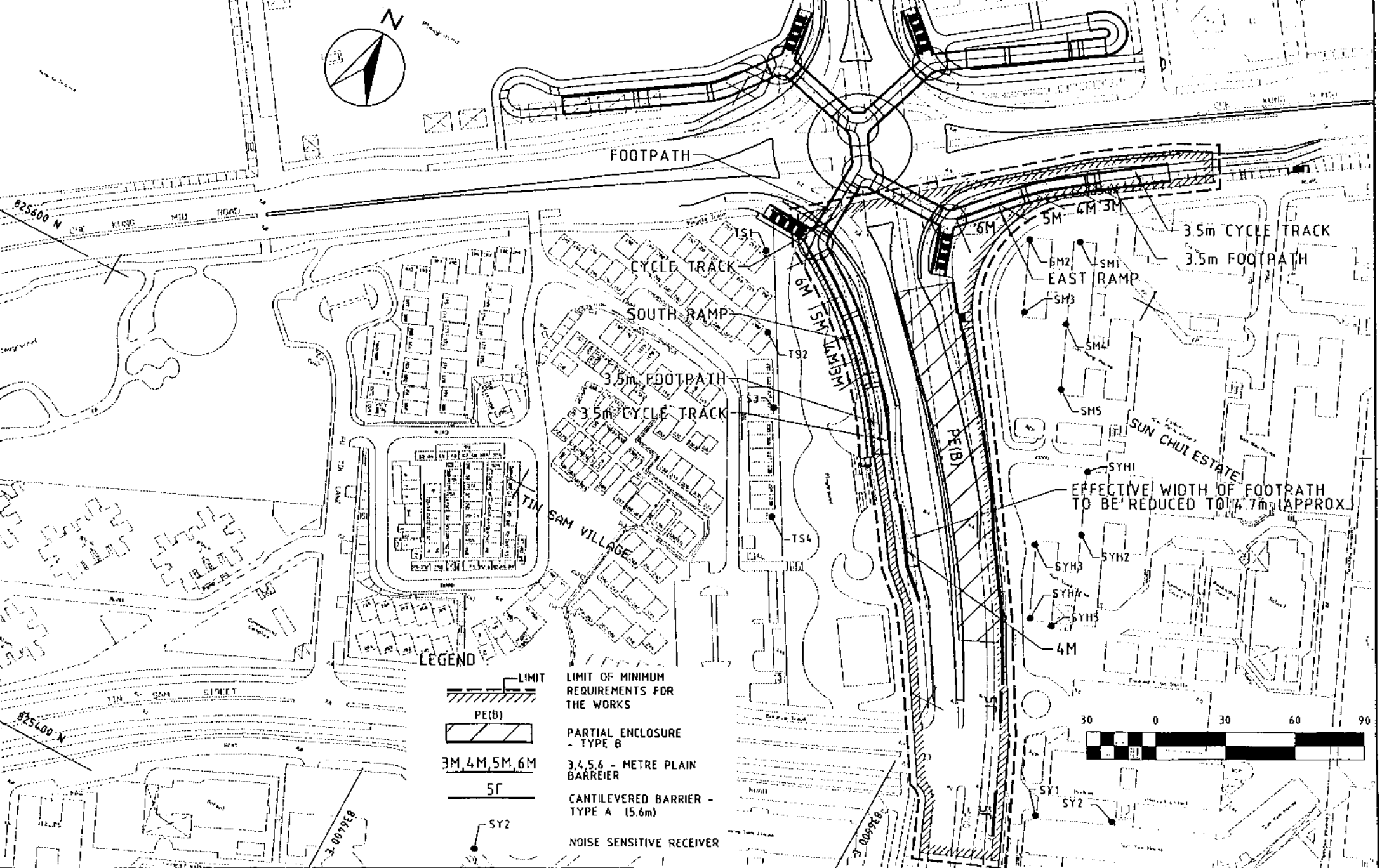
MITIGATION MEASURES FOR TIN SAM STREET - RECOMMENDED OPTION

N.T.S

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-8



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

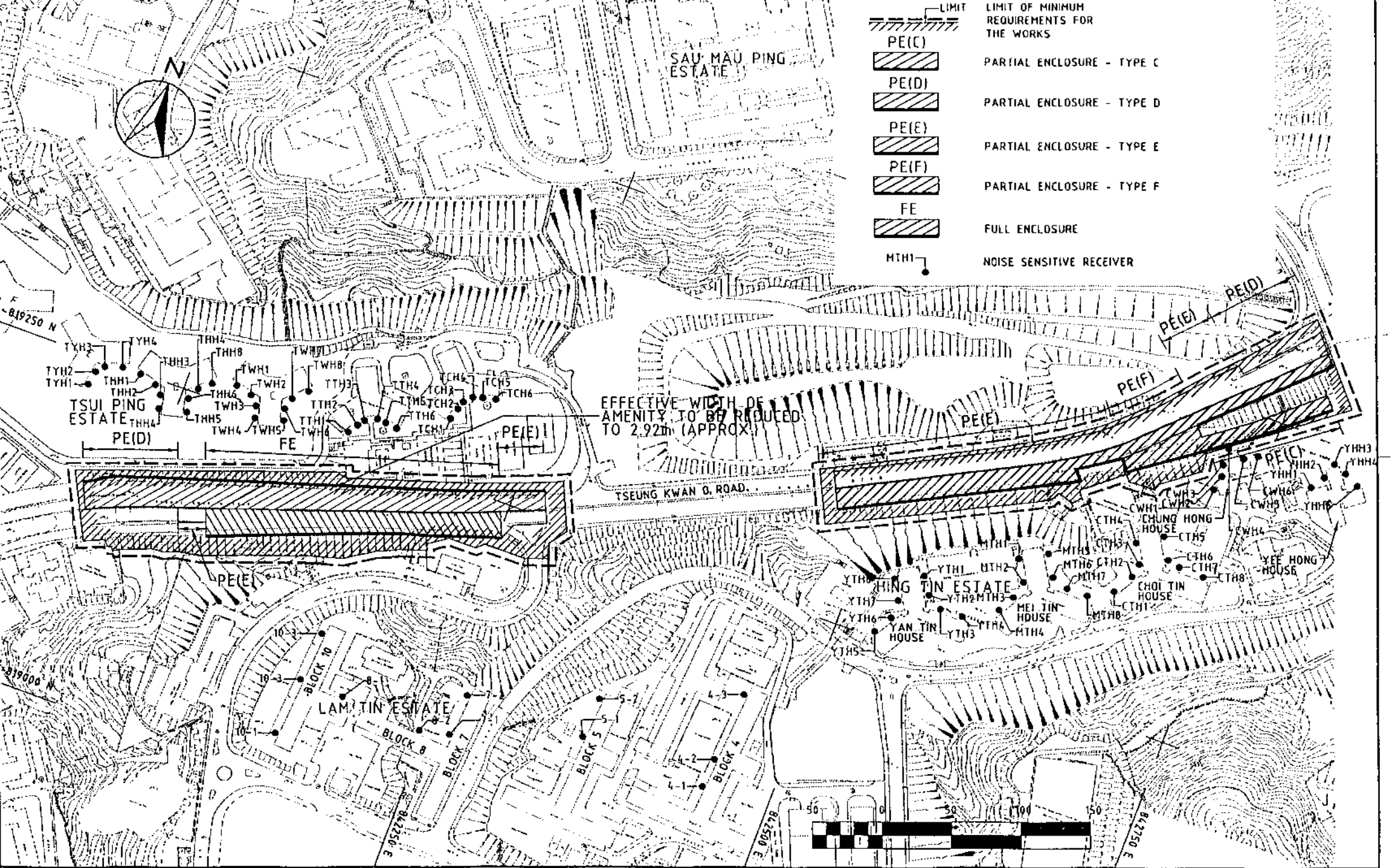
MITIGATION MEAUSRES FOR CHE KUNG MIU ROAD AND HUNG MUI KUK ROAD - RECOMMENDED OPTION

N.T.S

Maunsell
茂盛亞洲工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-9A



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

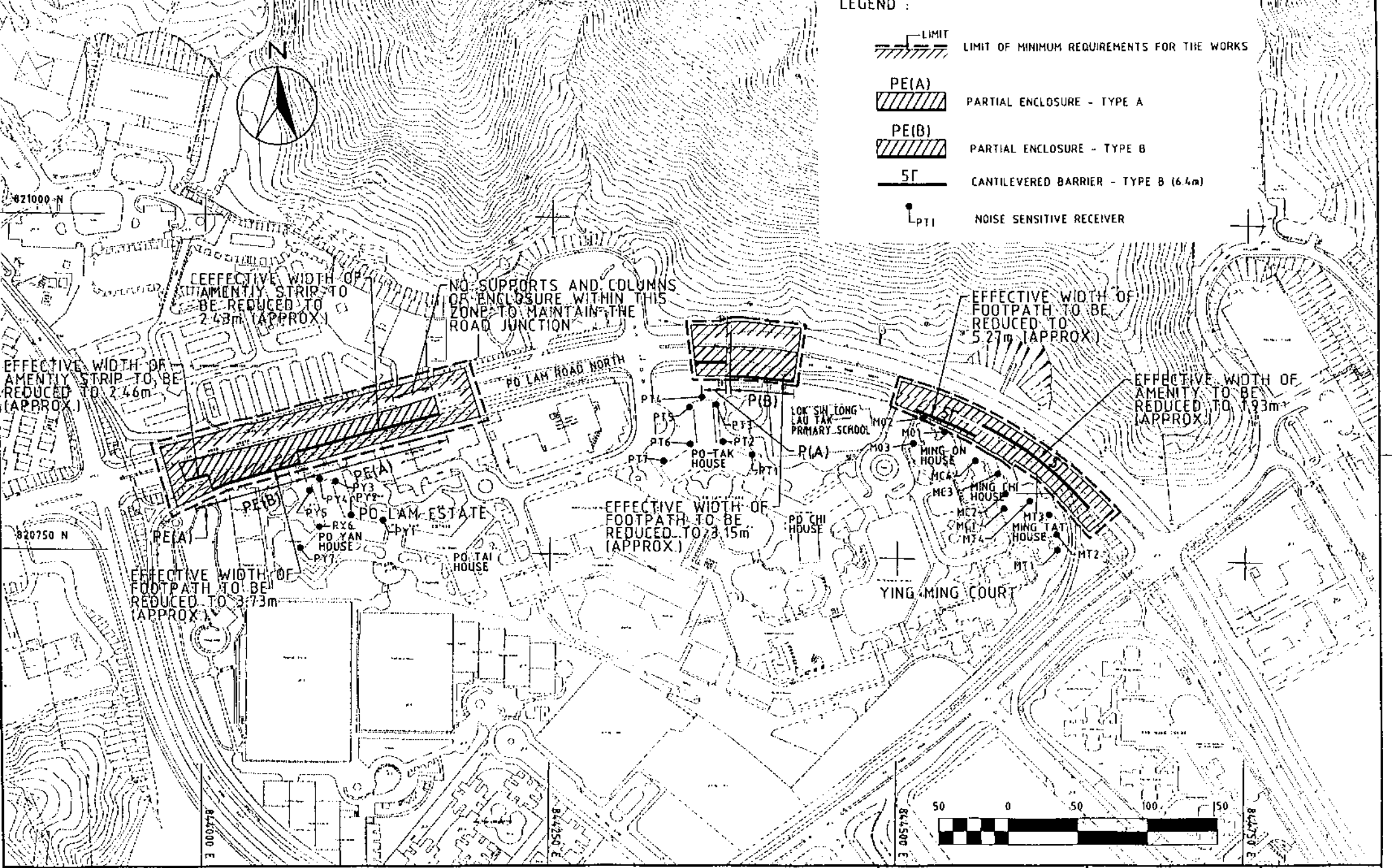
MITIGATION MEASURES FOR TSEUNG KWAN O ROAD - RECOMMENDED OPTION

N.T.S

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-10A



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

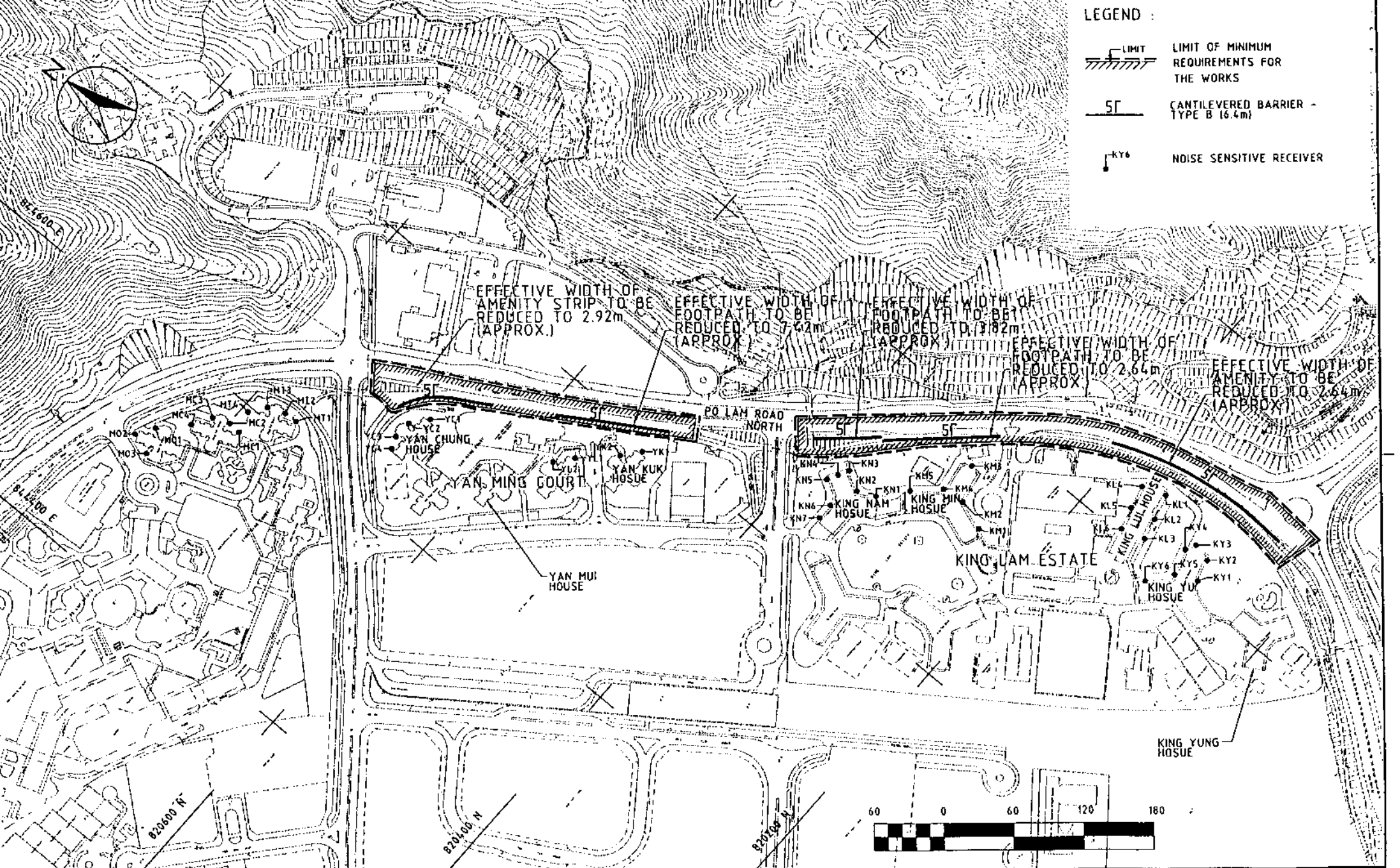
MITIGATION MEASURES FOR PO LAM ROAD NORTH AT PO LAM ESTATE AND YING MING COURT - RECOMMENDED OPTION

N.T.S

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-11A



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

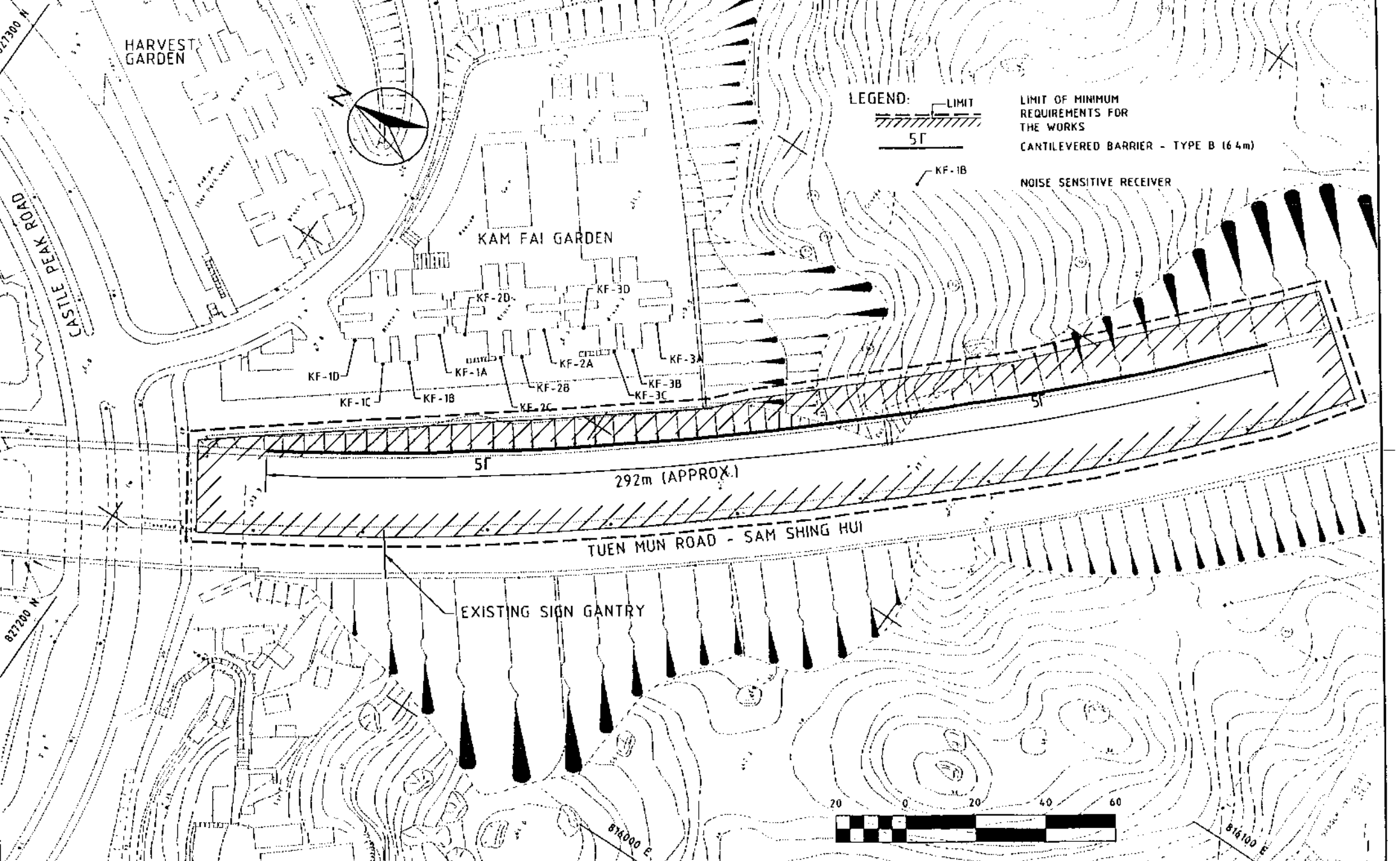
MITIGATION MEASURES FOR PO LAM ROAD NORTH AT YAN MING COURT AND KING LAM ESTATE - RECOMMENDED OPTION

N.T.S

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-12



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

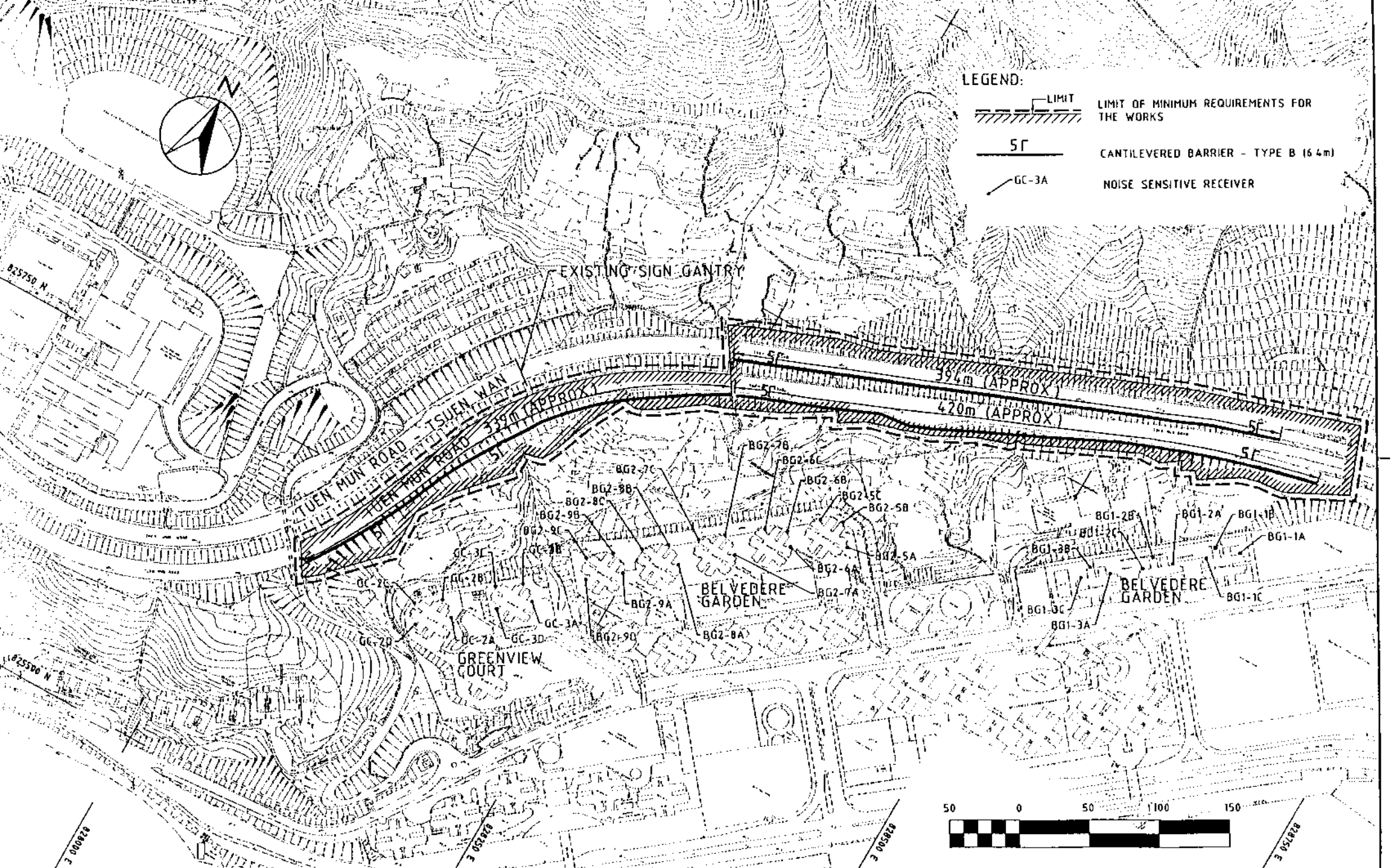
MITIGATION MEASURES FOR TUEN MUN ROAD, SAM SHING HUI - RECOMMENDED OPTION

N.T.S

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-13



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

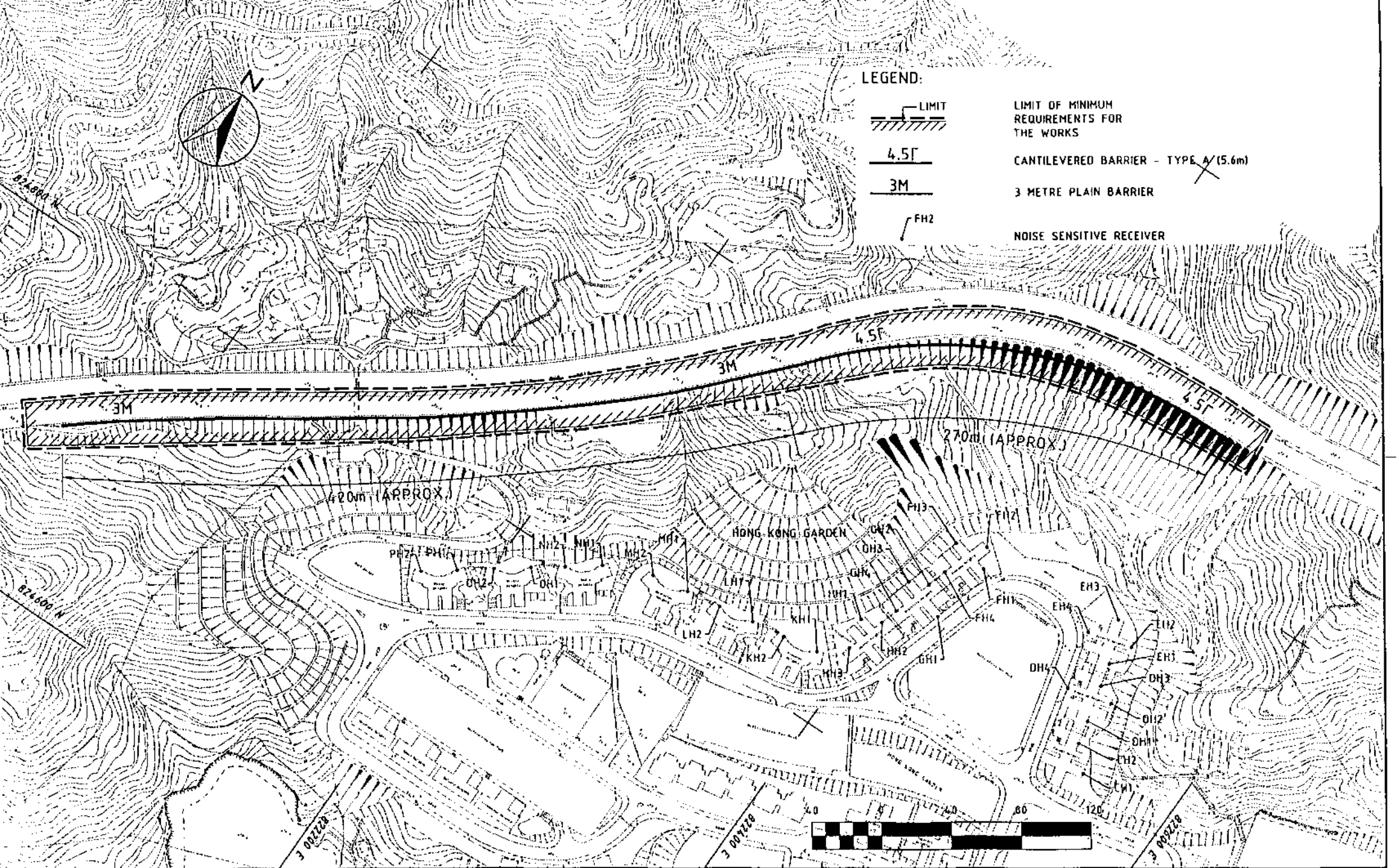
MITIGATION MEASURES FOR TUEN MUN ROAD, TSUEN WAN - RECOMMENDED OPTION

N.T.S

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-14A



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

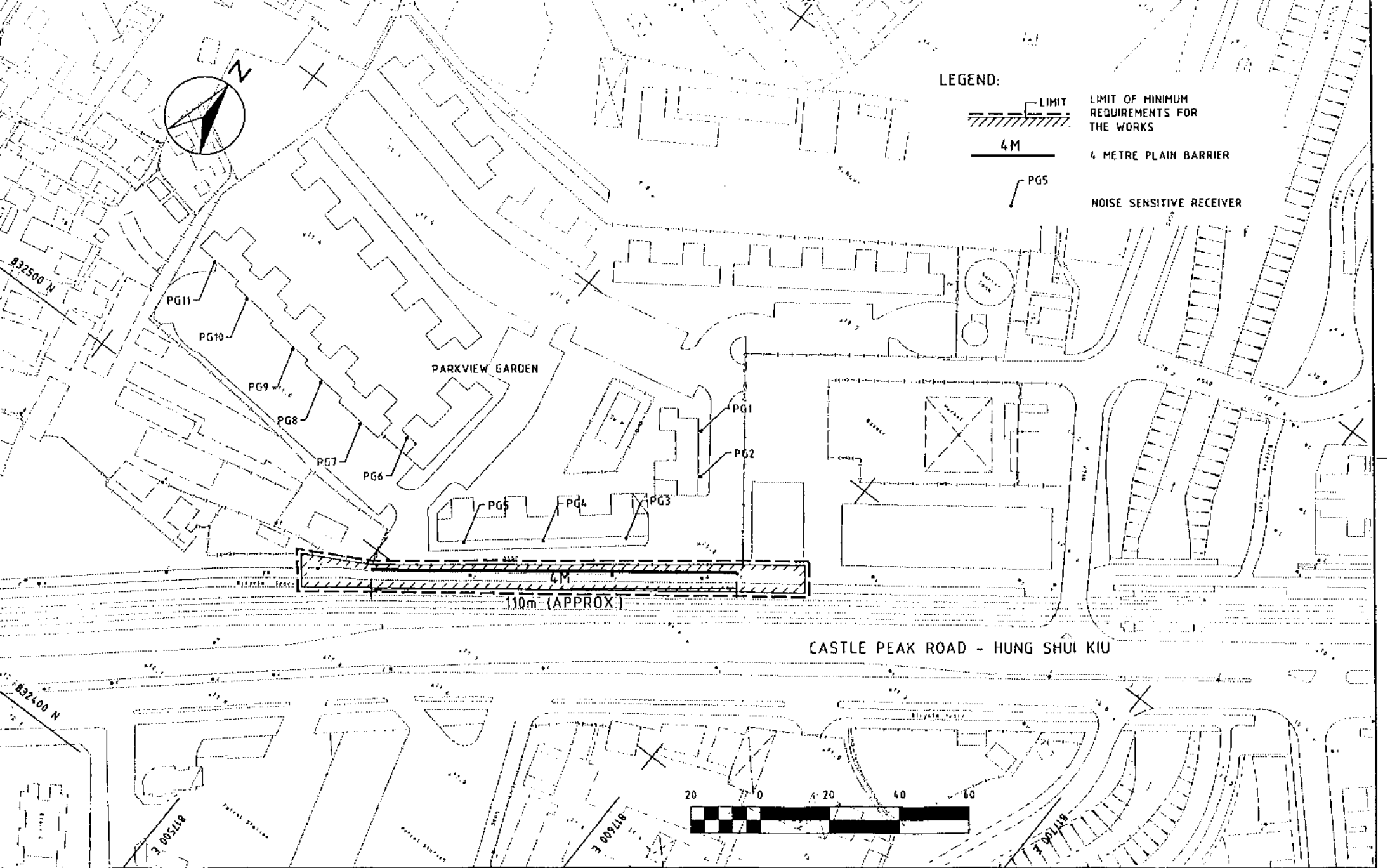
MITIGATION MEASURES FOR TUEN MUN ROAD, TSING LUNG TAU - RECOMMENDED OPTION

N.T.S

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-15A



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

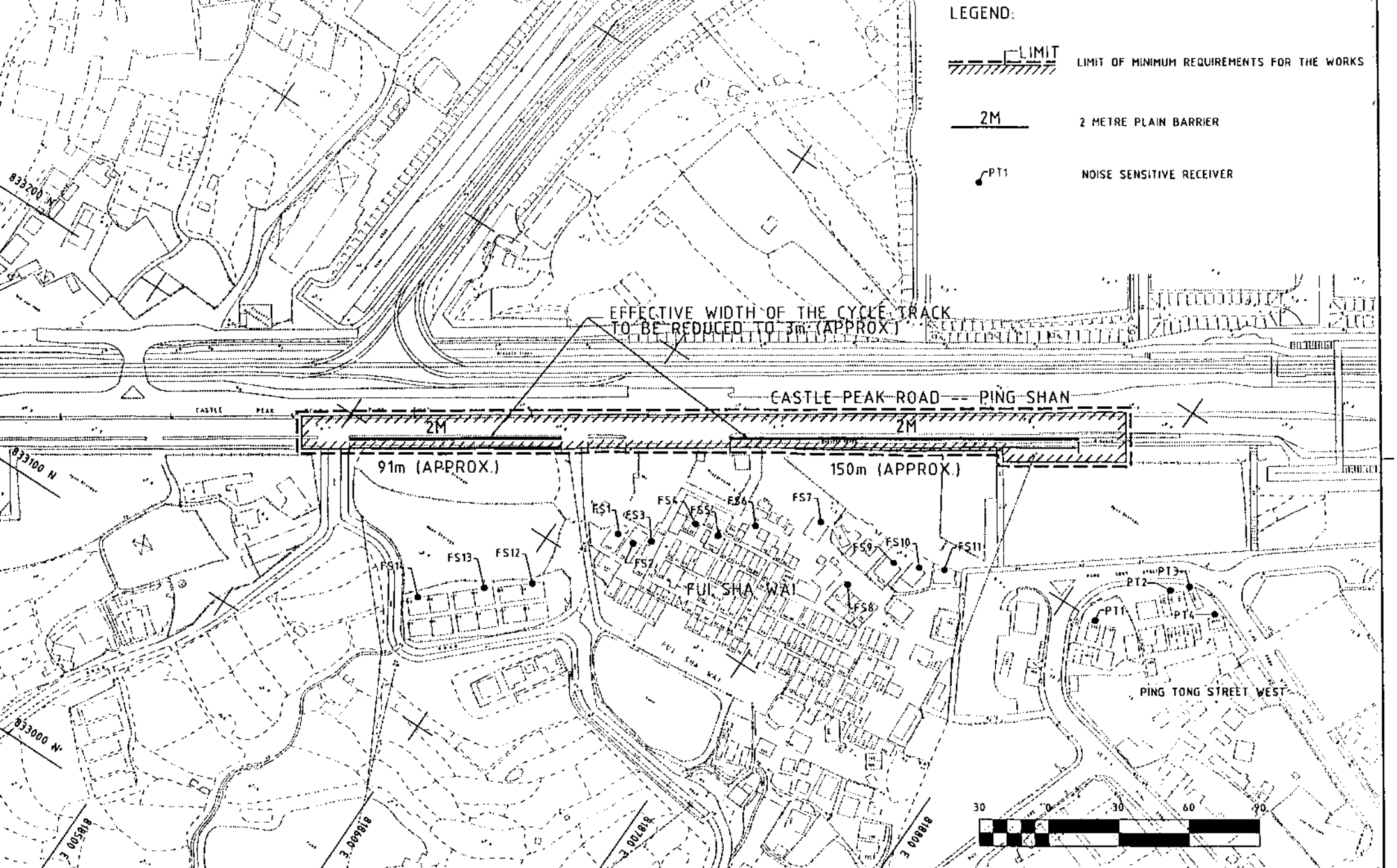
MITIGATION MEASURES AT CASTLE PEAK ROAD, HUNG SHUI KIU - RECOMMENDED OPTION

N.T.S

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-16



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

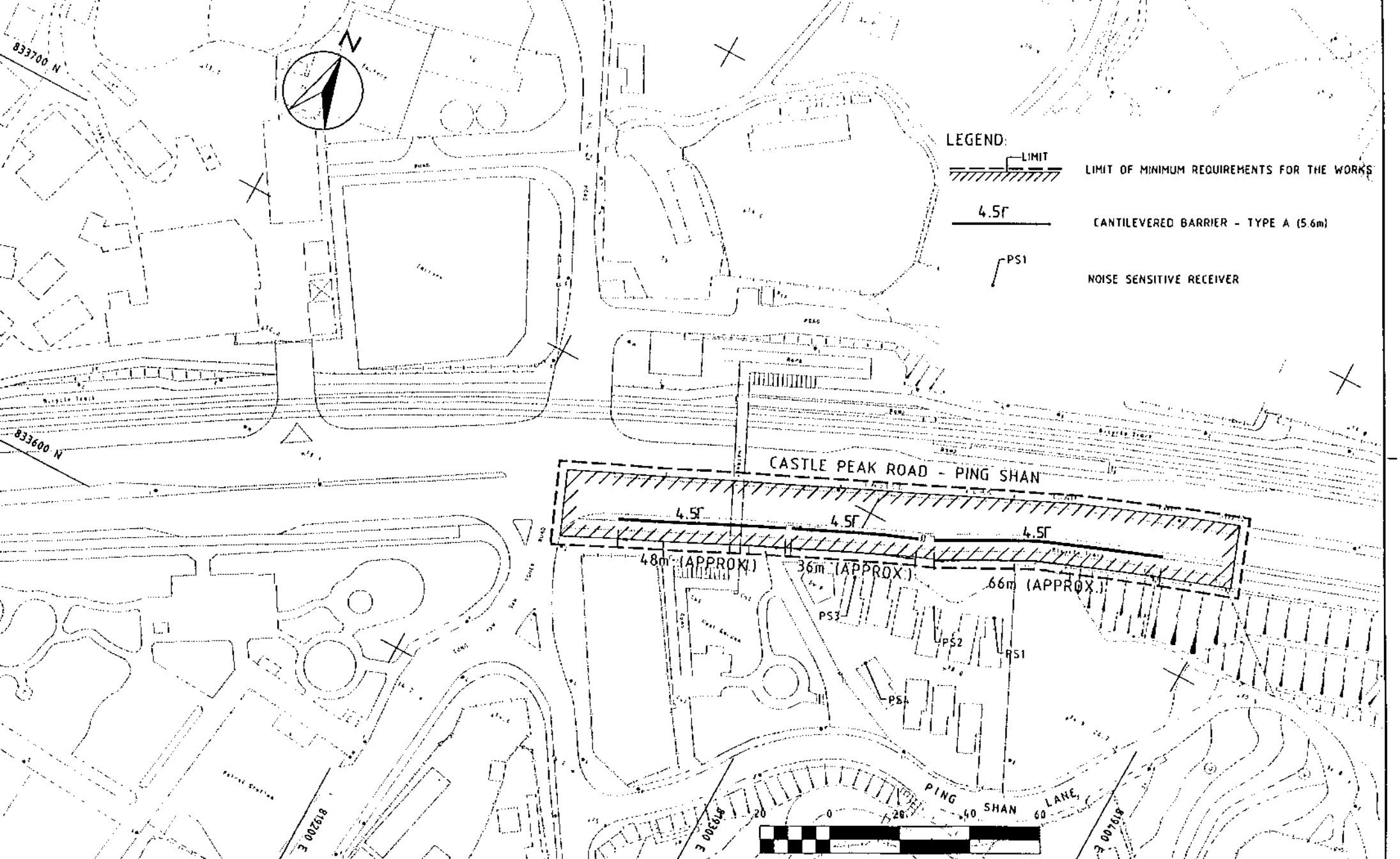
MITIGATION MEASURES FOR CASTLE PEAK ROAD, PING SHAN - RECOMMENDED OPTION

N.T.S

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-17



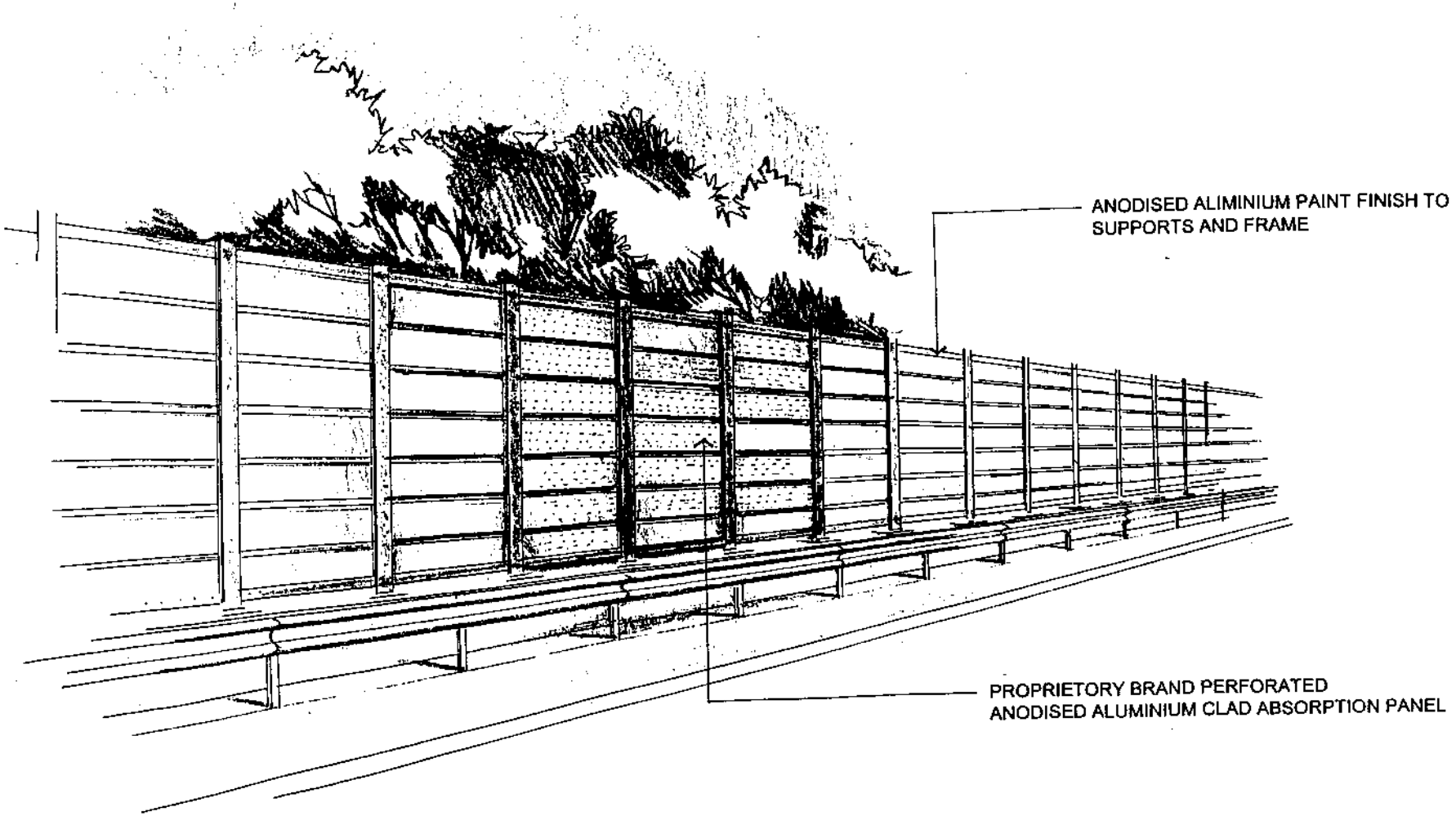
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

MITIGATION MEASURES FOR CASTLE PEAK ROAD, PING SHAN - RECOMMENDED OPTION

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 7-18A



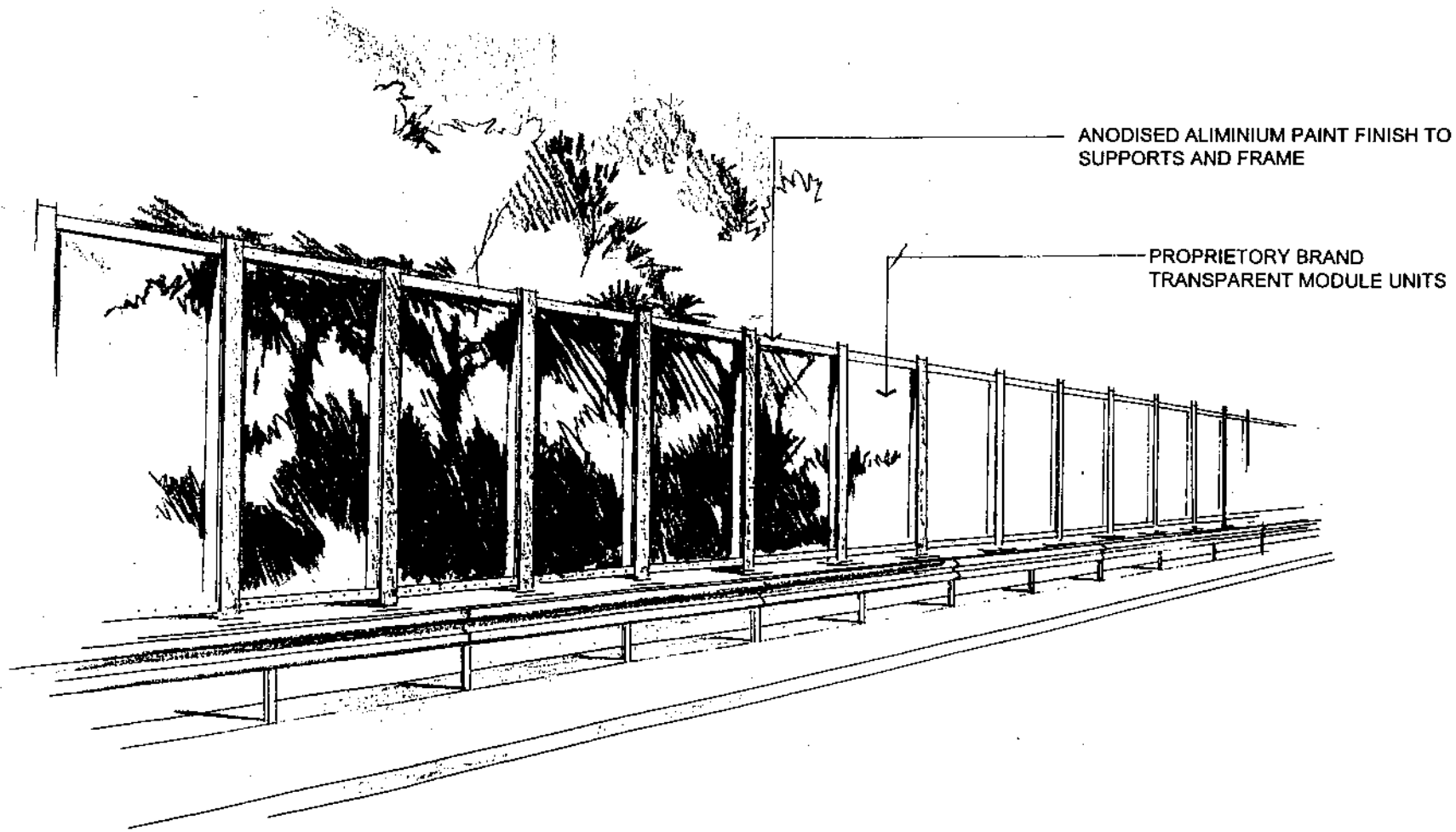
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

VERTICAL NOISE BARRIER (ABSORPTIVE)

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO. 95796

FIGURE: FIG 7-19



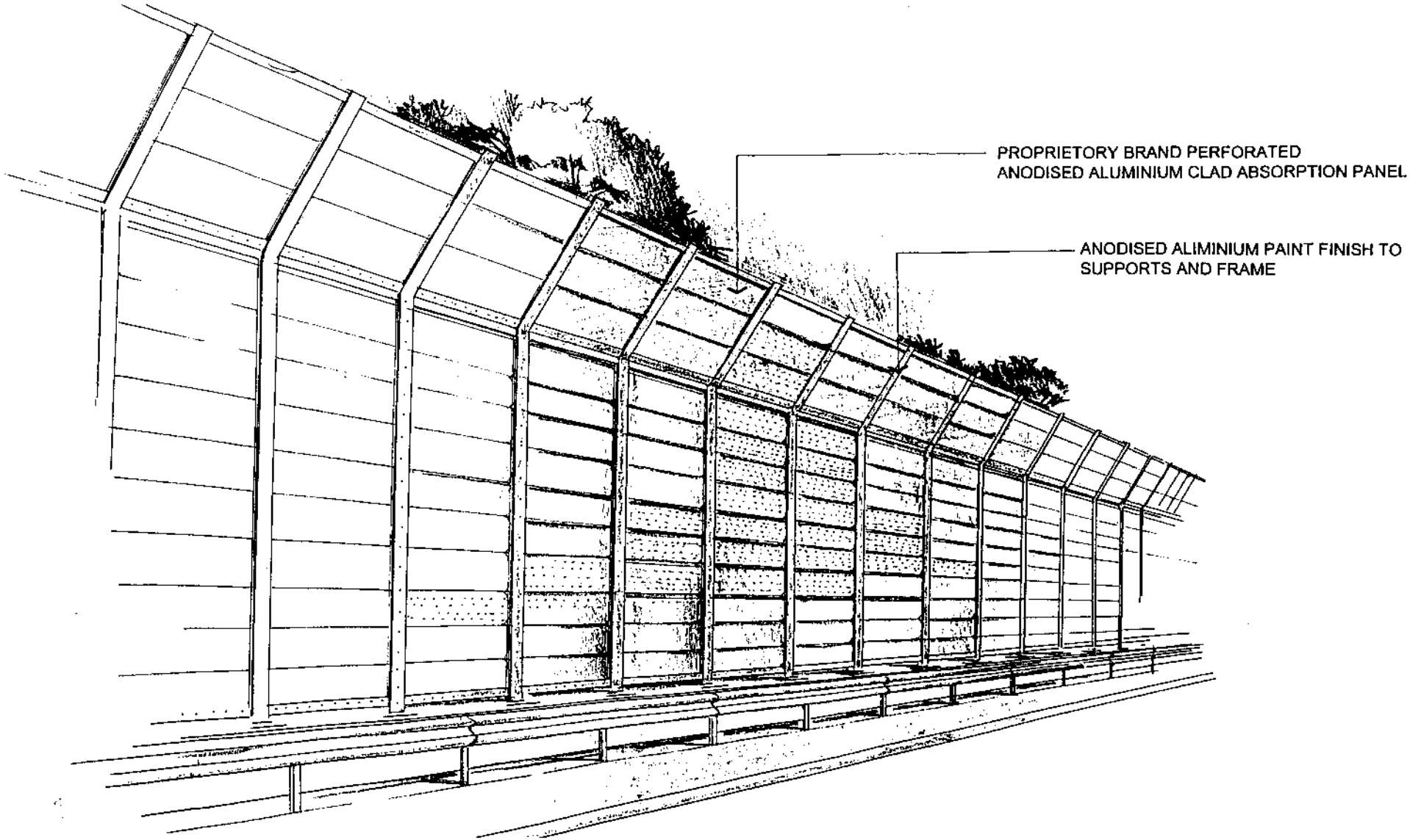
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

VERTICAL NOISE BARRIER (REFLECTIVE)

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO. 95796

FIGURE: FIG 7-20



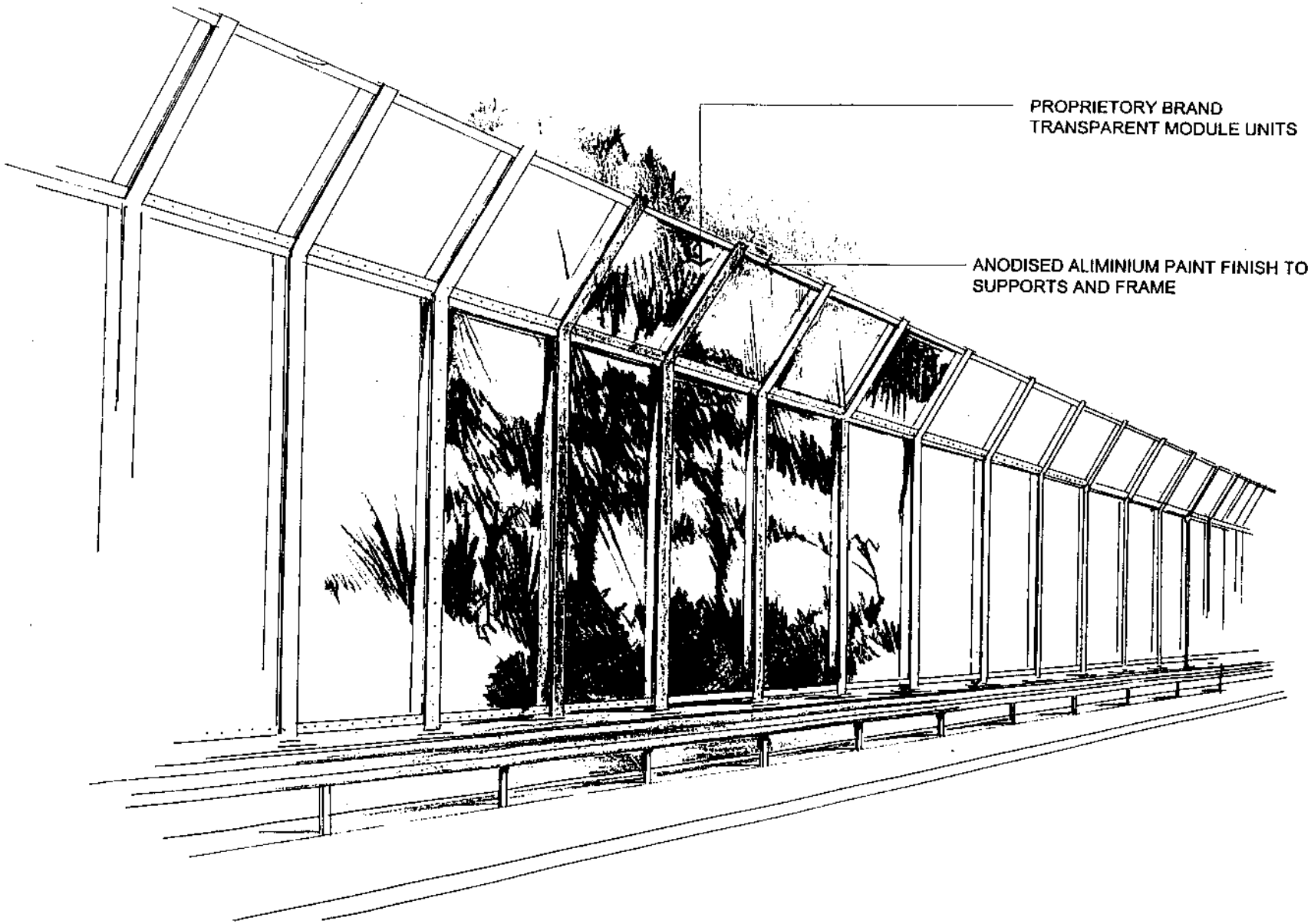
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

VERTICAL NOISE BARRIER (ABSORPTIVE)

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO. 95796

FIGURE: FIG 7-21



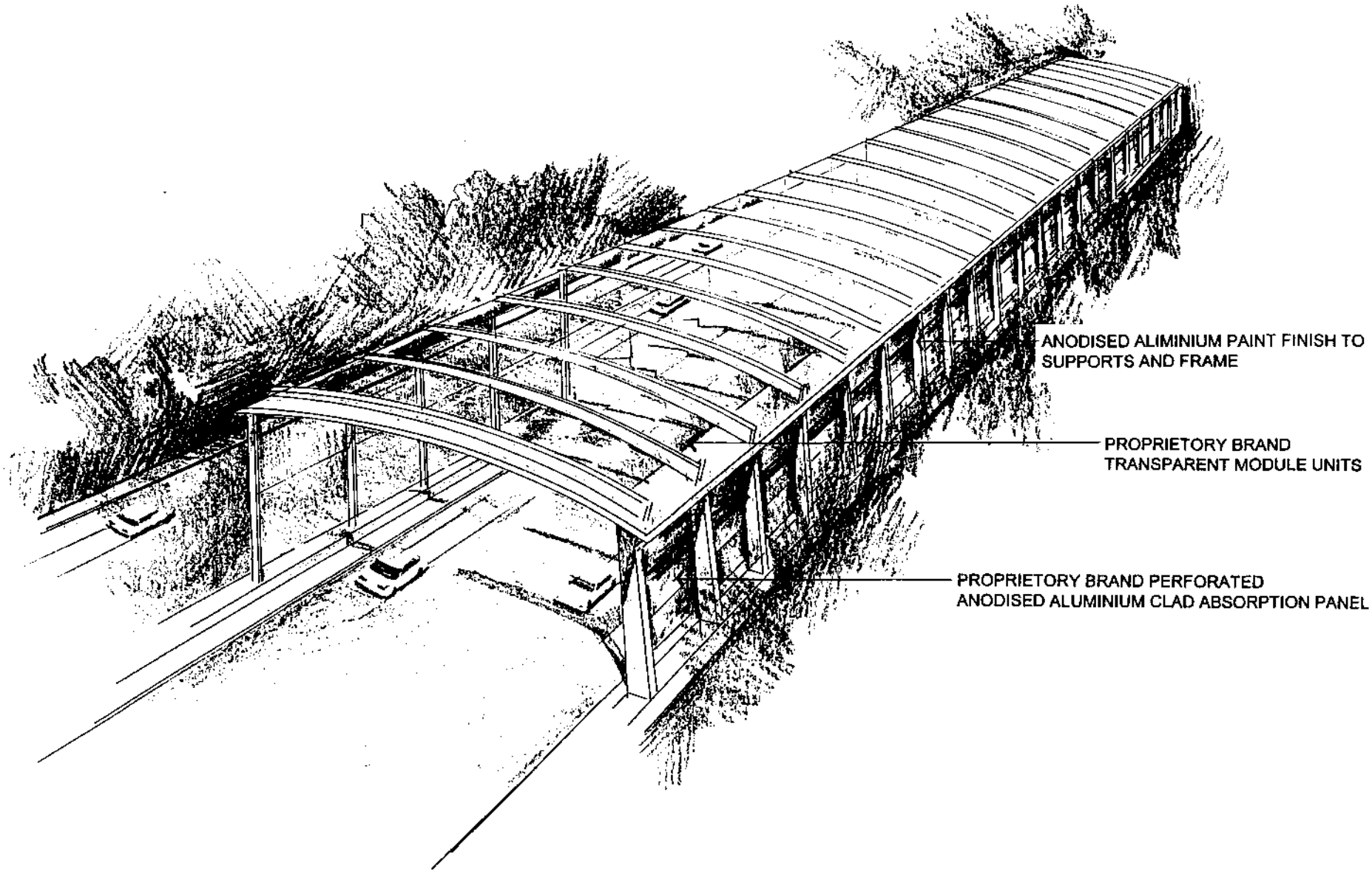
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

CANTILEVERED NOISE BARRIER (REFLECTIVE)

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO. 95796

FIGURE: FIG 7-22



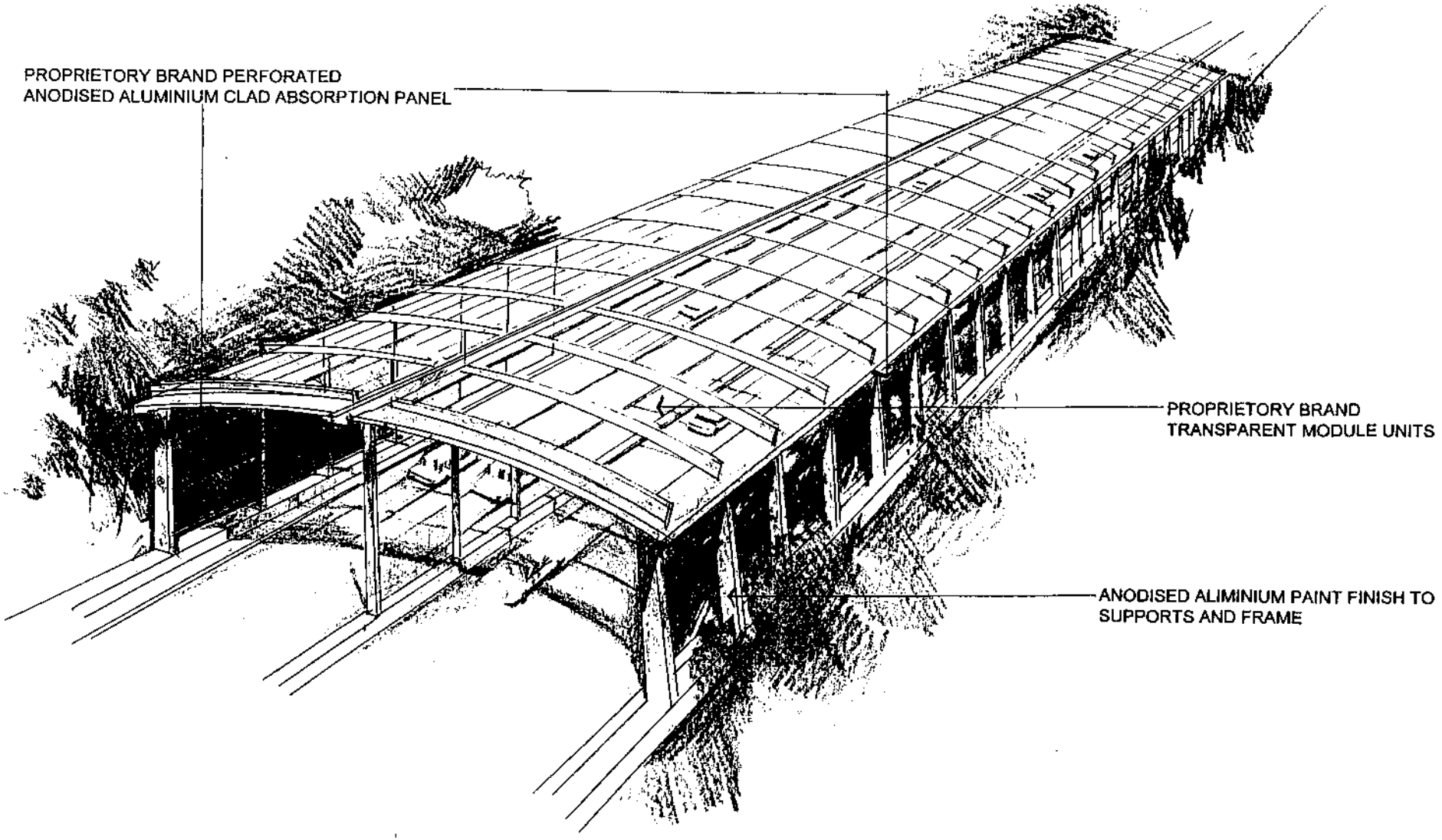
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

PARTIAL ENCLOSURE NOISE BARRIER

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO. 95796

FIGURE: FIG 7-23



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

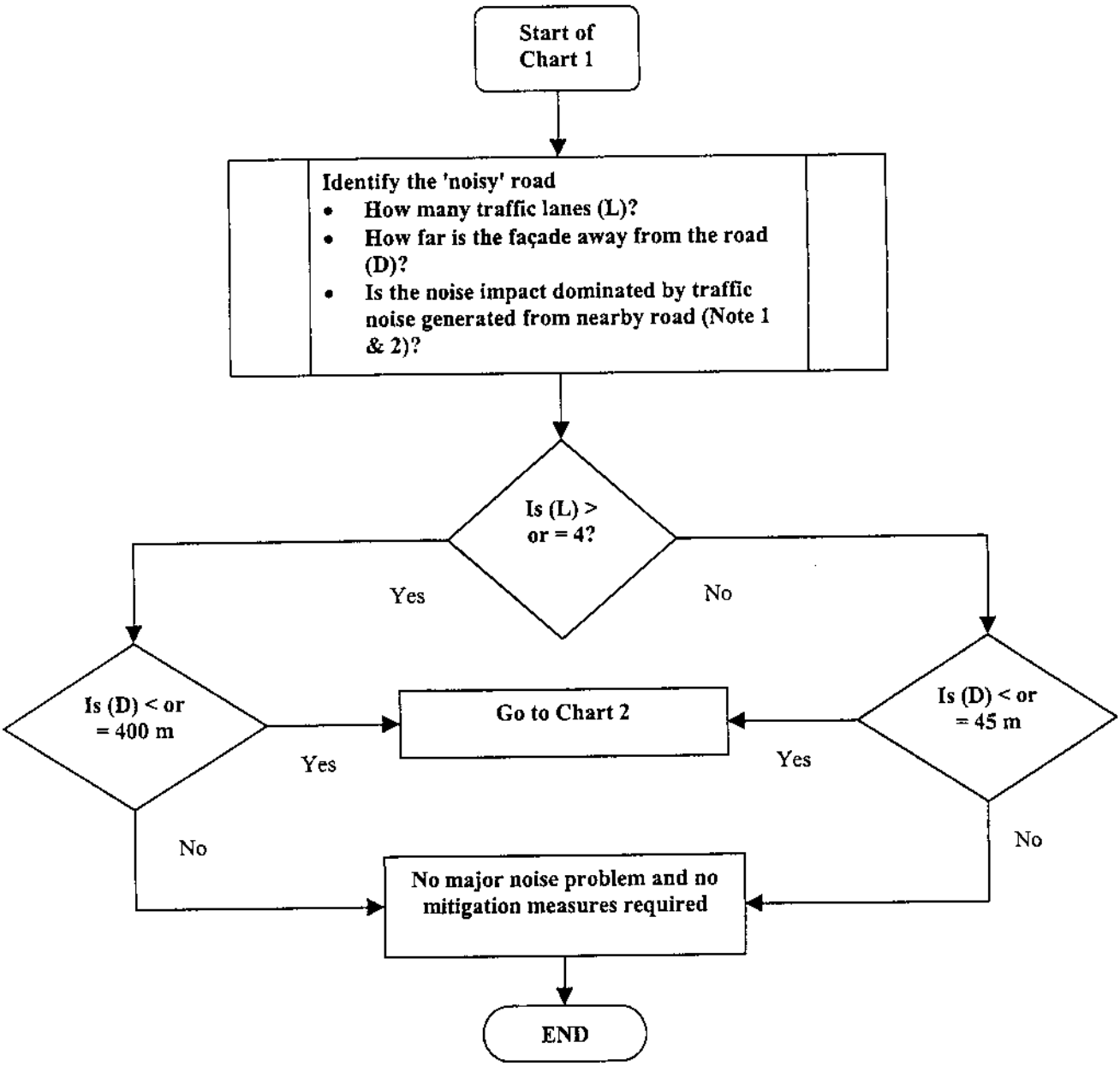
FULL ENCLOSURE NOISE BARRIER

Maunsell
茂盛(亞洲)工程顧問有限公司

JOB NO. 95796

FIGURE: FIG 7-24

Chart 1 - Identification of Problems



Note 1: If the noise impact is dominated by traffic noise generated from other roads i.e. roads other than the one under investigation, no practical scheme should be provided for the road under investigation.

Note 2: Noise impacts from other roads are considered predominant if the following conditions apply:

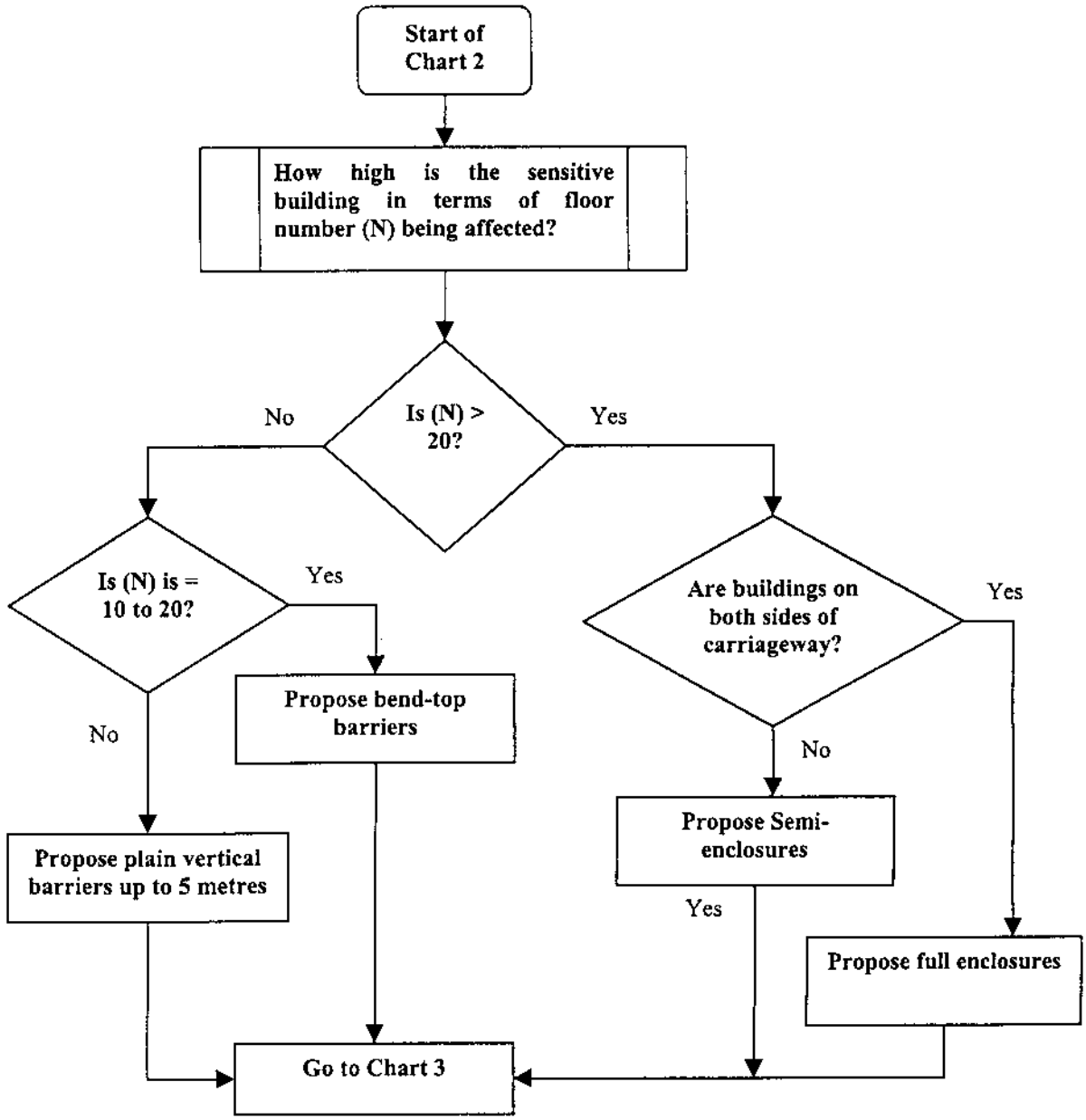
(a) Case 1: Other road has more or equal number of traffic lanes
The road is 50% closer to the receiver than the road under investigation, while the angle of view of the road is no less than 50%.

(b) Case 2: Other road has 50 % lesser number of traffic lanes*
The road is more than 80% closer to the receiver while the angle of view of the road is similar.

* In general, a single two-lane carriageway carries 800 vehicles per hour in two directions while a four-lane single carriageway or a dual two-lane carriageway carries 2,400 to 2,800 vehicles per hour in one direction

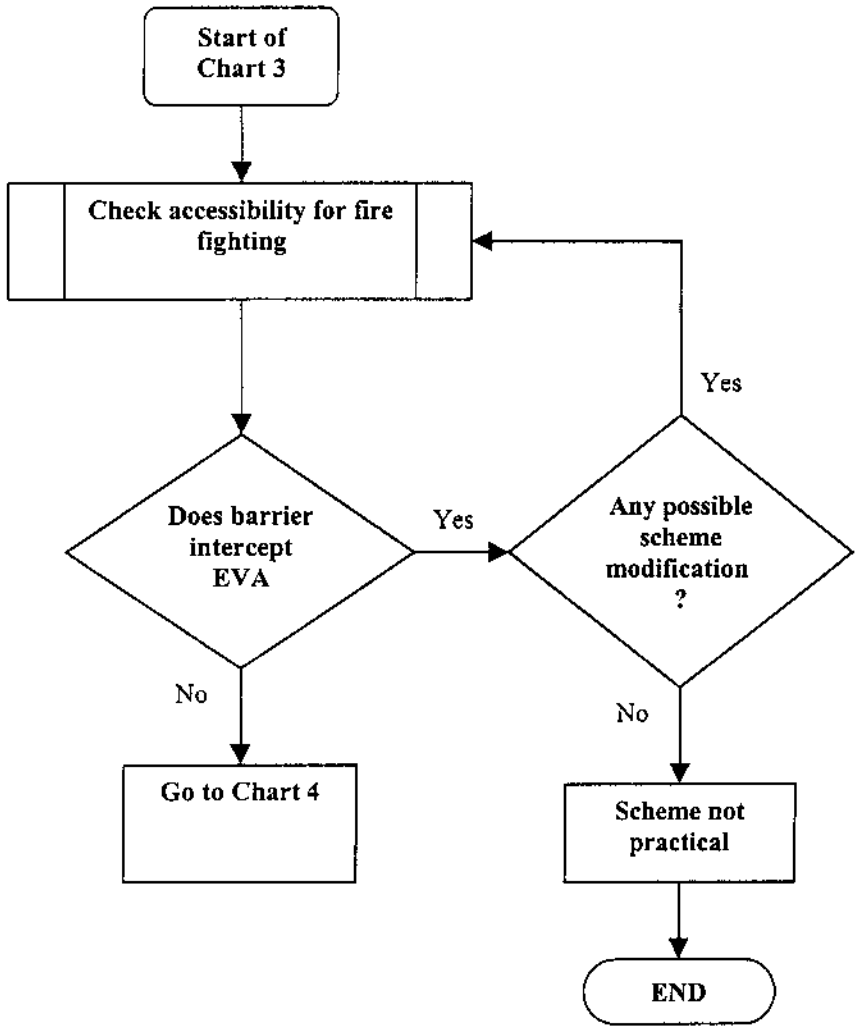
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES CHART 1 - IDENTIFICATION OF PROBLEMS	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO. 95796	FIGURE: FIG 8-2

Chart 2 - Selection of Barrier Forms



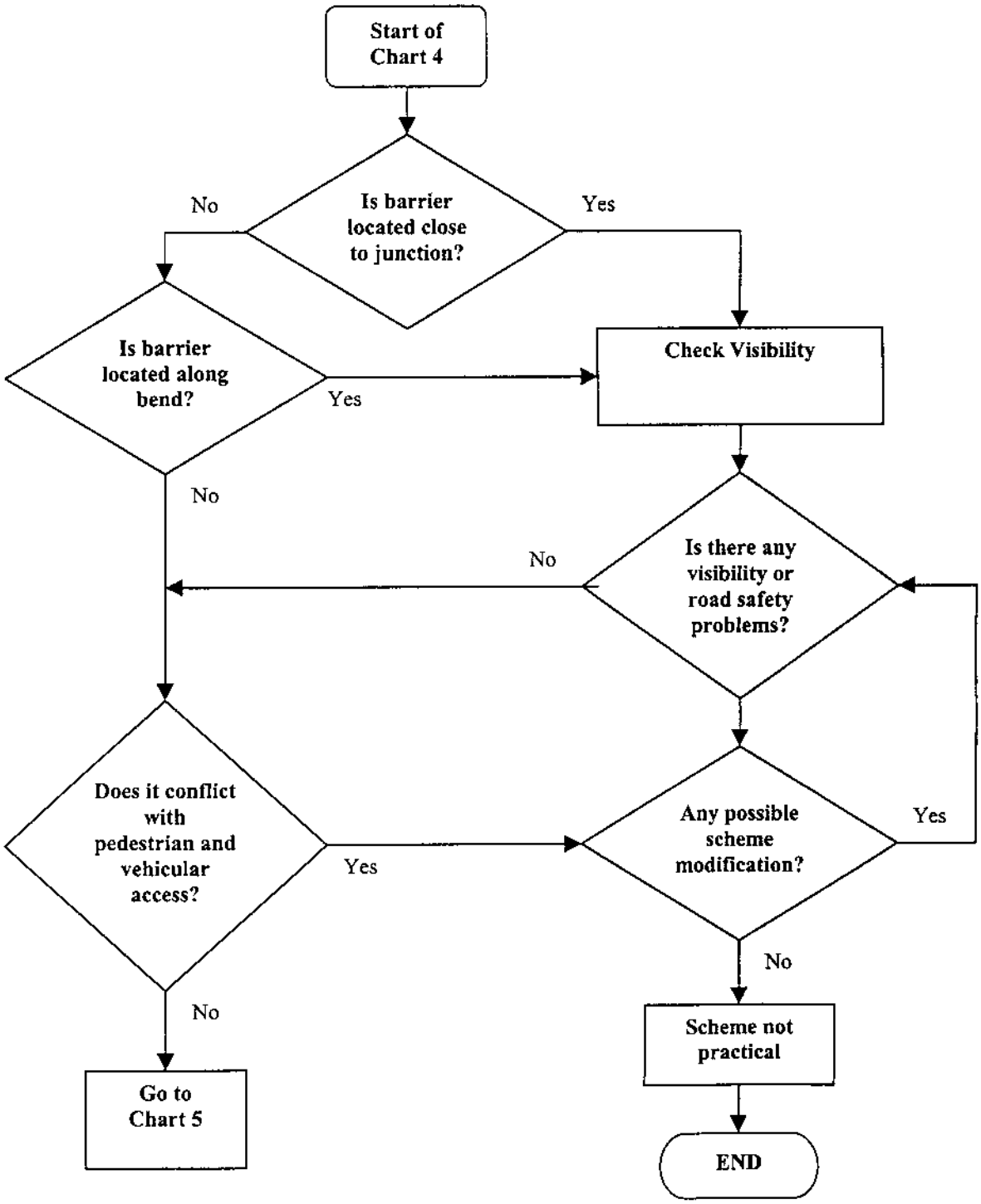
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES CHART 2 - SELECTION OF BARRIER FORMS	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO. 95796	FIGURE: FIG 8-3

Chart 3 - Emergency Access Consideration



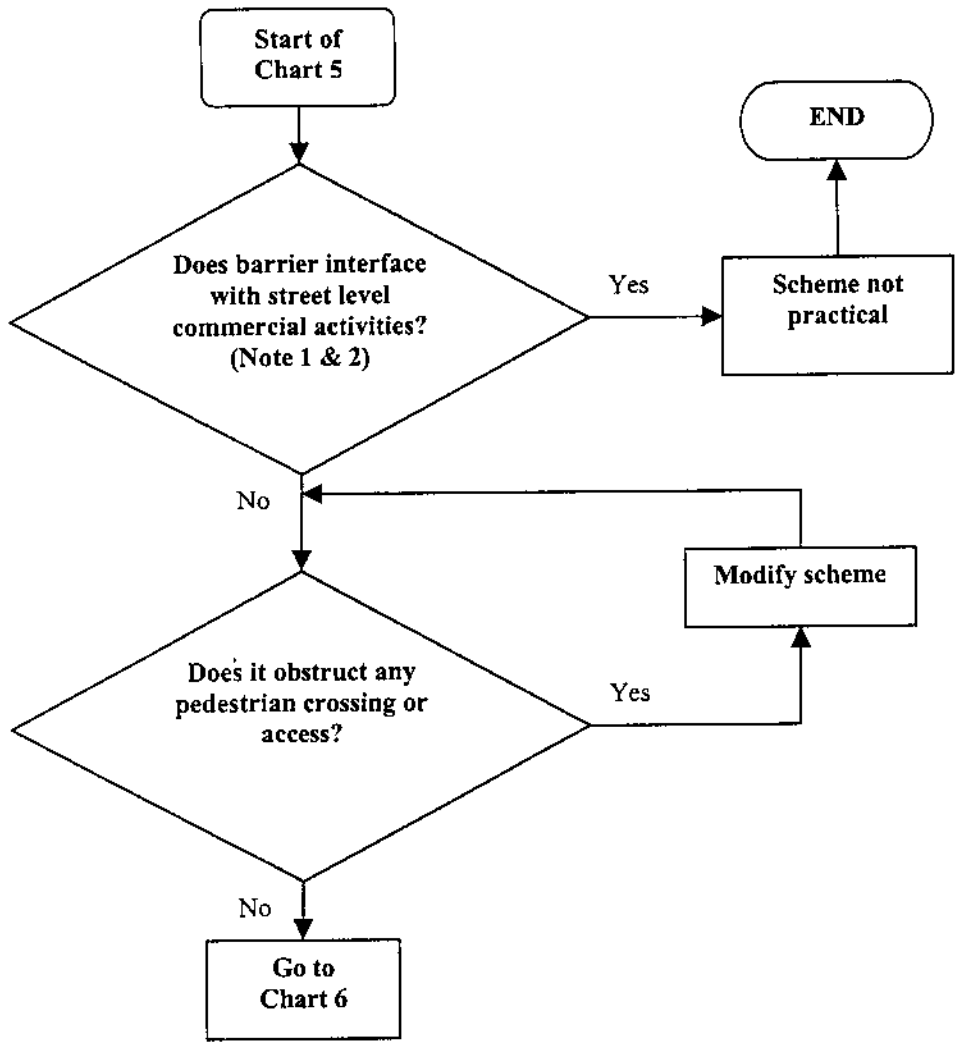
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES CHART 3 - EMERGENCY ACCESS CONSIDERATION	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO. 95796	FIGURE: FIG 8-4

Chart 4 - Road Safety Consideration



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES CHART 4 - ROAD SAFETY CONSIDERATIONS	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO. 95796	FIGURE: FIG 8-5

Chart 5 - Socio-economic Consideration

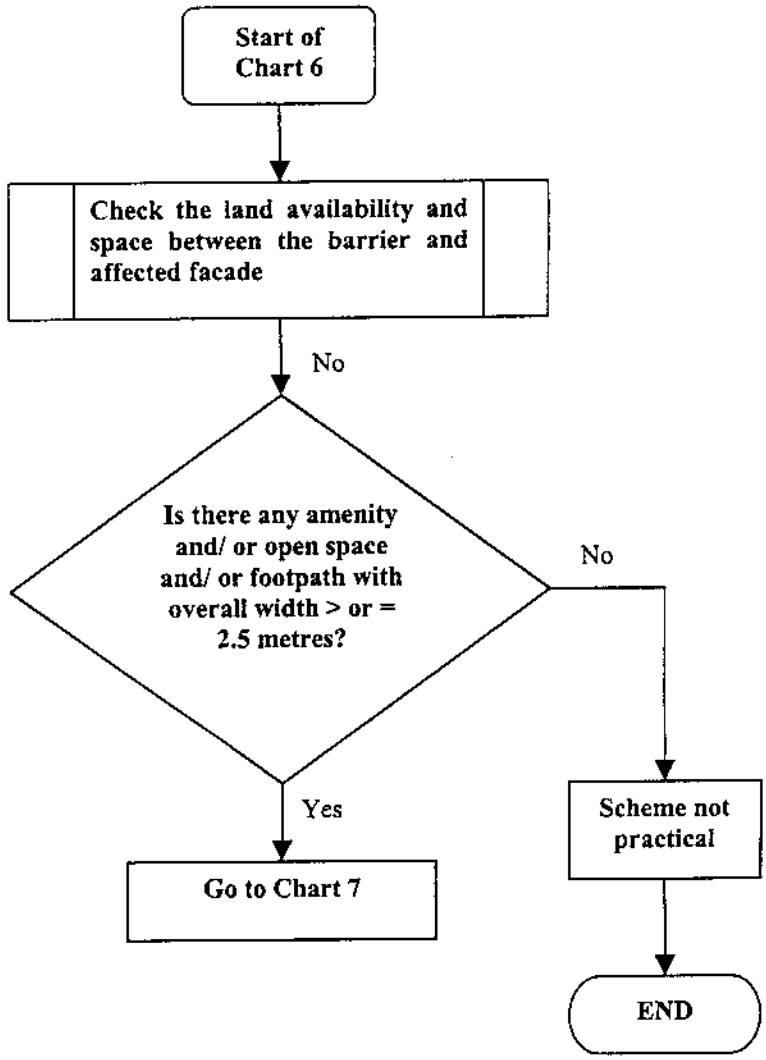


Note 1: Street level commercial activities include all shops, restaurant, cinemas, etc.

Note 2: Street level commercial activities are considered to be seriously interfered when the clearance between the affected shops, restaurant, cinemas, etc and the identified barrier is less than 10 metres.

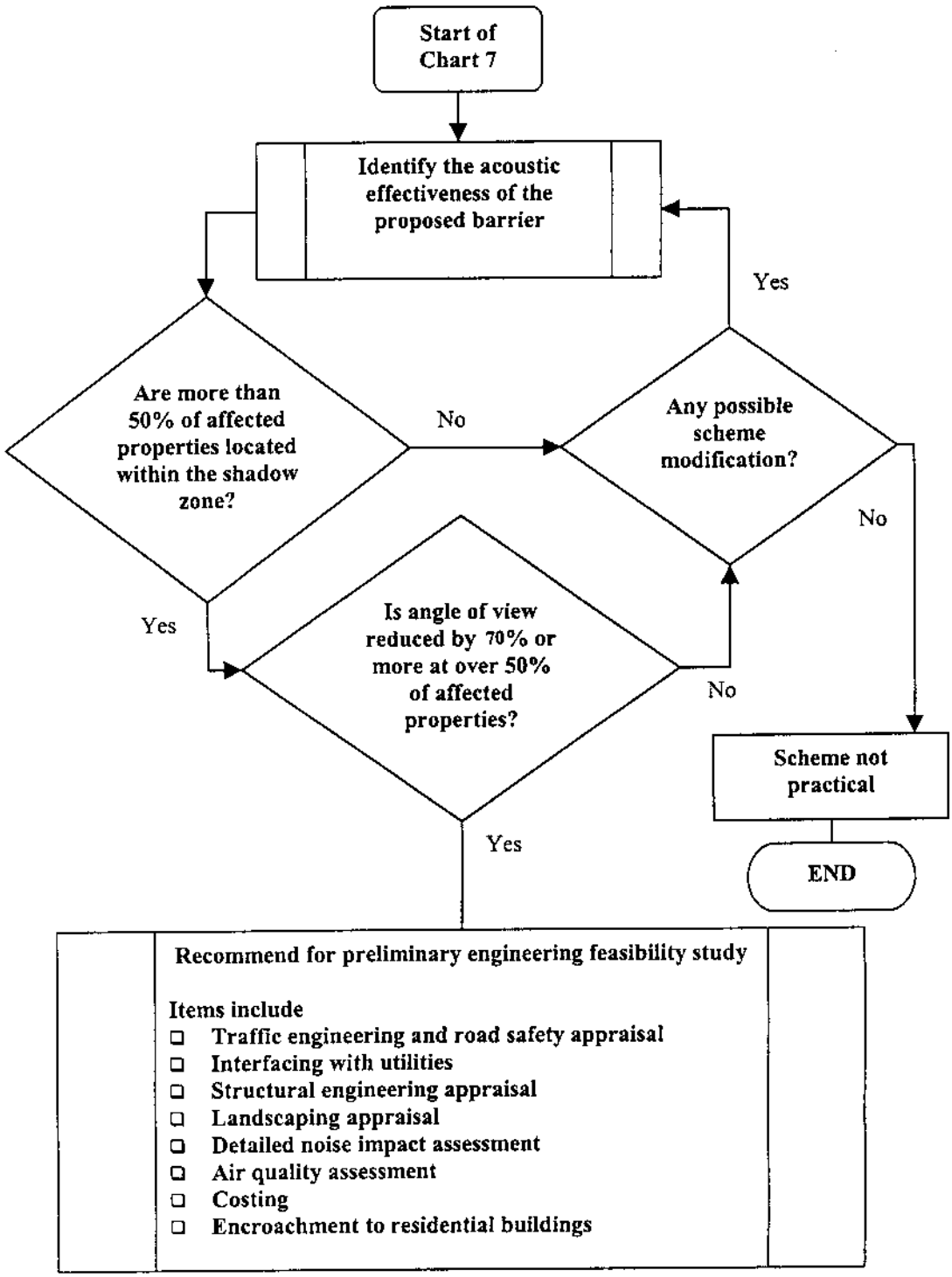
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES CHART 5 - SOCIO-ECONOMIC CONSIDERATIONS	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO. 95796	FIGURE: FIG 8-6

Chart 6 - Land Availability



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES CHART 6 - LAND AVAILABILITY	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO. 95796	FIGURE: FIG 8-7

Chart 7 - Acoustic Effectiveness



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES CHART 7 - ACOUSTIC EFFECTIVENESS	Maunsell 茂盛(亞洲)工程顧問有限公司	JOB NO. 95796	FIGURE: FIG 8-8

APPENDICES

Appendix A **Application of the proposed Working Tools for Cheung Pei Shan Road**

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) > 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Form

Start of Chart 2 → floor number (N) > 20 along westbound carriageway and 10 < N < 20 along eastbound carriageway → buildings on one side of the carriageway → propose semi-enclosure alongside westbound carriageway and 3m plain barrier and 4.5m bend-top barrier alongside eastbound carriageway → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → barrier intercept EVA fronting Tsui Shan House → modify the scheme by deletion of 110m partial enclosure fronting Tsui Shan House → check accessibility for fire fighting again → no interception with EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → barrier is not located close to junction → barrier is not located along bend → no conflict with pedestrian and vehicular access → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → creates no impact on street level commercial activities → creates no obstruction to pedestrian crossing or access → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → the existing westbound footpath and open space > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A **Application of the proposed Working Tools for Tung Tau Tsuen Road**

Chart 1: Identification of Problem

Start of Chart 1 → traffic lane (L) = 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) > 20 → buildings on one side of the carriageway → proposed semi-enclosure → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception of existing EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → identified barrier are close to junctions → visibility/road safety problems of junctions and conflict with pedestrian and vehicular access → scheme modification: consider using bend-top barrier → check visibility → no conflict with pedestrian and vehicular access and no visibility/road safety problem generated after such scheme modification → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → creates no impact on street level commercial activities → creates no obstruction to pedestrian crossing or access → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → both northbound and southbound footpath > 2.5m wide → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → less than 50% of affected properties located within the shadow zone → no other possible scheme can be found → scheme not practical → End

Appendix A Application of the proposed Working Tools for Fung Shue Wo Road

Chart 1: Identification of Problem

Start of Chart 1 → traffic lane (L) = 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) > 20 → alongside southbound carriageway and floor number (N) < 10 alongside northbound carriageway → proposed plain vertical barrier and semi-enclosures alongside northbound and southbound carriageway, respectively → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception of existing EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → identified barriers are close to junctions → visibility and road safety problems at bend is identified → Scheme modification: shift the bend-top barrier at bend away from the kerb line → check visibility again → no conflict with pedestrian and vehicular access and no visibility/road safety problem generated after such scheme modification → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → creates no impact on street level commercial activities → creates no obstruction to pedestrian crossing or access → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → both northbound and southbound amenity and/or footpath with overall width > 2.5m wide → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties →recommend for preliminary engineering feasibility study

Appendix A **Application of the proposed Working Tools for Yuen Wo Road**

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) > 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Form

Start of Chart 2 → floor number 10<(N)<20 alongside eastbound carriageway → propose bend-top barriers → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception of existing EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → the identified barriers is not located close to junction → The identified barriers is not located along bend → no conflict with pedestrian and vehicular access → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → creates no impact on street level commercial activities → creates no obstruction to pedestrian crossing or access → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → the eastbound footpath with width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located with the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A **Application of the proposed Working Tools for Tai Chung Kiu Road**

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) > 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) > 20 alongside eastbound carriageway → the facade are located alongside eastbound carriageway only → propose semi-enclosure → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception of EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → the identified barriers are not located close to junction → the identified barriers are not located along bend → the identified barrier fronting Ming Yiu Lau adjacent to the existing bus stop will conflict with the pedestrian access → scheme modification (provide 14m x 3m high opening) → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → no interface with street level commercial → no conflict with pedestrian crossing or access after providing 14m x 3m high opening → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → the eastbound amenity and/or open space and/or footpath with overall width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A **Application of the proposed Working Tools for Ma On Shan Road**

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) = 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) > 20 alongside westbound carriageway → the facade are located alongside eastbound carriageway only → propose semi-enclosures → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → interception of EVA at Heng On Estate → modify the scheme to exclude the section of barrier fronting the EVA at Heng On Estate → by adoption of such scheme modification no interception of EVA will be resulted → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → the proposed barriers are located close to junction → check visibility → scheme modification: avoid barriers at the existing roundabout → no visibility problem after such scheme modification → no conflict with pedestrian and vehicular access → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → The proposed barrier interface with street level commercial activities fronting Sunshine City → delete barriers fronting Sunshine City → creates no obstruction to pedestrian crossing or across → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → the eastbound amenity and/or open space and/or footpath with overall width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A Application of the proposed Working Tools for Che Kung Miu Road

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) = 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) > 20 alongside westbound carriageway → excluding the cleared Shatin Tau THA, the affected facade are located alongside westbound carriageway only → propose semi-enclosures → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception with EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → the proposed barriers are located close to junction → check visibility no visibility and road safety problems → no conflict with pedestrian and vehicular access → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → no interface with street level commercial activities no obstruction to pedestrian crossing or across → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → the affected amenity and footpath with overall width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A Application of the proposed Working Tools for Che Kung Miu Road J/O Hung Mui Kuk Road

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) > 4 → distance between Che Kung Miu Road and facade at Tin Sam Village and Sun Chui Estate, and between Hung Mui Kuk Road and facade at Sun Chui Estate and Tin Sam Village (D) < 400 → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) of facade at Tin Sam Village < 10; floor number (N) of facade at Sun Chui Estate > 20 → propose semi-enclosure to cover southbound carriageway of Hung Mui Kuk Road; plain barriers alongside northbound carriageway of Hung Mui Kuk road and westbound carriageway of Che Kung Miu Road underneath south ramp of future footbridge to protect Tin Sam Village; plain barriers underneath east ramp of future footbridge → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception with EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → the proposed barriers are located close to junction → check visibility → the proposed barriers are detailed with no generation of visibility problem → scheme modification required to cope with future footbridge, roundabout and Route 16 above Che Kung Miu Road across Hung Mui Kuk Road → deletion of proposed barrier alongside westbound carriageway of Che Kung Miu Road fronting Tin Sam Village → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → no interface with street level commercial activities → existing pedestrian access are maintained by modifying the scheme → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → the affected amenity, footpath and open spaces with overall width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A **Application of the proposed Working Tools for Tin Sam Street**

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) = 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) of identified facade at Tin Sam Village < 10 and Carado Garden > 20 alongside eastbound carriageway, and floor number of Lok Sam House (N) > 10 and < 20 alongside westbound carriageway → propose plain barrier and semi-enclosure for eastbound carriageway fronting Tin Sam Village < 10 and Carado Garden respectively, and bend-top barriers fronting Lok Sam House and Wing Sam House → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception with EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → the proposed barriers and located close to junction → check visibility → scheme modification: shift the support of barrier at bend fronting Carado Garden towards Carado Garden to comply with visibility requirement → no conflict with pedestrian and vehicular access → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → no interface with street level commercial activities except those fronting Tin Sam Village → delete the proposed barriers fronting Tin Sam Village no obstruction to pedestrian crossing or access → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → the affected amenity, footpath and open space with overall width >2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A Application of the proposed Working Tools for Tseung Kwan O Road

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) = 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) of identified facade of Tsui Ping Estate, Lam Tin Estate, Hing Tin Estate and Hong Wah Count > 20 → buildings on both side of carriageway at the western end of affected road section; buildings on westbound carriageway at the eastern end of affected road section → propose full enclosure at western end and semi-enclosure at eastern end → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception with EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → the proposed barriers and not located close to junction nor along bend → the proposed barriers alongside westbound carriageway fronting Hing Tin Estate will conflict with the vehicular access for maintenance of the existing service reservoir → scheme modification → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → no interface with street level commercial activities → no obstruction of pedestrian crossing or access → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → amenity and/or open space and/or footpath with overall width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A Application of the proposed Working Tools for Po Lam Road North

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) = 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) of identified facade at Po Lam Estate, Ying Ming Count, Yan Ming Count and King Lam Estate > 20 → buildings are located alongside eastbound carriageway of Po Lam Road → propose semi-enclosure → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception with EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → proposed barrier are located close to junctions → check visibility → scheme modification to provide sufficient visibility at junctions → scheme modification to cope with existing pedestrian access (e.g. footbridge) → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → no interface with street level commercial activities → no obstruction with pedestrian crossing or access → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → amenity and/or footpath with overall width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A **Application of the proposed Working Tools for Tuen Mun Road, Sam Shing Hui**

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) > 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) of identified facade at Kam Fai Garden > 10 but < 20 → propose bend-top barriers → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception with EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → barrier are not located to junction nor along bend → no conflict with pedestrian and vehicular access → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → no interface with street level commercial activities → no obstruction with pedestrian crossing or access → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → amenity and/or open space and/or footpath with overall width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A **Application of the proposed Working Tools for Tuen Mun Road, Tsuen Wan**

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) > 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) Belvedere Garden, Greenview Court exposed to traffic noise is between 10 to 20; and floor number (N) of Yau Kom Tau Village exposed to traffic noise is simulated as between 10 and 20 → propose bend-top barriers → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception with EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → barrier are not located close to junction → barrier are located along bend →check visibility→deletion of barriers fronting Yau Kom Tau Village alongside both slow and fast lane of eastbound carriageway to provide visibility under desirable minimum requirement→ no conflict with pedestrian and vehicular access→Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → no interface with street level commercial activities → conflict with existing subway and footbridge → scheme modification → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → amenity and/or open space with overall width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties

Appendix A **Application of the proposed Working Tools for Tuen Mun Road, Tsing Lung Tau**

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) > 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → in according to the existing topographic profile, floor number (N) of Hong Kong Garden exposed to traffic noise < 10 → propose plain vertical barrier alongside the westbound slow lane carriageway → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception with EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → barrier are not located close to junction → barrier are located along bend → check visibility → scheme modification: more the plain barriers at bend away from the carriageway to provide desirable visibility requirement → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → no interface with street level commercial activities → no obstruction to pedestrian crossing or access → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → amenity and/or open space with overall width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → identify the acoustic effectiveness of the proposed barrier → replace the plain barriers at bend with bend-top barriers → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A **Application of the proposed Working Tools for Castle Peak Road, Hung Shui Kiu**

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) > 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) < 10 → propose plain vertical barrier → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception with EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → barrier is not located close to junction nor along bend → no conflict with pedestrian but shall complies with LRT routing → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → no interface with street level commercial activities → no obstruction with pedestrian crossing or access → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → amenity and/or footpath with overall width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix A **Application of the proposed Working Tools for Castle Peak Road, Ping Shan**

Chart 1: Identification of Problems

Start of Chart 1 → traffic lane (L) > 4 → distance between the facade and the road kerb (D) < 400m → Go to Chart 2

Chart 2: Selection of Barrier Forms

Start of Chart 2 → floor number (N) < 10 → propose plain vertical barrier → Go to Chart 3

Chart 3: Emergency Access Consideration

Start of Chart 3 → no interception with EVA → Go to Chart 4

Chart 4: Road Safety Consideration

Start of Chart 4 → barrier is not located close to junction → check visibility → scheme modification: delete a portion of barrier adjacent to Castle Peak Road - Ping Shan J/O minor road of Fu Sha Wai → no conflict with pedestrian and vehicular access after such modification → Go to Chart 5

Chart 5: Socio-economic Consideration

Start of Chart 5 → no interface with street level commercial activities → existing pedestrian crossing or access fronting Ping Shan Lane are maintained → Go to Chart 6

Chart 6: Land Availability

Start of Chart 6 → amenity and footpath with overall width > 2.5m → Go to Chart 7

Chart 7: Acoustic Effectiveness

Start of Chart 7 → more than 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties located within the shadow zone → angle of view reduced by 70% or more at over 50% of affected properties → recommend for preliminary engineering feasibility study

Appendix B Derivation of Chart I

(a) Two-lane Single Carriageway

Assume:

Volume of Traffic (Q)	= 800 veh/hr.
Speed Correction	= +3.5dB(A)
Angle of View Correction	= 160 degrees

Basic Noise Level	= 10 x log 800 + 41.2 + 3.5 = 73.7dB(A)
Angle of view correction	= - 0.5dB(A)
Facade correction	= +2.5dB(A)

In order that the L_{10}(1hr) at facade be reduced to 70dB(A), the distance correction must be

= 73.7 - 0.5 + 2.5 - 70
= 5.7dB(A)

Therefore, the distance required = 45m

(b) Four-lane Dual Carriageway

Assume:

Volume of traffic	= 5,200veh/hr
Speed correction	= +4.5dB(A)
Angle of view	= 160 degrees

Basic Noise Level	= 10 log 5,200 + 41.2 + 4.5 dB(A) = 82.9 dB(A)
Angle of view correction	= - 0.5 dB(A)
Facade correction	= +2.5 dB(A)

In order that the L10(10hr) at facade be reduced to 70 dB(A), the distance correction must be

= 82.9 - 0.5 + 2.5 - 70
= 14.9 dB(A)

Therefore, the distance required = 400m

Appendix C Derivation of Chart 2

Form of Barrier [1]	Vertical Height of Barrier (m) [2]	No. of Floors Protected excluding ground floor [3]
Plain Barrier	3	3
	4	4
	5	5
Cantilevered Barrier	5.6	7
	6.4	10
	4.7	6
Partial Enclosures/Full Enclosures	N/A	>10

Note:

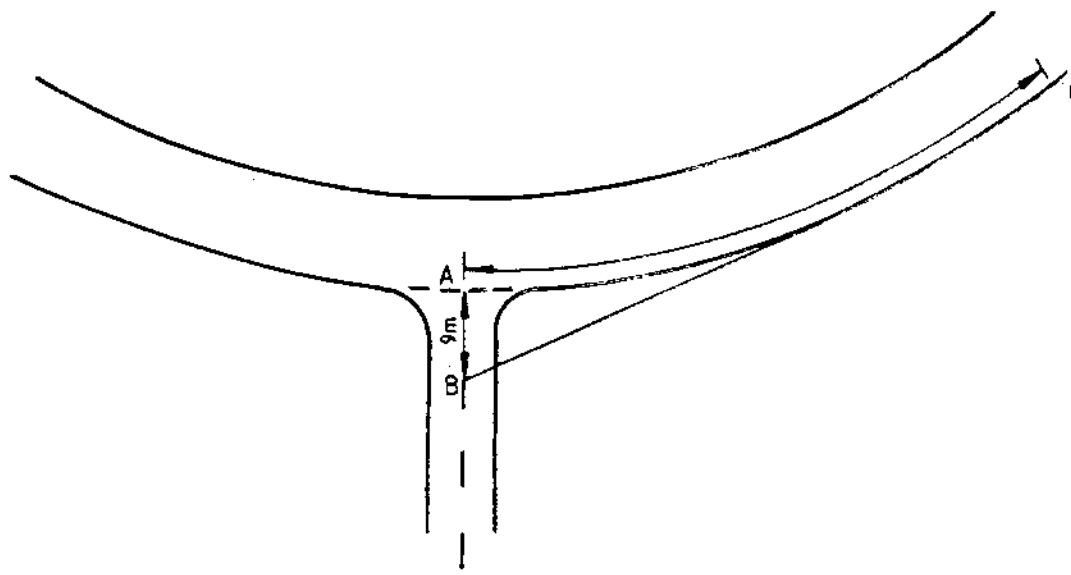
1. Assume barrier is erected at 18m from the affected facades and 3m from the road kerb.
2. The height is measured from ground to the highest point of barrier.
3. Indicate the number of floors within the shadow zone of the barrier. Assume 2.8m per floor and ground floor is non-residential.

Appendix D Visibility Splays at Priority Junctions

(a) The visibility should be available between points 1.05m above the road level and provided by means of a visibility splay whose area is defined by lines joining the points A, B and C as shown in Diagram No. 4.3.8.1 of T.P.D.M.V. 2.4.

(b) For roads within estates and other local roads of minor nature or experiencing low spends the distance AC above relating to the 50 km/h design speed may be reduced to 50m.

(c) In difficult situations the dimension AB may be reduced to 4.5m and in exceptional circumstances 2m but the distance AC as recommended above should always be provided. If AB is greater than 15m high minor road approach speeds can be expected and this situation should receive special consideration. (The dimensions of lines AB and AC also govern the need for "stop" control as opposed to "give way" control).



DESIGN SPEED OF MAJOR ROAD (kph)	120	100	85	70	60	50
DISTANCE AC (m)	300	225	165	125	95	70

VISIBILITY SPLAYS AT PRIORTY JUNCTIONS

DIAGRAM 4.3.8.1.

Appendix D Visibility Area at Run-ins

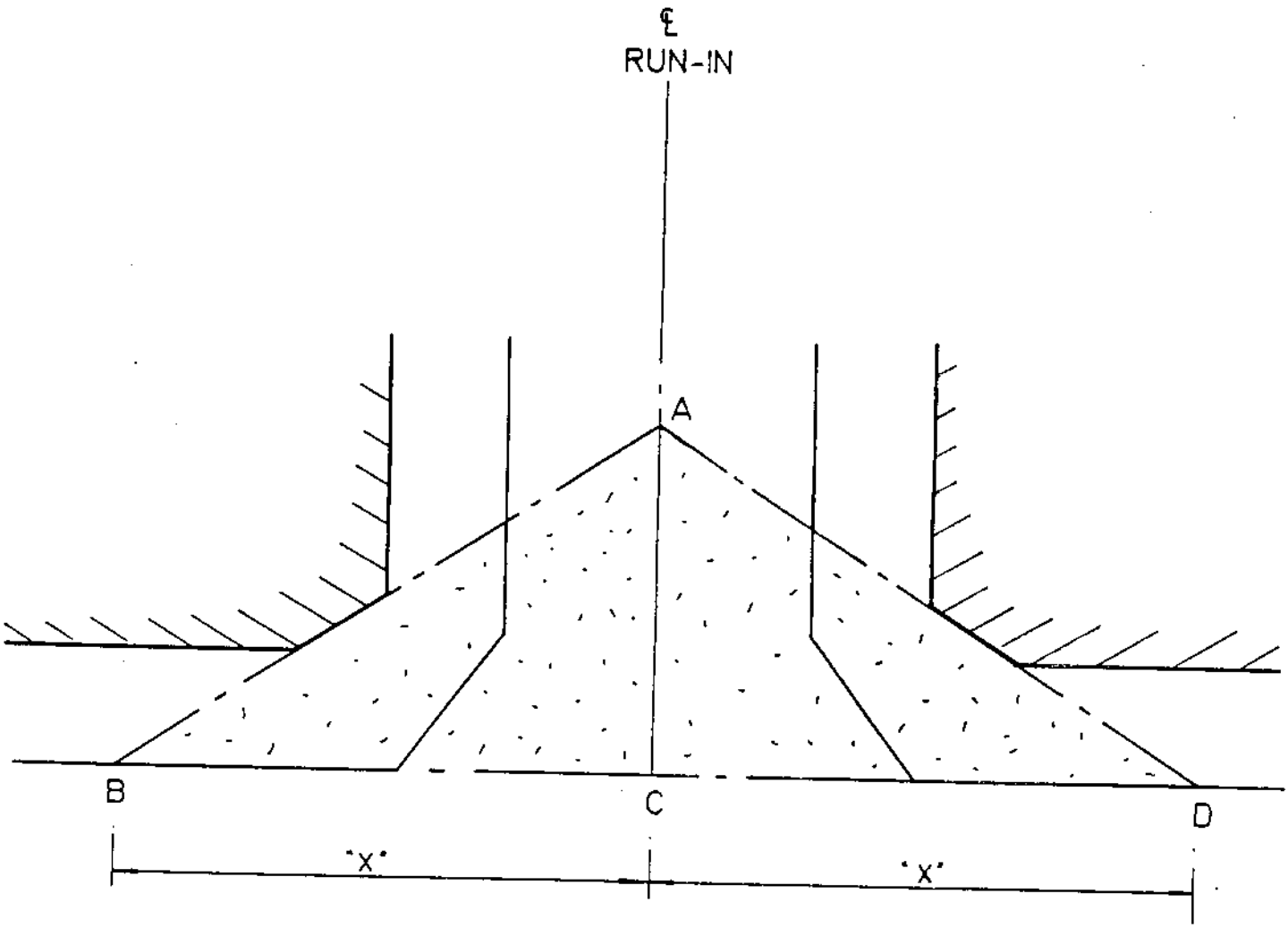
(a) Visibility from a run-in should be obtainable between points 1.05m above the road and run-in level over the area described by ABCD in Diagrams 3.6.3.4 of T.P.D.M.V. 2.3

(i) AC is a line 4.5m in length measured along the centre line of the run-in from the continuation of the nearer edge of the carriageway of the road to which the run-in has access, and

(ii) BC and CD, are "x"m in length, and "x" is in accordance with the following table and is measured along the nearer edge of the road to which the run-in has access.

Length of Visibility Line "x"

Design Speed of Main Road (km/h)	x(m)
80 or over	150
70	130
60	120
50	60



VISIBILITY AREA AT RUN-INS

DIAGRAM 3.6.3.4

Appendix D **Grade Separated Interchange**

(a) Visibility distance are related to the design speed of the road as shown in the following table

Visibility Distances at Grade Separated Interchanges

Design Speed (km/h)	Desirable Minimum (m)	Absolute Minimum (m)
120	300	225
100	225	165
85	165	125
70	125	95
60	95	70
50	70	50
40	50	40
30	40	30

Appendix D Siting of Signal Equipments

(a) The minimum requirement is one traffic signal installed 1m from the stopline, on the nearside of the carriageway. If at all possible a second primary signal is installed if there is a central island or central divider, at the other end of and 1m beyond the stopline. Minimum visibility distances from the primary signals as given in the following table should be satisfied for achieving a safe layout.

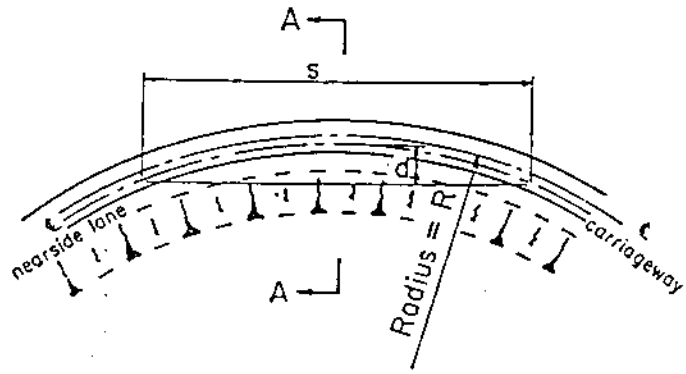
85 percentile approach speed	Visibility distance
50 km/h	70m
60km/h	95m
70 km/h	125m
85 km/h	165m
100 km/h	225m

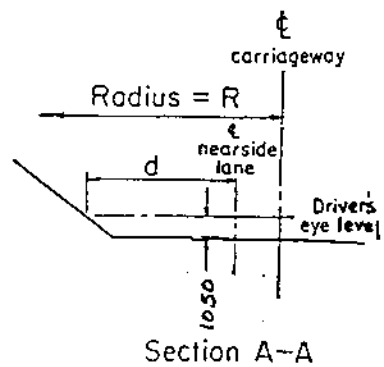
Appendix D **Sight Distance**

(a) The following table shows the sight distance that should be provided on the approaches to junctions or accesses. Sight distance should be measured between a minimum drivers' eye height of 1.05m, to an object height of 1.05m, both above the centre line of each lane. If follows that junction and accesses should not be provided on sharp curves, where extensive widening of verges, cutting and bridge structures would be required to provide the required visibility. For lower speed Urban Roads, where there are little or no restrictions on pedestrians and accesses, the sight distances shown in the table should be provided throughout the road.

Sight Distance

Design Speed (km/h)	Desirable Minimum (m)	Absolute Minimum (m)
120	300	225
100	225	165
85	165	125
70	125	95
60	95	70





Section A–A

Appendix D **Visibility at Roundabout**

(a) Visibility distance should be measured between a driver's have height of 1.05m and an object height of 1.05m, both measured from the centre line of each lane.

(b) the forward visibility at the approach to a roundabout shall not be less than that shown below. The visibility distance should be measured to the "Give Way" line as shown in Diagram 4.5.11.1 of T.P.D.M.V. 2.4.

Sight Distance

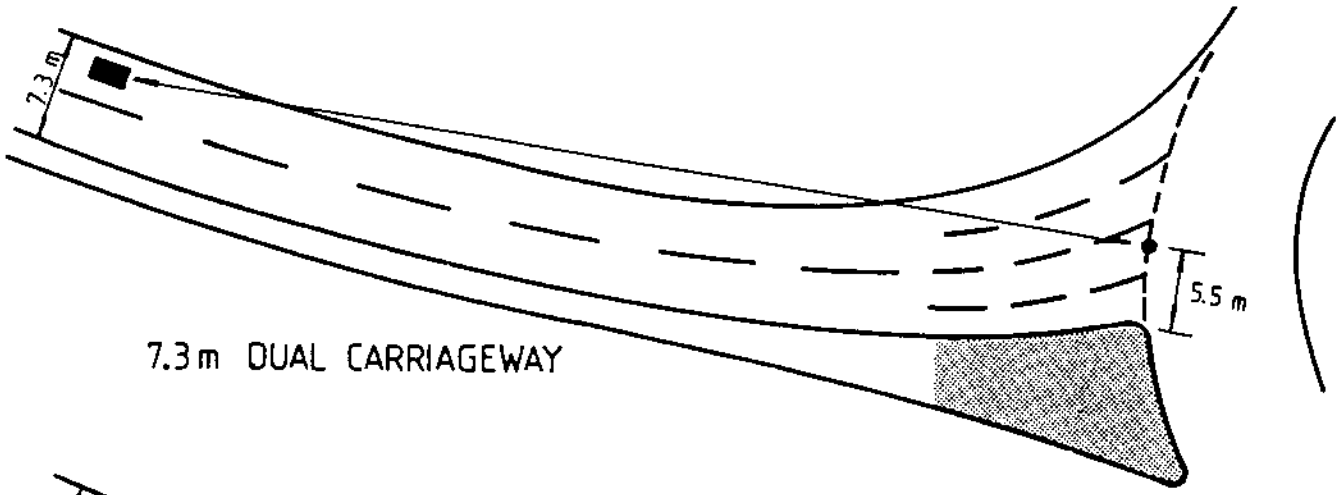
Design Speed (km/h)	100	85	70	60	50
Desirable Minimum (m)	225	165	125	95	70
Absolute Minimum (m)	165	125	95	70	50

(c) No noise mitigation measures shall be erected at a roundabout within a distance of 15m back from the "Give Way" line as shown in Diagram No. 4.5.11.2, 4.5.11.3 and 4.5.11.4 of T.P.D.M.V. 2.4.

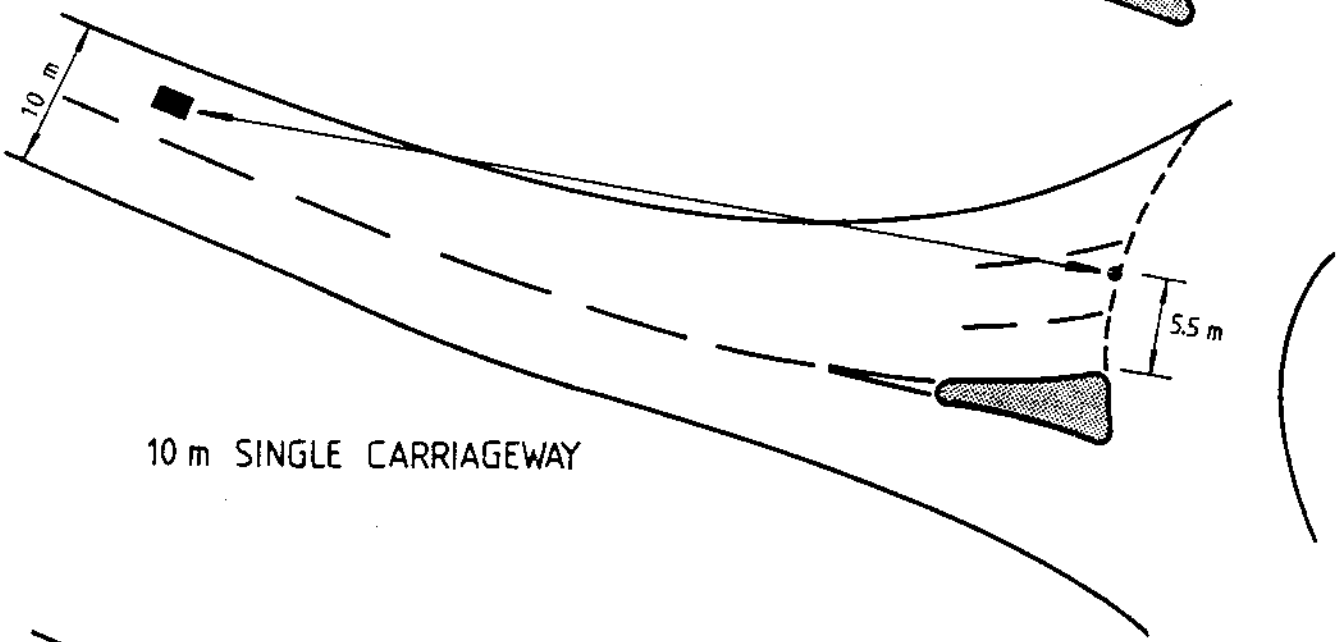
(d) During the detailed design stage, where a pedestrian crossing is located across the entry to a roundabout, drivers approaching the roundabout should have visibility to the crossing of a distance not less than that shown in (b). Additionally, drivers at the "Give Way" line of one entry should be able to see the full width of a crossing located at the next entry if this is within 50m of the roundabout. This requirements, illustrated in Diagram No. 4.5.11.5 of T.P.D.M.V. 2.4, may be difficult to achieve in urban areas owning to adjacent roadside development.

T.P.D.M.V. 2.4.

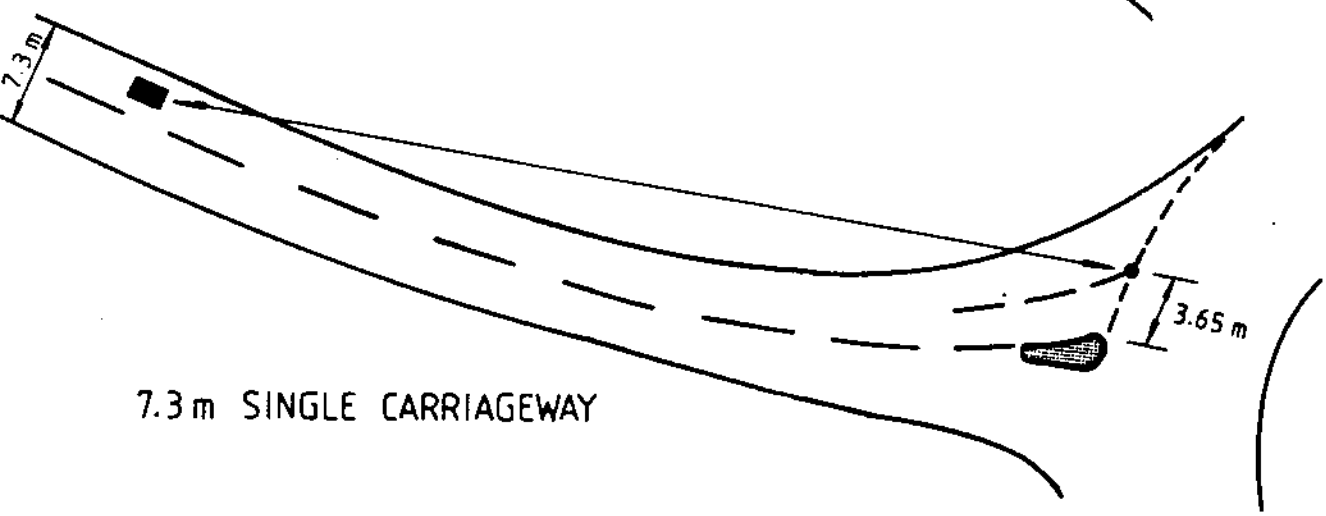
DESIRABLE / MINIMUM VISIBILITY DISTANCE
FOR APPROACH ROAD DESIGN SPEED



7.3 m DUAL CARRIAGEWAY



10 m SINGLE CARRIAGEWAY



7.3 m SINGLE CARRIAGEWAY

MEASUREMENT OF APPROACH VISIBILITY

DIAGRAM 4.5.11.1

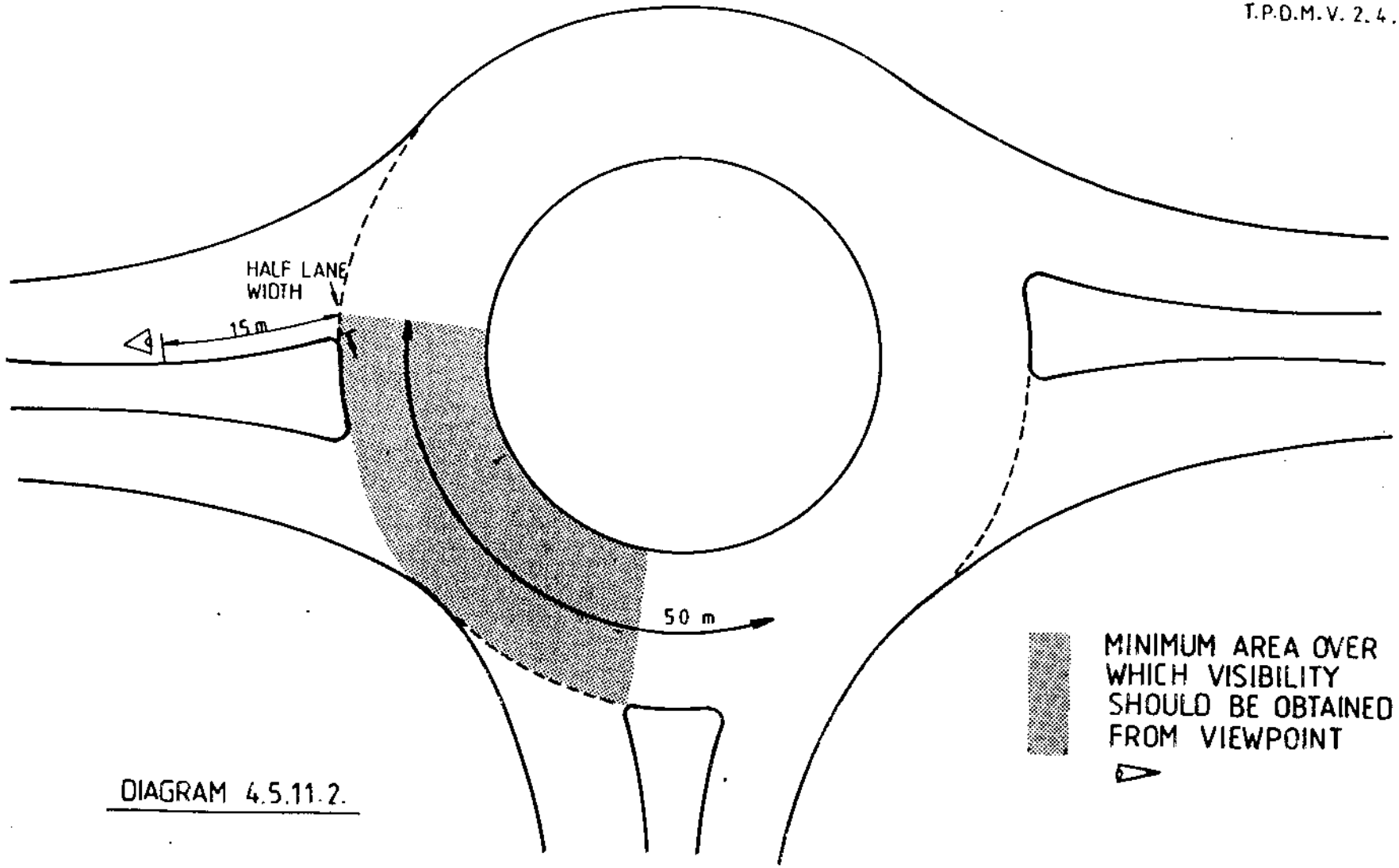


DIAGRAM 4.5.11.2.

VISIBILITY TO THE RIGHT REQUIRED AT ENTRY

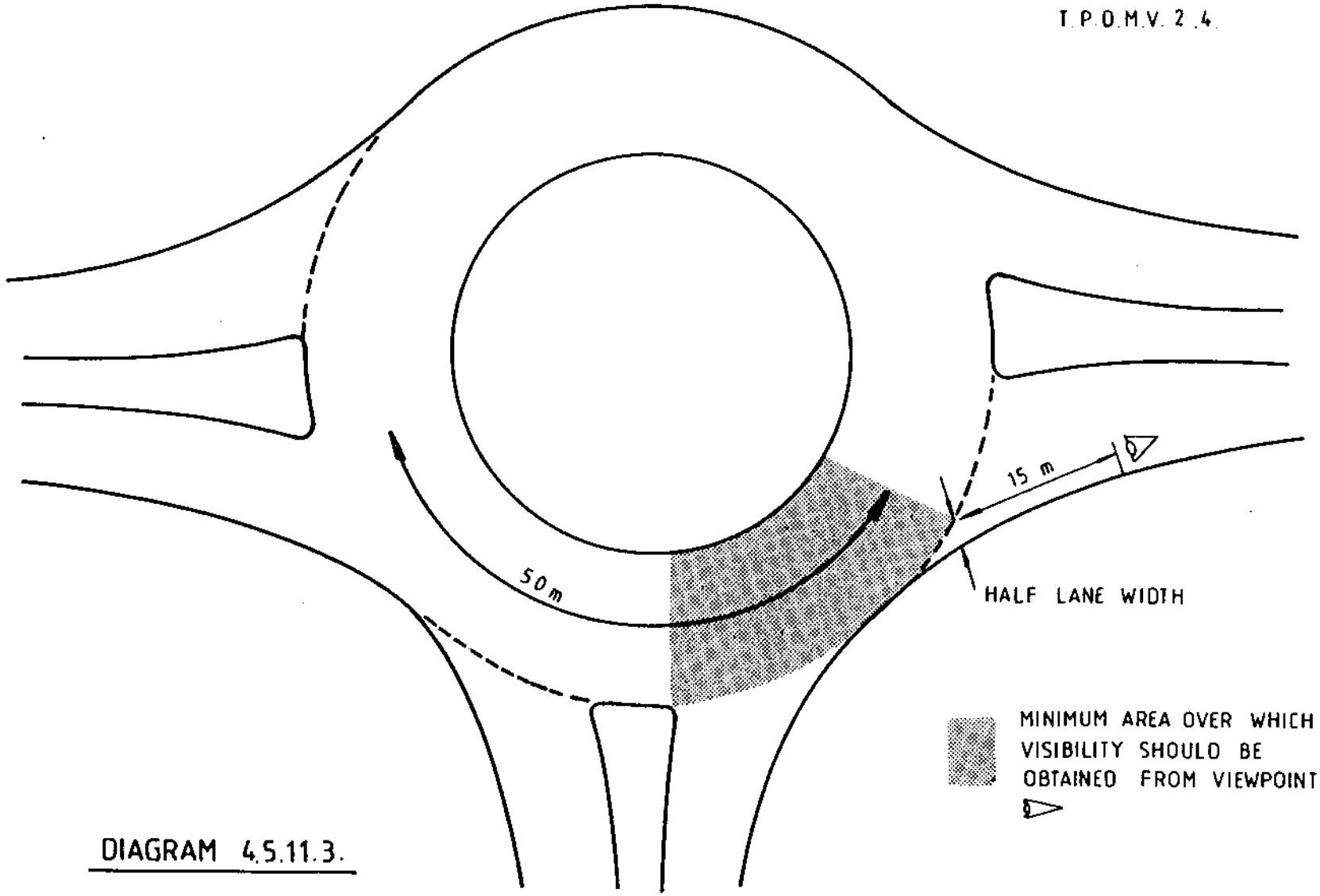


DIAGRAM 4.5.11.3.

FORWARD VISIBILITY REQUIRED AT ENTRY

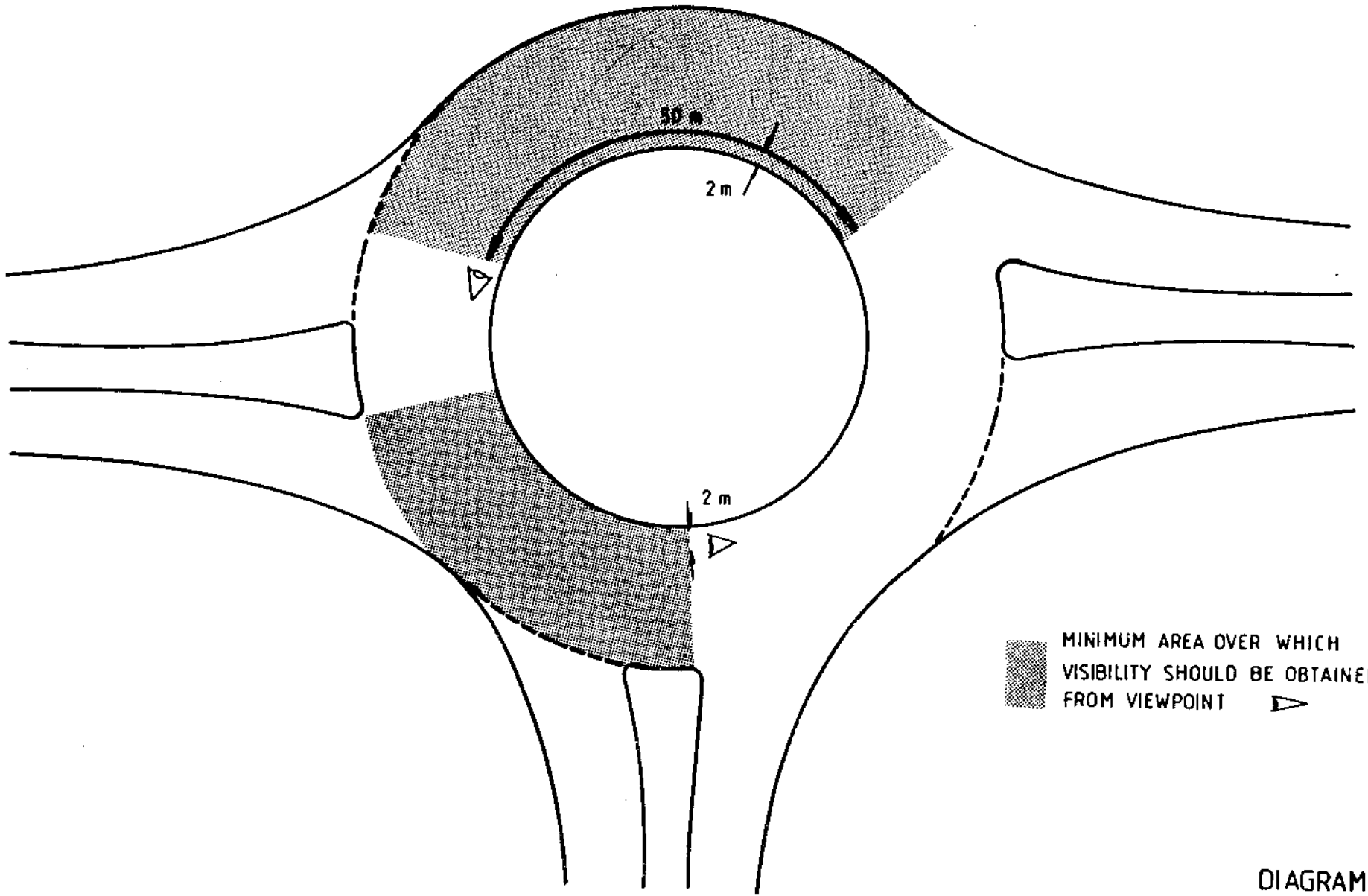
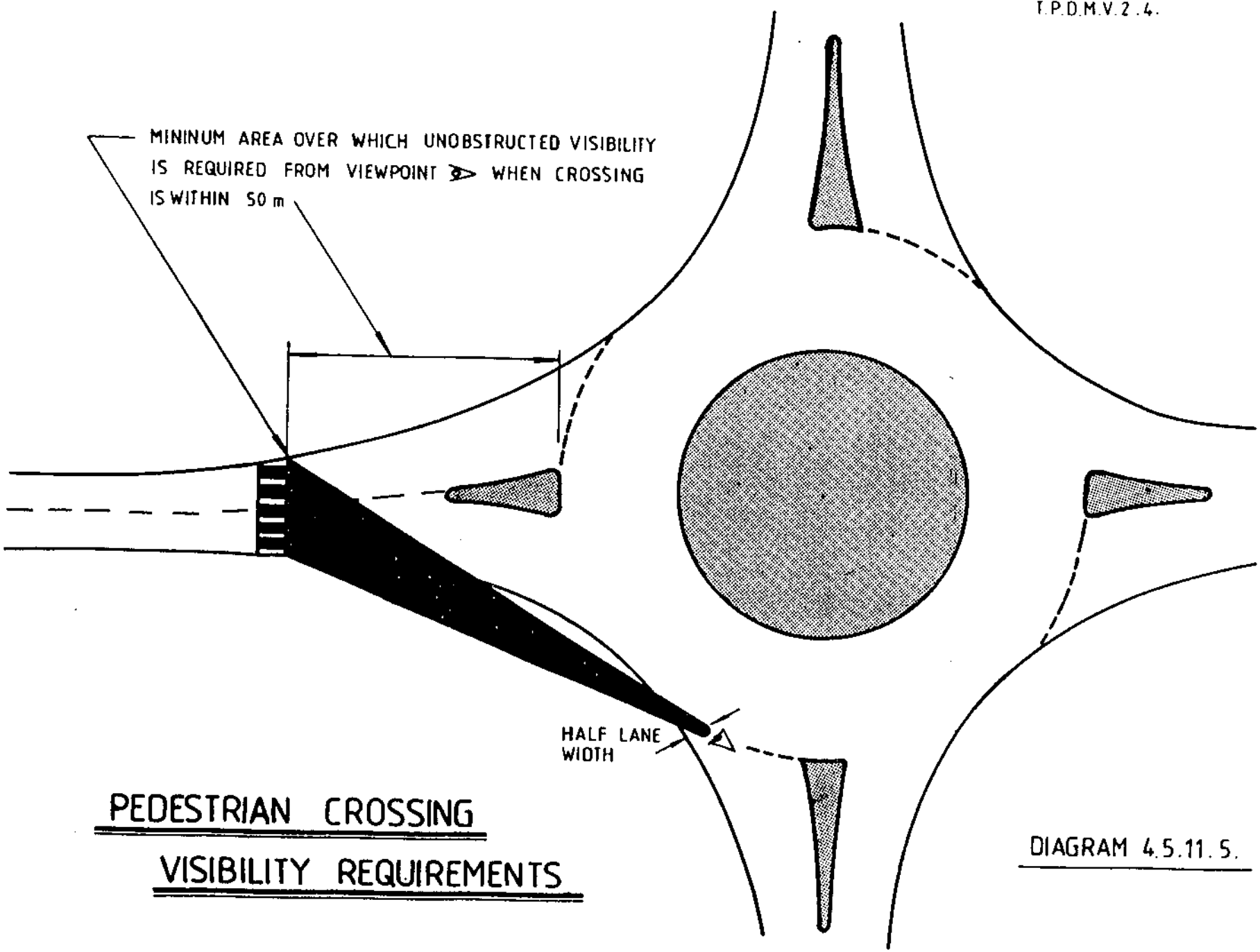


DIAGRAM 4.5.11.4.

CIRCULATORY VISIBILITY REQUIRED



PEDESTRIAN CROSSING
VISIBILITY REQUIREMENTS

DIAGRAM 4.5.11.5.