HIGHWAYS DEPARTMENT
HONG KONG GOVERNMENT

AGREEMENT NO. CE23/93

IMPROVEMENT TO CASTLE PEAK ROAD FROM SIU LAM TO SO KWUN TAN

NOISE IMPACT ASSESSMENT

FINAL REPORT
(ISSUE 1)

JUNE 1995

Highways Department
3rd floor, Ho Man Tin Government Offices
88 Chung Hau Street
Ho Man Tin
Kowloon

Peter Fraenkel BMT (Asia) Ltd.
with
Enpac Limited
Urbis Travers Morgan Limited

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IMPROVEMENT TO CASTLE PEAK ROAD
FROM SIU LAM TO SO KWUN TAN

NOISE IMPACT ASSESSMENT STUDY

CONTENTS

CHAPTER ONE
INTRODUCTION

1. INTRODUCTION

1.1 Background to the Assessment

The section of Castle Peak Road from Siu Lam Interchange to So Kwun Tan is to be improved to increase its capacity in order to cater for the increasing traffic demand arising from developments along Castle Peak Road and to relieve the heavy traffic flow on Tuen Mun Road prior to the planned opening of Route 3 - Country Park Sector in 1998.

The stretch of Castle Peak Road for which improvement works are proposed is currently a single 7.3m wide carriageway with one traffic lane in each direction. The proposed improvement works would upgrade the road to a dual two lane carriageway.

As part of the overall planning process for the road improvement works, Highways Department (New Territories Region) appointed Peter Fraenkel BMT (Asia) Ltd. in association with Enpac Ltd. and Urbis Travers Morgan Ltd. to carry out this Noise Impact Assessment Study. The purpose of the Study is to provide information on the nature and cumulative extent of the potential noise impacts on the environment resulting from the proposed improvements to Castle Peak Road.

The Study objectives, the duties of the consultants and the Study Output required as defined in the Brief are at Appendix 1. The location of that section of Castle Peak Road for which upgrading is proposed is shown in Figure 1. The Study Area is shown in Figure 2.

1.2 Purpose and Structure of the Assessment Report

The purpose of this report is to summarise the work done and to present the findings and recommendations as required by the Brief.

The study was carried out in 4 distinct phases, each of which included a number of inter-related tasks.

The first phase involved the collection and review of all available relevant data, including planning and landuse data and traffic information. The site was visited and likely noise sensitive receivers were identified. The noise impact criteria were established and agreed with the EPD and predicted traffic flows for Castle Peak Road and Tuen Mun Road up to the year 2011 were obtained from a Local Traffic Study which was commissioned for this purpose.

Section 2, "Methodology", and Section 3, "The Site", present the output of this first phase of the Study.

In the second phase of the study, the current noise impact of the existing roads was identified both by field monitoring and by modelling. The impacts of both construction noise during construction of the road improvement works and operational noise subsequent to the completion of the improvements were predicted.

The findings of this phase of the Study are presented in Section 3 "The Site" (current noise impact), Section 4 "The Proposed Scheme", and Section 5 "Noise Assessment".

In the third phase of the study, the impacts of the second phase were compared against the noise impact criteria, and the requirements for mitigation established. The various direct technical noise mitigation measures were examined to identify the extent of noise reduction that it was feasible to achieve at sensitive receivers. Preliminary design and costing of various optimised solutions was carried out. The visual and landuse impact of these solutions was assessed and proposals derived for mitigating such impacts. The costs associated with these proposals were indicated.

This phase of the Study is presented in Section 6 "Noise Mitigation Options", Section 7 "Noise Mitigation Proposals" and Section 8 "Landscape and Visual Impact of Mitigation Measures".

The final phase of the study involved consideration of the necessary monitoring and audit requirements. The need for further baseline monitoring prior to commencing construction was identified, as well as the level of monitoring throughout the construction period to ensure compliance with contract requirements. Appropriate post project audit requirements were also proposed.

The findings of this phase of the study are put forward in Section 9 "Environmental Monitoring and Audit".

The above work permitted the impact of the proposed road improvement works to be identified, suitable mitigation measures to be evaluated, and the most cost-effective measures to be proposed in Section 10 "Conclusions". The resulting recommendations of the Consultant are presented in the final section of the report, Section 11, "Recommendations".

Comments received from various Government Departments during the course of the study, and the Consultants responses to those comments, are included at Appendix 2.

CHAPTER TWO
METHODOLOGY

2. METHODOLOGY

2.1 Sources of Noise

Castle Peak Road is a two-lane two way road linking Tsuen Wan to the east and Tuen Mun to the west, and serving the industrial activities, eg. cargo handling and container storage, and the residential developments along the road and the coast. At present it carries heavy traffic at peak hours and has a high percentage of heavy vehicles.

Current levels of traffic noise are aggravated by the existence of a number of empty container storage parks around So Kwun Tan. Excessive noise is caused by trucks with empty containers rolling over uneven road surfaces.

During the construction of the proposed improvement works, traffic flows in both directions will be maintained. Thus, noise will be generated not only by the construction equipment, but also by normal traffic flows. It is expected that the empty container storage parks at So Kwun Tan will be closed down during the course of the next few years, so that a reduction in the percentage of heavy goods vehicles could be expected. In particular, noise from trucks carrying empty containers would be expected to decrease.

On completion of the improvement works, traffic flows are expected to increase rapidly, both as a result of continued development along Castle Peak Road itself and because of diversion of traffic from the heavily trafficked Tuen Mun Road. The proportion of heavy vehicles on Castle Peak Road is likely to increase again, as drivers seek alternative routes to avoid congestion on Tuen Mun Road.

The proximity of Tuen Mun Road to Castle Peak Road, particularly along the eastern half of the study area, and the high volumes of traffic on Tuen Mun Road (4-5 times as much as current Castle Peak Road traffic flows) mean that its noise contribution at the chosen Noise Sensitive Receivers (NSRs) is significant. Noise from this source has been taken into account during all stages of the analyses.

2.2 Noise Impact Assessment Criteria

2.2.1 Construction Noise

Construction works are expected to proceed only during the non-restricted daytime hours. There is no Noise Control Ordinance (NCO) criterion for daytime construction noise. However, Practice Note for Professional Persons PN2/93 issued by the Environmental Protection Department in May 1993 recommends that noise at the facade of dwellings during the period between 7 am - 7 pm should not exceed 75 dB(A) Leq (30 min.). This level has been adopted as the daytime construction noise assessment criterion.

2.2.2 Operational Noise

The impact of operational noise has been assessed with reference to the Hong Kong Planning Standards and Guidelines (HKPSG). In the event that the predicted facade noise levels in 2011 due to the combined effects of Castle Peak Road and Tuen Mun Road exceed the maximum recommended noise levels in the HKPSG, all practical direct technical measures for noise reduction have been examined and proposed, where appropriate, with a view to

fulfilling the HKPSG noise criteria and minimizing the noise contribution from the improved Castle Peak Road. In cases where no practical direct technical remedies can be applied, NSRs which may qualify for indirect technical remedies under the established policy contained in the Exco's directive "Equitable Redress for Persons Exposed to Increased Noise Resulting from the Use of New Roads" have been identified. For the purpose of determining the eligibility for consideration for indirect technical remedies, reference has been made to the three criteria used in the UK Noise Insulation Regulations 1975, with the HKPSG level in place of the specified level in the UK regulations. Those criteria are as follows:

i. The predicted overall noise level from the improved road, together with other traffic noise in the vicinity, must not be less than the HKPSG criteria of L_{10} (peak hour) 70 dB(A) for sensitive residential facades, and 55 dB(A) for sensitive facades of homes for the aged and hospital wards;

ii. The predicted noise level is at least 1.0 dB(A) more than the prevailing noise level, i.e. the total traffic noise level existing before the works to construct the road were commenced. Since works are expected to start in the near future, the proposed prevailing noise level has been based on the most recent traffic counts available in the Annual Traffic Census (1992) and from Transport Department;

iii. The contribution to the increase in the noise level from the improved road must be at least 1.0 dB(A).

2.3 Measurement of Noise

Field noise measurements were taken at six monitoring stations (see Figures 6-8 for locations). The measurements were made at 1.0m from the external facade of the NSR at the monitoring station, during peak traffic hours 8am to 10am on normal weekdays.

Two types of sound level meter were used, B&K 2231 and Rion NL-14, both of which comply with IEC 651:1979 (type 1) and 804:1985 (type 1) specifications for precision sound level meters. Before and after each set of readings, the meter was checked against a calibrated noise source. L_{10}, L_{eq} and L_{90} noise levels over 30 minutes were obtained at each receiver.

2.4 Noise Assessment

2.4.1 Construction Noise

For construction noise, the plant sound power method outlined in BS5228: Part 1: 1984 (Section A.3.3) has been used to examine the equivalent noise level over an assessment period of 30 minutes. The notional position of the plant has been taken as defined in the *Technical Memorandum on Noise from Construction Work other than Percussive Piling* (Section 2.7, for linear construction site).

In addition to the two new 7.3m carriageways, the following will be constructed:

- a new 54-m single carriageway bridge over the river near Block 6 of the Gold Coast Development;
- a new footbridge across Castle Peak Road opposite Fiona Garden.

The original scheme drawings (NH 20570A, 20571A and 20572A) showed retaining structures opposite Tsing Lung Road, at Fiona Garden, outside the Castle Bay development, and alongside Tuen Mun Road. However, subsequent discussions with GEO have determined that none of these walls will be required. Some kind of soil treatment adjacent to the Government quarters at Siu Lam will need to be provided. A soil nail solution is currently planned for stabilisation of this slope.

In addition to the construction noise generated by the road improvement works, there will be noise associated with the construction of the noise mitigation measures. It is probable that high barriers and partial enclosures over the carriageway will require piled foundations, in addition to concreting operations and steel framework erection associated with the construction of the barrier superstructure. Bored pile foundations have been assumed for the construction noise impact assessment.

It is likely that the contractor will work in more than one location at a time. However, since traffic must continue to flow at all times, activities will be limited to one carriageway. At a single location, it will not be feasible for earthworks, drainage, kerbing and paving to be carried out simultaneously. Thus, for carriageway construction, the noise assessment is based on simultaneous operation of plant for a single activity only.

As a worst-case scenario, footbridge construction noise will be added to carriageway construction noise outside Fiona Garden. Bridge, soil nail slope and noise barrier construction will proceed as stand-alone operations, and are not combined with the noise of road widening.

If substantial barriers are required to mitigate noise at Fiona Garden, their incorporation in the proposed footbridge may make its design and appearance unacceptable. In this case a subway may be substituted. It is considered that construction noise associated with a subway will be less intrusive than that for construction of a footbridge. This assessment has therefore been based on construction of a footbridge.

2.4.2 Operational Noise

The UK DOT procedure has been used to calculate present (1992) traffic noise levels and predict future (2011) noise levels. The calculations have been made for a list of 41 Noise Sensitive Receivers (NSRs), which are taken to be representative of all the receivers, both existing and future, that would be affected by traffic noise from the proposed improvement works. The calculations give readings at the most exposed facades of the selected NSRs. The NSRs are further described at paragraph 3.2.

Morning peak hour traffic (8am - 10am) on Castle Peak Road and Tuen Mun Road was considered in the assessment.

The calculations were based on traffic flows obtained from the following sources:

- 1992 Castle Peak Road flows and composition are from traffic counts performed by TD in May and August 1992 at two locations:

  (i) junction of Castle Peak Road and So Kwun Wat Road (used to obtain approximate flows and composition west of Tsing Tai Road);
  (ii) Castle Peak Road at Siu Lam Interchange (used to obtain approximate flows

and composition east of Tsing Tai Road, assuming that the number of heavy vehicles observed at So Kwun Wat Road remains unchanged at Siu Lam Interchange).

- 2011 Castle Peak Road flows and composition are taken from the Local Traffic Study carried out by the Consultants as part of this consultancy agreement.
- 1992 Tuen Mun Road flows are from traffic counts performed by TD in August 1992. The proportion of heavy vehicles was obtained from the 1992 annual traffic census (Core Station No. 5012).
- 2011 Tuen Mun Road flows and composition are taken from the Local Traffic Study mentioned above.

The planning and population assumptions on which the Local Traffic Study traffic predictions are based are presented in brief in Appendix 3, Local Traffic Study Summary.

2.5 Noise Mitigation Assessment

The requirements for noise mitigation were identified from an examination of the predicted noise levels at the NSRs assuming no mitigation measures are taken, for both construction stage and operational stage noise.

The length and height of noise barriers and enclosures required was systematically evaluated by use of the Noise Barrier Cost Reduction Procedure STAMINA/OPTIMA methodology. The programme calculated the sound energy passing over the barrier segments. The information was used interactively to identify the most efficient noise barrier design.

The STAMINA/OPTIMA programme concept has been adopted to supplement the UK DOT procedure for traffic noise level calculation.

2.6 Visual Impact Assessment

2.6.1 Background to the Visual Assessment

The assessment of the landscape and visual impact of the proposed noise barriers has been carried out with respect to EPD advice note (2/90) relating to the 'Application of the EIA Process to Major Private Sector Projects' and Chapter 10 of the HKPSG - Landscape and Conservation.

A distinction is commonly drawn between visual impacts and impacts on the landscape, where:

a. visual impact relates to the changes arising from development on the views of the landscape from individual 'receiver groups' e.g. local residents or visitors to the country parks within an area.

b. landscape impact relates to the effect upon the physical characteristics or components which make up a landscape, e.g. the topography, vegetation, watercourses, settlements, transport corridors, etc.

As the physical location of the proposed noise barriers would be contained entirely within the works area of the new road, there would not be any direct impact on the existing landscape. The impact on the landscape would be limited to changes in character resulting from the introduction of new elements. In this respect landscape impact would be equivalent to visual impacts. This assessment, therefore, concentrates principally on the visual impacts.

2.6.2 Methodology

The form of the visual impact assessment adopted for the project has been developed to address issues that are typical of this sort of development. The following section outlines the main components of the methodology.

a. Appraisal of the Baseline Conditions and Description of the Project

In order for impacts to be evaluated objectively the baseline conditions of the existing landscape context must first be established. This will include identification and assessment of the following elements:

- the area of the study from within which views of the proposed structures would be possible, i.e. the 'Visual Envelope',
- the pattern of the landscape including topography, natural drainage and vegetation cover, built development, access and circulation, etc
- the character of the landscape and the local architecture, and
- receiver groups.

b. Identification of Visual Impacts

Potential visual impacts (both positive and negative) will be considered both in the short term, during construction, and in the long term during operation.

The assessment of visual impacts is then structured by receiver groups in order to present a systematic and structured appraisal. Receivers are identified through the definition of a Visual Envelope within which views of the proposed barriers would be possible and through the categorization of individuals into user groups within that envelope area:

Receiver Type	Sensitivity to Visual Impact
Residents	High
Users of recreational facilities	High
Users of community facilities	Moderate
Travellers	Low
Employees within business and industrial areas	Low

The visual assessment will also consider the quality of the view for motorists and pedestrians using the road in terms of 'serial views' i.e. the sequence of visual experiences for motorists travelling in each direction

This assessment of the potential visual impacts, and the mitigation measures proposed to ameliorate them, deal strictly with the impact arising from the introduction of the noise barriers along the new road corridor. It does not include an assessment of the impact resulting from the construction of the road itself. In this respect, as a known future development, the road is assumed to have already been constructed, and like the existing Tuen Mun Road, is regarded as a detractor in landscape.

c. Evaluation of Impacts

The degree of severity of the visual impacts have been categorised into severe, moderate, slight and insignificant impacts.

Impacts on visual amenity are predicted by identifying changes such as:

- character and value of existing views,
- degree of change to existing views,
- proximity of receiver,
- sensitivity of receiver,
- number of receivers in the group,
- availability and amenity value of alternative views.

2.7 Visual Impact Mitigation and Residual Impacts

2.7.1 Identification of appropriate landscape mitigation measures

The principal objective of the landscape mitigation measures is to minimise the visual impact of the new noise barriers.

As the broad height, shape and surface type of the barriers has been determined by the required noise attenuation on local residential properties, the landscape measures are concerned mainly with the finished appearance or 'architectural treatment' of the structures.

2.7.2 Identification of residual impacts

An assessment is made of the likely reduction in visual impact that might be achieved through the landscape measures and is given in conclusion as a statement of the 'residual impact'.

CHAPTER THREE
THE SITE

3. THE SITE

3.1 Site Description

Castle Peak Road has existed for many decades. It serves more or less continuous development throughout its length. Its regional function of connecting the western New Territories with urban Kowloon is largely superseded by Tuen Mun Road which was completed in the early 80s, but because of ever increasing demand it continues to carry through traffic between Tuen Mun and Tsuen Wan. It also serves public transport routes.

The length of Castle Peak Road assessed in this study extends from its junction with So Kwun Tan Road in the west to its grade separated junction with Tuen Mun Road at Siu Lam to the east. It is shown on Figures 3 to 5.

The road is a single carriageway not more than 7.3 metres wide throughout. Its vertical and horizontal alignments are below contemporary standards. Footpaths, where they exist at all, are generally sub-standard.

Travelling from the west the road crosses a river on a straight alignment with low rise village buildings of Kar Wo Lei to the left side of the road. Beyond the river the Gold Coast highrise development abuts the road on the right hand side. There is a priority junction with the Development Road which is just beyond another priority junction to the left. Beyond Gold Coast the road curves sharply left. Visibility is limited by rising ground to the left where a home for the aged is situated. There is a priority junction with Tsing Lung Road to the right on the apex of the bend.

The road descends into a valley and curves right. On the left hand side there is container storage with new village houses above. Development on the right is up to 150m away beyond cultivated fields.

Rising out of the valley the road curves right over a crest where visibility is limited. The road and footpaths are narrow. There are a few isolated dwellings to the left above the road, none closer than about 30 metres. Tuen Mun Road is now about 100 metres to the north. On the south side of Castle Peak Road there is currently no development. Beyond the crest the road descends and curves left at its junction with the road serving the site of the former Lok On Pai desalination plant. After the junction the road is more or less straight and level. There are fields and a petrol filling station on the left. To the right Tsing Tai Road runs parallel to and slightly above Castle Peak Road. It is about 60 metres distant and has houses on the side furthest from Castle Peak Road.

At Fiona Garden, a development abutting the right hand side of Castle Peak Road, there are two priority junctions. Castle Peak Road enters Tai Lam village at this point. The closest residential buildings are about 20 metres from the road on both sides. Bus bays on both sides are provided. Beyond the village there is a junction on the left and the road curves slightly right. The Castle Bay Development is on the right with the nearest dwelling less the 20 metres from the carriageway. From here to the study limit, Tuen Mun Road runs parallel and next to Castle Peak Road. The separation varies from 10 to 25 metres. There is another at grade priority junction on the right at the east end of the Castle Bay Development. Beyond that there is no development on the right hand side until the road begins to climb and curve to the right near Siu Lam. A Government quarters block lies 80 metres to the right. It is

served by a junction to the right which also leads to the Marine Police Station. From this junction it is about 120 metres to the junction with Tuen Mun Road. There is a steep cut slope on the right at the top of which are more government quarters, the nearest being about 25 metres from the road.

3.2 Representative Noise Sensitive Receivers

From a study of all residential buildings in the Study Area, it has been estimated that a total of 800 dwelling units (including 290 north facing Gold Coast units) will be affected by noise increases arising from increased traffic on the improved Castle Peak Road. For calculation of noise increase, a list of 41 representative NSRs has been used.

These 41 NSRs have been used to identify the impact of the operation noise from the improved road, and are shown on Figures 6 to 8. These receivers are briefly described in Table 3.1 overleaf. The approximate distance of each receiver to the nearside edge of the widened carriageway is also provided to give an indication of the proximity of the NSR to the roadway. A reduced list of 28 NSRs has been used in the construction noise assessment.

All of the chosen NSRs are residential receivers, with the exception of Yee On Residence for Senior Citizens (YO) and Siu Lam Hospital (SLH), which are institutional receivers. Some receivers, such as the CSQ group at Siu Lam, are government quarters serving staff required to work shifts. An NSR has been included at the site of the Lok On Pai desalination plant in order to assess the noise levels on any future development at this site. The Housing Authority site for future housing development at Area 56 (PSPS) has also been included, though it is unlikely that the widening of Castle Peak Road will have much effect on the noise levels at the site. The proximity of Tuen Mun Road means that traffic noise from this road will dominate. Other future developments considered are an approved comprehensive residential development at So Kwun Wat, and two further CDA sites along Castle Peak Road.

At the NSRs representing the Gold Coast and Peridot Court high rise developments noise measuring points have been taken at top, middle (M) and lowest (L) storey levels.

3.3 Existing Noise Levels

3.3.1 Operational Noise Assessment for Existing Traffic Flows

The traffic noise level at the sensitive facades of the selected Noise Sensitive Receivers (NSRs) was estimated from the existing traffic flows at peak hours input into the computer simulation model. Using the UK DOT (1988) procedure and 1992 traffic flows presented below in Table 3.2, prevailing traffic noise estimates have been obtained and are shown in Table 3.3.

Assumed base speeds (adjusted according to Chart 5 of the UK DOT procedure for proportion of heavy vehicles and road gradient) have been taken to be 70 kph on both Castle Peak Road and Tuen Mun Road. As Tuen Mun Road is currently surfaced with a pervious macadam surfacing, the consequent traffic noise reduction has been taken into account for traffic noise from Tuen Mun Road.

Table 3.1 - Representative Noise Sensitive Receivers

NSR ID	Name/Description	No. of Storeys	Approximate Base Elevation (mPD)	Closest Horizontal Distance to Widened CP Rd. (m)	No. of Dwellings Represented
SLH	Siu Lam Hospital (outbuilding)	2-3	59.0	100	10
AP1	Apartment (unnamed)	2	22.0	70	12
CSQ1	C.S.D. Staff Quarters	5	35.4	27	14
CSQ2	C.S.D. Staff Quarters	4	35.4	45	8
CSQ3	C.S.D. Staff Quarters	3-4	32.8	145	6
CSQ4	C.S.D. Staff Quarters	4	20.7	47	4
MPQ	Marine Police Staff Quarters	8	4.1	68	68
VH1	Village House	2-3	10.0	113	23*
CB1	Castle Bay Villas	2	2.0	20	11
CB2	Castle Bay Villas	2	25.6	13	10
TW	House at TWIL 23A	2	19.8	20	3
DM	Villa De Mer	2	12.5	49	12
AP2	Apartment (unnamed)	2	28.1	28	2
CP	Castle Peak Villa	6	15.3	122	36
IV	Ivanhoe Villa	3	18.0	20	4
FG	Fiona Garden	3	26.8	15	38
SG	Silvern Garden	2	22.1	51	18
VH2	Village House	1	20.0	29	16
KP	Kam Po Court	2	23.9	71	21
CDA	Lok On Pai Comprehensive Dev. Area	30	7.5	260	N/A
VH3	Village House	2	33.0	33	7
TS	Village House (temporary)	1	20.0	38	3
PC,PCM,PCL	Peridot Court	15	11.4	90	21,48,21
PI1	Pearl Island	3	30.0	55	8
PI2	Pearl Island	3	30.0	80	8
PI3	Pearl Island	3	30.0	100	12
PI4	Pearl Island	3	30.0	90	10
AP3	Gurkha Married Quarters	3	16.3	34	15
AP4	Gurkha Married Quarters	2	14.0	40	2
AP5	Gurkha Married Quarters	3	14.0	75	9
YO	Yee On Residence for Senior Citizens	2	16.0	7	11
BP	Beaulieu Peninsula	2-3	15.8	104	16
VH4	Village House	1-2	3.0	45	5
GC1,GC1M,GC1L	Gold Coast Block 6	25	6.0	22	24,48,24
GC2,GC2M,GC2L	Gold Coast Block 3	25	6.0	40	24,48,24
GC3,GC3M,GC3L	Gold Coast Block 1	25	6.0	70	24,48,24
VH5	Village House	2	28.0	42	2
VH6	Village House	2	15.0	22	5
VH7	Village House	1	3.3	45	6
VH8	Village House	1	3.3	20	4
PSPS	Proposed PSPS Housing at Area 56	-	30.0	460	N/A

* VH1 is due for redevelopment and thus not included in computing total numbers of affected dwellings.

Table 3.2 - Existing Traffic Flows and Proportion of Heavy Vehicles

1992 Morning peak hour (8am - 10am)	Castle Peak Road				Tuen Mun Road	
	West of Tsing Tai Road near Fiona Garden		East of Tsing Tai Road near Fiona Garden			
	E/b	W/b	E/b	W/b	E/b	W/b
Flow (veh/hr)	450	290	720	250	4370	2120
Proportion of heavy vehicles	21%	36%	13%	36%	45%	45%

The results of the analysis indicate that current traffic noise levels generally exceed HKPSG criteria in the eastern end of the Study Area, but not in the western end.

In the eastern end of the study area, Tuen Mun Road runs close to Castle Peak Road. Chosen NSRs are thus exposed to noise from both roadways in close proximity to sensitive facades. At all representative NSRs, with the exception of CSQ3, morning peak hour traffic noise levels exceed HKPSG standards.

In the western part of the alignment, traffic noise levels generally decline. The primary reason for the reduction is that the separation between Castle Peak Road and Tuen Mun Road is greater than over the eastern part of the alignment. As a result the contribution from the more distant Tuen Mun Road traffic diminishes. Secondarily, morning peak hour Castle Peak Road flows are slightly less to the west of the residential area around Tsing Tai Road

West of Tsing Fat Street, traffic noise levels exceed HKPSG standards only at the following representative NSRs:

- YO (Yee On Residence for Senior Citizens) is very close to Castle Peak Road, and is subject to more stringent HKPSG criteria;
- PSPS (the proposed Housing Authority PSPS site at Area 56) is exposed to high traffic noise levels from Tuen Mun Road.

3.3.2 Field Measurement of Existing Noise Levels

Field monitoring of traffic noise levels was carried out at 6 NSRs. The locations of the monitoring stations are shown on Figures 6 to 8 inclusive.

Noise levels were monitored between 8.00 am and 10.00 am on 10 November 1993 (Wednesday) at monitoring stations M1, M2 and M4, and over the same period on 12 November 1993 (Friday) at stations M3, M5 and M6.

The noise levels obtained from the monitoring are presented in Table 3.4 below.

Table 3.3 - Current Traffic Noise Levels at Representative NSRs

NSR	Storey/ Elevation	L_{10} (peak hour) Noise (dB(A))
		Overall Facade Noise Levels
		1992
SLH	3F/67mPD	73.4
AP1	2F/30mPD	75.7
CSQ1	5F/49mPD	76.7
CSQ2	4F/46mPD	74.4
CSQ3	4F/44mPD	65.9
CSQ4	4F/32mPD	73.7
MPQ	8F/26mPD	72.5
VH1	3F/18mPD	71.6
CB1	2F/26mPD	75.0
CB2	2F/26mPD	70.9
TW	2F/25mPD	71.3
DM	2F/18mPD	69.3
AP2	2F/34mPD	66.1
CP	6F/32mPD	69.2
IV	3F/26mPD	74.7
FG	3F/31mPD	73.1
SG	2F/28mPD	68.1
VH2	1F/23mPD	68.6
KP	2F/29mPD	68.3
CDA	15F/52.5mPD	64.4
VH3	2F/39mPD	56.2
TS	1F/23mPD	65.9
PC	15F/53mPD	68.6
PCM	7F/31mPD	67.5
PCL	GF/13mPD	67.5
PI1	3F/38mPD	67.1
PI2	3F/38mPD	65.9
PI3	3F/38mPD	63.6
PI4	3F/38mPD	65.0
AP3	3F/25mPD	69.1
AP4	2F/19mPD	69.2
AP5	3F/22mPD	66.2
YO	2F/22mPD	74.1
BP	3F/24mPD	61.3
VH4	2F/9mPD	63.9
GC1	25F/75mPD	68.1
GC1M	12F/34.5mPD	69.1
GC1L	GF/7.5mPD	70.0
GC2	25F/75mPD	68.7
GC2M	12F/34.5mPD	69.1
GC2L	GF/7.5mPD	67.6
GC3	25F/75mPD	66.7
GC3M	12F/34.5mPD	66.3
GC3L	GF/7.5mPD	62.9
VH5	2F/33.5mPD	60.9
VH6	2F/19.5mPD	70.3
VH7	GF/4.7mPD	62.9
VH8	GF/4.7mPD	64.7
PSPS	GF/30mPD	79.0

Table 3.4 - Field Noise Monitoring

Monitoring Station (NSR)	Description/ Time of Monitoring	Facade Noise Level during Morning Peak Hour (dB(A))			Calculated Level (dB(A))
		L_{10}	L_{90}	L_{eq}	L_{10}
M1 (GC1)	Block 6, Gold Coast (roof) 8.00-8.30am	67.2	60.7	64.6	68.1
M2 (YO)	Yee On Residence for Senior Citizens (ground floor) 8.50-9.20am	75.2	57.7	70.9	74.1
M3 (FG)	Fiona Garden (roof) 8.00-8.30am	74.7	64.7	71.4	73.1
M4 (VH2)	Village House (ground floor) 8.00-8.30am	70.7	52.3	66.9	68.6
M5 (KP)	Kam Po Court (3-4m above ground) 8.00-8.30am	68.7	63.3	66.7	68.3
M6 (MPQ)	Marine Police Staff Quarters (8th storey) 9.10-9.40am	69.9	66.8	68.6	72.5

A comparison of the above monitored noise levels with calculated noise levels shows reasonable agreement in values, with the difference between the monitored and calculated noise levels being 2dB(A) or less, except at monitoring station M6. In general, minor discrepancies may be attributed to differences in the actual and assumed traffic flows, both in terms of numbers and proportion of heavy vehicles. At monitoring station M6 (Marine Police Staff Quarters) where the calculated and monitored noise levels differ by more than 2 dB(A), the difference may be attributable to the fact that the northeast-facing facade assumed for calculations could not be monitored. Instead, the northwest-facing facade, which has a smaller angle of view of Castle Peak and Tuen Mun Roads, was used for monitoring, resulting in a lower noise level.

3.4 Land Uses

3.4.1 Assessment

The study area is located on the shallower south and west facing slopes below the Tai Lam Country Park and above the popular recreational beach areas at Cafeteria Beach and Siu Lam. There is a mix of urban and rural uses which will be affected by the improved road. This section of the report identifies the existing and future land uses within the study area from the statutory and non-statutory plans for the area, as the basis for the assessment of traffic noise

impacts from Castle Peak Road. Statutory and non-statutory zoning within and around the study area is shown on Figure 2.

3.4.2 Planning Context

a) NWNT Sub-region

The study area falls within the North West New Territories. This area is covered by the NWNT Sub-regional Planning Statement (SPS) which will be replaced by the NWNT Development Strategy Review (DSR) for which a second consultation review was published in November 1992. Subject to the consultation the Draft Final Report will then be published.

b) NWNT Sub-regional Planning Statement (SPS)

The SPS Land Use Plan designates land to the south of Castle Peak Road at Siu Lam, as Committed Urban Development Area (CUDA). Land to the north of the road alignment is zoned as a Countryside Conservation Area.

c) Territory Development Strategy (TDS) Review Development Options.

TDS has identified development pressures in NWNT which need to be catered for in future planning policies. Development pressure is primarily focussed on Tin Shui Wai, Kam Tin and San Tin/Lok Ma Chau. For this reason one of the main objectives of the study is to identify comprehensive development areas along the strategic transport routes as a solution to sporadic and uncoordinated developments within the sub-region. The study area is designated in all development options as an existing/planned urban area.

d) NWNT Development Strategy Review (DSR)

The DSR will replace the SPS and will incorporate and elaborate on the findings of TDS. The DSR is now subject to public consultation. Three development options are suggested which indicate that the study area is committed for general urban development. A recommended option will be selected in the middle of 1994, after the TDS has been finalised.

e) So Kwun Wat Development Permission Area Plan (DPA/TM-SKW/1)

The area to the north of Castle Peak Road is covered by the So Kwun Wat DPA Plan. DPA plans have statutory power and are being replaced by Outline Zoning Plans (OZPs). They were intended to control non-conforming uses within the New Territories. The road is on the southern edge of the plan area. Government Institution and Community land use (GIC) and Green Belt Zonings predominate in the area of the plan closest to the road. Certain areas are zoned Village Type Development (V) in recognition of existing topography and villages, including So Kwun Wat Tsuen, So Kwun Wat San Tsuen, Tai Lam Chung Tsuen, Luen On San Tsuen, Wong Uk and Wu Uk.

f) Tuen Mun Outline Zoning Plan (OZP:S/TM/8)

The planning of the area is controlled by the OZP which is a statutory plan and has legal effect. The area to the south of Castle Peak Road between Siu Lam and So Kwun Tan is covered by the Tuen Mun OZP. The land use proposals contained within the OZP broadly accord with those of the SPS. Land to the south of Castle Peak road is generally allocated to existing and possible future residential development. Residential development comprises residential type R(B), Comprehensive Development Areas, and three sites for village type development. Also abutting the road is a large open space reserve. No specific noise mitigation measures for residential land use are included within the Written Statement accompanying the OZP.

g) The non-statutory Tuen Mun Eastern Extension Area Planning Statement Plan (D/TM 4/1) covers the areas to the north of the Castle Peak Road, and defines the area as a Potential Urban Development Area. (PUDA)

3.4.3 Layout Plans

A number of Layout Plans cover the study area between So Kwun Tan and Siu Lam. These are non-statutory plans but provide more detail than the proposals contained within the statutory Outline Zoning Plan.

a) Tuen Mun New Town Areas 55A and 57 - Layout Plan (1987)

Area 55A to the east of Castle Peak Road is zoned mainly for Residential R(3) and G/IC facilities, including a fire station, a police station, schools, a sewage pumping station and a light rail terminal.

Area 57 to the west of the road includes a commercial complex attached to a marina and a residential area (R3). The commercial complex and residential area immediately abut the road.

b) Tuen Mun New Town Area 58 - Layout Plan (1992)

Area 58 to the south of the road adjoins area 57 to the north west. Area 58 includes a Military Camp (Married quarters), a residential area (Peridot Court), an area of Green Belt and a residential area.

Area 55 is located to the north of the road. It includes an area of special archaeological interest.

c) Tuen Mun New Town Area 59 - Layout Plan

To the south of the road there are a number of residential areas with some commercial and open spaces. An amenity area separates the Siu Lam Beach Area from the road. A government compound contains Marine Police and CSD facilities.

3.4.4 Current Land Use

To the south of the Castle Peak Road there are two water frontage related uses - a Marine

Police Base and an Excise Station. Elsewhere the subject area comprises a mix of agricultural land (either active or under-utilized), lorry parks, container storage and traditional village settlement.

To the west there are several new high rise residential developments which are currently under construction or have been recently completed. In addition to these is the more established Fiona Gardens residential development. As permitted development, it is unlikely that any of these developments have been obliged to adopt measures to mitigate the effects of increased traffic noise.

3.4.5 Land Status

The land is predominately Crown Land interspersed with a number of private lots.

3.4.6 Future Land Uses

The site of the former desalination plant is currently being used as a trans-shipment area. It is designated for residential use after 1997. Given the size of the site, its proximity to Castle Peak Road, and the lack of intervening structures it is likely that the development of the site will be constrained by resultant noise impacts or that substantial noise mitigation measures may be required.

A future comprehensive residential development proposed in the Siu Lam area fronting Tuen Mun Highway will have an estimated population of 4,870 persons. This development has been taken into account in the Local Traffic Study, and the traffic predictions on which the noise assessment is based take account of traffic generated by this development. It is understood that the development includes the construction of extensive bunds along the southern border of the site to screen the development from Tuen Mun Road and Castle Peak Road traffic noise.

As the traffic forecast for Castle Peak Road, Tai Lam section, without the road improvement is about 2,400 veh/hr during the peak traffic hours in 2011 with the planned Siu Lam Development (note: flows derived from "Proposed Residential Development at Siu Lam - Section 16 Planning Statement and Development Layout Plan", August 1993), while the traffic flow adopted for this study is 2,700 veh/hr. along the same section of Castle Peak Road after the proposed road improvement at 2011, it is expected that the improved Castle Peak Road would have minimal impact on the planned development which should have built-in self-protective noise mitigation measures as part of the planning requirements for the development.

Reclamations being formed to the south of the So Kwun Tan are not strictly within the defined study area, but are likely to be affected by the proposal if developed with noise sensitive uses.

There is extensive potential for recreational development around the high quality beach areas, and these, together with recent and future residential developments should be visually as well as physically shielded from the source of potential noise and visual impacts of the widened road through the introduction of landscape and noise mitigation measures.

CHAPTER FOUR
THE PROPOSED SCHEME

4. THE PROPOSED SCHEME

4.1 Description of Proposed Road Improvement

The existing road described in paragraph 3.1 above is to be improved to provide additional traffic capacity and at the same time enhance safety, through provision of wider continuous footpaths and increased visibility at junctions. In addition future maintenance costs will be reduced through provision of new road pavements designed to cater for predicted traffic flows.

The road will be improved to provide dual 2 lane carriageways each 7.3m wide. There will be a 3.5m wide footpath/verge on each side and the carriageways will be separated by a central reserve 3.2m wide comprising two 0.5m wide marginal carriageway strips with a 2.2m wide concrete profiled barrier.

Priority junctions will have separate turning lanes where appropriate and bus bays will be provided at all stops. Direct right turns from Fiona Gardens will be prohibited but provision of an at grade roundabout junction at the Tsing Fat Street/Castle Peak Road junction will allow the movement to be made.

The widening necessary to provide a second carriageway will require construction of widened embankments and cuttings. Some cuttings may require retaining walls or soil nailing techniques in order to stabilise steep slopes.

A new bridge will be required parallel to the existing one across the river at So Kwun Tan and a pedestrian bridge will be provided across Castle Peak Road at Fiona Garden to improve pedestrian safety.

Improvements to carriageway drainage will be made with construction of new culverts and outfalls where necessary.

4.2 Construction Details

Two way traffic will be maintained at all times during construction. New traffic lanes will be provided to allow diversion of traffic from the existing road so that it can be reconstructed to the new line, level and pavement thickness.

The improved road will be to the widths described above. Pavements will consist of crushed rock sub-base laid on a prepared sub-grade. The sub base will be overlaid with 3 or more layers of bituminous material.

The new bridge at So Kwun Tan will be a 3 span reinforced concrete structure on piled foundations. The intermediate supports will be constructed in temporary sheet pile cofferdams.

The footbridge at Fiona Gardens will be on bored piles. The main span will be precast or prefabricated and erected by crane.

4.3 Construction Activities

A 30-month construction programme for the road widening has been assumed, broken down as follows:

Months 1 and 2	Preliminary works and mobilization
Months 3-14	Earthworks and drainage along widened alignment
Months 15-20	Construction of new first carriageway kerbing and paving
Months 21-23	Breaking out of existing carriageway
Months 24-30	Construction of new second carriageway and drainage.

It is likely that the contractor will work in more than one location at a time. However, since traffic must continue to pass, activities will be limited to one carriageway. At a single location, it will not be feasible for earthworks, drainage, kerbing and paving to be carried out simultaneously. Thus, the construction noise assessment is based on simultaneous operation of plant for a single activity only.

Equipment requirements for each activity are provided in Table 4.1, along with sound power levels (SWL) for individual and massed equipment.

In addition to the plant listed in Table 4.1, different plant will be required for the bridge and retaining wall construction and for construction of any noise mitigation barriers. Detailed design of the structures has been substantially completed (except for noise barriers, preliminary design of which is presented in this report), and is understood to be as follows:

River Bridge: 3-span in-situ reinforced concrete superstructure on reinforced concrete intermediate supports and bank seats. Foundations to be bored piles. Intermediate support pile caps constructed within cofferdams.

Footbridge: 2-span precast concrete main deck with in-situ reinforced concrete staircase and ramps. Foundations are to be bored piles.

Retaining Wall: Soil nail slope.

Noise barriers/partial noise enclosures: Partial noise enclosures and 5m high vertical barriers will require bored pile foundations. Frames supporting noise panels to be in-situ concrete and/or prefabricated structural steel.

Equipment requirements for each activity are provided in Table 4.2, along with sound power levels for individual and massed equipment. A Construction Noise Permit will be required for percussive piling work done in connection with the bridge construction. Equipment requirements for Noise Barrier/Partial Enclosure construction are listed in Table 4.3.

Table 4.1 - Road Widening: Equipment Requirements and Input Assumptions

Activity Description	Equipment and Quantity		Assessment Input	
			SWL per piece dB(A)	Assumed on-time
Preliminary works and mobilization	Truck with crane	1	98	100%
	Drilling rig (diesel)	1	114	100%
Earthworks	Pneumatic breaker	1	110	70%
	D8 Ripper/Dozer	1	115	100%
	Dumptrucks	4	109	20%
	Loader	1	110	70%
	Vibrating roller	1	104	100%
	D4 Dozer	1	115	65%
Drainage	Dumptrucks	2	110	20%
	Backhoes	2	109	90%
	Truck with crane	1	98	100%
	Concrete mixer truck	1	107	80%
	Vibratory pokers	2	112	75%
Kerbing	Concrete mixer truck	1	107	80%
	Vibratory pokers	1	112	75%
	Dumptruck	1	109	20%
Paving (flexible)	Asphalt trucks	4	110	100%
	Paver	1	108	100%
	Rollers	2	103	100%
Excavation of existing carriageway	Pneumatic breaker	1	110	70%
	Backhoe	1	103	100%
	Trucks	2	109	20%

Notes: i. SWL values are from *BS 5228: Part 1: 1984*, using plant sound power methodology and results shown in Appendix C of that Standard. Exceptions are SWL values for pneumatic breaker and air compressor, for which values from Table 3 of the *Technical Memorandum on Noise from Construction Work other than Percussive Piling*, assuming silenced equipment, have been used.

ii. "On-time" estimates are generally obtained from *BS 5228: Part 1: 1984*, using estimates shown in Appendix C of that Standard. Estimates for breakers, air compressors and dumptrucks have been assumed.

Table 4.2 - Bridge and Soil Nail Slope Construction: Equipment Requirements and Input Assumptions

Activity Description	Equipment and Quantity		Assessment Input	
			SWL per piece dB(A)	Assumed on-time
Piling	Bored piling rigs	2	115	100%
	Mobile cranes	1	116	100%
	Pump trucks	1	109	50%
	Concrete mixer trucks	2	107	80%
	Vibratory pokers	4	112	75%
Temporary works sheet piling	Crane	1	Evaluated separately as percussive piling	
	Piling hammer (drop)	1		
	Compressor	1		
Pile cap construction	Excavator (backhoe)	1	109	85%
	Dumptrucks	2	109	20%
	Dewatering pump Compressor	1	100	100%
	Crane	1	116	100%
	Concrete mixer trucks	2	107	80%
	Vibratory pokers	4	112	75%
Pier construction	Compressor	1	100	100%
	Crane	1	98	100%
	Concrete pump truck	1	107	100%
	Concrete mixer trucks	2	107	80%
	Vibratory pokers	4	112	75%
Super-structure construction	Compressor	1	100	100%
	Mobile cranes	2	98	100%
	Concrete pump truck	1	107	100%
	Concrete mixer trucks	2	107	80%
	Vibratory pokers	4	112	75%
Soil Nail Slope	Compressors	2	100	100%
	Rock drills	2	102	100%
	Excavator (backhoe)	1	109	100%
	Dumptrucks	2	98	20%

Notes: i. SWL values are from *BS 5228: Part 1: 1984*, using plant sound power methodology and results shown in Appendix C of that Standard. Exceptions are SWL values for pneumatic breaker and air compressor, for which values from Table 3 of the *Technical Memorandum on Noise from Construction Work other than Percussive Piling*, assuming silenced equipment, have been used.

ii. "On-time" estimates are generally obtained from BS 5228: Part 1: 1984, using estimates shown in Appendix C of that Standard. Estimates for breakers, air compressors, dumptrucks, electric winch, and bored piling rig have been assumed.

As a worst-case scenario, footbridge construction noise is added to carriageway construction noise outside Fiona Garden. Bridge, retaining wall and noise barrier construction will proceed as stand-alone operations, and are not combined with the noise of road widening.

The appropriate combinations of noise barrier construction activities have been modelled at the various noise barrier locations indicated on Figures 9-14.

The predicted noise levels at the representative noise sensitive receivers due to the construction activities are presented in the next section of the report, "Noise Assessment."

Table 4.3 - Noise Barrier/Partial Enclosure Construction Equipment Requirements and Input Assumptions

Activity Description	Equipment and Quantity		Assessment Input	
			SWL per piece dB(A)	Assumed on-time
Piling (5m barrier and partial enclosure only)	Bored piling rigs	2	115	100%
	Mobile cranes	1	116	100%
	Pump trucks	1	109	50%
	Concrete mixer trucks	2	107	80%
	Vibratory pokers	4	112	75%
Pile cap/strip foundation construction (All barriers + partial enclosures)	Excavator (backhoe)	1	109	85%
	Dump trucks	2	109	20%
	Concrete mixer trucks	2	107	80%
	Vibratory pokers	4	112	75%
	Dewatering pump	1	100	100%
Structural Frame Construction (Concrete) (All barriers + partial enclosures)	Compressor	1	100	100%
	Concrete pump truck	1	107	100%
	concrete mixer truck	2	107	80%
	Vibratory pokers	4	112	75%
	Crane	1	116	100%
Structural Frame Erection (Steel) (5m barrier and partial enclosure only)	Mobile cranes	2	116	100%
	compressor	1	100	100%

Notes: i. SWL values are from *BS 5228: Part 1: 1984*, using plant sound power methodology and results shown in Appendix C of that Standard. Exceptions are SWL values for pneumatic breaker and air compressor, for which values from Table 3 of the *Technical Memorandum on Noise from Construction Work other than Percussive Piling*, assuming silenced equipment, have been used.

ii. "On-time" estimates are generally obtained from BS 5228: Part 1: 1984, using estimates shown in Appendix C of that Standard. Estimates for breakers, air compressors, dumptrucks, electric winch, and bored piling rig have been assumed.

4.4 Predicted Traffic Flows

Predicted traffic flows for the worst case scenario up to the year 2011 were obtained from the Local Traffic Study. The Local Traffic Study was commissioned because the only existing traffic predictions available for the road network in this area were flows derived from examination of the CTS-2 model predictions. This model is a strategy-level model and is not designed to give detailed traffic flow predictions. The Local Traffic Study set up a two-tier model of the local road network, and, using the CTS-2 predictions and ATC traffic counts to provide boundary conditions, produced more detailed and reliable estimates of traffic flows on Castle Peak Road and Tuen Mun Road within the study area for the years 2001, 2006 and 2011.

The predicted flows for Castle Peak Road and Tuen Mun Road for the year 2011 are presented in Table 4.4 below. The year 2011 was found to have heaviest peak traffic flows along both roads, and accordingly, these figures have been adopted for the traffic noise impact assessment.

Table 4.4 - Predicted Traffic Flows and Proportion of Heavy Vehicles

From	To		Predicted Actual Traffic Flow Year 2011	
			Flow (veh/hr)	Proportion heavy vehicles
Tuen Mun Rd.		EB WB	3772 3852	52% 61%
Siu Lam Interchange (W)	Marine Police Base Access	EB WB	1555 1178	EB 47% WB 57%
Marine Police Base Access	Lok Chui Street	EB WB	1538 1183	
Lok Chui Street	Kwun Fat Street	EB WB	1495 1167	
Kwun Fat St	Lok Yi Street	EB WB	1424 1230	
Lok Yi Street	Tsing Tai Road	EB WB	1419 1257	
Tsing Tai Road	Tsing Fat Street	EB WB	1428 1435	
Tsing Fat Street	Siu Sau Village Access	EB WB	1136 883	
Siu Sau Village Access	Tsing Lung Road	EB WB	1096 697	
Tsing Lung Road	Gold Coast East Access	EB WB	1073 656	
Gold Coast East Access	Kar Wo Lei Hill Rd	EB WB	1058 664	
Kar Wo Lei Hill Rd	Kar Wo Lei	EB WB	1036 688	
Kar Wo Lei	So Kwun Wat Rd	EB WB	1034 638	
So Kwun Wat Rd	Gold Coast West Access	EB WB	1088 549	

Assumed base speeds (adjusted according to Chart 5 of the UK DOT procedure for proportion of heavy vehicles and road gradient) have been taken as 70kph on Castle Peak Road and 70kph on Tuen Mun Road.

It may be noted from a comparison of Table 4.4 with Table 3.2 that while overall traffic on Castle Peak Road is predicted to increase by a factor of up to 4 the number of heavy vehicles is predicted to increase by a factor of up to 9. The noise impact of heavy vehicles is much greater than that for passenger cars.

CHAPTER FIVE
NOISE ASSESSMENT

5. NOISE ASSESSMENT

5.1 Construction Phase

Noise from construction other than percussive piling has been assessed with reference to *BS 5228: Part 1: 1984* and the *Technical Memorandum on Noise from Construction Work other than Percussive Piling*. The plant sound power method (Section A.3.3) in *BS 5228* forms the basis for the assessment. Notional source positions are obtained using the methodology outlined in Section 2.7 of the *Technical Memorandum on Noise from Construction Work other than Percussive Piling*.

Noise from percussive piling has been assessed with reference to the *Technical Memorandum on Noise from Percussive Piling*.

No evening or night-time construction activities are anticipated. Construction noise (other than that from percussive piling) is therefore assessed with reference to a daytime maximum criterion of 75 dB(A) L_{eq} (30 min).

Representative NSRs are the same as those identified for the operational noise impact assessment (except that a reduced number of NSRs is considered), and are shown in Figures 6 to 8 inclusive. All NSRs are residential except Yee On Residence for Senior Citizens and Siu Lam Hospital. The PSPS and CDA NSRs are not included in the construction noise assessment, as it is assumed that road construction will be completed ahead of development of these sites.

Where the construction site is linear, only the dominant portion of the site is considered for the purpose of determining the notional source position. The dominant portion is that portion of the site closest to the NSR and having a length to width ratio of 5:1. Otherwise, all items of powered mechanical equipment (PME) are assumed to be grouped at a position midway between the approximate geographical centre of the construction site and its boundary nearest to the NSR.

Construction Noise Assessment Results

Road Construction
The noise impact of road construction activities has been assessed based on the equipment assumptions of Table 4.1, with this plant concentrated at that point on the alignment closest to the NSR. The results of this assessment are presented in Table 5.1.

The results indicate that, at receivers within about 75 m of the alignment, the maximum construction noise levels can be anticipated to significantly exceed the assessment criterion of 75 dB(A) L_{eq}. Earthworks, construction of drainage, and road paving are the loudest activities expected.

Mitigation measures to reduce construction noise at sensitive facades are discussed in Section 6 of this report.

Construction of Road Bridge, Footbridge and Soil Nail Slope
Using the equipment assumptions of Table 4.2, the maximum facade noise levels that would be expected when plant is operating during construction of the road bridge, footbridge at

Table 5.1 - Road Construction Activities Noise Assessment

NSR I.D.	Facade Noise Level (dB(A)) due to Road Construction:					
	Prelim Works	Earthworks	Drainage	Kerbing	Paving	Pavement Excavation
GC1	82	87	85	80	85	79
VH4	81	87	84	80	85	79
YO	91	96	93	89	94	88
BP	69	74	71	67	72	66
AP3	82	87	85	80	85	79
PI1	69	74	71	67	72	66
TS	77	83	80	76	81	75
PC	71	76	74	70	75	68
VH3	77	82	80	75	80	74
KP	72	77	75	71	75	69
VH2	80	85	82	78	83	77
SG	75	81	78	74	79	73
FG	85	91	88	84	89	83
IV	87	92	90	86	90	84
CP	68	73	71	67	72	65
DM	75	80	78	73	78	72
AP2	79	85	82	78	83	77
TW	79	84	81	77	82	76
CB2	85	90	88	84	88	82
CB1	91	96	93	89	94	88
VH1	68	74	71	67	72	66
MPQ	77	82	80	76	80	74
CSQ4	83	88	86	81	86	80
CSQ3	67	72	69	65	70	64
CSQ2	75	80	78	74	79	72
CSQ1	79	84	81	77	82	76
AP1	72	77	75	70	75	69
SLH	68	73	71	66	71	65

Construction noise impact exceeding construction noise impact assessment criteria

Table 5.2 - Bridge and Retaining Wall Construction Activities Noise Assessment

NSR ID	Facade Noise Level (dB(A)) due to Bridge and Retaining Wall Construction:						
	Road Bridge				Footbridge		Slope
	Bored Piling	Pile Caps	Piers	Super-structure	Piers	Super-structure	Soil Nail
GC1	82	80	78	78	--	--	--
VH4	79	77	74	74	--	--	--
VH2	--	--	--	--	73	58	--
SG	--	--	--	--	71	56	--
FG	--	--	--	--	88	74	--
IV	--	--	--	--	82	67	--
CP	--	--	--	--	61	46	--
DM	--	--	--	--	66	52	--
AP2	--	--	--	--	73	59	--
CSQ2	--	--	--	--	--	--	73
CSQ1	--	--	--	--	--	--	76
AP1	--	--	--	--	--	--	69
SLH	--	--	--	--	--	--	65

Construction noise impact exceeding construction noise impact assessment criteria.

Fiona Gardens and soil nail slope at Siu Lam are given in Table 5.2. Only those NSRs which are close to the construction have been included in the assessment.

The greatest impact from the construction of the road bridge will result from percussive piling of steel sheet piles. This impact is examined separately.

Aside from percussive piling, the remaining activities associated with construction of the road bridge are expected to have impacts exceeding the assessment criterion at the Gold Coast development and Kar Wo Lei village.

Construction of the footbridge outside Fiona Garden is anticipated to result in excessive noise levels at Fiona Garden and Ivanhoe Villa (IV). These buildings will shield a number of other receivers in the vicinity from the noise of construction.

The noise from construction of the soil nail slope is expected to exceed the assessment criterion only at the closest of the Government Quarters (CSQ1), due to the relatively low SWL of the required equipment and to the screening effect of the nearby topography.

Percussive Piling at Road Bridge

Driving of temporary works sheet piles for the road bridge will require the use of a piling

hammer. The impact of this percussive piling is evaluated differently from that of other construction works, since percussive piling requires a Construction Noise Permit (CNP) specifying restricted working hours.

The receivers that will be affected by the piling are those in the Gold Coast development and in Kar Wo Lei represented by NSRs GC1 and VH4. According to the *Technical Memorandum on Noise from Percussive Piling*, these receivers are subject to an Acceptable Noise Level (ANL) of 85 dB(A).

The *Technical Memorandum* specifies a sound power level (SWL) of 129 dB(A) for a drop hammer driving sheet steel pile and 132 dB(A) for a diesel hammer. For this assessment values for the more commonly used diesel hammer have been adopted.

At ground level, the facade noise from unscreened percussive piling by diesel hammer is expected to reach:

- 89 dB(A) at NSR GC1
- 85 dB(A) at NSR VH4

and by drop hammer is expected to reach:

- 86 dB(A) at NSR GC1
- 82 dB(A) at NSR VH4

The exceedances of the ANL at the Gold Coast development indicate that a CNP for percussive piling using either a diesel or drop hammer will include restrictions on the hours during which percussive piling may take place. Driving of sheet piles using the drop hammer will be restricted to weekdays between 08.00-09.30, 12.00-14.00, and 16.30-18.00.

CNPs for non-percussive piling, such as bored piling, would only be required if this piling was expected to proceed between 19.00 and 07.00 or at any time on Sunday or a general holiday.

Noise Barrier Construction

The maximum facade noise levels that would be expected during construction of the noise barriers and partial enclosures shown on Figures 9-17, and based on the equipment requirements of Table 4.3 are given in Table 5.3 below.

An examination of the results show that noise levels at those NSRs closest to high barrier and partial enclosure construction (YO, PI, AP3, PC, TS, KP, SG, IV, DM, TW, CB1, CSQ1, CSQ2), resulting from barrier construction, will be even higher than that from pavement works, but that for those NSRs that are at some distance from barriers, pavement construction will be noiser. Noise levels at many NSRs are significantly above the 75dB(A) assessment criterion.

5.2 Operation Phase

The traffic noise level at the sensitive facades of the chosen NSRs was calculated based on the UK DOT (1988) procedure. The traffic flows used in the computer simulation were those presented in Table 4.4 previously.

The results of the analysis are presented in Table 5.4.

Table 5.3 - Noise Barrier Construction Activities Noise Assessment

NSR ID	Facade Noise Level dB(A)			
	Bored Piles	Pilecap/Spread Foundation Construction	Concrete Superstructure	Steel Superstructure
GC1	79	75	77	73
VH4	79	75	77	73
Y0	99	95	97	93
BP	74	70	72	68
AP3	84	85	88	82
PI1	80	78	76	74
TS	82	83	85	76
PC	79	75	77	73
VH3	73	71	73	67
KP	80	76	78	74
VH2	83	79	81	77
SG	83	79	81	77
FG	86	82	84	80
IV	93	89	91	87
CP	76	72	74	70
DM	85	81	83	79
AP2	84	80	82	78
TW	88	84	86	82
CB2	94	90	92	88
CB1	94	90	92	88
VH1	73	71	69	67
MPQ	81	77	79	75
CSQ4	84	80	82	78
CSQ3	74	70	72	68
CSQ2	84	80	82	78
CSQ1	89	85	87	83
AP1	78	74	76	72
SLH	75	71	73	69

Construction noise impact exceeding construction noise impact assessment criteria

Table 5.4 shows that current (1992) traffic noise already exceeds the HKPSG maximum at most representative NSRs. The Table also indicates that expected 2011 Tuen Mun Road traffic alone will contribute to excessive noise levels at many representative NSRs. Thus, the extent of Castle Peak Road mitigation generally must be determined with the aim of preventing deterioration in the present or future noise environment, i.e., ensuring that the widened Castle Peak Road increases noise levels by no more than 1.0 dB(A) over present levels and future Tuen Mun Road levels. At a limited number of representative NSRs which are well shielded by orientation or topography from Tuen Mun Road (VH2, YO, PI1-4, AP3-5 and VH4, 5, 7, 8), the extent of mitigation will be based not on this need to prevent deterioration, but rather on the need to keep noise from 2011 Castle Peak Road flows below HKPSG criteria.

At receivers toward the eastern end of the Study Area (approximately east of the Castle Bay development), the impact of increased traffic along Castle Peak Road is diminished by the predominating influence of Tuen Mun Road. Traffic flows along Tuen Mun Road are significantly higher than on Castle Peak Road. Further, Tuen Mun Road runs virtually adjacent to Castle Peak Road along this section of the alignment.

As a result of the relative position of the two road alignments and of the imbalance in traffic flows, NSRs closer to Tuen Mun Road (represented by NSRs AP1 and VH1) experience little deterioration in their noise environments attributable to Castle Peak Road. Receiver SLH is the exception to this observation, since its most exposed facade is somewhat protected by topography from the noise of Tuen Mun Road traffic. Noise from Castle Peak Road is comparatively more significant at this receiver.

The road alignments and flows also mean that NSRs closer to Castle Peak Road (e.g., the Marine Police and Correctional Services Quarters) are subject to slightly higher traffic noise from Tuen Mun Road than from Castle Peak Road. Noise from Castle Peak Road contributes sufficiently (about 2 to 4 dB(A)) to the overall noise level to warrant the consideration of mitigation measures along the eastern section of Castle Peak Road. However, mitigation measures along Castle Peak Road are unlikely to have much effect on reducing noise from Tuen Mun Road. As a result the overall noise levels at NSRs will remain well in excess of the HKPSG criterion of 70dB(A) even if noise mitigation measures are installed to reduce the noise contribution from Castle Peak Road.

In the central part of the Study Area (approximately between Castle Bay development and Peridot Court), the influence of Tuen Mun Road traffic diminishes as the horizontal and vertical alignments of Tuen Mun Road and Castle Peak Road diverge. Generally, the contribution from Castle Peak Road traffic predominates over that from Tuen Mun Road traffic in this area.

Also in this area, a number of residential facades (e.g., those in Fiona Garden and Castle Bay) are found in very close proximity to the widened Castle Peak Road. This results in a more severe traffic noise impact from that road.

Furthermore, a number of NSRs, represented by AP2 and VH2, are situated between Castle Peak Road and Tuen Mun Road. These NSRs have sensitive facades facing directly toward Castle Peak Road and away from Tuen Mun Road. At these facades, the influence of Tuen Mun Road traffic is negligible.

Table 5.4 - Current and Future Traffic Noise Levels at Representative NSRs without Mitigation

NSR	L_{10}(peak hour) Noise (dB(A))					
	Overall Facade Noise Levels and Comparison			Contributions from Separate Roads in 2011		
	2011 (1)	1992	Difference (2)	Castle Peak Rd	Tuen Mun Rd	Castle Peak Rd: Contribution to Overall Noise Level (3)
SLH	76.6	73.4	3.2	72.1	74.7	1.9
AP1	77.6	75.7	1.9	70.9	76.5	1.1
CSQ1	80.8	76.7	4.2	78.1	77.5	3.3
CSQ2	77.7	74.4	3.3	73.9	75.4	2.3
CSQ3	69.4	65.9	3.5	65.8	66.9	2.5
CSQ4	77.9	73.7	4.2	75.2	74.5	3.4
MPQ	76.7	72.5	4.2	74.0	73.3	3.4
VH1	73.3	71.6	1.6	60.8	73.0	0.3
CB1	79.2	75.0	4.2	76.1	76.2	3.0
CB2	75.6	70.9	4.7	73.4	71.6	4.0
TW	74.8	71.3	3.4	70.0	73.0	1.8
DM	74.2	69.3	4.9	71.7	70.5	3.7
AP2	73.0	66.1	6.9	72.2	65.3	7.7
CP	73.5	69.2	4.3	70.8	70.1	3.4
IV	82.1	74.4	7.7	81.7	71.3	10.8
FG	81.4	73.1	8.2	81.2	67.0	14.4
SG	75.6	68.1	7.5	75.1	65.8	9.8
VH2	77.7	68.6	9.1	77.7	45.4	32.3
KP	75.2	68.3	6.9	74.6	66.6	8.6
CDA	68.8	64.4	4.3	66.6	64.7	4.1
VH3	63.4	56.2	7.2	63.4	--	63.4
TS	71.9	65.9	6.0	71.2	62.9	8.5
PC	74.0	68.6	5.4	73.2	66.4	7.6
PCM	73.7	67.5	6.2	73.3	62.9	10.8
PCL	73.2	67.5	5.7	72.5	65.0	8.2
PI1	74.2	67.1	7.1	74.2	--	74.2
PI2	73.0	65.9	7.1	73.0	--	73.0
PI3	70.6	63.6	7.0	70.6	--	70.6
PI4	72.0	65.0	7.0	72.0	--	72.0
AP3	76.0	69.1	6.8	75.9	57.2	18.8
AP4	75.7	69.2	6.5	75.5	62.2	13.5
AP5	72.8	66.2	6.7	72.7	57.7	15.1
YO	81.2	74.1	7.1	81.2	--	81.2
BP	68.0	61.3	6.7	67.9	52.7	15.3
VH4	70.4	63.9	6.5	70.4	--	70.4
VH5	68.1	60.9	7.2	68.1	--	68.1
VH6	77.1	70.3	6.8	76.9	63.6	13.5
VH7	69.9	62.9	7.0	69.9	--	69.9
VH8	71.7	64.7	7.0	71.7	--	71.7
GC1	73.8	68.1	5.7	73.3	64.6	9.2
GC2	74.5	68.7	5.8	74.0	65.0	9.5
GC3	72.1	66.7	5.4	71.2	64.6	7.5
GC1M	75.6	69.1	6.5	75.4	61.4	14.2
GC2M	75.6	69.1	6.5	75.4	61.5	14.1
GC3M	72.5	66.3	6.2	72.2	61.4	11.4
GC1L	76.7	70.0	6.7	76.6	57.3	19.4
GC2L	74.3	67.6	6.7	74.3	54.6	19.7
GC3L	68.8	62.9	5.9	68.4	58.3	10.5
PSPS	80.0	74.0	1.0	58.6	80.0	0.0

NSRs which do NOT qualify for Equitable Redress under the eligibility criteria for insulation, para 2.2.2

As a result of these factors, traffic noise from Castle Peak Road contributes more significantly to the overall facade noise level at most receivers in this part of the Study Area. The contribution of Castle Peak Road traffic to the overall noise level increases to 3-15 dB(A) at facades facing both Tuen Mun and Castle Peak Roads, rising with proximity to Castle Peak Road. At facades facing only Castle Peak Road, traffic noise levels at 2011 (which are attributable only to Castle Peak Road) significantly exceed both the HKPSG recommended maximum and the prevailing noise level.

Calculations demonstrate the need for mitigation measures to reduce the absolute level of Castle Peak Road traffic noise, and to reduce its contribution to the overall traffic noise level.

In the western end of the Study Area (approximately west of Peridot Court), the influence of Tuen Mun Road is further reduced as its horizontal and vertical alignments diverge further from those of Castle Peak Road. Except at Housing Authority's PSPS site in Area 56, the impact of Castle Peak Road traffic on the selected NSRs greatly exceeds that of Tuen Mun Road traffic.

A large number of sensitive facades, such as those represented by YO, PI and VH4, face away from Tuen Mun Road and toward Castle Peak Road. At these facades, the influence of Tuen Mun Road is further reduced.

At receivers in this part of the Study Area, the need for mitigation measures to reduce the future Castle Peak Road traffic noise level by as much as 10 dB(A) is required.

CHAPTER SIX
NOISE MITIGATION OPTIONS

6. NOISE MITIGATION

6.1 Noise Mitigation Options - Construction Phase

6.1.1 The most effective mitigation measure for construction noise is to control noise at its source. In the case of powered mechanical equipment, this involves either selecting silenced equipment, or reducing the transmission of noise using mufflers, silencers, or acoustic enclosures.

6.1.2 Construction noise may be mitigated through several measures:

(a) Noisy equipment and activities should be sited by the Contractor as far from sensitive receivers as is practical.

(b) Noisy plant or processes should be replaced by quieter alternatives where possible. For example, pneumatic concrete breakers can be silenced with mufflers and bit dampers, or can be replaced with electric hydraulic breakers. Silenced diesel and gasoline generators and power units, as well as silenced and super-silenced air compressors, can be readily obtained.

(c) Noisy activities can be scheduled to minimise exposure of nearby NSRs to high levels of construction noise. For example, noisy activities can be scheduled for midday, or at times coinciding with periods of high background noise (such as during peak traffic hours). Prolonged operation of noisy equipment close to dwellings should be avoided.

(d) Idle equipment should be turned off or throttled down. Noisy equipment should be properly maintained and used no more often than is necessary.

(e) The power units of non-electric stationary plant and earth-moving plant can be quietened by vibration isolation and partial or full acoustic enclosures for individual noise-generating components.

(f) Construction activities can be planned so that parallel operation of several sets of equipment close to a given receiver is avoided.

(g) If possible, the numbers of operating items of powered mechanical equipment should be reduced.

(h) Construction plant should be properly maintained and operated. Construction equipment often has silencing measures built in or added on e.g. bulldozer silencers, compressor panels, and mufflers. Silencing measures should be properly maintained and utilised.

(i) Limited hours of use for powered mechanical equipment are recommended; a ten-hour period from 8:00 a.m. to 6:00 p.m. is suggested. Hours of use could be further restricted by the Resident Engineer if sufficient and justifiable complaints from affected villagers are received.

6.1.3 In addition to the above measures, construction noise along the roadway may be mitigated by the early construction of traffic noise barriers. These barriers, designed to attenuate the

impact of traffic noise, will also attenuate the impact of construction noise. Alternatively, temporary barriers or screens could be used.

6.1.4 Though not effective in reducing noise levels, the establishment of good community relations can be of great assistance to both the contractors and NSRs. Residents along Castle Peak Road should be notified in advance of planned operations, and informed of progress. Notification of blasting operations is particularly important. If necessary, a liaison body can be established to bring together representatives of the affected communities, the government, and the contractors. In addition, residents may be provided with a telephone number for the Resident Engineer's office, where they may register complaints concerning excessive noise. If justified, the Resident Engineer may authorise noisy operations to cease or to be conducted at more restricted hours.

6.2 Noise Mitigation Options - Operation Phase

6.2.1 Traffic noise may be controlled at source, along its path, or at NSR facades. The various options available for mitigating traffic noise are reviewed in the following paragraphs, and their suitability for use on Castle Peak Road is assessed.

6.2.2 Control at Source

Controlling traffic noise at its source involves the design of quieter vehicles, traffic management and road surface treatments, all of which result in less noise being generated.

(i) *Quieter Vehicles*

This is outside the scope of this study.

(ii) *Traffic Management*

Traffic management measures may be introduced, such as reducing traffic flow or vehicle speed or limiting the use of the road by heavy vehicles. This section of Castle Peak Road however is classified as a district distributor and thus restricting its use by heavy vehicles is not a viable alternative. Other traffic management measures would be difficult to effectively enforce, and would reduce the capacity of the road, thus partially defeating the purpose of the road improvement works. Traffic management measures for traffic noise reduction would be impractical on this section of Castle Peak Road.

(iii) *Road Surface Treatments*

A pervious macadam paving surface (also known as friction course surfacing) has high acoustic absorption characteristics that can significantly reduce traffic noise levels. In the Calculation of Road Traffic Noise, the presence of pervious macadam paving reduces basic traffic noise levels by 3.5 dB(A).

In practice, the use of pervious macadam paving is restricted, due to its maintenance requirements. Sections of roadway subject to stop-start traffic (including areas with steep gradients, or around bus stops and junctions) are not favoured for application of pervious macadam. Experience has shown that in favourable conditions, i.e. high

speed through traffic roads, such surfacing has a service life of up to 3 years. There have been applications which have survived only a matter of weeks. Some improvements in service life have been obtained by the use of more expensive materials in the surfacing mixture. The performance of pervious macadam surfaces in Hong Kong is presently being studied, but as the results of the study are not yet available, the evaluation of this kind of paving material for use in this study area has been based on fairly subjective criteria.

The improved Castle Peak Road will have a number of junctions, run-ins and bus bays, and will have vertical and horizontal curves in its alignment. The road therefore would not be ideal for the application of friction course surfacing. Frequent maintenance and repair of the surfacing, particularly at junctions, would be required. The stretch of road from Siu Lam interchange to Kwun Fat Street at the eastern end of Tai Lam village has relatively few junctions involving few turning movements. Friction course surfacing would require less frequent maintenance along this section of road than at Tai Lam village or So Kwun Tan. The maintenance requirements for friction course surfacing on Castle Peak Road from its intersection with Kwun Fat Street to its intersection with Tsing Tai Road (Tai Lam village area), are likely to be very high due to the number of junctions, run-ins and bus bays along this short section of roadway. The benefits of the reduced traffic noise would be offset by the inconvenience of frequent surfacing repair and replacement operations. Very high wear is likely to be experienced at the roundabout at the junction of Tsing Fat Street and Castle Peak Road, and again further west, along that section of carriageway from in front of the Peridot Court development to the western end of the improvement works, where there is a sharp horizontal curve and several junctions, run-ins and bus bays. A rigid pavement construction would be necessary at all bus bays, which would give rise to road drainage problems at the interface between the friction course surfacing and the rigid pavement.

Potential sources of additional traffic noise can be minimised by omitting manhole covers in the carriageway as far as possible during detailed design and by close supervision of finished pavement level tolerances during construction.

It was noted, in reviewing the available utilities and drainage drawings for Castle Peak Road, that it is proposed to install fresh and salt water mains and the Eastern Coastal Sewerage Extension sewer in the carriageways rather than at the footpath. Where possible, these services should be diverted to the footpaths or to the central median space, to avoid placing manhole covers and valve chambers in the carriageway.

6.2.3 Control along Noise Path

Controlling traffic noise along its path includes interception by designing the road alignment to incorporate natural or man made topographic barriers or by constructing purpose-built barriers of different types.

i) *Road Alignment*

Road alignment can be designed so that it incorporates features which will reduce traffic noise at sensitive developments.

The road alignment can be altered so that the distance between the carriageway and

the affected receiver is increased, thus permitting greater natural attenuation of noise along the path to the receiver. The horizontal alignment of the improved Castle Peak Road is fixed by the existing road alignment. Additionally, many of the existing receivers are quite close to the roadside, on both sides of the carriageway. In adjusting the currently planned alignment to increase the distance to any particular NSR, the distance to NSRs on the opposite side of the road would decrease.

Thus, modifications to the horizontal alignment can have very little net benefit in reducing traffic noise at NSRs.

Effective noise control can also be achieved by designing the vertical alignment of the road so that it runs through steep cuttings near noise sensitive developments. The existing road alignment restricts the alignment of the improved road. Existing topography, the proximity of NSRs to the carriageway, the number of junctions with existing side roads, and the necessity to maintain uninterrupted two-way traffic flow along the route during construction works combine to make the option of lowering the vertical alignment so that the road is at a depressed level when compared to the adjacent NSR's technically infeasible.

It is concluded that it would not be practical or effective to alter the road alignment to control traffic noise from Castle Peak Road. It is noted that the planned road alignment will incorporate steep cuttings near some NSRs (VH3, CB2, CSQ1, CSQ2) which will be effective in reducing noise levels at these NSRs.

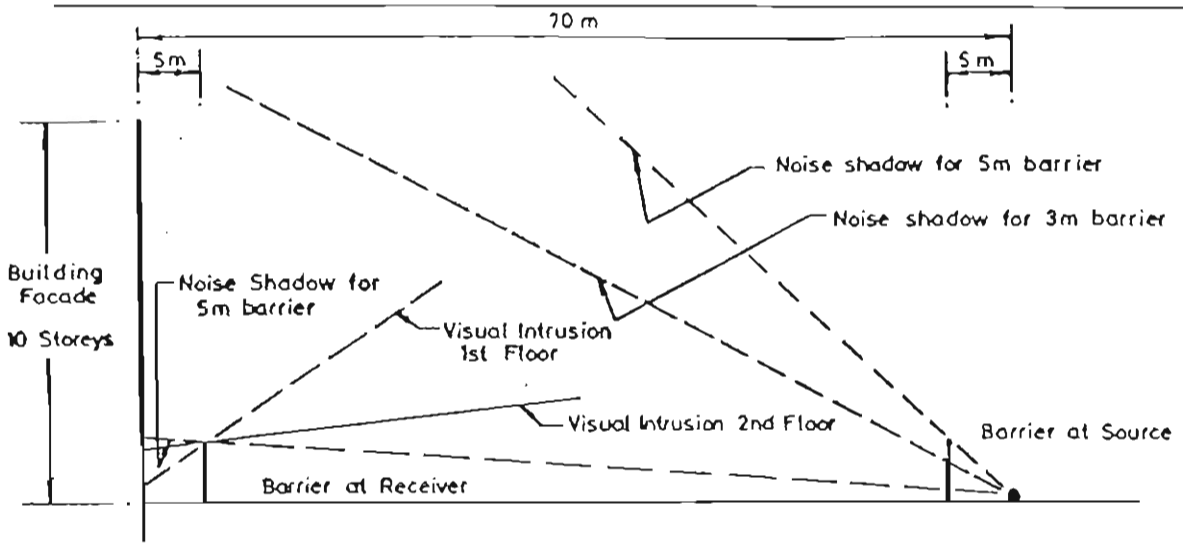
(ii) *Barriers - General*

Barriers may be provided along the sides and centre of the double carriageway. A concrete barrier between the eastbound and westbound carriageways, to separate opposing traffic flows, is shown in the preliminary design drawings along the entire alignment, and its presence has been assumed in all noise calculations. In order to maintain adequate sight-lines on curves and approaching intersections, the height of this barrier is restricted to 1.0m. However, no such restrictions have been assumed for the roadside barriers and partial enclosures, and barrier heights up to 5m have been considered in this assessment.

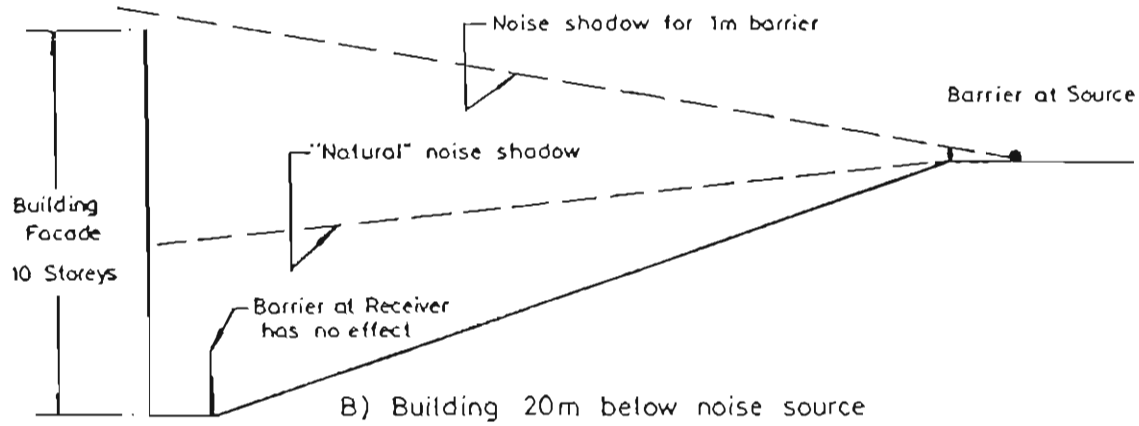
Barriers are most effective when provided close to the noise source. Their location close to receivers may be considered, but in this location they will always be more visually intrusive. This is because they will not be perceived as part of the highway infrastructure and will merely be an unnecessary obstruction to views.

Plate 6A overleaf illustrates this by showing diagrammatically at a, b and c, a 10 storey building facade located 70 metres from a highway noise source, and level with it, 20 metres below it and 20 metres above it respectively. The very limited effectiveness of barriers close to the receiver and their intrusive visual effects are shown.

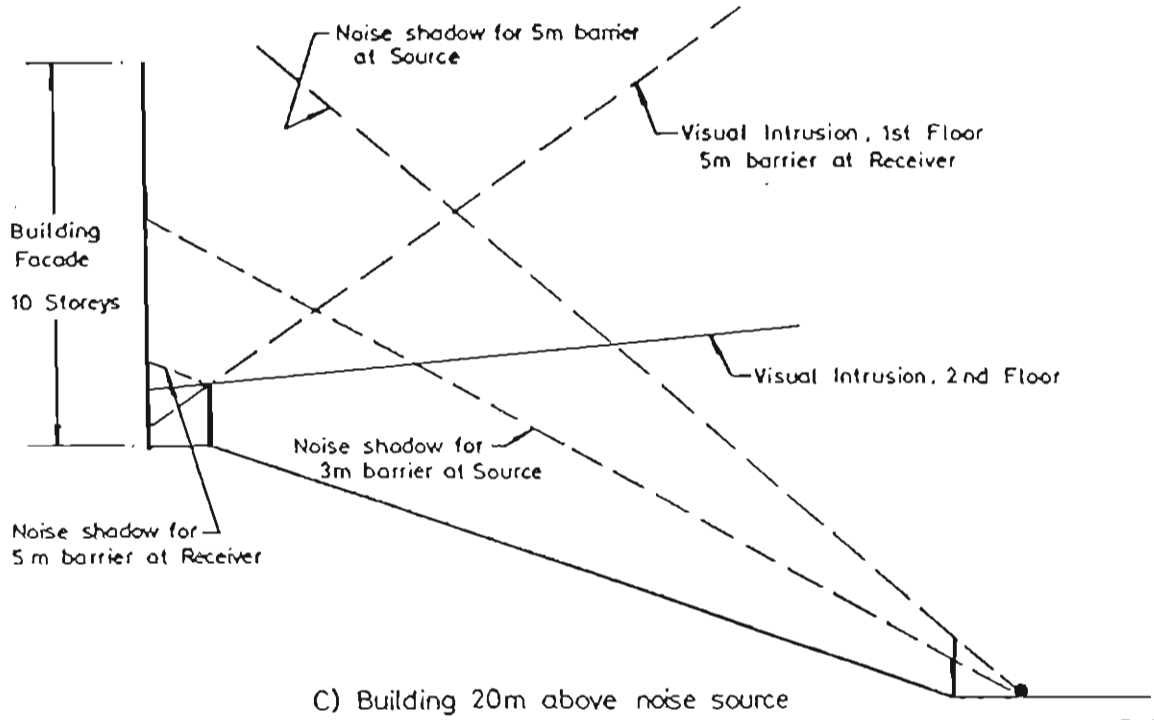
For these reasons provision of barriers close to the receivers will not be considered further.



A) Building level with noise source



B) Building 20m below noise source



C) Building 20m above noise source

PLATE 6A

(iii) *Concrete Profile Safety Barrier*

Barriers up to 1.0m high are effective in some locations particularly in shielding NSRs from noise on the opposite carriageway. The HyD standard concrete profile barrier is 800mm high for vehicle containment but may be increased to 1m high with approval of TD & HyD when it would provide such a screen. Where a concrete profile barrier is provided at the edge of the carriageway, its back, vertical face can be masked by planting if required as shown in Figure 18.

(iv) *Barriers 2 to 3m High*

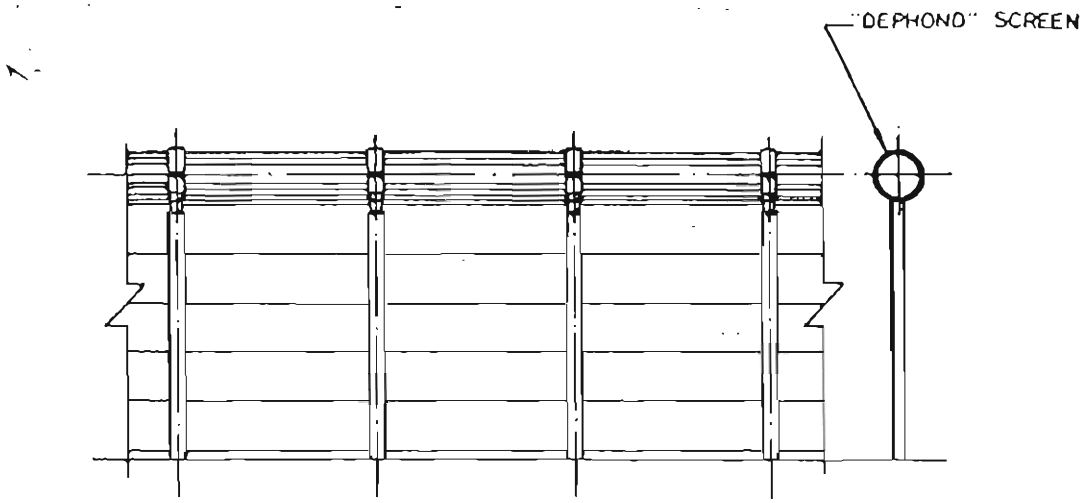
Barriers up to 3m in height may be designed as free standing walls on suitable spread foundations. A simple, cost effective form of construction is illustrated in Figure 19. The barrier comprises vertical steel joists at about 6m centres with precast concrete planks spanning between them. Alternatively, brick walls could be used, where appropriate. There are also a number of proprietary panel systems on the market for use in noise barriers, some of which have absorptive properties and others which are effective in reflecting noise only. There are variations in detailed shape and materials of such barriers.

One example of a specialist proprietary product is the Dephond Screen Noise Reducer. It is illustrated in Plate 6B. The manufacturer of the screen claims that installing it atop a barrier increases the barrier's effectiveness by replacing the non-absorptive top edge with an absorptive cylinder. Sound waves are refracted and absorbed by the cylinder as they pass over it, thus reducing noise on the shielded side. The manufacturer asserts that installing the screen is equivalent to increasing barrier height by 3 to 4 times the diameter of the cylinder. The costs of providing the Dephond Screen have been estimated, based on the manufacturer's claims for its performance and are included in paragraph 6.6. However, it is stressed that the effectiveness of the Screen in protecting higher-level NSRs, such as those that are present along Castle Peak Road, is not certain, and the performance of the Screen is not proven in Hong Kong.

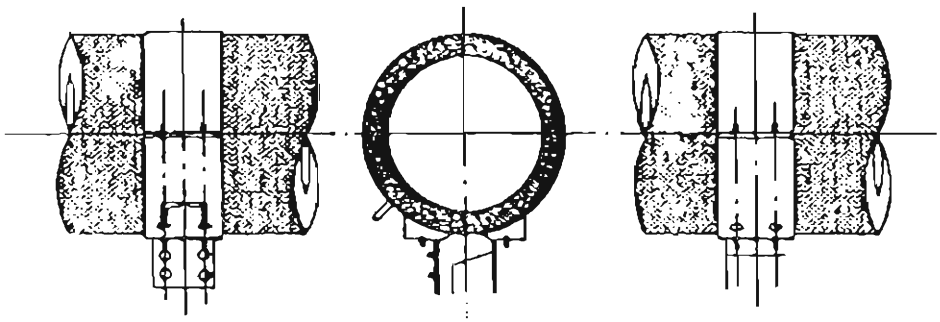
Alternatively barriers may be formed by earth bunds. Such bunds cannot be formed with side slopes steeper than 1 vertical to 1.5 horizontal and it follows that earth bunds of 2m or 3m height even on flat ground would require a minimum land width of 6 or 9m respectively. The variations in the topography adjacent to the roadside and the proximity of the NSRs make earth bund barriers unsuitable for use along this section of Castle Peak Road. In addition, the wide openings required in bunds at the many junctions and run-ins would render them ineffective at many locations along the study area.

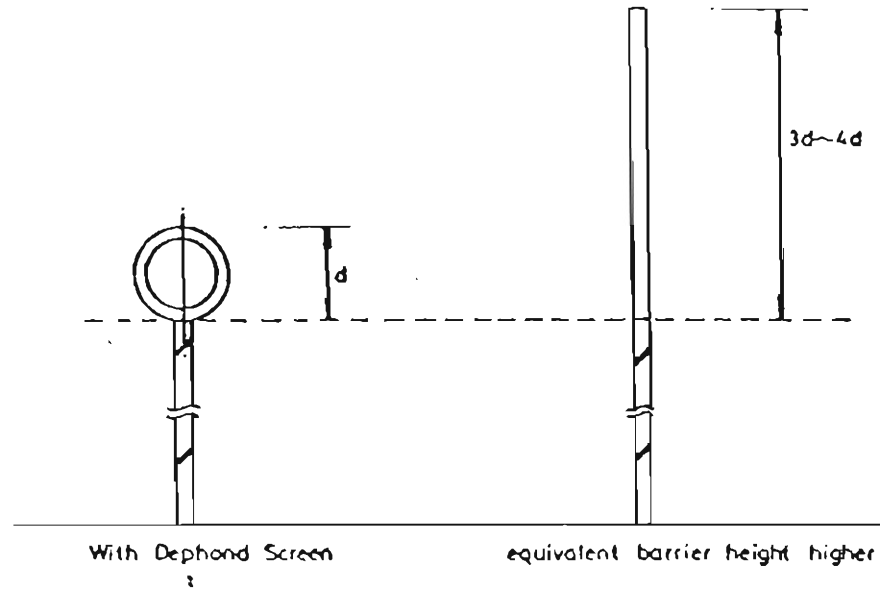
(v) *Barriers 3 to 5m High*

Where a barrier much in excess of 3m high is required, it is found that extensive foundation works are required for a free standing fence, or for an equivalent top bent/cantilever barrier, to resist the high wind load forces generated on it. Foundation options are shown in Plate 6C.1. Typical arrangements for free-standing barriers are shown on Figure 20. The option of using a steel portal frame spanning the carriageway at intervals to support the vertical barrier has also been examined. Though this option would require much less foundation work, the extra cost of the



SCHEMATIC DETAILS

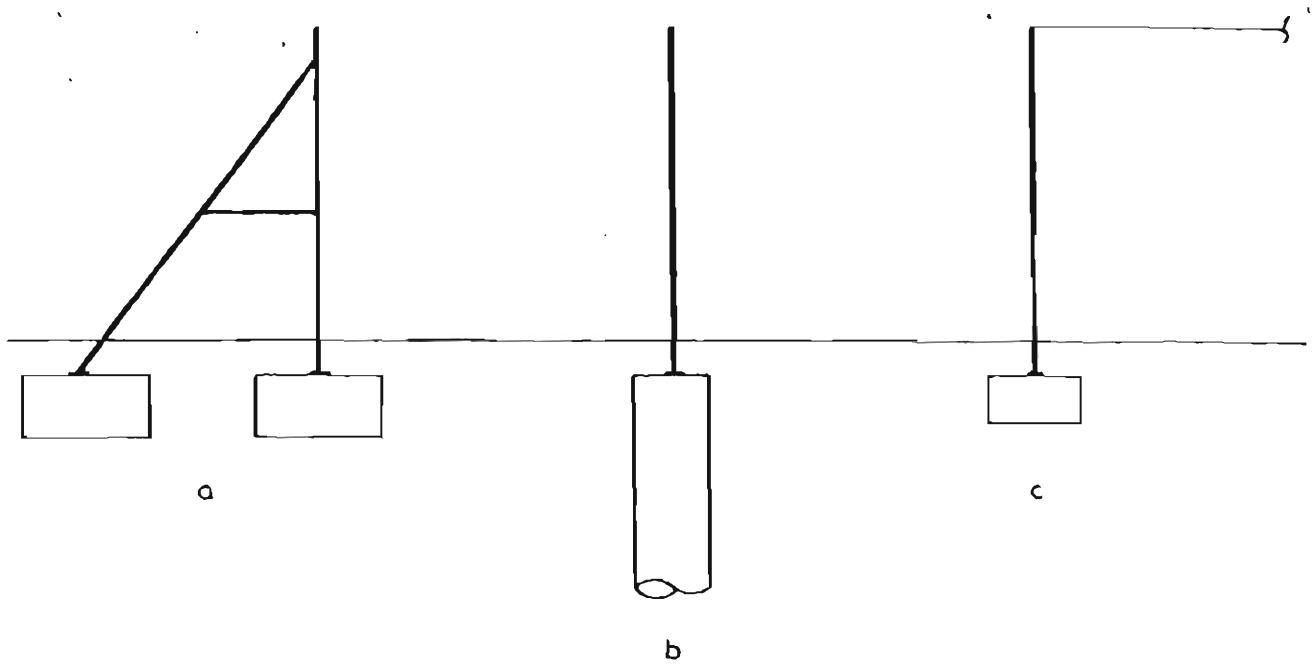




ALLEGED EFFECTIVENESS

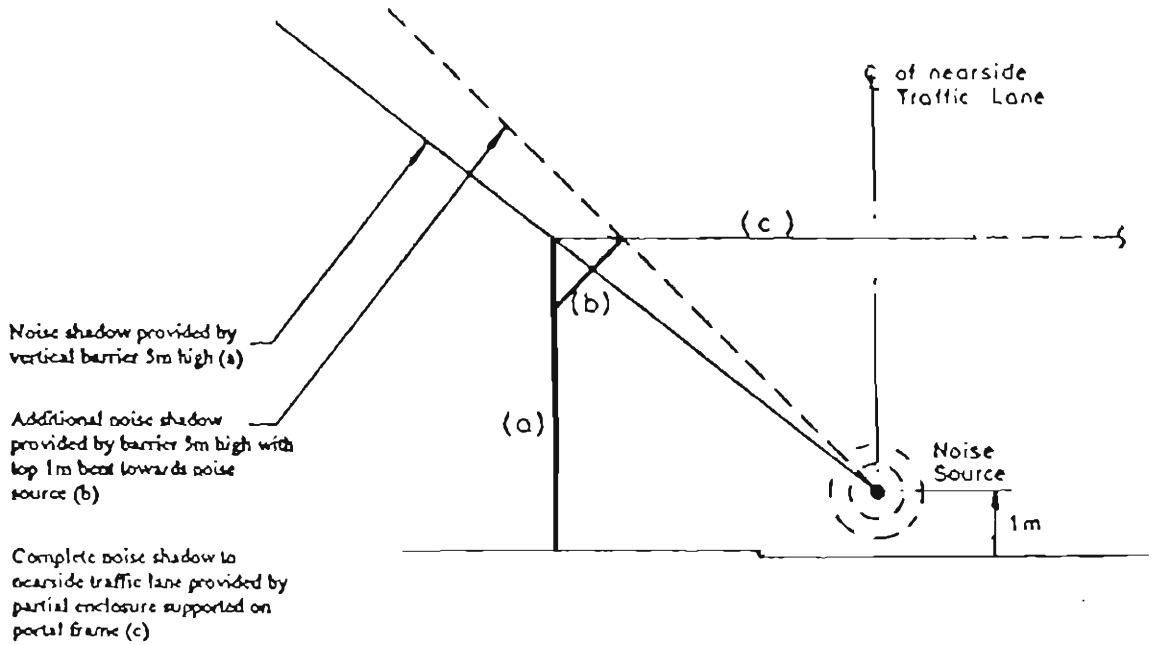
SOURCE : MANUFACTURER

PLATE 6B



ALTERNATIVE SUPPORTS FOR BARRIERS HIGHER THAN 3 METRES

PLATE 6C.1



EFFECTIVENESS OF BENDING VERTICAL BARRIER
AND OF PARTIAL ENCLOSURE ON PORTAL FRAME

PLATE 6C.2

steel framework makes it uneconomical. It would also be more visually intrusive than a free-standing wall.

It is noted that along much of the section of Castle Peak Road to be improved, the natural ground elevation on either side of the road is higher or lower than the road. Thus, an added complexity in the design of foundations to support noise barriers is the requirement that the stability of the roadside slopes not be adversely affected both during construction of the foundations, and afterwards when the noise barriers are in operation. This applies to all barriers and noise enclosures.

A concrete profile safety barrier will be required at the carriageway edge, where the pedestrian footpath is located between the carriageway and noise barrier, to ensure pedestrian safety. The barrier would also have the advantage of protecting the noise barriers from the direct impact of vehicles.

(vi) *Barriers In Excess of 5m High (Partial Enclosure)*

In cases where vertical barriers of 5m in height provide inadequate noise mitigation, higher barriers would be required. Vertical barriers in excess of 5m in height are clearly not practical as wind overturning forces on the barrier would become excessive. An alternative solution is to bend the barrier so that it partially covers the source of the noise, as illustrated in Plate 6C.2.

A free standing partial enclosure would require piled foundations and would also need large structural frame members at close spacing to support the overhanging roof section of the partial enclosure. The partial enclosure could alternatively be supported on a lighter steel portal frame spanning the carriageway, resting on spread foundations.

(vi) *Full Noise Enclosure*

Full noise enclosures, completely enclosing both carriageways of the improved Castle Peak Road, may be the only effective means of direct noise mitigation for certain sensitive receivers, particularly for the higher level apartments in the high rise developments at the So Kwun Tan end of the study area.

Full noise enclosure would consist of steel portal framework spanning both carriageways and supporting a cladding of noise absorptive panelling. A central support for the frame at the central median would reduce the amount of steelwork required for the framework, but could have a negative impact on driver sightlines.

It is anticipated that the roof and upper portions of the side walls of such structures would be covered with a suitable transparent material, both to permit as much natural lighting as possible within the enclosure, and for aesthetic reasons.

(vii) *Materials for Barriers Higher Than 1m*

Barriers generally comprise some kind of structural framework with appropriate foundations on which are mounted panels of various materials. Such materials include:-

- Paraglas LS-CC (shatter-resistant acrylic glass) reduces noise by about 29 dB(A) (15mm thick) and 32 dB(A) (20mm thick). It is not absorptive, so reflection to opposite facades must be considered.

- Axxis Sunlife (polycarbonate sheet) reduces noise by about 26 to 30 dB(A), depending on its thickness (ranging from 8 to 12mm). This material is not absorptive, so reflection to opposite facades must be considered.

- Insokell aluminum/mineral fibre sandwich panels comply with the German standard ZTV-Lsw-81 for soundwalls, which requires that a reduction of at least 25 dB(A) through the barrier be achieved. These panels have a perforated surface with a high absorption coefficient over a wide range of frequencies.

- A GRC (glassfibre reinforced concrete) barrier 10mm thick with a surface mass of about 20kg/m^2 has a measured average sound reduction of about 30 dB(A). GRC panels may be reflective, dispersive, or absorptive.

- Concrete 150mm thick with a surface density of 346 kg/m^2 is capable of reducing noise between 500 and 1000 Hz by 41 to 45 dB(A). The same thickness of lightweight concrete, having a surface density of 173 kg/m^2, would be capable of reducing noise between 500 and 1000 Hz by 37 to 41 dB(A).

All barriers depend on solid construction for their effectiveness. The barrier components should be assembled without gaps in order to prevent sound from being transmitted through the breaks.

All materials should have fire resistance of 2 hours as a precaution in the event of vehicle accidents causing fire.

(viii) *Barrier Location at Roadside*

Barriers could be constructed at the edge of the carriageway, with the footpaths on the opposite side of the barriers to the carriageway, or at the rear of the footpath, with the carriageway and footpath on the same side of the barrier.

Noise barriers constructed at the road edge would interfere with driver visibility and sight lines at curves in the road alignment and at junctions and run-ins. Barriers would have to be set back from the road edge sufficiently to provide for minimum visibility. The footpath width of 3.5 metres would then have to be allowed for behind the barrier. At certain locations, it would be necessary to resume additional lands. At other locations, where existing structures are close to the edge of the planned carriageway, it may not be possible to maintain the footpath at the planned 3.5m width if barriers are positioned between the footpath and the roadside.

The structural frame supporting the noise barrier panels would have to be designed to resist impact from vehicles if located at the kerbside. Barriers at the rear of the footpath could be protected from direct impact by placing standard concrete profile barriers between the carriageway and the footpath.

Maintenance and cleaning of structures at the road edge would be more difficult than at the rear of the footpath. Temporary closure of the kerbside traffic lane might be required during periods of maintenance.

Pedestrians are more likely to feel uncomfortable if walking on a footpath that is between the road carriageway and noise barrier structures than they would if the footpath was located behind the barriers. The barriers would tend to create a feeling of being "trapped" between the traffic and the barriers. Pedestrians walking behind the footpath would experience discomfort next to high barriers, where they would have a greater feeling of the barrier towering over them.

At bus stop locations, it would be necessary to have the noise barriers located at the rear of the footpath, resulting in discontinuities/openings in the barriers should the barriers generally be positioned at the roadside edge.

Partial or full enclosures would have possible air quality concerns, particularly for pedestrians. Where full enclosures are required, pedestrians would have to be kept outside the enclosure structure. If partial enclosures are required, barriers built between the carriageway and footpath would 'enclose' a smaller volume than barriers built at the rear of the footpath (see Figure 36). Pedestrians would also be kept outside of the 'enclosed' space.

On balance, it is felt that it is preferable to locate vertical barriers at the rear of the footpath. Partial enclosures, on the other hand, may be more advantageously sited at the roadside edge, where they do not affect driver visibility. At locations where visibility is affected, the partial enclosures should be sited at the rear of the footpath. Footpaths will be taken as outside of full enclosure structures.

6.2.4 Control at NSRs

Control of traffic noise at the receiver includes insulation of sensitive facades, use of self-protecting buildings, orientation of building facades, setback distances, and internal arrangement of rooms to screen sensitive areas.

Most receivers along the alignment are of older construction, and do not incorporate any of these measures to reduce traffic noise. However, it appears that the Gold Coast Development has incorporated such features in the six highrise blocks recently built adjacent to Castle Peak Road. Non-sensitive bathroom and kitchen windows, meter rooms and refuse rooms face Castle Peak Road. Where sensitive bedroom facades face the roadway, glazing and air conditioning units have been installed.

These measures do not however remove Government's responsibility for mitigation measures since the need for direct mitigation has not been addressed in the existing lease conditions.

Existing receivers that will be affected by increased traffic noise levels following improvement to Castle Peak Road could be protected by the insulation of sensitive facades. This would involve the provision of good quality glazing and air conditioning units. Insulation can reduce total noise levels at the receivers by up to 25dB(A). The outdoor noise environment would not of course receive benefit from this insulation.

Current practice in noise assessment and mitigation in Hong Kong is that the provision of noise insulation at receivers only be considered as a remedial measure to be applied should the implementation of all feasible direct technical remedies (para 6.2.2 and 6.2.3) prove to be ineffective. Those receivers which meet the three eligibility criteria for insulation (para 2.2.2) after implementation of direct technical measures are then considered for insulation by Exco.

6.3 Physical Impact of Mitigation Measures

6.3.1 Lighting

(i) *Barriers*

Barriers are unlikely to have significant impact on the design of lighting. Where it is deemed desirable to place lighting columns at the back of the verge it may be possible to incorporate them within the barrier at detailed design stage without impairing the noise mitigation properties of the barrier.

(ii) *Partial Enclosures*

The partial enclosure at a height of about 6.0m clearly requires a special detailed design to accommodate conventional height lighting columns in the same verge as the enclosure. Alternatively the lighting column must be at the central median which will make access for maintenance difficult. Figure 21 shows the relative disposition of 10m high lighting columns in the central reserve and partial enclosures. Transparent panels are proposed for the roof of partial enclosures. However, it is likely that a film of dirt would build up on the faces of these panels in a relatively short period of time. Lighting from standard 10m high lighting columns would be affected. A special lighting design would therefore probably be necessary for partial enclosures, either with reduced height columns or luminaries attached to the structure.

(iii) *Full Enclosures*

Conventional lighting will not be possible and special designs will be required either with reduced height columns or with luminaries attached to the structure.

6.3.2 Air Quality

(i) *Barriers*

Solid barriers up to 5m high erected 3.2m from the carriageway are no worse than urban streets with buildings abutting the footpath.

(ii) *Partial Enclosures*

Covering of part of a traffic lane is likely to have an adverse effect on air quality beneath the enclosure particularly when traffic is slow moving or stopped or at bus stops for example. In Figure 21 a possible method of mitigating against deteriorating Air Quality is shown where the bottom 500mm of side panelling is omitted allowing air circulation. This can only be allowed where detailed noise calculations indicate

that noise mitigation is not impaired. A kerbside 1m high concrete profile barrier must be provided to prevent noise leakage through the opening, to provide safety for pedestrians and to protect the noise enclosure structure from vehicle impact.

Figure 36 shows a partial enclosure located between the carriageway and footpath. The 'enclosed' volume under the enclosure is less than for the option where the enclosure covers the footpath as well as the kerbside traffic lane.

Any deterioration in Air Quality would be less for the partial enclosure positioned between the footpath and the carriageway. In addition, pedestrians would not be required to walk within the 'enclosed' volume.

(iii) *Noise Enclosure*

Air quality will inevitably deteriorate within a full noise enclosure particularly in times of heavy traffic flow. Where the length of enclosure exceeds about 220 metres provision for forced ventilation is required, and fire service and other emergency services need to be considered. Such provision would require further environmental studies of air quality at the ventilation system exits.

6.3.3 Amenity

(i) *Barriers*

Kerbside concrete profile barriers can be said to increase amenity because they provide a physical separation between traffic and pedestrians.

Barriers up to 5m high at the rear of the footpath with suitable visual mitigation would not necessarily detract from the amenity value of the footpaths.

(ii) *Partial Enclosures*

Partial enclosures could be said to increase amenity value by providing shelter from wind and rain particularly at bus stops.

(iii) *Noise Enclosures*

Noise enclosures of any significant length would detract from amenity. There are few if any precedents for footpaths within what are effectively vehicular tunnels. Bus stops within such enclosures would be undesirable because of the noise and air quality environment for waiting passengers and would thus need to be relocated from their optimum positions. Pedestrian footpaths would have to be routed outside the enclosures, and emergency service access along these footpaths would have to be provided.

6.3.4 Visibility

(i) *Concrete Profile Barriers*

These have been proposed in the preliminary design drawings and are therefore accepted. It is however noted that with the details of proposed horizontal and vertical alignment and cross section given it may not be possible to achieve the desirable minimum visibility.

(ii) *Other Barriers*

Provided they are located a minimum of 3m from the carriageway edge, barriers higher than a concrete profile barrier will not cause obstruction to visibility. A minimum footpath width of 3.5m has been proposed and the proposed works site limit is generally well beyond the edge of the footpath. Exceptions are a continuous length of about 470m adjacent to the Gold Coast Development and two short lengths elsewhere, one outside the Yee On Residence and one on the west bound carriageway to the east of VH3.

(iii) *Noise Enclosures and Partial Enclosures*

A conceptual portal frame design for a full enclosure would require supports in the central reservation. The spacing of these supports could be up to 12 metres. Alternatively by adopting a truss girder for the horizontal support the need for central columns could be eliminated altogether. The free standing design for the partial enclosure would not affect driver visibility if located at the rear of the footpath. However, if located at the kerbside, a minimum setback would be required at certain locations.

(iv) *Visibility at Junctions*

At priority junctions and run-ins the Traffic Planning and Design Manual lays down criteria for visibility at a height of 1.05m above the road surface at junctions and run-ins. Visibility requirements at junctions for a main road design speed of 70kph are shown in Figure 25. Criteria are less onerous at run-ins. Minimum visibility requirements are discussed in Section 7.8.

6.3.5 Noise

It is proposed that vertical barriers be positioned to the back of the footpaths, primarily to maintain adequate sightlines along the road. This will mean that pedestrians will be exposed to unmitigated traffic noise levels, as they will be required to walk between the traffic and the noise barriers. The acoustic properties of the barrier material will have to be carefully assessed at the detailed design stage to ensure that noise levels for pedestrians are not increased by noise reflection from the barrier.

6.3.6 Emergency Services

Continuous barriers, partial or full noise enclosures will have an impact on emergency services. In the event of fire in roadside properties, access for appliances will be rendered difficult and access to hydrants will be impaired unless more hydrants are provided. At some

locations where buildings are very close to the roadside, the construction of barriers may impede access to that facade of the building closest to the barrier. This is particularly so in the case of Yee On Residence for Senior Citizens. Emergency access from carriageway to footpath, and from footpath through noise barriers at certain locations, will have to be incorporated into the detailed design to ensure adequate access for emergency personnel. Detailed design, particularly of partial or full enclosures will need to be reviewed and agreed by Fire Services Department (FSD), who have expressed concern that fire fighting operations, especially access, water supply and radio communications may be impaired. Details of these impacts could only be assessed by FSD when detailed drawings of the noise barriers and/or enclosures become available. The Commissioner of Police has also expressed concern that enclosures and high barriers may inhibit recovery of vehicles such as container trucks which might overturn in traffic accidents. If full noise enclosures are adopted, it is likely that emergency and recovery procedures similar to those in operation at tunnels and underpasses in the territory would have to be adopted.

Where partial noise enclosures extend over the carriageway, it may be necessary on occasion to remove noise panels locally from the roof of the enclosure to permit efficient operation of recovery vehicles (lifting cranes). Cantilever type partial enclosures would present less obstruction to recovery vehicles than enclosures supported on a portal frame spanning the carriageways.

6.4 Maintenance Requirements

6.4.1 Concrete profile barriers can be considered largely maintenance free.

6.4.2 Free standing barriers have now been erected in a number of locations but only relatively recently. As yet Highways Department have not had opportunity to build up data on maintenance requirements and costs although it is noted that little cleaning is required.

Replacement of damaged sections is required from time to time. Steel components will require repainting.

6.4.3 Partial enclosures or full enclosures will require maintenance cleaning but again with the few enclosures, e.g. on Kwun Tong Bypass, presently erected in the Territory, a record of maintenance cleaning is not yet available.

6.4.4 Porous friction course, being more sensitive to accidental damage, for example from defective wheels or traffic accidents, probably requires more maintenance patching than asphaltic concrete. If it is subjected to regular abrasive wear by stopping/accelerating or heavy turning traffic or by exposure to fuel oil spillage then it requires ad hoc maintenance by replacement.

6.5 Feasible Noise Mitigation Options - Operation Phase

6.5.1 The preceding review of the various traffic noise mitigation options has identified the use of road surface treatments, vertical barriers, partial and full enclosures, and insulation at the receivers as being the options available for consideration in mitigating traffic noise levels from the improved Castle Peak Road.

6.5.2 Road Surface Treatment

It is recognised that conditions along the improved Castle Peak Road will not be ideal for friction course surface treatment and that a relatively high level of maintenance will be required. This is reflected in the cost estimates for friction course surfacing. It would not be feasible to provide friction course surfacing at Tai Lam village, at the Tsing Fat/Castle Peak Road intersection or on the carriageways in front of the Gold Coast Development, because of the expected severe wear on the surfacing at these locations. Friction course surfacing has not been considered at these locations in the optimisation of noise mitigation measures.

The provision of friction course surfacing along the remaining stretches of Castle Peak Road has been considered, and its effectiveness in controlling traffic noise has been assessed, as one of several options, in Section 7.

6.5.3 Vertical Noise Barrier

Vertical noise barriers up to a maximum height of 5 metres are technically feasible along the full length of the improved Castle Peak Road. Openings would have to be incorporated into barrier design at road junctions, run-ins and pedestrian access to properties. The barriers should be located at the rear of the footpath. Free-standing barriers should be adopted where possible. Piled foundations for the higher barriers will probably be required, as the large size of spread foundations necessary to ensure stability would interfere with services and utilities planned for installation in the footpath. This is particularly so near junctions, where there tends to be a greater density of ducting and piping.

6.5.4 Partial Noise Enclosures

Partial noise enclosures, enclosing a single lane of traffic, can be considered feasible. A cantilevered form of construction is to be preferred for aesthetic and emergency services reasons. The partial enclosures should be sited between the carriageway and footpath where driver visibility permits as this would reduce 'enclosed' volume of air. Where partial enclosures at the road edge interfere with visibility, they should be moved to the rear of the footpath. An opening in the enclosure wall to permit pedestrian access through the wall would be required at any location where there is a change in location of barrier/enclosure from carriageway edge to rear of footpath.

A partial enclosure over two lanes of traffic (i.e. a single carriageway) would require a portal frame supporting structure across the roadway. The structure could seriously impede emergency services, in particular recovery vehicle operations, and could have significant impacts on air quality in the enclosed area. Bus bays and footpaths would have to be kept outside of the enclosure. Partial enclosure of more than one lane of traffic is therefore considered impractical for implementation along Castle Peak Road, and is not considered as an option in the preliminary design of noise mitigation measures. Particular considerations against the use of partial enclosures covering a single carriageway along various sections of the route are very similar to those for full noise enclosures, as outlined in 6.5.5 following.

6.5.5 Full Noise Enclosure

i) General

Full noise enclosures, enveloping both carriageways of the improved road, have a number of serious disadvantages, including safety and emergency service aspects, driver safety, air quality, possible need for forced ventilation, difficulties in carrying out maintenance and cleaning of overhead noise panels, special lighting requirements and the resiting of bus bays away from their optimum locations. Future road widening works would become very difficult and expensive and could require complete reconstruction of the full enclosure. In addition, at the locations where full enclosures might be required (at Gold Coast and Peridot Court high rise developments and at Tai Lam village) there are a number of junctions, run-ins and pedestrian accesses for which provision must be made. The necessary openings in the side walls of the enclosures would allow noise to escape from the enclosure, meaning that the "full enclosure" effect could not be achieved.

The route can be broken into three sections when assessing the practicality of noise enclosures, namely the So Kwun Tan section from the Gold Coast Development to Tsing Fat Street Junction, the Tai Lam village section from Tsing Fat Street Junction to Kwun Fat Street junction, and the Siu Lam section from Kwun Fat street junction to Siu Lam interchange.

ii) So Kwun Tan Section

Along the So Kwun Tan section, full noise enclosures would likely be required in front of the Gold Coast Development and Peridot Court to sufficiently protect these dwellings from excessive traffic noise.

In front of the Gold Coast Development, the full enclosure would have an opening for the junction of the development access road with Castle Peak Road, which would reduce significantly its effectiveness in terms of noise reduction. Two bus bays would require relocation. Two junctions would be within the enclosure and one further (Tsing Lung Rd) just beyond the likely end of the enclosure. Turning movements at junctions within and at the entrance to a tunnel-like structure would have very significant adverse safety impacts, as it is generally recognised that the sudden change in light conditions resulting when entering and leaving the enclosure and the reduced effectiveness of the use of traffic aids within tunnels decreases driver awareness. The proximity of Yee On Residence for Senior Citizens to the roadside means that the recommended sightline distance for drivers eastbound could not be maintained. Emergency services access to the facade of this and adjacent receivers fronting the roadside would be completely blocked. Finally, the existing bridge over the river to the west of Gold Coast Block 1 would require considerable strengthening, or reconstruction, to support the additional loading from the enclosure.

In front of the Peridot Court development, a full noise enclosure would affect one junction (Tsing Lung Road), a pedestrian footpath access and a run-in. The junction with Tsing Lung Road would likely be just beyond the western end of an enclosure, and westbound drivers emerging from the enclosure would have to adjust immediately to the changing light conditions. The safety of turning and crossing manoeuvres at the junction would be adversely affected. Two bus bays would require relocation.

In addition, sightline constraints at the western and eastern ends of the enclosure would require the enclosure structure to be set back from the roadside edge and to span up to 26 to 27 metres. This span would require a very heavy construction unless central median supports are incorporated into the enclosure design. Supports at the central median would have further adverse impacts on driver visibility, and should be avoided where possible.

iii) Tai Lam Section

At Tai Lam village, a full enclosure would have to make allowance for openings for four junctions, three run-ins, and several pedestrian accesses. Therefore noise reduction effectiveness will be significantly reduced. Many of the receivers along the roadside would probably still meet the eligibility criteria for insulation. Two bus bays would have to be relocated away from the village area which they serve. The planned pedestrian footbridge would not be feasible, and an alternative underpass would have to be designed around the foundations for the enclosure. A full enclosure would not necessarily affect driver sightlines, though, as mentioned previously, there would be general reduction in driver safety, particularly at the junctions of Tsing Fat Street, Tsing Tai Road and Kwun Fat Street with Castle Peak Road. Emergency service access to the facade of that block of Fiona Gardens fronting the roadside would be severely impaired. Additional fire hydrants through the village would have to be installed behind the enclosure. A noise enclosure through Tai Lam village would also effectively cut the village community in two, and would be a physical barrier between residents to the north of Castle Peak Road and those to the south.

iv) Siu Lam Section

At Siu Lam, a full enclosure would have an opening for the access road to the CSD staff quarters, which would reduce the effectiveness of the noise protection provided. In addition, sightlines for west bound traffic between Siu Lam junction and the access road to the CSD quarters will be considerably shorter than the minimum requirements for a 70 kph road because of the steep cutting at the base of receiver CSQ1. Combined with the safety implications of entering a 'tunnel' (sudden lighting changes), the reduced sightline distance would lead to unsafe conditions for turning manoeuvres at the access road junction.

A clear span of 26-27 metres would be needed for the enclosure structure, as central median supports would adversely affect sightlines for eastbound traffic due to the sharp horizontal curve on the road on the approach to the Siu Lam Interchange junction. Thus a heavy and expensive construction would be required for the enclosure structure. Two bus bays serving the CSD quarters would have to be eliminated. The footpath along the eastbound carriageway of the road may also have to be eliminated, as there would be insufficient space between the outside face of the enclosure and the steep slope at the edge of Tuen Mun Road to allow for its construction.

Based on the above general and particular considerations it is concluded that the provision of full noise enclosures along Castle Peak Road is not feasible. In particular, the reduction in driver safety associated with having junctions and run-ins within or just beyond a tunnel-like structure would be unacceptable. Full enclosures are therefore not considered further.

6.5.6 Insulation at the Receiver

Current practice in noise impact mitigation in Hong Kong is to consider the application of insulation measures at affected receivers only as a remedial measure for those receivers that cannot be effectively protected using any of the direct technical measures of controlling noise. In the preliminary design of the noise mitigation measures, the number of receivers which would qualify for consideration for provision of insulation under the three eligibility criteria has been estimated for each of the options proposed. The number of receivers meeting the eligibility criteria if no direct technical measures are taken to control noise is also identified.

6.5.7 Feasible Options

In summary, the practical noise mitigation options for implementation along all sections of Castle Peak Road within the Study area are vertical barriers up to 5m high and partial enclosures covering the kerbside traffic lane. In addition, friction course surfacing could be considered feasible for use along those sections of the route where it could be expected to have a reasonable service life. Maintenance requirements are expected to be high at these locations. Friction course surfacing is considered to be unsuitable for use on the carriageway from the western limit of the study area to just east of the Tsing Lung Road junction, and through the centre of Tai Lam village. Full noise enclosures are considered to be impractical for use at any location along the section of Castle Peak Road under study.

6.6 Unit Costs

6.6.1 Mitigation Costs Considered

Barriers considered include profile concrete barrier, free standing barriers of various types, and partial enclosures. Costs for friction course surfacing have been estimated and finally, for comparison purposes, costs for providing noise mitigation at the receivers have been presented. Insulation costs for residual noise mitigation required at receivers for each direct mitigation option proposed have also been estimated.

6.6.2 Profile Concrete Barrier

This barrier is likely to form an integral part of the roadworks and as such will generally be included in the roadworks costs. Separate costs for this study are therefore not required.

6.6.3 Free Standing Barriers

The elements of cost for free-standing barriers comprise foundations, concrete and/or steel framework and noise panels, which may be of various proprietary materials, or of solid concrete/brick construction.

6.6.4 Partial Enclosures

Construction details as for 6.6.3.

6.6.5 Derivation of Capital Costs

Unit costs for foundations and steel supports have been derived from recent contracts for

which the Consultants have acted as Engineer. In each case appropriate factors (10% p.a. increase since date of tender) have been applied to derive 1994 prices. Costs for bored pile foundations have been obtained from two specialist piling contractors. The estimates of material quantities are based on the Report Drawings.

Unit costs for concrete structural members and infill panels have been derived from first principles using unit prices for reinforced concrete.

Budget quotations have been obtained for proprietary noise barrier sheets in 12mm polycarbonate sheet (Axxis - Sunlife), acrylic glass (Paraglass LS-CC), aluminium/mineral fibre sandwiches (Insokell) and glass reinforced concrete (GRC Asia). The agent for the Dephond barrier has also provided indicative budget costs.

Capital costs for friction course have been based on information supplied by HyD Research and Development Division.

Capital costs for provision of mitigation at the receiver have been based on figures given in the Lantau Port Peninsula Study and reported figures for compensation under the Western Harbour Crossing Scheme. For the purposes of the costing, it has been assumed that two sealed window units and two 1hp air conditioners would be required at each dwelling unit.

6.6.6 Derivation of Maintenance Costs

Annual Maintenance Costs have been calculated for each year from 1997 to 2011 and totalled. Discounted maintenance costs over a thirty year maintenance period and, for insulation at the receiver, over a fifty year period, have also been computed, and are presented in Appendix 4. A discount rate of 0% has been used. The Net Present Value of the various options with discount rates of 4% and 10% are also included at Appendix 4.

Maintenance costs for concrete profile barriers have not been assessed as they are deemed to be included in regular highway maintenance costs.

It has not been possible to obtain detailed records of costs of maintaining noise barriers and enclosures. An allowance of 5% of discounted capital cost per annum has therefore been assumed for replacement and maintenance.

For friction course surfacing an estimate has been made of the likely frequency of replacement at various locations. It has been estimated that the whole surfacing will need to be replaced at intervals of between 1½ and 2 years. Total maintenance cost is based on milling and replacing the existing friction course together with allowance for replacement of road markings. No allowance has however been made for the costs due to traffic congestion and delays which would arise during such resurfacing.

Maintenance costs for insulation at the receiver have been derived from first principles and include for maintenance and eventual replacement of air conditioning units and include operation costs for the units.

6.6.7 Unit Rate

(i) *Barriers*

Estimated costs in HK$ per linear metre of various types of barrier as follows have been calculated and are shown in Table 6.1. It should be noted that they are estimated capital costs only and total discounted maintenance costs are assessed below at 6.6.8.

Type

A 1m high concrete profile barrier
B1 3m high steel post with concrete planks
B2 3m high concrete post with GRC panels
B3 3m high steel post with concrete planks and Dephond Screen Noise Reducer
C1 5m high vertical barrier with concrete planks (portal frame)
C2 5m high vertical barrier with concrete planks (free standing)
C3 5m high vertical barrier with GRC wall and with top 2m Paraglass (free standing)
C4 5m high vertical barrier with Insokell (free standing)
D1 Partial enclosure one lane, concrete wall, Paraglass roof (portal frame)
D2 Partial enclosure one lane, GRC wall, Paraglass roof (portal frame)
D3 Partial enclosure one lane, concrete wall, Paraglass roof (cantilever)
D4 Partial enclosure one lane, GRC wall, Paraglass roof (cantilever)
D5 Partial enclosure one lane, Insokell wall and roof (cantilever)
D6 Partial enclosure one lane, GRC wall, Axxis polycarbonate sheet roof (cantilever)

Table 6.1 - Unit Costs for Construction of Various Types of Barrier

Type	Cost per lin.m. HK$					
A	included in roadworks					
B	(B1) 3,030	(B2) 5,670	(B3) 6,990	-	-	-
C	(C1) 42,410	(C2) 13,920	(C3) 24,495	(C4) 20,000	-	-
D	(D1) 64,273	(D2) 75,010	(D3) 57,370	(D4) 73,190	(D5) 72,230	(D6) 54,750

(ii) *Friction Course*

A rate of $76/m^2$ at 1993 prices has been provided by Highways Department for provision of friction course on a new carriageway. This gives a cost of $1,225 per lin.m. of dual carriageway at 1994 prices.

(iii) *Mitigation at Receiver*

Each living unit requiring mitigation is assumed to require provision of two sealed window units and two 1hp airconditioners. A cost of $17,600 per dwelling has been

derived.

6.6.8 Annual Maintenance Costs

Annual maintenance costs have been estimated over 15 year and 30 year operation periods, and also for 50 years for insulation at the receiver. The 30 year cost estimates are presented in Appendix 4. The 50 year maintenance and operating costs for providing insulation at the receiver are given below.

(i) *Barriers and Enclosures*

Costs for Type A are deemed to be included within normal highway maintenance budgets.

Costs for all other types are assessed at 5% of initial capital cost. Total maintenance cost for years 1997 to 2011 is therefore 0.7 times the capital cost at 1994 prices and the total barrier costs are therefore 1.7 times the figures given in Table 6.1.

(ii) *Friction Course*

An annual maintenance cost of $68 per square metre has been derived. This gives a total through life cost of $952 per square metre or $13,900 per metre of dual carriageway.

(iii) *Mitigation at Receiver*

It has been assumed that the airconditioners provided would require annual maintenance costs of $500 each and need to be replaced every 7½ years, giving a cost of $30,000 per dwelling unit over 15 years and $105,000 per dwelling unit over 50 years.

6.6.9 Annual Operating Costs

(i) *Mitigation at Receiver*

The annual energy cost for operating a 1hp airconditioner 15 hours per day for a year has been put at $3,200. The total discounted cost for the period 1997 to 2011 is thus $96,000 per dwelling unit, and over the period 1997 to 2046, is $320,000 per dwelling unit.

CHAPTER SEVEN
NOISE MITIGATION PROPOSALS

7. NOISE MITIGATION PROPOSALS

7.1 Noise Mitigation Proposals - Construction Phase

7.1.1 The mitigation measures outlined above in Section 6.1 should permit the construction noise assessment limits to be achieved in most cases.

7.1.2 Evaluation of the exact effectiveness of the noise control measures at a given receiver requires a knowledge of the planned construction schedule, which is not available at this stage. The effectiveness of the measures can be estimated. Stationary and earth-moving plant, including compressors, concrete pumps, excavators, bulldozers, loaders, and dumptrucks, can reduce their noise generation through proper maintenance of the exhaust system and through exhaust silencers. Additionally, engine noise is amenable to reduction through isolation of vibrating engine components, installation of partial or full acoustic enclosures of noise-generating components, and damping of vibrating panels. U.S. tests have shown that partial or full enclosures can achieve noise reductions of 10 and 25 dB(A) respectively.

Super-silenced compressors incorporate acoustic casing linings, mufflers, and anti-vibration mounts to isolate the engine and compressor unit for the chassis. A reduction of 5 dB(A) can be achieved with the use of a super-silenced compressor relative to a silenced compressor.

For piling operations, the piling hammer head and the top of the pile may be enclosed in an acoustic screen, resulting in a sound reduction of 5 to 10 dB(A). Completely enclosing the drop hammer in a box with an opening at the top for crane access will reduce sound even further; a typical L_{eq} sound level (at 10m) for a completely enclosed drop hammer is 75 dB(A).

7.1.3 While it is not feasible to dictate the methods of construction to be employed by the contractor, noise control requirements can be incorporated in the tender/contract documents, specifying the noise standards to be met and requirements for noise monitoring on the site.

Possible noise control provisions include the following:

a) The Contractor shall comply with and observe the Noise Control Ordinance and its subsidiary regulations in force in Hong Kong.

b) The Contractor shall provide an approved integrating sound level meter to IEC 651 : 1979 (Type 1) and 804 : 1985 (Type 1) and the manufacturer's recommended sound level calibrator for the exclusive use of the Engineer at all times. The Contractor shall maintain the equipment in proper working order and provide a substitute when the equipment is out of order or otherwise not available.

The sound level meter including the sound level calibrator shall be verified by the manufacturers every two years to ensure they perform to the same levels of accuracies as stated in the manufacturer's specifications. That is to say the equipment shall have been verified within the two years previous to the time of use.

c) In addition to the requirements imposed by the Noise Control Ordinance, to control noise generated from equipment and activities for the purpose of carrying out any construction work other than percussive piling during the time period from 0700 to 1900 hours on any day not being a general holiday (including Sundays), the following

requirements shall also be complied with:

(i) The noise level measured at 1m from the most affected external facade of any nearby noise sensitive receivers from the construction work alone during any 30 minute period shall not exceed an equivalent sound level (Leq) of 75 dB(A).

(ii) Should the limits stated in the above sub-clause (i) be exceeded, the construction shall stop and shall not recommence until appropriate measures acceptable to the Engineer, to ensure compliance, have been implemented.

Any stoppage or reduction in output resulting from compliance with this clause shall not entitle the Contractor to any extension of time for completion or to any additional costs whatsoever.

d) Before the commencement of any work, the Engineer may require the methods of working, equipment and sound-reducing measures intended to be used on the Site to be made available for inspection and approval to ensure that they are suitable for the project.

e) The Contractor shall devise and arrange methods of working and carry out the Works in such a manner so as to minimise noise impacts on the surrounding environment, and shall provide experienced personnel with suitable training to ensure that these methods are implemented.

f) The Contractor shall ensure that all plant and equipment to be used on site are properly maintained in good operating condition and noisy construction activities shall be effectively sound-reduced by means of silencers, mufflers, acoustic linings or shields, acoustic sheds or screens or other means to avoid disturbance to any nearby noise sensitive receivers.

g) Notwithstanding the requirements and limitations set out in item c) above and subject to compliance with clauses e) and f) above, the Engineer may upon application in writing by the Contractor, allow the use of any equipment and the carrying out of any construction activities for any duration provided that he is satisfied with the application which, in his opinion, is of absolute necessity and that adequate noise insulation has been provided to any educational institutions that might be affected, or of emergency nature, and not in contravention with the Noise Control Ordinance in any respect.

h) No excavator mounted breaker shall be used within 125m of any noise sensitive receivers. The Contractor shall use hydraulic concrete crushers whenever applicable.

i) The only equipment that shall be allowed on the Site for rock drilling works will be quiet drilling rigs with a sound power level not exceeding 110 dB(A). Conventional pneumatically driven drilling rigs are specifically prohibited.

j) For the purposes of the above clauses, any domestic premises, hotels, hostel, temporary housing accommodation, hospital, medical clinic, educational institution, place of public worship, library, court of law, performing arts centre or office building shall be considered a noise sensitive receiver.

k) The Contractor shall, when necessary, apply as soon as possible for a construction noise permit in accordance with the Noise Control (General) Regulations, display the permit as required and copy to the Engineer. The Contractor is to note that neither the Authority nor its employees can influence the issue or terms of a construction noise permit.

7.1.4 Tables 5.1-5.4 present the maximum anticipated facade noise levels when all powered mechanical equipment items are concentrated at a position closest to the NSRs concerned. While the actual noise levels may not be and most probably will not be as high as those predicted due to the actual siting of the equipment, duration of work and other site factors, they do indicate that some NSRs are more prone to excessive construction noise impact than others and that specific noise mitigation measures are warranted.

Mitigation options and possible noise control provisions which can generally be applied to this site have been proposed in 6.1.2 and 7.1.3. The application of these measures to control noise at specific locations is illustrated by an example.

High noise levels are predicted at NSR YO during the construction of the partial noise enclosure. The noisiest activities are the piling and concrete superstructure construction. In order to reduce the maximum anticipated noise levels to 75dB(A), it would be necessary for the contractor to implement a package of mitigation measures. Appendix 5 presents such a package of measures that could ensure a reduction of 20dB(A), though in practice, such drastic noise reduction may not be required.

7.2 Noise Mitigation Proposals - Operation Phase

7.2.1 Introduction

As outlined in Section 6 above, increases in noise levels arising from traffic on the improved road may be mitigated by provision of barriers, friction course surfacing or a combination of both.

From Table 5.4 it is clear that the future noise levels, if unmitigated, will be considerably in excess of the noise criterion in the HKPSG at most of the NSR locations. Preliminary calculations have shown that unless a substantial portion of Castle Peak Road traffic in the study area is totally enclosed, and noise mitigation measures are also implemented along Tuen Mun Road over the eastern section of the study area, the HKPSG noise criterion cannot be met.

Given no works programme for noise mitigation along Tuen Mun Road and the impracticality of fully enclosing Castle Peak Road, as discussed in 6.5.5, the only alternative is to maximize the protection of the NSRs from the Castle Peak Road traffic noise using all practical direct technical remedies, while redressing the residual impact with indirect technical remedies.

The assessment methodology outlined in paragraph 2.5 has been adopted to identify the effectiveness of various combinations of barriers, partial enclosures and friction course surfacing along the improved road. An interactive approach has been used to determine the most effective noise mitigation measures to achieve the HKPSG. In the event that the HKPSG noise criteria cannot be achieved within practical limits, noise mitigation measures which would provide the maximum protection have been determined. In order to redress the residual impact, the eligibility criteria have been used to determine the number of dwellings

eligible for consideration for insulation under the Exco directive.

Two sets of proposals are presented in the following sections 7.2.2 and 7.2.3, one based on the provision of friction course surfacing combined with noise barriers, and the other based on the use of noise barriers only to provide noise control. Both of these alternative schemes provide direct technical remedies that maximise the protection from traffic noise from Castle Peak Road for the existing and planned NSRs.

7.2.2 Noise Barriers With Friction Course (Option 1)

In this option, friction course road surfacing has been assumed to be provided on Castle Peak Road from Siu Lam Interchange to the junction with Kwun Fat Street and from just east of the sharp horizontal bend at Yee On Residence for Senior Citizens eastward to the run-in for the access road to NSR VH3. Friction course surfacing has also been assumed between the junction of Tsing Fat Street with Castle Peak Road and the junction of Tsing Tai Road with Castle Peak Road. The extent of the noise barriers proposed in conjunction with the friction course is indicated on Figures 9-11. The type and exact layout of the barriers would be subject to detailed design.

The predicted noise levels for Castle Peak Road in 2011 are shown in Table 7.1. Comparison with Table 5.4 shows that these proposals result in the number of NSRs which do not qualify for equitable redress under the eligibility criteria rising from 6 to 25. The three eligibility criteria for insulation are:

(i) The predicted overall noise level from the new or improved road, together with other traffic noise in the vicinity, must not be less than the HKPSG criteria;

(ii) the predicted noise level is at least 1.0 dB(A) more than the prevailing noise level, ie, the total traffic noise level existing before the works to construct the road were commenced;

(iii) the contribution to the increase in the noise level from the new or improved road must be at least 1.0 dB(A).

Despite the extensive barriers proposed, combined with friction course on certain sections of the road, the residual noise levels from Castle Peak Road and Tuen Mun Road at a number of NSRs is unacceptably high and these NSRs would qualify for consideration for equitable redress under the above criteria. The reasons that direct technical remedies are ineffective at these NSRs are discussed as follows:

i) NSR - SLH, Siu Lam Hospital
Though on the north side of Tuen Mun Road, this receiver is partly shielded from Tuen Mun Road traffic noise by topography as it is at the crest of a steep cutting, with Tuen Mun Road at the base of the cutting. Castle Peak Road is at a similar elevation to SLH on the opposite side of Tuen Mun Road, and thus has a relatively significant traffic noise impact on SLH. The 5m barriers (A10 and A11) at Siu Lam interchange will tend to reflect Castle Peak Road noise northwards. This effect can be reduced by the use of noise absorbing panels in the noise barrier, and it may be possible to reduce the traffic noise contribution from Castle Peak Road sufficiently so that SLH no longer qualifies for consideration for insulation. However, the overall noise level at SLH would remain very high.

Table 7.1 - Current and Future Traffic Noise Levels at Representative NSRs Noise Barriers with Friction Course (Figures 9-11)

NSR	L_{10} (peak hour) Noise (dB(A))						Overall Noise Level Difference btn Mitigated/ Unmitigated
	Overall Facade Noise Levels and Comparison			Contributions from Separate Roads in 2011			
	2011 (1)	1992	Difference (2)	Castle Peak Rd	Tuen Mun Rd	Castle Peak Rd: Contribution to Overall Noise Level (3)	
SLH	76.2	73.4	2.8	70.9	74.7	1.5	0.4
AP1	77.2	75.7	1.5	69.2	76.5	0.7	0.4
CSQ1	79.6	76.7	2.9	75.4	77.5	2.1	1.2
CSQ2	76.5	74.4	2.1	70.0	75.4	1.1	1.2
CSQ3	68.0	65.9	2.1	61.3	66.9	1.1	1.4
CSQ4	75.3	73.7	1.6	67.5	74.6	0.8	2.6
MPQ	74.3	72.5	1.8	67.6	73.3	1.0	2.4
VH1	73.1	71.6	1.5	58.3	73.0	0.1	0.2
CB1	77.1	75.0	2.1	69.8	76.2	0.9	2.1
CB2	72.3	70.9	1.4	64.1	71.6	0.7	3.3
TW	73.6	71.2	2.3	64.5	73.0	0.6	1.2
DM	71.3	69.3	2.0	63.3	70.5	0.8	2.9
AP2	72.7	66.1	6.6	71.8	65.3	7.4	0.3
CP	72.0	69.2	2.8	67.4	70.1	1.9	1.5
IV	78.6	74.4	4.2	77.7	71.3	7.3	3.5
FG	80.9	73.1	7.8	80.7	67.0	13.9	0.5
SG	71.4	68.1	3.3	70.0	65.8	5.6	4.2
VH2	76.6	68.6	8.0	76.6	45.4	31.2	1.1
KP	70.1	68.3	1.8	67.5	66.6	3.5	5.1
CDA	67.3	64.4	2.9	63.8	64.7	2.6	1.5
VH3	62.1	56.2	5.9	62.1	-	62.1	1.3
TS	67.5	65.9	1.6	65.4	63.4	4.1	4.4
PC	71.9	68.6	3.3	70.5	66.4	5.5	2.1
PCM	70.0	67.5	2.5	69.0	62.9	7.1	3.7
PCL	69.2	67.5	1.7	67.1	65.0	4.2	4.0
PI1	72.9	67.1	5.8	72.9	-	72.9	1.3
PI2	70.3	65.9	4.4	70.3	-	70.3	2.7
PI3	66.1	63.6	2.5	66.1	-	66.1	4.5
PI4	69.8	65.0	4.8	69.8	-	69.8	2.2
AP3	65.9	69.1	-3.2	65.3	57.2	8.7	10.1
AP4	70.2	69.2	1.0	69.4	62.2	8.0	5.5
AP5	66.5	66.2	0.3	65.9	57.7	8.8	6.3
YC	67.6	74.1	-6.5	67.6	-	67.6	13.6
BP	65.5	61.3	4.2	65.3	52.7	12.8	2.5
VH4	70.4	63.9	6.5	70.4	-	70.4	0.5
GC1	73.8	68.1	5.7	73.3	64.6	9.2	0.0
GC2	74.4	68.7	5.7	73.9	65.0	9.4	0.1
GC3	72.1	66.7	5.4	71.2	64.6	7.5	0.0
GC1M	75.8	69.1	6.7	75.6	61.4	14.4	-0.2
GC2M	76.2	69.1	7.1	76.0	61.5	14.7	-0.6
GC3M	72.6	66.3	6.3	72.3	61.1	11.5	-0.1
GC1L	76.6	70.0	6.6	76.5	57.3	19.3	0.1
GC2L	74.2	67.6	6.6	74.2	54.6	19.6	0.1
GC3L	66.8	62.9	3.9	66.1	58.3	8.5	2.0
VH5	66.5	60.9	5.6	66.5	-	66.5	1.6
VH6	72.8	70.3	2.5	72.3	63.6	9.2	4.3
VH7	69.3	62.9	6.4	69.3	-	69.3	0.6
VH8	71.7	64.7	7.0	71.7	-	71.7	0.0
PSPS	80.0	79.0	1.0	57.5	80.0	0.0	0.0

NSRs which do NOT qualify for Equitable Redress under eligibility criteria for insulation para 2.2.2

ii) NSR - CSQ1 and CSQ2 Government Staff Quarters

CSQ1 Government Staff Quarters is sited on a hilltop overlooking Castle Peak Road, and is very close to the roadside. Vertical barriers up to 5m high or partial enclosures along the westbound carriageway in front of CSQ1 are not very effective in reducing Castle Peak Road noise at this receiver because of its elevated location, overlooking the road.

The noise contribution from Castle Peak Road to the overall noise level at CSQ2, which is next to CSQ1, but set back some distance from the crest of the hilltop, only marginally exceeds the eligibility criteria. Suitable attention to design of the barriers locally at the junction of the adjacent access road with Castle Peak Road should ensure that noise levels at this NSR are sufficiently controlled so that it would not qualify for consideration for provision of insulation. For the purpose of this assessment, however, CSQ2 is considered as meeting the three eligibility criteria.

Again, overall noise levels at both NSRs would exceed the HKPSG criterion.

Thus, the 5m high barrier combined with friction course surfacing can reduce the noise contribution from Castle Peak Road sufficiently to ensure that all sensitive receivers at Siu Lam Interchange, apart from CSQ1 and CSQ2, do not qualify for insulation.

iii) NSR - Tai Lam Village Area (AP2, VH2, CP, IV, FG, SG)

Due to the number of junctions, run-ins and bus-stops along the road at Tai Lam village, friction course surfacing would have unacceptably high maintenance requirements. It has only been considered for the straight stretch of carriageway from the junction with Tsing Fat Street to the junction with Tsing Tai Road.

Existing NSRs at Tai Lam village to the north of Castle Peak Road are represented by VH2 and AP2. Both these NSRs are on high ground, overlooking the road. Maximum protection would be provided by partial enclosure along the eastbound carriageway of the road. However, breaks in the partial enclosure are inevitable at several run-ins, including a petrol filling station, and at Kwun Fat Street junction. Pedestrian openings would also be necessary at some locations in the barrier to permit access from the village development to the planned bus stop and pedestrian bridge. It has been found that because of these openings and the elevated level of the NSRs, they would still meet all three eligibility criteria no matter what barrier configuration is adopted. Thus, barriers are not proposed along the north side of Castle Peak Road at Tai Lam Village, as they are considered ineffective.

On the southern side of the road, openings in barriers would occur at the junctions of Tsing Tai Road and Lok Yi Street with Castle Peak Road. A number of residential facades are in close proximity to Castle Peak Road (represented by FG and IV) while others, though more distant from the roadside, are on rising ground. The provision of the maximum extent of partial enclosure possible along the westbound carriageway edge through Tai Lam village would still leave high residual noise levels, with many NSRs (IV, CP, FG, SG) meeting the eligibility criteria for consideration for equitable redress.

A 5m high vertical barrier along the western bound carriageway between Tsing Fat Street and Tsing Tai Road, combined with friction course, can control noise sufficiently at those receivers along Tsing Tai Road (represented by KP) so that they would not qualify for insulation. However, a very extensive length of barrier - 280m - is required to protect relatively few dwellings. The barriers do not provide sufficient noise control at the Silvern Garden apartments (SG) because this development is next to the Tsing Tai Road junction.

It has therefore been concluded that barriers and partial enclosures alone are not sufficiently effective to justify their erection at the Tai Lam village area, except for a length of 5m barrier (A6) on the westbound carriageway, as shown on Figure 10.

iv) NSR - PC, Peridot Court

The NSR PC is the closest of the Peridot Court high-rise towers to the carriageway. It is feasible to provide friction course surfacing to the carriageway in front of PC. It has been found that it is not feasible to control noise sufficiently at all the apartments PC to avoid provision of insulation at this tower. However, by erecting a length of partial enclosure (A5) as shown on Figure 9, total noise levels at lower to mid-level apartment facades can be reduced to just below the 70dB(A) guideline. Only the upper level apartments would experience traffic noise levels in excess of the HKPSG level. Noise levels at the adjacent towers which are slightly further from the carriageway, and shielded somewhat by PC, would be less than 70dB(A). Thus, the partial enclosure provides effective noise control for those Peridot Court towers not modelled. This should be confirmed at detailed design, when the exact configuration of the enclosure is defined.

v) NSR - GC1-3, Gold Coast Development

The section of Castle Peak Road in front of the Gold Coast Development has several junctions, bus bays and a sharp horizontal curve. Friction course surfacing is not a feasible option for this stretch of the road.

Noise barriers and partial enclosures have been modelled to the fullest extent practical along the westbound carriageway at the So Kwun Tan end of the Study Area and have been found to be not effective in protecting the apartments in Gold Coast Towers 1-6. Because of the proximity of the towers to the roadside only total enclosures could provide effective noise control at these sensitive receivers, and as discussed in 6.5.5 ii), a full enclosure is considered not practical for this section of the route.

It is therefore concluded that no practical, effective direct noise mitigation measures can be implemented for the Gold Coast Development.

vi) NSR - PI1, Pearl Island

The dwellings represented by NSR PI1 face a section of Castle Peak Road along which friction course surfacing cannot be provided. Newer houses in the Pearl Island development have recently been constructed at the crest of a platform on a hillside overlooking Castle Peak Road. NSR PI1 has been taken as the dwelling closest to the road. Because of its elevation, extensive partial enclosures along the eastbound

carriageway have been found to be ineffective. Noise levels at the older development on the hilltop above PI1 are acceptable and these dwellings would not qualify for consideration for insulation. The partial enclosure (A1) proposed for controlling noise at YO also provides sufficient reduction in noise at many of the newer dwellings that are slightly further from the road than PI1 (eg PI2-4).

vii) NSR - VH6, Village House

This NSR is adjacent to an opening in barrier A2 at a run-in. Effective noise control by direct mitigation is not feasible at this location.

viii) NSR - VH8, Village House

The village house represented by VH8 is at the junction of So Kwun Wat Road with Castle Peak Road, and is at the extreme western end of the study area. The noise contribution from increased Castle Peak Road traffic outside the study area and from the So Kwun Wat Road junction would render any noise barriers ineffective here. The dwellings would meet the eligibility criteria for equitable redress, despite provision of the maximum practical direct noise mitigation measures here. Therefore no direct mitigation is proposed.

7.2.3 Noise Barriers Without Friction Course (Option 2)

The extent of proposed noise barriers and partial enclosures without friction course road surfacing is indicated on Figures 12-14. The type (height) and the precise location of barrier would be subject to detailed design.

The barrier/enclosure configuration results in predicted noise levels as shown in column 1 of Table 7.2. Columns 1, 2 & 3 in the table show the values of noise to be compared with the eligibility criteria for provision of noise mitigation at the receiver.

Comparison with Table 5.4 shows that these proposals result in the number of NSRs which do not qualify for equitable redress under the eligibility criteria increasing from 6 to 23 out of a total of 41.

Again, a large number of NSRs cannot be sufficiently protected from the effects of traffic noise from Castle Peak Road and Tuen Mun Road, and will still qualify for consideration for equitable redress under the eligibility criteria. The reasons why barriers and partial enclosures cannot reduce noise levels at these NSRs are discussed briefly in the following paragraphs:

Table 7.2 - Current and Future Traffic Noise Levels at Representative NSRs Noise Barriers without Friction Course (Figures 12-14)

NSR	L_{10} (peak hour) Noise (dB(A))						
	Overall Facade Noise Levels and Comparison			Contributions from Separate Roads in 2011			
	2011 (1)	1992	Difference (2)	Castle Peak Rd	Tuen Mun Rd	Castle Peak Rd: Contribution to Overall Noise Level (3)	Overall Noise Level Difference btn Mitigated/ Unmitigated
SLH	76.7	73.4	3.3	72.4	74.7	2.0	-0.1
AP1	77.8	75.7	2.1	71.9	76.5	1.3	-0.2
CSQ1	79.7	76.7	3.0	75.6	77.5	2.2	1.1
CSQ2	76.3	74.4	1.9	69.1	75.4	0.9	1.4
CSQ3	67.4	65.9	1.5	57.9	66.9	0.5	2.0
CSQ4	75.0	73.7	1.3	64.9	74.5	0.5	2.9
MPQ	73.8	72.5	1.3	64.4	73.3	0.5	2.9
VH1	73.3	71.6	1.7	61.3	73.0	0.3	0.0
CB1	77.6	75.0	2.6	72.1	76.2	1.4	1.6
CB2	72.6	70.9	1.7	65.8	71.6	1.0	3.0
TW	73.7	71.3	2.4	65.2	73.0	0.7	1.1
DM	71.3	69.3	2.0	63.4	70.5	0.8	2.9
AP2	73.6	66.1	7.5	72.9	65.3	8.3	-0.6
CP	72.0	69.2	2.8	67.5	70.1	1.9	1.5
IV	78.7	74.4	4.3	77.8	71.3	7.4	3.4
FG	81.3	73.1	8.2	81.1	67.0	14.3	0.1
SG	72.0	68.1	3.9	70.8	65.8	6.2	3.6
VH2	79.0	68.6	10.4	79.0	45.4	33.6	-1.3
KP	70.6	68.3	2.3	68.4	66.6	4.0	4.6
CDA	67.6	64.4	3.2	64.5	64.7	2.9	1.2
VH3	63.5	56.2	7.3	63.5		63.5	-0.1
TS	69.1	65.9	3.2	67.8	63.4	5.7	2.8
PC	72.6	68.6	4.0	71.4	66.4	6.2	1.4
PCM	70.9	67.5	3.4	70.2	62.9	8.0	2.8
PCL	70.1	67.5	2.6	68.5	65.0	5.1	3.1
PI1	73.0	67.1	5.9	73.0	-	73.0	1.2
PI2	70.3	65.9	4.4	70.3		70.3	2.7
PI3	66.1	63.6	2.5	66.1		66.1	4.5
PI4	69.8	65.0	4.8	69.8		69.8	2.2
AP3	66.4	69.1	-2.7	65.8	57.2	9.2	9.6
AP4	70.4	69.2	1.2	69.7	62.2	8.2	5.3
AP5	66.9	66.2	0.7	66.3	57.7	9.2	5.9
YO	67.6	74.1	-6.5	67.6		67.6	13.6
BP	65.5	61.3	4.2	65.3	52.7	12.8	2.5
VH4	70.4	63.9	6.5	70.4		70.4	0.1
GC1	73.8	68.1	5.7	73.3	64.6	9.2	0.0
GC2	74.5	68.7	5.8	74.0	65.0	9.5	0.0
GC3	72.1	66.7	5.4	71.3	64.6	7.5	0.0
GC1M	75.8	69.1	6.7	75.6	61.4	14.4	-0.2
GC2M	76.2	69.1	7.1	76.0	61.5	14.7	-0.6
GC3M	72.7	66.3	6.4	72.4	61.1	11.6	-0.2
GC1L	76.6	70.0	6.6	76.5	57.3	19.3	0.1
GC2L	74.2	67.6	6.6	74.2	54.6	19.6	0.1
GC3L	66.9	62.9	4.0	66.2	58.3	8.6	1.9
VH5	68.3	60.9	7.4	68.2		68.3	-0.2
VH6	74.8	70.3	4.5	74.5	63.6	11.2	2.3
VH7	69.3	62.9	6.4	69.3	-	69.3	0.6
VH8	71.7	64.7	7.0	71.7	-	71.7	0.0
PSPS	80.0	79.0	1.0	58.2	80.0	0.0	0.0

NSRs which do NOT qualify for Equitable Redress under eligibility criteria for insulation, para 2.2.2

i) NSR - SLH, Siu Lam Hospital, AP1, Apartment Block

Though these NSRs are on the north side of Tuen Mun Road, they are partly protected from traffic noise from Tuen Mun Road by topography - they are at an elevated level above Tuen Mun Road. The Castle Peak Road noise contribution is sufficiently large to qualify the NSRs for consideration for insulation. The partial noise enclosures (B10) and (B11) along the westbound carriageway of Castle Peak Road tend to focus and reflect Castle Peak Road noise northwards. This effect can be reduced through the use of noise absorption panels in the partial enclosure, and, at detailed design stage, it may be possible to reduce the Castle Peak Road traffic noise contribution sufficiently so that SLH and AP1 would no longer qualify for provision of insulation by incorporating absorptive panelling into the barriers.

ii) NSR - CSQ1 Government Staff Quarters

CSQ1 Government Staff Quarters is sited on a hilltop overlooking Castle Peak Road, and is very close to the roadside. The partial enclosure proposed along the westbound carriageway edge in front of CSQ1 is not effective due to the elevated location of the NSR, overlooking the road.

iii) NSR - CB1, Castle Bay Villas

This NSR is adjacent to the junction of Lok Chui Street and Castle Peak Road. Despite the provision of partial enclosures on both sides of the junction, noise levels from the improved Castle Peak Road will contribute sufficiently to the noise environment at the receiver so that it would meet the criteria for consideration for insulation. It can also be seen that the overall noise level at the NSR remains very high, at 77.6 dB(A) despite the fact that the maximum possible extent of barrier/partial enclosure is in place. Partial enclosures (B7) and (B8) are required to protect CB2, TW and DM.

iv) NSR - Tai Lam Village Area (AP2, CP, IV, FG, SG, VH2, KP)

As discussed previously in Option 1, it is not feasible to provide effective direct noise control measures through Tai Lam village, due to the number of junctions, run-ins and pedestrian access. Extensive noise barriers through the village would also have a severe impact on the character of the village, effectively cutting the village in two. Sensitive receivers along Tsing Tai Road can be effectively protected by provision of an extended length of barrier along the westbound carriageway (B12). The protected receivers are represented by NSR KP. The barrier provides an overall noise reduction of almost 5dB(A) at KP giving predicted overall noise levels just over the HKPSG guideline. Residual noise levels would still be sufficiently high to qualify the receivers for consideration for insulation, but with sufficient attention at the detailed design stage this may be avoided.

v) NSR - PC, Peridot Court

A partial enclosure (B5) is shown on Figure 12 in front of PC, and while residual noise levels at the majority of apartments in the tower modelled in the noise assessment exceed the eligibility criteria and would qualify for insulation, the partial enclosure would effectively reduce the facade noise levels at the apartments at that

tower block furthest back from the road, and possibly at the tower block adjacent to PC, to below the limits defined by the HKPSG.

vi) NSR - GC1-3, Gold Coast Development

As discussed under Option 1, feasible direct mitigation options are ineffective for the Gold Coast towers adjacent to the roadway.

vi) NSR - PI1, Pearl Island, VH6 and VH8, Village Houses

For reasons outlined in paragraph 7.2.2 above, no effective direct noise mitigation measures can be proposed at these NSRs.

7.2.4 Overall Noise Reduction

A measure of the effectiveness of the direct noise mitigation measures of Options 1 and 2 in reducing the overall noise level has been obtained by comparing the overall noise at the NSRs at year 2011 for the scenario without any direct mitigation (Table 5.4) with the overall noise levels at year 2011 for each of the two options. The rightmost columns of Tables 7.1 and 7.2 indicate the reduction in overall noise levels at the NSRs resulting from the installation of the proposed direct technical mitigation measures. It can clearly be seen that for NSRs SLH, AP1, CSQ1, 2 and 4, MPQ, VH1, CB1, CB2 and TW, that while the direct mitigation measures proposed are effective in reducing the noise contribution from the improved Castle Peak Road so that these receivers would not qualify for consideration for insulation under the eligibility criteria, these measures will have little effect in reducing the overall noise level. Overall noise levels at these NSRs will be almost as high with noise barriers and/or friction course surfacing as without, and will be well above the HKPSG criterion.

The reason for this anomaly is the proximity of Tuen Mun Road to Castle Peak Road. Between Siu Lam Interchange and Tai Lam village, Tuen Mun Road runs adjacent to and parallel with Castle Peak Road. Traffic flows on Tuen Mun Road are much higher than those on Castle Peak Road, both currently and in the future. The traffic noise generated by the Tuen Mun Road traffic dominates the noise environment at this eastern end of the study area. The noise mitigation measures provided along Castle Peak Road are not effective in controlling noise from Tuen Mun Road. Overall noise levels are therefore reduced by less than 3dB(A) generally at the protected NSRs over the eastern section of the study area, where the two roads are closest. Thus, at those NSRs that would not qualify for consideration for equitable redress under Option 1 or Option 2, the increase in the noise level that would occur should the mitigation measures be removed would be barely perceptible to the human ear.

Along the western (Gold Coast) end of the study area, where the separation between Tuen Mun Road and Castle Peak Road is much greater, the effectiveness of the noise mitigation measures is more clearcut. The traffic noise from Castle Peak Road dominates the noise environment (except at the PSPS site, which is next to Tuen Mun Road and distant from Castle Peak Road) along this section of the study area. Therefore, at NSRs where direct mitigation can effectively reduce traffic noise from Castle Peak Road, there is also a significant reduction in the overall noise level (eg YO, AP3, AP4, AP5, PI2-4, BP). At many of these NSRs, the overall noise level is less than the 70dB(A) HKPSG criterion. The direct mitigation measures can clearly be seen to be effective, in that were they not in place, noise levels at the protected NSRs would be significantly higher.

In view of the ineffectiveness of direct noise mitigation measures in controlling the overall noise level at sensitive receivers along the eastern portion of Castle Peak Road that is to be improved, a third direct mitigation option is presented, with no direct mitigation measures proposed along this eastern section of the roadway.

7.3 No Direct Noise Mitigation at Siu Lam (Option 3)

It can be seen that noise barriers and/or friction course surfacing can be provided along the eastern Siu Lam section of Castle Peak Road to control noise from Castle Peak Road to a sufficient extent so that almost all of the affected NSR's do not qualify under the eligibility criteria for consideration for equitable redress. It has also been shown that, due to the proximity of Tuen Mun Road, with its much higher traffic flows, there will be very little difference in the overall noise levels at these same NSRs if no barriers or friction course surfacing are constructed to mitigate Castle Peak Road traffic noise. The HKPSG criterion of 70 dB(A) cannot be met by implementing practical direct technical mitigation along Castle Peak Road. Noise barriers and friction course surfacing along this section of the road will give little real benefit in terms of noise reduction to the residents of the protected NSRs.

A third option for noise mitigation of Castle Peak Road would be to eliminate all direct noise mitigation measures along this eastern section and to consider the provision of noise insulation as a remedial measure at all the affected NSRs. Good quality noise insulation can reduce overall noise levels inside the sensitive receivers by between 15 and 25dB(A). The additional number of dwelling units that would qualify for consideration for insulation if no noise barriers or friction course road surfacing were provided east of Tsing Tai Road would be about 110 units, of which about 80 units are government quarters at Siu Lam Interchange.

Noise barriers would be provided to the west of Tsing Tai Road, as proposed for Options 2. Figures 15 to 17 present the details of Option 3, No Direct Mitigation at Siu Lam. Table 7.3 presents the predicted noise levels associated with this option.

While outside facade noise levels at most NSRs along the eastern half of the study area will be unmitigated and will remain well above the HKPSG criterion with this Option 3, remedial measures could at least reduce noise levels inside the NSRs more effectively than could be achieved using the direct technical mitigation solutions identified in Options 1 and 2.

7.4 Effectiveness of Proposals

The effectiveness of the three mitigation measures in terms of the reduction in overall noise levels at affected NSRs can be compared by estimating the number of dwelling units at which predicted 2011 traffic noise levels will exceed the HKPSG criterion. At present, current traffic noise levels exceed 70 dB(A) at approximately 200 dwelling units (Current Traffic Noise Levels - Table 3.3). By the year 2011, following improvement to Castle Peak Road, it is predicted that traffic noise will exceed the HKPSG criterion at approximately 740 dwelling units along the road (Future Traffic Noise Levels at Representative NSRs without mitigation - Table 5.4). The estimated number of dwellings at which the noise levels are predicted to exceed HKPSG following implementation of the packages of direct technical remedies of Options 1 to 3 are as follows:-

Option 1	570 dwellings
Option 2	610 dwellings
Option 3	610 dwellings

Option 1, which combines friction course surfacing with barriers and partial enclosures, can reduce noise levels to below the HKPSG criterion at 22% of the dwellings (170 units) at which noise levels would otherwise exceed the criterion. Options 2 and 3 can reduce the noise levels to below the criterion at 17% of the dwellings (130 units). Thus, in terms of the effectiveness in controlling overall noise at the NSRs, there is very little difference between the three options.

7.5 Residual Impact of Mitigation Options

The residual impact of Options 1 , 2 and 3 have been identified in Tables 7.1, 7.2 and 7.3. A total of approximately 740 dwelling units would qualify for consideration for equitable redress because of the increase in traffic noise levels from the improved Castle Peak Road if no direct mitigation measures are implemented.

The number of dwelling units where residual noise levels, following implementation of the direct mitigation measures proposed under Options 1, 2 and 3, still meet the criteria for consideration for equitable redress, have been estimated and are summarised in Table 7.4 below.

It can be seen that in spite of the extensive direct technical mitigation measures proposed, up to 80% of the dwelling units affected will still qualify for consideration for insulation. The locations of the units qualifying for consideration for insulation are presented at Appendix 6.

Table 7.3 - Current and Future Traffic Noise Levels at Representative NSRs Indirect Mitigation at Siu Lam (Figures 15-17)

NSR	L_{10} (peak hour) Noise (dB(A))						
	Overall Facade Noise Levels and Comparison			Contributions from Separate Roads in 2011			
	2011 (1)	1992	Difference (2)	Castle Peak Rd	Tuen Mun Rd	Castle Peak Rd: Contribution to Overall Noise Level (3)	Overall Noise Level Difference btn Mitigated/ Unmitigated
SLH	76.6	73.4	3.2	72.1	74.7	1.9	0.0
AP1	77.6	75.7	1.9	70.9	76.5	1.1	0.0
CSQ1	80.8	76.7	4.1	78.1	77.5	3.3	0.0
CSQ2	77.7	74.4	3.3	73.9	75.4	2.3	0.0
CSQ3	69.4	65.9	3.5	65.9	66.9	2.5	0.0
CSQ4	77.9	73.7	4.2	75.2	74.5	3.4	0.0
MPQ	76.7	72.5	4.2	74.0	73.3	3.4	0.0
VH1	73.2	71.6	1.6	60.7	73.0	0.2	0.1
CB1	79.2	75.0	4.2	76.2	76.2	3.0	0.0
CB2	75.5	70.9	4.6	73.3	71.6	3.9	0.1
TW	74.7	71.3	3.4	69.9	73.0	1.7	0.1
DM	74.2	69.3	4.9	71.7	70.5	3.7	0.0
AP2	73.2	66.1	7.1	72.4	65.3	7.9	-0.2
CP	73.3	69.2	4.1	70.5	70.1	3.2	0.2
IV	81.7	74.4	7.3	81.3	71.3	10.4	0.4
FG	81.3	73.1	8.2	81.1	67.0	14.3	0.1
SG	72.0	68.1	3.9	70.8	65.8	6.2	3.6
VH2	79.0	68.6	10.4	79.0	45.4	33.6	-1.3
KP	70.6	68.3	2.3	68.4	66.6	4.0	4.6
CDA	67.7	64.4	3.3	64.6	64.7	3.0	1.1
VH3	63.5	56.2	7.3	63.5	-	63.5	-0.1
TS	69.1	65.9	3.2	67.8	63.4	5.7	2.8
PC	72.6	68.6	4.0	71.4	66.4	6.2	1.4
PCM	70.9	67.5	3.4	70.2	62.9	8.0	2.8
PCL	70.1	67.5	2.6	68.5	65.0	5.1	3.1
PI1	73.0	67.1	5.9	73.0	-	73.0	1.2
PI2	70.3	65.9	4.4	70.3	-	70.3	2.7
PI3	66.1	63.6	2.5	66.1	-	66.1	4.5
PI4	69.8	65.0	4.8	69.8	-	69.8	2.2
AP3	66.4	69.1	-2.7	65.8	57.2	9.2	9.6
AP4	70.4	69.2	1.2	69.7	62.2	8.2	5.3
AP5	66.9	66.2	0.7	66.3	57.7	9.2	5.9
YO	67.6	74.1	-6.5	67.6	-	67.6	13.6
BP	65.5	61.3	4.2	65.3	52.7	12.8	2.5
VH4	70.4	63.9	6.5	70.4	-	70.4	0.0
GC1	73.8	68.1	5.7	73.3	64.6	9.2	0.0
GC2	74.5	68.7	5.8	74.0	65.0	9.5	0.0
GC3	72.1	66.7	5.4	71.3	64.6	7.5	0.0
GC1M	75.8	69.1	6.7	75.6	61.4	14.4	-0.2
GC2M	76.2	69.1	7.1	76.0	61.5	14.7	-0.6
GC3M	72.7	66.3	6.4	72.4	61.1	11.6	-0.2
GC1L	76.6	70.0	6.6	76.5	57.3	19.3	0.1
GC2L	74.2	67.6	6.6	74.2	54.6	19.6	0.1
GC3L	66.9	62.9	4.0	66.2	58.3	8.6	1.9
VH5	68.3	60.9	7.4	68.3	-	68.3	-0.2
VH6	74.8	70.3	4.5	74.5	63.6	11.2	2.3
VH7	69.3	62.9	6.4	69.3	-	69.3	0.6
VH8	71.7	64.7	7.0	71.7	-	71.7	0.0
PSPS	80.0	79.0	1.0	58.2	80.0	0.0	0.0

NSRs which do NOT qualify for Equitable Redress under the eligibility criteria for insulation, para 2.2.2

Table 7.4 - Dwelling Units Eligible for Consideration for Equitable Redress

	Approx. No. of Dwellings Meeting Eligibility Criteria	Approx No. of Dwellings Protected	
		No.	%
No direct mitigation measures	740	-	-
Direct Mitigation Option 1	444	296	40%
Direct Mitigation Option 2	496	244	33%
Direct Mitigation Option 3	601	139	19%

7.6 Planned Development Sites

There are a number of sites within the study area which have recently been rezoned as Comprehensive Development Areas, and there is a large approved residential development site north of Tuen Mun Road west of the Siu Lam Interchange (Figure 2). In addition, there are several areas zoned for residential type 'B' development along Castle Peak Road within the study area. The effect of traffic noise from the improved Castle Peak Road on these sites is reviewed in this section.

7.6.1 The approved comprehensive residential area in the Siu Lam area fronts the north side of Tuen Mun Road. The NSR VH1 represents an existing village house structure within this approved development area, and predicted noise levels at VH1 can be taken as representative of the existing development at the site. Existing overall facade noise level at VH1 is 71.6dB(A) (Table 5.4), already above the HKPSG guidelines. Noise levels in 2011 are expected to increase to 75.6dB(A), but the contribution of Castle Peak Road traffic noise to this increase is negligible. At this site Tuen Mun Road traffic noise completely dominates the noise environment. It is understood that the planned development will provide for noise control along its boundary with Tuen Mun Road through the construction of extensive earth bunds. These measures should be designed to protect the development from Tuen Mun Road and the unimproved Castle Peak Road. The increase in traffic volume on the improved Castle Peak Road at 2011 compared with that predicted for the unimproved road at 2011 is only 300 vehicles/hour (see section 3.4.6). The additional traffic noise impact due to this increase in traffic would be minimal.

7.6.2 The Comprehensive Development Area at the site of the former desalination plant at Lok On Pai is represented by a notional NSR, CDA. The notional NSR is the 15th storey of a residential block on the northern edge of the development area. The noise level at present is 64.4dB(A) (Table 5.4), which would be acceptable. The noise level at the design year would be expected to increase to 68.8dB(A), just below the 70dB(A) HKPSG guideline level. This would indicate that specific noise control measures would not be necessary for development of this site. However, given that the predicted noise level for 2011 is only marginally below 70dB(A), it is recommended that a more detailed site specific study be carried out when detailed planning for development of the site commences, to confirm the findings of this study.

7.6.3 The Comprehensive Development area at Siu Sau, on what is now a container storage area, is bounded by Castle Peak Road on the south and Tuen Mun Road on the north. No notional NSR has been adopted to model this CDA, but noise levels at the southern boundary of the site will be as for NSRs, TS and VH6, which are existing village-type houses in the valley. From Table 5.4, it can be seen that the current noise levels at VH6 is already marginally above the 70dB(A) HKPSG guidelines. By the year 2011, noise levels at both VH6 and TS are considerably above this level, and both NSRs would qualify for equitable redress under the eligibility criteria, unless direct noise control measures are implemented. Thus, future development at this site will need to incorporate noise control measures to protect sensitive receivers from excessive noise from Castle Peak Road traffic. Similar noise control measures will have to be adopted on the northern boundary of the site to mitigate Tuen Mun Road traffic noise.

7.6.4 The third Comprehensive Development Area is at So Kwun Tan, on the northern side of Castle Peak Road. The area abuts a section of the road just west of the western limit of the improvement works. No NSR has been adopted to model noise levels at this site. If traffic on that section of Castle Peak Road that is to be widened is considered separately from traffic on the road that is beyond the road improvement project area, it is possible that noise control measures would not be required at the site. However, any development here will have to consider traffic noise from all of Castle Peak Road, So Kwun Wat Road and Tuen Mun Road. Noise control measures will have to be implemented to protect sensitive receivers exposed to high traffic noise levels from these sources.

7.6.5 Most of the residential type 'B' (R(B)) zoned areas contain existing developments. However, several sites zoned for R(B) are as yet undeveloped, notably along the southern side of Castle Peak Road east of Peridot Court and on both sides of the junction of Tsing Fat Street and Castle Peak Road. The setback distance from the roadside for development would have to be quite large in order to keep traffic noise levels below 70 dB(A), even if partial enclosures are provided continuously along the edge of the carriageway. This is illustrated by Peridot Court (PC) which is set back some 90m from the roadside edge. Partial enclosure along the southern edge of the roadway can only protect lower level apartments. Noise levels at the facades of the higher level apartments still exceed the HKPSG criterion. It is evident that the taller the development, the further back from the carriageway edge it must be if it is to meet the HKPSG criterion. The sites along Castle Peak Road are limited by the coastline to the south and by Tuen Mun Road to the north. Thus, the large setback distances required will severely reduce the development potential of these sites. Instead of providing extensive barriers along the roadside, and specifying setbacks for development, it would be more appropriate to limit development to single aspect development, with rooms with non-sensitive uses (kitchens, bathrooms, meter rooms etc) facing the roadway, and all sensitive use rooms facing away from the roadway. In this way, the development potential of the sites can be maximised, while the cost of noise barrier construction is kept to a minimum.

7.6.6 A Housing Authority site for future development at Area 56 has also been identified. This site is north of Tuen Mun Road at So Kwun Tan and is represented by NSR PSPS. The distance of this site from Castle Peak Road means that the contribution of Castle Peak Road traffic noise to the overall facade noise level at PSPS is negligible. Therefore, no noise control measures to deal specifically with Castle Peak Road traffic noise would be required at any future development here. It is noted that traffic noise from Tuen Mun Road is already very high however, and any future development will have to address mitigation of traffic noise from this source.

7.7 Cost Estimates

7.7.1 Total Cost

Total costs, including capital, maintenance and running costs, have been derived for each of the three noise mitigation options presented. Total costs of providing insulation at all 740 affected dwelling units, with no direct mitigation measures provided, have also been estimated.

The unit costs for the various barrier types have been identified in 6.6 The barrier costs presented in this section are based on barriers utilising GRC and acrylic glass panelling systems. This combination of materials is recommended (Section 8) as being most appropriate for mitigation of the visual impact of the barriers, though it is a more costly solution than some of the other options available.

Total costs based on high, low and average barrier construction unit rates are included at Appendix 4.

Total costs presented in Table 7.5 below are based on a maintenance period of fifteen years for direct mitigation measures and residual insulation. Running costs associated with air conditioning units at insulated receivers have also been included over this period.

Table 7.5 - Total Costs (including Maintenance 1997 to 2011)
(Costs at 1994 prices)

			Option 1 (HK$ m)	Option 2 (HK$ m)	Option 3 (HK$ m)	No direct mitigation (HK$m)
DIRECT MITIGATION	Capital Cost	Barriers	50.7	64.0	31.0	-
		Friction Course	1.5	-	-	-
	Maintenance Cost	Barriers	35.5	44.8	21.7	-
		Friction Course	16.1	-	-	-
Cost of Direct Mitigation			**103.8**	**108.8**	**52.7**	**-**
INDIRECT MITIGATION	Capital Cost		7.8	8.7	10.6	13.1
	Maintenance Cost		13.3	14.9	18.0	22.2
	Running Cost		42.6	47.6	57.7	71.1
Cost of Indirect Mitigation at Receiver			**63.7**	**71.2**	**86.3**	**106.4**
TOTAL COST			**167.5**	**180.0**	**139.0**	**106.4**

Table 7.6 below presents the total project costs for each of the three options identified, with maintenance costs for barriers and friction course surfacing discounted over a 15 year operations period, as for Table 7.5, but with indirect mitigation measures (insulation) costed over an extended period of fifty years.

The build-up of the total costs for each option, along with total costs including maintenance and operating costs over the period 1997-2026 has also been computed and is included at Appendix 4.

Table 7.6 - Indirect Mitigation Costs (1997-2046)
(Costs at 1994 prices - discount rate 0%)

		Option 1 (HK$m)	Option 2 (HK$m)	Option 3 (HK$m)	No Direct Mitigation (HK$m)
INDIRECT MITIGATION	Capital Cost	7.8	8.7	10.6	13.1
	Maintenance Cost	46.6	52.0	63.1	77.7
	Running Cost	142.1	153.7	192.3	236.8
Total Cost of Indirect Measures		**196.5**	**219.4**	**266.0**	**327.6**
Total Cost of Direct Mitigation (Maintenance 1997-2011) from Table 7.5		**103.8**	**108.8**	**52.7**	**-**
TOTAL COST		**300.3**	**328.2**	**318.7**	**327.6**

7.7.2 Cost Effectiveness

The cost effectiveness of the various noise mitigation options has been assessed based on the costs presented in Table 7.5. The total project cost for each option includes both direct mitigation measures and indirect mitigation measures at receivers where residual noise levels remain high. The total cost for each option is the cost for protecting all of the affected units from excessive noise. As a measure of cost effectiveness, cost of mitigation per receiver has been identified and is presented in Table 7.7 below.

Table 7.7 - Summary of Costs and Cost of Effectiveness

	Capital Cost of Direct Mitigation Measures	Maintenance Cost of Direct Mitigation Measures	Cost of Mitigation at Receiver*	Total Cost	Receivers (out of 820) requiring mitigation at receiver		Order of Cost of Mitigation per Receiver
	% of Roadworks Estimate	HK$m.	HK$m.	HK$m.	No.	%	HK$ 000
Option 1 Noise barriers/partial enclosures with friction course surfacing as shown in Figures 9, 10, 11 and referred to in Table 7.1	52.2 35%	51.6	63.7	167.5	444	60	226
Option 2 Noise barriers/partial enclosures as shown in Figures 12, 13 and 14 and referred to in Table 7.2	64.0 43%	44.8	71.2	180.0	496	67	243
Option 3 Noise barriers/partial enclosures shown in Figures 15, 16 and 17	31.0 21%	21.7	86.3	139.0	601	81	188
No direct mitigation, mitigation at affected receivers by glazing and airconditioning	- -	-	106.4	106.4	740	100	144

* *These costs are estimates of the cost of insulating all receivers that would qualify for consideration for equitable redress under the three eligibility criteria. Following consideration by Exco, insulation may not actually be provided.*

The relative order of the various options, when comparing the cost of mitigation per receiver, is sensitive to the period over which maintenance and operating costs are considered. The direct mitigation measures have relatively high capital costs and low maintenance costs, while the provision of insulation at sensitive receivers has a low initial capital cost but high maintenance and operating cost. Thus, from Table 7.6, which is based on an extended period of 50 years for maintenance and operating costs for the insulation at receivers, Option 3 is seen to be a more expensive solution than Option 1, which contrasts with the situation shown on table 7.7 (15 year maintenance and operating period), where Option 3 is the most cost

effective of the three options.

The relative cost of mitigation per receiver is also sensitive to the discount rate adopted in estimating the net present value of the maintenance and operating costs. A discount rate of 0% has been adopted in estimating the above costs. Cost estimates based on discount rates of 4% and 10% are also presented in Appendix 4. The higher the discount rate adopted, the less significant the ongoing maintenance and operating costs become, and the options minimising capital cost become more attractive relative to those with high capital cost.

The cost of indirect mitigation assumes that the total cost of providing, maintaining and operating the insulation system (window units, air conditioners) is assigned to "noise insulation", and other costs/benefits of the insulation are not considered. Some of the sensitive receivers at which noise levels from the increased Castle Peak Road would be unacceptable may already have air-conditioning installed for the purpose of providing temperature control. The installation of sealed window units and air conditioning for noise control at other dwelling units would also confer the considerable advantage of temperature control to the occupants, along with the disadvantage that sealed window units would remove the occupants freedom to open those windows.

The installation of noise barriers has a number of disadvantages, as outlined in Sections 6 and 8. However, it is very difficult to put a cost on these disbenefits, as they generally relate to personal perception (visual impact, feelings of being trapped between barrier and traffic, 'tunnel' effect on drivers etc.) and emergency services access. No attempt has been made to quantify these disbenefits in cost terms in this report, but such disbenefits must nevertheless be considered in the selection of the favoured option.

7.8 Visibility and Land Resumption Requirements

The siting of vertical noise barriers along the roadside edge can have an effect on visibility and driver sightlines. Minimum visibility standards at junctions are set out on Figure 25. Barriers must be constructed so that they do not reduce the visibility distance of road users to below the recommended 125m for a 70kph design speed road. The sightlines at each junction along the route are shown on Figures 22-24. Sightlines at the inside radii of horizontal curves in the road alignment can also be impaired by the barriers.

7.8.1 Option 1

The layout of barriers presented on Figures 9, 10 and 11 would require barriers to be set back beyond the back of the footpath next to junctions J3, J4, J6, J8 and J10. A typical detail of the barrier treatment at these setbacks is indicated on Figure 25. The barrier should be returned along the access road, and stepped down from its full height where this is required for noise control purposes. It is expected that such returns would be required at junctions J3, J8 and J10, but not at J4 or J6.

It will not be possible to provide the recommended sightlines for a 70kph road at J10 without carrying out extensive slope excavation and constructing a retaining wall in front of CSQ1 government quarters at Siu Lam Interchange. The sightline clearance for 50kph design speed could be provided, and may indeed be acceptable at this location as westbound traffic approaching the junction will have just entered Castle Peak Road off the Siu Lam Interchange and are therefore unlikely to have reached 70kph by the time junction J10 is visible to them.

Should the recommended sightlines for the 70kph design speed be required at J10, then it will be impractical to provide any noise barriers along the stretch of road between J10 and Siu Lam Interchange.

Barriers at the rear of footpaths at the sharp horizontal curve at Yee On Residence for Senior Citizens (YO) (barrier A1) and again at the long curve west of Siu Lam Interchange (in front of Marine Police Quarters, MPQ) (barriers A10 and A11) would reduce sightlines to below the recommended lengths. At YO, the sightline would be well below the absolute minimum requirements. As junction J3 (Tsing Lung Road) is on this curve, it is necessary to set back the barriers on the north side of the roadway to ensure visibility is maintained. It is not possible to provide the recommended visibility distance however due to the proximity of YO to the roadside, though the absolute minimum requirement can be provided. The required set back is indicated on Figure 26. The horizontal curvature in front of MPQ is not as sharp as at YO. Barriers at the rear of the footpath on the inside radius of the curve would permit clear visibility of 100 metres ahead for westbound traffic in the kerbside lane. As there are no junctions or run-ins off the west bound carriageway within the curvature it would be acceptable to site the barriers at the rear of the footpath.

There are advantages to siting partial enclosures at the kerbside edge of the footpath, where visibility requirements permit. There are four lengths of partial enclosure in Option 1. Barrier A1 (Figure 9) is about 160m long, and is along the eastbound carriageway, in front of YO. It would be possible to locate the westmost 50m of the barrier at the edge of the carriageway without affecting visibility, but the eastern 110m of barrier would curtail visibility and must be at the rear of the footpath and even further set back, as discussed above. Barrier A5 (Figure 9) is a 90m length of partial enclosure in front of Peridot Court (PC) on the westbound carriageway. While the enclosure is on a straight section of road, westbound traffic approach the barrier from a horizontal curve. A barrier at the carriageway edge would reduce visibility for westbound traffic to below the minimum requirement. Therefore, it will be necessary to position the barrier at the rear of the footpath. Barriers A7 and A8 are both adjacent to the junction of Lok Chui Street and Castle Peak Road. It would not be possible to position A8 at the carriageway edge because of the junction visibility requirements, but the western end of barrier A7 could be sited between the footpath and the carriageway.

7.8.2 Option 2

The barrier layout for Option 2 is presented in Figures 12, 13 and 14. Junctions J3, J4, J6, J8 and J10 would be affected by the proposed barriers and treatment at these junctions to ensure minimum visibility standards are met would be as for Option 1 above.

Barrier B1, in front of YO, is similar to barrier A1 of Option 1, and must be set back from the rear of the footpath at the sharp horizontal curve in front of YO. Barriers B9, B10 and B11, on the inside radius of the horizontal curve on Castle Peak Road from Siu Lam Interchange westwards, would not need to be set back from the rear of the footpath, with the exception of B11, locally, next to junction J10.

Six lengths of partial enclosure are proposed under this option. Barriers B1 and B5 are the same as barriers A1 and A5 of Option 1. It would be feasible to position only a short length of B1 at the carriageway edge. Barrier B5, as for A5, could not be located at the carriageway edge, but would have to be at the rear of the footpath. The western portion of barrier B7, fronting the Castle Bay Villas, could be located between the footpath and

carriageway. Barrier B8, next to Castle Bay development at junction J8, will have to be set back from the rear of the footpath, as shown in Figure 26, to maintain visibility at junction J8. Barriers B10 and B11 are on the westbound carriageway of Castle Peak Road, along the inside radius of a horizontal curve. These barriers should also be positioned at the rear of the footpath to maintain visibility requirements for westbound road traffic. Thus, it is not possible to position partial enclosures between the footpath and carriageway without adversely affecting visibility, except for short lengths of barrier B1, and B7.

7.8.3 Option 3

Option 3 proposes indirect noise mitigation for affected NSRs along the central (Tai Lam village) and eastern (Siu Lam) sections of the route. A much reduced barrier layout is proposed, as shown in Figures 15, 16 and 17. Only junction J3, Tsing Lung Road and J4, Tsing Fat Street, are affected by the barriers. Barriers proposed (C1 to C6) are the same barriers as barriers A1 to A6 of Option 1, and so, the same conclusions regarding visibility and barrier set back apply.

7.8.4 Land Resumption Requirements

In general, the proposed works limit for the widening of Castle Peak Road is well beyond the edge of the footpath, and adequate space is available for construction of noise barriers for any of the three noise mitigation options presented. However, there are several locations where barriers must be set back from the rear of the footpath, and will be beyond the works limit. It will be necessary to extend the works limit at these locations.

The partial enclosure in front of Yee On Residence for Senior Citizens (barriers A1, B1 and C1 of Options 1, 2 and 3 respectively) must be set back some 1.6m from the rear of the footpath. A further 2m beyond the face of the barrier should be allowed for foundation construction. Thus, the works limit along the northern side of the eastbound carriageway should be 3.6-4m beyond the footpath. At the south east corner of YO, the works limit is only 1m from the rear of the footpath. It will be necessary to extend the works limit here. The extent of the land resumption required is shown on Figure 26.

The works limit at junction J3 is very close to the rear of the footpath. High vertical barriers (barriers A3, A4, B3, B4 and C3, C4 of Options 1, 2 and 3 respectively) are proposed for both sides of this junction, and in order to ensure sufficient working space for construction of these barriers at the junction and on both sides of the junction, a minimum setback from the rear of the pavement of 3 to 4m is recommended. Figure 26 indicates the land resumption required.

Finally, at junction J8 (Lok Chui Street) there is insufficient space on the west side of the junction to construct a return on the vertical barriers proposed under Option 1 and 2. (Barriers A8, B7), should detailed design of the noise mitigation measures identify the need for such a return. It is recommended that the work limits be extended at J8 to allow for such. Again, Figure 26 indicates the extent of the extra land resumption proposed. If Option 3 is selected as the preferred option, land resumption at this location would not required.

7.9 Further Studies Required

Prior to proceeding with the detailed design of the noise mitigation measures of Options 1,

2 or 3, further studies will be required to provide the detailed information needed to identify the precise extent of the mitigation required, and to provide the inputs for engineering design of noise barriers. These studies are identified in the following paragraphs.

7.9.1 Survey of Sensitive Receivers

Surveys of sensitive receivers likely to be affected by traffic noise from the improved Castle Peak Road have been carried out in sufficient detail to give estimates of the total numbers of dwelling units represented by each NSR, and to identify existing and future topographic shielding.

Further, more detailed, surveys of all sensitive receivers along the route will be required to fully identify those facades and windows that qualify for consideration for insulation under the eligibility criteria. These surveys should record the number and location of windows in sensitive facades, orientation of facades to Castle Peak and Tuen Mun Roads, use of the rooms behind individual windows, and quality of existing glazing and whether mechanical ventilation is installed or not. This information will be used to draw up a full list of dwelling units that qualify for consideration for equitable redress, along with details of the extent of indirect mitigation measures that would be required at each dwelling. This document could then be put to Exco.

7.9.2 Noise Assessment

Further noise assessment will be required as part of the detailed design of the proposed mitigation measures. The assessment carried out as the basis of this report is sufficient to identify the overall layout and form of direct mitigation to be implemented along the route. Noise levels at a number of representative sensitive receivers have been calculated. Following the detailed survey of sensitive receivers discussed in 7.9.1, further modelling will be necessary for some sensitive receivers at which it is not immediately obvious from referring to the representative NSRs whether residual noise levels would require further mitigation or not. Residual noise levels at several of the NSRs are marginal for each of the mitigation options outlined in this report, and further assessment will be required, interactively with the detailed design of barriers to determine the final residual noise levels. The finalising of barrier design at junctions, run-ins and other openings will require further detailed assessment. It may be possible to reduce barrier lengths or necessary to increase lengths following the selection of barrier types and exact forms. Noise assessment will be an important element in the finalisation of exact barrier layout and form in detailed design.

7.9.3 Site Investigation

Considerable lengths of high vertical barrier and partial enclosure are required along the route. Design forces will be largely lateral, requiring the barrier foundation system to generate large lateral resistance. While spread footings will be adequate for vertical barriers up to 3m in height, piled foundations will probably be required for barriers higher than this, and for partial enclosures.

Where relatively shallow spread foundations are to be adopted for barrier support, sufficient information for design purposes would be obtained from the site investigation works for the road improvement works. Depending on the extent of the site investigation for the roadworks, additional trial pits could be specified at regular intervals along the line of these barriers.

For the higher barriers and partial enclosures, where piled foundations would be required, additional boreholes along with laboratory testing of soil samples obtained, will be necessary to identify the soil profile and lateral resistance characteristics of the soil layers along the line of the proposed foundations. A preliminary investigation with boreholes spaced at about 50m along the line of the proposed barriers would be sufficient for design of the piled foundation, with further boreholes at closer spacing being carried out by the contractor ahead of piling operations to confirm design assumptions.

7.9.4 Detailed Design of Noise Barrier Structures

The detailed design of the noise barriers will require a review of materials, barrier panel layout and proposals for mitigation of the visual impact of the barriers. Structural design of the barrier frame should be carried out in accordance with the "Structures Design Manual for Highways and Railways" and the relevant parts of "BS 5400 - Steel Concrete and Composite Bridges" where appropriate.

CHAPTER EIGHT
LANDSCAPE AND VISUAL IMPACT OF MITIGATION MEASURES

8. LANDSCAPE AND VISUAL IMPACT OF MITIGATION MEASURES

8.1 Landscape and Visual Context

8.1.1 Introduction

From Siu Lam to So Kwun Tan the Castle Peak Road undulates across a series of small headlands and intervening bays and valleys, running between the line of the Tuen Mun Road and the coastal plain. The area is generally well vegetated with linear belts of trees running between the two road corridors and larger blocks of woodland on the relatively undisturbed hillslopes and surrounding areas of partially cultivated agricultural land.

Along the road corridor there are numerous properties, most commonly two or three storey modern houses set in short terraces within small estate developments, or simple single storey detached buildings set within the wooded hillside.

8.1.2 Siu Lam to Castle Bay

From its junction with the expressway, the Castle Peak Road runs around the back of a small bay between two wooded headlands. It lies just below the expressway, and is separated by a short embankment slope, half covered with trees. Below the embankment is a wide area of flat land which extends out to the beach and is mostly under cultivation.

On the headland by the expressway interchange there are two low rise residential blocks, Correctional Services Department Quarters as well as an eight storey Marine Police Quarters residential block in the bay area just below. Further out on the headland near the Excise Station there are two more residential blocks which are orientated back toward the beach.

On the west side of the bay at Siu Lam San Tsuen, there is a large housing development with two short terraces of houses, having views to the east back across the bay.

8.1.3 Siu Lam San Tsuen

There are similar housing blocks along the south side of the road interspersed with detached houses set within small woodland blocks, for the next 350-400m as the road cuts behind the headland into a small valley. On the other side, the expressway moves further to the north and there are several detached properties on the densely wooded slope in between. There is some land under cultivation in the valley bottom but as the land falls away to the coast and the south west, this farming activity gives way to storage area and commercial use.

8.1.4 Siu Sau

The road rises to the north west across another headland and then down into the small valley at Siu Sau. The sides of the valley are densely wooded with a small number of detached properties set high up. In the valley floor to the north side of the road is an open container storage area. To the south there are the larger residential blocks of Peridot Court set in grounds with a common swimming pool and tennis court area alongside the road, with the terraced houses of the Gurkha Married Quarters behind and the towers of the Gold Coast development beyond.

8.1.5 So Kwun Tan

The road turns north west as it rounds another headland and enters the So Kwun Wat Valley. The Yee On Residence for Senior Citizens is cut into the headland just above the road on the north with a large development of terraced houses at Pearl Island further up the hillside above. Along the south frontage are the six new towers of the Gold Coast development, and as the road crosses a bridge and out onto the valley floor on a bridge structure it passes the associated marina area. The low lying village at Kar Wo Lei is set along the river banks to the north of the road.

8.2 Proposed Noise Barriers

Two main proposals for direct mitigation of increased traffic noise have been derived in this study. The two proposed layouts are shown in Figures 9, 10 and 11 and in Figures 12, 13 and 14. For the purposes of this section of the report they are referred to as Option 1 and Option 2 respectively. A third option, Option 3, is proposed as a further alternative adopting the same configuration of barriers as Option 2 at the Gold Coast, but with no barriers for the central and eastern sections of the route. The total visual impact for this Option 3 would be as detailed in paragraphs 8.3.4 c), 8.3.6 and 8.3.8 below.

All proposals incorporate barriers ranging from 1m to 5m in height together with lengths of partial enclosure over one lane of one carriageway. Option 1 incorporates friction course surfacing on Castle Peak Road.

Where indicated the barriers would be continuous along the road, except where breaks are required for access to existing sites. Treatment of the barriers at junctions and run-ins is discussed in Section 6.3.4.

For the purposes of the visual assessment it has been assumed that the barriers would be formed with concrete panels set within a steel framework. The proposed landscape measures to mitigate the assessed visual impact will be based on alternative surface treatments.

8.3 Visual Assessment

The visual assessment which follows is illustrated by reference to Figures 27, 28 and 29; and 30, 31 and 32 for Options 1 and 2 respectively.

8.3.1 Siu Lam to Castle Bay - Option 1

a. In the section of the new road between the Siu Lam junction with Tuen Mun Road and Castle Bay the noise barriers would affect two principal receiver groups.

b. The upper storeys of the CSD Quarters blocks (CSQ1 and CSQ2) set on top of the headland at Siu Lam will have west facing views across the existing woodland on the slopes below, along the line of the road for some 200m. All the apartments in the Marine Police Quarters (MPQ) block face directly out onto the road some 70m away.

c. In all these views the new 5m high barriers (A10) and (A11) would be seen in the context of the wooded slope below the expressway, with some views through to the

cutting slopes on the north side of it, and the natural hillslopes of the Tai Lam Country park in the far distance. This scene would be punctuated by the movement of the traffic along Tuen Mun Road.

d. The barriers would form a strong linear, man-made element in the landscape, whose uniform appearance would contrast with the surrounding natural elements. They would, however, be similar in nature to the existing detractors in the landscape, the expressway and its cutting slopes and traffic.

e. Their construction would result in a change in the composition of the landscape, and an increase in the dominance of the man-made elements in the view. The visual impact on this group of receivers would be mostly be slight on those properties some distance from the barriers, and moderate on those close by.

8.3.2 Siu Lam to Castle Bay - Option 2

a. The proposed noise barrier structures within Option 2 would affect three user groups in this section of the road.

b. All apartments in the Marine Police Quarters (MPQ) would have views directly out onto the road, and the 5m high barrier (B9) would screen out the vegetation on the far side of the road. The visual impact would be severe.

c. From the (CSQ 1) and (CSQ 2) apartments, and those residents further out on the headland, the proposed barriers would be apparent in views to the west along the side of the road, dominating the background to the intervening woodland. They would result in a moderate visual impact.

8.3.3 Castle Bay to Siu Lam San Tsuen - Option 1

a. The terrace houses at Castle Bay (CB1, CB2) would have partial views to the rear, out onto barriers (A8), only some 10 m away. The upper floor of the adjacent detached house at TNIL23A (TW) and those of the terrace houses, Villa de Mer (DM), 40m further down the slope would have similar views.

b. The two properties set on Castle Peak Road at Lot No 994 in DD 381 (Ivanhoe Villa) (IV), and the three houses at the end of the terrace at Fiona Garden on the opposite side of Castle Bay Road would have short, partial views of barrier (A7) to the east for up to 30 m along the length of the road.

c. The terrace of houses on the west side of the Fiona Garden development that back onto Tsing Tai Road would have views along the line of the barriers (A6) for up to 250 m, and the three terrace houses (Silvern Garden) (SG), on the opposite side of the road would have clear views directly out onto the barriers, some 50 m away.

d. Further to the west along Tsing Tai Road there would be views from some of the upper floor rooms of the houses at Kam Po Court (KP) looking straight out, down onto the barriers (A6) some 70m away.

e. On the north side of the road most of the detached properties are screened from the road by the existing vegetation. One pair of houses in this section of the road would

have views of the barriers across the road. All of them are slightly elevated above the level of the road, and residents would look out down onto the top of the barriers between 20 and 40 m away.

f. In this section the visual envelope narrows considerably as the topography and the vegetation give the road an enclosed character, restricting views to the road corridor.

g. In the views from all these properties, the barriers would be seen at close hand where due to their size they would form very dominant elements in the landscape, obscuring a significant portion of many views. They would tend to be seen against a well vegetated backdrop, which would put their uniform appearance into sharp contrast. The visual impact on properties would be mainly moderate to severe.

h. In addition to the visual impact on specific properties there would more widespread landscape, visual and land use impacts resulting from the barriers in this option on local Siu Lam Tsuen community. The introduction of sizeable lengths of noise barrier through the heart of the village area will visually and physically divide it into two halves, resulting in a high degree of severance for residents in moving within the village area, and they would have a severe impact on its character and form.

8.3.4 Castle Bay to Siu Lam San Tsuen - Option 2

a. In this section of the road the proposed barriers (B6, B7, B8) would have a similar effect to those proposed in Option 1.

b. The barriers in Option 2 in front of the terraced houses (CB1, CB2) and adjacent house (TW), Villa de Mer (DM) and Ivanhoe Villa (IV) would be the same height as those in Option 1 and would form dominant elements in a small scale landscape corridor, resulting in a moderate to severe visual impact.

c. The impact on Fiona Gardens (FG), Silvern Garden (SG), Kam Po Court (KP), and other properties in this section would be the same as under Option 1 above.

8.3.5 Siu Sau - Option 1

a. Views of the road and the barriers from the small detached properties on the north side of the road at Siu Sau would be largely screened by the topography and the surrounding woodland, and the container storage activities. Only the building at the entrance to the container storage area (TS) would have clear views of the barriers (A2) and (A5). Indeed, the barriers would serve to screen some of the heavy goods traffic, but would also cut out open views of the woodland beyond. The visual impact would be moderate.

b. On the south side of the Castle Peak Road, the low-lying residential development at Peridot Court (PC), the neighbouring Gurkha Married Quarters (AP3) beyond and Beaulieu Peninsula (BP) would have views up to the 5 m high barrier (A3) and (A4) and partial enclosure (A5) along the edge of the road, partially screened by the existing woodland belt on the road embankment. The barriers would be more clearly visible from the tennis court and swimming pool area at the foot of the embankment.

c. They would be seen against the partially wooded backdrop of the valley. Although

they would screen the movement of the traffic, they would represent a strong linear element running through the landscape, and due to their size and uniformity would result in a slight to moderate visual impact.

8.3.6 Siu Sau - Scheme Option 2

a. The proposed 3m high barrier (B2) along the northern frontage at Siu Sau would serve to screen some of the heavy goods traffic, but also would obstruct the existing views of the woodland areas on the south side of the road from the buildings at the entrance to the storage areas (TS). The visual impact would be slight to moderate.

b. To the south of the road there would be a moderate visual impact on Peridot Court (PC) where the proposed partial enclosure (B6) would obstruct views of the woodland on the hillslope to the north of the road. The barrier would be more easily visible from the tennis court and swimming pool area at the foot of the embankment.

c. The 5m barriers along the road by the terraced apartments (AP3) and Beaulieu Peninsula (BP) immediately to the west, would result is the same slight to moderate visual impact as those of Option 1.

8.3.7 So Kwun Tan - Option 1

a. As the Castle Peak Road turns north west it becomes clearly visible from the six new residential towers at the Gold Coast (GC), set some 40 to 50 m back from the south west frontages, and from the intervening passive landscaped open space. The partial enclosure (A1) on the north side and the 5m barrier (A3) on the south side, would be seen against the backdrop of the hillslope beyond with the residential blocks surrounded by woodland. The visual impact would be slight to moderate.

b. On the opposite side of the road the Yee On Residence for Senior Citizens (YO) is set only some 5 to 10 m from the road and has low level views across it to the Gold Coast development beyond. The proposed partial enclosure (A1) would effectively obstruct all lower floor views, resulting in a severe impact.

8.3.8 So Kwun Tan - Option 2

a. The extent of the barriers (B1) and (B3) in front of the Gold Coast (GC) would be the same as those in Option 2 and in consequence the visual impact would be only slight to moderate.

b. The partial enclosure (B1) in front of the Yee On Residence for Senior Citizens (YO) would have the same obstructing effect on existing views as in option (i) and would result in a similar severe visual impact.

c. There would be no significant impact on the views down from the apartments at Pearl Island (PI), nor on the village houses at Kar Wo Lei Village (VH4).

8.3.9 Visual Impact from the Highway

All barriers would be located at the back of the footpath (or beyond) due to sightline and safety clearance requirements. The barriers will enclose the pedestrian footpath in with the

road corridor. This will result in a dramatic reduction in the quality of environment for pedestrians in some sections, due to loss of visual amenity in obstructing views out from the road, wind funnelling along the road, and increasing safety fears due to the perceived proximity of the traffic (especially HGV's) and the lack of means of escape.

The effect will be greatest with the higher barriers especially where they occur on both sides of the road, or in partial enclosure. The latter, in particular, would create the feeling for pedestrians of being in a traffic tunnel, with loss of views out and serious concerns about the proximity to the traffic.

8.4 Landscape Mitigation Measures

8.4.1 Noise Barriers - General

a. The noise assessment has determined the size and form of the barriers to achieve the required noise attenuation in Options 1, 2 and 3. The mitigation of the visual impact of the barriers is limited, therefore, only to possible architectural treatment in blending them into the surrounding landscape setting.

b. The closer the barrier is located to the source of noise (in this case at the carriageway surface level) the greater its attenuating effect. Due to sight line requirements it would only be possible to locate barriers at the back of the kerb in a few places. For the most part they have to be set at the back of the adjoining footpath and at some entrances and run-ins taken back further. As the transition between the two locations would pose various practical and aesthetic problems, it is proposed to locate all barriers at the back of the footpath.

c. The need to provide roofing panels to form a partial enclosure to the road at some locations requires the use of a framework bridging over the carriageway, either cantilevered from the back of the footpath or supported by a second series of posts located in the central divider to the road, or spanning the full width of the road.

d. It is possible that a framework spanning the carriageway will also need to be adopted for the 5 m high panels to allow a simple transition between them and the sections of partial enclosure and to stiffen them against the effects of wind loading. Otherwise barriers would be free-standing fence structures, supported by the one set of posts.

e. The higher barriers and the partial enclosures are likely to reduce the light levels within the road corridor. It is proposed therefore that the upper 1 or 2 m of the vertical barriers, and the roof panels of the enclosures, be formed in clear perspex to minimise this effect, and to reduce the visual height of the barriers. The height of proposed lighting columns may also need to be reviewed.

8.4.2 Aesthetic Treatment

a. The majority of views affected by the barriers are from the downhill side of the road, and from a similar level where the barriers would be seen against a backdrop composed largely of vegetation with isolated buildings and items of street furniture. This backdrop has predominantly, a densely textured pattern of dark green and brown colours highlighted by the pattern of shadow effects.

b. In order to achieve the objective of creating a wide variety of surface patterns, within the practical limitations of producing a large number of panels, it is proposed that a series of, say four to six different types of composite panel be produced, with the lower parts in a solid panel, and the upper in transparent perspex or similar material with the same material used for the roof panels of the partial enclosure.

c. The solid surface of the lower part of the panels would be finished in a dark green and brown camouflage pattern. This would be overlain with a framework of raised strips formed in areas of varying pattern and density, and of different depth to create different textures and shading effects. This would have an appearance similar to the typical backdrop and would be equivalent to roadside edge planting.

d. There is in some sections a limited amount of space in which to incorporate climbing plants to the outside of the barriers. These would assist in creating the texture and pattern of a well vegetated backdrop.

e. Most views are of the external faces of the barriers as they screen most of the neighbouring properties. The internal face will however be seen by both motorists and pedestrians along the road, and in several oblique views along the road. To maintain the continuity of the surface treatment it is proposed that the internal face be coloured in the same way as the external, but not superimposed with the same patterning framework.

f. Highly detailed and patterned panels of this sort, would most easily be formed in, say, glass reinforced concrete (GRC), fabricated by panel in molds and then simply bolted to a steel framework.

g. The overall form and composition of colour and surface patterning of the panels would be developed at the detailed design stage of the noise mitigation measures.

8.5 Statement of Residual Impact

8.5.1 Residual Impact

The proposed architectural treatment of the barriers would help to mitigate their visual impact in all affected views, and would reduce the impact at many of them to an acceptable level.

Several of the properties, however, are very close to the road and the barriers will be dominant elements in the landscape, obstructing much of the previous view. The treatment of the surface finishes will only tone down their impact on these properties, and in cases the residual impact will still be relatively high.

8.5.2 Option 1

a. Siu Lam

At Siu Lam Beach the proposed treatment of the 5m high barriers (A10) and (A11) to make them representative of roadside planting would help to blend them into the landscape backdrop, successfully mitigating the impact on the more distant views from the headland (CSQ1 and CSQ2). There would, however, still be a slight

residual visual impact on the Marine Police Quarters (MPQ).

b. Castle Bay to Siu Lam San Tsuen

In the section from Castle Bay to Siu Lam San Tsuen the mitigating treatment of the barriers would be less effective, as more of the view points are very close to the road and the 5m high and partially enclosed barriers would constitute a large obstructing element within the view. The impact on Castle Bay Villas (CB1, 2), Ivanhoe Villas (IV), the house at TNIL23A (TW) and Silvern Gardens (SG) would still be moderate. However the impact in other less immediate views would be reduced to slight.

c. Siu Sau

At Siu Sau the impact on views from the building to the north of the road (TS), would be successfully mitigated by the proposed treatment, tying the appearance of the barriers into the surrounding pattern of vegetation.

d. So Kwun Tan

The impact on the Yee On Residence for Senior Citizens (YO) and the adjacent residential block (No.14) is likely to still be moderate to severe even with the proposed mitigation, as the barrier structure would effectively obstruct most ground floor views from these buildings.

The visual impact on the residential towers of the Gold Coast (GC) would still be slight for apartments on the lower floors as the 5 m high barrier (A3) would still form a substantial element obstructing a significant proportion of the view.

8.5.3 Option 2

a. Siu Lam

At Siu Lam Beach the proposed treatment of the 5m high barrier and partial enclosure to make them representative of roadside low scrub planting would help to blend them into the landscape backdrop, reducing the visual impact on the Marine Police Quarters (MPQ) to slight to moderate, and on (CSQ1) and (CSQ2) to insignificant levels.

b. Castle Bay to Siu Lam San Tsuen

In the section from Castle Bay to Siu Lam San Tsuen the mitigating treatment of the barrier (B6, B7, B8, B12) would have only limited effect, as more of the view points are very close to the road and the 5m high barriers and partial enclosures would constitute large obstructing elements within the view. The impact on Castle Bay (CB2), TNIL23A (TW), the adjacent terrace houses Villa de Mer (DM), and Ivanhoe Villas (IV), would still be moderate to slight.

c. Siu Sau

At Siu Sau the impact on views from the buildings to the north of the road (TS), would be successfully mitigated, with the proposed treatment tying the appearance of

the barriers into the surrounding pattern of vegetation.

d. So Kwun Tan

The impact on the Yee On Residence for Senior Citizens (YO) and the adjacent residential block (No.14) would be moderate to severe even with the proposed mitigation, as the barrier structure would effectively obstruct most ground floor views from these buildings.

The visual impact on the residential towers of the Gold Coast (GC) would be reduced to slight.

8.6 Costs

Architectural treatment of barriers and landscape planting are each expected to be less than 5% of the total project cost. Allowances for some architectural treatment have already been included in the estimates for the barriers themselves. In these circumstances and where costs at this stage are only $\pm 20\%$, detailed estimates of cost of the proposed visual impact mitigation are not considered justified.

CHAPTER NINE
ENVIRONMENTAL MONITORING AND AUDIT

9. ENVIRONMENTAL MONITORING AND AUDIT

9.1 General Requirements

An environmental monitoring and audit programme performs three functions. It ensures that noise from the construction and operation of the project are kept to acceptable levels; it establishes procedures for checking that mitigation measures, if needed, have been applied and are effective; and it provides the means by which compliance may be checked, exceedances documented, and corrective action recorded.

It should be noted that monitoring during the operation of the widened roadway is not specified by Government. A limited operation audit is recommended, however, both to confirm the findings of the EIA and to ensure that noise impacts are kept to acceptable levels.

Detailed monitoring schedules and audit requirements should be incorporated into the construction contract for the widening of Castle Peak Road. The clauses containing these schedules and requirements should be formulated in consultation with EPD.

The environmental monitoring and audit requirements will need to be reviewed and revised at regular intervals during the environmental monitoring and audit programme by the Highways Department.

9.1.1 Technical and Personnel Requirements

Monitoring and auditing should be conducted by qualified and experienced personnel. Monitoring staff will liaise with the site manager and resident site engineer during construction, and with EPD during operation.

The contractor should be responsible for providing an approved integrating sound level meter to the IEC 651 : 1979 (Type 1) and 804 : 1985 (Type 1). The meter should be for the exclusive use of the monitoring personnel, and be available at all times during the continuance of the contract. The meter should be maintained by the contractor in proper working order throughout the contract, and should be replaced if necessary when it is under repair.

During monitoring, the following information is useful and should be recorded:

(a) the measured values of L_{Aeq}, together with details of the appropriate time periods;

(b) details of the instrumentation and measurement methods used, including details of sampling technique, position of the microphone relative to the site, and system calibration data;

(c) any factors that may have adversely affected the reliability or accuracy of the measurements;

(d) plans of the site and neighbourhood, showing relative positions of the plant and Noise Sensitive Receivers;

(e) notes of site activities during monitoring periods;

(f) notes on observed weather conditions, e.g., wind speed and direction, temperature, presence of rain or mist, etc.

9.1.2 Environmental Monitoring and Audit Manual

The contractor should prepare an Environmental Monitoring and Audit (EM&A) Manual, which would include:

(a) the construction programme;

(b) the location, frequency and type of monitoring and audit requirements;

(c) the locations of NSRs;

(d) forms or procedures for the presentation of monitoring data;

(e) equipment service and calibration records;

(f) action plans in the event of exceedances of Trigger, Action, and Target levels (see 9.3 below), and a record of actions taken in the event of such exceedances;

(g) complaint and consultation procedures.

9.2 Baseline Monitoring

Baseline monitoring should be conducted in order to establish or confirm the existing noise environment in the study area, before the commencement of construction activities.

Baseline monitoring should consist of 24-hour noise monitoring at a given location for a period of one week. The parameters measured should include L10, L30, and $L_{eq\ (30\ min)}$. During the construction programme, it may be desirable to check the baseline monitoring results by repeating a 24-hour noise measurement during a typical day when construction activities are not taking place.

9.3 Compliance Monitoring (Construction)

Compliance noise monitoring will be required to verify compliance with the guidelines for construction noise (in particular, any criteria contained in the contract documents) and with the requirements of any Construction Noise Permits.

As part of the monitoring schedules, three levels have been derived to monitor compliance with environmental objectives and to provide early warning of potential problem areas. The three levels are:

- *Trigger Level*: This level acts as an "early warning" of deterioration, so that closer monitoring of noise levels may be initiated, possible sources of the noise may be identified, and early mitigation measures enacted to prevent further deterioration. This level may be defined as receipt of one independent complaint (directed either to EPD or the site office).

- *Action Level*: Achievement of this level indicates that noise levels have increased from the Trigger Level, and that corrective action is required before conditions

further deteriorate and relevant standards are not met. This level may be defined as receipt of more than one independent complaint in a two-week period.

- *Target Level*: This is the upper limit, or maximum permissible level that will still comply with the appropriate regulation. In the absence of statutory controls to limit daytime (07.00-19.00 hrs) construction noise, a limit of 75 dB(A) (L_{Aeq} 30 min) or 10 dB(A) over the prevailing background noise level (whichever is lower), may be adopted as the Target Level. For noise from percussive piling, the Target Level is defined as 85 dB(A), in accordance with Table 1 of the *Technical Memorandum on Noise from percussive Piling*. Exceedance of the Target Level is generally not permitted.

  Daytime compliance monitoring should be undertaken at least three times per week. Additional compliance monitoring may be conducted in response to complaints. From 07.00 to 19.00 on any day not being a general holiday, measured equivalent continuous A-weighted sound level (L_{Aeq}) sound levels (other than those from percussive piling) should not exceed the Target Level over any 30-minute period at 1 metre from the worst-affected external facade of the nearest noise sensitive receiver. General calibration and measurement procedures are defined in the *Technical Memorandum on Noise from Construction Work other than Percussive Piling* and the *Technical Memorandum on Noise from Percussive Piling*. Noise measurements should not be made during periods of high background noise (such as during peak traffic hours), or in the presence of fog, rain, or excessive steady or gusty winds.

  When complaints are received or the Target Level is exceeded, the following Action Plan is recommended:

Table 9.1 - Action Plan for Noise Compliance Monitoring

Event	Action	
	Engineer	Contractor
If noise level exceeds Target Level	- Notify Contractor. - Require Contractor to propose measures to reduce noise. - Increase monitoring frequency.	- Submit noise mitigation proposals to the Engineer. - Implement noise mitigation measures.
One independent complaint is received	- Notify Contractor. - Conduct measurement. - Investigate noisy operations.	
More than one independent complaint is received within a 2 week period	- Notify Contractor. - Investigate and analyze. - Require Contractor to propose measures for the analysed noise problem. - Increase monitoring frequency to check mitigation effectiveness.	- Submit noise mitigation proposals to engineer. - Implement noise mitigation proposals.

During construction, a monthly monitoring report should be prepared by the monitoring personnel within 7 days of the end of each month. The report should contain the following information:

(a) project data, including project programme to date;

(b) summary of monitoring parameters and relevant criteria (i.e., Trigger, Action, and Target level);

(c) monitoring equipment in use, and the locations, dates, duration and frequency of monitoring;

(d) monitoring results;

(e) where noise levels exceeded criteria levels, identification of the excessive noise source(s) and a report on the action taken;

(f) details of complaints received, and action taken in response to them.

In addition to noise monitoring, during construction the effectiveness of mitigation measures should be checked by ensuring that any silenced construction equipment is properly used and maintained, any noise barriers are properly positioned and maintained, and good site practice is maintained. During construction, the hours of operation should also be checked and monitored on a regular basis.

9.4 Post-Project Auditing (Operation)

A post-project audit should be carried out after completion of the widening to assess the environmental performance of the road. This audit should be started after a sufficiently long interval so that findings are representative of the operational phase of the road. The post-project audit is intended to verify the findings of the EIA, and assess the effectiveness of mitigation measures. If environmental objectives are not being achieved, the audit can help indicate where additional controls might be effective.

The post-project audit would involve monitoring of 24-hour L_{Aeq} noise levels at representative NSRs. A single monitoring event at each selected NSR is considered sufficient, ensuring that the monitoring period coincides with typical traffic conditions.

CHAPTER TEN
CONCLUSIONS

10. CONCLUSIONS

10.1 Noise Impacts

The proposed improvements to Castle Peak Road will increase the capacity of the road. A Local Traffic Study has predicted that traffic levels on the road by the year 2011 will be approximately three times the present volume. Heavy vehicle numbers are predicted to increase by five times.

The impact of the traffic noise from these increased traffic flows has been assessed on 41 selected Noise Sensitive Receivers (NSRs), and the resulting noise levels at the most exposed facades are presented in Table 5.4. Predicted levels at most of the NSRs are above the HKPSG guideline of 70dB(A), and many of the NSRs would qualify for consideration for equitable redress under the three eligibility criteria unless noise mitigation measures are implemented. Three combinations of direct mitigation measures have been identified and the resulting residual noise impacts at the NSRs are presented in Tables 7.1 (Option 1), 7.2 (Option 2) and 7.3 (Option 3).

The total number of dwellings (units) affected by the scheme and represented by the selected NSRs is approximately 740 units.

Despite the extensive direct mitigation measures considered in Options 1, 2 and 3, residual noise levels at many of the affected dwellings would still be well in excess of the HKPSG criterion and furthermore at more than 50% of these dwellings would remain high enough that these units would still qualify for consideration for equitable redress under the eligibility criteria.

Likely construction noise impacts from the road construction works have been predicted and it has been found that for NSRs within about 75m of the proposed works, noise levels could significantly exceed the assessment criteria of 75dB(A). For those NSRs close to proposed noise barriers, noise levels from barrier construction will also be considerably more than 75dB(A). Noise from percussive piling for bridge foundation works at the road bridge next to Kar Wo Lei village is likely to exceed the 85dB(A) Acceptable Noise Level at Gold Coast Block 6.

10.2 Mitigation Proposals

10.2.1 Feasible mitigation methods identified include mitigation at noise source using friction course road surfacing and mitigation along the noise path using vertical barriers up to 5m high and partial enclosures. Mitigation at the receiver could be achieved by providing high quality glazing for window units together with mechanical ventilation. Current practice in Hong Kong is to consider mitigation at the receiver only after exhausting all other available options.

10.2.2 The application of friction course to the road surface reduces the noise generated by traffic. However, the surfacing does have maintenance problems when used on roadways with stop-start traffic, bus bays, junctions, etc. and is not suitable for large sections of Castle Peak Road within the study area. It is only considered as a feasible solution in this study along stretches of the roadway where maintenance requirements would not be too onerous. The use of friction course surfacing even on these stretches will involve

frequent maintenance, which will disrupt traffic flows. The alternating of different types of carriageway wearing courses over relatively short lengths of carriageway is also far from ideal.

10.2.3 Barriers are most effective when located next to the noise source, ie at the kerbside. However, difficulties with forward visibility for road users in some locations and the practical difficulties of changing the siting of barriers from front of footpath to back of footpath at particular locations, lead to the conclusion that barriers should be at the back of the footpath wherever they are required.

10.2.4 Noise barriers up to 3m high may be constructed as free-standing barriers supported on spread foundations. Noise barriers higher than 3m may require more substantial piled foundations, or, alternatively, may be supported on a steel portal framework spanning the carriageway. This latter option is significantly more costly than a piled foundation however.

10.2.5 Partial enclosures over the kerbside lane of traffic are feasible, though very costly. At several locations, partial enclosures have been found necessary to protect sensitive receivers. Partial enclosures could be constructed as top-bent or cantilevered type barriers, supported on pile foundations, or as a portal frame system spanning the carriageway, with acoustic infill panels as required. While it would be preferable to locate partial enclosures at the carriageway edge rather than the rear of the footpath, for both environmental and cost reasons, this is not possible because, at the proposed partial enclosure locations, barriers at the carriageway edge will interfere with driver sightlines. Therefore, partial enclosures will generally be located at the rear of the footpath.

10.2.6 For highrise receivers of the Gold Coast, only a total noise enclosure over both carriageways could provide effective direct mitigation of noise. It has been found that total noise enclosures are not feasible for implementation along the route however.

10.2.7 All barriers in excess of 1m in height, and partial enclosures, have an effect on driver sightlines, particularly at junctions.

It will be necessary to set barriers back from the rear of the footpath at some locations to maintain minimum standards for sightlines. The works limit will need to be extended at three locations, as shown on Figure 26 to accommodate this set back.

10.2.8 The large number of junctions and accesses to properties along the route mean that openings in the barriers are unavoidable. The effectiveness of noise barriers and partial enclosures is significantly reduced by these openings.

10.2.9 Mitigation of noise at the receiver will be by the provision of good quality window units and glazing, and by provision of air conditioning units.

10.2.10 Construction noise can be mitigated by specifying requirements in the construction Contract and by carrying out adequate monitoring under supervision to ensure the requirements are met. Further reduction in construction noise impact could be provided by erecting the proposed traffic noise mitigation barriers prior to starting road and bridgeworks.

10.3 Effectiveness of Mitigation Schemes Identified

10.3.1 Direct Technical Remedies

(i) To meet the criteria for mitigating traffic noise in the design year 2011, direct technical remedies can be implemented. The maximum practical extent to which such remedies could be provided, allowing for the necessary access to the improved highway, would be as indicated on Figures 9-11 (Option 1, Noise Barriers with Friction Course) and Figures 12-14 (Option 2, Noise Barriers without Friction Course). The capital cost of these measures would be of the order of HK$50-65 million, or roughly 40% of the estimated cost of the construction works for the road improvement scheme. Maintenance costs for the proposed mitigation measures would range from HK$ 40-55 million over the first 15 years of operation. Residual noise levels at over 50% of the 740 dwelling units affected by the traffic noise from the improved Castle Peak Road would still meet the three eligibility criteria, and would qualify for consideration for equitable redress (insulation). Insulating these dwellings (including maintenance and operation over a 15 year period) would cost HK$60-70 million, giving a total estimated cost of HK$165-180 million for noise mitigation along the route.

(ii) Direct mitigation measures to mitigate traffic noise from Castle Peak Road are not effective at reducing traffic noise from the more heavily trafficked Tuen Mun Road. Along the eastern half of the study area, Tuen Mun Road runs parallel and adjacent to Castle Peak Road. The noise generated by the Tuen Mun Road traffic dominates the overall noise level at most of the sensitive receivers on this section of the route. Reducing traffic noise from Castle Peak Road by providing extensive barriers, partial enclosures and friction course, while protecting receivers from noise from this source, has little or no effect on the overall noise level. Thus, residents at dwellings along that section of Castle Peak Road close to Tuen Mun Road would suffer from noise levels almost as high with direct mitigation measures on Castle Peak Road as without. There is little practical benefit to be gained from the inclusion of direct noise mitigation measures along this section of the route. The benefit obtained is that, technically, affected dwellings can be sufficiently protected against noise from Castle Peak Road so that they do not meet the criteria for equitable redress, and so, will not qualify for consideration for insulation. This must be weighed against the significant negative visual and amenity impacts of high barriers and partial enclosures on the semi-rural small scale character of the road corridor, and the high cost of the construction and maintenance of these noise mitigation measures.

(iii) The only practical way to ensure that there is a real improvement in the noise environment for residents of dwellings along the eastern section of the route is to provide insulation at the dwellings. Overall noise levels could be reduced to below 70dB(A) inside the sensitive receiver building representing a significant improvement on the current noise environment. An option whereby direct technical remedies are proposed only where they provide a significant improvement in overall traffic noise at the targeted receivers is presented in Figures 15-17 (Option 3). No noise barriers are proposed along the eastern section of the route. The capital cost of the direct mitigation measures is about HK$30-35 million, about half that of Options 1 and 2. Maintenance costs would also be less, at HK$20-25 million over a 15 years operating period. The cost of insulation would be increased to HK$85-90 million reflecting the larger number of dwellings qualifying for consideration for insulation. The capital

cost of noise mitigation (including provision of insulation at all qualifying dwellings) for this option, at $135-140 million, is $30-40 million less expensive than Options 1 and 2.

10.3.2 Mitigation at Receiver

The study indicates that it is more cost effective to provide noise insulation at all affected sensitive receivers along the route, rather than to include direct technical solutions to control noise levels. Insulation of affected receivers would have no negative visual impacts, and would result in much lower overall noise levels inside the receivers than could be achieved by barriers or friction course surfacing. Outside noise levels would be unmitigated. However, the cost effectiveness is very sensitive to the period over which maintenance and operating costs for insulation measures are considered, and for periods in excess of about 15 years, direct remedies would become more cost effective.

10.4 Environmental Impact of Mitigation Methods

The semi-rural small scale character of the road corridor, the proximity of the buildings affected by the road, and the size, length and man made nature of the proposed noise barriers would make them dominant elements in the majority of views along the new road, and would result in severe visual impact on many properties.

The proposed mitigation measures involve the architectural treatment of the barriers to help blend them into the surrounding landscape. This treatment would reduce the level of visual impact in all cases. In longer range views the treatment would be largely successful in ameliorating the visual impact to acceptable levels. In shorter range views the size of the barriers within the scale of the view make mitigation much less effective and at a significant number of locations, the residual visual impact is still moderate.

A balance needs to be drawn between the beneficial effects of the noise reduction likely to be achieved by the barriers and their cost and visual and amenity impacts. While the construction and maintenance costs have been estimated it has not proved possible to put a cost on visual and amenity impact.

10.5 Costs and Cost Effectiveness

10.5.1 Table 10.1 summarises the estimated total costs of the three options proposed. The purpose of the options is to reduce noise levels at the NSRs to meet the HKPSG 70 dB(A) criterion. In each case the Table shows the number and percentage of the total of 740 receivers estimated to be subject to increased noise that would still require mitigation at the receiver following implementation of the proposed direct mitigation measures. The options are presented in the order in which they have been discussed in the report. In order to assess cost effectiveness the last column gives an indication of the order of cost of mitigation for each noise sensitive receiver identified in the study.

Costs have also been presented for provision of insulation at all 740 sensitive receivers, with no direct mitigation measures adopted along the route, for comparison purposes.

Maintenance and operating costs for direct and indirect mitigation measures are based on a

fifteen year operating period.

10.5.2 It is clear that Option 1, the combined use of barriers and friction course, can minimise the number of sensitive receivers that would quality for consideration for equitable redress due to increased traffic noise from Castle Peak Road. Using this guideline to compare the relative effectiveness of the three options, Option 1 is the most effective.

10.5.3 Option 2, direct noise mitigation using barriers only, is more costly and protects less sensitive receivers than Option 1. Therefore, Option 1 is to be preferred over Option 2.

10.5.4 The third direct mitigation option, Option 3, is seen to be more cost effective than either Options 1 or 2, but leaves a larger number of dwelling units meeting the three criteria qualifying them for consideration for equitable redress. As discussed in 10.3. iii), this option does not include direct mitigation at locations where these measures would be ineffective in improving the overall noise environment at the targeted receivers. If the operating period considered for the insulation at receivers is increased from 15 years to 50 years, then this option would be less cost effective than Option 1, due to the greater number of receivers that may require insulation.

10.5.5 Finally, it is seen that in terms of cost effectiveness, provision of insulation at all affected receivers would be preferred to implementation of any of the direct mitigation measures of Options 1, 2 or 3. However, if the operating period is extended from 15 years to 50 years, the provision of insulation would provide to be the least cost effective option.

10.5.6 The relative order of cost of mitigation per affected receiver is sensitive to the length of the operating period and the discount rate adopted for costing purposes. Longer operating periods and lower discount rates tend to make Options 1 and 2, with higher capital cost, but lower ongoing costs, more attractive relative to Option 3.

10.5.7 It is apparent from the figures derived in this report that no combination of direct mitigation measures can remove the need for indirect mitigation measures at many of the NSRs. Option 1, combining barriers and friction course surfacing comes closest, but still leaves more than 50% of the affected residences meeting the requirements for consideration for equitable redress. The noise barriers and enclosures are not effective at these residences largely because of openings in the noise structures required for junctions and run-ins, or because of their elevated level compared with the road, and because of the high traffic noise from the adjacent Tuen Mun Road.

10.5.8 The estimated cost of the road improvement works is $150 million. It can clearly be seen that the capital cost of the direct mitigation proposed under Options 1 to 3 is a very significant additional cost, ranging from 21% of the roadworks cost for Option 3 to 43% for Option 2.

Table 10.1 - Summary of Costs and Cost of Effectiveness (Costs at 1994 prices - Discount Rate 0%)

	Capital Cost of Direct Mitigation	Maintenance Cost of Direct Mitigation Measures	Cost of Mitigation at Receiver*	Total Cost	Receivers (out of 740) requiring mitigation at receiver		Order of Cost of Mitigation per Receiver
	% of Roadworks Cost Estimate						
	HK$m.	HK$m.	HK$m.	HK$m.	No.	%	HK$ 000
Option 1 Noise Barriers with Friction Course Figures 9, 10, 11	52.2 35%	51.6	63.7	**167.5**	444	60	226
Option 2 Noise Barriers without Friction Course Figures 12, 13, 14	64.0 43%	44.8	71.2	**180.0**	496	67	243
Option 3 No Direct Mitigation at Siu Lam Figures 15, 16, 17	31.0 21%	21.7	86.3	**139.0**	601	81	188
No direct mitigation, mitigation at affected receivers by glazing and airconditioning	- -	-	106.4	**106.4**	740	100	144

* *These costs are estimates of the cost of insulating all receivers that would qualify for consideration for equitable redress under the three eligibility criteria. Following consideration by Exco, insulation may not actually be provided.*

10.6 Further Studies

Further studies are required before proceeding to detailed design of noise mitigation measures. A detailed survey of all affected sensitive receivers, followed by further noise modelling to determine the detailed layout and type of barriers at junctions and run-ins, and to identify all dwellings that would qualify for consideration for equitable redress will be needed. Site investigation will be required at those locations where barriers and partial enclosures are proposed, particularly for high barriers and partial enclosures.

10.7 Environmental Monitoring and Audit

10.7.1 Baseline monitoring should be carried out prior to the commencement of any construction activity on site, to establish the existing noise environment in the study area. Compliance monitoring of construction noise can be carried out by the Contractor under supervision of the Engineer during construction. Detailed monitoring and audit requirements for the construction phase should be specified in the construction contract.

10.7.2 A post-project audit at some time after completion of the project, when traffic levels have built up along Castle Peak Road, would provide a useful assessment of the effectiveness of the mitigation measures adopted.

11. RECOMMENDATIONS

11.1 Construction Noise

To meet the requirements for mitigating construction noise in accordance with specified criteria it is recommended that:-

- The construction contractor be required to comply with the measures listed in para 6.1.2 as far as is practical.
- The construction contract specification includes the provisions of para 7.1.3 a) to k) inclusive.
- Compliance with the specification be monitored in accordance with Section 9.3 of the report.
- Where possible any permanent noise mitigation proposals recommended be installed prior to roadworks construction.

11.2 Traffic Noise

11.2.1 Recommended Mitigation Scheme

The recommended noise mitigation scheme for implementation along the improved Castle Peak Road from So Kwun Tan to Siu Lam Interchange is the scheme presented in this report as Option 3, no Direct Mitigation at Siu Lam. The extent of the direct noise mitigation measures proposed are indicated on Figures 15 to 17 inclusive. The recommended direct mitigation measures would reduce peak hour traffic noise levels to below the HKPSG criterion of 70dB(A) at approximately 130 dwelling units at which traffic noise levels would be considerably in excess of 70dB(A) were no mitigation measures installed. Even with the extensive noise barriers recommended, some 600 dwelling units would still meet the eligibility requirements for consideration for equitable redress. It is recommended that the provision of acoustic insulation measures be considered at these dwellings.

The use of friction course surfacing along the improved Castle Peak Road is not recommended, even though, if combined with noise barriers and partial enclosures, it can improve the overall noise environment at a number of dwellings. Maintenance requirements for the friction course surfacing along Castle Peak Road would be quite onerous, to the extent that this type of surfacing is considered not practical for use along the route within the study area.

Options 1 and 2 as presented in this report are not recommended as they would result in the provision of extensive noise barriers at locations where these barriers would provide little or no practical improvement in the overall noise environment when compared with the unmitigated noise environment.

11.2.2 Other Recommendations

The following additional recommendations are made:-

(i) negotiations for extension of the works limit at two locations as indicated on Figure 26 be commenced;

(ii) a detailed survey of all affected sensitive receivers should be commissioned;

(iii) a soil investigation should be commissioned to provide information for foundation design of noise barriers;

(iv) further detailed noise assessment should be carried out following completion of the survey in (ii) above, and in conjunction with the detailed design of noise barriers if necessary, to identify facades/windows at all affected sensitive receivers that qualify for consideration for equitable redress, and to finalise details of noise barrier design;

(v) future development along the route, particularly at the three CDA sites, should be required to incorporate traffic noise mitigation measures as identified in Section 7.6.

11.3 Monitoring and Audit

It is recommended that monitoring and audit be carried out as discussed in Section 9.

CHAPTER ELEVEN
RECOMMENDATIONS

APPENDIX 1

THE STUDY BRIEF

APPENDIX 1 - THE STUDY BRIEF

A1.1 Study Objectives

A1.1.1 The Study shall provide information on the nature and cumulative extent of potential noise impacts on the environment resulting from the proposed improvement to Castle Peak Road between So Kwun Tan and Siu Lam.

A1.1.2 The Study shall:-

(i) describe the characteristics of the proposed development and related facilities and the requirements for their development;

(ii) identify and describe the environment relating to noise and the elements of the community likely to affect/be affected by the proposed development;

(iii) minimize the noise nuisance arising from the proposed roadworks and related facilities, and its construction and operation;

(iv) identify, assess and evaluate the net noise impacts and cumulative effects expected to arise due to the construction and operation of the development in relation to the existing and planned community and the neighbouring land uses;

(v) identify, assess and specify methods, measures and standards for the inclusion into the design, which are necessary to mitigate these noise impacts to an acceptable level;

(vi) identify and assess the side/second effects to the community and environment of the inclusion of the proposed mitigation measures into the design and to recommend the most suitable method(s) to be used; and

(vii) recommend environmental monitoring and audit requirements necessary to ensure the effectiveness of the noise mitigation measures adopted.

A1.2 Duties of the Consultant

A1.2.1 With due consideration of the technical requirements for the noise impact assessment study as detailed in Annex 1 of this Brief, the Consultants shall:-

(i) assemble information on the background to the project, and on alignments and projected traffic volumes on the proposed road;

(ii) identify all existing and future land use;

(iii) assemble, assess and interpret existing noise data and practice;

(iv) identify the current noise impact of existing roads on present and future land uses in the area as a basis for determining the noise impact of the proposed project on existing and proposed developments;

(v) carry out surveys of existing levels of noise pollution in the area and identify existing

effects of such pollution;

(vi) derive environmental standards relating to noise from existing laws of Hong Kong and planning standards (largely from the Hong Kong Planning Standards Guideline (HKPSG), Chapter 9);

(vii) define the functional requirements based on environmental standards relating to noise;

(viii) discuss the implications of the proposed project and consider alternative noise mitigation measures (including both direct and indirect remedies) within the ambit of proposing and optimum and cost-effective mitigation package with cost estimates;

(ix) carry out or have carried out all necessary surveys, levels and soundings and make such investigations and inquiries as are necessary for the satisfactory completion of the Assignment;

(x) identify the need for any resumption, clearance and reprovisioning and liaise with relevant bodies and assist with negotiations for any resumption, clearance and reprovisioning that may be required for the mitigation measures;

(xi) identify all facilities, installations and existing rights that may be affected by the Assignment;

(xii) prepare necessary land requirement plans showing the extent of land requirements for noise mitigation measures;

(xiii) determine the extent of further ground investigations and surveys and further studies required for detailed design purposes (in relation to the proposed mitigation measures);

(xiv) prepare preliminary designs, plans, drawings, profiles, sections, specifications and calculations for noise mitigation measures;

(xv) prepare all necessary documents for the Advisory Committee on the Appearance of Bridges and Associated Structures (ACABAS) submission;

(xvi) prepare, supply and present all drawings and display materials required for submissions to district Boards, the Town Planning Board, the Regional Council and the ACABAS, and attend meetings as and when instructed by the Director's Representative; and

(xvii) prepare and supply discussion papers, technical papers, draft reports and final reports, documents, and drawings as may be reasonably required by the Director's Representative for compliance with the appropriate Statutory Regulations, Government Procedures, Instructions and Circulars in connection with the study.

A1.3 Study Output

A1.3.1 The Consultants shall within three months from the commencement date of the Agreement submit to the Director's Representative 30 copies of the draft Noise Impact Assessment Report which shall inter alia include the following:-

(i) a summary of existing and future noise pollution levels at adjacent buildings and future developments for the proposed project;

(ii) conceptual designs and details of noise amelioration measures for the proposed project deemed necessary on environmental grounds;

(iii) cost estimates of amelioration measures for the proposed project;

(iv) records of the entire background of the noise assessment such as the details of alternative mitigation proposals considered, evaluation details including cost-effective analysis, technical calculations and their side/second effects to the community & environment;

(v) specific aspects of the proposed noise abatement measures including drawings and descriptive information which portrays their design details, anticipated effectiveness in relation to the noise levels and/or existing levels together with their estimated costs and benefits;

(vi) a discussion of construction noise analysis information, including contract provisions to minimise or eliminate exposure to high noise levels related to the Noise Sensitive Receivers; and

(vii) documentation and discussion of the comments from the Government representatives during the course of the study.

A1.3.2 The Consultants shall within five months from the commencement date of the Agreement submit to the Director's Representative 80 copies of the final Noise Impact Assessment Report and 250 copies of the Executive Summary Report.

A1.3.3 The Consultants shall prepare, supply and present all drawings and display materials required for submissions to District Boards, the Town Planning Board, the Regional Council and the Advisory Committee on the Appearance of Bridges and Associated Structures (ACABAS), and attend meetings as and when instructed by the Director's Representative.

A1.3.4 All final and draft Noise Impact Assessment Reports should normally be made available to the public and should be prepared with this in mind. This will involve placing confidential or non-environmental material in appendices that can be removed prior to public release.

A1.3.5 Reports shall be of A4 size, except that drawings shall be presented in A3 size.

APPENDIX 2

COMMENTS ON DRAFT FINAL REPORT ISSUED APRIL 1994, AND CONSULTANTS RESPONSE TO COMMENTS

APPENDIX 2

COMMENTS ON DRAFT FINAL REPORT ISSUED APRIL 1994 AND SUBSEQUENT REVISED ISSUE 3 (JANUARY 1995) AND ISSUE 5 (APRIL 1995), AND CONSULTANTS RESPONSE TO COMMENTS

Comments made by respective Government departments on the Draft Final Report No. 7146/005 Issue 2 dated April 1994 (HyD NT memo ( ) in HNT 54/144 (51) II of 10 May 1994) Issue 3 dated January 1995 and Issue 5 dated March 1995 are summed up below.

	DEPARTMENT/OFFICE		DATE RECEIVED	COMMENTS	
				NO	YES
1.	DEP	(Attn: Mr. Stanley C F Lau)	02.03.94[1]		X
1.	DEP SPEL	--	12.04.95[5]		X
2.	SEPO(RA), EPD	(Attn: Mr. Johnson Wong)	08.06.94[2]		X
2.	DEP (RA), EPD	--	19.04.95[5]		X
3.	PEPO(NP), EPD	(Attn: Mr. James Wong)	NIL		
		(Attn: Mr. Andrew Cheung)	20.04.95[5]		X
		--	09.03.95[3]		X
4.	CE/MN, DSD	(Attn: Mr. H C Tam)	24.05.94[2]	X	
5.	DEMS	(Attn: Mr. George H W Liu)	13.05.94[2]	X	
		--	06.02.95[3]		X
		--	12.04.95[5]	X	
6.	D of FS	(Attn: Mr. Szeto Yat-san)	16.06.94[2]		X
		--	07.02.95[3]	X	
		--	19.04.95[5]	X	
7.	DLO/TM	(Attn: Mr. T S Mak)	16.05.94[2]	X	
		(Attn: Mr. H.M. Ip)	14.02.95[3]	X	
		--	22.02.95[3]		X
8.	DO/TM	(Attn: Mr. Ho Chee-chong)	20.05.94[2]	X	
		(Attn: Mr. Eugene Fung)	13.02.95[3]	X	
		--	20.04.95[5]	X	
9.	CGE/Advisory	(Attn: Mr. W C Lee)	17.06.94[2]		X
		(Attn: Mr. Y.K. Shiu)	16.02.95[3]	X	
		--	13.04.95[5]	X	
10.	D of A&F	(Attn: Mr. Cary P H Ho)	28.05.94[2]	X	
		--	08.02.95[3]	X	
11.	DPO/TM & YL	(Attn: Mr. T Y Lee)	04.07.94[2]		X
		(Attn: Mr. K.S. Lee)	14.02.95[3]		X
		--	13.04.95[5]	X	
12.	D of RS	(Attn: Mr. Vincent Leung)	06.06.94[2]	X	
		--	20.02.95[3]	X	
		--	11.04.95[5]	X	

	DEPARTMENT/OFFICE		DATE RECEIVED	COMMENTS	
				NO	YES
13.	C of P (CSO Traffic)	(Attn: Mr. K L Wong)	16.03.94[1]		X
		--	19.04.95[5]	X	
14.	PM(NT West)	(Attn: Mr. S C D Tam)	17.05.94[2]	X	
		--	10.02.95[3]	X	
15.	CE/MNW, WSD	(Attn: Mr. Ip Shu-tak)	20.07.94	X	
16.	C for T, TD	(Attn: Mr. Tony Wong)	20.06.94[2]		X
	TE(NTW), TD		01.03.94[1]		X
17.	D Arch S	(Attn: Mr. L R Urmonas)	21.06.94[2]		X
		(Attn: Mr. David Tong)	21.02.95[3]	X	
18.	SLA, HyD	(Attn: Mr. C T Ma)	25.07.94[2]	X	
		--	17.02.95[3]	X	
19.	CHE/Str	(Attn: Mr. Chan King-yuen)	16.03.94[1]		X
		--	16.02.95[3]		X
		--	12.04.95[5]		X
20.	CHE/Lighting	(Attn: Mr. Ko Sing-yiu)	01.06.94[2]		X
		(Attn: Mr. K.K. Law)	08.02.95[3]	X	
		--	12.04.95[5]	X	
21.	CHE/(R&D)	(Attn: Mr. K W Chung)	13.05.94[2]	X	
		(Attn: Mr. Norman Li)	15.02.95[3]		X
		--	18.04.95[5]		X
22.	CHE(D&M)/NT	(Attn: Mr. P L Kan)	24.06.94[2]		X
		--	17.02.95[3]	X	
23.	CHE(CW)/NT	(Mr. T S K Lai)	06.06.94[2]		X
24.	D of Housing	(Mr. Kelvyn Hymas)	08.06.94[2]		X
		--	18.02.95[3]		X
		--	25.04.95[5]		X
26.	C of CS	(Mr. Tsang Kwong-chung)	27.07.94[2]	X	
		(Attn: Mr. Yu Kam-fai)	14.02.95[3]		X
		--	12.04.95[5]		X
27.	SE/Planning, HyD	(Attn: Mr. Norman W.P. Mak)	14.02.95[3]	X	
28.	CE/PM, HyD	(Attn: Mr. T.S.K. Lai)	05.05.95[5]	X	

[1] Comments on Issue 1 of the report.
[2] Comments on Issue 2 of the report.
[3] Comments on Issue 3 of the report.
[5] Comments on Issue 5 of the report.

The Consultant's response to comments are tabulated on the following sheets.

Item No.	Department/Letter Ref. (DEP)	Comment	Response
1.	Director of Environmental Protection EP2/N4/35 02.03.1994 DFR Issue 1	Comment to the DFR Working Group Meeting:	
		1. para 2.2.2 "... the ExCo would consider on the merits of each case for indirect technical remedies, based on the criteria suggestion in CRTN of the UK DOT as follows:"	Wording of paragraph 2.2.2 of DFR has been amended.
		2. para 2.3 delete "morning", and specify/clarify which peak hour, at where.	Para 2.3 - wording amended to indicate peak hour and location of field noise monitoring station.
		3. para 2.4.1 It has been discussed in the working group meeting that the footbridge may become an underpass walkway opposite Fiona Garden, due to the complexity of the structure involved. The consultant may have to revise this para.	Due to technical and engineering difficulties in providing effective noise mitigation for receivers at Tai Lam Village, it is not currently proposed that noise barriers be installed opposite Fiona Gardens. Thus the footbridge may be constructed as planned. An underpass will not be required.
		4. para 2.4.2 It has been discussed in the WG that the traffic flow would need to be reviewed. HyD is to push TD for a test run, but would also consider to appoint an independent traffic consultant to assess the potential traffic flow in the year 2011. The consultant may have to revise this para and any subsequent amendments. For DB consultation purposes, noise environment with and without the proposed road scheme should also be presented for comparison. The field measurements obtained should be used to calibrate the prediction model. Please clarify the measurement locations.	A Local Traffic Study has been completed and the noise assessment has been revised to take account of the lower predicted traffic flows. Issue 3 of the DFR presents the revised findings of the consultants based on the traffic predictions from the Local Traffic Study. Field noise measurements are in reasonable agreement with the model predictions. The noise environment for the existing road has been presented in Table 3.3 and that for the proposed road scheme in Table 5.4.
		5. para 2.5 "The STAMINA/.... has <u>been</u> adopted to .... "	Para 2.5 - text has been amended.

Item No.	Department/Letter Ref. (DEP)	Comment	Response
1.	Director of Environmental Protection EP2/N4/35 2.3.1994 DFR Issue 1	6. Table 3.3 Please specify the height of the reference point and/or the floor and flat reference number.	Details of the height of the reference point and the floor of the building have been added to Table 3.3. Flat reference number has not been identified at this stage. A detailed survey of all NSRs will be required for detailed design of direct noise mitigation measures.
		7. para 3.3.2 and Table 3.4 Shown on Figures 6 to 8 inclusive? Please check. Please include data from 1992 prediction in the table. VH2 measured values is off-peak value, while YO and MPQ value have $\pm$4dB differences. Please clarify the situations of measured values and predicted values, in particular, the assessment locations for YO, VH2 and MPQ.	Figure reference has been corrected. Predicted noise levels from the noise assessment model have been included in Table 3.4. Remeasurement of noise levels at VH2 has been carried out. The difference between the measured and predicted noise levels at NSR MPQ has been explained in para. 3.3.2.
		8. para 4.3 Please clarify the traffic flow data with HyD/TD.	Para 4.3 has been revised to take account of the findings of the Local Traffic Study.
		9. Table 5.1 Please separate out piling works for assessment.	Piling is not included in Table 5.1. Bored piling for bridge foundations is included in Table 5.2 while percussive piling associated with sheet piling for bridge foundations is dealt with separately in para. 5.1. of the text.
		10. Table 5.2 Please high-light those NSRs which satisfy all 3 CRTN test conditions and put forward for noise mitigation considerations.	NSRs <u>not</u> satisfying all three CRTN test conditions have been highlighted on all tables concerning operational noise levels.
		11. para 5.2 Estimated noise levels at design year without the proposed scheme should be included.	This would require further work on the Local Traffic Model to produce predicted traffic flows on Castle Peak Road and Tuen Mun Road for the case where Castle Peak Road was not improved. The three CRTN test criteria do not require an estimate of noise levels at the design year without the development to be made.

Item No.	Department/Letter Ref. (DEP)	Comment	Response
1.	Director of Environmental Protection EP2/N4/35 02.03.1994 DFR Issue 1	Table 5.3 Further traffic noise levels at NSRs should be clarified with assessment locations, approx. no. of flats affected by the Castle Peak Road with and without the scheme.	The NSR assessment location has been added to Table 3.3. A field survey has been carried out and approximate numbers of dwellings/sensitive windows affected by Castle Peak Road traffic noise with no direct mitigation measures, and with each of the direct mitigation measures options presented have been identified in the appropriate sections of the revised DFR.
		12. para 6.1.3 Please consider to replace the words 'block' by 'attenuate' and, 'transmission' by 'impact'.	Text of revised DFR has been amended.
		13. para 6.1.4 The consultant should consider and make recommendations on mitigation measures based on the assessment criteria only, advising people to close their windows may politicize the issue.	Noted - text of revised DFR has been amended.
		14. para 6.2.2 Please compare the capital and running cost of pervious macadam surfaces and barriers, semi-enclosures and covers. Traffic management at Castle Peak Road may not be practicable.	Capital and maintenance costs of the various feasible direct technical measures have been compared in Section 7 of the revised DFR. It is agreed that traffic management would not be a practical option for controlling traffic noise along Castle Peak Road, and this option has now been screened out in para 6.2 of the revised DFR.
		15. para 6.2.3 Could the centre barrier be higher? Please comment on the effectiveness at each location.	In order to maintain adequate sight lines, the central median barrier should be no higher than 1.0m.
		16. para 6.2.4 Although the Gold Coast Development has incorporated some noise mitigation measures, it does not eliminate the Government's responsibility to provide necessary mitigation measures as such requirement has not been addressed in the existing lease condition.	Noted - text of para 6.2.4 has been revised to incorporate a statement to this effect.

Item No.	Department/Letter Ref. (DEP)	Comment	Response
1.	Director of Environmental Protection EP2/N4/35 02.03.1994 DFR Issue 1	17. para 6.3.3 There is no noise control provision under S.O.O. Recommended Noise Pollution Control Clauses for construction works are attached herewith for your reference. Please incorporate the appropriate portion in the document.	Para 7.1.3 of the revised DFR has been amended to exclude reference to S.O.O. and to include Recommended Noise Pollution Control Clauses where relevant.
		18. para 6.5.6 Please include top-bent/cantilever type barrier options for comparison.	Cantilever type construction has been considered for the partial enclosure over kerbside lane and added to the list of unit rates in para 6.6.7 of the revised DFR.
		19. Table 6.2 Please include those NSRs, identified in Table 5.3, which satisfied all 3 test conditions only.	NSRs which do not satisfy all three CRTN test conditions have been highlighted on all relevant tables.
		20. Table 9.2 'L30' should read 'L50'? Please clarify.	
		21. HyD commented the proposed arrangement of including the footpath/walkway inside the enclosure/partial enclosure would need further consideration. The consultant should elaborate the acoustic properties and performance of various types of barrier proposed.	While complete enclosures are no longer considered feasible, partial noise enclosures are proposed at some locations. It is agreed that the acoustic properties and performance of various types of barriers must be assessed, to determine the most suitable form of barrier, but it is felt that this is a detailed rather than a conceptual design issue.
		22. para 11.2.2 They have reservation on this 'recommendation' as it simply states the fact and is not one of the recommendation.	The Recommendations section has been completely rewritten in the revised DFR.
		23. para 11.3 They reserve comment on this section as it is unusual to have such paragraph. The consultant should clarify their recommendations.	The Recommendations section has been completely rewritten in the revised DFR.

Item No.	Department/Letter Ref. (DEP)	Comment	Response
1.	Director of Environmental Protection EP2/N4/35 02.03.1994 DFR Issue 1	24. Fig 12 They have no objection to the use of sloping dwarf walls in general. However, due to the limited width (3.5m) from the back of footpath to the noise barrier, the sloping dwarf walls might not be practicable as it will take up quite a lot of space	Noted - the sloping dwarf wall is presented as an option that could be considered where space permits.
		25. Fig 19-22 The arrangement of the GRC panelling and their patterns should avoid creating confusion to the motorists. In general, if the patterns are too detailed or change too frequent, they might not be appreciated by the motorists. Please clarify whether the same patterns will be used on both sides of the barriers. They would suggest at least one colour copy of the Typical Elevation of Pattern should be submitted in future submissions to illustrate the visual effect.	Noted - the original Fig. 19-22 attempted to portray the range of various patterns that could be adopted. The figures have now been revised to present a single coherent pattern. It is proposed that the same colour and pattern would be used on both sides of the barriers, though it is only proposed that the raised strip framework be on the outer face of the barriers.

Item No.	Department/Letter Ref. (SEPO(RA),EPD)	Comment	Response
2.	Senior Environmental Protection Officer, EPD ( ) in EP2/N4/35 II 08.06.1994 DFR Issue 2	EPD understand that government departments still have different views on the traffic data provided by TD, and a local traffic study is currently being undertaken by the Consultants to produce detailed local traffic figures for the use of the captioned NIA report. Moreover, should partial/full enclosures be adopted, an Air Quality Impact Assessment (AQIA) should be carried out to confirm that these noise mitigation measures would be acceptable from air quality point of view. As such, the NIA should not be finalised until local traffic figures are produced and the AQIA be carried out to confirm that there is no adverse air quality impact. EPD would like to reserve their comments on the NIA report until the local traffic flow data be clarified and agreed by the concerned departments.	Local Traffic Study has now been completed and results have been incorporated in the revised DFR. Partial noise enclosures over a single kerbside lane are proposed at some locations, but their extent is significantly reduced compared to the proposals of Issue 2 of the DFR. Full enclosures of one or both carriageways are not proposed.
	Senior Environmental Protection Officer, EPD EP2/N4/35V 19.04.1995 DFR Issue 5	Add "The EM&A requirements will need to be reviewed and revised at regular intervals during the EM&A programme by Highways Department" to Section 9 of the Final Report.	The text has been incorporated into section 9.1 of the Final Report.

Item No.	Department/Letter Ref. (PEPO(NP, EPD)	Comment	Response
3.	PEPO(NP), EPD (Mr. James Wong) DFR Issue 2	Nil return.	Noted.

Item No.	Department/Letter Ref. (PEPO(NP), EPD)	Comment	Response
3.	PEPO(NP), EPD EP2/N4/35 III 09.03.95 DFR Issue 3	1. Throughout the report the consultant has made reference to the three Exco criteria for consideration for insulation. This is incorrect. The ExCo's directive does not contain the three criteria. The criteria adopted by EPD are made reference to the set of three criteria used in the U.K. Noise Insulation Regulation 1975 for determining the eligibility for indirect mitigation measures. We would recommend the consultant refer to the three criteria simply as "eligibility criteria for insulation".	Noted, reference to ExCo criteria will be revised to "eligibility criteria for insulation" in subsequent issues of the report.
		2. Section 2.2.2 - We suggest to amend this para to read as follows: "The impact of operational noise has been assessed with reference to the noise limits in the HKPSG. Provision of direct technical remedies to the affected NSRs will follow the established policy contained in ExCo's directive "Equitable Redress for Persons Exposed to Increased Noise Resulting from the Use of New Roads". For redressing the residual impact after incorporation of all practicable direct technical remedies, ExCo would consider providing indirect technical remedies on the merit of the individual case. For the purpose of determining the insulation eligibility, reference is made to the set of three criteria used in the U.K. Noise Insulation Regulations 1975, with HKPSG level in place of the specified level in the U.K. regulations as follows:"	Noted. First paragraph of Section 2.2.2 has been amended as follows in DFR Issue 5: The impact of operational noise has been assessed with reference to the Hong Kong Planning Standards and Guidelines (HKPSG). In the event that the predicted facade noise levels in 2011 due to the combined effects of Castle Peak Road and Tuen Mun Road exceed the maximum recommended noise levels in the HKPSG, all practical direct technical measures for noise reduction have been examined and proposed, where appropriate, with a view to fulfilling the HKPSG noise criteria and minimizing the noise contribution from the improved Castle Peak Road. In cases where no practical direct technical remedies can be applied, NSRs which may qualify for indirect technical remedies under the established policy contained in the Exco's directive "Equitable Redress for Persons Exposed to Increase Noise Resulting from the Use of New Roads" have been identified. For the purpose of determining the eligibility for consideration for indirect technical remedies, reference has been made to the three criteria used in the UK Noise Insulation Regulation 1975, with the HKPSG level in place of the specified level in the UK regulations. Those criteria are as follows:

Item No.	Department/Letter Ref. (PEPO(NP), EPD)	Comment	Response
3.	PEPO(NP), EPD EP2/N4/35 III 09.03.95 DFR Issue 3	3. Section 3.4.6, 2nd para - The consultant should justify the last sentence with noise calculations. Based on our own preliminary assessment, the proposed noise barrier of this development will not be effective to screen noise from Castle Peak Road (CPR) because of the difference in the PD levels between CPR and Tuen Mun Roads. As discussed in the Working Group Meeting, the consultant should compare the traffic flows between CTS-II 2011 and the findings in the Local Traffic Study for this project.	Section 3.4.6 has been expanded to address the issue of the impact of noise from the improved CPR on the planned residential development at So Kwun Wat in more detail.
		4. Sections 5, 6 & 7.1 - The construction noise impact on some the NSRs is quite alarming, eg. up to 99dB(A) at YO. The consultant is required to proposed more specific noise mitigation measures for the identified construction work and particular locations (in addition to those identified in Section 6) to reduce the noise impact at those severely affected NSRs. The consultant should also indicate the resulting noise levels at the NSRs after incorporating all the recommended mitigation and control measures.	It is not desirable to dictate construction programming or methods of construction to the contractor, and as such, any assessment of noise mitigation measures to mitigate construction noise can be hypothetical only. At this stage of the project it is more appropriate to clearly define the upper limits of construction noise that will be acceptable, and the methods and frequency of monitoring to ensure compliance with these limits. Nevertheless, a sample calculation has been done for receiver YO to demonstrate that it is feasible to meet the 75dB(A) criterion for noise from construction works other than percussive piling. This calculation will be included in appendix in subsequent issues of the report.
		5. Tables 5.4, 7.1, 7.2 & 7.3 - Noise levels predicted for Tuen Mun Road appear to have been over-estimated. Our calculations at two sample points (at CSQ1 & MPQ) are approx. 2dB lower than the consultant's figures. We suspect the consultant have not taken into account open-textured surface for Tuen Mun Road.	Open textured surfacing on Tuen Mun Road has not been taken into account in noise calculations to date. Noise calculations will be updated to take this into account in subsequent issues of the report.

Item No.	Department/Letter Ref. (PEPO(NP), EPD)	Comment	Response
3.	PEPO(NP), EPD EP2/N4/35 III 09.03.95 DFR Issue 3	6. Section 6.2.3(vi) - The consultant should clarify/explain why vertical barriers in excess of 5m high are clearly not practical.	Vertical barriers in excess of 5m are not practical because the large wind overturning moment on the structure would require heavy foundations and structure to remain stable. In addition, the higher the barrier the more obtrusive it will be and the greater the negative visual impact.
		7. Section 6.2.4, 4th para - Improvement works on CPR should not impose unnecessary constraints on future developments. The consultant should calculate the anticipated noise impacts on these future developments and propose practical mitigation measures to overcome the problem, if any.	Section 7.6 of subsequent issues of the report will be expanded to examine the effect of CPR traffic noise on future development sites in more detail.
		8. Section 6.2.4, 5th para - The last sentence is incorrect. The provision of window insulation and air conditioning at NSRs would only treat the remedial problem by creating a quieter <u>indoor</u> environment. It does not mean that the affected receiver will meet the HKPSG criteria which specify the <u>outdoor</u> noise levels.	Text of section 6.2.4 will be amended in subsequent issues of the report.
		9. Section 6.3.6 - Only those reasons which will definitely prohibit the implementation of any mitigation measures should be included in the report. Reasons such as water supply, radio communications, vehicle rescue etc. which may or may not prohibit the use of full enclosures are not so convincing as they have been overcome in other road enclosures built in Hong Kong and elsewhere.	In order to assess the feasibility of particular mitigation measures, it is necessary to examine all the advantages and disadvantages of implementing that particular measure before reaching a conclusion. To overlook particular problems associated with a measure under consideration on the basis that the particular problems have been overcome elsewhere will give an unbalanced picture of the situation. No one reason on its own is sufficient to eliminate full enclosures from consideration, but the combination of so many disadvantages together if implemented along this section of CPR is sufficient to regard them as being infeasible.

Item No.	Department/Letter Ref. (PEPO(NP), EPD)	Comment	Response
3.	PEPO(NP), EPD EP2/N4/35 III 09.03.95 DFR Issue 3	10. Section 6.5.5 - As discussed during the Working Group Meeting on 8/3/95, the consultant should re-arrange this section so that general constraints/ disadvantages of full enclosures would be described first. Then specific reasons for not providing full enclosures at each location/road section would be described in detail.	Section 6.5.5 will be rearranged in subsequent issues of the report to highlight more clearly the specific disadvantages of full enclosures at each road section.
		11. The consultant should avoid, as far as possible, the use of wordings which are vague, such as "unlikely" & "probably" in the argument against full enclosures.	Noted.
		12. Section 7.2.1, 2nd para - The third sentence is not strictly correct. The extent of the noise mitigation measures should be designed to aim to meet HKPSG requirements.	Noted, wording will be revised.
		3rd para - The last sentence should be amended to read" .... maximise the protection from traffic noise from Castle Peak Road for the existing and planned NSRs."	Noted, wording will be incorporated.
		13. Section 7.2.2 i) - The assessment on mitigation measures for CSQ1 & CSQ4 is vague and confusing. If partial enclosure in Option 2 can eliminate insulation for CSQ1 & CSQ4, such partial enclosure could be added to Option 1.	Noted, wording will be revised to clarify this section.
		If suitable barrier design locally at the junction can eliminate insulation for CSQ4, why does CSQ4 qualify for consideration for insulation in Table 7.1?	Barrier design locally at junctions is not carried out as part of this study, but rather at the detailed design stage. CSQ4 only just satisfies the three criteria for insulation. A little more protection from the barrier configuration at the junction would probably be sufficient to reduce the contribution of traffic noise from CPR to below 1.0dB(A), thus CSQ4 would not qualify for insulation. However, until such time as the detailed design calculations are carried out, it must be assumed that CSQ4 qualifies for insulation as indicated on Table 7.1.

Item No.	Department/Letter Ref. (PEPO(NP), EPD)	Comment	Response
3.	PEPO(NP), EPD EP2/N4/35 III 09.03.95 DFR Issue 3	13. iii) - A more detailed noise modelling on PC is required to determine the effectiveness of the proposed partial enclosure and to calculate the resultant noise levels at the NSR so as to determine the no. of dwellings meeting the criteria for insulation.	More detailed modelling of receiver PC should be carried out at detailed design stage of the noise mitigation measures. The objective of this study is to look at and compare alternative schemes for noise mitigation, and to recommend the most appropriate, but not to carry out detailed design of that scheme. The level of modelling carried out on PC is considered adequate for the purposes of this study.
		iv) - The consultant should fully justify why full enclosures, partial enclosures, barriers or friction course are not provided for the straight section of the CPR at the So Kwun Tan end. If 50% of the dwellings at Gold Coast can be protected with barriers and partial enclosures, serious considerations should be made to examine the feasibility of incorporating these mitigation measures.	Full enclosures have been eliminated from further consideration in Section 6 of the report. Barriers and partial enclosures to protect the Gold Coast NSR's have been examined along the westbound carriageway at So Kwun Tan, but have not been found to be effective (ie they can only protect less than 50% of the Gold Coast dwellings).
		14. Table 7.1 - VH8 is missing.	NSR VH8 will be added to Table 7.1 in subsequent issues of the report.
		15. Section 7.2.3 (Option 2) & Section 7.4 (Option 3) - As discussed in the Working Group Meeting, if the 5m high barrier (A6) as identified in Option 1 is effective in reducing noise from CPR, it should be added to Options 2 & 3.	The 5m barrier (A6) of Option 1 is effective because it is combined with friction course surfacing. It is not effective for Options 2 or 3 because friction course is not used for these options. However it will be examined again, taking into account the existing friction course surfacing on T.M.R.
		16. Section 7.2.3 iii) - A more detailed calculation is needed to assess the effectiveness of the partial enclosures of Option 2. The phrase "it is felt that" should be avoided.	Agreed. This more detailed assessment should be carried out during the detailed design of the barriers. The assessment carried out in this study is sufficient to indicate that the partial enclosure is effective at this location. Detailed design will determine exactly which dwellings will be satisfactorily protected and which should be considered for provision of insulation.
		17. Section 7.4, 3rd para - Insulation at NSRs would not reduce the noise levels to below the HKPSG criterion which is an exterior noise level.	Noted, text will be suitably reworded in subsequent issues of the report.

Item No.	Department/Letter Ref. (PEPO(NP), EPD)	Comment	Response
3.	PEPO(NP), EPD EP2/N4/35 III 09.03.95 DFR Issue 3	18. Section 7.6 - According to the Study Brief, the consultant should address in detail the potential noise impact of the improvement works on the planned community and the neighbouring land uses. An indication of the noise levels that would be experienced by these planned NSRs should be included in the report. The consultant should also propose constraints, if any, on these planned land uses in order to meet with HKPSG requirements because of the improvement works.	Noted, Section 7.6 will be expanded to provide more detail on the potential noise impact on the planned community and neighbouring land uses.
		19. VH1 is not a good representative point to assess the future noise exposure of the approved comprehensive residential development which will be high-rise in nature.	Noted.
		20. Section 11.2.3 - Following the discussion in the Working Group Meeting, this section would need to be re-written.	Noted.
		21. Figures 9-17 - We would suggest the names of the NSRs should be shown as well for easy reference. No. of dwellings meeting the eligibility criteria for insulation for each NSR should also be shown (either on these figures or on separate sheets).	It is felt that adding the full names of the NSRs to Figures 9-17 would only serve to make the figures appear crowded. Identification of NSRs by use of the NSR I.D. initials that are adopted throughout this report is considered adequate. The numbers of dwellings meeting the eligibility criteria for insulation for each NSR will be included in a new appendix in subsequent issues of the report.

Item No.	Department/Letter Ref. (PEPO(NP), EPD)	Comment	Response
3.	PEPO(NP), EPD EP2/N4/35 III 20.04.1995 DFR Issue 5	1. Throughout he DFR, there are occasions where the consultant still refers to the "eligibility criteria for insulation" as the "ExCo criteria" despite our previous comment. Further amendment is therefore required.	Noted, while all references to "ExCo criteria" have been amended in the text, those on the Figures have been overlooked. The Figures will now be amended.
		2. Although the consultant has addressed our concerns on construction noise and provided an estimate of the resultant noise levels at the NSRs with recommended noise mitigation measures, we are concerned that some of the equipment sound power level (SWL) used, as adopted from BS5228 are significantly below the values for the same type of equipment in the Technical Memorandum on Noise from Construction Work Other Than Percussive Piling. The consultant should justify using the SWL values in BS5228 and ensure that the SWLs of equipment used in the actual construction will not exceed the quote SWLs.	Recent noise measurements of commonly used construction equipment in Hong Kong indicate that the SWL values of modern construction plant are much closer to the values in BS5228 rather than those in the Technical Memorandum on Noise from Construction Work other than Percussive Piling. It does not matter if the SWL of particular items of plant used by the contractor exceed the quoted SWL's in BS5228 as long as the facade noise levels at affected NSRs are within the construction noise criterion. It is up to the contractor how he meets the noise control criteria.
		3. Section 6.2.4, 4th para - The last sentence is still incorrect despite our previous comment. The HKPSG criterion refers to the outdoor noise level and not the indoor environment.	It is stated in the same paragraph that the outdoor noise environment would receive no benefit from the provision of insulation at the receiver. Reference to the 70dB(A) HKPSG criterion will be removed from the paragraph.
		4. Section 7.2.1, 3th para - It is better to reword the last part of the sentence to read" ... to maximize the protection of the NSRs from traffic noise due to Castle Peak Road using all practical direct technical remedies and to redress the residual impact with indirect technical remedies".	Agreed.
		5. Section 7.2.1, 4th para - The interactive approach used to optimise the mitigation measures should be aimed at meeting the HKPSG requirements as far as practicable.	Noted, paragraph will be reworded accordingly.
		6. Table 7.1 - Despite our previous comment, VH8 is still missing.	Noted, VH8 will be included on Table 7.1 in the Final Report.

Item No.	Department/Letter Ref. (PEPO(NP), EPD)	Comment	Response
3.	PEPO(NP), EPD EP2/N4/35 III 20.04.1995 DFR Issue 5	7. Section 7.2.2(v) - The consultant has not answered our concerns raised in our previous comment (fax dd 9/3/95 item 12). Surely the friction course recommended for the other sections covers bus stops and junctions. Thus why is it not feasible to use friction course for the straight section outside Gold Coast after the sharp curve. If noise barriers and partial enclosures are practical and effective in reducing traffic noise level and approx. 50% of apartments at Gold Coast would be protected, why are these direct measures not included in any of the options?	Friction course surfacing is unsuitable for use on CPR at the Gold Coast because of the number of junctions and bus bays in a short stretch of road. Friction course is not really a practical solution for CPR. This will be stated more clearly in the Final Report. Noise barriers and partial enclosures are able to protect less than 50% of the dwellings at the Gold Coast. They are not effective in protecting these NSR's 7.2.2 (v) will be reworded to remove any ambiguity on this matter.
		8. Section 7.2.2 (ii) & Figure 11 - If the 5m high barrier together with friction course can protect the CSD Staff Quarters apart from CSQ1, then CSQ2 should not be highlighted for equitable redress on Figure 11.	CSQ2 marginally qualifies for equitable redress (Table 7.1) and is therefore highlighted as such on Figure 11. 7.2.2(ii) states that during detailed design of the barrier at the junction in front of CSQ2, it could be possible to reduce the contribution of CPR traffic noise at the NSR so that it no longer qualifies for equitable redress. 7.2.2(ii) will be reworded to remove any ambiguity.
		9. Section 7.4 - The 4th para is quite incorrect. One cannot say that Option 3 has real benefit for residents in the eastern section. The overall exterior facade noise levels at these NSRs will be well above the HKPSG criterion. Direct technical measures should only be dropped because they would not be effective in reducing the overall noise levels at these NSRs. Indirect technical remedies would then be considered as a compensation. As mentioned before, the 70dB(A) criterion does not refer to the indoor noise level. The second sentence is therefore irrelevant.	It is agreed that in selecting Option 3 over Options 1 and 2, the implementation of direct technical remedies is dropped because they are not effective in reducing overall noise levels at the NSRs. It is also agreed that provision of residual acoustic insulation at dwellings will not improve outside noise levels. However, as insulation can significantly reduce indoor noise levels, there is a benefit for those living at these dwellings. If there were no benefit, then there would be little point in providing insulation at all. As far as the residents of the affected NSRs are concerned, the provision of insulation will reduce the impact of traffic noise when they are inside their dwellings, while implementation of Options 1 or 2 would result in very little reduction in traffic noise either inside or outside the dwellings.

Item No.	Department/Letter Ref. (PEPO(NP), EPD)	Comment	Response
3.	PEPO(NP), EPD EP2/N4/35 III 20.04.1995 DFR Issue 5	10. Section 7.4 5th para The first sentence of the last para is not right. One cannot say that Option 3 has advantages over the other two options in terms of noise protection because the overall exterior facade noise levels at the NSRs would be higher if direct measures are dropped in the eastern section. The second sentence is also incorrect, guideline for determining the direct noise mitigation measures is NOT to minimize the number of NSRs requiring insulation. The guideline for designing any direct noise mitigation measures is to aim at meeting the HKPSG criteria as far as practicable.	Noted. See our response to item 9. Section 7.4 of the report will be redrafted to better accommodate both points of view.
		10. Section 11.21. - only recommendations in-line with established government policy should be made and the established policy is to implement all practicable direct noise mitigation measures so as to meet with the HKPSG requirement as far as practicable.	Agreed.
		11. To be in-line with the established guideline for determining the direct technical remedies, the consultants are required to provide the following figures to quantify noise impact due to the improvement works and the success rate of the proposed noise mitigation measures: (i) No. of dwellings exceeding the HKPSG criterion with improvement to Castle Peak Road but without noise mitigation measures. (ii) No. of dwellings exceeding the HKPSG criterion with improvement to Castle Peak Road and with the recommended noise mitigation measures.	Agreed, additional information will be included at Section 7.4 of the Final Report.
		12. Appendix 2 - Comments and Responses on subsequent issues of the DFR should also be included here.	Agreed, Appendix 2 of the Final Report will be expanded.

Item No.	Department/Letter Ref. (PEPO(NP), EPD)	Comment	Response
3.	PEPO(NP), EPD EP2/N4/35 III 20.04.1995 DFR Issue 5	13. Appendix 4 - Measure E, what is ref: EA/95013? There is a typo error in the last sentence of the last para.	ref: EA/95013 should read "Based on a recent noise measurement by the Consultant". Noted.

Item No.	Department/Letter Ref. (CE/MN, DSD)	Comment	Response
4.	Chief Engineer/ Mainland North, DSD ( ) in MN 14/3/M 24.05.1994 DFR Issue 2	No comments	Noted.

Item No.	Department/Letter Ref. (DEMS)	Comment	Response
5.	Electrical & Mechanical Services Dept. (9) in K87/053 13.05.1994 DFR Issue 2	No comments.	Noted.
	Electrical & Mechanical Services Dept. (14) in K87/053 06.02.1995 DFR Issue 3	The attention of the responsible consultants and/or contractors is drawn to the existing traffic light signals and aids equipment on street adjacent to the site, particularly multi-core communication cables and signal aspect cables. Care must be taken to ensure that this equipment is properly protected from damage during the works.	Noted.
	Electrical & Mechanical Services Dept. (29) in K87/053 12.04.1995 DFR Issue 5	No comment.	

Item No.	Department/Letter Ref. (D of FS)	Comment	Response
6.	Director of Fire Services (30) in FSD 10/7596/93 16.6.94 DFR Issue 2	FSD have the following comments: 6.3.2 Details of the provision of forced ventilation, fire services and other emergency services should be submitted to FSD for comment. 6.3.5 replace "2m or more in height or" in line 1 by a comma. 6.3.5 add the following after "... be impaired." in line 6: "Details of these impacts could only be assessed when detailed drawings are available." Please note that the general comment in their previous letter Ref. (19) in this series is still valid.	Full noise enclosures are no longer being considered for noise mitigation purposes. Therefore, there will be no requirement for forced ventilation on the project. Details of provision for fire and other emergency services will be forthcoming during detailed design of the proposed barriers and partial enclosures. Para 6.3.6 of revised DFR - text amended. Para 6.3.6 of revised DFR - text amended.
	Director of Fire Services (6) in FSD 10/7596/93 II 07.02.95 DFR Issue 3	No comment.	Noted.
	Director of Fire Services (7) in FSD 10/7596/93 III 19.04.95 DFR Issue 5	No comment.	Noted.

Item No.	Department/Letter Ref. (DLO/TM)	Comment	Response
7.	District Lands Officer, Tuen Mun (17) in L/M No. to DLOTM 230/3/249 I 16.05.1994 DFR Issue 2	No comments. However please note that if the proposed mitigation measures require resumption of private lots, such land requirement should be included in the Road Scheme to be gazetted.	Noted - land resumption requirements have been addressed in Section 7 of the revised DFR.
	District Lands Officer, Tuen Mun (5) in L/M to DLOTM 230/3/249 III 14.02.1995 DFR Issue 3	No comment.	Noted.
	District Lands Officer, Tuen Mun (12) in L/M to DLOTM 230/3/249 III 22.02.1995 DFR Issue 3	The additional land requirements identified in Figure 26 will involve a change of resumption limit of the project and the draft resumption plan in respect of private land affected will have to be revised. A longer period will be required for processing before the gazetting of the Scheme and Plan for the project can proceed.	Noted.

Item No.	Department/Letter Ref. (DO/TM)	Comment	Response
8.	District Officer (Tuen Mun) 20.05.1994 DFR Issue 2	No comment.	Noted.
	(32) in TM 131/6/99 II 13.02.1995 DFR Issue 3	An "Executive Summary" document should be produced.	Noted. An "Executive Summary" will be issued with the Final Report.
	(12) in TM 131/6/99 III 20.04.1995	No comment.	Noted.

Item No.	Department/Letter Ref. (CGE/Advisory)	Comment	Response
9.	Chief Geotechnical Engineer/Advisory, GEO, CED GCA 2/C2/95 17.06.1994 DFR Issue 2	(1) Caisson wall will not be used to support the proposed cut slope ajdacent to the Correctional Department Staff Quarters at Siu Lam, soil nails will be used instead. As a matter of fact, the whole road improvement project will not involve any caisson wall construction. Therefore, the following sections of the Report concerning caisson wall should be revised accordingly: (a) para. 3 in Section 2.4.1 on page 4; (b) the last para. in Section 4.4 on page 20; (c) Table 5.2 on page 25; and (d) the second para. on page 26.	Noted - the relevant sections of the revised DFR have been amended.
		(2) If noise barriers and enclosures are used, the foundations for these structures should be designed and constructed in such a way that the slopes above and below Castle Peak Road will not be adversely affected.	Noted - will need to be considered during detailed design of barriers.
	Chief Geotechnical Engineer/Advisory GEO, CED CGA 2/C2/95 16.02.95 DFR Issue 3	No comment.	Noted.
	Chief Geotechnical Engineer/Advisory GEO, CED CGA 2/C2/95 13.04.95 DFR Issue 5	No comment.	Noted.

Item No.	Department/Letter Ref. (D of A&F)	Comment	Response
10.	Director of Agriculture & Fisheries (33) in TF/NT-121/92 08.02.1995 DFR Issue 3	No comment.	Noted.
	Director of Agriculture & Fisheries 28.05.1994 DFR Issue 2	No comment on the Noise Impact Assessment.	Noted.

Item No.	Department/Letter Ref. (DPO/TM & YL)	Comment	Response
11.	District Planning Officer/TM & YL, Planning Dept. ( ) in PDTM 4/5/9 04.07.1994 DFR Issue 2	DPO/TM have the following comments: Para 3.4.2 Tuen Mun Outline Zoing Plan	
		(a) Amendments to Tuen Mun Outline Zoning Plan S/TM/7 have been gazetted on 21./4.94. Pertaining to the study area, the major changes are the designation of three Comprehensive Development Areas (CDA) in planning areas 55 and 59. Please refer to the notes accompanying the draft OZP (S/TM/8) for details.	The amendments to the TMOZP have been reviewed. Para 3.4.2 has been rewritten in the light of these amendments.
		Para 3.4.6	
		(b) The Town Planning Board (TPB) gave consideration to an application for comprehensive residential development in Siu Lam area fronting Tuen Mun Highway under Section 16 of the Town Planning Ordinance at its meeting on 15.10.93. This S16 application in So Kwun Wat Development Permission Area was approved with conditions by TPB with a total estimated population of about 4,870 persons. It should be taken into account of in the noise assessment of the road widening project.	The approved application for comprehensive residential development at So Kwun Wat Development Permission Area has now been taken into account in the noise assessment study.
		DPO/TM are given to understand that a local traffic study will look into the traffic forecast in the study area with a view to updating/reviewing the traffic flow estimates. To this end, their office is requested by the study Consultants to provide population and employment forecasts for the transport modelling. The above mentioned changes in statutory plans and committed S16 development will be reflected in the information conveyed to the Consultants. Presumably, the changes in planned uses will also be reflected in the selection of representative noise sensitive receivers (NSR) within the study area.	The above updated information has been taken into account during the Local Traffic Study, and the predicted traffic flows from the Study allow for the traffic that will be generated by the proposed developments. In addition, the impact of the proposed road improvement on CDA sites and approved development site at So Kwun Wat has been addressed in 7.6 of this report.

Item No.	Department/Letter Ref. (DPO/TM & YL)	Comment	Response
11.	District Planning Officer/TM & YL, Planning Dept. ( ) in PDTM 4/5/9 Pt. 4 14.02.1995 DFR Issue 3	1. Para 3.4.2 (f) Draft Tuen Mun Outline Zoning Plan No. S/TM/8 has replaced draft Tuen Mun Outline Zoning Plan No. S/TM/7 as the statutory plan of the area. It would be more appropriate to incorporate the second paragraph into the first paragraph. It is suggested that this paragraph should read as follows: (f) Tuen Mun Outline Zoning Plan (OZP : S/TM/8) The planning of the area is controlled by the OZP which is a statutory plan and has legal effect. The area to the south of Castle Peak Road between Siu Lam and So Kwun Tan is covered by the Tuen Mun OZP. The land use proposals contained within the OZP broadly accord with those of the SPS. Land to the south of Castle Peak Road is generally allocated to existing and possible future residential development. Residential development comprises residential type R(B), Comprehensive Development Areas and village type development. Also abutting the road is a large open space reserve. No specific noise mitigation measures for residential land use are included within the Written Statement accompanying the OZP.	Agreed. Wording of para 3.4.2(f) of Final Report has been amended as recommended.
		2. Figure 2 should be amended to reflect the latest zoning on the Tuen Mun Outline Zoning Plan No. S/TM/8.	Noted. Figure 2 of the Final Report has been updated.
	District Planning Office/TM&YL, Planning Dept. PDT 4/5/9 V 13.04.1995 DFR Issue 5	No comment.	Noted.

Item No.	Department/Letter Ref. (RSD)	Comment	Response
12.	Director of Regional Services (41) in RSD 1/HQ 752/81(8) V 06.06.1994 DFR Issue 2	No specific comment.	Noted.
	Director of Regional Services (83) in RSD 1/HQ 762/81(8) V 20.02.1995 DFR Issue 3	No comment.	Noted.
	Director of Regional Services (9) in RSD 1/HQ 752/81(8) VI 11.04.1995 DFR Issue 5	No comment.	Noted.

Item No.	Department/Letter Ref. (C of P (CSO Traffic))	Comment	Response
13.	Commissioner of Police (CSO Traffic) (48) in CP/T 216/141 Pt 18 16.03.1994 DFR Issue 1	CSO Traffic is concerned that the proposed noise barriers would probably cause obstruction to recovery vehicles specially heavy mobile crane, in case a container truck turns on its side on the particular section.	Noise enclosures are no longer being proposed as a feasible noise mitigation measure. Partial noise enclosures over a single lane are still being proposed. An alternative cantilever option for the partial noise enclosure is put forward in the revised DFR (Figure 2.1). It should be possible to operate recovery vehicles in most instances with this barrier construction, though it is conceivable that on occasion it may be necessary to remove panels from the cantilevered structure to lift overturned vehicles. This will have to be addressed during detailed design of the barriers/partial enclosures.
	Commissioner of Police (CSO Traffic) (19) in CP/T/TMB 216/141 XXIII 19.04.1995 DFR Issue 5	No comment.	Noted.

Item No.	Department/Letter Ref. (DO(NTW))	Comment	Response
14.	Project Manager (NT West) 17.05.1994 DFR Issue 2	HyD memo ref. HNT 54/144(51) II dated 10.5.94 is referred. They have no comment on the draft final report on the Noise Impact Assessment.	Noted.
	Project Manager (NT West) NTW 2/TH/541 08.02.1995 DFR Issue 3	No comment.	Noted.

Item No.	Department/Letter Ref. (CE/MNW, WSD)	Comment	Response
15.	Chief Engineer/MNW, WSD WWO/M1217/1744/92 II 20.07.1994 DFR Issue 2	They have no comment onto the draft final report from their water supply point of view.	Noted.

Item No.	Department/Letter Ref. (TD)	Comment	Response
16.	Traffic Engineering (NTW) Div., Transport Dept. ( ) in NR L/M 146/194-C6 01.03.1994 DFR Issue 1	CTD refer to the letter from the Consultant under Ref. 7146/ME-1/088 dated 7.2.94 and the discussion in the Steering Group meeting held on 9.2.94. They have the following comment on the captioned draft Final Report from the district traffic engineering point of view: A. <u>General</u> a. It is noted that the maintenance requirements of the 'noise' structure and its implications are not addressed in the Report. b. Please clarify the design provision, etc. in safeguarding the integrity of the 'noise' structures and associated panels, etc. in the event of an accident when the structure is hit by a fully loaded container vehicles. B. <u>Sec. 6.2.2</u> They do not support the proposal to use traffic management measures to control the traffic noise.	Maintenance requirements have been addressed in Sections 6 and 7 of the revised DFR. It is intended that the 'noise' structures be constructed at the back of the footpaths. A standard concrete profile barrier will be erected at the carriageway kerb to protect pedestrians. This barrier would also protect the noise structures from direct impact by fully loaded container vehicles. Nevertheless, the Consultants recommend that the main structural elements of the noise structures be designed to resist impact from such vehicles without failing. Panel design should be such that panels above and to the sides of any panel that fails under impact do not rely on the failed panel for their stability. The Consultants agree that traffic management measures are not a viable option for Castle Peak Road. This option has been screened out in para 6.2 of the revised DFR.

Item No.	Department/Letter Ref. (TD)	Comment	Response
16.	Traffic Engineering (NTW) Div., Transport Dept. ( ) in NR L/M 146/194-C6 01.03.1994 DFR Issue 1	C. Sec. 6 & Figure No. 22 a. They have reservation about the stanchions proposed to be located in the central divider as it would have adverse visibility implications particularly at road bends, at road junctions, at pedestrian crossings, etc.	An alternative cantilever form of partial enclosure is included in the revised DFR. If adopted at detailed design, this form of construction would not require stanchions be located in the central divider.
		b. The proposed headroom of 5.5m is not considered adequate. As discussed, please consult CP(CSO/T) on his requirement in this regard.	Minimum headroom has been increased to 6m in the revised DFR.
		D. Sec. 8 & Figure Nos. 23-26 a. The layout of the barriers requires review as it did not appear to have adequately allowed for visibility requirement at road junctions, run-in/out, pedestrian crossings, etc.	The barrier set-back distances have been reviewed to ensure that visibility requirements at junctions and run-ins are maintained, and to identify the need for any further land resumption that might be required. Figures 26 of the revised DFR.
		b. The footpath with a width of 3.5m is required to be maintained. However, they would have no objection to compress the central divider slightly.	Footpath width of 3.5m would be maintained. Figure 18 of the revised DFR has been amended accordingly.

Item No.	Department/Letter Ref. (TD)	Comment	Response
16.	Urban (Kln) & NT Regional Offices, TD ( ) in NR 146/194-C6 20.06.1994 DFR Issue 2	They refer to the DFR atttached to D. of HyD's memo HNT 54/144(51) II dated 10.5.94. They have no comments.	Noted.

Item No.	Department/Letter Ref. (D Arch S)	Comment	Response
17.	Senior Architect/CMB, ASD ASD 10/92051/TEC/ HyD/1 III 21.06.94 DFR Issue 2	D Arch S have one comment in relation to the design of noise barriers. The report acknowledges the adverse conditions to pedestrians in the partial or full enclosure situations where the barrier is positioned at the back of the adjoining footpath. (para 8.3.9 refers). Where sight line conditions allow, every effort should be made at the detailed design stage to extricate the pedestrians from the traffic tunnel by having the barriers located at back of kerb. D Arch S cannot therefore, accept the last sentence of para 8.4.1.b per se without justification, as an imaginative design approach could overcome the problems mentioned therein.	It is acknowledged that it is undesirable for a number of reasons to have pedestrian footpaths within partial or full enclosures. The revised DFR purposes that limited partial enclosures and no total enclosures be installed at the site. Partial enclosures are not proposed for both sides of the carriageway at any location. There are other issues as well as driver sight lines which would support locating partial enclosures at the back of the footpath including increased safety fears for drivers, the high density of drainage and utility services in the footpath, barrier foundation size, ease and safety of maintenance work on the barriers. Nevertheless, where sightlines permit, further consideration could be given to locating the barriers at the kerbside during detailed design. Sections 6.2.3 viii) and 7.8 of Issue 3 of the DFR discuss barrier location and driver forward visibility in more detail.

Item No.	Department/Letter Ref. (D Arch S)	Comment	Response
17.	Senior Architect/CMB, ASD ASD 10/92051/TEC/ HyD/1 (VII) 21.02.1995 DFR Issue 3	1. The positioning of the barriers may need further examination. According to para 6.2.3 (viii), partial enclosures may be constructed on either side of the footpath depending on whether visibility at that particular location is affected or not. This is considered inappropriate from an urban design point of view.	The road is classified as a district distributor road and is in a rural area. The improved road will have a posted speed limit of 70 kph. It will be necessary to provide minimum sightline clearance at junctions and run-ins. The predominately sinuous alignment must also be taken into account. To maintain continuity of appearance and design, and to minimise the impact on the existing built form, barriers would only be sited along the kerb line where they could be erected so, in substantial, uninterrupted sections. There are few locations along the improved Castle Peak Road where this can be achieved.
		2. The design of the barriers may need to be reviewed. The following enhancements are suggested:-	Noted. Design of barrier panels would be reviewed within the detailed design of site specific barriers:
		(i) provide at intervals full height clear acrylic panels to break the scale of the GRC wall.	(i) agreed, full height clear panels will be incorporated into the illustrations in the Final Report.
		(ii) provide planters at the base of the GRC wall.	(ii) planting along the road is to be provided as part of the road widening works contract. This will be located beyond the extent of the footpath, and, therefore, outside the barriers. It is intended that climbing plants should be incorporated into the planting scheme to grow up the panels and provide additional visual softening. Incorporation of raised planter beds within the line of the barrier is not considered appropriate because: - it would increase the area of land take, within what is already a narrow corridor,

Item No.	Department/Letter Ref. (D Arch S)	Comment	Response
17.	Senior Architect/CMB, ASD ASD 10/92051/TEC/ HyD/1 (VII) 21.02.1995 DFR Issue 3		- it would require a much larger and longer term maintenance commitment to be successful due to harsh environment for plants immediately at kerb side, and would require a separate irrigation system, - planting would not act as a screen to views from neighbouring land uses, - the extent of any planting within the area of the proposed footpath would be subject to the same sight line restrictions as the barriers themselves, and opportunities for inclusion are limited.
		(iii) review supporting details of the acrylic panels to increase transparency.	(iii) the size and configuration of the supporting frame would be calculated within the detail design of the barriers. As a guiding principal, member sizes would be kept to a safe minimum to reduce their visual appearance and to limit cost.

Item No.	Department/Letter Ref. (SLA, HyD)	Comment	Response
18.	Senior Landscape Architect, HyD HYDT 12/6/38 25.07.1994 DFR Issue 2	They have the following comments: 1. Low barriers, say less than 1.3m, should be used as far as possible. If the use of a tall barrier or a total enclosure is unavoidable, then the structure should be located between the footpath and the carriageway. The structure may have to set back from the kerb at the inner bands, but that should be accommodated by local widening and reduction of the footpath width. If people are being forced to use a footpath enclosed within the noise barrier, they shall avoid using it, and the 3.5m wide footpath would be necessary.	Low barriers are not sufficiently effective as noise barriers along the route. Extensive high barriers and partial enclosures are required. There are a number of disadvantages to siting high barriers both between the carriageway and the footpath and at the rear of the footpath. This issue was discussed in 5th Working Group Meeting, when it was decided that, on balance, it would be preferable to locate barriers at the back of the footpath. Due to the road alignment, and the required foundation size for high barriers, the barriers would need to be set back from the edge of the carriageway along much of their length. It was thought that it would be intimidating for pedestrians to walk along the back of a high vertical barrier, as it would tower over them, though it was recognised that it would be even more unattractive to walk between the barriers and the carriageway. Comments on the location of the barriers have also been received from ASD (supporting kerbside barriers) and Chief Highway Engineer (DM)/NT (supporting barriers at back of footpath). It is evident that the location of the barriers, along sections of the road where sight lines would permit a kerbside location, should be further reviewed at detailed design.
		2. The total enclosure should be given a more aesthetically pleasing appearance.	Total enclosures are not recommended at any location by the revised DFR.
	Senior Landscape Architect, HyD HYDT 12/6/38 17.02.1995 DFR Issue 3	No comment.	Noted.

Item No.	Department/Letter Ref. (CHE/Str)	Comment	Response
19.	Chief Highway Engineer/Structures, HyD (37) in STR 5/30/250 16.03.1994 DFR Issue 1	1. <u>Proposed noise barrier on existing bridge</u> The existing bridge west of Kar Wo Lei village might not be able to support the proposed 2m high noise barrier. You may appreciate that the provision of the additional noise barrier at this bridge would introduce substantial loadings on the bridge and may not be structurally feasible, as no reserve capacity has been allowed for erection of noise barrier in the original design. The consultants should work out an optimal height of the proposed noise barrier, taking account of the practicality of attaching this barrier to the bridge and the fact that the NSR to be protected are lying below the deck level of the bridge.	The revised DFR, incorporating traffic figures from the Local Traffic Study, has found that noise barriers are no longer required on the existing bridge west of Kar Wo Lei village.
		2. <u>Proposed noise enclosure</u>	
		(a) The issue of ventilation should be addressed in the DFR.	Ventilation has been addressed in Section 6 of the revised DFR. However total enclosures are not proposed at any location along the improved Castle Peak Road.
		(b) Adequate emergency access should be provided along the kerb allowing maintenance personnel and rescuers entering from the carriageway to the footpath or vice visa.	Agreed. This is a detailed design issue. Reference to emergency access is made in para 6.3.6 of the revised DFR.
		(c) Design codes for the proposed enclosure should be stated in the DFR. In deciding the spacing of the main frames of the enclosure, consultants should ensure that the enclosure is structurally fit to sustain the environmental loadings, such as allowance for forces generated by wind drag, vehicle collision loads, earthquake and maintenance loading on the roof of enclosure etc.	Appropriate design codes for detailed design have been included in Section 7 of DFR. Concept design sufficient to confirm feasibility of the barrier structures and for development of budget costs has been carried out for this NIA.

Item No.	Department/Letter Ref. (CHE/Str)	Comment	Response
19.	Chief Highway Engineer/Structures, HyD (37) in STR 5/30/250 16.03.1994 DFR Issue 1	(d) As accumulation of dirt will be quickest on the face closest to the traffic, ie inside face of the enclosure, consultants' attention is drawn to the smoothness of the internal surface of the enclosure. Likewise, selection of acrylic sheet at the bottom panels should be considered reducing the visible effects of the build up of dirt. As such, maintenance aspect of the proposed enclosure should also be addressed in the DFR.	Maintenance aspects have been addressed briefly in Section 6 of the revised DFR. Selection of panel materials is a matter for detailed design. It is understood that the Maintenance section of HyD do not prefer the use of proprietary forms of panelling. Additionally, smooth faced panels would not be suitable at locations where sound absorption is required (as opposed to sound reflection).

Item No.	Department/Letter Ref. (CHE/Str, HyD)	Comment	Response
19.	Chief Highway Engineer/Structures, HyD (47) in STR 5/30/250 01.06.1994 DFR Issue 2	1. <u>Proposed noise barrier on existing bridge across So Kwun Wat River</u> They note that the Consultant propose to reduce the height of the proposed noise barrier on this existing bridge from 2m to 1m. This reduced height is almost similar to that of the existing aluminium parapet on the bridge. In order to minimise the disturbance on the bridge, the consultants should propose an appropriate fixing detail for mounting noise barrier on the bridge parapet.	The revised DFR, incorporating traffic figures from the Local Traffic Study, has found that noise barrier will no longer be required on the existing bridge near Kar Wo Lei village.
		2. <u>Proposed noise enclosure</u>	
		(a) The proposed noise enclosure fronting Fiona Garden may not be practical as its incorporation to the proposed footbridge would make the design and the appearance of the footbridge unacceptable. If the proposed noise enclosure is genuinely required, we consider that a subway may be substituted subject to the agreement of Transport Department as it has adverse implications on both the design and construction programmes.	The revised DFR does not propose any vertical noise barriers/partial enclosures at Fiona Garden. The original footbridge design will therefore not be affected.
		(b) The design of noise mitigation structures should in general comply with the Structures Design Manual for Highways and Railways, Highways Department 1993.	Agreed. A statement to this effect has been incorporated into Section 6 of the revised DFR.
		(c) Design codes for the proposed enclosure should be stated in the DFR. In deciding the spacing of the main frames of the enclosure and hence the appearance of the enclosure, consultants should ensure that the enclosure is structurally fit to sustain the environmental loadings, such as wind drag, vehicle collision loads, earthquake force, and maintenance loads on the roof of enclosure, etc. (CHE(CW)/NT letter ref. ( ) in HNT 54/144 (51) III dated 19 July 1994 informed the Consultant that the above comment given by CHE/Str should also be considered in finalising the report.)	Design codes have been included in Section 7 of the revised DFR. Concept design for the NIA has been sufficient to confirm the feasibility of the proposed structures. Detailed structural design is outside the scope of the present study.

Item No.	Department/Letter Ref. (CHE/Str, HyD)	Comment	Response
19.	Chief Highway Engineer/Structures, HyD STR 5/30/250 16.02.1995 DFR Issue 3	1. Para 4.3 - Footbridge. "Foundation design is near completion" should read "Foundation to be bored piles".	Noted - text of para 4.3 will be amended.
		2. Appendix 2 - Response to Comments "Appropriate design codes for detailed design have been included in Section 7 of DFR" has been quoted. Please advise which paragraph.	Appropriate design codes are included in Section 7.9.4 of the Final Report.
		3. Appendix 3 - Cost Estimate for Noise Mitigation Options Para A.3.2.2 Should present worth factor be $1/(1+0.1)^n$ rather than $(1-0.1)^n$?	It is agreed that present worth is more correctly calculated as $1/(1+0.1)^n$. Cost estimates in the Final Report have been revised accordingly.
	Chief Highway Engineer/Structures, HyD (53) in STR 5/30/250 12.04.1995 DFR Issue 4	1. Para 4.3 - Footbridge "foundation design is near completion" should read "foundation to be bore piles".	Noted - text of para 4.3 has been amended in Issue 5 of DFR and in the Final Report.
		2. Appendix 2 - Response to Comments In which paragraph of the report are the appropriate design codes for detailed design of the noise barrier structures.	The appropriate design codes are listed in Section 7.9.4 of Issue 5 of DFR and in the Final Report.

Item No.	Department/Letter Ref. (CE/Lighting)	Comment	Response
20.	Chief Engineer/ Lighting, HyD (36) in HL 06/12P (9) 01.06.1994 DFR Issue 2	CE/Lighting state that the partial enclosures as proposed in the Consultant's report will affect the performance of standard road lighting. The transparent panels will easily become dirty in such environment. They suggest special lighting should be used in partial enclosures same as in full enclosures. Please also clarify which department will takeover the maintenance and cleaning responsibilities for these enclosures and special lighting.	Agreed - revised DFR has been amended accordingly.
	Chief Engineer/ Lighting, HyD (70) in HL 06/12P (10) 08.02.1995 DFR Issue 3	No comment.	Noted.
	Chief Engineer/ Lighting, HyD (21) in HL 06/12P II 12.04.1995 DFR Issue 5	No comment.	Noted.

Item No.	Department/Letter Ref. (CHE/R&D)	Comment	Response
21.	Chief Highway Engineer/Research & Development, HyD HRD 14/240TH 13.05.1994 DFR Issue 2	No comments.	Noted.
	Chief Highway Engineer/Research & Development, HyD HRD 14/240TH 15.02.1995 DFR Issue 3	An annual maintenance cost of $68 per square metre for friction course material has been used in the calculation of maintenance costs. The Consultant is asked to submit their calculation deriving this cost to CHE/R&D for comment.	Noted. Copy of the detailed cost estimate, and the underlying assumptions on which this was based, were passed to GE/PM for onward transmission to CHE/R&D. Consultants letter ref. 7146/PRO-1/223 dated 14.02.95.
	Chief Highway Engineer/Research & Development, HyD unreferenced list of comments distributed at 7th S.G. meeting DFR Issue 5	1. <u>Para 6.2.2 (iii)</u> i) On what basis has the consultant based on the 3.5db(A) reduction of traffic noise by pervious macadam?	In the UK DOT procedure, "Calculation of Road Traffic Noise", the presence of pervious macadam wearing course is taken to reduce basic traffic noise levels by 3.5dB(A). UK research has shown that pervious macadam surfacing can reduce traffic noise by 3.5dB(A) for vehicle speeds greater than 75km/hr and 2.5dB(A) for vehicle speeds less than 75km/hr.
		ii) What is the material pervious macadam?	Pervious macadam is similar to friction course.
		iii) The report stated that experience has shown that in favourable conditions such surfacing has a service life of up to 3 years. What are the favourable conditions referred by the Consultant? In addition, how does the Consultant draw the 3 year service life conclusion? Any deviation on the assumed service life would result to a large difference on the maintenance cost of friction course material.	Favourable conditions for the use of friction course are on roads with non-stop through traffic, few junctions and without steep gradients or sharp horizontal curvature. The three year service life for friction course under such conditions is based on the Consultants experience both in Hong Kong and overseas. It is recognised that variations in assumed service life would result in a large variation in the cost of maintenance. However, for the purposes of the cost effectiveness analysis, it was necessary to make some assumptions.

Item No.	Department/Letter Ref. (CHE/R&D)	Comment	Response
21.	Chief Highway Engineer/Research & Development, HyD unreferenced list of comments distributed at 7th S.G. meeting DFR Issue 5	(iv) Could the Consultant justify his statement that friction course surfacing would require less maintenance along the section of Castle Peak Road from Siu Lam interchange to Kwun Fat Street at eastern end of Tai Lam Village?	From an examination of the total length of the Castle Peak Road to be improved, it can be seen that along certain sections, where there are a number of junctions, run-ins, bus bays, sharp curves or steep gradients in close proximity, the use of friction course surfacing would not be feasible, as the surfacing would have a very short lifespan. Along other sections of the road, such as from Siu Lam Interchange to Kwun Fat Street, where there are not so many junctions, bus bays etc and traffic could be expected to flow somewhat more freely, it would be feasible to maintain a friction course surfacing. It is when compared to the maintenance requirements for friction course at a section such as that through Tai Lam village, that the friction course surfacing from Siu Lam to Kwun Fat Street would require less maintenance. Conditions along even this stretch of CPR are far from ideal however, and maintenance requirements would be high. Friction course surfacing was investigated because it is an effective noise reduction option.
		2. <u>Para 11.2.1 (iii)</u> This Division considers that using friction course material as a noise mitigation measure of the project should not be considered.	Agreed. Friction course surfacing is regarded as being impractical for use along CPR, due to the high maintenance requirements. The use of friction course surfacing is not recommended in the Final Report.

Item No.	Department/Letter Ref. (CHE/R&D)	Comment	Response
21.	Chief Highway Engineer/Research & Development, HyD unreferenced list of comments distributed at 7th S.G. meeting DFR Issue 5	3. Appendix 3 (i) The Consultant quoted that the whole noise reducing surfacing material will have to be replaced every 3 years and the friction course material on new bus bays will have to be replaced every year. In addition, he also pointed out that the friction course material on roundabout junction will have to be replaced every 4 months. Comments should be sought from CHE(DM)/NT on the above frequent maintenance requirement of the laid surfacing.	Noted.
		(ii) The cost of regulating layer, road stud installation and pothole patching appears to have not been included in the Consultant's maintenance cost calculation.	The cost of regulating layer and pothole patching have not been included in the maintenance cost calculation. The cost of road studs has been included. The cost estimates have been produced in sufficient detail for comparative assessment purposes in this study.
		4. All bus bays should be constructed with rigid carriageway.	Noted. A statement to this effect has been included at Section 6.2.2(iii) of the Final Report.

Item No.	Department/Letter Ref. (CHE(D&M)/NT)	Comment	Response
22.	Chief Highway Engineer (DM)/NT (58) in HNT/602/TM/1 24.06.1994 DFR Issue 2	CHE(D&M)/NT have the following comments on the draft NIA report:-	
		Para. 6.2.2 (iii) On sections of road with frequent stop-start slow moving traffic the pervious macadam paving will only have a short span of service life. From maintenance point of view, it is not preferred to have this kind of paving on local roads.	It is recognised that conditions on the improved Castle Peak Road are not ideal for friction course paving. It has been assumed that complete resurfacing would be required at 1½ to 2 year intervals for the purpose of cost comparison with the provision of noise barriers/partial enclosures. Despite the ongoing maintenance requirements, friction course is seen as having much reduced secondary impacts on the environment when compared with barriers/partial enclosures. The use of friction course on the eastern (Siu Lam) and western (So Kwun Wat) ends of the section of Castle Peak Road will reduce the extent of noise barriers required significantly. Friction course surfacing has only been considered at those sections of Castle Peak Road where it could be expected to have a reasonable service life.
		Para 6.2.3 Barriers It is not preferred to install different types of noise barriers along the road. As far as possible one single type of noise barrier should be used. Also, noise barriers in proprietary forms are not preferred as it will be difficult to control readiness of its future local supply and its cost for our maintenance purpose. The barrier, where it is designed in panel construction, should not be vulnerable to vandalism. Our maintenance section reserves our right to comment on the type and design details of the barrier chosen for construction until all the information is available at the design stage.	Comments are noted. Various types of noise barriers are included in the DFR for cost comparison purposes. It would not be intended that different types of barriers be used at different locations.
		Para 10.2.3 The Consultant's recommendation that all barriers should be installed at the back of the footpath wherever they are required is supported by them.	Noted.

Item No.	Department/Letter Ref. (CHE(D&M)/NT)	Comment	Response
22.	Chief Highway Engineer (DM)/NT (11) in HNT/602/TM/1 II 13.02.1995 DFR Issue 3	No comment.	Noted.

Item No.	Department/Letter Ref. (CHE(CW/NT))	Comment	Response
23.	Chief Highway Engineer (CW)/NT ( ) in HNT 54/144 (51) II 06.06.1994 DFR Issue 2	Their comments on the Draft Final Report are:	
		(i) para 3.3.2 - the year in which the noise levels were monitored should be stated;	Agreed.
		(ii) para 6.3.4 - at which location the desirable minimum visibility cannot be achieved. Please illustrate;	Indicated on Figures 22-24 of revised DFR.
		(iii) para 6.5.8(iv) - how to make up the total discounted maintenance cost for the mitigation for receiver;	Details of cost estimates are presented in Appendix 2 of the revised DFR.
		(iv) para 7.4.8 - "KP1" should be "KP"?	Agreed.
		(v) para 8.4.2(f) - "GCR" should be "GRC";	Agreed.
		(vi) para 8.5.3(d) - the first line should read "The impact on the Yee On...";	Agreed.
		(vii) Table 10.1 - (a) two more columns containing the capital and maintenance costs should added for cost comparison; (b) the cost at which year, although para 6.5.5 has been specified, should be stated;	Capital and maintenance costs are identified in Section 7 of the report. It is felt that expansion of Table 10.1 to include separate columns for these costs would reduce the clarity of the Table.
		(viii) para 11.1 - "para 6.3.3" should be "para 7.1.3";	Agreed.
		(ix) Figure 2 - (a) "TUN MUN" should be "TUEN MUN"; (b) the "Proposed Road" is not clear; (c) for the Land Use Zoning Sources, the zoning area should be marked clearly whether they are located on which side of the boundary;	Figure 2 has been amended in the revised DFR.

Item No.	Department/Letter Ref. (CHE(CW/NT))	Comment	Response
23.	Chief Highway Engineer (CW)/NT ( ) in HNT 54/144 (51) II 06.06.1994 DFR Issue 2	(x) Figure 9 - no access point has been allowed at the run-ins;	Figure 9 has been amended in the revised DFR.
		(xi) Figure 23 - the barrier layout at run-ins are missing;	Figures 23-25 have been amended in the revised DFR, and are now numbered 22-24.
		(xii) Regarding (x) & (xi) above, please clarify whether the opening at the run-ins has been considered in the noise assessment; and	Openings in barriers at run-ins have been considered in the noise assessment.
		(xiii) It is understood (as specified by TD) that a minimum footpath width of 3.5m should be maintained, Figure 12 showing the general arrangement of the 1 metre high noise barrier should be modified. In addition, additional land at the back of footpath may be required for the erection of the proposed noise barriers/semi-enclosure/enclosure. To what extent and at which location the additional land is required should be clearly stated in the report. At some critical locations where the extension of the works site limit is impracticable, what is the feasible solution?	Figure 12 has been modified in the revised DFR. Land requirements have been addressed in Section 7 of the revised DFR.

Item No.	Department/Letter Ref. (D of Housing)	Comment	Response
24.	Planning Officer/5 for Director of Housing HD(P) 7/3/TM5/1 08.06.1994 DFR Issue 2	Not having received the study papers from CHE(CW)/NT, HD would like clarification of the following points arising from the issue of the DFR to them on 30.5.94.	
		(a) Para 11.2.3: extraction of the traffic forecasts from CTS-2 is questionable as CTS-2 is a strategic study which is probably too coarse for local traffic forecasts requiring an up-to-date statistical base. Since development proposals of any significance normally require local traffic studies to support them, a similar approach appears desirable for your study.	A Local Traffic Study (LTS) was commissioned and the revised traffic flows obtained from the Study have been incorporated in the revised DFR.
		(b) What account has been taken of the Tuen Mun Port Development Study and the Railway Development Study, which have implications for inter-urban traffic flows on Castle Peak Road in 2011?	The mentioned studies were reviewed by the sub-consultants for the LTS and all relevant findings were incorporated in the input to the LTS.
		(c) What hinterland land uses, flat numbers and population totals are assumed for local roads feeding into Castle Peak Road, particularly So Kwun Wat Road?	The LTS was carried out in July and August of this year (1994). The most up-to-date planning data for So Kwun Wat Road and other local roads feeding into Castle Peak Road was made available to LTS sub-consultants, Messrs Delcan, by Planning Department.
		(d) Please specify what scale of development is assumed for Area 56 PSPS and whether account has been taken of changes in the quarterly Public Housing Development Programme since inception of your study.	The traffic noise generated by the improved Castle Peak Road has very little effect on the Area 56 PSPS site. As such, the single point NSR that has been used to model future development at the site is considered adequate for the purposes of this noise assessment. A site specific assessment study will likely be required at the site taking account of the scale of the development to address the high Tuen Mun Road traffic noise.

Item No.	Department/Letter Ref. (D of Housing)	Comment	Response
24.	Planning Officer/5 for Director of Housing HD(P) 7/3/TM5/1 18.02.1995 DFR Issue 3	1. Paragraphs 3.4.3, 3.4.6 and 7.6 do not refer to Area 56 Layout Plan (which has been under preparation by the Planning Department for some time) or the likely redevelopment of military sites immediately west of the study area. The study's traffic forecasts, particularly for So Kwun Wat Road catchment, may therefore be underestimates.	Population and living quarter estimates for Area 56 Layout Plan were obtained from Planning Department and were taken into account in developing the transport model for the Local Traffic Study. Area 56 has not been specifically mentioned in sections 3.4.3 and 3.4.6 of the Draft Final Report as it lies outside of the study area. The redevelopment of the military sites at Pearl Island, Perowne Barracks and Gordon Hard is still in the early stages of planning, so the potential additional traffic generated by these sites in the future cannot be determined at this stage. The Territorial Strategic Model developed for the Local Traffic Study (and endorsed by Transport Department) was built up based on the latest CTS-2 data available at the time, and did include the military barracks areas. Although it is uncertain whether the CTS-2 data had accounted for the redevelopment of the military sites, it is worth noting that the traffic study concluded that the demand traffic flows on the improved Castle Peak Road will be higher than the actual flows by the year 2011, due to junction capacity constraints. In this respect, the actual traffic forecasts used in the noise impact assessment would not be underestimated.
		2. Appendix 2 - Responses to Comments Item No. 24 comment(c) HD was not consulted on the Local Traffic Study and therefore the NIA Final Report should contain an appendix on the land uses and populations assumed for traffic forecasting purposes.	A new appendix is included in the Final Report which summarises the land uses and populations assumed for traffic forecasting purposes. A copy of the planning data received from Planning Department and on which the Local Traffic Study estimates were based, has been dispatched to H.D. under cover of Consultants letter ref. 7146/DFR/818 dated 21.05.95.

Item No.	Department/Letter Ref. (D of Housing)	Comment	Response
24.	Planning Officer/5 for Director of Housing HD(P) 7/3/TM5/1 25.05.1995 DFR Issue 5	It is noted that the Area 56 population assumptions in the Local Traffic Study do not take account of the Area 56 draft Layout Plan, which makes provision for a design population of 4550 'R3' type housing. While this draft Layout Plan was circulated late in the study process, it is understood that Tuen Mun East has been under consideration by the Planning Department for some time as a Potential Growth Area, with significant population growth in addition to the PSPS development.	The Local Traffic Study was carried out in July and August 1994, and was based on the population and living quarter estimates supplied by Planning Department at that time. The population estimates for Area 56 did not include the 'R3' type housing mentioned, and therefore is an underestimate. The effect of this on the traffic forecasts for Castle Peak Road will not however, be significant. The forecasts predict that the peak hour demand traffic flows (the total traffic demand irrespective of the road network capacity constraints) will exceed the peak hour actual traffic flows (traffic volumes that can realistically pass through the road network during the time period simulated by the traffic model) by the year 2011. Thus, an increase in the demand traffic flow occasioned by an increase in the population estimates for Area 56 will have very little impact on the actual peak hour traffic flows, as CPR will have little additional capacity to cater for increased demand during the peak hour. As the NIA utilises the peak hour traffic volumes in the noise assessment process, the Area 56 population underestimate will not have a significant impact on the noise assessment results. The Local Traffic Study has identified that by the year 2011, a number of junctions along the improved Castle Peak Road will be over capacity, and acting as constraints on traffic volumes along Castle Peak Road. Further studies were recommended to identify suitable improvement schemes for these junctions.

Item No.	Department/Letter Ref. (CS)	Comment	Response
25.	Commissioner of Correctional Services (44) in PD WKS 171/015 III 27.07.1994 DFR Issue 2	No comment on the Draft Final Report.	Noted.
	Commissioner of Correctional Services (68) in PDWKS 171/015 III 14.02.1995 DFR Issue 3	Existing and predicted traffic noise levels at CSD quarters at Siu Lam are well above HKPSG guidelines. CSD staff at these quarters are required to perform shift duties. It is suggested that the Consultants address the special circumstances of CSD staff separately and that noise insulation be provided at all four CSD quarters buildings in addition to all other technical remedies proposed.	The fact that CSD staff quartered at Siu Lam are required to work shift duties has been highlighted in the Final Report. It is proposed that no direct technical measures be implemented to control noise from Castle Peak Road traffic at Siu Lam, as all such measures are ineffective. It is proposed instead that affected NSR's be considered for provision of remedial measures in the form of noise insulation at the receivers. Noise insulation is recommended in the final report for those CSD quarters identified as CSQ1, CSQ2 and CSQ4. The predicted traffic noise levels at CSQ3 are less than 70dB(A), and as such, meet the HKPSG criterion. Noise insulation is not being recommended for this unit.
	Commissioner of Correctional Services (23) in PD WKS 171/015 IV 12.04.1995 DFR Issue 5	Anticipated that noise barriers near Siu Lam (in front of CSQ1) would not be effective in reducing CPR traffic noise because of the elevated location of CSQ1.	It is agreed that vertical barriers and partial enclosures in front of CSQ1 are not effective. For that reason, it is recommended in the Final Report that no barriers be installed here, but that remedial noise insulation be considered at affected NSR's instead.

Item No.	Department/Letter Ref. (HyD)	Comment	Response
26.	Senior Engineer/Planning HyD HyD T5/541 TH to GE/PM 14.02.95 DFR Issue 3	Comments refer to Section 6.6 Unit Costs.	
		1. It is noted that unit costs cover capital cost, maintenance cost and operating cost. Capital costs can be verified by GE/PM.	Noted.
		2. As regards maintenance costs, there is at present no established rule on how the costs for noise barriers are to be derived. Dependent on the type of structure to be adopted for the barriers, the consultant's estimates can be checked-based on HyD maintenance cost for highway structures which is currently under updating and revision by CHE/Struct to include cleansing cost. As regards maintenance costs for the friction course, CHE/R&D is in a better position to comment on this particularly in view of the short life span adopted in the assumption. Finally it is noted that staff cost has not been included in the calculation of maintenance cost.	Noted.
		3. It is recommended that GE/PM cross-check operating costs for air-conditioners with EMSD, though it is understood that maintenance and operating costs for air-conditioners which form part of the remedial measures recommended, are to be borne by the affected residents.	Noted.

Item No.	Department/Letter Ref. (HyD/PM)	Comment	Response
27.	Chief Engineer/Project Management, HyD (1) in HYD MWPMO 541TH/EIA 05.05.95 DFR Issue 5	No comment	Noted.

Item No.	Department/Letter Ref. (SPEL)	Comment	Response
28.	Secretariat for Planning Environment and Lands (7) in PEL B(E) 55/02/63(95) 12.04.95 DFR Issue 5	EPD to comment on details of the NIA.	Noted.

APPENDIX 3

LOCAL TRAFFIC STUDY SUMMARY

APPENDIX 3 - LOCAL TRAFFIC STUDY SUMMARY

A3.1 Introduction

The purpose of the Local Traffic Study (LTS) was to provide detailed traffic forecasts for the design years 2001, 2006 and 2011 for those sections of Castle Peak Road (CPR) and Tuen Mun Road (TMR) between So Kwun Wat Road and Siu Lam Interchange. These traffic forecasts are then used as the input data for predicting traffic noise from the improved CPR during the first fifteen years of its operation.

A3.2 Forecast Methodology

In order to produce the traffic forecasts to the required level of detail, it was necessary to set up a transport model to predict the effects on traffic flow of road improvement schemes, capacity constraints at intersections, future land use and population changes.

The computer program suite SATURN (Simulation and Assignment of Traffic to Urban Road Networks) was used as a tool to assist in modelling traffic flow estimates within the study area for the design years of 2001, 2006 and 2011. SATURN is a suite of traffic network analysis programs which can function as a combined traffic simulation and assignment model for the analysis of traffic management/improvement schemes, and as a simulation model of individual junctions. It is particularly suitable for the analysis of relatively minor network changes and was therefore considered the most appropriate model for this study.

The CTS-2 road network and trip matrices were adopted as the basis for the transport modelling. Appropriate modifications, to reflect differences between observed and modelled traffic, were incorporated where necessary. Peak hour traffic flows were required for the NIA. Therefore, the LTS predicts peak hour flows for the AM peak hour, which has been found to be the critical peak within the study area.

A3.3 Data Collection

Data was required for coding of the transport model networks, construction of trip matrices and for calibration and validation of the local transport model. This data was collected from a number of sources as follows:

- Traffic counts by the Consultant (June 1994)
- Licence plate survey by the Consultant (June 1994)
- Transport Department
- Planning Department (land use and population estimates)
- Various development study reports

Extracts from the data received from planning department on land use and population estimates are included at the end of this LTS summary (Section A3.7).

A3.4 Transport Model

To enable projection of AM peak hour traffic for the design years of 2001, 2006 and 2011, a two-tiered modelling approach was adopted. The two-tier model hierarchy encompasses the Territorial Strategic Model (TSM) and the Study Area Model (SAM).

The purpose of the TSM is to investigate the effect on traffic distribution of the strategic road network, based on latest CTS-2 road network and trip matrices. The TSM was modelled in SATURN as a buffer network and it covered all areas of the territory as modelled by CTS-2.

The road network and trip matrices have been updated to incorporate planned improvements to the road network up to the design years and to take account of discrepancies between the 1991 CTS-2 and data obtained from more recent ATC AM peak hour traffic counts.

The updated road network and trip matrices were used to produce new strategic traffic forecasts for each design year. These figures were used as boundary conditions for the SAM for various design years.

The SAM was modelled in SATURN as a simulation network. As such it possessed much greater zonal and network details than the TSM, permitting assessment of the effects of land use and highway network interaction. Other features modelled included priority intersections, roundabouts, signalled junctions, one-way systems, banned turns and lane sharing arrangements.

The SAM included the whole NIA study area from approximately 400m west of the junction of Castle Peak Road/So Kwun Wat Road to 1km east of Brothers Point. This ensured coverage of Tuen Mun Road, Castle Peak Road and all other major roads within the CTS-2 zone 157.

A3.5 Traffic Forecasts

Forecast actual and demand traffic flows along Tuen Mun Road and various sections of Castle Peak Road within the study area were examined. Actual flows are the traffic volumes that can pass through the road network during the time period simulated as predicted by the transport model. These figures are in general lower than the demand flows which correspond to the total traffic demand irrespective of network capacity constraints.

A comparison of the design years actual and demand traffic flows for Tuen Mun Road and various stretches of Castle Peak Road are summarised in Table A3.5.1. Actual traffic flows less than demand traffic flows result from capacity constraints imposed by road junctions within the study area, causing queue backs onto adjacent intersections and stifling their capacities. The heavy traffic on Castle Peak Road results from proposed developments in the area, saturation of Tuen Mun Road with traffic overspilling onto Castle Peak Road and the lack of alternative routes for dispersion of the excess vehicle demand on the Tuen Mun/Tsuen Wan Corridor.

To enable fair comparison and analysis among the different modes of transport, projection of traffic demand for various design years was conducted in passenger car units (pcu's).

This breakdown is particularly important for conducting an accurate assessment of traffic noise, as the contribution of heavy vehicles to noise levels is much greater than that of passenger cars.

Percentage composition of different vehicle types along Tuen Mun Road and Castle Peak Road for the design years of 2001, 2006 and 2011 were derived using CTS-2 forecasts and are summarised in Table A3.5.2.

Table A3.5.1 - Comparison of Actual and Demand Traffic Flows

From	To		2001		2006		2011	
			Actual	Demand	Actual	Demand	Actual	Demand
Tuen Mun Road	Tuen Mun Road	EB	5,614	6,861	5,407	7,527	5,393	8,088
		WB	4,981	4,981	4,312	4,312	5,816	5,816
Brothers Point Sand Depot Access	Seamen's Training Centre Access	EB	1,077	2,586	877	2,927	928	3,605
		WB	1,287	1,287	1,306	2,207	1,239	1,717
Seamen's Training Centre Access	Tai Lam Chung Road	EB	1,073	2,584	873	2,928	924	3,608
		WB	1,297	1,279	1,066	2,196	996	1,707
Tai Lam Chung Road	Siu Lam Interchange (E)	EB	1,092	2,712	883	3,112	932	3,838
		WB	1,181	1,387	1,024	2,320	960	1,876
Siu Lam Interchange (E)	Siu Lam Village Access	EB	587	3,187	209	3,633	219	4,636
		WB	1,095	1,095	1,183	2,000	1,091	1,617
Siu Lam Village Access	Siu Lam Interchange (W)	EB	763	3,214	372	3,677	381	4,685
		WB	1,104	1,104	1,222	2,006	1,108	1,628
Siu Lam Interchange (W)	Marine Police Base Access	EB	1,662	3,045	1,946	3,465	2,162	4,335
		WB	1,200	1,200	1,757	2,434	1,731	2,168
Marine Police Base Access	Lok Chui Street	EB	1,635	3,021	1,896	3,447	2,137	4,315
		WB	1,192	1,192	1,768	2,438	1,738	2,170
Lok Chui Street	Kwun Fat Street	EB	1,620	3,007	1,753	3,395	2,077	4,266
		WB	1,184	1,184	1,747	2,403	1,715	2,139
Kwun Fat Street	Lok Yi Street	EB	1,538	2,968	1,662	3,362	1,978	4,246
		WB	1,205	1,205	1,861	2,425	1,808	2,172
Lok Yi Street	Tsing Tai Road	EB	1,532	2,967	1,667	3,379	1,972	4,264
		WB	1,210	1,210	1,901	2,460	1,847	2,208
Tsing Tai Road	Tsing Fat Street	EB	1,505	2,955	1,623	3,361	1,984	4,358
		WB	1,225	1,225	2,042	2,565	2,108	2,444
Tsing Fat Street	Siu Sau Village Access	EB	1,416	2,900	1,350	3,233	1,578	4,115
		WB	1,235	1,235	1,417	2,653	1,297	2,396
Siu Sau Village Access	Tsing Lung Road	EB	1,368	2,878	1,304	3,205	1,523	4,081
		WB	1,251	1,251	1,155	2,667	1,024	2,403
Tsing Lung Road	Gold Coast East Access	EB	1,341	2,874	1,276	3,210	1,491	4,083
		WB	1,289	1,286	1,102	2,728	963	2,461
Gold Coast East Access	Kar Wo Lei Hill Road	EB	1,332	2,886	1,259	3,220	1,470	4,095
		WB	1,308	1,308	1,116	2,746	975	2,478
Kar Wo Lei Hill Road	Kar Wo Lei	EB	1,284	1,284	1,232	3,260	1,439	4,126
		WB	1,340	1,378	1,176	2,899	1,011	2,619
Kar Wo Lei	So Kwun Wat Road	EB	1,282	2,891	1,228	3,258	1,436	4,123
		WB	1,269	1,379	1,105	2,900	937	2,620
So Kwun Wat Road	Gold Coast West Access	EB	1,229	2,868	1,311	3,334	1,512	4,223
		WB	1,290	1,586	947	2,637	807	2,374

Note: Figures shown are for Castle Peak Road unless otherwise stated.
Figures shown are in passenger car units (PCU)

Table A3.5.2 - Vehicle Composition from CTS-2

Road	Design Year	Direction	Vehicle Type					PCU Factor
			Car	Taxi	GV	OB	PT	
Tuen Mun Road	2001	EB	48%	3%	41%	2%	6%	1.44
		WB	37%	3%	52%	1%	7%	1.54
	2006	EB	47%	3%	45%	2%	4%	1.43
		WB	39%	2%	52%	2%	5%	1.50
	2011	EB	45%	3%	46%	2%	4%	1.43
		WB	36%	3%	55%	2%	4%	1.51
Castle Peak Road	2001	EB	55%	2%	36%	1%	6%	1.39
		WB	40%	6%	46%	1%	7%	1.48
	2006	EB	48%	3%	41%	2%	6%	1.44
		WB	43%	3%	46%	1%	7%	1.49
	2011	EB	50%	3%	42%	2%	3%	1.39
		WB	39%	4%	51%	2%	4%	1.47

Notes: 1. GV - Goods Vehicle.
2. OB - Other Bus.
3. PT - Public Transport.

A3.6 Conclusions and Recommendations

A3.6.1 Link traffic forecasts along Tuen Mun Road and various stretches of Castle Peak Road within the study area are summarised in **Table A3.5.1**. For Castle Peak Road, the link flows range from 209 to 2,162 pcus/hr.

A3.6.2 Projected vehicle compositions for Tuen Mun Road and Castle Peak Road are summarised in **Table A3.5.2** for the design years.

A3.6.3 A number of junctions on Castle Peak Road were found to be over capacity by the year 2001 based on the layouts proposed in the Castle Peak Road Improvement project. These junctions would in effect pose capacity constraints on traffic volumes along Castle Peak Road. The situation would be exacerbated with the increase in traffic demand by 2006. More intersections were found to be over capacity by 2011 and delays at these locations would be substantial.

A3.6.4 It is therefore proposed that further studies are carried out to make recommendations on intersection capacity improvement schemes to improve the overall Castle Peak Road capacity with the objective of better meeting the predicted heavy traffic demand.

A.3.7 Land Use and Population Estimates on which the LTS was based

Extracted from data supplied by Planning Department.

Table A3.7.1 - Population Estimate by Planning Area

Planning Area	2001	Upon Full Development
55	5,770	9,510
56	16,110	16,670
57	3,160	3,130
58	3,430	4,180
59	1,220	2,590
So Kwun Wat DPA	5,470	7,520
Total	35,160	43,600

Table A3.7.2 - Existing Employment by Planning Area

Gold Coast Development in Area 57	480
Container Storage in Area 55B	30
Container Storage in Area 55A	170
Provisional Airport Authority	290
Transhipment Centre in Area 59	390
Marine Police Base and Custom &	520
Excise Establishment in Area 59	30
Siu Lam Hospital & Psychiatric Centre in So Kwun Wat DPA	
Container Storage in So Kwun Wat DPA	
Total:	1,910

Living Quarter Estimate by Housing Type and Planning Area

Planning Area	Housing Type	2001	Upon Full Development
55	R3	1520	1986
55	SQ	37	0
55	VE	281	567
55	VO	119	87
55	VR	356	534
55	CRCD	0	439
Sub Total		2313	3613
56	PSPS	5000	5000
56	SQ	20	0
56	VE	167	327
56	VO	107	107
Sub Total		5294	5434
57	R3	1316	1316
Sub Total		1316	1316
58	GIMI	172	172
58	R3	1359	1684
58	TBLS	1	0
Sub Total		1532	1856
59	CRCD	0	2090
59	GC	1	1
59	GIDQ	99	99
59	R3	320	929
59	SQ	14	0
59	VO	9	0
Sub Total		443	3119
* So Kwun Wat DPA	Low Density Residential	1680	1680

* for the approved S.16 application development in Siu Lam only.

1.3 Users should be aware that the bottom-up approach to population forecasting, such as that used herein, will usually produce forecastswhich in sum exceed the territorial forecasts. But in view of the myriad of entrepreneurial decisions, site-specific problems, procedural and contract problems which affect each site, it is difficult to identify with certainty which projects in this Development Programme will not form land on-schedule, which sites will not be sold, on which sites developers will delay completion, and how or when the flats built will be occupied. Such site-specific information, where available, is taken into account in the monitoring of the short-term forecasts.

1.4 Users are advised, therefore, to seek the advice of the Project Manager of each development office at an early stage in planning projects.

2.0 Housing Types

2.1 The meaning of each type of housing covered in Part 4A(1) and Part 4A(2) is largely covered in the definitions of planned uses on pages and of this programme. Only the temporary living quarters are not covered therein. Private temporary living quarters includes squatters, backlane and rooftop structures, and other temporary housing such as huts, contractors mat sheds and nissen huts, and simple stone structures due for clearance under Part 6 of the programme. Public Sector temporary housing includes Housing Authority Temporary Housing Areas and Cottage Areas.

2.2 The forecasts included in Part 4 B(1) and Part 4 B(2) show population and living quarters build up for each planning area by planned uses and housing types as indicated in the codes in the first and second column of the tables. The meanings of the housing type/planned use codes are indicated below:

Type of Housing/Planned Use	Code
Industrial:	
Workshop	IW
Industry type A	IA
Industry type B	IB
Industry type C	IC
Commercial:	
Commercial (incl. Hotel)	C
--- Hotel (single bed)	CH1
--- Hotel (double beds)	CH2
Residential:	
Comprehensive Development Area	CRCD
Town Centre	TC

Commercial/Residential	CR
Residential 1	R1
Residential 2	R2
Residential 3	R3
Residential 4	R4
Village Old Housing	VO
Village Extension	VE
Village Resite	VR
Government Non Departmental Quarters on CR	GRCR
Government Non Departmental Quarters on R1	GR1
Government Non Departmental Quarters on R2	GR2
Government Non Departmental Quarters on R3	GR3
Housing Authority Rental Estates	RS
HOS/PSPS	HOS
Housing Society Estates	HS
Government community:	
Government Community	GC
Ambulance Station	GCAM
Combined Ambulance Station/Fire Station	GCAF
CarPark(all types)	GCPK
Civic Centre/Cultural Complex A	GCCA
Civic Centre/Cultural Complex B	GCCB
Church	GCCH
Cooked Food Centre (stand alone)	GCCF
Clinic/Health Centre	GCCL
Polyclinic	GCCP
Specialist Clinic	GCCS
District Community Centre	GCC1
Area Community Centre	GCC2
Neighbourhood Community Centre	GCC3
Children Centre	GCC4
Youth Centre	GCC5
Home for the Aged	GCC6
Crematorium/Columbarium/Cemetery/ Funeral Parlour	GCCM
Education: Primary School	GCEP
Education: Secondary School	GCES
Education: Tertiary	GCET
Education: Special School/Other Ed Facility	GCEO
Divisional Fire Station	GCFD
Sub-divisional Fire Station	GCFS
Hospital	GCH
Indoor Recreation Centre A	GCIA
Indoor Recreation Centre B	GCIB
Indoor Recreation Centre C	GCIC
Library	GCLI
Magistracy	GCMA
Market	GCMK

Multiple Use Government Community	GCMU
District Police Station	GCP1
Divisional Police Station	GCP2
Sub-divisional Police Station	GCP3
Regional Police Headquarters	GCP4
NT Police Traffic HQ	GCP5
Post Office	GCPO
Monastery, Religious House	GCMN
Public Toilet	GCPT
Refuse Collection Point	GCRP
Sports Complex	GCSC
Swimming Pool Complex	GCSP
Stadium	GCST
Transport Terminus	GCTT
Other Government Community	GCOU
Institutions/Departmental Quarters:	
Departmental Quarters not elsewhere class'fd	GIDQ
Penal Institution	GIPI
Training Institution	GITI
Residential Institutions n.e.c.	GIRI
Military Institutions	GIMI
Other Institutions	GIOU
Other Government Uses:	
Depot	GODP
Ferry pier	GOFP
Offices	GOOF
Plant Nursery	GOPN
Other Uses including: Service Reservoirs Sewage Treatment Works Pumping stations	GOOU
Open Space:	
District Open Space	DO
District Open Space (non intensive)	DON
Urban Fringe Park	DOFP
Local Open Space	LO
Amenity Area	AA
Green Belt	GB
Countryside Conservation Area	CCA
Landscape Protection Area	LPA
Agricultural Land	AL
Other Specified Uses:	
Cargo Handling Area	OCHA
Container Port Area	OCPA
Container Facilities	OOCF

Bus/PLB Depot	OBUS
MTR/KCR/LRT Station	OSTN
MTR/KCR/LRT Depot	ODEP
MTR Ventilation Building	OVNT
Petrol Filling Station	OPFS
Electricity Substation	OESS
Telephone Exchange	OTEX
Slaughter House	OSH
Other Specified Uses	OOSU
Ferry Pier	OFP
Lai Chi Kok Amusement	OLCK
Monastery Belt	OMB
Undetermined Uses:	U
Roads:	
Primary & Distributor Roads & Reserves	MR
KCR/MTR/LRT and Reserves	TR
Local Road	LR
Temporary Uses:	
Temporary Industrial Area	TIA
Temporary Housing Area, Cottage Area	THA
Temporary Works Area	TWA
Other Temporary Use	TOU
Squatter Housing/Factories	SQ
Back Lane Structure	TBLS
Roof Top Structure	TSRT
Other Temporary Housing	TOH

3. Rural Tuen Mun Population

3.1 The area covered by Rural Tuen Mun includes the area within the Tuen Mun Administration District boundary but excludes the Tuen Mun New Town area and the Yuen Long-Tuen Mun Corridor (South) (Please refer to location plan in appendix IV). According to the 1992 WGPD Forecast, the population in the Rural Tuen Mun District was 3,920.

3.2 Due to the sporadic distribution of rural population, rural Tuen Mun is not covered by the types of engineering packages outlined in para. 6 in Part 1. The balanced development concept aimed for Tuen Mun is therefore not applicable to the rural area.

APPENDIX 4

COST ESTIMATES FOR NOISE MITIGATION OPTIONS

APPENDIX 4 - COST ESTIMATES FOR NOISE MITIGATION OPTIONS

A4.1 Introduction

The detailed cost estimates for all three direct noise mitigation options, along with the cost for indirect mitigation at receivers where residual noise levels are too high, are presented in this Appendix. Unit costs have been derived as discussed in Section 6.6 of the report and the assumptions made in the derivation of these costs, along with maintenance and operation costs where relevant, have been explained in that same section.

Cost estimates are presented for four scenarios for each mitigation option: i) maintenance and operating costs for direct and indirect mitigation costed over a fifteen year operating period; ii) as for i) except maintenance and operation cost for indirect mitigation costed over a fifty year period; iii) maintenance and operating costs for direct and indirect mitigation costed over a thirty year operating period; and iv) as for iii) except maintenance and operating cost for indirect mitigation costed over a fifty year period.

Cost estimates for maintenance and operating costs are discounted to the year 1994, and in this appendix, three discount scenarios have been presented - 0%, 4% and 10%. The costs presented in the main body of the report are based on 0% discount rate.

A4.2 Option 1 Noise Barriers With Friction Course

A4.2.1 Capital Cost: Direct Mitigation Measures

Lengths of barriers are taken from Figures 9, 10 and 11.

In addition, friction course surfacing is applied to a total length of dual carriageway of 1190 linear metres.

Residual insulation measures could be required at up to 444 residential units.

The capital cost of the noise barriers, based on the unit costs presented in Table 6.1 of the report are given in Table A3.1 below.

Table A4.1 Option 1 Noise Barrier Capital Costs

Barrier Type	Length	Rate $ per lin. m.			Cost $ x 10^3		
		High	Low	GRC and acrylic glass	High	Low	GRC and acrylic glass
3m Vertical Barrier	230m	6990	3030	5,670	1,608	697	1,305
5m Vertical Barrier	670m	42,410	13,920	24,495	28,415	9,327	16,412
Partial Enclosure	450m	75,010	54,750	73,190	33,757	24,638	32,936
Total					**63,780**	**34,662**	**50,653**

The costs for noise barriers adopted is the cost of barriers using a combination of GRC and acrylic glass acoustic panels, as proposed in Section 8.4 of the report.

	HK$ '000
Capital Cost for Barriers	50,653
Capital Cost for Friction Course 1190 lin m x $1,225 per lin. m	1,458
	52,111

A.4.2.2 Maintenance Cost: Direct Mitigation Measures

a. Discount Rate 10%

Maintenance costs are discounted to 1994 prices. Maintenance is first considered for the year 1998, one year after completion of project construction. Thus, spending in 1998 when discounted back to 1994, at a discount rate of 10%, must be factored by $1/(1+0.1)^4$ to give the net value of that sum in 1994 terms. Similarly, for any sum spent in the year 1994 + n, where n is any positive whole number, the value of that money in 1994 terms is given by the product of that sum and $1/(1+0.1)^n$. Thus, to identify the value in 1994 of monies spent on maintenance each year over the period 1998-2011 inclusive, the annual maintenance estimate for a single year should be factored by:

$$\sum_{n=4}^{n=17} 1/(1+0.1)^n = 5.53$$

Similarly, the factor to be applied for a thirty year operating period, 1998 - 2026 inclusive, is given by:

$$\sum_{n=4}^{n=32} 1/(1+0.1)^n = 7.03$$

Maintenance costs for 15 and 30 year operating periods, in 1994 net worth, are therefore:

1998 - 2011	HK$ '000
Barriers	
$50,653 x 10^3 x 5% x 5.53	14,006
Friction course	
$68 per m^2 x 16900m^2 x 5.53	6,355
	20,361

1998 - 2026	HK$ '000
Barriers	
$50,653 x 10^3 x 5% x 7.03	17,805
Friction course	
$68 per m^2 x 16900m^2 x 7.03	8,079
	25,884

b. Discount Rate 4%

From A.3.2.2a, the net present value of maintenance over the period 1998-2011 at a 4% discount rate is given by factoring the annual maintenance estimate, in 1994 prices by:

$$\sum_{n=4}^{n=17} 1/(1+0.04)^n = 9.38$$

and for the period 1998-2026, by:

$$\sum_{n=4}^{n=32} 1/(1+0.04)^n = 15.10$$

Maintenance costs for 15 and 30 year operating periods are therefore:

1998 - 2011	HK$ '000
Barriers	
$50,653 x 10^3 x 5% x 9.38	23,757
Friction course	
$68 per m^2 x 16,900m^2 x 9.38	10,779
	34,536

1998 - 2026	HK$ '000
Barriers	
$50,653 x 10^3 x 5% x 15.10	38,244
Friction course	
$68 per m^2 x 16,900m^2 x 15.10	17,353
	55,597

c. Discount Rate 0%

With a discount rate of 0%, the total maintenance costs at 1994 prices are simply the annual maintenance cost at 1994 prices factored by the number of years over which the maintenance costs are being considered.

Maintenance costs for 15 and 30 year operating periods are therefore:

1998 - 2011	HK$ '000
Barriers	
$50,653 x 10^3 x 5% x 14 yrs	35,458
Friction course	
$68 per m^2 x 16,900m^2 x 14 yrs.	16,089
	51,547

1998 - 2026	HK$ '000
Barriers	
$50,653 x 10^3 x 5% x 29 yrs.	73,447
Friction course	
$68 per m^2 x 16,900m^2 x 29 yrs.	33,327
	106,774

A4.2.3 Cost of Indirect Mitigation

Up to 444 dwelling units may require insulation.

a. Discount Rate 10%

1998 - 2011	HK$ '000
Capital Cost of Insulation	
444ea x $17,600	7,815
Maintenance Cost	
444ea x ($500 x 2 x 5.53 + $4,000 x 2 (.42 + .20))	4,658
Operating Cost	
444ea x ($3,200 x 2 x 5.53)	15,715
	28,188

Note, under maintenance costs, $4,000 x 2 x .42, for example, represents the current value of the money spent in year 2003 to replace two air conditioning units at each residential unit.

1998 - 2026	HK$ '000
Capital Cost of Insulation 444ea x $17,600	7,815
Maintenance Cost 444ea x ($500 x 2 x 7.03 + $4000 x 2 x 0.77)	5,857
Operating Cost 444ea x ($3,200 x 2 x 7.03)	19,977
	33,649

1998 - 2046

Factor to be applied to annual maintenance and operating costs to obtain 1994 value of future spending on these items over the period 1997 - 2046:

$$\sum_{n=4}^{n=52} 1/(1+0.1)^n = 7.43$$

	HK$ '000
Capital Cost of Insulation 444ea x $17,600	7,815
Maintenance Cost 444ea x ($500 x 2 x 7.43 + $4000 x 2 x 0.81)	6,177
Operating Cost 444ea x ($3,200 x 2 x 7.43)	21,114
	35,106

b. Discount Rate 4%

1998 - 2011	HK$ '000
Capital Cost of Insulation 444ea x $17,600	7,815
Maintenance Cost 444ea x ($500 x 2 x 9.38 + $4,000 x 2 x (0.70+0.51))	8,463
Operating Cost 444ea x ($3,200 x 2 x 9.38)	26,655
	42,933

1998 - 2026	HK$'000
Capital Cost of Insulation 444ea x $17,600	7,815
Maintenance Cost 444ea x ($500 x 2 x 15.1 + $4,000 x 2 x 1.89)	13,418
Operating Cost 444ea x ($3,200 x 2 x 15.1)	42,909
	64,142

1998 - 2046

Factor to be applied to annual maintenance and operating costs to obtain 1994 value of future spending on these items over the period 1997 - 2046:

$$\sum_{n=4}^{n=52} 1/(1+0.4)^n = 18.97$$

	HK$ '000
Capital Cost of Insulation 444ea x $17,600	7,815
Maintenance Cost 444ea x ($500 x 2 x 18.97 + $4,000 x 2 x 2.4)	16,948
Operating Cost 444ea x ($3,200 x 2 x 18.97)	53,906
	78,669

c. Discount Rate 0%

1998 - 2011	HK$ '000
Capital Cost of Insulation 444ea x $17,600	7,815
Maintenance Cost 444ea x ($500 x 2 x 14 yrs + $4,000 x 2 x 2 times)	13,320
Operating Cost 444ea x ($3,200 x 2 x 15 yrs)	42,624
	63,759

1998 - 2026	HK$'000
Capital Cost of Insulation	
444ea x $17,600	7,815
Maintenance Cost	
444ea x ($500 x 2 x 29 yrs + $4,000 x 2 x 4 times)	27,084
Operating Cost	
444ea x ($3,200 x 2 x 30 yrs)	85,248
	120,147

1998 - 2046	HK$ '000
Capital Cost of Insulation	
444ea x $17,600	7,815
Maintenance Cost	
444ea x ($500 x 2 x 49 yrs + $4,000 x 2 x 7 times)	46,620
Operating Cost	
444ea x ($3,200 x 2 x 50 yrs)	142,080
	196,515

A4.2.4 Total Costs

Total costs for Option 1 are summarised in Tables A3.2 to A3.4.

Table A4.2 - Option 1 Total Cost : Discount Rate 10%

			Direct Costs 1997-2011		Direct Costs 1997-2026	
			Indirect Mitigation Costs		Indirect Mitigation Costs	
			1997-2011	1997-2046	1997-2026	1997-2046
DIRECT MITIGATION	Capital Cost	Barriers	50,653	50,653	50,653	50,653
		Friction Course	1,458	1,458	1,458	1,458
	Maintenance Cost	Barriers	14,006	14,006	17,805	17,805
		Friction Course	6,355	6,355	8,079	8,079
Cost of Direct Mitigation			**72,472**	**72,472**	**77,995**	**77,995**
INDIRECT MITIGATION	Capital Cost		7,815	7,815	7,815	7,815
	Maintenance Cost		4,658	6,177	5,857	6,177
	Operating Cost		15,715	21,114	19,977	21,114
Cost of Indirect Mitigation at Receiver			**28,188**	**35,106**	**33,649**	**35,106**
TOTAL COST			**100,660**	**107,578**	**111,644**	**113,101**

Table A4.3 - Option 1 Total Cost : Discount Rate 4%

			Direct Costs 1997-2011		Direct Costs 1997-2026	
			Indirect Mitigation Costs		Indirect Mitigation Costs	
			1997-2011	1997-2046	1997-2026	1997-2046
DIRECT MITIGATION	Capital Cost	Barriers	50,653	50,653	50,653	50,653
		Friction Course	1,458	1,458	1,458	1,458
	Maintenance Cost	Barriers	23,757	23,757	38,244	38,244
		Friction Course	10,779	10,779	17,353	17,353
Cost of Direct Mitigation			**86,647**	**86,647**	**107,708**	**107,708**
INDIRECT MITIGATION	Capital Cost		7,815	7,815	7,815	7,815
	Maintenance Cost		8,463	16,948	13,418	16,948
	Operating Cost		26,655	53,906	42,909	53,906
Cost of Indirect Mitigation at Receiver			**42,933**	**78,669**	**64,142**	**78,669**
TOTAL COST			**129,580**	**165,316**	**171,850**	**186,377**

Table A4.4 - Option 1 Total Cost : Discount Rate 0%

			Direct Costs 1997-2011		Direct Costs 1997-2026	
			Indirect Mitigation Costs		Indirect Mitigation Costs	
			1997-2011	1997-2046	1997-2026	1997-2046
DIRECT MITIGATION	Capital Cost	Barriers	50,653	50,653	50,653	50,653
		Friction Course	1,458	1,458	1,458	1,458
	Maintenance Cost	Barriers	35,458	35,458	73,447	73,447
		Friction Course	16,089	16,089	33,327	33,327
Cost of Direct Mitigation			**103,658**	**103,658**	**158,885**	**158,855**
INDIRECT MITIGATION	Capital Cost		7,815	7,815	7,815	7,815
	Maintenance Cost		13,320	46,620	27,084	46,620
	Operating Cost		42,624	142,080	85,248	142,080
Cost of Indirect Mitigation at Receiver			**63,759**	**196,515**	**120,147**	**196,515**
TOTAL COST			**167,417**	**300,173**	**279,032**	**355,400**

A4.3 Option 2 Noise Barriers Without Friction Course

A4.3.1 Capital Cost : Direct Mitigation Measures

Lengths of barriers required are taken from Figures 12, 13 and 14. Capital costs are presented in Table A3.5.

Table A4.5 Option 2 Noise Barrier Capital Costs

Barrier Type	Length	Rate $ per lin.m.			Cost $ x 10^3		
		High	Low	CRC and Acrylic Glass	High	Low	GRC and Acrylic Glass
3m Vertical Barrier	220m	6,990	3,030	5,670	1,538	667	1,247
5m Vertical Barrier	620m	42,410	13,920	24,495	26,295	8,631	15,187
Partial Enclosure	650m	75,010	54,750	73,190	48,757	35,588	47,574
Total					**76,590**	**44,886**	**64,008**

A4.3.2 Maintenance Cost: Direct Mitigation Measures

a. Discount Rate 10%

1998 - 2011 HK$ '000

Barriers
$64,008 x 10^3 x 5% x 5.53 17,699

1998 - 2026

HK$ '000

Barriers
$64,008 x 10^3 x 5% x 7.03 22,499

b. Discount Rate 4%

1998 - 2011 HK$ '000

Barriers
$64,008 x 10^3 x 5% x 9.38 30,020

1998 - 2026

HK$ '000

Barriers
$64,008 x 10^3 x 5% x 15.1 48,327

c. Discount Rate 0%

1998 - 2011	HK$ '000
Barriers	
$64,008 x 10³ x 5% x 14 yrs	44,806
1998 - 2026	
	HK$ '000
Barriers	
$64,008 x 10³ x 5% x 29 yrs	92,812

A4.3.3 Cost of Indirect Mitigation
Up to 496 dwelling units may require insulation.

a. Discount Rate 10%

1998 - 2011	HK$ '000
Capital Cost of Insulation	
496ea x $17,600	8,730
Maintenance Cost	
496ea x ($500 x 2 x 5.53 + $4,000 x 2 x 0.62)	5,204
Operating Cost	
496ea x ($3,200 x 2 x 5.53)	17,555
	31,489
1998 - 2026	HK$ '000
Capital Cost of Insulation	
496ea x $17,600	8,730
Maintenance Cost	
496ea x ($500 x 2 x 7.03 + $4,000 x 2 x 0.77)	6,543
Operating Cost	
496ea x ($3,200 x 2 x 7.03)	22,317
	37,590
1998 - 2046	HK$ '000
Capital Cost of Insulation	
496ea x $17,600	8,730
Maintenance Cost	
496ea x ($500 x 2 x 7.43 + $4,000 x 2 x 0.81)	6,900
Operating Cost	
496ea x ($3,200 x 2 x 7.43)	23,586
	39,216

b. Discount Rate 4%

1998 - 2011	HK$ '000
Capital Cost of Insulation 496ea x $17,600	8,730
Maintenance Cost 496ea x ($500 x 2 x 9.38 + $4,000 x 2 x 1.21)	9,454
Operating Cost 496ea x ($3,200 x 2 x 9.38)	29,776
	47,960

1998 - 2026	HK$ '000
Capital Cost of Insulation 496ea x $17,600	8,730
Maintenance Cost 496ea x ($500 x 2 x 15.1 + $4,000 x 2 x 1.89)	14,990
Operating Cost 496ea x ($3,200 x 2 x 15.1)	47,934
	71,654

1998 - 2046	HK$ '000
Capital Cost of Insulation 496ea x $17,600	8,730
Maintenance Cost 496ea x ($500 x 2 x 18.97 + $4,000 x 2 x 2.4)	18,933
Operating Cost 496ea x ($3,200 x 2 x 18.97)	60,219
	87,882

c. Discount Rate 0%

1998 - 2011	HK$ '000
Capital Cost of Insulation 496ea x $17,600	8,730
Maintenance Cost 496ea x ($500 x 2 x 14 yrs + $4,000 x 2 x 2 times)	14,880
Operating Cost 496ea x ($3,200 x 2 x 15 yrs)	47,616
	71,226

1998 - 2026	HK$ '000
Capital Cost of Insulation	
496ea x $17,600	8,730
Maintenance Cost	
496ea x ($500 x 2 x 29 yrs + $4,000 x 2 x 4 times)	30,256
Operating Cost	
496ea x ($3,200 x 2 x 30 yrs)	95,232
	134,218

1998 - 2046	HK$ '000
Capital Cost of Insulation	
496ea x $17,600	8,730
Maintenance Cost	
496ea x ($500 x 2 x 49 yrs + $4,000 x 2 x 7 times)	52,080
Operating Cost	
496ea x ($3,200 x 2 x 50 yrs)	158,720
	219,530

A4.3.4 Total Costs

Total costs for Option 2 are summarised in Tables A3.6 to A3.8

Table A3.6 - Option 2 Total Cost : Discount Rate 10%

			Direct Costs 1997-2011		Direct Costs 1997-2026	
			Indirect Mitigation Costs		Indirect Mitigation Costs	
			1997-2011	1997-2046	1997-2026	1997-2046
DIRECT MITIGATION	Capital Cost	Barriers	64,008	64,008	64,008	64,008
		Friction Course	-	-	-	-
	Maintenance Cost	Barriers	17,699	17,699	22,499	22,499
		Friction Course	-	-	-	-
Cost of Direct Mitigation			**81,707**	**81,707**	**86,507**	**86,507**
INDIRECT MITIGATION	Capital Cost		8,730	8,730	8,730	8,730
	Maintenance Cost		5,204	6,900	6,543	6,900
	Operating Cost		17,555	23,586	22,317	23,586
Cost of Indirect Mitigation at Receiver			**31,489**	**39,216**	**37,590**	**39,216**
TOTAL COST			**113,196**	**120,923**	**124,097**	**125,723**

Table A4.7 - Option 2 Total Cost : Discount Rate 4%

			Direct Costs 1997-2011		Direct Costs 1997-2026	
			Indirect Mitigation Costs		Indirect Mitigation Costs	
			1997-2011	1997-2046	1997-2026	1997-2046
DIRECT MITIGATION	Capital Cost	Barriers	64,008	64,008	64,008	64,008
		Friction Course	-	-	-	-
	Maintenance Cost	Barriers	30,020	30,020	48,327	48,327
		Friction Course	-	-	-	-
Cost of Direct Mitigation			**94,028**	**94,028**	**112,335**	**112,335**
INDIRECT MITIGATION	Capital Cost		8,730	8,730	8,730	8,730
	Maintenance Cost		9,454	18,933	14,990	18,933
	Operating Cost		29,776	60,219	47,934	60,219
Cost of Indirect Mitigation at Receiver			**47,960**	**87,882**	**71,654**	**87,882**
TOTAL COST			141,988	181,910	183,989	200,217

Table A4.8 - Option 2 Total Cost : Discount Rate 0%

			Direct Costs 1997-2011		Direct Costs 1997-2026	
			Indirect Mitigation Costs		Indirect Mitigation Costs	
			1997-2011	1997-2046	1997-2026	1997-2046
DIRECT MITIGATION	Capital Cost	Barriers	64,008	64,008	64,008	64,008
		Friction Course	-	-	-	-
	Maintenance Cost	Barriers	44,806	44,806	92,812	92,812
		Friction Course	-	-	-	-
Cost of Direct Mitigation			**108,814**	**108,814**	**156,820**	**156,820**
INDIRECT MITIGATION	Capital Cost		8,730	8,730	8,730	8,730
	Maintenance Cost		14,880	52,080	30,256	52,080
	Operating Cost		47,616	158,720	95,232	158,720
Cost of Indirect Mitigation at Receiver			**71,226**	**219,530**	**134,218**	**219,530**
TOTAL COST			**180,040**	**328,344**	**291,038**	**376,350**

A4.4 Option 3 No Direct Mitigation at Siu Lam

A4.4.1 Capital Cost: Direct Mitigation Measures

Lengths of barriers required are taken from Figures 15, 16 and 17. Capital costs are presented in Table A3.9 below

Table A4.9 Option 3 Noise Barrier Capital Costs

Barrier Type	Length	Rate $ per lin.m.			Cost $ x 10^3		
		High	Low	GRC and Acrylic Glass	High	Low	GRC and Acrylic Glass
3m Vertical Barrier	120m	6,990	3,030	5,670	839	364	681
5m Vertical Barrier	490m	42,410	13,920	24,495	20,781	6,821	12,003
Partial Enclosure	250m	75,010	54,750	73,190	18,752	13,687	18,297
Total					**40,372**	**20,872**	**30,981**

A4.4.2 Maintenance Cost: Direct Mitigation Measures

a. Discount Rate 10%

1998 - 2011 HK$ '000

Barriers
$30,981 x 10^3 x 5% x 5.53 8,567

1998 - 2026

Barriers
$30,981 x 10^3 x 5% x 7.03 10,890

b. Discount Rate 4%

1998 - 2011 HK$ '000

Barriers
$30,981 x 10^3 x 5% x 9.38 14,530

1998 - 2026

Barriers
$30,981 x 10^3 x 5% x 15.1 23,391

c. Discount Rate 0%

1998 - 2011	HK$ '000
Barriers $30,981 x 10^3 x 5% x 14 yrs	21,687
1998 - 2026	
Barriers $30,981 x 10^3 x 5% x 29 yrs	44,923

A.4.4.3 Cost of Indirect Mitigation

Up to 601 dwelling units may require insulation

a. Discount Rate 10%

	HK$ '000
1998 - 2011	
Capital Cost of Insulation 601ea x $17,600	10,578
Maintenance Cost 601ea x ($500 x 2 x 5.53 + $4,000 x 2 x 0.62)	6,305
Operation Cost 601ea x ($3,200 x 2 x 5.53)	21,271
	38,154

1998 - 2026	HK$ '000
Capital Cost of Insulation 601ea x $17,600	10,578
Maintenance Cost 601ea x ($500 x 2 x 7.03 + $4,000 x 2 x 0.77)	7,928
Operation Cost 601ea x ($3,200 x 2 x 7.03)	27,041
	45,547

1998 - 2046	HK$ '000
Capital Cost of Insulation 601ea x $17,600	10,578
Maintenance Cost 601ea x ($500 x 2 x 7.43 + $4,000 x 2 x 0.81)	8,360
Operation Cost 601ea x ($3,200 x 2 x 7.43)	28,579
	47,517

b. Discount Rate 4%

1998 - 2011	HK$'000
Capital Cost of Insulation 601ea x $17,600	10,578
Maintenance Cost 601ea x ($500 x 2 x 9.38 + $4,000 x 2 x 1.21)	11,456
Operation Cost 601ea x ($3,200 x 2 x 9.38)	36,080
	58,114

1998 - 2026	HK$ '000
Capital Cost of Insulation 601ea x $17,600	10,578
Maintenance Cost 601ea x ($500 x 2 x 15.10 + $4,000 x 2 x 1.89)	18,163
Operation Cost 601ea x ($3,200 x 2 x 15.10)	58,081
	86,822

1998 - 2046	HK$ '000
Capital Cost of Insulation 601ea x $17,600	10,578
Maintenance Cost 601ea x ($500 x 2 x 18.97 + $4,000 x 2 x 2.40)	22,941
Operation Cost 601ea x ($3,200 x 2 x 18.97)	72,967
	106,486

c. Discount Rate 0%

1998 - 2011	HK$'000
Capital Cost of Insulation 601ea x $17,600	10,578
Maintenance Cost 601ea x ($500 x 2 x 14 yrs + $4,000 x 2 x 2 times)	18,030
Operation Cost 601ea x ($3,200 x 2 x 15 yrs)	57,696
	86,304

1998 - 2026	HK$ '000
Capital Cost of Insulation 601ea x $17,600	10,578
Maintenance Cost 601ea x ($500 x 2 x 29 yrs + $4,000 x 2 x 4 times)	36,661
Operation Cost 601ea x ($3,200 x 2 x 30 yrs)	115,392
	162,631

1998 - 2046	HK$ '000
Capital Cost of Insulation 601ea x $17,600	10,578
Maintenance Cost 601ea x ($500 x 2 x 49 yrs + $4,000 x 2 x 7 times)	63,105
Operation Cost 601ea x ($3,200 x 2 x 50 yrs)	192,320
	266,003

A4.4.4 Total Costs

Total costs for Option 3 are presented in Tables A3.10 to A3.12.

Table A4.10 - Option 3 Total Cost : Discount Rate 10%

			Direct Costs 1997-2011		Direct Costs 1997-2026	
			Indirect Mitigation Costs		Indirect Mitigation Costs	
			1997-2011	1997-2046	1997-2026	1997-2046
DIRECT MITIGATION	Capital Cost	Barriers	30,981	30,981	30,981	30,981
		Friction Course	-	-	-	-
	Maintenance Cost	Barriers	8,567	8,567	10,890	10,890
		Friction Course	-	-	-	-
Cost of Direct Mitigation			**39,548**	**39,548**	**41,871**	**41,871**
INDIRECT MITIGATION	Capital Cost		10,578	10,578	10,578	10,578
	Maintenance Cost		6,305	8,360	7,928	8,360
	Operating Cost		21,271	28,579	27,041	28,579
Cost of Indirect Mitigation at Receiver			**38,154**	**47,517**	**45,547**	**47,517**
TOTAL COST			**77,702**	**87,065**	**87,418**	**89,388**

Table A4.11 - Option 3 Total Cost : Discount Rate 4%

			Direct Costs 1997-2011		Direct Costs 1997-2026	
			Indirect Mitigation Costs		Indirect Mitigation Costs	
			1997-2011	1997-2046	1997-2026	1997-2046
DIRECT MITIGATION	Capital Cost	Barriers	30,981	30,981	30,981	30,981
		Friction Course	-	-	-	-
	Maintenance Cost	Barriers	14,530	14,530	23,391	23,391
		Friction Course	-	-	-	-
Cost of Direct Mitigation			**45,511**	**45,511**	**54,372**	**54,372**
INDIRECT MITIGATION	Capital Cost		10,578	10,578	10,578	10,578
	Maintenance Cost		11,456	22,941	18,163	22,941
	Operating Cost		36,080	72,967	58,081	72,967
Cost of Indirect Mitigation at Receiver			**58,114**	**106,486**	**86,822**	**106,486**
TOTAL COST			**103,625**	**151,997**	**141,194**	**160,858**

Table A4.12 - Option 3 Total Cost : Discount Rate 0%

			Direct Costs 1997-2011		Direct Costs 1997-2026	
			Indirect Mitigation Costs		Indirect Mitigation Costs	
			1997-2011	1997-2046	1997-2026	1997-2046
DIRECT MITIGATION	Capital Cost	Barriers	30,981	30,981	30,981	30,981
		Friction Course	-	-	-	-
	Maintenance Cost	Barriers	21,687	21,687	44,923	44,923
		Friction Course	-	-	-	-
Cost of Direct Mitigation			**52,668**	**52,668**	**75,904**	**75,904**
INDIRECT MITIGATION	Capital Cost		10,578	10,578	10,578	10,578
	Maintenance Cost		18,030	63,150	36,661	63,105
	Operating Cost		57,696	192,320	115,392	192,320
Cost of Indirect Mitigation at Receiver			**86,304**	**266,003**	**162,631**	**266,003**
TOTAL COST			138,972	318,671	238,535	341,907

A.4.5 No Direct Mitigation

A4.5.1 Cost of Indirect Mitigation

Up to 740 dwelling units may require insulation

a. Discount Rate 10%

1998 - 2011	HK$ '000
Capital Cost of Insulation 740ea x $17,600	13,024
Maintenance Cost 740ea x ($500 x 2 x 5.53 + $4,000 x 2 x .62)	7,763
Operating Cost 740ea x ($3,200 x 2 x 5.53)	26,190
	46,977

1998 - 2026	
Capital Cost of Insulation 740ea x $17,600	13,024
Maintenance Cost 740ea x ($500 x 2 x 7.03 + $4,000 x 2 x 0.77)	9,761
Operating Cost 740ea x ($3,200 x 2 x 7.03)	33,294
	56,079

1998 - 2046	
Capital Cost of Insulation 740ea x $17,600	13,024
Maintenance Cost 740ea x ($500 x 2 x 7.43 + $4,000 x 2 x 0.81)	10,293
Operating Cost 740ea x ($3,200 x 2 x 7.43)	35,189
	58,506

b. Discount Rate 4%

1998 - 2011	HK$ '000
Capital Cost of Insulation	
740ea x $17,600	13,024
Maintenance Cost	
740ea x ($500 x 2 x 9.38 + $4,000 x 2 x 1.21)	14,104
Operating Cost	
740ea x ($3,200 x 2 x 9.38)	44,424
	71,552
1998 - 2026	
Capital Cost of Insulation	
740ea x $17,600	13,024
Maintenance Cost	
740ea x ($500 x 2 x 15.1 + $4,000 x 2 x 1.89)	22,363
Operating Cost	
740ea x ($3,200 x 2 x 15.1)	71,514
	106,901
1998 - 2046	
Capital Cost of Insulation	
740ea x $17,600	13,024
Maintenance Cost	
740ea x ($500 x 2 x 18.97 + $4,000 x 2 x 2.4)	28,246
Operating Cost	
740ea x ($3,200 x 2 x 18.97)	89,842
	131,112

c. Discount Rate 0%

1998 - 2011	HK$ '000
Capital Cost of Insulation	
740ea x $17,600	13,024
Maintenance Cost	
740ea x ($500 x 2 x 14 yrs + $4,000 x 2 x 2 times)	22,200
Operating Cost	
740ea x ($3,200 x 2 x 15 yrs)	71,040
	106,264

1998 - 2026

Capital Cost of Insulation	
740ea x $17,600	13,024
Maintenance Cost	
740ea x ($500 x 2 x 29 yrs + $4,000 x 2 x 4 times)	45,140
Operating Cost	
740ea x ($3,200 x 2 x 30 yrs)	142,080
	200,244

1998 - 2046

Capital Cost of Insulation	
740ea x $17,600	13,024
Maintenance Cost	
740ea x ($500 x 2 x 49 yrs + $4,000 x 2 x 7 times)	77,700
Operating Cost	
740ea x ($3,200 x 2 x 50 yrs)	236,800
	327,524

APPENDIX 5

SAMPLE CALCULATION FOR MITIGATION OF CONSTRUCTION NOISE

APPENDIX 5
SAMPLE CALCULATION FOR MITIGATION OF CONSTRUCTION NOISE

Predicted maximum construction noise levels at Noise Sensitive Receiver Yee On Home for Senior Citizens (YO) are very high, at over 90 dB(A) for most construction activities. The following sample calculations indicate one possible combination of measures that could be implemented to control noise levels from the construction of partial enclosures in front of YO.

In order to reduce the maximum anticipated construction noise at YO to an acceptable level, the following measures may be used:

(a) Reduce the items of powered mechanical equipment;
(b) Fit more efficient exhaust sound reduction equipment;
(c) Keep closed the machine's enclosure panels;
(d) Acoustically dampen panels and covers;
(e) Erect acoustic screen between the machine and the receivers, though it may be difficult due to site constraints at YO;
(f) Use super-silenced generator of the vibratory poker in acoustic enclosure.

The measures assumed for the purpose of this example are identified as measures A to E:

	Sound reduction
A. Fit more efficient exhaust or sound reduction equipment	5 - 10 dB(A)
B. Keep closed the machine's enclosure panels Acoustically dampen panels and covers.	5 - 10 dB(A)
C. Erect acoustic screen between the machine and noise - sensitive receiver	Up to 15 dB(A)
D. Enclose the power generator of the vibratory poker in acoustic enclosure	Up to 20 dB(A)

E. User super silenced mobile crane, SWL about 90 dBA (Based on a recent noise measurement by the Consultants)

The above measures are then applied to the construction equipment requirements for the various construction activities (see Table 4.3), as indicated in Table A4.1 below:

Table A5.1 - Mitigated Construction Activities

Activity	Equipment	Mitigation
Piling (5m barrier and partial enclosure only)	Bored piling rigs Mobile cranes Pump trucks Concrete mixer trucks Vibratory pokers	A, C, reduce the quantity from 2 to 1 E B, C C, reduce the quantity from 2 to 1 C, D, reduce the quantity from 4 to 1
Pile cap/strip foundation construction (All barriers + partial enclosures)	Excavator (Backhoes) Dump trucks Concrete mixer trucks Vibratory pokers Dewatering pump Compressor	A, B, C C C, reduce the quantity from 2 to 1 C, D, reduce the quantity from 4 to 1 A, B, C
Structural frame construction (Concrete) (All barriers + partial enclosures)	Compressor Concrete pump truck Concrete mixer truck Vibratory pokers Crane	A, B, C C C C, D, reduce the quantity from 4 to 2 C, E
Structural frame erection (Steel) (5m barrier and partial enclosure only)	Mobile cranes Compressor	E A, B, C

The anticipated noise reductions for each item of equipment based on BS5228:1984 after implementation of each of the above measures, and the overall noise reductions for the various construction activities are presented on Table A4.2. The maximum noise level at YO is 75.3dB(A), slightly over the 75dB(A) guideline.

Table A5.2 (Part 1) - Noise Reduction Calculation for Construction Noise at NSR YO

Activity	Piling (5m barrier and partial enclosure only)										
	SWL dB(A) per piece	% on time	K(T) adjustment	SWL per piece	No. of pieces	SWL (total)	Screen effect	Distance (m)	Distance Correction	Facade Correction	Facade Noise Level
Bored piling rigs	105.0	100%	0.0	105.0	1	105.0	15	8	-26.1	3	66.9
Mobile cranes	90.0	100%	0.0	90.0	1	90.0	0	8	-26.1	3	66.9
Pump trucks	109.0	50%	-3.0	106.0	1	106.0	15	8	-26.1	3	67.9
Concrete mixer trucks	107.0	80%	-1.0	106.0	1	106.0	15	8	-26.1	3	68.0
Vibratory pokers	112.0	75%	-1.2	110.8	1	110.8	20	8	-26.1	3	67.7
					Total SWL:	113.6				Overall Facade Noise Level:	74.5
Activity	**Pile cap/strip foundation construction (All barriers + partial enclosures)**										
Excavator (Backhoes)	109.0	85%	-0.7	108.3	1	108.3	15	8	-26.1	3	70.2
Dump trucks	109.0	20%	-7.0	102.0	2	105.0	15	8	-26.1	3	67.0
Concrete mixer trucks	107.0	80%	-1.0	106.0	1	106.0	15	8	-26.1	3	68.0
Vibratory pokers	112.0	75%	-1.2	110.8	1	110.8	20	8	-26.1	3	67.7
Dewatering pump	100.0	100%	0.0	100.0	1	100.0	15	8	-26.1	3	61.9
Compressor					Total SWL:	114.3				Overall Facade Noise Level:	74.7

Note: Results are in dB(A) unless otherwise indicated.

Table A5.2 (Part 2) - Noise Reduction Calculation for Construction Noise at NSR YO

Activity	Structural frame construction (Concrete)										
	SWL dB(A) per piece	% on time	K(T) adjustment	SWL per piece	No. of pieces	SWL (total)	Screen effect	Distance (m)	Distance Correction	Facade Correction	Facade Noise Level
Compressor	105.0	100%	0.0	100.0	1	100.0	15	8	-26.1	3	61.9
Concrete pump truck	107.0	100%	0.0	107.0	1	107.0	15	8	-26.1	3	68.9
Concrete mixer truck	107.0	80%	-1.0	106.0	2	109.0	15	8	-26.1	3	71.0
Vibratory pokers	112.0	75%	-1.2	110.8	2	113.8	20	8	-26.1	3	70.7
Crane	90.0	100%	0.0	90.0	1	90.0	15	8	-26.1	3	51.9
					Total SWL:	115.8				Overall Facade Noise Level:	75.3
Activity	Structural frame erection (Steel)										
Mobile cranes	90.0	100%	0.0	90.0	2	93.0	0	8	-26.1	3	69.9
Compressor	100.0	100%	0.0	100.0	1	100.0	5	8	-26.1	3	71.9
					Total SWL:	100.8				Overall Facade Noise Level:	74.1

Note: Results are in dB(A) unless otherwise indicated.

APPENDIX 6

DWELLING UNITS MEETING ELIGIBILITY CRITERIA FOR CONSIDERATION FOR EQUITABLE REDRESS

APPENDIX 6 - DWELLING UNITS MEETING ELIGIBILITY CRITERIA FOR CONSIDERATION FOR EQUITABLE REDRESS

Table 6.1 - Dwelling Units Meeting Eligibility Criteria for Consideration for Equitable Redress

NSR	Storey/Elevation	No. of Dwelling Units Represented	Units Meeting Eligibility Criteria		
			Option 1	Option 2	Option 3
SLH	3F/67mPD	10	6	6	6
AP1	2F/30mPD	12	0	12	12
CSQ1	5F/49mPD	14	14	14	14
CSQ2	4F/46mPD	8	8	0	8
CSQ3	4F/44mPD	6	0	0	0
CSQ4	4F/32mPD	4	0	0	4
MPQ	8F/26mPD	68	0	0	68
VH1*	3F/18mPD	23	0	0	0
CB1	2F/26mPD	11	0	11	11
CB2	2F/26mPD	10	0	0	10
TW	2F/25mPD	3	0	0	3
DM	2F/18mPD	12	0	0	12
AP2	2F/34mPD	2	2	2	2
CP	6F/32mPD	36	36	36	36
IV	3F/26mPD	4	4	4	4
FG	3F/31mPD	38	38	38	38
SG	2F/28mPD	18	18	18	18
VH2	1F/23mPD	16	16	16	16
KP	2F/29mPD	21	0	21	21
CDA	15F/52.5mPD	N/A	-	-	-
VH3	2F/39mPD	7	0	0	0
TS	1F/23mPD	3	0	0	0
PC	15F/53mPD	21	21	21	21
PCM	7F/31mPD	48	0	16	16
PCL	GF/13mPD	21	0	0	0
PI1	3F/38mPD	8	8	8	8
PI2	3F/38mPD	8	0	0	0
PI3	3F/38mPD	12	0	0	0
PI4	3F/38mPD	10	0	0	0
AP3	3F/25mPD	15	0	0	0
AP4	2F/19mPD	2	0	0	0
AP5	3F/22mPD	9	0	0	0
YO	2F/22mPD	11	0	0	0
BP	3F/24mPD	16	0	0	0
VH4	2F/9mPD	5	0	0	0
GC1	25F/75mPD	24	24	24	24
GC1M	12F/34.5mPD	48	48	48	48
GC1L	GF/7.5mPD	24	24	24	24
GC2	25F/75mPD	24	24	24	24
GC2M	12F/34.5mPD	48	48	48	48
GC2L	GF/7.5mPD	24	24	24	24
GC3	25F/75mPD	24	24	24	24
GC3M	12F/34.5mPD	48	48	48	48
GC3L	GF/7.5mPD	24	0	0	0
VH5	2F/33.5mPD	2	0	0	0
VH6	2F/19.5mPD	5	5	5	5
VH7	GF/4.7mPD	6	0	0	0
VH8	GF/4.7mPD	4	4	4	4
PSPS	GF/30mPD	N/A	-	-	-

* NSR scheduled for redevelopment