5. ASSESSMENT FOR MITIGATION MEASURES ON TSING TSUEN BRIDGE

5.1 Identification of Noise Sensitive Receivers (NSRs)

5.1.1 Tsing Tsuen Bridge consists of a dual two lane carriageway which forms a link between Tsing Yi North and Tsuen Wan. The eastern and western approaches of the bridge is a major noise source for the residents in Riviera Gardens adjacent to the eastern approach road and Tsing On TIIA and Cheung On Estate adjacent to the western approach.

5.1.2 Based on site surveys, existing representative NSRs were identified along the alignment and shown in Fig 5-1 & 5.2. Details of these NSRs is provided as follows:

NSR ID	Name of Building	No. of Storey	No. of Dwellings per Floor
OM	On Mei House	34	24
OP	On Pak House	34	24
OC	On Chiu House	34	24
SP	St. Paul's Village	3	1
A	Hoi Nga Mansion	40	8
B	Hoi Kwu Mansion	40	8
C	Hoi Sing Mansion	40	8
D	Hoi Fung Mansion	40	8
E	Hoi Wai Mansion	40	8
F	Hoi Yat Mansion	40	8
G	Hoi Kwai Mansion	40	8
H	Hoi Yin Mansion	40	8
J	Hoi Yue Mansion	40	8

5.1.3 Planned receivers including the Villa Esplanada and Tierra Verde on both sides of the western approach of Tsing Tsuen Road Bridge were not identified as NSRs in the Study and the noise impacts have been/would be addressed in their respective noise impact assessments.

5.2 Traffic Noise Impact Assessment

Tsing Tsuen Road

The prevailing road traffic noise levels at the representative NSRs at both ends of Tsing Tsuen Road in year 1998 are shown in Table 3 of Appendix A1. About 2606 dwellings are predicted to be exposed to noise levels exceeding the HKPSG by up to 11 dB(A). The highest overall noise level of 81 dB(A) is predicted to be around the fifth floor of C-2, a sensitive facade overlooking the heavy trafficked flyover. The noise levels at the rest of the facades range between 62 to 80 dB(A).

Noise levels at NSR SP are within the 70 dB(A) criterion and therefore noise mitigation measures are not required.

5.3 Proposed Mitigation Scenarios for Engineering Consideration

5.3.1 In order to mitigate the noise impact at the upper-floor receivers along Tsing Tsuen Bridge, two effective mitigation options were identified in the Technical Paper for Traffic Noise Impact Assessment (Appendix A1) assuming enclosure posts were located at the edges of the flyovers and were described as follows:

Option I: Two 5.5m high partial enclosures to be located along the eastbound carriageway in front of Riviera Gardens and Cheung On Estate as shown in Figure 3.7 & 3.8 of Appendix A1.

Option II: Instead of two partial enclosures covering the eastbound carriageway, two partial enclosures covering the entire flyover to be located along the same extent and location as *Option I*. The typical configuration of this type of partial enclosure is shown in Figure 3.9 of Appendix A1.

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

5.3.3 With partial enclosures, the use of absorptive barrier panels along the side and with transparent reflective panels at the canopy are considered more appropriate in order to minimise the effect of noise reflection through the open edges of the partial enclosures and/or through the clearance between the edge of flyover and independent structure.

5.4 Engineering Feasibility

5.4.1 Both mitigation options involved the erection of noise enclosures on the existing flyover. The original design calculations of the flyovers have been examined in the HyD office. Preliminary assessment was carried out to examine the capacity of the flyover structures for resisting additional lateral loads, i.e. wind loads, acting on the noise barriers under the current highways design standard.

5.4.2 It was revealed that the original design of the flyover structures did not allow for any future provisions of noise barriers. The structural design was also carried out before the issue of SDM in 1993 which is in fact more stringent in loading requirement than before. As any modification works from the barrier installation would inevitably put on extra stresses to the existing structure, the structure after modification is unlikely to meet the design standard of SDM.

5.4.3 As advised by HyD/Structure during the First SMG Meeting held on 11.9.98, any additional loading to existing flyovers designed before August 1993 should not degrade the current structural analysis. However, depending on the results of structural analysis, HyD may accept a less stringent approach. Whilst the portion of the structure would need to be strengthened to cater for the new barrier, it may not be necessary to upgrade the whole flyover to meet the new design standard.

5.4.4 In this regard, structural assessment of the existing flyovers were carried out and the assessment calculations were given in Appendix C. The assessment indicated that the overstress caused by the additional loading from the proposed barrier would be quite significant and in the order of 100%. In order to rectify the overstress condition, the following strengthening works have been identified:

- demolition and reconstruction of edge parapet of the bridge deck;
- casting additional slabs to the underside of the cantilever flanges. Extensive drilling is required for the dowel bar installation;
- installing additional prestress tendons and anchor blocks within the void of the deck; and
- reconstruction of the bridge bearings, plinths and fixings.

The general layout of strengthening works were illustrated in Fig. 5-12.

The above strengthening works, in particular the replacement of bridge bearings, would require the bridge closure for a substantial period of time i.e. about 6 months. Meanwhile, significant alternation works, in particular the extensive drilling and breaking operations on the bridges, would pose a significant hazard to the structural integrity of existing structures. Therefore, the proposed strengthening works were not considered as practical and desirable. Independent structure should be considered to support the proposed noise enclosures instead.

5.4.5 The use of external support to strengthen the existing flyover has also been considered in order to minimize the extent of direct modification works on the flyover. This would involve the external mounting of partial enclosure structural frame onto the bridge deck and installation of steel props and bracing along the span to support the bridge deck for the additional loading. The conceptual arrangement is illustrated in Fig. 5-13. However, the arrangement would not be considered as feasible because of the following constraints:

- the extent of structural interaction and load sharing between the existing support system and the external support system cannot be quantified. Although it may be possible to replace the whole existing support system by the external support system, the cost effectiveness would not be justified.

- the space underneath the flyover may not be available for the construction and installation of the external support system. In the case of Tsing Yi Approach Section, the space underneath the Tsing Tsuen Bridge is under MTRC jurisdiction and therefore is not available for use.

- the construction traffic access and lifting would be restricted by the available headroom underneath the flyover.

- the extensive use of steel frame underneath the flyovers would have adverse visual impact to the surrounding environment.

- the installation of external support system would pose constraints to future inspection and maintenance of the existing flyover.

5.4.6 In general, no noise mitigation measures could be erected directly on the flyover due to structural constraints and based on experience on other flyover projects, it would be unlikely practicable to install noise mitigation measures to existing flyovers as additional loading of the measures are usually not allowed in the flyover design. Strengthening of the flyover were also not considered as a feasible option. Therefore, it is recommended the proposed mitigation measures should be supported on independent structure located alongside the existing flyover without affecting the existing flyover structure. In the following section, the feasibility of providing the independent support structure is further examined.

5.4.7 Buildability

Tsing Yi Approach Section

5.4.7.1 Independent support structures for the barriers or enclosures on the western approach of the flyover, i.e. the approach structure on Tsing Yi side, was highly constrained by the availability of lands for its construction.. As indicated in Fig. 5-10, the independent structure will be in conflict with the existing road and MTRC's access road (i.e. EVA) underneath the flyover and encroach into the boundary of Cheung On Estate. In addition, the independent structure will also be in conflict with the 11kVs power cables and main drainage pipe of 900 mm diameter underground as shown in Fig. 5-6 & 5-8.

5.4.7.2 HD have been consulted with regard to the installation of the proposed barriers within the boundary of Cheung On Estate. HD indicated in their letter ref. HD(P)1/2/16 dated 12.10.98 that they generally support the proposal to mitigate traffic noise from Tsing Tsuen Road. However, since over 70% of domestic flats in Cheung On Estate have been sold under the Tenants Purchase Scheme, any proposed mitigating measures would require the consent of the Housing Authority and owners of domestic units.

5.4.7.3 DSD have also been consulted on the potential conflict between the barrier independent support structure and the 900 mm diameter drainage pipe. It was noted from DSD's letter ref. ( ) in MS 8/CE95/97 dated 22.10.98 that they would consider the situation when diversion proposal was submitted to them.

5.4.7.4 Based on the above consideration, only the section of noise barriers within the boundary of Cheung On Estate could be assumed feasible for erection at this stage and would be put forward for review in acoustic effectiveness. The feasible extent and location of independent structure is as shown in Fig 5-3 (Sheet 1) and 5-5. The land requirement plan is shown in Fig. 5-14.

Tsuen Wan Approach Section

5.4.7.5 The feasible extent and location of the proposed barriers on the eastern approach of the flyover, i.e. the approach structure on Tsuen Wan side, with independent support structure were further examined for other constraints at grade on site and is shown in Fig. 5-3(Sheet 2), 5-4 & 5-5. The land requirement plan is shown in Fig. 5-15.

5.4.7.6 Details of the existing utilities and services including stormwater drains and sewers within the study area have been obtained from various utility companies and government departments. The layout of drainage and sewerage are shown in Fig. 5-6 & 5-7. The layout of existing utilities and services are shown in Fig. 5-8 & 5-9. It was found that the extent and location of the barriers in general did not have major impact on the existing drainage, utilities and services.

5.4.7.7 Details of land status in the vicinity of the flyover are shown in Fig. 5-10 and 5-11. The extent and location were constrained by the adjacent boundary of Riviera Gardens, RSD's recreational ground, cargo handling area and staircase access. The extent given in Fig. 5-3 assumed that the part of the RSD's recreational ground can be resumed for the installation of independent support structure in order to maximise the extent of noise coverage for further review of acoustic effectiveness.

5.4.7.8 RSD have been consulted on the above issue. It was indicated in their letter ref. (26)in RSD 1/TW 866/90 III dated 9/11/98 that the proposed barrier location might not intrude into RSD's recreational ground as observed by them on site. However, during construction, some of the lands may be affected. In that situation, the operation of facilities and users of the venues should not be affected.

5.4.7.8 Piled foundation would generally be required for supporting the independent structure because of space limitation and its height and a minimum working space of 10 m width should be provided for the piling operation and construction. A further clearance of 2 m should be provided between the barriers and the flyover structure for future access of inspection and maintenance staffs.

5.4.8 Traffic Engineering

5.4.8.1 The sitting of the proposed barriers on independent structure did not degrade the existing highway clearance to fall below the absolute minimum requirement as stated in the TPDM. The visibility of road users are generally maintained with the independent structure. The flyover does not have bus stop and pedestrian crossing within the study section.

5.4.9 Traffic Management During Construction

5.4.9.1 The proposed location of barriers would not have any significant impact on the existing traffic within the Study areas

5.4.10 Safety

5.4.10.1 The proposed barriers did not impose any potential hazard or reduce the degree of safety. Impacts on pedestrian safety, accessibility for emergency vehicles, fire fighting and rescue operation, loading/unloading activities etc. were insignificant with the proposed extent and location in Fig.5-3.

5.5 Review on Acoustic Effectiveness and Findings

5.5.1 Following the engineering assessment based on physical constraints on site, the feasible extent and location of the barriers is given in Fig. 5-3 and traffic noise impact assessment was reviewed to assess their acoustic effectiveness. Details of the assessment is provided in the Supplementary Paper to the Traffic Noise Impact Assessment in Appendix A2.

Tsing Yi Approach Section

5.5.2 The findings of the assessment indicated that the proposed extent of location of the barriers could only provide 12% of protection for the affected dwellings. Although the level of protection is low, it would still be a feasible option for noise reduction from engineering perspective, subject to the priority of project funding and future consultation with the public and concerned departments.

Tsuen Wan Approach Section

5.5.3 The findings of the assessment indicated that the proposed extent of location of the barriers could provide 46% of protection for the affected dwellings. However, it would be feasible to construct the mitigation measures from engineering perspective. Other side effects such as air quality, visual and landscape impacts would be assessed in the following sections.

5.6 Air Quality Assessment

5.6.1 Air quality assessment has been carried out for the proposed partial enclosure locations and details are given in Appendix B. The assessment results indicated that there was no adverse impact on the air quality due to the installation of partial enclosures.

5.7 Visual/Landscape Assessment

5.7.1 The scale of independent structure for the proposed barrier adjacent to the flyover, which is of 20m high, would be visually intrusive to the adjacent residents, pedestrians and users in the RSD recreational ground.

5.7.2 The independent structures would also necessitate the loss of trees and vegetation alongside the flyover and embankment where the barrier posts are located.

5.7.3 As the landscape character is well established, the visual/landscape impact of noise barrier and independent structure would be significant. Measures to reduce visual/landscape impacts will be developed for the generic design of the noise mitigation measures and for submission to the ACABAS for in-principle approval.

5.8 Environmental Gains and Losses Account

5.8.1 The environmental gains and losses of the recommended noise barriers to the flyover is summarised below:

Environmental Losses	Environmental Gains	Mitigation Measures
• Visual intrusion due to replacement of tree with noise enclosures and its support structure. • Visual confinement of pedestrians and vehicles. • Landscape loss of tree and planting. • May have localized effects on the air quality but with no significant degradation of air quality at the exposed facades. • Encroach into playground adjacent to Cheung On Estate.	• 12% of exposed facades can be protected in terms of noise attenuation at the Tsing Yi approach. • 46% of exposed facades can be protected in terms of noise attenuation at the Tsuen Wan approach. • Screening of traffic for high-rise residents.	• Sensitive design of noise mitigation to integrate it within the existing visual and landscape context. • Screening and amenity planting. • Reprovisioning of affected playground at Cheung On Estate

5.9 Cost Estimation

5.9.1 Tsuen Wan Approach

5.9.1.1 The direct construction cost for the proposed partial noise enclosures of 125m Type I and 160m Type II approximate in length as shown in Fig. 5-3 (Sheet 2), 5-4 & 5-5 have been estimated based on the rates at December 98 Price Level and is summarised in the following table:

Item	Quantity	Unit	Rate (HK$)	Amount (HK$)
Excavation	290	m^3	100	29,000
Backfilling and Compaction	290	m^3	50	14,500
Formwork, Class F2	335	m^2	280	93,800
Formwork, Class F5	355	m^2	450	159,750
Blinding	26	m^3	880	22,880
Concrete Grade 30/20	590	m^3	930	548,700
Reinforcement	139	t	5,000	695,000
Structural Steelwork	1,954	t	25,000	48,850,000
Noise Barrier Sheeting	8,540	m^2	2,500	21,350,000
800 dia. Bored Piles	860	m	7,400	6,364,000
1200 dia. Bored Piles	825	m	10,000	8,250,000
Sub-Total				86,377,630
Add 20% for General Preliminaries & Site Safety				17,300,000
Total Base Cost Estimate (Dec 1998 Price Level)				103,677,630 (HK$103.7M)

5.9.1.2 The indirect construction cost including cost for utilities, street furniture and traffic diversion is assumed to be 20% of the direct construction cost and estimated to be HK$20.7M.

5.9.1.3 Total construction cost is estimated to be **HK$124.4M** at Dec 98 Price Level.

5.9.1.4 The recurrent costs including the annual maintenance cost and annual staff cost at Dec 97 Price Level as obtained from HyD/Str are summarised as below:

Annual maintenance cost	–	HK$227.6/sq.m x 6871 sq.m =	HK$1.57M
Annual staff cost	–	HK$68.3/sq.m x 6871 sq.m =	HK$0.47M

5.9.2 Tsing Yi Approach

5.9.2.1 The direct construction cost for the proposed partial noise enclosures of 150m Type II approximate in length as shown in Fig. 5-3(Sheet 1) & 5-5 have been estimated based on the rates at December 98 Price Level and is summarised in the following table:

Item	Quantity	Unit	Rate (HK$)	Amount (HK$)
Excavation	210	m^3	100	21,000
Backfilling and Compaction	210	m^3	50	10,500
Formwork, Class F2	210	m^2	280	58,800
Formwork, Class F5	210	m^2	430	90,300
Blinding	16	m^3	880	14,080
Concrete Grade 30/20	413	m^3	930	384,090
Reinforcement	98	t	5,000	490,000
Structural Steelwork	1,693	t	25,000	42,325,000
Noise Barrier Sheeting	3,420	m^2	2,500	8,550,000
1200 dia. Bored Piles	775	m	10,000	7,750,000
Sub-Total				59,693,770
Add 20% for General Preliminaries & Site Safety				11,939,000
Total Base Cost Estimate (Dec 1998 Price Level)				71,632,770 (HK$71.7M)

5.9.2.2 The indirect construction cost including cost for utilities, street furniture and traffic diversion is assumed to be 20% of the direct construction cost and estimated to be HK$14.3M.

5.9.2.3 Total construction cost is estimated to be **HK$86M** at Dec 98 Price Level.

5.9.2.4 The recurrent costs including the annual maintenance cost and annual staff cost at Dec 97 Price Level as obtained from HyD/Str are summarised as below:

Annual maintenance cost	=	HK$227.6/sq.m x 2340 sq.m =	HK$0.54M
Annual staff cost	=	HK$68.3/sq.m x 2340 sq.m =	HK$0.16M