HONG KONG GOVERNMENT
ENVIRONMENTAL PROTECTION DEPARTMENT

Agreement No.: CE 95/97

Noise Mitigation Measures on Existing Flyovers

Feasibility Study

Final Report

August 1999

MAUNSELL CONSULTANTS ASIA LTD

Environmental Protection Department

Agreement No. CE 95/97

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

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1. INTRODUCTION

1.1 Background

1.1.1 In January 1994, the Government carried out the second review of the 1989 White Paper "Pollution in Hong Kong - A Time to Act" and identified the need to review the practicability of reducing noise impacts due to traffic on existing roads. As a consequence, a two-stage study was launched to assess the feasibility of reducing traffic noise using direct technical remedies.

1.1.2 The Stage 1 "Scoping Study for Providing Retroactive Road Traffic Noise Mitigation Measures" was completed in December 1996 and a list of roads with potential for retroactive noise mitigation was identified. The Stage 2 "Feasibility Study for Providing Retroactive Road Traffic Noise Mitigation Measures" continued to assess the engineering feasibility of the recommendations made in Stage 1 study and was completed in mid 1998.

1.1.3 Flyovers were specifically excluded from both of these studies. As most of the existing flyovers were located in densely populated areas and largely sat on top of other roads, independent structures for noise mitigation such as barriers and enclosures were considered impractical. However with the latest engineering know-how, direct remedies on existing flyovers do not appear to be infeasible. Subsequently, a separate study was commissioned in October 1996 and is referred as "Scoping Study for Providing Direct Technical Remedies on Existing Flyovers" (hereafter called 'Scoping Study').

1.1.4 In the Scoping Study, a total of 188 existing flyovers were examined. Taking into account the location of flyovers, government constraints, special requirements and acoustic effectiveness of the direct noise mitigation measures, 11 flyovers were recommended for further investigation. In order to optimize the utilization of resources and to meet the tight time frame, 3 of these flyovers have been selected for a detailed assessment of engineering feasibility in providing direct technical remedies, namely, Kwai Chung Road Flyover, Ap Lei Chau Bridge and Tsing Tsuen Bridge. The selection covers typical flyover-receiver configurations, type of direct technical remedies and both high/low implementation priorities.

1.1.5 Feasibility Study on Kwai Chung Road Flyover has recently been completed by the same Consultant Team under the supplementary assignment in the "Feasibility Study for providing Retroactive Road Traffic Noise Mitigation Measures". The other two flyovers, namely Ap Lei Chau Bridge and Tsing Tsuen Bridge, are covered by the assignment in this feasibility study. The findings on the three flyovers would be presented in the Final Report in this study.

1.2 The Assignment

1.2.1 Maunsell Consultants Asia Ltd. in association with Enpac Ltd., Hassell Ltd. and Consolidated Consulting Engineers Ltd. were commissioned by the Environmental Protection Department (EPD) to perform the Study under Agreement No. CE 95/97 in June 1998. The overall study is under the management of the Noise Management and Policy Group (NMPG) within EPD.

1.2.2 The Study is primarily focused on the engineering feasibility providing noise mitigation measures such as barriers and enclosures on the two existing flyovers. Study results of the separate study on Kwai Chung Road Flyover under "Feasibility Study for Providing Retroactive Road Traffic Noise Mitigation Measures" would also be incorporated into this Study Report. The findings of the Study would form the basis for the formulation of implementation strategy to tackle traffic noise from existing flyovers.

1.2.3 The specific objectives, approach, methodology, task definition, liaison, and programme of the Study were covered in the Inception Report issued in 13th July 1998. Services as stated in Clause 6 of the Brief of the Agreement No. CE 95/97 were provided.

1.3 Structure of the Report

1.3.1 This report summaries, concludes and generalises the findings of the above assignment and is divided into the following sections.

1.3.2 Section 1 introduces the background and objectives of the Study.

1.3.3 Section 2 highlights the methodology adopted in the Scoping Study on Existing Flyovers and the changes since the completion of the Scoping Study.

1.3.4 Section 3 outlines the approach and methodology adopted in the Study.

1.3.5 Section 4, 5 & 6 describe the scheme development process for the selection of appropriate and effective direct technical mitigation measures at the three existing flyovers, including Ap Lei Chau Bridge, Tsing Tsuen Bridge and Kwai Chung Road Flyover.

1.3.6 Section 7 presents the simplified assessment procedures for providing noise mitigation measures on existing flyovers in a more generalised basis.

1.3.7 Section 8 outlines the development of priority ranking system.

1.3.8 Section 9 provides recommendations on implementation strategy.

1.3.9 Section 10 summarises the findings of the above and give recommendation if applicable for any further site investigation, surveys and study necessary to fulfil the Objectives of the Study.

2. REVIEW OF SCOPING STUDY ON EXISTING FLYOVERS

2.1 Methodology

2.1.1 In October 1996, ERM Hong Kong was commissioned by EPD to carry out the Scoping Study for providing noise mitigation measures on existing flyovers.

2.1.2 Data on all of the flyovers within the Territory were collected for analysis in the study. The selection of suitable flyovers for consideration with direct technical measures were divided into three major steps:

- to identify a list of flyovers that are suitable for further consideration with regard to the provision of direct technical remedies through a coarse screening of all flyovers in the territory;
- to assess the constraints in design and implementation of each mitigation measure to satisfy the requirements of various Government departments; and
- to predict the noise levels at the worst affected Noise Sensitive Receivers (NSRs).

2.1.3 The results of these three steps were used to prepare a list of recommended flyovers to which direct technical measures could be applied to bring environmental improvements to nearby NSRs. In each case, the recommendations included:

- the optimal form of the direct technical remedies;
- cost estimates for the remedies; and
- the likely noise reduction and number of dwellings to be benefited with the measures in place.

2.1.4 Seven key tasks were completed and they included the following sections:

2.1.5 Task 1 - Coarse Screening of Noisy Flyovers

2.1.5.1 A total of 188 flyovers in the territory were subjected to a multi-factor coarse screening process. Flyovers were excluded form further consideration if they met any one of the following three criteria:

- ***Location of flyovers:***

  Flyovers which are located within Central Business District (CBD) and industrial and business areas were excluded from the review as commercial and industrial developments are not considered to be noise sensitive.

- ***Use of noise mitigation measures:***

  Flyovers with existing direct technical remedies to reduce noise levels were excluded from the review.

- ***Completion of an Environmental Impact Assessment (EIA):***

  Flyovers which had been subject to an EIA on or before 1997 were excluded from further consideration.

2.1.6 Task 2 - Assessment of Government Constraints for Direct Technical Remedies

2.1.6.1 Consideration was given to the special requirements of the various Government departments including the Highways Department (HyD), Transport Department (TD) and Fire Services Department (FSD).

2.1.6.2 Site visits were also conducted to collect the required information for the appraisal of physical site conditions and the effect that these constraints would have on the implementation of the mitigation measures. Heavily constrained flyovers that the necessary requirements could not be satisfied were excluded from further study.

2.1.7 Task 3 - Prediction of Noise Levels at the Nearest NSRs

2.1.7.1 It is noted that the current policy does not require protection of NSRs to redress the traffic noise problem arising from existing roads. Whilst road traffic noise problem was more amenable through planning process, for the purpose of analysing noise from existing roads, it was considered appropriate to adopt similar criteria for planning new roads or designating new NSRs. Those criteria according to the HKPSG required that the noise level L10(1hr) at the external facade due to road traffic should not exceed 70 dB(A) for domestic premises.

2.1.7.2 Calculation of Road Traffic Noise (CRTN) procedures, as published by the UK Department of Transport, were used to predict the noise levels at the nearest NSRs. Further consideration would be performed if the flyover was the dominant source of noise in the vicinity and that the noise level L10(1hr) at the external facade exceeded Hong Kong Planning Standard and Guidelines (HKPSG) Criteria for domestic premises.

2.1.8 Task 4 - Assessment of Direct Technical Remedies

2.1.8.1 The effectiveness of the potential direct technical measures including vertical barriers, cantilevered barriers, semi-enclosure, and full enclosures were assessed using CRTN procedures where the flyovers were suitable for treatment. It was anticipated that in some areas it would not be possible to provide sufficient mitigation to achieve the HKPSG standard. In these cases, the number of dwellings to be benefited from the remedies and the resultant reduction in noise level were employed to prioritise the selected flyovers.

2.1.8.2 It should be noted that the assessment did not consist of detailed noise modelling which was recommended to be carried out in Stage 2 study.

2.1.9 Task 5 - Compilation of a List of Recommended Flyovers for Treatment

2.1.9.1 A list of flyovers was complied for treatment based upon the findings of the previous tasks. The list of recommended flyovers included details of the most appropriate type of barriers or enclosures, the estimated cost and the predicted noise reduction together with number of dwellings benefited from the measures. A ranking system based on 'cost per dB per dwelling' was established to prioritise candidate flyovers for further consideration.

2.1.10 Task 6 - Programme for Implementation

2.1.10.1 A programme was prepared to enable the optimum implementation of the recommended remedial measures on the basis of effectiveness.

2.1.11 Task 7 - Recommendations for Further Studies

2.1.11.1 The findings from the previous tasks were used to formulate recommendations regarding the engineering and environmental feasibility of the remedial measures for consideration in future studies.

2.1.12 The Scoping Study on Flyovers did not attempt to consider the detailed design of any direct technical remedies. Instead it attempted to provide information which would form the basis for Stage 2 study. It would be during these later stages of study that other issues such as engineering and structural considerations would be dealt with.

2.2 Results of the Scoping Study on Existing Flyovers

2.2.1 General

2.2.1.1 Based on the screening method adopted in the Scoping Study, the following 11 flyovers were prioritised and recommended for consideration in greater depth:

Priority	Flyover	Location	Direct Technical Remedies Recommended
1	NT71	Tsing Tsuen Road - near Riviera Gardens & Cheung On Estate	Semi-enclosure
2	K2	Kwai Chung Road - near Mei Foo Sun Chuen	5 m cantilevered barrier
3	K4	West Kowloon Corridor - between Willow Street & Tong Mi Road	3 m barrier
4	NT62	Tsuen Wan Road - near Clague Garden Estate	Semi-enclosure
5	K53	Kwun Tong Bypass - near Laguna City	5 m cantilevered barrier
6	NT25	Sha Tin Road - near City One Garden	Enclosure
7	H26	IEC - Oil Street to Tin Chiu Street	Semi-enclosure
8	H34	IEC - near Heng Fa Chuen	Semi-enclosure
9	K56	Tseung Kwan O Road - near Tsui Ping South Estate	Semi-enclosure
10	NT69	Tseung Kwan O Road - near Kwai Fong Estate	Semi-enclosure
11	H41	Ap Lei Chau Bridge	3 m barrier

2.2.1.2 As suggested in the Scoping Study, further consideration such as detailed cost estimation for noise mitigation measures, air quality and ventilation, public and traffic disruption, loss of sun light, visual impact, maintenance and structural impacts should be provided during this Study.

2.2.2 Ap Lei Chau Bridge

2.2.2.1 Ap Lei Chau Bridge was identified in the Scoping Study as a major noise source for the residents in Shan Ming Street, Ping Lam Street and San Shi Street. A 3 m high barrier was expected to reduce the noise from the flyover by 10 dB(A), and an overall noise reduction by approximately 5 dB(A).

2.2.2.2 The extent of noise mitigation measures on the flyover as recommended in the Scoping Study was illustrated in Fig. 1-1

2.2.3 Tsing Tsuen Bridge

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

2.2.3.2 The extent of noise mitigation measures on the flyover as recommended in the Scoping Study were illustrated in Fig. 1-2 & 1-3.

2.2.4 Kwai Chung Road Flyover near Mei Foo Sun Chuen

2.2.4.1 Kwai Chung Road Flyover was identified as the second priority site in the Scoping Study. It is a multi-lane carriageway which runs through Mei Foo Sun Chuen, linking Tsuen Wan Road to the north and Cheung Sha Wan Road to the south. A 5m cantilevered barrier has been identified to be erected adjacent to the Kowloon bound carriageway of the flyover to protect the NSR's at the building blocks located to the east of the flyover at Phase VI and Phase VII of Mei Foo Sun Chuen.

2.2.4.2 FSD has advised EPD earlier in other occasion that noise mitigation measures along Kwai Chung bound carriageway of the flyover were not acceptable because of their obstruction to the fire fighting and rescue operation at Blocks 9, 11, 17 21 and 23 in Phase I of Mei Foo Sun Chuen.

2.2.4.3 As pointed out in the comments of Regional Highway Engineer/Hong Kong Region, Highways Department in his letter ref. HH 63/50 (CE) dated 17/01/97 on the working paper on the Scoping Study on Existing Flyovers, the existing section of Kwai Chung Flyover adjacent to Mei Foo Sun Chuen is structurally not feasible to support the addition of a noise barrier. The noise barrier and the flyover should therefore be structurally independent from each other.

3. APPROACH AND METHODOLOGY

3.1 General

3.1.1 The findings, conclusion and recommendation of the Scoping Study on Existing Flyovers will form a basis for further assessment particularly in terms of maintenance consideration, structural impact, public and traffic disruption, etc.

3.2 Noise Assessment

3.2.1 Noise Standards and Regulations

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

3.2.2 Identification of Noise Sensitive Receivers (NSRs)

3.2.2.1 In the Study, the existing NSRs in the vicinity of the flyovers have been identified based on the recommendations of the Scoping Study and the most updated survey maps.

3.2.2.2 Site visits have been made subsequently to verify the information and to determine the heights of the affected buildings and the approximate number of dwellings presently exposed to traffic noises from the flyovers.

3.2.2.3 Relevant Government departments such as Highways Department, Housing Department, Lands Department, etc. as well as the Mass Transit Railway Corporation (MTRC) and the Kowloon Canton Railway Corporation (KCRC) have been consulted for the latest information on both existing and planned development.

3.2.2.4 Assessment points representing NSRs of different floor levels and angles of view of the flyovers have been determined based on the information gathered from survey maps and site visits.

3.2.3 Identification of Barrier Extent and Locations

3.2.3.1 In general, the location of noise barriers should be established as close to the noise source on the flyover as possible to achieve higher protection subject to the presence of footpath and roadside equipment and furniture (i.e. emergency telephones, lighting columns, fire hydrants, gantry signs, safety barriers etc.).

3.2.3.2 The extent of barriers should be maximised as far as possible to ensure that the NSRs are protected and shielded from the traffic noises.

3.2.3.3 The likely location and extent for the installation of noise barriers would be established based upon the above considerations as well as all physical constraints identified on site.

3.2.3.4 Where the physical erection of noise barriers on the existing flyovers were not considered as feasible, the use of independent support structures on ground would be examined.

3.2.4 Identification of Barrier Forms

3.2.4.1 The alignment and profile of the flyover and associated slip roads in relation to the configuration of the NSRs would likely dictate the forms of noise mitigation measures to be used.

3.2.4.2 Vertical barriers of various height are generally used to achieve specific noise attenuation in the existing flyovers. However, for those barriers taller than 5 metres above carriageway, it would be more effective to use cantilevered barriers with curved or inclined canopy to provide a less intrusive appearance and higher mitigation effectiveness.

3.2.4.3 Partial/Full enclosures would be required at location where traffic noises cannot be effectively attenuated by using the vertical or cantilevered barriers. Special consideration should be given to the impacts on illumination, air quality, sightline, fire fighting and other site constraints if enclosures are used.

3.2.5 Development of Noise Model

3.2.5.1 ENPAC's in-house model which was developed on the basis on the UK's Department of the Transport procedure described in "Calculation of Road Traffic Noise", HMSO, Welsh Office 1988, has been used to calculate the L_{10}(1-hr) noise levels at the representative NSRs. The model used traffic figures obtained from actual traffic counts in 1998 as input data.

3.2.5.2 Actual traffic counts were adopted where census information was not obtained from the Annual Traffic Census. The flyovers being investigated in the Study are subject to a limit of 50 kph. This speed limit also formed part of the basis in the noise model.

3.2.6 Development of Mitigation Measures and Options

Ap Lei Chau Bridge & Tsing Tsuen Bridge

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

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

3.2.6.3 Noise mitigation scenarios will only be established when practical locations for erection of mitigation have been identified within the site boundaries as the site constraints imposed by the limit of structural capacity of the flyovers, adjacent roads and developments, underground utilities and safety aspects would be critical in urban area.

Kwai Chung Road Flyover

3.2.6.4 Since the site constraints imposed by the limit of structural capacity of the flyover, underground utilities alongside the edge of slip roads, development of future infrastructure, etc. were so serious, noise mitigation scenarios could only be established when practical locations for the erection of mitigation measures have been identified within the site boundary.

3.3 Engineering Consideration

3.3.1 As the flyovers are close to the residential area, engineering considerations, particularly on the identification of site constraints, would be most important for the establishment of feasible mitigation measures. These considerations included buildability, traffic engineering, traffic management during construction and safety which would be discussed in the following sections.

3.3.2 Buildability

3.3.2.1 Buildability is a term given to the degree of difficulty that a proposed noise barrier would be implemented. Space limitation and maintenance requirements are crucial factors in the assessment. Maintenance considerations include the needs to minimise types of noise barriers/enclosures and to allow proper access for inspection/repairing/ maintenance.

3.3.2.2 In Hong Kong, wind pressure is the governing factor in the design of noise barriers. The design wind pressures as specified in the Structures Design Manual (SDM) published by the Highways Department are generally high by international standards. Noise barriers are therefore subject to high bending moments and shear forces on their bases. The size of bases for supporting these barriers may not be able to fit into the edges of the flyover structure.

3.3.2.3 In addition, wind loads acting on these barriers will finally transfer to the flyover structure including bearings. Any strengthening works or replacement of bearings may require road closure for months and cause significant disruption to traffic flow. Thus, detailed structural assessment of the flyovers shall only be carried out when other constraints on site do not constitute a major problem to the barrier installation on the flyovers.

3.3.2.4 Underground utilities including drainage and sewerage works are usually very congested especially at urban area, the foundation for independent structures to support barriers or enclosures, if found necessary, will inevitably lead to serious conflicts with them.

3.3.2.5 Consideration should be given to any necessitated diversion or reprovision of these existing utilities, if necessary, for the implementation of the proposed barrier. Further consultation with relevant utilities undertaker would be necessary for their requirements.

3.3.2.6 Utilities and services records were obtained from a number of utility companies and Government departments in early July 1998. They included the following:

- China Light & Power Company Limited
- The Hong Kong Electric Company Limited
- Hong Kong Telecommunication Limited
- The Hong Kong and China Gas Company Limited
- Wharf Cable Limited
- Hutchison Communication Limited
- New T&T Hong Kong
- New World Telephone Company Limited
- Rediffusion (HK) Limited
- Drainage Services Department
- Highways Department
- Transport Department
- Water Supplies Department

3.3.2.7 Whenever possible, noise mitigation measures to protect NSRs adjacent to the flyover will be proposed alongside its parapet. However, when necessary, elevated barriers or enclosures supported by independent structure, i.e. with relatively high columns erected on ground level, will also be considered. Under such circumstance, piled foundation will be considered necessary.

3.3.2.8 The foundation of the proposed barriers shall be engineering feasible, structurally sound and with minimum disturbance to the existing utilities inside the bridge structure and/or underground and road/bridge furniture. Reprovision works shall be designed to cope with the proposed foundation, if necessary.

3.3.2.9 The proposed barriers shall not have adverse impact on the road illumination during any time of the day in order to ensure the safety of drivers and pedestrians.

3.3.3 Traffic Engineering

3.3.3.1 The sitting of the proposed mitigation measures on the flyover or at-grade shall maintain sufficient highway clearance to ensure that the compliance of requirements as stated in Transport Planning and Design Manual (TPDM).

These requirements include visibility of road users for signing, at bend and road junctions during and after the installation of the barriers.

3.3.4 Traffic Management During Construction

3.3.4.1 Besides the effect on traffic after the implementation of the proposed mitigation measures, the impact on the existing traffic at the sites in question during construction stage shall also be carefully assessed if found necessary.

3.3.4.2 Consideration will also be given to the extent of traffic/pedestrian diversion and the feasibility for carrying out such diversion. Consultation exercise with relevant Government departments such as Transport Department, Police etc. shall be carried out, if necessary. Such information assists the preparation of realistic construction programme for the proposed mitigation measures.

3.3.5 Safety

3.3.5.1 In addition to all technical/engineering considerations, safety and disruption to the public are one of the major concerns in the Study. The erection of any noise barriers shall not impose potential hazard or reduce the degree of safety in any aspect.

3.3.5.2 Consideration has been given to the impacts on pedestrian safety, accessibility for emergency vehicles, fire fighting and rescue operations, loading/unloading activities, bus stopping operation, etc.

3.3.5.3 Consultation has been made with Fire Services Department for the emergency access and fire fighting requirements on the flyovers and adjacent buildings. The requirements would have a direct impact on whether the proposed barrier locations are acceptable. Location of existing fire hydrants should be identified and the installation of barriers and enclosures should not affect the fire fighting operation. In the case of noise enclosure, the risk/hazard to road users in case of vehicle explosion/fire occurred inside the enclosure should also be considered.

3.3.5.4 Rectification works should be addressed in the preliminary design of noise barriers, if necessary, to ensure the safety of road users and residents in the area in question.

3.4 Landscape and Visual Assessment

3.4.1 The introduction of noise mitigation measures to specific study locations will generate landscape impacts.

3.4.2 The assessment would be based upon the direct technical mitigation measures identified within the study area. Any potential impacts upon existing landscape and impacts to existing views from residential/public properties, or from footpaths and roads, would be classified as slight, moderate or severe according to the significance of the impact within the existing environment.

3.5 Air Quality Assessment

3.5.1 As agreed with Air Policy Group of Environmental Protection Department on 4th March 1997 in the Feasibility Study of Agreement No. CE 8/96 and on 2nd September 1998 in this Study, air quality analysis model has been established to carry out air quality assessment for identified mitigation measures.

3.6 Environmental Gains and Losses Account

3.6.1 The identified noise mitigation measures may generate positive or negative effects on the environment in the vicinity of the studied flyovers. Environmental gains and losses account for the mitigation measures will be elaborated.

3.7 Cost Estimation

3.7.1 Preliminary estimation of direct and indirect construction costs for the identified mitigation measures would be carried out and based on the rates at December 1998 prices obtained from recently returned tenders of other projects. Contingencies and price fluctuation beyond December 98 would not be included.

3.7.2 Apart from the construction cost estimation, the recurrent consequence in terms of annual maintenance cost and annual staff cost based on the rates obtained from Highways Department would be provided for reference.

4. ASSESSMENT FOR MITIGATION MEASURES ON AP LEI CHAU BRIDGE

4.1 Identification of Noise Sensitive Receivers (NSRs)

4.1.1 Ap Lei Chau Bridge consists of a dual two lane carriageway which forms a link between Aberdeen and Ap Lei Chau. The Ap Lei Chau approach of the bridge is a major noise source for the residents in Shan Ming Street, Ping Lam Street and San Shi Street.

4.1.2 Based on site surveys, existing representative NSRs were identified along the alignment and shown in Fig 4-1. Details of these NSRs is provided as follows:

NSR ID	Name of Building	No. of Storey	No. of Dwellings per Floor
TC	Toho Court	22	2
RH	Rousseau Heights	10	3
SM	Sun Ming Building	7	6
NT	Nam Tack Mansion	5	2
NF	Ning Fung Mansion	22	6
WF	19 Wai Fung Street	5	2
HL	Hoi Lee Building	23	6
SO	Shan On House	35	8
CO	Choi On House	35	8

4.1.3 Planned receivers including the proposed HOS development in Ap Lei Chau was not identified as NSR in the Study and the noise impacts would be addressed in their respective noise impact assessments. NSRs WF, HL, SO and CO are facing away and/or distanced from the flyover. Results of noise impact assessment indicate that noise levels at these NSRs are dominated by traffic noise arising from other existing roads and hence these NSRs are excluded from further evaluation in the Study.

4.2 Traffic Noise Impact Assessment

4.2.1 <u>Ap Lei Chau Bridge</u>

The prevailing road traffic noise levels at the representative NSRs along Ap Lei Chau Bridge in year 1998 are shown in Table 2 of Appendix A1. About 77 dwellings are predicted to be exposed to noise levels exceeding the HKPSG by up to 9 dB(A). The highest overall noise level of 79 dB(A) is predicted to be at the top floor of SM-2, a sensitive facade overlooking the heavy trafficked bridge and road (i.e. Ap Lei Chau Bridge and Ap Lei Chau Bridge Road), of which the traffic noise contributed by Ap Lei Chau Bridge Road is 78.3 dB(A). The noise levels at the rest of the facades range between 62 to 77 dB(A).

4.3 Proposed Mitigation Scenarios for Engineering Consideration

4.3.1 In order to mitigate the noise impact at the upper-floor receivers along Ap Lei Chau Bridge, two effective mitigation options were identified in the Technical Paper for Traffic Noise Impact Assessment (Appendix A1) assuming barriers were located at the edge of the flyovers and were described as follows:

Option I: Two 5m plain barriers, separated by a subway entrance, of a total length of 130m long, are to be erected along the northbound carriageway at the edge of structure to protect the receivers at various heights along Ap Lei Chau Bridge. The location of these barriers is shown in Fig. 3.5 of Appendix A1.

Option II: Instead of two 5m plain barriers, two 4.5m Inverted L-shaped barriers with 1.5m canopy at 45° are to be erected along the exact same extent and location as *Option I*. The type of configuration of the Inverted L-shaped barrier is shown in Figure 3.6 of Appendix A1.

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

4.3.3 As the study area is located within urban character, the use of absorptive barrier panels along the side and with transparent reflective panels at the canopy are considered more appropriate.

4.4 Engineering Feasibility

4.4.1 Both Options involves the erection of cantilevered barriers on the existing flyover approach structure which is mainly high retaining wall of 10-15 m. The original design calculations of the retaining wall have been examined in the HyD office. Structural assessment was carried out to examine the capacity of the retaining structure for resisting additional lateral loads, i.e. wind loads, acting on the noise barriers under the current Highways design standard. Details of the assessment calculations are given in Appendix C.

4.4.2 It was found that the retaining wall did not allow for provisions of the above noise barriers in its design As height of the barriers is substantial, existing structure did not have adequate spare capacity to carrying these additional loading, direct installation of the barriers on the existing structure were not considered as feasible. Therefore both options should only be considered with independent support.

4.4.3 Buildability

4.4.3.1 The feasible extent and location of the proposed barriers to be supported by independent support structure were further examined for other constraints at grade on site and is finalised in Fig. 4-2 & 4-3. The preliminary land requirement plan is shown in Fig. 4-7.

4.4.3.2 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 and is shown in Fig. 4-4. The layout of existing utilities and services are shown in Fig. 4-5. It was noticed that the extent and location of the barriers would affect the existing drains and associated drainage reserve within the USD (Urban Services Department) recreational area. However, DSD has commented in their letter ref : (11) in DSD HK 8/CE 9597 dated 7.10.98 that the affected drains and drainage reserves can be realigned to suit the proposed barrier subject to detailed design and USD's agreement to surrender the land concerned.

4.4.3.3 Details of land status in the vicinity of the flyover are shown in Fig. 4-6. The extent and location were constrained by the adjacent recreational ground, church site and subway staircase access. USD has commented in their letter ref. : (4) in USDP 6/402/97 IV dated 13.10.98 that any proposed structure should be located outside their recreational ground in order not to affect the operation of the facilities and cause disturbances to the users of the venues. USD has further indicated in their letter ref: (11) in USDP 6/402/971V dated 2.11.99 that suitable measures should be taken so that the operation and use of their venues would not be affected during the construction period of the noise barrier structure.

4.4.3.4 Since the independent structure would be of about 15 m high in order to support the proposed barriers, piled foundation would be required. In general, 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. However, this 2m clearance should be reduced as much as possible in order to improve the structural effectiveness of the noise mitigation system, subject to agreement from the HyD/Str on maintenance requirement.

4.4.4 Traffic Engineering

4.4.4.1 The sitting of the proposed barriers on independent structure would 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.

4.4.5 Traffic Management During Construction

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

4.4.6 Safety

4.4.6.1 The proposed barriers would 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 considered insignificant.

4.5 Review on Acoustic Effectiveness and Findings

4.5.1 Following the engineering assessment based on physical constraints on site, the feasible extent and location of the barriers is given in Fig. 4-2 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.

4.5.2 The findings of the assessment indicated that the above proposed extent of location of the barriers could only provide 44% 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.

4.6 Air Quality Assessment

4.6.1 Details of the air quality impact assessment is given in Appendix B. In summary, as vertical or cantilevered barriers have limited potential for trapping air from the carriageway, it was considered that no adverse impact on the air quality near the proposed barriers would result from the their installation.

4.7 Visual/Landscape Assessment

4.7.1 The scale of independent structure for the proposed barrier, which is of 15m high, would be visually intrusive to the adjacent residents, pedestrians and users in the USD recreational ground and sitting area.

4.7.2 The independent structure would also disrupt the view of featured landscape finishes on the existing retaining walls and necessitate the loss of trees and plants at its location.

4.7.3 As the landscape character is well established and overall landscape quality is high, 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.

4.8 Environmental Gains and Losses Account

4.8.1 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 barrier and its support structure. • Visual confinement of pedestrians and vehicles. • Landscape loss of tree, planting and featured wall finishes. • May have localized effects on the air quality but with no significant degradation of air quality at the exposed facades.	• 44% of exposed facades can be protected in terms of noise attenuation. • Screening of traffic for high-rise residents.	• sensitive design of noise mitigation to integrate it within the existing visual and landscape context.

4.9 Cost Estimation

4.9.1 The direct construction cost for the proposed bent top vertical noise barriers of 95m approximate in length as shown in Fig. 4-2 & 4-3 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	60	m^3	100	6,000
Backfilling and Compaction	60	m^3	50	3,000
Formwork, Class F2	65	m^2	280	18,200
Formwork, Class F5	150	m^2	450	67,500
Blinding	10	m^3	880	8,800
Concrete Grade 30/20	190	m^3	930	176,700
Reinforcement	45	t	5,000	225,000
Structural Steelwork	150	t	25,000	3,750,000
Noise Barrier Sheeting	795	m^2	2,500	1,987,500
1200 dia. Bored Piles	495	m	10,000	4,950,000
Sub-Total				11,192,700
Add 20% for General Preliminaries & Site Safety				2,200,000
Total Base Cost Estimate (Dec 1998 Price Level)				13,392,700 (HK$13.4 M)

4.9.2 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$2.7M.

4.9.3 Total construction cost is estimated to be **HK$16.1M** at Dec 98 Price Level.

4.9.4 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$190.6/sq.m x 800 sq.m ≈ HK$0.15M
Annual staff cost = HK$57.2/sq.m x 800 sq.m ≈ HK$0.05M

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

6. ASSESSMENT FOR MITIGATION MEASURES ON KWAI CHUNG ROAD FLYOVER

6.1 Identification of Noise Sensitive Receivers (NSRs)

6.1.1 Kwai Chung Road Flyover is a multi-lane carriageway which runs through Mei Foo Sun Chuen and connects Tsuen Wan Road with Cheung Sha Wan Road. On both sides of the flyover, there are high-rise residential and commercial developments. The space underneath the flyover is generally occupied by the market place, the elderly centre, mini-shops, bus terminus and various recreational facilities, etc. which play a very important part in the daily living of the local residents.

6.1.2 NSRs were identified mainly at the high-rise residential blocks of Mei Foo Sun Chuen on both sides of the flyover. NSRs adjacent to the northbound carriageway were situated above the level of the podium and flyover. NSRs adjacent to southbound carriageway were situated above the ground level and often with very little horizontal clearance from the flyover.

6.1.3 The general layout and features of the study area are shown in Fig. 6-1 & 6-2.

6.2 Traffic Data for Model Analysis

6.2.1 Surveys were undertaken to obtain necessary traffic data for the air/noise impact assessment in the study area (See Figure 6-17).

6.3 Development of Mitigation Measures

6.3.1 Development of Mitigation Scenarios

6.3.1.1 Kwai Chung Road Flyover and its associated roads form part of the heavily trafficked link in the area. Major constraints in term of buildability, potential conflicts with the existing MTR station and future West Rail station, etc. have been carefully investigated before the development of mitigation options.

6.3.1.2 Fig. 6-1 indicates the identified location of NSRs and the predicted road traffic noise levels at the NSRs under unmitigated conditions were presented in the following table :

NSR	Floor	Predicted Noise Levels, dB(A)
1	1	78
	5	77
	10	76
	15	75
	17	75
2	1	85
	5	84
	10	82
	15	81
	17	80
3	1	85
	5	83
	10	82
	15	81
	17	80
4	1	79
	5	79
	10	78
	15	77
	17	77
5	1	77
	5	78
	10	77
	15	77
	17	77
6	1	79
	5	81
	10	80
	15	79
	17	79
7	1	80
	5	81
	10	80
	15	79
	17	79
8	1	79
	5	81
	10	80
	15	79
	18	78
9	1	80
	5	82
	10	81
	15	80
	18	79
10	1	85
	5	83
	10	81
	15	79
11	1	81
	5	84
	10	81
	15	79
	18	79

NSR	Floor	Predicted Noise Levels, dB(A)
12	1	75
	5	80
	10	79
	15	77
	18	77
13	1	68
	5	74
	10	74
	15	74
	18	74
14	1	76
	5	76
	10	75
	15	75
	17	74
15	1	77
	5	83
	10	80
	15	79
	17	78
16	1	69
	5	79
	10	78
	15	77
	17	76
17	1	70
	5	80
	10	79
	15	78
	17	78
18	1	82
	5	82
	10	81
	15	80
	17	79
19	1	79
	5	80
	10	79
	15	78
	17	77
20	1	68
	5	71
	10	72
	15	72
	19	74
21	1	75
	5	77
	10	77
	15	77
	19	76
22	1	78
	5	79
	10	79
	15	78
	16	75

6.4 Engineering Feasibility

6.4.1 Mitigation options for protecting the identified NSRs at Mei Foo Sun Chuen generally require the installation of barriers or enclosures along the edges of the flyover. As the height of these barriers/enclosures would be substantial, i.e. about 5m high, significant additional loading would be imposed on the existing structure.

6.4.2 Checking the compliance of the latest design standards was the first step being taken in the assessment. Design calculations of the existing flyover have been examined at the HyD office. The original design was found to be carried out in 1966 and had been based on BS 153: Part 3A. As the current design standard in SDM regarding bridge loading is more demanding, the flyover may not meet the current design requirements even without any barriers/enclosures. Detailed structural assessment of a typical "land span" deck of the existing flyover are given in Appendix D. The assessment results indicated that the existing bridge deck would not be capable of taking the current design loading.

6.4.3 HyD/Hong Kong Region has also commented in his letter ref. HH63/50(CE) dated 17/01/97 that the study section of Kwai Chung Flyover is structurally not feasible to cater for the addition of a noise enclosure. Either independent structure should be provided to support the noise enclosure or the flyover should be strengthened to enable the enclosures to rest on it.

However, for strengthening works, the amount of works involved and disruptions to the public in terms of social impacts and all possible consequential effects on traffic, and environment would be significant and should not be underestimated. It would also cause much inconvenience to and objections from the nearby residents during the construction stage. As a result, development of noise barrier/enclosure proposal with independent supports would be more preferable and feasible. Typical strengthening works involved are briefly indicated below:

- Enlarging/strengthening the existing bridge parapets to accommodate columns of the noise barriers/enclosures;
- strengthening the existing deck beams to support the additional vertical and lateral loads;
- replacing the existing bridge bearings by those which can resist higher lateral loads;
- strengthening the existing piers and piles caps;
- installing additional piles to strengthen the existing bridge foundation; and
- installing external support to strengthen the existing deck.

6.4.4 The use of external support to strengthen the existing deck 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. However, the arrangement would not be considered as feasible due to the following constraints:

- the extent of structural interaction and load sharing between the existing support system and the external support system cannot be quantified.

- the space underneath the flyover is not available for the construction and installation of the external support system because of the existing road, bus terminus, market and facilities underneath the flyover.

- the construction traffic access and erection 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.

6.4.5 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.

6.4.6 The Scoping Study recommended that vertical barriers of 5m height above the level of the flyover would be the most effective option. In the light of the discussion in the preceding section, independent structure would need to be constructed at ground level to provide the barrier support. The construction will inevitably cause serious disruption to the residents and the public at Mei Foo Sun Chuen.

6.4.7 Due to the complexity of the site conditions and the large number of interface problems, the site are divided into several study areas (i.e. Areas A to J defined by the areas directly adjacent to the sections of barrier proposed on both sides the flyover) for ease of reference and further investigation. These labelled sections are also shown in Figures 6-1 & 6-2.

6.4.8 Buildability

6.4.8.1 Details of the existing utilities and services including storm water drains and sewers within the study area have been obtained from various utility companies and government departments. The existing utilities on the structure and at ground level are shown in Figures 6-3 to 6-8 and 6-11 to 6-16.

6.4.8.2 Two crucial physical constraints have been identified for the erection of barrier/enclosure at ground level, namely the MTR protected zone and the drainage reserve.

MTR Protected Zone

6.4.8.3 A large part of the study area lies within the Mass Transit Railway (MTR) protection zone surrounding Mei Foo Station which would be a sizeable obstacle to the construction of the at-grade barrier/enclosure because of potential conflicts with MTR's maintenance works.

6.4.8.4 As advised in MTRC's letter (ref. C/CWM/NP/0530/LAW 15 dated 9th January 1998) and Practice Note for Authorised Persons and Registered Structural Engineers (AP/RSE) No. 77 issued by the Building Authority, the erection of noise barrier/enclosures within the existing MTR protection zone shall be subject to special scrutiny by Government and under strict monitoring requirements.

Drainage Reserve

6.4.8.5 As advised by Drainage Services Department (DSD), certain areas would also be constrained by defined drainage reserve. Construction in these areas again be subject to approval. Figures 6-11 to 6-16 show the extent of these drainage zones.

Area A

6.4.8.6 The area to the west of Lai Wan Road adjacent to Kwai Chung Flyover would be further confined by the proposed West Rail, Mei Foo station. This station was proposed to be a piled structure with lowest finished ground level at -2.0 mPD and highest finished ground level at +17.7mPD spanning underneath and across the flyover. Thus, the erection of noise mitigation measures in this area would be almost impossible. The extent of the proposed West Rail, Mei Foo station is shown in Figure 6-10.

6.4.8.7 This area locates alongside the southbound slip road fronting Phase VII Block No. 10 of Mei Foo Sun Chuen. The existing underground utilities and services along this section include a 200ϕ gas main and a 150ϕ freshwater main. Diversion of these utilities would be required for the erection of barrier/enclosure.

6.4.8.8 This area also includes a 6m wide drainage reserve zone surrounding 225ϕ drainage pipes and manholes which span the area beneath the flyover. The provision of structural supports for the barrier within this reserve would need to be agreed by DSD. A continuous barrier would only be possible if the pipes and manholes could be diverted. This would prove to be difficult as they are situated in the market area. It is unlikely that the barrier could be repositioned due to a lack of space.

6.4.8.9 Permanent market buildings are situated along this section right up to the boundary with the car park of the commercial complex. Due to the limited space between the two structures, the construction of the proposed barrier would necessitate the demolition, relocation and reconstruction of the affected buildings at a significant cost (See Figure 6-2)

6.4.8.10 The situation has been further complicated by the extremely congested pipe works scattered across the wall of the commercial complex. In addition, the bottom one metre of the wall of Mei Foo Sun Chuen extends outwards by approximately 200mm.

6.4.8.11 The parapet of the flyover is also located very close to Mei Foo Sun Chuen. Clearance is often less than one metre and this would obstruct the construction and maintenance of the proposed barrier.

Area B

6.4.8.12 This area is located adjacent to Area A and fronting the existing podium of Phase VII at Mei Foo Sun Chuen.

6.4.8.13 The existing underground utilities and services along this section include a 200ϕ gas main, a 150ϕ freshwater main, public lighting cables, CLP cables and MV cables. The erection of proposed barrier/enclosure would require the diversion of these utilities.

6.4.8.14 A small drainage channel runs along the length of this section parallel to the footpath. The proposed barrier would encroach into the drainage reserve around this channel.

6.4.8.15 The proposed barrier also encroached into the 6m wide drainage reserve, the surrounding area of 225ϕ drainage pipes and manholes. Permission will have to be obtained from DSD for the erection of the barrier supports. Without the permission from DSD, this could make a continuous barrier impossible unless the pipes and the manholes could be diverted. Relocation of the barrier supports to avoid the encroachment would not be possible due to the limited space between the flyover and the commercial complex (See Figure 6-2).

6.4.8.16 The clearance between the flyover and Mei Foo Sun Chuen is often less than one metre and this would obstruct the construction and the necessary maintenance of the proposed barrier. The steps extending from the shops beyond the boundary of the commercial complex create another obstacle to the space for providing barrier supports.

Area C

6.4.8.17 This is an area located adjacent to Area B fronting Phase VII Block No. 7 of Mei Foo Sun Chuen.

6.4.8.18 The existing underground utilities and services along this section are the same as those in Area B. Again a small drainage channel and a drainage reserve are need to be taken into consideration for any barrier provision..

6.4.8.19 There are a few retail outlets in this area consist of catering business. The necessary ventilation outlets, air-conditioning and extraction equipment extend outwards from Mei Foo Sun Chuen right up to the edge of the flyover. This would further reduce the already limited space available for the proposed noise barrier. Relocation of the equipment or establishments might be the only solution but this would affect the business of the commercial development and the cost could be prohibitive.

6.4.8.20 Again, similarly to Area A, space at ground level is reduced in some sections. The commercial complex at the ground level extends outwards by approximately 200mm.

Area D

6.4.8.21 This area locates alongside the southbound carriageway of the flyover fronting Block Nos. 1 and 3 of Phase VII at Mei Foo Sun Chuen.

6.4.8.22 There are no major existing underground utilities or services located in the area other than a small section of public lighting cable. The cable would require relocation to accommodate the proposed barrier.

6.4.8.23 Area D is intersected by drainage reserve zones for 225ϕ drainage pipes and manholes. This would make a continuous barrier more complicated to construct unless DSD allows barriers to be erected within the affected drainage reserve area. Alternatively, the barrier could sit at a distance away from the flyover to allow the foundations lie outside of the drainage reserves.

6.4.8.24 A concrete basketball court located beneath the flyover may require either relocation or re-orientation to accommodate the barrier. The alternative could again be positioning the barrier at a distance away from the flyover. This might however reduce the effectiveness of the barrier.

6.4.8.25 Construction of the barrier might also require the rearrangement the existing refuse collection point (See Figures 6-1 & 6-2). The existing pedestrian access underneath the flyover next to the refuse collection point would be blocked and therefore, the removal of refuse at this collection point will be seriously affected. An alternative would be to reduce the length of the barrier but this might reduce its effectiveness.

Area E

6.4.8.26 This area is located alongside the northbound carriageway of the flyover fronting Phase II Block Nos. 5 and 9 of Mei Foo Sun Chuen.

6.4.8.27 The drainage reserves of 225ϕ sewer, 225ϕ drainage pipes and manholes are passing this area. The extent of drainage reserves restricts the possibility of positioning the barrier if no permission is granted by DSD for the erection of barriers within the drainage reserve area. There are no other existing underground utilities or services in the area.

6.4.8.28 The constraints imposed by the existing basketball court described in Area D also apply to Area E.

Area F

6.4.8.29 This area runs alongside the slip road and carriageway in the southbound direction fronting Phase II Block Nos. 5 and 9, and Phase I Block Nos. 9, 15 and 21.

6.4.8.30 The existing underground utilities and services along the southern side of the flyover include a 250ϕ gas main, telephone cables and electricity cables.

6.4.8.31 A covered U-channel and its surrounding of a 6m wide drainage reserve zone runs along the entire length of this section. This drainage reserve effectively covers the entire width of the footpath in this area. This means that relocating this drainage channel would not create space free from the drainage reserve.

6.4.8.32 This section is also intersected at various points by drainage reserves for 225ϕ drainage pipes and manholes spanning the area beneath the flyover. The drainage reserve for the U-channel would further confine the alignment of barrier.

6.4.8.33 Towards Lai Wan Road, the identified barrier would need to sit at a distance from the flyover to accommodate the permanent market buildings extending outwards beyond the boundary of the above flyover.. This solution would however require the relocation of the U-channel. The alternative would require the demolition, relocation and reconstruction of these affected buildings. The drainage channels in this area are very important to the operation of the shops which create a large flow of water from cleaning fish, vegetables and the premises themselves (See Figure 6-2).

6.4.8.34 The lack of space experienced by the other areas due to the flyover in close proximity with Mei Foo Sun Chuen also applies to Area F. Clearance again is sometimes less than one metre which would impede the construction and maintenance of the barrier. This would rule out construction in this area as the Fire Services Department has commented (letter ref. (20) in FSD4/130/94 on the Scoping Study) that the horizontal clearance between the outer edge of the flyover structure and the building facade should be at least 4.5m.

Area G

6.4.8.35 This area is located alongside the southbound carriageway of the flyover fronting Phase IV Block No. 81.

6.4.8.36 A short freshwater main section is located within this area. However it would be relatively easy to have it diverted as the freshwater main does not extend too far into the area that would be used by the identified barrier. There are no other existing underground utilities or services in the area.

6.4.8.37 The land is being used as a landscape area with trees, shrubs and grass. This would have to be cleared for the construction of the barrier, if necessary (See Figure 6-2).

Area H

6.4.8.38 This area is located alongside the southbound carriageway of the flyover over the existing bus terminus next to Area D.

6.4.8.39 The existing underground utilities and services within this area include electricity, telephone and public lighting cables together with a gas main. A few 250ϕ storm water pipes with manholes situated in a drainage reserve have been found in this area. An existing 450ϕ storm water pipe also runs across this area towards the manhole underneath the flyover.

6.4.8.40 This section intersects the existing bus terminus, a latrine to the west, Mei Lai Road and a road which connects Lai Chi Kok Road and Cheung Sha Wan Road to the east. It falls within the MTR protection zone with 16m minimum clearance from the MTR tunnel. The erection of barrier along this section would seriously affect the existing latrine and the operation of the bus terminus.

Area I

6.4.8.41 This section is located opposite to Area H and along the westbound carriageway of the flyover at the existing bus terminus between Area E and Area G.

6.4.8.42 The existing underground utilities and services which include 600ϕ and 250ϕ storm water pipes are found within the drainage reserve of this section. The affected area includes the existing bus terminus and the service roads that fall inside the MTR protection zone.

Area J

6.4.8.43 This area is located along the northbound carriageway of the flyover abutment fronting Phase IV Block Nos. 113, 115, 117 and 119 adjacent to Lai Chi Kok Road.

6.4.8.44 No utilities or services were found inside this area. However, this section falls inside the MTR protection zone. The existing slope shown on Figure 6-1 and respective figures has been amended to retaining wall to cope with the widening of Lai Chi Kok Road at that section. Thus, there is insufficient road space to incorporate a barrier along that widened road section. In addition, the

existing parapet on top of this retaining wall has found to be insufficient to accommodate a noise barrier.

Area K

6.4.8.45 This section is located along the southbound carriageway of the flyover and opposite to Area G. Besides a telephone cable and few 250ϕ storm water pipes with manholes have been encroached in the drainage reserve. No other existing utilities or services has been found in this area.

6.4.8.46 This section encroaches into the MTR protection zone with a 8m minimum clearance from the MTR tunnel. The land is currently used as a landscape area with trees.

6.4.9 Traffic Engineering

6.4.9.1 In general, the siting of the roadside barriers should not degrade the existing highway standards to fall below the absolute minimum requirement as stated in the Transport Planning and Design Manual (TPDM). These include visibility requirements for signing, siting of pedestrian crossings and bus stops, etc.

6.4.9.2 At the flyover level, the road sections under consideration are generally straight with no junctions, crossings, bus stops or pedestrians. Under the flyover is an existing bus terminus, a bustling market and recreational area. The barrier could seriously affect the pedestrian and traffic flow and the livelihoods of all those who work or live in the vicinity of the flyover.

Area A

6.4.9.3 Traffic on the flyover would not be severely affected by the implementation of the proposed barrier. The section is generally straight with no junctions, crossings, bus stops or pedestrians. Currently there is no access for pedestrians available beneath the flyover so the erection of the proposed barrier/enclosure would not have major impact to pedestrians.

Area B

6.4.9.4 In terms of traffic impact on Area B it would be similar to those on Area A at the flyover level. Beneath the flyover, pedestrians flows from the two main entrances of the shopping complex to the market area are heavy. The structural supports of the proposed noise barrier could block the pedestrian flows and would need to repositioned to avoid the disruption. It is important to maintain the current interaction between the north side of Mei Foo Sun Chuen and the area under the flyover. Additionally, the passageway between the shopping complex and Mei Foo Centre For the Elderly would be blocked by the proposed barrier.

Area C

6.4.9.5 The impact on Area A would apply to Area C at flyover level. Shops are located beneath this section of the flyover. The supports for the proposed barrier could block the pedestrians gaining access to these shops. This could mean that the shops and the residents would be impeded by the proposed barrier and it would need to be repositioned to avoid the blockage.

6.4.9.6 The footpath located beneath the flyover beside the commercial complex is very narrow. The proposed barrier would take up some of the available space possibly hindering an important pedestrian route.

Area D

6.4.9.7 No major impact would be anticipated on the flyover level in terms of traffic engineering and it would be similar to Area A. The area under the flyover is a junction connecting both sides of Mei Foo Sun Chuen. The pedestrian and vehicular traffic should not be impeded by the proposed barrier/enclosure.

6.4.9.8 The relocation of the basketball court under the flyover would need to be reviewed if its would be warranted.

Area E

6.4.9.9 On the flyover, visibility for vehicles joining Kwai Chung Road Flyover from the adjoining slip-road would be adversely affected if the barrier were to be constructed. This would be an important safety consideration as Kwai Chung Road Flyover is a particularly busy stretch of road with an hourly flow of 5382 vehicles (in both directions) during the morning peak hour.

6.4.9.10 Similarly to Area D, the area beneath the flyover is a major junction connecting both sides of Mei Foo Sun Chuen. The proposed barrier should not impede the pedestrian flow because a large area is available beneath the flyover.

Area F

6.4.9.11 The impact on Area F in terms of traffic engineering would be similar to that of Areas A to E above the level of the flyover. Shops are located at ground level along the whole length of this section. The proposed barrier would restrict access to and from certain shops which could seriously affect the livelihoods of the shop-owners and residents.

6.4.9.12 There is a large pedestrian flow from this side of the flyover into the market area especially during noon time. Any barriers along this area may restrict the pedestrian flow and possibly causing congestion.

Area G

6.4.9.13 No major impact is anticipated at the flyover due to the provision of the possible noise barrier. At ground level, the barrier would not encroach onto the paved areas and the existing landscape. Pedestrians will not be affected by the implementation of the noise barrier. However, the visibility for traffic vehicle turning from Lai Chi Kok Road to Cheung Sha Wan Road would be seriously affected and it would not comply with TPDM requirements.

Area H

6.4.9.14 Since the section of road under consideration are generally straight with no junctions, pedestrian crossing, bus stops or pedestrians, no adverse impact on traffic using the flyover would be expected from the proposed barrier.

6.4.9.15 The area under the flyover consists of a refuse collection point, a latrine at the west end, a bus terminus in the middle section with connections to Mei Lai Road, Lai Chi Kok Road and Cheung Sha Wan Road.

6.4.9.16 The erection of barriers along this section of road would block the internal roads of the existing bus terminus, minibus stop, the adjacent road link and Mei Lai Road. Re-provisioning of the bus terminus and mini-bus stop would be required.

Area I

6.4.9.17 The traffic impact on Area I would be similar to Area H on the flyover. Similarly, the internal roads of the existing bus terminus and the mini-bus stop together with Mei Lai Road and the adjacent link road would be blocked by the proposed barrier along this section of road.

Area J

6.4.9.18 The bridge abutment as shown on the base of Figure 6-1 has recently been changed to a retaining wall for the widening of Lai Chi Kok Road. There is no sufficient clearance between the edge of the widened Lai Chi Kok Road and the newly constructed retaining wall to incorporate of the proposed barrier. In fact, the width of widened carriageway would be further reduced by the erection of the barrier along this section.

6.4.9.19 The visibility of traffic turning from Lai Chi Kok Road to Cheung Sha Wan Road through the existing link road adjacent to Area J would be impeded by supports of the proposed barriers.

Area K

6.4.9.20 No major impact is expected on the flyover due to the provision of barriers. The situation is similar to Area G. Pedestrians would not be affected by the erection of a noise barrier but the visibility for vehicle turning from Cheung

Sha Wan Road to Lai Chi Kok Road through the road link would be adversely affected.

6.4.10 Safety

6.4.10.1 The implementation of the mitigation option should not impose potential hazard or reduce the degree of safety. Impact assessment on pedestrian safety, accessibility for emergency vehicles, fire fighting and rescue operations, loading/unloading activities, bus stopping operation, etc. have been conducted at the affected areas.

6.4.10.2 The extent of rectification works will be addressed in the preliminary design if the degree of road safety to the road users and residents need to be compromised.

Area A

6.4.10.2 There are windows facing from the car park of the commercial complex at the flyover level. Fire fighting operations through these windows would be impossible if the barrier is implemented.

6.4.10.3 Emergency access to the car park above the commercial complex would be blocked by the noise barrier. The residential properties might not be affected too significantly as the wall around the boundary of the complex is already a few meters above the level of the flyover.

6.4.10.4 There is currently no pedestrians or vehicles access above or below the flyover so the proposed barrier would not have adverse impact on safety in general.

Area B

6.4.10.5 The two main entrances to the commercial complex from the market are located at this section at ground level. The structural supports for the proposed barrier could block these two entrances which would eliminate the major escape exits from the north side of Mei Foo Sun Chuen. Access for fire fighting or emergency operations would no longer be possible from this side of the commercial complex if these entrances were blocked.

6.4.10.6 Lighting would need to be provided as the barrier would block most of the natural light that falls from the gap between the flyover and the commercial complex. Addition lighting would be needed in the passageway between the shopping complex and Mei Foo Centre for the elderly. Without this additional lighting, the passageway would be almost entirely cloaked in darkness.

6.4.10.7 There are no bus stopping or large scale loading/unloading activities so the barrier would have no negative impact on those activities.

Area C

6.4.10.8 There are windows from the catering establishments of the adjacent building. The blocking of these windows would have a vitally impact on fire fighting operation during emergency.

6.4.10.9 Many smaller retail outlets have their main entrances along this section at ground level. Constructing the noise barrier here would cause the shops be cut off from the rest of the surrounding area. The barrier's supports would block the footpath running alongside the shops of the complex possibly eliminating access. The supports would also create large obstacles to the pedestrians using this footpath.

6.4.10.10 The barrier would also block a large percentage of the daylight that falls onto this area. Sufficient lighting would need to be provided to avoid degradation to pedestrian safety.

6.4.10.11 There are no bus stopping or large scale loading/unloading activities so the barrier would not have any further negative impact to these activities.

Area D

6.4.10.12 Above the flyover, there is no access to Mei Foo Sun Chuen so the implementation of the barrier would not reduce the safety aspect during emergencies. The access to the existing refuse collection point underneath the flyover would be blocked. There are no bus stopping or large scale loading/unloading activities so the barrier would not have any further negative impact.

Area E

6.4.10.13 Apart from the blockage of access to the existing refuse collection point, the comments for Area D apply to Area E for both above and below the level of the flyover.

Area F

6.4.10.14 The Fire Services Department commented on the Scoping Study and recommended that there should be a minimum clearance of 4.5m between the flyover and the Noise Sensitive Receivers. In Area F the clearance is often less than one metre which is significantly below the recommended minimum. The Fire Services Department has advised that no direct noise mitigation measures should be implemented along the northbound carriageway of Kwai Chung Road Flyover immediately adjacent to Phase I of Mei Foo Sun Chuen.

6.4.10.15 The barrier would block a number of residential windows which would render external fire fighting operations to these properties impossible. The proposed barrier would also block some of the daylight for the market and recreational

areas below the flyover. Additional lighting would probably not be required as a number of existing lights are present at this location.

6.4.10.16 There are no bus stopping operations or large scale loading/unloading activities so the barrier would not have any further negative impact.

Area G

6.4.10.17 There is no access to Mei Foo Sun Chuen from the level of the flyover so the implementation of the barrier would not reduce the safety aspect during emergency operations. No access for pedestrians to the flyover is allowed so pedestrian safety would not be an issue.

6.4.10.18 Beneath the flyover, there are no bus stopping operations or large scale loading/unloading activities so the barrier would not have any negative impact.

Area H

6.4.10.19 The impacts in terms of safety by the erection of barriers along section H would be similar to that of Area G at the flyover level. However, the buses and mini-bus stoppings would be seriously affected by the barriers at ground level. The existing latrine could be relocated to accommodate the foundation and supports of the barrier along this section of road.

Area I

6.4.10.20 The impacts generated by the erection of a barrier along this section of road will be similar to that of Area H.

Area J

6.4.10.21 Apart from the traffic safety mentioned previously, no other impacts on road users in terms of safety would be foreseen by the erection of a barrier along this section.

Area K

6.4.10.22 The impacts on Area K with respect to safety would be similarly to that of Area G.

6.5 Summary

6.5.1 In view of the above findings, judgement can be rendered at this stage to identify possible locations for the erection of noise mitigation measures. Findings for the areas under consideration are summarised as follows:

Areas A & B

6.5.2 The lack of space in Areas A & B is the main constraint which renders the barrier construction not feasible. It would be unlikely that the barrier could be constructed without blocking part of the main entrances.

Area C

6.5.3 Again the lack of space would not allow the implementation of a barrier/enclosure. The safety implications during emergency situations would also be unacceptable.

Area D

6.5.4 Construction of a barrier along this section of road would intersect with the existing drainage reserve zone surrounding 225ϕ drainage manholes, thus approval on the alignment of the barrier should be sought from DSD. Alternatively, the length of the barrier may have to be reduced to avoid encroachment into the drainage reserve zones.

6.5.5 The proposed barrier would also affect the livelihood of Mei Foo Sun Chuen residents by blocking the access to the existing refuse collection point and affecting the usage of the existing basketball court located underneath the flyover.

Area E

6.5.6 Similar to Area D, the existence of drainage reserves is one of the principal constraints in this area. The proposed barrier would severely reduce the visibility of vehicles entering Kwai Chung Road Flyover from the northbound slip road of Lai Chi Kok Road. As a result, the construction of a barrier along this section would obstruct the visibility of road users.

Area F

6.5.7 Construction of a barrier in Area F would not be practical. The main constraint would be the 4.5m horizontal clearance between the outer edge of the flyover and the building facade required by the Fire Services Department.

Area G

6.5.8 The visibility for traffic turning from Lai Chi Kok Road to Cheung Sha Wan Road through the road beneath the flyover would be an insurmountable constraint as a result of the construction of the barrier supports.

Areas H & I

6.5.9 Blockage of the existing bus terminus and mini-bus stop beneath the flyover together with Mei Lai Road and the adjacent link road rules out the construction of barriers along these two sections. Furthermore, these barriers would encroach into the existing drainage reserve and fall inside the MTR protection zone so that the requirements as stated in 6.4.8.3 and 6.4.8.4 should also be considered.

Area J

6.5.10 The lack of clearance between the flyover and the edge of the widened Lai Chi Kok Road would render the construction of a barrier along this section of road not feasible.

Area K

6.5.11 Once again, reduction of visibility for traffic turning from Cheung Sha Wan Road to Lai Chi Kok Road through the link road underneath the flyover leaves the implementation of a barrier along this section not practical. In addition, this area is located close to the MTR tunnel and the requirements as stated in 6.4.8.3 should be followed.

6.5.12 In view of the above, it is noted that the majority of the study areas along Kwai Chung Road Flyover near Mei Foo Sun Chuen cannot be mitigated by direct noise mitigation measures such as barriers and enclosures owing to the presence of insurmountable constraints. Area D is considered to be the only engineering feasible location for the implementation of barriers/enclosures provided that the requirements of MTRC can be fulfilled and impacts on livelihood of residents can be resolved or minimised.

6.5.13 However, the erection of a barrier/enclosure along Area D only would be insignificant to the overall acoustic effectiveness because of its very limited extent. As a result, no direct mitigation measures has been recommended for Kwai Chung Road Flyover near Mei Foo Sun Chuen.

7. SIMPLIFIED WORKING TOOLS FOR FLYOVER ASSESSMENT

7.1 Introduction

7.1.1 The feasibility of mitigating noise from existing flyovers is generally dependent on the local site constraints and the type of sensitive developments to be protected. While it is desirable to undertake a detailed feasibility study to identify all these site constraints for direct noise mitigation measures on existing flyovers, it is useful to adopt simplified procedures for initial assessment, since the study usually takes time to complete. To this end, a working tool is developed to enable an assessor to carry out a desk-top study to assess if the required mitigation is at all feasible before the mitigation is subject to a detailed feasibility study.

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

7.1.3 The simplified assessment procedures are illustrated in six flow charts which cover the following aspects of the investigation :

- identification of problems at the subject site;
- selection of a barrier form for the identified problems;
- availability of space and land for the likely barrier provision;
- implication of the identified barrier form on the provision of existing emergency access and fire fighting requirements; and
- implication of the identified barrier form on road safety, pedestrian and vehicular movements.

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

7.1.4 This set of assessment procedures can serve as a quick working tool to identify any initial feasible extent and location of noise mitigation measures before any detailed assessment is put forward. If the assessment is positive, a preliminary engineering feasibility study should then be carried out to confirm the viability of the proposal and the acoustic effectiveness should be evaluated. An overview of the simplified procedures is shown in Appendix E1. The applicability of these procedures to the 3 existing flyovers, namely Ap Lei Chau Bridge, Tsing Tsuen Bridge and Kwai Chung Road Flyover, is illustrated in Appendix E2.

7.2 Identification of Problems

7.2.1 Problem identification procedures are given in Chart 1 of Appendix E1. The identification is based on the number of lanes (L) and the distance of the subject road from the affected facade (D). Annex I of Appendix E1 gives the technical basis for the formulation of Chart 1.

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

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

7.3 Selection of Barrier Form

7.3.1 When a flyover has been identified as noisy, the next step is to review the site conditions and determine the form of noise barrier to mitigate the noise impact on the affected buildings. Plain vertical noise barriers would be effective to protect up to about 5th floor receivers above carriageway level in the flyover. For receivers in the mid floor range, i.e. from 5th to 10th floor, a bend top barrier would normally be required. Receivers at floors above 10th would need semi-enclosures to be installed on the subject road. Chart 2 provides a quick procedure to assist the assessor to identify the likely form of barrier on the subject site. Annex II of Appendix E1 gives the technical basis for formulation of Chart 2.

7.3.2 Once the barrier forms are determined, initial assessment of the flyover structure shall be followed. However, from experience on other flyover project and engineering assessment in this study, it would be in general unlikely practicable to install noise mitigation measures to existing flyovers as additional loading of the measures are usually not allowed in the flyover design. Therefore, it is recommended that the approach of using independent support structure shall be adopted in retrofitting existing flyovers.

7.4 Space/Land Availability

7.4.1 Having established the possibility of providing barriers on independent structures to mitigate the noise impact, the available space or lands on site for construction of the proposed noise barrier should be examined. Independent

support structure for the barriers will require lands for its installation on ground. This is to confirm the space/land requirements for the installation of the proposed barrier independent support on ground. Chart 3 provides a quick process to identify the minimum space required for installation of the proposed barrier at ground level from the consultants' experience in other projects.

7.5 Emergency Access and Fire Fighting Considerations

7.5.1 Provision of noise barriers may often create an obstruction between the carriageway and the affected development. This is especially the case in an existing development where usually no provision is made for any noise barrier in the emergency vehicle access (EVA) for fire fighting and emergency vehicles.

7.5.2 For fire fighting, it is essential that the affected facades should be within reach of the fire engines. In general, a minimum horizontal clearance of 4.5m shall be maintained between the outer edge of the proposed noise barrier and the building facade as indicated in Chart 4.

7.6 Road Safety Considerations

7.6.1 Chart 6 focuses on the road safety aspects, which cover the basic traffic engineering requirements, stipulated in the TPDM. A detailed investigation would involve the measurements of visibility splays and speed of traffic. As a quick assessment, Chart 5 has been designed to provide a step-by-step procedure to identify a suitable a scheme which duly considers all likely implication of the scheme to road safety and pedestrian and vehicle access.

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

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

7.7 Preliminary Engineering Feasibility Study and Acoustic Effectiveness.

7.7.1 When no insurmountable obstacle appears to exist in the first six rounds of quick assessment, the identified mitigation measures would be recommended for preliminary engineering feasibility study and the following key issues should be assessed in detailed in order to confirm their viability :

- traffic engineering and road safety appraisal;
- interfacing with utilities;
- structural engineering appraisal;
- landscape appraisal;

- air quality assessment;
- side effects;
- costing; and
- implementation strategy.

7.7.2 Apart from the above engineering assessment, the noise assessment should be carried out and the level of protection to the affected NSRs should be evaluated. This would provide a useful reference on the acoustic effectiveness of the mitigation measures and contribute to the consideration of implementation priority.

8. DEVELOPMENT OF PRIORITY RANKING SYSTEM

8.1 Ranking based on Population Exposure

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

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

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

Higher priority is given to the mitigation scheme which aims to protect more dwellings affected by traffic noise according to definition (b) or to protect more dwellings adversely affected by traffic noise according to definition (a). The method described in (a) would provide a more rational result, as the top prioritised mitigation schemes would tend to protect more population and sites to achieve a higher reduction.

8.2 Ranking based on Cost-effectiveness

8.2.1 Alternatively, the recommended mitigation schemes for the identified road sections may be ranked in terms of cost-effectiveness of the schemes. Higher priority is given to the scheme with lower cost of construction per dwelling protected. In this assessment, the cost of construction should include the following:

- direct cost of construction (i.e. capital cost);
- indirect cost of construction for diversion of any affected utilities and services, road signs and other street level furniture which is assumed to be a percentage of the capital cost;
- cost for land resumption; and
- recurrent costs which include annual maintenance cost and annual staff cost as obtained from HyD/Str.

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

8.3 Recommended Ranking System

8.3.1 The first ranking system, i.e. based on population exposure, prioritises the mitigation schemes according to the severity and extent of the noise problem. Both noise levels and the number of dwellings being exposed to the noise are

duly considered in such prioritisation. From the prospective of the District Boards and the public at large, this system is a more logical choice. From a technical prospective, it is also a right choice.

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

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

8.4 Priority Ranking of the Recommended Mitigation Measures

8.4.1 Based on the above evaluation of ranking systems, the recommended mitigation measures at the studied flyovers have been prioritised and summarized in terms of recommended noise mitigation measures and costs. Table 8-1 presents the summary of these mitigation measures, Table 8-2 presents the cost summary of these measures and Table 8-3 shows priority ranking based on population exposure (ie. Z (dB exceedance of 70 dB(A) x no. of dwelling), has been proposed for implementation. Taking into account the percentage of protected dwellings in the ranking criteria, the priority for the recommended schemes would remain the same. A comparison of the two approaches is shown in Table 8-4 for reference.

8.4.2 The capital cost estimation for the implementation of these recommended measures as shown in Table 8-2 have been based on the figures worked out in Section 4.9 & 5.9. The recurrent consequence in terms of financial and staffing implication have also estimated in Section 4.9 & 5.9 based on the latest information such as annual unit maintenance and annual unit staff cost for noise barriers/enclosures obtained from HyD/Str. They are summarized as follows:

Flyover Location	Annual Maintenance Cost (HK$ M/year)	Annual Staff Cost (HK$ M/year)
Ap Lei Chau Bridge	0.15	0.05
Tsing Tsuen Bridge		
• Tsuen Wan Approach	1.57	0.47
• Tsing Yi Approach	0.54	0.16

Note: Recurrent Costs are given at Dec 97 Price Level

Table 8-1 Mitigation Summary Table

Location	Protected NSRs	No. of exposed dwelling	No. of dwelling protected	No. of dwelling benefited	Recommended noise mitigation measures	% of Protection
Ap Lei Chau Bridge	Toho Court Rousseau Heights Sun Ming Building Nam Tack Mansion Ning Fung Mansion	77	34	74	Bent top Vertical Barrier (95m)	44
Tsing Tsuen Bridge - Tsuen Wan Approach	Rivera Gardens: Hoi Nga Mansion Hoi Kwu Mansion Hoi Sing Mansion Hoi Fung Mansion Hoi Wai Mansion Hoi Yat Mansion Hoi Kwai Mansion Hoi Yin Mansion Hoi Yue Mansion	1545	714	960	Partial Enclosure Type I (125m) + Type II (160m)	46
Tsing Tsuen Bridge - Tsing Yi Approach	Cheung On Estate: On Mei House On Pak House On Chiu House	1061	122	657	Partial Enclosure Type II (150m)	12

Table 8-2 Cost Summary Table

Location	Direct Construction Cost	Indirect Construction Cost	Total Construction Cost	Total Cost per dwelling protected	Total Cost per dwelling benefited
Ap Lei Chau Bridge	HK$13.4M	HK$2.7M	HK$16.1M	HK$0.48M	HK$0.22M
Tsing Tsuen Bridge - Tsuen Wan Approach	HK$103.7M	HK$20.7M	HK$124.4M	HK$0.18M	HK$0.13M
Tsing Tsuen Bridge - Tsing Yi Approach	HK$71.7M	HK$14.3M	HK$86M	HK$0.71M	HK$0.13M

Note 1: Total Construction Costs are given at Dec 98 Price Level and include the followings:
(a) direct construction cost (capital cost); and
(b) indirect construction cost includes cost for utilities, street furniture and traffic diversion (assuming 20% of the capital cost for medium diversion).

Note 2: No resumption on private land is considered necessary for the implementation of the recommended measures at each flyover location.

Note 3: Land resumption on "semi-government land" for erection of the recommended measures fronting Cheung On Estate at the Tsing Yi approach section of Tsing Tsuen Bridge is necessary.

Table 8-3 Priority of Mitigation

Priority Ranking	Location	Total No. of dwelling exposed	Sum of Exposure Levels (Priority Criterion)	Recommended noise mitigation measures	Total Cost
1	Tsing Tsuen Bridge - Tsuen Wan Approach	1545	5754	Partial Enclosure Type I (125m) + Type II (160m)	HK$124.4M
2	Tsing Tsuen Bridge - Tsing Yi Approach	1061	3030	Partial Enclosure Type II (150m)	HK$86M
3	Ap Lei Chau Bridge	77	349.5	Bent top Vertical Barrier (95m)	HK$16.1M

Note: Exposure Level = Mean Exceedance x No. of Dwellings

Table 8-4 Sensitivity Analysis of Priority of Mitigation

Location	**Priority based on Exposure Level**			**Priority with account of % protection**		
	No. of dwelling exposed	Sum of Exposure Levels	**Priority Ranking**	% of Protection	(% of Protection) x (Sum of Exposure Level	**Priority Ranking**
Tsing Tsuen Bridge - Tsuen Wan Approach	1545	5754	**1**	46	2647	**1**
Tsing Tsuen Bridge - Tsing Yi Approach	1061	3030	**2**	12	364	**2**
Ap Lei Chau Bridge	77	349.5	**3**	44	134	**3**

9. IMPLEMENTATION STRATEGY

9.1 Overview

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

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

9.2 Key Statutory, Administrative and Consultative Steps

9.2.1 Status Process

9.2.1.1 The project needs to be gazette under the Roads (Works, Use and Compensation) Ordinance. The timing for the gazette procedures is shown in the typical project programme (Fig 9-1) that includes allowance for ExCo papers submission under the Ordinance.

9.2.2 Administrative Steps

9.2.2.1 The project will be subdivided into packages based on the priority rating and jurisdiction (See Table 9-1). The key administrative steps for each of the packages are highlighted as follows:

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

9.2.3 Consultation

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

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

9.3 Staffing

9.3.1 Government In-house Staff verse Consultants

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

9.3.1.2 Typical project programme of the proposed mitigation measures for the studied flyovers is illustrated in Fig. 9-1.

9.3.1.3 The desirable target for completion of all the identified measures on the studied flyovers, namely Ap Lei Chau Bridge and Tsing Tsuen Bridge, would be within a 6 year period in three separate phases which take into account of the process for resources allocation exercises, design and construction of the various packages. An outlined implementation programme is indicated below:

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Tsing Tsuen Bridge - Tsuen Wan Approach		Phase I				
Tsing Tsuen Bridge - Tsing Yi Approach			phase II			
Ap Lei Chau Bridge				Phase III		

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

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

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

9.4 Funding for Consultants

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

9.5 Process

9.5.1 Contract Options

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

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

Table 9-1 Project Implementation Table

Phasing	Location	Protected NSRs	No. of exposed dwelling	No. of dwelling protected	No. of dwelling benefited	% of Protection	Total Cost	Total Cost per dwelling protected	Total Cost per dwelling benefited	Sum of Exposure Level (Priority Criterion)	Recommended noise mitigation measure
I	Tsing Tsuen Bridge - Tsuen Wan Approach	Rivera Gardens: Hoi Nga Mansion Hoi Kwu Mansion Hoi Sing Mansion Hoi Fung Mansion Hoi Wai Mansion Hoi Yat Mansion Hoi Kwai Mansion Hoi Yin Mansion Hoi Yue Mansion	1545	714	960	46	HK$124.4M	HK$0.18M	HK$0.13M	5754	Partial Enclosure Type I (125m) + Type II (160m)
II	Tsing Tsuen Bridge - Tsing Yi Approach	Cheung On Estate: On Mei House On Pak House On Chiu House	1061	122	657	12	HK$86M	HK$0.71M	HK$0.13M	3030	Partial Enclosure Type II (150m)
III	Ap Lei Chau Bridge	Toho Court Rousseau Heights Sun Ming Building Nam Tack Mansion Ning Fung Mansion	77	34	74	44	HK$16.1M	HK$0.48M	HK$0.22M	349.5	Bent top Vertical Barrier (95m)

10. CONCLUSION AND RECOMMEDATIONS

10.1 General

10.1.1 This Report has presented the preliminary engineering feasibility study and traffic noise impact assessment for the three existing flyovers, namely, Ap Lei Chau Bridge, Tsing Tsuen Bridge and Kwai Chung Road Flyover near Mei Foo Sun Chuen, and recommended any feasible mitigation measures to be provided.

10.1.2 Side effects of the recommended mitigation measures including environmental and visual impacts and air quality impacts have been examined. Cost effectiveness and implementation strategy were also explored in the study.

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

10.1.4 A set of working tools with simplified assessment procedures has been established to enable the initial assessment of any feasible mitigation options for existing flyovers. The applicability was verified from the findings of the three studied flyovers.

10.2 Ap Lei Chau Bridge

10.2.1 After completion of the noise assessment and engineering assessment for the above flyover at the Ap Lei Chau approach section, it was recommended that noise mitigation measures with 6m high bent-top vertical barriers would be required to provide the necessary protection to the receivers.

10.2.2 Structural assessment of the existing retaining wall has been carried out. It was found that neither provision was made in the original design nor there were sufficient spare capacities to cater for the additional loading from the proposed barriers. As the resulting overstress condition in the existing structure was found to be serious, independent structure with foundation at ground level was required to support the noise barriers.

10.2.3 The feasible extent and location of the independent structure in Ap Lei Chau Bridge was constrained by the presence of adjacent development, USD recreational grounds and subway access and only about 95m of barrier in length can be provided. The recommended location and cross section is shown in Fig. 4-2 & 4-3. About 44% of protection for the affected dwellings can be achieved.

10.2.4 It should be noted that if the recommended mitigation measures are to be implemented, USD in particular should be fully consulted as any proposed structure are required to be located outside their recreational grounds and the operation and use of their venues should not be affected during construction.

10.2.5 Side effects such as air quality and visual/landscape impacts have been assessed. It was considered that the recommended barriers would have no adverse impact on the local air quality. However, the massive steelwork appearance of the independent structure would have serious visual intrusion to the residents and disruption to the established landscaped environment.

10.2.6 Preliminary construction cost of the above mitigation works was estimated at about HK$16.1M (Dec 98 Prices). Annual maintenance cost and annual staff cost as obtained from HyD/Str were estimated at HK$0.15M and HK$0.05M (Dec 97 Prices) respectively.

10.2.7 Sum of exposure level was found to be 389.5. Implementation priority based on the Population Exposure Ranking is the lowest comparing with Tsing Tsuen Bridge.

10.3 Tsing Tsuen Bridge

10.3.1 After completion of the noise assessment and engineering assessment for the above flyover at the Tsing Yi approach section and Tsuen Wan approach section, it was recommended that noise mitigation measures with about 6m high partial enclosures would be required to provide the necessary protection to the receivers.

10.3.2 Structural assessment of the existing flyover has been carried out. It was found that neither provision was made in the original design nor there were sufficient spare capacities to cater for the additional loading from the proposed enclosures.

10.3.4 Structural assessment has been carried out on the flyovers. It was found that the resulting overstress condition of the structural members was serious. Strengthening of bridge deck to cater for the noise barrier installation has been examined but was not considered as practical because of the requirements of bridge closure for a substantial period of time and extensive alteration works. Therefore, independent structure with foundation at ground level was required to support these noise enclosures.

Tsing Yi Approach Section

10.3.5 The feasible extent and location of independent structure for the Tsing Yi approach of Tsing Tsuen Bridge was constrained by existing road, EVA underneath the bridge and the recreational facilities within Cheung On Estate lot boundary. In addition, it would be in conflict with existing utilities and drainage and require diversion.

10.3.6 Housing Department has indicated their general support for locating the independent structure within Cheung On Estate subject to consultation with the Housing Authority and owners of domestic units. The recommended location and cross sections are illustrated in Fig. 5-3(Sheet 1) and 5-5. Only about 12% of protection for the affected dwellings can be achieved. 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.

10.3.7 Side effects such as air quality and visual/landscape impacts have been assessed. It was considered that the recommended barriers would have no adverse impact on the local air quality. However, the massive steelwork appearance of the independent structure would have serious visual intrusion to the residents and disruption to the established landscaped environment.

10.3.8 Preliminary construction cost of the above mitigation works was estimated at about HK$86M (Dec 98 Prices). Annual maintenance cost and annual staff cost as obtained from HyD/Str were estimated at HK$0.54M and HK$0.16M (Dec 97 Prices) respectively.

10.3.9 Sum of exposure level was found to be 3030. Implementation priority based on the Population Exposure Ranking is in the second position.

Tsuen Wan Approach Section

10.3.10 The feasible extent and location for the independent structure for Tsuen Wan approach of Tsing Tsuen Bridge was constrained by the adjacent boundary of development, RSD's recreational ground and staircase access. The recommended layout and cross section of the enclosures are given in Fig. 5-3 (Sheet 2), 5-4 & 5-5. RSD has indicated that the proposed independent structure might not intrude into their recreational ground as observed by them on site. However, during construction, some of their lands may be affected. Therefore, RSD should be fully consulted if the recommended mitigation measures are to be implemented.

10.3.11 With the above extent of mitigation measures, about 46% of protection for the affected dwellings can be achieved.

10.3.12 Side effects such as air quality and visual/landscape impacts have been assessed. It is considered that the proposed partial enclosures would have no adverse impact on the air quality. However, the massive steelwork appearance of the independent structure would have serious visual intrusion to the residents and disruption to the established landscaped environment.

10.3.13 Preliminary construction cost of the above mitigation works was estimated at about HK$124.4M (Dec 98 Prices). Annual maintenance cost and annual staff cost as obtained from HyD/Str were estimated at HK$1.57M and HK$0.47M (Dec 97 Prices) respectively.

10.3.14 Sum of exposure level was found to be 5754. Implementation priority based on the Population Exposure Ranking is in the first position.

10.4 Kwai Chung Road Flyover near Mei Foo Sun Chuen

10.4.1 No noise mitigation measures can be recommended for this flyover. Practicality of erecting the noise barriers/enclosures on the flyover or independent structure at grade was the crucial concern in the study area.

10.4.3 Results of the structural assessment indicated that the existing bridge structure of Kwai Chung Road Flyover does not have adequate spare structural capacity to cater for additional vertical and lateral loads for the proposed noise mitigation measures. Strengthening of the existing structures were also not considered as feasible because the amount of works involved and disruptions to the public in terms of social impacts and all possible consequential effects on traffic and environment would be significant and should not be underestimated.

10.4.4 Independent structure was not considered as feasible because of the lack of space and the existence of drainage reserves at its location. In addition, it would obstruct the fire fighting operation. As advised by FSD in their letter ref. (13) in FSD/PG4/130/94III of 19.2.99, the following requirements should be complied before any mitigation measures were considered feasible:

- vehicular access with a minimum width of 6 metres should be provided adjacent to the flyover;
- horizontal clearance of not less than 4.5 metres between the flyover and the building facade should be maintained;
- the flyover should not be the only access to building facades; and
- fire fighting operation should not be obstructed by the erection of direct technical mitigation measures.

10.4.7 Apart from the above constraints, the presence of recreational area and daily pedestrian movement and commercial activities in the vicinity of the flyover, in particular, the area below the flyover would pose another constraint for the erection of direct technical mitigation measures.

10.4.8 The presence of MTR Mei Foo Station and its protection boundary would further reduce the possibility of any implementation of direct technical mitigation measures on independent structure within these areas. Any construction works within the MTR protection zone would be subject to special scrutiny by Government and under strict monitoring requirement as stipulated in the Practice Note for AP/RSE No. 77 issued by the Building Authority.

10.4.9 In addition, the area to the west of Lai Wan Road adjacent to Kwai Chung Flyover would be confined by the proposed West Rail, Mei Foo station. This station was proposed to be a piled structure with lowest finished ground level at -2.0 mPD and highest finished ground level at +17.7mPD spanning underneath and across the flyover. Thus, the erection of noise mitigation measures in this area would be almost impossible.

10.4.10 In conclusion, no feasible extent and location of direct technical mitigation measure has been recommended for the existing Kwai Chung Road Flyover near Mei Foo Sun Chuen.

10.5 Overall Summary of Results and Recommendations

10.5.1 Based on engineering assessment on the studied flyovers and experience on other flyover projects, it would be in general unlikely practicable to install noise mitigation measures directly to existing flyovers as additional loading of the measures are usually not allowed in the flyover design. It is recommended independent support structure shall be adopted in retrofitting existing flyovers.

10.5.2 The feasibility/practicability, benefits and priority ranking of the implementation of the proposed noise mitigation measures with independent support structures at the studied flyovers are summarized as follows:

Flyover Location	Proposed Mitigation Measures	Feasibility/ Practicability	No. of dwelling exposed	% of Protection	Sum of Exposure Levels (Priority Ranking)
Tsing Tsuen Bridge - Tsuen Wan Approach	Partial Enclosure Type I (125m) + Type II (160m)	Feasible & Practical	1545	46	5754 (1)
Tsing Tsuen Bridge - Tsing Yi Approach	Partial Enclosure Type II (150m)	Feasible. % of protection is low but exposure level is high	1061	12	3030 (2)
Ap Lei Chau Bridge	Bent top Vertical Barrier (95m)	Feasible & Practical	77	44	349.5 (3)
Kwai Chung Road Flyover near Mei Foo Sun Chuen	Bent top Vertical Barrier [as proposed in the Scoping Study]	Not feasible & Not practical	-	-	-

10.5.3 The implementation strategy, costs, side effects and land issues for the proposed mitigation measures on those flyovers which are concluded as feasible are summarized as follows:

Flyover Location	Implement-ation Strategy (Programme)	Total Construct-ion Cost (HK$)	Total Recurrent Cost (HK$)	Air Quality Effects	Aesthetical Effects	Land Requirement
Tsing Tsuen Bridge - Tsuen Wan Approach	Phase I (Year 1 to 4)	124.4M	2.04M	Not Significant	Significant*	No Resumption of Private Land
Tsing Tsuen Bridge - Tsing Yi Approach	Phase II (Year 2 to 5)	86M	0.7M	Not Significant	Significant*	Resumption on "semi-government land within Cheung On Estate **
Ap Lei Chau Bridge	Phase III (Year 3 to 6)	16.1M	0.2M	Not Significant	Significant*	No Resumption of Private Land

Note : (1) Total Construction Costs are given at December 1998 price level.
(2) Total Recurrent Costs are given at December 1997 price level as obtained from HyD/Str.

* - Aesthetical Effects are significant. Measures to reduce the impacts will be developed for the generic design of the noise mitigation measures and for submission to the ACABAS for in-principle approval.

** - Resumption of land adjacent to Tsing Tsuen Bridge within Cheung On Estate Boundary is necessary. Consultation with the Housing Authority and the owners of the domestic units should be made before implementation of the proposed measures.

10.5.4 The specific criteria for retroactive noise mitigation on the studied flyovers are indicated as follows:

Flyover Location	Availability of Space for Installation of Proposed Measures	Emergency Access & Fire Fighting Not Obstructed	Road Safety such as Driving Visibility and Vehicular/ Pedestrian Access Not Affected
Tsing Tsuen Bridge - Tsuen Wan Approach	✔	✔	✔
Tsing Tsuen Bridge - Tsing Yi Approach	✔	✔	✔
Ap Lei Chau Bridge	✔	✔	✔
Kwai Chung Road Flyover near Mei Foo Sun Chuen	×	×	×

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

10.6 Recommendations for Further Works

10.6.1 If the identified mitigation measures for Ap Lei Chau Bridge and Tsing Tsuen Bridge are put forward for implementation, the following further works are recommended to proceed:

- ground investigation and topographical surveys to confirm the actual ground condition and geological data;
- confirmation of land requirement with the Lands Department and relevant government departments/parties;
- consultation with the District Offices, the public and the utility undertakers;
- review of the socio-economic implications;
- environmental study review;
- engineering study review;
- detailed ACABAS submission;
- detailed design of mitigation structures;
- detailed cost estimation and cash flow analysis;
- detailed implementation programme.

10.6.2 Due consideration should be given to the maintenance requirements in the detailed design of the identified mitigation measures as follows:

- minimise the types of noise barriers/enclosures wherever possible; and
- allow access for inspection and maintenance.

APPENDIX A1

Technical Paper No. 2 -
Traffic Noise Impact Assessment

Technical Paper No. 2
Traffic Noise Impact Assessment

Contents

FIGURES

1. INTRODUCTION

1.1 Background

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

1.2 Study Objectives

The objectives of this paper are as follows :

- to advise Director's Representative the acoustical effectiveness of provision of direct mitigation measures on the two existing flyovers namely the Apleichau Bridge and the Tsing Tsuen Road near Riviera Gardens and Cheung On Estate; and

- to carry out a review of the findings in the *Scoping Study for Providing Direct Technical Remedies on Existing Flyovers* and to recommend alterations to the proposed measures therein, if necessary, in light of the changes subsequent to the completion of the Scoping Study.

1.3 Technical Paper Structure

This Technical Paper consists of 4 sections, as follows :

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

2. REVIEW OF SCOPING STUDY

2.1 Apleichau Bridge

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

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

2.2 Tsing Tsuen Road

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

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

3. TRAFFIC NOISE IMPACT ASSESSMENT

3.1 Noise Standards and Regulations

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

3.2 Noise Sensitive Receivers

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

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

Table 1 Description of NSRs

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

3.3 Assessment Methodology

Noise Model

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

Traffic Figures

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

Development of Mitigation Measures

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

Evaluation of Noise Mitigation Measures

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

3.4 Traffic Noise Impact Assessment

Ap Lei Chau Bridge

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

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

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

Tsing Tsuen Road

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

3.5 Proposed Mitigation Scenarios

Ap Lei Chau Bridge (ALCB)

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

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

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

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

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

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

Evaluation of Effectiveness

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

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

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

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

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

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

- Background noise level

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

NSRs	Floor	Breakdown and Overall Noise Levels at Various Level in dB(A)		
		Flyover	Other Roads	Overall
OC3	1	69.5	63.3	70
	5	*77.5*	61.7	*78*
	10	*77.3*	62.1	*77*
	15	*76.7*	62.7	*77*
	20	*76.1*	62.4	*76*
	25	*75.5*	61.5	*76*
	30	*74.9*	61.6	*75*
	34	*74.5*	61.3	*75*
SP1	1	59.2	57.7	62
	3	64.0	60.3	66
SP2	1	65.3	64.7	68
	3	68.3	65.5	70
SP3	1	66.3	65.3	69
	3	68.4	65.9	70
SP4	1	65.8	62.8	68
	3	67.4	63.3	69
A-1	1	63.6	-	64
	5	66.5	-	67
	10	*70.9*	-	*71*
	15	*71.1*	-	*71*
	20	*70.9*	-	*71*
	25	*70.6*	-	*71*
	30	70.4	-	70
	35	70.0	-	70
	40	69.7	-	70
B-1	1	*65.0*	-	65
	5	*70.5*	-	*71*
	10	*73.8*	-	*74*
	15	*73.6*	-	*74*
	20	*73.3*	-	*73*
	25	*72.8*	-	*73*
	30	*72.4*	-	*72*
	35	*72.0*	-	*72*
	40	*71.6*	-	*72*
B-2	1	67.3	34.1	67
	5	*75.0*	43.0	*75*
	10	*76.9*	48.1	*77*
	15	*76.5*	48.1	*77*
	20	*76.0*	48.1	*76*
	25	*75.5*	48.0	*76*
	30	*74.9*	48.0	*75*
	35	*74.4*	47.9	*74*
	40	*73.9*	47.8	*74*

\- Background noise level

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

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

\- Background noise level

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

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

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

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

Table 4 Comparison of Mitigation Options for Ap Lei Chau Bridge

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

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

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

Tsing Tsuen Road

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

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

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

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

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

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

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

Table 6 Comparison of Mitigation Options for Tsing Tsuen Road

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

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

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

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

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

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

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

- Background noise level

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

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

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

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

Evaluation of Effectiveness

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

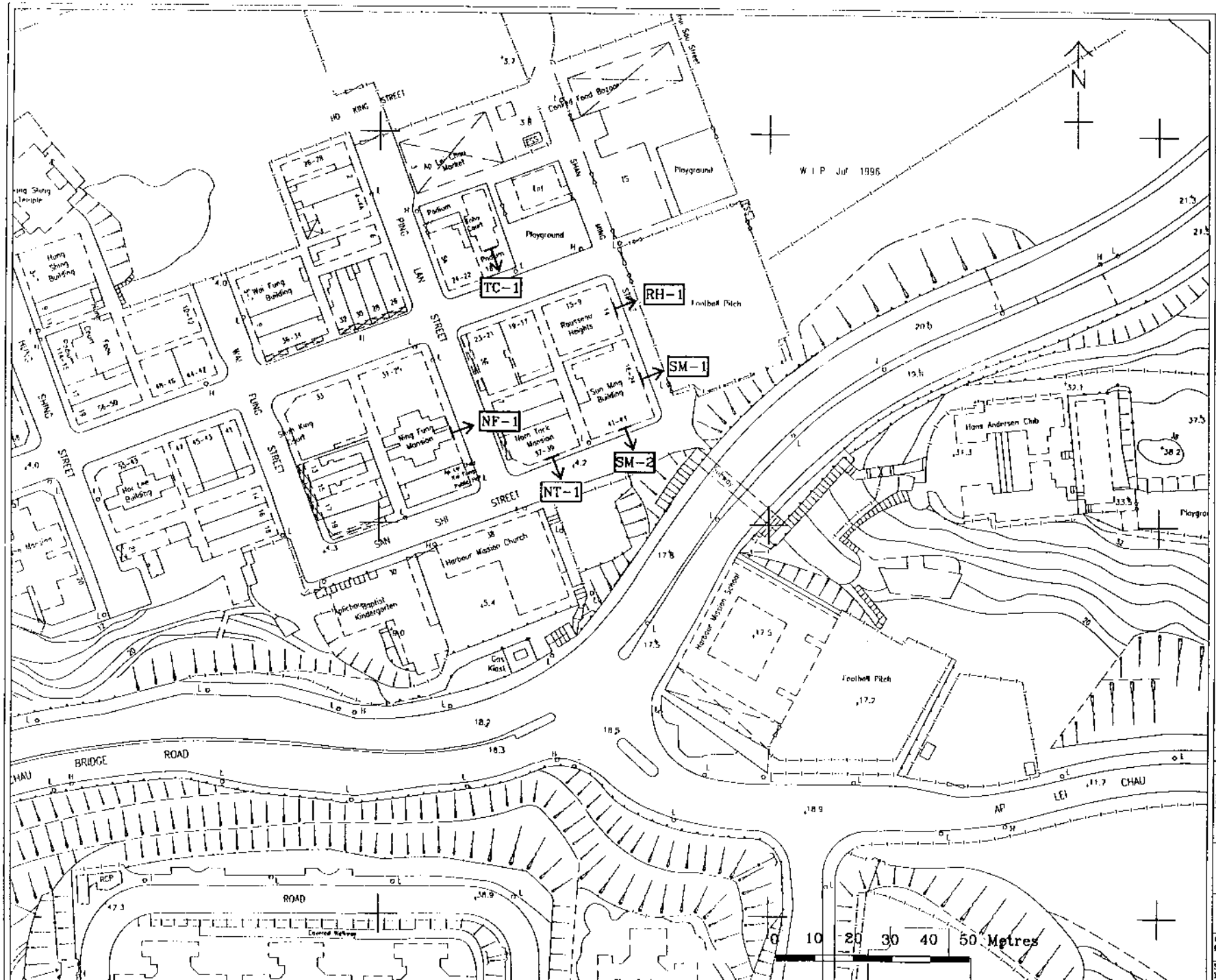
As for the western end of Tsing Tsuen Road near Cheung On Estate, the noise protection provided by the implementation of Mitigation Option I and Mitigation Option II is 53% and 86%, respectively. As such, mitigation Option II is also considered to be a more effective option in terms of noise abatement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

Table 7 Effectiveness Comparison of Mitigation Options for Tsing Tsuen Road

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

4. CONCLUSION & RECOMMENDATION

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



LEGEND

→ SM-1 LOCATION OF REPRESENTATIVE NSR

ENVIRONMENTAL PROTECTION DEPARTMENT

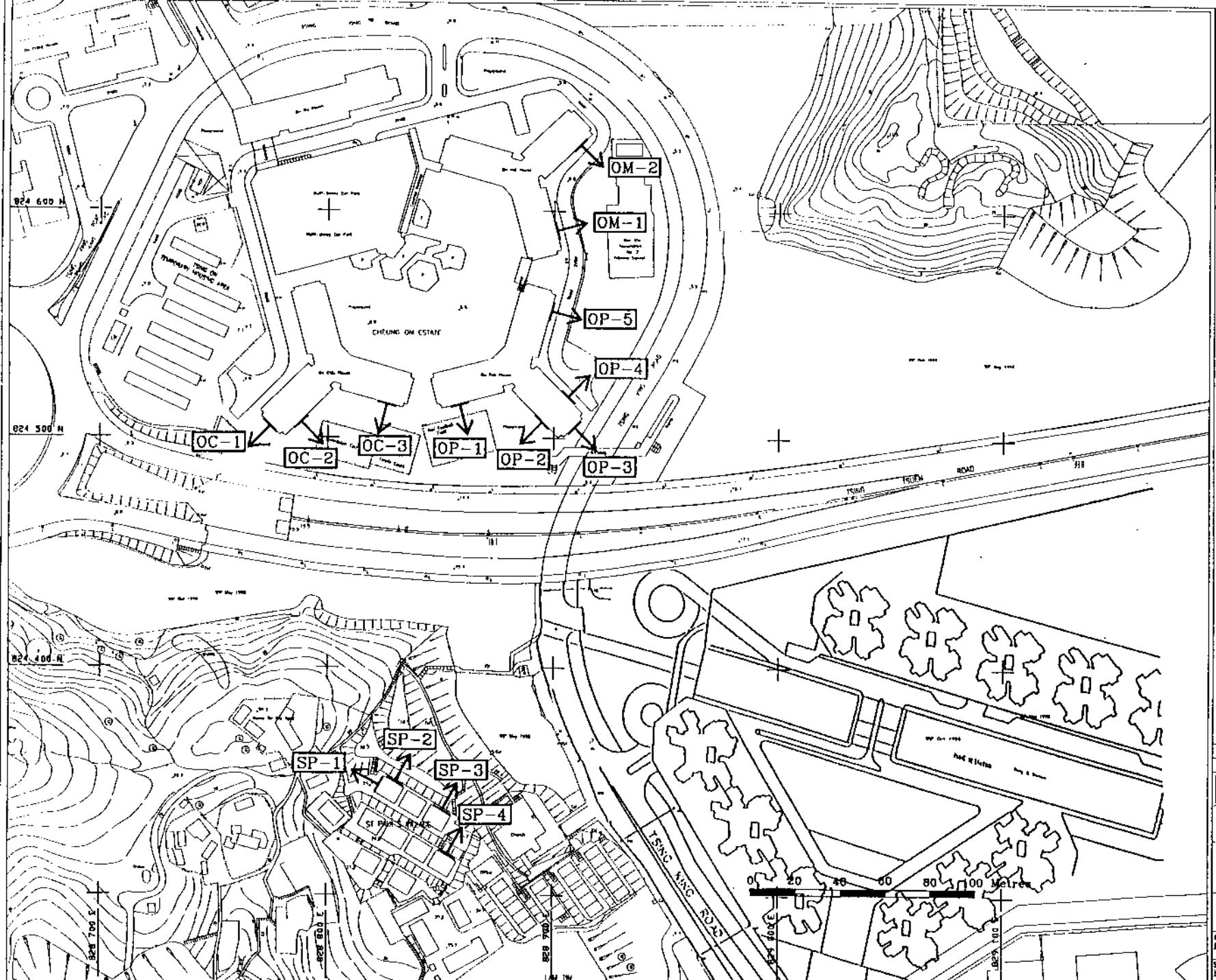
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATIONS OF REPRESENTATIVE NSR ALONG AP LEI CHAU BRIDGE

MAUNSELL CONSULTANTS ASIA LTD

FIGURE NO. FIGURE 3-1

SCALE AS SHOWN



LEGEND

OM-1 LOCATION OF REPRESENTATIVE NSR

ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATIONS OF REPRESENTATIVE NSR ALONG TSING TSUEN ROAD (SHEET 1 OF 2)

MAUNSELL CONSULTANTS ASIA LTD.
滿盛(亞洲)工程顧問有限公司

FIGURE NO. FIGURE 3-2

SCALE AS SHOWN

ISSUE

LEGEND

→ J-2 LOCATION OF REPRESENTATIVE NSR

ENVIRONMENTAL PROTECTION DEPARTMENT

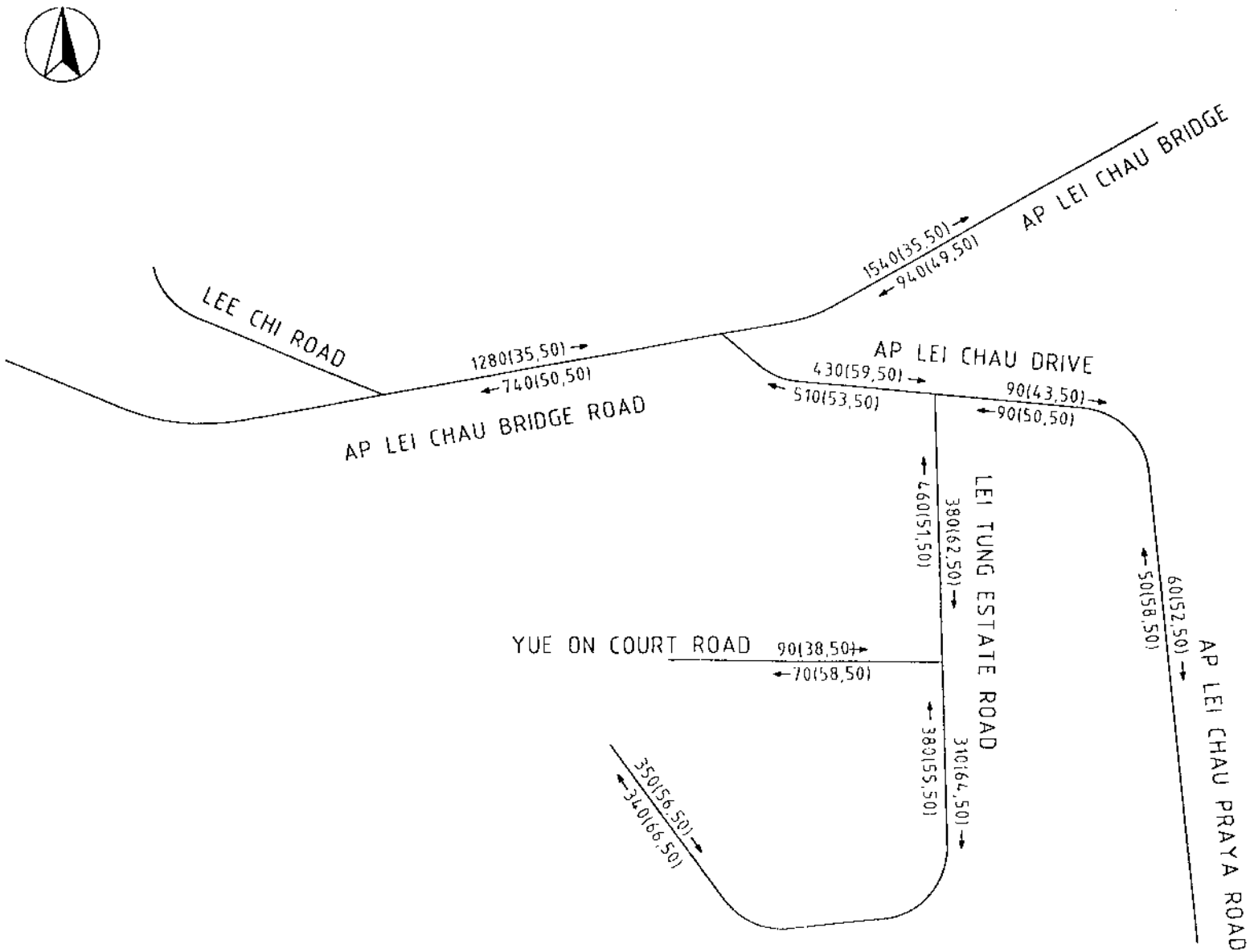
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATIONS OF REPRESENTATIVE NSR ALONG TSING TSUEN ROAD (SHEET 2 OF 2)

HAUNSELL CONSULTANTS ASIA LTD.
漢銓諮詢工程顧問有限公司

FIGURE NO. FIGURE 3-2

SCALE



ENVIRONMENTAL PROTECTION DEPARTMENT

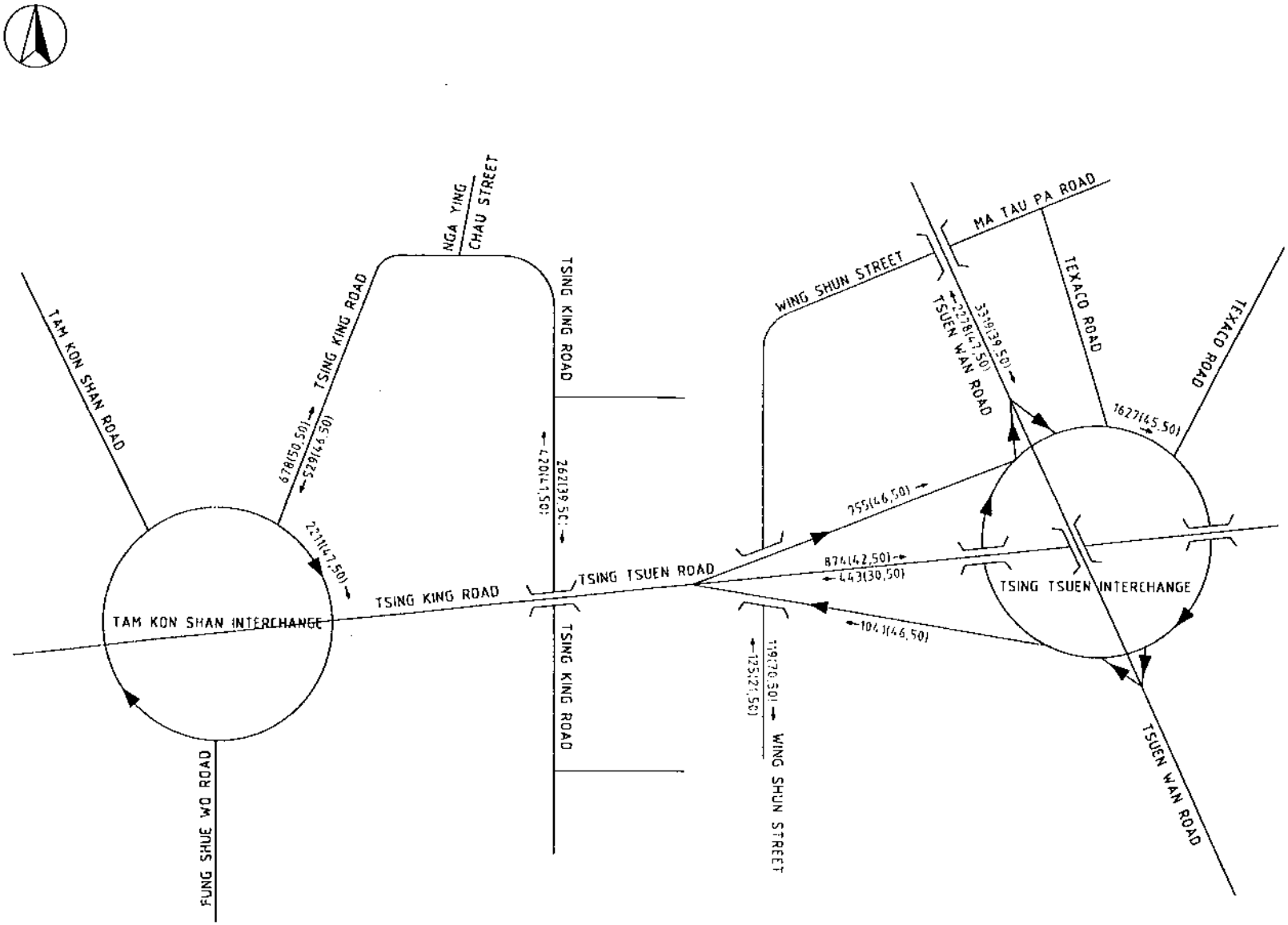
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TRAFFIC FLOW DIAGRAM FOR AP LEI CHAU BRIDGE IN 1998

MAUNSELL CONSULTANTS ASIA LTD.
茂盛(亞洲)工程顧問有限公司

FIGURE NO. FIGURE 3-3

SCALE N. T. S.



LEGEND

1000(20,50)

- 1000 — TRAFFIC FLOW (veh/hr)
- 20 — % HEAVY VEHICLE
- 50 — SPEED LIMIT (kph)

ENVIRONMENTAL PROTECTION DEPARTMENT

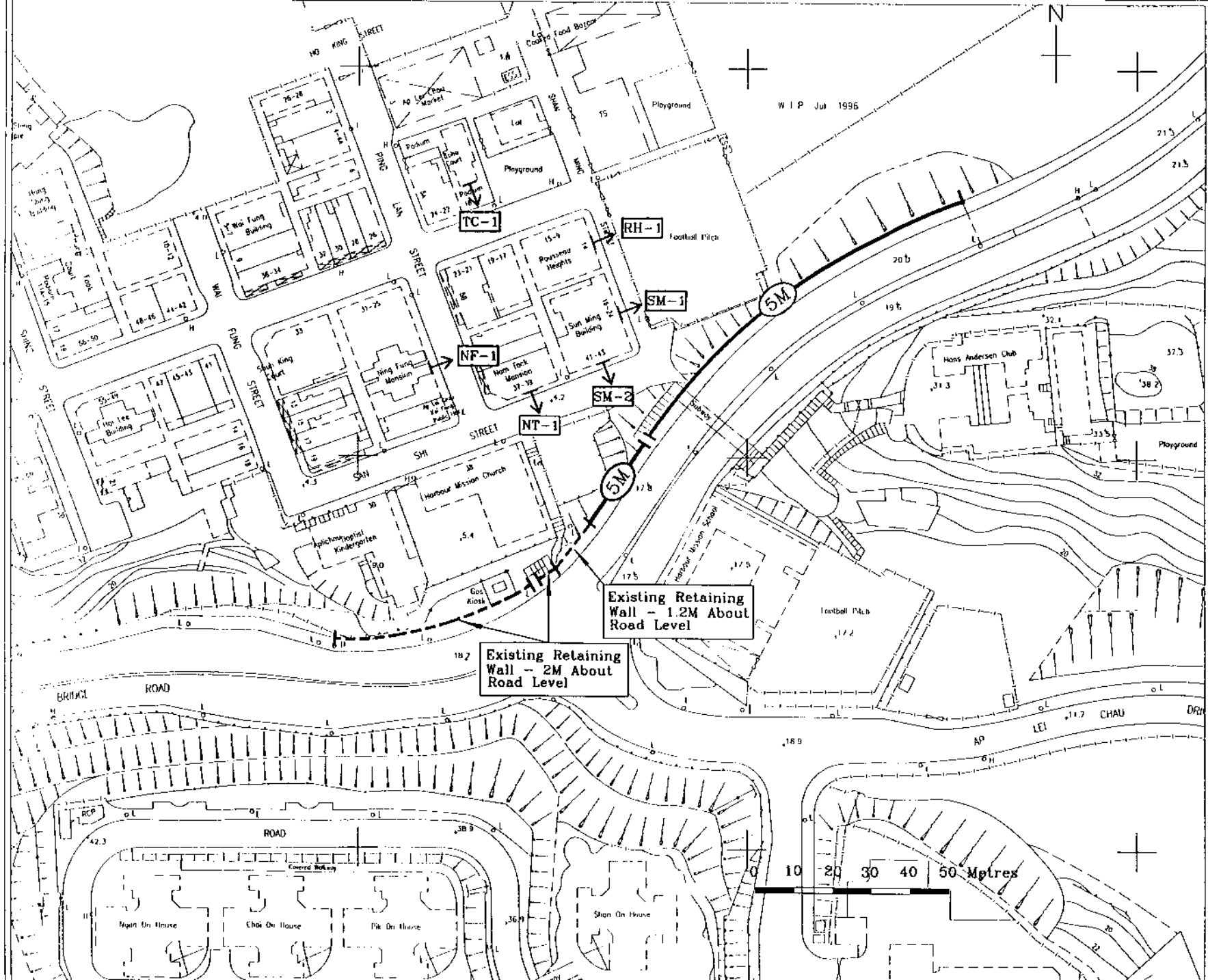
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TRAFFIC FLOW DIAGRAM FOR TSING TSUEN ROAD IN 1998

MAUNSELL CONSULTANTS ASIA LTD.
茂盛(亞洲)工程顧問有限公司

FIGURE NO. FIGURE 3-4

SCALE N. T. S.



LEGEND

5M — PROPOSED 5M PLAIN BARRIER

ENVIRONMENTAL PROTECTION DEPARTMENT

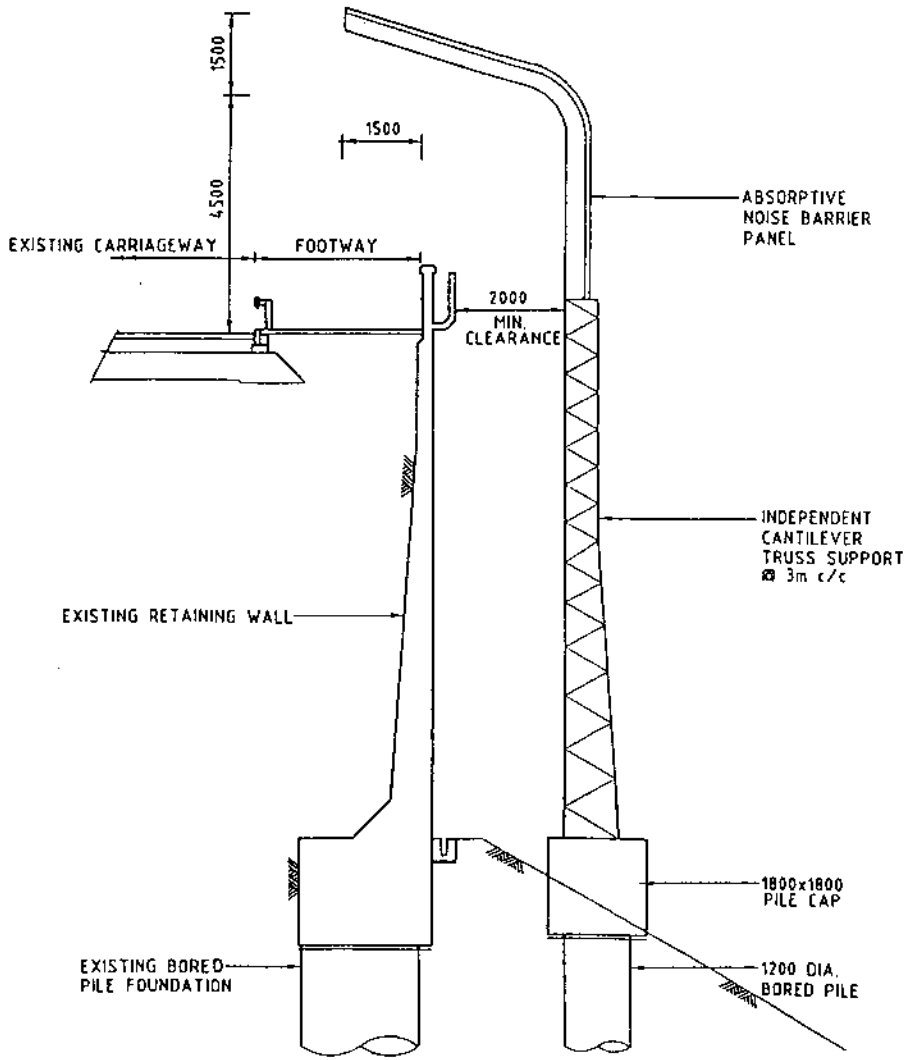
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATION OF PROPOSED NOISE BARRIER

MAUNSELL CONSULTANTS ASIA LTD
茂盛(亞洲)工程顧問有限公司

FIGURE NO. FIGURE 3-5

SCALE AS SHOWN



ENVIRONMENTAL PROTECTION DEPARTMENT

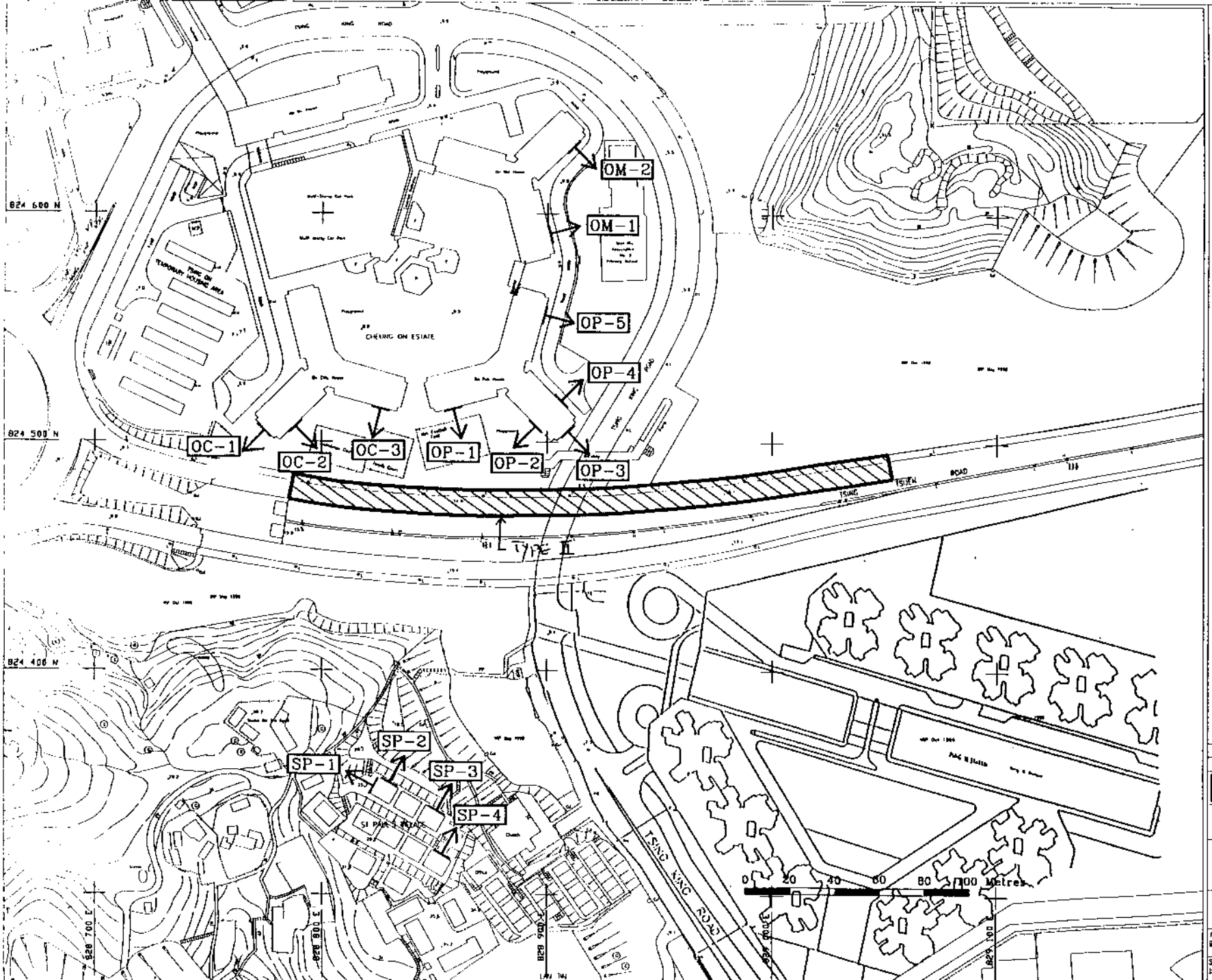
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

CROSS-SECTION OF INVERTED-L SHAPED NOISE BARRIER

MAUNSELL CONSULTANTS ASIA LTD

FIGURE NO. FIGURE 3-6

SCALE



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATION OF PROPOSED PARTIAL ENCLOSURE (SHEET 1 OF 2)

MAUNSELL CONSULTANTS ASIA LTD.
茂盛(亞洲)工程顧問有限公司

FIGURE NO. FIGURE 3-7

SCALE AS SHOWN

LEGEND

PARTIAL ENCLOSURE

ENVIRONMENTAL PROTECTION DEPARTMENT

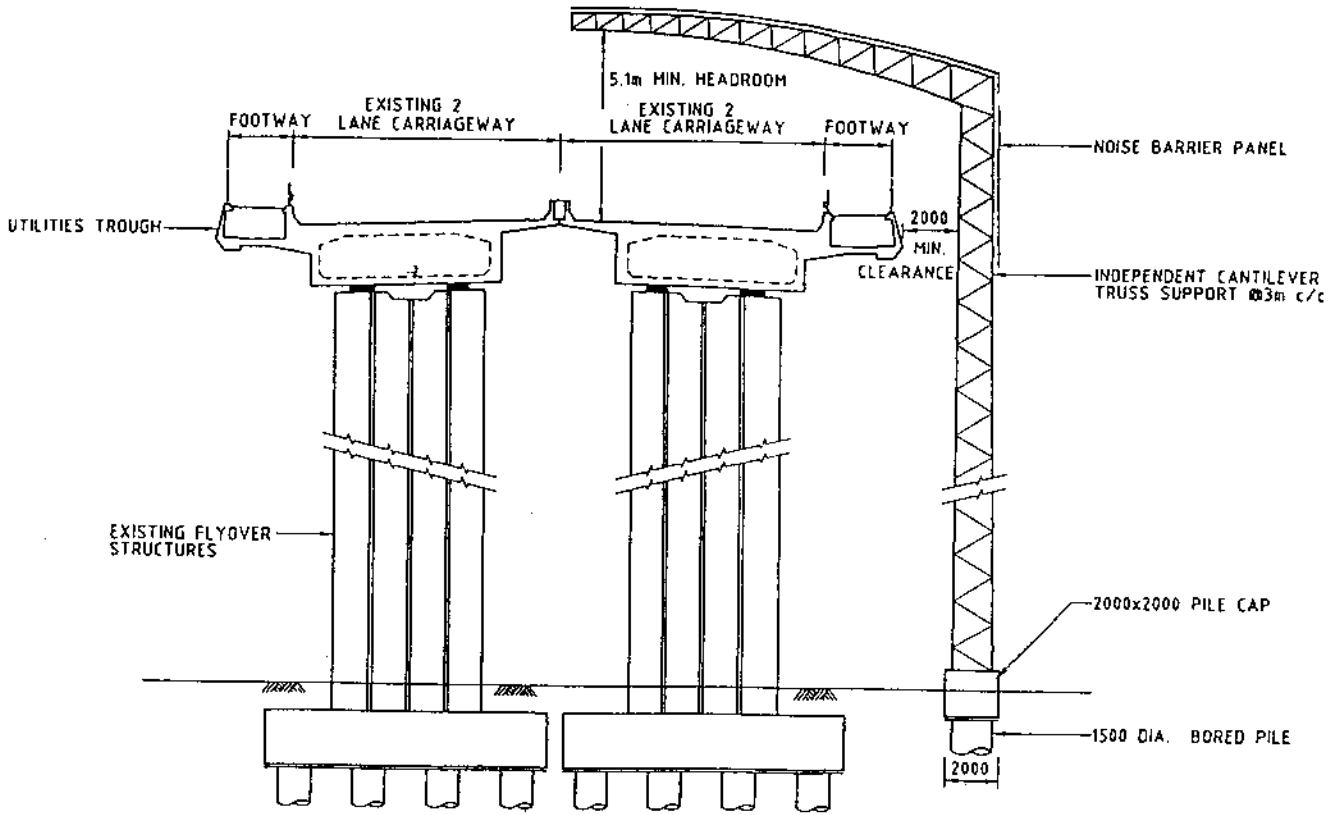
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATION OF PROPOSED PARTIAL ENCLOSURE (SHEET 2 OF 2)

MAUNSELL CONSULTANTS ASIA LTD.
茂盛(亞洲)工程顧問有限公司

FIGURE NO. FIGURE 3-7

SCALE AS SHOWN



ENVIRONMENTAL PROTECTION DEPARTMENT

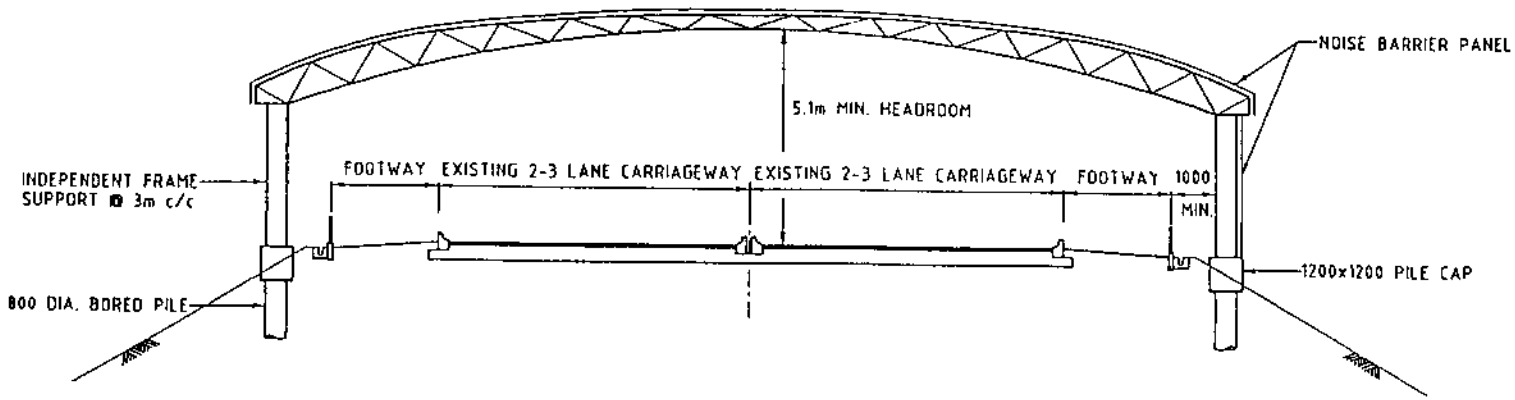
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

CROSS-SECTION OF PARTIAL ENCLOSURE (TYPE 1)

HAUNSELL CONSULTANTS ASIA LTD

FIGURE NO. FIGURE 3-8

SCALE



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

CROSS-SECTION OF PARTIAL ENCLOSURE (TYPE 1)

MAUNSELL CONSULTANTS ASIA LTD

FIGURE NO FIGURE 3-9

SCALE

APPENDIX A2

Technical Paper No. 2 - Traffic Noise Impact Assessment (Supplementary Paper)

Technical Paper No. 2
Traffic Noise Impact Assessment
(Supplementary Paper)

Contents

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FIGURES

1. INTRODUCTION

Following the former Technical Paper No. 2 on "Traffic Noise Impact Assessment" which addresses the traffic noise impacts solely on acoustical grounds, Working Paper No. 1 on "Mitigation Measures" was prepared to assess the practical and engineering constraints of the proposed mitigation measures and a practical form of measures were resolved. The purpose of this supplementary paper is to incorporate the findings of both Working Papers and re-assess the acoustical effectiveness of feasible mitigation measures.

2. AP LEI CHAU BRIDGE

Two sections of 5 m inverted L-shaped barriers about 45m and 50m in length along the eastbound carriageway are proposed to protect the NSRs located adjacent to the flyover. The layout of barriers is shown in Figure 1. A typical cross-section of the barrier on separate, independent structure is shown in Figure 2.

A summary of the predicted road traffic noise levels at representative NSRs after the implementation of the proposed barriers is presented in Table 1. As shown in Table 1, the noise levels at a few of the NSRs are predicted to be reduced by upto 7 dB(A). The high noise levels at the upper floors of the low-rises fronting Ap Lei Chau Bridge are attributed to the gaps between barriers due to site constraints. Other NSRs (i.e. TC-1 and NF-1) are not protected because they are also affected by road traffic noise contributions from the at-grade Ap Lei Chau Bridge Road.

Under the proposed mitigation scheme, a total number of 34 dwellings or 44 percent of the affected dwellings are protected, and the breakdown is presented in Table 2.

Table 1 Unmitigated and Mitigated Noise Levels for Ap Lei Chau Bridge

NSR	Floor	Overall Noise Levels at Various Levels,dB(A)		
		Assessment Criterion	Unmitigated	Mitigated
TC-1	1	70	65	64
	5	70	70	68
	10	70	*72*	*71*
	15	70	*74*	*72*
	20	70	*74*	*72*
	22	70	*73*	*72*
RH-1	1	70	63	60
	5	70	*71*	66
	10	70	*74*	69
SM-1	1	70	62	58
	5	70	*71*	67
	7	70	*77*	70
SM-2	1	70	64	61
	5	70	*75*	70
	7	70	*79*	*73*
NT-1	1	70	66	64
	5	70	*75*	*73*
NF-1	1	70	68	67
	5	70	*73*	*72*
	10	70	*75*	*74*
	15	70	*74*	*73*
	20	70	*74*	*74*
	22	70	*74*	*74*

Table 2 Effectiveness of Proposed Mitigation Measure for Ap Lei Chau Bridge

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

3. SECTION OF TSING TSUEN ROAD NEAR RIVIERA GARDENS

Considering the space and engineering constraints along Tsing Tsuen Road near Riviera Gardens, two segments of partial enclosures about 100m and 185m long along the eastbound carriageway are proposed to protect the NSRs at Riviera Gardens as described in Figure 3. Typical cross-sections of the partial enclosures are shown in Figure 4.

A summary of predicted road traffic noise levels at representative NSRs after the implementation of these proposed partial enclosures is shown in Table 3. As shown in Table 3, the noise levels at the NSRs are predicted to be reduced by upto 16 dB(A). Due to the limited extent of the partial enclosures, many of the dwellings cannot be fully protected.

As a result, a total number of 714 dwellings or 46 percent of the affected dwellings are protected, and the breakdown is presented in Table 4.

Table 3 Unmitigated and Mitigated Noise Levels for Tsing Tsuen Road near Riviera Gardens

NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Assessment Criterion	Unmitigated	Mitigated
A-1	1	70	64	64
	5	70	67	67
	10	70	*71*	*71*
	15	70	*71*	*71*
	20	70	*71*	*71*
	25	70	*71*	*71*
	30	70	70	70
	35	70	70	70
	40	70	70	70
B-1	1	70	65	62
	5	70	*71*	68
	10	70	*74*	*71*
	15	70	*74*	*71*
	20	70	*73*	70
	25	70	*73*	70
	30	70	*72*	70
	35	70	*72*	69
	40	70	*72*	70
B-2	1	70	67	63
	5	70	*75*	*72*
	10	70	*77*	*73*
	15	70	*77*	*73*
	20	70	*76*	*72*
	25	70	*76*	*72*
	30	70	*75*	*72*
	35	70	*74*	*72*
	40	70	*74*	*72*
C-1	1	70	67	62
	5	70	*76*	*72*
	10	70	*76*	*72*
	15	70	*76*	*71*
	20	70	*75*	*71*
	25	70	*74*	*71*
	30	70	*74*	*71*
	35	70	*73*	*71*
	40	70	*73*	70
C-2	1	70	69	66
	5	70	*81*	*78*
	10	70	*80*	*77*
	15	70	*79*	*76*
	20	70	*78*	*76*
	25	70	*77*	*75*
	30	70	*76*	*75*
	35	70	*76*	*74*
	40	70	*75*	*74*

Table 3 (Cont.) **Unmitigated and Mitigated Noise Levels for Tsing Tsuen Road near Riviera Gardens**

NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Assessment Criterion	Unmitigated	Mitigated
C-3	1	70	70	66
	5	70	***80***	*77*
	10	70	***80***	*76*
	15	70	*79*	*75*
	20	70	*78*	*75*
	25	70	*77*	*75*
	30	70	*76*	*74*
	35	70	*76*	*73*
	40	70	*75*	*73*
D-1	1	70	67	61
	5	70	*75*	68
	10	70	*74*	68
	15	70	*74*	68
	20	70	*73*	67
	25	70	*73*	67
	30	70	*72*	69
	35	70	*72*	68
	40	70	*71*	68
D-2	1	70	*72*	59
	5	70	***80***	68
	10	70	*79*	68
	15	70	*78*	67
	20	70	*77*	70
	25	70	*77*	*71*
	30	70	*76*	70
	35	70	*75*	70
	40	70	*75*	70
D-3	1	70	*72*	59
	5	70	***80***	64
	10	70	***80***	65
	15	70	*79*	67
	20	70	*78*	*71*
	25	70	*77*	*71*
	30	70	*76*	70
	35	70	*76*	70
	40	70	*75*	70
E-1	1	70	70	63
	5	70	*74*	64
	10	70	*74*	65
	15	70	*74*	65
	20	70	*73*	65
	25	70	*73*	64
	30	70	*73*	64
	35	70	*72*	64
	40	70	*72*	64

Table 3 (Cont.) **Unmitigated and Mitigated Noise Levels for Tsing Tsuen Road near Riviera Gardens**

NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Assessment Criterion	Unmitigated	Mitigated
F-1	1	70	*74*	67
	5	70	*76*	67
	10	70	*75*	67
	15	70	*75*	67
	20	70	*74*	66
	25	70	*74*	66
	30	70	*74*	66
	35	70	*73*	66
	40	70	*73*	66
G-1	1	70	*79*	*75*
	5	70	*78*	*75*
	10	70	*78*	*74*
	15	70	*77*	*73*
	20	70	*76*	*73*
	25	70	*75*	*72*
	30	70	*75*	*72*
	35	70	*74*	*71*
	40	70	*74*	*71*
G-2	1	70	*79*	*77*
	5	70	*79*	*77*
	10	70	*78*	*76*
	15	70	*77*	*75*
	20	70	*77*	*75*
	25	70	*76*	*75*
	30	70	*76*	*74*
	35	70	*75*	*74*
	40	70	*75*	*73*
G-3	1	70	*75*	*75*
	5	70	*75*	*75*
	10	70	*75*	*75*
	15	70	*74*	*74*
	20	70	*74*	*74*
	25	70	*73*	*73*
	30	70	*73*	*73*
	35	70	*73*	*73*
	40	70	*72*	*72*
H-1	1	70	*77*	*76*
	5	70	*77*	*76*
	10	70	*76*	*76*
	15	70	*76*	*76*
	20	70	*76*	*75*
	25	70	*75*	*75*
	30	70	*75*	*74*
	35	70	*75*	*74*
	40	70	*74*	*74*

Table 3 (Cont.) **Unmitigated and Mitigated Noise Levels for Tsing Tsuen Road near Riviera Gardens**

NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Assessment Criterion	Unmitigated	Mitigated
J-1	1	70	*75*	*74*
	5	70	*75*	*75*
	10	70	*75*	*74*
	15	70	*74*	*74*
	20	70	*74*	*74*
	25	70	*74*	*74*
	30	70	*73*	*73*
	35	70	*73*	*73*
	40	70	*73*	*73*
J-2	1	70	*76*	*75*
	5	70	*76*	*76*
	10	70	*76*	*76*
	15	70	*76*	*76*
	20	70	*76*	*75*
	25	70	*75*	*75*
	30	70	*75*	*75*
	35	70	*75*	*75*
	40	70	*75*	*74*

Table 4 **Effectiveness of Proposed Mitigation Measure for Tsing Tsuen Road near Riviera Gardens**

NSRs	Number of Dwellings Exceeding the HKPSG criterion	
	Without Mitigation	With Mitigation
Riviera Gardens		
Hoi Nga Mansion	142	95
Hoi Kwu Mansion	167	124
Hoi Sing Mansion	190	159
Hoi Fung Mansion	261	25
Hoi Wai Mansion	152	0
Hoi Yat Mansion	165	0
Hoi Kwai Mansion	258	218
Hoi Yin Mansion	148	148
Hoi Yue Mansion	62	62

4. SECTION OF TSING TSUEN ROAD NEAR CHEUNG ON ESTATE

As Housing Department generally supports the proposal to mitigate traffic noise from Tsing Tsuen Road, an independently supported partial enclosure within the boundary of Cheung On Estate has been further examined. A partial enclosure of 150m long is shown in Figure 5.

A summary of predicted road traffic noise levels at representative NSRs after the implementation of the proposed partial enclosures is shown in Table 5. As shown in Table 5, the noise levels at the NSRs are predicted to be reduced by 1-9 dB(A). Due to the limited extent of the partial enclosures, many of the dwellings cannot be fully protected. As a result, only 122 dwellings or 12 percent of the affected dwellings are protected, and the breakdown is presented in Table 6.

Table 5 Unmitigated and Mitigated Noise Levels for Tsing Tsuen Road near Cheung On Estate

NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Assessment Criterion	Unmitigated	Mitigated
OM1	1	70	67	67
	5	70	69	69
	10	70	*72*	*71*
	15	70	*71*	*71*
	20	70	*72*	*71*
	25	70	*72*	*72*
	30	70	*72*	*72*
	34	70	*71*	*71*
OM2	1	70	69	69
	5	70	69	69
	10	70	*71*	*71*
	15	70	*71*	*71*
	20	70	*71*	*71*
	25	70	*71*	*71*
	30	70	*71*	*71*
	34	70	*71*	70
OP1	1	70	*71*	67
	5	70	*78*	*71*
	10	70	*77*	*73*
	15	70	*77*	*74*
	20	70	*76*	*73*
	25	70	*76*	*73*
	30	70	*75*	*73*
	34	70	*75*	*72*
OP2	1	70	*72*	*71*
	5	70	*78*	*74*
	10	70	*78*	*75*
	15	70	*77*	*75*
	20	70	*76*	*74*
	25	70	*76*	*74*
	30	70	*75*	*73*
	34	70	*75*	*73*

Table 5 (Cont.) Unmitigated and Mitigated Noise Levels for Tsing Tsuen Road near Cheung On Estate

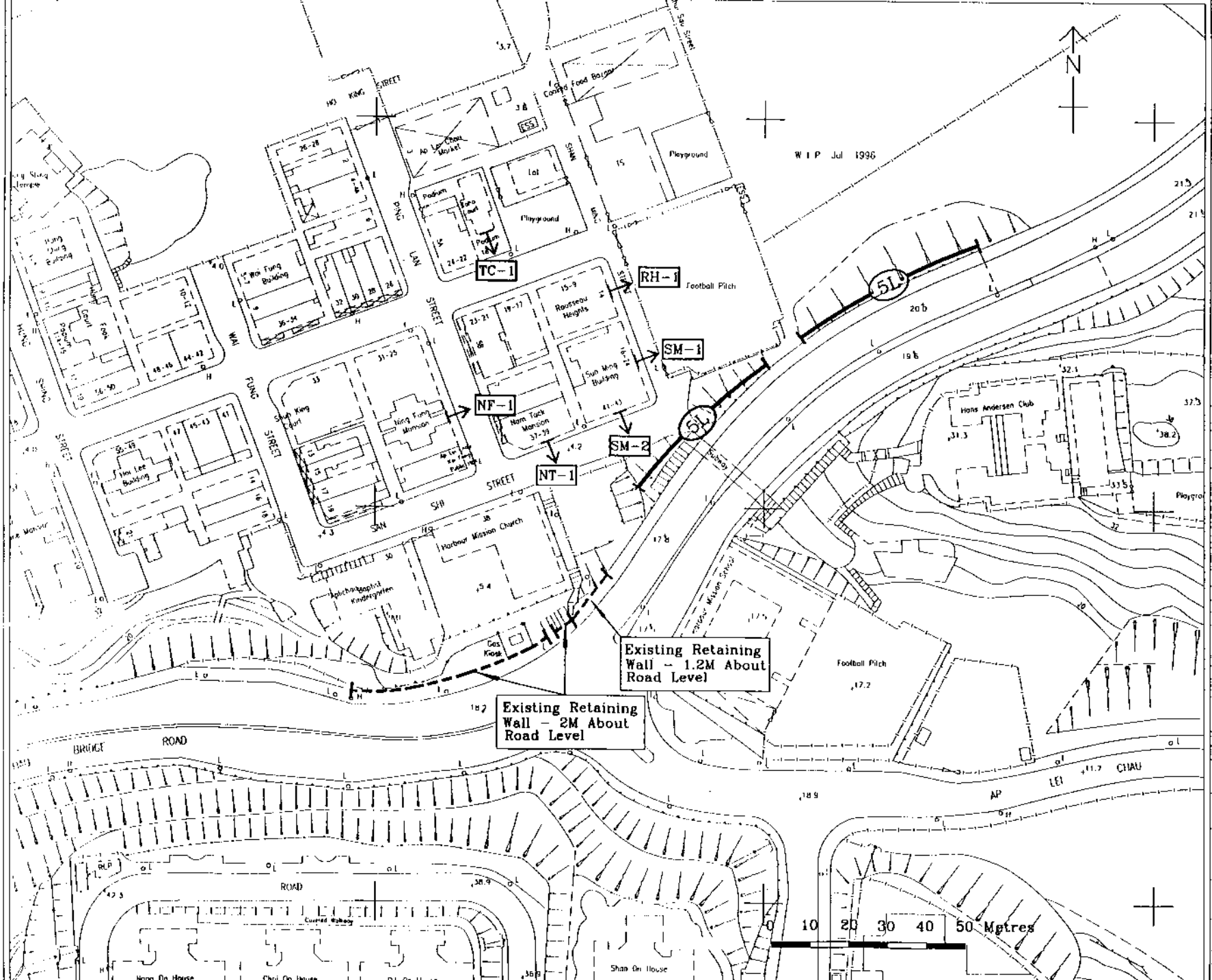
NSRs	Floor	Overall Noise Levels at Various Level, dB(A)		
		Assessment Criterion	Unmitigated	Mitigated
OP3	1	70	*76*	*76*
	5	70	*79*	*79*
	10	70	*79*	*78*
	15	70	*78*	*77*
	20	70	*77*	*76*
	25	70	*76*	*75*
	30	70	*76*	*75*
	34	70	*75*	*74*
OP4	1	70	*73*	*73*
	5	70	*75*	*75*
	10	70	*75*	*75*
	15	70	*74*	*74*
	20	70	*73*	*73*
	25	70	*73*	*73*
	30	70	*72*	*72*
	34	70	*72*	*72*
OP5	1	70	70	70
	5	70	*72*	*72*
	10	70	*73*	*73*
	15	70	*72*	*72*
	20	70	*72*	*72*
	25	70	*72*	*72*
	30	70	*72*	*72*
	34	70	*71*	*71*
OC1	1	70	*77*	*72*
	5	70	***80***	*75*
	10	70	*79*	*78*
	15	70	*78*	*78*
	20	70	*77*	*77*
	25	70	*77*	*76*
	30	70	*76*	*76*
	34	70	*76*	*75*
OC2	1	70	*72*	64
	5	70	*79*	*71*
	10	70	*78*	*76*
	15	70	*77*	*75*
	20	70	*76*	*74*
	25	70	*76*	*74*
	30	70	*75*	*73*
	34	70	*75*	*73*
OC3	1	70	70	65
	5	70	*78*	69
	10	70	*77*	*73*
	15	70	*77*	*74*
	20	70	*76*	*73*
	25	70	*76*	*73*
	30	70	*75*	*72*
	34	70	*75*	*72*

Table 6 Effectiveness of Proposed Mitigation Measure for Tsing Tsuen Road near Cheung On Estate

NSRs	Number of Dwellings Exceeding the HKPSG criterion	
	Without Mitigation	With Mitigation
Cheung On Estate		
On Mei House	201	200
On Pak House	556	489
On Chiu House	304	250

5. CONCLUSION & RECOMMENDATION

This paper has re-assessed the acoustical effectiveness of feasible noise mitigation measures as identified in the Final Report. Upon examining the practical forms of the 5m inverted L-shaped barriers for Ap Lei Chau Bridge and the 5.5m partial enclosures for both ends of Tsing Tsuen Road, it is found that these measures provide 44%, 46% and 12 % of protection for the affected dwellings.



ENVIRONMENTAL PROTECTION DEPARTMENT

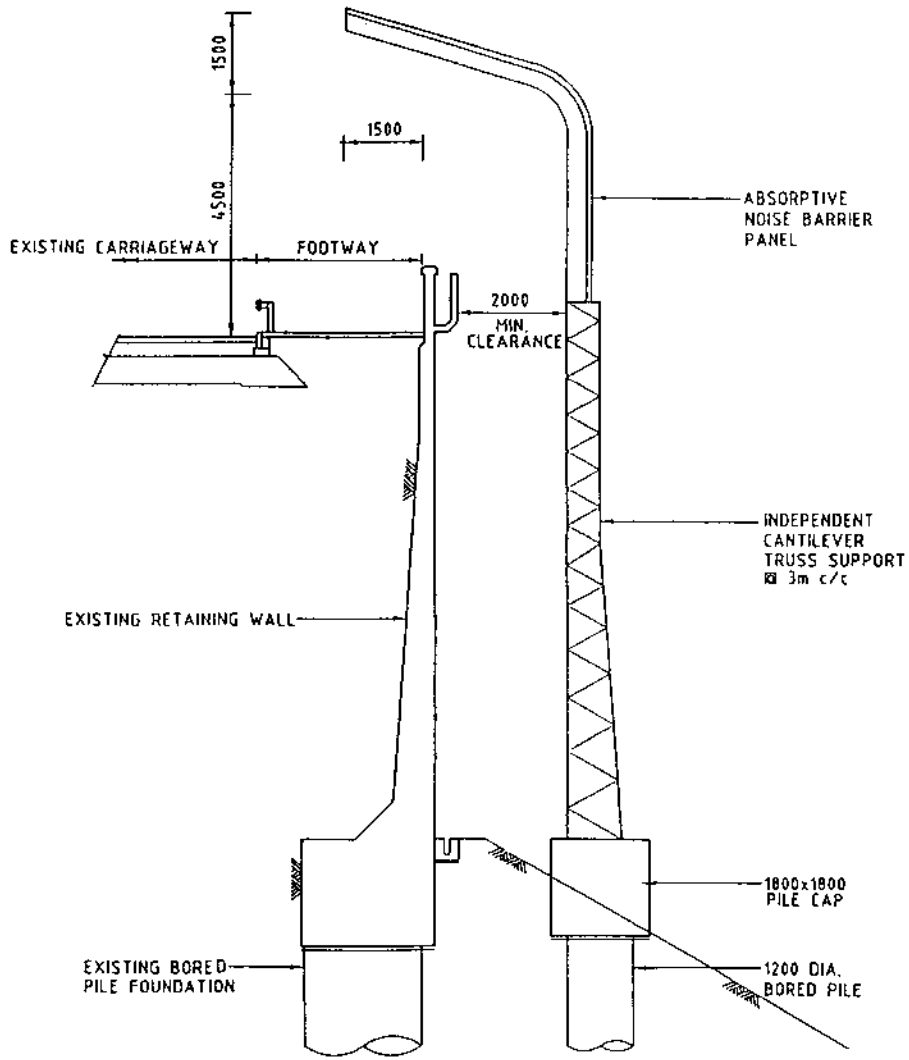
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATION OF PROPOSED NOISE BARRIER

MAUNSELL CONSULTANTS ASIA LTD
茂盛(亞洲)工程顧問有限公司

FIGURE NO. 圖號 FIGURE 1

SCALE 比例 AS SHOWN



ENVIRONMENTAL PROTECTION DEPARTMENT

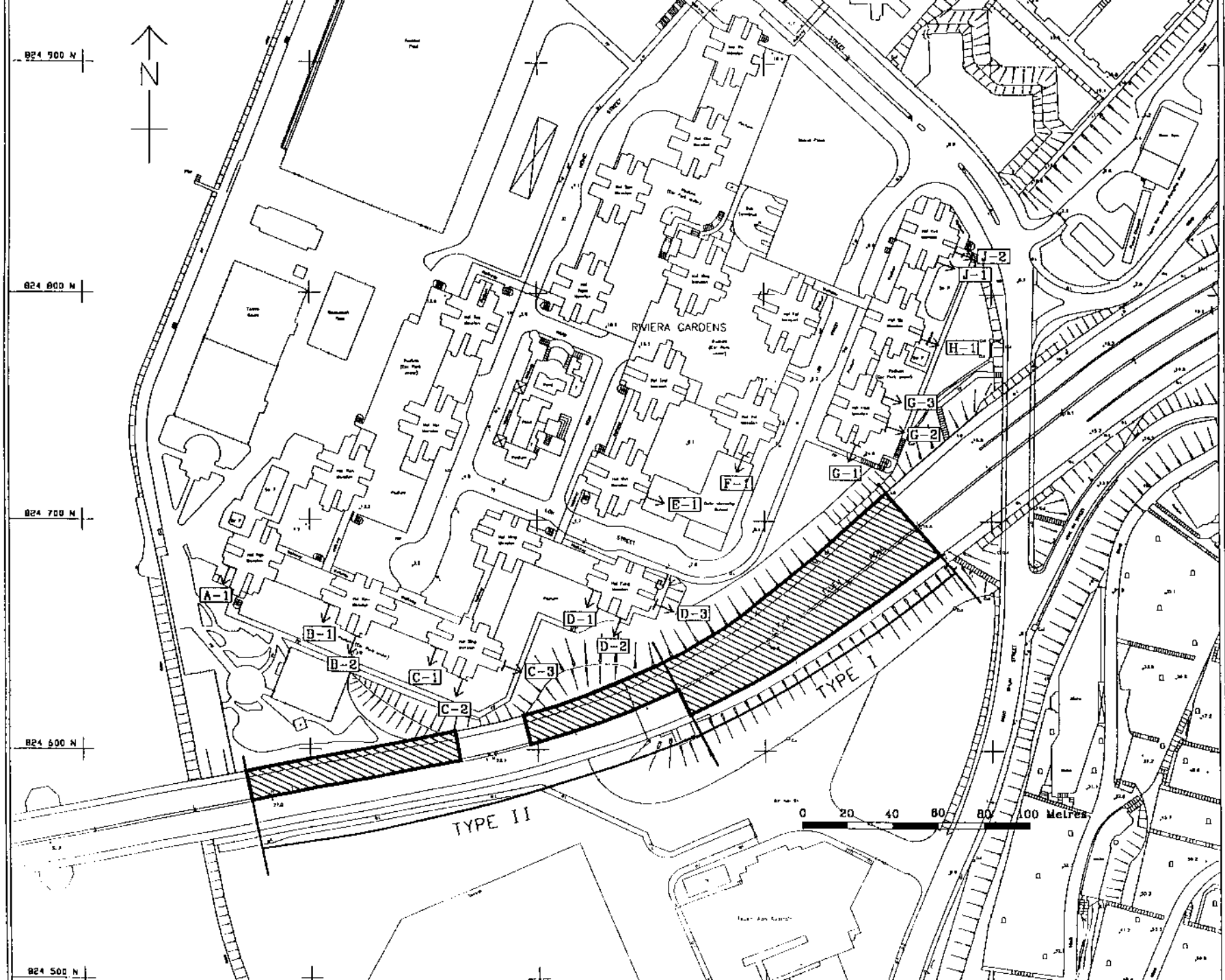
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

CROSS-SECTION OF INVERTED-L SHAPED NOISE BARRIER

MAUNSELL CONSULTANTS ASIA LTD

FIGURE NO. FIGURE 2

SCALE N. T. S



LEGEND

J-2 LOCATION OF REPRESENTATIVE NSR

TYPE I - PARTIAL ENCLOSURE COVERING THE ENTIRE WIDTH OF CARRIAGEWAY

TYPE II - PARTIAL ENCLOSURE COVERING EASTBOUND CARRIAGEWAY

ENVIRONMENTAL PROTECTION DEPARTMENT

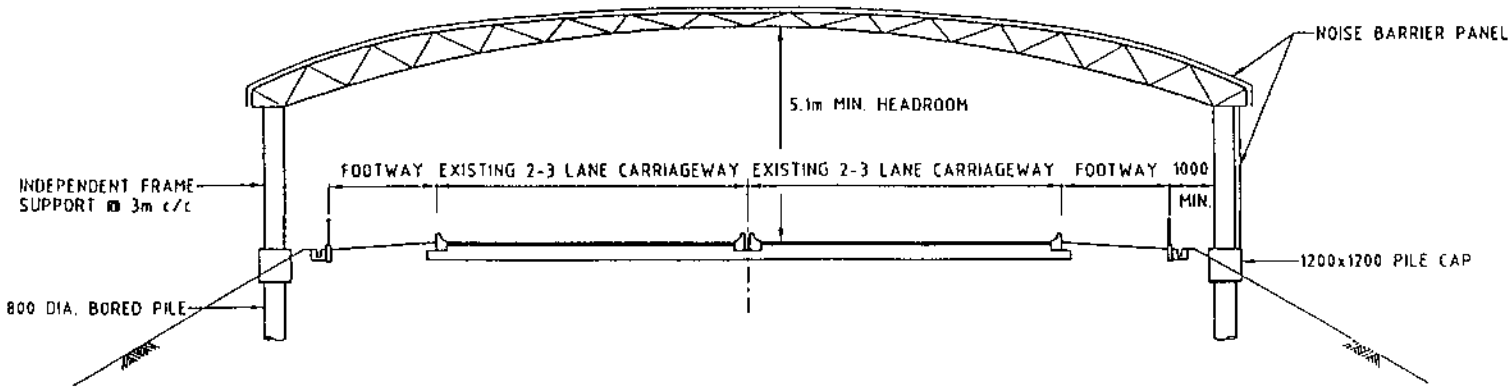
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATIONS OF PROPOSED PARTIAL ENCLOSURES

MAUNSELL CONSULTANTS ASIA LTD.
茂盛(亞洲)工程顧問有限公司

FIGURE NO. FIGURE 3

SCALE AS SHOWN



ENVIRONMENTAL PROTECTION DEPARTMENT

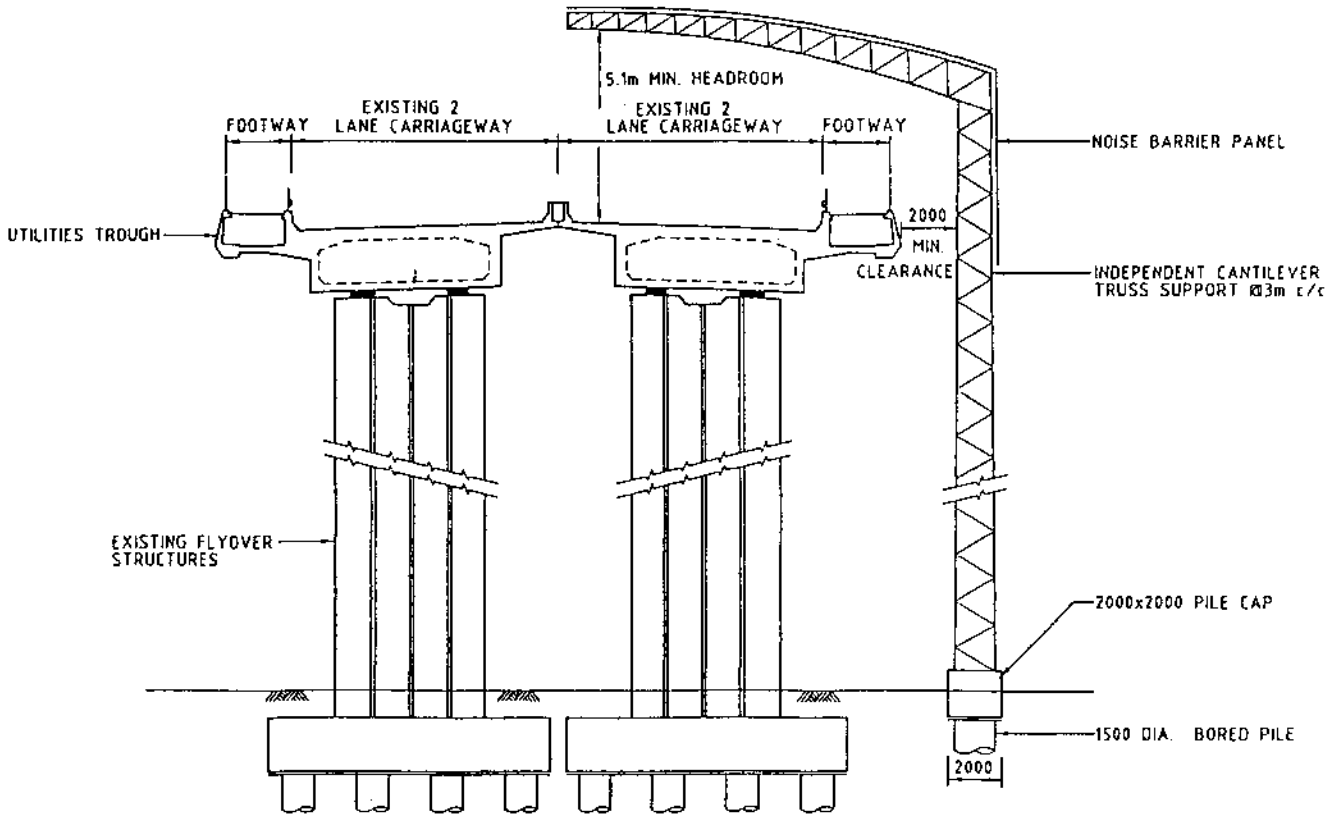
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

CROSS-SECTION OF PARTIAL ENCLOSURE (TYPE 1) (SHEET 1 OF 2)

MAUNSELL CONSULTANTS ASIA LTD

FIGURE NO. FIGURE 4

SCALE AS SHOWN



ENVIRONMENTAL PROTECTION DEPARTMENT

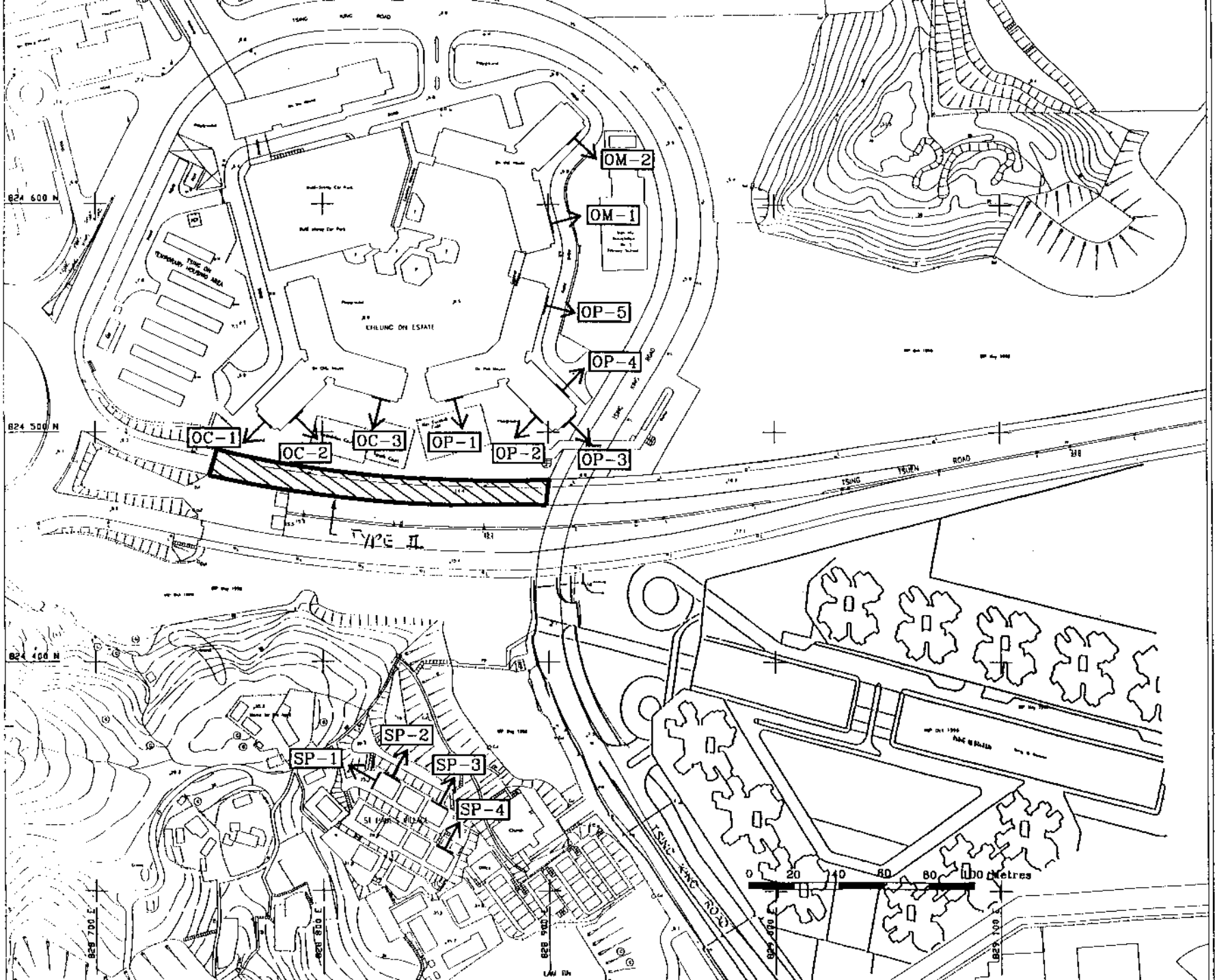
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

CROSS-SECTION OF PARTIAL ENCLOSURE (TYPE 1) (SHEET 2 OF 2)

MAUNSELL CONSULTANTS ASIA LTD

FIGURE NO. FIGURE 4

SCALE AS SHOWN


LEGEND
OM-1 LOCATION OF REPRESENTATIVE NSR
PARTIAL ENCLOSURE
OM-2
OM-1
OP-5
OP-4
OP-3
OP-2
OP-1
OC-3
OC-2
OC-1
SP-1
SP-2
SP-3
SP-4
824 600 N
824 500 N
824 400 N
826 700 E
826 800 E
826 900 E
829 100 E
TSING TSUN ROAD
SHEK PIK ROAD
EHEUNG ON ESTATE
TEMPORARY TSING ON HOUSING AREA
SI LAM VILLAGE
LAU PA
TYPE II
0 20 40 60 80 100 Metres
ENVIRONMENTAL PROTECTION DEPARTMENT
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS
LOCATION OF PROPOSED PARTIAL ENCLOSURE
HAUNSELL CONSULTANTS ASIA LTD
FIGURE NO.
FIGURE 5
SCALE
AS SHOWN

APPENDIX B

Technical Paper No. 3 -
Air Quality Impact Assessment

Technical Paper No. 3
Air Quality Impact Assessment

Contents

1. INTRODUCTION

Working Paper No. 1 has identified and evaluated noise mitigation measures to redress the impacts by road traffic noise on existing residential buildings along Ap Lei Chau Bridge and Tsing Tsuen Road. The measures comprising inverted L-shaped noise barriers and partial enclosures were considered acoustically effective and aesthetically acceptable in the urban setting. However, these barriers or enclosures have the potential to localize the air pollutants. It remains to be shown therefore that these measures would not result in unacceptable air quality at the air sensitive receivers, which include dwellings, sitting out areas, playgrounds, sports grounds etc., as defined in the HKPSG.

This Technical Paper has been prepared to address the air quality issue that may arise from the potential implementation of the noise mitigation measures. Pedestrians and drivers are not considered as air sensitive in this context because the time they spend on the road is short compared to the averaging time for the calculation of the pollutant concentrations.

2. OPTIMAL MITIGATION SCHEMES

Following an evaluation of several options for the two flyovers based on engineering, environmental and cost considerations, the following mitigation measures, comprising inverted L-shaped barriers and partial enclosures, are considered to be the most optimal schemes for the two sites. Typical cross section of the barriers and enclosures on independent structures are illustrated in Appendix A.

2.1 Ap Lei Chau Bridge

The optimal mitigation scheme for Ap Lei Chau Bridge consists of two sections of 5 m high inverted L-shaped barriers about 45m and 50m in length along the eastbound carriageway to protect the NSRs located adjacent to the flyover.

Figure 2-1 shows the location of the proposed barriers and representative air sensitive receivers (ASRs) likely to be affected as a result of implementation of the noise mitigation measures. Table 2-1 describes the ASRs in further details.

Table 2-1 Description of ASRs along Ap Lei Chau Bridge

ASR ID	Name of ASR	Current Uses
HA	Hans Andersen Club	Vacated
HM	Harbour Mission School	Vacated
SO	Shan On House	Residential
CO	Choi On House	Residential
FM	Fortune Mansion	Residential
BK	Baptist Kindergarten	School
FP	Football pitch	Outdoor Recreation

2.2 Tsing Tsuen Road

The optimal mitigation scheme for Tsing Tsuen Road near Riviera Gardens consists of two segments of partial enclosures, one about 95m in length along the eastbound carriageway and another 185m in length partly covering the eastbound carriageway and along part of its length, covering the full-width of the carriageway, to protect the NSRs at Riviera Gardens.

For the other end of Tsing Tsuen Road near Cheung On Estate, the optimal mitigation scheme consists of a 150m long partial enclosure along the eastbound carriageway in front of Cheung On Estate.

Figures 2-2 and 2-3 show the locations of the proposed partial enclosures and representative air sensitive receivers likely to be affected as a result of implementation of the noise mitigation schemes. Table 2-2 gives further details of the ASRs.

Table 2-2 Description of ASRs along Tsing Tsuen Road

ASR ID	Name of ASR	Current Uses
HS	Hoi Sing Mansion	Residential
HF	Hoi Fung Mansion	Residential
HK	Hoi Kwai Mansion	Residential
SC	Sunley Centre	Industrial
OC	On Pak House	Residential
OP	On Chiu House	Residential
AG	Home for the Aged	Convalescent Home
SP	St. Paul's Village	Residential
V1	Tierra Verde	Residential
V2	Tierra Verde	Residential
TC	Tennis Court	Outdoor Recreation

3. ASSESSMENT METHODOLOGY

3.1 Air Pollutants

Motor vehicles generate a variety of airborne pollutants, including carbon monoxide, nitrogen oxides, particulates, and trace amounts of volatile organic compounds. However, the air pollutants of concern are nitrogen dioxide and respirable suspended particulate since the concentrations of carbon monoxide and volatile organic compounds produced by motor vehicles are usually far below the level that cause health effects.

Air pollutants come under the control of the Air Pollution Control Ordinance, which calls for compliance with a set of health-related air quality objectives (AQO) for seven pollutants. Petrol vehicles contribute more carbon monoxide, while diesel-powered vehicles emit more nitrogen oxides and particulate matter. Under the current emission controls, emissions from petrol vehicles will be reduced as a result of more vehicles being fitted with catalytic converters which convert carbon monoxide to carbon dioxide. In view of the lower emission rates and the high statutory limit for carbon monoxide, the key air pollutants are considered to be Nitrogen Dioxide (NO_2) and

Respirable Suspended Particulate (RSP). Compliance with the concentration levels shown below in Table 3-1 is required.

Table 3-1 Air Quality Objectives

Parameter	Maximum Permitted Average Concentration ($\mu g/m^3$)		
	1 hour	24 hours	Yearly
RSP	--	180	55
NO_2	300	150	80

Notes: *All criteria are Hong Kong Air Quality Objectives.
*Hourly criterion for NO_2 not to be exceeded more than three times per year.
*24-hour criteria not to be exceeded more than once per year.
*Expressed at the reference condition of 298K and 101.325 KPa.

3.2 Traffic Flows

The existing morning peak hour traffic flows, i.e. traffic flows in 1998 as used for noise impact assessment in Working Paper No. 1, were adopted for the present assessment. These traffic flows are assumed to be free flowing at the speed limit (50 kph) with no queuing.

3.3 Vehicle Emissions

Emission factors for RSP and NOx were taken from the Fleet Average Emission Factors - EURO2 Model provided by EPD for the year 1998. Based on these figures, the composite emission factors for the road links were calculated as the weighted average of the emission factors of different types of vehicles. No speed correction or other adjustments were made.

3.4 Meteorological Conditions

The worst-case meteorological conditions were adopted in the modelling. This involves a wind speed of 1m/s blowing at a worst wind angle to each sensitive receiver. The standard deviation of the wind direction varies from place to place. A suitable value for use for the various sites is 18 degrees as used previously for other similar sites. The stability is assumed to be Class D during day-time and Class F for night-time.

The following summarizes the meteorological conditions adopted in the model calculations :

Wind Speed	1 m/s
Wind Direction	worst-case
Wind Direction Variation	18 degrees
Stability Class	D or F
Mixing Height	500 m
Temperature	25°C

3.5 Modelling Method

The USEPA California Line Source Dispersion Model - CALINE4 was used to model the air quality at the representative air sensitive receivers. The NO_2 option of the model was adopted to calculate the NO_2 concentrations, and RSP was modelled as particulate in the model.

All at-grade roads have zero elevation and elevated roads have elevations which are equal to the heights of the roads above ground in the model. In order to estimate the effects of the recommended mitigation measures on the air quality at the nearby ASRs, the model was set up to incorporate the type of barriers proposed. According to the model description, there is no exact method to calculate the effects arising from road-side barrier structure.

In the case of inverted L-shaped barriers and partial enclosures, the road link with a barrier was artificially elevated to a height that is equivalent to the height of the barrier. In addition, the road link was laterally shifted by an amount equivalent to the horizontal extent of the barrier into the carriageway.

The Type I partial enclosure covering both carriageway of Tsing Tsuen Road has been further modelled as a tunnel in accordance with the recommendation of PIARC 91. The volume of pollutants was assumed to eject from the portal as a portal jet such that 2/3 of the total emissions was dispersed within the first 50m of the portal and 1/3 of the total emissions within the second 50m.

3.6 Ambient Pollutant Concentrations

In order to be consistent with other similar calculations, the following daily peak values, as recorded at the Central Western Air Quality Monitoring Station in 1996 [Air Quality in Hong Kong, 1996], were adopted in the model calculation of NO_2 at the receiver locations:

O_3 = 0.03 ppm
NO = 0.07 ppm
NO_2 = 0.05 ppm

The annual average NO_2 and RSP background concentrations for Central Western and Tsuen Wan are as follows:

Central Western	Tsuen Wan
NO_2 = 47 $\mu g/m^3$	NO_2 = 59 $\mu g/m^3$
RSP = 52 $\mu g/m^3$	RSP = 53 $\mu g/m^3$

4. IMPACT ASSESSMENT

The following sections present an assessment of the air quality impact at the worst-hit levels of the representative ASRs with and without the noise mitigation measures. Sample computer output is given in Appendix B.

4.1 Ap Lei Chau Bridge

The proposed inverted L-shaped barriers tend to limit the lateral dispersion of air pollutants towards the low-rise buildings along the eastbound carriageway of the flyover. At the same time, ASRs locating in front of the barrier will be subject to slightly more severe pollution impact. As shown in Table 4-1, the maximum 1-hour NO_2 and 24-hour RSP concentrations at most of the ASR locations with and without the proposed noise mitigation measures are practically unaffected except for the indicative assessment point at HA, which is located on the opposite side of the barrier. The RSP concentration at HA is slightly higher during the mitigated scenario because of the limited lateral dispersion of pollutants. On the other hand, the football pitch locating behind the barriers will receive some minor benefit from the implementation of the measures.

The 1-hour NO_2 and 24-hour RSP isopleths for the unmitigated and mitigated scenarios are presented in Figures 4-1 to 4-4.

Table 4-1 1-Hour NO_2 and 24-Hour RSP Concentrations at ASRs along Ap Lei Chau Bridge

ASR	NO2, μg/m³		RSP,μg /m³	
	Unmitigated	Mitigated	Unmitigated	Mitigated
HA	160	160	133	139
HM	216	216	171	171
SO	103	103	93	92
CO	122	122	107	107
FM	103	103	91	91
BK	160	160	129	129
FP	160	122	134	113

Note: Background concentrations are included.

4.2 Tsing Tsuen Road

The proposed partial enclosures tend to limit the lateral dispersion of air pollutants towards Riviera Gardens and Cheung On Estate. The result is a positive impact for the low level receivers at Riviera Gardens and the tennis courts outside of Cheung On Estate. On the other hand, the partial enclosures tend to deflect the air pollutants towards the opposite side of the road and/or towards the portal ends. However, the pollutant concentration levels at ASRs opposite Cheung On Estate (i.e. AG, SP, V1, V2) are practically unaffected by the erection of a partial enclosure. Conversely, the pollutant concentrations at ASR HK are slightly higher after the implementation of the partial enclosures as HK is located near the eastern portal of the enclosure.

Table 4-2 gives the maximum 1-hour NO_2 and 24-hour RSP concentrations without and with the noise mitigation measures at the identified ASR locations, and Figures 4-5 to 4-12 present the corresponding contours for the unmitigated and mitigated scenarios. As far as these receivers are concerned, the effects are minor and all concentrations are within the AQO.

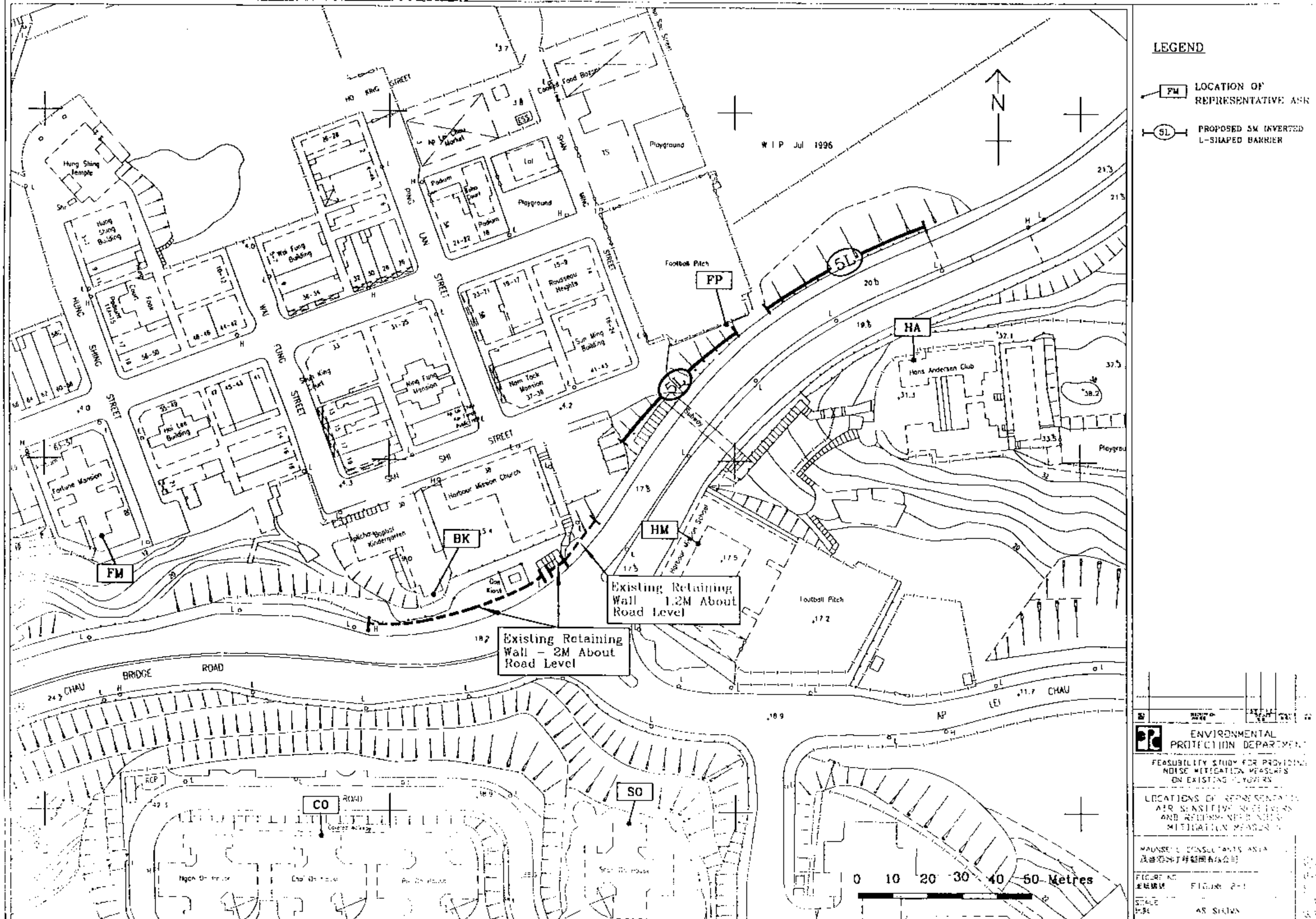
Table 4-2 1-Hour NO_2 and 24-Hour RSP Concentrations at ASRs along Tsing Tsuen Road

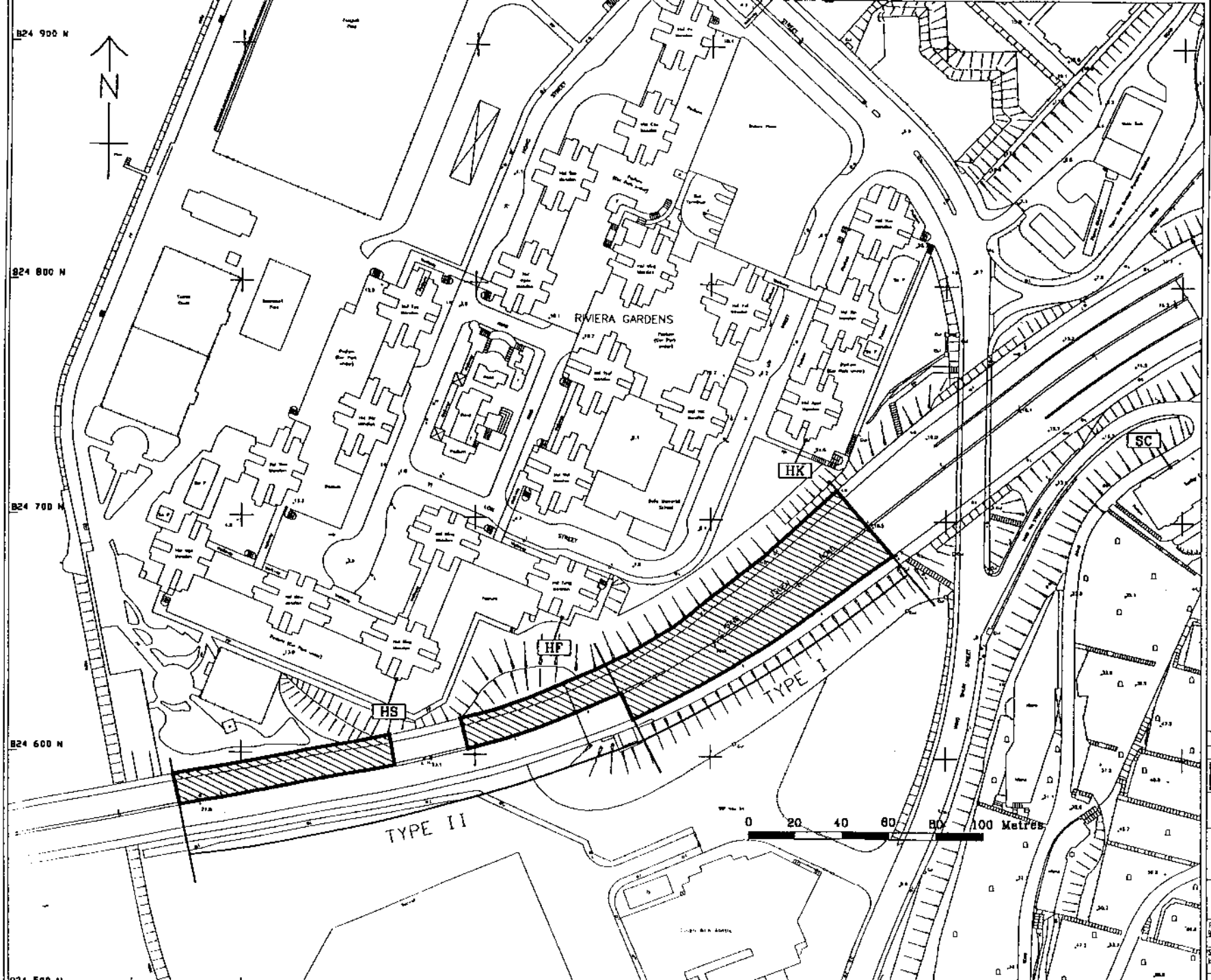
ASR	NO2, μg/m3		RSP,μg /m3	
	Unmitigated	Mitigated	Unmitigated	Mitigated
HS	122	103	125	113
HF	160	141	149	138
HK	160	179	154	169
SC	122	122	120	114
OC	141	141	125	125
OP	103	103	108	108
AG	103	103	105	104
SP	103	103	100	100
V1	103	103	100	100
V2	103	103	107	106
TC	141	122	135	122

Note: Background concentrations are included.

5. CONCLUSION

Using the modelling methodology as described above, it has been shown that the proposed noise mitigation measures would not produce any significant, adverse air quality impact on the nearby air sensitive receivers. In some cases, there appears to be minor benefit to the receivers mainly because the noise structures limit the lateral dispersion or diffusion of air pollutants to the receivers.


LEGEND
FM LOCATION OF REPRESENTATIVE ASR
5L PROPOSED 5M INVERTED L-SHAPED BARRIER
N
W I P Jul 1996
0 10 20 30 40 50 Metres
Existing Retaining Wall 1.2M About Road Level
Existing Retaining Wall - 2M About Road Level
FM
BK
HM
FP
HA
CO
SO
5L
5L
HO KING STREET
PING LAN STREET
WAI FUNG STREET
HUNG SHING STREET
SHI SAN STREET
SHAN MING STREET
AP LEI CHAU BRIDGE ROAD
AP LEI CHAU
Hung Shing Temple
Hung Shing Building
Wai Fung Building
Fortune Mansion
Hoi Lee Building
King Fung Mansion
Rousseau Heights
Sun Ming Building
Nam Tock Mansion
Harbour Mission Church
Aplichau Baptist Kindergarten
Harbour Mission School
Hans Andersen Club
Football Pitch
Playground
Cooked Food Bazaar
Ap Lei Chau Market
Subway
ENVIRONMENTAL PROTECTION DEPARTMENT
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS
FIGURE NO.
SCALE
AS SHOWN



LEGEND

HS — LOCATION OF REPRESENTATIVE ASR

TYPE I - PARTIAL ENCLOSURE COVERING THE ENTIRE WIDTH OF CARRIAGEWAY

TYPE II - PARTIAL ENCLOSURE COVERING EASTBOUND CARRIAGEWAY

ENVIRONMENTAL PROTECTION DEPARTMENT

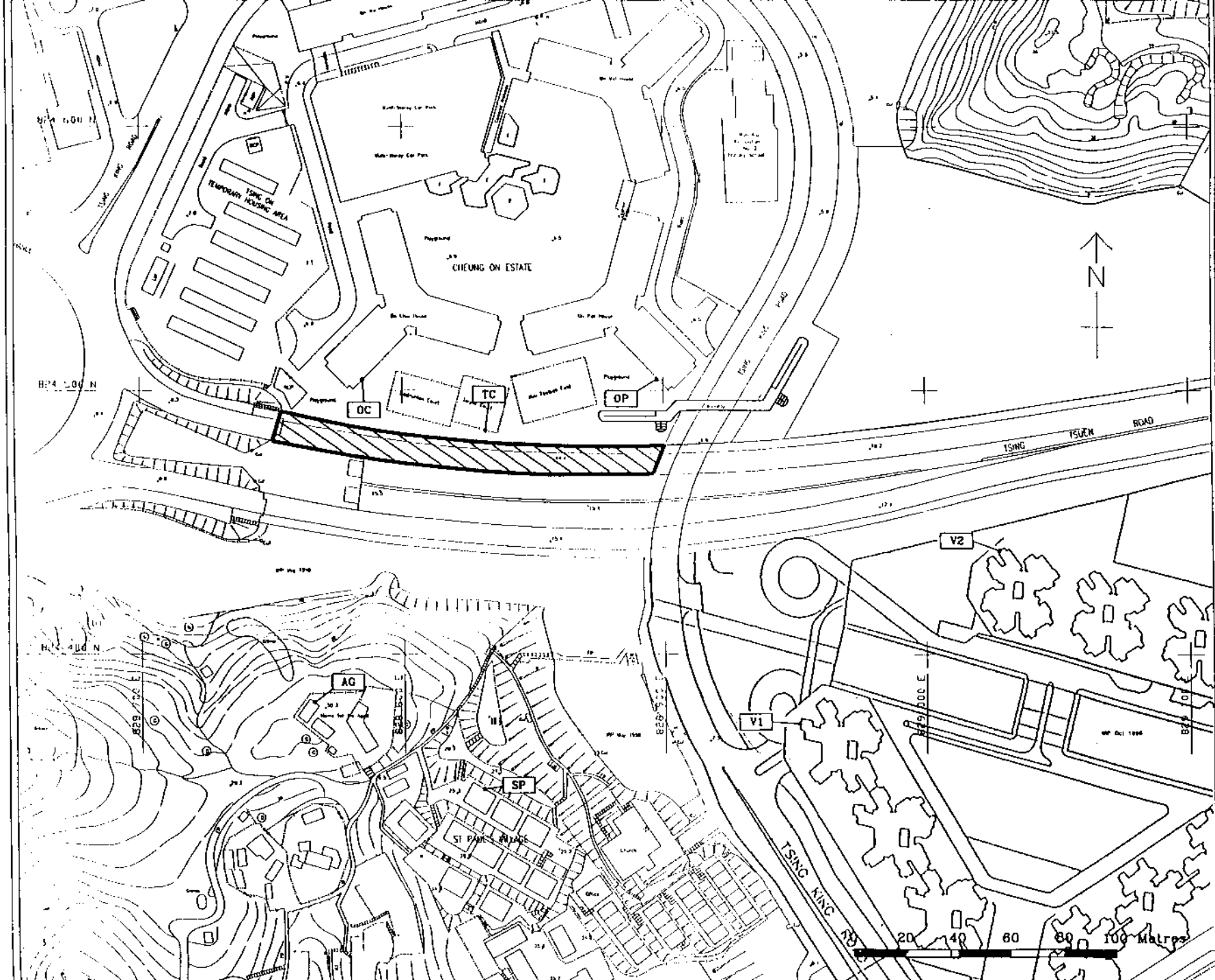
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATIONS OF REPRESENTATIVE AIR SENSITIVE RECEIVERS AND RECOMMENDED NOISE MITIGATION MEASURES

MAUNSELL CONSULTANTS ASIA LTD

FIGURE NO. FIGURE 2.2

SCALE AS SHOWN



ENVIRONMENTAL PROTECTION DEPARTMENT

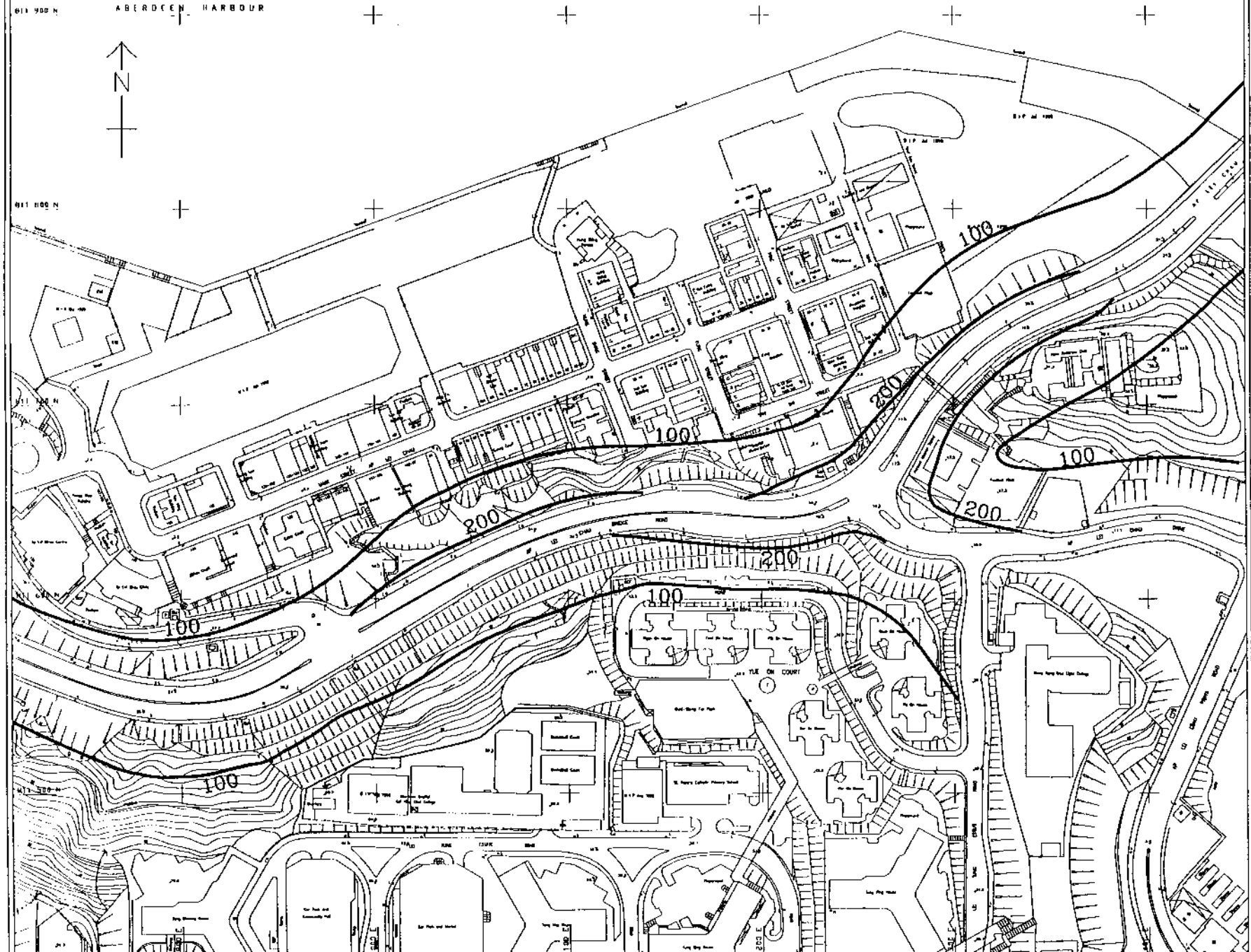
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATIONS OF REPRESENTATIVE AIR SENSITIVE RECEIVERS AND RECOMMENDED NOISE MITIGATION MEASURES

MAUNSELL CONSULTANTS ASIA LTD

FIGURE NO. FIGURE 2-3

SCALE AS SHOWN



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

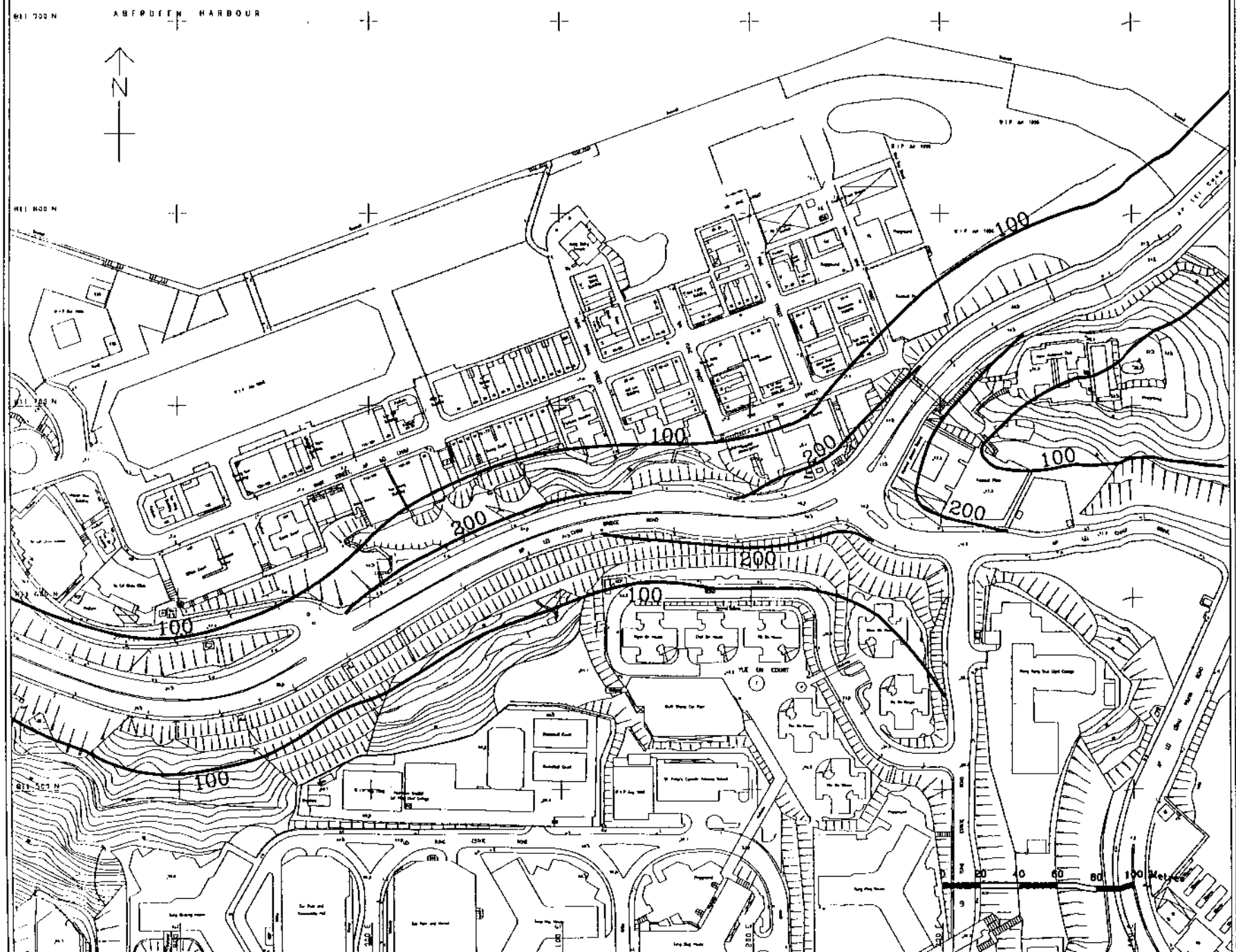
PREDICTED 1-HOUR AVERAGE NO_2 CONCENTRATIONS ($\mu g/m^3$) CONTOURS AT 1.5M ABOVE GROUND - UNMITIGATED

MAUNSELL CONSULTANTS ASIA LTD.
寶威亞洲工程顧問有限公司

FIGURE NO.
圖表編號 FIGURE 4-1

SCALE
比例 AS SHOWN

Maunsell



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

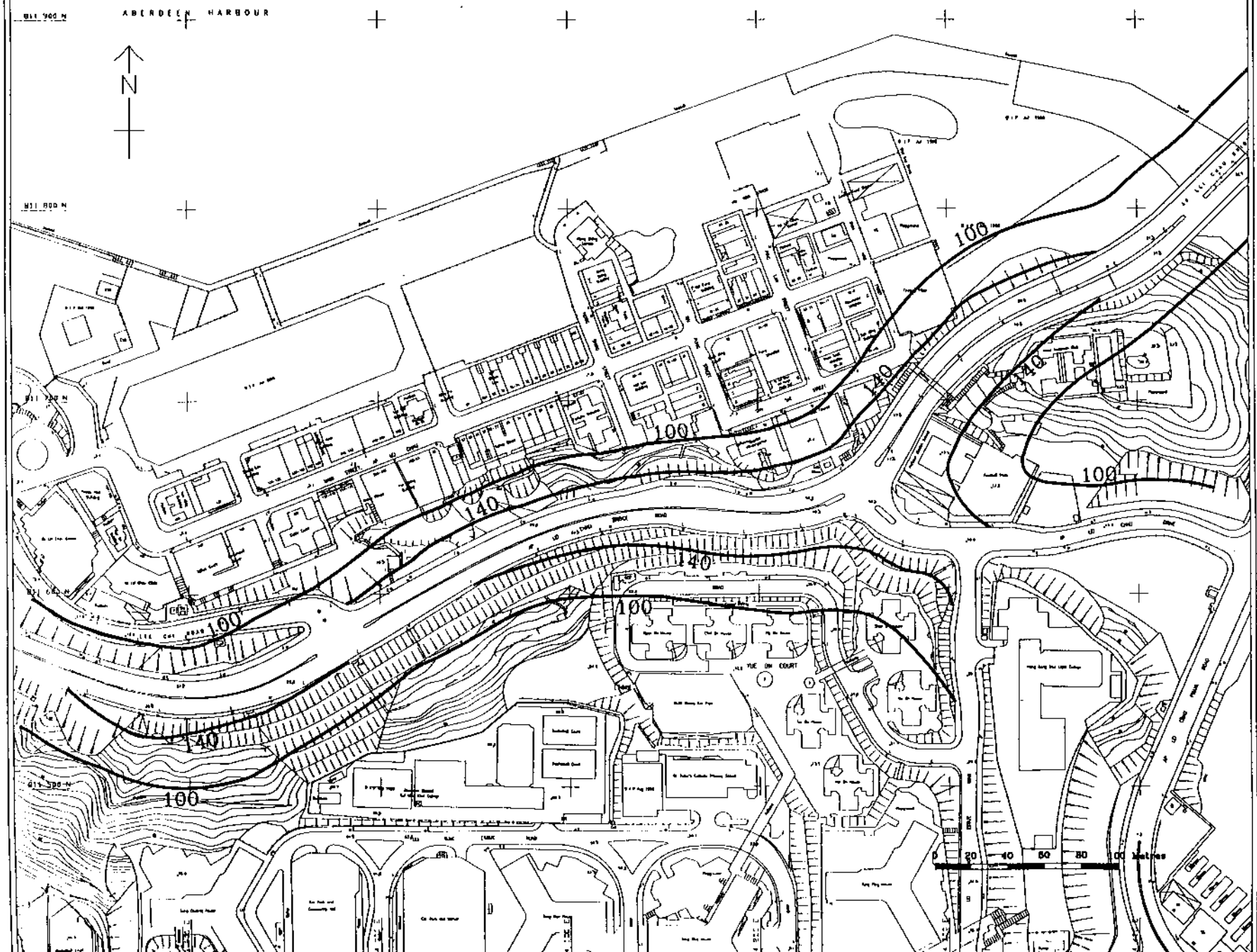
PREDICTED 1-HOUR AVERAGE NO_2 CONCENTRATION($\mu g/m^3$) CONTOURS AT 1.5M ABOVE GROUND - MITIGATED

MAUNSELL CONSULTANTS ASIA LTD
滙盛亞洲工程顧問有限公司

FIGURE NO. 圖號 FIGURE 4-2

SCALE 比例 AS SHOWN

Issue/Rev.



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

PREDICTED 24-HOUR AVERAGE RSP CONCENTRATION($\mu g/m^3$) CONTOURS AT 1.5M ABOVE GROUND - UNMITIGATED

MAUNSELL CONSULTANTS ASIA LTD.
茂盛(亞洲)工程顧問有限公司

FIGURE NO. 圖表編號 FIGURE 4-3

SCALE 比例 AS SHOWN

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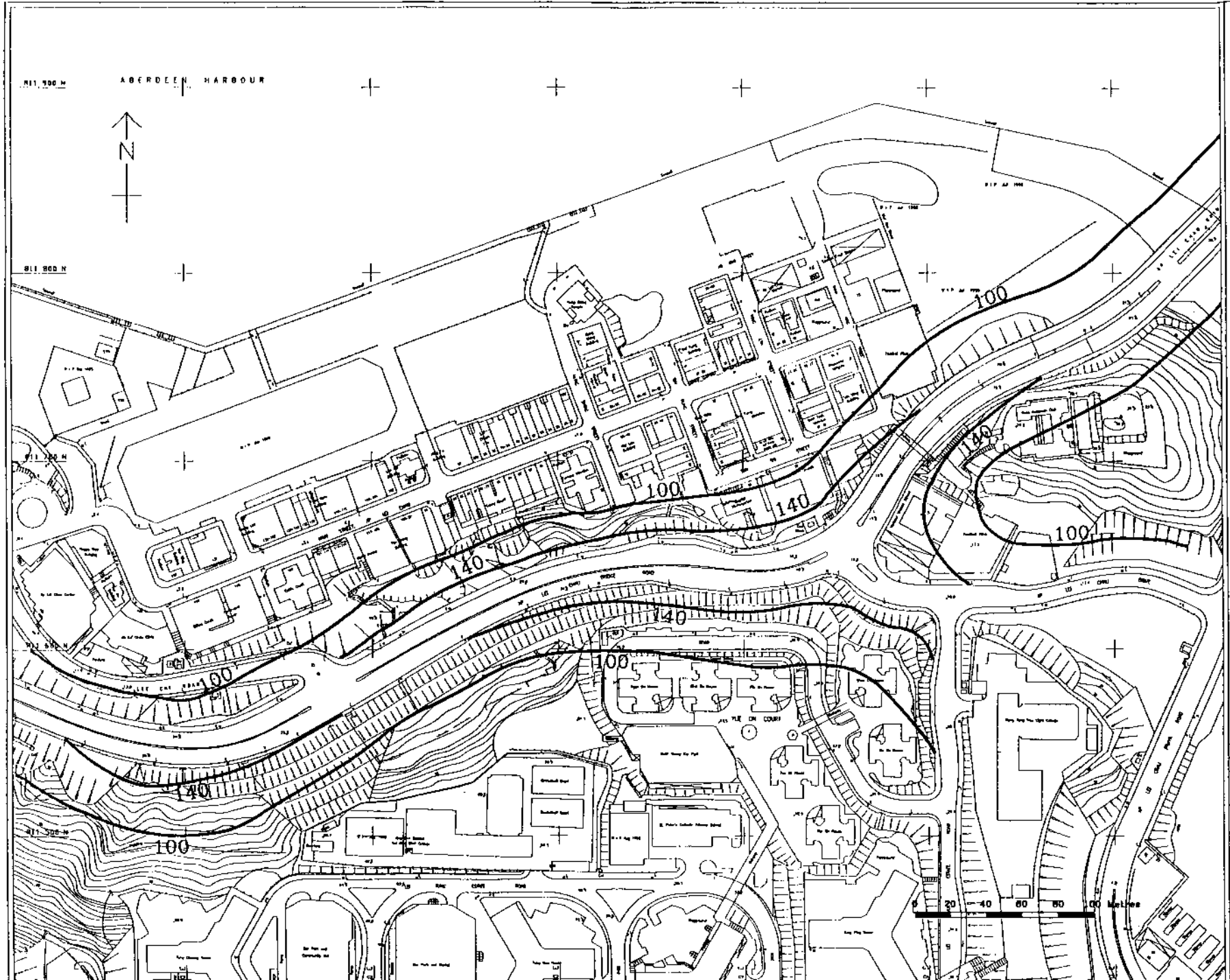


ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

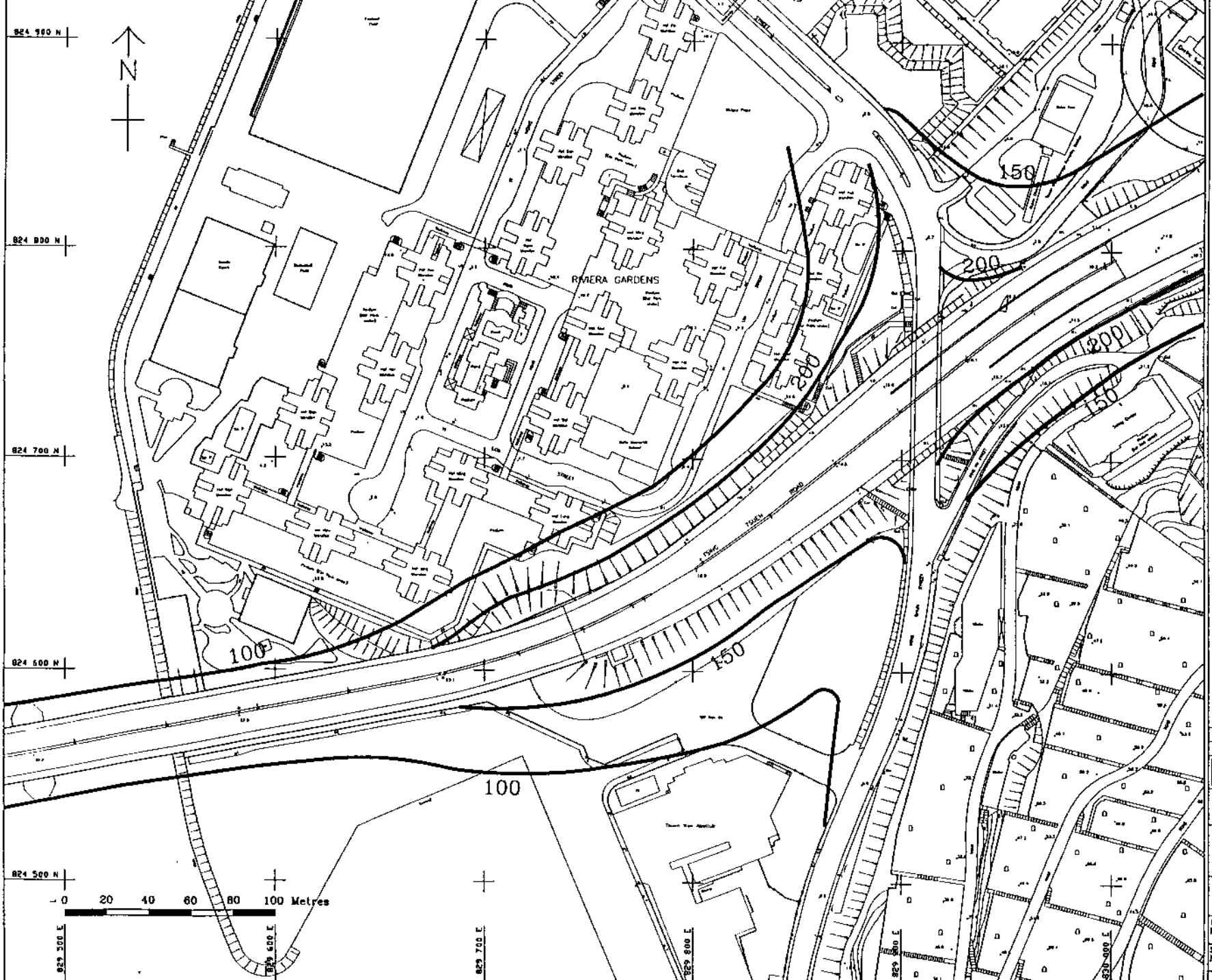
PREDICTED 24-HOUR AVERAGE RSP CONCENTRATION($\mu g/m^3$) CONTOURS AT 1.5M ABOVE GROUND - MITIGATED

MAUNSELL CONSULTANTS ASIA LTD.
茂盛顧問工程師有限公司

FIGURE. NO. 圖紙編號 FIGURE 4-4

SCALE 比例 AS SHOWN

maunsell



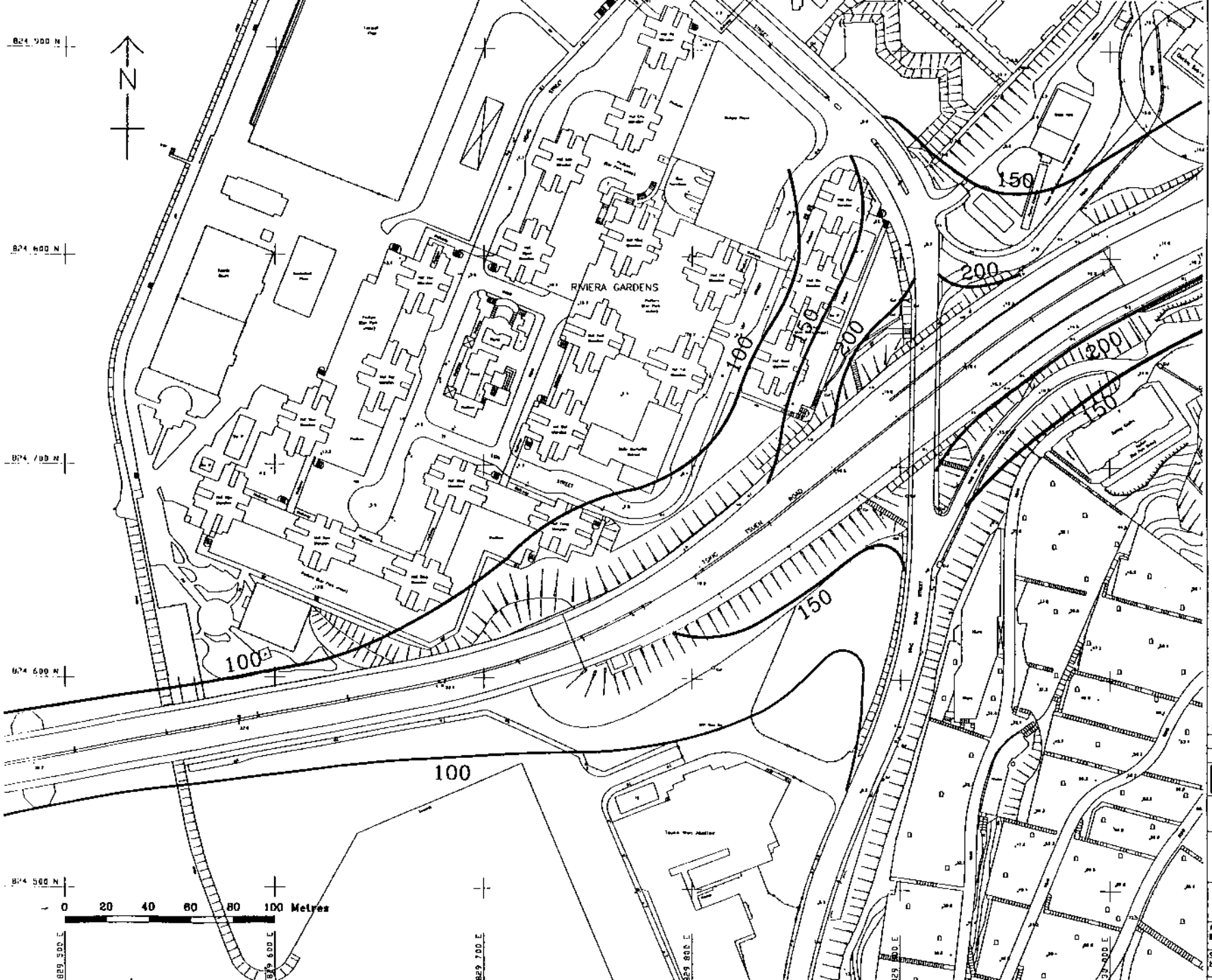
ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

PREDICTED 1-HOUR AVERAGE NO_2 CONCENTRATION($\mu g/m^3$) CONTOURS AT 1.5M ABOVE GROUND - UNMITIGATED

HAUNSELL CONSULTANTS ASIA LTD. 浩盛諮詢工程顧問有限公司	
FIGURE NO. 圖表編號	FIGURE 4-5
SCALE 比例	AS SHOWN

Haunsell



ENVIRONMENTAL PROTECTION DEPARTMENT

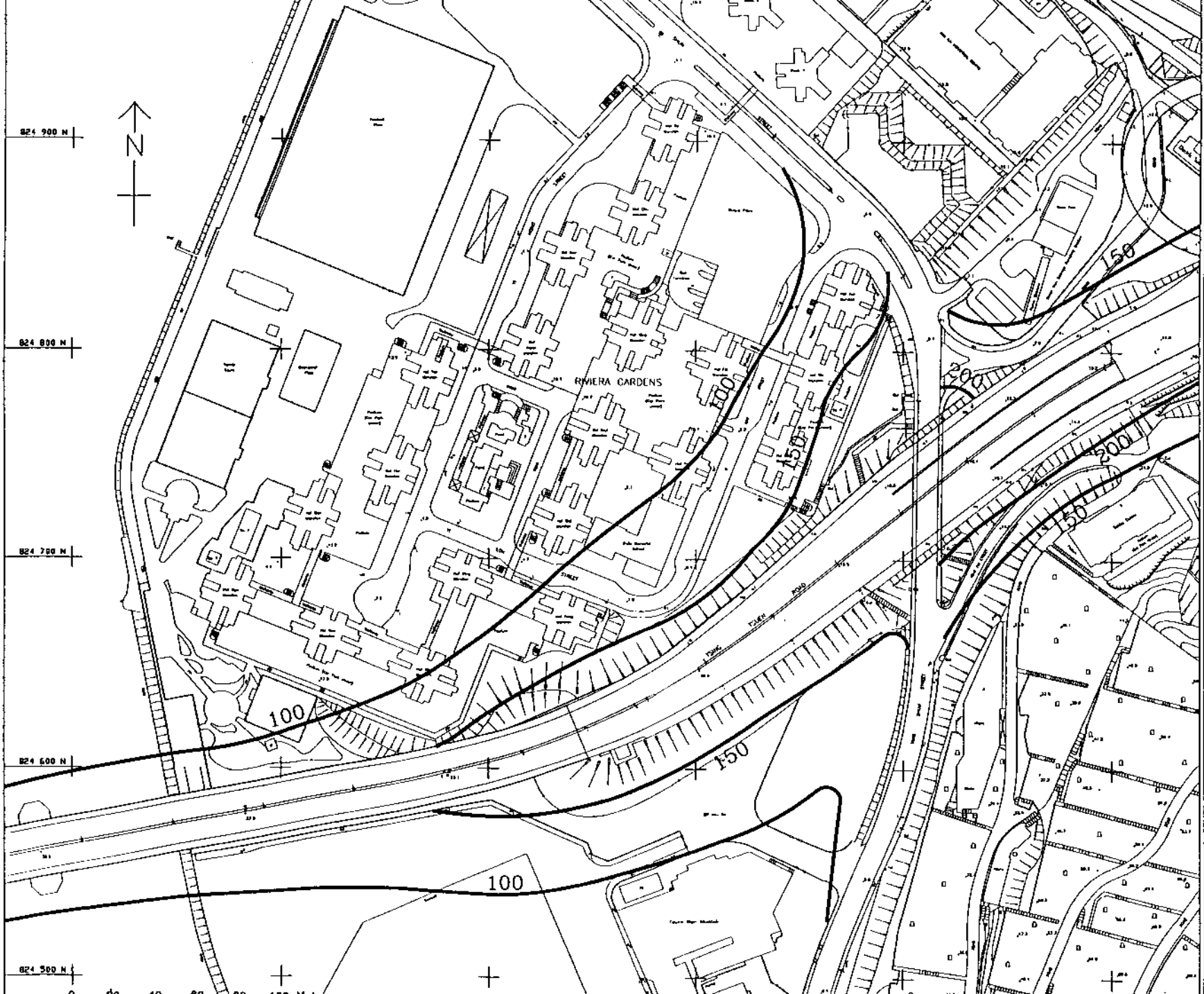
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

PREDICTED 1-HOUR AVERAGE NO_2 CONCENTRATION($\mu g/m^3$) CONTOURS AT 1.5M ABOVE GROUND - MITIGATED

MAUNSELL CONSULTANTS ASIA LTD.
茂盛(亞洲)工程顧問有限公司

FIGURE NO. FIGURE 4-6

SCALE AS SHOWN



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

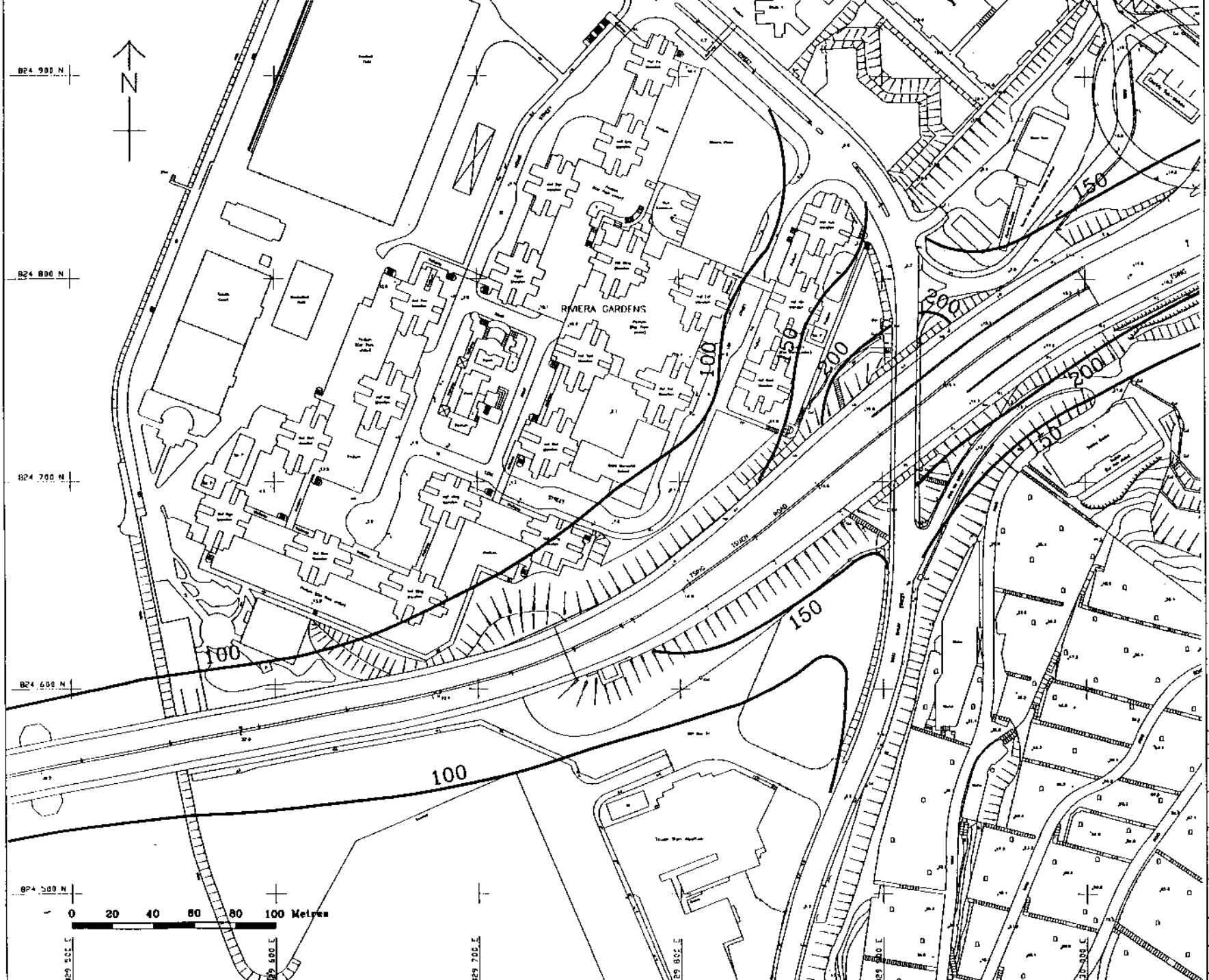
PREDICTED 24-HOUR AVERAGE RSP CONCENTRATION($\mu g/m^3$) CONTOURS AT1.5M ABOVE GROUND - UNMITIGATED

MAUNSELL CONSULTANTS ASIA LTD.
茂盛(亞洲)工程顧問有限公司

FIGURE NO.
圖號編號 FIGURE 4-7

SCALE
比例 AS SHOWN

Resume



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

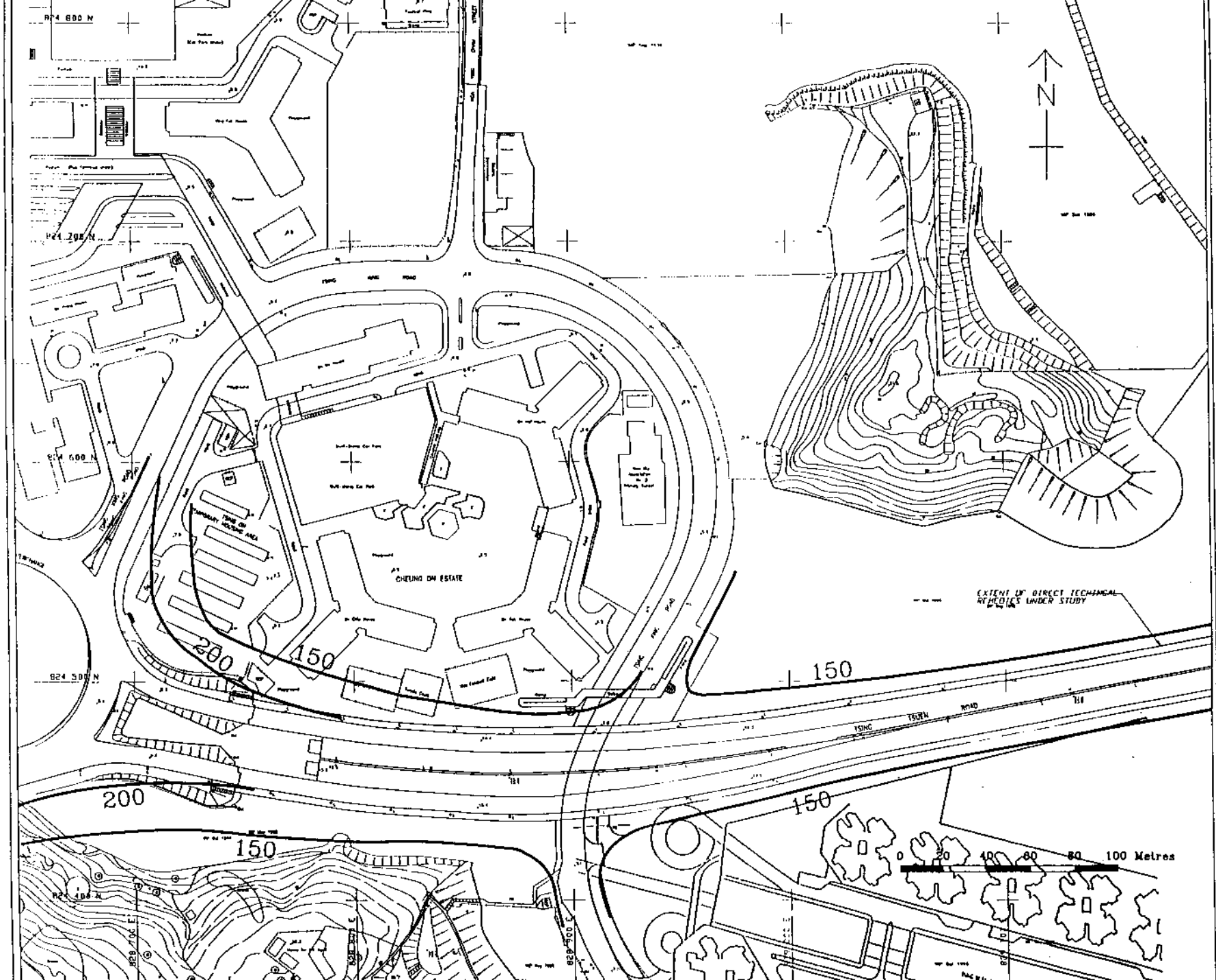
PREDICTED 24-HOUR AVERAGE RSP CONCENTRATIONS ($\mu g/m^3$) CONTOURS AT 1.5M ABOVE GROUND - MITIGATED

MAUNSELL CONSULTANTS ASIA LTD
滿盛咨詢工程顧問有限公司

FIGURE NO.
圖表編號 FIGURE 4-8

SCALE
比例 AS SHOWN

maunsell



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

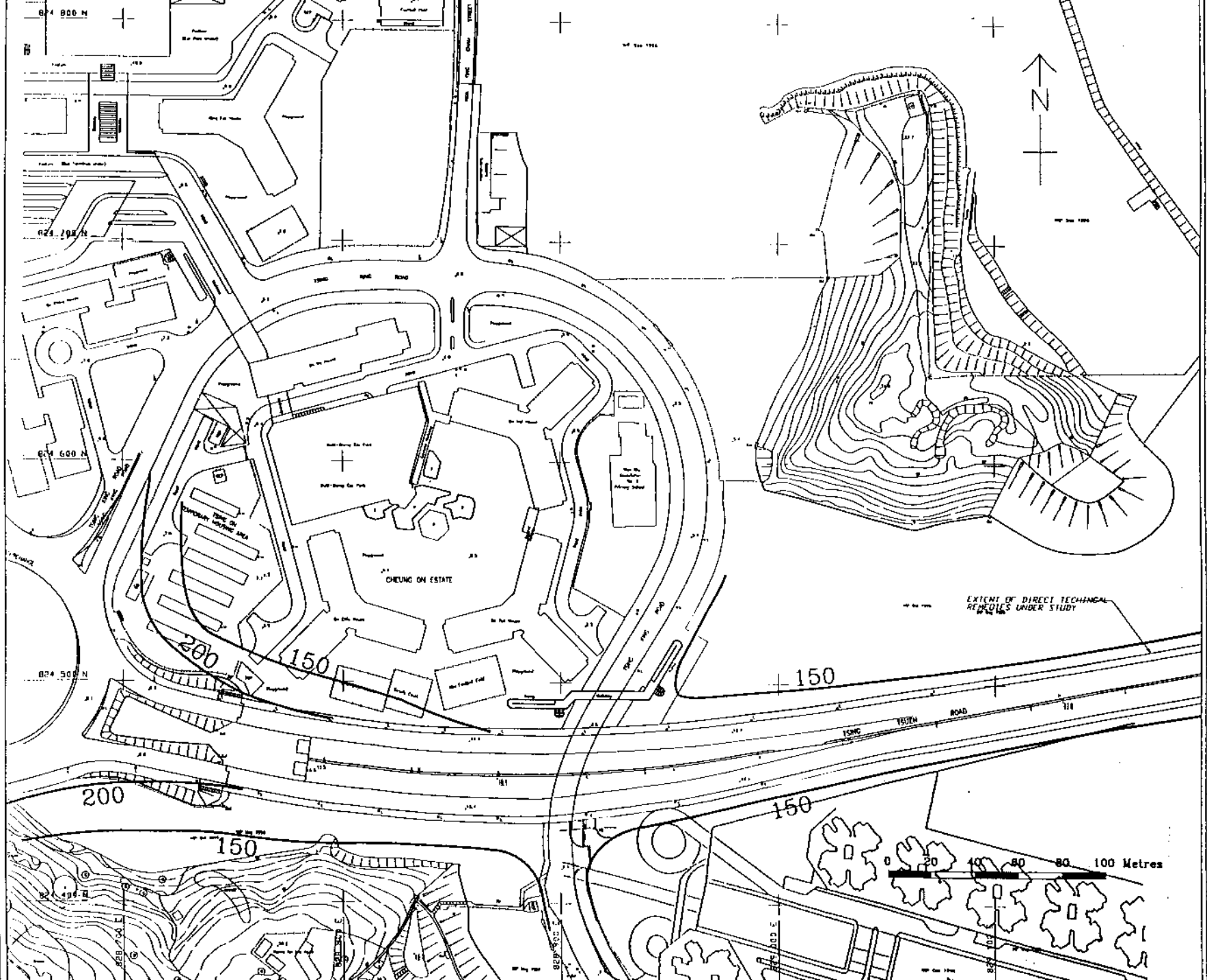
PREDICTED 1-HOUR AVERAGE NO_2 CONCENTRATIONS ($\mu g/m^3$) CONTOURS AT 1.5M ABOVE GROUND - UNMITIGATED

MAUNSELL CONSULTANTS ASIA LTD.
茂盛(亞洲)工程顧問有限公司

FIGURE NO. FIGURE 4-9

SCALE AS SHOWN

Maunsell



ENVIRONMENTAL PROTECTION DEPARTMENT

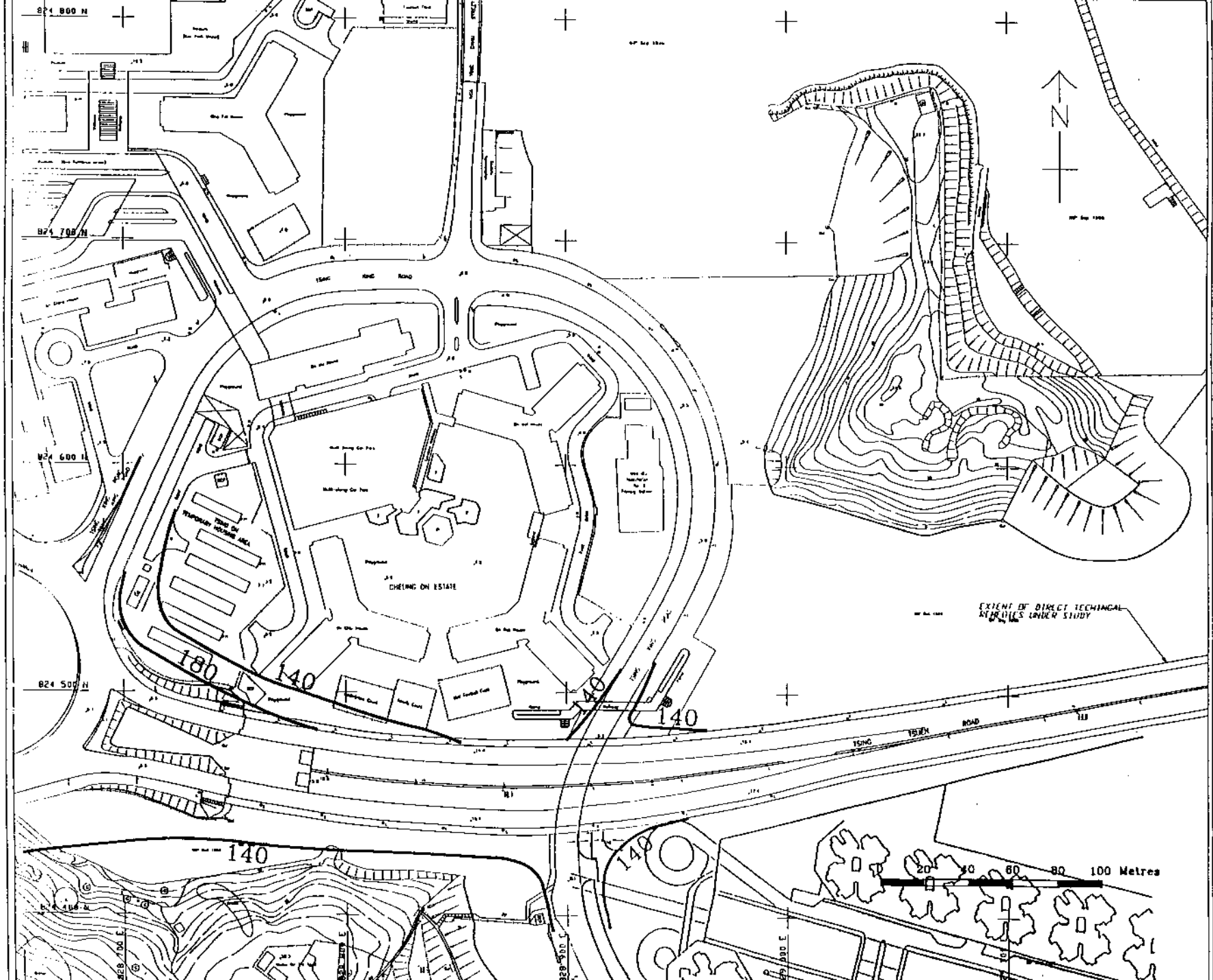
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

PREDICTED 1-HOUR AVERAGE NO_2 CONCENTRATION($\mu g/m^3$) CONTOURS AT 1.5M ABOVE GROUND - MITIGATED

HAUNSELL CONSULTANTS ASIA LTD 漢威諮詢工程顧問有限公司

FIGURE NO. 圖表編號 FIGURE 4-10

SCALE 比例 AS SHOWN



ENVIRONMENTAL PROTECTION DEPARTMENT

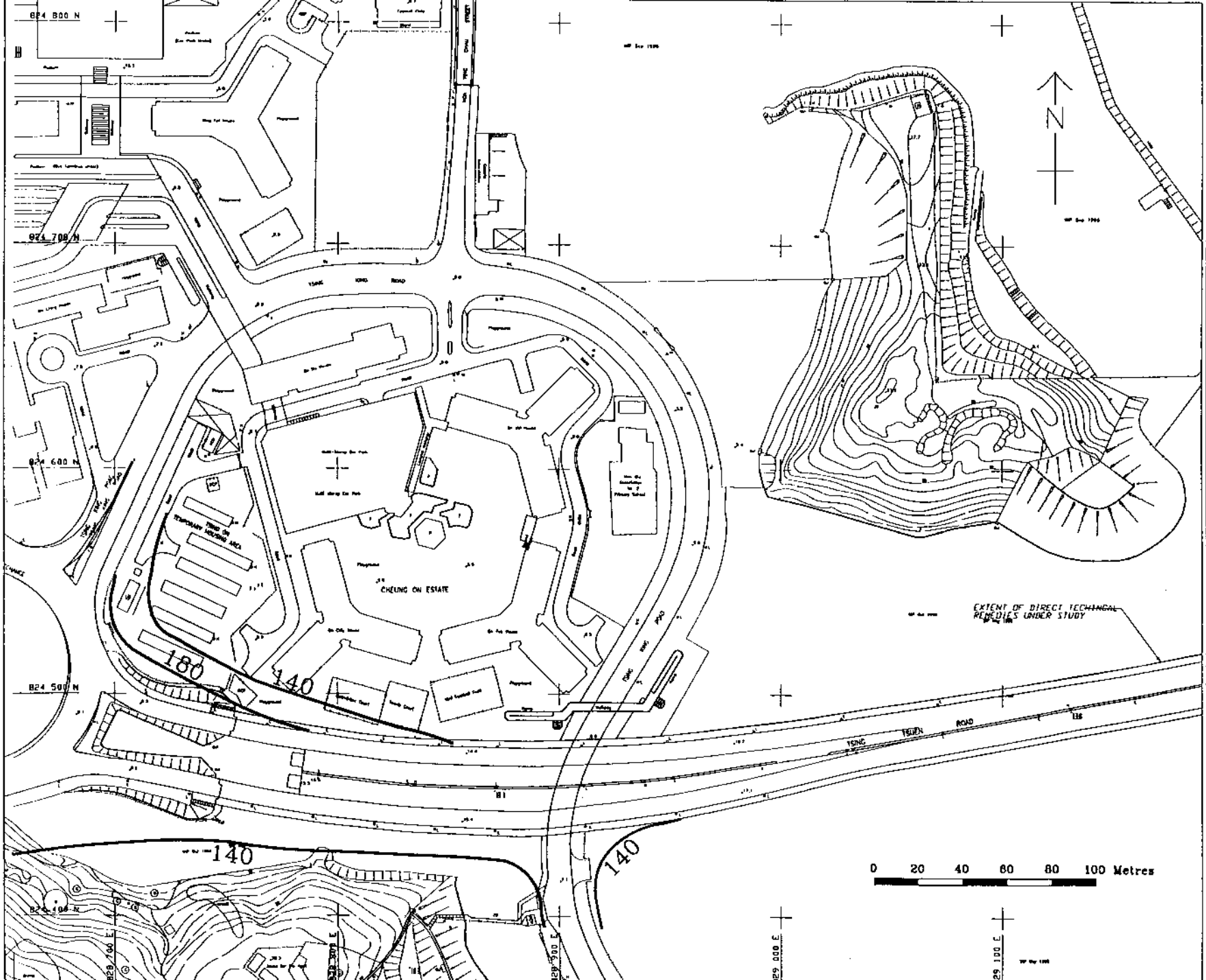
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

PREDICTED 24-HOUR AVERAGE RSP CONCENTRATIONS (μg/m³) CONTOURS AT 1.5M ABOVE GROUND - UNMITIGATED

MAUNSELL CONSULTANTS ASIA LTD.
茂盛(亞洲工程顧問有限公司)

FIGURE NO. 圖號編號 FIGURE 4-11

SCALE 比例 AS SHOWN



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

PREDICTED 24-HOUR AVERAGE RSP CONCENTRATION($\mu g/m^3$) CONTOURS AT 1.5M ABOVE GROUND - MITIGATED

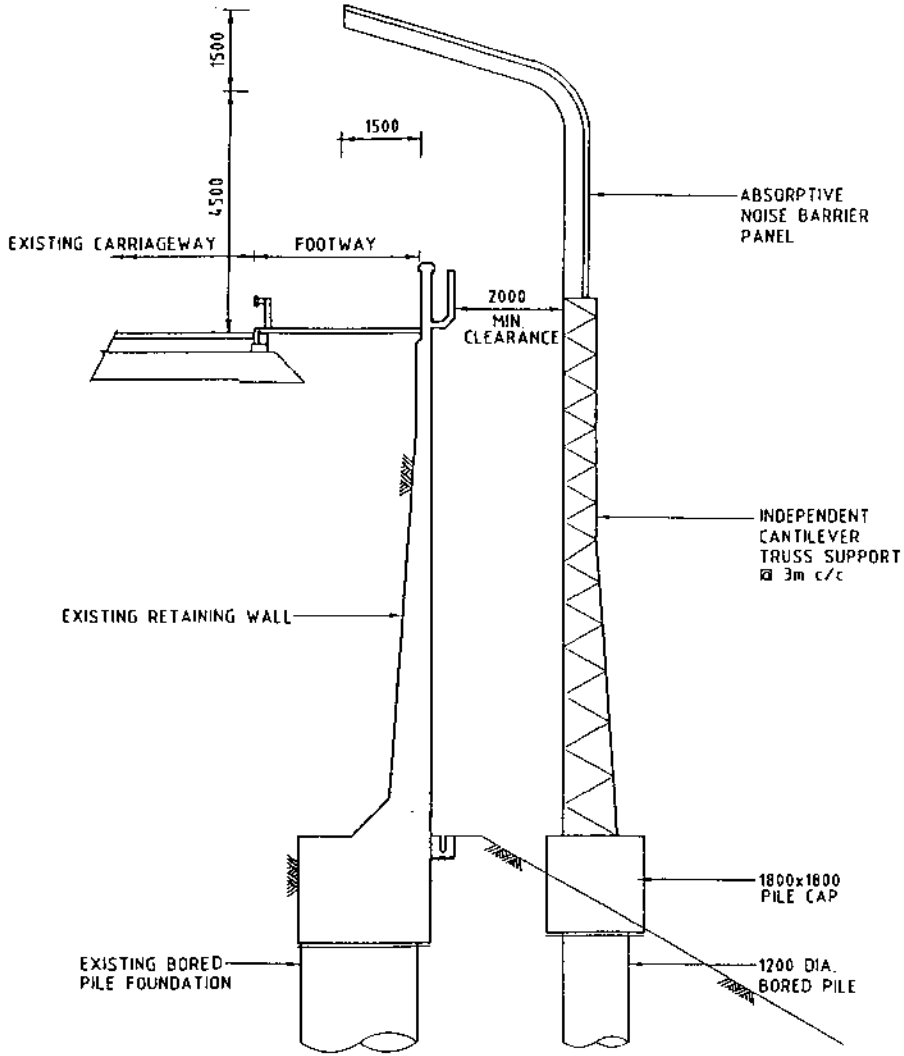
HAUNSELL CONSULTANTS ASIA LTD.
漢威亞洲工程顧問有限公司

FIGURE NO. 圖表編號 FIGURE 4-12

SCALE 比例 AS SHOWN

Haunsell

APPENDIX A



ENVIRONMENTAL PROTECTION DEPARTMENT

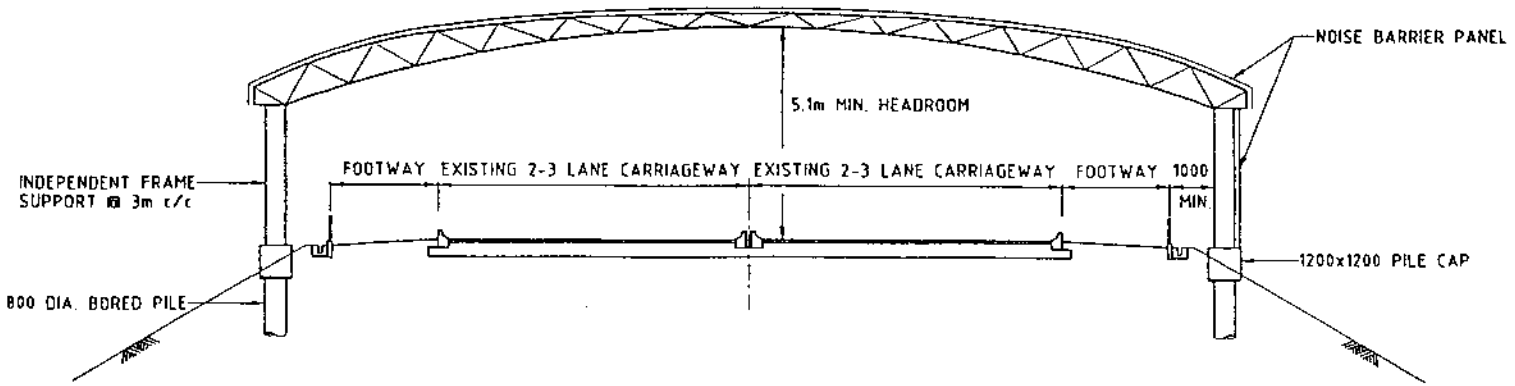
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

CROSS-SECTION OF INVERTED-L SHAPED NOISE BARRIER

MAUNSELL CONSULTANTS ASIA LTD

FIGURE NO FIGURE A1

SCALE N. T. S.



ENVIRONMENTAL PROTECTION DEPARTMENT

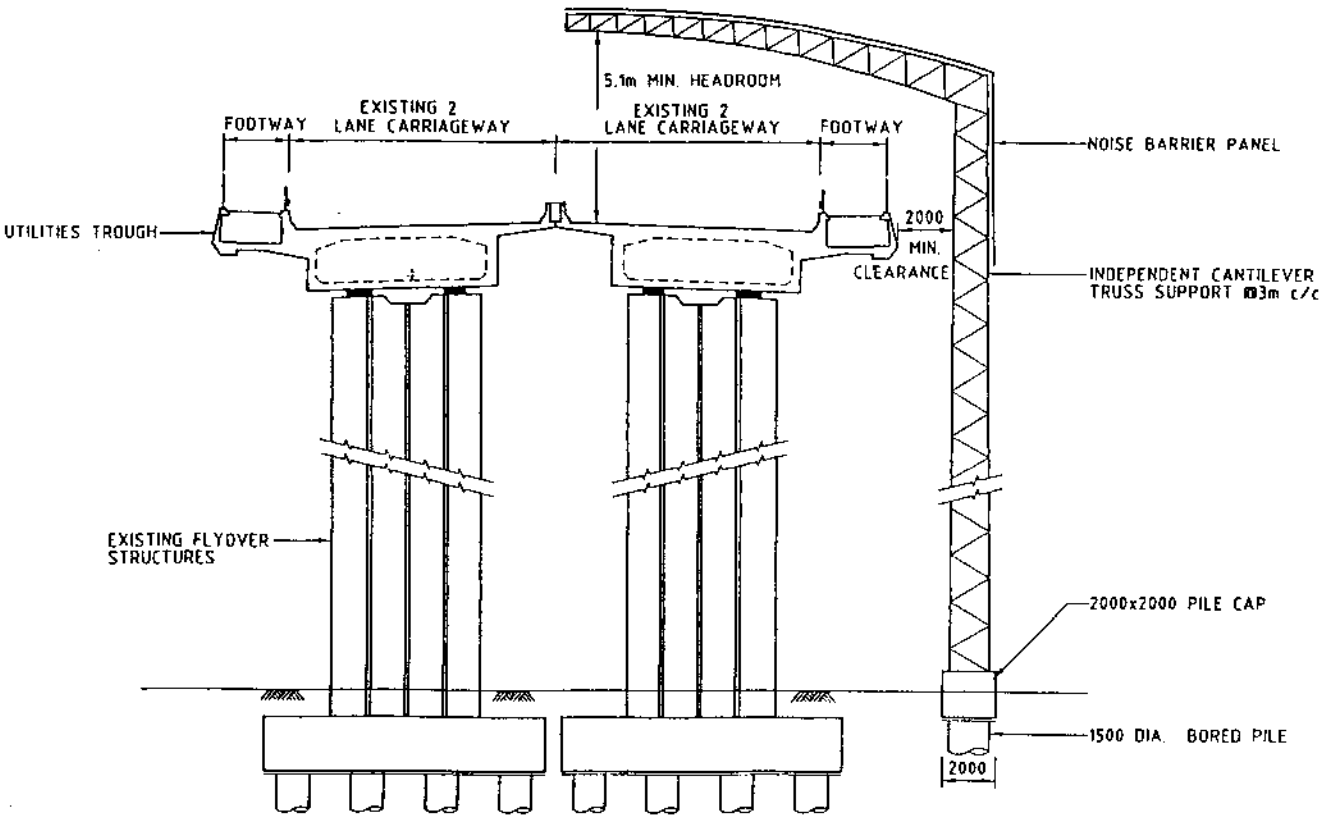
FEASIBILITY STUDY FOR PROVISION OF NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

CROSS-SECTION OF PARTIAL ENCLOSURE (TYPE 1) (SHEET 1 OF 2)

MAUNSELL CONSULTANTS ASIA LTD
茂盛(亞洲)工程顧問有限公司

FIGURE NO 圖號 FIGURE A2

SCALE



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

CROSS-SECTION OF PARTIAL ENCLOSURE (TYPE II) (SHEET 2 OF 2)

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FIGURE NO. FIGURE A2

SCALE

APPENDIX B

CALINE4: CALIFORNIA LINE SOURCE DISPERSION MODEL
JUNE 1989 VERSION
PAGE 1

JOB: Retroactive: AP LEI CHAU (UN-mitigrated)
RUN: 11 (WORST CASE ANGLE)
POLLUTANT: NO2

I. SITE VARIABLES

U= 1.0 M/S Z0= 100. CM ALT= 1. (M)
BRG= WORST CASE VD= .0 CM/S
CLAS= 4 (D) VS= .0 CM/S
MIXH= 500. M TEMP= 25.0 DEGREE (C)
SIGTH= 18. DEGREES

NOX VARIABLES

NO2= .05 PPM NO= .07 PPM O3= .03 PPM KR= .004 1/SEC

II. LINK VARIABLES

LINK DESCRIPTION	LINK COORDINATES (M) X1	Y1	X2	Y2	TYPE	VPH	EF (G/MI)	H (M)	W (M)
A. 2A	34419	11636	34373	11630	AG	180	9.39	.0	13.0
B. 2B	34373	11630	34310	11627	AG	180	9.39	.0	13.0
C. 3	34313	11400	34310	11514	AG	690	9.02	.0	14.0
D. 4A	34310	11514	34255	11529	AG	160	4.07	.0	14.0
E. 4B	34255	11529	34231	11604	AG	160	4.07	.0	14.0
F. 4C	34231	11604	34138	11603	AG	160	4.07	.0	14.0
G. 5	34310	11514	34309	11626	AG	840	8.23	.0	16.0
H. 6	34310	11618	34250	11654	AG	940	8.55	.0	18.0
I. 7A	34491	11860	34404	11775	BG	2480	7.30	18.0	24.0
J. 7B	34404	11775	34361	11754	BG	2480	7.30	18.0	24.0
K. 7C	34361	11754	34316	11732	AG	2480	7.30	.0	24.0
L. 7D	34316	11732	34283	11693	AG	2480	7.30	.0	24.0
M. 7E	34283	11693	34250	11654	AG	2480	7.30	.0	24.0
N. 8A	34250	11654	34222	11641	AG	2020	7.04	.0	24.0
O. 8B	34222	11641	34133	11645	AG	2020	7.04	.0	24.0
P. 8C	34133	11645	34041	11612	AG	2020	7.04	.0	24.0
Q. 8D	34041	11612	33948	11556	AG	2020	7.04	.0	24.0
R. 8E	33948	11556	33884	11546	AG	2020	7.04	.0	24.0
S. 8F	33884	11546	33808	11574	AG	2020	7.04	.0	24.0
T. 9	34214	11752	34167	11734	AG	110	6.95	.0	16.0
U. 0A	34214	11752	34232	11706	AG	95	5.90	.0	16.0
V. 0B	34232	11706	34184	11689	AG	95	5.90	.0	16.0
W. 0C	34184	11689	34167	11734	AG	95	5.90	.0	16.0
X. 11	34167	11734	33883	11627	AG	230	6.65	.0	16.0

III. RECEPTOR LOCATIONS

RECEPTOR	COORDINATES (M) X	Y	Z
1. HA	34353	11730	2.0
2. HM	34288	11674	2.0
3. SO	34270	11596	5.0
4. CO	34179	11592	5.0
5. FM	34117	11678	5.0
6. BK	34213	11662	2.0
7. FP	34296	11740	2.0

IV. MODEL RESULTS (WORST CASE WIND ANGLE)

RECEPTOR	BRG (DEG)	PRED CONC (PPM)	CONC/LINK (PPM) A	B	C	D	E	F	G	H
1. HA	255.	.11	.00	.00	.00	.00	.00	.00	.00	.00
2. HM	251.	.14	.00	.00	.00	.00	.00	.00	.00	.01
3. SO	358.	.08	.00	.00	.00	.00	.00	.00	.00	.01
4. CO	47.	.09	.00	.00	.00	.00	.00	.01	.00	.00
5. FM	127.	.08	.00	.00	.00	.00	.00	.00	.00	.00
6. BK	109.	.11	.00	.00	.00	.00	.00	.00	.00	.02
7. FP	182.	.11	.00	.00	.00	.00	.00	.00	.01	.01

APPENDIX C

Structural Assessment calculations for Ap Lei Chau Bridge & Tsing Tsuen Bridge

Environmental Protection Department

Agreement No. CE 95/97

Noise Mitigation Measures on Existing Flyovers
Feasibility Study

Calculation File No. : 93598/C02
Structural Assessment of Existing Flyovers
(Ap Lei Chau & Tsing Tsuen Bridge)

September 1998

MAUNSELL CONSULTANTS ASIA LTD.

Issue 1
September 1998

Design Statement

Design Element : Noise Barrier + foundation.
(Preliminary Design)

Design Code : SDM
BS 5400 Part 3 + 4
BD 37/88.
Pile Design + Construction CIRO Pub. No

Materials :

Concrete for foundation to CS1 : 1990
Grade 30/20 , Cover = 75mm

Reinforcement to CS2 : 1995
Grade 460 (f_y = 460 N/mm²)

Structural steel to BS4466
Grade 50C (f_y = 355 N/mm²)

Loading

Dead load, unit weight for concrete = 24.5 kN/m³
for steel = 78 kN/m³

Roof = 2.5 kPa

Live load, uni. l = 0.5 kN/m²
(for maintenance)

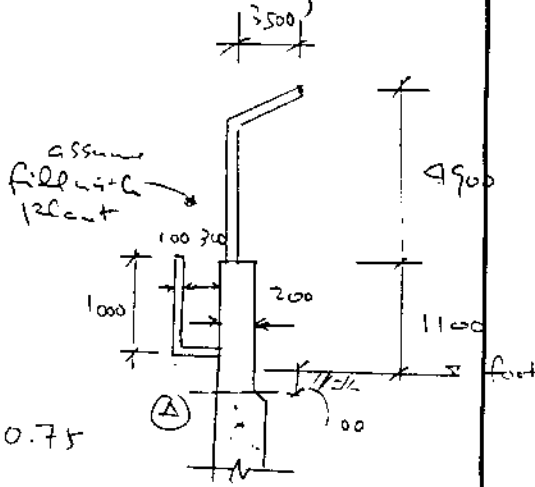
Wind load. loaded q_z = 1.2 kPa
unloaded q_z = 3.8 kPa

C_D = 1.3 for wall BD 37/88 Table 5
C_D = 1.4 for deck Fig 5.

C_L = ±0.75 for deck.

(1) Ap Lei Chau Bridge

Check capacity of upper wall of retaining str. to take additional load from barrier.



(i) Check M at (A)

loading (per m run)

Wind load (unfactored)

$q = 3.8$ kPa

$C_D = 1.3$ approx., $C_L = 0.75$

Trans. area $= 6 \times 1 = 6\ m^2$, vert area $= 3.5 \times 1 = 3.5\ m^2$

$\therefore$ Trans. WL $= 3.8 \times 1.3 \times 6 = 29.7$ kN/m

Vertical WL $= 3.8 \times 0.75 \times 3.5 = 10.0$ kN/m

$f_{cu} = 30$
$f_y = 42$
Cover = c

Design $M_{WL} = 29.7 \times 3.1 + 10.0 \times 1.75$
$= 109.6$ kNm/m

Roof DL (acc) $= 2.5 \times 3.5 = 8.75$ kN/m

Upstand DL (acc) $= 1 \times 0.4 \times 24.5 = 9.8$ kN/m

Design $M_{DL} = 8.75 \times 1.75 + 9.8 \times (0.2 + 0.1) = 18.34$ kNm

ULS M $= (109.6 \times 1.4 + 18.3 \times 1.15) \times 1.1$ (γ_{fL}, γ_{fL}, γ_{f3})
$= 192$ kNm

Reinforcement provided in drg. 93791/10/2411B, = T12/150

Moment Capacities $= 0.87 f_y A_s z$
$= 0.87 (425)(753)(142.3 \times 10^{-6})$
$= 40$ kNm
$<< 192$ kNm

where $d = 200 - 40 - \frac{12}{2} = 154$
$z = (1 - \frac{1.1 f_y A_s}{f_{cu} b d}) d$
$= (1 - \frac{1.1 \times 425 \times 753}{30 \times 1000 \times 154}) d$
$= 0.924\ d$
$= 142.3$ mm

failed (380% overstress)

(ii) Check M at base of wall. (i.e. at pile cap top level)

For Type 1 or 2 retaining wall as shown in Dwg No. 93791/10/2402B. (wall th. = 10
with T40/1

depth from (A) to wall base
= 9.4 m.

design ULS horizontal load = $29.7 \times 1.4 \times 1.1$ (γ_{fL} γ_{fS})
(wL) = 45.8 kN/m

∴ total additional moment from noise barrier
= $168 + 45.8 \times 9.4 = 599$ kNm.
(168 = 109 × 1.4 × 1.1)

existing design moment from cal. file. 93791/10/
= 3328 kNm (sheet 1)

∴ Total design moment
= 3328 + 599 = 3927 kNm

existing moment capacities (from cal. fil
= 3634 kNm < 3951 kNm
failed
(8% overstress)

(iii) Check M at 4 m above base of wall (wall th. = 650
(with T25/10

depth from (A) to (wall base + 2m) = 5.4 m

total additional moment from noise barrier
= $168 + 45.8 \times 5.4 = 415$ kNm

existing design moment from cal. file
= 849 kNm.

∴ total design moment
= 849 + 415 = 1264 kNm

existing moment capacities
= 946 kNm < 1264 kNm
failed (34% overstress)

(iv) Check M at 8 m above base of wall (wall th. = 300 mm with T16/100

depth from (A) to (wall base + 8 m)
= 1.4 m.

total additional moment from noise barrier
= 168 + 45.8 × 1.4 = 232 kNm

existing design moment from Cds fig.
= 59.2 kNm

∴ total design moment = 232 + 59.2
= 291.2 kNm

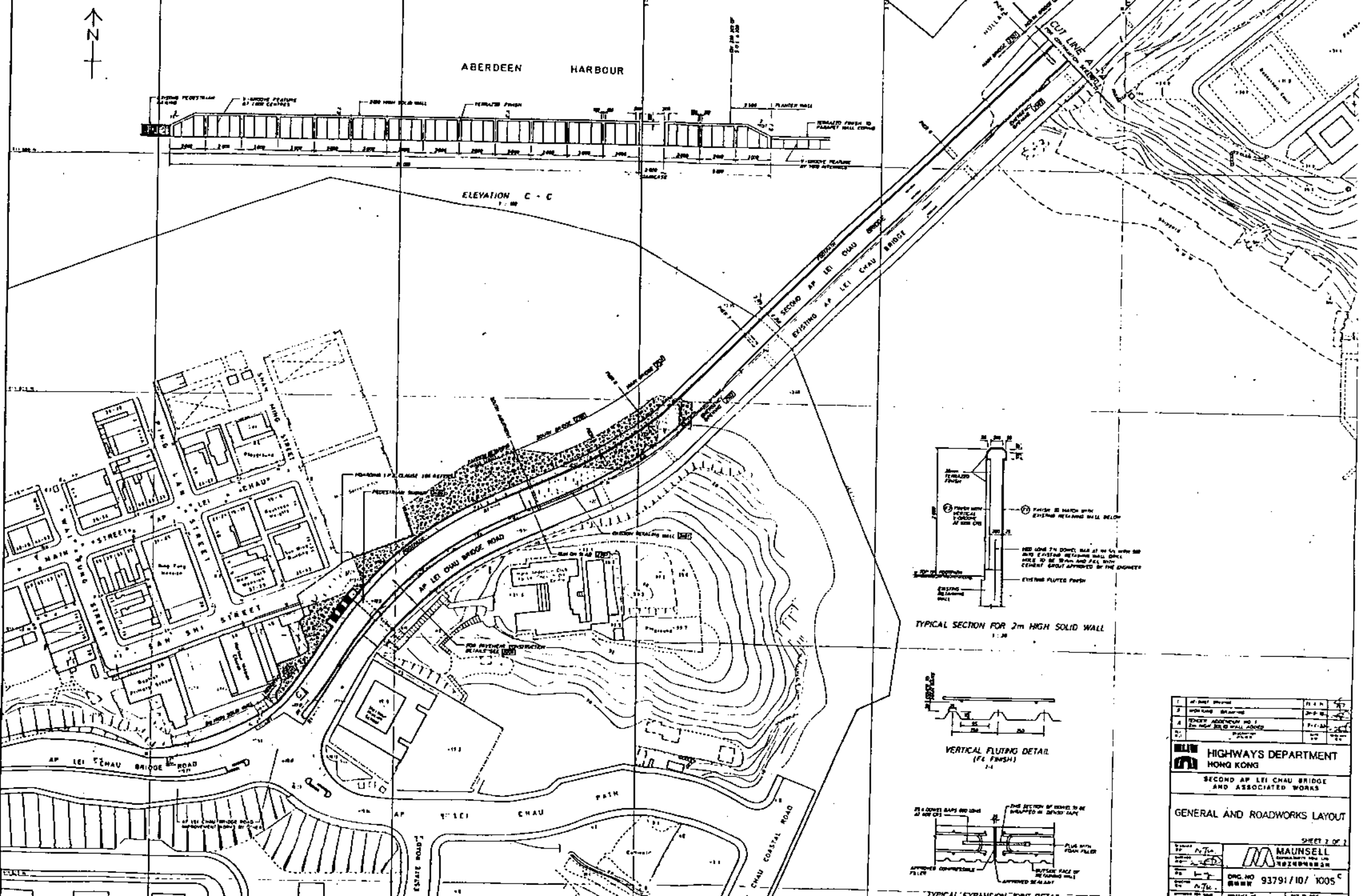
existing moment capacities
= 220.7 kNm < 291.2 kNm

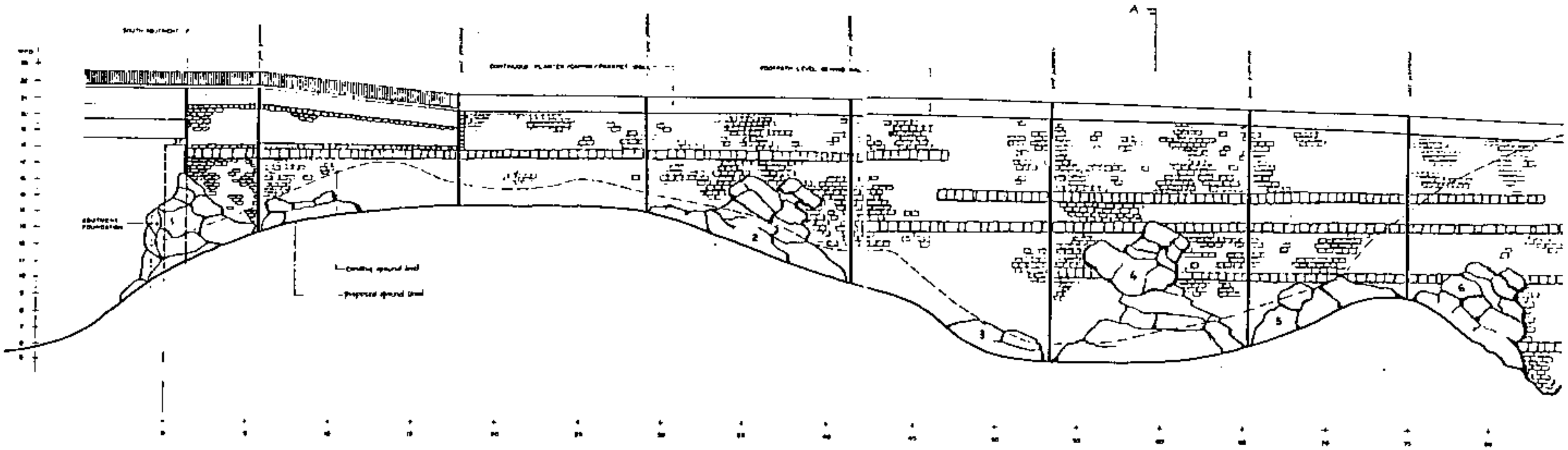
failed
(32% overstress)

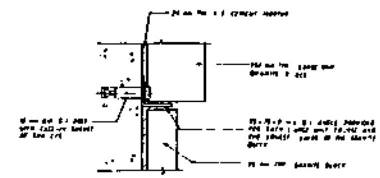
Summary

The proposed barriers would overstress the retaining wall in bending (and shear). Overstress is more serious at the top 2 m parapet wall and generally at about 33% for most part of the wall stem.

To rectify the situation, the top 2 m parapet wall would have to be demolished and rebuilt. Additional thickness of wall would have to be cast against the existing wall from top to bottom. However, strengthening work to founding bored piles would not be practical.

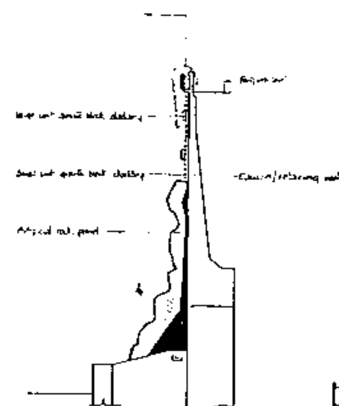

N
ABERDEEN HARBOUR
CUT LINE A-A
ELEVATION C - C
EXISTING AP LEI CHAU BRIDGE
SECOND AP LEI CHAU BRIDGE
AP LEI CHAU BRIDGE ROAD
AP LEI CHAU ESTATE ROAD
AP LEI CHAU COASTAL ROAD
AP LEI CHAU PATH
SAN SHI STREET
SAN WING STREET
SAN MING STREET
SAN LEI CHAU STREET
TYPICAL SECTION FOR 2m HIGH SOLID WALL
VERTICAL FLUTING DETAIL
(FE FINISH)
HIGHWAYS DEPARTMENT
HONG KONG
SECOND AP LEI CHAU BRIDGE
AND ASSOCIATED WORKS
GENERAL AND ROADWORKS LAYOUT
SHEET 2 OF 2
MAUNSELL
DRG. NO 93791/10/1005 C

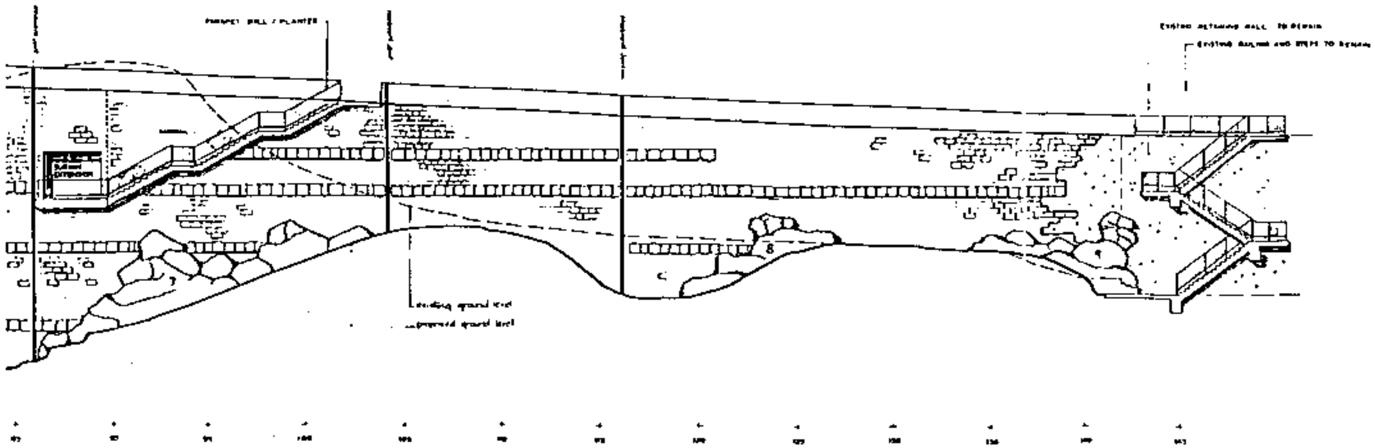




FIXING DETAIL FOR LARGE UNIT STONE

Section A-A (scale 1:10)





Small unit natural granite block cladding

Large unit natural granite block cladding

Artificial rock panels

Notes -

AS-BUILT DRAWING

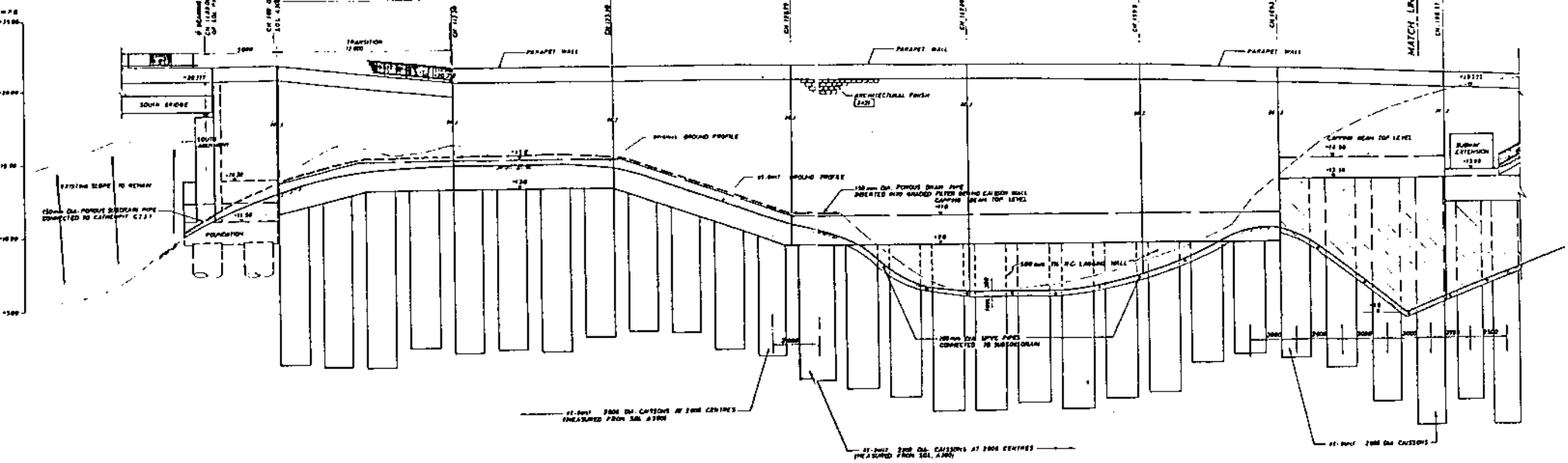
HIGHWAYS DEPARTMENT
HONG KONG

SECOND AP LEI CHAU BRIDGE AND ASSOCIATED WORKS

RETAINING WALL
ARCHITECTURAL FINISHES

MAUNSELL

DRG. NO 93791 / 10 / 2431



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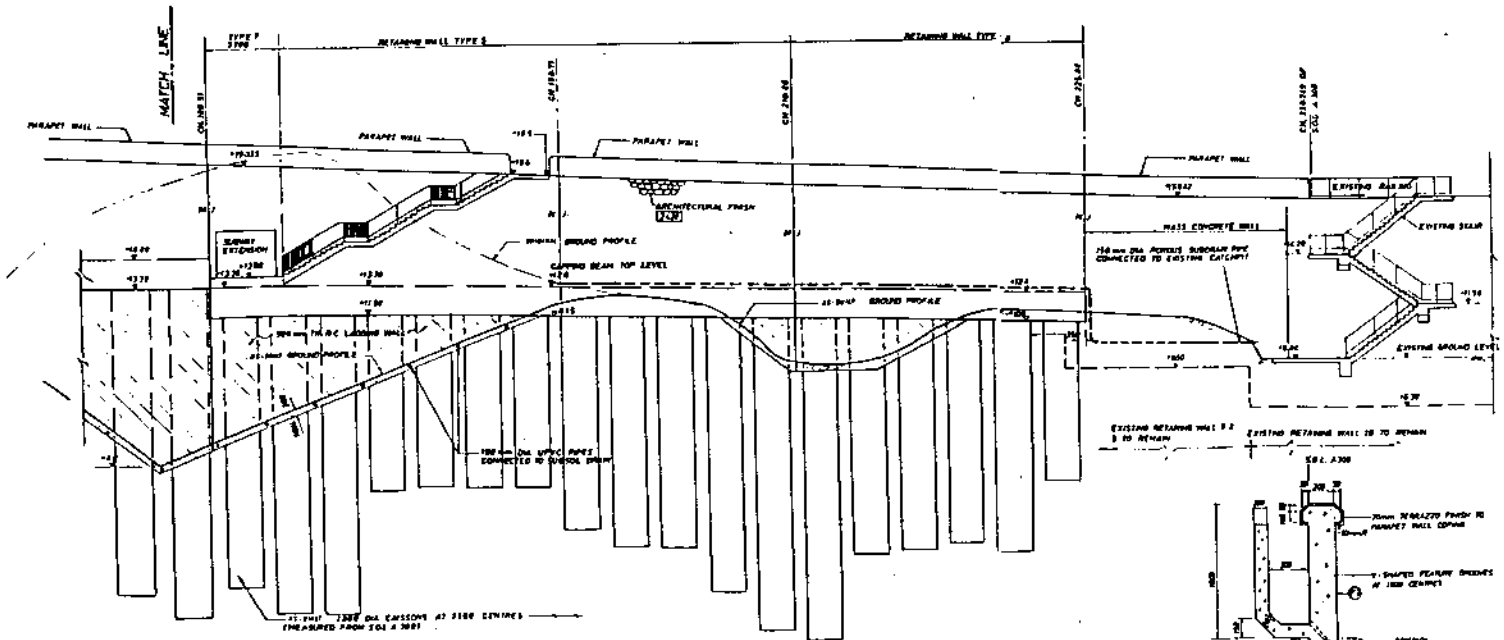
CUT-OFF LEVEL AT ⊕	+11.75	+12.45	+12.855	+13.075	+13.075	+13.075	+13.075	+13.075	+12.4	+11.43	+10.4	+9.38	+9.075	+9.075	+9.075	+9.075	+9.075	+9.075	+9.075	+9.075	+9.075	+9.075	+9.075	+9.075	+12.455	+12.455	+12.455
DESIGN TOPSOIL LEVEL	+9.92	+10.64	+11.395	+11.875	+11.875	+11.875	+11.875	+11.875	+11.2	+10.23	+9.2	+8.18	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+11.255	+11.255	+11.255
TOP LEVEL	+9.92	+10.64	+11.395	+11.875	+11.875	+11.875	+11.875	+11.875	+11.2	+10.23	+9.2	+8.18	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+7.875	+11.255	+11.255	+11.255

DEVELOPED ELEVATION



	CA28	CA29	CA30	CA31	CA32	CA33	CA34	CA35	CA36	CA37	CA38	CA39	CA40	CA41	CA42	CA43	CA44	CA45
CUT OFF LEVEL AT ⊕	+11.955	+11.955	+11.955	+11.955	+11.95	+11.95	+11.85	+11.55	+11.50	+11.45	+11.40	+11.35	+11.30	+11.25	+11.20	+11.20	+11.10	+11.00
DESIGN TOPSOIL LEVEL	+11.255	+11.255	+11.255	+11.255	+11.25	+11.25	+11.15	+10.85	+10.80	+10.75	+10.70	+10.65	+10.60	+10.55	+10.50	+10.50	+10.40	+10.30
TOP LEVEL	+11.255	+11.255	+11.255	+11.255	+11.25	+11.25	+11.15	+10.85	+10.80	+10.75	+10.70	+10.65	+10.60	+10.55	+10.50	+10.50	+10.40	+10.30

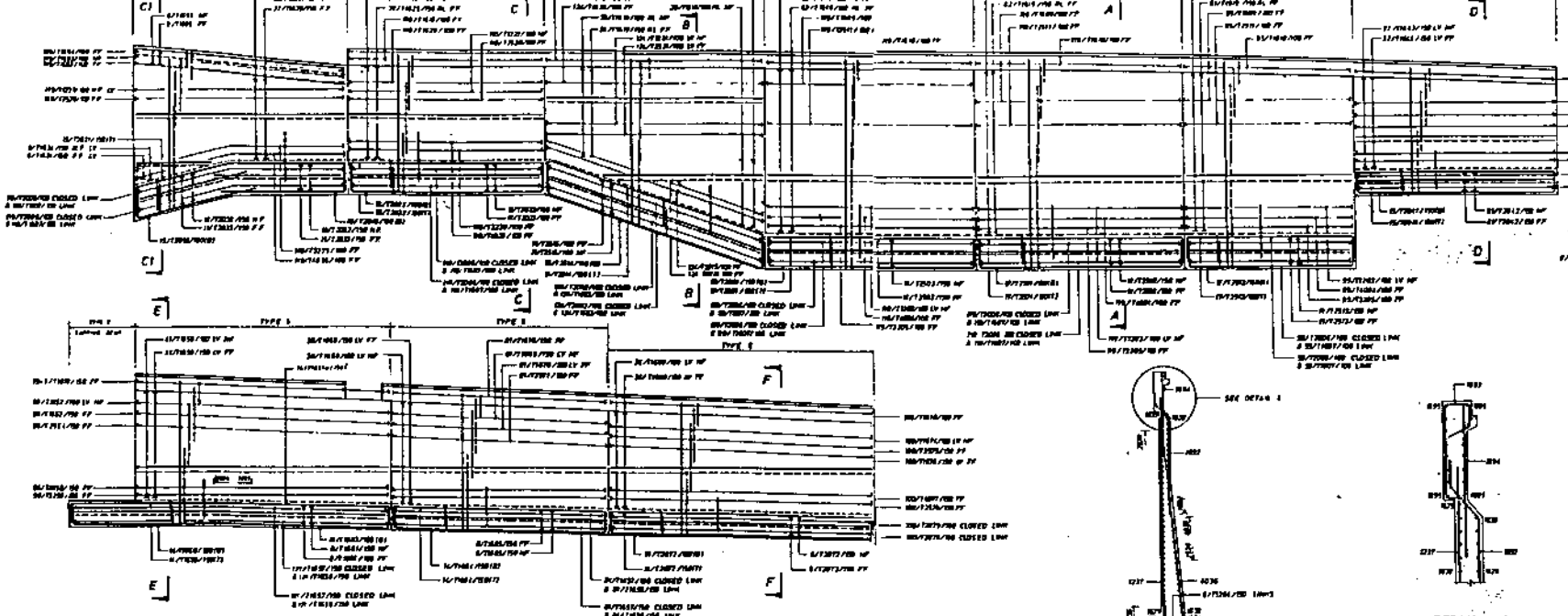
HIGHWAYS DEPARTMENT
HONG KONG

SECOND AP LEI CHAU BRIDGE AND ASSOCIATED WORKS

RETAINING WALL ELEVATION

MAUNSELL

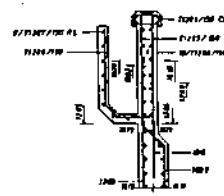
DRG NO 93791/10/2402



ELEVATION OF RETAINING WALL
1 : 100

SECTION C1 - C1
1 : 50

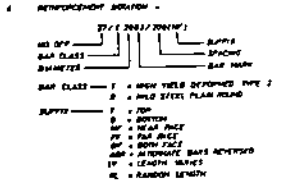
DETAIL L
1 : 20



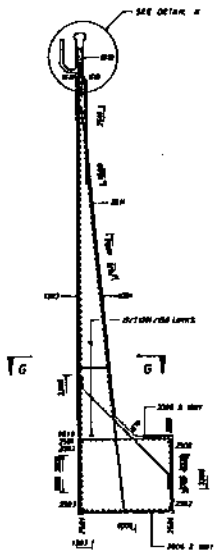
DETAIL K
1 : 20

NOTES :-

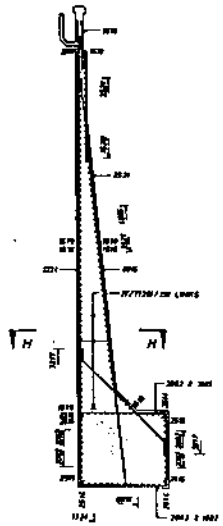
1. THIS DRAWING TO BE READ IN CONJUNCTION WITH RELEVANT GENERAL ARRANGEMENT DRAWING CHE No. 93791/10/2401 TO 2403
2. CONCRETE GRADE 30 OC 30 / 20
3. COVER TO REINFORCEMENT TO BE 40 mm UNLESS OTHERWISE STATED
4. REINFORCEMENT NOTATION :-



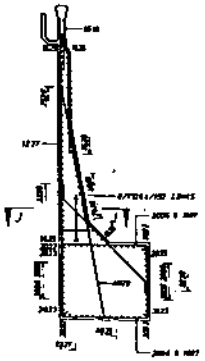
5. MINIMUM LAP LENGTH
   - 48 23 x DIA OF BAR FOR HIGH YIELD DEFORMED TYPE 2
   - 56 35 x DIA OF BAR FOR MILD STEEL PLAIN ROUND



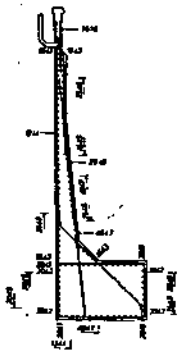
SECTION A - A
1 : 50



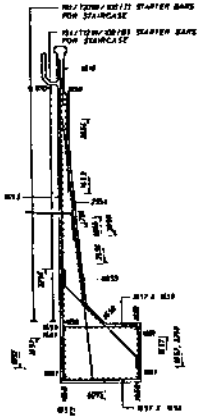
SECTION B - B
1 : 50



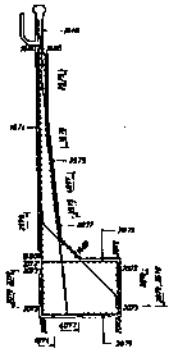
SECTION C - C
1 : 50



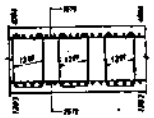
SECTION D - D
1 : 50



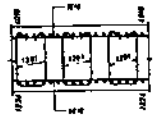
SECTION E - E
1 : 50



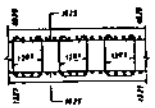
SECTION F - F
1 : 50



SECTION G - G
1 : 25



SECTION H - H
1 : 25



SECTION J - J
1 : 25

HIGHWAYS DEPARTMENT
HONG KONG

SECOND AP LEI CHAU BRIDGE AND ASSOCIATED WORKS

RETAINING WALL R C. DETAILS

MAUNSELL CONSULTANTS ASIA LTD

DRG. NO. 93791 / 10 / 2411

DATE OF ISSUE MAY / 91 / 30

(II) Tsing Tsuen Bridge

(A) Assessment of bearing loads.

Additional Wind load from noise barriers :

barrier height = 6 m approx.

P_z = 3.8 kPa (unloaded)

C_D = 1.4 approx.

Transverse Wind Area = 45 (span length of deck) × (6 + 2.3) (str. depth of deck)
= 374 m²

∴ transverse wind force
= 3.8 × 1.4 × 374
= 1990 kN.

From observation in as-built dgs
73607/14TW/0660R
0440R
0441R
} select 0660R as pattern app

∴ max. (wind load + 120km. load) case, trans. load on bear

= 730 kN approx

new (wind load + 120km load) case, trans. load on bear

= 1990 kN >> 803 kN (Critical Seismic Case) — 173% (Overstress)

This is a significant increase in transverse load.

∴ Any direct installation of barriers on bridge deck will not be feasible.

Note ① bearing replacement would seriously disrupt traffic flow & pedestrian flow.

② Bridge was designed before August 1993

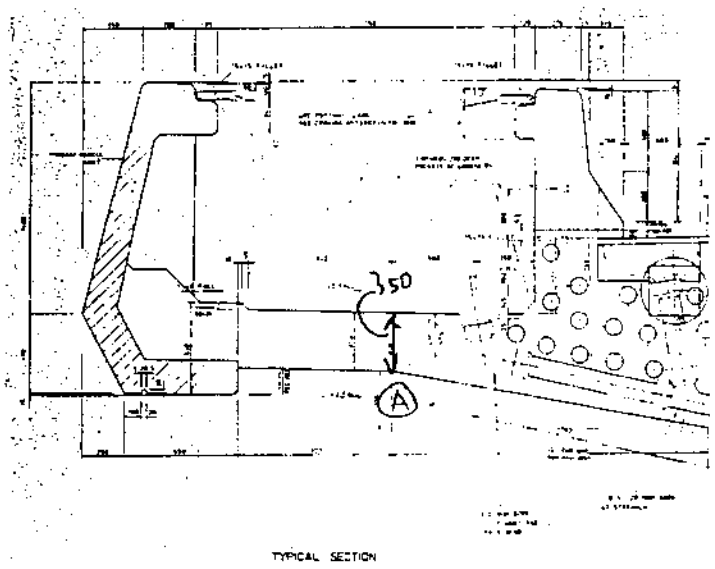
(B) Edge Barrier

Check bending capacity at (A)

Assume barrier post at 1 m c/c

Wind area (trans.)
= 1 × 6 m
= 6 m²

trans. wind force
= 3.8 × 1.4 × C
= 32 kN/m.



TYPICAL SECTION

Note : f_{cu} = 45 N/mm²
f_y = 250 N/mm²
Y20/150 rein-force
(effective width =

additional moment at (A) due to transverse wind force

$= 32 \times (\frac{6}{2} + 1.35 + \frac{0.35}{2}) = 145$ kNm/m (nom.)

$= 145 \times 1.4 \times 1.1$ (ULS)
(γ_{fu} γ_{fs})
= 224 kNm/m

existing design ULS moment = 87 kNm/m

∴ Total design ULS moment = 224 + 87
= 311 kNm/m

existing moment capacities = 172 kNm/m < 31
(73807/W1 - P.623 of original calcs.)

failed !
< 81 % overstress

Strengthening may not be feasible as there were prestress cables within the box section and the overstress % is significant.

(C) Prestressed Bridge Deck

Survey of existing SLS Stresses Condition

Stage 3 deck (ref. file 73807/vol.13)

minimum stresses (SLS) = 0.034 N/mm² (web 1) - P. 6.1/3/1
= 0.051 N/mm² (web 3) - P. 6.1/3/1

Stage 4 deck (ref. file 73807/vol. 7)

minimum stresses = 0.102 N/mm² (web 1) - P. 6.1/4/1

Stage 6 deck

minimum stresses = 0.02 N/mm² (web 3) - P. 6.1/6/1

Stage 11 deck

minimum stresses = 0.044 N/mm² (web 1) - P. 6.1/11/1

Note : the above min. stresses were very close to the stress limit of 0 N/mm².

Any additional load from noise barriers and strengthening work (i.e. thickening of structural member) would certainly overstress the prestressed member

Strengthening of prestressed member may require the use of external prestressing, the scale of which would be significant and costly.

(D) Deck Torsion.

assume torsional restraint is provided at piers

∴ torsional span = 45 m, height of barrier = 6 m

Add'l wind area = 45 × 6
= 270 m²

wind force (unfactored)
= 3.8 × 1.4 × 270
= 1437 kN (nom.)
= 1437 × γ_{f1} × γ_{f3} = 1437 × 1.4 × 1.1 = 2213 kN.

∴ Add'l. wind torsion at support (ULS)
= 2213 × ($\frac{6}{2}$ + $\frac{2.3}{2}$) × $\frac{1}{2}$
= 4592 kNm

↑ half of the torsion received by pier at each side of the span

Note:
Generally torsion → on deck is only in the order of 3500 kNm and the assessment result would be even worse.

Existing design torsion on deck
= 4645 kNm. max.
(at section 108 of cal. file 73807/vol. 11 P. 7.1/19)

∴ torsion will be increased by $\frac{4592}{4645}$ = 99%

Note: To tackle such a magnitude of additional torsion would be a major problem as web links and flange reinforcement would have to be increased.

Also the effect on shear have not been included yet and design code requires to design reinforcement for combined shear and torsion effects. The overstress condition would be even worse.

Pier :

For Column at Grid E2, E3 & E4
of Eastern Approach Bridge.

Size = 4500 × 1500

existing design (ULS)
Case (I)
$N = 25940$ kN
$M_T = 7560$ kNm
$M_L = 43400$ kNm.
(bearing friction case)

((cal. file 73807/vol P.7.1/4 -
(i.e. with horizontal = 5% of permanent load)

Case (II)
$N = 26614$ kN
$M_T = 27525$ kNm
$M_L = 9712$ kNm
(wind case)

Additional wind moment from barrier :

Wind area = 45 × 6 = 270 m²

Wind force (ULS) = 3.8 × 1.4 × 270 × 1.4 × 1.1
= 2212 kN.

additional wind moment in M_T = 2212 × (19.5 + 2.3 + 3)
(pier height, deck depth, barrier c...)
= 54860 kNm

existing Capacity

$M_{TU} = 3.9 \times 4.5^2 \times 1.5 \times 10^3 = 118463$ kN

$M_{LU} = 4.9 \times 4.5 \times 1.5^2 \times 10^3 = 49613$ kN.

existing interacting check of moment in both dir.
$\frac{M_T}{M_{TU}} + \frac{M_L}{M_{LU}} = 0.064 + 0.875$ ((case I
$= 0.939 < 1.0$
(marginal to limit)

$= 0.23 + 0.2$ ((case II
$= 0.43 < 1.0$
(o.k.)

with additional moment = 54860

$\frac{M_T}{M_{TU}} + \frac{M_L}{M_{LU}} = 0.43 + \frac{54860}{118463} = 0.89 < 1.$

(still o.k.)

Foundation Bored Piles (Dia. 1200)

Axial capacity = 5000 × π × $\frac{1.2^2}{4}$ = 5655 kN.

(with rock bearing capacity = 5000 kPa)

For piles at Grid E2 of Eastern Approach.

existing max. pile load = 3548 kN (P.7.11/-)
existing min pile load = 888 kN.

Ref dwg no. 061R.

I_t (trans.) = (1.4² + 4.2²) × 3 × 2 = 117.6 m⁴

Addl'l moment from wind (nom.) = 54860/(1.4 × 1.1)
= 35623 kNm

Addl'l pile load = ± $\frac{35623}{117.6}$ × 4.2
= ± 1273 kN

∴ resulting max. pile load = 3548 + 1273
= 4821 kN

resulting min. pile load = 888 − 1273
= −385 kN.

(uplift on piles)

Underpass Structure

At the support edge of wing wall, Cross section = 6500 × 700 mm

$q = 3.8$ kN/m² cantilever span = 10m

$C_0 = 1.4$ appx

wind area = $6 \times 10 = 60$ m²

wind force = $3.8 \times 1.4 \times 60$
= 320 kN

lever arm = $\frac{10}{2} = 5$ m

∴ additional wind moment
= $320 \times 5 = 1600$ kNm (nominal)
= $1600 \times 1.4 \times 1.1 = 2464$ kNm (ULS)

existing design M = 12494 kNm.

existing moment capacity:

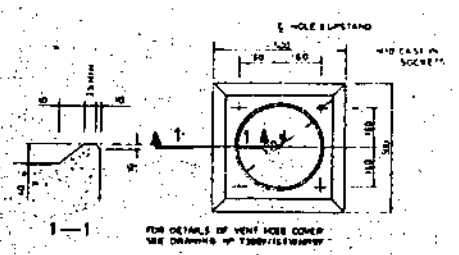
$z = \left(1 - \frac{1.1 \times 415 \times 73986}{40 \times 6500 \times 602}\right) d$

$= 0.789\, d$

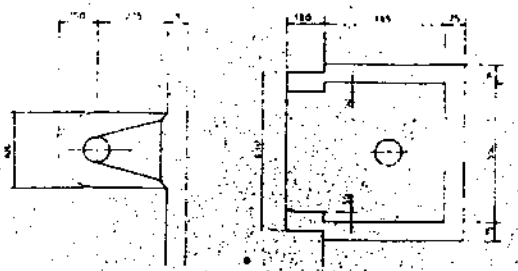
M capacity = $0.87 (425)(0.789 \times 602)(73986) \times 10^{-6}$
= 12994 kNm
< $M_{ex.} + M_{add}$
= 12494 + 2464
= 14958 kNm
(15% overstress)

Note
$f_{cu} = 40$
$f_y = 42$
$d = 60$
$A_s = 2Y$
$= 7355$

Torsional moment from noise barrier loading would be significant to the wing wall section as well.

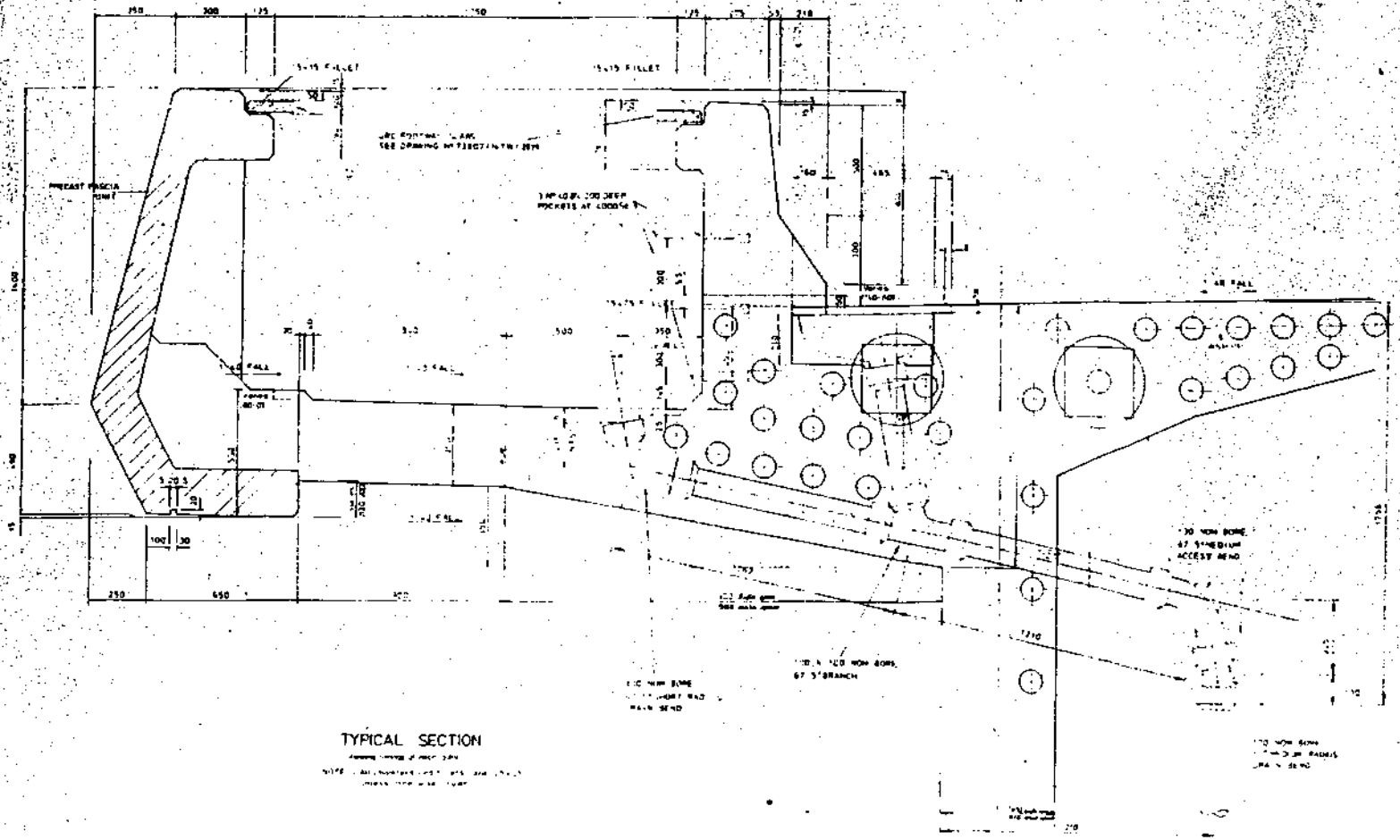


PLAN ON VENT HOLE



PLAN ON SERVICE BAY GULLY

PLAN ON ROAD GULLY



TYPICAL SECTION

NOTES

1. Except as noted.
2. Dimensions are in millimetres unless otherwise shown.

MAEDA ORIENTAL LTD.

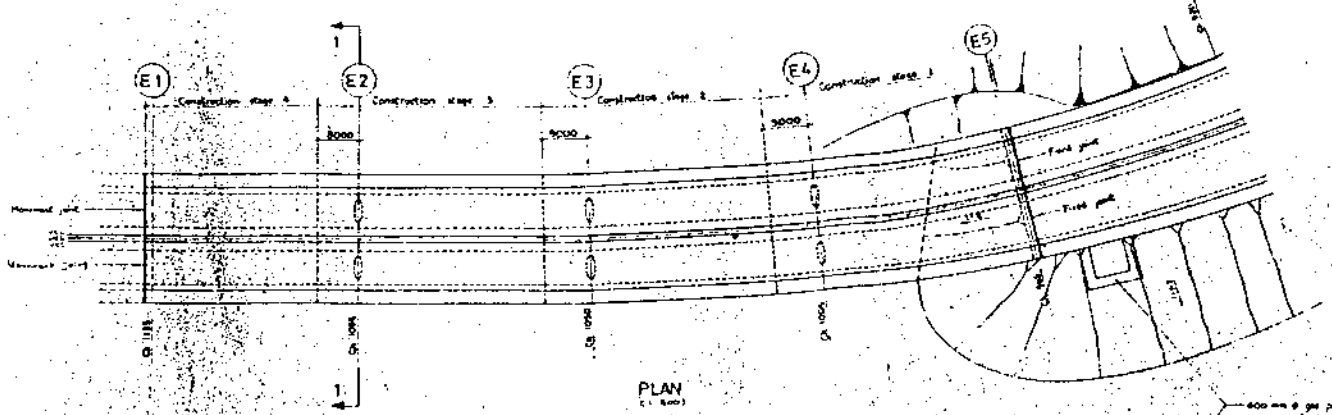
TSUEN WAN NEW TOWN
TSING YI DEVELOPMENT

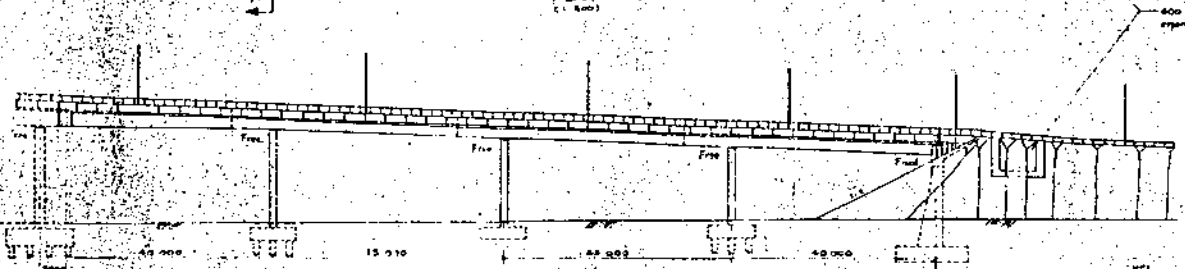
NTDD CONTRACT 14/TW/82
TSING YI NORTH BRIDGE
MAIN CROSSING

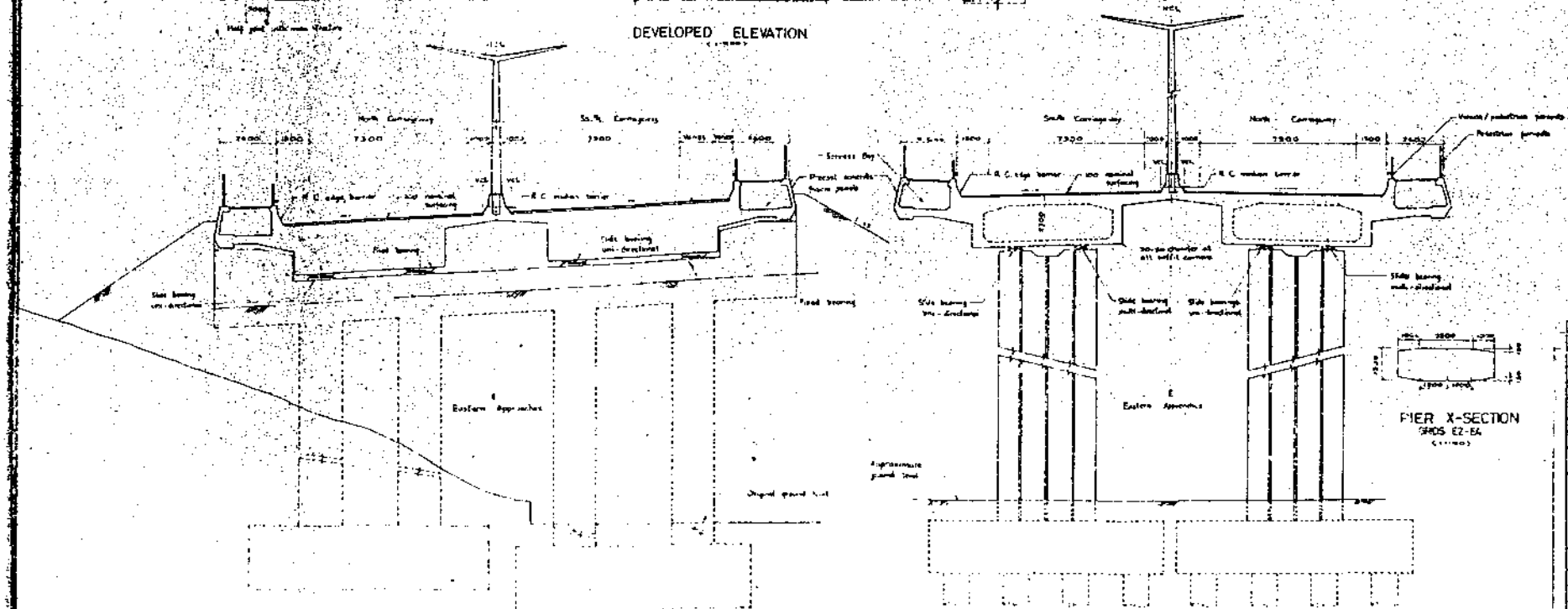
FINISHINGS

SERVICE BAY CONCRETE PLINTH AND DRAINAGE DETAILS

Drawing No. 73607/14TW/2018







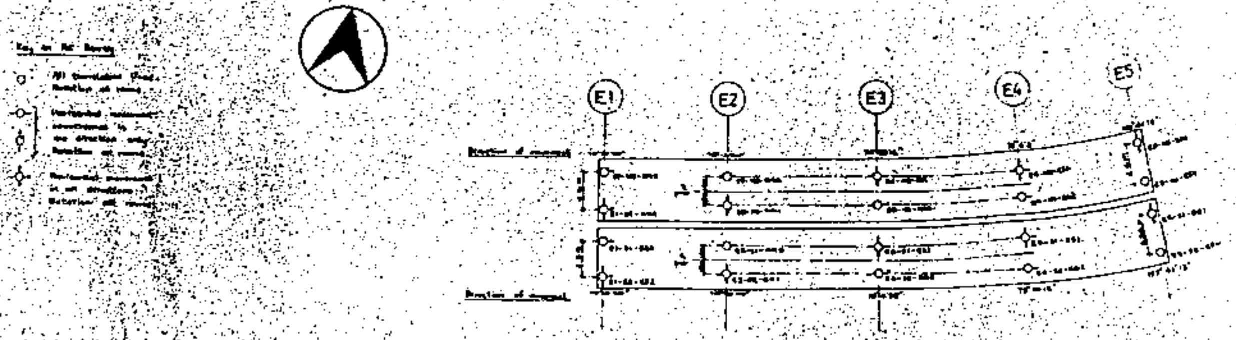
TSUEN WAN NEW TOWN
TSING YI DEVELOPMENT

NTDD CONTRACT. K/TW/82
TSING YI NORTH BRIDGE
EASTERN APPROACHES

General Arrangement

Drawing no. 71807/14TW/0606R

Scott Wilson Kirkpatrick & Partners
Consulting Engineers



ARTICULATION AND SETTING OUT PLAN

Effect number	Horizontal movement (long.) [illegible]	E1		E2		E3		E4		E5	
1	Temperature variation	115	165	36	50	29	33	11	15	-	-
2	Shrinkage and creep	0	225	0	74	0	56	0	36	-	-
3	Friction	0	8	0	10	0	9	4	10	-	-
4	Longitudinal braking force	3	5	1	1	1	1	1	1	-	-
5	Wind forces	8	8	2	2	2	8	2	8	-	-
6	Seismic forces	45	45	26	26	26	26	26	26	-	-
	Worst combination	150	441	[illegible]	166	49	144	37	57	-	-

TABLE OF LONGITUDINAL BEARING MOVEMENTS

Type	Units	[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			ES2		
Number required		2			2						[illegible]			6			2		
Specification		Vertical	Horizontal Longitudinal	Horizontal Transverse	Vertical	Horizontal Longitudinal	Horizontal Transverse	Vertical	Horizontal Longitudinal	Horizontal Transverse	Vertical	Horizontal Longitudinal	Horizontal Transverse	Vertical	Horizontal Longitudinal	Horizontal Transverse	Vertical	Horizontal Longitudinal	Horizontal Transverse
Vertical loading	kN																		
permanent loads only		[illegible]			3645			9645			4371			9655			4371		
permanent loads plus HA load		[illegible]			4640			11639			5611			11650			5671		
permanent loads plus HA load & wind load		4966			4463			12116			5705			12016			5705		
permanent loads plus HB load		5540			5546			12545			6371			13646			6271		
permanent loads plus HB load & wind load		5750			5757			13122			6445			13125			6445		
Horizontal loading & associated min. vertical load	kN																		
braking or traction or the plus associated load		2592	670	250	2597	475	Free	3515	Free	250	2831	Free	250		Free	Free		Free	Free
wind plus permanent loads		2394	703	343	2234	506		4441		793	2969		418						
seismic plus permanent loads		2413	1016	307	2415	1015		4416		843	1601		350						
[illegible] plus permanent loads		3640	1643	185	3640	1535		[illegible]		876	[illegible]		775						
Rotation due to	rad																		
permanent loads			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]	
permanent loads plus HB load			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]	
Maximum bearing size	mm	[illegible]			[illegible]			[illegible]			[illegible]			[illegible]			[illegible]		

SCHEDULE OF BEARINGS

TSUEN WAN NEW TOWN
TSING YI DEVELOPMENT

KTDD CONTRACT 14/TW/82
TSING YI NORTH BRIDGE
EASTERN APPROACHES

Superstructure
Bearing Schedule &
Setting Out Details

Drawing no. 73807/14TW/0680R

Scale N.T.S.

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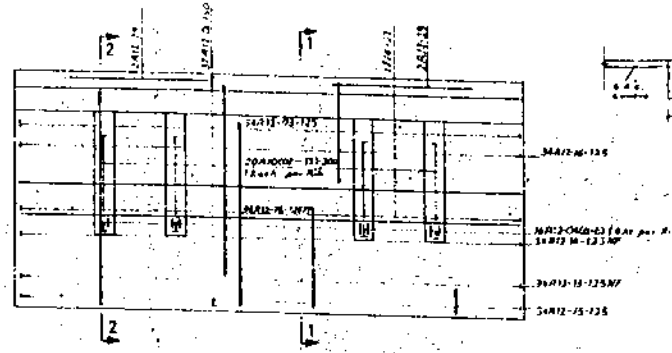
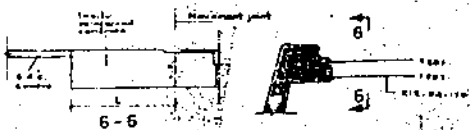
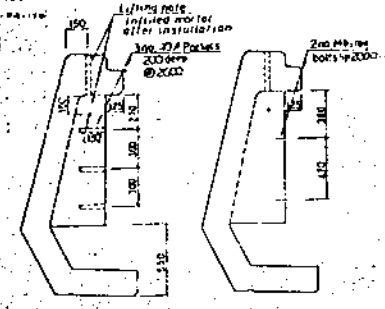


REINFORCEMENT DETAILS OF TYPICAL UNIT

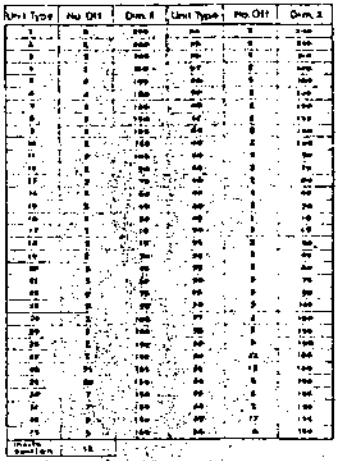


6-6

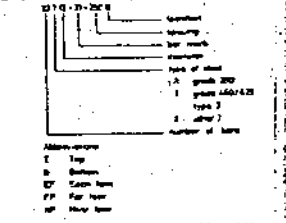
DETAILS AT INSITU SECTIONS

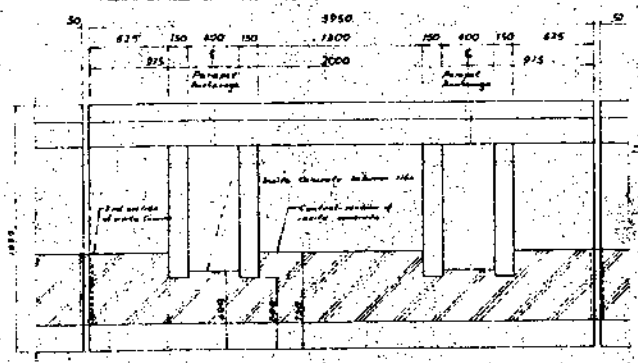


RIB SECTION

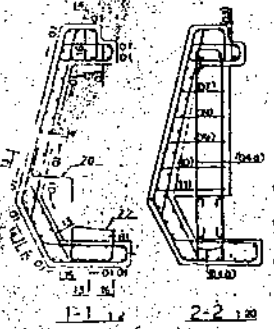


Unit Type	No. Off	Dim. X	Unit Type	No. Off	Dim. X





PROFILE



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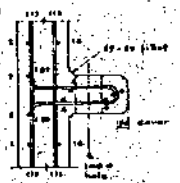
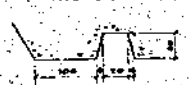
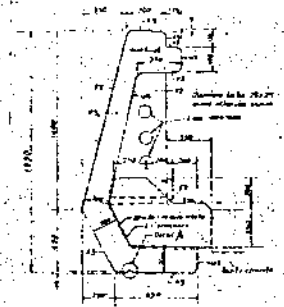


3-3

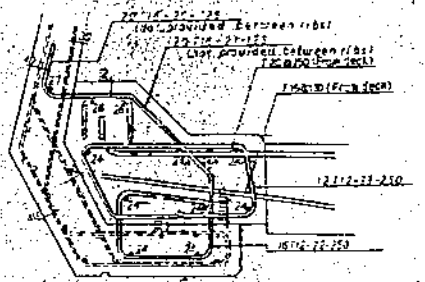
RIB DETAILS



DETAIL A



TYPICAL SECTION



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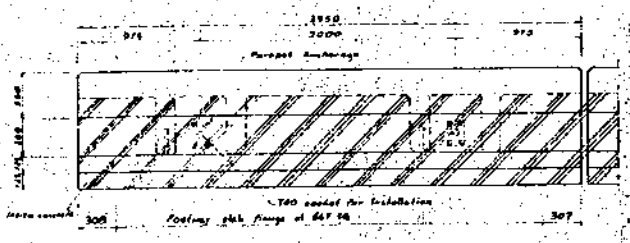
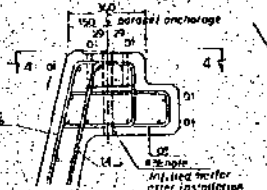
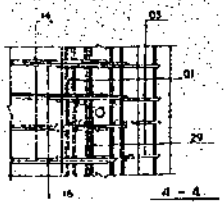




Detail of Parapet anchorage



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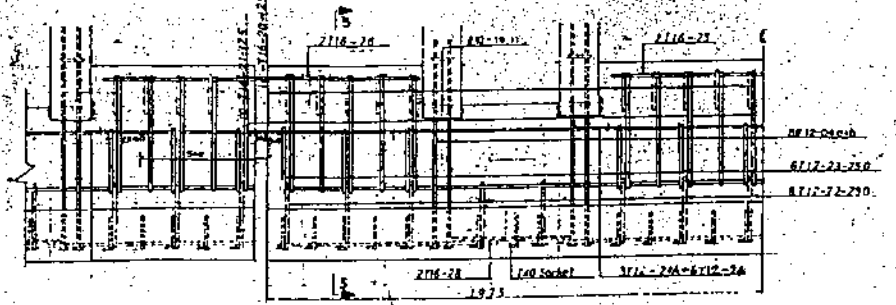
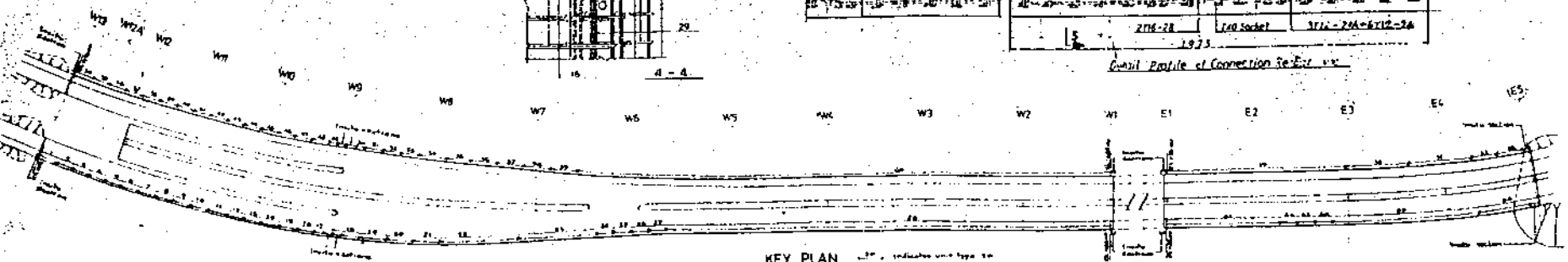


Detail Profile at Connection to E.T. W4



KEY PLAN

TSUEN WAN, NEW TOWNS
TSING YI DEVELOPMENT

NTDD CONTRACT No.TW/02
TSING YI NORTH BRIDGE
APPROACHES - GENERAL

Superstructure
R.C. Details
Precast Fascia Units

Drawing No. 738071/4TW/0710R

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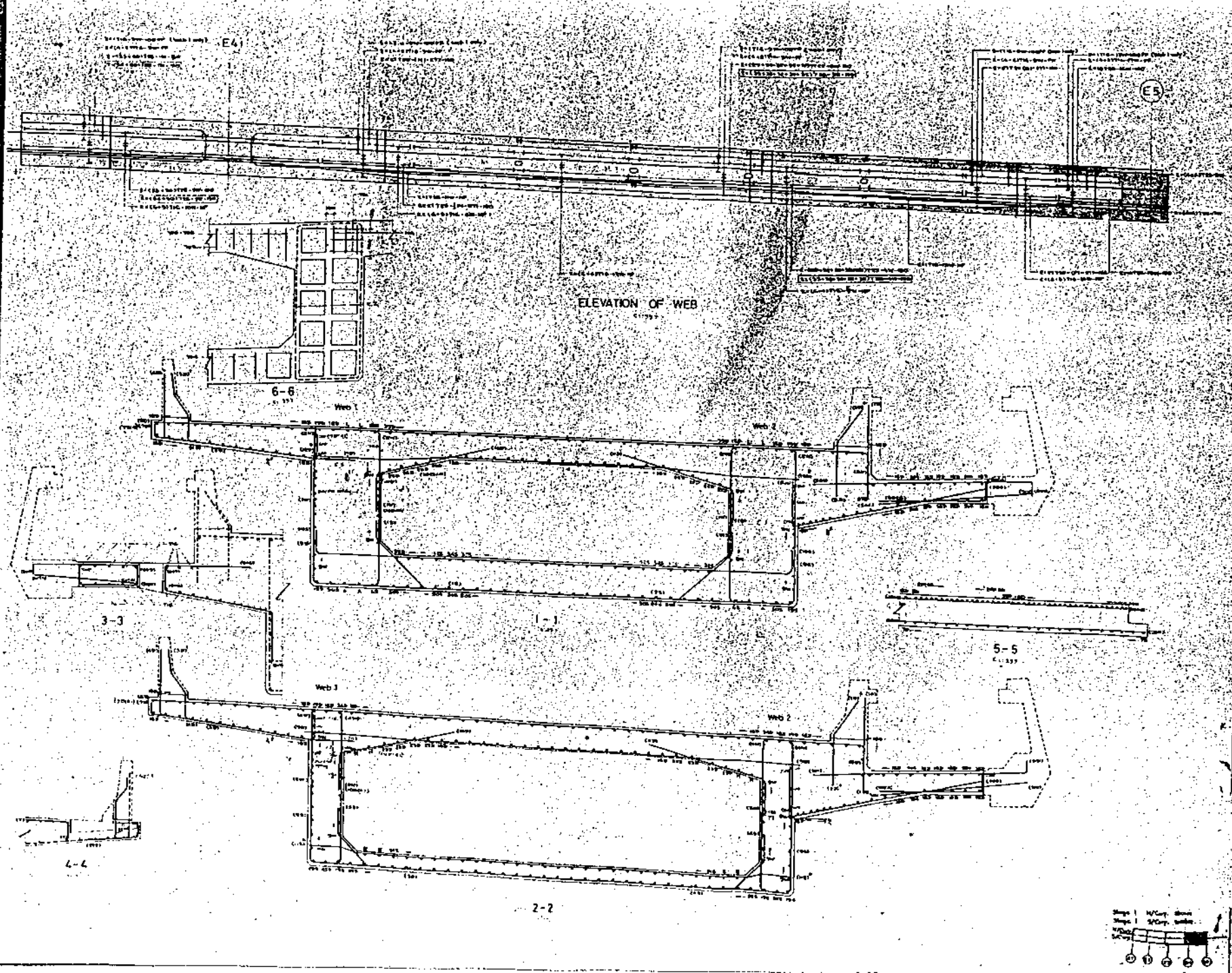

TSUEN WAN NEW TOWN
TSING YI NORTH BRIDGE
EASTERN APPROACHES
Superstructure
R.C. Details
Stage 1
Sheet 2 Of 13
Scott Wilson Kirkpatrick & Partners
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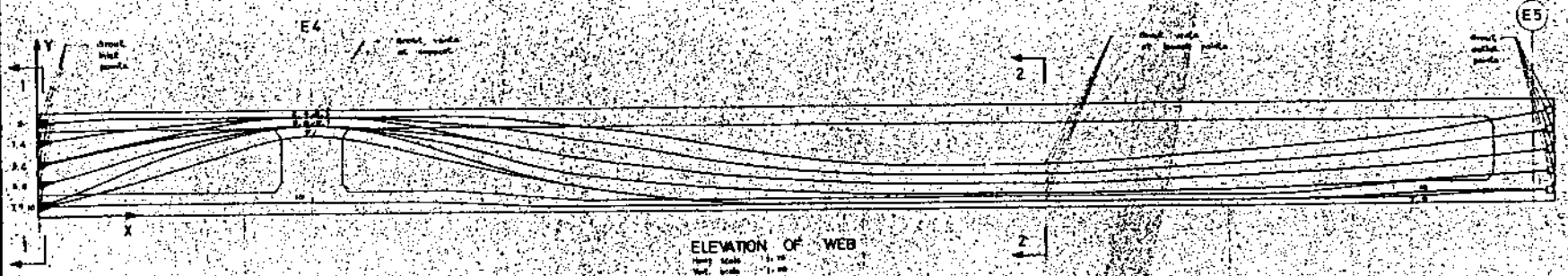
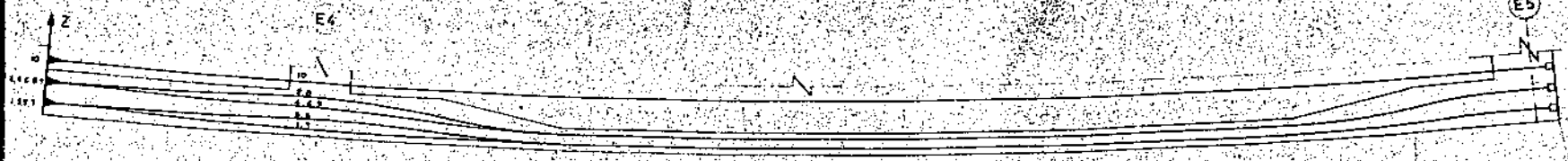


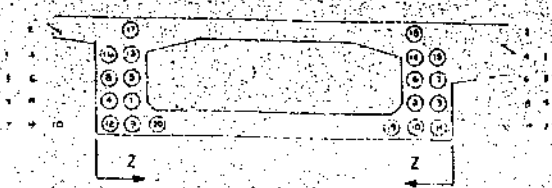
ELEVATION OF WEB

X	0	2 250	4 500	6 750	9 000	11250	13500	15 000	17250	19500	21 000	23250	25500	27 000	29250	31500	33 000	35150	37500	39 000	41250	43500	45 000	47250	49500	49 750
Y3	2040	2160	2168	2169	2165	2165	2163	2120	1948	1765	1590	1340	1160	1020	919	848	810	1068	1142	1230	1344	1686	1940	1779	2098	2040
Y1, Y4	1995	1818	1990	2100	2188	2188	2168	1860	1605	1416	1260	1068	862	790	769	766	760	827	889	960	1062	1176	1360	1481	1868	1995
Y5	1150	1810	1800	2080	2169	1958	1781	1580	1289	1047	926	741	656	595	564	551	548	574	638	668	787	818	889	1029	1168	1150
Y6	1150	1460	1750	1880	1955	1877	1718	1950	1279	1047	926	741	656	595	564	551	548	574	638	668	787	818	889	1029	1168	1150
Y5, Y6	708	915	1135	1850	1958	1849	1537	1250	888	686	600	477	389	360	350	349	348	349	395	360	366	448	506	584	697	708
Y7	260	893	940	1770	1935	1765	1544	1010	649	536	370	193	139	138	135	135	139	165	168	198	189	136	150	209	697	260
Y8	260	915	940	1860	1745	1511	1138	900	631	481	370	192	139	135	135	135	139	155	156	196	196	196	210	259	598	260
Y10	250	250	250	250	250	256	189	165	125	109	135	128	129	129	129	129	125	125	126	125	126	166	240	259	598	250

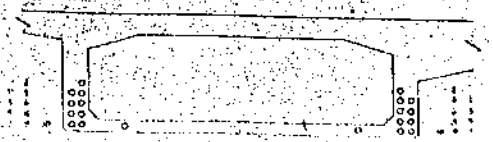


PLAN OF WEB

X	0	2 250	4 500	6 750	9 000	11 250	13 500	15 000	17 250	19 500	21 000	23 250	25 500	27 000	29 250	31 500	33 000	35 250	37 500	39 000	41 250	43 500	45 000	47250	49500	49 750
Z2,Z8	750	746	758	834	855	775	552	619	555	559	395	345	359	395	355	356	391	555	599	355	356	451	563	696	750	780
Z4,Z6	750	746	675	634	620	618	499	388	395	355	355	359	395	335	355	355	391	395	599	359	556	451	563	696	758	770
Z3,Z5	270	784	925	964	949	345	218	114	145	145	191	145	145	149	145	145	145	149	145	145	149	171	208	258	678	270
Z1,Z7	270	254	327	321	149	145	145	148	149	149	149	145	145	149	145	145	145	149	145	145	149	171	208	258	678	1210
Z9	1190	1190	1190	1190	1190	1190	1190	1190	1190	1198	1190	1198	1198	1190	1190	1198	1190	1198	1198	1190	1198	1198	1190	1198	1198	1190



1 - 1



2 - 2

TSUEN WAN NEW TOWN
TSING YI DEVELOPMENT

NTDD CONTRACT 14/TW/82
TSING YI NORTH BRIDGE
EASTERN APPROACHES

Superstructure
Prestressing Tendon Profiles
Stage 1

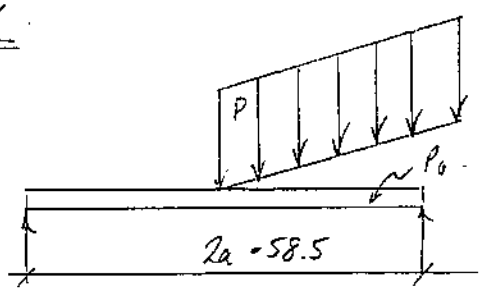
Drawing No. 73807/14/TW/0630R

Scott Wilson Kirkpatrick & Partners

APPENDIX D

Structural Assessment calculations for Kwai Chung Road Flyover near Mei Foo Sun Chuen

LAMA SPAN DECK



BS153: PART 3A

P_o (UDL) = 208 lb/ft²
P (KEL) = 2,700 lb/ft.

BS5400 : PART 2

SDM / THELE 17 { P_o (UDL) = 320 lb/ft² (Assuming uniform load W = 3m)
P (KEL) = 2,700 lb/ft.

$\therefore M_y = M_{bb} \times \frac{4P_o}{\pi} + \frac{P}{a} M_{ax} \times b.$

$= 0.244 \times \frac{80.9}{2} \times \left(\frac{11 \times 320}{3.14} + \frac{2700}{58.5/2} \right)$

$= 9.86 \ (1408 + 92.2)$

= 4,932 #'/ft wide (reduced due to distribution analysis)
(1966 3,965 #'/ft wide)

Local Bending:

$a_m = 12.5"$ $L = 76"$ $a_e = 12.5/76 = 0.164 = a_B$

$r_{ab} = 7.5"$ $r_p = \frac{7.5"}{7} = 1.07 = r_B$

$b = 0.5$

Use FEM for UDL = $0.097 \times wL^2$ } C.O. factor use 0.633
FEM for H Load = $0.15 \times PL$ }

Cantilever Moment at A

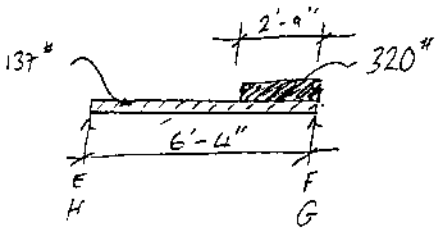
$M = (20 \times 2.5 + 716) \times (1.25 + 1.17)$

$= 2220$ #'/ft.

Span AB, BC, CD, DE, HI, IJ, JK & KL (P.L only)

$M_c = 534$ #'/ft.

Span EF & GH.



$M_E = M_H = 0.095 \times 137 \times 6.33^2 + \frac{0.095}{0.0833} \times 0.042 \times (2.75 \times 320) \times 6.33 + 13$

$= 521 + 267 + 13$

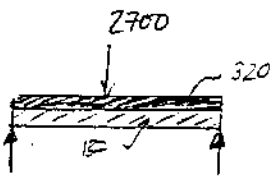
$= 801$ #'/ft.

$M_F = M_G = 0.095 \times 137 \times 6.33^2 + \frac{0.095}{0.0833} \times 0.112 \times (2.75 \times 320) \times 6.33 + 13$

$= 521 + 712 + 13$

$= 1246$ #'/ft.

Span FG



$M_F = 0.095 \times (137 + 320) \times 6.33^2 + 13 + 0.15 \times 2700 \times 6.33$

$= 1740 + 13 + 2560$

$= 4313$ #'/ft.

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0.633

PROJECT No. 9
DATE 5/98
BY Cor

	#'	A		B		C		D		E		F	
FEM	-2220	-534		-534	-534	-534	-534	-534	-534	-534	-801	-1246	-434
D		-1686		0	0	0	0	0	0	-134	+134	-1534	+1534
C.O		0		+1065	0	0	0	0	+85	0	+971	-85	-971
D		0		-533	+533	0	0	+43	-43	+486	-486	-443	+443
C.O.		337		0	0	-337	-27	0	-308	+27	+280	+308	-280
D		-337		0	0	+155	-155	-104	+104	+127	-127	-294	+294
C.O		0		+213	-98	0	+66	+98	-80	-66	+186	+80	-186
D		0		-156	+156	+33	-33	-89	+89	+126	-126	-133	+133
C.O.		+99		0	-21	-99	+56	+21	-80	-56	+84	+80	-84
D		-99		-11	+11	+78	-78	-51	+51	+70	-70	-82	+82
C.O.		+7		+63	-49	-7	+32	+49	-44	-32	+52	+44	-52
D		-7		-56	+56	+20	-20	-47	+47	+42	-42	-48	+48
C.O		+35		+4	-13	-35	+30	+13	-27	-30	+30	+27	-30
D		-35		-9	+9	+33	-33	-20	+20	+30	-30	-29	+29
C.O		+6		+22	-21	-6	+13	+21	-19	-13	+18	+19	-18
D		-6		-22	+22	+10	-10	-20	+20	+16	-16	-19	+19
C.O		+14		+4	-6	-14	+13	+6	-10	-13	+12	+10	-12
D		-14		-5	+5	+14	-14	-8	+8	+13	-13	-11	+11

-3353 #'

For span M for span FG

$$M = \frac{1}{8}(320 + 137) \times 6.82^2 - \frac{1}{4} \times 2220 \times 6.82$$

$$= 6562\ \#'/ft.$$

∴ Local sagging $M = 6562 - 3353 = 3209\ \#'/ft.$

∴ Max sagging $M = 4932 \times 0.95 + 3209$
$= 7594\ \#'/ft.$
$= 94,728\ \#''/ft.$ (1966 → 78,500 #"/ft)

Hogging Moment.

$$M_g = 0.1292 \times 40.45 \left(\frac{4 \times 370}{3.14} + \frac{2700}{29.25} \right)$$

$$= 5.23(500)$$

$$= 2615\ \#'/ft.$$ due to Morice Analysis (1966 ⇒ 1,950 #'/ft)

Local bending

By Morice analysis & Local bending.

Cantilever Mag. at A' & L'

$$M = 716 \times 2.42 = 1720\ \#'$$

Span EC, = JJ

$$M_L = 0.095(320 + 137) \times 6.33^2 \div 12.$$

$$= 1740\ \#' \pm 12\ \#'$$

$$= 1753\ \#'/ft.$$

Span CD, DE, HI & JK

$$M_L = 4313\ \#'/ft.$$

Span HB, EF, IG, GH, & KL

$$M_L = 521 + 13$$

$$= 534\ \#'/ft$$

	A	B	C	D	E	F	G	H	I	J	K	L
EM.	-1720	-534	-534	-1753	-1753	-4313	-4313	-4313	-4313	-534	-534	-534	-534	-534	-4313	-4313	-1753	-1753	-4313	-4313	-534	-534	7720
D		0.	-610	+610	-1280	+1280	0	0	+1890	-1890	0	0	0	0	-1890	+1890	+1280	-1280	+1280	+1890	-1890	0	
C.		+386	0	+810	-386	0	-810	-1196	0	0	+1196	0	0	+1196	0	-810	-1196	+810	+810	-1196	-810	0	+1196	
D		0	+405	-405	+193	-193	-193	+193	0	0	598	-598	-598	598	-405	+405	+1003	-1003	-1003	+1003	+405	-405	0	
0		256	0	-122	+256	+122	+122	0	-122	+378	0	-378	-378	+256	+378	-635	-256	+635	+635	-256	-635	0	+256	
P		0.	-61	+61	-67	+67	-61	+61	+250	-250	-189	+189	+317	-317	-507	+507	+446	-446	-446	+446	+318	-318	0	
0		+39	0	+42	-39	+39	-42	-158	-39	+120	+158	-201	-170	+321	+201	-282	-321	+282	+282	-201	-282	0	+201	
?		0	+21	-21	+139	-39	-58	+58	+41	-41	-180	+180	+221	-221	-242	+242	+302	-302	-242	+242	+141	-141	0	
0		-13	0	-25	+13	+37	+25	-26	-37	+114	+26	-140	-114	+153	+140	-191	-153	+153	+191	-89	-153	0	+153	
'		0	-13	+13	+12	-12	-26	+26	+76	-76	-83	+83	+134	-134	-166	+166	+153	-153	-140	+140	+77	-77	0	
'		+8	0	-8	-8	+16	+8	-48	-16	+53	+48	-85	-53	+105	+85	-97	-105	+89	+97	-49	-89	0.	+49	
		0	-4	+4	+12	-12	-28	+28	+35	-35	-67	+67	+79	-79	-91	+91	+97	-97	-73	+73	+45	-45	0	
					-3008	-3008	-5376	-5375	-2735	-2161														
					-3008#'		-5376#'		-2198#'															

Revised

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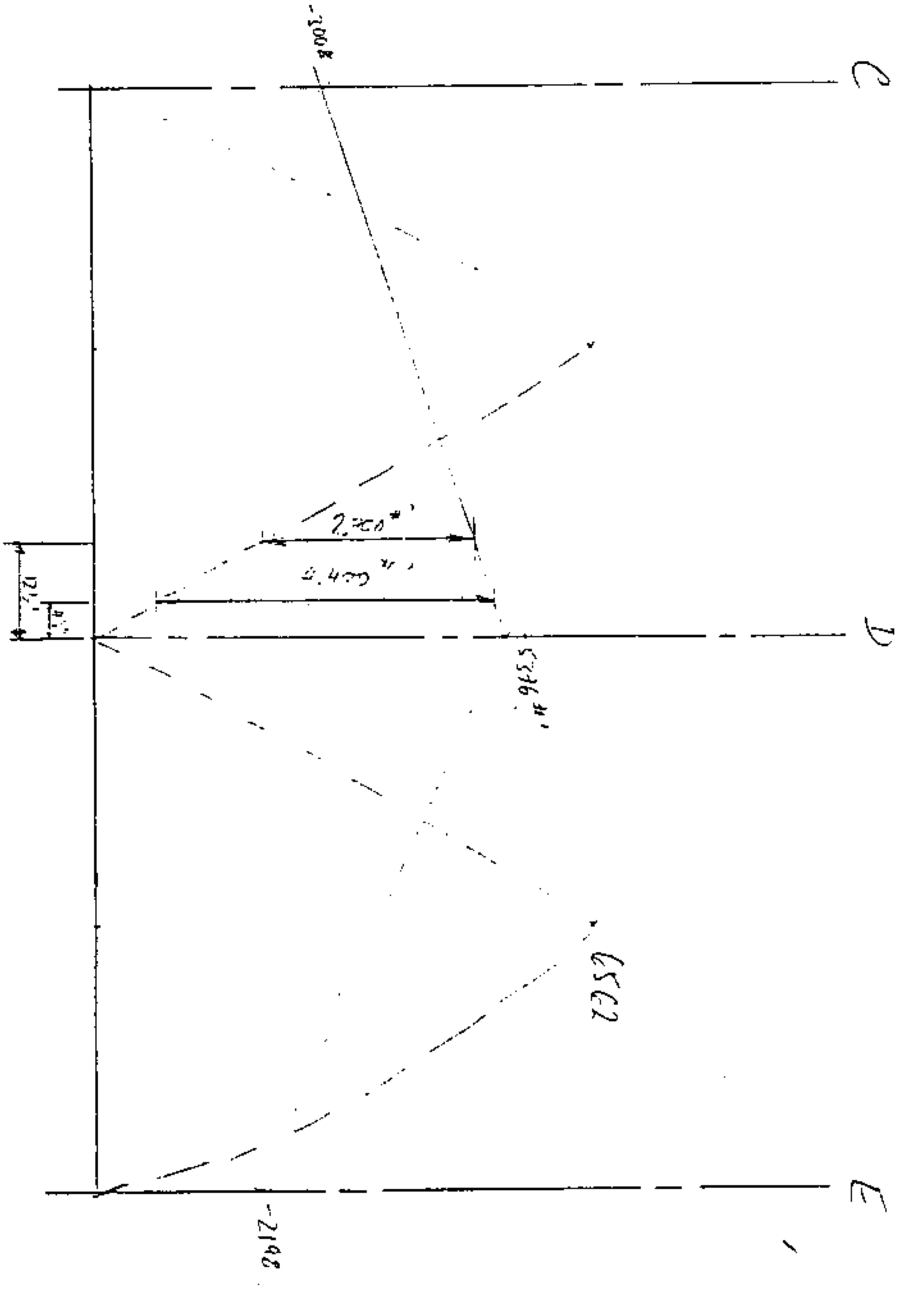
PROJECT No. 45.7
DATE 5/98
BY Grace
SHEET
CHKD



LOCAL BENDING MOMENT DIAGRAM
C-D-E

Max hogging moment at 4½" from ℄ of Beam
= 4,400 + 2615 = 7015 #"/ft = 84,180 #"/ft

Max hogging moment at 12½" from ℄ of Beam.
= 2,700 + 7615 = 5315 #"/ft = 63,780 #"/ft.

∴ Design M = 84,180 #"/ft (1966 → 70,400 #"/ft) h = 14½'
= 63,780 #"/ft (1966 → 49700 #"/ft) h = 7"

$Q = \frac{63780}{12 \times 5.25^2} = 193$ (1966 Q=1

try ½ HT. @ 6"℄

$f_s = \frac{63780}{0.392 \times 0.85 \times 5.25} = 36,368$ psi

$T = \frac{12/6 \times 5.75 \times 30 \times 10^6 \sqrt{6.5}}{12 \times 7^3/12 / 3.5 \times 36,368} = \frac{224 \times 10^6}{3.56 \times 10^6} = 63 \not> 70$

(1966 50.3)

∴ unacceptable

Check at 4½" from ℄ of Beam.

$f_s = \frac{24,180}{0.393 \times 0.85 \times 12.75} = 19,765$ psi $\not<$ 18,500 psi

(1966 16,600 psi)

∴ unacceptable

APPENDIX E1

Flow Charts for Simplified Assessment Procedures for Providing Noise Mitigation Measures on Existing Flyovers

Simplified Assessment Procedures for Providing Noise Mitigation Measures on Existing Flyovers

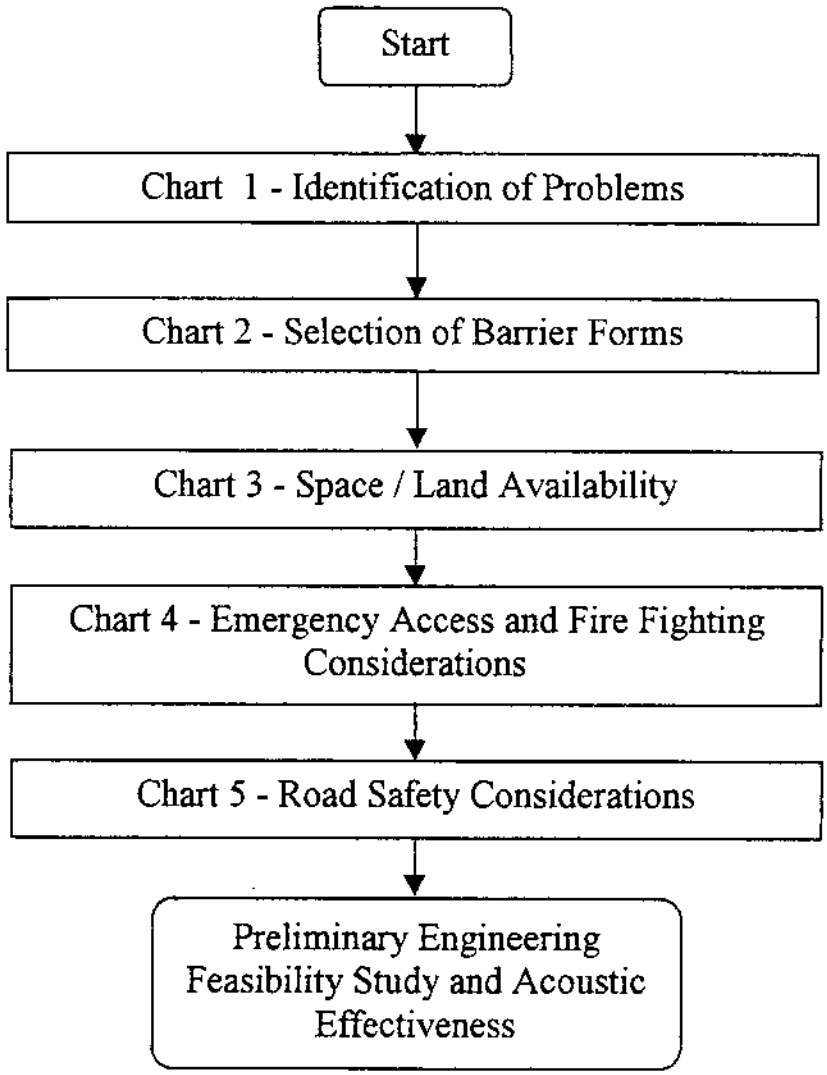
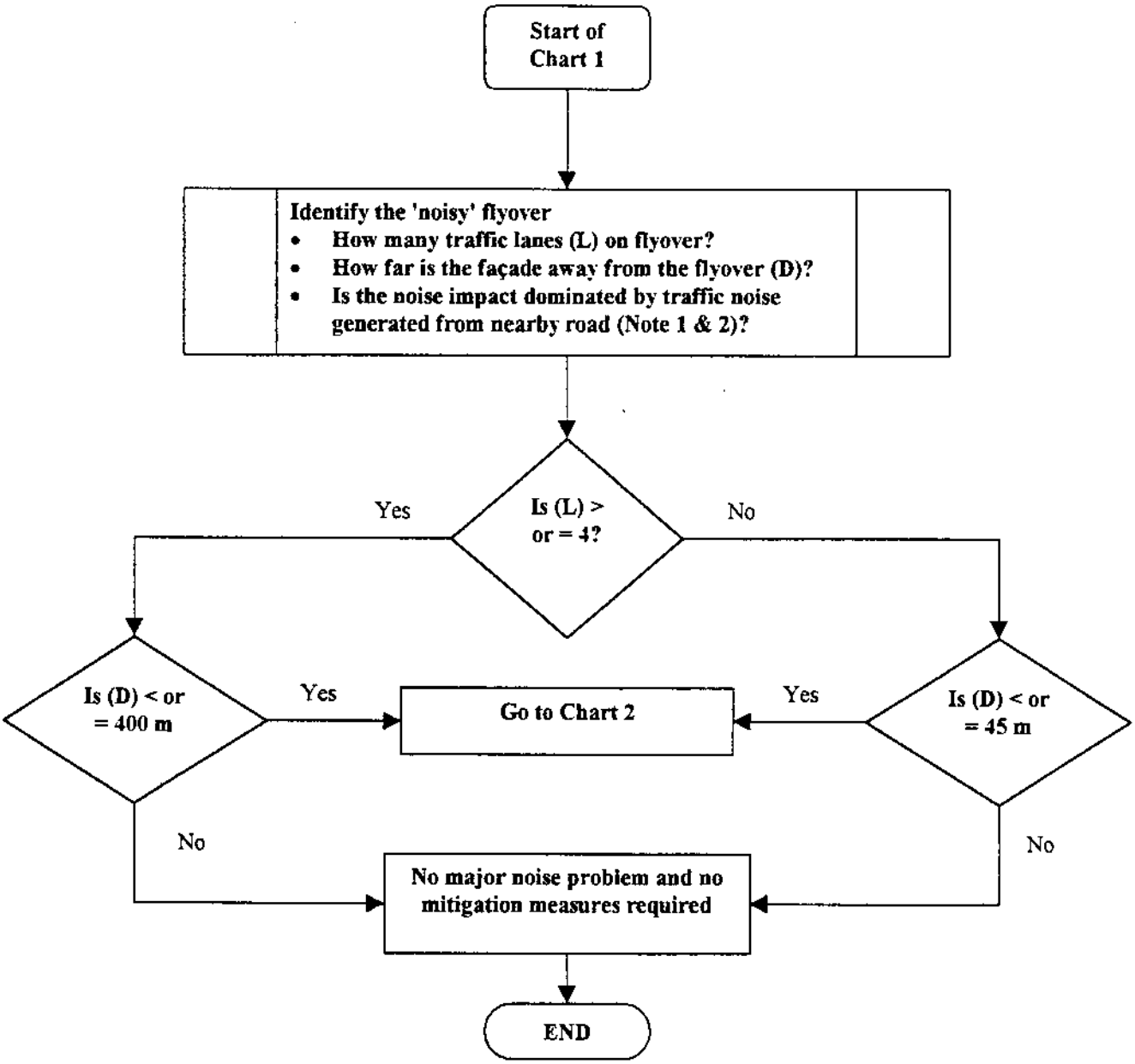


Chart 1 - Identification of Problems



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

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

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

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

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

Chart 2 - Selection of Barrier Forms

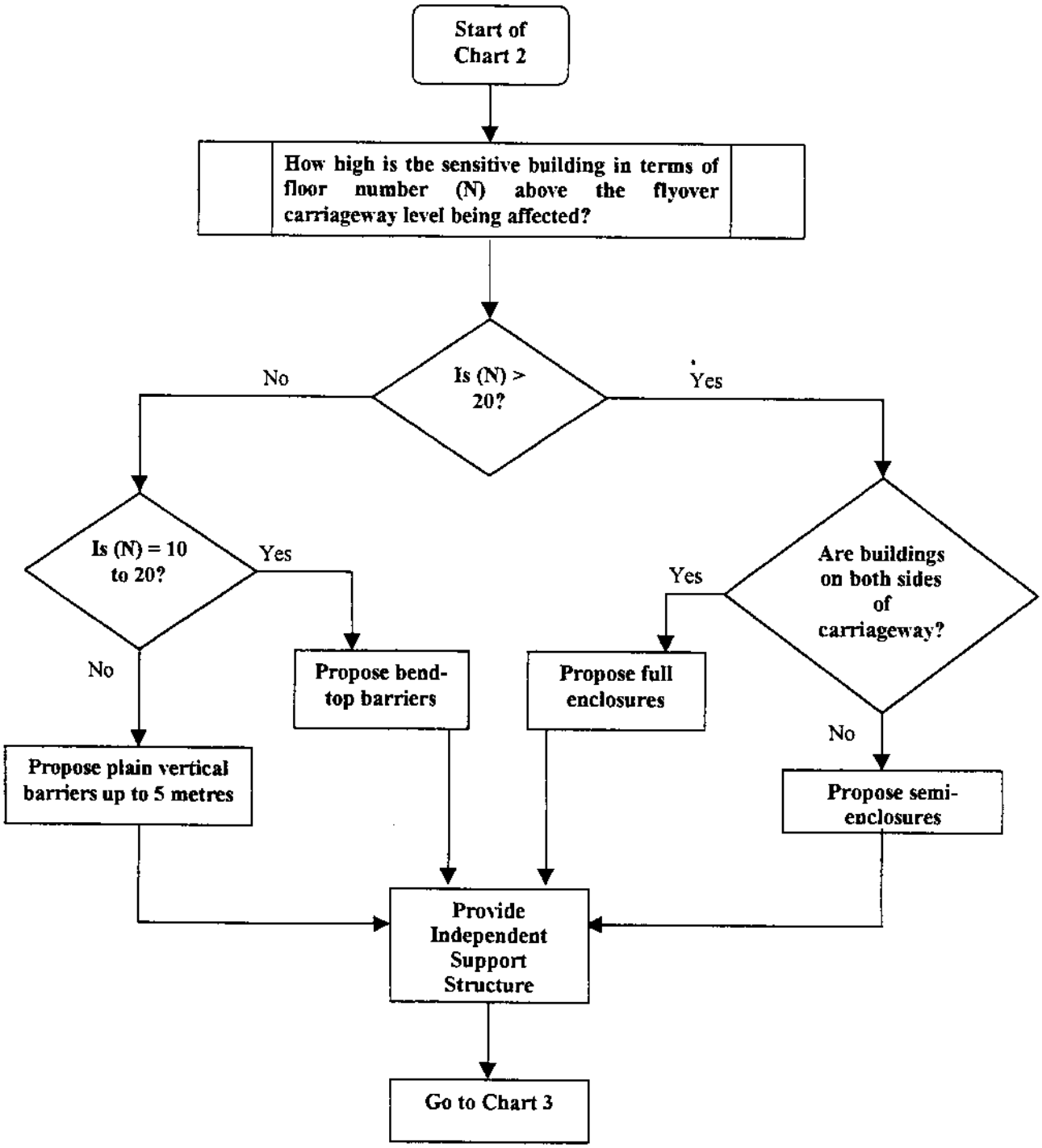
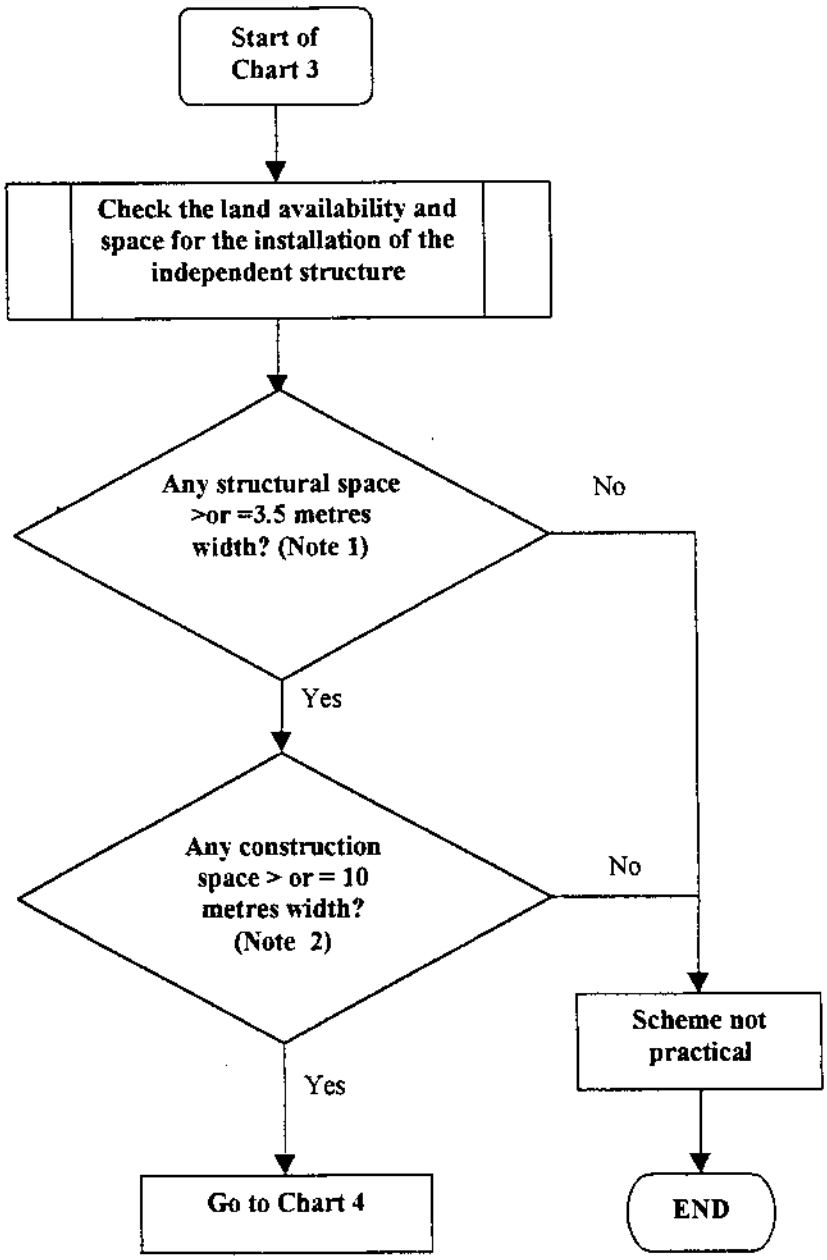


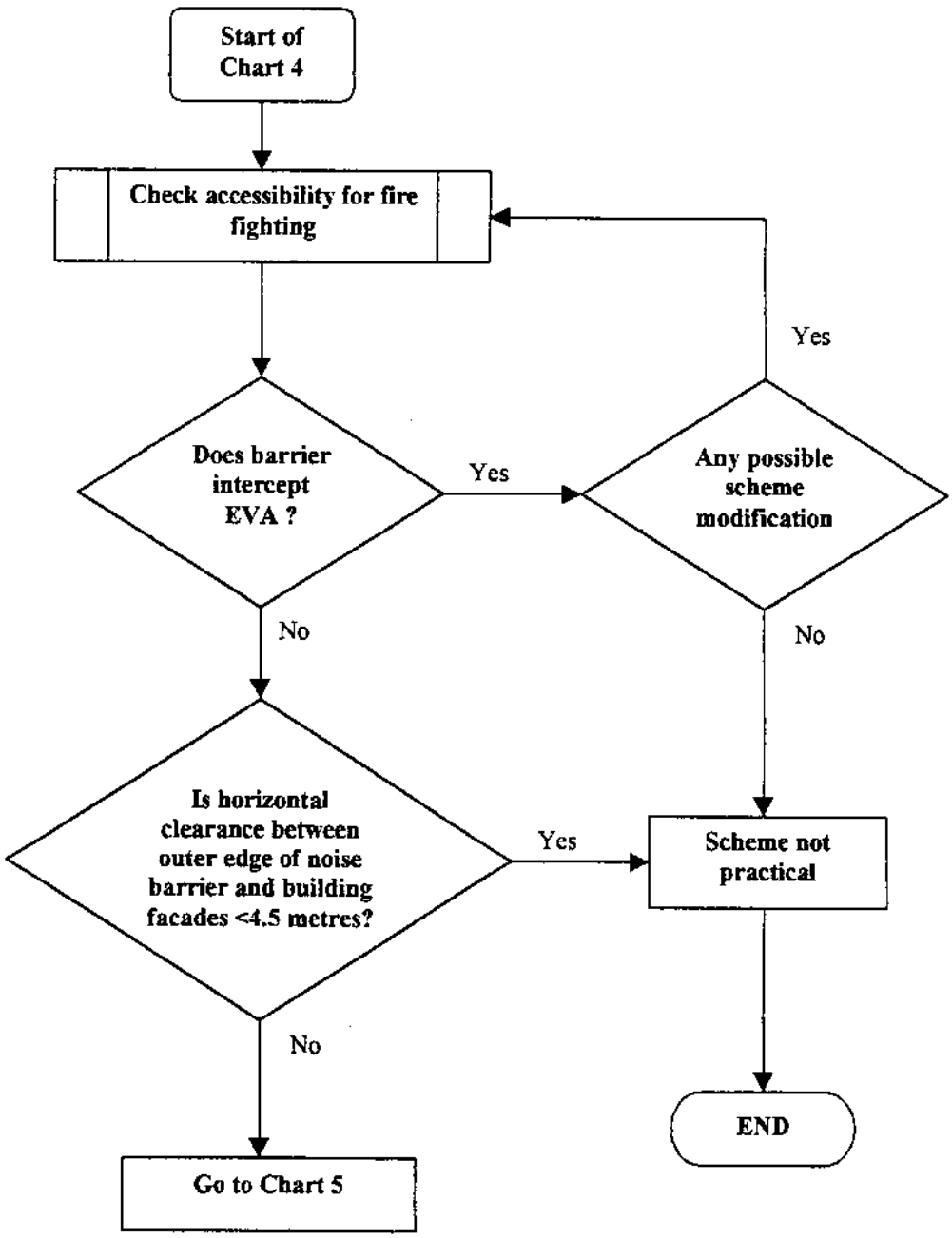
Chart 3 - Space/Land Availability



Note 1 : Adequate structural space shall be provided for the installation of independent structure. In general, at least 3.5 m width strip of land wil be required for locating the foundation of independent structure with reasonable maintenance clearance.

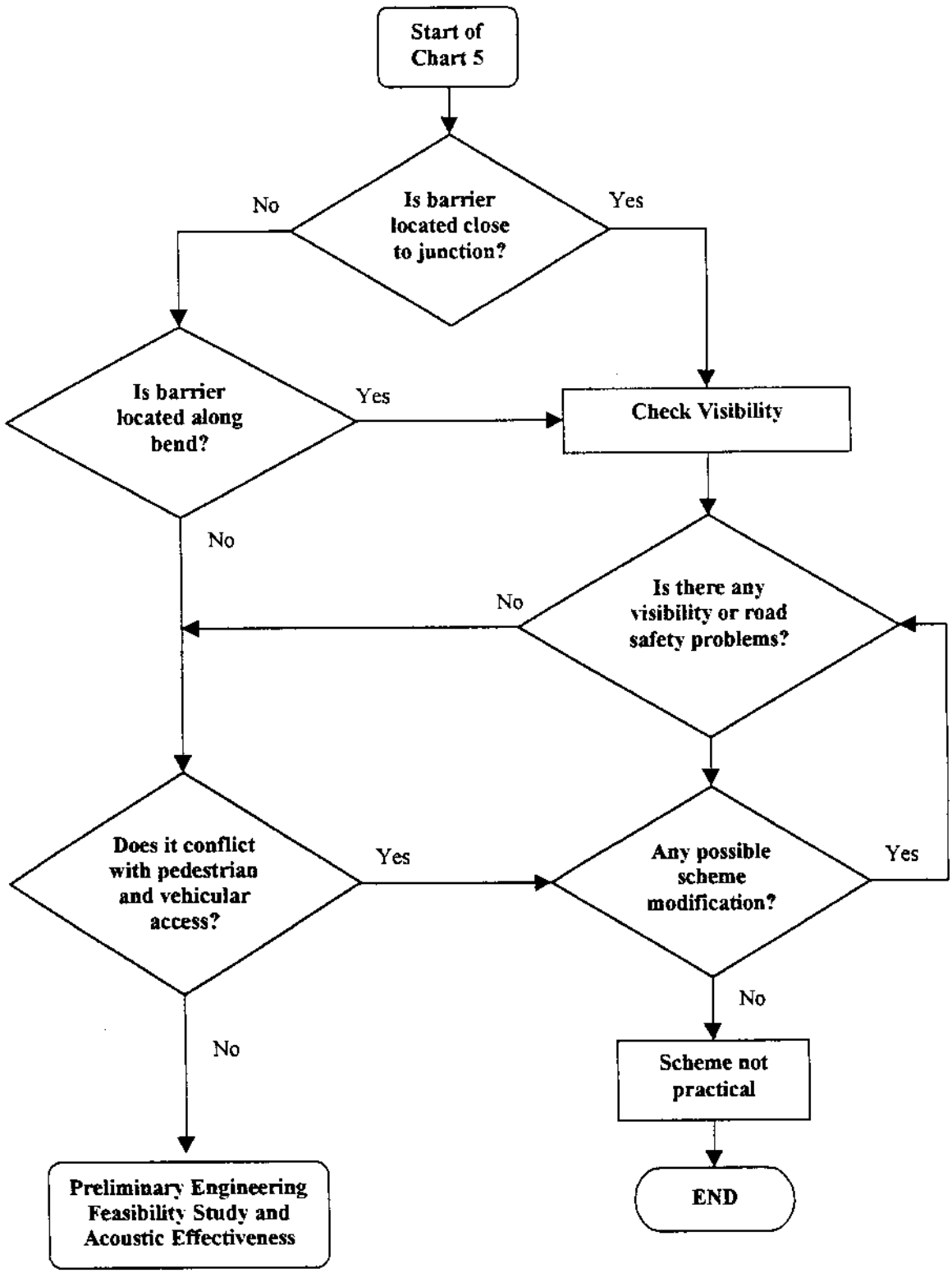
Note 2 : Adequate construction space shall be provided for the foundation works of the independent structure. At least 10 m width strip of land will be required for the operation of piling plants and excavation.

Chart 4 - Emergency Access and Fire Fighting Considerations



Note : EVA - Emergency Vehicular Access for fire fighting.

Chart 5 - Road Safety Considerations



Preliminary Engineering Feasibility Study and Acoustic Effectiveness

	Recommend for preliminary engineering feasibility study **Items include** ❑ **Traffic engineering and road safety appraisal** ❑ **Interfacing with utilities** ❑ **Structural engineering appraisal** ❑ **Landscaping appraisal** ❑ **Air quality assessment** ❑ **Side Effects** ❑ **Costing** ❑ **Implementation strategy** **Conduct Noise Assessment and Evaluate the Level of Protection to the NSRs**	

Annex 1 **Derivation of Chart I**

(a) Two-lane Single Carriageway

Assume:

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

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

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

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

Therefore, the distance required = 45m

(b) Four-lane Dual Carriageway

Assume:

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

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

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

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

Therefore, the distance required = 400m

Annex II Derivation of Chart 2

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

Note:

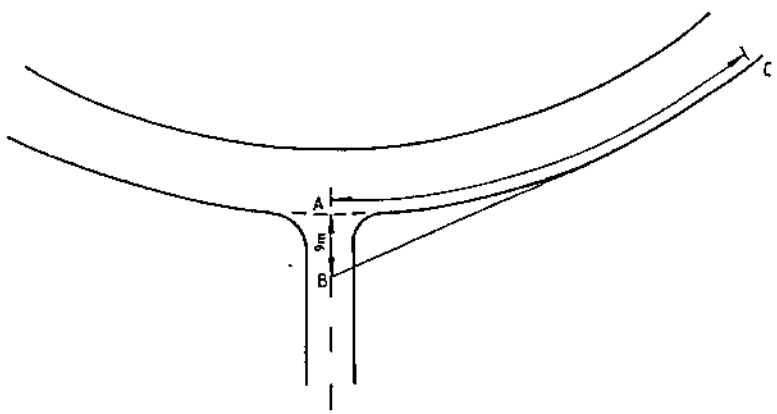
1. Assume barrier is erected at 18m from the affected facades and 3m from the road kerb.
2. The height is measured from ground to the highest point of barrier.
3. Indicate the number of floors within the shadow zone of the barrier. Assume 2.8m per floor and ground floor is non-residential.

Visibility Splays at Priority Junctions

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

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

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



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

VISIBILITY SPLAYS AT PRIORTY JUNCTIONS

Visibility Area at Run-ins

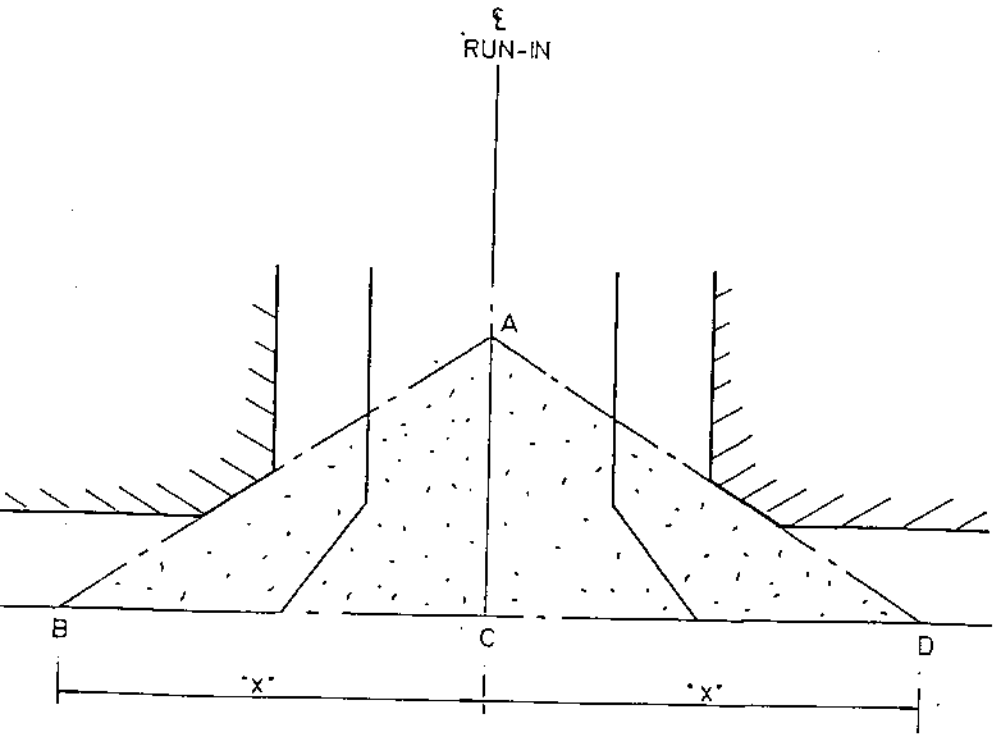
(a) Visibility from a run-in should be obtainable between points 1.05m above the road and run-in level over the area described by ABCD in Diagrams 3.6.3.4 of T.P.D.M.V. 2.3

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

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

Length of Visibility Line "x"

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



VISIBILITY AREA AT RUN-INS

DIAGRAM 3.6.3.4

Grade Separated Interchange

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

Visibility Distances at Grade Separated Interchanges

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

Siting of Signal Equipments

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

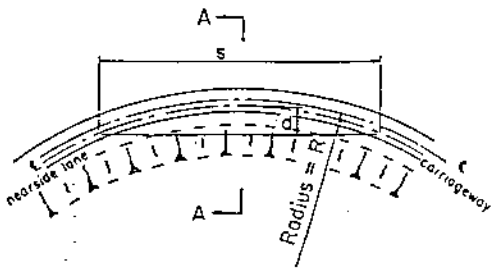
85 percentile approach speed	Visibility distance
50 km/h	70m
60km/h	95m
70 km/h	125m
85 km/h	165m
100 km/h	225m

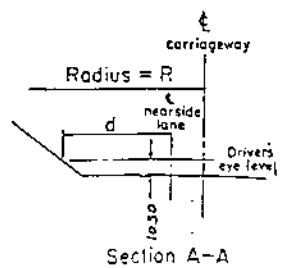
Sight Distance

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

Sight Distance

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





Visibility at Roundabout

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

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

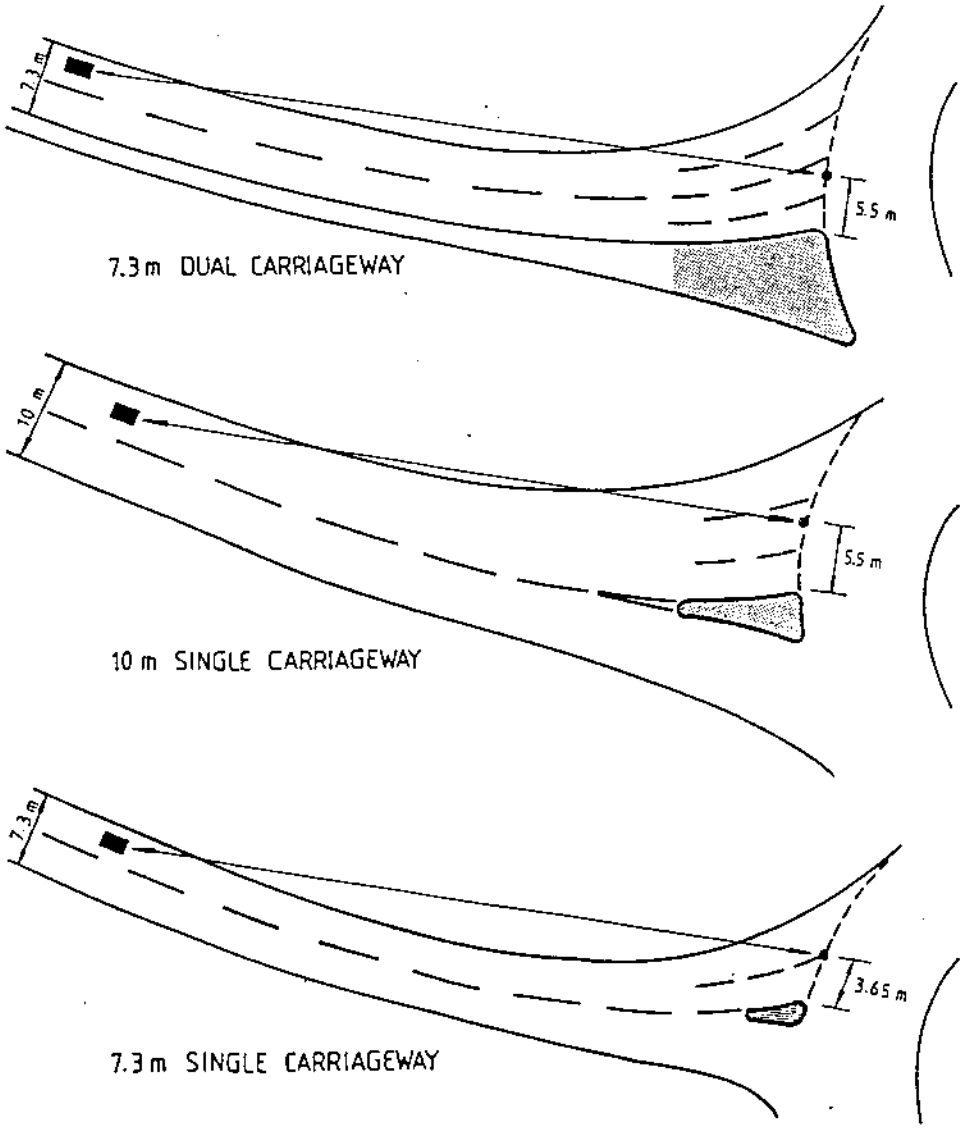
Sight Distance

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

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

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

DESIRABLE / MINIMUM VISIBILITY DISTANCE
FOR APPROACH ROAD DESIGN SPEED



MEASUREMENT OF APPROACH VISIBILITY

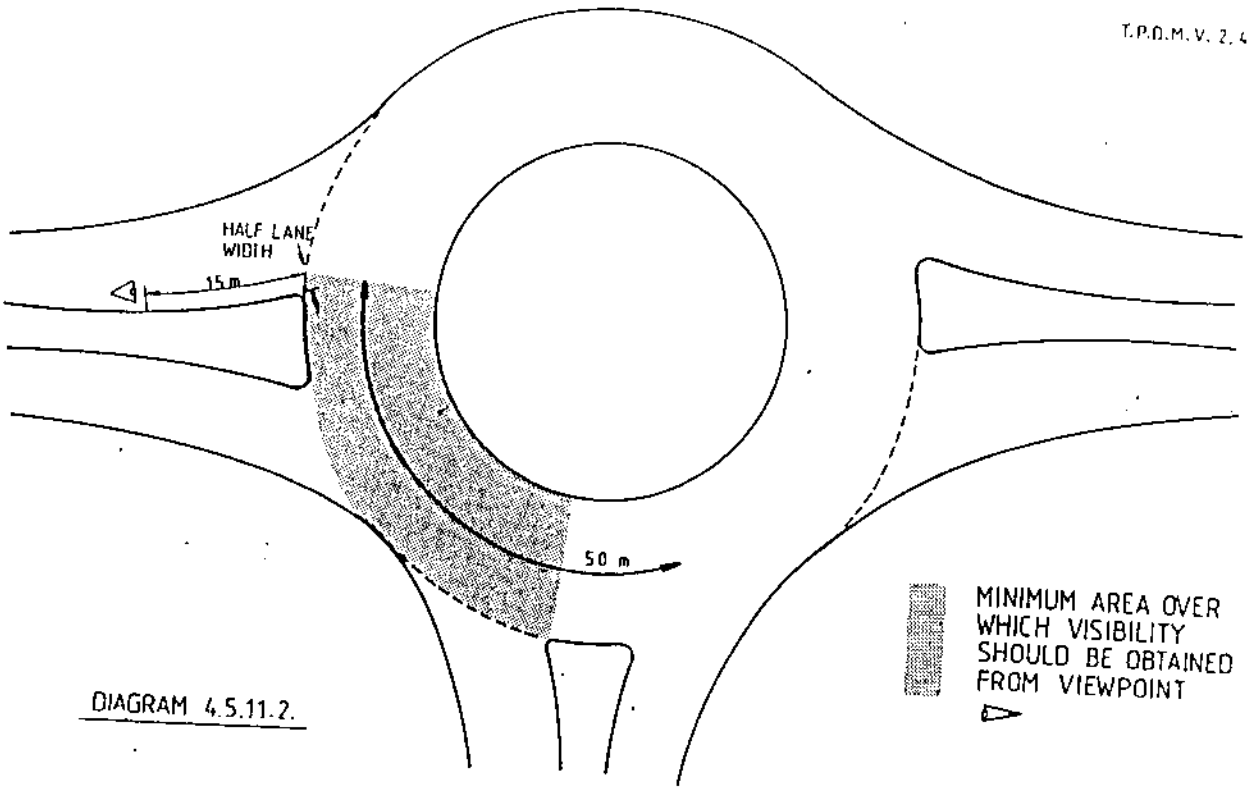


DIAGRAM 4.5.11.2.

VISIBILITY TO THE RIGHT REQUIRED AT ENTRY

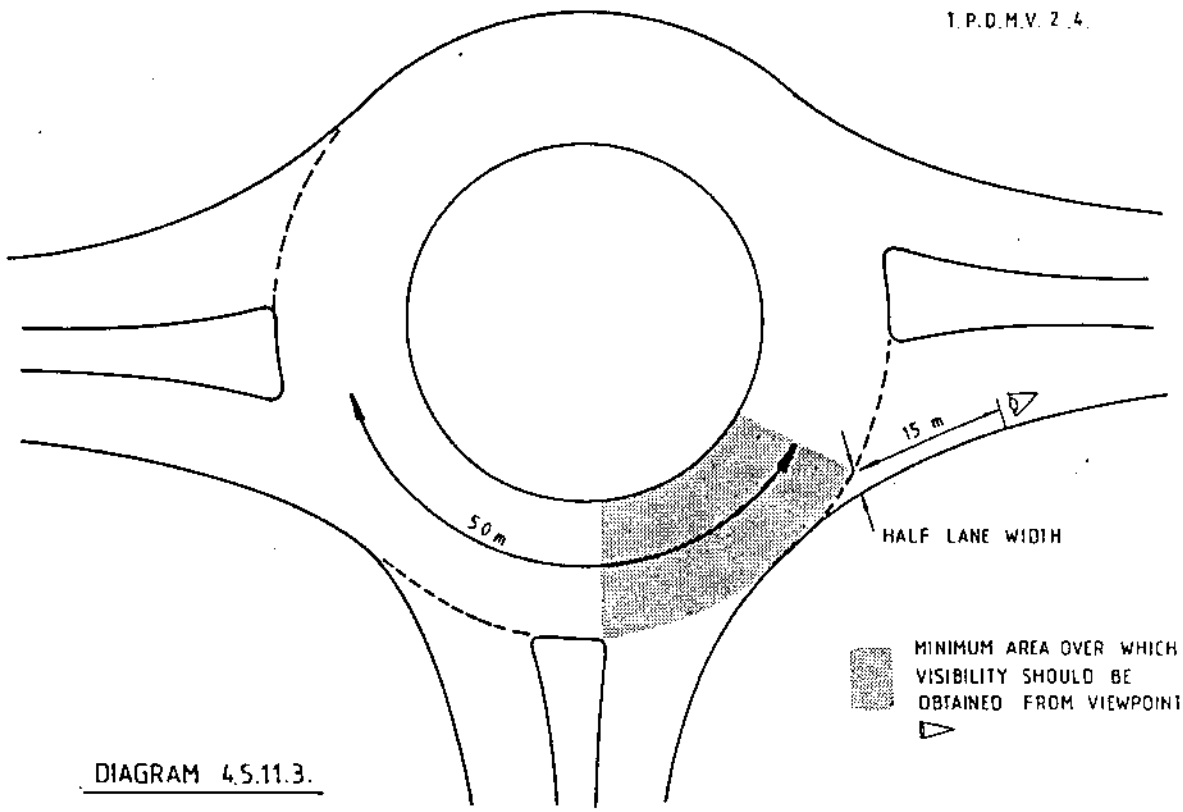


DIAGRAM 4.5.11.3.

FORWARD VISIBILITY REQUIRED AT ENTRY

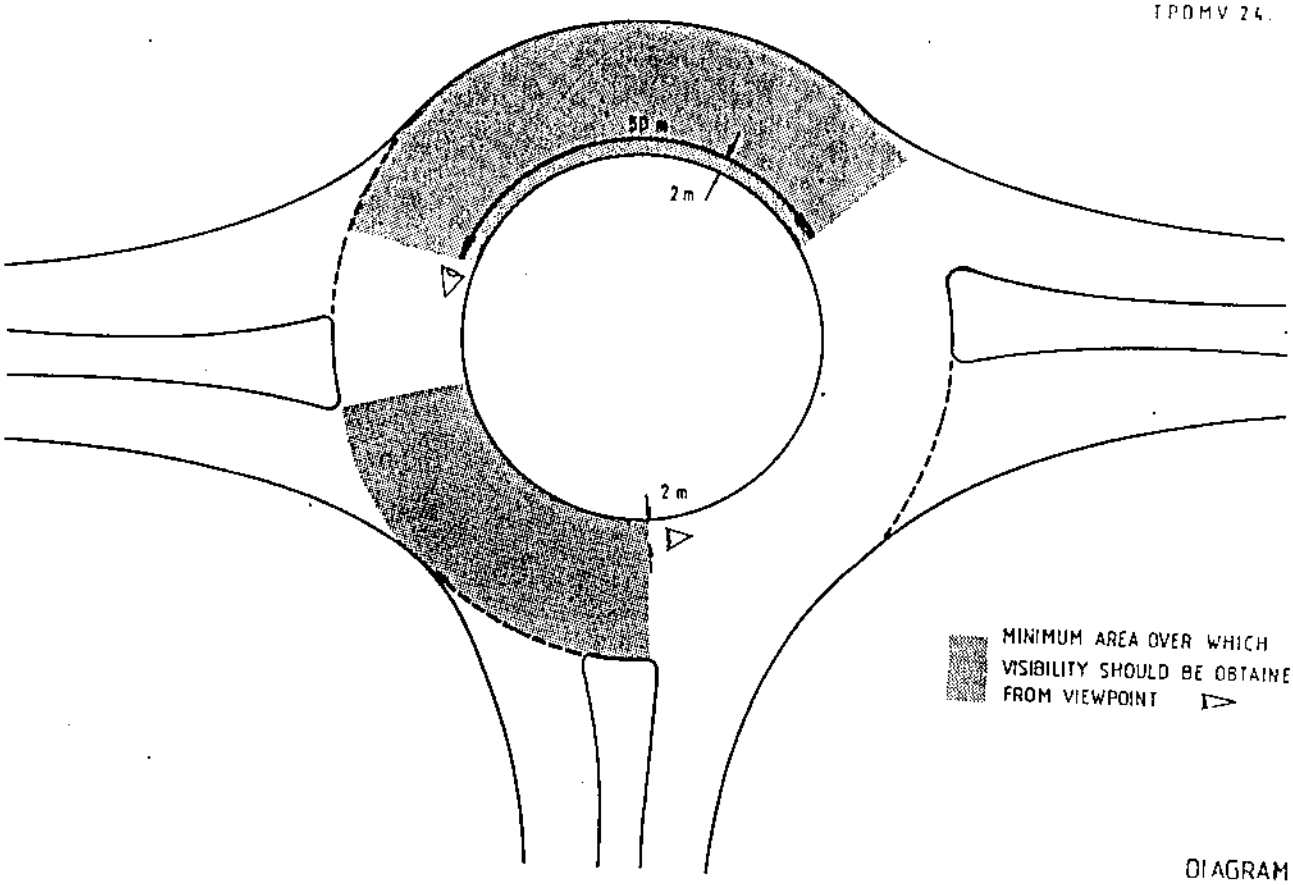
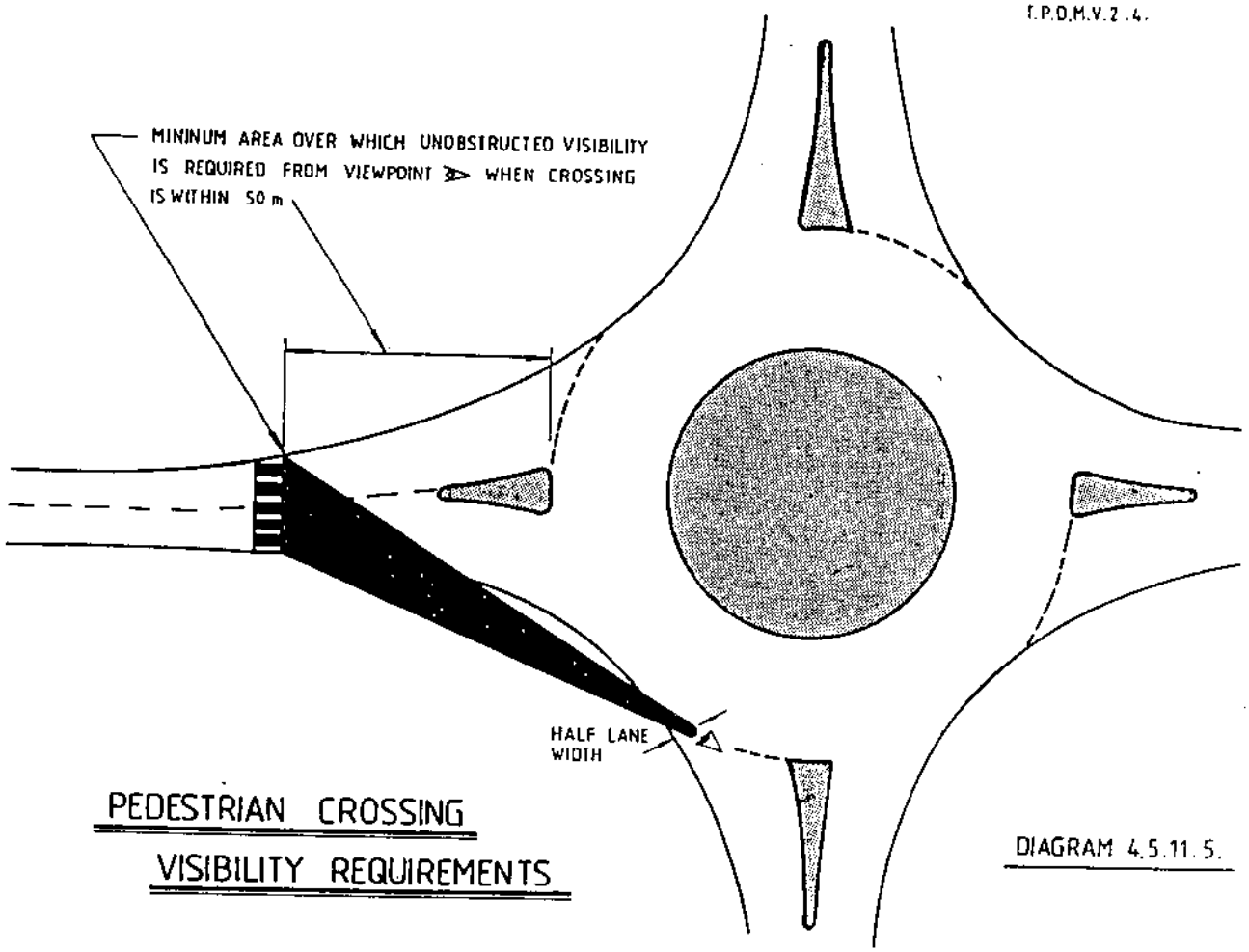


DIAGRAM 4.5

CIRCULATORY VISIBILITY REQUIRED



PEDESTRIAN CROSSING VISIBILITY REQUIREMENTS

DIAGRAM 4.5.11.5.

APPENDIX E2

Application of Simplified Assessment Flow Charts

Appendix E2:

1. Application of the proposed Working Tools for Ap Lei Chau Bridge

Chart 1: Identification of Problems

Start of Chart 1 → traffic lanes on flyover (L) = 4 → distance between building facade and flyover edge barrier (D) < 400m → noise impact is not dominated by traffic noise generated from nearby road → Go to Chart 2

Chart 2: Selection of Barrier Form

Start of Chart 2 → floor numbers about flyover carriageway level (N) = 10 to 20 → bend-top barrier → Go to Chart 3

Chart 3: Space /Land Availability

Start of Chart 3 → open area for structural space > 3.5m width is available → open area for construction space > 10m width is available → Go to Chart 4

Chart 4: Emergency Access and Fire Fighting Considerations

Start of Chart 4 → barrier does not intercept EVA → horizontal clearance between other edge of noise barrier and building facades > 4.5m is available → Go to Chart 5

Chart 5: Road Safety Consideration

Start of Chart 5 → barrier is not located close to junction → barrier is not located along bend → no conflict with pedestrian and vehicular access → Recommend for preliminary engineering feasibility study and acoustic effectiveness evaluation

2(A). Application of the proposed Working Tools for Tsing Tsuen Bridge - Tsing Yi Approach

Chart 1: Identification of Problems

Start of Chart 1 → traffic lanes on flyover (L) = 4 → distance between building facade and the flyover edge barrier (D) < 400m → noise impact is not dominated by traffic noise generated from nearby road → Go to Chart 2

Chart 2: Selection of Barrier Form

Start of Chart 2 → floor numbers above flyover carriageway level (N) > 20 → sensitive buildings on one side of the carriageway → propose semi-enclosure alongside eastbound carriageway → Go to Chart 3

Chart 3: Space/Land Availability

Start of Chart 3 → open area for structural space > 3.5m width is available only within Cheung On Estate subject to further consultation (note: there are space constraints to the east of Cheung On Estate due to the existing access road underneath the flyover) → open area for construction space > 10m width is available → Go to Chart 4

Chart 4: Emergency Access and Fire Fighting Considerations

Start of Chart 4 → barrier does not intercept EVA fronting Cheung On Estate (note: any barriers located to the east of Cheung On Estate would be in conflict with the EVA underneath the flyover, which is under MTRC's jurisdiction) → horizontal clearance between other edge of noise barrier and building facades > 4.5m is available → Go to Chart 5

Chart 5: Road Safety Consideration

Start of Chart 5 → barrier is not located close to junction → barrier is not located along bend → no conflict with pedestrian and vehicular access → Recommend for preliminary engineering feasibility study and acoustic effectiveness evaluation

2(B) Application of the proposed Working Tools for Tsing Tsuen Road - Tsuen Wan Approach

Chart 1: Identification of Problems

Start of Chart 1 → traffic lanes on flyover (L) = 4 → distance between building facade and the flyover edge barrier (D) < 400m → noise impact is not dominated by traffic noise from nearby road → Go to Chart 2

Chart 2: Selection of Barrier Form

Start of Chart 2 → floor numbers above flyover carriageway level (N) > 20 → buildings on one side of the carriageway → propose semi-enclosure alongside eastbound carriageway → Go to Chart 3

Chart 3: Space/Land Availability

Start of Chart 3 → open area for structural space > 3.5m width is available → open area for construction space > 10m width is available → Go to Chart 4

Chart 4: Emergency Access and Fire Fighting Considerations

Start of Chart 4 → barrier does not intercept EVA fronting Riviera Gardens → horizontal clearance between other edge of noise barrier and building facades > 4.5m is available → Go to Chart 5

Chart 5: Road Safety Consideration

Start of Chart 5→ barrier is not located close to junction → barrier is not located along bend → no conflict with pedestrian and vehicular access → Recommend for preliminary engineering feasibility study and acoustic effectiveness evaluation

3. Application of the proposed Working Tools for Kwai Chung Road Flyover

Chart 1: Identification of Problems

Start of Chart 1 → traffic lanes on flyover (L) = 4 → distance between building facade and the flyover edge barrier (D) < 400m → noise impact is not dominated by traffic noise from nearby road → Go to Chart 2

Chart 2: Selection of Barrier Form

Start of Chart 2 → floor numbers above flyover carriageway level (N) = 10 to 20 → buildings on both side of the carriageway → propose noise full enclosure → Go to Chart 3

Chart 3: Space/Land Availability

Start of Chart 3 → open area for structural space > 3.5m width is not available → open area for construction space > 10m width is not available → Scheme not practical

APPENDIX F

Responses to Comments on Final Report (Issue 1, Mar 1999)

Appendix F
Agreement No. CE 95/97
Feasibility Study for Providing Noise Mitigation Measures on Existing Flyovers
Responses to Comments on Final Report
Index

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Feasibility Study for Providing Noise Mitigation Measures on Existing Flyovers
Responses to Comments on Final Report

	Comments	Responses
(1)	**D of Plan/Urban Design Unit** **Letter ref. ( ) in UD/S/ENV/14(II) dated 10.4.99** I refer to your ref. letter AC:pct:93598/01-0105 dated 18.3.1999 in relation to the captioned report and have no particular comments from an urban design point of view.	Noted.
(2)	**D of RS/Planning** **Letter ref. (2) in RSD 2/HQ 715/97 VI dated 8.4.99** I refer to your letter dated 18.3.99 and have no comment on the above Final Report.	Noted.
(3)	**AC for T, TE(NTW)** **Letter ref. NR 181/161-1 dated 7.4.99** I refer to your above letter dated 18/3/1999 with the captioned final report. Please be informed that I have no further comment on the final report in respect of the proposed noise mitigation measures on Tsing Tsuen Bridge.	Noted.
(4)	**AC for T, ATCD/HK** **Letter ref. (10) in ATCH 171/200-53 dated 30.3.99** I refer to your above quoted report regarding the captioned matter. Please be informed that we have no comment on your report form the ATC point of view.	Noted.
(5)	**EPD** **Letter ref. EP 42/T6/1 A1 VII dated 1.4.99** I refer to the captioned report submitted to us on 18.3.99. Our comments on the report are contained in Annex A for your immediate action. Please note that comments indicated in my letter ref. EP 42/T6/1 A1 VII of 18.3.99 are also relevant. As a related issue, please check and chase those parties who do not offer their comments yet. This serves as a coordinated reply from our department.	Noted. Noted.

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(2)	**D of RS/Planning** **Letter ref. (2) in RSD 2/HQ 715/97 VI dated 8.4.99** I refer to your letter dated 18.3.99 and have no comment on the above Final Report.	Noted.
(3)	**AC for T, TE(NTW)** **Letter ref. NR 181/161-1 dated 7.4.99** I refer to your above letter dated 18/3/1999 with the captioned final report. Please be informed that I have no further comment on the final report in respect of the proposed noise mitigation measures on Tsing Tsuen Bridge.	Noted.
(4)	**AC for T, ATCD/HK** **Letter ref. (10) in ATCH 171/200-53 dated 30.3.99** I refer to your above quoted report regarding the captioned matter. Please be informed that we have no comment on your report form the ATC point of view.	Noted.
(5)	**EPD** **Letter ref. EP 42/T6/1 A1 VII dated 1.4.99** I refer to the captioned report submitted to us on 18.3.99. Our comments on the report are contained in Annex A for your immediate action. Please note that comments indicated in my letter ref. EP 42/T6/1 A1 VII of 18.3.99 are also relevant. As a related issue, please check and chase those parties who do not offer their comments yet. This serves as a coordinated reply from our department.	Noted. Noted.

Appendix F
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Comments	Responses
Annex A - Comments on Final Report	
General Comments	
1. Prior comments contained in my letter ref. EP 42/T6/1 A1 VII of 18.3.99 are relevant.	Noted.
Specific Comments	
2. S.5.4.6 : Please elaborate the constraints involved with respect to e.g. space requirements, construction traffic impact, etc.	Noted and included.
3. S.5.9.1.4 & S.5.9.2.4 : As advised by HyD, the unit rate for the maintenance cost of noise enclosure is based on the "plan area" but not "plane area". Please check and confirm if the appropriate areas have been adopted for estimating the maintenance costs.	Noted. The area used for estimating the maintenance costs were amended.
4. S.7.7.3 : The meaning of the last sentence is not clear. Clarification and elaboration are required.	Noted. The last two sentences were deleted.
5. S.10.4.4 : To avoid confusion, replace "As commented by FSD in their letter ..... on the Scoping Study" with "As advised by FSD in their letter ref. (13) in FSD/PG4/130/94 III of 19.2.99".	Noted and amended.
6. Appendix E2 : The sample application of the Working Tools shall be amended to suit Comments (1) above. On Tsing Tsuen Bridge - Tsing Yi approach, you should have identified using Charts 4 & 5 that there are space and emergency access constraints for the area to the east of Cheung On Estate.	Noted and amended.
Comments on Air Quality Impact Assessment	
7. You should provide detailed calculations in : i. arriving at emissions at tunnel portals. ii. converting the portal emissions into line source emissions in the Caline4 model.	Please refer to Annex I for the detailed calculations.
8. Further to your responses to our previous comments, you should address the following further comments :	

Appendix F
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Responses to Comments on Final Report

Comments	Responses
i. Item (a) - The effect of cantilevered barriers will shift the traffic emission both horizontal and vertically closer to the receptor HA which is contrary to your assumption. Hence, the concentration level at HA in the mitigated scenario would not be lower than that of the unmitigated scenario.	Please refer to Annex I for our responses.
ii. Item (c) - It is unreasonable to assume the height of the receptor HA to be 16 metres below the emission sources in the mitigated scenario as the receptor HA is physically higher than the road surfaces (which are the sources). Please use a physically realistic simulation or a conservative approach.	Please refer to Annex I for our responses.
iii. Item (i) - It is still not clear from your response whether the pollutants' concentrations were determined at the worst hit levels of the selected ASRs. Please indicate in the report at what level (i.e, ground level, mid level or flag pole level) of the selected ASRs that the pollutants' concentrations were determined. In any case, the pollutants' concentrations at the worst hit levels of the selected ASRs should be determined.	As shown in the previous modelling exercise, the worst-hit level is shown to be the lowest level. Therefore, the pollutant concentrations at the worst-hit levels have been determined as summarized in this study.
iv. Item (k) - We noted that the study is to retroactively implement noise mitigation measures on existing flyovers. However, to determine the air quality impact of the noise mitigation measures, we iterate that the combined effect of traffic volume and emission factors should be considered such that the year selected for assessment represents the worst scenario.	By comparing the emission factors from *the Fleet Average Emission Factors – EURO2 Model* provided by EPD from the years 1998 to 2011, the trend for the vehicular emission factors gradually decrease with time. Thus, the year 1998 vehicular emission factors selected for assessment represent the worst-case scenario.
v. Item (m) - For clarity, please indicate in the report that background levels were included for the predicted pollutants' concentrations.	Footnotes have been added to indicate that background concentrations are included in the predicted pollutants' concentrations.

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Comments	Responses
Other typos, omissions & errors 9. The following typos, omissions and/or errors are observed :	
(a) S.2.1.7.1 & S.2.1.7.2 : While you have noted my earlier comments on the DFR, you however have not placed S.2.1.7.2 before S.2.1.7.1 for a more logical presentation.	Noted and amended.
(b) S.6.4 : My earlier comments on the DFR regarding the elaboration of the constraints associated with the use of external support to strengthen the flyover are not incorporated yet.	Noted and included.
(c) S.10.3.6 & Table 6 of Appendix A1 : My prior comments on the DFR are noted but however not incorporated into the text yet.	Noted and amended.
(d) Appendix A2, S.4 : "Figure 3" should read Figure 5".	Noted and amended.
EPD **Letter ref. EP 42/T6/1 A1 VII dated 18.3.99** I refer to the captioned report submitted to us for comments. A no. of salient items of the captioned report are observed and are indicated in Appendix A for your necessary reference. Notwithstanding the above and in view of the tight programme, please circulate the report to all concerned parties **immediately** and request them to return their comments **within 2 weeks.** Annex A - Preliminary Comments on Final Report (Advanced Copy)	
1. S.5.7 : It is agreed that the ACABAS submission on the generic design of the noise mitigation measures would be made separately. To avoid doubt, you are required to indicate in the report that measures to reduce visual/landscape impacts will be developed for the generic design of the noise mitigation measures and for submission to ACABAS for in-principle approval.	Noted. Relevant texts are amended.

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Feasibility Study for Providing Noise Mitigation Measures on Existing Flyovers
Responses to Comments on Final Report

Comments	Responses
2. S.7.4.1 & Chart 3 : As discussed during the progress meeting held on 27.1.99, you advised that no noise mitigation measures could be erected directly on the identified flyovers due to structural constraints. You further advised that, based on your experience on other flyover projects, it would be in general unlikely practicable to install noise mitigation measures to existing flyovers as additional loading of the measures are usually not allowed during flyover design. Considering the above, you recommended that the approach of using independent support structure shall be adopted in retrofitting existing flyovers. In this regard, you may like to review if Chart 3 is required as part of the Working Tool and amend relevant text including Appendix E2 accordingly. Also, you should clearly spell out the above in the engineering assessment, conclusions and/or recommendations sections.	Noted. Relevant texts are amended and Chart 3 is deleted. Appendix E1 & E2 are amended accordingly.
3. S.8 :	
(a) Whilst you have evaluated and identified particular ranking systems to prioritise the proposed noise mitigation schemes, the ranking results as well as the recommendation on the specific implementation priority are not clearly stated in the report. Please review and add the above to appropriate section (s).	Noted and included in S.8.4.
(b) You are required to review the implementation priority of the proposed mitigation schemes taking into account of e.g. % of protection. In this regard, you may like to make reference the CE 8/96 Study.	Noted and included in Table 8-4.

Appendix F
Agreement No. CE 95/97
Feasibility Study for Providing Noise Mitigation Measures on Existing Flyovers
Responses to Comments on Final Report

Comments	Responses
4. S.9.3.1.3 & Figure 9-1 :	
(a) According to the typical project programme given in Figure 9-1, the overall time required for implementing the noise mitigation measures including all administrative, design and construction activities is about 4 years. However, it is noted from the outlined implementation programme shown in S.9.3.1.3 that all the identified mitigation measures are to be completed within 3 years (with 1.5 years allowed for each flyover). Apparently there are contradictions among the 2 programmes and clarifications/ amendments are required.	Noted and amended.
(b) On the outlined implementation programme, it is not clear whether you propose to implement the identified noise mitigation measures in a single phase or in 3 separate phases. Clarification is required.	Noted and amended. The identified noise mitigation measures are proposed to be implemented in 3 separate phases.
(c) On the typical project programme, the programme shall be started on the "zero" date rather than after the 1st quarter.	Noted and Fig. 9-1 is amended.
5. S.10 : Whilst you have noted my prior comments on the conclusions and recommendations of the Study, it is however noted that you did not incorporate the necessary amendments into the report :	
(a) The feasibility/practicability and benefits of the implementation of the proposed noise mitigation measures (i.e. a summary statement of the overall results and your concrete recommendations is required). For instance, it is not clear what is your specific view/recommendation on the retrofitting measures for Tsing Yi approach section of Tsing Tsuen Road (e.g. feasible & practical, feasible but the low % protection does not warrant implementation, not feasible & not practical, etc.	Noted and included in S.10.5.2.

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Responses to Comments on Final Report

Comments	Responses
(b) The implementation strategy and any particulars need to be addressed/ considered (e.g. cost, programme, aesthetical effects, etc.), if the proposed mitigation measures are concluded feasible and practical (i.e. a summary statement of the overall results and your concrete recommendation is required).	Noted and included in S.10.5.3.
(c) Criteria for retroactive noise mitigation (i.e. the specific criteria identified in the Study e.g. obstruction to emergency access & fire fighting, road safety, availability of space, etc. shall be clearly indicated in layman terms in the report).	Noted and included in S.10.5.4.
(d) The application of the Working Tool (i.e. your recommendation on the use of the Working Tool).	Noted and included in S.10.5.5.
In addition to the above, please consider if review of the socio-economic implications due to the proposed mitigation measures should be added to S.10.5.1 as a recommendation for further works. Also please provide a summary statement whether any land resumption is required or not (if yes, where and what the cost and time implications are).	Noted. S.10.5.1 is amended to include the requirement. Land requirement statement is included in S.10.5.3.
(6) **D of HyD/Structures** **Letter ref. ( ) in STR 5/1/23 dated 1.4.99** I refer to your letter dated 18 March 1999 and have no comments on the captioned final report.	Noted.
(7) **D of TD, PM/NTW** **Letter ref. (16) in NTW 4/3/89 dated 1.4.99** I refer to your letter dated 18/03/99 and have no comments on the Report.	Noted.

Appendix F
Agreement No. CE 95/97
Feasibility Study for Providing Noise Mitigation Measures on Existing Flyovers
Responses to Comments on Final Report

	Comments	Responses
(8)	**D of HyD/NTW** **Letter ref. ( ) in HNT/63/56 dated 24.3.99** I refer to your above quoted letter of 18 March 1999 enclosing with a copy of the above report. I have no comment on the final report. Please also seek comments from CHE/K, HyD on the assessment for Kwai Chung Road Flyover near Mei Foo Sun Chuen.	Noted. A copy of the final report has been circulated to HyD/K under our letter ref: AC:wnw:93598/01-0108 dated 8.4.99 for comments. Please refer to Item (21).
(9)	**D of H/CPO** **Letter ref. HD(P) 1/2/16 dated 29.3.99** I refer to your captioned Final Report and the associated Responses to Comments on Draft Final Report (no. 10). Please note that, as a basic principle, every attempt must be made to reduce noise nuisance from the existing flyovers to surrounding residents. As such, please indicate what alternative noise mitigation measures may be available to the residents in Cheung On Estate should independent partial enclosure be found to be ineffective due to the physical constraints. Your response to my previous comments should be amended accordingly.	MCAL Response Letter ref. AC:jcwy:93598/01-0107 dated 30.3.99. Thank you for your letter ref: HD (P) 1/2/16 dated 29th March 1999 regarding comments on the "Responses to Comments" Item (10) in Appendix D the above Final Report. Please be advised that the above study is intended to identify any feasible direct technical remedies such as roadside barriers, semi-enclosures and enclosures on existing flyover. Mitigation measures other than the above direct technical remedies would be outside the scope of the above study. We would be glad to refer your comments to EPD/NMPG for their consideration. For your information, EPD is currently implementing a territorised "Quiet Road Surface Programme" to reduce traffic noise by applying Low Noise Road Surface on high speed roads. A copy of the Study Brief Clause 6.1.4. (i)(6) is enclosed herewith for your reference. Should you have any further queries, please feel free to contact us.
(10)	**D of B/TS** **Letter ref. (2) in BD(CR) CONS/10 Pt.V dated 25.3.99** I have no comment on the Final Report for the captioned study circulated on 18.3.1999.	Noted.

Appendix F
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Feasibility Study for Providing Noise Mitigation Measures on Existing Flyovers
Responses to Comments on Final Report

	Comments	Responses
(11)	**AC for T, TE(HK)** **Letter ref. HR 182/193-1B dated 26.3.99** I refer to your letter of 18th March 1999 and have no comment on the captioned final report.	Noted.
(12)	**DEMS** **Letter ref. (6) in L/M 148-79-98 dated 31.3.99** I refer to your letter ref. AC:pct:93598/01-0105 dated 18.3.99. Please be informed that this Department has no further comment to make regarding the captioned report. Should further assistance be required from us, please feel free to contact the undersigned.	Noted.
(13)	**D of HA** **Letter ref. HAD/D/16A/46 dated 30.3.99** Thank you for your Final Report and please be informed that we have no comment on it.	Noted.
(14)	**DSD/HK&I** **Letter ref. (18) in DSD HK 8/CE9597 dated 27.3.99** I refer to your letter of 18/3/1999 and have no further comment to the Final Report for the captioned study.	Noted.
(15)	**CED, GEO/PGCE** **Letter ref. ( ) in GCFM 5/6/20 - 151 dated 29.3.99** I refer to your above referenced letter dated 18.3.99 distributed to this office among others. The Geotechnical Engineering Office has no comments on the captioned final report.	Noted.
(16)	**D of TD/TS, HQ** **Letter ref. (24) in TDD 2/1/254 dated 25.3.99** I refer to your letter dated 23.3.99 circulating the captioned report and have no comments.	Noted.

Appendix F
Agreement No. CE 95/97
Feasibility Study for Providing Noise Mitigation Measures on Existing Flyovers
Responses to Comments on Final Report

	Comments	Responses
(17)	**D of TD, PM/HKI&I** **Letter ref. ( ) in HKIS 4/1/309 dated 24.3.99** I refer to your above reference letter of 18.3.99 and have no comments on the captioned Final Report.	Noted.
(18)	**D of L/Tech Inf** **Letter ref. (4) in LD 5/5060/94 VII dated 25.3.99** I refer to your letter of 18.3.99. I have no further comment on the captioned final report.	Noted.
(19)	**DUS** **Letter ref. (14) in USDP 6/402/97 IV dated 25.3.99** I refer to your letter dated 18 March 1999 and have no comment on the Final Report.	Noted.
(20)	**DWS, CE/MSW** **Letter ref. (5) in WSD/MSW 1744/1076/89 Pt.2 dated 25.3.99** I refer to your letter dated 18.3.1999 and have no further comment on the final report.	Noted.
(21)	**D of HyD/K** **Letter ref. KH 8/4/154 (D3) dated 13.4.99** I refer to your above-referenced letter dated 8.4.99 to me regarding the captioned subject. Please note that the Kwai Chung Road Flyover near Mei Foo Sun Chuen falls within the boundary of this Region. As far as this Region is concerned, I have no adverse comments on the captioned report.	Noted. Noted.
(22)	**DSD/MS** **Letter ref. ( ) in MS 8/CE/95/97 dated 16.4.99** I have no comment on this Draft Final Report.	Noted.

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Responses to Comments on Final Report

	Comments	Responses
(23)	**C of P/Traffic Management Bureau** **Letter ref. (11) in LM/96 in CP/T/TMB 216/61 Pt.3 dated 26.3.99** No comments on the Final Report	 Noted.
(24)	**D of FS** **Letter ref. (16) in FSD/PG 4/130/94 III dated 3.5.99** Thank you for your letter of 18.3.99 enclosing the captioned report for my comment. I have no further comments on the captioned report except that the deletion of the criterion on determining the interception of barrier with fire hydrants and valves is not supported. Please reinstate such criterion into Chart 5 of appendix E1 of the report as I have pointed out in my letter of 19.2.99 that it would not be difficult to apply this criterion in the assessment procedure.	 Please be advised that the interception of barrier with fire hydrants and values can be avoided by modifying the layout of barriers locally to suit the fire fighting requirements.
(25)	**D of H/CCE** **Letter ref. HD(CE)105/65 dated 3.5.99** I have no comment on the technical assessments in the Report. However, I would like to point out that the cost of the mitigation measures should take account of the number of households that can benefit from the improvement scheme. It is therefore advisable to assess the total number of households that can benefit in each scheme in the detailed design stage and work out the cost of mitigation measures per improved household (e.g. with a certain dBA reduced) for deciding on how to implement the scheme.	 Noted and included in Table 8-1 and 8-2.
(26)	**D of HyD/HK Region** **Letter ref. ( ) in HH 63/50 (DSW) dated 14.5.99** I refer to your above letter received earlier. As I confirmed in our subsequent telephone discussion, I have no further comments on the final report.	 Noted.

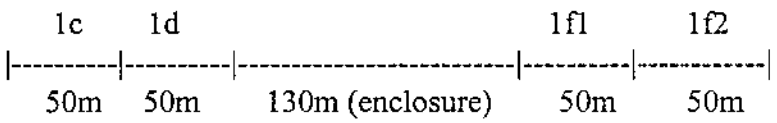
Annex I :

Responses to comments on Air Quality Impact Assessment:

Response to Item 7. i) and ii)

A sample calculation of the composite emission factor for Tsing Tsuen Road (with enclosure) is presented below:

Segments:



The traffic composition is:

Private Car	LGV	HGV	Bus	Total
1072.95	1043.58	598.235	598.235	3313

Emission factors E.F. = Σ Ei * Ni / Σ Ni
where Ei is the fleet average emission factor of NOx or RSP in the year 1998 and Ni is the number of particular type of vehicles

$$\therefore \text{ E.F. for Nox} = \frac{(1.63*1072.95+2.05*1043.58+11.15*598.235+11.92*598.235)}{3313}$$

= 5.339 gm/veh-km

$$\text{E.F. for RSP} = \frac{(0.026*1072.95+0.578*1043.58+1.37*598.235+1.419*598.235)}{3313}$$

= 0.694 gm/veh-km

Mass of pollutant inside enclosure = E.F. of the road * traffic flow * length of the enclosure

∴ Mass of NOx inside enclosure = 5.339 * 3313 * 0.13 = 2299.45 gm
Mass of RSP inside enclosure = 0.694 * 3313 * 0.13 = 298.90 gm

Mass of pollutant in each 50m segment = E.F. of the road * traffic flow * 0.05
∴ Mass of NOx in each 50m segment = 5.339 * 3313 * 0.05 = 884.41 gm
Mass of RSP in each 50m segment = 0.694 * 3313 * 0.05 = 114.96 gm

According to PIARC 91, pollutant is assumed to emit completely out of the enclosure and each 'portal' emits 1/2 of the total mass. For each 'portal', 2/3 and 1/3 of the emitted mass are assumed to accumulate in the first and second 50 metres, respectively.

∴ Mass of NOx in the first 50m = 2/3 * 1/2 * 2299.45 + 884.41 =1650.89 gm
Mass of RSP in the first 50m = 2/3 * 1/2 * 298.90 + 114.96 = 214.59 gm

Similarly,
Mass of NOx in the second 50m mil = 1/3 * 1/2 * 2299.45 + 884.41 =1267.65 gm
Mass of RSP in the second 50m mil = 1/3 * 1/2 * 298.90 + 114.96 = 164.78 gm

∴ Emission Factor of NOx in the first 50m = actual mass / traffic flow / 0.05
= 1650.89/3313/0.05
= 9.966 gm/veh-km
= 16.04 gm/veh-mil

Similarly,
Emission Factor of RSP in the first 50m mil = 214.59/3313/0.05 = 2.08 gm/veh-mil
Emission Factor of NOx in the second 50m mil = 1267.65/3313/0.05 = 12.32 gm/veh-mil
Emission Factor of RSP in the second 50m mil = 164.78/3313/0.05 = 1.60 gm/veh-mil

Response to Item 8. i) and ii)

According to the *FHWA User's Guide for CALINE4 – A Dispersion Model for Predicting Air Pollutant Concentrations near Roadways* (Section 9.2), "The model assumes that air flow will adjust to gradual changes in topography. Therefore, receptor and link heights are referenced to the ground level in their immediate vicinity, not to a fixed elevation datum."

Therefore, in our modeling exercise, although the ASR HA is physically higher than the road surfaces (which are the sources), the modeled height of the ASR HA is still measured from its local ground level.

To further study the effect of the cantilevered barriers, the 1-hour average NO_2 and 24-hour average RSP concentration at ASR HA at various elevations are predicted and listed in the following table:

Height above local ground level (m)	1-hour Average NO_2 Concentrations (μgm^{-3})*		24-hour Average RSP Concentrations (μgm^{-3})*	
	Unmitigated	Mitigated	Unmitigated	Mitigated
2	160	141	133	123
4	141	141	124	122
6	141	141	115	119
8	122	122	106	112
10	103	122	99	104
12	103	103	92	97
14	85	103	87	90
16	85	85	90	90
18	85	85	90	90
20	85	85	88	88
22	85	85	84	84

* Background of NO_2 concentration of 47 μgm^{-3} and RSP concentration of 52 μgm^{-3} are included.

From the above results, the highest 1-hour average NO_2 and 24-hour average RSP are predicted at 2m high. The RSP concentrations at levels 6 metres to 14 metres above local ground in the mitigated scenario are worse than that in the unmitigated scenario. This further demonstrates the lateral dispersion or diffusion of air pollutants arising from the roadside barrier structures.

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Feasibility Study for Providing Noise Mitigation Measures on Existing Flyovers
Supplementary Responses to EPD's Comments on Final Report/Executive Summary

	Comments	Responses
(1)	**EPD** **Letter ref. EP 42/T6/1 A1 VII dated 10.8.99** I refer our telecom (Alfred Cheng/Edwin Chui) earlier today regarding the captioned. As discussed, I understand that you have duly responded and incorporated all comments from various departments on the Final Report and the Draft Executive Summary. Please incorporate minor comments from our Air Policy Group (see Annex A), and issue the Final Report and Executive Summary to all concerned parties by 16.8.99. **Annex A:** Comments on Responses to Comments & Amended Pages of Final Report (MCA's letter ref. AC:pct:93598/01-0114) **Responses to Comments** a) Item 8i and 8ii, p.F2 to F3 - The proposed L-shaped noise barriers, along the eastbound carriageway of the existing Ap Lei Chau bridge, will limit the lateral dispersion of air pollutants towards the receivers at **the back of the noise barriers**. However, receiver HA, which is on the opposite side of the flyover facing **the front side of the noise barriers**, will be subject to more severe pollution impact as the lateral dispersion of pollutants from vehicles is now all forced towards receiver HA (without the noise barriers, the lateral dispersion will be in two directions). Therefore, in calculating the pollutants' concentrations at receiver HA due to the effect of the noise barriers, the source height should not be required to be adjusted but the horizontal distance between the source and receiver HA **should be shortened with the length equal to the overhung cantilever**. Hence, this will increase the pollutants' concentrations at receiver HA instead of lower it as shown in Table 4-1 of Annex I. **Amended Pages of Final Report** b) The modelling results for receivers HA shown in	**MCA's response letter** **Ref. 98018a/FWM90813.01** Further to your comments dated 10 August 1999 (Ref. EP42/T6/1 A1 VII), we would like to respond as follows: The modelling methodology for ASR HA has been revised in accordance with the suggested methodology. The modelling results for ASR HA has been

Appendix F
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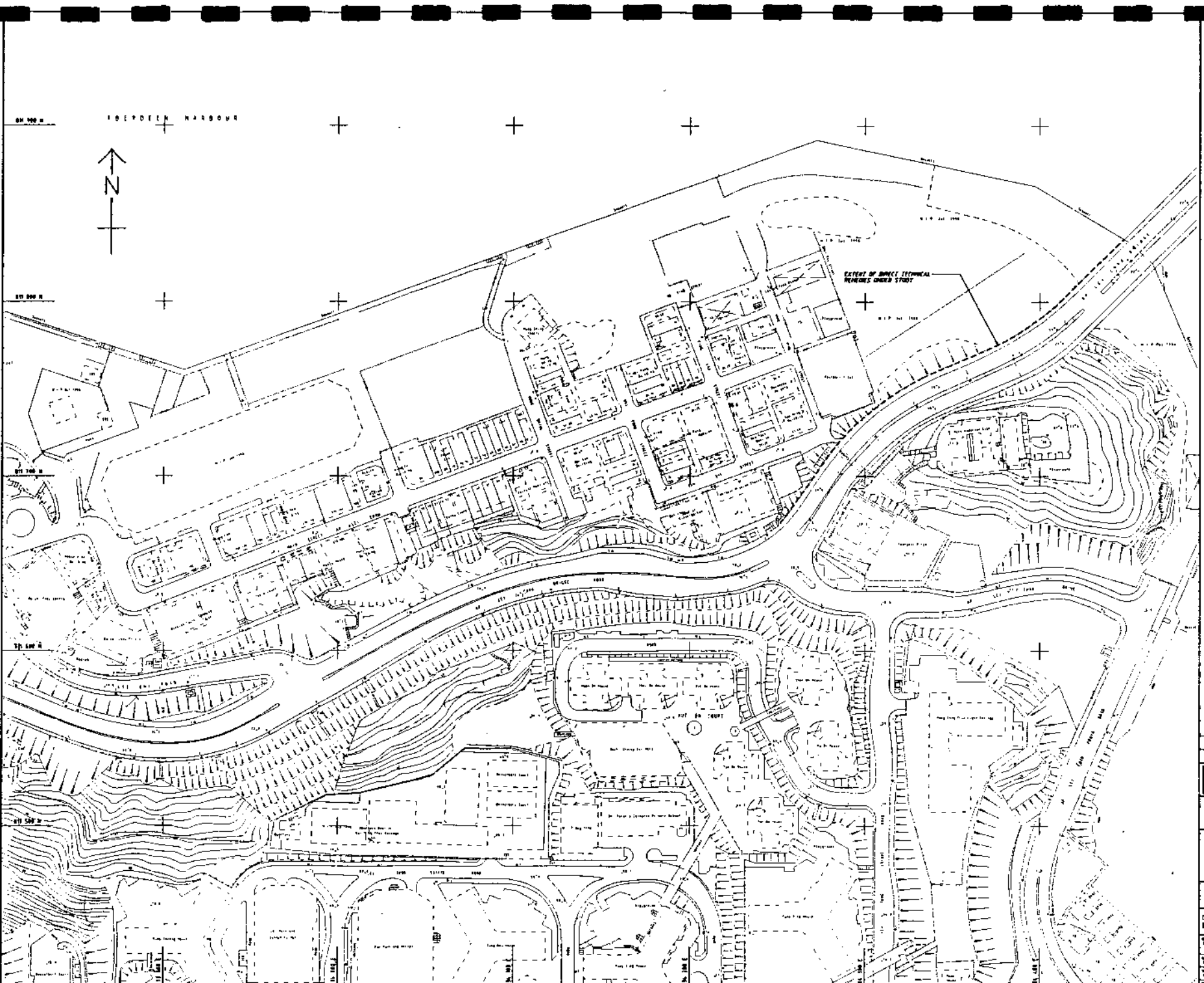
Feasibility Study for Providing Noise Mitigation Measures on Existing Flyovers
Supplementary Responses to EPD's Comments on Final Report/Executive Summary

	Comments	Responses
	Table 4-1 are unacceptable with the reasons shown in comments a) above. Please revise the assessment for receiver HA.	revised in Table 4-1. Please refer to the attached pages.
	c) It is noted from the consultants' response that the pollutant concentrations were determined at the worst-hit levels of the selected ASRs. Please also indicate this in the text of the Air Quality Impact Assessment for clarity of the report readers.	Text has been added in Section 4.
	Draft Executive Summary (MCA's letter ref. AC:pct:93598/01-0117)	
	a) There are still outstanding comments on the air quality impact assessment . Hence, the air quality impacts indicated in the Executive Summary should be subject to the findings of the air quality impact assessment.	Text in p.2 of the Executive Summary is consistent with the updated findings of this study.

FIGURES



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

AP LEI CHAU BRIDGE
LOCATION & KEY PLAN

MAUNSELL CONSULTANTS ASIA LTD

DRG NO Figure 1-1

PRELIMINARY

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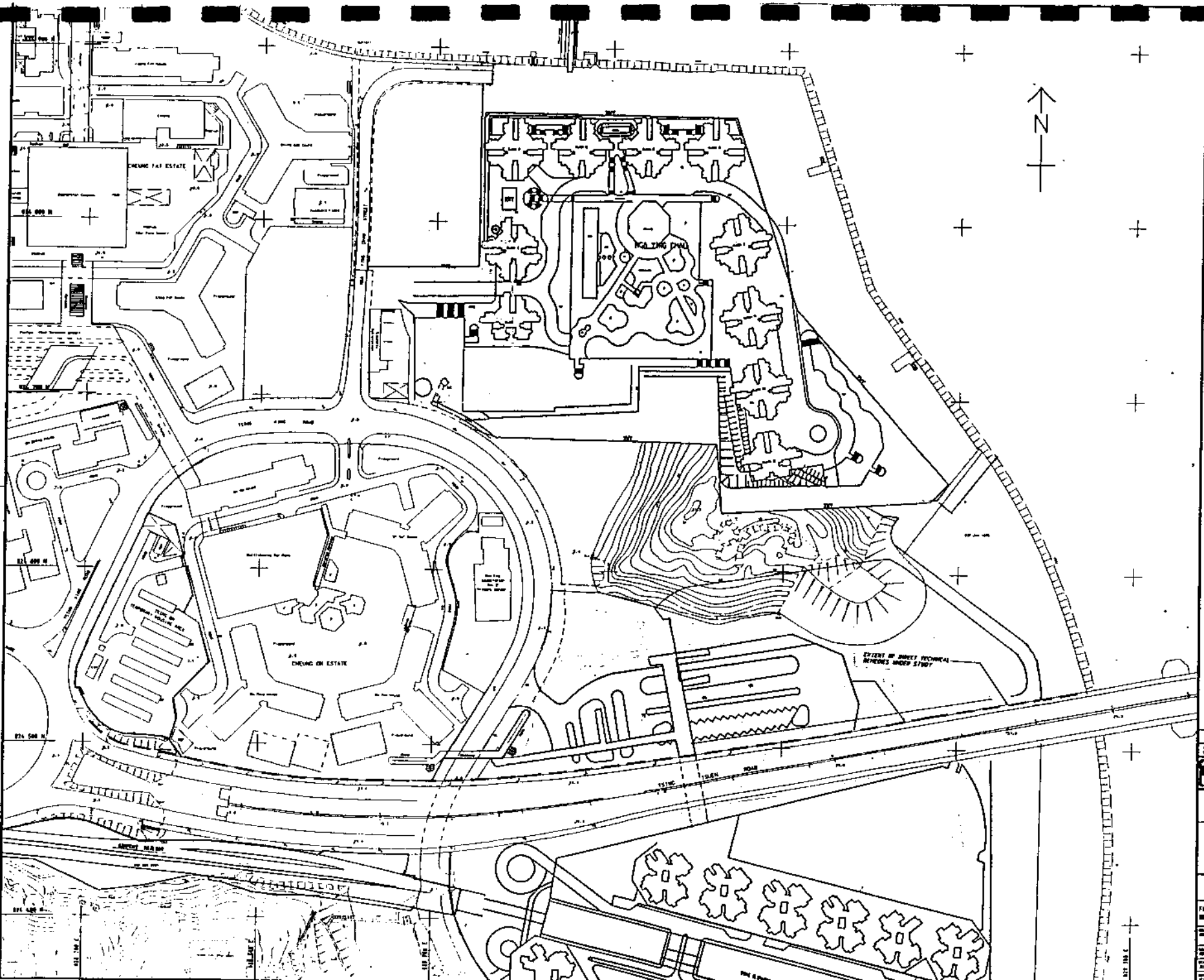

ENVIRONMENTAL PROTECTION DEPARTMENT

FEASUBRITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE LOCATION & KEY PLAN

SHEET 1 OF 2

MAUNSELL CONSULTANTS ASIA LTD.

FIGURE NO. FIGURE 1.2

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CE 95/97

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PRELIMINARY

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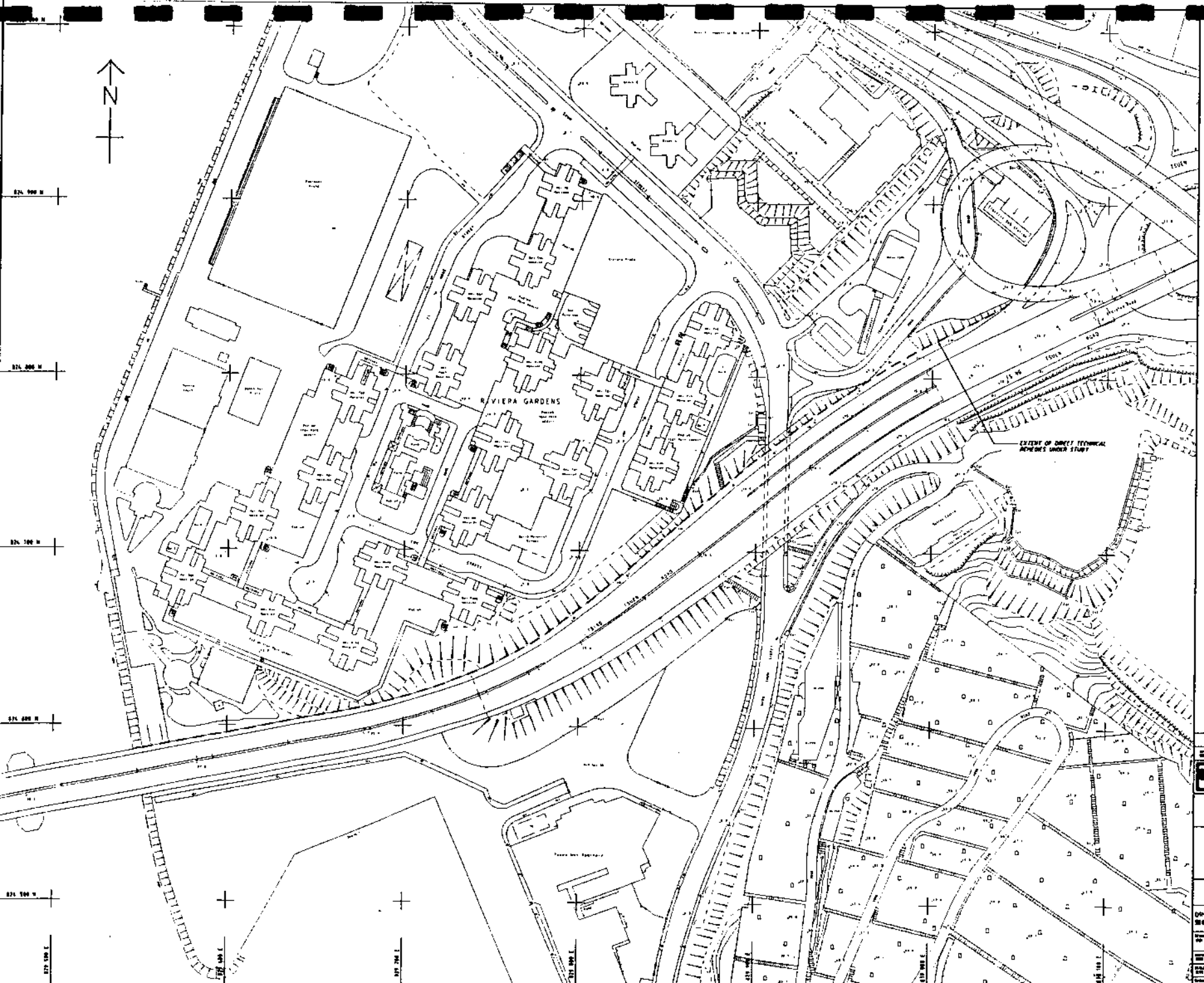


ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE
LOCATION & KEY PLAN

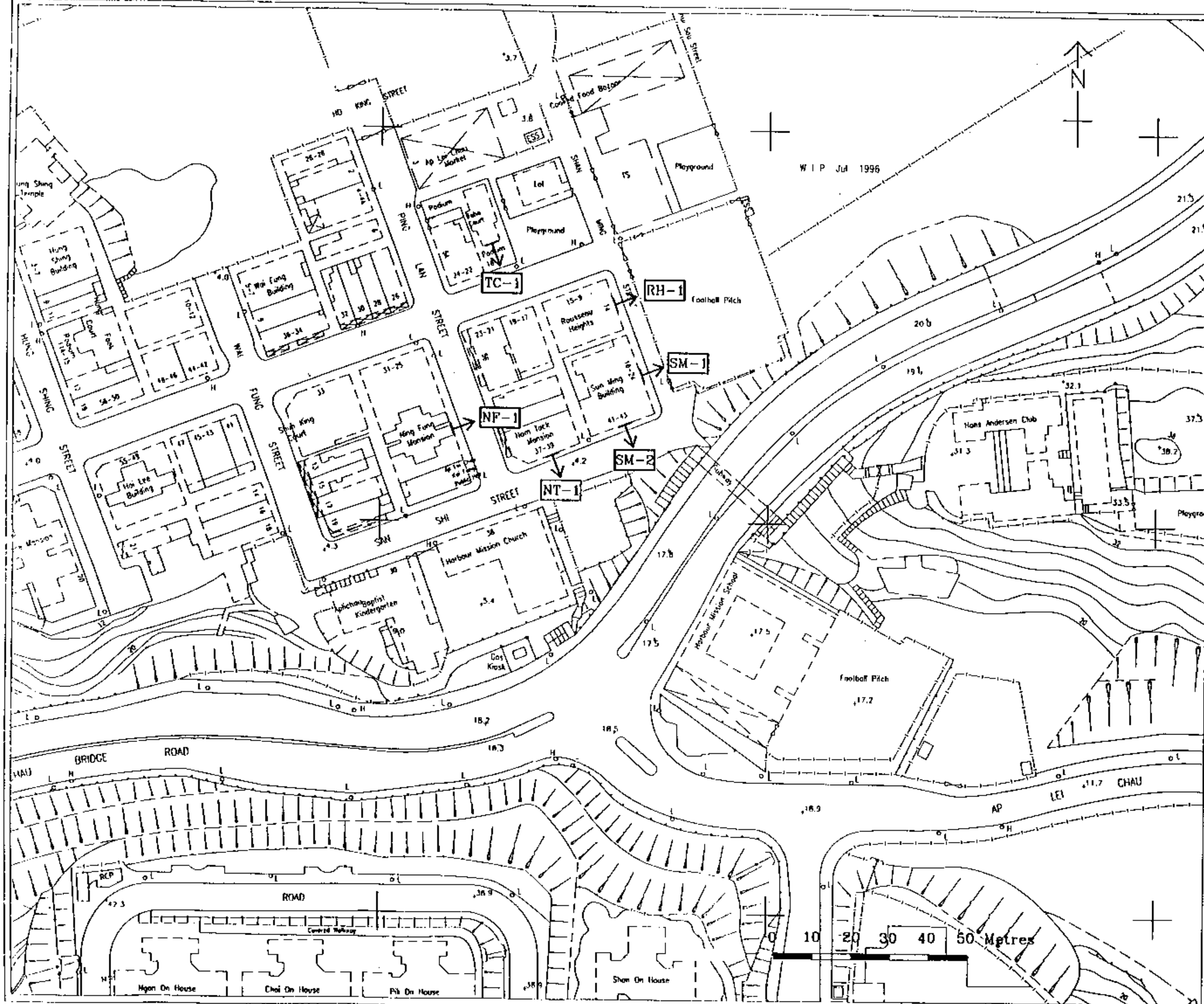
SHEET 2 OF 2

MAUNSELL CONSULTANTS ASIA LTD

Figure 1-3

PRELIMINARY

Maunsell



LEGEND

SM-1 LOCATION OF REPRESENTATIVE NSR

ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATIONS OF REPRESENTATIVE NSR ALONG AP LEI CHAU BRIDGE

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FIGURE NO. Figure 4-1

SCALE AS SHOWN

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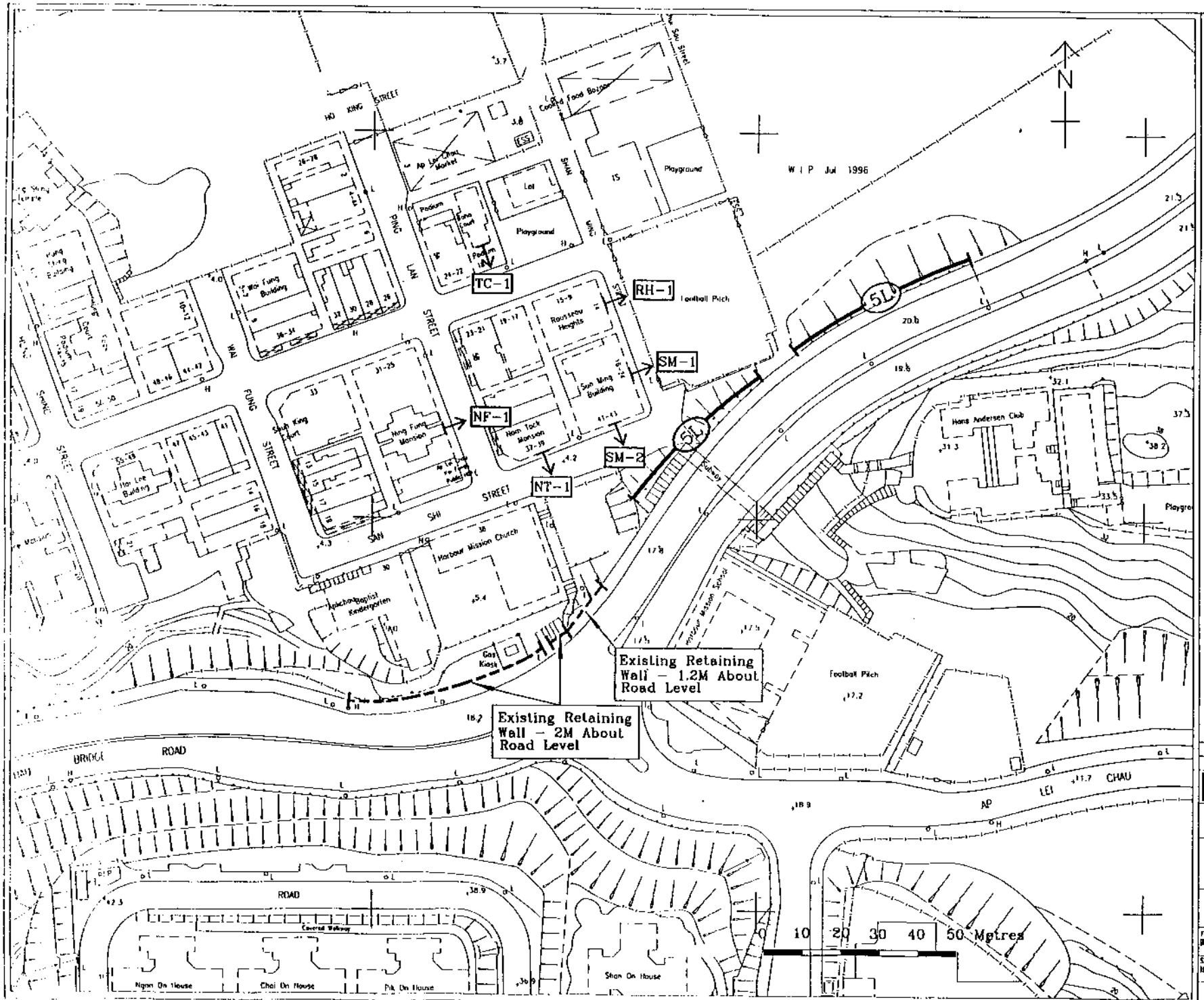

ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

Ap Lei Chau Bridge
- Location of Proposed Noise Barrier

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FIGURE NO. Figure 4-2

SCALE AS SHOWN

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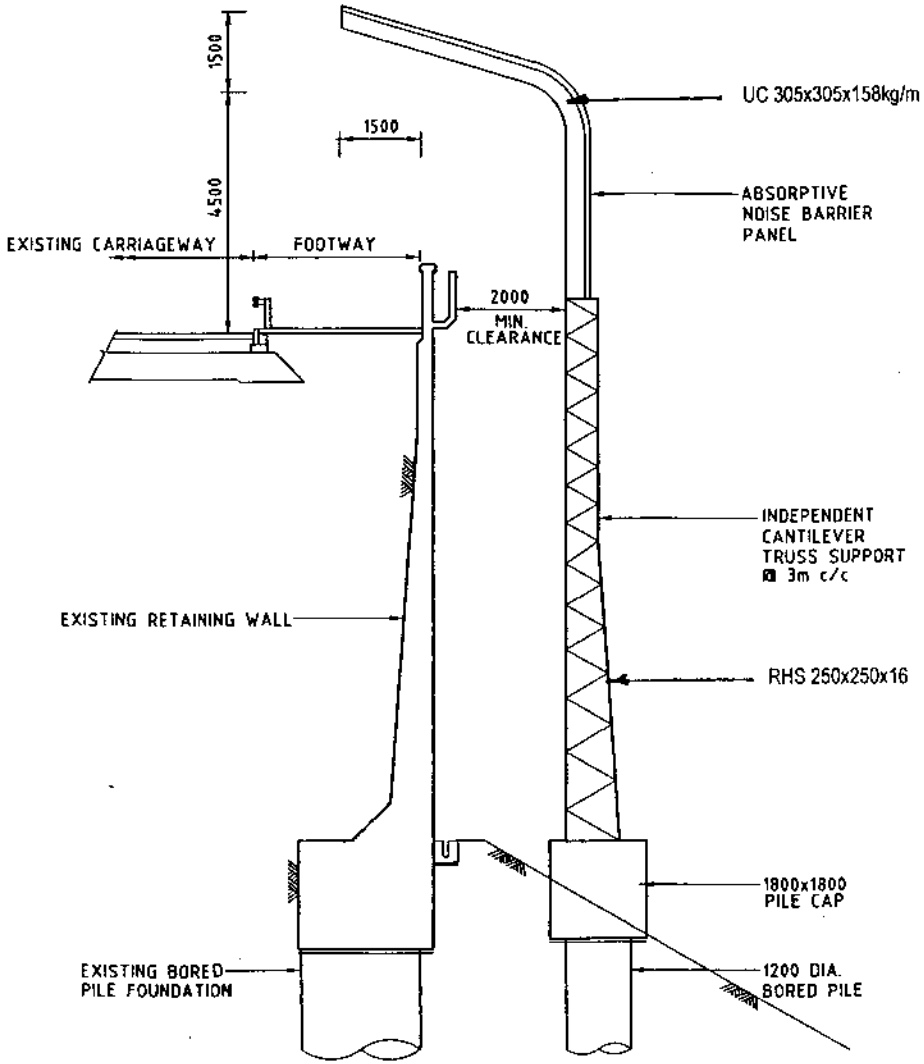


SCALE 1 : 100

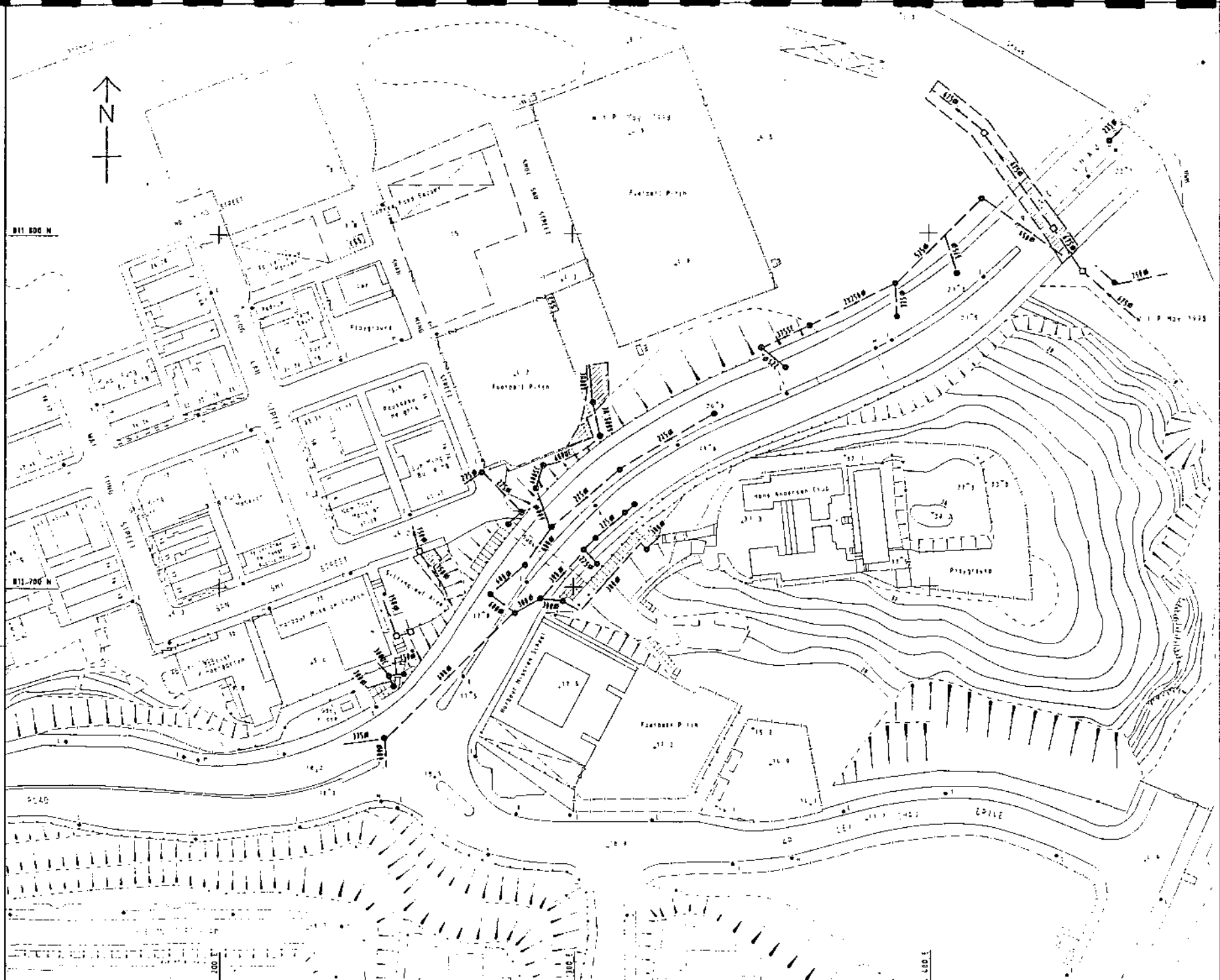
ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

Ap Lei Chau Bridge - Cross Section of Inverted-L Shaped Noise Barrier

Figure 4-3

Maunsell



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASUBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

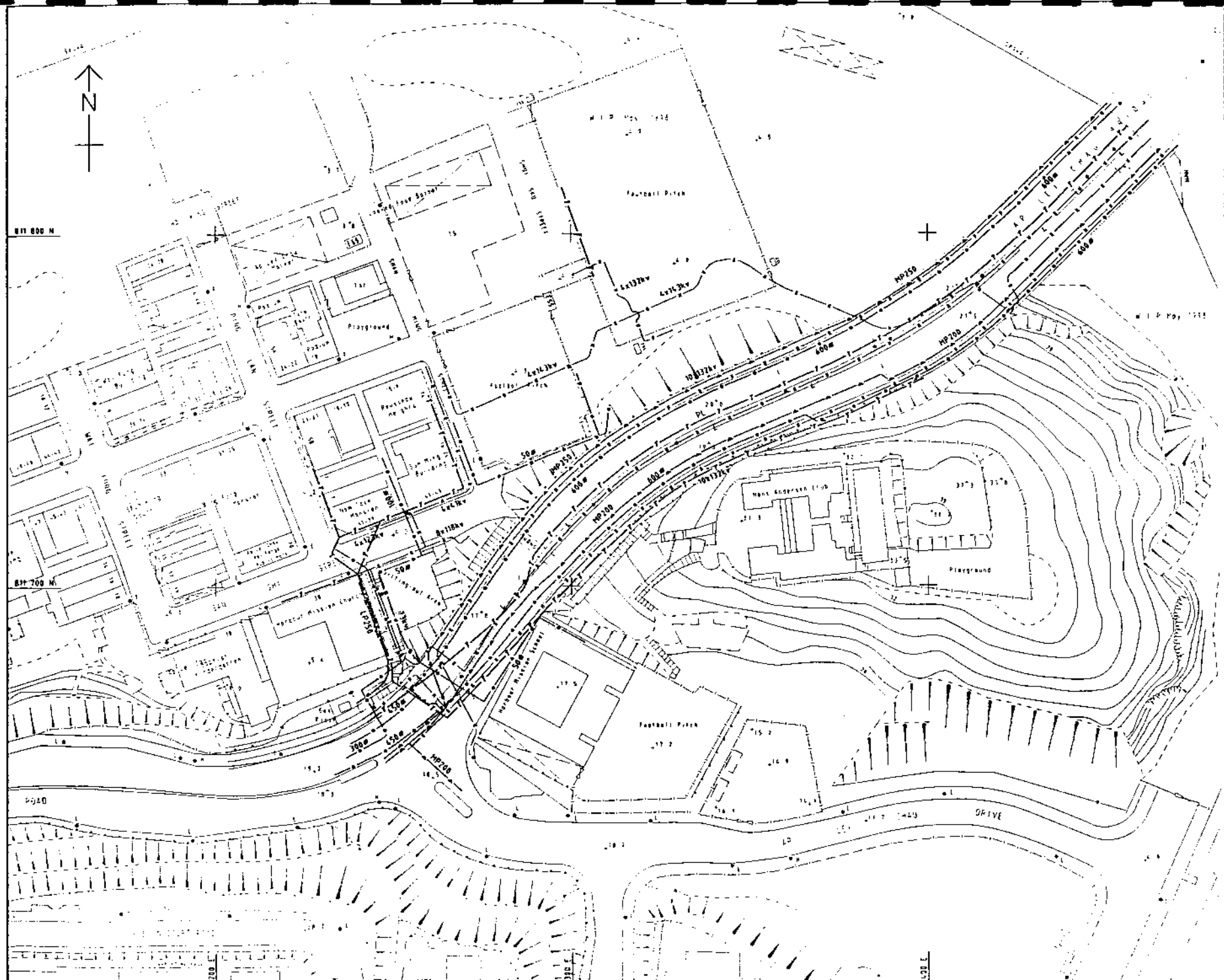
AP LEI CHAU BRIDGE
EXISTING LAYOUT OF
DRAINAGE AND SEWERAGE

MAUNSELL CONSULTANTS ASIA LTD

DRG. NO. Figure 4-4

PRELIMINARY

Maunsell



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASUBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

AP LEI CHAU BRIDGE
EXISTING LAYOUT OF UTILITES AND SERVICES

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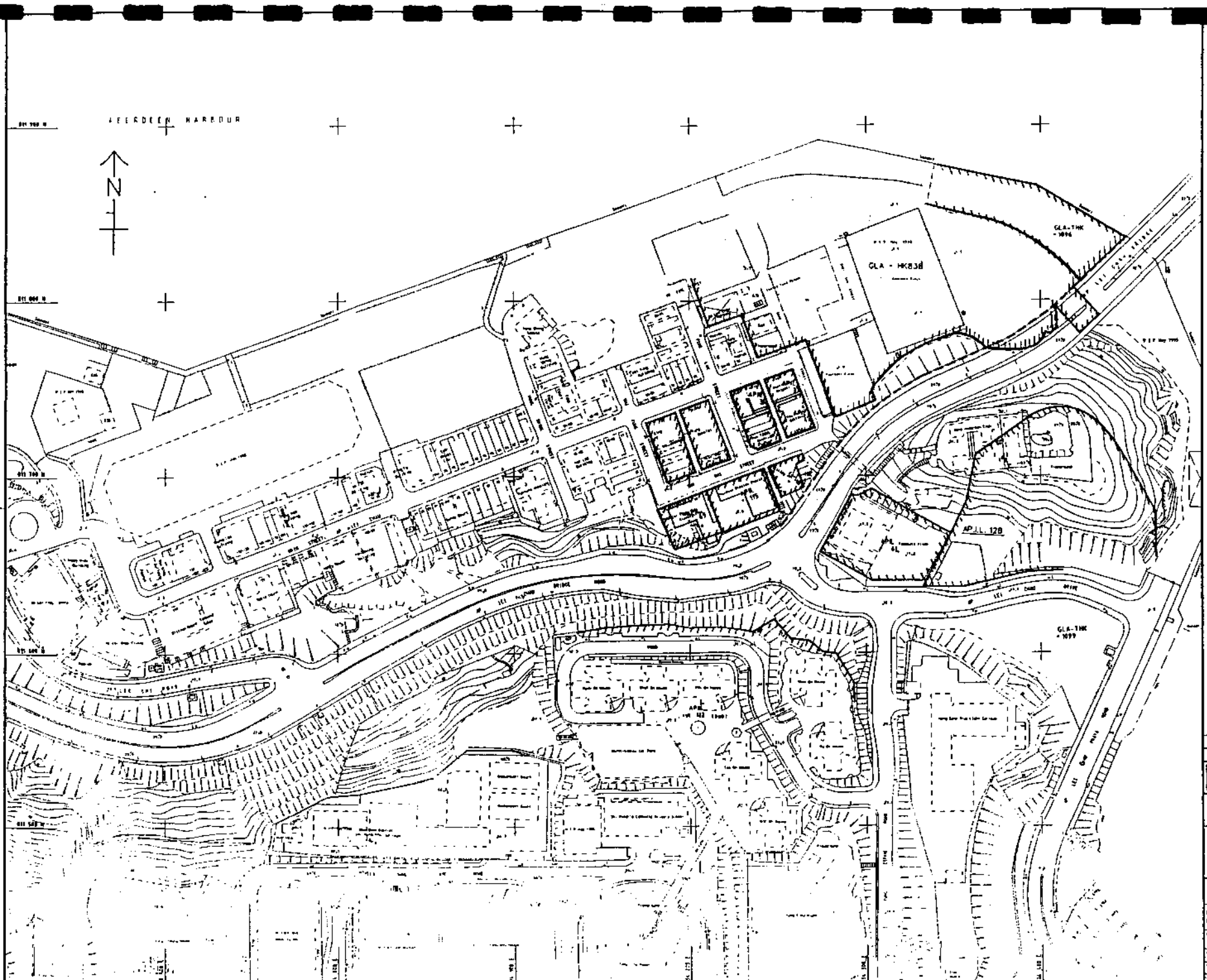
DRG. NO. Figure 4-5

PRELIMINARY



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

AP LEI CHAU BRIDGE
LAND STATUS PLAN

MAUNSELL CONSULTANTS ASIA LTD.

FIGURE NO. Figure 4-6

PRELIMINARY

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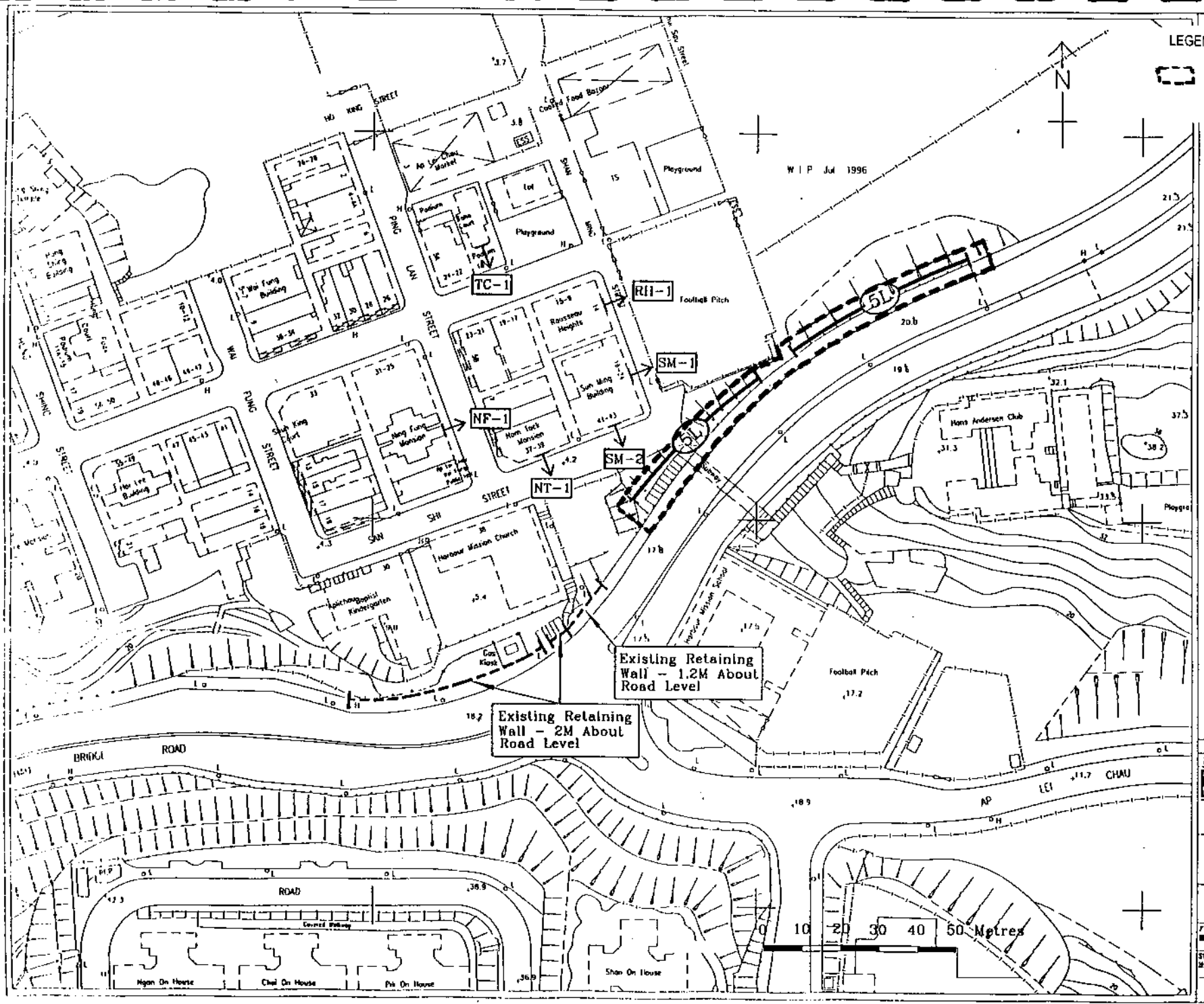
LEGEND:
BOUNDARY OF LANDS FOR POSITIONING MITIGATION STRUCTURE
N
W I P Jul 1996
TC-1
RH-1
SM-1
NF-1
SM-2
NT-1
5L
Existing Retaining Wall - 1.2M About Road Level
Existing Retaining Wall - 2M About Road Level
Football Pitch
Hans Andersen Club
Harbour Mission School
Apichau Baptist Kindergarten
Shan On House
Ngan On House
Chai On House
Pik On House
BRIDGE ROAD
AP LEI CHAU
0 10 20 30 40 50 Metres
ENVIRONMENTAL PROTECTION DEPARTMENT
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS
AP LEI CHAU BRIDGE
LAND REQUIREMENT PLAN
MAUNSELL CONSULTANTS ASIA LTD
FIGURE NO.
Figure 4-7
SCALE
AS SHOWN
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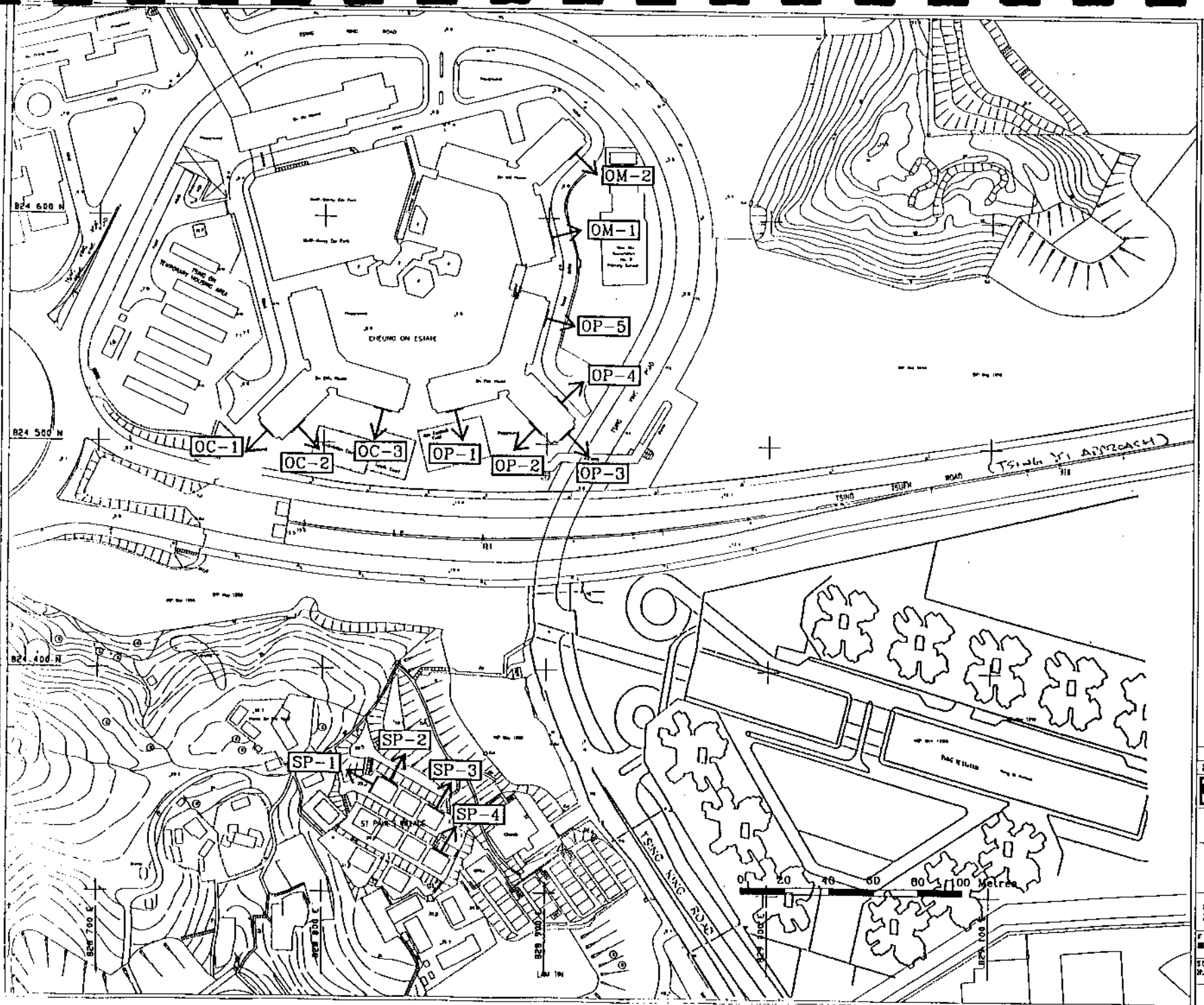

LEGEND

OM-1 LOCATION OF REPRESENTATIVE NSR

ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATIONS OF REPRESENTATIVE NSR ALONG TSING TSUEN ROAD (SHEET 1 OF 2)

MAUNSELL CONSULTANTS ASIA LTD

FIGURE NO. Figure 5.1

SCALE AS SHOWN

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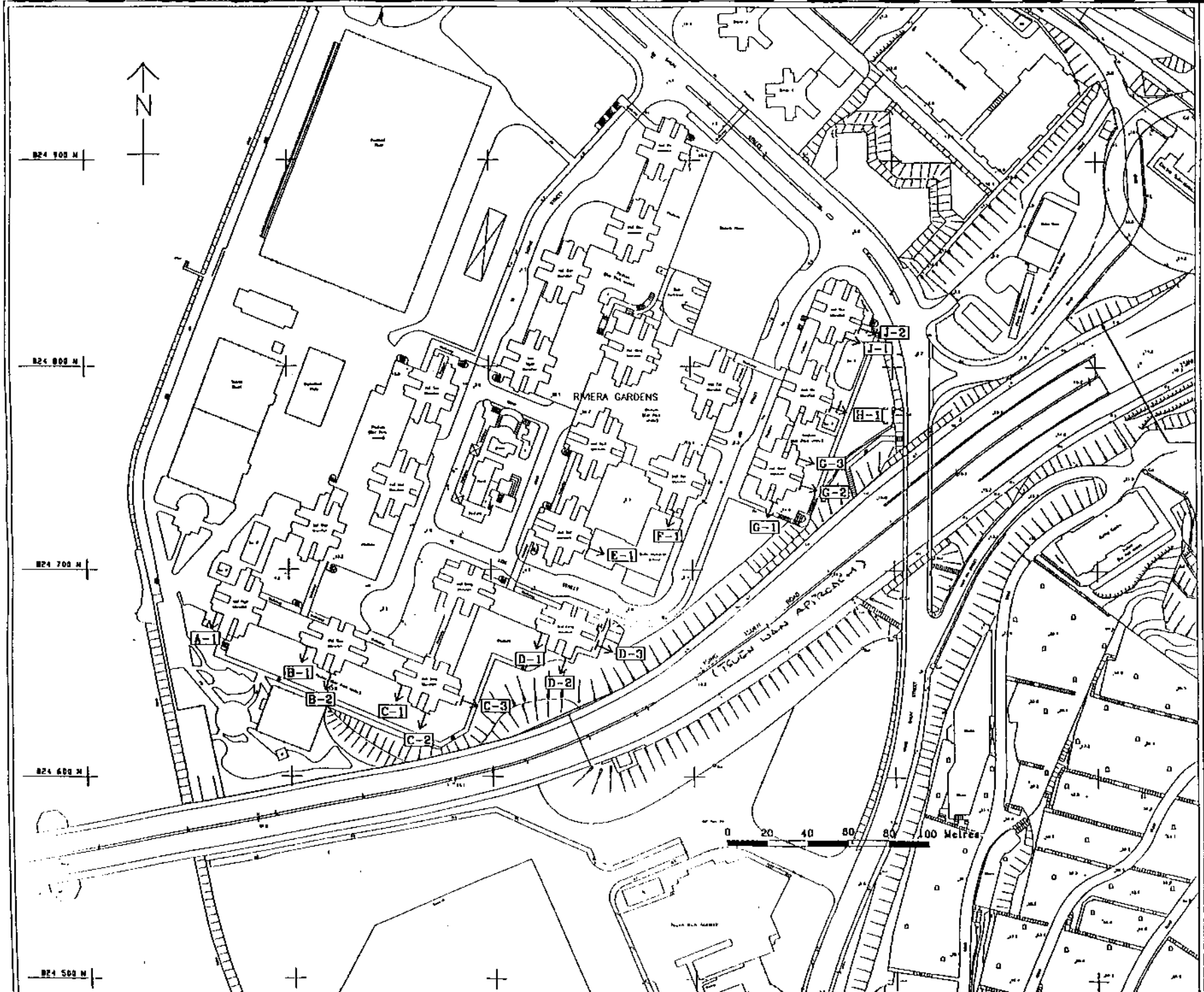

LEGEND

→ J-2 LOCATION OF REPRESENTATIVE NSR

ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

LOCATIONS OF REPRESNTATIVE NSR ALONG TSING TSUEN ROAD (SHEET 2 OF 2)

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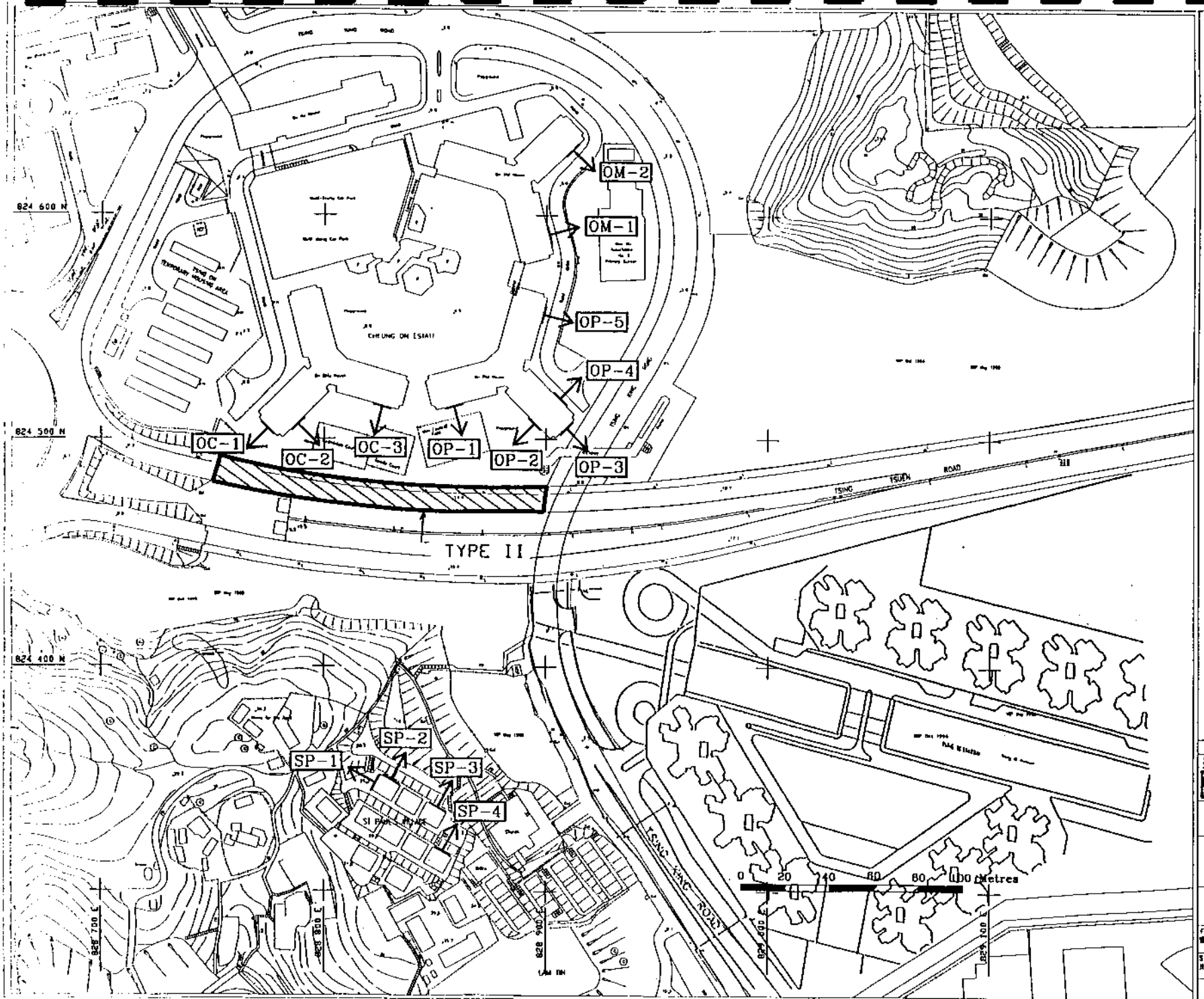
FIGURE NO. Figure 5-2

SCALE AS SHOWN


LEGEND
OM-1 LOCATION OF REPRESENTATIVE NSR
PARTIAL ENCLOSURE
OM-2
OM-1
OP-5
OP-4
OP-3
OP-2
OP-1
OC-3
OC-2
OC-1
SP-1
SP-2
SP-3
SP-4
TYPE II
TSING TSUEN ROAD
TSING KING ROAD
824 600 N
824 500 N
824 400 N
828 700 E
828 800 E
828 900 E
824 100 E
0 20 40 60 80 100 Metres
ENVIRONMENTAL PROTECTION DEPARTMENT
FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS
Tsing Tsuen Bridge - Location of Proposed Partial Enclosures
HAUNSELL CONSULTANTS ASIA LTD
FIGURE NO. Figure 5-3
SCALE AS SHOWN
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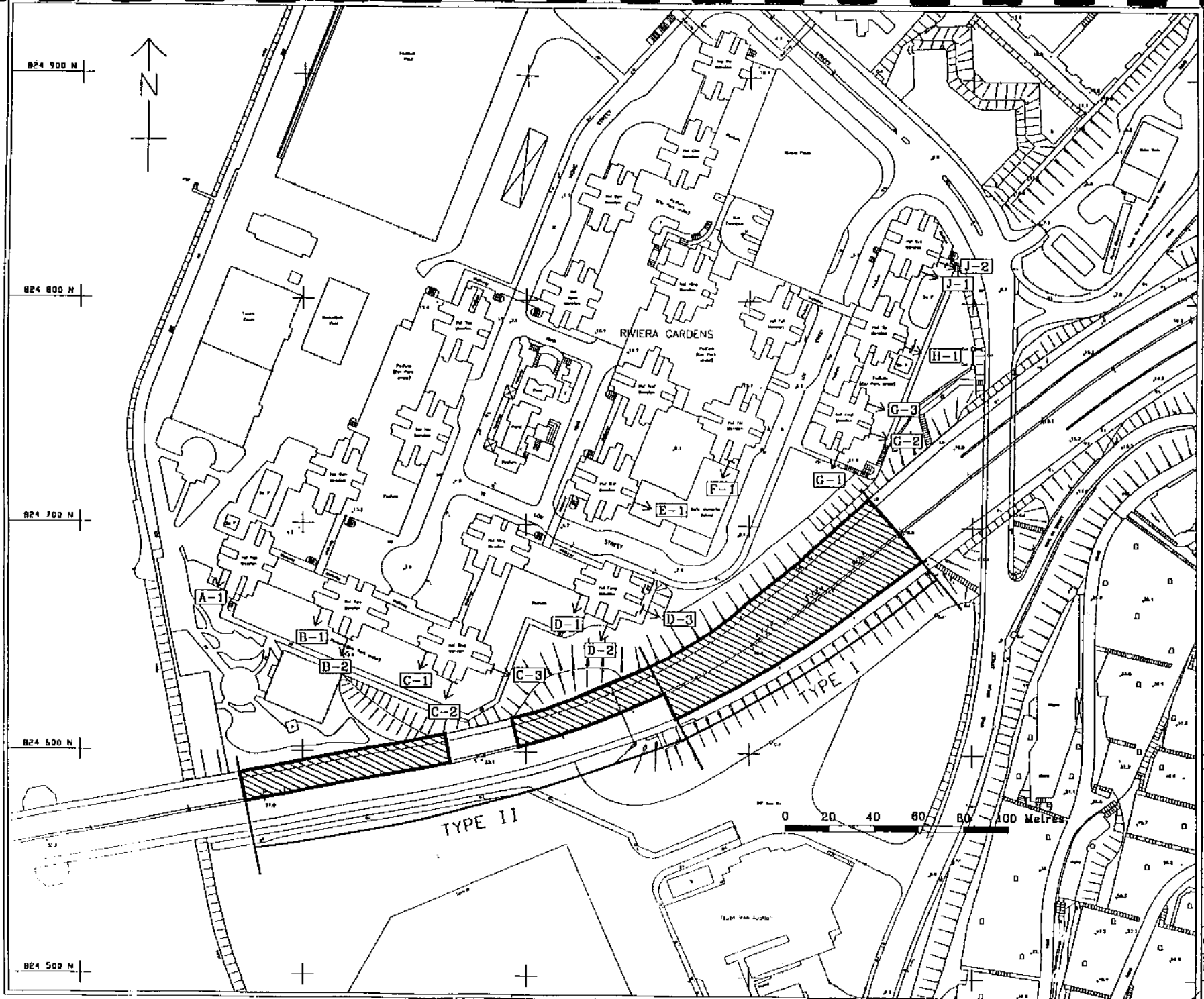

LEGEND

J-2 LOCATION OF REPRESENTATIVE NSR

TYPE I - PARTIAL ENCLOSURE COVERING THE ENTIRE WIDTH OF CARRIAGEWAY

TYPE II - PARTIAL ENCLOSURE COVERING EASTBOUND CARRIAGEWAY

ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

Tsing Tsuen Bridge - Location of Proposed Partial Enclosures

(Sheet 2)

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FIGURE NO. Figure 5-3

SCALE AS SHOWN

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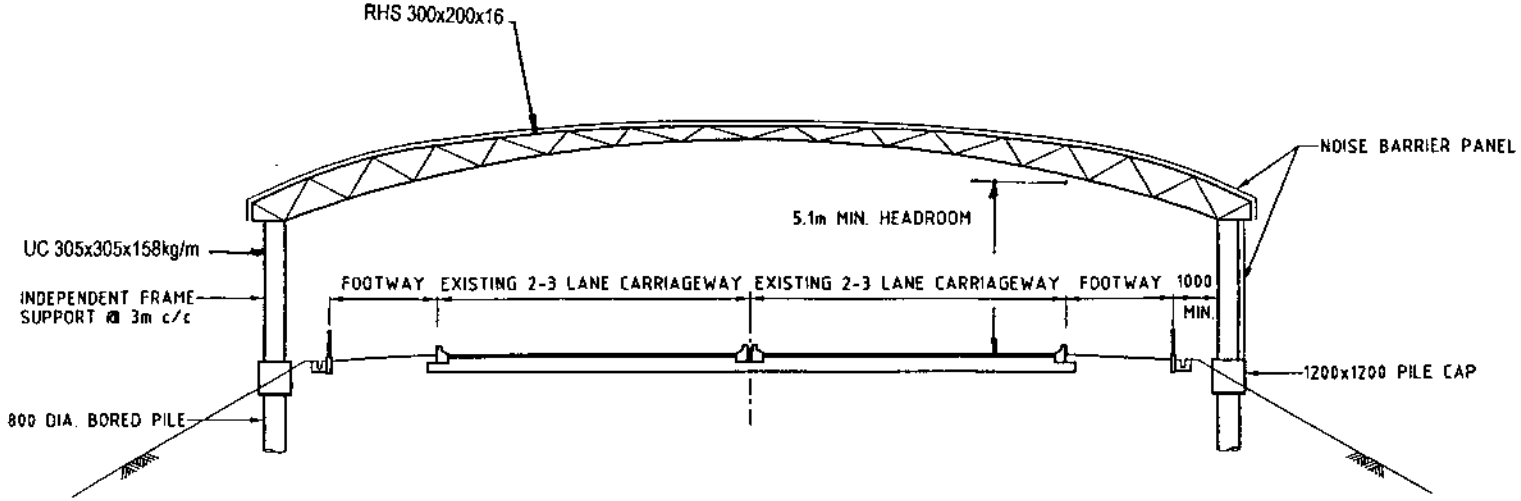

SCALE 1 : 200

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ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

Tsing Tsuen Bridge - Cross Section of Partial Enclosure Type I (SHEET 1 OF 2)

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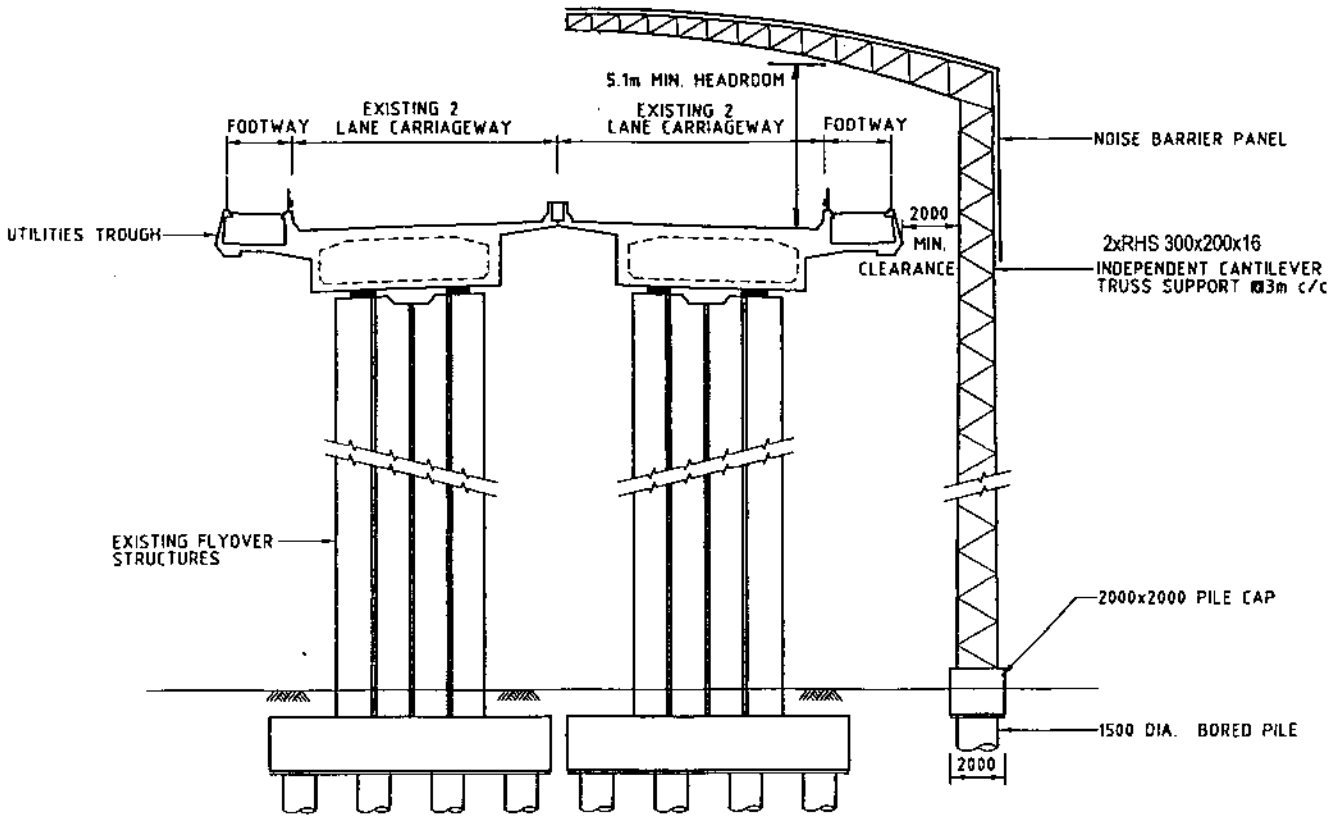
DRG. NO. Figure 5-4

maunsell



SCALE 1 : 200

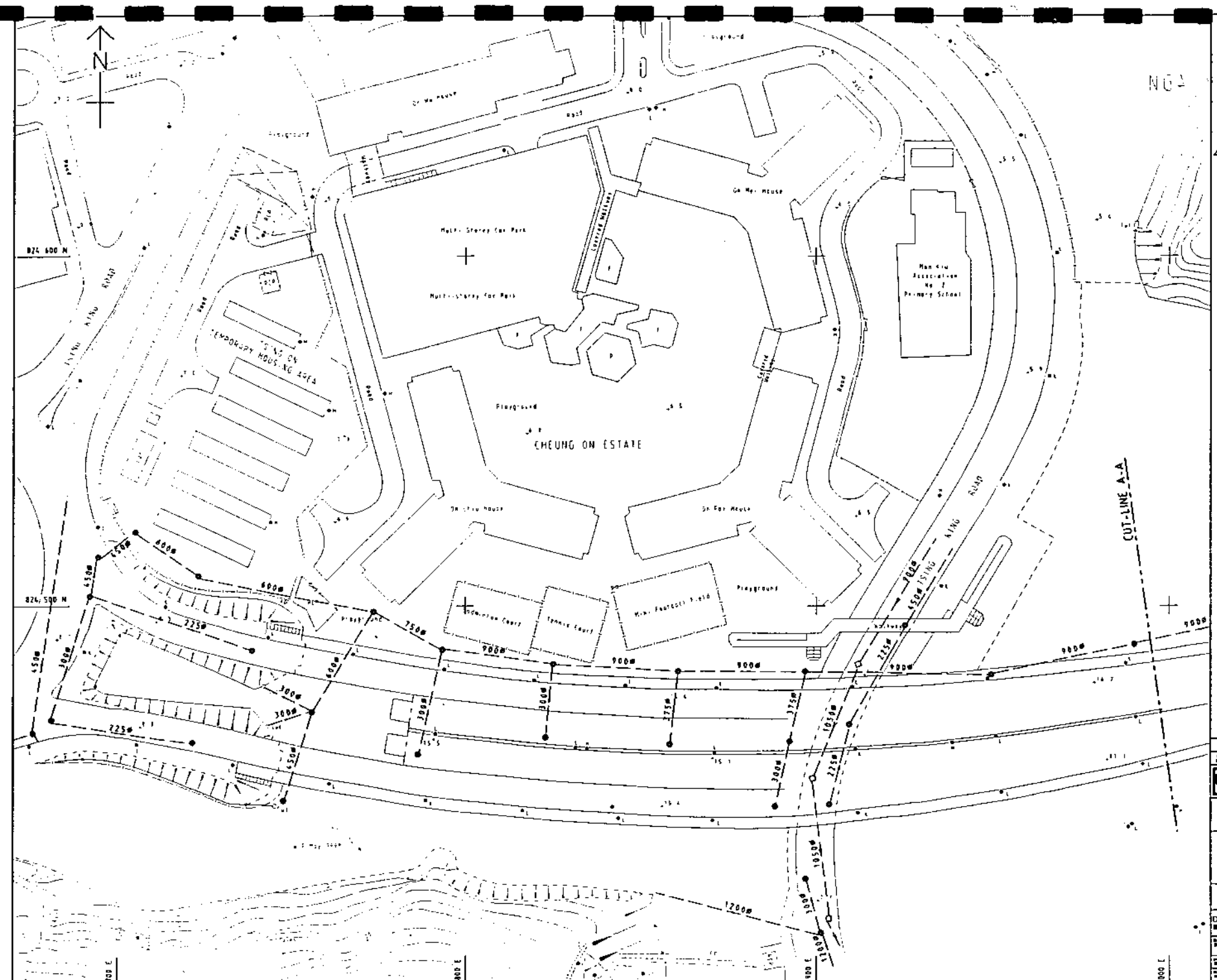
ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

Tsing Tsuen Bridge - Cross Section of Partial Enclosure Type II (SHEET 2 OF 2)

DRWG. NO. Figure 5-5

Maunsell



LEGEND:

- EXISTING STORMWATER DRAINAGE
- EXISTING FOUL SEWERAGE
- EXISTING STORMWATER MANHOLE
- EXISTING FOUL SEWERAGE MANHOLE
- EXISTING CATCHPIT
- DRAINAGE RESERVE

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ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE
EXISTING LAYOUT OF DRAINAGE AND SEWERAGE
(SHEET 1)

MAUNSELL CONSULTANTS ASIA LTD

DRG. NO. FIGURE 5-6

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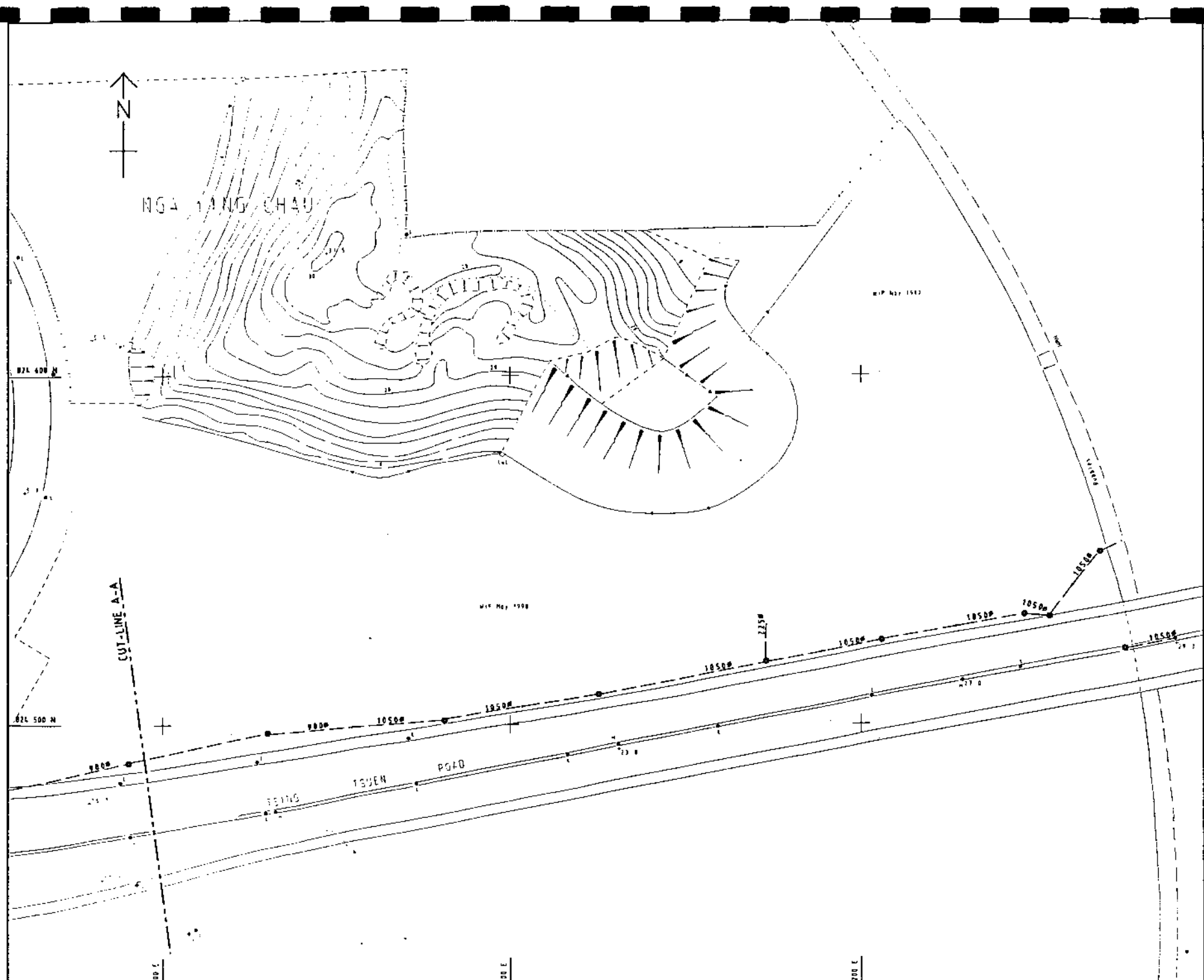

LEGEND

- EXISTING STORMWATER DRAINAGE
- EXISTING FOUL SEWERAGE
- EXISTING STORMWATER MANHOLE
- EXISTING FOUL SEWERAGE MANHOLE
- EXISTING CATCHPIT
- DRAINAGE RESERVE

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ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE EXISTING LAYOUT OF DRAINAGE AND SEWERAGE

MAUNSELL CONSULTANTS ASIA LTD

ORG. NO. FIGURE 5-6

PRELIMINARY

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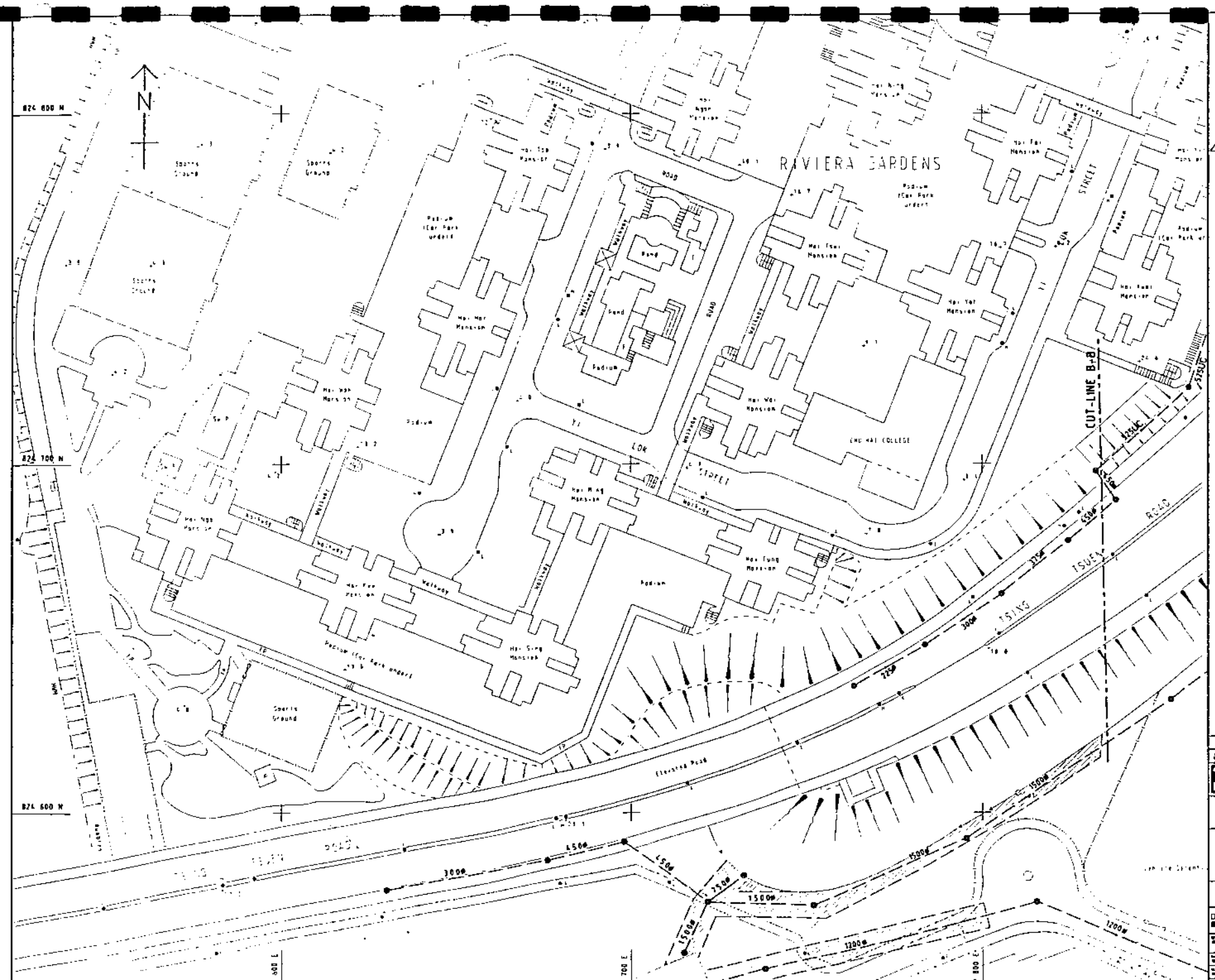

-	FIRST ISSUE	AC	CW	AUG '98

ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE
EXISTING LAYOUT OF DRAINAGE AND SEWERAGE (SHEET 1)

MAUNSELL CONSULTANTS ASIA LTD

ORG. NO. [redacted] FIGURE 5-7

AC | CE 95/97 | PRELIMINARY

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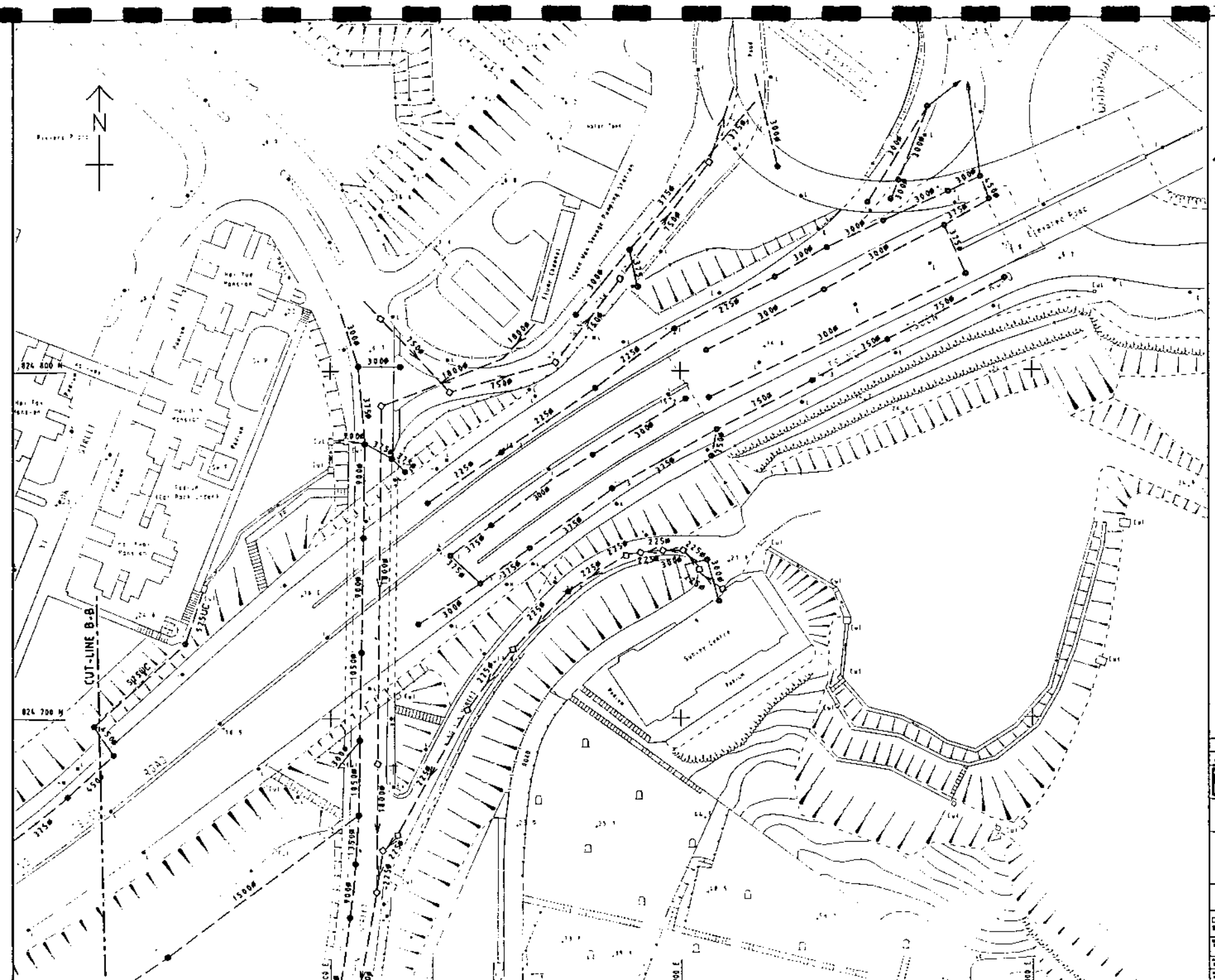

LEGEND:

- EXISTING STORMWATER DRAINAGE
- EXISTING FOUL SEWERAGE
- EXISTING STORMWATER MANHOLE
- EXISTING FOUL SEWERAGE MANHOLE
- EXISTING CATCHPIT
- DRAINAGE RESERVE

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ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE
EXISTING LAYOUT OF
DRAINAGE AND SEWERAGE
(SHEET 1)

MAUNSELL CONSULTANTS ASIA LTD

DRG. NO. [redacted] FIGURE 5-7

AC

PRELIMINARY

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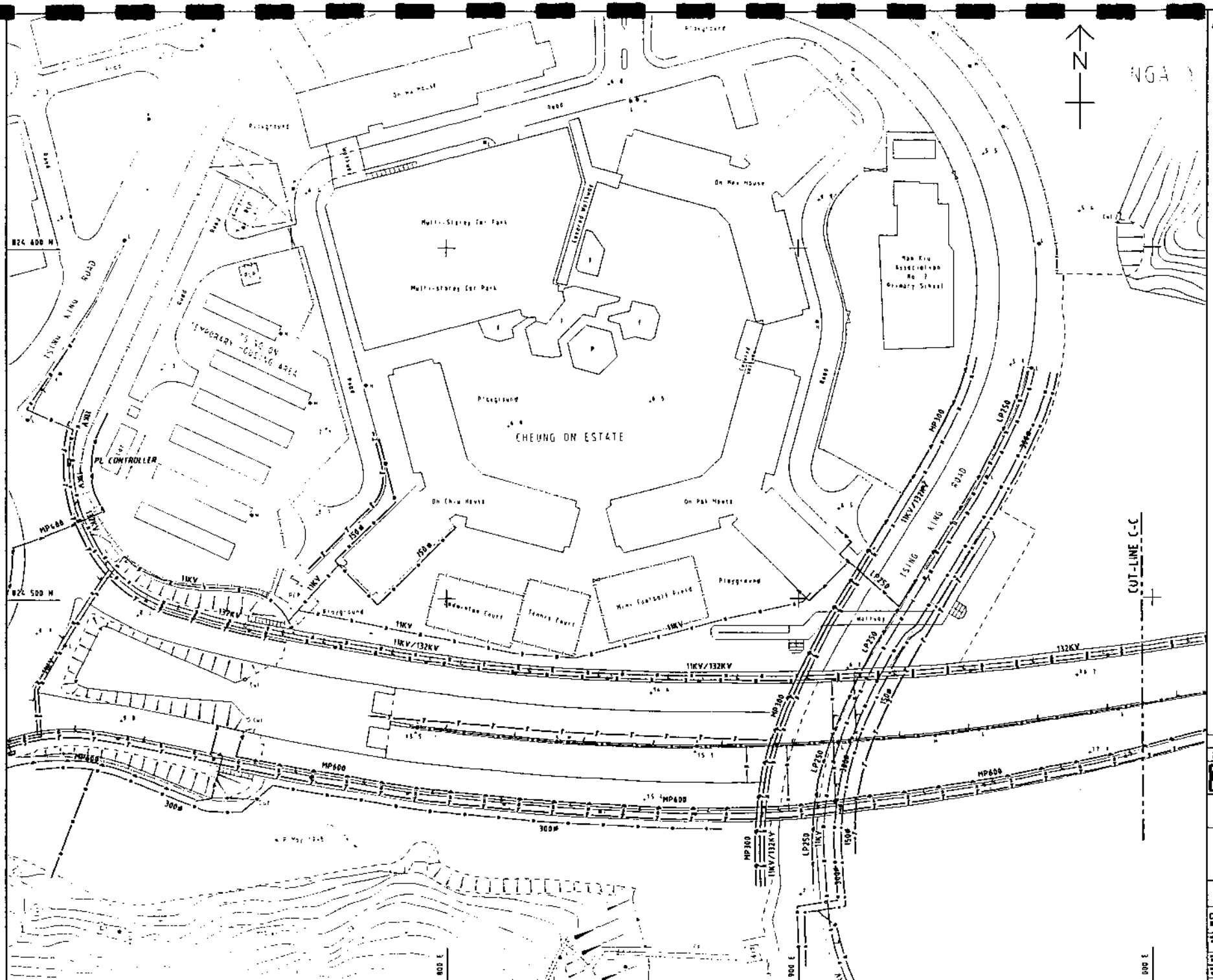

LEGEND:

WATERSUPPLY
- EXISTING FRESH WATER SUPPLY
- EXISTING SALT WATER SUPPLY

ELECTRICITY
- 11KV — EXISTING HIGH TENSION CABLE
- EXISTING PUBLIC LIGHTING CABLE

TELEPHONE
- EXISTING TELEPHONE DUCT

GAS
- EXISTING PRESSURE GASMAIN

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ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE
EXISTING LAYOUT OF UTILITIES AND SERVICES
(SHEET 1)

MAUNSELL CONSULTANTS ASIA LTD

ORG. NO. FIGURE 5-8

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ZYM		PRELIMINARY
SMK		

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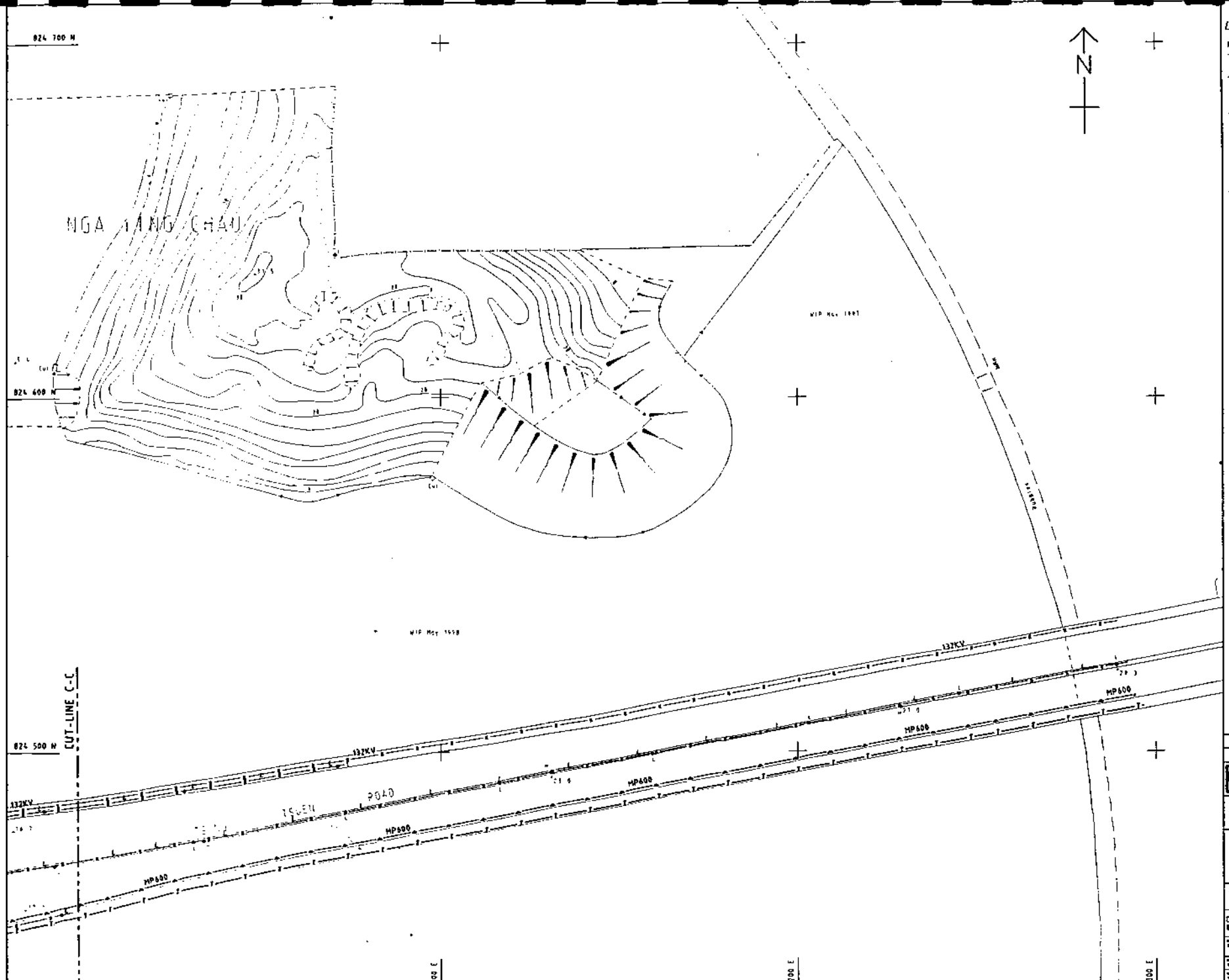

LEGEND.

WATERSUPPLY
- EXISTING FRESH WATER SUPPLY
- EXISTING SALT WATER SUPPLY

ELECTRICITY
- 11KV EXISTING HIGH TENSION CABLE
- EXISTING PUBLIC LIGHTING CABLE

TELEPHONE
- EXISTING TELEPHONE DUCT

GAS
- EXISTING PRESSURE GASMAIN

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ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE
EXISTING LAYOUT OF UTILITIES AND SERVICES

MAUNSELL CONSULTANTS ASIA LTD

DRG. NO. FIGURE 5-8

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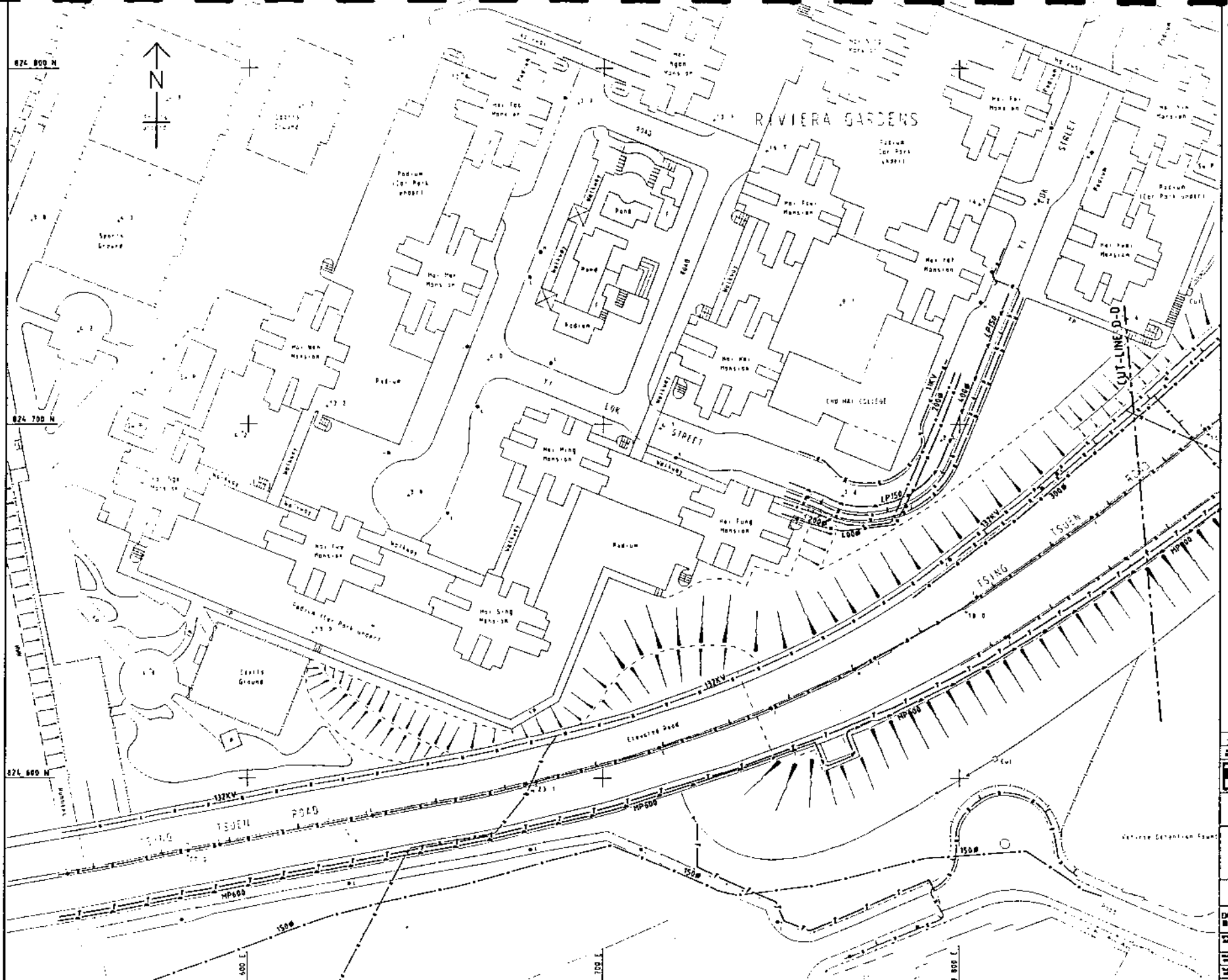
PRELIMINARY

Maunsell



LEGEND:

WATERSUPPLY
- EXISTING FRESH WATER SUPPLY
- EXISTING SALT WATER SUPPLY

ELECTRICITY
- 11KV — EXISTING HIGH TENSION CABLE
- EXISTING PUBLIC LIGHTING CABLE

TELEPHONE
- EXISTING TELEPHONE DUCT

GAS
- EXISTING PRESSURE GASMAIN

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ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE
EXISTING LAYOUT OF UTILITIES AND SERVICES

MAUNSELL CONSULTANTS ASIA LTD

DRG. NO. FIGURE 5-9

AE | (E MS/93) | PRELIMINARY

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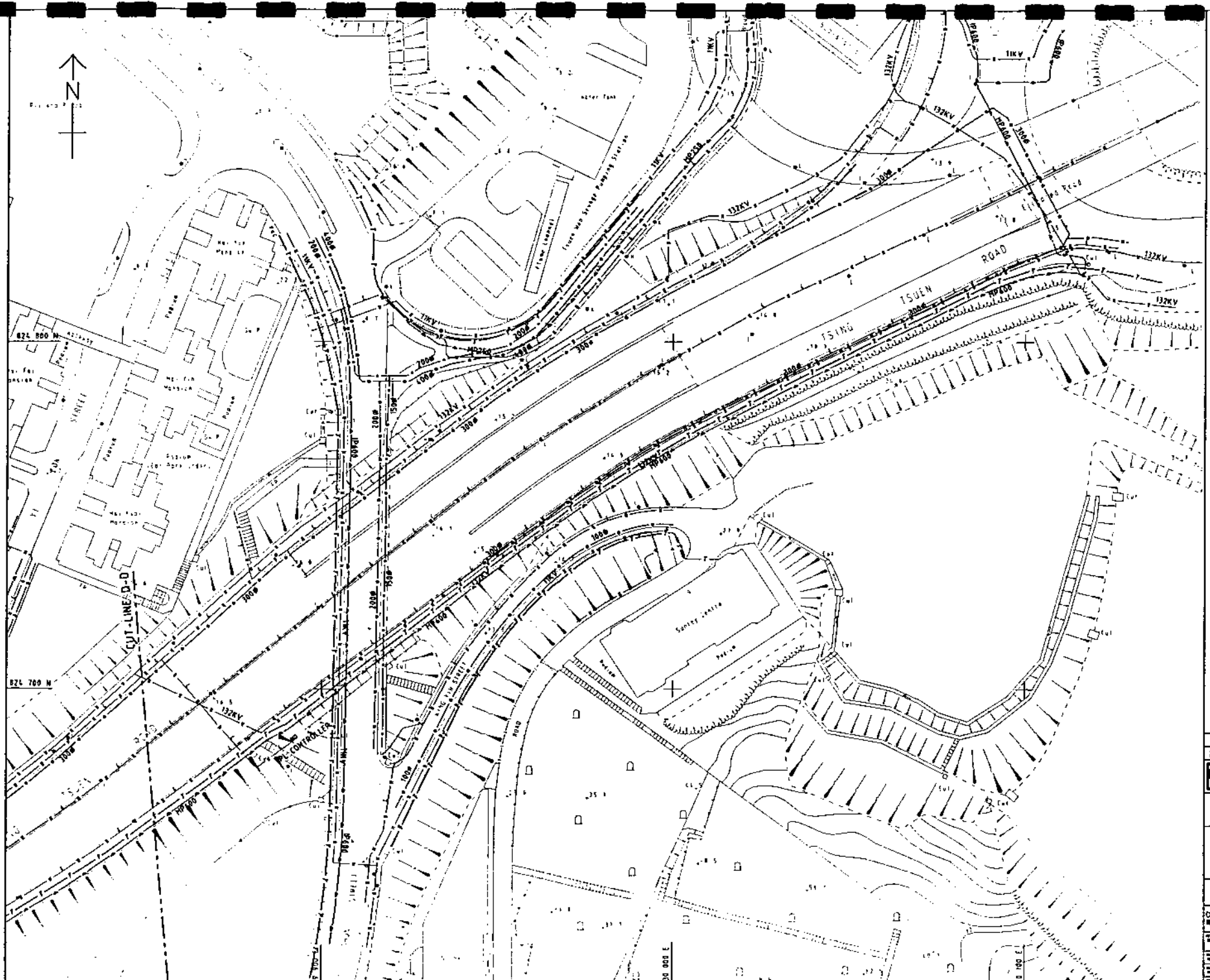
LEGEND:
WATERSUPPLY
EXISTING FRESH WATER SUPPLY
EXISTING SALT WATER SUPPLY
ELECTRICITY
11KV
EXISTING HIGH TENSION CABLE
EXISTING PUBLIC LIGHTING CABLE
TELEPHONE
EXISTING TELEPHONE DUCT
GAS
EXISTING PRESSURE GASMAIN
TSING TSUEN ROAD
CUT-LINE D-D
PL CONTROLLER
824 800 N
824 700 N
FIRST ISSUE
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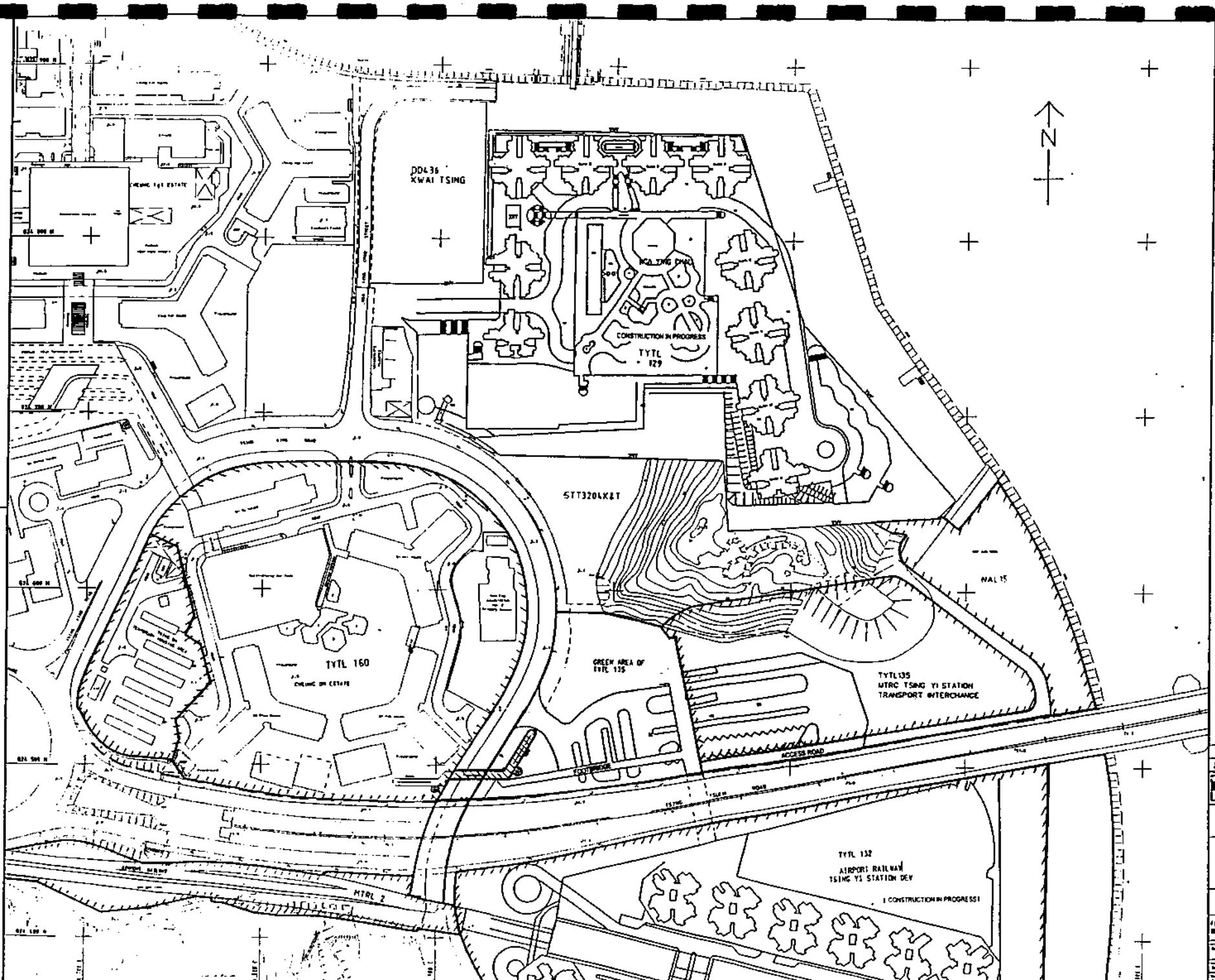
TSING TSUEN BRIDGE EXISTING LAYOUT OF UTILITIES AND SERVICES
(SHEET 2)
MAUNSELL CONSULTANTS ASIA LTD
ORG. NO.
FIGURE 5-9
PRELIMINARY
Maunsell



ENVIRONMENTAL
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FEASIBILITY STUDY FOR PROVIDING
NOISE MITIGATION MEASURES
ON EXISTING FLYOVERS

TSING TUEN BRIDGE
LAND STATUS PLAN

SHEET 1 OF 1

MAUNSELL CONSULTANTS ASIA LTD.

FIGURE NO. Figure 5-10

PRELIMINARY

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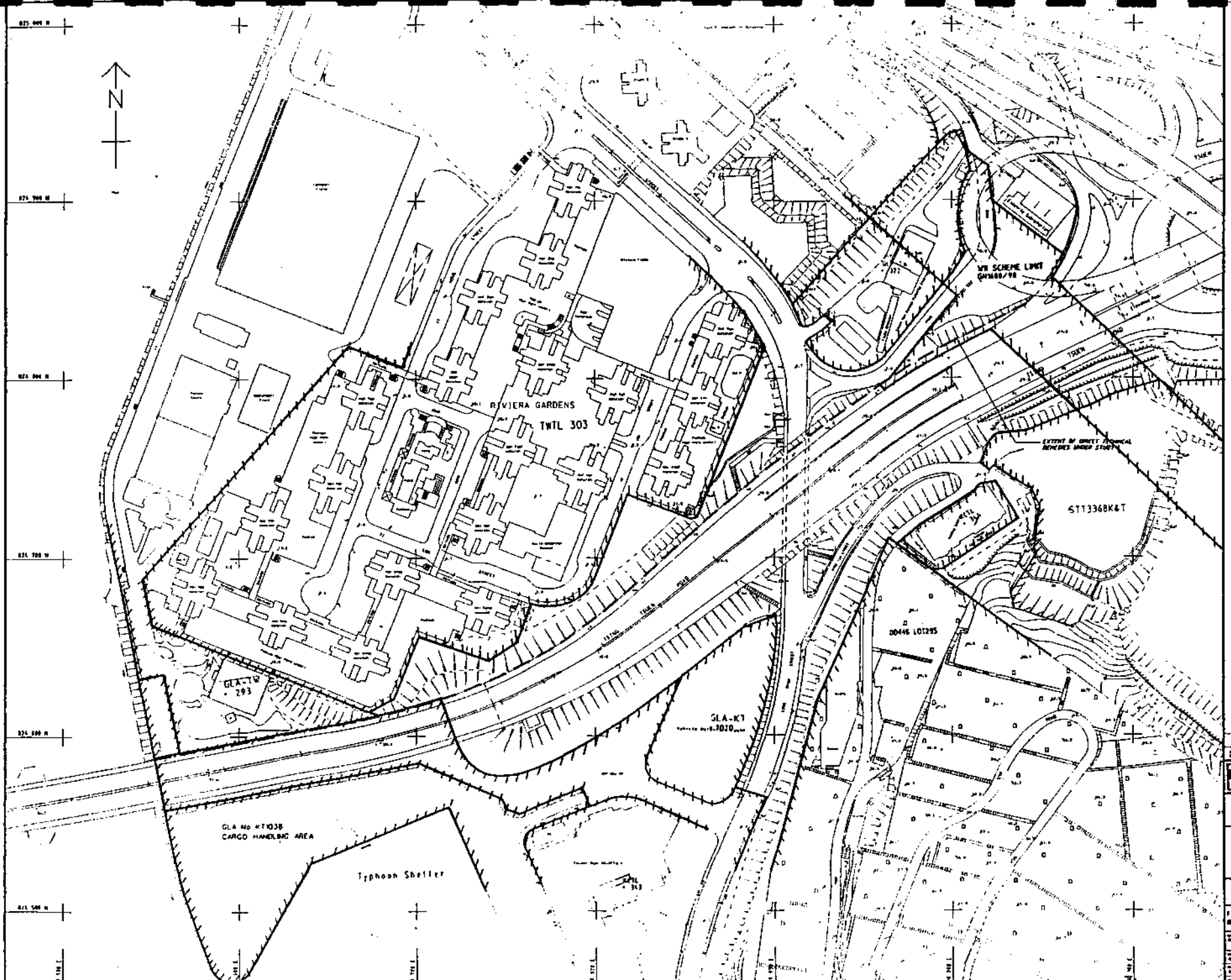

ENVIRONMENTAL PROTECTION DEPARTMENT

FEASUBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TUEN BRIDGE
LAND STATUS PLAN

SHEET 1 OF 1

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FIGURE NO. Figure 5-11

PRELIMINARY

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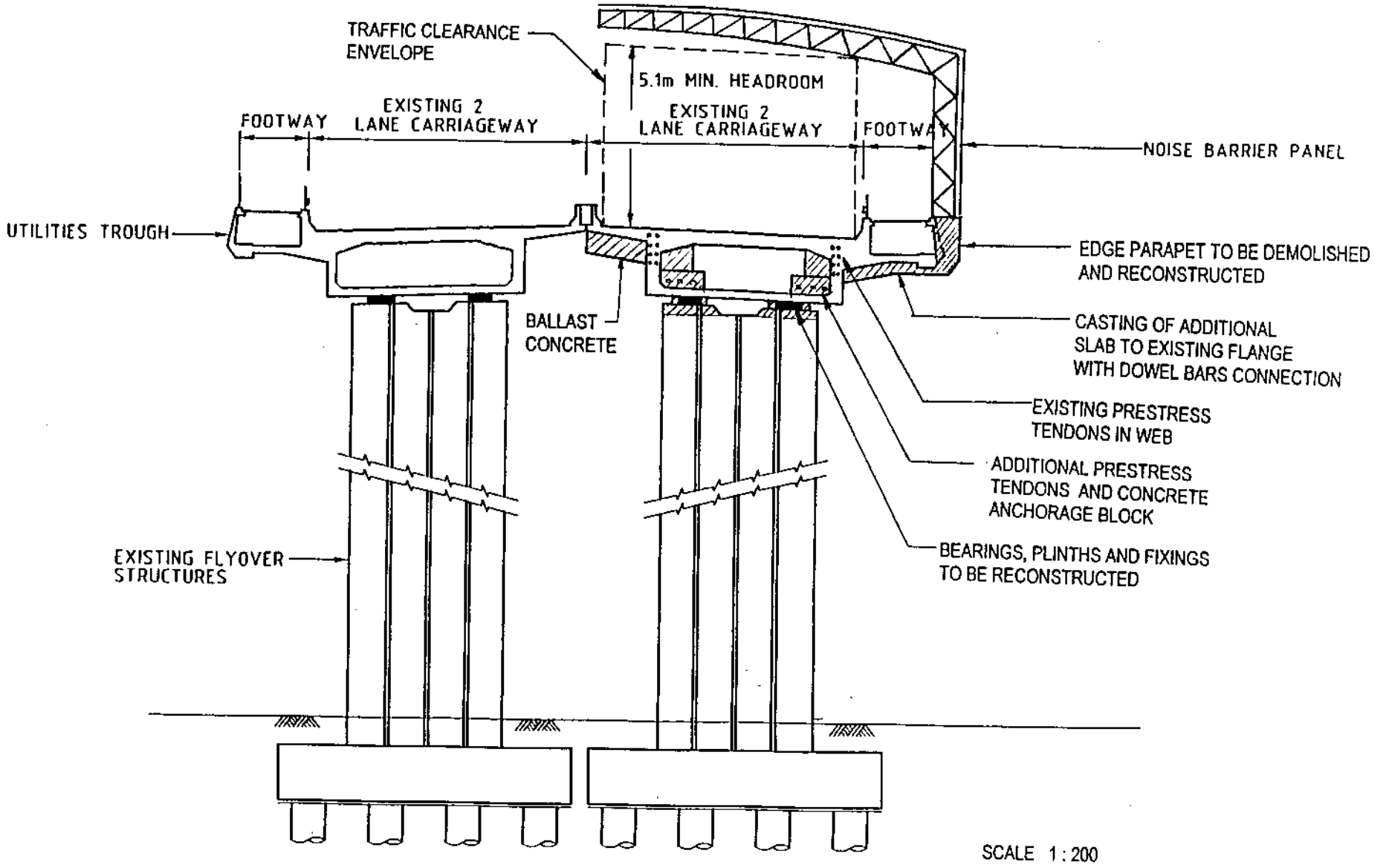

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE - CONCEPTUAL DETAILS OF BRIDGE STRENGTHENING WORKS FOR NOISE BARRIER DIRECT INSTALLATION ON FLYOVER

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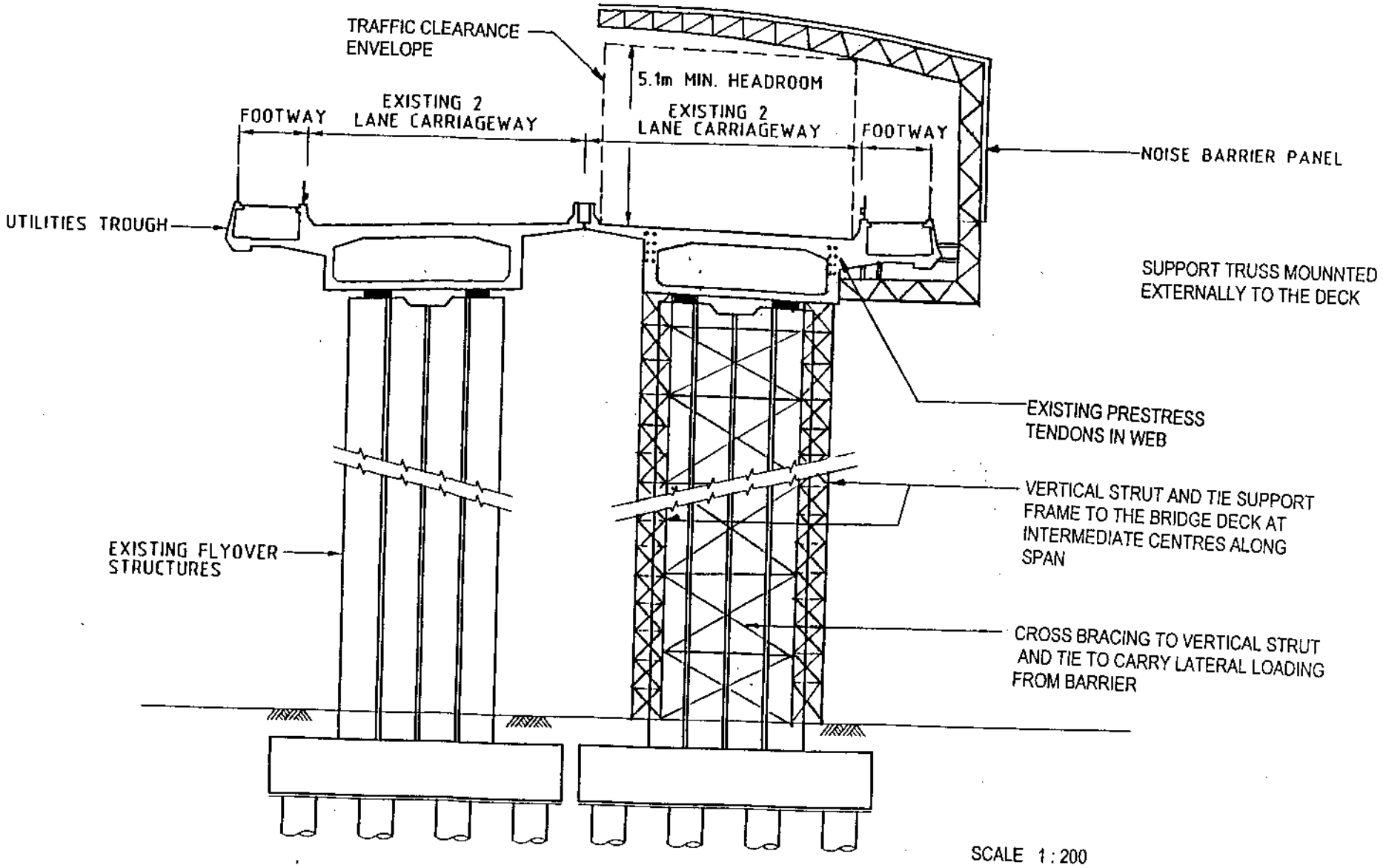
FIGURE: 5-12



FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE - CONCEPTUAL DETAILS OF BRIDGE STRENGTHENING WITH EXTERNAL SUPPORT

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茂盛(亞洲)工程顧問有限公司

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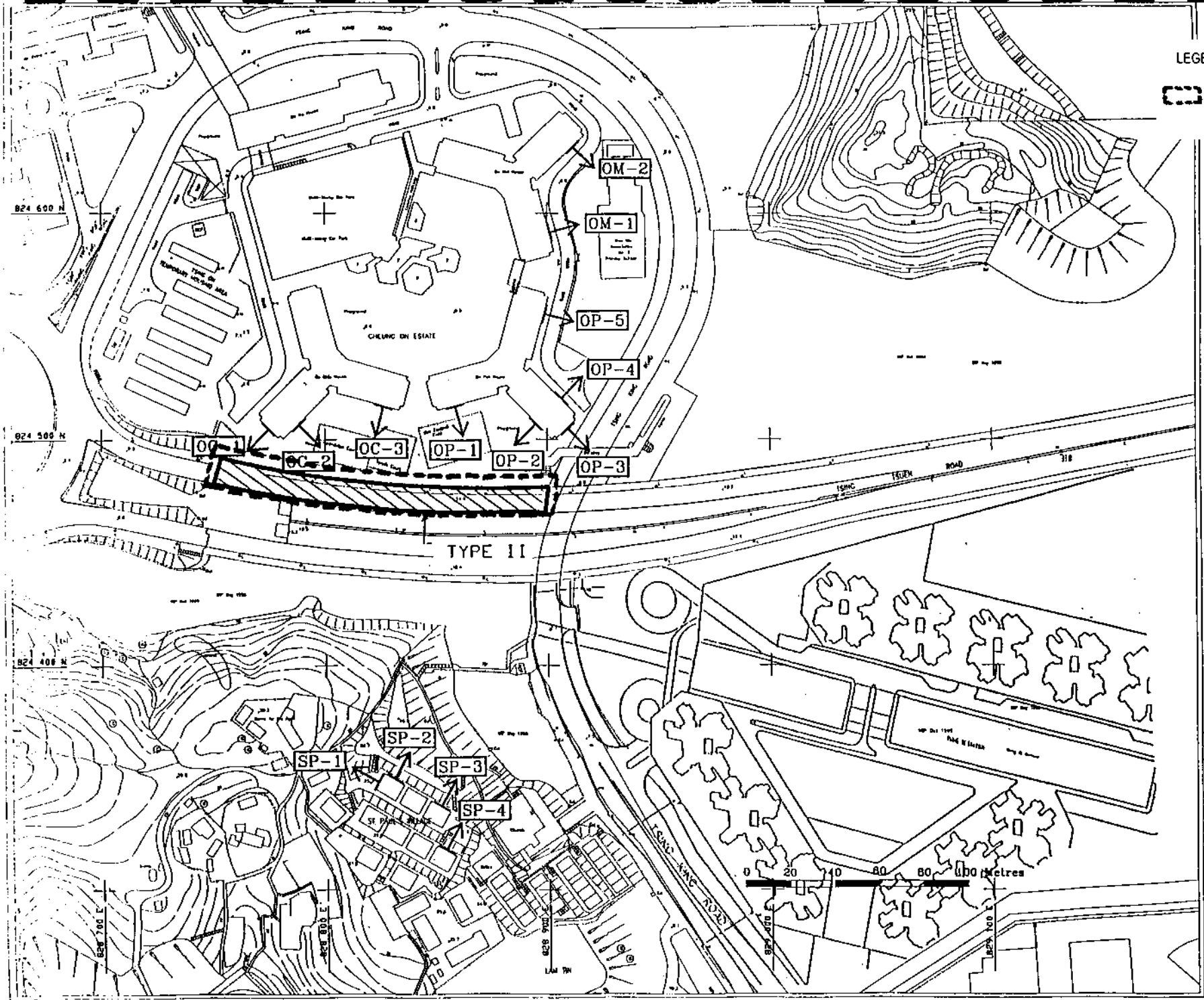
FIGURE: 5-13



ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE
LAND REQUIREMENT PLAN
(SHEET 1)

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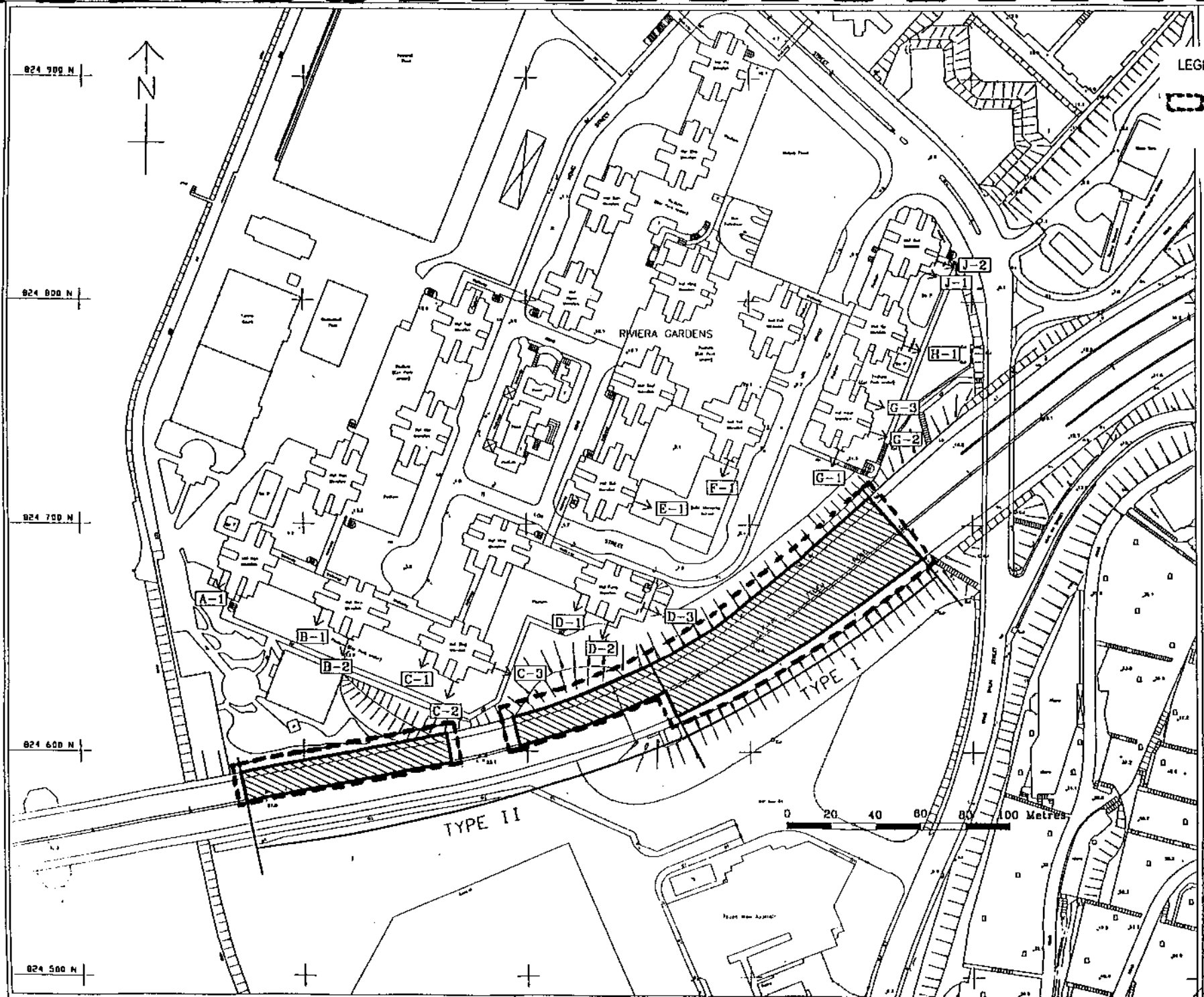
FIGURE NO	Figure 5-14
SCALE	AS SHOWN

Maunsell



LEGEND:

BOUNDARY OF LANDS FOR POSITIONING MITIGATION STRUCTURE

ENVIRONMENTAL PROTECTION DEPARTMENT

FEASIBILITY STUDY FOR PROVIDING NOISE MITIGATION MEASURES ON EXISTING FLYOVERS

TSING TSUEN BRIDGE
LAND REQUIREMENT PLAN
(SHEET 2)

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FIGURE NO. Figure 5-15

SCALE AS SHOWN

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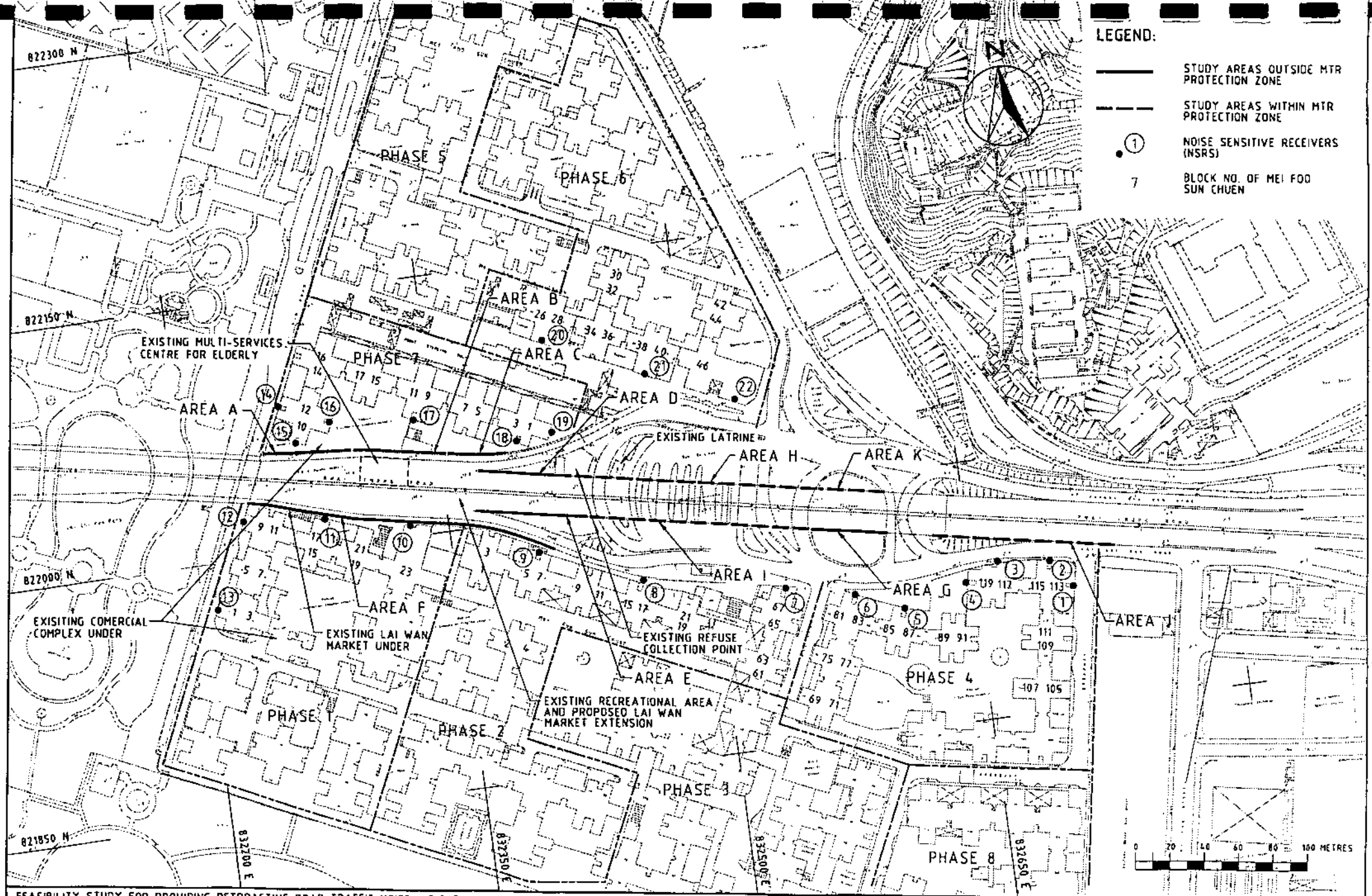


FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

GENERAL LAYOUT PLAN OF STUDY AREA FOR KWAI CHUNG ROAD FLYOVER NEAR MEI FOO SUN CHUEN

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

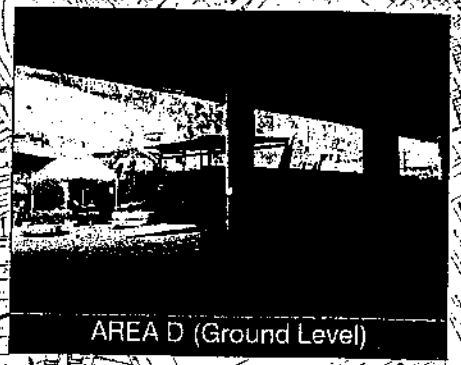
FIGURE: FIG 6-1

(GF) P:\PROJECTS\95796\REPORT-4\FIG1-1.DGN

AREA A (Ground Level)

AREA B (Ground Level)

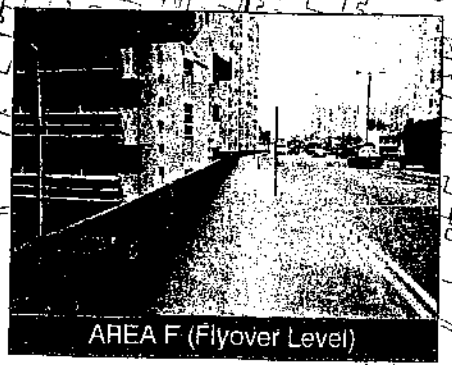
AREA C (Ground Level)



AREA D (Ground Level)

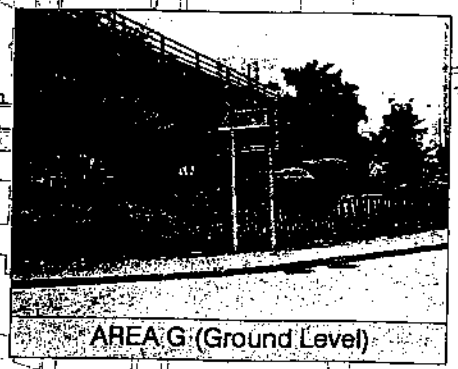
AREA E (Flyover Level)

AREA F (Ground Level)



AREA F (Flyover Level)

AREA B & C (Flyover Level)



AREA G (Ground Level)

FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

SITE FEATURES AT KWAI CHUNG ROAD FLYOVER

SCALE 1 : 2500

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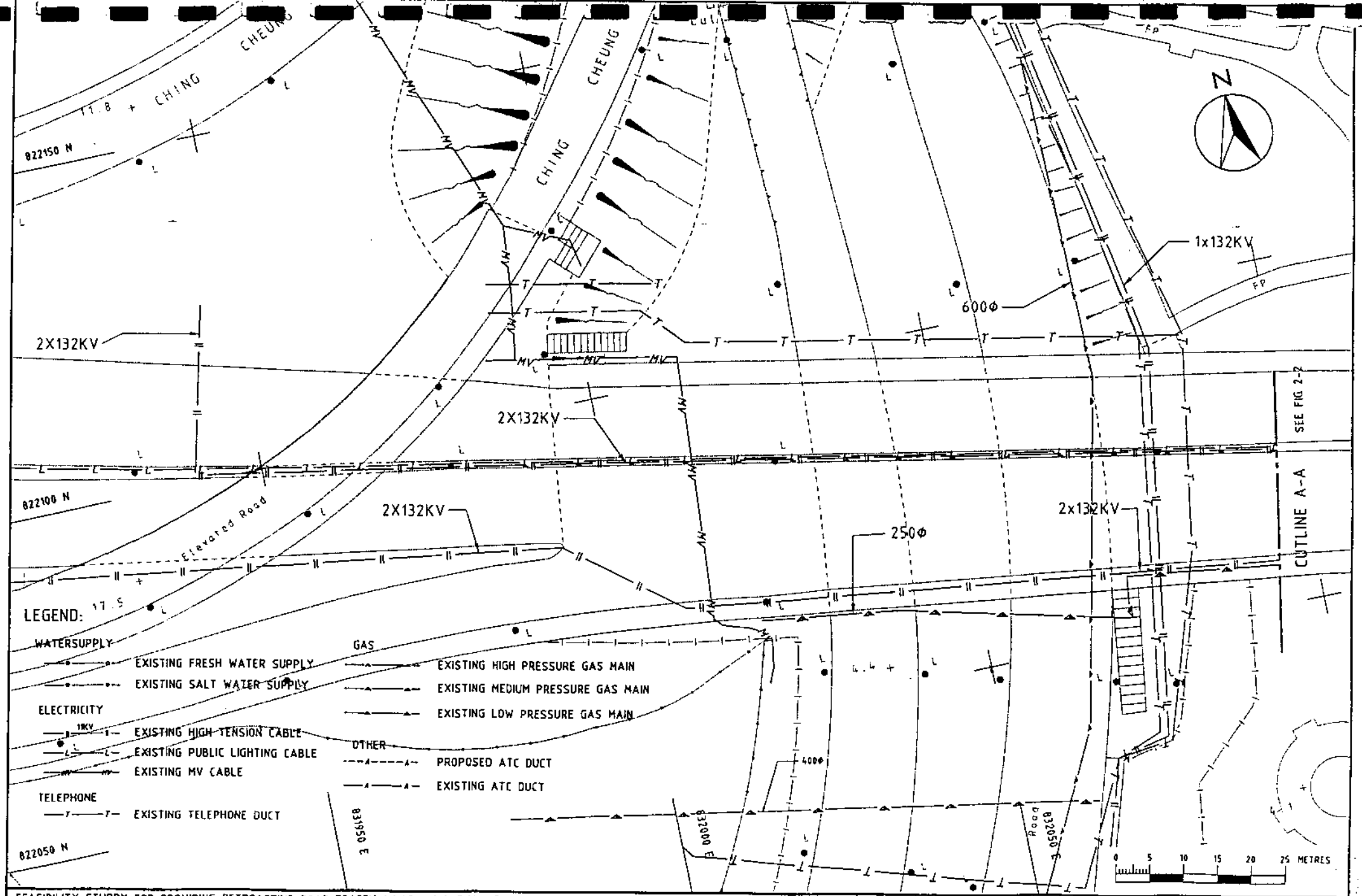
JOB NO.: 95796

FIGURE: FIG 6-2



FEASIBILITY STUDDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

EXISITNG UTILITIES AND SERVICES AT KWAI CHUNG ROAD FLYOVER

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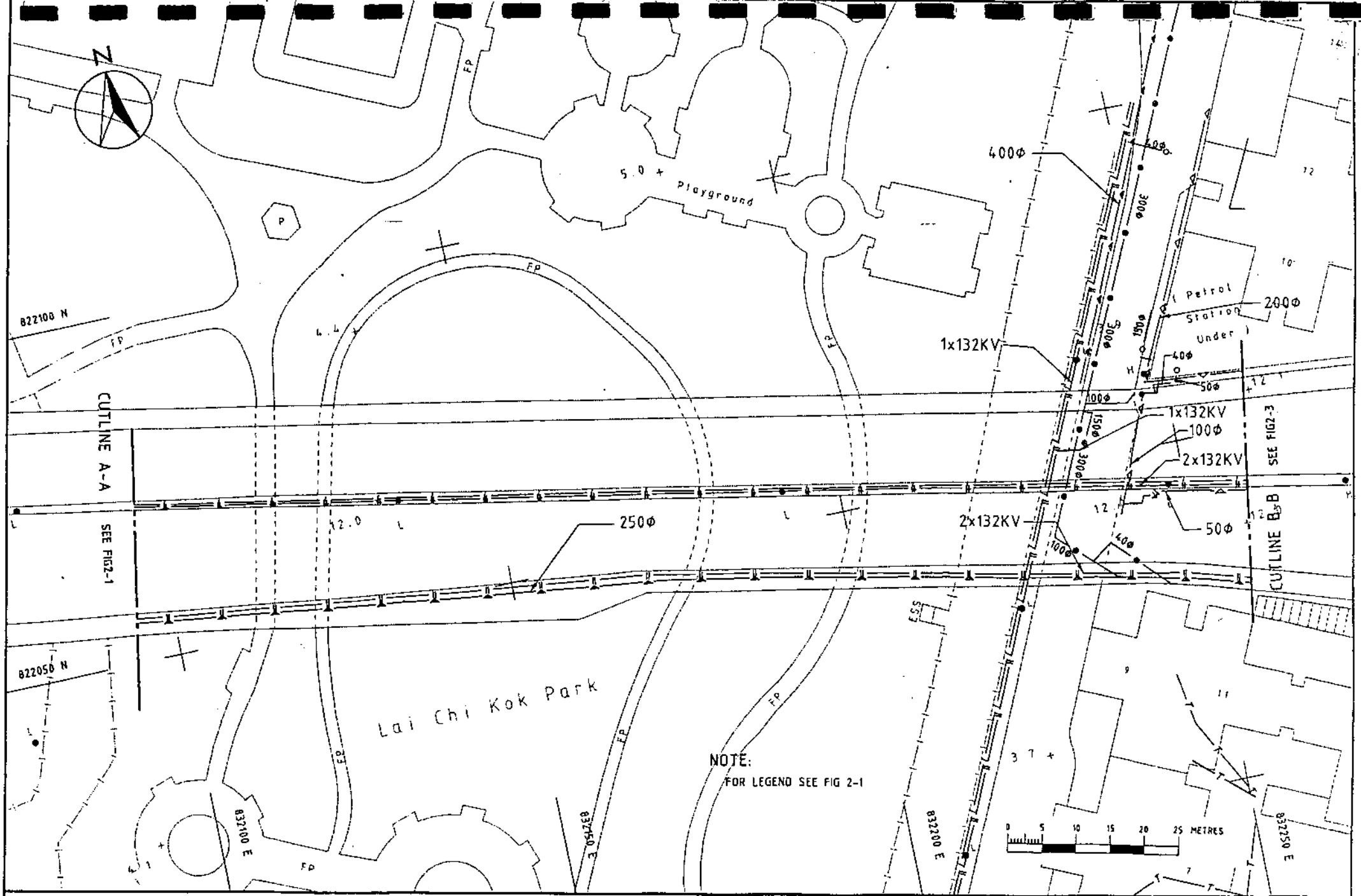
JOB NO.: 95796

FIGURE: FIG 6-3



FEASIBILITY STUDY FOR PROVIDIGN RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

EXISTING UTILITIES AND SERVICES AT KWAI CHUNG ROAD FLYOVER

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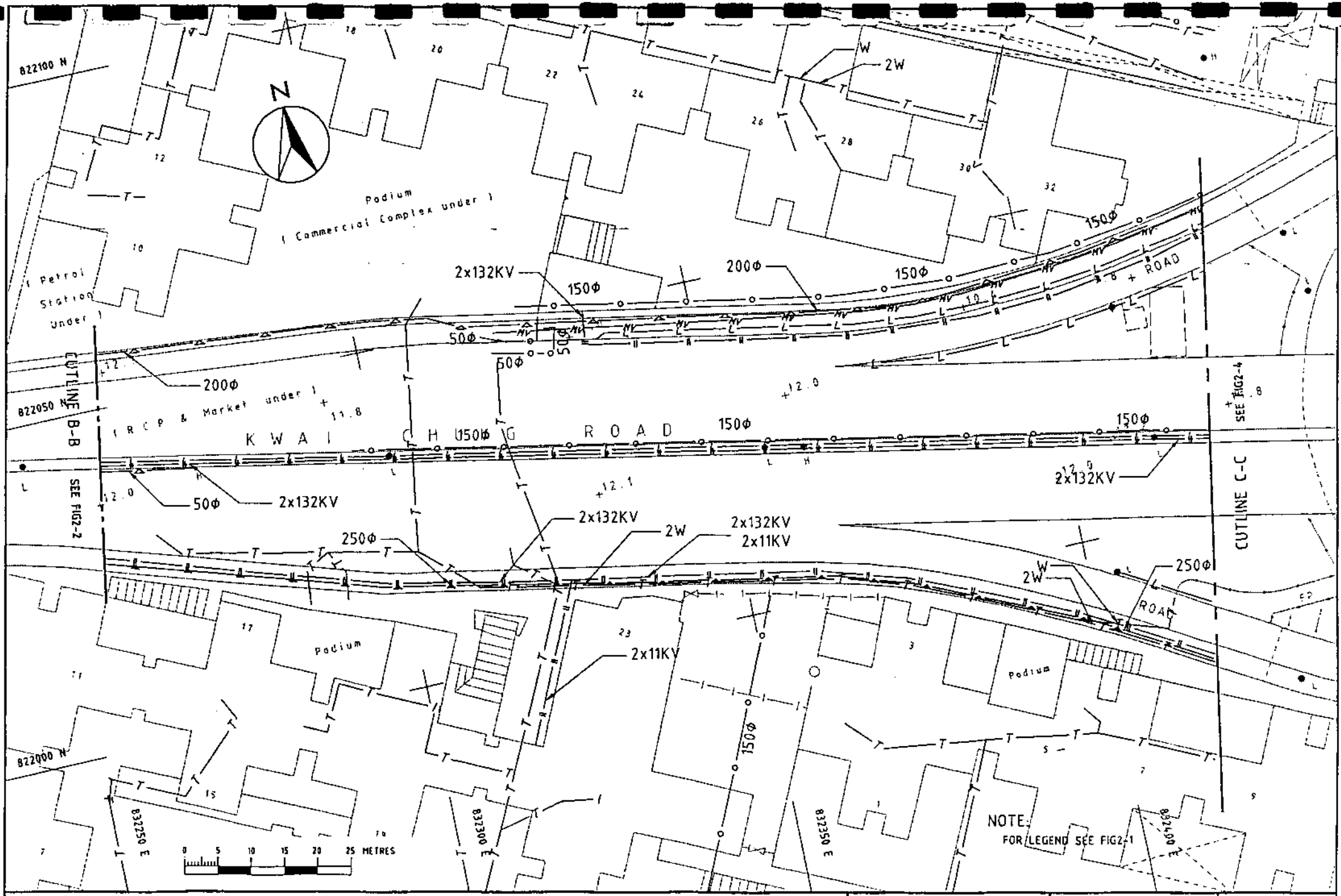
JOB NO.: 95796

FIGURE: FIG 6-4



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

EXISTING UTILITIES AND SERVICES AT KWAI CHUNG ROAD FLYOVER

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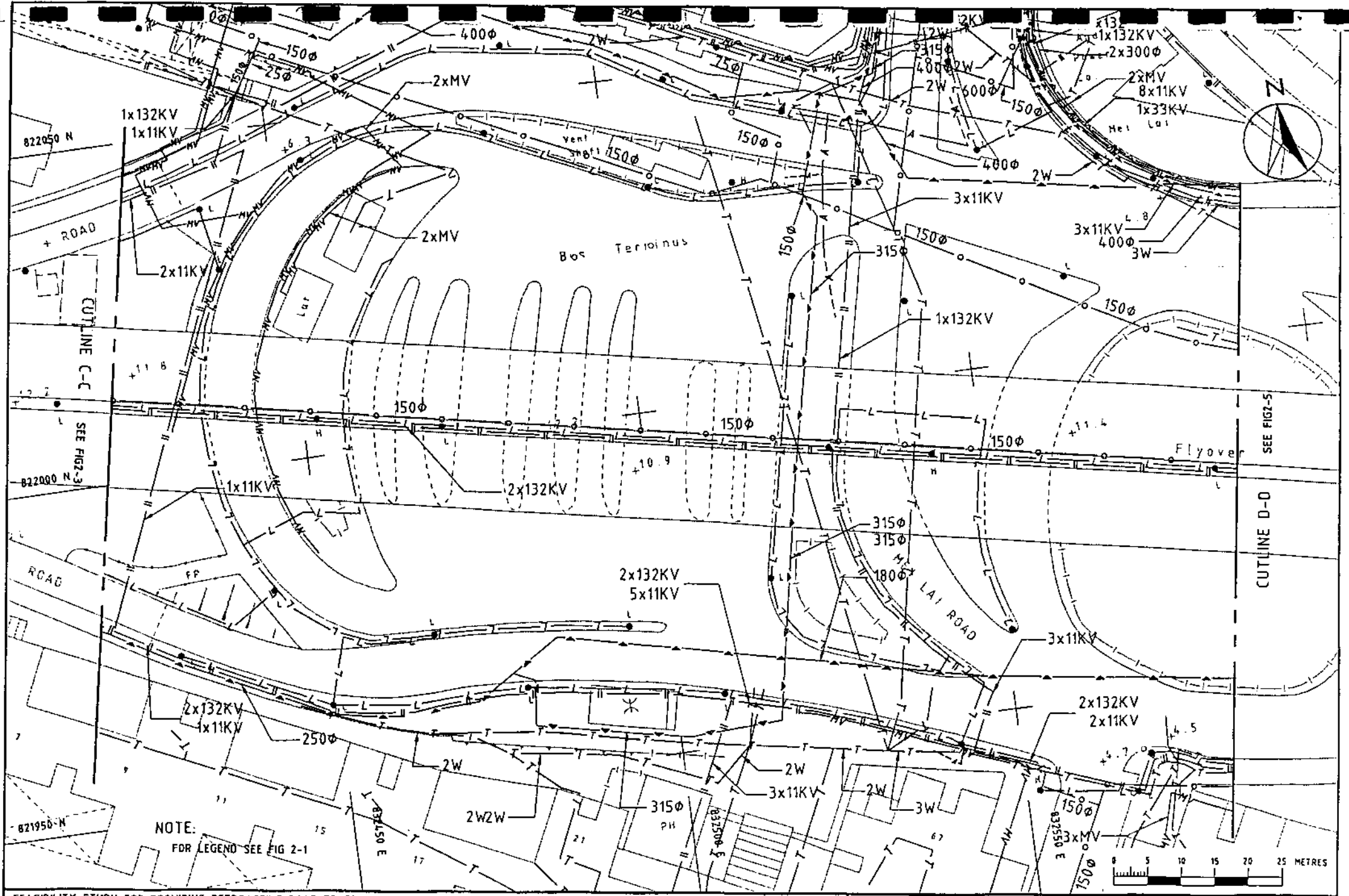
JOB NO.: 95796

FIGURE: FIG 6-5



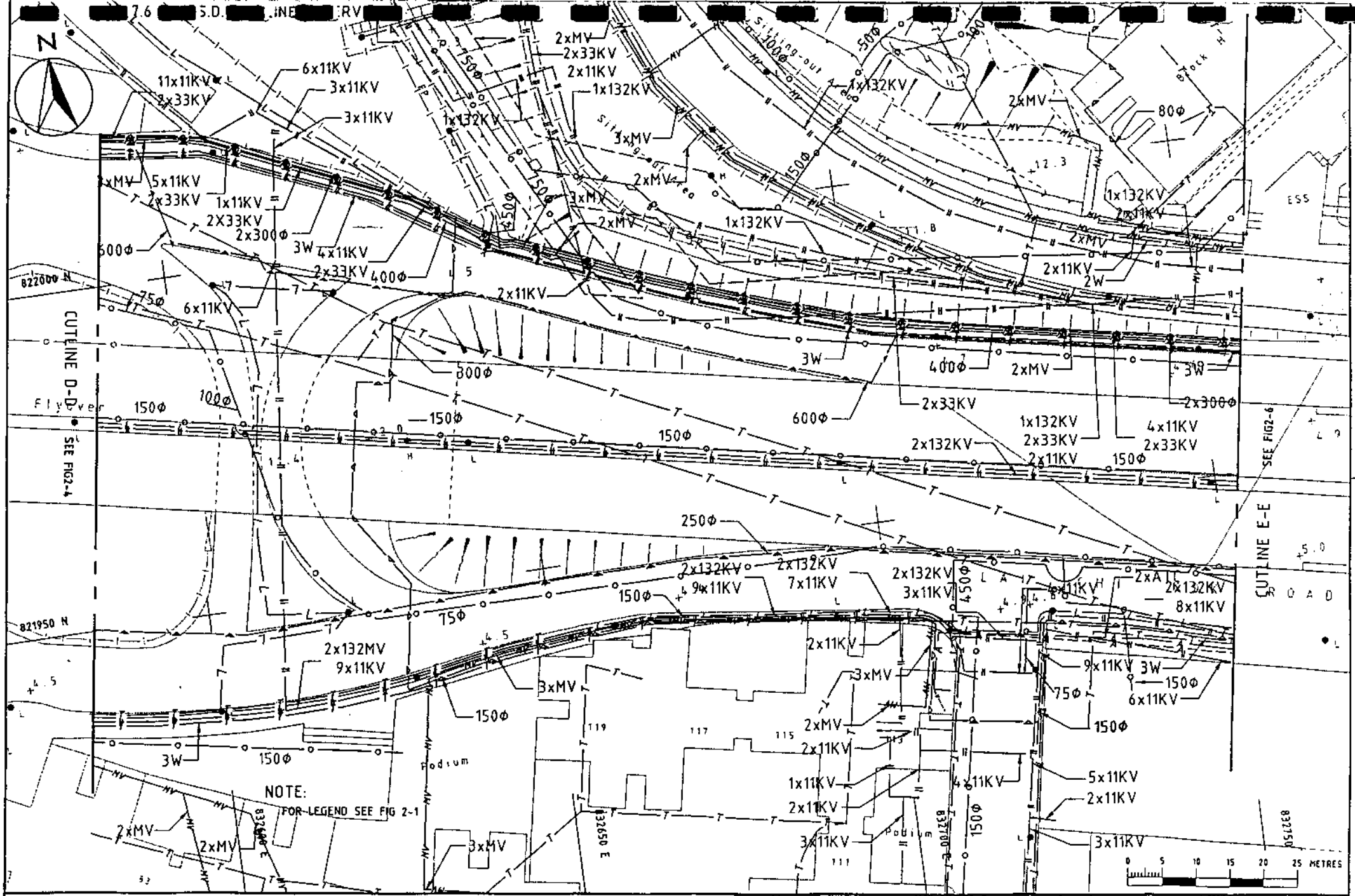
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

EXISTING UTILITIES AND SERVICES AT KWAI CHUNG ROAD FLYOVER

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 6-6



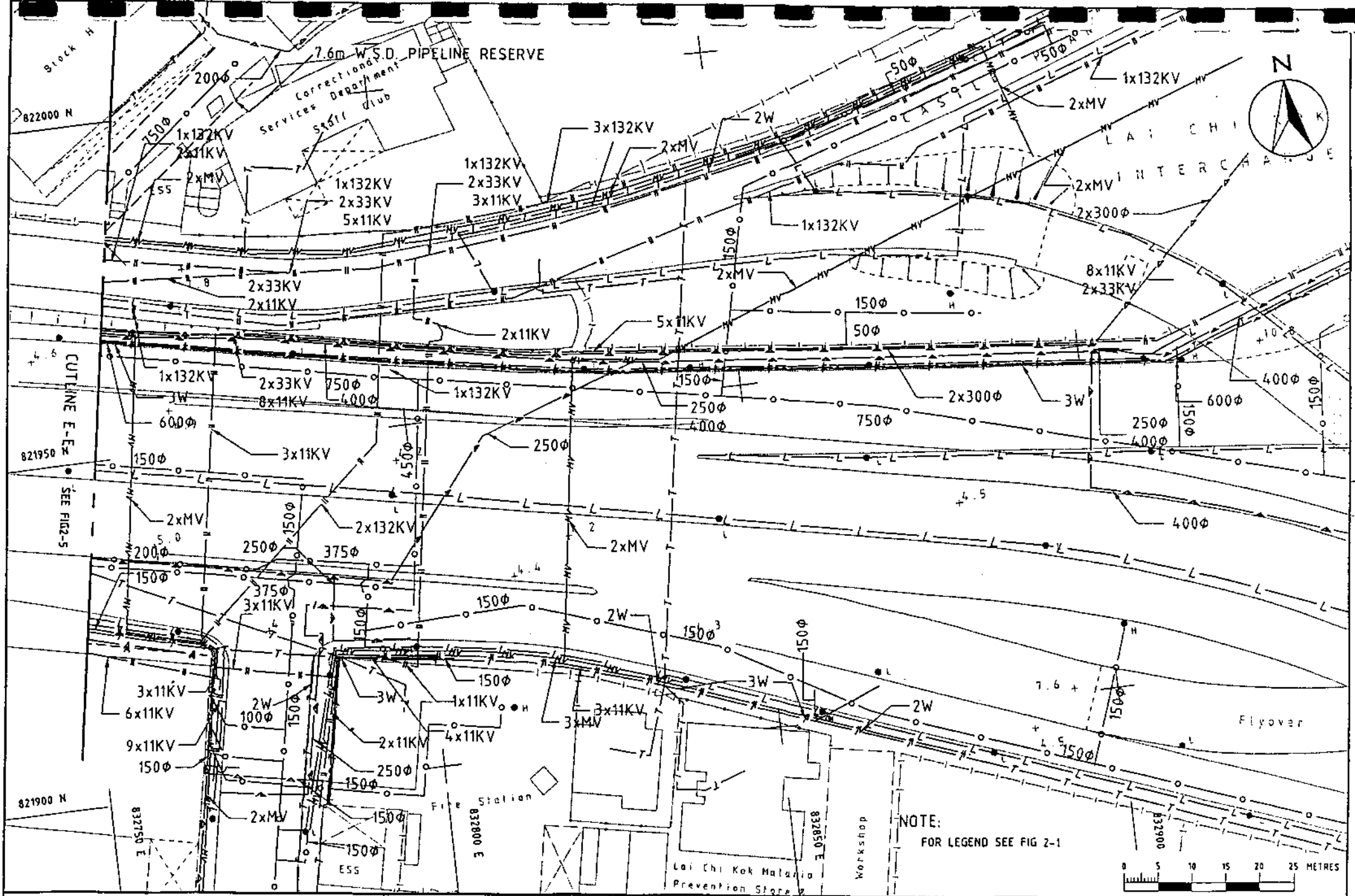
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

EXISTING UTILITIES AND SERVICES AT KWAI CHUNG ROAD FLYOVER

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 6-7



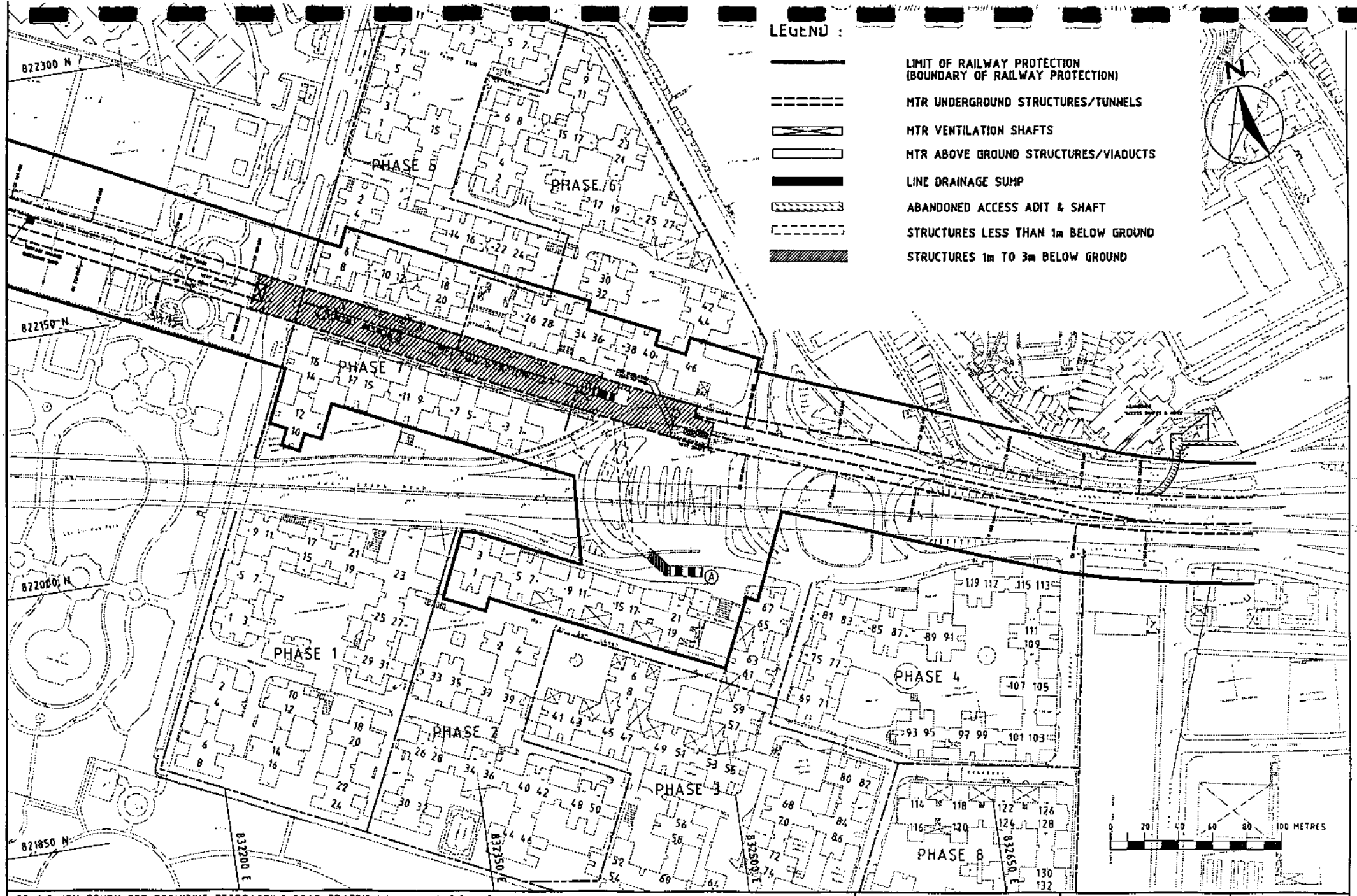
FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

EXISTING UTILITIES AND SERVICES AT KWAI CHUNG ROAD FLYOVER

Maunsell 茂盛(亞洲)工程顧問有限公司

JOB NO.: 95796

FIGURE: FIG 6-8



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

MASS TRANSIT RAILWAY-
RAILWAY PROTECTION PLAN, MEI FOO STATION AND TUNNELS

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茂盛(亞洲)工程顧問有限公司

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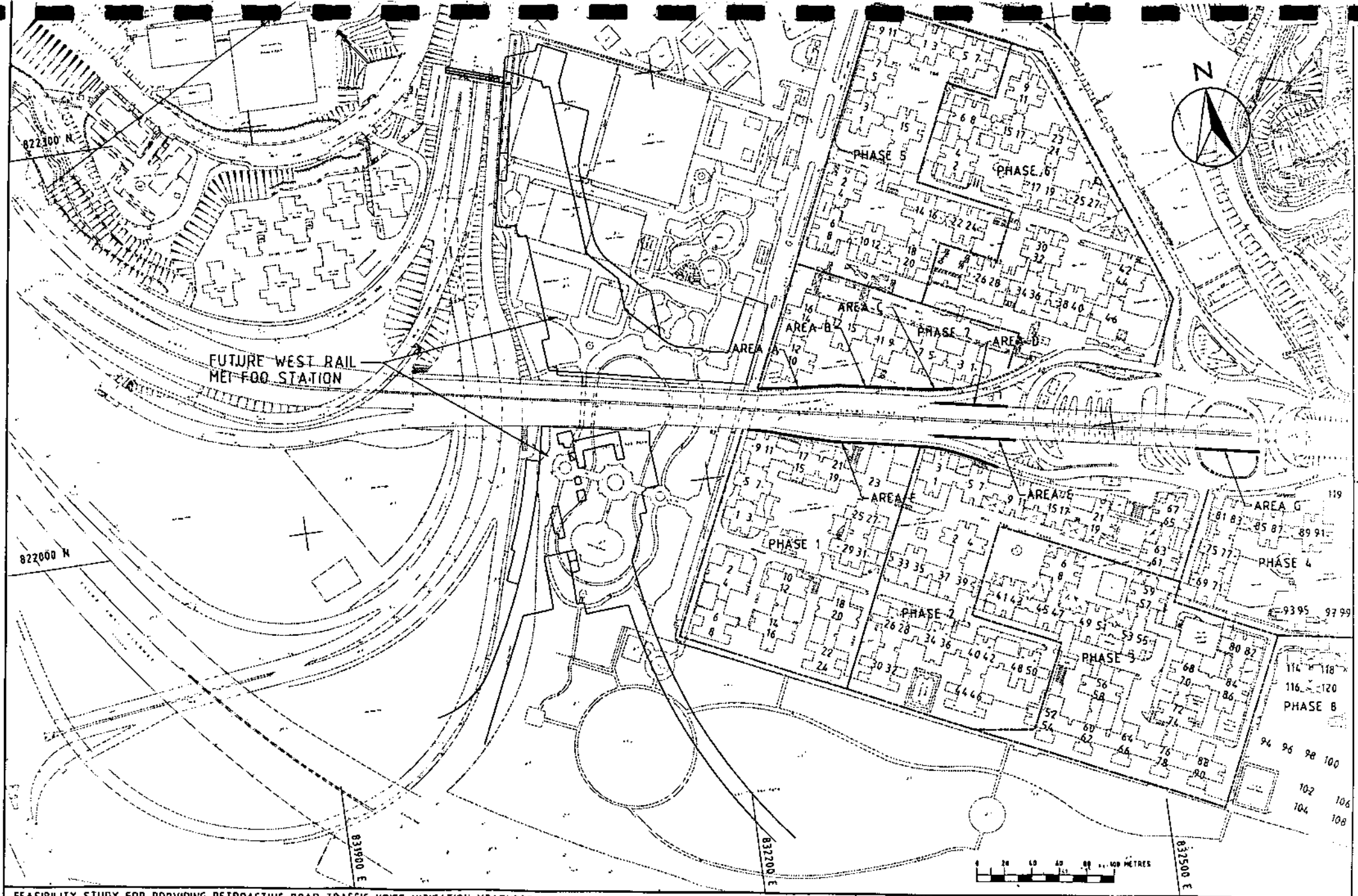
FIGURE: FIG 6-9



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

FUTURE WEST RAIL MEI FOO STATION

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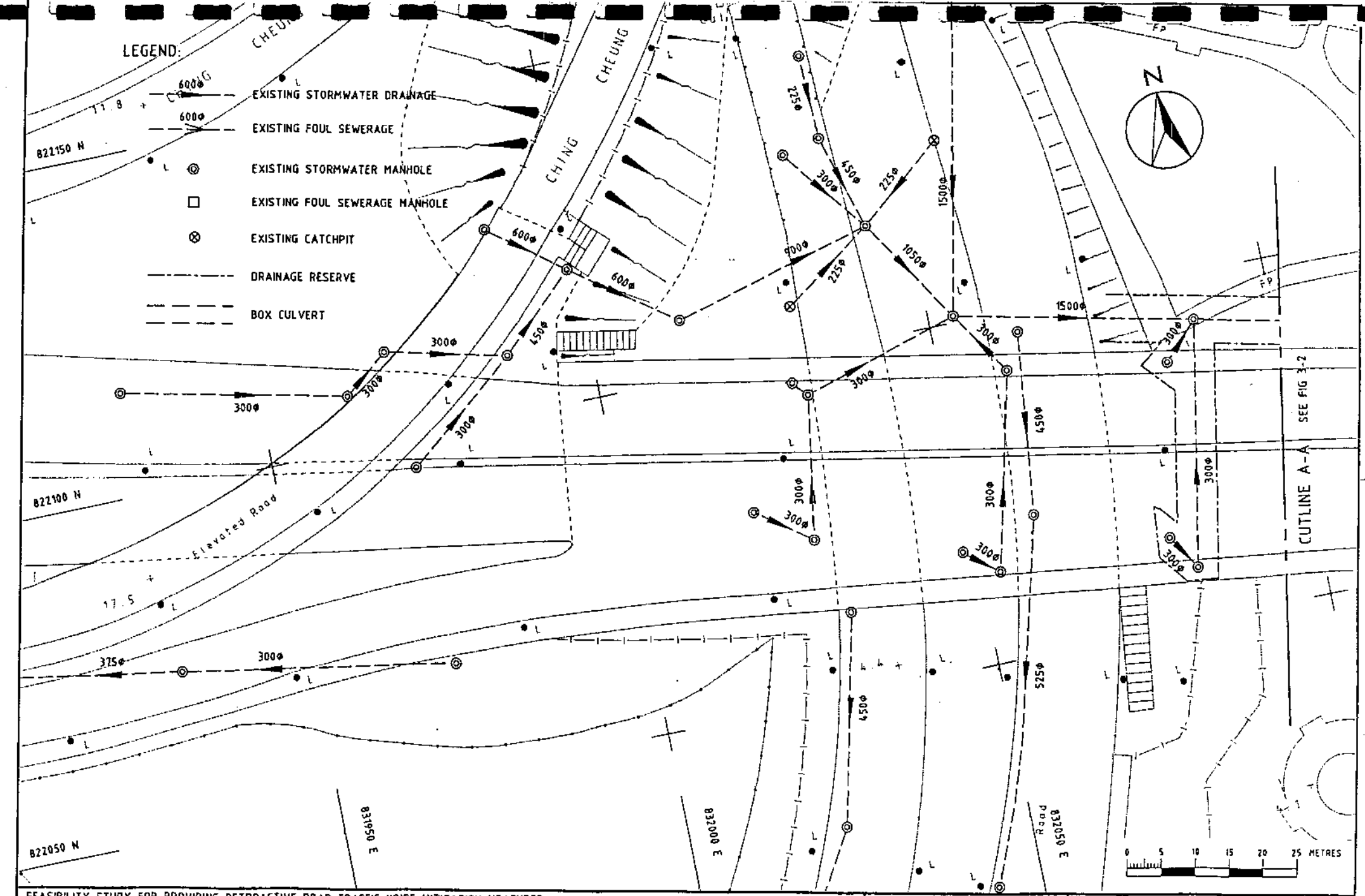
FIGURE: FIG 6-10



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

EXISTING DRAINAGE AND SEWERAGE AT KWAI CHUNG ROAD FLYOVER

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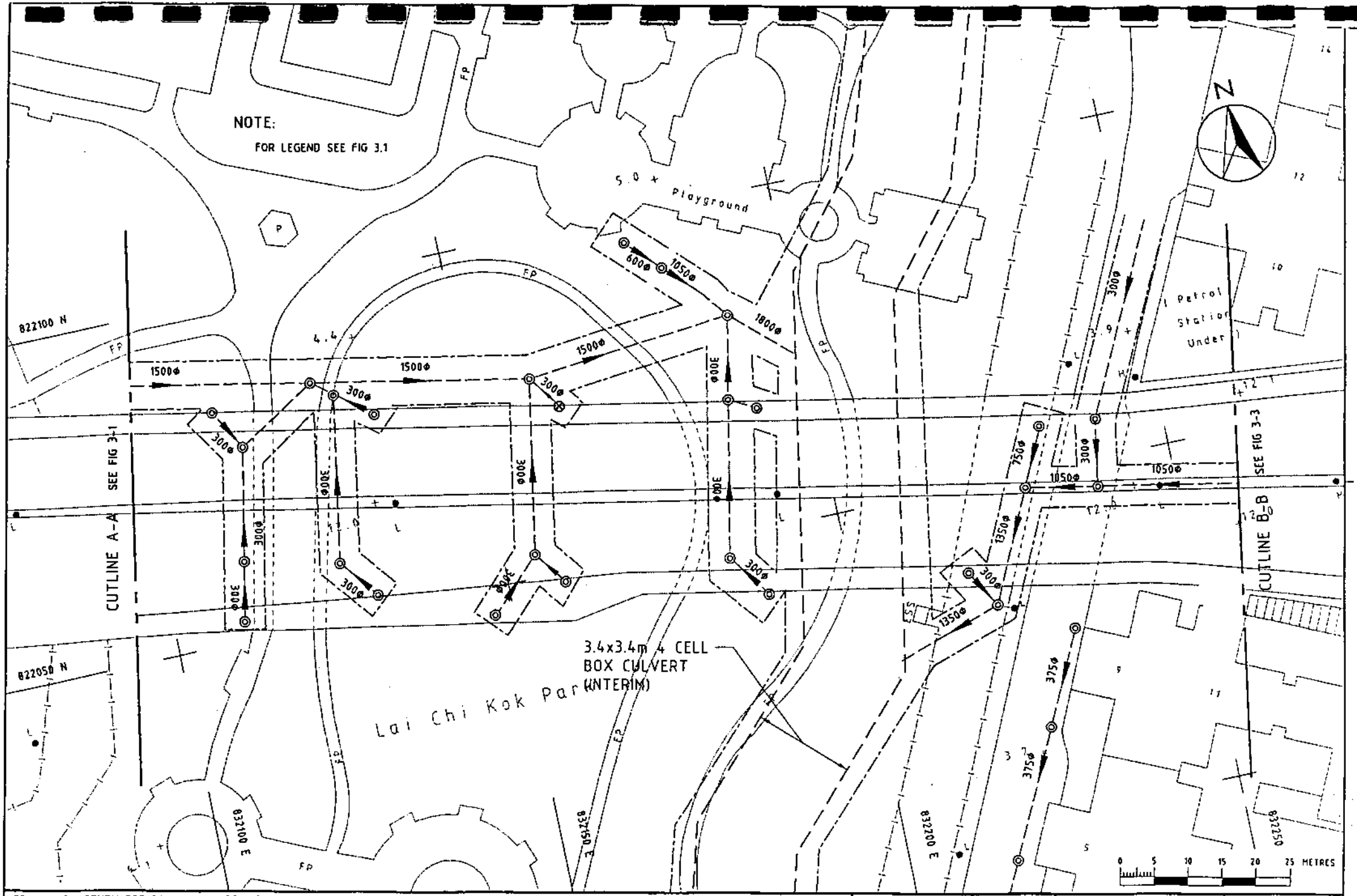
FIGURE: FIG 6-11



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EXISTING DRAINAGE AND SEWERAGE AT KWAI CHUNG ROAD FLYOVER

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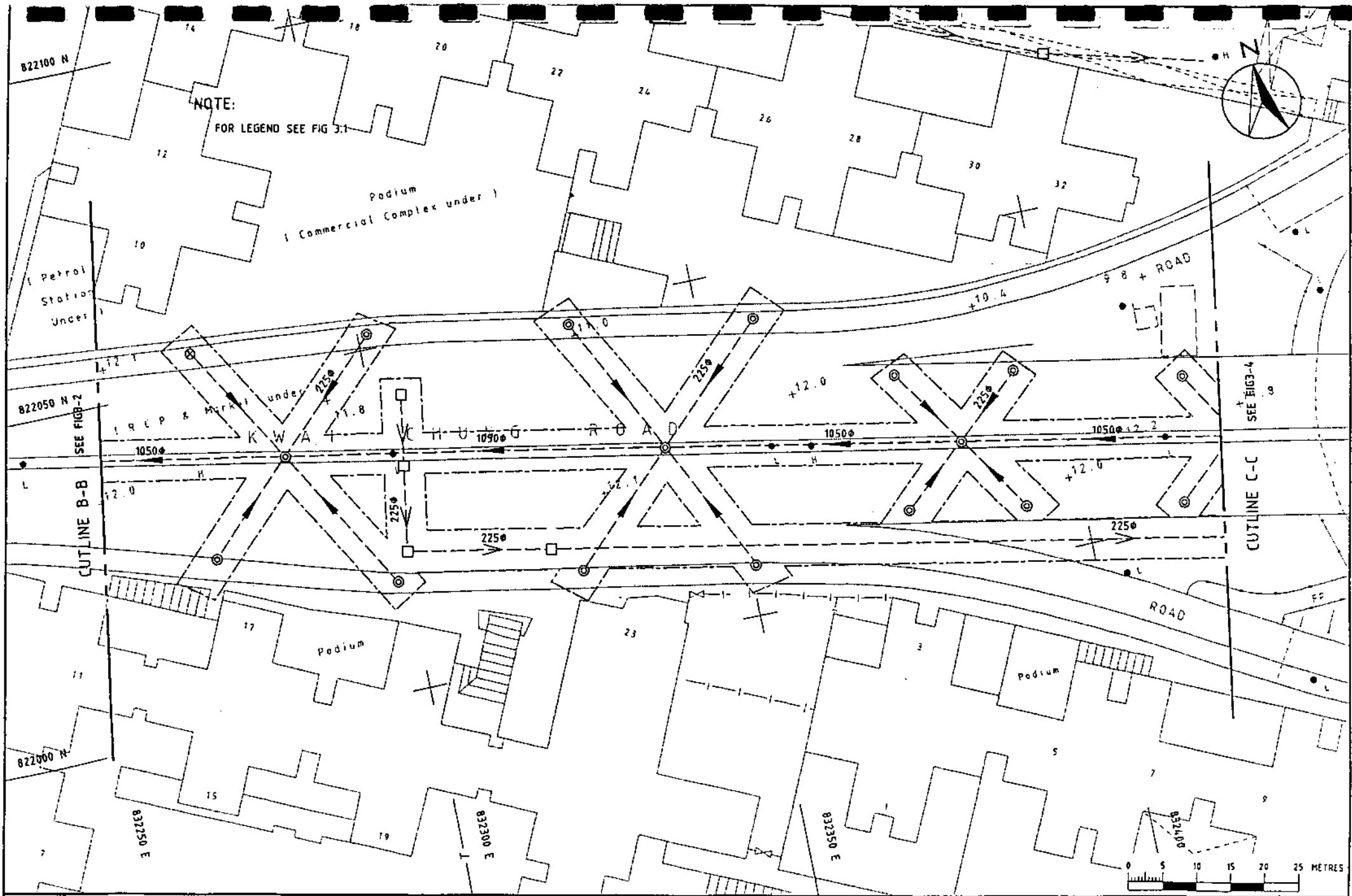
FIGURE: FIG 6-12



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

EXISTING DRAINAGE AND SEWERAGE AT KWAI CHUNG ROAD FLYOVER

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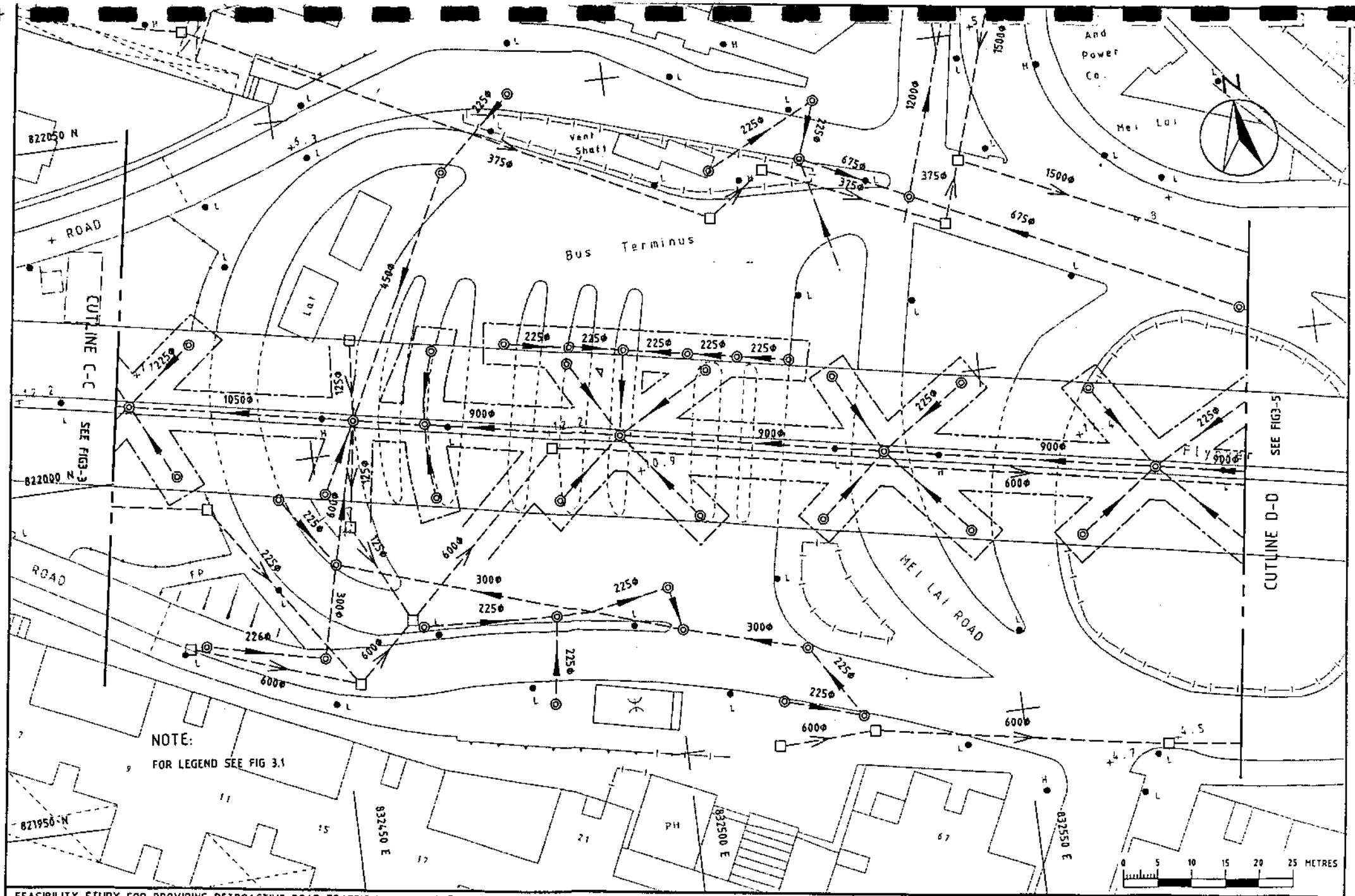
FIGURE: FIG 6-13



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

EXISTING DRAINAGE AND SEWERAGE AT KWAI CHUNG ROAD FLYOVER

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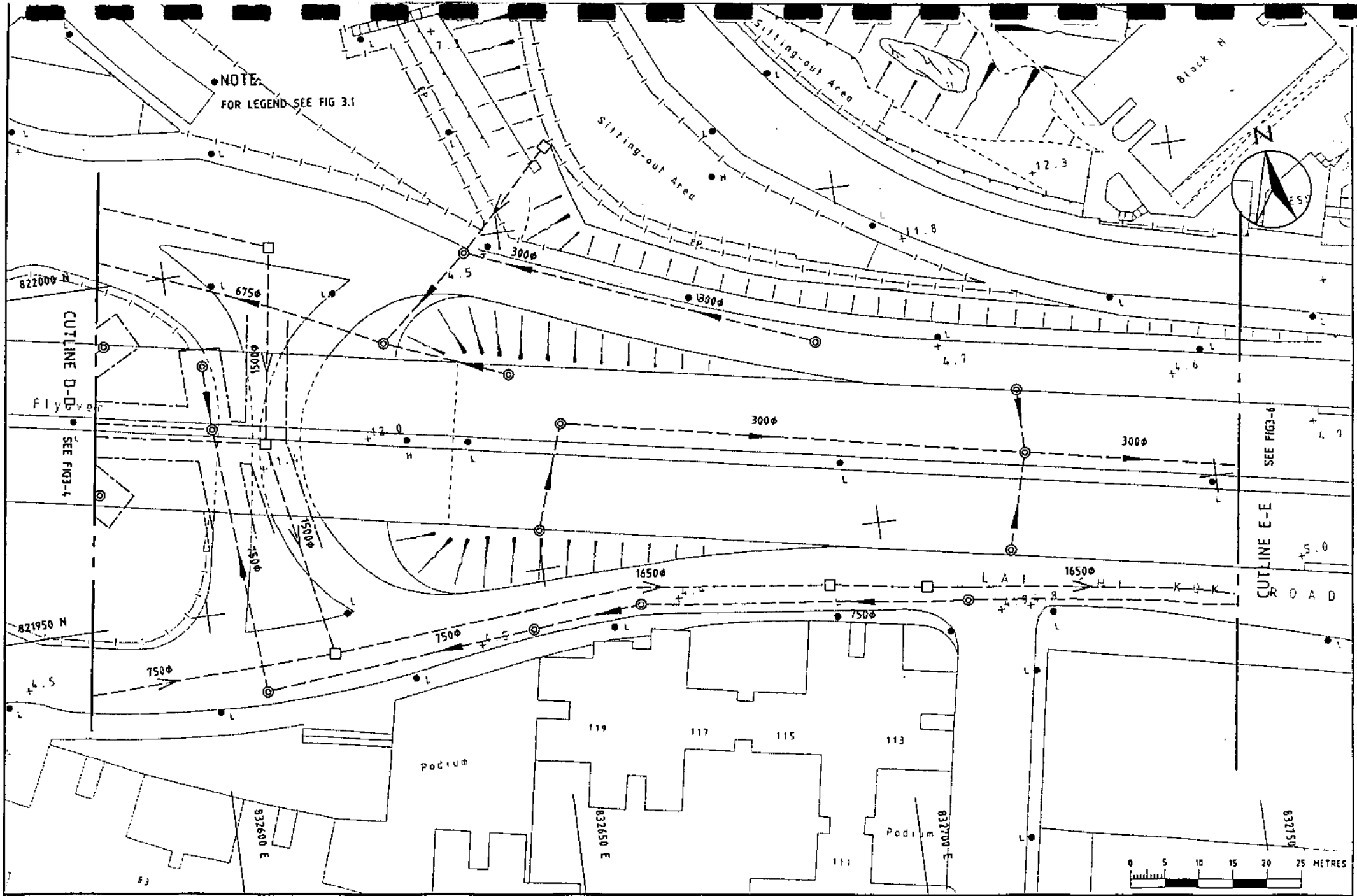
FIGURE: FIG 6-14



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

EXISTING DRAINAGE AND SEWERAGE AT KWAI CHUNG ROAD FLYOVER

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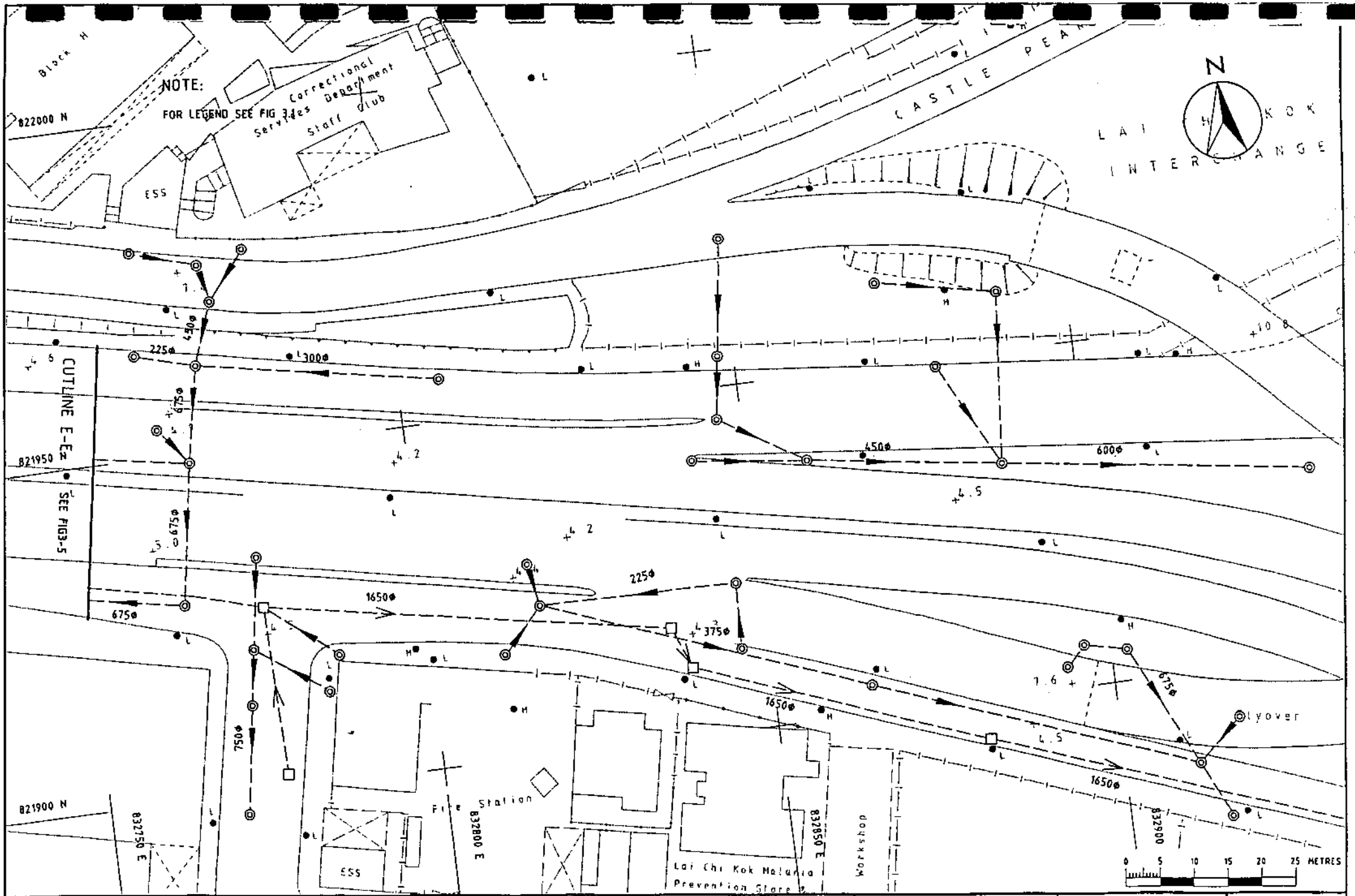
FIGURE: FIG 6-15



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

EXISTING DRAINAGE AND SEWERAGE AT KWAI CHUNG ROAD FLYOVER

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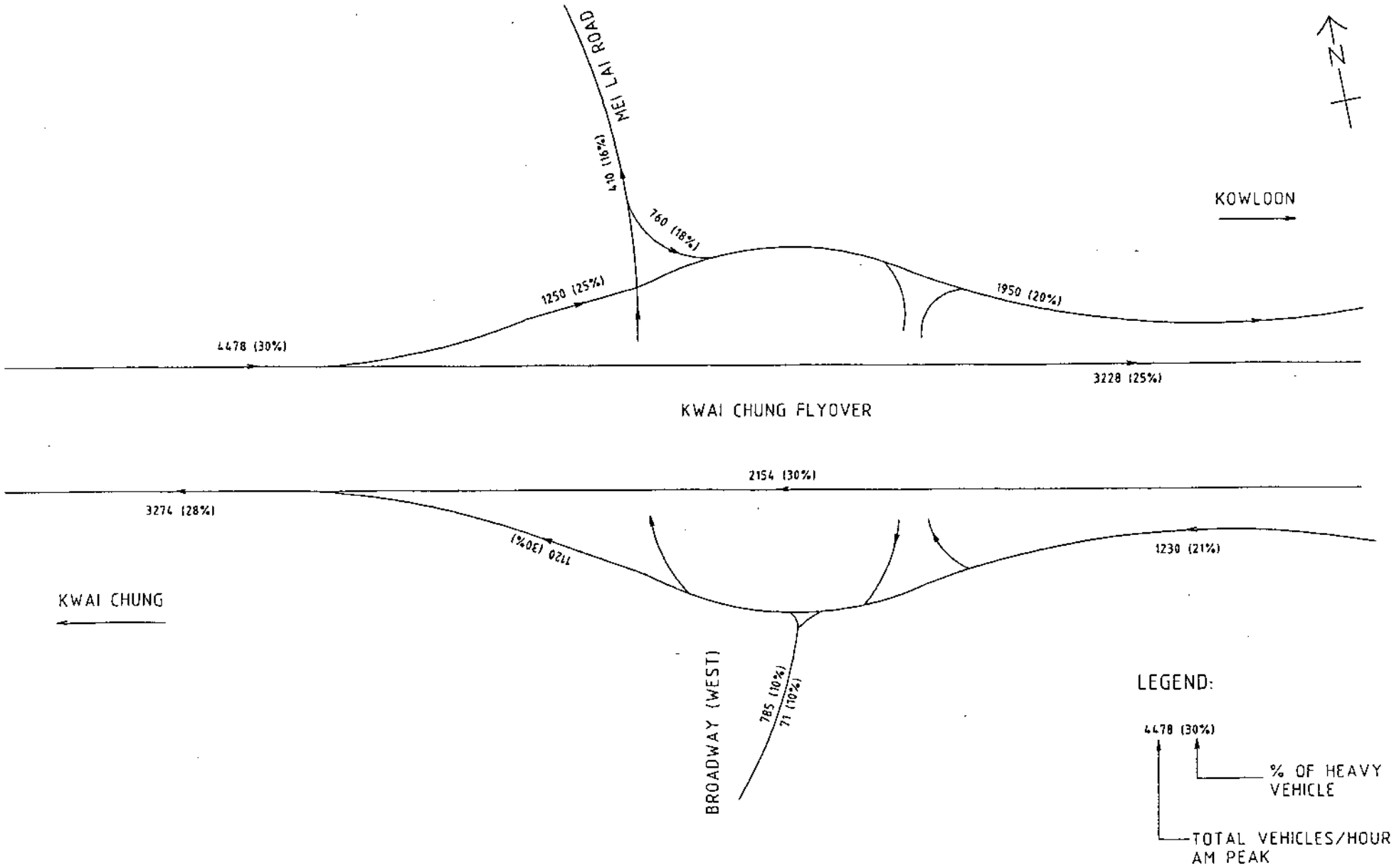
FIGURE: FIG 6-16



FEASIBILITY STUDY FOR PROVIDING RETROACTIVE ROAD TRAFFIC NOISE MITIGATION MEASURES

UPDATED TRAFFIC DATA NEAR KWAI CHUNG ROAD FLYOVER NEAR MEI FOO SUN CHUEN

N.T.S.

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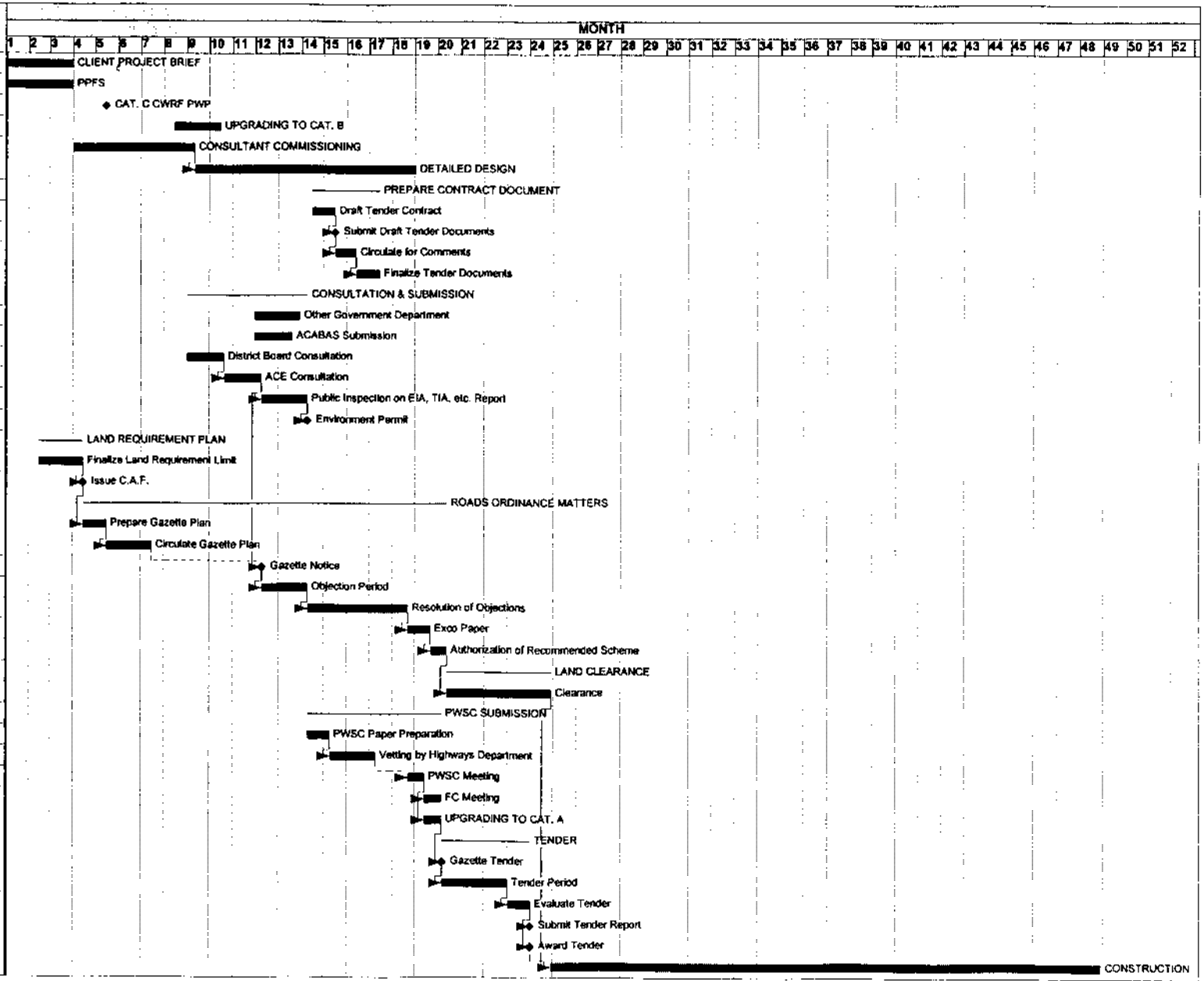
FIGURE: FIG 6-17

Act ID	Activities	Orig. Dur.
1000	CLIENT PROJECT BRIEF	90d
1010	PPFS	90d
1020	CAT. C CWRF PWP	0
1030	UPGRADING TO CAT. B	62d
1040	CONSULTANT COMMISSIONING	163d
1050	DETAILED DESIGN	295d
1060	PREPARE CONTRACT DOCUMENT	90d *
1070	Draft Tender Contract	31d
1080	Submit Draft Tender Documents	0
1090	Circulate for Comments	28d
1100	Finalize Tender Documents	31d
1110	CONSULTATION & SUBMISSION	161d *
1120	Other Government Department	60d
1130	ACABAS Submission	50d
1140	District Board Consultation	50d
1150	ACE Consultation	50d
1160	Public Inspection on EIA, TIA, etc. Report	61d
1170	Environment Permit	0
1180	LAND REQUIREMENT PLAN	59d *
1190	Finalize Land Requirement Limit	59d
1200	Issue C.A.F.	0
1210	ROADS ORDINANCE MATTERS	486d *
1220	Prepare Gazette Plan	31d
1230	Circulate Gazette Plan	61d
1240	Gazette Notice	0
1250	Objection Period	61d
1255	Resolution of Objections	134d
1260	Exco Paper	30d
1270	Authorization of Recommended Scheme	22d
1280	LAND CLEARANCE	139d *
1290	Clearance	139d
1300	PWSC SUBMISSION	179d *
1310	PWSC Paper Preparation	30d
1320	Vetting by Highways Department	61d
1330	PWSC Meeting	22d
1340	FC Meeting	23d
1350	UPGRADING TO CAT. A	23d
1360	TENDER	118d *
1370	Gazette Tender	0
1380	Tender Period	88d
1390	Evaluate Tender	30d
1400	Submit Tender Report	0
1410	Award Tender	0
1420	CONSTRUCTION	730d



Agreement No. CE95/97
Feasility Study for Providing Noise Mitigation Measures on Existing Flyovers

Typical Project Programme

Figure 9-1

Early bar
Summary bar
Start milestone point
Finish milestone point