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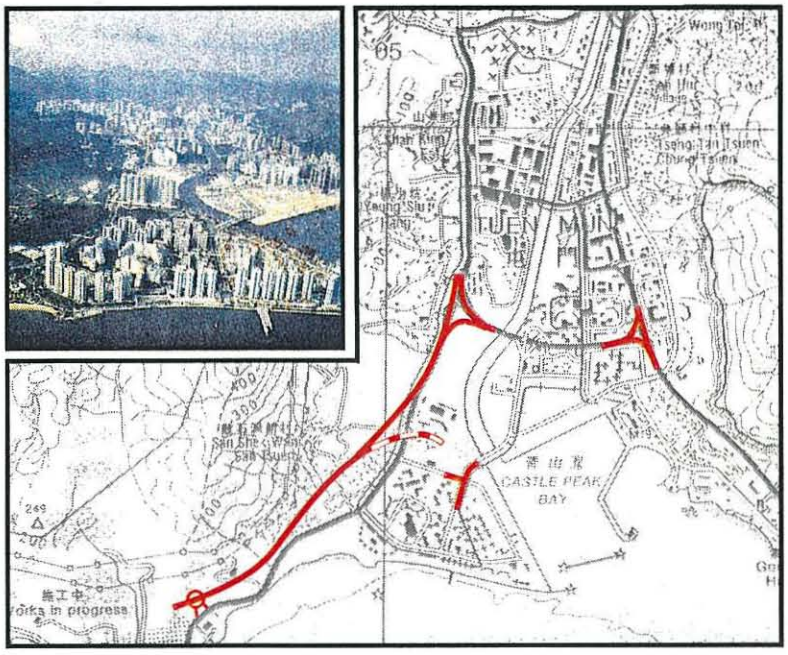
Territory Development
Department, Hong Kong

Foothills Bypass, Tuen Mun Road/Wong Chu Road Interchange and Other Road Junction Improvement Works

Agreement No. CE 44/95



Final Environmental Impact Assessment

January 1997

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

Aspinwall Clouston
ERM (Hong Kong)
Parsons Brinckerhoff (Asia)
SWK Atria

FINAL REPORT

Territory Development Department

Foothills Bypass and Other Road Junction Improvement Works: *Final Environmental Impact Assessment*

6 January 1997

Reference C1507/49768

For and on behalf of ERM-Hong Kong, Ltd

Approved by: [signature]

Position: Technical Director

Date: 6 January 1997

CONTENTS:

1 INTRODUCTION

1.1 PREAMBLE

In April 1996, the Territory Development Department (TDD) commissioned Scott Wilson Kirkpatrick (SWK), in association with ERM-Hong Kong, Ltd (ERM), Aspinwall Clouston, SWK Atria and Parsons Brinckerhoff to undertake the design and construction of a bypass along the foothills of Castle Peak (Foothills Bypass), and improvements to Tuen Mun Road (Road P1)/Wong Chu Road (Road P3) interchange and D11/D13/D14/44A road junction (Agreement No CE44/95).

The Project forms part of the Tuen Mun Area 38 development. The proposed development of Area 38 includes the River Trade Terminal (RTT) and Area 38 Special Industrial Area (SIA), which are scheduled for completion in 1999 and 2002 respectively.

The Foothills Bypass and associated road works which are scheduled to be completed by the end of 2001, are being implemented to overcome anticipated traffic problems within Tuen Mun, due to the proposed developments of the RTT and SIA. The Bypass is primarily required to provide an alternative route for traffic, thereby diverting traffic away from various residential areas in Tuen Mun and in particular, to mitigate the environmental impact on Lung Mun Road. The road improvement works will provide the additional traffic capacity necessary to service the proposed SIA and RTT developments.

ERM is responsible for the Environmental Impact Assessment (EIA) as part of the Foothills Bypass Study. The purpose of the EIA is to identify and evaluate the potential impacts on the surrounding environment arising from the construction and operation of the Bypass and improvement works in relation to servicing Area 38, and to examine and evaluate mitigation measures on environmental, engineering and cost effectiveness grounds, and recommend an optimum package for implementation.

SWK and ERM have worked on a number of projects within the Study Area. The most recent of these projects is the *Reclamation and Servicing of Tuen Mun Area 38 for Special Industries - Improvement to Roads and Junctions within Tuen Mun Environmental Impact Assessment* (*Road Improvement EIA*). The *Road Improvement EIA* was commissioned by the Highways Department in 1995, to assess the potential environmental impacts associated with the improvement to roads and junctions within Tuen Mun in relation to the Area 38 Study. A noise mitigation package comprising noise enclosures, barriers, cantilever barriers and low noise road surfacing was recommended to benefit residents in the vicinity of Wong Chu Road. The results and recommendations of the Road Improvement EIA have been presented to Tuen Mun District Board in February 1996 and endorsed by the Advisory Council on Environment (ACE) in May 1996.

1.2 STUDY AREA

The *Foothills Bypass EIA* covers the same Study Area as the *Road Improvement EIA* and therefore, those works previously assessed and endorsed under the *Road Improvement EIA* will not be revisited. Works that were not assessed under the

Road Improvement EIA include the Junction at Wu Shan and Wu King Roads, the road works associated with the widening of Wong Chu Road Bridge over the Tuen Mun Nullah and the southernmost section of the alignment.

Consequently, the *Foothills Bypass EIA* will focus on that part of the Study Area which was not assessed by the *Road Improvement EIA* and any new and/or changed engineering design details (i.e., the Wong Chu Road Bridge works). Please refer to *Figure 1.2a*, which identifies that section of the Foothills Bypass Study Area which was already assessed and endorsed in the *Road Improvement EIA* as well as the current *Foothills Bypass EIA* Study Area.

1.3 OBJECTIVES OF THE ENVIRONMENTAL IMPACT ASSESSMENT

The objective of the EIA is to identify and evaluate the potential impacts on the surrounding environment arising from the construction and operation of the Bypass and improvement works in relation to servicing Area 38, and to examine and evaluate mitigation measures on environmental, engineering and cost effectiveness grounds, and recommend an optimum package for implementation. The EIA consolidates all the environmental assessment findings, including comments from Government covering all the important environmental issues. The EIA also includes the general requirements of the Environmental Monitoring and Audit (EM&A) Study which will be necessary to ensure the implementation and effectiveness of the adopted environmental protection and pollution control measures. Specific EM&A requirements are discussed in the *EM&A Manual*.

Specific objectives of the EIA are as follows:

(a) to describe the proposed Project and associated works together with the requirements for carrying out the proposed Project;

(b) to identify and describe the elements of the community and environment likely to be affected by the proposed Project;

(c) to identify and quantify emission sources and determine the significance of impacts on sensitive receivers and potential affected uses;

(d) to identify and quantify any potential losses or damage to flora, fauna and natural habitats;

(e) to propose the provision of mitigation measures so as to minimize pollution, environmental disturbance and nuisance during construction and operation of the Project;

(f) to identify, predict and evaluate the residual (i.e., after practicable mitigation) environmental impacts and cumulative effects expected to arise during the construction and operational phases of the Project in relation to the sensitive receivers and potential affected uses;

(g) to identify, assess and specify methods, measures and standards, to be included in the detailed design, construction and operation of the Project which are necessary to mitigate these impacts and reduce them to acceptable levels;

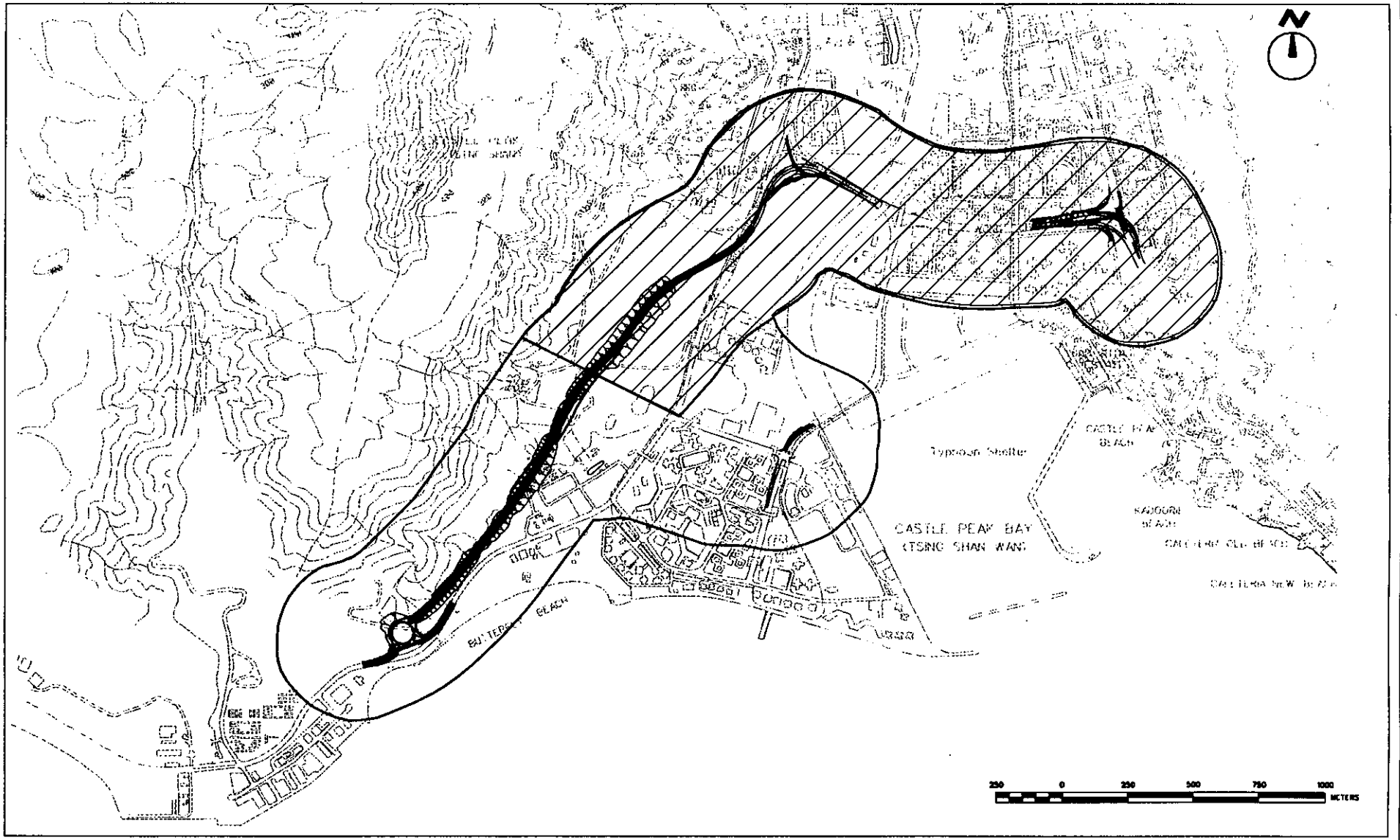


FIGURE 1.2a Environmental Impact Assessment Study Area

Date : 27 June 1996	Drawing No.: Contract/C1507/C1507_2
Sources : Base map - Lands Dept. 1:20k topo	
Prepared by ERM's GIS & MAPPING Group	

KEY

- Road Works Assessed by the Road Improvement EIA
- Foothills Bypass EIA Study Area
- Proposed Foothills Bypass and Other Road Junction Improvement Works

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(h) to design and specify the environmental monitoring and audit requirements necessary to ensure the implementation and the effectiveness of the environmental protection and pollution control measures adopted; and

(i) to identify any additional studies necessary to fulfil the objectives to the requirements of this EIA Study.

1.4 *STRUCTURE OF THE REPORT*

In meeting the objectives set out above, the remainder of this Report is organised as follows:

- *Section 2* describes the main features of the Foothills Bypass and associated road junction improvements;
- *Section 3* presents the land use and archaeology context of the Study Area;
- *Section 4* identifies the potential construction and operational impacts associated with air quality;
- *Section 5* discusses the noise impacts likely to occur during the construction and operational phases, together with appropriate recommendations for their mitigation;
- *Section 6* identifies and reviews the water quality impacts arising from the construction and operation of the Foothills Bypass and associated road works and recommends effective mitigation measures;
- *Section 7* describes the ecological impacts arising from the construction and operation of the Foothills Bypass and associated road improvement works and puts forward effective mitigation measures;
- *Section 8* addresses the solid waste management implications arising from the construction and operation of the Foothills Bypass and associated road improvements, considers waste reduction and disposal options and identifies control and mitigation measures;
- *Section 9* discusses the environmental monitoring and audit requirements arising from the assessment of construction and operational impacts from the Foothills Bypass and related road works and provides recommendations for their application; and
- *Section 10* presents the overall conclusions of the EIA.

Annexes, located at the end of this Report include:

Annex A	Calculation of TSP Emission Rate and Samples of Air Modelling Input and Output Files (FDM& CALINE4);
Annex B	Hong Kong Government Legislation and Guidelines Relating to Ecology; and
Annex C	List of Plant Species Recorded During Field Surveys.

2 PROJECT DESCRIPTION

2.1 ROUTE ALIGNMENT

2.1.1 *Foothills Bypass*

The Foothills Bypass will extend from Wong Chu Road to Tuen Mun Area 45, along the foothills of the Castle Peak range. The Bypass will comprise a dual 2-lane carriageway on embankment. The Bypass will connected to Lung Mun Road by a circular roundabout located in Area 45.

2.1.2 *Lung Mun Road/Wong Chu Road Interchange Improvements*

The northern section of the Foothills Bypass, which was assessed in the *Road Improvement EIA*, remains virtually the same as the scheme that was endorsed in May 1996 (see the *Road Improvement EIA* for further details). The only minor engineering change is the widening of the existing Wong Chu Road Bridge over the nullah to reduce the weaving of traffic and make allowances for traffic not joining the Bypass.

2.1.3 *Road Junction Improvements to D11/D13/D14/44A*

The road improvement works at the junction of D11/D13/D14/44A are required to increase capacity and reduce congestion in addition to providing an alternative route to and from the west of Tuen Mun and encourage traffic away from the section of Lung Mun Road which leads to the Wong Chu Road/Lung Mun Road/Tsing Wun Road interchange. The road junction improvement works will include:

- widening Hoi Wong and Wu King roads;
- modifying the roadside kerbs and the Light Rail Transit Reserve on Hoi Wong Road;
- site formation works, including the incorporation of a retaining wall;
- resuming land adjacent to Wu King Estate to provide for the widening of Wu King Road; and
- resurfacing the D11/D13/D14/44A junction.

2.2 CONSTRUCTION PHASE

2.2.1 *Foothills Bypass*

The construction phase of the Foothills Bypass and associated road works is expected to take 36 months, with works commencing in 1998 and terminating by the end of 2001.

The main construction activities associated with the Bypass will comprise:

- bulk earthworks;
- cut and fill construction;
- road embankment formation; and
- Bypass road works.

These activities are described in more detail in the air quality and noise sections of this Report (*Sections* 4 and 5 respectively).

The construction activities of the Foothills Bypass will mainly be taking place on Government land. Two construction sites are proposed along the Bypass, one at the northern end of the Bypass in Area 19 and the other in the vicinity of the roundabout. Access to both sites would be via Lung Mun Road. A third construction site is proposed in the northern section of Area 18 and a fourth site adjacent to the P1/P3 Interchange.

2.2.2 *Widening of Wong Chu Road Bridge*

The main construction activities associated with the widening of the Wong Chu Road Bridge are:

- bored piling and pile cap construction;
- cofferdam construction; and
- bridge beam and deck construction.

2.2.3 *Road Junction Improvements to D11/D13/D14/44a*

The major activities associated with the road junction improvements are:

- demolition works;
- earthworks;
- road works; and
- retaining wall construction.

The construction activities, as well as the work site, for these road improvement works will be located at the D11/D13/D14/44a road junction.

2.2.4 *Fill Requirements*

The earthworks required for the Project will comprise embankment formation for the Foothills Bypass in Areas 19 and 45; an earthworks solution to Area 19 slopes and excavation to form the Area 45 Interchange with Lung Mun Road. It is estimated that there will be a total requirement for 2,200,000 m^3 of fill for the Project, spread over the construction period.

2.3 *Operational Phase*

Traffic Forecasts

The traffic forecasts that have been used in the final EIA are based on a modified version of the Tuen Mun Port Development Study traffic model. The forecast traffic flows from the Tuen Mun Port Development (TMPD) Study, excluding traffic associated with the Tuen Mun Port development for all design years, were

originally agreed as the basis for traffic analysis related to Foothills Bypass, Wong Chu Road, Lung Mun Road and other roads under this assignment. The traffic flows were also adopted in previous EIA Study.

It was considered essential to review and update the 1996 and future years' traffic flows as the Tuen Mun Port development was as yet not committed and the construction programme for the Special Industries Area and River Trade Terminal at Tuen Mun Area 38 also differed from that adopted for the TMPD Study. A considerable increase in 1995 flows was also observed at Transport Department's monitoring station located at the eastern end of Wong Chu Road. Since 1995, an eastbound lane on Tuen Mun Road has been designated as a bus-only lane during the AM peak period. The bus-only lane scheme reduces the number of eastbound lanes for normal traffic from the previous three to the current two.

In view of the above, a 16-hour classified turning movement traffic survey was therefore undertaken in late June 1996 to update the TMPD Study's 1996 traffic forecasts at the Tuen Mun Road/Wong Chu Road Interchange (P1/P3), Hoi Wong Road/Wong Chu Road (D11/P3) Interchange and Lung Mun Road/Wong Chu Road/Tsing Wun Road (D15/P3) Interchange. Discussions with relevant departments determined that results from the additional traffic survey would be more representative of the existing (1996) traffic situation than the modelled flows estimated in the TMPD Study. The 1996 survey results have therefore been adopted as the 1996 traffic pattern for this Study. In addition, 2001, 2006 and 2011 traffic flows on the other roads within the Study Area were also revised to reflect the traffic patterns for different design years. The revised traffic figures were agreed by Transport Department.

For the purpose of assessing the operational phase impacts, traffic forecasts for the year 2011 have been identified as the worst case scenario in relation to vehicle emissions and noise impacts. The Transportation Department has advised the Foothills Bypass Study Team that the latest available design year to be adopted for planning data and traffic figures for a Government project is 2011. Traffic figures beyond 2011 have not yet been estimated and, therefore, 2011 traffic figures have been utilised for this Project.

3 LAND USE

3.1 INTRODUCTION

The Foothills Bypass Study Area generally includes residential (R), Government/ Institution and Community facilities (G/IC), Green Belt (GB) and open space (O) land uses. The Study Area also includes a few industrial (I) uses. The areas of road widening and junction improvement in the northern section of the route at the Wong Chu Road/Tuen Mun Road Interchange and Wong Chu Road/Lung Mun Road Interchange; and to the south at the Wu King and Wu Shan Road junction, are mainly surrounded by residential uses, with supporting G/IC facilities and pockets of Green Belt and open space (see *Figure 3.1a*).

The land uses along the Foothills Bypass, which extends from Areas 18 and 19 in the north to the southern boundary (Area 45), predominantly comprise Green Belt and planned G/IC uses that are mostly recreational.

The following section describes the land use, archaeological and ecological designations of the Study Area in further detail and assesses the potential impacts associated with the proposed Bypass and associated road improvement works.

3.2 EXISTING CONDITIONS

3.2.1 *Land Use*

Several residential estates are located along the route near the Wong Chu Road/Tuen Mun Road Interchange. These estates include: Harvest Garden, Alpine Garden, Hong Kong Garden, Chi Lok Fa Yuen, On Ting Estate and Siu Lun Court. In the area surrounding this interchange, there are also G/IC facilities which include tennis courts, churches and a school. A Green Belt area exists on Tuen Mun Road, southwest of the Wong Chu Road/Tuen Mun Road Interchange.

At the next major road improvement works area, Wong Chu Road/Lung Mun Road Interchange, a girls' hostel, boys' school, school for the handicapped and monastery are located on Lung Mun Road in an area designated for G/IC use. A part of this G/IC site is being considered for possible recreational facilities including tennis courts, a soccer pitch and volleyball court. Just outside the Study Area boundary in this area is the Tsing Shan Tsuen Site of Special Scientific Interest (SSSI). Beyond the Tsing Shan Tsuen SSSI is the Castle Peak SSSI, which is some 500 m from the Study Area boundary.

Southeast of the Wong Chu Road/Lung Mun Road Interchange is Area 18, where a private sector participation scheme (PSPS) development is proposed. The PSPS development is programmed for completion in March 1998. In addition to the PSPS development, the most recent Layout Plan (Plan No L/TM 18/2) shows a hotel, neighbourhood community centre and an electrical substation proposed in the northern section of Area 18, just south of Wong Chu Road. The land in the vicinity of the proposed footbridge over Lung Mun Road,

adjacent to the Area 18 PSPS Site, will not be available for Foothills Bypass construction works until mid 1998.

Residential, G/IC and Open Space land uses are located at the road widening work site at the junction of Wu King and Wu Shan Roads. The residential estates, Wu King Estate and Siu Shan Court, are located adjacent to the road improvement work site.

Along the Foothills Bypass route, the predominant land use is Green Belt. Eight watercourses run down from the slopes of Castle Peak and cross the route alignment, excluding the nullah which passes under the Wong Chu Road Bridge into Castle Peak Bay. The alignment passes through sections of woodland and cultivated orchards in Area 45.

Other uses along the Foothills Bypass include G/IC, open space and other specified uses. Several recreational uses are included in the Tuen Mun Recreation and Sports Centre, located in Areas 19 and 45, under the management of the Regional Services Department (RSD). The Sports Centre comprises a horse riding school, gateball court cum archery facility, a golf driving range and a park. As confirmed by RSD in June 1996, there are no current plans to expand the Sports Centre. Land within Area 19 which is currently occupied by RSD for the golf driving range will become available for the Project in July 1998.

The southern most section of the Study Area, Area 45, includes high voltage China Light and Power overhead electricity pylons and cables, a temporary RSD tree nursery, private orchards, and a container storage area. The Pillar Point Vietnamese Refugee Camp is located approximately 250 m away from the southern boundary of the Study Area. The camp is scheduled to be closed in mid 1997. Industrial, Green Belt, G/IC and residential zones are the other designated land uses at the southern boundary of the Study Area. However, the residential zones to the south of Lung Mun Road, near Butterfly Beach will be taken up by the proposed roundabout of the Foothills Bypass.

3.2.2 *Archaeology*

The Antiquities and Monument Office (AMO) has also identified three sites of archaeological and historical importance. Two of these sites are located in the Green Belt landuse area around Shek Kok Tsui Village and the third is located at the eastern border of the Study Area.

The first site, Hung Lau, was constructed in the 1920s. It is classified as a Grade 1 site, which is for buildings of outstanding merit. The farm's owner, Li Ki-tong, was an ardent follower of Dr Sun Yat-sen, and the farm was used as a meeting place as well as a refuge for anti-Qing revolutionaries. Every effort should be made to preserve this site.

The second site, Shek Kok Tsui Archaeological Site, is classified as a Special Site of Archaeological Interest (SSAI) and may contain artefacts which date back to the Late Neolithic Tang period. The last excavation study in this area was undertaken in November 1978, and it is believed that some archaeological deposits may still exist on the site. However, part of this site was lost by the construction of the Tuen Mun New Town Development.

The third site, Sam Shing Temple (or Shing Miu), is located southwest of Tuen Mun Road on the land designated as Green Belt. Although it does not have a

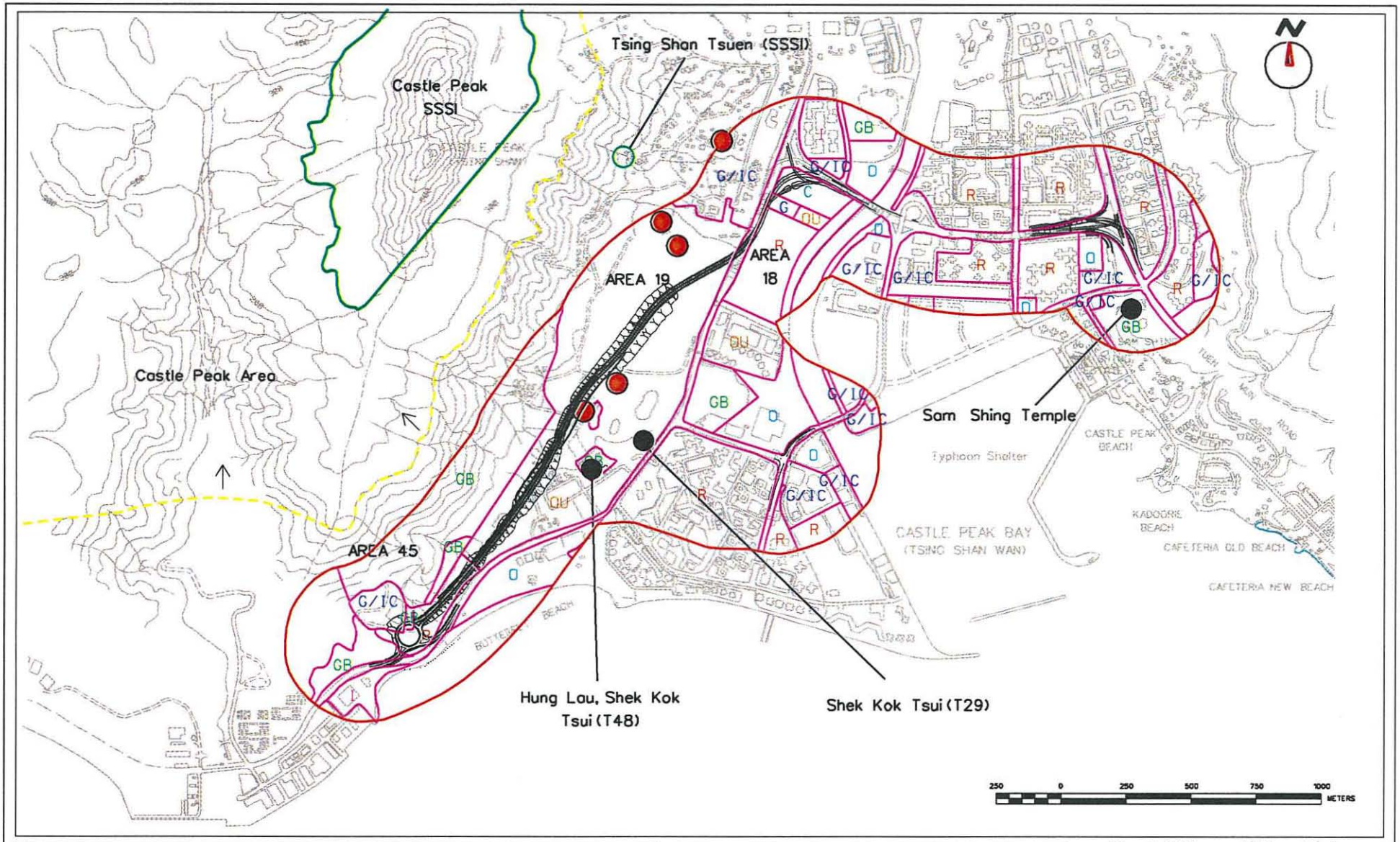

FIGURE 3.1a Existing Landuse, Archaeological Sites and SSSIs

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Sources : Base map - Lands Dept. 1:20k topo	

Prepared by ERM's GIS & MAPPING Group

KEY

- Study Area
- SSSI
- Castle Peak Area
- Archaeological Sites
- Grave Sites

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grade allocated to it, the AMO identified it as a site having historical importance. The construction of the temple was completed in 1921 by Po Tsai Wui. It is dedicated to the worship of the Buddha, Confucius and LoZi.

3.2.3 *Graves*

Five grave sites were identified within the Study Area. Of particular concern will be four of the five southernmost graves, which will most likely need to be removed and relocated. The northernmost grave site, which will be unaffected by the works, is located near the Tsing Shan Tsuen SSSI and outside the Area 19 Slope Remedial Works Area (see *Figure 3.1a*). Additional graves may be affected outside the Study Area due to the slope remediation works; the extent of which has not yet been confirmed.

3.3 *POTENTIAL IMPACTS*

3.3.1 *Land Use*

The potential land use impacts associated with the Foothills Bypass and associated road improvement works are identified below.

- Landtake of Government land along the Foothills Bypass.
- Landtake from the RSD golf driving range and horse riding school. The acquisition of the majority of this land was agreed with RSD prior to this Study.
- Landtake along Lung Mun Road, including part of the bicycle track.
- Landtake from the bicycle track along Wo Shan Recreation Playground and in the vicinity of the covered pedestrian walkway on Wui King Road.
- Landtake from short term tenancies currently used for container storage and other uses in the vicinity of Area 45. The extent and periods required for any land application and clearance need to be identified, particularly for the southern section of the Foothills Bypass where the extent of the works may impinge on areas that are currently short term tenancies, a RSD tree nursery and orchards. It is recommended that preliminary land requirement plans are prepared early in order to commence any initial land resumption procedures necessary.

3.3.2 *Archaeology*

None of the three archaeological/historical sites are expected to be affected by the proposed Bypass alignment and associated junction improvement works as the nearest of these sites is approximately 100 m away.

3.3.3 *Graves*

Four of the five southernmost graves are likely to be affected by the proposed works. Grave sites located outside the Study Area may be affected by the Area 19 Slope Remediation works.

3.4 MITIGATION MEASURES

3.4.1 Land Use

The following mitigation measures are recommended for the landtake issues identified in *Section 3.3.1.*

- Work areas should be effectively cordoned off and access to the sites restricted to the public. These types of mitigation measures are further discussed in *Sections 4, 5, 6* and *7.*
- As the majority of the RSD landtake was to land reserved for a future road, the facility layouts should be able to accommodate these changes, enabling the continued use of these sporting facilities.
- Reinstate bicycle tracks and elevated walkways as soon as practicable in order to minimise disruption.

3.4.2 *Archaeology*

No mitigation measures are proposed as there are no anticipated impacts to archaeology.

3.4.3 *Graves*

Existing graves affected by the Foothills Bypass road embankment and Area 19 slope works will need to be removed and reprovisioned elsewhere. The District Office (DO) and District Lands Office (DLO) will need to be consulted on the available options.

3.5 CONCLUSIONS

While the landtake impacts associated with the Foothills Bypass and associated road improvement works are significant, the majority of the land is either Government owned or allocated for a future road reserve. Land which is not owned by the Government or set aside for roadworks is concentrated in the southern section of the Study Area and includes a container storage area, a RSD tree nursery and orchards.

Archaeological impacts are not anticipated as the nearest archaeological site is approximately 100 m from the proposed Bypass alignment and associated junction improvement works.

Several graves are likely to be affected by the proposed works and, therefore, DO and DLO should be consulted.

4 AIR QUALITY

4.1 INTRODUCTION

This section of the Report assesses the potential air quality impact on Air Sensitive Receivers (ASRs) associated with the construction of the Foothills Bypass and road improvement works at the Wu Shan Road/Hoi Wong Road/Wu King Road (D11/D13/D14/44A) junction. The potential vehicular emission impact during the operational phase of the Foothills Bypass, including road improvements at junction D11/D13/D14/44A is also assessed.

Construction dust and vehicular emission impacts from the road improvement works at Tuen Mun Road/Wong Chu Road Interchange (P1/P3) and Wong Chu Road/Lung Mun Road Interchange (P3/D15) were assessed in the *Road Improvement EIA* which was endorsed by ACE in May 1996. Details of the construction dust impact arising from the road improvement works at the above junctions should be referred to in the *Road Improvement EIA* issued in March 1996.

4.2 GOVERNMENT LEGISLATION AND STANDARDS

The principal legislation for the management of air quality is the *Air Pollution Control Ordinance* (APCO) (Cap 311). The whole of the Hong Kong Territory is covered by the *Hong Kong Air Quality Objectives* (HKAQOs) which stipulate the statutory limits of typical air pollutants and the maximum allowable number of exceedances over specific periods. The HKAQOs are shown in *Table 4.2a* below.

Table 4.2a ***Hong Kong Air Quality Objectives***

Pollutant	Concentration in micrograms per cubic metre (i)			
	Averaging Time			
	1 Hour (ii)	8 Hours (iii)	24 Hours (iii)	1 Year (iv)
Total Suspended Particulates (TSP)			260	80
Respirable Suspended Particulates (v) (RSP)			180	55
Nitrogen Dioxide (NO_2)	300		150	80
Carbon Monoxide (CO)	30,000	10,000		

Note:
(i) Measured at 298°K (25°C) and 101.325 kPa (one atmosphere).
(ii) Not to be exceeded more than three times per year.
(iii) Not to be exceeded more than once per year.
(iv) Arithmetic means.
(v) Respirable suspended particulates mean suspended particles in the air with a nominal aerodynamic diameter of 10 micrometres and smaller.

In addition, EPD recommends a maximum level of hourly TSP of 500 $\mu g\ m^{-3}$ at the identified sensitive receivers.

The main roads within the Study Area are Tsing Wun Road, Lung Mun Road, Wong Chu Road, Hoi Wong Road and Wu Shan Road. Traffic on these major roads is the main source of air quality impact in the Study Area contributing to the existing background air quality. Since the commencement of the Tuen Mun Area 38 Development in 1995, the associated stockpiles located in Areas 16 and 19 have also contributed to the background dust level in the Tuen Mun Area. Industrial uses in Tuen Mun are concentrated in the Tai Hing area at the northern part of Tuen Mun. In light of the distance between Tai Hing and the Study Area, the influence of industrial emissions on the background air quality is limited.

Future background dust levels may be elevated by construction works associated with the proposed Private Sector Participation Scheme (PSPS) developments in Area 18. However, the duration of the construction work will be short-term and air quality in the Tuen Mun area will be dominated by vehicular emissions after the PSPS development is completed.

In the vicinity of Pillar Point, land uses include a number of industrial premises, sewage treatment works and cement works. Lung Mun Road is the main road in the area. The air quality at Pillar Point is effected by industrial and vehicular emissions. Construction works for the Tuen Mun Area 38 Development, located south of Pillar Point and Siu Lang Shui, commenced in 1995. Fugitive dust generated within the Area 38 work sites also contributes to the background dust levels.

A Special Industrial Area (SIA) and River Trade Terminal (RTT) have been proposed in Tuen Mun Area 38. Reclamation works associated with the RTT are expected to commence at the end of 1996 although the facility itself will not be completed until 1999. Fugitive dust generated from the construction works will contribute to the background air quality in the area. In addition, a feasibility study of a centralised incineration facility (CIF) in the SIA has been carried out. It is understood that the development may not proceed, however, if the CIF is located in the area, the air quality at Pillar Point will be affected by emissions from the facility.

Dust monitoring has been conducted for the *Road Improvement EIA EM&A* at the following four monitoring stations: Tuen Mun Swimming Complex in Area 16; the Boys' Home at Tuen Mun in Area 19; the Light Railway Depot and the Pillar Point Refugee Camp, as indicated in *Figure 4.3a*. Dust impact monitoring has been carried out at these monitoring stations since November 1995, indicating no increase in the current dust levels. As these monitoring stations are within the Foothills Bypass Study Area, the baseline monitoring results at these stations have been adopted for this Study.

The *Road Improvement EIA EM&A* monitoring stations are concentrated in the north-east and south-west sections of the Study Area. To supplement the existing baseline data, additional daily averaged total suspended particulates (TSP) baseline monitoring was undertaken for two consecutive weeks at Chau Chun Yau Primary School located in Siu Shan Court. Baseline results for these five monitoring stations are summarised in *Table 4.3a* below.

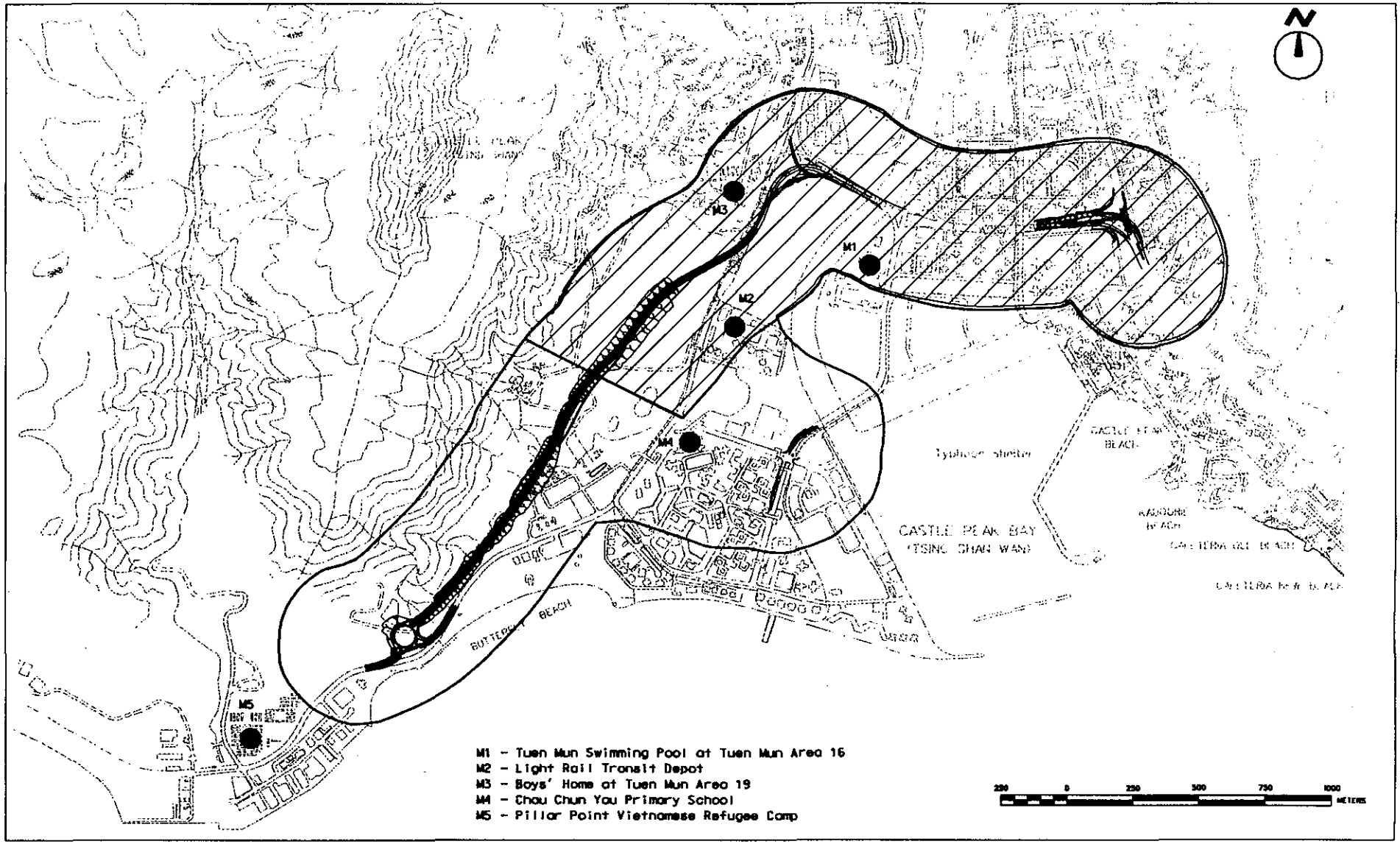

FIGURE 4.3a Locations of Dust Monitoring Stations

Date : 27 June 1996 | Drawing No.: Contract/C1507/C1507_12

Sources : Base map - Lands Dept. 1:20k topo

Prepared by ERM's GIS & MAPPING Group

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Table 4.3a *Dust Baseline Monitoring in the Tuen Mun Area*

Code	Monitoring Location	Monitoring Period	24-hour averaged TSP Level ($\mu g\ m^{-3}$)
M1	Tuen Mun Swimming Pool at Tuen Mun Area 16	13 - 27 November 1995	157
M2	Light Rail Transit Depot, adjacent to New Tuen Mun Centre	18-23 November 1995 & 8-17 December 1995	145
M3	Boys' Home at Tuen Mun Area 19	30 October 1995 - 12 November 1995	145
M4	Chau Chun Yau Primary School in Siu Shan Court	11 - 25 June 1996	34
M5	Pillar Point Vietnamese Refugee Camp	24 October 1995 - 7 November 1995	249

The baseline monitoring results show that the dust levels in the Tuen Mun and Pillar Point areas are generally high. The 24-hour TSP levels measured in the Tuen Mun area for monitoring stations M1-M3 range from 145 to 157 $\mu g\ m^{-3}$. Chau Chun Yau Primary School (M4) 24-hour TSP levels were lower than those measured at Stations M1-M3. It should be noted that the baseline levels measured in June were probably affected by the wet weather. The Pillar Point Vietnamese Refugee Camp 24-hour TSP levels were 249 $\mu g\ m^{-3}$. Since the baseline monitoring at the Pillar Point Vietnamese Refugee Camp was undertaken after the commissioning of the public dump in Tuen Mun Area 38, the baseline dust monitoring was effected by construction dust.

With reference to the TSP baseline monitoring results, shown in *Table 4.3a*, the background TSP level in the Tuen Mun area as a whole is considered to be an average of TSP levels measured at M1-M3, i.e. 149 $\mu g\ m^{-3}$. Monitoring results at Chau Chun Yau Primary School have been greatly influenced by the wet season and are therefore excluded from the analysis. In the Pillar Point area, it is expected that dust concentrations will decrease with the completion of the Area 38 reclamation works. The air quality at Pillar Point will be dominated by traffic emissions and is therefore, considered to be similar to the air quality in the Tuen Mun area. A baseline level of 149 $\mu g\ m^{-3}$ has been assumed.

In additional to the TSP monitoring, several short-term ambient air quality monitoring programmes were conducted between 1985 and 1990 for a number of EIA studies for Tuen Area 38 developments. In addition, RSP levels were monitored during the EIA study for the *Road Improvement EIA*. The baseline air quality data from the Tuen Mun Port Development Study has been used in this Study and is summarised below in *Table 4.3b*.

Table 4.3b *Ambient Air Quality of Tuen Mun Area*

Pollutant	Average Concentration ($\mu g\ m^{-3}$)	Location	Source
NO_2	36	Hung Shui Kiu	TMPDS
CO	800	Tai Hing Estate	TMPDS
RSP	78	Wu Siu Ku School at On Ting Estate	EIA for Improvement to Roads and Junctions within Tuen Mun

TMPDS: Tuen Mun Port Development Study

Representative air sensitive receivers (ASRs) have been identified according to the criteria set out in the *Hong Kong Planning Standards and Guidelines* (HKPSG) and the *Air Pollution Control Ordinance* (APCO) and through initial site inspections and review of land use plans of the Study Area. Existing and future developments including residential premises, educational institutions and areas/buildings for active recreational activities are identified as ASRs. As recommended by EPD, industrial uses are included in this Study to assess the potential air quality impact.

For the construction of the Foothills Bypass, a total of ten ASRs have been identified (ASR1-ASR10) in the vicinity of the Foothills Bypass including residential, recreational and industrial uses. During the operational stage of the Foothills Bypass, the Vietnamese Refugee Camp will be relocated and therefore, it is not considered as an ASR. For the road improvement works at the Wu King/Hoi Wong roads junction, four existing sensitive uses are identified (ASR11-ASR14). The locations and elevations of these ASRs are shown in *Figure 4.4a* and the distances between the ASRs and the Foothills Bypass construction area and alignment are summarised in *Table 4.4a*.

Table 4.4a ***Identified Air Sensitive Receivers***

Section	ASR	Locations	Elevation (mPD)	Horizontal Distance from the nearest work site Boundary (m)	Horizontal Distance from the nearest Alignment (m)
Foothills Bypass Section	ASR1	PSPS site at Area 18	5	95	100
	ASR2	Boys' Home	29	155	160
	ASR3	Tuen Mun Recreational Sports Centre	10	30	65
	ASR4	Sun Tuen Mun Centre	6	195	246
	ASR5	San Shen Wan Tsuen Phase II	74	155	180
	ASR6	Riding Course	10	60	90
	ASR7	Football Field at Butterfly Beach	6	85	110
	ASR8	Butterfly Beach	6	70	75
	ASR9	Industrial Uses at Pillar Point	6	120	20
	ASR10	Pillar Point Vietnamese Refugee Camp	11	330	n/a[1]
Wu Shan/ Hoi Wong/ Wu King Roads Junction	ASR11	Wu Shan Recreation Playground	5	40	50
	ASR12	Wu Fai House, Wu King Estate	6	50	55
	ASR13	Wu Choi House, Wu King Estate	6	10	10
	ASR14	Clinic	5	40	40

[1] Pillar Point Vietnamese Refugee Camp is expected to close in mid 1997. Therefore, the camp is not considered as an ASR for the operational phase.

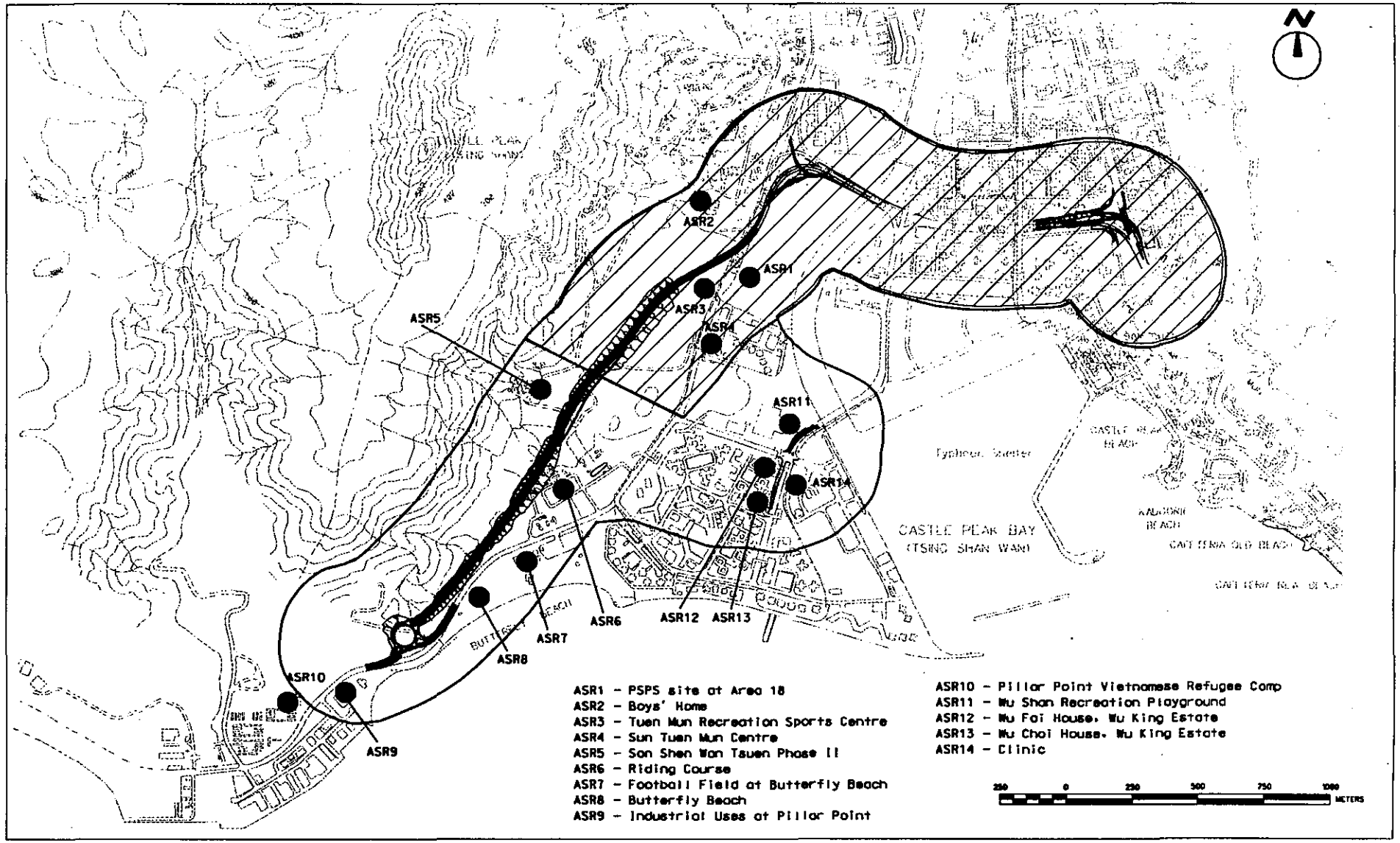

FIGURE 4.4a Locations of Air Sensitive Receivers

Date : 27 June 1996	Drawing No.: Contract/C1507/C1507_13
Sources : Base map - Lands Dept. 1:20k topo	
Prepared by ERM's GIS & MAPPING Group	

KEY

- Road Works Assessed by the Road Improvement EIA
- Foothills Bypass EIA Study Area
- Proposed Foothills Bypass and Other Road Junction Improvement Works

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4.5 CONSTRUCTION PHASE

4.5.1 *Potential Sources of Impact*

The extent of earthworks and excavation for the road improvement works at the junction of Wu Shan Road/Hoi Wong Road will be minor. However, extensive earthworks are expected for the Foothills Bypass construction. It is estimated that 2,200,000 m^3 of fill will be required for the embankment construction and 420,000 m^3 of spoil will be generated within the work site. Therefore, the potential dust nuisance associated with the Bypass is a major concern.

Construction of the Foothills Bypass will involve several main construction works including (i) site clearance and establishment of temporary access roads, (ii) earthworks for the interchange, (iii) interchange roadworks, (iv) earthworks for the Bypass embankment, (v) Bypass roadworks and (vii) landscaping. It is proposed that the Foothills Bypass be constructed using the cut and fill method, although drilling and blasting may be required depending on the geological conditions. Major sources of dust will be from excavation, drilling, filling, bulldozing, material handling and vehicular movements on unpaved work sites during earthworks construction. During the roadwork stage, large amounts of concrete will be required, possibly necessitating an on-site batching plant. For the roadwork construction, the main construction activity will be concreting and the major fugitive dust source will be concrete mixing and concrete truck movements on unpaved areas. It has been assumed that raw materials for concrete mixing will be enclosed and the main dust source will be from the transportation of sand, aggregate and cement to the storage silo.

It is anticipated that the Bypass haul road will be the major source of dust impact. Fifty trucks per hour will be required during the peak period of earthworks construction. In the air model, the haul road is assumed to be located at the western edge of the Foothills Bypass worksite, where it is further away from the ASRs in the Tuen Mun Area and at a higher level in order to mitigate the dust impact.

Road improvement works at the Wu King/Hoi Wong road junction will include the widening of Hoi Wong and Wu King Roads. Construction activities at the junction will include the construction of the retaining wall at Hoi Wong Road and roadworks at Hoi Wong and Wu King Roads. Excavation and earthworks are expected during the construction stage. However, construction works will be limited by a 10 m square work site area and, hence dust impacts are not expected. Nevertheless, general dust control measures as part of good construction site practice should be implemented (see *Section 4.5.5*).

The extent of the impacts depend on the distances between the work sites and the sensitive receivers (buffer distance), the construction methods employed and the number of plant and vehicles used. Construction works for the Foothills Bypass and the junction improvement works will mainly be foundation works and road construction. Only a small number of construction equipment, namely excavators, cranes, compressors, concrete pumps and trucks will be used and the overall exhaust emissions from these plant are expected to be limited.

4.5.2 *Construction Dust Assessment Methodology*

Dispersion Model

The Fugitive Dust Model (FDM) was used to model the extent of impacts from the construction of the Foothills Bypass. Six categories of dust size were assumed in the model and are presented in *Table 3.5a*. For more details regarding the FDM Model, please refer to *Annex A*. Particle size multipliers for these five categories are established in the *Compilation of Air Pollutant Emission Factors, 5th Edition, US Environmental Protection Agency, 1996, (AP-42)* for various fugitive dust sources. The dominant dust source for the construction of the Foothills Bypass is anticipated to be vehicle movements within unpaved work sites. Therefore, the emission rate proportion arising from haul road movements for each dust size have been established for this model and based on Section 13.2.2-4 of AP-42. The dust size and the proportion for the dispersion model are summarised in *Table 4.5a*. The gravitational settling velocity for each dust category was calculated by the FDM.

Table 4.5a ***Dust size and the Portion of Emission Rate***

Dust Size (μm)	Portion of Emission Rate
0-2.5	0.095
2.5-5.0	0.105
5.0-10	0.16
10-15	0.14
15-30	0.3
30-100	0.2

Meteorological Input

Sequential meterological data from the Royal Observatory was used for assessing the dust impacts using historical meterological conditions. The nearest weather station is the Tuen Mun Station. Data obtained from the Station used in the model includes wind speed, wind direction, temperature, stability and mixing height (1993). Vehicle movements, material handling, bulldozing and drilling are anticipated construction works during the daytime, while wind erosion on the unpaved work site is expected to be 24-hours a day. Therefore, meterological data relevant to these working periods was selected for the modelling.

Dust Emission Rates

Particulate emission rates for the potentially dusty sources have been determined based on the US *EPA Compilation of Air Pollution Emission Factors, 5th Edition* (AP-42). The emission factors used in the modelling assessment are tabulated in *Table 4.5b*.

The dust emission from material handling is dependent on the moisture of the excavated spoil. The emission rates for material handling in AP-42 are based upon a moisture content range of 0.25% - 4.8%. The spoil is typically wet in Hong Kong and hence, a moisture content of 4.8% was assumed. As advised by the engineers, the density of loose spoil is 1425 kg m^{-3} and this figure was subsequently used in the model.

Table 4.5b *Emission Factors for Construction Activities at the Work Sites*

Activities	Emission Factor	Remarks
Material handling	0.12 g Mg^{-1}	• Based on USEPA AP-42 Vol. 1 5th Edition, Section 13.2.4-4. • Assume moisture content of 4.8%.
Bulldozing	0.499g s^{-1}	• Based on USEPA AP-42 Vol. 1, 5th Edition, Section 11.9-5, Table 11.9-1.
Rock drilling	0.59kg $hole^{-1}$	• Based on USEPA AP-42 Vol. 1, 5th Edition, Section 11.9-11, Table 11.9-4.
Wet drilling	0.084g/Mg	• Based on USEPA AP-42 Vol. 1, 5th Edition, Section 11.19-2, Table 11.19-.2
Wind erosion over exposed area	2.3 kg $hectare^{-1}$ day^{-1}	• Based on USEPA AP-42 Vol. 1, 5th Edition, Section 11.9-12, Table 11.9-4.
Truck movements on unpaved haul road	3.85 g veh^{-1} m^{-1}	• Based on USEPA AP-42 Vol. 1, 5th Edition, Section 13.2.2-1. • Assume typical silt content of road surface to be 10 %; vehicle speed of 35kph; vehicle weight of 20 tonnes and 10 wheels per vehicle and total travelled distance of 9km.

Assessment Parameter

Fugitive dust particles generated within construction work sites are generally 0-100 μm in size. The potential drift distance of particles is governed by the initial projection height, the particle's terminal settling velocity and the degree of atmospheric turbulence. Particles that are 30-100 μm in diameter are likely to undergo impeded settling and would settle within a distance of 100 m from the source. Whilst particulates of 0-30 μm, i.e. Total Suspended Particulates (TSP), would contribute to the dust impact and the concentration of TSP.

1-hour TSP Levels

Ten hour work days have been assumed and the corresponding meterological data was included for the FDM. The model predictions were made on an hourly basis for the different construction activities. The highest predicted TSP levels were presented and compared to the recommended 1-hour limit of 500 μg m^{-3}.

24-hour TSP Impact

The time variation of dust emissions is not considered in the FDM, therefore, the daily TSP impact for daytime construction activities was modelled with the default option of an 8-hour averaging period. Meterological data was used for the period 0900 - 1700. The 24-hour TSP impact was then estimated by multiplying the modelled results by a conversion factor to take account of the 8-hour construction period, i.e. one-third of the 8-hour TSP concentrations predicted from the model (8 hours out of 24 hours = ⅓). Dust impact from wind erosion is expected to be 24-hours a day and the daily TSP impact was modelled with the default option of a 24-hour averaging period using the 1993 meterological data. The predicted 24-hour TSP levels from daytime activities and wind erosion were added together and compared with the AQO of 260 μg m^{-3}.

4.5.3 *Prediction of the Construction Air Quality Impact*

The 1-hour TSP levels arising from the earthworks and roadwork construction for the proposed Foothills Bypass and the Interchange at the identified ASRs in the Tuen Mun and Pillar Point areas are shown in *Table 4.5c* below. The background TSP levels of 149 $\mu g\ m^{-3}$ measured in the Tuen Mun area have been added to the modelling results to provide the cumulative impacts.

4.5.4 *Evaluation of the Air Quality Impact from Foothills Bypass*

As shown in *Section* 4.3, the 24-hour TSP level measured in Tuen Mun is approximately 150 $\mu g\ m^{-3}$, indicating that the existing background dust level is high. Construction works associated with the Foothills Bypass are likely to contribute to the cumulative dust impact at the ASRs.

As indicated in *Table 4.5c*, the predicted 24-hour TSP levels at the ASRs will comply with the AQO criteria of 260 $\mu g\ m^{-3}$ during the earthworks and roadwork construction. However, the predicted 1-hour TSP levels arising from earthworks associated with the Foothills Bypass and the Interchange would exceed the recommended hourly TSP level of 500 $\mu g\ m^{-3}$ by 25 % at the Industrial Uses in Pillar Point, where the predicted 1-hour TSP level is 626 $\mu g\ m^{-3}$. Predicted 1-hour TSP levels at other ASRs are mostly approaching or above 300 $\mu g\ m^{-3}$ which is 70 - 80 % of the criteria. Modelling results show that there is a potential for dust impacts and, therefore, dust suppression measures should be implemented to mitigate the dust impacts caused by earthworks at the Interchange and embankment construction along the Foothills Bypass.

The predicted 24-hour TSP levels will be within the AQO for 24-hour TSP level during the Foothills Bypass construction without mitigation. However, dust mitigation measures are recommended as the 1-hour TSP level exceeded the guideline level for some identified ASRs and, therefore, good site practice to reduce the off site dust impact should be implemented.

4.5.5 *Mitigation Measures*

Potential dust impacts are anticipated during the earthworks construction associated with the Foothills Bypass and the roundabout. In order to mitigate the dust nuisance, dust mitigation measures are recommended to minimise the nuisance to acceptable levels. Dust mitigation measures for the dusty construction activities associated with the Foothills Bypass and associated road junction improvements, including material handling, are listed below.

Drilling

- where breaking of rock and concrete, for the Bypass or the Wu Shan/Hoi Wong roads junction is required, watering should be applied to control dust. Water spray should be used during the handling of excavated material on construction sites at active cuts and at excavation and fill sites where dust is likely to be created;

Materials Handling

- the heights from which excavated materials are dropped should be controlled to a practical height to minimize the fugitive dust arising from unloading;

- all stockpiles of aggregate or spoil should be enclosed or covered and water applied;

Table 4.5c ***Predicted 1-hour and 24-hour TSP Levels at the Identified ASRs***

ASR	Description	Earthworks for Foothills Bypass and Interchange		Roadwork for Foothills Bypass and Interchange	
		Predicted 1-hour TSP Levels	Predicted 24-hour TSP Levels	Predicted 1-hour TSP Levels	Predicted 24-hour TSP Levels
ASR1	PSPS site at Area 18	252	161	189	154
ASR2	Boys' Home	382	167	236	156
ASR3	Tuen Mun Recreational Sports Centre	330	169	222	157
ASR4	Sun Tuen Mun Centre	249	163	191	155
ASR5	San Shen Wan Tsuen Phase II	192	157	167	152
ASR6	Riding Course	288	168	212	157
ASR7	Football Field at Butterfly Beach	294	168	210	157
ASR8	Butterfly Beach	367	175	241	160
ASR9	Industrial Uses at Pillar Point	626	187	333	163
ASR10	Pillar Point Vietnamese Refugee Camp	300	169	216	157

Remark: Background level of 149 $\mu g\ m^{-3}$ included.

Vehicle Dust

- effective water sprays should be used to control the potential dust emission sources (e.g. unpaved areas and active construction sites) on work sites;
- vehicles that have the potential to generate dust impacts while transporting materials should have properly fitted side and tail boards;
- materials transported by vehicles should be covered, with the cover properly secured and extended over the edges of the side and tail boards;
- materials should also be dampened, if necessary, before transportation;
- the travelling speed on haul roads should be limited to 15 kph to reduce the traffic induced dust dispersion and re-suspension within the site;
- wheel washing facilities should be provided at the exits of all work sites to minimise the quantity of material deposited on public roads;

Earthworks

- the amount of exposed soil and the dust generation potential should be kept to a minimum, this can be accomplished by re-vegetation of completed earthworks, surface compaction and minimising the extent of exposed soil. This will be most relevant along the Foothills Bypass.

For all the assessed sites, the most effective dust control measures should be incorporated into the detailed construction contracts to ensure impacts are minimised. In predicting the likely amount of dust suppression, the effectiveness of the above mitigation has been evaluated based on the AP42. In predicting the likely amount of dust suppression, it has been assumed that there will be:

- a 50 %reduction through frequent watering during the handling of spoil;
- a 70 % reduction in dust emission from vehicle movements on unpaved haul roads by restricting speed to 15 kph and by frequent surface watering and compacting; and
- an 85 % reduction in dust emission from drilling by wet drilling and watering on drilling areas.

Table 4.5d shows the predicted dust levels arising from the earthworks associated with the Foothills Bypass and roundabout at the identified ASRs with the implementation of dust mitigation measures.

Table 4.5d *Predicted 1-hour TSP Levels arising from Earthworks with Mitigation*

ASR	Descriptions	Predicted 1-hour TSP Levels
ASR1	PSPS site at Area 18	215
ASR2	Boys' Home	299
ASR3	Tuen Mun Recreational Sports Centre	266
ASR4	Sun Tuen Mun Centre	211
ASR5	San Shen Wan Tsuen Phase II	177
ASR6	Riding Course	238
ASR7	Football Field at Butterfly Beach	240
ASR8	Butterfly Beach	286
ASR9	Industrial Uses at Pillar Point	450
ASR10	Pillar Point Vietnamese Refugee Camp	261

Remark: Background level of 149 μg m^{-3} included.

The dust impacts would be reduced with the implementation of dust mitigation measures. Predicted 1-hour TSP levels using the recommended dust suppression measures are shown in *Table 4.5d*. The predicted 1-hour TSP level at the Industrial Uses (ASR9) is 450 μg m^{-3} with mitigation and therefore, meets the EPD's recommended criteria. As indicated from the modelling results, the air quality in the Study Area should be acceptable with no exceedances of the criteria. Additionally, the dust impact is modelled with the assumption that all construction activities, including drilling, material handling and vehicle movements were taking place at one time. The construction works within the site are likely to be more varied and, therefore, the dust impacts arising from the Foothills Bypass construction should be lower than the predictions.

There are potential developments in the vicinity of the Foothills Bypass work site. Since the details of the programme of development and layout are not fully known, dust levels are presented in the form of contour to indicate the overall dust impacts in the area. The worst case is predicted for 1-hour TSP levels and dust contour for 1-hour TSP levels with mitigation is, therefore, presented, as shown in *Figure 4.5a*. Contour of 1-hour TSP levels shows similar levels to those predicted for identified ASRs. The 1-hour TSP levels are above the criteria at the Foothills Bypass work site, however, the 1-hour TSP levels are within the EPD's criteria in the surroundings.

4.5.6 *Evaluation of Cumulative Air Quality Impact*

During the peak construction period of the Foothills Bypass in 1999, construction works at Wong Chu Road/Lung Mun Road Interchange Section are also being carried out simultaneously. ASRs in the vicinity of the Interchange including PSPS site at Area 18, Boys' Home, Tuen Mun Recreation Sports Centre and Sun Tuen Mun Centre will be affected by construction works of the Foothills Bypass and the Interchange. Fugitive dust impact from the Interchange has been carried out in the *Road Improvement EIA (ERM, March 1996)*, and the predicted 1-hour TSP levels with dust mitigation measures are summarised in *Table 4.5e*.

Table 4.5e *Predicted 1-hour TSP Levels Arising from Foothills Bypass and Wong Chu Road/Lung Mun Road Interchange with Mitigation*

ASR	Descriptions	Predicted 1-hour TSP Levels		
		Foothills Bypass[1]	Wong Chu Road/Lung Mun Road Interchange[2]	Cumulative Impact
ASR1	PSPS site at Area 18	215	229	444
ASR2	Boys' Home	299	72	371
ASR3	Tuen Mun Recreational Sports Centre	266	53	319
ASR4	Sun Tuen Mun Centre	211	32	243

Remark: [1] Background Level of 149 μg m^{-3} included.
[2] Background Level excluded.

As indicated in *Table 4.5e*, the predicted 1-hour TSP levels from the Foothills Bypass and the Interchange at the identified ASRs were 243 - 444 μg m^{-3} and are within the EPD's criteria, implying that the air quality is acceptable with the implementation of mitigation measures on the two worksites.

In the southern section of the Foothills Bypass, industrial uses at Pillar Point and the Vietnamese Refugee Camp (ASRs 9-10 respectively) will be potentially affected by the construction works of RTT. However, the construction work of RTT will be completed in 1999 and the construction works will mainly be paving which is not considered a dusty construction activity. Therefore, no cumulative dust impact is anticipated.

4.5.7 *EM&A Requirements*

Environmental monitoring and auditing of dust is recommended during the construction phase of the Foothills Bypass and associated road improvement works. Several monitoring locations have been identified in the vicinity of the ASRs. For further information regarding the dust EM&A requirements, please refer to *Section 9* of this Report or the *Environmental Monitoring and Audit Manual.*

4.5.8 *Conclusions*

The construction of the Foothills Bypass at Tuen Mun and the Interchange in Area 45 will inevitably lead to dust emissions. It is predicted that construction activities during the embankment establishment works would give high hourly TSP concentrations. Mitigation measures are therefore necessary to control dust emissions from construction activities through good site practice. Additionally, it is recommended that baseline dust monitoring and dust impact monitoring should be carried out prior and during the construction of the Foothills Bypass. Details of the recommended environmental monitoring and audit schedule are presented in *Section 9* of this Report as well as the *Environmental Monitoring and Audit Manual.*

4.6 *Operational Phase*

4.6.1 *Potential Sources of Impact*

As shown in *Figure 5.6b*, the 2011 peak hour traffic flows on the Foothills Bypass is 1980 vehicles per hour. The 2011 traffic flows on Wu King Road, Wu Shan

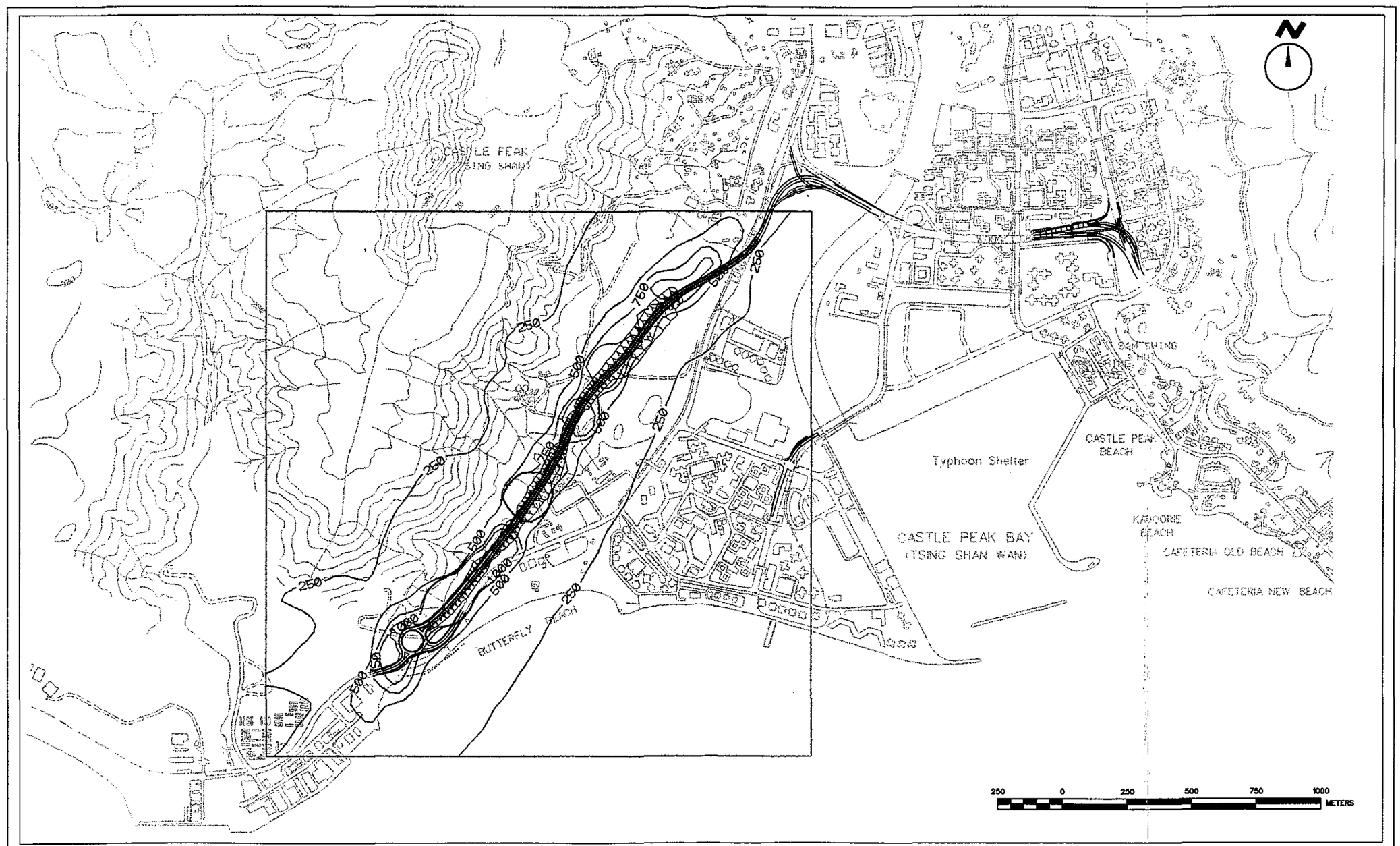

FIGURE 4.5a Predicted 1-hr TSP Levels Arising from Foothills Bypass with Mitigation in $\mu g\ m^{-3}$

Date : 29 Nov 1996	Drawing No.: /Contract/C1507/C1507_26
Sources : Base map - Lands Dept. 1:20k topo	
Prepared by ERM's GIS & MAPPING Group	

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Road and Hoi Wong Road will increase with the road improvement works. Vehicular emissions will be the major air pollutants during the operational phase of the Foothills Bypass and associated roadworks. Nitrogen dioxide (NO_2), carbon monoxide (CO) and respirable suspended particulates (RSP) are the major pollutants that will contribute to the air quality impact at the existing and potential developments in the vicinity of the Foothills Bypass and the Wu King/Hoi Wong roads junction.

The widening of Wong Chu Road over the nullah has been proposed. The purpose of the widening works is to provide optimum turning movements and maintain vehicle capacity. With the widening works, Wong Chu Road will shift southward by approximately 5 m. Air quality impacts from Wong Chu Road have been assessed in the *Road Improvement EIA*. Since there is only a minor change in the alignment, the air quality will not change from that discussed in the *Road Improvement EIA* issued in March 1996.

4.6.2 *Assessment Methodology*

The CALINE4 model has been used to predict the pollutant levels of NO_2, RSP and CO at the identified ASRs due to vehicular emissions from the Foothills Bypass and the roadworks at the Wu King/Hoi Wong roads junction.

The projected traffic flows during the peak hour for the design year 2011 were provided by the Traffic Consultant. The traffic flow is predicted to be highest during the morning period and, therefore, was employed in the model to assess the worst case scenario. *Table 4.6a* shows the traffic composition and total hourly traffic flow during the morning peak hour in the year 2011 for the Foothills Bypass. Road segments of the Foothills Bypass and the Wu Shan Road/Hoi Wong Road/Wu King Road junction included in the Study are presented in *Figure 4.6a.*

Table 4.6a ***Traffic Composition for the Foothills Bypass***

Segment Code	Road	Traffic Composition (veh hr^{-1})					Total Traffic Volume (veh hr^{-1})
		Private Cars	Taxi	Bus	LGV	HGV	
A	Foothills Bypass	940	380	60	500	1160	3040
B	Foothills Bypass Interchange - Foothills Bypass E/B	410	150	10	230	540	1340
C	Foothills Bypass Interchange - Foothills Bypass W/B	530	230	50	270	620	1700
D	Foothills Bypass Interchange	410	150	10	230	540	1340
E	Lung Mun Road Slip Road E/B to Foothills Interchange	400	170	10	240	500	1320
F	Lung Mun Road Slip Road W/B to Foothills Interchange	530	230	50	270	610	1690
G	Lung Mun Road	1330	920	170	650	1480	4550
H	Hoi Wong Road	1250	1130	170	90	210	2850
I	Wu Shan Road	520	650	90	90	200	1550
J	Wu King Road	500	740	120	30	70	1460
K	Wu Chiu Road	270	380	70	20	40	780

Emission factors of NO_2, RSP and CO for each vehicular type in 2011 were based on EPD information. *Table 4.6b* shows the emission factors supplied by EPD which were originated from the US EPA MOBILE IV program and adopted for the US FTP 75 driving cycle.

Table 4.6b ***Emission Factors for Each Vehicle Type***

Vehicle Type	Emission Factor (g veh^{-1} km^{-1})		
	CO	NO_x	RSP
Private Car	13.508	1.321	0.041
Taxi	0.910	0.779	0.238
Bus	9.017	8.578	0.897
Light Goods Vehicles	1.122	1.803	0.361
Heavy Goods Vehicles	8.410	7.061	0.566

The composite emission factors as shown in *Table 4.6c* were derived from the traffic mix from *Table 4.6a* for the year 2011 and the emission factors in *Table 4.6b*. Gaseous pollutants were assumed to be inert and levels of NO_2 were taken as 20% of the total NO_x emission.

Table 4.6c ***Composite Emission Factors in g veh^{-1} km^{-1}***

Segment Code	Road	CO	NO_x	RSP
A	Foothills Bypass	7.86	3.67	0.34
B	Foothills Bypass Interchange - Foothills Bypass E/B	7.88	3.71	0.34
C	Foothills Bypass Interchange - Foothills Bypass W/B	7.85	3.63	0.34
D	Foothills Bypass Interchange	7.88	3.71	0.34
E	Lung Mun Road Slip Road E/B to Foothills Interchange	7.67	3.57	0.33
F	Lung Mun Road Slip Road W/B to Foothills Interchange	7.84	3.61	0.33
G	Lung Mun Road	7.37	3.42	0.33
H	Hoi Wong Road	7.48	1.98	0.22
I	Wu Shan Road	6.59	2.28	0.26
J	Wu King Road	6.25	1.93	0.24
K	Wu Chiu Road	6.39	2.01	0.25

As the peak hour traffic occurs during the daytime, neutral meterological conditions have been assumed. Typical input parameters for the model are listed below:

- Wind Speed — 1 m s^{-1}
- Wind Direction — worst case for each receivers
- Stability Class — D
- Mixing Height — 500 m
- Standard Deviation — 20 degree
- Temperature — 25°C

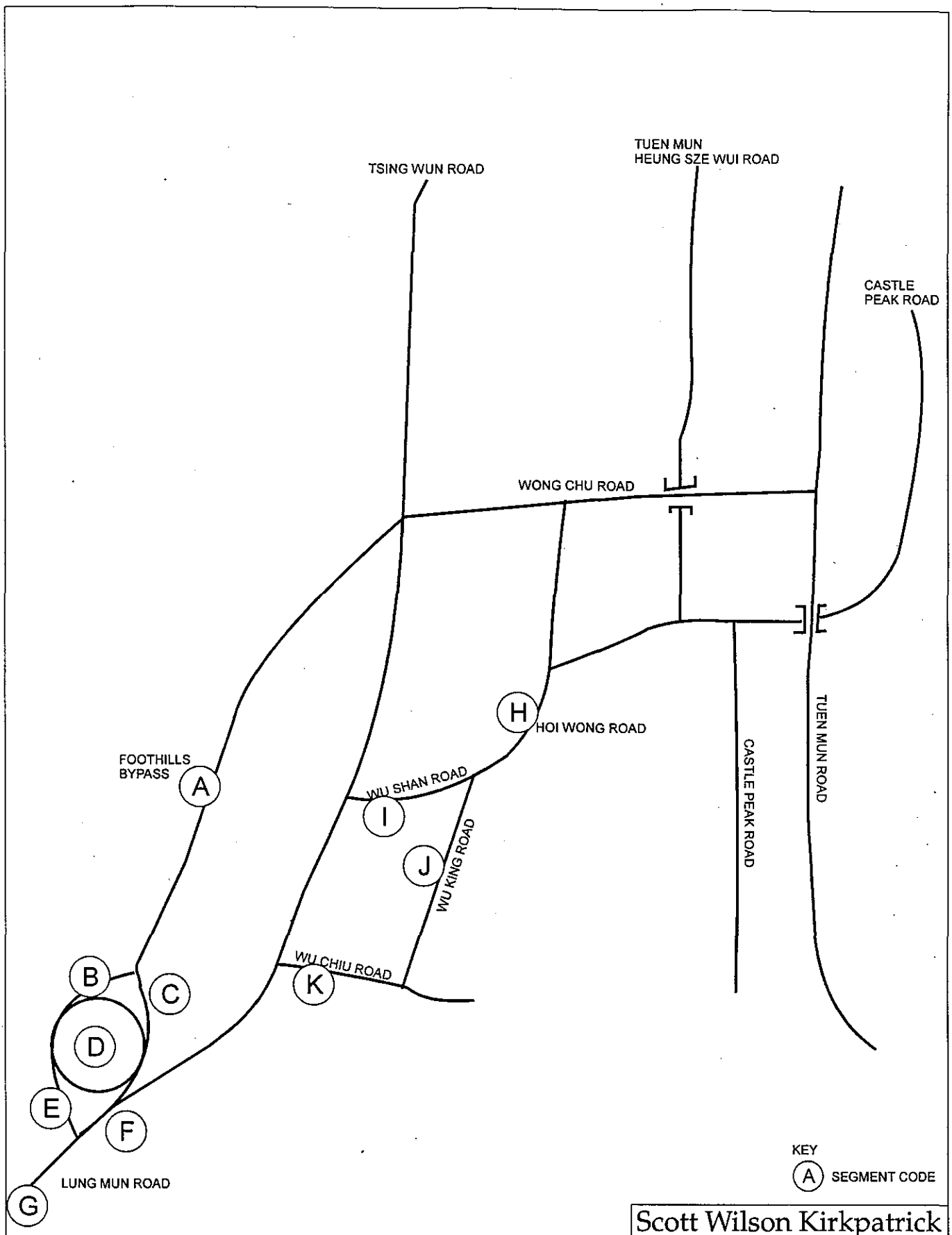

FIGURE 4.6a - SKETCH OF ROADS IN THE STUDY AREA

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There is no current hourly criteria for the RSP. The hourly results were converted to a daily average and compared with the daily criteria of 180 $\mu g\ m^{-3}$. A conversion factor of 0.4 was used to convert hourly RSP to daily RSP. It was assumed that the peak hour traffic would last for 10-hours and the wind would be blowing at the direction of worst impact for 24-hours.

4.6.3 *Assessment Results*

The 1-hour NO_2 and CO and 24-hour RSP levels arising from the vehicle emissions from the Foothills Bypass have been predicted at the identified ASRs. Background pollution levels, as listed in *Table 4.3b*, have been added to the predicted pollutant concentrations to estimate the cumulative impact under the worst-case wind directions. The prediction results are shown in *Table 4.6d*.

Table 4.6d ***Predicted Pollutant Levels at Air Sensitive Receivers Arising from the Foothills Bypass***

ASR	Locations	Predicted Pollutant Concentrations ($\mu g\ m^{-3}$)		
		CO	NO_2	RSP
A1	PSPS site at Area 18	1387	92	88
A2	Boys' Home	1272	81	86
A3	Tuen Mun Recreational Sports Centre	1674	119	93
A4	Sun Tuen Mun Centre	1122	66	84
A5	San Shen Wan Tsuen Phase II	1111	66	83
A6	Riding Course	1352	89	88
A7	Football Field at Butterfly Beach	1283	81	86
A8	Butterfly Beach	1421	92	89
A9	Industrial Uses at Pillar Point	2640	205	111
A11	Wu Shan Recreation Playground	1479	74	87
A12	Wu Fai House, Wu King Estate	1916	100	93
A13	Wu Choi House, Wu King Estate	1778	92	92
A14	Clinic	1525	81	89
AQO ($\mu g\ m^{-3}$)		30,000	300	180

4.6.4 *Evaluation of Impacts*

Hourly averages of NO_2 and CO, as well as daily averages of RSP arising during the operation of the Foothills Bypass, were predicted at ASRs A1-A9. *Table 4.6d* shows that the pollutant levels at the identified ASRs are within the AQOs. Therefore, the air quality impact resulting from the operation of the Foothills Bypass should be acceptable.

For the road improvement works at the junction of Wu King, Hoi Wong and Wu Shan roads, the predicted pollutant levels are within the AQOs at the four identified ASRs (A11-A14) and, therefore, the air quality impact is considered to be acceptable.

As discussed in *Section 5*, noise barriers have been proposed at the Foothills Bypass to mitigate the noise impacts at the Boys' Home and Sun Tuen Mun Centre. Barriers will cause pollutants to accumulate on the roads and will be dispersed at a higher elevation, increasing impacts on ASRs along the alignment. However, as the predicted pollutant levels at the ASRs close to the barriers including the PSPS site, Boys' Home and Sun Tuen Mun Centre are only 50% of the AQO criteria, it is expected that the HKAQO will still be satisfied with the incorporation of barriers.

Landuse in the surroundings of the Foothills Bypass might be changed, hence, pollutant levels are presented in the form of contour to indicate the overall air quality impacts in the study area. 1-hour CO, NO_2 and 24-hour RSP concentrations are presented in *Figures 4.6b-d*. The predicted CO, NO_2 and RSP concentrations are within the AQOs, implying that there are no adverse air quality impact arising from the Foothills Bypass and no constraints of future development in the surroundings are anticipated.

4.6.5 *Mitigation Measures*

Air quality at the sensitive receives will comply with the AQOs and, therefore, mitigation measures are not required.

4.6.6 *EM&A Requirements*

Environmental monitoring and auditing is not recommended during the operational phase of this Project.

4.6.7 *Conclusions*

The results of the air quality assessment for the operational phase of the Foothills Bypass and the road improvements at the Wu King/Hoi Wong roads junction indicate that the predicted pollutant levels at ASRs comply with the HKAQOs requirements. Therefore, the air quality in the Tuen Mun and Pillar Point areas are acceptable during the operational phase of the Foothills Bypass including the road improvement works at the Wu King/Hoi Wong roads junction.

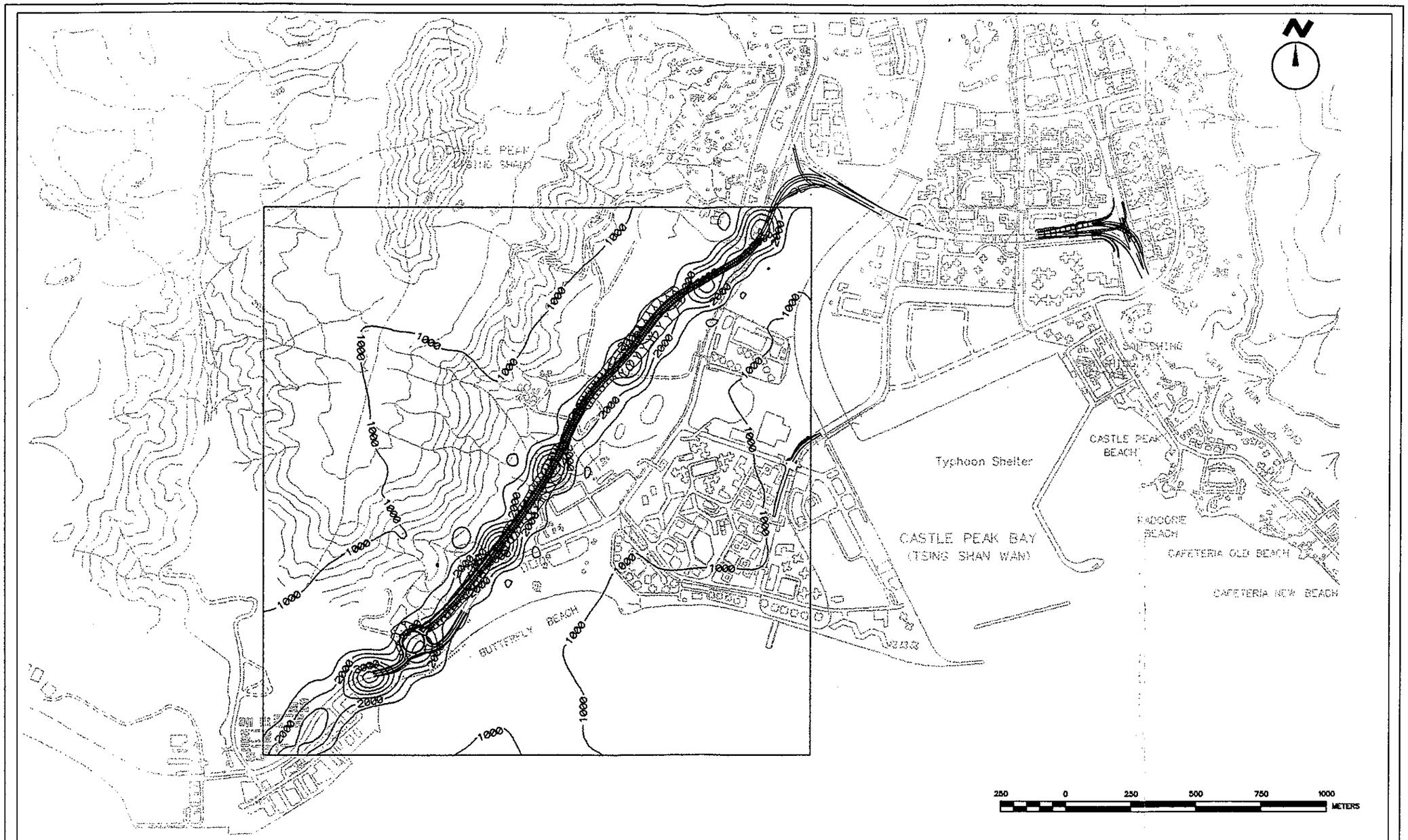

FIGURE 4.6b Predicted 1-hr CO Concentrations Arising from Foothills Bypass in $\mu g\ m^{-3}$

Date : 12 Dec 1996	Drawing No.: /Contract/C1507/C1507_27
Sources : Base map - Lands Dept. 1:20k topo	
Prepared by ERM's GIS & MAPPING Group	

KEY

— CO Contour

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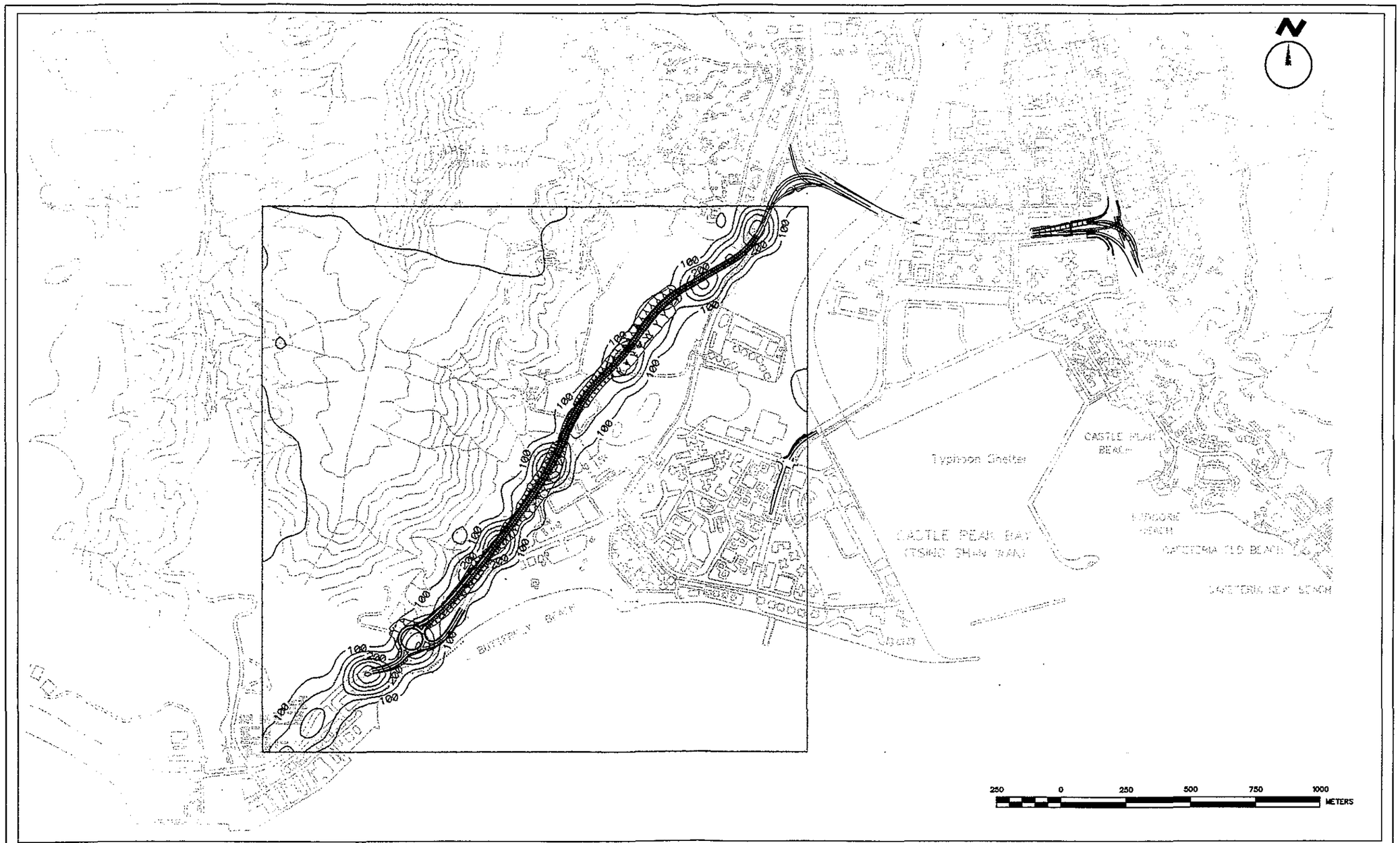

FIGURE 4.6c Predicted 1-hr NO2 Concentrations Arising from Foothills Bypass in $\mu g\ m^{-3}$

Date : 12 Dec 1996	Drawing No.: /Contract/C1507/C1507_28
Sources : Base map - Lands Dept. 1:20k topo	
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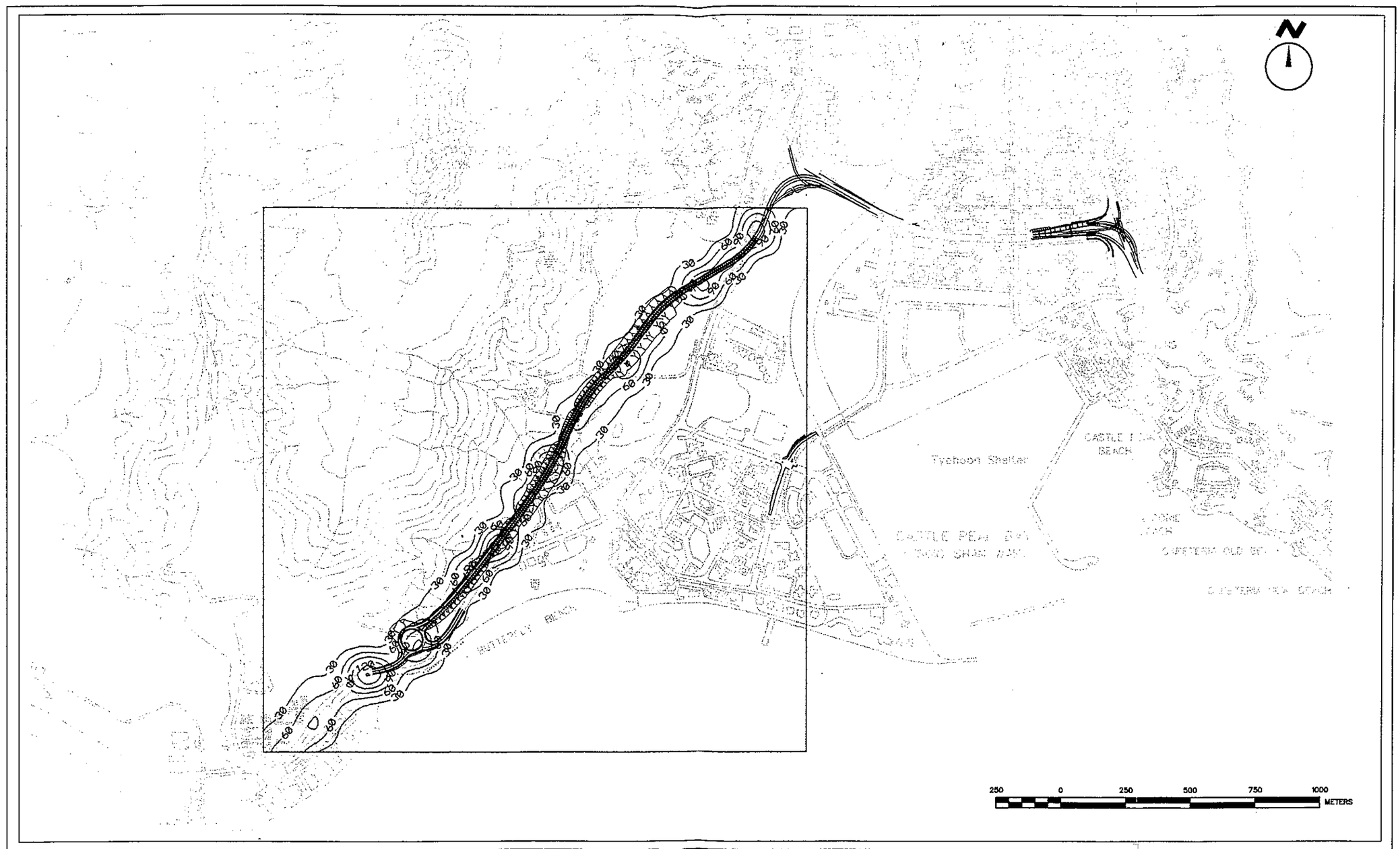

FIGURE 4.6d Predicted 24-hr RSP Concentrations Arising from Foothills Bypass in $\mu g\ m^{-3}$

Date : 12 Dec 1996	Drawing No.: /Contract/C1507/C1507_29

Sources : Base map - Lands Dept. 1:20k topo

Prepared by ERM's GIS & MAPPING Group

KEY

— RSP Contour

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5 NOISE IMPACT

5.1 INTRODUCTION

This section provides a detailed environmental noise assessment of the potential construction and operational impacts arising from the Foothills Bypass. Where noise impacts are found to exceed relevant criteria, a range of potential mitigation measures will be recommended to mitigate unacceptable impacts.

The Study Area includes the Foothills Bypass, improvements to the D11/D13/D14/44A road junctions and the widening works for a section of the existing bridge on Wong Chu Road over the nullah. A detailed noise model of the Foothills Bypass and associated road improvement works has been carried out to assess potential impacts at all Noise Sensitive Receivers (NSRs) in the Study Area. For the purposes of this assessment, a representative sample number of NSRs have been considered to provide an assessment of the likely effects of the scheme.

The *Road Improvement EIA* (Agreement No. CE36/94) for Tuen Mun Road/Wong Chu Road Interchange (P1/P3) and Wong Chu Road/Lung Mun Road Interchange (P3/D15) assessed the northern section of the Foothills Bypass, and the EIA was endorsed by ACE in May 1996. Consequently, the area covered in the Road Improvement EIA has not been re-assessed in the Foothills Bypass EIA. Details of the construction and operational noise impacts arising from these road improvement works should be referred to in the *Road Improvement EIA* issued in March 1996.

Road sections covered here are the southern section of the Foothills Bypass, and the Junction D11/D13/D14/44A at Wu Shan and Wu King Roads. Since the endorsement of the *Road Improvement EIA*, widening the section of Wong Chu Road above the Tuen Mun Nullah has been proposed. Although the Wong Chu Road Bridge is in the Road Improvement EIA Study Area, the environmental implications of this road widening have been studied and the findings are incorporated in this EIA.

5.2 GOVERNMENTAL LEGISLATION AND STANDARDS

5.2.1 *Construction Noise*

In Hong Kong the control of construction noise other than Percussive Piling outside of daytime, weekday working hours (0700-1900, Monday through Saturday), excluding Public Holidays, is governed by the *Noise Control Ordinance* (NCO) and the subsidiary technical memoranda namely *Technical Memorandum on Noise From Construction Work Other Than Percussive Piling* (TM1) and for construction work conducted on or after 1 November 1996, a subsidiary technical memoranda, *Technical Memorandum on Noise from Construction Work in Designated Area* (TM3), will also be applied. The control of Percussive Piling (at all times) is governed by the *Technical Memorandum on Noise From Percussive Piling* (TM2). These technical memoranda prescribe the permitted noise levels for construction work depending upon working hours and the existing noise climate.

The NCO criteria for the control of noise from powered mechanical equipment (PME) are dependant upon the type of area containing the *Noise Sensitive Receiver* (NSR) rather than the measured background noise level. The NCO requires that noise levels from construction at affected NSRs be less than a specified *Acceptable Noise Level* (ANL) which depends on the *Area Sensitivity Rating* (ASR) for the NSR under consideration.

It is intended that the construction activities of the proposed works should be planned and controlled in accordance with the NCO. Works requiring the use of PME during restricted hours (i.e. outside of 0700-1900 Monday through Saturday, and at all times during public holidays), particularly at night (2300-0700), will require a *Construction Noise Permit* (CNP) and will need to achieve the applicable ANL. The ANL is derived from the *Basic Noise Levels* (BNL) determined in TM1 by applying corrections for the duration of the works and the effect of any other nearby sites operating under a CNP. For this assessment, current information indicates that these corrections are negligible and therefore have been set to zero. As a result, the ANLs are equal to the BNLs. The ANLs for the construction work other than percussive piling and for the construction work in designated areas are shown in *Tables 5.2a and 5.2b* below.

Table 5.2a ***Acceptable Noise Levels for Construction Noise Other than Percussive Piling (ANL, $L_{Aeq,\ 30\ min.}$ dB)***

Time Period	ASR"A"	ASR"B"	ASR"C"
All days during the evening (1900-2300) and general holidays (including Sundays) during the day and evening (0700-2300)	60	65	70
All days during the night-time (2300-0700)	45	50	55

Table 5.2b ***Acceptable Noise Levels for Construction Noise in Designated Areas (ANL, $L_{Aeq,\ 30\ min.}$ dB)***

Time Period	ASR"A"	ASR"B"	ASR"C"
All days during the evening (1900-2300) and general holidays (including Sundays) during the day and evening (0700-2300)	45	50	55
All days during the night-time (2300-0700)	30	35	40

Although the NCO does not provide for the control of construction activities during normal working hours, a limit of $L_{Aeq,\ 30\ min}$ 75 dB is proposed in the *Practice Note For Professional Persons, Professional Persons Environmental Consultative Committee, Noise from Construction Activities - Non-statutory Controls, June 1993* (ProPECC *PN2/93*). This limit has been applied on major construction Projects, including the Lantau and Airport Railway (LAR), and is now generally accepted in Hong Kong. Therefore, an $L_{Aeq,\ 30\ min}$ 75 dB limit will be adopted in this Study in order to protect residential NSRs.

For schools, the ProPECC *PN2/93* recommends noise levels during normal school days of $L_{Aeq,\ 30\ min}$ 70 dB, this is lowered to $L_{Aeq,\ 30\ min}$ 65 dB during student exam periods.

There are further subsidiary regulations, *Noise Control (Hand held percussive breakers) Regulations* and *Noise Control (Air Compressors) Regulations* controlling the noise from hand held breakers and air compressors which require

compliance with the relevant noise emission standards and the fixing of noise emission labels to the plant (i.e. $L_{Aeq, 30min}$ 114 dB for hand-held breakers and $L_{Aeq, 30min}$ 109 dB for air compressors).

Percussive piling is only permitted within the constraints of a CNP. TM2 sets out the requirements for working under a CNP, the determination of the permitted hours of operations and, when necessary, other conditions. Percussive piling is prohibited during restricted hours (1900-0700) unless specifically exempted. ANLs for percussive piling are set out in TM2 and are dependent on the type of NSR. The ANLs for daytime percussive piling are presented in *Table 5.2c*.

Table 5.2c *Acceptable Noise Levels for Daytime Percussive Piling ($L_{Aeq, 30 min}$ dB)*

Type of Receptor	Acceptable Noise Level
Noise Sensitive Receiver (NSR) with no windows or other openings	100
NSR with central air conditioning systems	90
NSR with windows or other openings but without central air conditioning system	85

It should be noted that for hospitals, clinics, schools, courts of law or other particularly sensitive receivers, the ANL is $L_{Aeq, 30 min}$ 10 dB below that quoted in *Table 5.2c*.

The permitted hours of operations are determined by comparing the Corrected Noise Level (CNL) and the ANL at the NSR. *Table 5.2d* presents the permitted hours of operation for percussive piling.

Table 5.2d *Permitted Hours of Operation for Percussive Piling*

Amount by which CNL exceeds ANL ($L_{Aeq, 30 min}$ dB)	Permitted hours of operation on any day not being a holiday
More than 10	0800 to 0900 AND 1230 to 1330 AND 1700 to 1800
Between 1 and 10	0800 to 0930 AND 1200 to 1400 AND 1630 to 1800
No exceedance	0700 to 1900

5.2.2 *Road Traffic Noise*

Hong Kong Planning Standards and Guidelines (HKPSG) recommend that road traffic noise levels at openable windows of residential buildings be limited to $L_{A10,peak\ hour}$ 70 dB to minimise disturbance to residents. Also, the HKPSG recommend that road traffic noise levels at openable windows of educational institutions should be limited to $L_{A10,peak\ hour}$ 65 dB. All predicted traffic noise levels in this report have been assessed in respect of these criteria. Direct remedies should be incorporated in the road design (e.g. highway alignment, noise barriers, low noise road surfaces etc.) should exceedances over the HKPSG criteria be identified.

In cases where practicable direct mitigation measures would not be wholly adequate in mitigating noise impacts, the resulting residual impacts would be assessed against the qualification criteria for indirect measures (e.g. noise insulation).

The criteria for indirect mitigation embodies the conditions specified in paragraph 6 of the UK's methodology for the Calculation of Road Traffic Noise 1988 (CRTN) as applied to Hong Kong under ExCo Directive "Equitable Redress for Persons Exposed to Increased Noise resulting from the use of New Roads", such that all three of the following conditions are met by the Foothills Bypass which is considered as a new road.

i) The combined expected maximum traffic noise level, i.e. the overall noise level, from the new or altered roads together with other traffic in the vicinity is more than the specified noise level ($L_{A10,peak\ hour}$ 65 and 70 dB for educational institutions and residual dwellings respectively).

ii) The overall noise level is at least 1.0 dB(A) more than the prevailing noise level (the prevailing noise level being the total traffic noise level existing before the works to contract or improve the road begin).

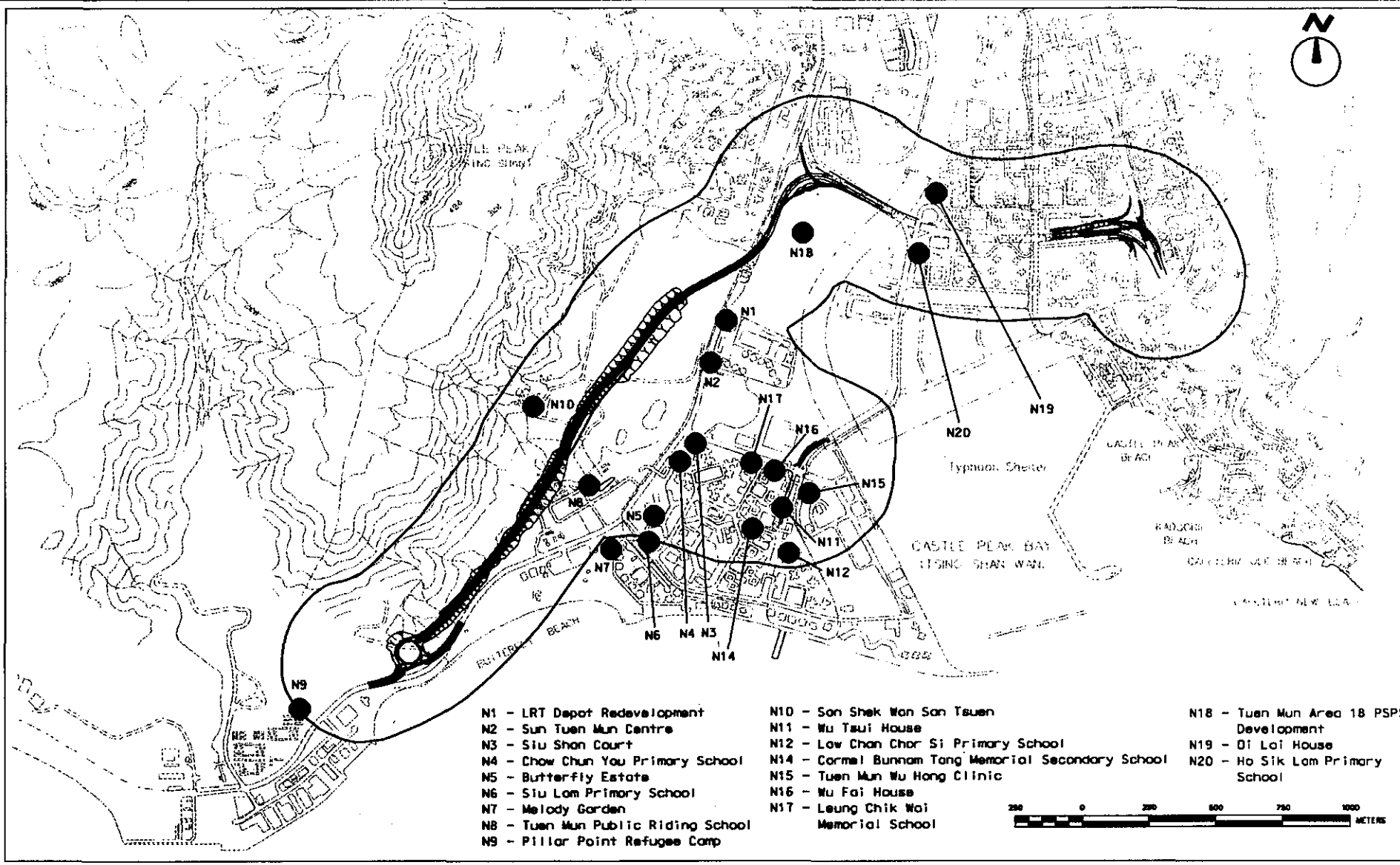
iii) The contribution to the increase in the overall noise level from the new or altered road is at least 1.0 dB(A).

5.3 *NOISE SENSITIVE RECEIVERS*

Noise Sensitive Receivers (NSRs), as defined by HKPSG and the NCO, were identified through site inspections and review of land use plans of the Study Area. Existing and future developments including residential premises and educational institutions have been identified as NSRs; these are listed in *Table 5.3a* below with their Area Sensitivity Rating, and depicted in *Figure 5.3a*. The Area Sensitivity Ratings in *Table 5.3a* are subject to the agreement by the noise control authority which is the EPD.

Table 5.3a *Noise Sensitive Receivers & Area Sensitivity Ratings*

Receiver	Noise Sensitive Receivers	No of Floors	Area Sensitivity Rating
Foothills Bypass Section			
N1	Proposed LRT Depot Development	44 + 8 podium	B
N2	Block 1 - Sun Tuen Mun Centre	44 + 8 podium	B
N3	Kin King House - Siu Shan Court	21	B
N4	Chow Chun Yau Primary School	7	B
N5	Tip Ying House - Butterfly Estate	8 - 19	B
N6	Siu Lam Primary School	7	B
N7	Melody Garden	29	B
N8	Tuen Mun Public Riding School	1	B
N9	Pillar Point Refugee Camp[a]	2	B
N10	San Shek Wan San Tsuen	3	B
Junction D11/D13/D14/44A			
N11	Wu Tsui House	24	B
N12	Law Chan Chor Si Primary School	7	B
N14	Carmel Bunnam Tang Memorial Secondary School	7	B
N15	Tuen Mun Wu Hong Clinic	3	B
N16	Wu Fai House	24	B
N17	Leung Chik Wai Memorial School	7	B



N1 - LRT Depot Redevelopment
N2 - Sun Tuen Mun Centre
N3 - Siu Shan Court
N4 - Chow Chun You Primary School
N5 - Butterfly Estate
N6 - Siu Lam Primary School
N7 - Melody Garden
N8 - Tuen Mun Public Riding School
N9 - Pillar Point Refugee Camp
N10 - San Shek Wan San Tsuen
N11 - Wu Tsui House
N12 - Law Chan Chor Si Primary School
N14 - Cormel Bunnam Tong Memorial Secondary School
N15 - Tuen Mun Wu Hong Clinic
N16 - Wu Fai House
N17 - Leung Chik Wai Memorial School
N18 - Tuen Mun Area 18 PSPS Development
N19 - Di Lai House
N20 - Ho Sik Lam Primary School

FIGURE 5.3a Location of Noise Sensitive Receivers (NSR)

Date : 27 June 1996 | Drawing No.: Contract/C1507/C1507_3

Sources : Base map - Lands Dept. 1:20k topo

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KEY

Foothills Bypass EIA Study Area

Proposed Foothills Bypass and Other Road Junction Improvement Works

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Receiver	Noise Sensitive Receivers	No of Floors	Area Sensitivity Rating
Widened Bridge Section on Wong Chu Road			
N18	Tuen Mun Area 18 PSPS Development	25 - single aspect 40 - standard cruciform	B
N19	Oi Lai House	24	B
N20	Ho Sik Lam Primary School	7	B

(a) Excluded from operational noise assessment as N9 will be phased out before the commissioning of the Foothills Bypass.

The proposed LRT Depot Development (N1) will be occupied after the construction of Foothills Bypass, therefore it has been excluded from the construction noise assessment.

The Sun Tuen Mun Centre has been excluded from the construction noise assessment as it was covered by the *Road Improvement EIA* and there are no major engineering changes in the construction methodology identified from the current information.

The Private Sector Participation Scheme (PSPS) residential development in Tuen Mun Area 18 has been excluded from the operational noise assessment as it will incorporate the following measures for mitigating the road traffic noise impacts from Lung Mun Road and Wong Chu Road:

- single aspect residential blocks will be located adjacent to the site boundary to protect the cruciform blocks behind; and

- residential blocks to the west of the site will be set back from Lung Mun Road with other non-noise sensitive buildings such as the car park block between Lung Mun Road and the single aspect blocks.

It is understood that the detailed design is currently being undertaken by the development architect and the final design of the PSPS will ensure compliance to the HKPSG $L_{A10, peak\ hour}$ 70 dB criterion. It is anticipated that this noise mitigation design will also provide protection against the noise impacts of the Foothills Bypass construction. Although air gaps between the single aspect blocks would allow propagation of the construction noise to reach the cruciform blocks behind, this is not considered to be critical as the construction noise generation will be temporary and the works are expected to move along the alignment rather than remain stationary. The construction noise would not be a constraint upon the PSPS layout design, and is more appropriate to be dealt with at source.

The landuse to the north of Area 18 PSPS and near the D15/P3 Junction has been assigned for a proposed neighbourhood community centre (NCC). The NCC is likely to be impacted by noise from the nearby roads and the roadworks. However, without the definite design of the development, the extent of noise impacts could not be assessed. Owing to the proximity of the NCC to the roads, the NCC is likely to require noise mitigation measures and the noise constraints imposing upon the development would be similar to Area 18. It is recommended that the adjacent commercial landuse should be used as a noise buffer between the NCC and the nearby roads.

The Tuen Mun Public Riding School (N8) is considered a NSR as verbal riding instructions are given during outdoor training activities. The existing Golf

Centre is a leisure use and is not classified as a NSR according to the HKPSG. Therefore, it has been excluded from the Study. It should be noted that the planned landuse to the south of Lung Mun Road, near Butterfly Beach will be taken up by the proposed roundabout of the Foothills Bypass (Area 45).

5.4 BASELINE CONDITIONS

The existing background noise levels in the Study Area are given in *Table 5.4a*. The noise monitoring locations are shown in *Figure 5.4a*. The background noise levels at Butterfly Estate, Melody Garden and San Shek Wan San Tsuen were measured during June 1996, at either AM or PM peak hours of weekdays. A-weighted $L_{10(30min)}$, $L_{eq(30min)}$ and $L_{90(30min)}$ were measured with a Type I Bruel & Kjaer 2236 Integrating Sound Level Meter, in a 'fast' response. Before and after each measurement, the meter was calibrated using a Bruel & Kjaer Calibrator model 4231. The noise measurements were carried out at a distance of 1 m from the facade of the NSR, at a height of 1.2 m above ground. The predominant background noise sources were observed to be road traffic, Light Rail Transit (LRT) movements, insects and birds.

Table 5.4a ***Measured Background Noise Levels in the Study Area***

Location	Measured Background Noise Levels, dB(A)			Predominant Noise Sources
	$L_{10(30\ min)}$	$L_{eq(30\ min)}$	$L_{90(30\ min)}$	
M3 Pillar Point Refugee Camp	62.8	71.0	60.5	road traffic in particular heavy vehicles
M4 Butterfly Estate	63.5	61.8	57.0	road traffic, LRT, insects, birds
M5 Melody Garden	65.5	62.9	59.0	road traffic, LRT, insects, birds, ventilation systems
M6 San Shek Wan Tsuen	59.0	58.1	56.5	road traffic, insects, birds, local community activities

5.5 CONSTRUCTION PHASE

5.5.1 *Potential Sources of Noise Impact*

The nature, duration of construction activities, type of plant likely to be employed and the tentative construction programme are given in *Figure 5.5a*.

Foothills Bypass Construction

Major construction activities for the Foothills Bypass section, which could be potential sources of noise impact are as follows :

- site clearance and temporary access road (Code 5.1);
- earthworks excavation (Code 5.3);
- bypass roadworks (Code 5.4);
- road pavement and finishes (Code 5.5); and

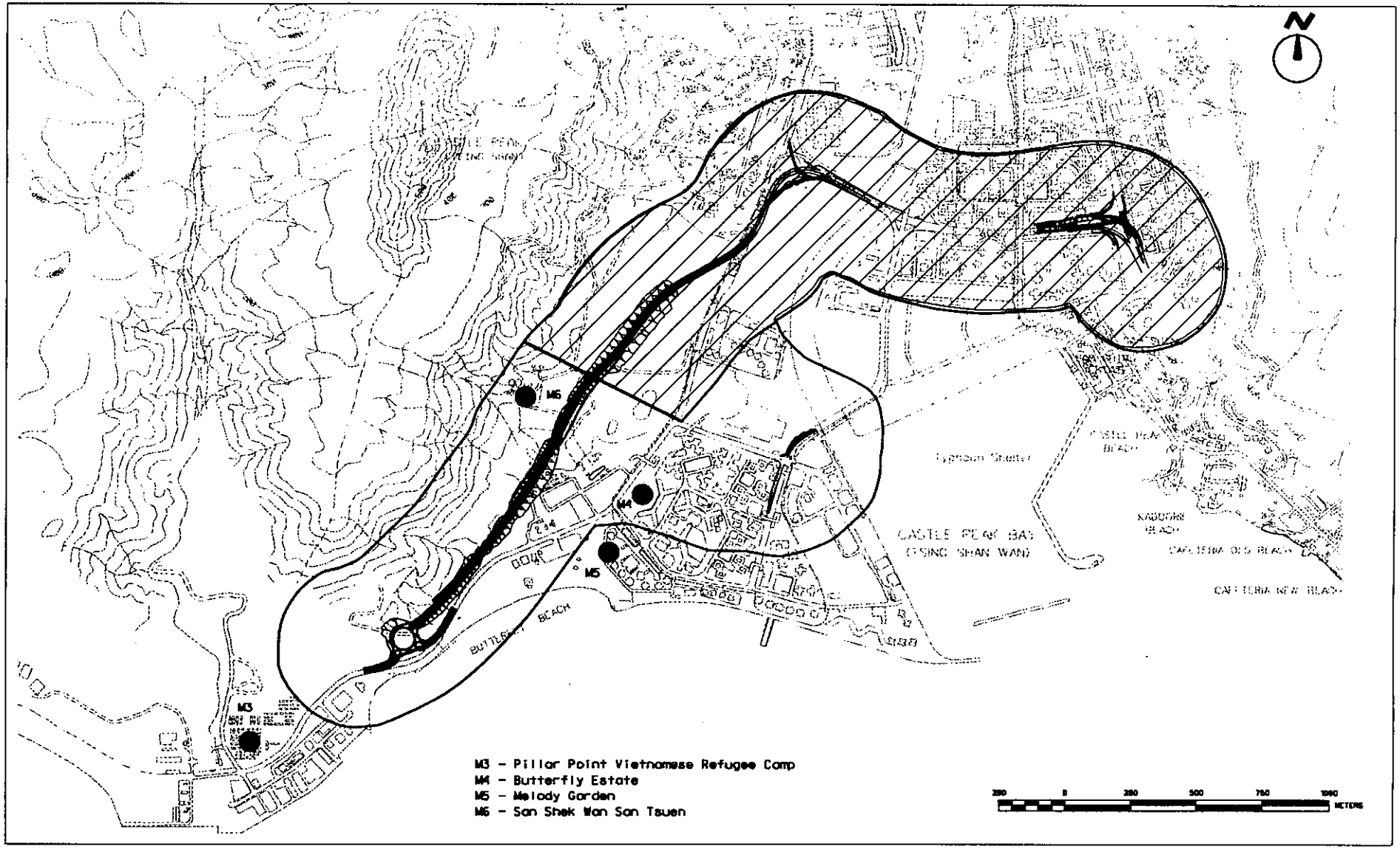

FIGURE 5.4a Locations of Noise Monitoring Stations

Date : 27 June 1996	Drawing No.: Contract/C1507/C1507_4
Sources : Base map - Lands Dept. 1:20k topo	
Prepared by ERM's GIS & MAPPING Group	

KEY

- Road Works Assessed by the Road Improvement EIA
- Foothills Bypass EIA Study Area
- Proposed Foothills Bypass and Other Road Junction Improvement Works

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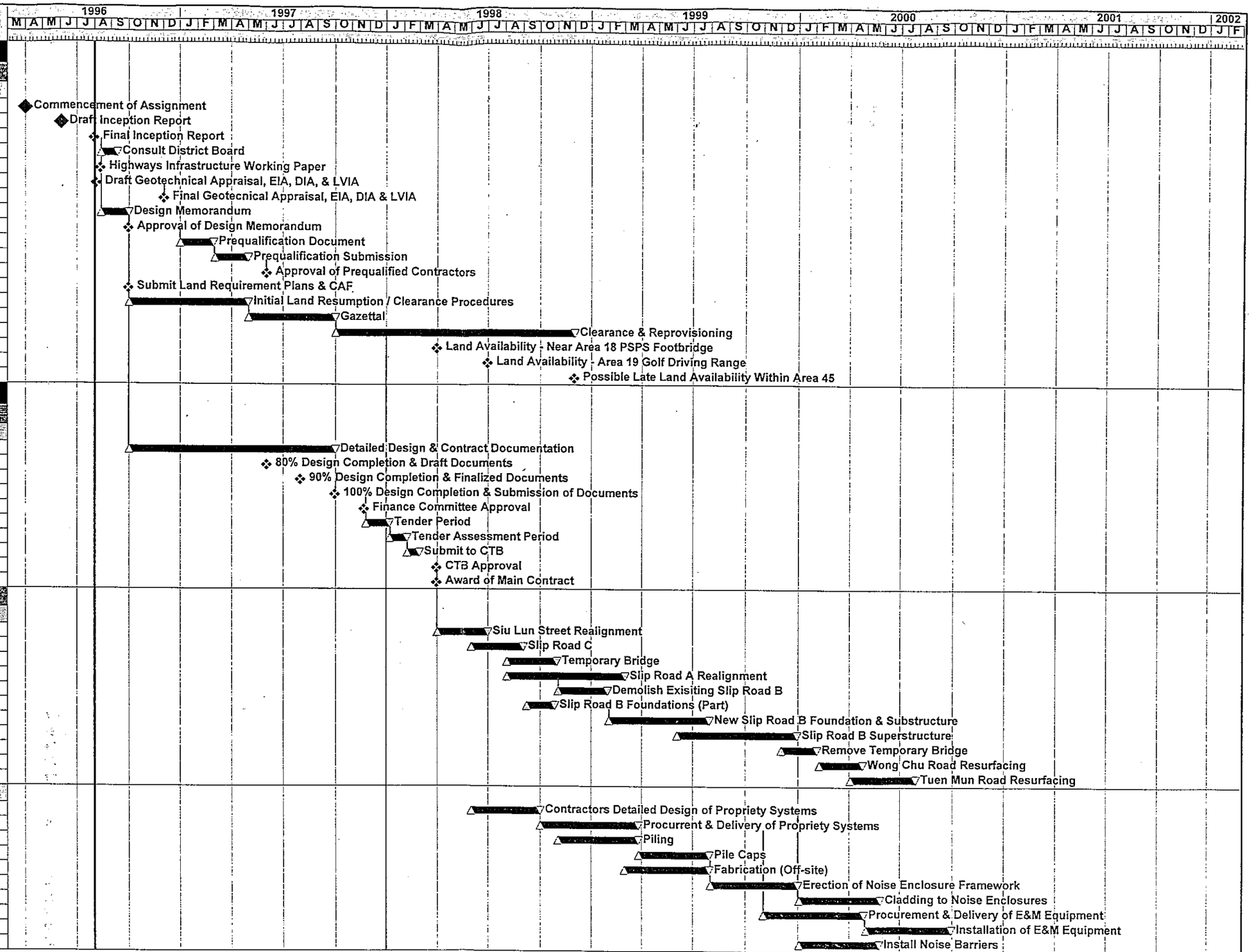
Activity ID	Orig Dur	Early Start	Early Finish
GENERAL			
10000	0	01APR96A	
10100	0	03JUN96A	
10200	0		01AUG96
10300	21	13AUG96	10SEP96
10350	0		12AUG96*
10400	0		05AUG96*
10500	0		02DEC96*
10600	35	13AUG96	30SEP96
10700	0	01OCT96	
10800	43	01JAN97*	28FEB97
10900	43	03MAR97	30APR97
11000	0	03JUN97*	
11100	0	01OCT96	
11200	152	01OCT96	30APR97
11300	109	01MAY97	30SEP97
11400	305	01OCT97	01DEC98
11500	0	01APR98*	
11600	0	01JUL98*	
11700	0	01DEC98*	
MAIN CONTRACT A			
Design & Tender Stage			
20000	261	01OCT96	30SEP97
20010	0		02JUN97*
20020	0		01AUG97*
20030	0		01OCT97*
20035	0		21NOV97*
20040	31	24NOV97	05JAN98
20050	25	05JAN98	06FEB98
20060	16	06FEB98	27FEB98
20070	0	01APR98*	
20080	0	01APR98	
Construction Stage			
P1 / P3 Junction			
21000	65	01APR98	30JUN98
21010	66	01JUN98*	31AUG98
21020	65	03AUG98*	30OCT98
21030	151	03AUG98*	01MAR99
21040	65	02NOV98*	29JAN99
21050	36	07SEP98*	26OCT98
21060	130	01FEB99*	30JUL99
21070	151	03JUN99*	30DEC99
21080	46	03DEC99*	04FEB00
21090	56	07FEB00*	24APR00
21100	85	03APR00*	28JUL00
Noise Enclosures / Barriers to Wong Chu Road			
22000	88	01JUN98*	30SEP98
22010	127	01OCT98*	26MAR99
22020	105	02NOV98*	26MAR99
22030	91	26MAR99*	30JUL99
22040	110	01MAR99*	30JUL99
22050	110	02AUG99*	31DEC99
22060	105	03JAN00*	26MAY00
22070	129	01NOV99*	27APR00
22080	110	01MAY00*	29SEP00
22090	103	03JAN00*	24MAY00



Project Start 01APR96
Project Finish 30MAR01
Data Date 02AUG96
Plot Date 05AUG96

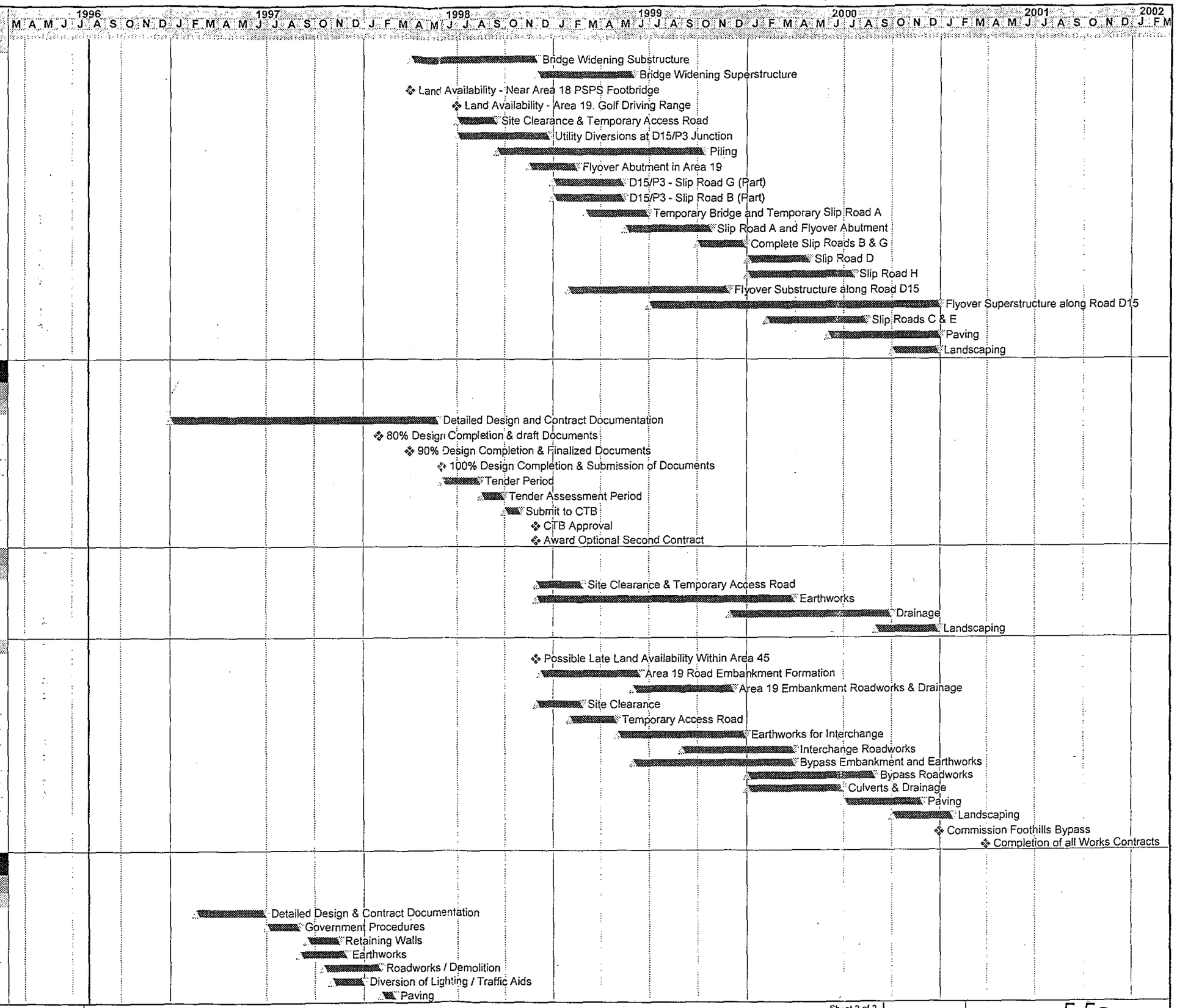
Early Bar
Progress Bar

TEMP

Agreement CE44/95
Foothills Bypass
Design / Construction Programme

Figure No. 5.5a
Scale

Activity ID	Orig Dur	Early Start	Early Finish
Bypass Northern Section & D15/P3 Junction			
22800	175	01APR98	01DEC98
22810	131	02DEC98	02JUN99
22900	0	01APR98*	
22910	0	01JUL98*	
23000	55	01JUL98	15SEP98
23010	128	01JUL98	25DEC98
23020	284	15SEP98*	15OCT99
23040	66	16NOV98*	15FEB99
23050	96	01JAN99*	14MAY99
23060	96	01JAN99*	14MAY99
23070	85	03MAR99*	29JUN99
23080	119	17MAY99*	28OCT99
23090	65	01OCT99*	30DEC99
23100	85	03JAN00*	28APR00
23110	145	03JAN00*	21JUL00
23120	218	29JAN99*	30NOV99
23130	394	01JUL99*	02JAN01
23140	136	08FEB00*	15AUG00
23160	153	01JUN00*	01JAN01
23170	65	02OCT00*	29DEC00
MAIN CONTRACT B			
Design & Tender Stage			
30000	364	01JAN97*	25MAY98
30010	0	02FEB98*	
30020	0	01APR98*	
30030	0	03JUN98*	
30040	55	01JUN98*	14AUG98
30050	33	17AUG98*	30SEP98
30060	22	01OCT98*	30OCT98
30070	0	01DEC98*	
30080	0	01DEC98*	
Construction Stage			
Area 19 Slope Remedial Works			
31001	64	01DEC98*	26FEB99
31002	349	01DEC98*	31MAR00
31003	218	01DEC99*	29SEP00
31004	86	01SEP00*	29DEC00
Bypass Area19 South Section & Area45 Interchange			
31006	0	01DEC98*	
31007	135	08DEC98*	14JUN99
31008	138	01JUN99*	09DEC99
31009	64	01DEC98*	26FEB99
31010	65	01FEB99*	30APR99
31020	175	03MAY99*	31DEC99
31030	153	01SEP99*	31MAR00
31040	219	01JUN99*	31MAR00
31050	174	03JAN00*	31AUG00
31060	130	03JAN00*	30JUN00
31070	109	03JUL00*	30NOV00
31080	85	02OCT00*	26JAN01
31090	0	01JAN01*	
32000	0		30MAR01*
TERM CONTRACT			
D11/D13/D14/44A Junction			
40000	96	17FEB97*	30JUN97
40002	45	01JUL97*	01SEP97
40008	45	16SEP97*	17NOV97
40010	65	02SEP97*	01DEC97
40020	77	17OCT97*	02FEB98
40030	45	03NOV97*	02JAN98
40040	20	03FEB98*	02MAR98



Project Start	01APR96
Project Finish	30MAR01
Data Date	02AUG95
Plot Date	31DEC96

Early Bar
Progress Bar

TEMP

Agreement CE44/95
Foothills Bypass
Design / Construction Programme

Figure No. 5.5a

Scale

- flyover abutment in Area 19 (Code 5.6).

All construction works are expected to be carried out during the daytime, non-restricted hours. Percussive piling activities are not expected in the construction of the Foothills Bypass. For drainage and box culvert construction and landscaping work, an extensive use of PME is not anticipated. They will be small scale works compared with the activities identified above and, therefore, are unlikely to produce greater noise impacts than the rest of the construction activities.

The construction plant inventory for each of the above major activities, and their corresponding sound power levels (SWL), are given in *Table 5.5a* below.

Table 5.5a ***Construction Activities for the Foothills Bypass Section and Sound Power Levels***

Activity Code	Type of Activity	Power Mechanical Equipment / Noise Sources	TM CNP No.	Sound Power Level $L_{Aeq,30min}$ dB	No of Plant	Total Sound Power Level, $L_{Aeq,30min}$ dB
5.1	Site Clearance	Bulldozer/Ripper	030	115	2	
		Excavator	081	112	1	
		Generator	101	108	2	
		Compressor	002	104	2	
		Loader	081	112	1	
		Lorry	141	112	2	
		Scraper	204	119	2	
		Motor Grader	104	113	1	**125**
5.3	Earthworks	Bulldozer/Ripper	030	115	2	
		Excavator	081	112	1	
		Dumper	066	106	4	
		Dump Truck	067	117	2	
		Lorry	141	112	1	
		Driller Rig	166	100	1	
		Loader	081	112	1	**124**
5.4	Roadworks	Concrete Truck	044	109	1	
		Dozer	030	115	1	
		Dump Truck	067	117	2	
		Grader	104	113	1	
		Backhoe	081	112	1	**122**
5.5	Road Paving	Vibratory Road Roller	186	108	1	
		Asphalt Paver	004	109	1	
		Lorry	141	112	2	**117**
5.6	Flyover Abutment	Concrete Pump	047	109	1	
		Concrete Truck	044	109	2	
		Crane	048	112	2	
		Drilling Rig	166	100	1	**118**

Improvements to Junction D11/D13/D14/44A

It is expected that the extent of construction works for the junction improvements would be minor and the duration of the works will be shorter, compared with the Foothills Bypass construction. The major construction activities which could be potential sources of noise impact are:

- demolition (Code 5.8);
- retaining wall construction (Code 5.9);
- earthworks (Code 5.10);
- roadworks (Code 5.11);
- diversion of utilities (Code 5.12); and

- road paving (Code 5.13).

A scheme plan of the junction improvement works is shown in *Figure 5.5b*. The construction works are expected to be carried out during the daytime, non-restricted hours. It has been proposed that a non-percussive piling method would be adopted for the construction of the retaining walls. The construction plant inventory and the corresponding sound power levels (SWL) for the plant teams are given in *Table 5.5b* below.

Table 5.5b *Construction Activities for the Junction Improvements and Sound Power Levels*

Activity Code	Type of Activity	Power Mechanical Equipment / Noise Sources	TM CNP No.	Sound Power Level $L_{A\,eq,\,30\,min}$ dB	No. of Plant	Total Sound Power Level, $L_{A\,eq,\,30\,min}$ dB
5.8	Demolition	Pneumatic method				
		Silenced Compressor	002	100	2	
		Pneumatic Handtool	026	110	2	
		Grab Lorry	141	112	1	116
		or				
		Alternative method				
		Silenced Generator	102	100	2	
		Electric Handtool	029	105	2	
		Grab Lorry	141	112	1	114
5.9	Retaining Wall Construction	Mini Backhoe	081	112	1	
		Concrete Truck	044	109	1	114
5.10	Earthworks	Swivel Skip Dumper	066	106	1	
		Mini Backhoe	081	112	1	
		Truck	141	112	1	
		Silenced Electric Pump	281	88	1	116
5.11	Roadworks	Mini Backhoe	081	112	1	
		Concrete Truck	044	109	1	114
5.12	Diversion of Utilities	Grab Lorry	141	112	1	
		Truck	141	112	1	115
5.13	Road Paving	Vibratory Road Roller	186	108	1	
		Asphalt Paver	004	109	1	
		Lorry	141	112	1	115

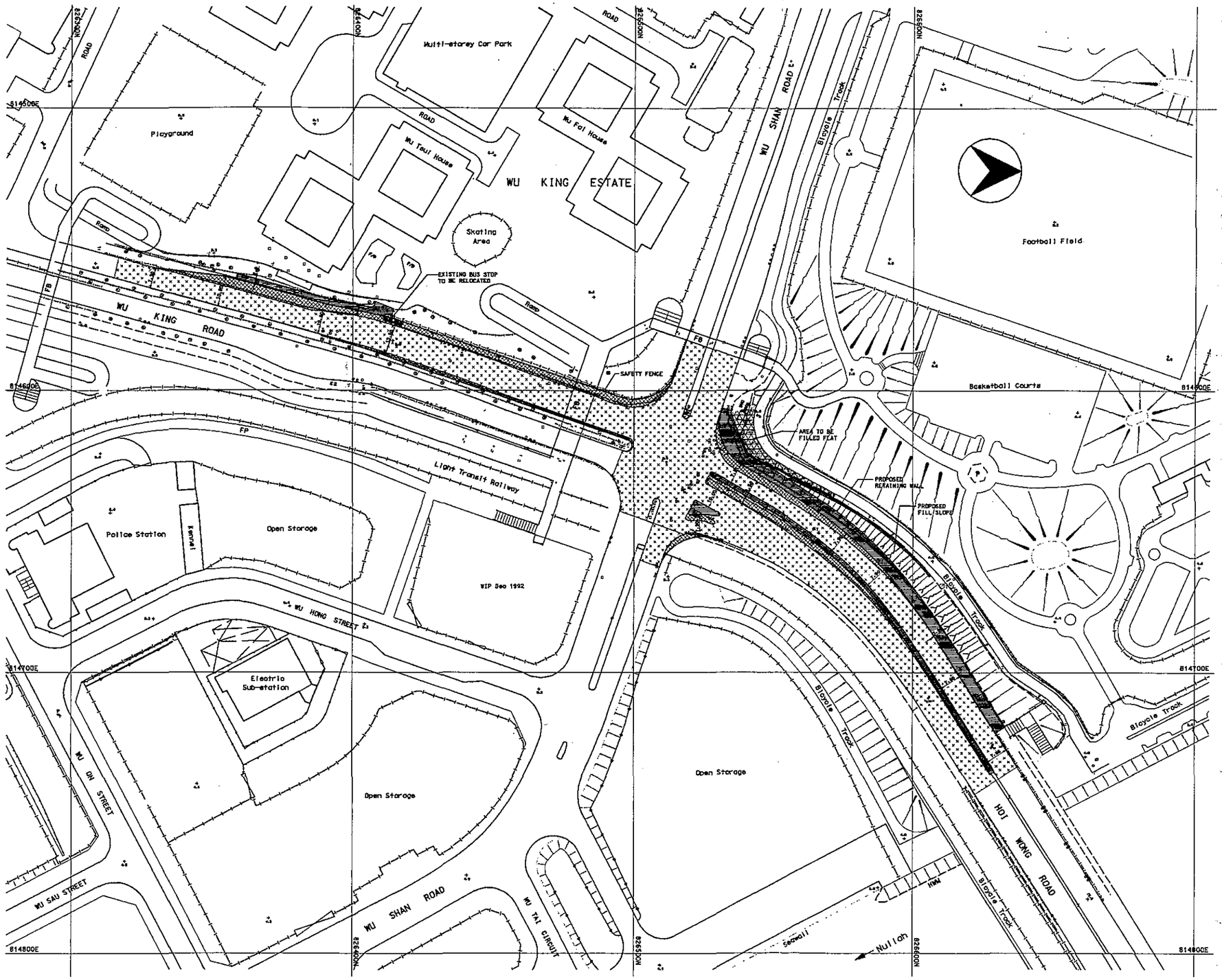
For demolition work, it has been proposed that a generator and electric hand tools in lieu of a pneumatic compressor and hand tools be used, in case the pneumatic working method is too noisy. The total sound power level of the alternative method would be 2 dB(A) quieter than the pneumatic method.

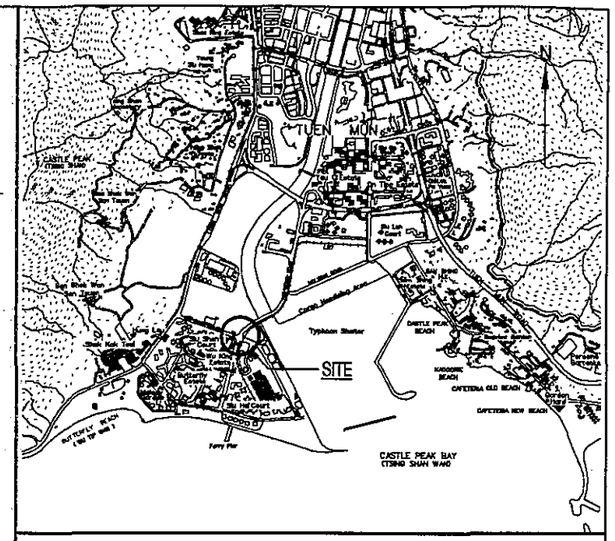
Widening of Wong Chu Road Bridge

Figure 5.5c is a scheme plan showing the widened Wong Chu Road section. The major construction activities which could be potential sources of noise impact are as follows :

- cofferdam construction (Code 5.14);
- bored piling and pile cap construction (Code 5.15);
- bridge beam and deck construction (Code 5.16); and
- paving (Code 5.17).

All construction works are expected to be carried out during the daytime, non-restricted hours. Due to the proximity of the bridge widening works to the nearby residents and schools, it has been proposed that the sheet piling method for the cofferdam construction would be by means of an oscillatory mechanism,





KEY PLAN

1. ALL DIMENSIONS ARE IN MILLIMETRE UNLESS OTHERWISE STATED.
2. ALL LEVELS ARE IN METRE ABOVE H.K.P.D.

LEGEND :

- PROPOSED CARRIAGEWAY
- PROPOSED FOOTPATH/ISLAND
- EXISTING CARRIAGEWAY TO BE RESURFACED
- AREA TO BE FILLED FLAT
- PROPOSED RETAINING WALL
- PROPOSED FILL SLOPE
- PROPOSED TYPE 2 RAILINGS
- PROPOSED SAFETY FENCE

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

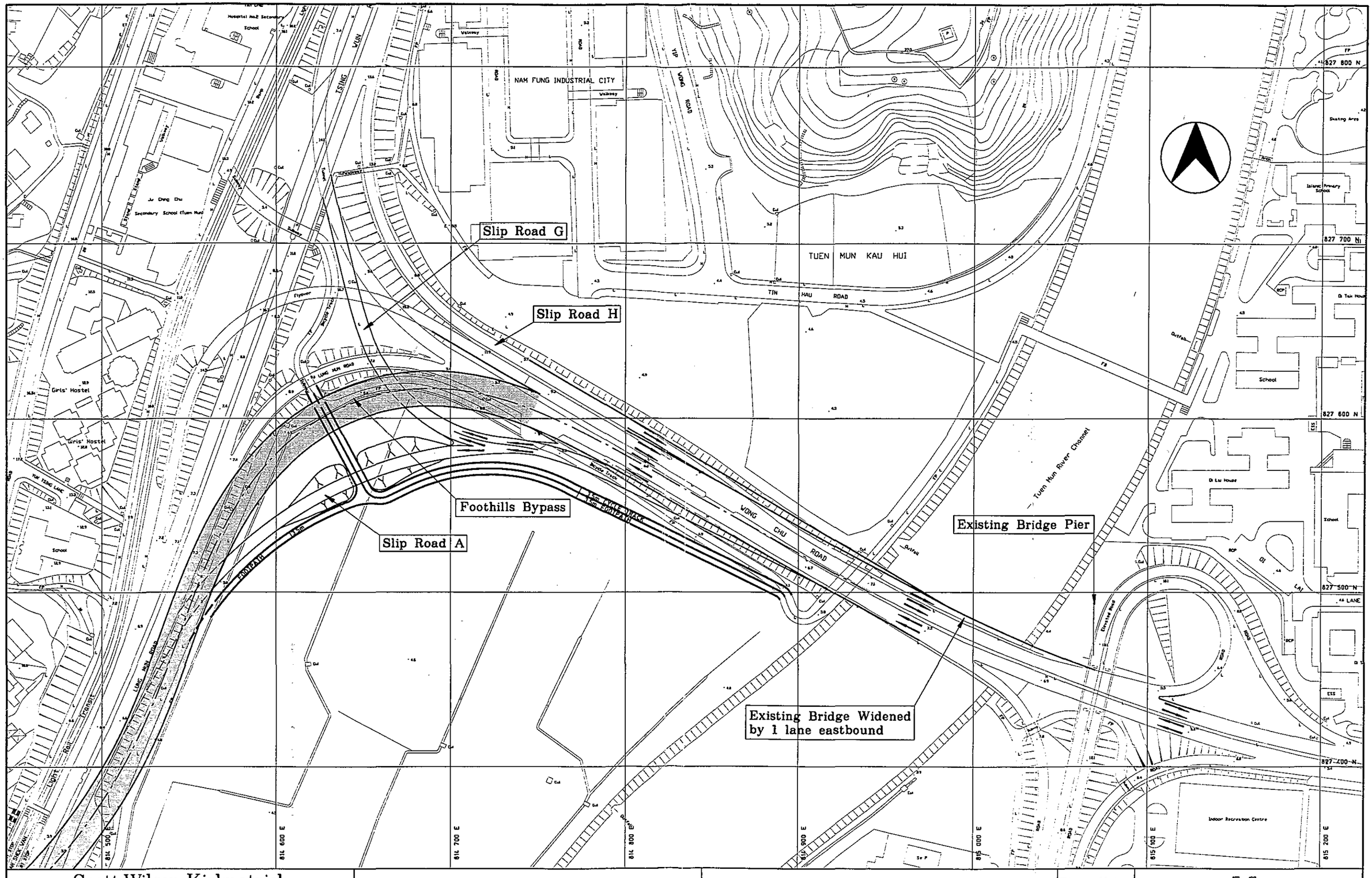
Aspinwall Clouston
ERM (Hong Kong)
Parsons Brinkerhoff (Asia)
SWK Atria

AGREEMENT NO. CE44 / 95
FOOTHILLS BYPASS
TUEN MUN ROAD / WONG CHU ROAD
INTERCHANGE AND OTHER ROAD JUNCTION
IMPROVEMENT WORKS

Improvements to Junction of Road D11 / D13 / D14 / D44A

Figure No.	5.5b
Scale	N.T.S.

SWK P:\CURRENT*25\FIG_5-5b.DGN THU 16 MAY 1996 12:30 Scale 1 : 1500 420 x 297



Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

Aspinwall Clouston
ERM (Hong Kong)
Parsons Brinkerhoff (Asia)
SWK Atria

AGREEMENT NO.CE44/95
FOOTHILLS BYPASS
TUEN MUN ROAD / WONG CHU ROAD
INTERCHANGE AND OTHER ROAD JUNCTION
IMPROVEMENT WORKS

Proposed Improvements to Lung Mun Road/Wong Chu Road Interchange

Figure No.	5.5c
Scale	

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and bored piling would be adopted in place of percussive methods for the construction of the bridge foundation, in order to minimize the potential construction noise impacts upon these NSRs. The construction plant inventory and the corresponding sound power levels (SWL) are given in *Table 5.5c* below.

Table 5.5c *Construction Activities for the Bridge Widening and Sound Power Levels*

Activity Code	Type of Activity	Power Mechanical Equipment / Noise Sources	TM CNP No.	Sound Power Level $L_{A\,eq,\,30\,min}$ dB	No. of Plant	Total Sound Power Level, $L_{A\,eq,\,30\,min}$ dB
5.14	Cofferdam Construction	Sheet Piling, Oscillatory Mechanism	165	115	1	
		Electric Water Pump	281	88	1	115
5.15	Bored Piling and Pile Cap Construction	Bored Piling Rig	165	115	1	
		Concrete Truck	044	109	1	
		Concrete pump	047	109	1	
		Vibratory Poker	170	113	2	119
5.16	Bridge Beam and Deck Construction	Crane	048	112	2	
		Lorry	141	112	1	
		Truck	141	112	1	
		Vibratory Poker	170	113	2	
		Concrete Truck	044	109	1	120
5.17	Road Paving	Vibratory Road Roller	186	108	1	
		Asphalt Paver	004	109	1	
		Lorry	141	112	1	115

5.5.2 *Evaluation Methodology*

As all construction works have been planned to be undertaken during the daytime non-restricted hours, the impact evaluation has been based on the noise criteria given in the ProPECC guidelines. Although the guidelines are non-statutory noise limits, any exceedances above the guidelines imply that the construction noise would be a potential impact and noise mitigation measures should be required.

For the prediction of construction noise levels, a methodology has been adopted based on the TM1, as percussive piling activities are not expected in the execution of works. The prediction procedures are as follows:

- locate the nearest NSR potentially affected by a specific construction activity;
- determine the maximum total site SWL for each construction activity based on an assumed plant inventory provided by Scott Wilson Kirkpatrick and SWLs for PME given in the TM;
- determine distance attenuation, and potential screening corrections for any topographical features etc. from the notional source point of the worksite to the NSR; and
- calculate the construction noise levels at NSRs by taking into account the maximum total site SWL, potential attenuation by distance and screening as mentioned above, and reflection effects of the facade of the NSR.

NSRs which are sufficiently distant from the works may not be impacted by construction noise, for example, when the separation distance between a NSR and a particular construction activity is more than the threshold distance identified in *Table 5.5d* below.

Table 5.5d *Threshold Distances for the Major Construction Activities*

Activity Code	Type of Activity	Site Sound Power Level of Activity, $L_{Aeq, 30\ min}$ dB	Threshold distance, m	
			Residence	School
Foothills Bypass Construction				
5.1	Site Clearance	125	178	316
5.3	Earthworks	124	158	282
5.4	Roadworks	122	126	224
5.5	Road Paving	117	71	126
5.6	Flyover Abutment	118	79	141
Improvements to Junction D11/D13/D14/44A				
5.8	Demolition	116	63	112
5.9	Retaining Wall Construction	114	50	89
5.10	Earthworks	116	63	112
5.11	Roadworks	114	50	89
5.12	Diversion of Utilities	115	56	100
5.13	Road Paving	115	56	100
Widening of Wong Chu Road				
5.14	Cofferdam Construction	115	56	100
5.15	Bored Piling and Pile Cap Construction	119	89	158
5.16	Bridge Beam and Deck Construction	120	100	178
5.17	Road Paving	115	56	100

The threshold distance was determined based on the following acoustic prediction formula:

SPL = SWL -20log(d) - 8 + 3 dB(A)

SWL is the site sound power level of the construction activity. SPL is the sound pressure level at a distance (d) from the notional source point; and is the ProPECC guidelines in this case, which is $L_{Aeq, 30min}$ 75 dB for residences and 70 dB for schools. The latter will be reduced to $L_{Aeq, 30min}$ 65 dB if the construction activity is undertaken during the school examination period. However, the $L_{Aeq, 30min}$ 70 dB guideline has been used for this noise assessment as examinations are occasional events during a calender year. It is recommended in *Section 5.5.5* that noise monitoring should be undertaken at the nearby schools in case the construction works are carried out during their examination periods.

5.5.3 *Construction Noise Impact Assessment*

Table 5.5e below presents the nearest separation distances measured between the worst case notional source points and the NSRs, and the predicted noise levels for each construction activity.

Table 5.5e *Nearest Separation Distances between NSRs and Individual Construction Activities, and Predicted Noise Levels, $L_{Aeq(30min)}$ dB*

NSR	Activity Code	Distance, m	Predicted Level, $L_{Aeq,30\ min}$ dB	Noise Criterion, $L_{Aeq,30\ min}$ dB	Noise Exceedances, $L_{Aeq,30\ min}$ dB
Foothills Bypass Construction					
N3	5.1	360	69	75	0
	5.3	360	68		0
	5.4	405	65		0
	5.5	405	60		0
	5.6	370	62		0
N4	5.1	365	69	70	0
	5.3	365	68		0
	5.4	405	65		0
	5.5	405	60		0
	5.6	N/A	N/A		N/A
N6	5.1	390	68	70	0
	5.3	390	67		0
	5.4	410	65		0
	5.5	410	60		0
	5.6	N/A	N/A		N/A
N7	5.1	325	70	75	0
	5.3	325	69		0
	5.4	345	66		0
	5.5	345	61		0
	5.6	N/A	N/A		N/A
N8	5.1	126	78	70	8
	5.3	126	77		7
	5.4	146	74		4
	5.5	146	69		0
	5.6	N/A	N/A		N/A
N9	5.1	410	68	75	0
	5.3	410	67		0
	5.4	300	67		0
	5.5	300	62		0
	5.6	N/A	N/A		N/A
N10	5.1	154	76	75	1
	5.3	154	75		0
	5.4	168	73		0
	5.5	168	68		0
	5.6	305	63		0
Improvements to Junction D11/D13/D14/44A					
N11	5.8	10	91	75	16
	5.9	182	64		0
	5.10	12	89		14
	5.11	12	87		12
	5.12	10	90		15
	5.13	10	90		15
N12	5.8	115	70	70	0
	5.9	N/A	N/A		0
	5.10	158	67		0
	5.11	129	67		0
	5.12	115	69		0
	5.13	129	68		0

NSR	Activity Code	Distance, m	Predicted Level, $L_{Aeq,30\ min}$ dB	Noise Criterion, $L_{Aeq,30\ min}$ dB	Noise Exceedances, $L_{Aeq,30\ min}$ dB
N14	5.8	80	73	70	3
	5.9	N/A	N/A		N/A
	5.10	95	71		1
	5.11	80	71		1
	5.12	80	72		2
	5.13	80	72		2
N15	5.8	65	75	75	0
	5.9	93	70		0
	5.10	60	75		0
	5.11	53	74		0
	5.12	60	74		0
	5.13	53	75		0
N16	5.8	35	80	75	5
	5.9	95	69		0
	5.10	46	78		3
	5.11	46	76		1
	5.12	35	79		4
	5.13	46	77		2
N17	5.8	160	67	70	0
	5.9	190	63		0
	5.10	160	67		0
	5.11	160	65		0
	5.12	160	66		0
	5.13	160	66		0
Widening of Wong Chu Road					
N18	5.14	200	64	75	0
	5.15	200	68		0
	5.16	200	69		0
	5.17	200	64		0
N19	5.14	135	67	75	0
	5.15	135	71		0
	5.16	135	72		0
	5.17	135	67		0
N20	5.14	150	66	70	0
	5.15	150	70		0
	5.16	150	71		1
	5.17	150	66		0

Foothills Bypass Construction

The predicted levels are within the ProPECC guidelines for all of the Foothills Bypass construction activities at the following locations:

- Siu Shan Court (N3);
- Chow Chun Yau Primary School (N4);
- Butterfly Estate (N5);
- Siu Lam Primary School (N6);
- Melody Garden (N7); and
- Pillar Point Refugee Camp (N9).

At the riding school (N8), the predicted levels are within the ProPECC guidelines for the road paving and the flyover abutment, but exceed the guidelines for the site clearance, earthworks and roadworks by 4 to 8 dB(A). It is expected that the noise exceedances from most of these activities can be reduced below 70 dB(A) by the use of noise barriers. As residual impacts would still

At San Shek San Tsuen (N10), the predicted levels are within the guidelines for most of the construction activities. A 1 dB(A) exceedance is anticipated during site clearance, although it is expected that the use of noise barriers would be adequate to ameliorate the exceedance.

Improvements to Junction D11/D13/D14/44A

The predicted noise levels for all the individual construction activities can meet the guidelines at the following locations:

- Law Chan Chor Si Primary School (N12);
- Tuen Mun Wu Hong Clinic (N15); and
- Leung Chik Wai Memorial School (N17).

At Wu Tsui House (N11), only the predicted noise level for the retaining wall construction can meet the guidelines. The predicted exceedances are 16 dB(A) for demolition, 15 dB(A) for diversion of utilities and road paving, 14 dB(A) for earthworks and 12 dB(A) for roadworks. These exceedance levels suggest that specific noise mitigation measures will be required to ameliorate the noise exceedances to within the guidelines. Details are provided in *Section 5.5.4.*

At Carmel Bunnam Tang Memorial Secondary School (N14), exceedances of the guidelines have been predicted for demolition (3 dB(A)), diversion of utilities (2 dB(A)), road paving (2 dB(A)), earthworks (1 dB(A)) and roadworks (1 dB(A)). It is expected that the use of noise barriers will be adequate to ameliorate these noise exceedances to meet the guidelines. However, these exceedances will be increased by 5 dB(A) if the construction works are undertaken during the school examination period. In this case, noise monitoring is recommended to ensure that the construction noise emissions can meet the $L_{Aeq, 30\ min}$ 65 dB guideline at the school. Alternatively, these construction works should be postponed after the school's examination periods, if avoidable, so that the impacts could be minimized.

At Wu Fai House (N16), there are predicted noise exceedances for demolition works (5 dB(A)), diversion of utilities (4 dB(A)), earthworks (3 dB(A)), road paving (2 dB(A)) and roadworks (1 dB(A)). It is expected that the use of noise barriers will be adequate to ameliorate these noise exceedances to meet the guidelines.

Widening of Wong Chu Road Bridge

The PSPS residential development in Tuen Mun Area 18 (N18), Oi Lai House (N19) and the Ho Sik Lam Primary School (N20) are unlikely to be impacted by the construction noise associated with the bridge widening works. All the predicted noise levels are within the guidelines except for a 1 dB(A) exceedance at N20 due to the bridge beam and deck construction. Noise barriers would be adequate to ameliorate this small exceedance to meet the guidelines.

Concurrent Activities

A number of concurrent activities have been identified from the construction programme (*Figure 5.5a*). Concurrent activities will be undertaken in the vicinity of the NSRs near Junction D11/D13/D14/44A and the riding school (N8). The predicted noise levels, due to the concurrent activities near Junction D11/D13/D14/44A are presented in *Table 5.5f* below.

The likely concurrent activities affecting the riding school (N8) will be from the embankment construction and earthworks excavation, and earthworks excavation with roadworks. The predicted noise levels are presented in *Table 5.5f*.

For the junction improvement works, the following exceedances are predicted due to the concurrent activities of demolition or roadworks with the diversion of utilities:

- 20 dB(A) at Wu Tsui House (N11);
- 4 dB(A) at Law Chan Chor Si Primary School (N12);
- 7 dB(A) at Carmel Bunnam Tang Memorial Secondary School (N14);
- 5 dB(A) at Tuen Mun Wu Hong Clinic (N15); and
- 9 dB(A) at Wu Fai House (N16).

Table 5.5f ***Predicted Noise Levels for Worst Case Concurrent Construction Activities ($L_{Aeq, 30min}$ dB)***

NSR	Concurrent Activities	Duration (mm/yy)	Noise Levels of Individual Activity, $L_{Aeq, 30\ min}$ dB	Total Noise Level, $L_{Aeq, 30\ min}$dB	Noise Criterion, $L_{Aeq, 30\ min}$dB
Concurrent Activities for Junction D11/D13/D14/44A					
N11*	5.10,5.8/5.11,5.12	Oct - Dec 1997	89,91/87,90	95	75
N12*	5.10,5.8/5.11,5.12	Oct - Dec 1997	67,70/67,69	74	70
N14*	5.10,5.8/5.11,5.12	Oct - Dec 1997	71,73/71,72	77	70
N15*	5.10,5.8/5.11,5.12	Oct - Dec 1997	75,75/74,74	80	75
N16*	5.10,5.8/5.11,5.12	Oct - Dec 1997	78,80/76,79	84	75
N17*	5.10,5.8/5.11,5.12	Oct - Dec 1997	67,67/65,66	72	70
Concurrent Activities affecting the Riding School					
N8	5.2,5.3	Jun 1999 - Mar 2000	75,77	79	70
	5.3,5.4	Jan 2000 - Mar 2000	77,74	79	

* As the construction programme indicates that either demolition or roadworks will be undertaken concurrently with the diversion of utilities, the noisier activity has been the basis for determining the total noise level.

It is believed that most of the above predicted exceedances are likely to be over-estimated as the junction improvement works will be small in scale and limited to widening a small section of Hoi Wong Road and realigning Wu King Road. It is not anticipated that a large number of PME will be operating together at one time, near the NSRs. It is likely that the works will progress along the road rather than remaining stationary and, therefore, the actual noise exceedances would be short-term and less than the above predicted levels.

Consideration of environmental monitoring and audit should be given to Sun Tuen Mun Centre, Tuen Mun Public Riding School, Wu Tsui House and Carmel Bunnam Tang Memorial Secondary School as considerable exceedances have been predicted at these locations. These concurrent activities should be avoided, if practicable, by re-arranging appropriately the sequence of these activities.

As the clinic (N15) is centrally air-conditioned, it will be adequately insulated from the noise of the concurrent construction activities.

Cumulative Noise Impacts

During the peak construction period of the Foothills Bypass northern section in 1999, construction works at Wong Chu Road and D15/P3 Junction will also be being carried out. The Area 18 PSPS development will be the nearest NSR to the works and is likely to be impacted by the cumulative effect of the two projects. It is understood that the single aspect blocks will be built along the boundary of the PSPS development, and will effectively mitigate the construction noise impacts. The cumulative noise impact will not affect Sun Tuen Mun Centre as it will be more than 0.7 km from the construction site at D15/P3 and would also be screened by the Area 18 PSPS development.

The construction period of the Foothills Bypass southern section will overlap with the River Trade Terminal (RTT) development. The nearest NSR is the Pillar Point Refugee Camp (N9). It is understood that N9 would close before July 1997, which is prior to the commencement of the RTT construction. Other nearby NSRs are Butterfly Estate (N5) and Melody Garden (N7) which are more than 1.7 km from the RTT. The RTT's construction noise impacts have been predicted more than 15 dB(A) below the ProPECC $L_{Aeq,\ 30\ min}$75 dB guideline[1] at these NSRs, therefore cumulative noise impacts are not anticipated.

5.5.4 *Mitigation Measures*

Good Site Practices and Management

The following good site practices and management can considerably reduce the potential for construction noise impacts on nearby NSRs and should be followed by the Contractors during each phase of construction:

- only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction programme;
- silencers or mufflers on construction equipment should be utilised and should be properly maintained during the construction programme;
- mobile plant should be sited as far away from NSRs as possible;
- plant known to emit noise strongly in one direction should, where possible, be orientated so that the noise is directed away from nearby NSRs;
- material stockpiles and other structures should be effectively utilised, where practicable, to screen noise from on-site construction activities;
- machines and plant (such as trucks) that may be in intermittent use should be shut down between the working periods or should be throttled down to a minimum; and
- simultaneous noisy activities should be avoided.

The noise benefits of these techniques can vary according to specific site conditions and operations, and whilst they would provide some attenuation, they cannot be assumed to guarantee a high level of noise mitigation.

Standard Noise Mitigation Measure

[1] River Trade Terminal at Tuen Mun Area 38 - Environmental Impact Assessment Final Report. Prepared by ERM-Hong Kong Ltd for River Trade Terminal Company Ltd. October 1996.

The use of noise barriers is considered to be a standard noise mitigation measure, and should be able to provide a noise reduction of 5-10 dB(A) under most circumstances. However, a potential reduction of 5 dB(A) has been assumed as a conservative estimate. The noise barriers could be in the form of either temporary fixed or mobile type barriers. Taking into account of the screening effect, the mitigated noise levels at each identified NSRs are presented in *Table 5.5g to i.*

Table 5.5g ***Foothills Bypass Construction - Predicted Noise Levels with the Use of Noise Barrier ($L_{Aeq,\ 30\ min}$ dB)***

NSRs	5.1 Site Clearance	5.3 earthworks	5.4 roadworks	5.5 road paving	5.6 flyover abutment
N3	64	63	60	55	57
N4	64	63	60	65	-
N6	63	62	60	55	-
N7	65	64	61	56	-
N8	73	72	69	64	-
N9	63	62	62	57	-
N10	71	70	68	63	58

Table 5.5h ***Improvements to Junction D11/D13/D14/44A - Predicted Noise Levels with the Use of Noise Barrier ($L_{Aeq,\ 30\ min}$ dB)***

NSRs	5.8 Demolition	5.9 retaining walls	5.10 earthworks	5.11 road works	5.12 Diversion of utilities	5.13 paving
N11	86	59	84	82	85	85
N12	65	-	62	62	64	63
N14	68	-	66	66	67	67
N15	70	65	70	69	69	70
N16	75	64	73	71	74	72
N17	62	58	62	60	61	61

Table 5.5i *Widening of Wong Chu Road - Predicted Noise Levels with the Use of Noise Barrier ($L_{Aeq,\ 30\ min}$ dB)*

NSRs	5.14 Cofferdam Construction	5.15 Bored Piling	5.16 Bridge beam & deck construction	5.17 paving
N18	59	63	64	59
N19	62	66	67	62
N20	61	65	66	61

These fixed or mobile noise barriers should be 3-5 m high, located between the noisy construction activities and the NSRs to be protected. They should have no openings or gaps, and be constructed of materials with a superficial density of at least 10 kg m^{-2}. According to TM1, this could provide as much as 5 dB(A) noise screening. However, the extent of screening reduction will be reduced if the NSR to be protected is a high rise building or close to the construction activities.

Mobile barriers can be located close to noisy plant, and this can be effective at screening NSRs from particular plant. For instance, a 3 m high mobile barrier with a skid footing and a small cantilevered upper portion can be located within a few metres of static plant and within about 5 m of more mobile plant such as excavators, bulldozers, etc. There should not be openings or gaps, otherwise, the overall effectiveness of the barriers can be reduced substantially. The material of construction for the barrier should have a superficial density of at least 10 kg m^{-2}. Based on the NSR heights and site geometry in this case, it is estimated that mobile noise barriers of this type, if carefully located, can produce at least 10 dB(A) screening for static plant and 5 dB(A) for mobile plant. Where the screening can be achieved at the upper floors of NSRs, greater benefits would result at the lower floors. The noise screening benefit for each plant considered in this Study is listed as follows:

- stationary plant - 10 dB(A) screening: vibratory poker, compressor, concrete pump, drilling rigs, generator, various hand tools; and
- mobile plant - 5 dB(A) screening: bulldozer, excavator, scraper, grader, truck, roller, asphalt paver, loader and crane.

Site-Specific Noise Mitigation Measures

Section 5.5.4 identified exceedances of the ProPECC guidelines, even with the use of noise barriers, at the Tuen Mun Public Riding School (N8) and Wu Tsui House (N11). The following noise mitigation measures which are specific to the site are recommended:

Tuen Mun Public Riding School (N8)

As the NSR is a low rise building and the construction site will be located uphill from the NSR, the use of mobile noise barriers would be effective in screening the noise from the PME for site clearance and earthworks excavation. The barriers should be sufficiently high and long enough to screen the line of sight to the PME, having no openings or gaps and a superficial surface density of at least 10 kg m^{-2}. It is recommended that a barrier height of 3-4 m would be appropriate. However, there would still be residual exceedances of 3 dB(A) for

site clearance and 2 dB(A) for earthworks excavation. The residual impacts of the site clearance could be further reduced by 3 dB(A) with substituting the scrapers with quieter PME and reducing the number of each type of PME used on site to one. By reducing the number of each type of PME to one, the predicted noise levels during the earthwork excavation operations could further reduced by 2 dB(A). Hence, the noise levels will be within the daytime construction noise limit.

Wu Tsui House (N11)

Owing to the proximity of the NSR to the construction activities, the use of noise barriers would be the most effective mitigation measure. As the NSR is a high rise residential building, barriers with a cantilevered upper portion would optimize the noise screening for the upper floors. The optimal barrier height would be limited by engineering constraints, but a height of 3-5 m is recommended. This could give a 5 dB(A) reduction but, residual impacts of 7-11 dB(A) would remain at N11 based on the predicted exceedances as shown in *Table 5.5h*.

In order to minimize the residual impacts, the Construction Contracts should include the following noise mitigation measures identified below.

- Use a generator and electric handtools rather than a compressor and pneumatic handtools for demolition work.

- Avoid operating more than one PME at a time for a particular construction activity.

The above measures would further reduce the noise by 4-6 dB(A) for demolition, 2 - 5 dB(A) for retaining wall construction and roadworks, 4-10 dB(A) for earthworks, 3 dB(A) for diversion of utilities and road paving. The mitigated noise levels taking into account of the screening effect and limited the PME operating during any one time to one are presented in *Table 5.5j*.

Table 5.5j ***Improvement to Junction D11/D13/D14/44A - Mitigated Noise Levels at N11 ($L_{Aeq,\ 30\ min}$ dB)***

Construction Activities	Predicted Noise Levels
5.8 Demolition	80-82
5.10 Earthworks	74-80
5.11 Road works	77-80
5.12 Diversion of utilities	82
5.13 Paving	82

The residual impacts at N11 would be:

- 5-7 dB(A) for demolition for a period of 1 month;
- maximum 5 dB(A) for earthworks for a period of 1 month;
- 2-5 dB(A) for roadworks for a period of 1 months;
- 7 dB(A) for diversion of utilities for a period of 2 months; and
- 7 dB(A) for road paving for a period of 1 month.

Considering the proximity of the NSR to these works, and the duration of the demolition work, the above noise mitigation measures and the use of quiet plant would be the most practicable means of reducing the noise impact. Although the impacts may not be mitigated completely, consideration should be given to the short-term nature of the impacts. The exceedances would be further minimized by good site practices and management, and environmental monitoring and audit.

It should be noted that these noise predictions have been based on worst case assumptions, assuming all PME items are located at a singular notional source point, nearest the NSRs, and operating simultaneously. Therefore, the predicted impacts are likely to be overestimated. The actual noise exposure of residents at Wu King Estate should be lower than the prediction, as the PME is likely to move along the works area rather than remain stationary and all the PME would not be operating simultaneously. Therefore, the noise exposure would not be continuous during each construction period.

Concurrent Activities

Concurrent activities are not recommended in the vicinity of N8 for the Foothills Bypass construction, and for the improvement works of the D11/D13/D14/44A Junction, as considerable exceedances have been predicted and the most practical measures would not be adequate for mitigating the impacts completely. If practicable, work sequence of the Junction improvement should be rearranged appropriately, in particular, the demolition work should not be undertaken with other activities and for any works to be carried out near Wu Tsui House (N11), Carmel Bunnam Tang Memorial School (N14), Tuen Mun Wu Hong Clinic (N15), and Wu Fai House (N16).

The noise control authority would be more concerned whether the most practical noise mitigation measures have been considered during the planning of a construction project in order to minimize its noise impacts. However, NCO criteria will be strictly imposed upon all construction activities to be carried out during the restricted hours. Details regarding restricted hour construction activities are provided in the following section.

Construction Activities During Restricted Hours

The restricted hours are all hours outside of 0700-1900 Monday through Saturday, as well as all day on Sunday and Public Holidays. If such works are required, the Contractor is required to obtain a CNP from the noise control authority, EPD. In order to obtain a CNP, the Contractor is required to demonstrate that compliance with the $L_{Aeq,\ 5\ minutes}$ levels given in *Table 5.2b*, as appropriate to the NSR, would be achieved.

In order for the restricted hours construction works to meet the NCO noise limits, it is expected that only quiet construction activities should be allowed.

5.5.5 *EM&A Requirements*

It is recommended that noise monitoring be carried out during the construction period of the Foothills Bypass at Sun Tuen Mun Centre (N2), Tuen Mun Public Riding School (N8), Wu Tsui House (N11), and Carmel Bunnam Tang Memorial Secondary School (N14). The monitoring is required to ensure compliance with the ProPECC guidelines in providing feedback to the Contractors for the

management of their operations. It is also recommended that noise monitoring be carried out at the nearby schools when the construction works are undertaken during the examination period of these schools.

5.5.6 *Conclusions*

The noise assessment indicated that unmitigated daytime construction activities of the Foothills Bypass, improvements to the Junction D11/D13/D14/44A and the widening of a section of Wong Chu Road over the nullah, would cause exceedances of the ProPECC guidelines at some of the nearby NSR locations.

Most of the construction noise impacts could be mitigated for most NSRs by appropriately designed noise barriers in the form of fixed temporary or mobile noise barriers, but specific measures such as the reduction of the number of PME and the use of quiet PME would be required for the riding school (N8) and Wu Tsui House (N11).

Compliance noise monitoring should be carried out during the construction period of the Foothills Bypass at the Sun Tuen Mun Centre, Tuen Mun Public Riding School, Wu Tsui House and Carmel Bunnam Tang Memorial Secondary School. The monitoring is also recommended at other nearby schools in case the works are undertaken during the school examination periods. The environmental monitoring and audit recommendations are further discussed in *Section 9*.

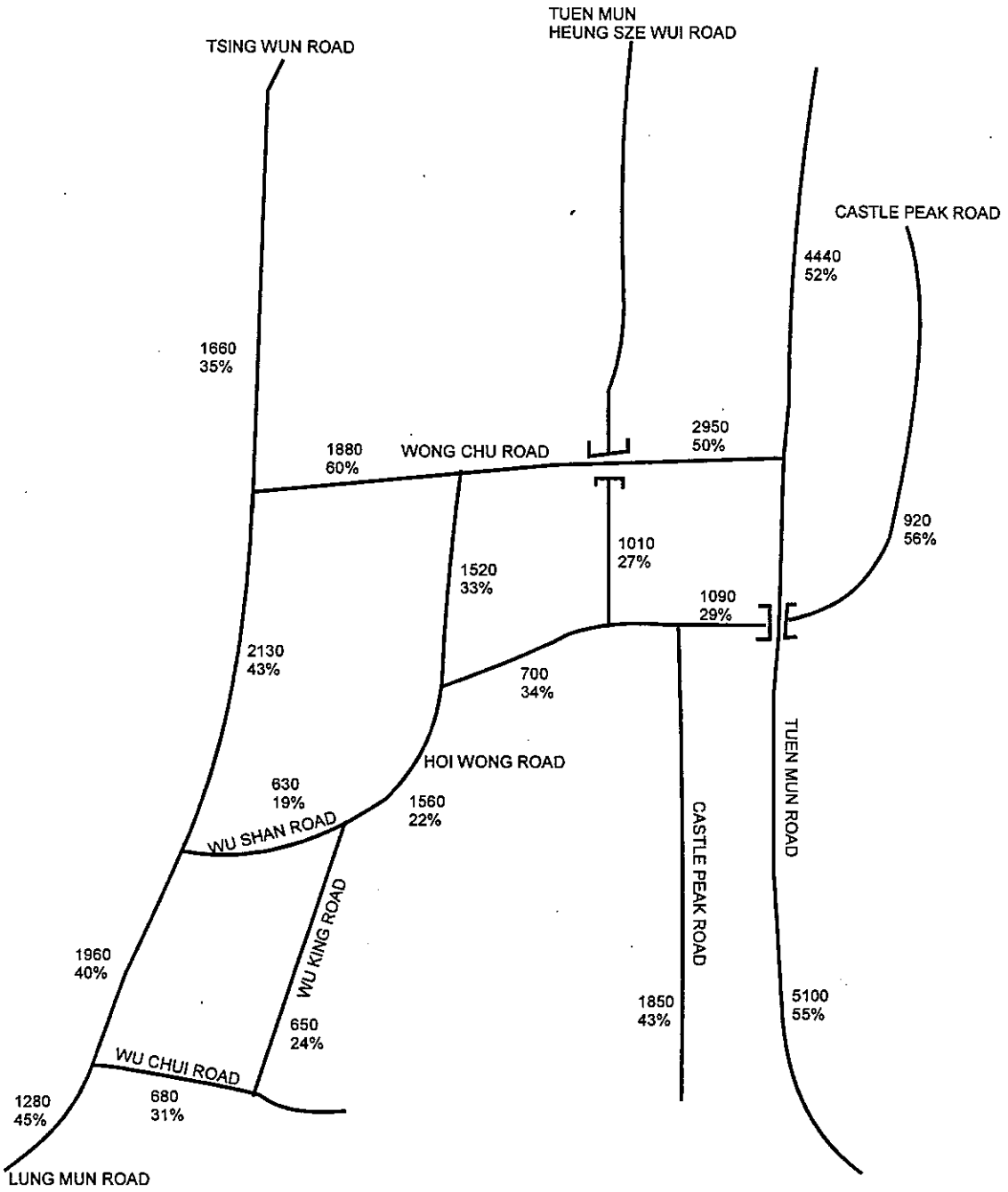
5.6 *OPERATION PHASE*

5.6.1 *Assessment Methodology*

Traffic noise levels have been predicted using the UK methodology *'Calculation of Road Traffic Noise, 1988'*. *Figures 5.6a and 5.6b* present traffic data on the road network within the Study Area at the prevailing year of 1996 and the future year of 2011. The latter is a worst case scenario within 15 years after the commissioning of the Foothills Bypass. The data include peak hour traffic flows and the percentage of heavy goods vehicles. Traffic speed limits were assumed to be 80 kph and 50 kph for the Foothills Bypass and all other roads respectively. As shown in *Figure 5.6b*, the 2011 peak hour traffic flows on the Foothills Bypass is 3040 vehicles per hour. The 2011 traffic flows on Lung Mun Road will be increased by 18-20% for sections of the road between Wu Shan and Wu Chui Road, and between Wu Chui Road and Area 45 Interchange. At Junction D11/D13/D14/44A, the future traffic flows on Wu King Road, Wu Shan Road and Hoi Wong Road will increase by 125, 144 and 83 percent respectively.

It is understood that the introduction of the Foothills Bypass is to provide a more direct access for future traffic generated from the Tuen Mun Area 38 Development and existing traffic from Tuen Mun west. However, Junction D11/D13/D14/44A will still provide an alternative route to traffic from Tuen Mun west. It was identified from both of the Tuen Mun Area 38 Development Study[2] and the Tuen Mun Port Development Study that there will be capacity deficiencies at this road junction, which are mainly due to the existing level of

[2] Final Report of the Expanded Development Study of Tuen Mun Area 38. Scott Wilson Kirkpatrick Consulting Engineers. October 1990.



KEY:

1580 = TRAFFIC FLOW IN VEHICLES PER HOUR

48% = PERCENTAGE OF HEAVY VEHICLES

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FIGURE 5.6a - 1996 AM PEAK TRAFFIC FLOWS ON THE EXISTING ROADS WITHIN THE STUDY AREA

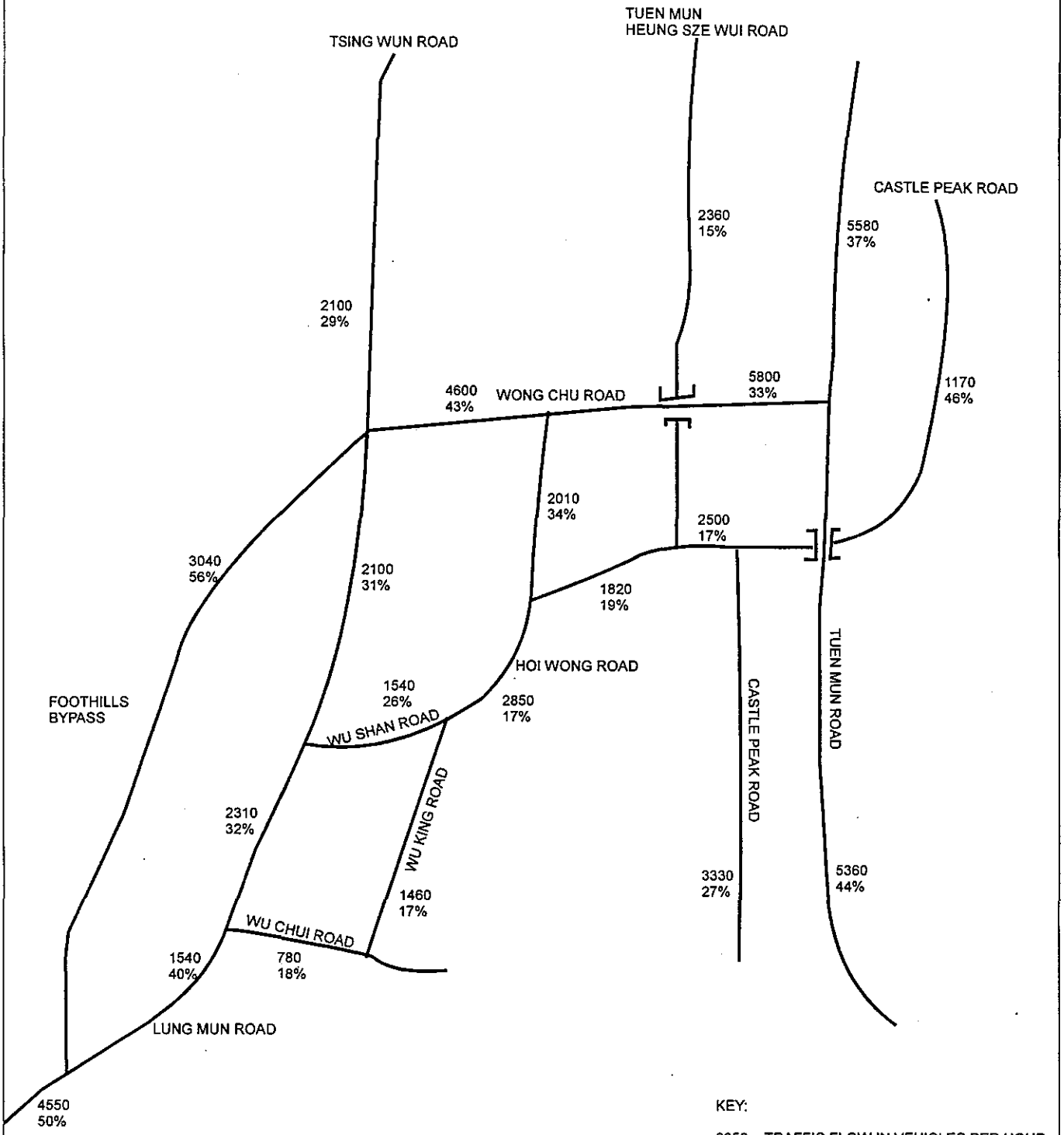

FIGURE 5.6b - 2011 AM PEAK TRAFFIC FLOWS ON THE FOOTHILLS BYPASS AND THE EXISTING ROADS WITHIN THE STUDY AREA

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traffic and the future traffic growth. The traffic changes in the Study Area mentioned above are therefore consistent with these planning assumptions.

For comparative purposes, and in respect of the ExCo Directive, prevailing noise levels have been calculated with traffic data for 1996.

The traffic noise assessment has considered a number of representative NSRs within the Study Area, as given in *Table 5.6a* below and also shown in *Figure 5.3a*. Detailed locations at N3, N7 and N8 are shown in *Figure 5.6c*. The majority of these NSRs are located along the road alignment of the Foothills Bypass but, some are located near the section of Wong Chu Road near the nullah where the bridge improvement works will be required.

The junction improvements works at Junction D11/D13/D14/44A will involve widening a small section of the road near the junction but not the entire road alignment, the widened roads have been considered as existing roads. Noise assessment has been carried out to investigate the noise effect of the Road Junction Improvement.

The widening of the section of Wong Chu Road over the nullah is intended to optimize the traffic movements whilst maintaining the capacity at the D15/P3 Junction. A sensitivity analysis has been carried out to evaluate the effect of such physical alteration to the road by comparing the predicted noise levels at Oi Lai House (N19) and Ho Sik Lam Primary School (N20) for the scenarios of with and without the widening. It indicated that it would have little effect upon the noise exposure of the nearby NSRs. Details are given in *Section 5.6.2*.

The predicted road traffic noise levels at NSRs within the Foothills Bypass section have been compared with the HKPSG noise criteria of $L_{A10,peak\ hour}$ of 70 dB for residential use and 65 dB for educational institutions. The HKPSG specifies guidelines to protect sensitive uses from road traffic noise and recommends direct remedies to be incorporated into the road design (e.g. highway alignment, noise barriers, low noise road surfaces, etc.) when exceedances are identified.

Table 5.6a ***Noise Sensitive Receivers for Road Traffic Noise Impact Assessment***

Receiver ID	Receiver Name	Elevation of Low/Mid/Top Floors (mPD)
Foothills Bypass Section		
N1	Proposed LRT Depot Development	27.8/81.0/137.0
N2	Block 1, Sun Tuen Mun Centre	33.4/86.6/142.6
N3-1	Lau King House, Siu Shan Court	10.4/35.6/63.6
N3-2	Kin King House, Siu Shan Court	10.4/35.6/63.6
N3-3	Hang King House, Siu Shan Court	10.4/35.6/63.6
N4	Chow Chun Yau Primary School	10.4/25.4
N5	Tip Mo House, Butterfly Estate	11.5/36.7
N6	Siu Lam Primary School	10.9/25.9
N7-1	Block 9, Melody Garden	11.3/36.5/64.5
N7-2	Block 10, Melody Garden	11.3/36.5/64.5
N8-1	Tuen Mun Public Riding School (facing Foothills Bypass)	12.6

Receiver ID	Receiver Name	Elevation of Low/Mid/Top Floors (mPD)
N8-2	Tuen Mun Public Riding School (facing Lung Mun Road)	12.6
N10	San Shek Wan San Tsuen	65.2
Widened Bridge Section on Wong Chu Road		
N19	Oi Lai House	9.2/31.6/76.4
N20	Ho Sik Lam Primary School	8.7/11.5/22.7

Other major assumptions for the noise assessment include direct noise mitigation measures for the Foothills Bypass and Wong Chu Road recommended in the endorsed *Road Improvement EIA*. These direct measures are summarized as follows:

- friction course road surfaces for the Foothills Bypass carriageway and Wong Chu Road, and standard impervious bituminous road surface for other roads within the Study Area;
- two noise enclosures along Wong Chu Road with a 5 m high cantilever noise barrier between;
- a 3m high noise barrier and a 5m high cantilever noise barrier alongside the northbound and southbound carriageways, respectively, of the Foothills Bypass northern section (as shown in *Figure 5.6d*);
- 5 m high cantilever barriers alongside slip roads at D15/P3 Interchange and a small segment of slip road connecting Wong Chu Road and Tuen Mun Road at P1/P3 Interchange; and
- 3 m high barriers for a number of slip roads at P1/P3 Interchange.

The extent of the 5m high cantilever barrier along Foothills Bypass will stretch from Junction D15/P3 to the west of Sun Tuen Mun Centre.

5.6.2 *Assessment of Noise Impact*

Foothills Bypass Section

Predicted prevailing and future year (2011) noise exposures at NSRs are presented in *Table 5.6b*.

A slight increase has been predicted for the noise exposure at the majority of the NSRs except for N3, N8 and N10. However, the predicted increase in Siu Shan Court (N3-3) is dominated by the increase in traffic noise due to traffic growth on Wu Shan Road rather than the Foothills Bypass.

At the riding school (N8), the predicted increase and decrease at different facades are about 5 dB(A). The resultant noise levels are 63.9 dB(A) and 66.1 dB(A) at the facade of N8 facing the Foothills Bypass and Lung Mun Road, respectively. These levels are considered acceptable as the facility is already air conditioned and therefore noise insulated. The corresponding free field noise levels are 61.4 dB(A) and 63.6 dB(A) (by deducting 2.5 dB(A) for facade reflections). With these background levels, speech interference would be little within three metres.

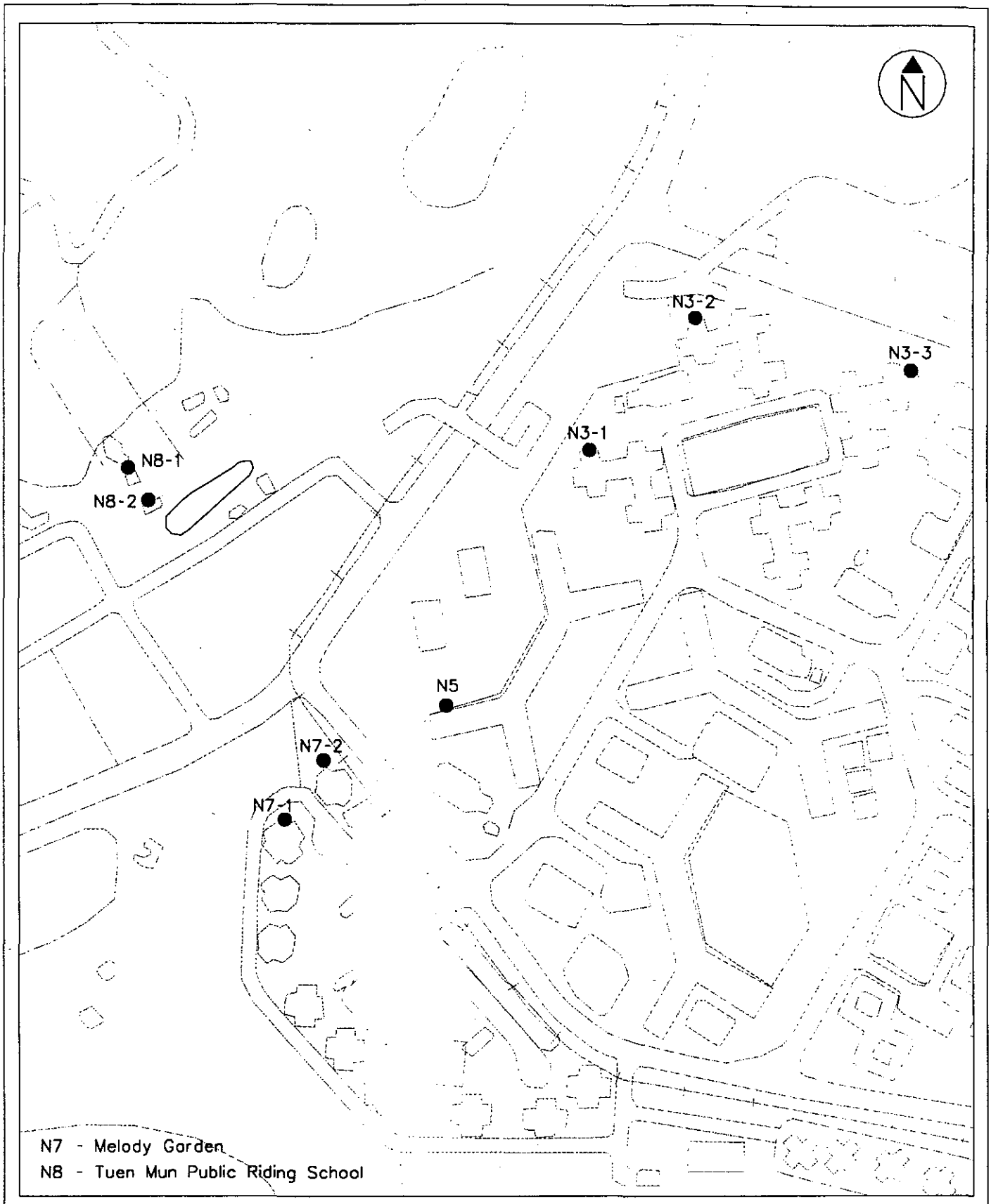

FIGURE 5.6c Detailed Locations at N3, N7 & N8

Date : 4 Nov 98	Drawing No.: /Contract/C1507/C1507_23
Sources: Base map LANDS DEPT. 1:20k topo	

Prepared by ERM's GIS & MAPPING Group

KEY	
●	Noise Sensitive Receiver (NSR) Location

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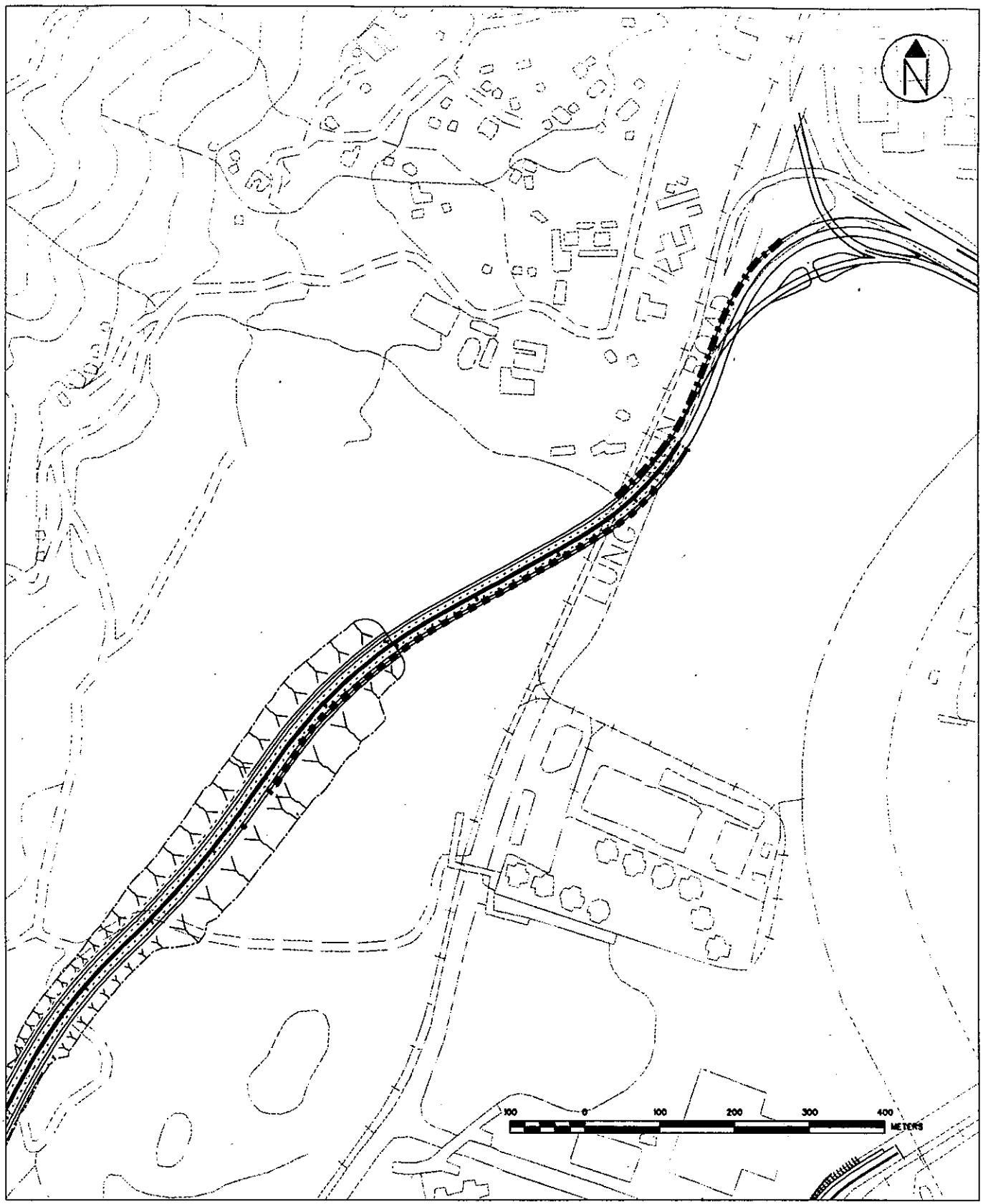

FIGURE 5.6d Roadside Noise Barriers Proposed for the Foothills Bypass Northern Section

Date : 1 Nov 96	Drawing No.: /Contract/C1507/C1507_31
Sources: Base map LANDS DEPT. 1:20k topo	

Prepared by ERM's GIS & MAPPING Group

KEY

- 3m Barrier Recommended in Road Improvement EIA
- 5m Cantilever Barrier Recommended in Road Improvement EIA

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Therefore, it is not expected that the traffic noise would be too loud for undertaking normal outdoor training which requires verbal instructions. At San Shek Wan San Tsuen (N10), the predicted increase is about 8 dB(A) but, the overall level is within the HKPSG criterion.

At the majority of the NSRs, the noise of the Foothills Bypass is well below the HKPSG criteria and will not be the major source of the traffic noise impacts. The existing NSRs along the Foothills Bypass are currently and will continue to be impacted by the noise from Lung Mun Road. With the Foothills Bypass, the scheme would offer a benefit in reducing the noise exposure of the majority of these NSRs due to the relief of traffic on Lung Mun Road, as shown in the last column of *Table 5.6b*.

The 3m noise barrier, 5m cantilever barrier and friction course for the Foothills Bypass northern section as recommended in the endorsed Road Improvement EIA will reduce the noise levels from the scheme at the nearby NSRs, such as the proposed LRT development (N1), Sun Tuen Mun Centre (N2) and the Boy's Home. For the LRT development, it is anticipated that traffic noise impacts will be further studied by the project's proponents during its detailed design in order to ensure adequate mitigation in the building design, particularly in respect of noise from Lung Mun Road. The Area 18 PSPS residential development will be occupied prior to the commissioning of the Foothills Bypass, and will be sufficiently protected from prevailing impacts from Lung Mun Road and future impacts with the Foothills Bypass due to its design which incorporates single aspect blocks.

Table 5.6b ***Predicted Prevailing and Future (Year 2011) Noise Exposure of NSRs at Low, Mid and Top Floors*** ***($L_{A10,\ peak\ hour}$ dB)***

	Prevailing Exposure	Future Exposure	Noise of Foothills Bypass	Change in Exposure Col(3) - Col(2)
N1	78.2	77.4	67.4	-0.8
	73.4	74.3	70.3	+0.9
	71.1	73.0	70.2	+1.9
N2	74.3	73.7	63.2	-0.6
	72.6	72.8	66.4	+0.2
	70.6	71.5	66.5	+0.9
N3-1	73.9	70.9	59.1	-3.0
	73.3	73.3	62.4	+0.0
	72.6	72.9	64.9	+0.3
N3-2	73.8	72.2	57.4	-1.6
	73.4	73.6	61.2	+0.2
	72.6	73.2	64.2	+0.6
N3-3	69.2	73.7	47.2	+4.5
	68.0	72.3	50.0	+4.3
	67.2	70.9	53.3	+3.7
N4	73.3	71.1	58.0	-2.2
	-	-	-	-
	73.1	73.1	60.2	+0.0
N5	73.2	71.2	60.8	-2.0
	-	-	-	-
	73.3	73.3	63.6	+0.0
N6	72.1	71.2	55.0	-0.9
	-	-	-	-
	71.3	70.6	56.2	-0.7

	Prevailing Exposure	Future Exposure	Noise of Foothills Bypass	Change in Exposure Col(3) - Col(2)
N7-1	71.4	69.4	59.1	-2.0
	71.0	71.3	62.0	+0.3
	70.1	70.9	63.8	+0.8
N7-2	74.7	73.2	62.0	-1.5
	74.0	74.3	64.8	+0.3
	72.7	73.5	66.4	+0.8
N8-1*	59.4	63.9	63.3	+4.5
N8-2*	71.4	66.1	58.8	-5.3
N10*	61.1	68.7	68.3	+7.6

* Single storey or village type low rise building

Wong Chu Road Widening

The predicted changes in traffic noise at Oi Lai House (N19) and Ho Sik Lam Primary School (N20) with the Wong Chu Road widening are presented in *Table 5.6c* below. These NSRs are nearest to the widened road. *Table 5.6c* shows that the widening of Wong Chu Road would have little effect upon the noise exposure of the nearby NSRs. Therefore, further noise mitigation would be unnecessary. The Hok Sik Lam Primary School is under the Noise Abatement Measures in Schools Programme (NAMISP), and its noise insulation will be completed before 1999 (i.e. before the commissioning of the Foothills Bypass).

Table 5.6c ***Predicted Changes in Road Traffic Noise Levels With the Wong Chu Road Widening ($L_{A10,peak\ hour}$ dB)***

NSRs	2011 Without Road Widening	2011 With Road Widening	Changes in Low/Mid/Top Floors
N19	67.1/74.9/75.7	66.7/74.9/75.7	-0.4/0/0
N20	72.8/73.8	72.8/73.8	0/0

D11/D13/D14/44A Junction

The D11/D13/D14/44A Junction will undergo minor junction improvement to increase the junction capacity. It has been considered that the junction improvement will not attract further traffic. The effect of the junction improvement on the nearby NSRs have been assessed. *Table 5.6d* presents the predicted noise levels at the identified NSRs for with and without junction improvement scenario. The predicted results indicated that the junction improvement would have little effect upon the noise exposure of the nearby NSRs.

Table 5.6d *Predicted Road Traffic Noise Levels ($L_{A10,\ peak\ hour}$ dB) for the Year 2011*

NSRs	2011 Without Junction Improvement	2011 With Junction Improvement	Change
	Low/Mid/Top	Low/Mid/Top	Low/Mid/Top
N11	75.7/73.0/71.0	76.0/73.3/71.0	+0.3/+0.3/0
N12	74.2/-/73.3	74.0/-/73.2	-0.2/-/-0.1
N13	72.6/-/71.5	72.4/-/71.3	-0.2/-/-0.3
N15	74.2	74:1	-0.1
N16	76.0/74.5/72.9	76.8/74.4/72.7	+0.8/+0.1/-0.2
N17	75.4/-/74.5	75.4/-/74.5	0/-/0

5.6.3 *Mitigation Measures*

Foothills Bypass

Friction course is effective for reducing tyre noise at high traffic speeds (3.5dB(A) reduction at 75 kph or above) and, therefore, it will be suitable as a direct noise mitigation measure for the Foothills Bypass. Friction course will not be recommended for local roads within the Study Area, which are subject to a speed limit of 50 kph. This is also in agreement with the liaison between EPD and Highways Department that friction course should normally not be accepted for local roads in future road proposals.

Traffic noise from the Foothills Bypass would be within the HKPSG criteria for all NSRs considered within the Study Area, and is not considered to be a dominant source of noise impact at most NSRs. The noise assessment has indicated that the traffic noise from Lung Mun Road is already a source of noise impact at the existing NSRs, and would remain as the dominant source with the development of Foothills Bypass. It has been considered that without the Foothills Bypass, Lung Mun Road could cater most of the projected future traffic on the Foothills Bypass. Therefore, the alignment of the Foothills Bypass is an overall mitigation measure in the Study Area in terms of the relief of traffic on Lung Mun Road and its distance from the existing NSRs currently impacted by the road. Taking into account of the different noise contributions, the existing NSRs are not considered to be impact by Foothills Bypass.

It should be noted that the road surface of the northern section of the Foothills Bypass will be friction course, a 3m high barrier and a 5m high cantilever barriers will be built along the roadside of the carriageway; and these are recommended in the endorsed *Road Improvement EIA*. This Foothills Bypass noise study confirms these measures will be appropriate together with friction course for the entire Foothills Bypass carriageway. Further mitigation measures would be significantly impaired by noise from the existing Lung Mun Road and not considered effective. Therefore, no additional direct mitigation measures are recommended.

Noise Insulation

With the above best practicable direct mitigation measures for the Foothills Bypass, residual impacts are still predicted at some NSRs and exceed the HKPSG noise criteria. These residual impacts have been assessed against the three ExCo

Directive qualifying criteria for indirect noise mitigation (i.e. noise insulation), in order to identify any NSRs which could be entitled for the insulation. Details of the assessment are given in *Table 5.6e* below. As shown in *Table 5.6e*, noise insulation would not be required for the existing dwellings and educational institutions along the Foothills Bypass since all three quantifying criteria would not be met at none of these NSRs.

Table 5.6e ***Determination of the Eligibility of Noise Insulation for NSRs (on Low, Mid and Top Floors) in Respect of the Three Criteria***

Receiver ID	Prevailing Exposure	Future Exposure	'New Road' Noise	'Existing Road' Noise	Meet ExCo Directive Criterion (i)	(ii)	(iii)	Eligible for Insulation
N2	74.3	73.7	63.2	73.3	yes	no	no	no
	72.6	72.8	66.4	71.7	yes	no	yes	no
	70.6	71.5	66.5	69.8	yes	no	yes	no
N3-1	73.9	70.9	59.1	70.6	yes	no	no	no
	73.3	73.3	62.4	72.9	yes	no	no	no
	72.6	72.9	64.9	72.2	yes	no	no	no
N3-2	73.8	72.2	57.4	72.0	yes	no	no	no
	73.4	73.6	61.2	73.4	yes	no	no	no
	72.6	73.2	64.2	72.6	yes	no	no	no
N3-3	69.2	73.7	47.2	73.7	yes	yes	no	no
	68.0	72.3	50.0	72.3	yes	yes	no	no
	67.2	70.9	53.3	70.9	yes	yes	no	no
N4	73.3	71.1	58.0	70.9	yes	no	no	no
	-	-	-	-	-	-	-	-
	73.1	73.1	60.2	72.9	yes	no	no	no
N5	73.2	71.2	60.8	70.7	yes	no	no	no
	-	-	-	-	-	-	-	-
	73.3	73.3	63.6	72.9	yes	no	no	no
N6	72.1	71.2	55.0	71.1	yes	no	no	no
	-	-	-	-	-	-	-	-
	71.3	70.6	56.2	70.1	yes	no	no	no
N7-1	71.4	69.4	59.1	69.0	no	no	no	no
	71.0	71.3	62.0	70.8	yes	no	no	no
	70.1	70.9	63.8	69.9	yes	no	no	no
N7-2	74.7	73.2	62.0	72.8	yes	no	no	no
	74.0	74.3	64.8	73.7	yes	no	no	no
	72.7	73.5	66.4	72.6	yes	no	no	no
N8-1	59.4	63.9	63.3	55.0	n/a	n/a	n/a	n/a
N8-2	71.4	66.1	58.8	65.2	yes	no	no	no
N10	61.1	68.7	68.3	58.3	n/a	n/a	n/a	n/a

Criterion (i) : Future exposure > HKPSG $L_{A10,peak\ hours}$ 65 and 70dB for educational institutions and residences respectively.
Criterion (ii) : Future exposure ≥ Prevailing exposure + 1dB(A).
Criterion (iii) : Future exposure ≥ Future exposure from existing roads + 1dB(A).
n/a : Not applicable as the noise exposure is < HKPSG criterion.

5.6.4 *Conclusions*

The Foothills Bypass will not contribute significantly to the 2011 traffic noise impacts. Its commissioning would reduce the traffic noise exposure at most of the NSRs which are currently impacted by Lung Mun Road with the exception of Siu Shan Court (N3), Tuen Mun Public Riding School (N8) and San Shek Wan San Tsuen (N10). However, Lung Mun Road will still be the dominant source of noise impacts in the future and Siu Shan Court (N3) will continue to be affected dominantly by road traffic noise from this existing road. Even though the road traffic noise levels at Tuen Mun Public Riding School (N8) and San Shek Wan

San Tsuen (N10) have been increase owing to the commissioning of the Foothills Bypass, noise levels at these NSRs are still within the HKPSG limits.

It is recommended that friction course is provided for the Foothills Bypass. Further mitigation for the Foothills Bypass would not be effective owing to the contribution of noise from the existing highways. On the basis of the noise exposure of the NSRs being reduced with the Foothills Bypass, indirect mitigation measures would not be required.

The D11/D13/D14/44A junction will not attract further traffic and the related increase in the predicted traffic noise levels from the junction improvement will be low. The widening of the existing Wong Chu Road Bridge over the nullah would have little effect upon the noise exposure of the nearby NSRs.

6 WATER QUALITY

6.1 INTRODUCTION

This section discusses the potential impacts on water quality associated with the construction activities of the Foothills Bypass and Road Junction and Improvement Works and recommends mitigation measures.

6.2 ENVIRONMENTAL LEGISLATION AND STANDARDS

The *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* (TM), issued under Section 21 of the *Water Pollution Control Ordinance* (WPCO), defines acceptable discharges into drainage systems and inland and marine waters.

The water sensitive receivers (WSRs) that may be affected by the construction and operation of the Foothills Bypass include the North Western Water Control Zone (NWWCZ) and a number of streams passing through the Study Area. Discharges into the NWWCZ will have to comply with the standards stipulated in *Table 10* of the TM.

It is also stipulated in the TM that new effluents to rivers, streams or storm water drains that are within 100 m of a gazetted bathing beach and flow through the beach area will not be allowed. Discharges to terrestrial drainage systems will also be required to comply with the TM.

6.3 BASELINE CONDITIONS

Marine Water Quality

Data obtained from routine Environmental Protection Department (EPD) marine water quality monitoring at a number of stations in the NWWCZ indicate that this zone is characterised by relatively high suspended solids and turbidity levels. Recently, inorganic nitrogen levels have increased and bacteriological water quality is also poor. Five gazetted beaches are located within the vicinity of the Study Area and are considered to be WSRs. These gazetted beaches are: Butterfly, Castle Peak, Kadoorie, Old Cafeteria and New Cafeteria (See *Figure 3.1a*). All the above WSRs could be subject to impacts on marine water quality from the construction of the Foothills Bypass.

River Water Quality

According to EPD's ***River Water Quality in Hong Kong For 1994,*** the Tuen Mun River has been identified as one of currently 12 priority watercourses due to its severe pollution. It is approximately 38 km long with a catchment area of about 16.5 km^2. As a priority watercourse, the government is undertaking measures to improve the water quality by reducing the pollution at source. There are six water quality monitoring stations along the Tuen Mun River (See *Figure 6.3a*).

The water quality monitoring results at San Hing Tsuen, located in the upstream section, were very poor. The other stations reported steady improvement and were rated "fair" in 1994.

Major sources of pollution in the upstream section include domestic sewage from unsewered areas, and industrial and livestock waste. The water quality of the lower section, which runs as a 4 km long open nullah through the Tuen Mun New Town area, was rated as "fair" in 1994. Part of the reason for improvement in water quality of the lower section is due to the diversion of polluted upstream water via a dry weather flow interceptor at Siu Hong Court and the rectification of expedient connections following the implementation of the WPCO in the area in 1992.

Fresh Water Quality

There are a total of eight streams within the Study Area. Three streams, labelled 4, 5 and 6 on *Figure 6.3b*, were identified in the ecological survey as freshwater streams with riparian habitats of local ecological interest. It is expected that these streams as well as the other five streams will be culverted.

Future Conditions

As discussed above, the Government is implementing several initiatives to improve the water quality conditions of the Tuen Mun River. The Tuen Mun Sewerage Master Plan, already underway and due to be completed by the year 2000, will eliminate pollution from domestic sewage from unsewered areas. Additionally, the recent installation of wastewater treatment facilities and the revision of the livestock waste control scheme in July 1995 are expected to reduce the pollution load of the river. Construction of culverts are being proposed for several of the streams in the Study Area to prevent further deterioration of the water quality from construction and operation activities of the Foothills Bypass (See *Figure 6.3b*).

6.4 CONSTRUCTION PHASE

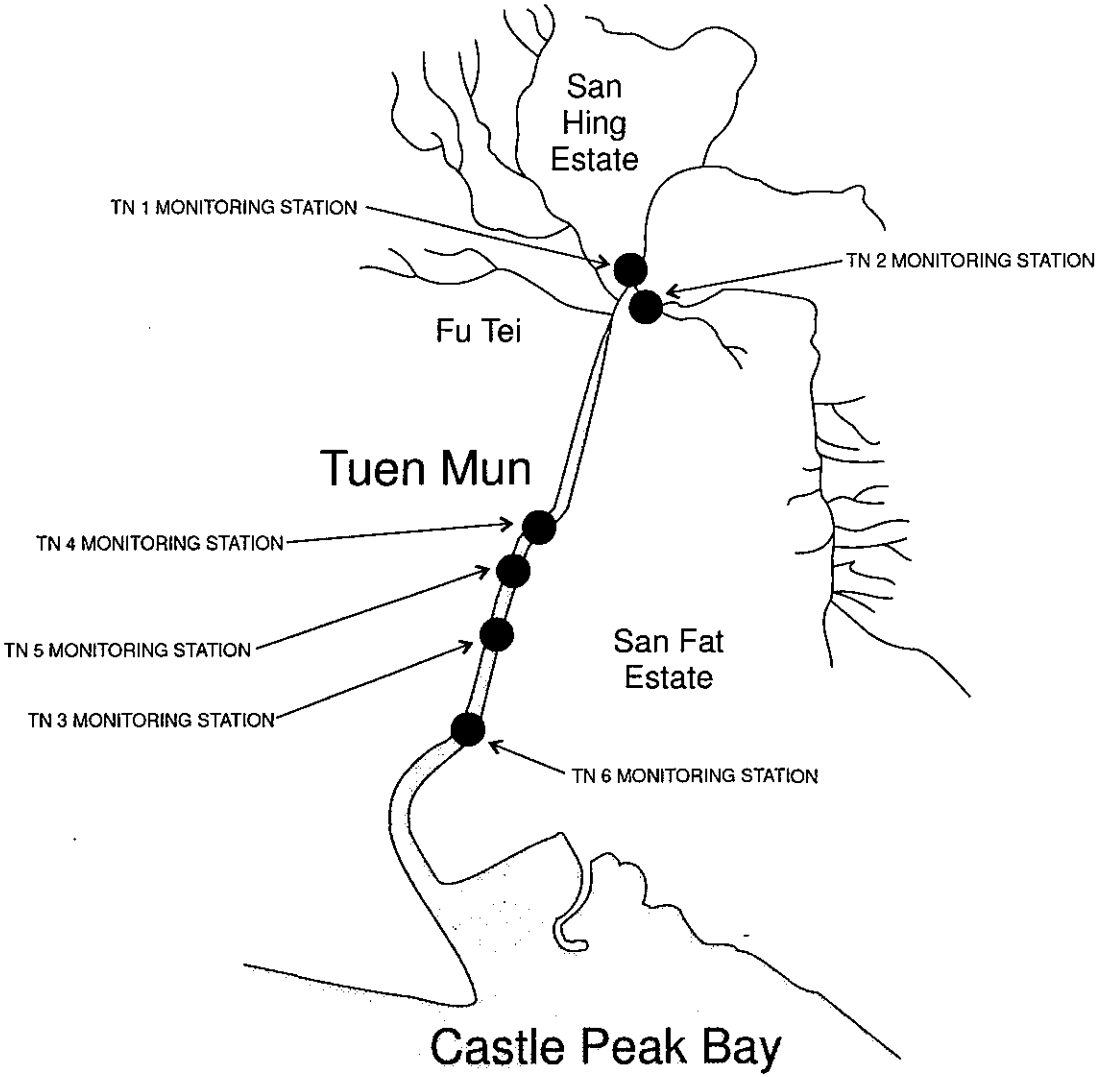
6.4.1 *Evaluation of Impacts*

Construction activities which have direct potential impacts on water quality will be from site formation work and the diversion of streams and other water courses. Impacts will include construction runoff and drainage, runoff from general construction activities, runoff from slope stabilising activities and sewage effluents.

Direct Impact Sources

Disturbances to Natural Processes

Construction methods used for the Foothills Bypass will involve the cutting and filling of existing topography particularly for the embankment which begins in Area 19, the road widening to the Wong Chu Road Bridge which crosses over the Tuen Mun nullah, and the culverting and temporary diversion of several streams and water courses. These activities may lead to scouring and resuspension of sediment which, if uncontrolled, will result in downstream increases in suspended solid (SS) levels and turbidity. However, interruption and



NOTE: TN=TUEN MUEN NULLAH

FIGURE 6.3a - TUEN MUN RIVER WATER QUALITY MONITORING STATIONS

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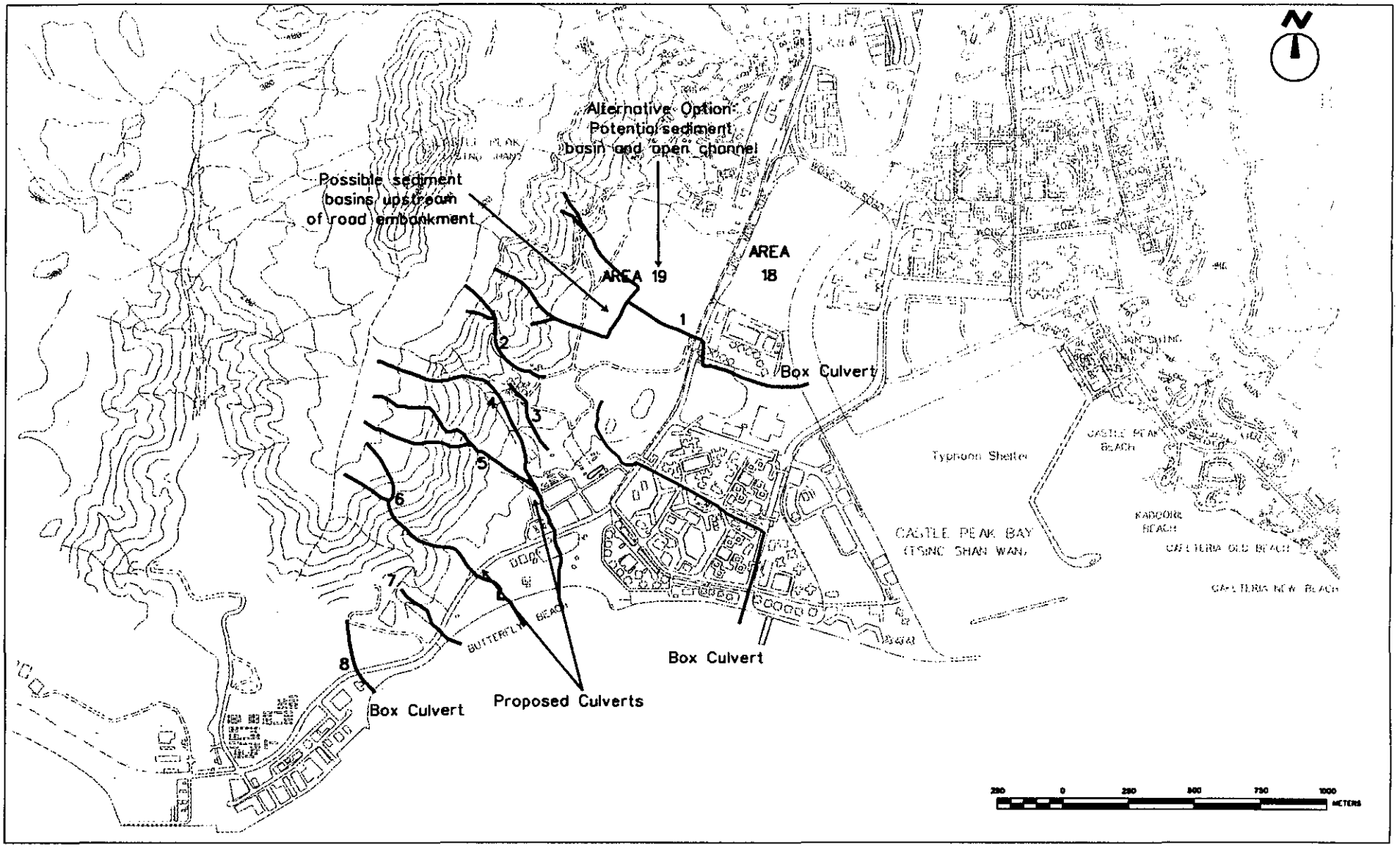

FIGURE 6.3b Drainage proposals

Date : 23 July 1996	Drawing No.: /Contract/C1507/C1507_7
Sources : Base map - Lands Dept. 1:20k topo Draft Engineering Inception Report, June 1996	
Prepared by ERM's GIS & MAPPING Group	

KEY

Streams / Watercourses

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disturbance to the streams are likely to be localised and temporary in most cases.

Increases in downstream siltation may occur occasionally and may adversely affect the downstream WSRs. As shown on *Figure 6.3b*, for stream 1 which crosses over Area 19, the downstream WSR will be the Tuen Mun nullah. Streams 2 through 6 will affect WSRs along the coastline east, west and directly on to Butterfly Beach. Given the existing poor water quality of the WSRs, further deterioration in the water quality of the streams and downstream sensitive receivers would be undesirable. It is therefore considered important that appropriate mitigation measures are implemented to minimise the scale, extent and severity of potential impacts on the water quality. Recommended mitigation measures are listed in *Section 6.5*.

Indirect Impact Sources

Indirect impact sources involve land based construction activities which, when improperly managed, will have the potential to affect nearby waters.

Construction Runoff and Drainage

Runoff and drainage from construction sites may contain increased loads of suspended solids and other contaminants. Potential sources of pollution from site drainage include:

- runoff and erosion from site surfaces, drainage channels, earthworks and stockpiles;
- drainage from dust suppression sprays;
- discharge from wheel washing facilities;
- fuel and lubricants from construction vehicles and machinery;
- cement-derived materials used for road pavement; and
- waste material and litter.

Construction runoff and drainage may cause both physical and biological effects. The physical effects which, may arise, include blockage of drainage channels, increased SS concentrations in receiving waters and accretion of SS with high pH from cement-derived materials. Possible biological effects which may affect aquatic life include localised reduction in dissolved oxygen levels caused by elevated SS concentrations.

However, with good site management and the observation of proper site practices to prevent runoff water and drainage water with high levels of SS from entering the surrounding waters, significant impacts on water quality are not expected. It is also expected that stabilisation of cut and fill slopes, will also minimise increased SS from erosion of exposed slope surfaces.

Runoff from General Construction Activities

General construction activities may cause water pollution from the following:

- debris and rubbish such as packaging, used construction materials and floating refuse; and

- spillages of liquids stored on site, such as oil, diesel and solvents etc, are likely to result in water quality impacts if they enter surrounding water bodies.

The effects on water quality from other construction activities is likely to be minimal provided that site boundaries are well maintained and good construction practice is observed to ensure full TM compliance to ensure that litter, fuels and solvents do not enter nearby water bodies.

Sewage Effluents

Sewage arising from the construction workforce will be a potential source of impact on water quality if it is discharged directly without treatment. At peak, there will be approximately 350 workers during earthworks activities. On site facilities will include a maintenance workshop and canteen facilities. Portable toilets or septic tanks, and the appropriate disposal arrangements will be required to handle the sewage of the workforce. Therefore, assuming appropriate arrangements are made to ensure that discharge standards are met, the effect of sewage discharge should be acceptable.

6.4.2 *Measures for Mitigation*

In order to prevent any deterioration in water quality, it will be important that appropriate measures are implemented to control runoff and drainage, and thereby prevent high loadings of SS from entering the nearby rivers or water bodies. Proper site management will be essential to minimise surface water runoff and good housekeeping practices should be implemented to ensure that debris and rubbish does not enter water bodies.\

Construction Runoff

The following mitigation measures should be implemented prior to the commencement of site preparation works.

- The boundaries of critical areas of earthworks should be marked and surrounded by dykes or embankments for flood protection.
- Temporary ditches/drainage trenches should be provided to collect all the runoff before discharging via sediment trap/retention pond into the stream.
- Permanent drainage channels should be installed as early as practicable in the course of construction, and should incorporate sediment basins or traps and baffles to enhance deposition rates.

Construction runoff should be controlled in the following manner to prevent runoff with high levels of SS.

- Sediment traps must be regularly cleaned and maintained by the contractor and daily inspections are necessary.
- Traps (temporary or permanent) should incorporate oil and grease removal facilities such as oil interceptors at areas where there are high risk of oil/grease pollution.
- Oil interceptors should be installed for the maintenance workshop and storage areas in compliance with EPD regulations. These should be emptied regularly and should have a by-pass to prevent flushing during periods of heavy rain.

- Ditches which tie into the temporary cut off drains or tarpaulin covers should be provided to reduce sediment runoff.

- Slope exposure during the wet season should be minimised through avoiding primary earthworks movements during the wet season and adopting, wherever possible, a construction sequence which reduces the exposed areas through maintaining short work faces.

- Spent cement mix or other paving materials should be collected in a separate collection system for either cleaning and reuse or disposal to landfill.

- Hydroseeding is recommended, wherever practical, to minimise exposed soil areas and reduce the potential for increased siltation and contamination of runoff.

- Disposal of any solid materials, litter or wastes to the stream should be prohibited.

- Accidental release of soil, debris or solid wastes into adjoining land and streams should be prevented by the installation of boarding at the site boundary, particularly along stream banks.

Oils and Solvents

To prevent spillages of fuel oils or other polluting fluids to coastal water, all fuel tanks and storage areas should be provided with locks and be sited on sealed areas, within bunds of a capacity equal to 110 % of the storage capacity of the largest tank.

Sewage

Portable toilets or septic tanks should be provided for the on-site construction workforce. Appropriate treatment and discharge should be in compliance with the *TM*.

Stream Culverting and Diversions

Stream culverting is proposed for several of the streams in the Study Area (See *Figure 6.3b*). Impacts to the water quality of these streams should be minimised as far as possible. In addition, temporary diversions of the streams should be constructed so as to allow the water flow to discharge without overflow, erosion or washout. The areas concerned should be properly reinstated after diversion to their original conditions so that the drainage pattern would not be affected.

6.4.3 *EM&A Requirements*

Due to the minor impacts expected on the water quality of the surrounding environment, no monitoring requirements are recommended during the construction phase. However, the mitigation measures described above will be observed and routinely audited by the EM&A Team to ensure its effectiveness. These include good site practices such as regularly cleaning and maintaining silt traps and checking the flow velocity in natural channels to assess erosion. Special attention should be paid for works along the streams.

6.4.4 *Conclusions*

The potential sources of water quality impacts from the construction activities of the Foothills Bypass will be similar to typical land based construction activities. These potential sources include: construction runoff and drainage; debris and rubbish; liquid spillages and sewage effluents. Mitigation measures should be implemented to prevent direct or indirect impact sources from adversely affecting streams and other water sensitive receivers such as the Tuen Mun nullah and beaches in the vicinity of the Bypass. Provided that the recommended mitigation measures are implemented and proper site management is followed, compliance with the TM is predicted and thus no adverse water quality impacts are expected to arise from the construction activities.

6.5 *OPERATIONAL PHASE*

6.5.1 *Introduction*

This section presents the potential water quality impacts associated with the operation of the Foothills Bypass and recommends mitigation measures.

6.5.2 *Potential Sources of Impacts*

The sole source of discharge from the operation of the Foothills Bypass will be runoff from the road.

6.5.3 *Evaluation of Impacts*

The operation of the proposed Foothills Bypass is not expected to generate a significant volume of discharge. Road runoff will not be contaminated under normal operating conditions and can be discharged into the storm water system. However, under non-routine operation, it may contain high levels of sediments and oil.

6.5.4 *Mitigation Measures*

The following mitigation measures for road runoff should be implemented in order to ensure that impacts during the operational phase are minimised and meet the existing regulatory requirements.

- Silt traps in gully inlets and oil interceptors should be installed along the route to minimize pollution to stormwater systems.
- Silt traps and oil interceptors should be cleaned and maintained regularly to ensure that they function properly.

Particular attention to minimise runoff should be given to sections of the Foothills Bypass along the Wong Chu Road Bridge over the Tuen Mun nullah and to the southern section of the Bypass near the Butterfly Beach coastline.

6.5.5 *EM&A Requirements*

The regular inspection cleaning and maintenance of sediment traps and oil interceptors will prevent operational inputs and, therefore, no water quality monitoring requirements are anticipated for the operational phase.

6.5.6 *Conclusion*

The operation of the proposed Foothills Bypass will inevitably result in surface road runoff. However, the routine road runoff is not expected to be contaminated and compliance with the TM is predicted and thus the operation will have minimal water quality impacts provided that the recommended mitigation measures are implemented.

7 ECOLOGY

7.1 INTRODUCTION

This section identifies and evaluates the potential ecological impacts associated with the construction and operation of the Foothills Bypass and recommends mitigation measures. The Foothills Bypass road alignment crosses several streams, riparian habitats, and Green Belt zones. Preliminary ecological surveys were undertaken for the IAWP which identified areas of potential ecological impacts associated with the construction and operation of the Foothills Bypass. The IAWP concluded that a four seasons survey was not necessary as no rare species were recorded on site, however, mitigation measures were recommended in order to minimize adverse impacts and loss of habitats of local ecological interest.

The objective of this assessment is to achieve the following:

- identify, describe and, where possible, quantify the existing ecological resources within the defined Study Area and potential impacts arising from the Project;
- identify and recommend, where feasible, alternative planning or engineering solutions to eliminate or mitigate adverse impacts and maximise ecological benefits; and
- where mitigation at the design and planning stages proves impracticable, recommend appropriate and viable revegetation programmes to reduce to the maximum practical extent the adverse effects on flora and fauna and on natural habitats in general.

The Study Area has been defined as a minimum distance of 300 metres from the proposed road alignment. Where appropriate, the area has been expanded to cover ecological features of interest, e.g. streams and water catchments. The route alignment to the north and west of the riding school and the RSD tree nursery passes through urban areas and managed landscapes and is of limited ecological value. This section of the route has, therefore, not been considered.

7.2 GOVERNMENT LEGISLATION

Annex B sets out the relevant Government legislation and guidelines that relate to the protection of animals, plants and their habitats in Hong Kong. It also lists other laws or controls that are indirectly relevant to ecology.

The main statutory requirements that are of particular relevance to the Foothills Bypass are:

- the *Town Planning Ordinance* and the guidance set out in the *Hong Kong Planning Standards and Guidelines* as it relates to Sites of Special Scientific Interest and Green Belt Zones;
- the *Forests and Countryside Ordinance*, which protects both natural and planted forests and listed rare plant species; and

- the *Wild Animals Protection Ordinance*, which protects listed species of wild animals. All birds and most mammals including bats are protected under this Ordinance.

The guidelines and requirements set in the *Town Planning Ordinance* will be most relevant during the planning stages of the Project. There are two existing SSSIs in the vicinity of the proposed road alignment: ***Castle Peak SSSI*** and ***Tsing Shan Tsuen SSSI***. ***Castle Peak SSSI*** was designated in 1980 to protect the rare and protected plant *Platycodon grandiflora* on the peak's grassy summit and rare plant species such as *Uvaria hamiltonii* found in the forest ravines. ***Tsing Shan Tsuen SSSI*** was designated in 1976 to protect the tree *Cinnamomum cassia*. Both SSSIs are located outside and up slope of the road alignment. Additionally, there are several areas of Green Belt identified on the draft Tuen Mun Outline Zoning Plan No. S/TM/8 exhibited 22/4/94. *Figure 3.1a* shows these locations in relation to the proposed road alignment.

The *Forests and Countryside Ordinance* and the *Wild Animals Protection Ordinance* will apply mainly during the construction period of the proposed works.

7.3 BASELINE CONDITIONS

7.3.1 *Review of Existing Information*

The only existing information from the Study Area is from the *Road Improvement EIA* (Agreement No CE 36/94). This EIA was commissioned by the Highways Department in 1995 and has the same Study Area as the Foothills Bypass EIA, with the exception of the junction at Wu Shan and Wu King Roads and the southernmost section of the alignment. The ecological assessment for the *Road Improvement EIA* found that the Foothills Bypass alignment did not impinge on the San Shek Wan Tsuen water course, although the associated construction work may affect the riparian areas of the initial section of the water course. However, this part of the water course has been channelised and the riparian areas already disturbed, therefore low ecological impacts were anticipated. Good construction site practices were recommended to minimise any impact on the upstream area, such as fenced off work sites and regular checks to ensure the work site boundary was not exceeded.

Existing data from other EIAs, research papers published in scientific journals, books, theses and data obtained from special interest groups and naturalists were reviewed for its relevance to the Foothills Bypass Project. It has been established that there are no other known existing flora and fauna records available for this Study Area.

7.3.2 *Assessment Methodology*

The following methods have been used for this Study:

- aerial photograph interpretation; and
- field survey of existing habitats, flora and fauna.

Aerial photographs for the area for the years 1945, 1961, 1973, 1984, 1990, 1993/4 and 1995 (May) were examined for an indication of the vegetation development on the site. Basic habitat types present on the site were noted for verification in the field.

7.3.3 *Survey Results*

Field survey work, habitat classification, flora and fauna identification and habitat assessment were carried out in the field during April and May 1996. *Figure 7.3a* identifies key areas of natural habitat within the Study Area. A list of plant species recorded during the field survey is provided in *Annex C*.

In the Study Area, identified habitats include plantation woodland, tall scrubland, grassland and low scrub, extensive areas under cultivation (mainly orchards and nursery sites), small areas of abandoned cultivation, freshwater streams and urban areas. There are limited areas of natural vegetation and, outside the urban zone, the majority of the Bypass crosses orchards of Longan and Rose-apple trees.

Two Green Belt zones are located near Hung Lau village. The northern area is a wooded hilltop with scattered graves, whilst the southern area consists of planted village trees and fung shui woodland around Hung Lau village. The other zones of Green Belt within the Study Area lie close to Lung Mun Road, near Butterfly Beach. They are designed to define the outer limits of the New Town and have a greater value as landscape features than areas of particular ecological importance.

Characteristics of each habitat type are described below with information such as species lists, dominant flora and fauna found and the presence of rare or protected species, where appropriate.

Plantation Woodland

There are small parts of the Study Area that are planted with exotic trees (such as *Acacia confusa, Lophostemon confertus, Eucalyptus* spp. and *Pinus elliottii*). These areas lack an understorey of associated species and are considered to be of greater landscape than ecological value. Two areas of plantation woodland are located near the Golf Driving Range and towards the southern end of the route off Lung Mun Road. Both of these areas are old borrow sites for the formation of Tuen Mun New Town which have been replanted.

Tall Scrubland with Scattered Pine

Natural tall scrubland with scattered, sometimes dense, native pine (*Pinus massoniana*) are found in two locations; on the northern boundary of the proposed road alignment in the vicinity of the existing pylons above the 20 m contour and on the knoll to the north east of Hung Lau village.

The scrubland is a community type commonly found in Hong Kong. Most of the species present are common including *Adiantus capilus-veneris, Eurya chinensis, Lycopodium scandens, Melastoma candidum, M. dodecandrum, Raphiolepis indica, Rhamnus chinensis, Pinus massoniana, Rhodomyrtus tomentosa, Rhus chinensis, Schima superba, Smilax china* and *Viburnum sempervirens*. Other species were recorded higher up the hillslopes including *Liquidamber formosana, Machilus oreophila* and *Schefflera octophylla*. No rare or protected plant species were recorded from scrubland.

Grassland and Low Scrub

This habitat type occurs infrequently in the Study Area and generally represents a fire regulated community which occurs extensively in Hong Kong. Typical species recorded include *Baeckea frutescens, Dicranopteris linearis* (dominant), *Dianella ensifolia, Rhodomyrtus tomentosa* and various grass species. Species recorded were common on the site and are common in Hong Kong. There are also some areas of planted grassland within the Study Area.

Cultivated Land (mainly orchards)

There are extensive areas of cultivated land, mainly for orchards, both within the Study Area and adjacent to it, predominantly for Longan and Rose-apples and bananas. Nursery sites also occur in the Study Area.

These areas of cultivation are of limited ecological value given the cultivation of the soil, the use of pesticides, herbicides and other chemicals including fertilisers, the high levels of disturbance and lack of cover. The orchards were, however, observed supporting flocks of common birds.

Abandoned Cultivation

An abandoned cultivation area exists north of Lung Mun Road and west of the RSD tree nursery. The area generally supports exotic species overgrown with creepers such as *Mikania guaco*, and is of limited ecological value. No rare or endangered plant species were recorded on the abandoned cultivation area.

Freshwater Streams and Watercourses

The Study Area contains eight watercourses (see *Figure 6.3b*). Some of the streams have been used for irrigating the cultivated land and now comprise man-made water courses with little associated natural habitat and vegetation.

The two streams which join immediately to the east of the RSD tree nursery, and a third one closer to the riding stables were the only streams within the Study Area which were found to be flowing in their natural state (*Figure 7.3a*). They have a sandy/rocky bottom with small boulders and are well vegetated on the stream banks. The vegetation present suggests that these streams flow year round.

Species associated with these streams include *Juncus* spp., *Cyperus* spp., *Acorus gramineus, Polygonum hydropiper, Rumex* spp., *Centella asiatica, Sagittaria sagittifolia, Trigonospora ciliata*. Streamside trees included the dominant *Celtis sinensis* with *Ficus pyriformis, Syzygium jambos, Cinnamomum parthenoxylon* and *C. camphora*. All these species are commonly found in similar habitats in Hong Kong and none of them are protected.

Two streams located near the southern boundary of the road alignment have been polluted either by scrap yards or villages. Both are engineered and partly culverted streams, with no ecological value.

Existing Flora and Fauna

A list of all plant species recorded from the Foothills Bypass site is provided in *Annex C*. To date no rare or protected plant species have been recorded on the

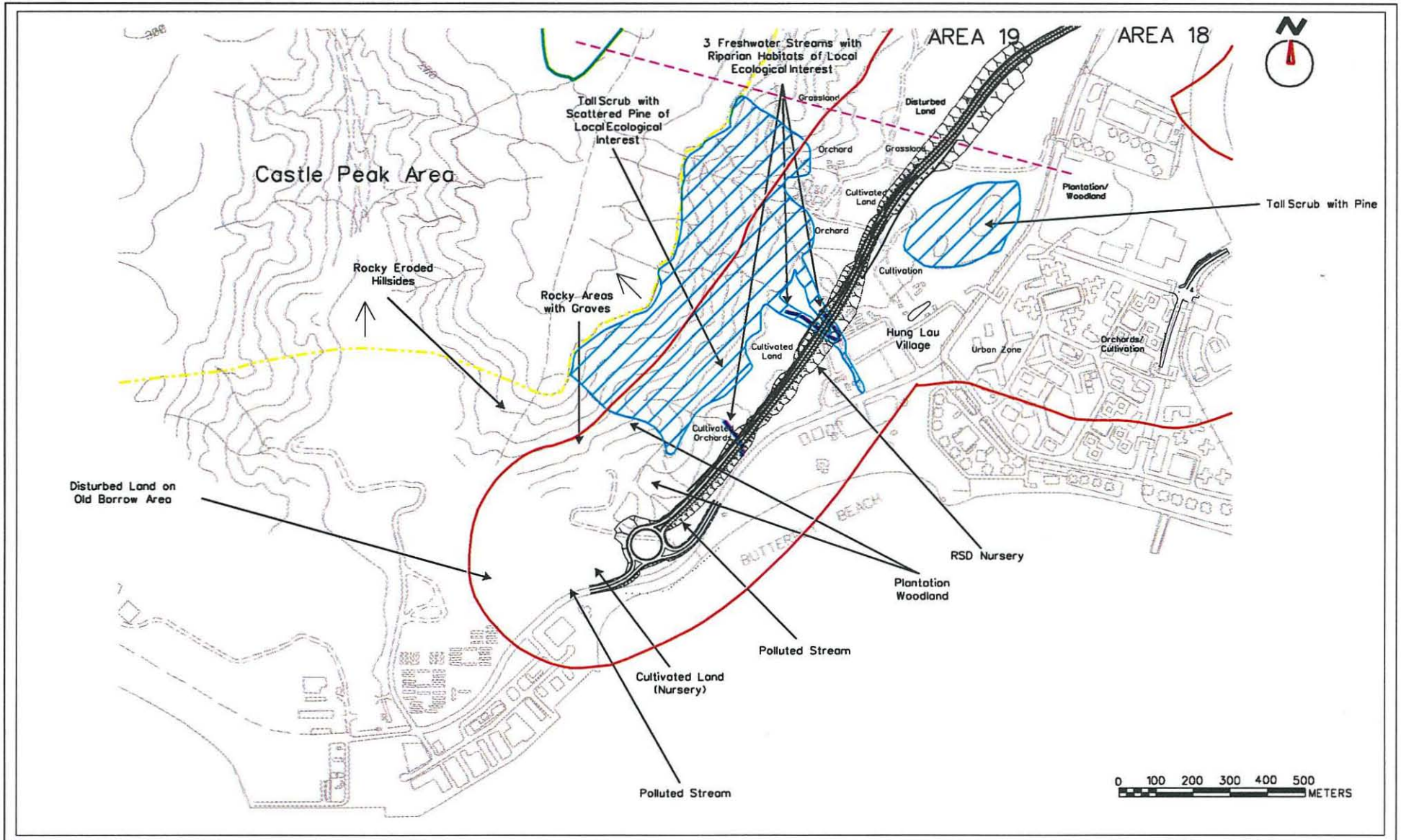

FIGURE 7.3a Summary Habitat Map Highlighting Key Areas of Natural Habitat

Date : 1 July 1996	Drawing No.: /Contract/C1507/C1507_6
Sources : Base map - Lands Dept. 1:20k topo	
Prepared by ERM's GIS & MAPPING Group	

KEY

- Study Area
- Castle Peak SSSI
- Key Natural Habitats
- Freshwater Streams
- Extent of Ecological Survey
- Castle Peak Area

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site. Birds observed during a survey in May 1996 are shown in *Table 7.3a*. It should be noted that the general survey was undertaken outside the main migration season (October to April), and therefore does not identify all species which utilise the site. The number of species recorded on site indicates that the mixed variety of habitats in the area provides several bird species with both cover and food.

Table 7.3a ***Birds recorded from the Study Area on 10th May 1996***

Common Name	Latin Name	Number
Black kite	*Milvus migrans*	1
Koel	*Eudynamis scolopacea*	>2
House swift	*Apus nipalensis*	4
Black drongo	*Dicrurus macrocenrcus*	2
Magpie	*Pica Pica*	3
Rufous-backed shrike	*Lanius schach*	2
Black-faced laughing-thrush	*Garrulax perspicallatus*	3
Blue magpie	*Urocissa erythrorhyncha*	2
Greater coucal	*Centropus sinensis*	10
Chinese bulbul	*Pycnonotus sinensis*	>3
Spotted dove	*Streptopelia chinensis*	1
Long-tailed tailorbird	*Orthotomus sutorius*	2

Although there is no existing information regarding invertebrate, amphibian or reptile species which may occur in the Study Area, it is expected that the habitat will support common species typical of the habitats present, eg. the rat snake *Pytas* spp. Two common amphibians, the Asian Common Toad *Bufo melanostictus* and Gunther's Frog *Rana guntheri* were recorded during field surveys at the site in May 1996.

Whilst no specific systematic survey has been undertaken to record mammals, it is considered that the site is unlikely to support many mammal species owing to the high level of cultivation and general disturbance. It is, however, likely to support common species such as the brown rat *Rattus norvegicus*. The upper areas of the Study Area are more remote, provide more shelter and cover and are contiguous with extensive areas of natural scrub/woodland. They are therefore more likely to support mammals such as barking deer and civets.

Sites of Conservation Interest

As mentioned in *Section 7.2*, there are two existing SSSIs in the vicinity of the proposed road alignment: ***Castle Peak SSSI*** and ***Tsing Shan Tsuen SSSI*** (*Figure 7.3a*). ***Castle Peak SSSI*** consists of an area of about 76.4 hectares. The Castle Peak summit is the most important site for the rare plant *Platycodon grandiflora*, which is protected under the *Forest and Countryside Ordinance* and the ravines provide habitat for rare plant species such as *Uvaria hamiltonii*.[3] ***Castle Peak SSSI*** is located approximately 1 km from the proposed alignment, at an elevation of 400 m, and therefore it is not expected to be affected by the proposed road works.

[3] Planning Department. 1995. Register of Sites of Special Scientific Interest.

Tsing Shan Tsuen SSSI was designated in 1976 to protect the cassia-bark tree *Cinnamomum cassis*.[4] Previously the area protected three trees, however, only one now exists at the Ho Shek Nunnery. The *Tsing Shan Tsuen SSSI* is not expected to be affected by the Project as it is located over 800 m from the Study Area and is upslope of the road works.

The Castle Peak area, which surrounds *Castle Peak SSSI*, has been designated as having botanical and landscape value. As the majority of this area is a Military Zone, access is restricted. Additionally, only limited records are available for this area. Ecological impacts upon this area are unlikely to be a concern as the route alignment passes over mainly unnatural, man-made habitats, and is well outside the area considered likely to be of botanical value.

There are also several areas of Green Belt identified on the draft Tuen Mun Outline Zoning Plan No. S/TM/8 exhibited 22/4/94, which fall within the Study Area. Two of these Green Belt zones are near Hung Lau village (*Figure 3.1a*). The northernmost is a wooded hilltop with scattered graves. This area lies close to the proposed route alignment and therefore care should be taken to ensure that it is protected. Although this area is considered to be of local conservation interest, it is of more value as a landscape area screening the proposed road from the nearby residential areas. The southern Green Belt zone, nearer to the Hung Lau village, is planted with village trees and fung shui woodland. It is unlikely that the southern area of Green Belt will be affected by the Project directly, but indirect impacts such as dewatering and pollution impacts should be considered at the detailed design stage.

The other zones of Green Belt within the Study Area lie close to the Lung Mun Road near Butterfly Beach. They are designed to define the outer limits of the New Town and are of greater landscape than ecological value.

Summary

In summary, the Study Area is considered to be of limited ecological value owing to extensive areas of disturbed habitats. No rare species or habitats of conservation importance have been recorded in the area to date.

7.4 CONSTRUCTION PHASE

7.4.1 *Potential Sources of Impact*

The proposed Project comprises the construction of a highway mainly on embankment and in sections at grade. During the construction phase, the Study Area, including all cut and fill slopes, will be disturbed and will require revegetation following construction where appropriate.

From the experience gained in equivalent road projects in the Territory, a number of ecological issues are commonly encountered. These include:

- the removal of habitats of ecological importance, e.g. loss of natural woodland, freshwater habitats, and tall scrubland, and disturbance to their ecological function;

[4] Ibid.

- The removal or disturbance to species of importance including rare or protected species, e.g. Orchids, bats, etc.
- the selection of engineering design principles, e.g. cut and fill works may have greater adverse ecological impact than tunnel;
- the construction techniques adopted may involve off-route ecological impacts due to construction access or requirement for storage/works areas elsewhere;
- possible damage that could be caused to the vegetation as a result of fire;
- hydrogeological impacts due to the alteration of water tables and catchments;
- safety requirements of heavily engineered slopes which preclude the re-establishment of replacement habitats;
- import and export of fill;
- any potential construction waste and potential run off into natural stream courses;
- requirements for water during construction and any potential associated impacts on local streams; and
- potential damage to surrounding areas from litter and construction materials.

7.4.2 *Evaluation of Impacts*

The evaluation criteria for ecological impacts set out in Annex 8 of the draft Technical Memorandum to the Environmental Impact Assessment Bill have been adopted for this EIA.

As indicated on *Figure 7.3a*, the ecological survey area begins south of Area 19 and the Tuen Mun golf course. The total land take area is approximately 17 ha, comprising a belt of land averaging 100 m in width (ranging from 230 m at the round-about to 70 m along the route) and 1700 m in length. Making the assumption that most of the existing vegetation will be lost, the following areas of existing habitats would be removed.

- Plantation Woodland - 0.5 ha
- Cultivated Land and Orchards - 6 ha
- Freshwater habitat - 0.6 ha

The impact on natural habitats is limited as the proposed alignment passes mainly through man-made habitats. Impacts to the freshwater streams and streamside habitats could be minimised with the use of bridges or large open culverts enabling these streams to be retained in their natural state. Additionally, losses may occur to existing tall scrub with scattered pine trees which border the land take area due to the requirement for cut slopes above the road, and impacts to these habitats should be minimised as far as possible.

7.4.3 *Recommended Mitigation Measures*

To mitigate the loss of habitat, it is recommended that the following measures be adopted:

- re-plant native species local to the area and species known to be of value to local and migratory species, as given in Corlett (1992)[5], wherever possible on-site during rehabilitation;

- retain existing natural habitats, ie design road level and subsequent cut and fill slopes, such that disturbance to the tall scrub is avoided as much as possible;

- design large open culverts for streams, particularly freshwater streams, to minimise impact on the freshwater habitat.

Mitigation measures for the loss of cultivated land and orchards are not considered necessary as this Study has indicated that these habitats are of low ecological value. However, measures such as re-planting as proposed in the above will compensate the loss of cultivation area which support common birds.

General

Measures to be adopted to minimise impacts during the construction phase include:

- erect fences on the boundary of construction sites before the commencement of works to prevent tipping, vehicle movements, and encroachment of personnel into sensitive areas;

- give explicit instructions to the workforce at the works sites concerning the importance of the area for wildlife and the limits of the construction work;

- schedule regular checks to ensure that the work site boundaries are not exceeded and that no damage is being caused to the surrounding areas;

- prevent the flow of pollutants and sediment into the streams and water bodies within the works boundaries;

- implement and maintain high standards of dust control to protect wildlife habitats adjacent to work sites;

- plan access routes to take into account the areas of ecological importance, as well as the identified noise and air quality constraints as described in *Sections 4* and *5;*

- while no direct impact on birds is predicted, particular attention should be paid to good site practices (as identified in this section under the 'general' heading) during the bird breeding season of March to May as a cautionary measure so that construction activities do not unduely effect common resident birds breeding in and around the Study Area; and

- undertake restoration and aftercare of temporary construction sites to standards as good as, or better than, the original condition.

[5] Corlett RT. 1992. Plants attractive to frugivorous birds in Hong Kong. Memoirs of the Hong Kong Natural History Society 19: 79-112.

7.4.4 *EM&A Requirements*

During the construction phase, it is recommended that ecological auditing be carried out to ensure that good site practices as recommended in *Section 7.4.3* are being effectively implemented. The primary tasks are as follows:

- briefing and training the contractor (and sub-contractor if applicable);
- establishing a site checklist, which should include site boundary fences and ensuring replanted local plant species are growing properly;
- marking special areas and features to be avoided;
- liaising with survey and construction crews to modify the layout as needed to avoid sensitive areas;
- reporting performance of construction crews; and
- immediately correcting situations which violate the intent of the mitigation plan.

Specific details regarding monitoring and auditing requirements are provided in the Environmental Monitoring and Auditing Manual.

7.4.5 *Conclusions*

This assessment has determined that the ecological resources of interest within the defined Study Area comprise plantation woodland, tall scrubland with scattered pine, grassland, low scrub, cultivated land, abandoned cultivation and freshwater streams. The habitats are considered to be of limited ecological value as the habitats are generally man-made and disturbed, with no rare or endangered species recorded. Impacts arising during construction are predicted to be disturbance to and loss of ecological habitats such as the three freshwater streamcourses located within the Study Area. Mitigation measures include implementing good site practices, designing engineering methods that will minimise impacts on habitats and enhancement features such as replanting native species local to the area. Mitigation measures have been recommended as far as possible and unacceptable impacts to ecological resources are not predicted to arise.

7.5 *Operational Phase*

7.5.1 *Potential Sources of Impact*

During the operational phase of the Foothills Bypass, the following operational impacts could arise:

- contaminated surface water runoff from the highway may cause damage to receiving stream courses, ie in the event of accidents and spillages on the road resulting in potential damage to receiving stream courses downstream; and
- air pollution from road traffic may have local effects on vegetation as airborne residues from fuel coat the leaves of plants, potentially restricting photosynthesis.

7.5.2 *Evaluation of Impacts*

Adverse ecological impacts can occur to watercourse habitats by way of contaminated surface water runoff arising from the highway. Three of the stream courses crossing the line of the road are of important ecological value and mitigation measures should be undertaken to minimize the impacts on streams.

As the road does not pass through any extensive habitats of particular ecological importance, impact from vehicle generated air pollution on adjacent vegetation will not be a concern.

7.5.3 *Recommended Mitigation Measures*

The following recommended mitigation measures should be implemented to minimise adverse impacts from contaminated surface water runoff arising from the highway. Consideration should be given to designing the road drainage so that contamination and spillage is intercepted within the boundary of the highway. Techniques, such as the use of petrol interceptors, silt traps etc should be specified for these sections of the road and sufficient up stands/curbs at the roadside should be introduced to contain any spillages from the Foothills Bypass.

7.5.4 *EM&A Requirements*

During the operation phase, it has been determined that ecological monitoring and auditing is not necessary.

7.5.5 *Conclusions*

This assessment has determined that the ecological impact during the operational phase will arise mainly from contaminated surface water runoff. Mitigation measures recommended include designing road drainage which will intercept contamination runoff and spillage. Provided mitigation measures are undertaken as far as possible, unacceptable impacts to ecological resources are not predicted to arise.

8 SOLID WASTE MANAGEMENT

8.1 INTRODUCTION

This Section identifies the potential waste arisings from the construction and operation of the Foothills Bypass and assesses the potential environmental impacts resulting from these wastes.

The options for waste minimisation, recycling, treatment, storage, collection, transport and disposal of waste arisings from the Foothills Bypass have been examined. Procedures for waste reduction and management are considered and mitigation measures for minimising the impacts of the wastes are recommended.

The operation of the Foothills Bypass will generate only minimal amounts of waste associated with littering and road maintenance activities. These wastes will have no significant environmental impacts and thus, have not been evaluated further in the EIA.

8.2 SENSITIVE RECEIVERS AND BASELINE CONDITIONS

The sensitive receivers for the Foothills Bypass with respect to waste management, have been identified in *Sections 4, 5 and 6*. These receivers may be affected by the storage, handling, collection, transport and disposal of waste generated by the construction of the Foothills Bypass. Baseline conditions have also been described in the previous sections.

8.3 ASSESSMENT CRITERIA AND METHODOLOGY

8.3.1 *Assessment Criteria*

The following legislation covers or has some bearing upon the handling, treatment and disposal of wastes in Hong Kong, and will be used as assessment criteria:

- *Waste Disposal Ordinance (Cap 354);*
- *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354);*
- *Crown Land Ordinance (Cap 28); and*
- *Public Health and Municipal Services Ordinance (Cap 132) - Public Cleansing and Prevention of Nuisances (Urban Council) and (Regional Council) By-laws.*

Waste Disposal Ordinance

The *Waste Disposal Ordinance* (WDO) prohibits the unauthorised disposal of wastes, with waste defined as any substance or article which is abandoned. Construction waste is not directly defined in the WDO but is considered to fall within the category of "trade waste". Trade waste is defined as waste from any trade, manufacturer or business, or any waste building, or civil engineering materials, but does not include animal waste.

Under the WDO, wastes can only be disposed of at a licensed site. A breach of these regulations can lead to the imposition of a fine and/or a prison sentence. The WDO also provides for the issuing of licences for the collection and transport of wastes. Licences are not, however, currently required to be issued for the collection and transport of construction and/or trade waste.

Waste Disposal (Chemical Waste) (General) Regulation

Chemical wastes as defined under the *Waste Disposal (Chemical Waste) (General) Regulation* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the *Regulation* if such substance or chemical occurs in such a form, quantity or concentration so as to cause pollution or constitute a danger to health or risk of pollution to the environment.

A person should not produce, or cause to be produced, chemical wastes unless he is registered with the EPD. Any person who contravenes this requirement commits an offence and is liable, upon conviction for a first offence, to a fine of up to HK$200,000 and to imprisonment for up to 6 months. The current fee for registration is HK$240.

Producers of chemical wastes must treat their wastes, utilising on-site plant licensed by EPD, or have a licensed collector take the wastes to a licensed facility. For each consignment of wastes, the waste producer, collector and disposer of the wastes must sign all relevant parts of a computerised trip ticket. This system is designed to allow the transfer of wastes to be traced from cradle to grave.

The *Regulation* prescribes the storage facilities to be provided on site including labelling and warning signs. To minimise the risks of pollution and danger to human health or life, the waste producer is required to prepare and make available written procedures to be observed in the case of emergencies due to spillage, leakage or accidents arising from the storage of chemical wastes. He must also provide employees with training in such procedures.

Crown Land Ordinance

Construction wastes which are wholly inert may be taken to public dumps. Public dumps usually form part of land reclamation schemes and are operated by the Civil Engineering Department (CED). The *Crown Land Ordinance* requires that dumping licences are obtained by individuals or companies who deliver suitable construction wastes to public dumps. The licences are issued by the CED under delegated powers from the Director of Lands.

Individual licences and windscreen stickers are issued for each vehicle involved. Under the licence conditions public dumps will accept only inert building debris, soil, rock and broken concrete. There is no size limitation on the rock and broken concrete, and a small amount of timber mixed with other suitable material is permissible. The material should, however, be free from marine mud, household refuse, plastic, metal, industrial and chemical waste, animal and vegetable matter and any other material considered unsuitable by the dump supervisor.

Public Cleansing and Prevention of Nuisances By-Laws

These *By-laws* provide a further control on the illegal tipping of wastes on unauthorised (unlicensed) sites. The illegal dumping of wastes can lead to fines of up to HK$10,000 and imprisonment for up to 6 months.

Additional Guidelines

Other 'guideline' documents which detail how the Contractor should comply with the regulations are as follows:

- *Waste Disposal Plan for Hong Kong (December 1989), Planning, Environment and Lands Branch Government Secretariat.*
- *Environmental Guidelines for Planning In Hong Kong (1990), Hong Kong Planning and Standards Guidelines, Hong Kong Government.*
- *New Disposal Arrangements for Construction Waste (1992), Environmental Protection Department & Civil Engineering Department.*
- *Code of Practice on the Packaging , Labelling and Storage of Chemical Wastes (1992), Environmental Protection Department.*

8.3.2 *Assessment Methodology*

The assessment of environmental impacts from waste generation is based on three factors:

- the type of waste generated;
- the amount of principal waste types generated; and
- the proposed reuse, recycling, storage, transport, treatment and disposal methods, and the impacts of these methods.

8.4 CONSTRUCTION WASTE IMPACTS

8.4.1 *Potential Sources of Impact*

General

Construction activities will result in the generation of a variety of wastes which can be divided into distinct categories based on their constituents, as follows:

- excavated inert material;
- construction and demolition waste;
- chemical waste; and
- general refuse.

The volumes and nature of each of these waste types arisings from the construction of the Foothills Bypass are identified below.

Excavated Inert Material

Excavated inert material is defined as inert virgin material removed from the ground and sub-surface. There will be a need to import over 1,000,000 m^3 of spoil for the construction of the road embankment alone and therefore there will be little or no surplus excavated materials generated by the construction of the Foothills Bypass. However, some vegetation from "greenfield sites" may be cleared and disposed of at landfill along with any unsuitable material that may occasionally arise.

Construction and Demolition Waste

Construction waste comprises unwanted materials generated during construction, including rejected structures and materials, materials which have been over ordered or are surplus to requirements and materials which have been used and discarded. Construction waste will arise from a number of different activities carried out by the Contractor during construction and maintenance activities; and may include:

- wood from formwork and falsework;
- equipment and vehicle maintenance parts;
- materials and equipment wrappings;
- unusable/surplus concrete/grouting mixes; and
- damaged/contaminated/surplus construction materials.

The volume of construction waste generated by the Foothills Bypass construction will be dependent on the operating procedure and site practices. At this stage, it is not possible to predict accurately the amount of construction waste that will be generated. However, it is anticipated that construction waste arisings will be in the order of 20 m^3 per month.

Demolition waste may be generated through the demolition of roads and buildings as part of construction. However, most of the construction areas for the Foothills Bypass are "greenfield sites" which have had no previous road or building development. The demolition waste arisings are likely to be restricted to road demolition at the intersections of the Foothills Bypass where it connects with the existing road network. The volumes of demolition wastes are therefore expected to be low.

Chemical Waste

Chemical Waste, as defined under the *Waste Disposal (Chemical Waste)(General) Regulation,* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the *Regulation.* A complete list of such substances is provided under the *Regulation,* however substances likely to be generated by construction activities for the Foothills Bypass will, for the most part, arise from the maintenance of equipment. These may include, but need not be limited to the following:

- scrap batteries or spent acid/alkali from their maintenance;
- used engine oils, hydraulic fluids and waste fuel;
- shutter release agents (chemical/oil based emulsions);
- spent mineral oils/cleaning fluids from mechanical machinery; and
- spent solvents/solutions, some of which may be halogenated, from equipment cleaning activities.

Estimates suggest that the monthly arisings at the construction site will consist primarily of a few hundred litres of used lubricating oils and small quantities of waste battery liquids.

General Refuse

The presence of a construction site with large numbers of workers and site offices and canteens will result in the generation of a variety of general refuse materials

requiring disposal. General refuse may include food wastes and packaging, waste paper and packaging from construction materials.

The Foothills Bypass construction sites will employ a minimum of 350 workers. Estimates of waste arisings based on the numbers of workers suggest that the general refuse produced at the Foothills Bypass will be in the order of 200 kg per day.

8.4.2 *Prediction and Evaluation of Impacts*

General

The nature and amount of the waste arisings from the construction of the Foothills Bypass and the potential environmental impacts which may arise from their handling, storage, transport and disposal are discussed in detail below, under the headings of each waste type.

Excavated Inert Materials

There will be only small volumes of excavated material generated by the Foothills Bypass construction. Due to the nature of the work, the majority of any excavated materials will be reused on-site in the construction of the road embankment. The potential air, noise and water impacts from the construction excavation works are covered in *Sections 4, 5 and 6* respectively.

Construction and Demolition Waste

The storage, handling, transport and disposal of construction and demolition wastes have the potential to create visual, water, dust and associated traffic impacts.

The impacts associated with demolition wastes may be higher than construction wastes due to the following reasons:

- the higher volumes of materials;
- segregation and recycling of materials; and
- the dry/dusty nature of the materials (resulting in air quality impacts).

The disposal of construction and demolition wastes is unlikely to raise any long term concerns because of the inert nature of most construction wastes. To conserve void space at landfill sites, construction waste must not be disposed of at a landfill site if it contains more than 20 % inert material by volume. It is therefore good practice to segregate wastes at construction sites before disposing of inert materials at public dumps for reclamation works and putrescible materials at a controlled landfill site. The production of construction wastes should be avoided by the careful control of ordering procedures which can result in surplus materials. The avoidance of over ordering and the segregation of materials will minimise waste arisings requiring landfill disposal. It will also assist in minimising costs should landfill charges be introduced.

Construction and demolition wastes currently form approximately 35 % of the annual take-up of limited landfill void available in Hong Kong, although this proportion has varied widely over recent years. Therefore, it is important to minimise, wherever possible, the wastes being delivered to landfill.

Chemical Waste

Chemical wastes may pose serious environmental and health and safety hazards if not stored and disposed of in an appropriate manner as outlined in the *Waste Disposal (Chemical Waste) (General) Regulation* and the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*. These hazards include:

- toxic effects to workers;
- adverse effects on air, water and land from spills;
- fire hazards; and
- disruption to sewage treatment works where waste enters the sewage system through damage to the sewage biological treatment systems.

Chemical wastes will arise principally as a result of maintenance activities. It is difficult to quantify the amount of chemical waste which will arise from the construction activities since it will be highly dependent on the Contractor's on-site maintenance intentions and the numbers of plant and vehicles utilised. However, it is anticipated that volumes will be small.

General Refuse

The storage of general refuse has the potential to give rise to adverse environmental impacts. These include odour if waste is not collected frequently (e.g. daily), windblown litter, water quality impacts if waste enters water bodies, and visual impact. The sites may also attract pests, vermin, and other disease vectors if the waste storage area is not well maintained and cleaned regularly. In addition, disposal of wastes, at sites other than approved landfills, can also lead to similar adverse impacts at those sites.

The environmental impacts from the various waste types are summarised in *Table 8.4.2*.

Table 8.4.2 ***Summary of Waste Management Impacts***

Waste Type	General Evaluation
Excavated Inert Materials	It is anticipated that only minimal quantities of surplus excavated materials will be generated and therefore the environmental impacts arising from their storage, handling and disposal will be negligible.
Construction and Demolition Waste	The quantities of demolition wastes which will be generated will be very small. Due to the inert nature of most construction waste and the availability of public dump sites, disposal not likely to raise long term environmental concerns.
Chemical Waste	A small volume of chemical waste, such as used lubricating oils from plant maintenance materials, will be produced. Storage, handling, transport and disposal must be in accordance with the *Code of Practice on the Packaging, Handling and Storage of Chemical Wastes*. Provided that this occurs, and chemical wastes are disposed of at a licensed facility, the contractor should be in compliance with all relevant regulations and there will be little environmental impact.
General Refuse	If good practice is adhered to and all feasible avoidance, reuse and recycling opportunities are taken, including minimising over ordering, there should be minimal impact.

8.5 MITIGATION MEASURES

8.5.1 *Introduction*

This section sets out recycling, storage, transportation and disposal measures which are recommended to avoid or minimise potential adverse impacts associated with waste arisings from the construction of the Foothills Bypass under the headings of each waste type. The Contractor should incorporate these recommendations into a comprehensive on-site waste management plan. Such a management plan should incorporate site specific factors, such as the designation of areas for the segregation and temporary storage of reusable and recyclable materials.

8.5.2 *Waste Management Hierarchy*

The various waste management options can be categorised in terms of preference from an environmental viewpoint. The options considered to be more preferable have the least impacts and are more sustainable in a long term context. Hence, the hierarchy is as follows:

- avoidance and minimisation, ie not generating waste through changing or improving practices and design;
- reuse of materials, thus avoiding disposal (generally with only limited reprocessing);
- recovery and recycling, thus avoiding disposal (although reprocessing may be required); and
- treatment and disposal, according to relevant laws, guidelines and good practice.

The Waste Disposal Authority should be consulted by the Contractor on the final disposal of wastes.

This hierarchy should be used to evaluate waste management options, thus allowing maximum waste reduction and often reducing costs. For example, by reducing or eliminating over-ordering of construction materials, waste is avoided and costs are reduced both in terms of purchasing and in disposing of wastes.

8.5.3 *Excavated Inert Materials*

Excavated materials are not considered likely to cause adverse impacts with respect to their disposal, since they will be reused on-site. As such, mitigation measures relating to the disposal of these materials are not considered necessary. If any surplus uncontaminated inert materials do arise then they may be delivered to public dumps and fill sites.

8.5.4 *Construction and Demolition Waste*

It has been estimated that approximately $20m^3$/month of construction waste will arise at the Foothills Bypass construction site. The likely generation rates of demolition wastes are estimated to be relatively low. In order to minimise waste

arisings and keep environmental impacts within acceptable levels, the mitigation measures described below should be adopted.

Careful design, planning and good site management can minimise over ordering and waste of materials such as concrete, mortars and cement grouts. The design of formwork should maximise the use of standard wooden panels so that high reuse levels can be achieved. Alternatives such as steel formwork or plastic facing should be considered to increase the potential for reuse.

The Contractor should recycle as much as possible of the construction waste on-site. Proper segregation of wastes on site will increase the feasibility of recycling certain components of the waste stream by recycling contractors. Concrete and masonry can be crushed and used as fill and steel reinforcing bar can be used by scrap steel mills. Different areas can be designated for such segregation and storage depending on site specific conditions.

The requirements for the handling and disposal of bentonite slurries should follow the *Practice Note For Professional Persons, Construction Site Drainage, Professional Persons Consultative Committee, 1994 (ProPECC PN 1/94).*

In accordance with the *New Disposal Arrangements for Construction Waste, Environmental Protection Department and Civil Engineering Department, 1992,* disposal of construction waste can either be at a specified landfill, or at a public dump, with the latter being the preferred option. Construction and demolition wastes currently comprise approximately 35 % of waste inputs to landfills. In order to maximise landfill life, Government policy prohibits the disposal of construction waste at landfill if it contains more than 20 % inert material by volume. Such inert wastes are directed to reclamation areas, where they have the added benefit of offsetting the need for removal of materials from terrestrial borrow areas for reclamation purposes.

If landfill disposal has to be used, the wastes will most likely be delivered to the WENT Landfill or Pillar Point Valley Landfill.

At present, Government is developing a charging policy for the disposal of waste to landfill. This will provide additional incentive to reduce the volume of waste generated when it is implemented.

8.5.5 *Chemical Waste*

For those processes which generate chemical waste, it may be possible to find alternatives which generate reduced quantities or even no chemical waste, or less dangerous types of chemical waste.

Chemical waste that is produced, as defined by *Schedule 1* of the *Waste Disposal (Chemical Waste) (General) Regulation,* should be handled in accordance with the *Code of Practice on the Packaging, Handling and Storage of Chemical Wastes* as follows.

Containers used for the storage of chemical wastes should:

- be suitable for the substance they are holding, resistant to corrosion, maintained in a good condition, and securely closed;

- have a capacity of less than 450 l unless the specifications have been approved by the EPD; and
- display a label in English and Chinese in accordance with instructions prescribed in Schedule 2 of the Regulations.

The storage area for chemical wastes should:

- be clearly labelled and used solely for the storage of chemical waste;
- be enclosed on at least 3 sides;
- have an impermeable floor and bunding, of capacity to accommodate 110 % of the volume of the largest container or 20 % by volume of the chemical waste stored in that area, whichever is the greatest;
- have adequate ventilation;
- be covered to prevent rainfall entering (water collected within the bund must be tested and disposed as chemical waste if necessary); and
- be arranged so that incompatible materials are adequately separated.

Disposal of chemical waste should:

- be via a licensed waste collector; and
- be to a facility licensed to receive chemical waste, such as the Chemical Waste Treatment Facility which also offers a chemical waste collection service and can supply the necessary storage containers; or
- be to a reuser of the waste, under approval from the EPD.

The Centre for Environmental Technology operates a Waste Exchange Scheme which can assist in finding receivers or buyers.

8.5.6 *General Refuse*

General refuse generated on-site should be stored in enclosed bins or compaction units separate from construction and chemical wastes. A reputable waste collector should be employed by the Contractor to remove general refuse from the site, separately from construction and chemical wastes, on a daily or every second day basis to minimise odour, pest and litter impacts. The burning of refuse on construction sites is prohibited by law.

General refuse is generated largely by food service activities on site, so reusable rather than disposable dishware should be used if feasible. Aluminium cans are often recovered from the waste stream by individual collectors if they are segregated or easily accessible, so separate, labelled bins for their deposit should be provided if feasible.

Office wastes can be reduced through recycling of paper if volumes are large enough to warrant collection. Participation in a local collection scheme should be considered if one is available.

8.5.7 *Summary*

This section describes waste management requirements and provides practical actions which can be taken to minimise the impacts arising as a result of the generation, storage, handling, transport and disposal of wastes.

Waste reduction is best achieved at the planning and design stage, as well as by ensuring that processes are run in the most efficient way. Good management and control can prevent the generation of significant amounts of waste. For unavoidable wastes, reuse, recycling and optimal disposal are most practical when segregation occurs on the construction site, as follows:

- excavated material (inert) suitable for reclamation or fill;
- construction waste (inert) for disposal at public dump;
- construction waste (non inert) for landfill;
- chemical waste; and
- general refuse.

The criteria for sorting solid waste is described in *New Disposal Arrangements for Construction Waste*. Waste containing in excess of 20 % by volume of inerts should be segregated from waste with a larger proportion of putrescible material.

Proper storage and site practices will minimise the damage or contamination of construction materials. On site measures may be implemented which promote the proper disposal of wastes once off-site. For example having separate skips for inert (rubble, sand, stone, etc) and non-inert (wood, organics, etc) wastes would help to ensure that the former are taken to public dumps, while the latter are properly disposed of at controlled landfills. Since waste brought to public dumps will not attract a charge, while that taken to landfill may attract some future charge, separating waste may also help to reduce waste disposal costs, should landfill charging be introduced.

Specifically, it is recommended that:

- wastes should be handled and stored in a manner which ensures that they are held securely without loss or leakage thereby minimising the potential for pollution;

- only reputable waste collectors authorised to collect the specific category of waste concerned should be employed;

- removal of demolition wastes should coincide with the demolition work;

- appropriate measures should be employed to minimise windblown litter and dust during transportation by either covering trucks or transporting wastes in enclosed containers;

- the necessary waste disposal permits should be obtained from the appropriate authorities, if they are required, in accordance with the *Waste Disposal Ordinance (Cap 354), Waste Disposal (Chemical Waste) (General) Regulation (Cap 354)* and the *Crown Land Ordinance (Cap 28)*;

- collection of general refuse should be carried out frequently, preferably daily;

- waste should only be disposed of at licensed sites and site staff and the civil engineering Contractor should develop procedures to ensure that illegal disposal of wastes does not occur;

- waste storage areas should be well maintained and cleaned regularly; and

- records should be maintained of the quantities of wastes generated, recycled and disposed, determined by weighing each load or other method.

Training and instruction of construction staff should be given at the site to increase awareness and draw attention to waste management issues and the need to minimise waste generation. The training requirements should be included in the site waste management plan.

8.6 *EM&A Requirements*

It is recommended that auditing of each waste stream should be carried out periodically by the EM&A Team to determine if wastes are being managed in accordance with approved procedures and the site waste management plan and to see if waste reduction targets are being achieved or could be improved. The audits should look at all aspects of waste management including waste generation, storage, recycling, treatment, transport, and disposal. An appropriate audit programme would be to undertake a first audit at the commencement of the construction works, and then to audit quarterly thereafter.

8.7 *Conclusion*

It is likely that only small quantities of excavated materials, if any, will require disposal off-site and only small volumes of construction, demolition and chemical wastes will be generated. However, mitigation measures relating to good practice have been recommended to ensure that adverse environmental impacts are prevented and that opportunities for waste minimisation and recycling are followed.

Provided that the recommendations put forward in this report are conscientiously acted upon, the storage, handling, collection, transport, and disposal of wastes arising from the Foothills Bypass construction will be in full compliance with the regulatory requirements.

9 ENVIRONMENTAL MONITORING AND AUDIT

9.1 INTRODUCTION

This Section describes the general requirements for the environmental monitoring and audit (EM&A) during the construction phase of the Foothills Bypass. As no operational impacts have been identified, EM&A is not recommended during the operational phase. The previous sections of this Report have identified the net environmental impacts and cumulative effects of the road works, defined measurable parameters likely to be affected by the works, and identified environmental mitigation and monitoring requirements for the construction and operational phases.

As part of the overall Foothills Bypass Study, ERM is responsible for the Environmental Monitoring & Audit (EM&A) of the construction phase. ERM have produced an *EM&A Manual* for the Project to accompany the EIA, this Manual is the first edition of a document that will evolve over the period of the Study. The scope and content of the Manual are based upon the findings of the EIA process and comprise the requirements and procedures for noise and dust monitoring and the scope of on-site auditing to be undertaken during the construction phase.

9.2 OBJECTIVES OF THE ENVIRONMENTAL MONITORING AND AUDIT PROGRAMME

The objectives of the EM&A for the construction phase of the Foothills Bypass comprise the following:

- to verify the environmental impacts predicted in the EIA Study;
- to provide a background against which to determine any short or long term environmental impacts arising from the construction of the Foothills Bypass and associated works;
- to determine Project compliance with contractual and regulatory requirements, and government standards and policies;
- to provide an early indication should any of the environmental control measures or practices fail to achieve the acceptable standards;
- to identify appropriate remedial action if unexpected problems or unacceptable impacts arise;
- to monitor the performance and effectiveness of mitigation measures; and
- to audit the environmental performance achieved during the management of construction activities.

A flow diagram, showing the main stages of the EM&A process is shown in *Figure 9.2a.*

9.3 THE EM&A MANUAL

The EM&A Manual sets out the protocols for the monitoring and audit of the Foothills Bypass Project.

The Manual provides comprehensive details of:

- the locations of sensitive receivers and the proposed dust and noise monitoring sites;
- requirements and mitigation measures both set out in the EIA, and any that are subsequently modified and endorsed by the EPD;
- details of the monitoring programme for dust and noise, including equipment lists, monitoring frequencies and data handling procedures; and
- details of the audit programme for dust, noise, water quality, ecology and waste, including timetabling and reporting.

9.4 MEASURES FOR MITIGATION

One of the objectives of the EM&A is to ensure that acceptable levels of environmental protection are achieved during the construction of the Foothills Bypass and associated works, and that adopted environmental mitigation measures are effective.

The measures to be taken for the mitigation of environmental impacts likely to occur during the construction phase of the Foothills Bypass Project have been established in the previous sections of this Report and are detailed in *Annex A* of the *EM&A Manual*.

9.5 ENVIRONMENTAL MONITORING AND AUDIT

9.5.1 *Monitoring*

The environmental performance of the Contractor on the Foothill Bypass and the effectiveness of environmental management practices and procedures employed onsite will be assessed through the regular and systematic monitoring of noise and dust levels and through planned audits of site activities and the measures adopted to control them.

The monitoring of environmental impacts will be carried out by the EM&A Consultants; the monitoring work will comprise dust and noise impacts at sensitive receivers in the vicinity of the works.

Action and Limit Levels

Action and Limit Levels (A/L Levels) are defined levels of impact recorded by the environmental monitoring activities. These levels are quantitatively defined for dust and noise in the Manual and described in principal below:

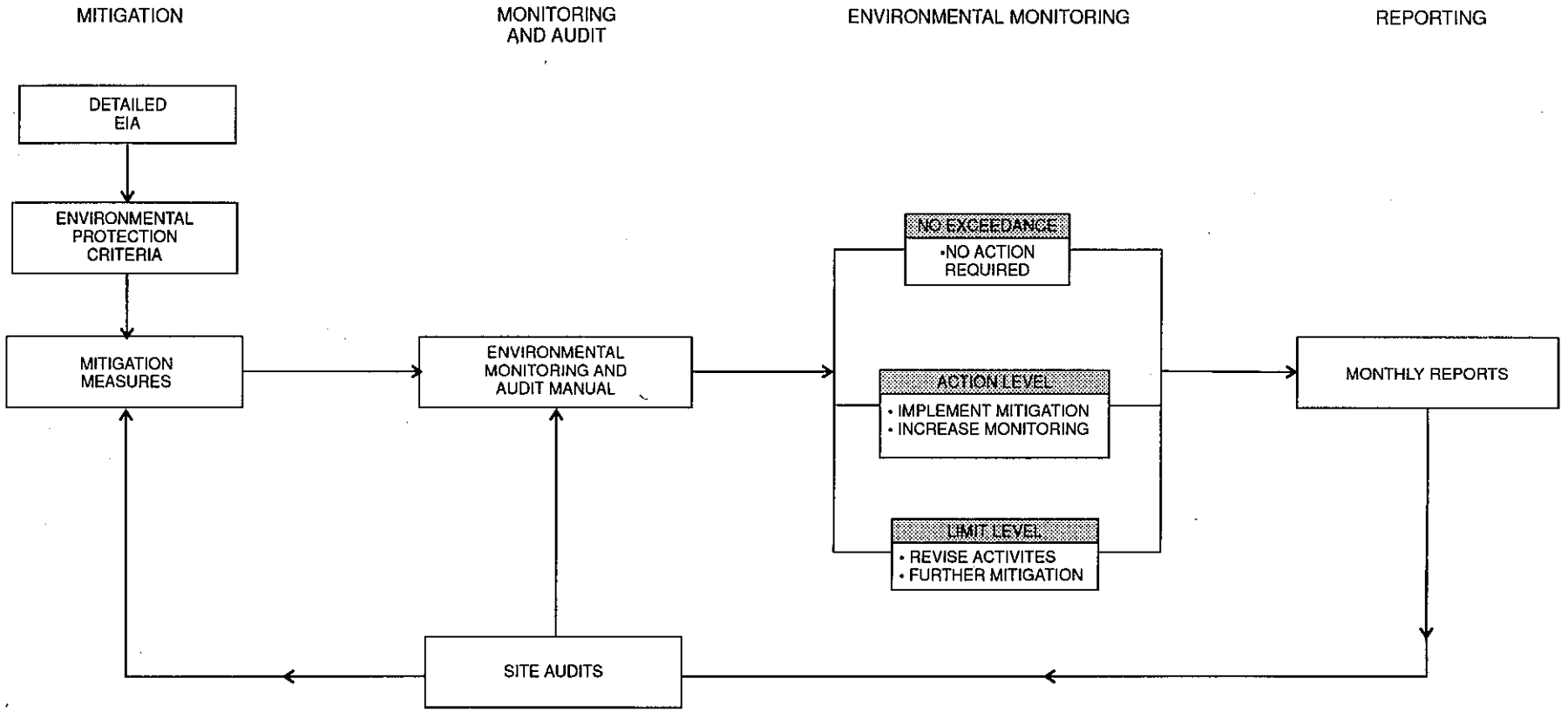

FIGURE 9.2a - IMPLEMENTATION OF MITIGATION AND ENVIRONMENTAL MONITORING AND AUDIT

Scott Wilson Kirkpatrick
CONSULTING ENGINEERS

Aspinwall Clouston
ERM (Hong Kong)
Parsons Brinckerhoff (Asia)
SWK Atria

- *Action Levels:* beyond which there is a clear indication of a deteriorating ambient environment for which appropriate remedial actions may be necessary to prevent environmental quality from going beyond the *Limit Levels*, which would be unacceptable; and

- *Limit Levels:* Statutory and/or agreed contract limits stipulated in the relevant pollution control ordinances, HKPSG levels or Environmental Quality Objectives established by EPD. If these are exceeded, works should not proceed without appropriate remedial action, including a critical review of plant and working methods.

Event Contingency Plans

The purpose of the Event Contingency Plans (ECP's) is to provide, in association with the monitoring and audit activities, procedures for ensuring that if any significant environmental incident (either accidental or through inadequate implementation of mitigation measures on the part of the contractor) does occur, that the cause is quickly identified and remedied, and that the risk of a similar event reoccurring is reduced. This also applies to the exceedance of statutory or agreed A/L criteria measured on a day to day basis by the EM&A programme.

A generic ECP is shown in *Table 9.5a*, the specific ECPs applicable to this Project are included in the Manual.

9.5.2 *Auditing*

In addition to the monitoring of dust and noise levels as means of assessing the ongoing performance of the Contractor, the EM&A Team will undertake regular audits of the Contractor's onsite practices and procedures. The primary objective of the audit programme will be to assess the effectiveness of the management systems established by the Contractor to implement the environmental mitigation measures recommended in the EIA.

Whilst the audit programme will complement the monitoring activity with regard to the effectiveness of dust suppression and noise attenuation measures, the criteria against which the audits will be undertaken will be derived from the clauses within the Contractual Documentation which seek to enforce the recommendations of the EIA and the management systems established by the Project Engineers. In this way, the efficacy of those measures applied to the control of impacts associated with water quality, ecology and waste will also be overseen by the EM&A Team.

The findings of site audits will be made known to site staff at the time of the audit to enable the rapid resolution of identified non-compliances. Non-compliances, and the corrective actions undertaken, will also be reported in the monthly EM&A Report. The Manual presents the scope and frequency of onsite audits and defines the range of issues the audit protocols will be designed to address.

9.6 *Enquiries, Complaints and Requests for Information*

All enquiries and complaints concerning the environmental effects of the works, irrespective of how they are received, will be reported to the EM&A Team and investigated in a similar manner to A/L Level exceedances.

9.7 REPORTING

A monthly EM&A Report will be produced which will present the monitoring and audit data for the preceding month in graphical and numerical formats with a full interpretation of the results. The Report will discuss the acceptability or otherwise of the dust and noise impacts monitored and the efficacy of the audited site practices, including mitigation measures.

Table 9.5a Event Contingency Plan

Event	Action: EM&A Consultant	ConstructionManager	Contractor
Action Level Exceedance	Inform the CM. Identify the impact source. Repeat measurement to confirm findings. If exceedance continues, discuss with the CM further appropriate mitigation measures. Increase monitoring frequency to demonstrate efficacy of remedial measures. If exceedance stops, additional monitoring can be ceased.	Inform Contractor immediately. Review Contractor's working methods. Discuss with the EM&A Consultant and the Contractor remedial actions required. Assess the effectiveness of remedial actions and keep the Contractor informed.	Submit proposals within 3 working days to the CM for remedial actions to reduce impacts. Amend proposals if required by the CM. Implement immediately the agreed proposals.
Limit Level Exceedance	Inform the CM. Investigate the cause of exceedance and identify main source. Repeat measurement to confirm findings. Liaise with the CM with remedial measures. Increase monitoring frequency to demonstrate efficacy of remedial measures. Assess effectiveness of remedial actions and keep the CM informed of the results. If exceedance stops, additional monitoring can be ceased.	Inform Contractor immediately. Review the Contractor's working methods. Discuss with the EM&A Consultant and the Contractor remedial actions required. Assess the effectiveness of remedial actions and keep Contractor informed.	Take immediate action to avoid further exceedance. Submit a further proposal for remedial actions to the CM immediately. Implement immediately the agreed proposals. Resubmit proposals if problem still not resolved.

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 INTRODUCTION

The findings of the Foothills Bypass EIA demonstrate that whilst varying levels of construction impacts have been predicted, provided that the recommended mitigation measures are undertaken, unacceptable impacts are not predicted to arise.

No adverse operational impacts have been identified.

Recommendations for environmental monitoring and auditing during the construction phase have been identified for air and noise to ensure regular and systematic monitoring during construction activities. Additionally, auditing will be carried out during construction activities to ensure the mitigation measures of the EIA for water quality, ecology and waste are being properly implemented and enforced. As no operational impacts have been identified, EM&A is not recommended during the operational phase.

10.2 CONCLUSIONS

10.2.1 *Land Use*

While the landtake impacts associated with the Foothills Bypass and associated road improvement works are significant, the majority of the land is either Government owned or allocated for a future road reserve. Land which is not owned by the Government or set aside for roadworks is concentrated in the southern section of the Study Area and includes a container storage area, a RSD tree nursery and orchards.

Archaeological impacts are not anticipated as the nearest archaeological site is approximately 100 m from the proposed Bypass alignment and associated junction improvement works.

Several graves are likely to be affected by the proposed works and, therefore, DO and DLO should be consulted.

10.2.2 *Air Quality*

The construction of the Foothills Bypass at Tuen Mun and the Interchange at Pillar Point will lead to dust emissions. It is predicted that construction activities during the embankment establishment works would exceed EPD's requirements at Pillar Point. However, with mitigation measures the dust emissions could be controlled to meet the HKAQOs and the hourly TSP concentration level.

In addition, it is recommended that baseline dust monitoring and dust impact monitoring should be carried out prior and during the construction of the Foothills Bypass.

During the operational phase, the predicted pollutant levels at the ASRs will comply with the HKAQOs requirements.

10.2.3 *Noise*

The noise assessment indicated that unmitigated daytime construction activities of the Foothills Bypass, improvements to the Junction D11/D13/D14/44A and the widening of a section of Wong Chu Road over the nullah, would cause exceedances of the ProPECC guidelines at some of the nearby NSR locations.

Most of the construction noise impacts could be mitigated for most NSRs by appropriately designed noise barriers in the form of fixed temporary or mobile noise barriers, but specific measures such as the reduction of the number of PME and the use of quiet PME would be required for the riding school (N8) and Wu Tsui House (N11). Even with the use of these specific measures, which are considered to be the best practicable means of reducing the noise impact, residual impacts of up to 7 dB(A) are still predicted at Wu Tsui house for the different construction activities. Wu Tsui House (N11) would be exposed to construction noise impact for up to 6 months.

Compliance noise monitoring should be carried out during the construction period of the Foothills Bypass at the Sun Tuen Mun Centre, Tuen Mun Public Riding School, Wu Tsui House and Carmel Bunnam Tang Memorial Secondary School. The monitoring is also recommended at other nearby schools in case the works are undertaken during the school examination periods. The environmental monitoring and audit recommendations are further discussed in *Section 9*.

The Foothills Bypass will not contribute significantly to the 2011 traffic noise impacts. Its commissioning would reduce the traffic noise exposure at most of the NSRs which are currently impacted by Lung Mun Road with the exception of Siu Shan Court (N3), Tuen Mun Public Riding School (N8) and San Shek Wan San Tsuen (N10). However, Lung Mun Road will still be the dominant source of noise impacts in the future and Siu Shan Court (N3) will continue to be affected dominantly by road traffic noise from this existing road. Even though the road traffic noise levels at Tuen Mun Public Riding School (N8) and San Shek Wan San Tsuen (N10) have been increase owing to the commissioning of the Foothills Bypass, noise levels at these NSRS are still within the HKPSG limits.

It is recommended that friction course is provided for the Foothills Bypass. Further mitigation for the Foothills Bypass would not be effective owing to the contribution of noise from the existing highways. On the basis of the noise exposure of the NSRs being reduced with the Foothills Bypass, indirect mitigation measures would not be required.

The D11/D13/D14/44A junction will not attract further traffic and the related increase in the predicted traffic noise levels from the junction improvement will be low. The widening of the existing Wong Chu Road Bridge over the nullah would have little effect upon the noise exposure of the nearby NSRs.

10.2.4 *Water*

The potential sources of water quality impacts from the construction activities will include: construction runoff and drainage; debris and rubbish; liquid spillages and sewage effluents. Mitigation measures should be implemented to prevent direct or indirect impact sources from adversely affecting streams and

other water sensitive receivers such as the Tuen Mun nullah and beaches in the vicinity of the Bypass.

No adverse water quality impacts are expected to arise from the construction activities provided that the recommended mitigation measures are implemented and proper site management is followed.

Surface road runoff will arise during the operation of the proposed Foothills Bypass. However, compliance with the TM is predicted provided that the recommended mitigation measures are implemented.

10.2.5 Ecology

The ecological resources of interest within the defined Study Area comprise of plantation woodland, tall scrubland with scattered pine, grassland, low scrub, cultivated land, abandoned cultivation and freshwater streams. The habitats are considered to be of limited ecological value as the habitats are generally man-made and disturbed, with no rare or endangered species recorded. Impacts arising during construction are predicted to be disturbance to and loss of ecological habitats such as the three freshwater stream courses located within the Study Area.

Ecological impacts could be mitigated through implementing good site practices, designing engineering methods that will minimise impacts on habitats and enhancement features such as replanting native species local to the area. Provided that the recommended mitigation measures are undertaken as far as possible, unacceptable impacts to ecological resources are not predicted to arise.

The ecological impact during the operational phase will arise mainly from contaminated surface water runoff. Recommended mitigation measures include designing road drainage which will intercept contamination runoff and spillage. Provided mitigation measures are undertaken as far as possible, unacceptable impacts to ecological resources are not predicted to arise.

10.2.6 Solid Waste Management

It is likely that only small quantities of excavated materials, if any, will require disposal off-site and only small volumes of construction, demolition and chemical wastes will be generated. However, mitigation measures relating to good practice have been recommended to ensure that adverse environmental impacts are prevented and that opportunities for waste minimisation and recycling are followed.

Provided that the recommendations put forward in this Report are conscientiously acted upon, the storage, handling, collection, transport, and disposal of wastes arising from the Foothills Bypass construction will be in full compliance with the regulatory requirements.

10.3 RECOMMENDATIONS FOR ENVIRONMENTAL MONITORING AND AUDIT

This EIA has identified that monitoring and auditing will be required for air and noise during the construction phase of the Foothills Bypass and associated road improvement works. Regular and systematic monitoring of noise and dust

levels will be carried out by the EM&A Team at sensitive receivers in the vicinity of the works.

Auditing for air and noise will assess the effectiveness of dust suppression and noise attenuation measures. Additionally, the auditing programme will enforce the mitigation measures of the EIA for water quality, ecology and waste.

The findings of site audits will be made known to site staff at the time of the audit to enable the rapid resolution of identified non-compliances. Non-compliances, and the corrective actions undertaken, will also be reported in the monthly EM&A Report. The *EM&A Manual* presents the scope and frequency of onsite audits and defines the range of issues the audit protocols will be designed to address.

As no operational impacts have been identified, EM&A is not recommended during the operational phase.

Annex A

Calculation of TSP Emission Rate and Samples of Air Modelling Input and Output Files (FDM & CALINE4)

Calculation of Dust Emission Factors for Construction Activities

(I) Material Handling

$$E = k(0.0016)\frac{(\frac{U}{2.2})^{1.3}}{(\frac{M}{2})^{1.4}}$$

where,

E = emission factor in Kilograms per tone
k = particle size multiplier, 0.74 for TSP
U = wind speed in metres per second
M = material moiture content in percent, 4.8%

(II) Drilling

$$E = 0.59$$

where

E = emission factor in Kg per tone per hole

(III) Wet Drilling

$$E = 0.084$$

where

E = emission factor in g per tone of materials to be drilled

(IV) Bulldozing

$$E = 2.6 * \frac{S^{1.2}}{M^{1.3}}$$

where

E = emission factor in Kg per hour
S = silt content of material, 6.9%, reference to mean value for overburden listed in Table 11.9-3, AP42
M = moisture content of material, 7.9%, reference to mean value for overburden listed in Table 11.9-3, AP42

(V) Vehicle movement on unpaved Haul Road

$$E = k(1.7)(\frac{s}{12})(\frac{S}{48})(\frac{W}{2.7})^{0.7}(\frac{w}{4})^{0.5}(\frac{365-p}{365})$$

where,

E = emission factor in Kilograms per vehilce per kilometre
k = particle size multiplier, 0.8 for TSP
s = silt content of road surface in percent, 10%
S = mean vehicle speed in kilometres per hour, 35 km hr^{-1}
W = mean vehicle weight in tones, 20 tones
w = mean number of wheels, 10 wheels per vehicle
p = number of days with at least 0.254 mm of precipitation per year, 100 days

(VI) Concrete Batching Plant

$$E = 0.164$$

where

E = emission factor in Kg per tone of concrete mixing

Samples of FDM Models Input & Output Files

(I) Foothills Bypass Earthwork Input File

```
Foothill Bypass Earthwork w/o mitigation
 1 1 1 1 1 1 3 1 3 3 1 1                                                    000  0  0
   56   10    6 3650
60.0000000100.0000001.000000002.5000000010.0000000
100.00000030.000000015.000000010.00000005.000000002.50000000
0.200000000.300000010.140000000.160000000.105000000.09500000
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 300.00000013901.300813427.188826103.87590.420417835.302818320.000000047.522.500
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 200.00459000020.000813126.625825885.125813103.125825749.50010.00000004.0002.500
(Tuen Mun 1993 Meteorologicaldata)
```

(I) Foothills Bypass Earthwork Output File

```
1                    FDM - (DATED 91109)

                     IBM-PC VERSION (1.01)
                     (C) COPYRIGHT 1991, TRINITY CONSULTANTS, INC.
                     SERIAL NUMBER 9142  SOLD TO ERM HONG KONG
                     RUN BEGAN ON 11/22/96 AT 21:41:26


     RUN TITLE:
          Foothill Bypass Earthwork w/o mitigation

          INPUT FILE NAME: EARTH93R.DAT
          OUTPUT FILE NAME: EARTH93R.LST


          CONVERGENCE OPTION 1=OFF, 2=ON                          1
          MET OPTION SWITCH, 1=CARDS, 2=PREPROCESSED              1
          PLOT FILE OUTPUT, 1=NO, 2=YES                           1
          MET DATA PRINT SWITCH, 1=NO, 2=YES                      1
          POST-PROCESSOR OUTPUT, 1=NO, 2=YES                      1
          DEP. VEL./GRAV. SETL. VEL., 1=DEFAULT, 2=USER           1
          PRINT 1-HOUR AVERAGE CONCEN, 1=NO, 2=YES                3
          PRINT 3-HOUR AVERAGE CONCEN, 1=NO, 2=YES                1
          PRINT 8-HOUR AVERAGE CONCEN, 1=NO, 2=YES                3
          PRINT 24-HOUR AVERAGE CONCEN, 1=NO, 2=YES               1
          PRINT LONG-TERM AVERAGE CONCEN, 1=NO, 2=YES             1
          BYPASS RAMMET CALMS RECOGNITION, 1=NO, 2=YES            1
          NUMBER OF SOURCES PROCESSED                            56
          NUMBER OF RECEPTORS PROCESSED                          10
          NUMBER OF PARTICLE SIZE CLASSES                         6
          NUMBER OF HOURS OF MET DATA PROCESSED                3650
          LENGTH IN MINUTES OF 1-HOUR OF MET DATA              60.
          ROUGHNESS LENGTH IN CM                             100.00
          SCALING FACTOR FOR SOURCE AND RECPTORS             1.0000
          PARTICLE DENSITY IN G/CM**3                          2.50
          ANEMOMETER HEIGHT IN M                              10.00

          GENERAL PARTICLE SIZE CLASS INFORMATION

                                    GRAV.                  FRACTION
            PARTICLE      CHAR.  SETTLING  DEPOSITION      IN EACH
               SIZE        DIA.  VELOCITY   VELOCITY         SIZE
              CLASS        (UM)  (M/SEC)    (M/SEC)        CLASS
              -----  ----------  --------  ----------     --------
                 1 100.0000000        **          **        .2000
                 2  30.0000000        **          **        .3000
                 3  15.0000000        **          **        .1400
                 4  10.0000000        **          **        .1600
                 5   5.0000000        **          **        .1050
                 6   2.5000000        **          **        .0950
          ----------
          ** COMPUTED BY FDM
1

          RECEPTOR COORDINATES (X,Y,Z)

(814414., 827180.,  5.)  (814447., 827412., 29.)  (814240., 827108., 10.)
(814310., 826942.,  6.)  (813658., 826782., 74.)  (813768., 826416., 11.)
(813629., 826157.,  6.)  (813480., 826030.,  6.)  (812920., 825625.,  6.)
(812765., 825557., 11.)  (
1

          SOURCE INFORMATION

                 ENTERED EMIS.      TOTAL
                  RATE (G/SEC,  EMISSION    WIND
                    G/SEC/M OR       RATE   SPEED      X1        Y1        X2        Y2  HEIGHT   WIDTH
               TYPE G/SEC/M**2)  (G/SEC)    FAC.     (M)       (M)       (M)       (M)     (M)     (M)
               ---- ----------- ---------- ------- -------- --------- --------- --------- ------- -------
                  3  .000000813   .00135  1.300 813098.  825746.     54.       31.  10.00     .73
                  3  .000000813   .01348  1.300 813156.  825836.    115.      144.  10.00    1.77
                  3  .000000813   .00160  1.300 813226.  825813.     26.       76.  10.00     .82
                  3  .000000139   .00017  1.300 813235.  825881.     58.       22.  10.00   52.19
                  3  .000000139   .00019  1.300 813273.  825929.     65.       20.  10.00   52.15
                  3  .000000139   .00014  1.300 813211.  825914.     51.       19.  10.00   35.13
                  3  .000000139   .00017  1.300 813257.  825946.     62.       20.  10.00   34.04
                  3  .000000139   .00026  1.300 813305.  825979.     48.       40.  10.00   46.70
                  3  .000000139   .00052  1.300 813357.  826035.    106.       35.  15.00   45.50
                  3  .000000139   .00044  1.300 813427.  826104.     90.       35.  20.00   47.52
                  3  .000000139   .00053  1.300 813489.  826167.     85.       45.  20.00   50.26
                  3  .000000139   .00103  1.300 813561.  826261.    151.       49.  24.00   56.32
 ******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
                  3  .000000139   .00240  1.300 813664.  826432.    247.       70.  28.00   55.26
 ******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
                  3  .000000139   .00042  1.300 813748.  826555.     50.       61.  32.00   58.42
 ******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
                  3  .000000139   .00118  1.300 813795.  826647.    154.       55.  34.00   61.19
 ******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
                  3  .000000139   .00055  1.300 813843.  826754.     79.       51.  34.00   60.98
 ******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
                  3  .000000139   .00094  1.300 813911.  826843.    135.       50.  34.00   48.83
 ******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
                  3  .000000139   .00236  1.300 814007.  826958.    171.      100.  34.00   55.95
 ******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
                  3  .000000139   .00245  1.300 814103.  827084.    146.      121.  27.00   47.63
 ******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
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            3      .000000139     .00119  1.300 814180.  827161.     84.     102.   25.00   37.34
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000000139     .00060  1.300 814244.  827200.     63.      69.   23.00   32.52
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000000139     .00084  1.300 814331.  827250.    137.      44.   19.00   29.82
            3      .000032800     .05446   .000 813098.  825746.     54.      31.   10.00     .73
            3      .000032800     .54386   .000 813156.  825836.    115.     144.   10.00    1.77
            3      .000032800     .06466   .000 813226.  825813.     26.      76.   10.00     .82
            3      .000005620     .00705   .000 813235.  825881.     58.      22.   10.00   52.19
            3      .000005620     .00752   .000 813273.  825929.     65.      20.   10.00   52.15
            3      .000005600     .00554   .000 813211.  825914.     51.      19.   10.00   35.13
            3      .000005620     .00695   .000 813257.  825946.     62.      20.   10.00   34.04
            3      .000005620     .01061   .000 813305.  825979.     48.      40.   10.00   46.70
            3      .000005600     .02097   .000 813357.  826035.    106.      35.   15.00   45.50
            3      .000005600     .01788   .000 813427.  826104.     90.      35.   20.00   47.52
            3      .000005620     .02133   .000 813489.  826167.     85.      45.   20.00   50.26
            3      .000005600     .04159   .000 813561.  826261.    151.      49.   24.00   56.32
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000005620     .09693   .000 813664.  826432.    247.      70.   28.00   55.26
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000005620     .01684   .000 813748.  826555.     50.      61.   32.00   58.42
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000005620     .04757   .000 813795.  826647.    154.      55.   34.00   61.19
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000005620     .02242   .000 813843.  826754.     79.      51.   34.00   60.98
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000005620     .03813   .000 813911.  826843.    135.      50.   34.00   48.83
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000005620     .09557   .000 814007.  826958.    171.     100.   34.00   55.95
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000005620     .09887   .000 814103.  827084.    146.     121.   27.00   47.63
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000005620     .04810   .000 814180.  827161.     84.     102.   25.00   37.34
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000005620     .02442   .000 814244.  827200.     63.      69.   23.00   32.52
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            3      .000005620     .03413   .000 814331.  827250.    137.      44.   19.00   29.82
            1      .148000000     .14800   .000 813863.  826908.      0.       0.   30.00     .00
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            2      .004590000     .63872   .000 814380.  827303. 814252.  827249.   19.00    4.00
            2      .004590000     .86712   .000 814252.  827249. 814087.  827157.   23.00    4.00
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            2      .004590000     .56893   .000 814087.  827157. 814013.  827058.   27.00    4.00
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            2      .004590000    1.61583   .000 814013.  827058. 813819.  826764.   30.00    4.00
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            2      .004590000     .88959   .000 813819.  826764. 813733.  826590.   34.00    4.00
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            2      .004590000    1.03370   .000 813733.  826590. 813603.  826406.   32.00    4.00
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            2      .004590000    1.01737   .000 813603.  826406. 813496.  826212.   26.00    4.00
******* WARNING!  RELEASE HEIGHTS GREATER THAN 20 M ARE NOT SUPPORTED BY FDM
            2      .004590000    1.49091   .000 813496.  826212. 813275.  825974.   20.00    4.00
            2      .004590000     .51726   .000 813275.  825974. 813184.  825907.   15.00    4.00
            2      .004590000     .28345   .000 813184.  825907. 813127.  825885.   10.00    4.00
            2      .004590000     .63179   .000 813127.  825885. 813103.  825750.   10.00    4.00
                                ==========
        TOTAL EMISSIONS        11.06091
        NOTE:  SOME SOURCE EMISSION RATES ARE A FUNCTION OF WIND SPEED AND TOTAL IS NOT CORRECT
1
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TOP 50 TABLE FOR 1 HOUR AVERAGES

RANK	RECEPTOR	X-COORDINATE	Y-COORDINATE	ENDING HOUR	CONCENTRATION	DEPOSITION
1	9	812920.0	825625.0	691	460.2745	8.9413
2	9	812920.0	825625.0	883	441.2788	14.3167
3	9	812920.0	825625.0	1447	271.5658	7.6804
4	9	812920.0	825625.0	1481	271.5642	7.7017
5	9	812920.0	825625.0	2120	257.4180	9.6369
6	9	812920.0	825625.0	3211	242.8808	9.3968
7	9	812920.0	825625.0	2659	236.9277	9.0909
8	9	812920.0	825625.0	984	233.1645	6.7761
9	9	812920.0	825625.0	890	233.1629	6.8255
10	9	812920.0	825625.0	2981	233.1581	6.9672
11	9	812920.0	825625.0	3339	227.8102	8.7762
12	9	812920.0	825625.0	539	225.4706	6.6512
13	9	812920.0	825625.0	3421	225.2125	8.9039
14	9	812920.0	825625.0	672	224.5743	7.8985
15	2	814447.2	827412.0	2109	222.5101	3.4962
16	8	813480.0	826030.0	891	209.5401	7.1587
17	8	813480.0	826030.0	32	209.5352	7.1846
18	8	813480.0	826030.0	2251	209.5120	7.3063
19	9	812920.0	825625.0	2421	208.0175	6.5829
20	9	812920.0	825625.0	990	207.2888	7.3845
21	9	812920.0	825625.0	889	197.6976	7.1829
22	9	812920.0	825625.0	879	194.6848	7.1999
23	8	813480.0	826030.0	1620	191.4189	7.0269
24	8	813480.0	826030.0	3345	191.4004	6.6684
25	8	813480.0	826030.0	3102	191.3972	6.6867
26	9	812920.0	825625.0	3460	186.3549	7.0475
27	9	812920.0	825625.0	3040	186.3513	7.1411
28	9	812920.0	825625.0	2831	186.3485	7.2128
29	9	812920.0	825625.0	541	180.8886	6.7038
30	9	812920.0	825625.0	527	180.8853	6.8691
31	9	812920.0	825625.0	2667	180.8833	6.9677
32	3	814240.0	827108.0	311	175.8474	7.7370
33	9	812920.0	825625.0	3192	175.6082	4.6179
34	8	813480.0	826030.0	1521	173.8819	6.4353
35	9	812920.0	825625.0	983	173.4901	6.5794
36	9	812920.0	825625.0	1011	173.2846	4.5721
37	9	812920.0	825625.0	878	171.6229	6.6940
38	9	812920.0	825625.0	2668	171.6172	6.8581
39	10	812765.3	825556.8	2120	170.9021	6.0279
40	8	813480.0	826030.0	11	170.8831	7.0415
41	3	814240.0	827108.0	11	164.9353	7.6564
42	9	812920.0	825625.0	1601	163.1929	4.4551
43	8	813480.0	826030.0	402	162.6292	5.6970
44	2	814447.2	827412.0	440	161.2617	4.2919
45	3	814240.0	827108.0	2109	161.1749	2.5454
46	9	812920.0	825625.0	784	160.3580	6.1706
47	9	812920.0	825625.0	978	160.3558	6.3023
48	8	813480.0	826030.0	3560	159.0874	5.8032
49	10	812765.3	825556.8	2659	158.2100	5.7573
50	8	813480.0	826030.0	3192	155.9553	5.0819

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HIGHEST AND SECOND HIGHEST VALUES FOR 1 HOUR AVERAGES

RECEPTOR	X-COORDINATE	Y-COORDINATE	HIGHEST VALUE	ENDING HOUR	DEPOSITION	SECOND HIGH	ENDING HOUR	DEPOSTION
1	814414.0	827180.0	97.0763	2109.	1.1889	85.0992	3465.	3.3786
2	814447.2	827412.0	222.5101	2109.	3.4962	161.2617	440.	4.2919
3	814240.0	827108.0	175.8474	311.	7.7370	164.9353	11.	7.6564
4	814309.9	826941.7	96.5422	331.	3.8981	88.7475	291.	3.9679
5	813657.8	826782.4	37.8039	1434.	1.1783	31.8494	1574.	.9955
6	813768.0	826416.0	130.3193	1620.	4.5993	127.6589	891.	4.1242
7	813629.1	826156.6	139.6349	1620.	4.9903	135.9241	891.	4.4277
8	813480.0	826030.0	209.5401	891.	7.1587	209.5352	32.	7.1846
9	812920.0	825625.0	460.2745	691.	8.9413	441.2788	883.	14.3167
10	812765.3	825556.8	170.9021	2120.	6.0279	158.2100	2659.	5.7573

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TOP 50 TABLE FOR 8 HOUR AVERAGES

RANK	RECEPTOR	X-COORDINATE	Y-COORDINATE	ENDING HOUR	CONCENTRATION	DEPOSITION
1	9	812920.0	825625.0	888C	112.2872	4.1446
2	9	812920.0	825625.0	544C	111.0292	4.2125
3	9	812920.0	825625.0	984	106.5203	3.7657
4	9	812920.0	825625.0	896C	88.6213	2.8688
5	9	812920.0	825625.0	784C	86.5231	5.1540
6	9	812920.0	825625.0	2672	85.6778	3.7714
7	9	812920.0	825625.0	760	82.7789	4.5922
8	9	812920.0	825625.0	3064C	78.6257	5.5872
9	9	812920.0	825625.0	696C	76.7124	1.4902
10	8	813480.0	826030.0	3464C	75.7276	3.5037
11	8	813480.0	826030.0	3536C	75.5433	4.7482
12	9	812920.0	825625.0	3480	73.4944	6.8078
13	9	812920.0	825625.0	184	72.9408	5.9319
14	9	812920.0	825625.0	776	72.5308	6.8834
15	9	812920.0	825625.0	3080	72.2091	4.9048
16	9	812920.0	825625.0	880C	71.9021	2.9938
17	8	813480.0	826030.0	2864C	71.4483	3.9348
18	9	812920.0	825625.0	192	70.9008	4.7320
19	9	812920.0	825625.0	216	70.0924	4.1609
20	9	812920.0	825625.0	176	69.1091	5.1647
21	9	812920.0	825625.0	3488	68.5069	6.3653
22	8	813480.0	826030.0	2816C	67.6705	5.6530
23	9	812920.0	825625.0	2680	66.0771	4.0389
24	9	812920.0	825625.0	2688	65.8442	5.3601
25	9	812920.0	825625.0	600C	65.6564	5.1759
26	9	812920.0	825625.0	3216C	65.5944	2.9351
27	9	812920.0	825625.0	3280	65.3277	6.0028
28	8	813480.0	826030.0	2552C	65.2966	6.3171
29	9	812920.0	825625.0	200	65.1065	3.7697
30	9	812920.0	825625.0	168	65.0266	4.0334
31	8	813480.0	826030.0	2664C	64.8641	2.7873
32	9	812920.0	825625.0	3288	64.2556	5.7533
33	9	812920.0	825625.0	792	64.2529	3.2865
34	8	813480.0	826030.0	800C	64.2438	4.0636
35	9	812920.0	825625.0	2912	64.0940	4.6310
36	9	812920.0	825625.0	3384	63.0333	6.0169
37	8	813480.0	826030.0	976	61.8495	4.0857
38	8	813480.0	826030.0	2936C	61.3156	5.2406
39	9	812920.0	825625.0	2744C	61.0021	5.1846
40	9	812920.0	825625.0	976	60.7316	2.7620
41	9	812920.0	825625.0	3552	60.6183	5.9019
42	8	813480.0	826030.0	3176C	60.5143	3.1754
43	9	812920.0	825625.0	3512C	59.7966	7.9247
44	8	813480.0	826030.0	296	59.5504	3.6195
45	9	812920.0	825625.0	2880	59.4674	3.3143
46	9	812920.0	825625.0	3040	58.8389	4.8868
47	8	813480.0	826030.0	3312	58.6560	5.7321
48	8	813480.0	826030.0	232C	58.1835	4.4226
49	10	812765.3	825556.8	544C	58.0872	2.0933
50	8	813480.0	826030.0	984	57.9176	2.5815

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HIGHEST AND SECOND HIGHEST VALUES FOR 8 HOUR AVERAGES

RECEPTOR	X-COORDINATE	Y-COORDINATE	HIGHEST VALUE	ENDING HOUR	DEPOSITION	SECOND HIGH	ENDING HOUR	DEPOSTION
1	814414.0	827180.0	34.4601	2360.	4.7766	32.8045	40.C	5.2684
2	814447.2	827412.0	51.2659	2112.C	1.2696	41.6203	904.C	1.3040
3	814240.0	827108.0	57.7966	3536.C	4.0397	55.0388	2816.C	4.8148
4	814309.9	826941.7	38.1795	296.	1.8349	32.3770	3592.C	2.0050
5	813657.8	826782.4	20.1924	1000.C	.7634	18.8967	2104.C	.9010
6	813768.0	826416.0	53.8000	3536.C	3.5290	50.8101	3464.C	2.1842
7	813629.1	826156.6	52.9720	3536.C	3.1252	50.5095	2816.C	4.1859
8	813480.0	826030.0	75.7276	3464.C	3.5037	75.5433	3536.C	4.7482
9	812920.0	825625.0	112.2872	888.C	4.1446	111.0292	544.C	4.2125
10	812765.3	825556.8	58.0872	544.C	2.0933	56.4113	984.	1.8912

RUN ENDED ON 11/22/96 AT 22:11:46

Samples of CALINE4 Models Input & Output Files

(I) Foothills Bypass CO Input File

```
Foothill Bypass - EIA (22 Nov 96)
1CO
      100.000000       28.000000    0.000000E+00    0.000000E+00          10
          20         1.000000           1            1
A1
A2
A3
A4
A5
A6
A7
A8
A9
A10
    14414.000000    27180.000000        1.500000
    14350.000000    27450.000000        1.500000
    14240.000000    27108.000000        1.500000
    14309.900000    26941.700000        1.500000
    13657.800000    26782.400000        1.500000
    13768.000000    26416.000000        1.500000
    13629.100000    26156.600000        1.500000
    13480.000000    26030.000000        1.500000
    12920.000000    25625.000000        1.500000
    12765.300000    25556.800000        1.500000
1
2
3
4
5
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7
8
9
10
11
12
13
14
15
16
17
18
19
20
          1    14531.400000    27515.340000    14472.990000    27360.600000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    14472.990000    27360.600000    14412.600000    27290.000000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    14412.600000    27290.000000    14183.200000    27125.900000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    14183.200000    27125.900000    14086.600000    27021.000000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    14086.600000    27021.000000    13946.900000    26788.200000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    13946.900000    26788.200000    13874.800000    26743.400000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    13874.800000    26743.400000    13789.400000    26643.700000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    13789.400000    26643.700000    13677.700000    26481.300000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    13677.700000    26481.300000    13539.190000    26255.810000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    13539.190000    26255.810000    13345.310000    26006.690000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    13345.310000    26006.690000    13212.940000    25872.190000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    13219.440000    25864.940000    13219.810000    25810.940000
    0.000000E+00       16.000000    0.000000E+00    0.000000E+00           0
          1    13219.810000    25810.940000    13167.690000    25778.690000
    0.000000E+00       16.000000    0.000000E+00    0.000000E+00           0
          1    13201.940000    25884.810000    13158.810000    25874.000000
    0.000000E+00       16.000000    0.000000E+00    0.000000E+00           0
          1    13158.810000    25874.000000    13130.130000    25844.190000
    0.000000E+00       16.000000    0.000000E+00    0.000000E+00           0
          1    13130.130000    25844.190000    13147.190000    25786.940000
    0.000000E+00       16.000000    0.000000E+00    0.000000E+00           0
          1    13158.000000    25782.940000    13107.190000    25726.810000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    13107.190000    25726.810000    12958.000000    25690.000000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    12958.000000    25690.000000    12816.000000    25562.000000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
          1    12816.000000    25562.000000    12731.000000    25424.000000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
31111Foothill
     3040.000000     3040.000000     3040.000000     3040.000000
     3040.000000     3040.000000     3040.000000     3040.000000
     3040.000000     3040.000000     3040.000000     1690.000000
     1690.000000     1340.000000     1340.000000     1340.000000
     3010.000000     4550.000000     4550.000000     4550.000000
      126.530000      126.530000      126.530000      126.530000
      126.530000      126.530000      126.530000      126.530000
      126.530000      126.530000      126.530000      126.200000
      126.200000      126.880000      126.880000      126.880000
      124.980000      118.530000      118.530000      118.530000
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    0.000000E+00       25.000000
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(II) *Foothills Bypass CO Output File*

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1                              IBM-PC VERSION 1.20
                               (C) COPYRIGHT 1987 , TRINITY CONSULTANTS, INC.
                               SERIAL NUMBER 5540
                               SOLD TO HONG KONG POLYTECHNIC
                               RUN BEGAN ON 11-22-96 AT 17:35:28

                CALINE4: CALIFORNIA LINE SOURCE DISPERSION MODEL
                         JULY 1985 VERSION
                         PAGE   1

                     JOB: Foothill Bypass - EIA (22 Nov 96)
                     RUN: Foothill          (WORST CASE ANGLE)
               POLLUTANT: CO
```

I. SITE VARIABLES

U=	1.0 M/S	Z0=	100. CM
BRG=	WORST CASE	VD=	.0 CM/S
CLAS=	4 (D)	VS=	.0 CM/S
MIXH=	500. M	AMB=	.0 PPM
SIGTH=	20. DEGREES	TEMP=	25.0 DEGREE (C)

II. LINK VARIABLES

LINK DESCRIPTION	LINK COORDINATES (M) X1	Y1	X2	Y2	TYPE	VPH	EF (G/MI)	H (M)	W (M)
A. 1	14531	27515	14473	27361	AG	3040	126.5	.0	24.0
B. 2	14473	27361	14413	27290	AG	3040	126.5	.0	24.0
C. 3	14413	27290	14183	27126	AG	3040	126.5	.0	24.0
D. 4	14183	27126	14087	27021	AG	3040	126.5	.0	24.0
E. 5	14087	27021	13947	26788	AG	3040	126.5	.0	24.0
F. 6	13947	26788	13875	26743	AG	3040	126.5	.0	24.0
G. 7	13875	26743	13789	26644	AG	3040	126.5	.0	24.0
H. 8	13789	26644	13678	26481	AG	3040	126.5	.0	24.0
I. 9	13678	26481	13539	26256	AG	3040	126.5	.0	24.0
J. 10	13539	26256	13345	26007	AG	3040	126.5	.0	24.0
K. 11	13345	26007	13213	25872	AG	3040	126.5	.0	24.0
L. 12	13219	25865	13220	25811	AG	1690	126.2	.0	16.0
M. 13	13220	25811	13168	25779	AG	1690	126.2	.0	16.0
N. 14	13202	25885	13159	25874	AG	1340	126.9	.0	16.0
O. 15	13159	25874	13130	25844	AG	1340	126.9	.0	16.0
P. 16	13130	25844	13147	25787	AG	1340	126.9	.0	16.0
Q. 17	13158	25783	13107	25727	AG	3010	125.0	.0	24.0
R. 18	13107	25727	12958	25690	AG	4550	118.5	.0	24.0
S. 19	12958	25690	12816	25562	AG	4550	118.5	.0	24.0
T. 20	12816	25562	12731	25424	AG	4550	118.5	.0	24.0

```
                CALINE4: CALIFORNIA LINE SOURCE DISPERSION MODEL
                         JULY 1985 VERSION
                         PAGE   2

                     JOB: Foothill Bypass - EIA (22 Nov 96)
                     RUN: Foothill          (WORST CASE ANGLE)
               POLLUTANT: CO
```

III. RECEPTOR LOCATIONS

RECEPTOR	COORDINATES (M) X	Y	Z
1. A1	14414	27180	1.5
2. A2	14350	27450	1.5
3. A3	14240	27108	1.5
4. A4	14310	26942	1.5
5. A5	13658	26782	1.5
6. A6	13768	26416	1.5
7. A7	13629	26157	1.5
8. A8	13480	26030	1.5
9. A9	12920	25625	1.5
10. A10	12765	25557	1.5

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. A1	10.	5.1	1.5	2.7	.9	.0	.0	.0	.0	.0
2. A2	208.	4.1	.0	.0	1.3	.8	.8	.2	.2	.2
3. A3	32.	7.6	.8	.6	6.2	.0	.0	.0	.0	.0
4. A4	243.	2.8	.0	.0	.0	.0	.7	.5	.6	.5
5. A5	189.	2.7	.0	.0	.0	.0	.0	.0	.0	.3
6. A6	233.	4.8	.0	.0	.0	.0	.0	.0	.0	.0
7. A7	241.	4.2	.0	.0	.0	.0	.0	.0	.0	.0
8. A8	242.	5.4	.0	.0	.0	.0	.0	.0	.0	.0
9. A9	253.	16.0	.0	.0	.0	.0	.0	.0	.0	.0
10. A10	64.	14.1	.0	.0	.0	.0	.0	.0	.0	.0

JOB: Foothill Bypass - EIA (22 Nov 96)
RUN: Foothill (WORST CASE ANGLE)
POLLUTANT: CO

IV. MODEL RESULTS (WORST CASE WIND ANGLE) (CONT.)

		CONC/LINK (PPM)											
RECEPTOR	*	I	J	K	L	M	N	O	P	Q	R	S	T
1. A1	*	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2. A2	*	.2	.2	.1	.0	.0	.0	.0	.0	.0	.1	.1	.0
3. A3	*	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
4. A4	*	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
5. A5	*	1.6	.7	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
6. A6	*	1.7	1.9	.4	.0	.0	.0	.0	.0	.1	.2	.2	.1
7. A7	*	.0	1.5	1.2	.1	.1	.1	.1	.1	.1	.3	.3	.2
8. A8	*	.0	.3	2.7	.2	.1	.2	.1	.2	.2	.6	.5	.3
9. A9	*	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	15.0	1.0
10. A10	*	.1	.2	.3	.1	.2	.0	.0	.1	.5	1.7	9.4	1.2

RUN ENDED ON 11-22-96 AT 17:35:44

(III) Hoi Wong/Wui King Roads Junction NO_2 Input File

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Wu King Rd/Hoi Wong Rd Junctn - EIA
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           6        1.000000           1           1
A1
A2
A3
A4
    14605.000000   26597.000000        1.500000
    14550.000000   26500.000000        1.500000
    14560.000000   26390.000000        1.500000
    14658.000000   26466.000000        1.500000
1
2
3
4
5
6
           1    14199.400000   26658.900000   14623.800000   26513.200000
    0.000000E+00       23.000000    0.000000E+00    0.000000E+00           0
           1    14623.800000   26513.200000   14587.700000   26405.200000
    0.000000E+00       29.000000    0.000000E+00    0.000000E+00           0
           1    14587.700000   26405.200000   14485.700000   26027.100000
    0.000000E+00       29.000000    0.000000E+00    0.000000E+00           0
           1    14485.700000   26027.100000   14199.300000   26082.600000
    0.000000E+00       18.000000    0.000000E+00    0.000000E+00           0
           1    14623.800000   26513.200000   14672.800000   26585.200000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
           1    14672.800000   26585.200000   14913.900000   26740.600000
    0.000000E+00       24.000000    0.000000E+00    0.000000E+00           0
31111Junction
     1550.000000     1460.000000     1460.000000      780.000000
     2850.000000     2850.000000
       36.753000       31.026000       31.026000       32.427000
       31.819000       31.819000
    0.000000E+00        1.000000           4      500.000000       20.000000
    0.000000E+00       25.000000
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(III) Hoi Wong/Wui King Roads Junction NO_2 Output File

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1                    IBM-PC VERSION 1.20
                     (C) COPYRIGHT 1987 , TRINITY CONSULTANTS, INC.
                     RUN BEGAN ON 07-23-96 AT 18:27:53


          CALINE4: CALIFORNIA LINE SOURCE DISPERSION MODEL
                   JULY 1985 VERSION
                   PAGE   1

              JOB: Wu King Rd/Hoi Wong Rd Junctn - EIA
              RUN: Junction          (WORST CASE ANGLE)
       POLLUTANT: NO2
```

I. SITE VARIABLES

```
     U=   1.0  M/S          Z0= 100. CM
   BRG= WORST CASE          VD=   .0 CM/S
  CLAS=     4  (D)          VS=   .0 CM/S
  MIXH=  500.  M           AMB=   .0 PPM
 SIGTH=   20.  DEGREES    TEMP= 25.0 DEGREE (C)
```

II. LINK VARIABLES

LINK DESCRIPTION	*	LINK COORDINATES (M) X1	Y1	X2	Y2	* TYPE	VPH	EF (G/MI)	H (M)	W (M)
A. 1	*	14199	26659	14624	26513	* AG	1550	36.8	.0	23.0
B. 2	*	14624	26513	14588	26405	* AG	1460	31.0	.0	29.0
C. 3	*	14588	26405	14486	26027	* AG	1460	31.0	.0	29.0
D. 4	*	14486	26027	14199	26083	* AG	780	32.4	.0	18.0
E. 5	*	14624	26513	14673	26585	* AG	2850	31.8	.0	24.0
F. 6	*	14673	26585	14914	26741	* AG	2850	31.8	.0	24.0

III. RECEPTOR LOCATIONS

RECEPTOR	*	COORDINATES (M) X	Y	Z
1. A1	*	14605	26597	1.5
2. A2	*	14550	26500	1.5
3. A3	*	14560	26390	1.5
4. A4	*	14658	26466	1.5

IV. MODEL RESULTS (WORST CASE WIND ANGLE)

RECEPTOR	*	BRG (DEG)	*	PRED CONC (PPM)	*	CONC/LINK (PPM) A	B	C	D	E	F
1. A1	*	182.	*	1.0	*	.3	.3	.2	.0	.1	.0
2. A2	*	60.	*	1.7	*	.7	.0	.0	.0	.5	.5
3. A3	*	37.	*	1.5	*	.1	.7	.2	.0	.2	.3
4. A4	*	304.	*	1.2	*	.8	.4	.0	.0	.1	.0

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RUN ENDED ON 07-23-96 AT 18:27:55
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Annex B

Hong Kong Government Legislation and Guidelines Relating to Ecology

HONG KONG LEGISLATION

With regard to the Hong Kong legislation, protection of animals and plants is provided by:

- *Forests and Countryside Ordinance*
- *Wild Animals Protection Ordinance*
- *Animals and Plants (Protection of Endangered Species) Ordinance.*

Protection for habitats is provided by:

- *Wild Animals Protection Ordinance* (covering Restricted Areas)

- *Town Planning Ordinance* which provides for the designation and protection through the planning process of coastal protection areas, Sites of Special Scientific Interest, green belts and other specified uses which promote conservation or the protection of the environment.

Forests and Countryside Ordinance (Cap. 96) of the Revised Edition 1984

The *Forests and Countryside Ordinance (Cap 96)* prohibits felling, cutting, burning or destroying of trees and growing plants in forests and plantations on government land, which includes the mangroves in Deep Bay. Its subsidiary Regulations prohibit the picking, felling or possession of listed rare and protected plant species.

The list of protected species in Hong Kong which comes under the *Forestry Regulations* was last amended on 11th June 1993 under the *Forestry (Amendment) Regulation 1993* made under section 3 of the *Forests and Countryside Ordinance (Cap. 96).*

Wild Animals Protection Ordinance (Cap 170) of the Revised Edition 1980

Under the *Wild Animals Protection*, designated wild animals are protected from hunting, whilst their nests and eggs are protected from injury, destruction and removal. All birds and most mammals, except some domestic pests are protected under this Ordinance. Prior approval from the Director of Agriculture and Fisheries is required for permission to destroy any of the protected wild animals listed in the Ordinance.

The Second Schedule of the Ordinance which lists all the animals protected was last revised in June 1992.

Animals and Plants (Protection of Endangered Species) Ordinance (Cap. 187) of the Revised Edition 1989.

The *Animals and Plants (Protection of Endangered Species) Ordinance* controls the local possession of any endangered species of animals and plants listed in its schedules.

It is designed to control trade in endangered species and restricting the local possession of them.

In addition, there are measures which cover the retention, removal and replacement of trees on development sites.

Wild Animals Protection Ordinance (Cap 170) of the Revised Edition 1980

The *Wild Animals Protection Ordinance* restricts access to designation areas of wildlife habitat. The Sixth Schedule lists areas in which entry or presence is restricted. Currently two areas are listed, part of the Deep Bay Marshes at Mai Po, which is restricted at all times of the year and the fung shui wood (an egretry) behind the village of Yim Tso Ha, Starling Inlet, which is restricted by 1st April to 30 September every year.

Town Planning Ordinance (Cap 131)

The recently amended *Town Planning Ordinance* provide for the designation of " ..... coastal protection areas, Sites of Special Scientific Interest (SSSIs), green belts or other specified uses that promote conservation or protection of the environment, e.g. Conservation Areas.

Where SSSIs are covered by statutory town plans, the land uses therein are controlled by the provision of the *Town Planning Ordinance.*

The authority responsible for administering the *Town Planning Ordinance* is the Town Planning Board (Planning Department).

OTHER EXISTING OR PROPOSED MECHANISMS OF PROTECTION IN HONG KONG

Hong Kong Planning Standards and Guidelines

The new revised Chapter 10 of the *Hong Kong Planning Standards and Guidelines (HKPSG)* covers "Landscape and Conservation". Chapter 9 of the same document covers the "Environment". This section details the principles of conservation, the conservation of natural landscape and habitats, historic buildings, archaeological sites and other antiquities. It also addresses the issue of enforcement. The Appendices list the legislation and administrative controls for conservation, other conservation related measures in Hong Kong and Government Departments involved in Conservation.

Sites of Special Scientific Interest (SSSI) in Hong Kong

Sites of Special Scientific Interest are identified by the Agriculture and Fisheries Department as a planning measure to ensure that government departments are aware of the scientific importance of such sites so that consideration are given to conservation when developments in or near such sites are proposed. Where SSSIs are covered by statutory plans, the land uses therein are controlled by the provision of the *Town Planning Ordinance.*

SSSIs may be land based or marine sites which are of special interest because of their flora, fauna, geographical, geological or physiographic features. The Planning Department maintains a register of the SSSIs. Once identified, SSSIs are shown on statutory and departmental plans prepared by the Planning Department.

Some 58 SSSIs have been identified and listed in the Register kept by the Planning Department. Approximately half of the SSSIs which fall inside the Country Parks and Special areas, are maintained by AFD.

Water Control Zones

Water Control zones are gazetted under the Water Pollution Control Ordinance Cap. 358 with the intention of controlling discharges.

INTERNATIONAL CONVENTIONS

Bonn Convention

Also through the United Kingdom, Hong Kong is a party to the Convention on the Conservation of Migratory Species of Wild Animals, the Bonn Convention.

The Bonn Convention has two major objectives:

- to provide strict protection for species listed in Appendix 1 of the Convention (migratory species in danger of extinction throughout all or a significant portion of their range); and

- to encourage Range States for such species to conclude agreements for the conservation and management of Appendix 11 species (migratory species which have an unfavourable conservation status and require international agreements for their conservation, or which have a conservation status which would significantly benefit from international cooperation).

The first objective above includes obligations to conserve and restore those habitats which are important in removing the species from danger of extinction, and to prevent, remove, compensate for or minimize the adverse effects of activities or obstacles that impede or prevent migration of the species.

This international agreement is of particular relevance to Deep Bay given its importance as a stop off point for migrating shorebirds using the Siberian-Australasian flyway.

Threatened Species or Red Data Book Species

Worldwide birds are listed as threatened or near threatened by the Bird Life/International Union for the Conservation of Nature (IUCN) Red Data Books. Deep Bay is of world importance, that is it regularly supports more than 1 % of the world population) for the Black-faced Spoonbill, Asiatic Dowitcher, Spotted Greenshank and Saunder's Gull.

Annex C

List of Plant Species Recorded During Field Surveys

SHRUBS, GRASSES AND HERBS

Acorus gramineus
Adiantus capillus-veneris
Arundinella spp.
Baeckea frutescens
Centella sinensis
Cibotium baronetz
Cyperus spp.
Dianella ensifolia
Dicranopteris linearis
Diospyros spp.
Eremochloa ciliaris
Eurya chinensis
Ficus variolosa
Fimbristylis miliacea
Impatiens chinensis
Imperata cylindrica
Juncus alatus
Juncus spp.
Lantana camara
Ligustrum sinensis
Liriope spicata
Lycopodium scandens
Melastoma candidum
Melastoma docecandrum
Melastoma sanguinium
Mikania guaco
Miscanthus floridulus
Musa paradisiaca (planted)
Paspalum conjugatus
Polygonum hydropiper
Pteris spp.
Raphiolepis indica
Rhodomyrtus tomentosa
Rosa spp.
Rumex spp.
Scirpus erectus
Smilax china

TREES

Acacia confusa (planted)
Aporusa chinensis
Artocarpus spp. (planted)
Bauhinia blakeana (planted)
Bridelia monoica
Casuarina stricta (planted)
Celtis sinensis
Cerbera manghas (planted)
Cinnamomum camphora
Cinnamomum parthoxylon
Citrus spp. (planted)
Diospyros kaki (planted)
Endospermum chinense
Eucalyptus spp. (planted)
Euphoria longan (planted)
Ficus elastica (planted)
Ficus variegata var. chlorocarpa
Ficus hispida
Ficus pyriformis
Lagerstroemia speciosa (planted)
Liquidamber formosana
Litchi chinensis (planted)
Litsea glutinosa
Lophostemon conferta (planted)
Macaranga tanarius
Machilus spp.
Mallotus paniculatus
Mangifera indica
Melia azedarach
Microcos paniculata
Myrica rubra
Pandanus tectorium
Phyllanthus emblica
Pinus elliottii (planted)
Pinus massoniana
Prunus ssp.
Psidium guajava (planted)
Punica granatum (planted)
Rhus hypoleuca
Sapium discolor
Schefflera octophylla
Schima superba
Syzygium jambos (planted)
Ternstroemia gymnanthera
Viburnum odoratissimum