Highways Department
Western Harbour Link Office

Agreement No. CE 27/92

ROUTE 3
COUNTRY PARK SECTION
AND TING KAU BRIDGE

PRELIMINARY DESIGN STAGE 2

Country Park Section - Ting Kau Bridge

Volume 4A
Environmental Assessment - Technical Report

FREEMAN FOX MAUNSELL

ROUTE 3

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Volume 4A

Environmental Assessment - Technical Report

TABLE OF CONTENTS

VOLUME 4A

VOLUME 4B

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

INTRODUCTION

CHAPTER 1

1. INTRODUCTION

1.1 BACKGROUND

The part of Route 3 which this EIA covers was originally divided into two sections - the Country Park Section (CPS) and the Ting Kau Bridge Section (TKB) and all previous reports used this terminology. However these have now been changed and the part of Route 3 covered by this EIA Report is now referred to as the Route 3 Country Park Section. This is divided into two sub sections; the Tai Lam Tunnel and Yuen Long Approach Road (TLT&YLA) and the Ting Kau Bridge (TKB). This terminology is used throughout this Final EIA Report.

Ting Kau Bridge (TKB) is the major southern component of Route 3 Country Park Section (CPS) and together with the Tai Lam Tunnel and Yuen Long Approach Roach (TLT & YLA) (Ting Kau to Au Tau) will become a major element in Hong Kong's land transport infrastructure. Apart from being the first and main approach to the new airport at Chek Lap Kok it will be a vital link to serve the growing traffic demand in the North West New Territories, West Kowloon and the expanding port at Kwai Chung.

At its southern end TKB will connect to the North West Tsing Yi Interchange which in turn connects to both the Tsing Ma Bridge, and CRA1 Route 3. At its northern landfall the TKB will feed the mainline Route 3 CPS-TLT & YLA and the Ting Kau interchange which in turn connects to the Tuen Mun Road (Route 2).

It is currently proposed that the Hong Kong airport at Kai Tak will be replaced by a new airport at Chek Lap Kok on the north coast of Lantau Island. The new airport which is scheduled to commence operations in 1997 will require extensive infrastructure development and the construction of connecting transport links which will additionally serve the proposed container terminals on Lantau Island. TKB as part of Route 3 CPS will form an integral part of this supporting transport network. The proposed location of the TKB and Route 3 CPS is shown in Figure 1.1. Since the original preliminary feasibility study to explore prospective alignments of Route 3 CPS, sections of the highway and bridge have been the subject of further feasibility studies. These progressive feasibility studies have considered environmental issues as part of their evaluation.

The Government now wishes to proceed with the construction of Route 3 CPS - TKB (including the north west Tsing Yi interchange) and the Country Park Section. Government wishes to implement the project on a Design and Build basis. A prerequisite to any development is a thorough assessment of the likely environmental impacts of the project.

Freeman Fox Maunsell have been commissioned to undertake the necessary environmental studies culminating in the preparation of an Environmental Impact Assessment (EIA) for both the TKB and TLT & YLA of Route 3 CPS as required in the Study Brief. This document is the draft EIA Report of the TKB section and will form the basis for the Final EIA Report in accordance with the Study Brief.

1.2 SCOPE AND OBJECTIVES OF THE EIA

1.2.1 Scope

The scope of the EIA for the TKB Section draws directly from the Consultancy Agreement no. CE 27/92, Route 3 CPS - Country Park Section and TKB Section, Stage 2 Preliminary

Design, Environmental Impact Assessment, Study Brief (the Study Brief). The TKB Section of the Route 3 CPS project has a number of environmental issues that need to be addressed as part of the study, these include:

- impacts on marine water quality and marine ecology resulting from dredging Rambler Channel for the bridge central support, breakwater, and seawall of the reclamation, and impacts of the support, breakwater and seawall reclamation on water flow (hydraulics) and flushing (water quality) in the channel;
- fresh water quality impacts;
- disposal of marine muds;
- risk of shipping collisions with the central support, and for petroleum products vessel, hazards and marine pollution from subsequent spill of hydrocarbons into the Channel;
- air quality impacts due to construction activities and operation of the roadway;
- noise during construction and operation of the roadway;
- effects on ecology;
- visual impact of the bridge;
- landscaping of the areas at either end of the bridge; and
- landuse issues such as severance of properties, roadways, and paths.

1.2.2 Objectives

In accordance with the Study Brief the EIA has the following objectives:

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

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

iii) to minimize pollution, environmental disturbance and nuisance arising from the development and related facilities, and its construction and operation;

iv) to identify, predict and evaluate the net potential environmental impacts and cumulative effects resulting from the construction and operation of the development in relation to the existing landscape and community, planned community and the neighbouring land uses;

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

vi) to recommend environmental monitoring and audit requirements necessary to ensure the effectiveness of the environmental protection measures adopted; and

vii) to identify additional studies where necessary to fulfil the objectives or requirements of this EIA Study.

1.3 RELATIONSHIP TO OTHER TRANSPORT INFRASTRUCTURE

1.3.1 Chek Lap Kok Airport

TKB will form an integral part of the transport infrastructure that is required to serve the new airport at Chek Lap Kok. The north west Tsing Yi interchange will receive traffic from the airport via the Tsing Ma Bridge and the Kap Shui Mun Bridge, together known as the Lantau Fixed Crossing (LFC). Traffic will flow either east towards Kowloon on CRA1 Route 3 CPS or north towards Yuen Long across TKB.

1.3.2 Kwai Chung and Container Terminal No.9

With the development of the new port facilities at Kwai Chung and in particular Container Terminal No.9 (CT9) there is a forecast increase in vehicular traffic through Tsing Yi, in particular along CRA1 Route 3 CPS, leading to the North West Tsing Yi Interchange and thus across the TKB.

1.3.3 West Kowloon Expressway

Traffic from the North West New Territories, the Peoples Republic of China (PRC) border and from the new airport will pass through the North West Tsing Yi Interchange, and eventually end up on the West Kowloon Expressway (WKE) (the major highway link between the proposed new Western Harbour Crossing (WHC) in the south, and Route 3 CPS).

1.3.4 Tuen Mun Road

At its northern end the TKB will allow traffic to use the Ting Kau Interchange to gain access to Tuen Mun Road (Route 2).

1.3.5 North West New Territories - Yuen Long and the PRC

TKB will enable traffic to flow north to the North West New Territories, in particular Yuen Long and further to the border of the PRC.

1.4 STUDY AREA

The Study Area of the EIA covers the northern landfall of TKB up to the Tuen Mun Road. A dividing line is shown in Figure 1.2, past which the route falls under the TLT & YLA section. Of particular note will be the implications of the bridge's central support, breakwater, and the northern reclamation area (required for the bridge's northern supports). At the southern landfall the area impacted by the bridge and the North West Tsing Yi Interchange will be assessed, these generally including the areas immediately adjacent to the alignment. Emphasis will be placed on water quality and impacts upon the northern Rambler Channel (also named Tsuen Wan Fareway but referred to as Rambler Channel in this report).

1.5 PROJECT CO-ORDINATION AND PROGRAMME

1.5.1 Liaison with Government Departments and Project Co-ordination

Meetings have been held with various Government departments these include the Agriculture and Fisheries Department (AFD), Highways Department (HyD) (Senior Landscape Architect), and the Environmental Protection Department (EPD). The meetings involved such aspects as alignment, adjacent landuse, key issues and proposed criteria and methodology for various aspects of the Study.

Discussions within the project design study team regarding construction and operation of the alignment and possible mitigation measures have been held continuously throughout the assessment. This has enabled the engineering feasibility of the mitigation measures and other factors such as broad associated costs to be considered during the design process.

1.5.2 Timetable for TKB Environmental Assessment

The TKB Final EIA Report has been delayed from its original schedule partly from waiting for essential data and more recently due to requirements for additional studies.

The following additional studies have been undertaken:

- Risk Appraisal of Ship Collisions;
- Quantitative Dust Assessments;
- WAHMO Hydraulic and Water Quality Modelling; and
- Haul Road Assessment.

These additional studies have been included in this report with the exception of the Haul Road Assessment and the WAHMO water modelling assessment which will be presented as Supplementary Reports.

Comments from the relevant departments/bodies pertaining to the Draft Final Report and the additional studies have been addressed and where appropriate incorporated into this Final EIA Report.

1.6 STRUCTURE OF THE REPORT

This Report is structured as follows:

Chapter 2 describes the project characteristics including road alignment details, construction activities and programme, and projected traffic flows.

Chapter 3 describes the existing environmental conditions within the Study Area.

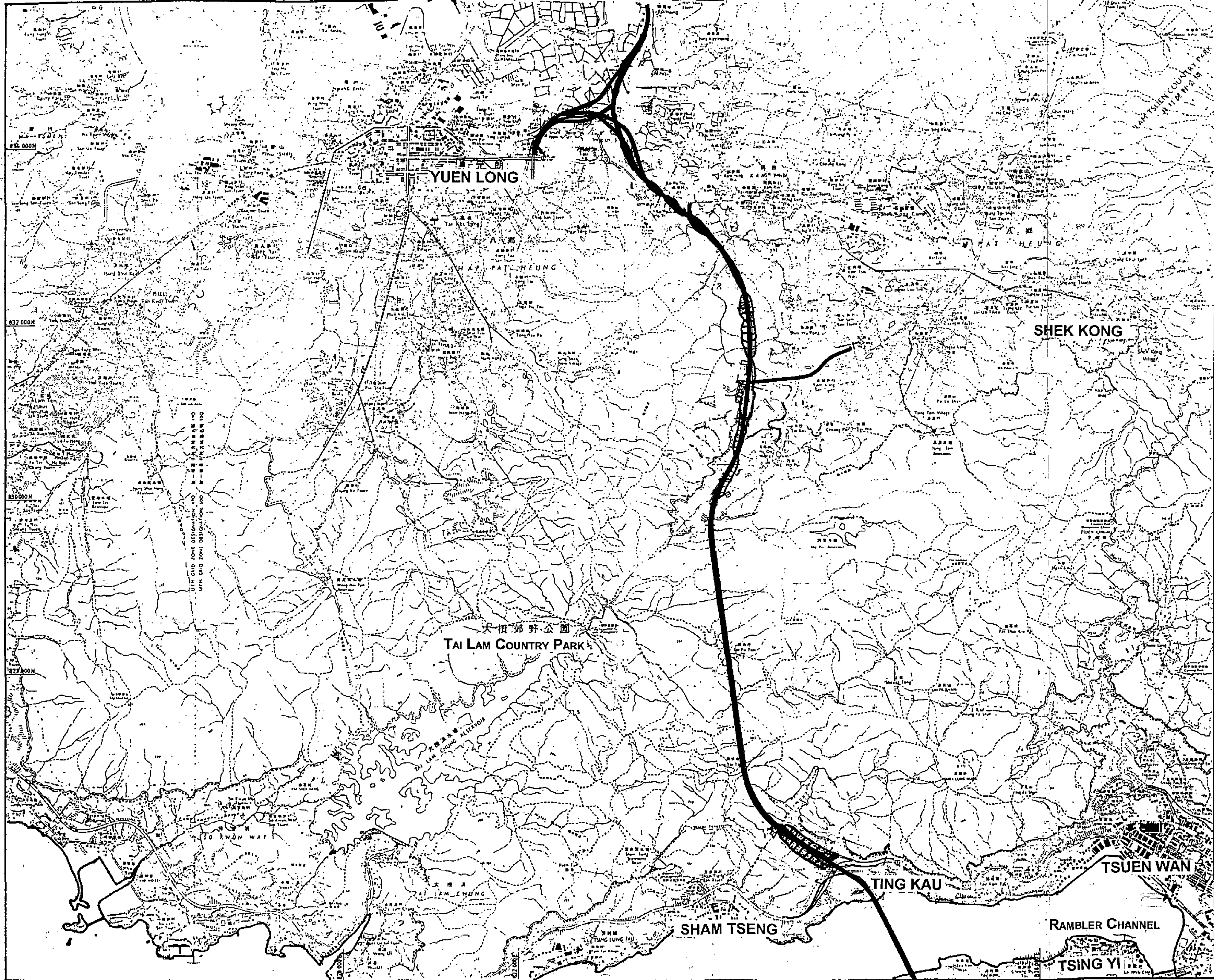
Chapters 4-11 detail the specialist studies involving the assessment of air quality, noise, water quality, waste and spoil management, visual, landscape, landuse, ecological impacts, and includes recommendations for impact mitigation.

Chapters 12 presents a shipping collision risk appraisal.

Chapter 13 details environmental monitoring and audit requirements.

Chapter 14 provides a summary of the TKB Study.

The Route 3 CPS studies have involved preparation of numerous reports and working papers. The EIA of the TKB Section has drawn on information contained in a number of these reports and these are referred to chronologically throughout this report. However, for completeness and additional information all reports and papers used during this study have been listed in the reference section at the back of this Report.



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HIGHWAYS DEPARTMENT

WESTERN HARBOUR LINK OFFICE

ROUTE 3 COUNTRY PARK SECTION AND TING KAU BRIDGE PRELIMINARY DESIGN STAGE 2

Figure 1.1

KEY PLAN

Drg No 92393/01/100

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LEGEND :

CUT SLOPE

FILL SLOPE

No.	Date	Description	Checked

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ROUTE 3 COUNTRY PARK SECTION AND TING KAU BRIDGE PRELIMINARY DESIGN STAGE 2

FIGURE 1.2

TING KAU BRIDGE, NORTH WEST TSING YI AND TING KAU INTERCHANGE

Drg. No. 92393/01/30

FREEMAN FOX MAUNSELL

PROJECT DESCRIPTION

CHAPTER 2

2. PROJECT DESCRIPTION

2.1 GENERAL

The TKB Section of Route 3 CPS comprises a cable stayed suspension bridge and approaches, connecting north west Tsing Yi with the main Route CPS, TLT & YLA (Figure 1.2).

The main features of the TKB development considered as part of this EIA include:

- The North West Tsing Yi Interchange located in the north west corner of Tsing Yi and connecting to the southern end of the bridge. This interchange facilitates connection to Ma Wan Island and to the North Lantau Expressway and Chek Lap Kok Airport. The Northwest Tsing Yi Interchange also connects in the south to Route 3 CRA1, leading to Hong Kong via the West Kowloon Expressway and the Western Harbour Crossing.

- The TKB which has a main span 420m long crossing the northern Rambler Channel. This is a cable stayed structure supported by two pylons. One main support pylon is located at northwest Tsing Yi, the other is located in mid channel.

- The mid channel bridge support (which will include a breakwater and rock island to protect the nine pylons that will support the approach section structure of the crossing), connecting the northern end of the bridge to the Ting Kau landfall.

- Two slip roads, ramps H and G, which run between the bridge at Ting Kau and the Tuen Mun Road (Route 2). They are both part of the Ting Kau Interchange.

The TKB alignment crosses over both Castle Peak and Tuen Mun Roads. The boundary of the two EIAs for Route 3 lies at the north abutment of the TKB approach structure (Figure 1.2). It should be noted that despite this division, 'knock on' effects will be taken into consideration.

2.2 STRUCTURAL CONSIDERATIONS

The main structural features of the Route 3 - TKB alignment are listed in Table 2.1 and described below.

2.2.1 North West Tsing Yi Interchange

North bound ramps C and D linking the LFC to TKB and to the North Tsing Yi Coastal Road will be constructed as part of the Route 3 project.

Although not required until TKB is opened, Ramps A and H are assumed to be constructed in advance of the other works as part of the LFC Interchange. This is because of the difficulty of constructing the ramps above the heavily trafficked interchange once the link to Chek Lap Kok Airport is opened.

2.2.2 Ting Kau Bridge and Approach Structure

TKB comprises a dual three lane structure with a main span which provides sufficient clearance for the vessels using the navigation route to the Rambler Channel.

Because of its proximity to the main shipping route around Ma Wan, a breakwater and rock island will be constructed to protect the piers from possible ship impact. The breakwater will run for approximately 350m from the base of the central support for the bridge, north west towards Casam Beach. A rock island is to be situated approximately mid-stream between the central bridge support and Lido Beach.

The height of the deck is at approximately +68mPD which allows connection to the Tsing Ma Bridge via the North West Tsing Yi Interchange and to Tuen Mun Road at the Ting Kau Interchange.

A reclamation for pylon support will be carried out at the headland between Lido Beach and Ting Kau Beach, on the Lido Beach side.

2.2.3 Ting Kau Interchange

The Ting Kau Interchange consists of four sliproads named ramps C, D, G and H. Ramps G and H are considered in this TKB EIA and the rest are considered in the TLT & YLA EIA.

Sliproad H will feed south bound Route 3 traffic onto the TKB from Tuen Mun Road east bound. Sliproad G takes north bound Route 3 traffic from TKB and feeds it onto Tuen Mun Road west bound (see Figure 1.2). The areas associated with the two sliproads (ramps G and H) will require significant landscape works.

Table 2.1 Ting Kau Bridge Alignment Details

Route Section	Vertical Alignment	Approximate corridor width
North west Tsing Yi Interchange, Mainline	Elevated + Excavated 65mPD	~ 38m
North west Tsing Yi Ramps	Elevated and in cuttings ~50mPD + ~78mPD	~ 13m
North west Tsing Yi Toll Plaza	Excavation for platform 62mPD	~ 112m
Ting Kau Bridge	68mPD	~ 38m
Ting Kau Interchange, Mainline	Elevated ~85mPD	~ 38m
Ting Kau Interchange Ramps G and H	Elevated and in cuttings ~68mPD to ~85mPD	~ 13m

2.3 CONSTRUCTION PHASE

2.3.1 Construction Sites

Detailed specifications of the construction sites are not yet available and these will be finalised during the detailed design stage. It is envisaged that the work areas for the two interchanges will be located to either landfall. The area approximately from the middle of the northern Rambler Channel and northward towards Ting Kau will be used for the bridge's central support/breakwater, and nine support pylons. In addition, the reclamation at Penny's Bay on Lantau Island has been proposed as a works site for TKB. The site could be used for storage of bulk material and at time of construction, required material could be shipped to the construction site in Ting Kau/Tsing Yi.

The choice of construction method dictates the nature of work areas required. It is envisaged that the two areas at either landfall will be required for staff offices, workshops, a possible batching plant, and storage of plant and materials.

Depending on the method of construction chosen for both the interchanges and the bridge, there may be a need for a large area set aside for a precasting yard, preferably located near a sliproad to facilitate transport of the precast segments by road. The chosen site will need to accommodate large storage areas and a batching plant, as well as the casting beds themselves, and facilities for disposal of wash water and waste concrete.

The route itself will form a linear works site, with activities taking place on all sections at some stage of the programme. There will be major concentrations of activity at intersections where embankments, sliproads and flyovers are to be constructed.

Of concern to the TKB Study is the spoil arisings from Tai Lam Tunnel Southern Portal. As it would be unsuitable to transport the large amount of material estimated by road and the site is difficult to access, a conveyor system has been proposed. During Stage 1 Design the excess material was proposed to be transported to a barge loading area at Ting Kau to be loaded on barges and dumped at the Lantau Port Site.

The proposed, and more appropriate, location at this stage is Gemini Beach. The proposed conveyor system alignment is shown in Figure 2.1 and runs across the hill contours and ridges from the southern portal, across Tuen Mun Road on a temporary structure to the proposed barge loading area. At Gemini Beach a jetty will need to be constructed.

Upon completion, the conveyor corridor will have to be reinstated to replace disturbed vegetation. An environmental assessment of the conveyor system is being undertaken and will be presented as part of the TLT & YLA EIA.

2.3.2 Construction Traffic

Construction traffic has been assessed in terms of access traffic and the internal traffic between the main works area for each section and the works sites in use at any given time.

For the two sections northwest Tsing Yi and Ting Kau, the traffic volumes associated with the respective works will be forwarded to the consultants once they are finalised for inclusion into the Final TKB EIA.

As details of work area sites have not been finalized it is not possible to comment on arrangement for access and egress. However once the details are available, it will be recommended that access provided to work sites be designed to minimize traffic disturbance, noise to noise sensitive receivers (NSRs) and limit impacts on air quality.

2.3.3 Construction Programme

A review of the construction sequencing indicates that an overall duration of four years is required for the construction of the various components and the project as a whole. The programme shows construction taking place between January 1995 and December 1998, however these starting and finishing dates may be revised with the construction period remaining at approximately 4 years duration.

2.3.4 Construction Activities

The main construction activities fall into the following main categories:

- Excavation
- Foundation works
- Superstructure works (TKB)
- Road construction - at grade

Excavation

Three large scale excavations will be undertaken to enable the construction activities to take place. These three areas of operation will occur at:

- North West Tsing Yi - where a major excavation is required to prepare a platform for the construction of the second phase of the North West Tsing Yi Interchange.

  The large-scale bulk excavation and removal of rock and soft material from North West Tsing Yi is a straight-forward operation. The material will be transported by lorry via haul roads to an existing barge loading point at Ngau Kok Wan. The small volume of fill which is required to complete the platform for the interchange will be obtained from within the site. It has been assumed for the purposes of the estimate that the filling material for the breakwater and rock island will be transported from North West Tsing Yi.

- Ting Kau - a major excavation is required to allow construction of the Ting Kau Interchange and connections to Tuen Mun Road.

  While the major bulk excavation will comprise standard methods, the lack of suitable crossing points on the busy Tuen Mun Road and Castle Peak Road the large volumes involved and the extremely steep descent to the site of the proposed barge loading point effectively preclude the hauling of spoil by truck. It has, therefore, been assumed that the spoil will be transported via a fixed conveyor system to the barge loading point except for those volumes which are required to form an embankment in the valley immediately south of the Tunnel and any reclamation for the barge loading facility itself.

- Rambler Channel - where a breakwater and rock island are to be constructed in the centre of the channel to protect the TKB north tower and approach structure piers. Also an area on the north coast of the channel has to be reclaimed to protect the adjacent bridge pier and to provide a loading point for surplus material from the Ting Kau excavation. Work in these three areas will progress simultaneously. However, one of the first operations will involve the removal of marine mud from the sites of the breakwater, rock island and the sea wall of the reclamation. A stability analysis of the various structures has confirmed that the full depth of mud has to be dredged.

A recent proposal from EPD to reclassify the levels of contamination of heavy metals in marine mud could add significantly to the cost and timing of removing and disposing of the mud. However, for the purposes of this exercise, it has been assumed that grab dredgers will be used and the mud will be bottom-dumped at a nominated disposal site.

Foundation Works

It is envisaged that piling and pile cap works will be undertaken for the nine bridge supports. However details are not currently available.

Superstructure works (TKB)

Construction of the elevated TKB approach structure may involve the in-situ casting of bridge piers, or the use of precast sections and transported to the bridge site for erection.

Road Construction - At Grade

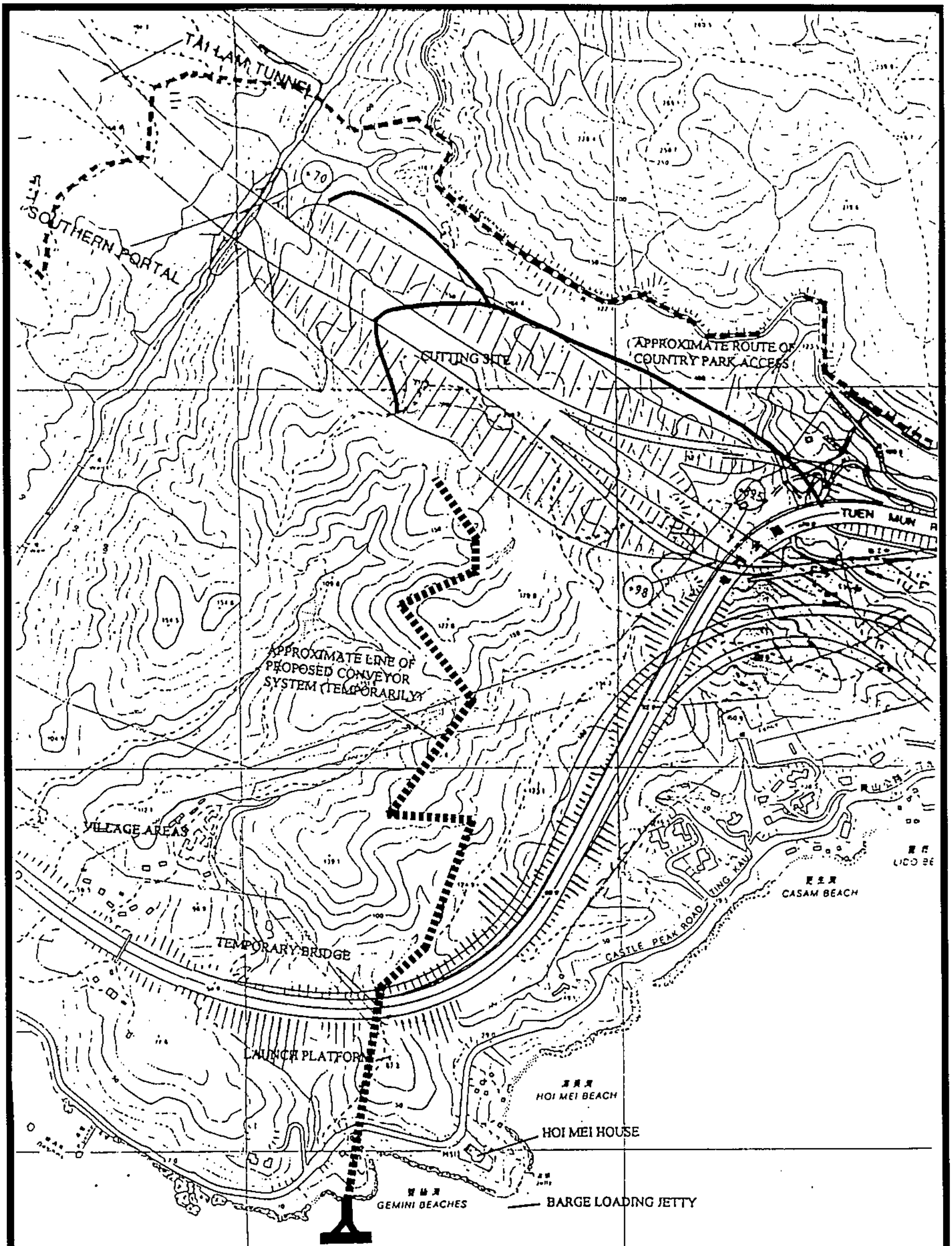
Following on from excavation activities, construction of at grade sections of the road involve forming a stable base from a series of layers of graded material. The material is placed and spread prior to being rolled by heavy plant. A bituminous surface is then layed by specialist plant and again rolled by heavy plant.

2.4 OPERATIONAL PHASE

In environmental terms, the main operational characteristics of the TKB and its associated interchanges that are of interest are traffic volumes and flows, which will result in noise and air quality impacts. Indicative traffic flows are shown in Figure 2.2. and 2.3.

The design speed for the Tsing Yi Interchange ramps A to E is 70km/hr, ramps F to J are 50km/hr, and at the Ting Kau Interchange the design speed of ramps G and H is 85km/hr.

The Bridge and interchanges are designed for free flow of traffic, with minimum braking and acceleration and no stopping except under extreme conditions. As traffic volumes increase approaching design capacity in 2011, it is anticipated that travelling speeds will fall.



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Job Title : ROUTE 3 TING KAU BRIDGE EIA	
Drg Title : PROPOSED CONVEYOR SYSTEM ALINGNMENT	
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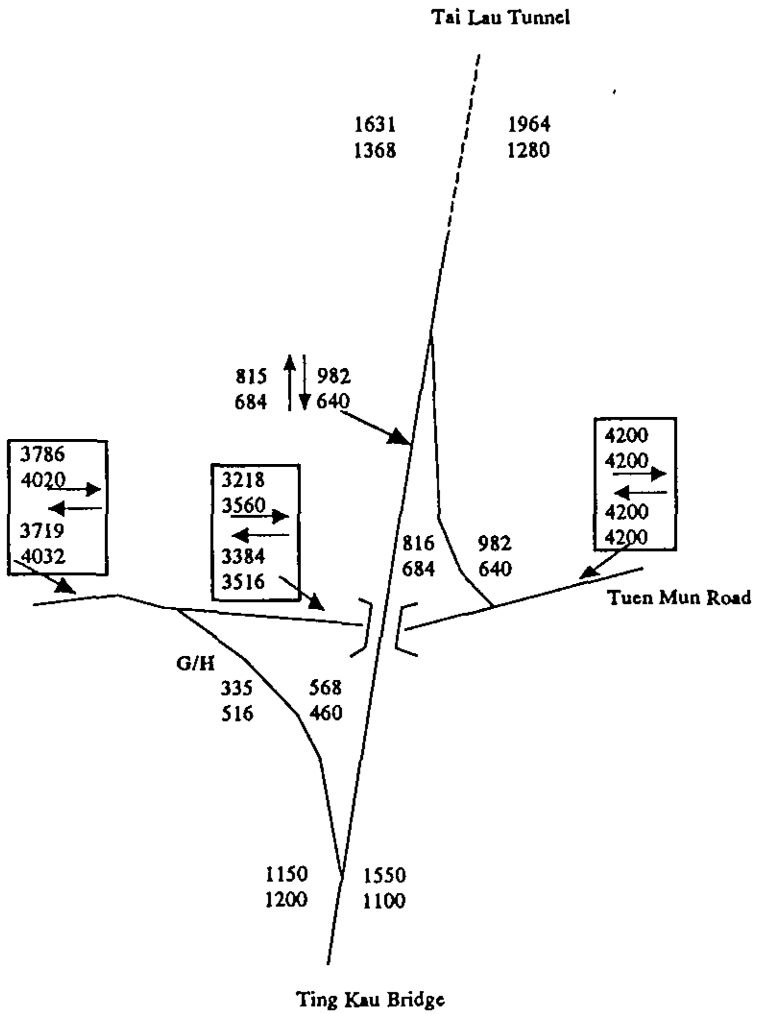
Date : Nov. 93	Fig. No. 2.1



Note:
1. Traffic flows supplied by Transport Department (converted from p.c.u to veh/hr by applying a factor of 1.65).

2. Flows on I/J, C/D and G/H are Freeman Fox Maunsell interpretation of Transport Department flows.

3. Saturation flow assumed on Tuen Mun Road.

FREEMAN FOX MAUNSELL	Drg. Title : TRAFFIC FLOWS 2001 AM/PM	Job Title : ROUTE 3 TING KAU BRIDGE EIA	
		Scale : NTS Date July 1993	Job No. 058000
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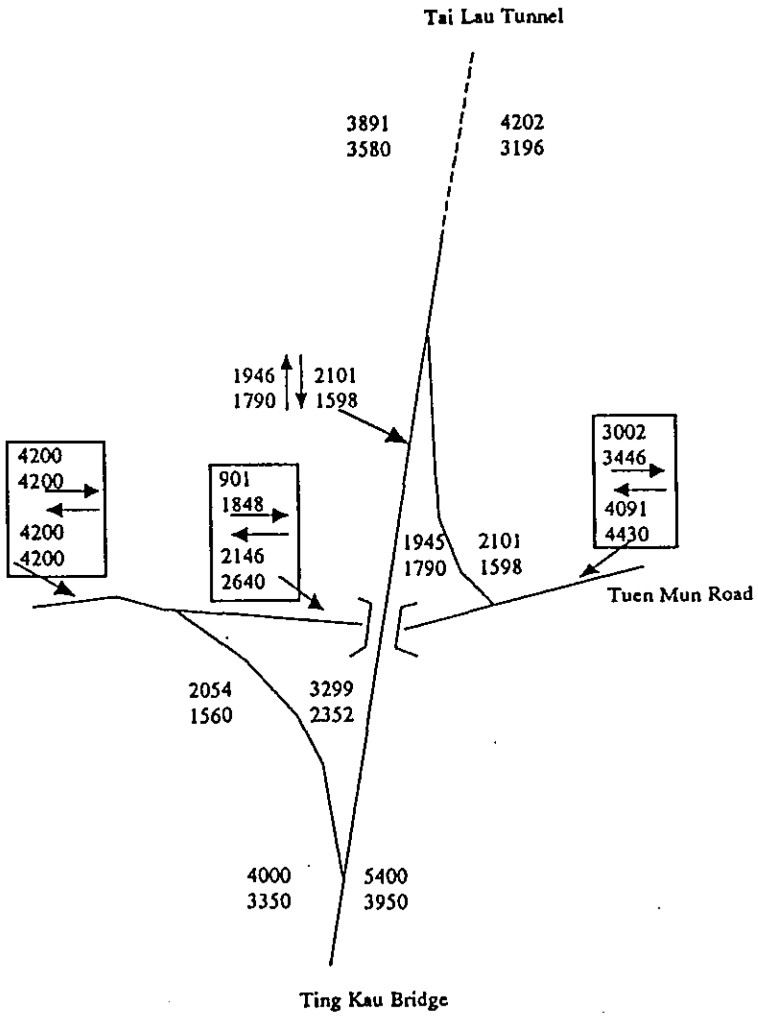

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FREEMAN FOX MAUNSELL	Drg. Title : TRAFFIC FLOWS 2011 AM/PM	Job Title : ROUTE 3 TING KAU BRIDGE EIA
		Scale : NTS; Date July 1993; Job No. 058000; Fig. No. 2.3

EXISTING ENVIRONMENT

CHAPTER 3

3 EXISTING ENVIRONMENT

3.1 INTRODUCTION

In order to provide a baseline against which to assess the potential environmental impacts of the TKB Section of Route 3 CPS, site surveys have been undertaken together with reviews of aerial photographs, maps, existing data and reports.

Route 3 is divided into two sections, Ting Kau Bridge and the Country Park. The boundary between these sections is at Tuen Mun Road with ramp G and H included in the TKB Section (Figure 1.1). The TKB study area therefore includes the north-west part of Tsing Yi Island, northern Rambler Channel and the coastal strip on the mainland at Ting Kau (Figure 1.2). On the mainland, work will be carried out along Tuen Mun Road, from Ho Mei Beach to Ting Kau Beach.

Three main areas that form the TKB Section have been identified and are described in this Chapter, (Tsing Yi, northern Rambler Channel and Ting Kau). Specific characteristics of the existing environment are described in Chapters 4-12.

3.2 GENERAL DESCRIPTION OF THE STUDY AREA

3.2.1 North West Tsing Yi

The north west of Tsing Yi Island, comprises steeply sloping hillsides rising abruptly from the coastline to a number of peaks, of which the highest is 218 m along the main ridge line. The vegetation cover is mainly sparse grassland mixed with some scrub species. The hills are visible from a number of residential areas both on Tsing Yi and the mainland due to their significant height. The natural drainage consists of a number of minor, seasonal water courses on the broadly flat slopes.

There is no residential development on this part of Tsing Yi but the rest of the island has been quite intensively developed for both residential and industrial purposes. Housing is mainly located to the east of the island.

Industrial development within the study area is concentrated along the coastal margin to the west and north of Tsing Yi Reclamation, and major cuttings have taken place to accommodate the industrial development which consists mainly of docking, storage and reclamation facilities. The industrial area is served by an access road along the coastline. The CRA1, part of Route 3, is presently under construction with borrow activities taking place on the western slopes of Tsing Yi. This will extend the vehicular access to the coastal industrial area.

Access to the proposed study area is at present extremely limited. There are a number of footpaths along the main ridge line leading to grave sites on the hills. The grave sites are mainly situated to the east of the study area and will not be affected by the proposed development.

3.2.2 Northern Rambler Channel

The proposed TKB links Tsing Yi Island and the mainland over Rambler Channel. Northern Rambler Channel carries a considerable amount of marine traffic which is mainly related to recreational facilities associated with beaches along the coast, and transport to the public cargo working areas in the central part of the channel. Most of the heavy marine traffic will use the shipping channel between Tsing Yi and Ma Wan Island and will not affect the northern Rambler Channel and TKB unless in cases of emergency or typhoons. A Dangerous Goods Anchorage (DGA) is presently situated in Rambler Channel south of Tsuen Wan. As this area is to be reclaimed it has been proposed that the DGA is to be moved to beneath TKB behind the breakwater. The consequence of this move will be further addressed in Chapter 12 Risk Appraisal.

3.2.3 Ting Kau

The study area on the mainland at Ting Kau encompasses the hillsides and costal areas between Tuen Mun Road in the north and the southern coast line. Between Castle Peak Road and Tuen Mun Road there is an undeveloped area with a slow rising hillside towards a peak at approximately 130 m. In this area there are a few footpaths crossing over the hill, which are mainly used for local recreation.

From Tuen Mun Road the hills and natural countryside rise northwards towards the Tai Lam Country Park to a peak at approximately 260 m. The hills are steep with quite deeply incised valleys. Vegetation in the areas that are not developed are composed primarily of scrub and stands of mature trees, creating a green view of the hillside.

The settlement pattern is dispersed, with a mixture of high-rise and low-rise development along the coast. The development at present is not dense, but new residential blocks are being built along the Castle Peak Road towards Tsuen Wan. From the settlements there are footpaths leading down to the beaches all along the coast at Approach, Ting Kau, Lido, Casam, Hoi Mei and Gemini. There is no major industrial development within this part of the study area.

The traffic in the area is primarily local, serving the residential development. The road network consists of Tuen Mun Road (between Tsuen Wan and Tuen Mun) and Castle Peak Road, being the original link between the settlements along the coast.

There is no access available from the Tuen Mun Road to the settlement at Ting Kau. Despite this the highway constitutes a major structure within the study area. The proposed interchange over Tuen Mun Road will have a significant impact on the road network in this area.

3.3 EXISTING AND COMMITTED IMPACT SOURCES

Existing and committed impact sources have been identified in relation to their effect on the existing environment and the Ting Kau Bridge development. Potential impact sources are identified and outlined below and their locations shown in Figure 3.1. Sources in adjacent areas have been included if it is considered that they may have an impact on the environment in the study area. The existing and committed impact sources are summarised in Table 3.1.

3.3.1 Noise

The main impact source is the traffic generated in Ting Kau. The housing along the coast is mainly affected by the traffic on Castle Peak Road, which serves all residential areas along the coast from Ting Kau to Sham Tseng and the west. Tuen Mun Road is heavily used but is relatively distant from residential areas.

Noise impact sources on Tsing Yi are mainly related to the industry along the north and west coastal strips, traffic serving these sites and the progressive earthworks for the proposed CRA1. As the construction of the bridge from Tsing Yi to Ma Wan proceeds, together with CRA1, this will increase the noise impact on the study area.

An area in Penny's Bay on Lantau Island has been proposed as a working area for Route 3. Activities on this site may have an impact on SRs in the area mainly concerning noise, air quality and water quality. However such impacts should be viewed in context of the changing nature of the area, resulting from the development of Lantau Port and Western Harbour. The Tuen Mun Road widening project will potentially cause impact on the noise levels, air quality and visual aspects in the study area. The project will require access from Castle Peak Road up the valley to the highway and it will not be possible to avoid disturbance during the construction period. In addition the proposed LFC may have an adverse effect on the noise levels in the area, particularly during the construction phase.

3.3.2 Air Quality

As there is only light industry in the area the main impact source on the air quality is the traffic. As the construction on Tsing Yi and Ting Kau proceeds, the quality of air will be affected by dust and vehicle emissions. Due to the south east prevailing wind in the area the traffic on Tuen Mun Road may affect the residential development along the coast. Construction of CRA1, the proposed LFC and the Tuen Mun Road widening project may have an adverse effect on the air quality in the area.

3.3.3 Water Quality

A major source of impact on the existing water quality in Hong Kong is the Pearl River, which delivers significant quantities of sediments and industrial effluent to local marine waters. No major industrial discharge presently has an outfall in the northern area of the Rambler Channel and there is only light industry on Tsing Yi. However, run-off from work areas on Tsing Yi contribute to some extent to the deterioration of water quality in Rambler Channel. A potential water quality impact source is the San Miguel brewery which is situated to the east of the proposed TKB. There are a number of outfalls along the coast from Sham Tseng to Tsuen Wan including a nullah outfall at Lido beach, these discharges are polluted as they receive sewage from unsewered local villages and squatter housing.

Although it is located outside the study area, the fish culture zone on Ma Wan may affect the water quality due to emissions such as fish excrement and excess food material.

3.3.4 Risk Aspect

A possible source of impact is the prospect of a ship colliding with any of the bridge piers or the breakwater. The proposed transfer of the DGA from Tsuen Wan in 1995 to TKB is also considered a potential impact source.

Table 3.1 Key Existing and Committed Impact Sources

ELEMENT		IMPACT CATEGORY					
		NOISE	AIR	WATER	VISUAL	WASTE	RISK
1.	Ting Kau Traffic	X	X				X
2.	Construction on Tsing Yi	X	X	X	X	X	
3.	Pearl River			X			
4.	San Miguel Brewery			X			
5.	Storm Water Outfalls			X			
6.	Fish Culture Zone on Ma Wan			X			
7.	Lantau Fixed Crossing	X	X		X		
8.	Penny's Bay Work Area	X	X	X			
9.	Widening of Tuen Mun Road	X	X		X		
10.	DGA						X

Note: X = potential impact an existing environmental quality

3.4 KEY EXISTING AND COMMITTED SENSITIVE RECEIVERS

Key existing SRs within and adjacent to the study area have been identified in relation to their susceptibility to noise, air quality, industry, cultural, recreational, ecological, visual and livelihood aspects. The SRs are listed below and include:

- Rambler Channel
- Residential development in Ting Kau
- The gazetted beaches along Rambler Channel and on Ma Wan
- Fish culture zone on Ma Wan
- Temple on Lido Beach

Further details of the SRs are presented in the appropriate Chapters. The location of the SRs are shown in Figure 3.2.

3.5 ENVIRONMENTAL QUALITY

3.5.1 Air Quality

Baseline air quality monitoring was carried out as part of the Stage 1 studies in 1990, measuring variations in particulate and gaseous pollutants at a number of different locations in the study area. The results from the study indicated that the levels for the measured parameters do not exceed the Hong Kong Air Quality Objectives (AQO). Even when taking into account the prevailing south east wind, the SRs are not subject to unacceptable air quality levels.

3.5.2 Noise

A baseline noise survey was carried out during April and May 1993 to determine background noise levels in the area. A Stage 1 survey has been reviewed to supplement the measured data and to establish an overall picture of the noise levels in the area. The area is characterized by it's quiet nature with low background levels (in the region of 50-55 dB(A)). The only significant noise sources are from the road traffic on Castle Peak Road and Tuen Mun Road.

3.5.3 Water Quality

Discharges into marine and inshore waters in Hong Kong are required to be within the limits set in the Technical Memorandum (Standards for Effluent Discharged into Drainage and Sewage Systems, Inland and Coastal Waters, EPD, 1991). The study area is situated within the Western Buffer Water Control Zone, which has recently been implemented. This means that the WQO have been confirmed for this zone and must be adhered to.

Discharges from Tsing Yi and north of Tuen Mun Road into Rambler Channel and the sea from small watercourses are generally clean and silt free. There is usually little flow in these streams, with the exception of extraordinary weather conditions, and they do not run through any heavy industrial areas. However, there are outfalls into Rambler Channel that are polluted by squatter areas and unsewered development.

A water quality monitoring station is located in Tsuen Wan bay to the east of the study area where monthly water sampling is carried out by EPD. The marine waters in western Hong Kong are greatly effected by the Pearl River which carries significant levels of pollutants. The pollution of marine waters is a very real problem in Hong Kong, with waters suffering from severe nutrient enrichment, high bacteriological content and red tides.

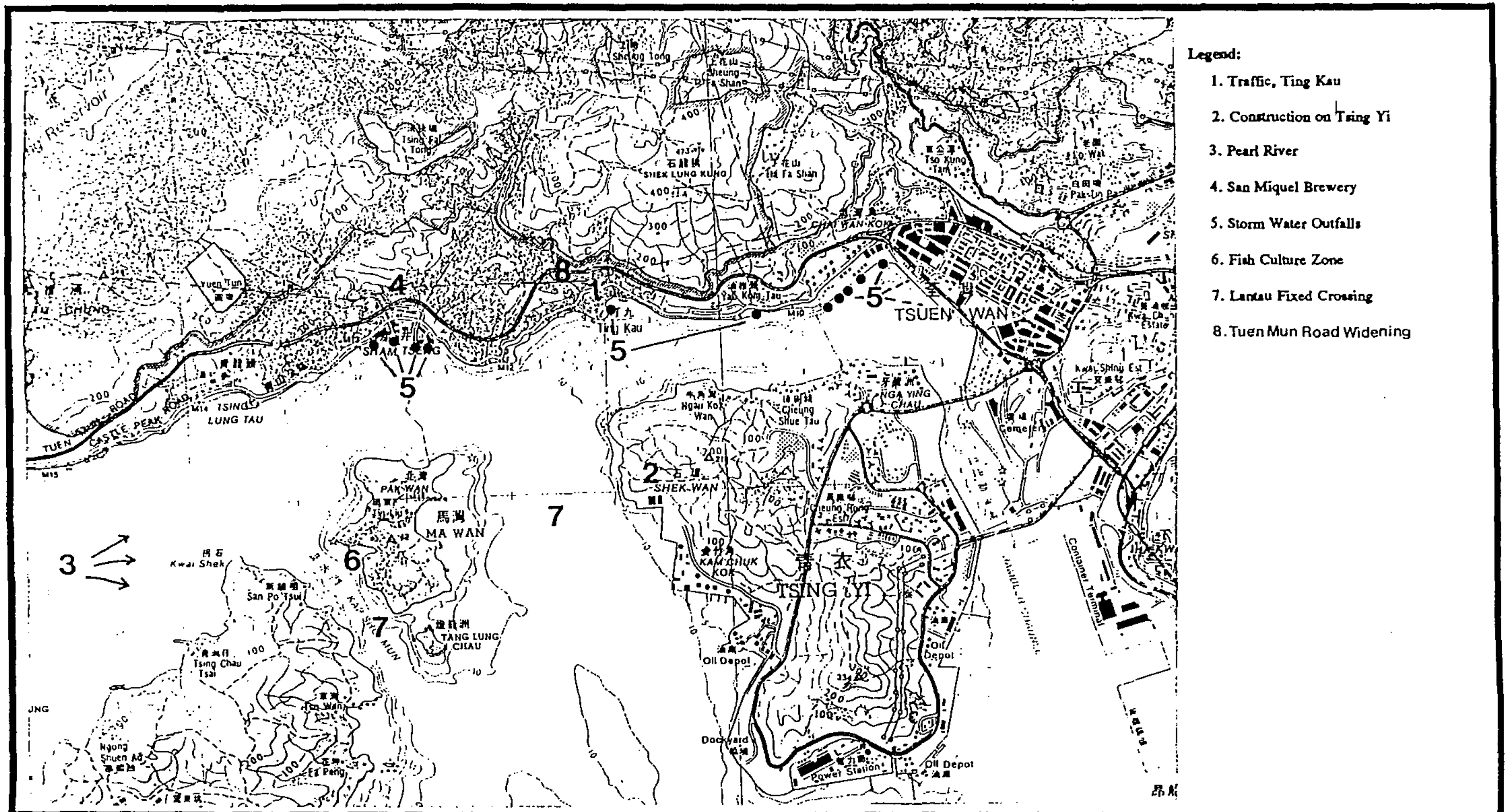
There are a number of gazetted beaches along Rambler Channel and one on Ma Wan that are within or adjacent to the study area (all within the Tsuen Wan District).

In the government publication "Bacteriological Water Quality of Bathing Beaches in Hong Kong" (EPD, 1991, 1992) beaches are ranked *"good"*, *"fair"*, *"poor"* or *"very poor"* depending on *E.coli* level in the water. No beaches in the area are ranked *"good"* in the report for 1992, but Casam and Lido beaches on the mainland and Tung Wan on Ma Wan are ranked as *"fair"*. Gemini beach been downgraded from being *"fair"* (1992) to *"poor"* (1993). Further, Approach, Ho Mei Wai, Angler's and Ting Kau beaches are ranked as *"poor"* and are unsuitable for swimming. The bacteriological water quality appears to have deteriorated in 1992/1993 compared with levels in 1990 and 1991.

3.5.4 Sediment Quality

Sediment quality within the study area has been established with reference to EPD's routine sampling and analysis programme, the "Contaminated Spoil Management Study" (Mott MacDonald 1991) and investigations for Route 3 Design Stage 1 and 2. The sediments in Rambler Channel are among the most contaminated areas in Hong Kong, contaminated with heavy metals as well as other pollutants such as nitrogen, phosphorous and hydrocarbons.

In the Contaminated Spoil Management Study a classification of mud was established to provide guidelines concerning dredging and disposal of dredged mud. In most locations sampled the sediments in Rambler Channel fall within Category C. Category C defines the mud as seriously contaminated, and must be dredged, transported and disposed of using special precautions. It cannot be dumped in the gazetted marine disposal grounds and must be effectively isolated from the environment upon final disposal.



FREEMAN FOX MAUNSELL

Drg. Title :

EXISTING AND COMMITTED IMPACT SOURCES

Job Title :

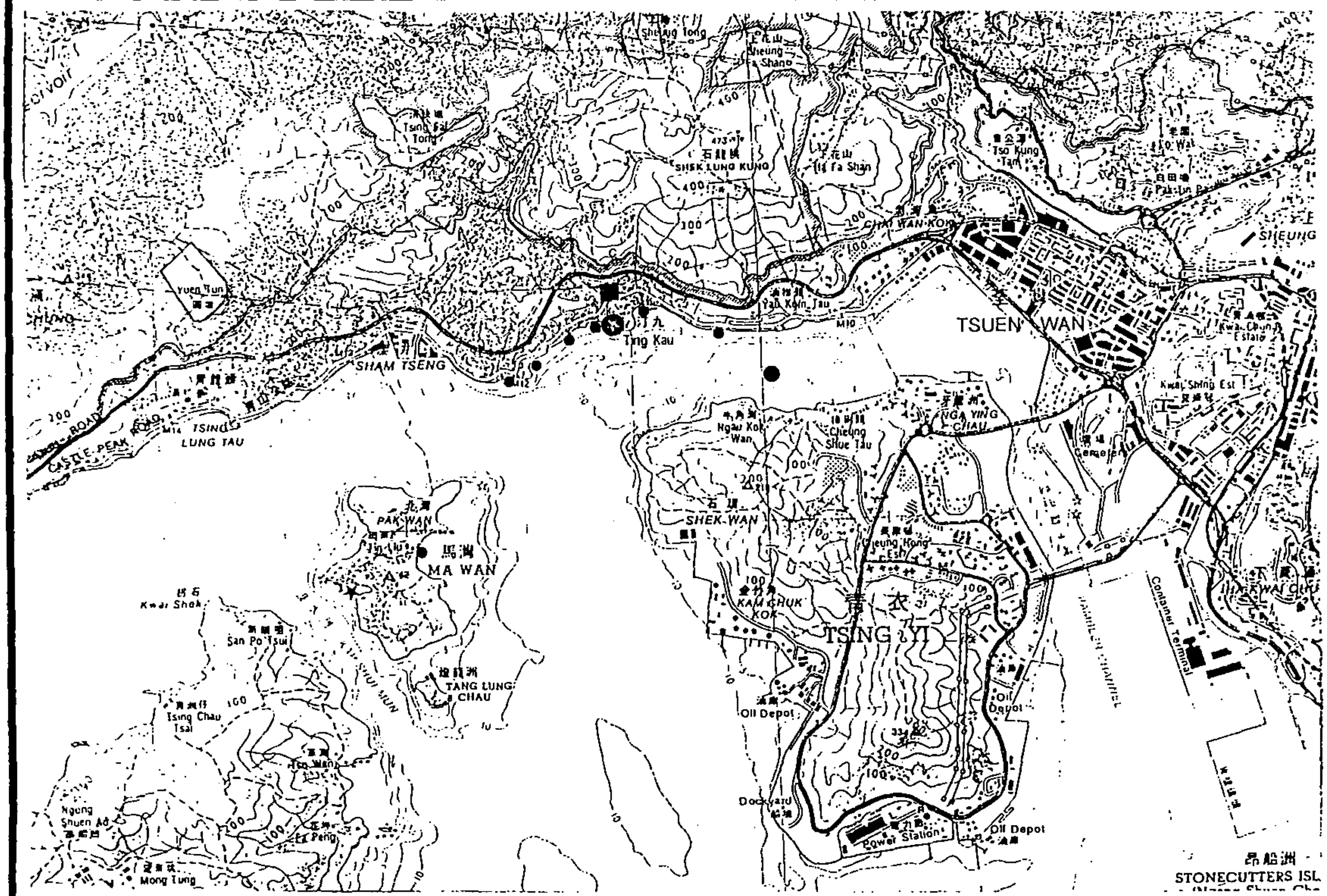
ROUTE 3 TING KAU BRIDGE EIA

Scale : 1:50 000

Date July 1993

Job No. 058000

Fig. No. 3.1



Legend:

- ● Rambler Channel
- ■ Residential Development in Ting Kau
- • Gazetted Beaches
- ✶ Fish Culture Zone
- ✪ Temple on Lido Beach

FREEMAN FOX MAUNSELL	Drg. Title : EXISTING SENSITIVE RECEIVERS	Job Title : ROUTE 3 TING KAU BRIDGE EIA
		Scale 1:50 000 / Date July 1993	Job No. 058000	Fig. No. 3.2

AIR QUALITY

CHAPTER 4

4. AIR QUALITY

4.1. INTRODUCTION

4.1.1 Study Area

The Study Area of the EIA covers the North West Tsing Yi Interchange, the Ting Kau Bridge and the Ting Kau Interchange. Ramps C and D are part of the Route 3 CPS, TLT & YLA area, which is examined in a separate EIA.

The operational air quality impact assessment has examined the effect of traffic on Route 3 CPS, starting from the point at which Ramps C, I and J join Route 3 CPS on Tsing Yi Island, and extending to the southern Tai Lam Tunnel portal.

Air quality impacts due to traffic on Ramps C, D, G and H (connecting Route 3 CPS with Tuen Mun Road), and on Tuen Mun Road for distances of approximately 1 km in both directions, have also been included.

The construction air quality impact assessment has examined the effects of earthworks, aggregate handling and storage, and traffic on unpaved haul roads. Dust-generating construction works are expected to extend over a large platform area on northwest Tsing Yi Island, an unpaved haul road between this site and Ngau Kok Wan, two areas of reclamation associated with the bridge, and along the alignments and landscaped areas associated with Route 3 CPS and its ramps in Ting Kau.

4.1.2 Existing Environment

Ting Kau Bridge: Southern Landfall

The southern TKB landfall is at northwest Tsing Yi Island. There is no residential development on this part of Tsing Yi, though there are some shipyards and storage facilities over 1 km to the east of the TKB landfall.

No baseline air quality measurements are available from this site; due to Route 3 CPS construction activities currently taking place, monitoring cannot now be performed. However, baseline air quality monitoring was conducted from 14 September to 11 October 1990 at the roof top of Ching Pak House, Cheung Ching Estate (Tsing Yi Island). Ambient concentrations of nitrogen oxide (NO), nitrogen oxides (NO_x), Total Suspended Particulates (TSP) and Respirable Suspended Particulates (RSP) were monitored, and are shown in Table 4.1. This assessment has used the mean concentration value to represent background pollutant levels in the study area.

TABLE 4.1 MONITORED POLLUTANT CONCENTRATIONS

Cheung Ching Estate, Tsing Yi Island September-October 1990

Pollutant	Pollutant Concentration ($\mu g/m^3$)		
	Mean	Hourly Maximum	Maximum 24-hr Average
Nitrogen Dioxide (NO_2)	39	132	64
Total Suspended Particulates (TSP)	72	--	108
Respirable Suspended Particulates (RSP)	34	--	52

Source: *Route 3 Technical Report No. 19: Environmental Impact Assessment (Draft)* (SPHW, November 1990), quoted in Table 4.1, *Route 3 Country Park Section and Ting Kau Bridge, Preliminary Design Stage 2: Initial Environmental Assessment* (Freeman Fox Maunsell, 1993).

Ting Kau Bridge: Northern Landfall

Route 3 CPS crosses the Rambler Channel via a 420m long cable stayed bridge. The height of the bridge deck reaches approximately 68 mPD. At Ting Kau, the bridge passes over reclamation and shoreline, then travels inland for about 700m on a viaduct.

The area over which the Route 3 CPS viaduct passes is characterised by residential development, and includes Tuen Mun Road and Castle Peak Road. There is no significant industrial development in the area.

The background air quality conditions monitored at Cheung Ching Estate (Table 4.1 above) are used as an indication of background air quality at Ting Kau.

4.2 AIR QUALITY ASSESSMENT: OPERATION PHASE

4.2.1 Assessment Criteria

The Hong Kong Air Quality Objectives stipulate maximum acceptable concentrations of pollutants in air. These concentrations are shown in Table 4.2.

TABLE 4.2 HONG KONG AIR QUALITY OBJECTIVES

POLLUTANT	Concentration ($\mu g/m^3$)	
	1 hour$_1$	24 hours$_2$
Total Suspended Particulates (TSP)	---	260
Respirable Suspended Particulates (RSP)	---	180
Nitrogen Dioxide (NO_2)	300	150

NOTES:
- Concentrations measured at 298°K (25°C) and 101.325 kPa.
- 1 One-hour criteria not to be exceeded more than three times per year.
- 2 24-hour criteria not to be exceeded more than once per year.

4.2.2 Assessment Methodology

Maximum one-hour concentrations of NO_2 and RSP have been predicted using CALINE4. Gases have been assumed to be inert, and concentrations of NO_2 have been taken as 20 percent of the total NO_x concentration. Since the elevation of Route 3 CPS (most of which is on bridge and viaduct) and Tuen Mun Road varies between about 50 and 90 mPD, a contour elevation of 50 mPD has been selected to represent ground level. The choice of this elevation reflects a limitation of the CALINE4 Model, which accepts source heights between 10 m above and 10 m below ground level; since receiver heights must be positive, and Route 3 CPS is elevated over the study area, the assessment elevation of 50 mPD has been chosen. Pollution concentrations below 50 mPD are expected to decrease, since road elevations are higher. The following input parameters to CALINE4 were used:

Wind Speed	2 m/s
Wind Direction	worst case
Wind Direction Variation	11.5 degrees
Stability Class	D
Mixing Height	500 m
Temperature	25 degrees C

The assessment has been based on future fleet average emission factors for NO_x and particulates; these factors are derived from the FTP 75 standard (for passenger cars, taxis, and 2.5 ton vans) and the US Transient 88 standard (for goods vehicles).

The assessment has been based on morning peak hour flows for the years 2001 and 2011 on the Ting Kau Bridge, its associated slip roads, and the Tuen Mun Road. Traffic flows are provided in Appendix A2.

It should be noted that the flows used were based on traffic volumes for the major links supplied by Transport Department. As they were unable to provide detailed link flows, nor for Tuen Mun Road, it was necessary to make some assumptions on those link flows based on certain links being saturated, at the suggestion of TD. These traffic flows were generally thought to be conservative and should indicate the maximum provision of mitigation measures. We suggest the level of mitigation required must be examined in more detail based on potential franchisees predicted traffic levels, at detailed design stage.

4.2.3 Impact Assessment

Four contours showing future impacts from NO_2 and RSP in years 2001 and 2011 are provided in Figures 4.1 to 4.4. The hourly pollution contours include assumed background pollutant concentrations (taken as the mean concentrations recorded at Ching Pak House).

Assessed against the AQO maximum concentration of 300 $\mu g/m^3$ for NO_2, it is anticipated that future pollutant levels very close to Tuen Mun Road will approach this concentration in the year 2001. However, sensitive receivers are not expected in such close proximity to the roadway. Along the Route 3 CPS alignment, NO_2 concentrations are expected to remain well within AQO criteria.

In the year 2011, traffic along Tuen Mun Road decreases from 2001 levels, and the NO_2 levels decline as a result. However, increasing traffic flows on Route 3 raise the NO_2 levels by the bridge and viaduct so that they meet the AQO maximum concentration of 300 $\mu g/m^3$ in close proximity to the road deck. However, the presence of a future sensitive facade in such close proximity to the viaduct is not expected.

RSP concentrations in the year 2001 are expected to exceed the AQO maximum close to Tuen Mun Road, but not in the area of the Ting Kau Bridge deck.

In 2011, increasing traffic along Route 3 CPS brings about an increase in RSP concentrations along the bridge deck. The maximum 1-hour RSP concentration is expected to reach the AQO 24-hour maximum around the level of the bridge deck, but there is no corresponding AQO 1-hour maximum against which to assess this finding. Pollution levels at ground level will be less than those at the elevation shown in Figure 4.3 and 4.4.

Areas along the shore at Ting Kau Beach, Lido Beach and Casam Beach are not expected to experience excessive pollution levels due to traffic on Route 3 CPS and Tuen Mun Road.

4.2.4 Mitigation Measures

Pollution levels immediately adjacent to both Route 3 and Tuen Mun Road are expected to be high, but only those sensitive receivers near Tuen Mun Road, which are at approximately the same elevation as the nearby road, are expected to potentially experience unacceptably high pollution levels, particularly in 2001. Reduced traffic flows along Tuen Mun Road in 2011 should reduce pollution levels along that road. Since Route 3 CPS is built on viaduct, receivers at ground level are not expected to be subjected to unacceptable pollution levels from traffic on the Ting Kau Bridge section; therefore the need for mitigation measures is not anticipated. Nevertheless, future governmental action may bring about mitigation by reducing emission levels from individual vehicles. In 1995, a standard for vehicle diesel fuel will be introduced to limit its pollution (especially particulate) potential. Automotive emission standards will also be tightened in 1995; currently, all newly-imported small vehicles require pollution controls (such as catalytic converters) to comply with the revised standards. A more stringent vehicle inspection and maintenance programme for commercial vehicles is being considered.

4.3 AIR QUALITY ASSESSMENT: CONSTRUCTION PHASE

4.3.1 Introduction

Works Area

The works area for construction activities associated with the north Tsing Yi Interchange will be located near the TKB landfall. The works area will house staff offices, workshops, a concrete batching plant, and storage facilities for plant and materials, including an aggregate stockpile. This assessment has assumed that the aggregate is delivered to the site by barge, unloading at Ngau Kok Wan.

Construction Programme

Construction is expected to take four years. Currently, the construction programme is anticipated to start in January 1995, though this date is subject to change.

Construction Activities

Three large-scale excavations are planned, which will be conducted simultaneously:

Northwest Tsing Yi Island

A platform will be made for construction of the second phase of the NW Tsing Yi Interchange. The works will entail large-scale bulk excavation and removal of rock and soft material, which will be transported via a haul road to barges at Ngau Kok Wan. This study has assumed that the haul road is unpaved but gravelled. The small volume of fill which is required to complete the platform for the interchange will be obtained from within the site.

Ting Kau

Similar earthworks are required for construction of the Ting Kau Interchange. This will involve major bulk excavation using standard methods. Further, the areas associated with Ramps G and H will require significant landscape works. Excavated material from the cutting (in the TLT & YLA Section) south of the Tai Lam Tunnel Portal, will be transported to a loading point at tne Gemini Beaches via a fixed conveyor system. It has been assumed that the conveyor system is provided with a cover to prevent spillage of the spoil during transport.

Rambler Channel

A breakwater and rock island are to be built around the central bridge support. Fill material will be transported by barge from the excavation at Northwest Tsing Yi. At Ting Kau, east of Lido Beach, an area of reclamation is planned which will provide for a bridge support pylon. This reclamation will be formed using excavation spoils brought to the area by barge.

The Ting Kau Bridge superstructure will be built using pre-cast or cast-in-situ members. A significant amount of construction dust is not expected to result from this operation.

The Route 3 CPS viaduct in Ting Kau will be built on concrete piles. The piles will be bored, and concrete will be delivered to the site in lorry mixers. Ramps G and H will similarly use ready-mix concrete and bored piles. Some earth cutting will be required for these ramps, involving the use of excavators and rock drills.

Dust will be emitted during earthworks and formation of the viaduct foundations. Other minor sources which are unlikely to have a significant impact on air quality include asphalt emissions during laying of the road surface, and exhaust emissions from powered mechanical equipment.

The impact of fugitive dust depends on its quantity and drift potential. Large particles tend to settle out near the source, creating a local nuisance, while smaller particles are dispersed further from the source. The distance that particles will drift is determined by their injection height, terminal settling velocity, and the degree of atmospheric turbulence.

4.3.2 Assessment Criteria

For construction dust, EPD's maximum acceptable TSP level in air over a one-hour period is 500 $\mu g/m^3$. The maximum acceptable TSP concentration averaged over a 24-hour period is shown in Table 2 above, and is 260 $\mu g/m^3$.

4.3.3 Assessment Methodology

Construction Phase Air Quality Modelling

One-hour and 24-hour average concentrations of TSP have been calculated using the Fugitive Dust Model (FDM). Dust sources (including the haul road) have been modelled as area sources, with area size, location, dust generation and density provided as inputs. Emission factors from the US EPA publication *Compilation of Air Pollutant Emission Factors (AP-42)* have been used and are given in Appendix A3, along with weather data from 1992 from the Royal Observatory's Tuen Mun Station.

Given the rate of dust generation, the impacts on the air quality at sensitive receivers will depend primarily on the settling rates of the particulates under both calm and windy conditions. Particles with size greater than 30 microns tend to settle out within a few metres of the source under typical wind conditions; smaller particles have much slower rates of settling, and are therefore more affected by wind turbulence. A category of particle size (0 to 30 microns) with a particle density of 2500 kg/m^3 has been assumed.

In the absence of a well-defined construction programme at this stage of the assessment, it has been assumed that construction is proceeding simultaneously at all sites associated with the Ting Kau Bridge section of Route 3 CPS.

4.3.4 Impact Assessment

The results of air quality modelling to determine 1-hour and 24-hour construction dust concentrations at ground level are shown in Figures 4.5 and 4.6.

Due to the size of the construction sites and the number of assumed concurrent construction activities, adverse air quality impacts (exceeding the desirable limit of 500 $\mu g/m^3$) are expected at nearby sensitive receivers. Both the 1-hour and 24-hour desirable maxima are expected to be exceeded at receivers in Ting Kau. However, in reality all of the sites will not be undertaking the same activities concurrently and construction dust generation is amenable to mitigation measures, such as those discussed in Section 4.3.5 below.

Although background dust levels reflecting mean 1990 dust concentrations nearby have been incorporated into the assessment, the cumulative effects of other large construction projects in the area (such as CRA1, Lantau Fixed Crossing, and Tuen Mun Road widening) are not included, and will further degrade air quality.

4.3.5 Mitigation Measures

The control of dust during earthworks is commonly achieved by wetting or covering exposed earth. Watering is the most common dust control method for exposed site surface, but its effectiveness depends on the degree of coverage and the frequency of application. Effective water sprays should be used during delivery and handling of fill when dust is likely to escape. The effectiveness of wetting can be prolonged by the use of wetting agents that agglomerate dust particles; however, the use of chemical wetting agents may have adverse effects on plants and animals exposed to contaminated runoff.

To help control dust generated by the transport of soil by dumptruck, materials with the potential to create dust should not be loaded to a level higher than the side and tail boards, and should be dampened and covered before transport. Dust levels can be further reduced by providing a gravel surface (assumed for this assessment) or a temporary sealed surface on the haul road.

As has been assumed in this assessment, the conveyor system which will be installed as part of the TLT & YLA Section works to remove excavation spoils should be covered. This will prevent accidental spilling of the moving load, and will help to minimise windborne losses. At both ends of the conveyor system, measures should be taken to minimise losses during handling. Wetting and the use of windbreaks near loading, unloading, and transfer points are recommended. Alternatively, if these points can be confined in a shed, a baghouse filter may be used to filter dust during transfer or loading.

The calculated dust concentrations are the worst case situation only. With appropriate control measures, it is expected that the dust standards could be met. Dust control measures should be incorporated in the contract documents. These control measures should be agreed with EPD.

4.3.6 Monitoring and Audit Requirements

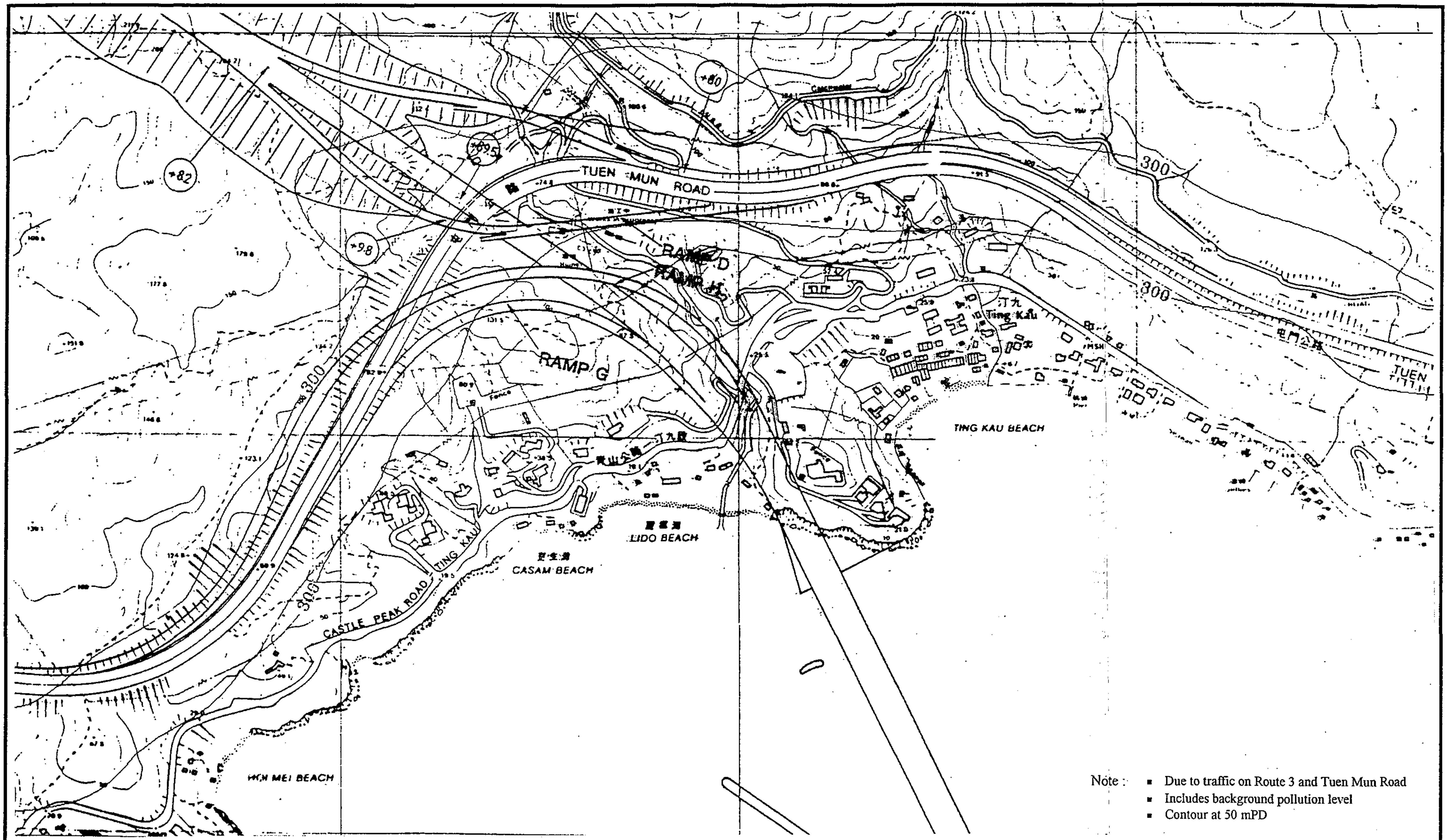
The objective of a monitoring and audit programme is to identify as early as possible a deterioration in air quality due to construction dust, and enact measures to reduce its impact. Outline monitoring and audit schedules and essential action plans are presented in Chapter 13.

4.4 CONCLUSIONS

Operational air quality has been assessed using CALINE4 to predict NO_2 and RSP pollution concentrations in 2001 and 2011. The assessment has been based on expected traffic flows along Route 3 CPS and Tuen Mun Road, and has included background pollution levels.

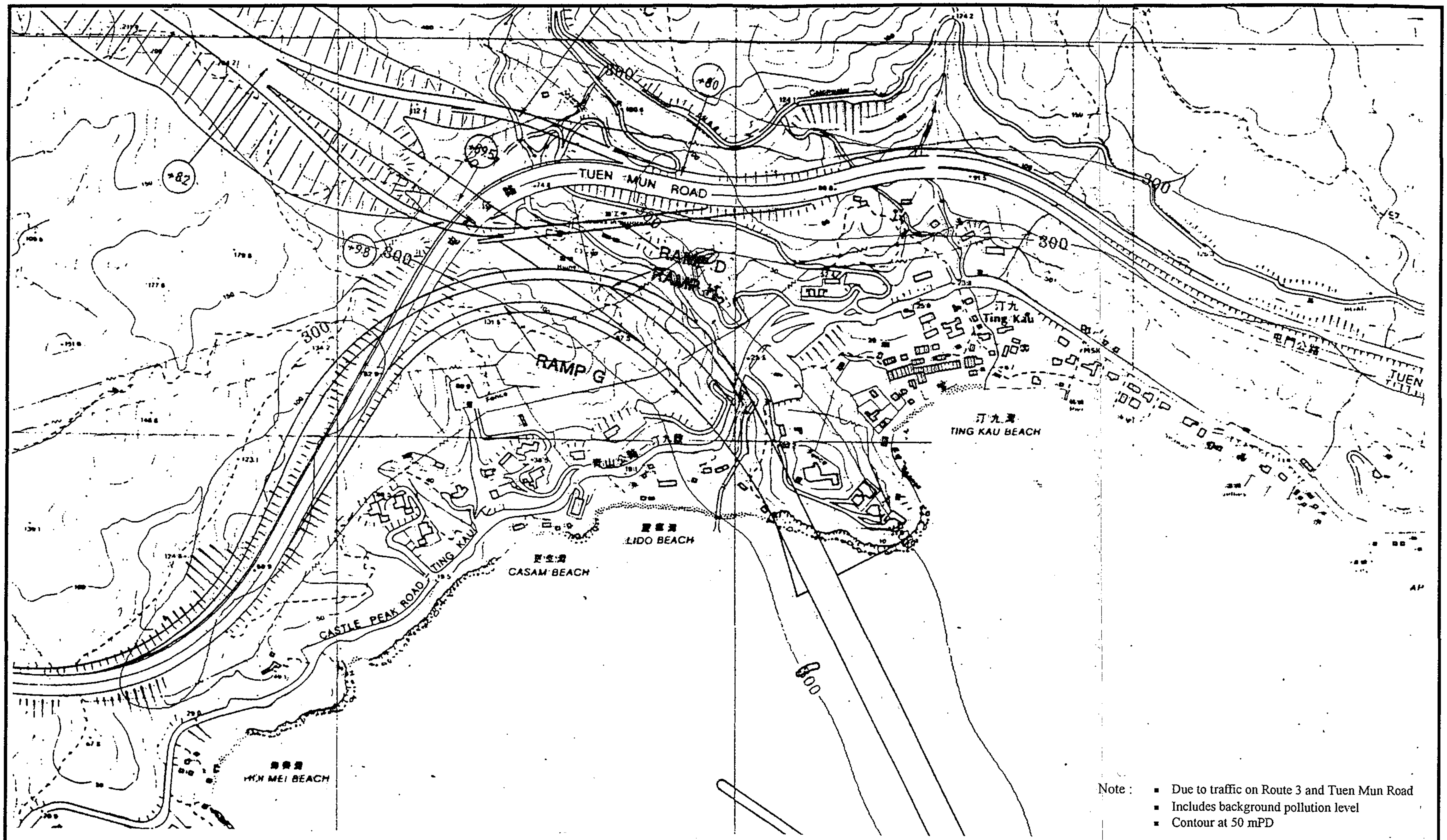
The assessment has found that NO_2 pollution levels can be expected to exceed AQO standards along Tuen Mun Road particularly in the year 2001. These concentrations are anticipated in close proximity to the road alignment. Levels near the Ting Kau Bridge deck are also expected to exceed AQO standards, but should disperse to acceptable levels at sensitive receiver elevations.

Construction dust is expected to exceed 1-hour and 24-hour desirable maximum concentrations. This is due to the large construction area, and the number of concurrent construction activities assumed. Other construction projects operating simultaneously in the area will further degrade local air quality. Mitigation measures, primarily the wetting and covering of exposed dust sources, have been recommended for inclusion in contract documents. A construction monitoring programme has also been recommended.



Note :
- Due to traffic on Route 3 and Tuen Mun Road
- Includes background pollution level
- Contour at 50 mPD

FREEMAN FOX MAUNSELL	Drg. Title : MAXIMUM NO_2 CONCENTRATIONS : 2001	Job Title : ROUTE 3 - TING KAU BRIDGE EIA		
		Scale : N.T.S Date Nov. 93	Job No. 058 000	Fig No. 4.1



FREEMAN FOX MAUNSELL

Drg. Title : MAXIMUM NO_2 CONCENTRATIONS : 2011

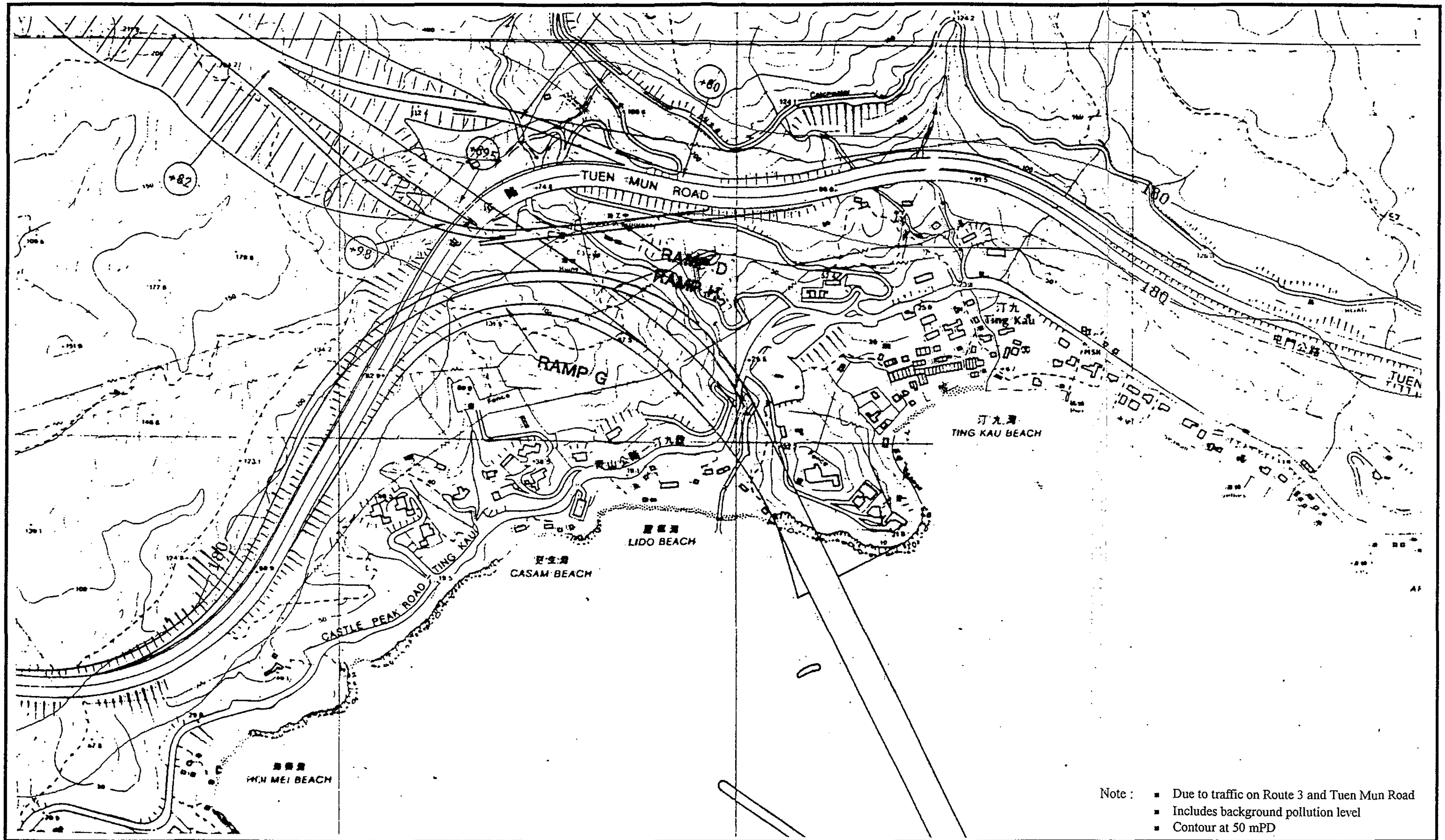
Job Title : ROUTE 3 - TING KAU BRIDGE EIA

Scale : N.T.S

Date Nov. 93

Job No. 058 000

Fig No. 4.2



Note :
- Due to traffic on Route 3 and Tuen Mun Road
- Includes background pollution level
- Contour at 50 mPD

FREEMAN FOX MAUNSELL	Drg. Title : MAXIMUM RSP CONCENTRATIONS : 2001	Job Title : ROUTE 3 - TING KAU BRIDGE EIA		
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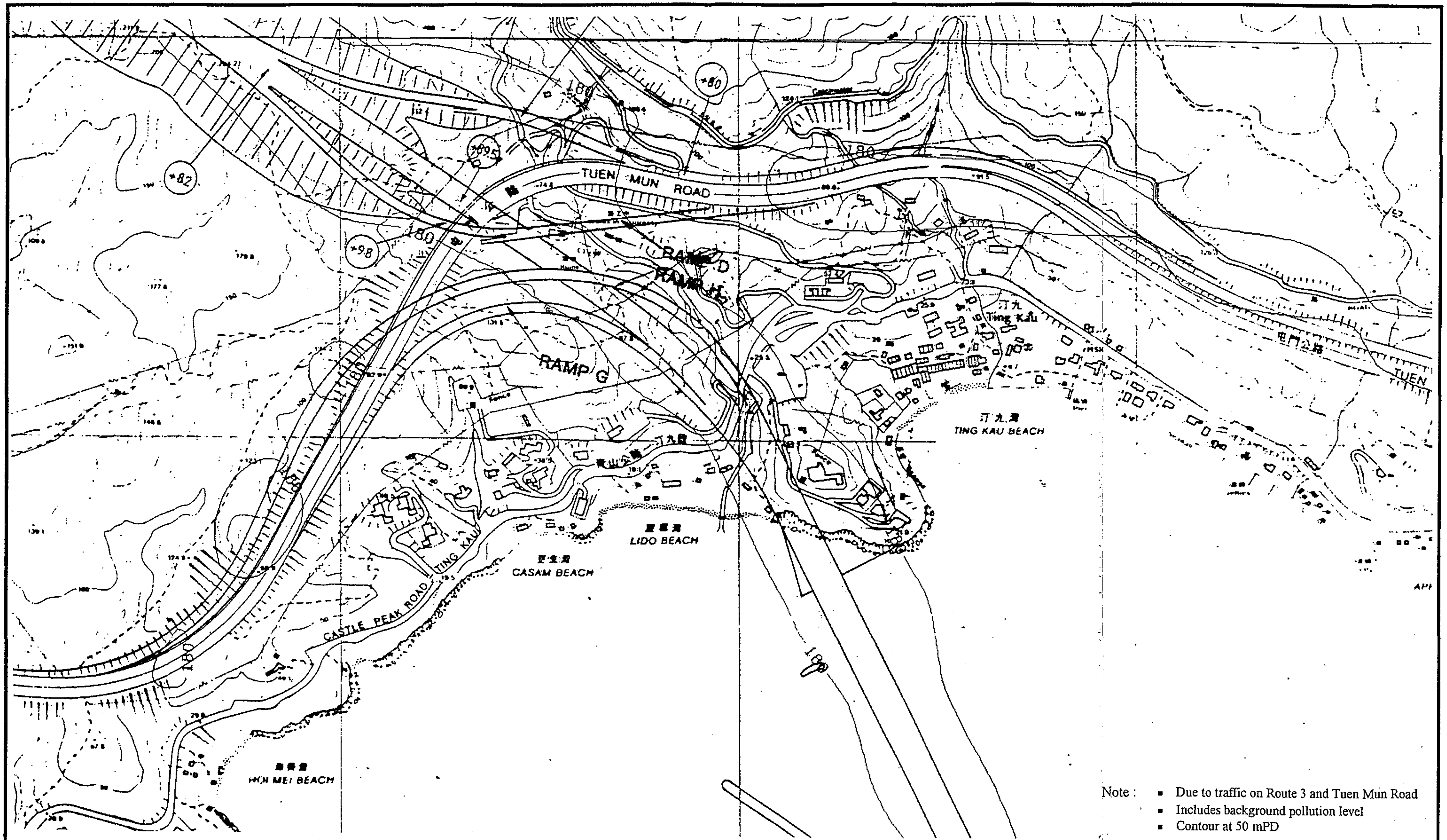
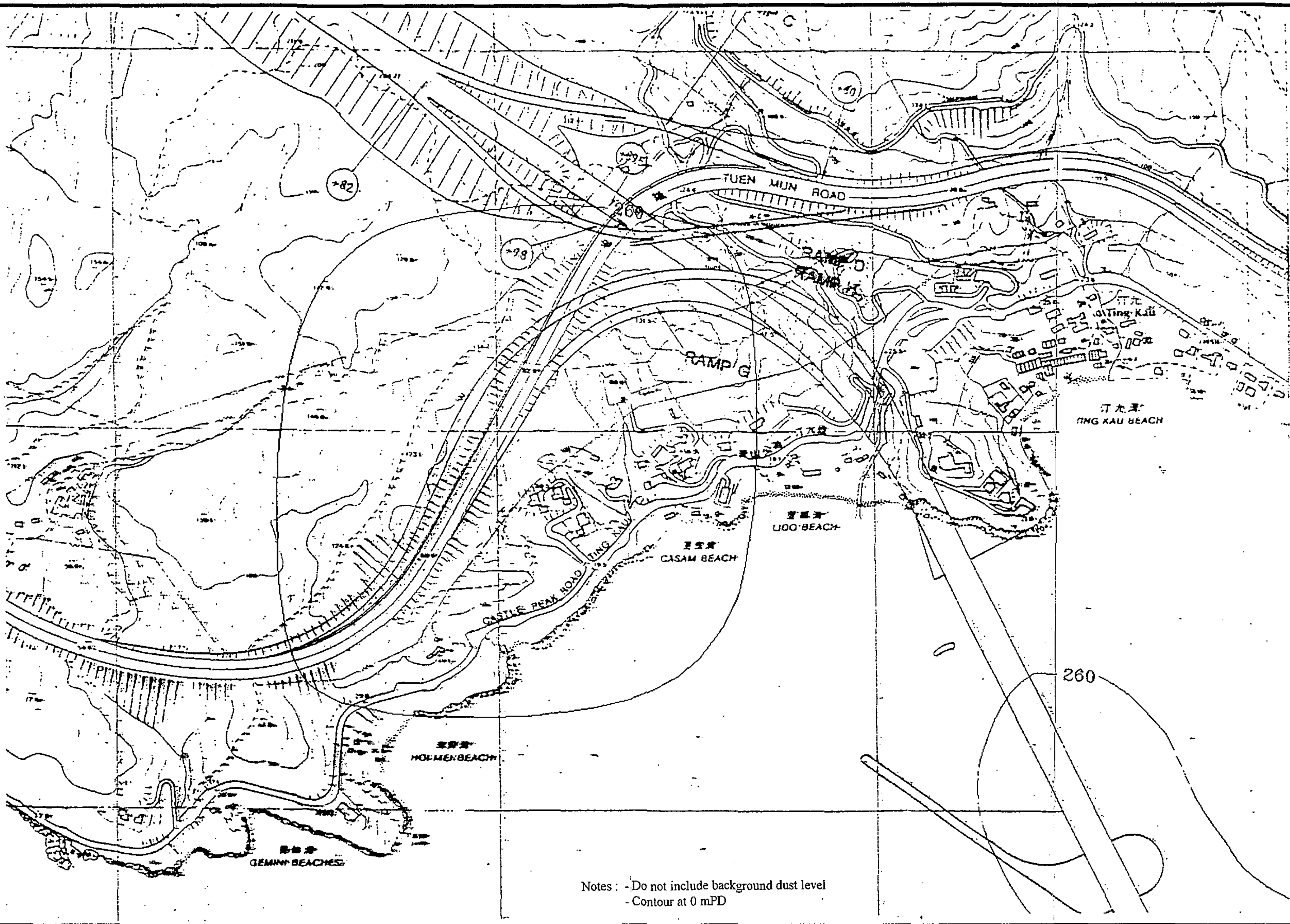


Note :
- Due to traffic on Route 3 and Tuen Mun Road
- Includes background pollution level
- Contour at 50 mPD

FREEMAN FOX MAUNSELL	Drg. Title : MAXIMUM RSP CONCENTRATIONS : 2011	Job Title : ROUTE 3 - TING KAU BRIDGE EIA
		Scale : N.T.S / Date Nov. 93 / Job No. 058 000 / Fig No. 4.4



Notes : - Do not include background dust level
- Contour at 0 mPD

FREEMAN FOX MAUNSELL

Drg. Title : MAXIMUM DUST CONCENTRATIONS 24 HOUR AVERAGE

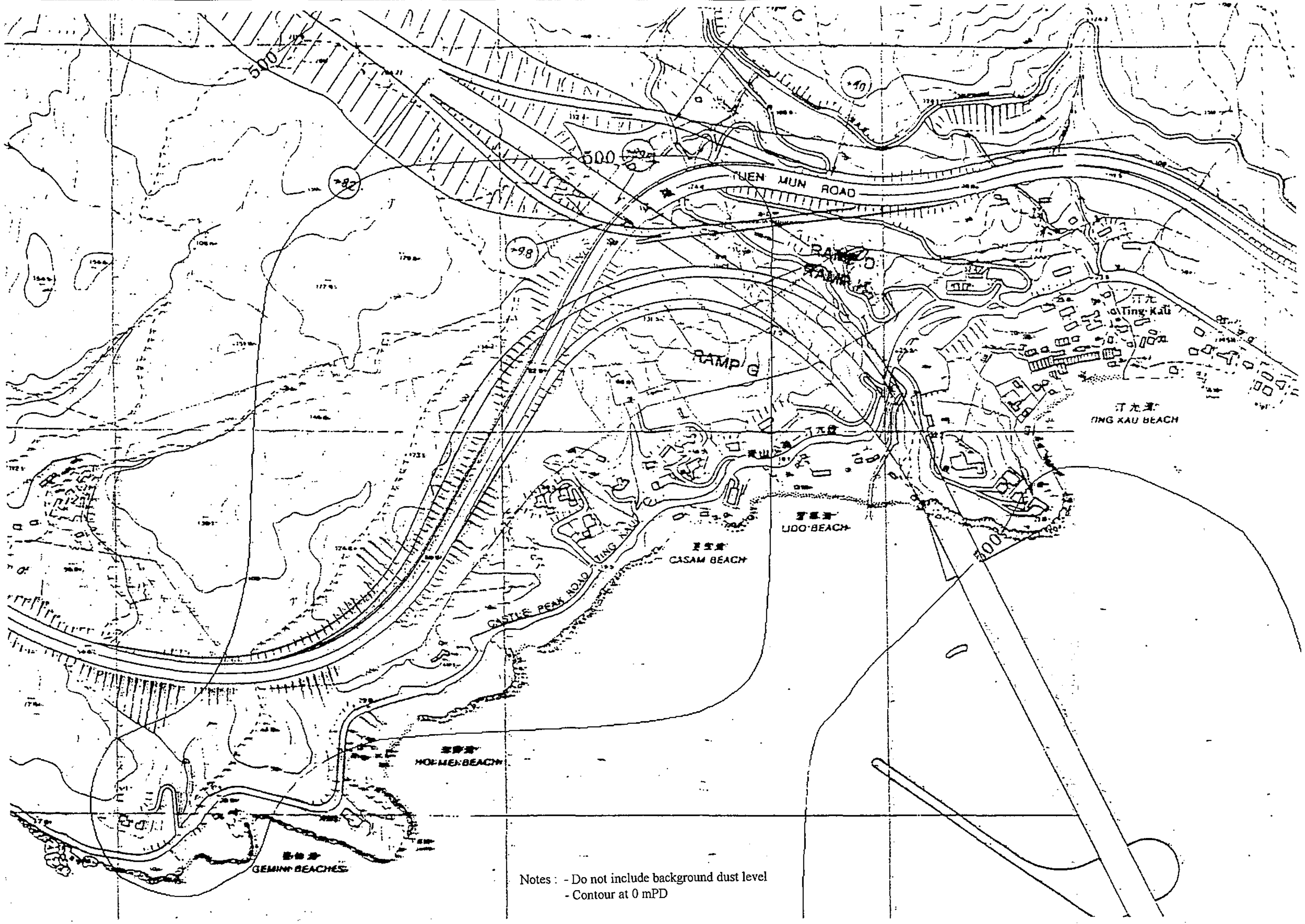
Job Title : ROUTE 3 - TING KAU BRIDGE EIA

Scale : N.T.S

Date Nov. 93

Job No. 058 000

Fig No. 4.5



Notes : - Do not include background dust level
- Contour at 0 mPD

FREEMAN FOX MAUNSELL	Drg. Title : MAXIMUM DUST CONCENTRATIONS 1 HOUR AVERAGE	Job Title : ROUTE 3 - TING KAU BRIDGE EIA	
		Scale : N.T.S	Job No. 058 000
		Date Nov. 93	Fig No. 4.6

NOISE

CHAPTER 5

5. NOISE

5.1 ENVIRONMENTAL NOISE SURVEY

An environmental (background) noise survey was conducted at four locations adjacent to the alignment of the proposed roads. The measurement locations chosen are shown in Figure 5.1, as TK1 to TK4.

Twenty-four hour environmental noise surveys were conducted at each measurement position over the period between 6th to 19th May 1993. These surveys recorded hourly L_{eq}, L10, L50 and L90 noise levels for each hour of the twenty four hour period. Noise measurement equipment used was as follows:

Sound Level Meter	Bruel & Kjaer Type 2231
Preamplifier	Bruel & Kjaer Type 2639
Condenser Microphone	Bruel & Kjaer Type 4155
Calibrator	Bruel & Kjaer Type 4230
Windscreen	Bruel & Kjaer UA 0237

Results of the surveys are attached as Appendix A5. In all cases reported noise levels correspond to noise levels at one metre in front of the facade, at upper storey level.

At all measurement positions the noise climate was dominated by traffic noise from Tuen Mun Road and Castle Peak Road, with lesser contributions from marine traffic, wildlife within the surrounding wooded areas and construction work on Tsing Yi Island.

5.2 CONSTRUCTION PHASE NOISE IMPACT ASSESSMENT

5.2.1 Methodology

Noise Assessment Criteria

Noise from construction activities is controlled under the Noise Control Ordinance (NCO). The use of powered mechanical equipment, other than percussive piling equipment, for construction work in the construction site within restricted hours, i.e. any period outside of the hours between 0700 and 1900 on normal weekdays, requires a Construction Noise Permit (CNP). The details are set out in the *Technical Memorandum on Noise from Construction Work other than Percussive Piling.*

The potentially affected NSRs are all within 400m of the Tuen Mun Road. With reference to the Transport Department's Annual Traffic Census for the year 1991, and in particular the near-by Core Counting Station 5012, it has been determined that the average daily traffic flow for this road is significantly above 30,000 and the hourly flow does not drop below 300 vehicles per hour during any hour (with the possible exception of Sunday night). The Tuen Mun Road can thus be considered as an *influencing factor* as described in the Technical Memorandum. It is considered that all the NSRs are either directly or indirectly affected by Tuen Mun Road. It is considered that the Ting Kau area qualifies as a low density residential area.

Under the definitions of the *Technical Memorandum on Noise from Construction Work other than Percussive Piling* the Basic Noise Levels for the NSRs are considered to be as presented in Table 5.1 below:

Table 5.1 Basic Noise Levels at Ting Kau (dB(A))

Time Period	Indirectly Affected NSRs	Directly Affected NSRs
1900 to 2300 hours AND general holidays 0700 to 2300 hours	65	70
All days 2300 to 0700	50	55

Daytime works during non-restricted hours are not subject to NCO control, however limits of 75 dB(A) or 10 dB(A) above the background noise level are often used as guides to acceptable noise levels.

Approach

A construction phase noise impact assessment has been conducted, based upon the procedures outlined in the *Technical Memorandum on Noise from Construction Work other than Percussive Piling*. Since the NSRs are potentially impacted by noise from construction work at a number of different locations, some of which are at a large distance from the receivers it has been considered appropriate to account for acoustic losses due to air absorption in the construction noise analysis.

The atmospheric attenuation coefficient has been derived in accordance with ISO/DIS 9613 part 2, 1992. Over the typical day time weather conditions normally occurring in Hong Kong, atmospheric absorption will tend to be highest under conditions of high air temperature and humidity. The analysis has thus been based upon conservatively low estimates for these parameters, i.e. an air temperature of 20° Celsius and relative humidity of 70%. Since the receivers are located in a semi-rural area with predominately absorptive ground cover, such as grass and vegetation, it was also considered appropriate to incorporate corrections for ground attenuation. Again reference was made to ISO/DIS 9613 part 2, 1992, in order to derive appropriate attenuation coefficients.

With reference to the attached construction noise calculations (Appendix A6.1). The allowances for air and ground absorption are stated in individual columns, labelled " AIR ABS " and " GRND ABS " respectively. For construction noise level calculations conducted in strict accordance with the Technical Memorandum, these 'air abs.' and 'grnd abs' corrections would be zero. Thus the construction noise levels calculated for this assessment are in all cases lower than would be calculated in strict accordance with the Technical Memorandum. The difference in noise level calculated by the two alternative methods increases as the individual corrections for air and ground absorption increase. Air absorption increases with distance between the noise source and the receiver. Ground absorption increases as the sound propagation distance, that is over acoustically absorbent terrain, increases. For the purposes of the current assessment, areas of water have been taken to have zero ground absorption.

- **Works Areas**

Due to the complex geometry of the site it was considered appropriate to sub-divide the site into sections termed zones. These zones are listed below:

Zone A: Tsing Yi Island

Zone B: Bridge and areas beneath. This zone has been further subdivided into:

B1, covering Tsing Yi Island adjacent to the shore-line,
B2, the central Breakwater/ Rock Island and
B3, bridge supports rising from the sea-bed,

Zone C: Reclamation Area adjoining Ting Kau and road above,

Zone D: Main Route 3 above Ting Kau,

Zone E: Ramps G and H,

Zone F: Cutting adjacent to Tuen Mun Road, (to the west of Route 3)

Zone G: Ramps C and D,

Ramps C and D are to be constructed as part of the TLT & YLA road BOT contract. However there will be an overlap during which construction of these ramps and the TKB approach could occur simultaneously and the noise assessment allows for this. This should be confirmed during the EIA of the detailed design.

- **Construction Programme**

Preliminary analysis of the construction programme revealed that construction noise would be at its highest levels during the third quarter of the first year. Noise calculations presented herein are for this worst case period.

Over the three year construction period, it is anticipated that the first six months may be significantly quieter than the worst case period analyzed. The amount of plant on the site will build up over this period. Noise levels calculated for the third quarter will be fairly representative for the remainder of the programme until various noisy activities, particularly drilling, are completed during the final six months of the programme. Thus the presented results can be assumed to be representative of the middle two years of the three year construction programme.

- **Construction Activities**

Calculations were based upon all carpentry operations using powered equipment, such as electric planers and circular saws, being conducted in an enclosed, or substantially screened yard, to be located at least 100 metres from the nearest residential building.

It is understood that the contractor will wish to get vehicular access to all support column locations. This should not be a major problem on the Tsing Yi side of the bridge or over the water where boats can be used. At Ting Kau a Haul/Access road may need to be provisioned. The environmental impact assessment of this road will be covered in a supplementary paper the TKB Haul/Access Road EIA.

It is assumed that Zone C access for all large equipment will be by barge. The same comment also applies to bridge columns south of the Castle Peak Road. For all column locations to the north of Castle Peak Road it is believed that the contractor will wish to construct some form of temporary vehicular access. It has been assumed for the purposes of the current assessment, that it will not pass any closer to residential properties than the alignment of the proposed roads.

5.2.2 Impact Assessment - No Mitigation

Detailed construction noise calculations were initially performed for locations one metre from the facade of each of six NSRs. These NSRs were judged to include the worst affected receivers for the various areas of construction activity. These NSR locations (numbered 1 to 6) are shown in Figure 5.2. The calculated noise levels are stated below in Table 5.2.

These basic noise level calculations do not account for any noise mitigation except that in the case of the type of *poker vibrators* that are expected to be used, the sound power level given under item CNP170 of the Technical Memorandum is considered to be unduly high. In this isolated case noise data has been used from BS 5228: Part 1: 1984, for a 2kW poker vibrator.

Table 5.2 Noise Level Predictions for Worst Case Construction Noise - No Mitigation

Location	Noise Level dB(A)
NSR1	80.7
NSR2	78.6
NSR3	85.3
NSR4	76.7
NSR5	84.2
NSR6	75.4

It is currently envisaged that all significant construction work will take place during periods not covered by the NCO, i.e. Monday to Saturday between 0700 hours and 1900 hours, the predicted noise levels without mitigation were however sufficiently high in order to conclude that significant construction noise mitigation measures would need to be adopted. Thus further detailed analysis of the scenario without mitigation was considered to be unnecessary.

5.2.3 Impact Assessment - Mitigation

Mitigation Measures

The noise mitigation considered took various forms. In order to mitigate noise from drilling and similar activities, erection of fixed solid (nominally four metre high) hoardings around noise generating activities was considered. With a solid timber fence it is estimated that acoustic screening accounting for a 10 decibel noise reduction could be achieved for this type of activity at all NSRs. In the calculations the treatment was considered for breakers and rock drills. Such treatment was also considered to be practical for the barge mounted concrete mixers and pumps serving the reclamation zone on the Ting Kau shore, and concrete lorry mixers serving column locations within 70 metres of NSRs.

The second form of noise mitigation considered involved reducing the number of plant items used. This was only applied to noisier plant items for which noise barriers were considered to be impractical due to the high mobility of the plant, e.g. lorries and tug boats.

All fixed carpentry operations requiring the use of powered equipment should be conducted in an enclosed or substantially screened yard to be located at least 100 metres from the nearest residential building.

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

Construction noise may be mitigated through several measures which can include:

- Noisy equipment and activities should be sited by the Contractor as far from close-proximity sensitive receivers as is practical. Prolonged operation of noisy equipment close to dwellings should be avoided.

- Noisy plant or processes should be replaced by quieter alternatives where possible. Silenced diesel and gasoline generators and power units, as well as silenced and super-silenced air compressors, can be readily obtained.

- Noisy activities can be scheduled to minimise exposure of nearby NSRs to high levels of construction noise. For example, noisy activities can be scheduled for midday, or at times coinciding with periods of high background noise (such as during peak traffic hours). As far as possible, noisy operations during teaching hours should be avoided near the existing schools.

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

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

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

- If possible, reduce the numbers of operating items of powered mechanical equipment.

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

- Temporary noise barriers or earth embankments may be used to screen specific receivers. The barrier material should have a mass per unit of surface area of at least 7 kg/m^2. The panels should be absorptive with an acoustic lining, and have a noise reduction capability of up to 10 dB(A).

Evaluation of the exact effectiveness of these measures at a given receiver requires a knowledge of the planned construction schedule, which is not available at this stage.

NSRs Affected

A noise map incorporating mitigation measures is presented in Figure 5.3a the noise map has been derived using a grid of points, each 10 metres apart, all at five metres above ground level. The colour plotted corresponds to the noise level at the centre of each grid. Generally the noise map should be treated as free field noise levels. Thus in order to establish the noise level at one metre from the facade of a building, a correction of +3dB(A) will generally be applicable to the plotted noise level.

From the construction noise assessment including mitigation, ten buildings have been identified for which noise levels at one metre from the most exposed part of the facade will be above 75dB(A). These buildings are identified on Figure 5.3b.

From discussions with the Hong Kong Government Census and Statistics Department it is understood that occupancy data is not available for individual buildings. In order to estimate the number of occupants of these affected buildings, reference has been made to data for "village cluster groups" numbers 334, from the 1991 population 2 and 3 census. From this data we have derived an average occupancy of 3.3 persons per occupied living quarter. Thus we estimate that approximately 33 residents will be impacted by construction noise levels exceeding 75dB(A), at some time during the construction programme. It is suggested that provision of noise insulation for these affected properties should be considered.

Sample construction noise calculations with the best practical level of noise mitigation described above have been prepared for NSRs 1 to 6 These are included in Appendix A6.1. Results for these calculations are as stated in Table 5.3.

Table 5.3 Noise Level Predictions for Worst Case Construction Noise - Best Practical Noise Mitigation Incorporated

Location	Noise Level dB(A)
NSR1	77.7
NSR2	75.9
NSR3	81.4
NSR4	75.8
NSR5	81.6
NSR6	72.6

5.3 OPERATIONAL PHASE NOISE ASSESSMENT

5.3.1 Methodology

Noise Assessment Criteria

The Hong Kong Planning Standards and Guidelines (HKPSG) recommend that peak hour L10 traffic noise levels should not exceed 70 dB(A) at openable window locations ventilating habitable rooms of residential buildings. More stringent criteria apply for other types of buildings such as schools. No such other buildings exist for this section of the road alignment.

Approach

Traffic noise calculations have been based on the U.K. Department of Transport's "The Calculation Of Road Traffic Noise". The calculations have been based upon traffic flow data for the year 2011 provided by Transport Department. The peak flow hour for the overall network has been used, this is the morning peak hour. This data, together with speed limit data for the road network is presented in Appendix A2. (see note regarding these flows in 4.2.2).

The following traffic speeds have been assumed for each of the roads:

Ting Kau Bridge	97 km/hr
Tuen Mun Road	70 km/hr
Slip Roads/ Link Roads	85 km/hr

The speed limits have been based on:

- TKB: assumed speed of 97 km/hr was derived in accordance with CRTN, from speed limits (100 km/hr for the main link) and road classification.
- Tuen Mun Road: 70 km/hr as requested by EPD.
- Slip/Link Roads; vehicle speed 85/70 km/hr as recommend by Transport Department.

The use of pervious friction course road surfacing was assumed for all of the new roads.

Noise levels have been calculated at locations one metre from the facade for the six worst affected NSRs. These are shown in Figure 5.3.

5.3.2 Traffic Noise Impact Assessment - No Mitigation

Table 5.4 Noise Level at 1m From Most Exposed Facade - No Noise Barriers

Road	NSR1	NSR2	NSR3 west facade	NSR3 north facade	NSR4	NSR5	NSR6
Tuen Mun Rd	59.58	59.13	62.56	66.37	59.38	58.50	54.39
Ramp G	53.47	60.24	64.29	55.24	56.11	62.08	53.85
Ramp H	61.32	65.39	66.67	61.57	57.90	60.90	56.97
Ramp C	57.22	45.73	62.09	64.37	40.83	59.77	38.74
Ramp D	59.10	49.16	61.92	65.50	41.66	59.14	40.37
Main Bridge	61.75	64.66	67.42	62.46	55.30	63.78	55.14
TOTAL	**64.8**	**66.7**	**70.0**	**71.5**	**61.0**	**66.4**	**58.8**

NB: +2.5dB(A) facade correction factor included.

Due to the extremely complex topography of the site and the fact that noise contributions from six separate roads must be considered at each receiver location, it is considered impractical to provide full documentation of the several thousand road traffic noise calculations performed. To illustrate the calculation procedure a sample calculation detailing the noise contribution from the main Route 3 CPS road at NSR3 west facade is included in Appendix A6.2.

Supplementary information is provided in the noise contour map, presented as Figure 5.4. This gives noise contours at 5 metres above ground level. These contours are free field contours and do not account for the modification of the sound field directly in front of the various building facades. Thus these free field noise levels will neither account for the +2.5 dB(A) increase in noise level at the building facade due to noise reflection, nor the reduction in noise due to the NSR building blocking the view of certain road sections.

In view of these factors the noise contours provide indicative information only at points close to buildings.

The results of our calculations show that the 70 dB(A) noise criteria will only be exceeded at one facade of one NSR. This affected facade is the north facade of NSR3.

5.3.3 Traffic Noise Impact Assessment - Mitigation

Calculations have been performed in order to derive a noise barrier configuration that will reduce the noise level at this affected facade to an acceptable level. The results of these calculations are given in Table 5.5 below.

Table 5.5 Noise Level dB(A) at 1m From North Facade of NSR3 With Noise Barrier

Road	NSR3 north facade
Tuen Mun Rd	64.47
Ramp G	55.24
Ramp H	61.57
Ramp C	64.37
Ramp D	59.88
Main Bridge	62.46
TOTAL	**70.0**

The road side noise barrier considered was 400m in length and 3 metres high, located on the southern edge of the hard shoulder of Ramp D (Ramp D is to be constructed as part of the TLT & YLA contract). The required barrier length is shown on Figure 5.5 which also shows noise contours for traffic noise with the barrier in place.

The use of a noise barrier or receiver mitigation in the form of insulation are considered to be effective technical remedies and both constitute feasible mitigation measures.

Since the noise barrier described above is required to reduce noise levels at one building only, it is not recommended as a cost effective noise control solution. Providing noise insulation to the affected building would be a more cost effective solution and is recommended.

[Costing of mitigation measures is not within the scope of the current study however some general information has been obtained from other projects in response to a request from EPD. While this information may be useful to the detail design contractor it must be stressed that this should only be used for indicative purposes.

- Sha Tin Route 5 Barriers - plexiglas panel fixed onto the viaduct parapet.

0.7m (1.5m incl. parapet)	HK$2,100/m
1.2m (2.0m ")	HK$3,600/m
3.2m (4.0m ")	HK$8,500/m

- Road T7 Sha Tin - noise barrier on ground, wall and paraglass.

  3m high barrier HK$14,000/m

- Road T5 Sha Tin - noise barrier on ground, wall and paraglass with more elaborate finishes and design.

  3m high barrier HK$28,500/m

All costings are at today's prices i.e. current December 1992 plus 5% added.]

No detail of any large scale development adjacent to the route has been identified, therefore detailed noise mitigation for planned development is impossible to provide. If high rise residential buildings are to be built next to the road in the future, then they will have to consider Route 3 CPS TKB as a constraint. It is recommended that the design of any new residential or noise sensitive building should be based upon self protection, with bathrooms, kitchens, storeroom and stair wells etc. located on the noise exposed side of the buildings.

5.4 NOISE MONITORING AND AUDIT REQUIREMENTS

Noise Monitoring is required to confirm compliance with assessment criteria for construction noise. Monitoring and audit requirements including outline schedules and action plans are detailed in Chapter 13.

5.5 RECOMMENDATIONS

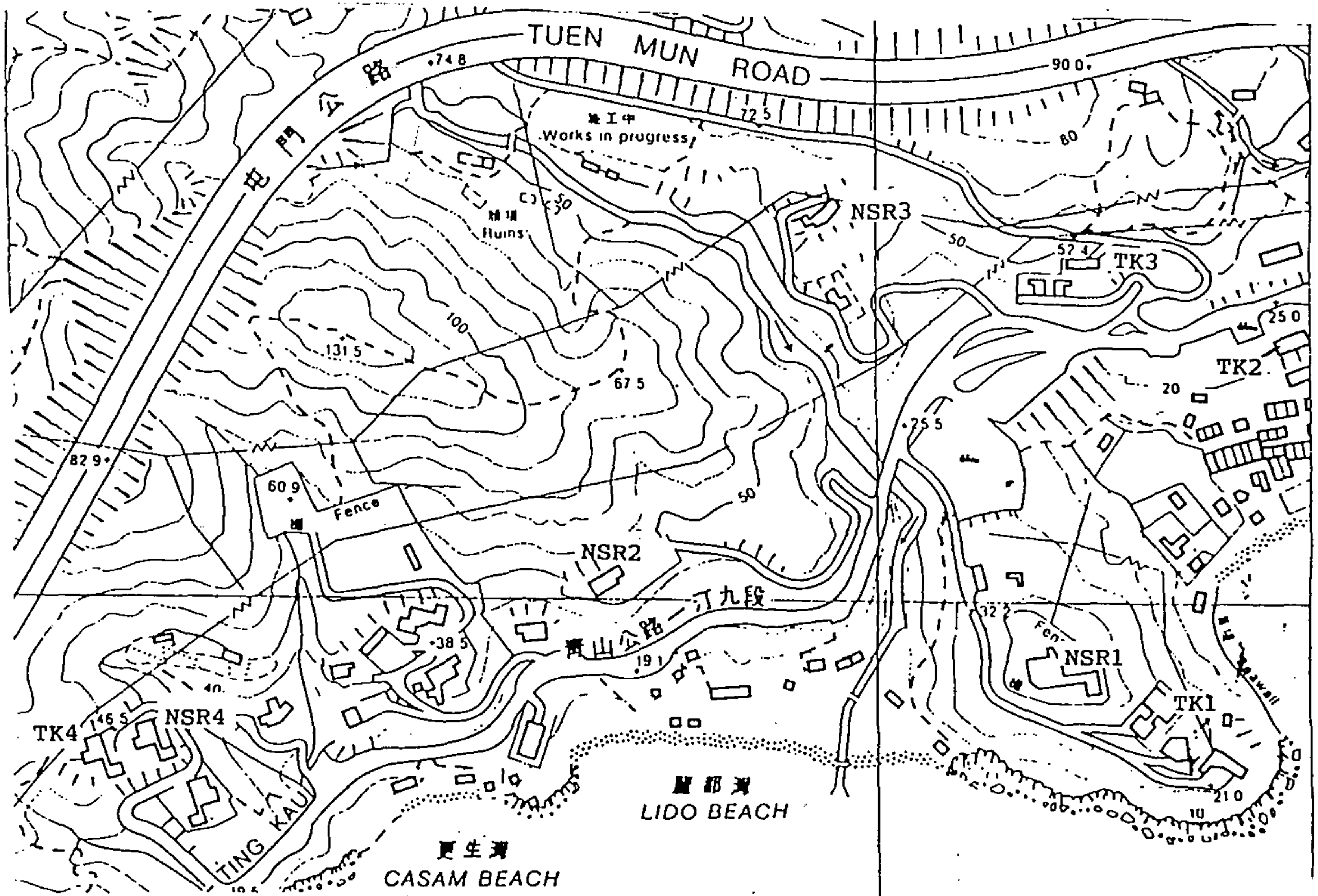
During construction, it is recommended that the 10 dwellings affected by excessive noise levels (with solid fixed noise hoardings around noisy activities considered), should be provided with noise insulation.

Only one dwelling is affected by excessive noise during the operation at TKB and hence mitigation at the receiver (noise insulation) is considered more cost effective and practical than provision of a noise barrier.

5.6 CONCLUSIONS

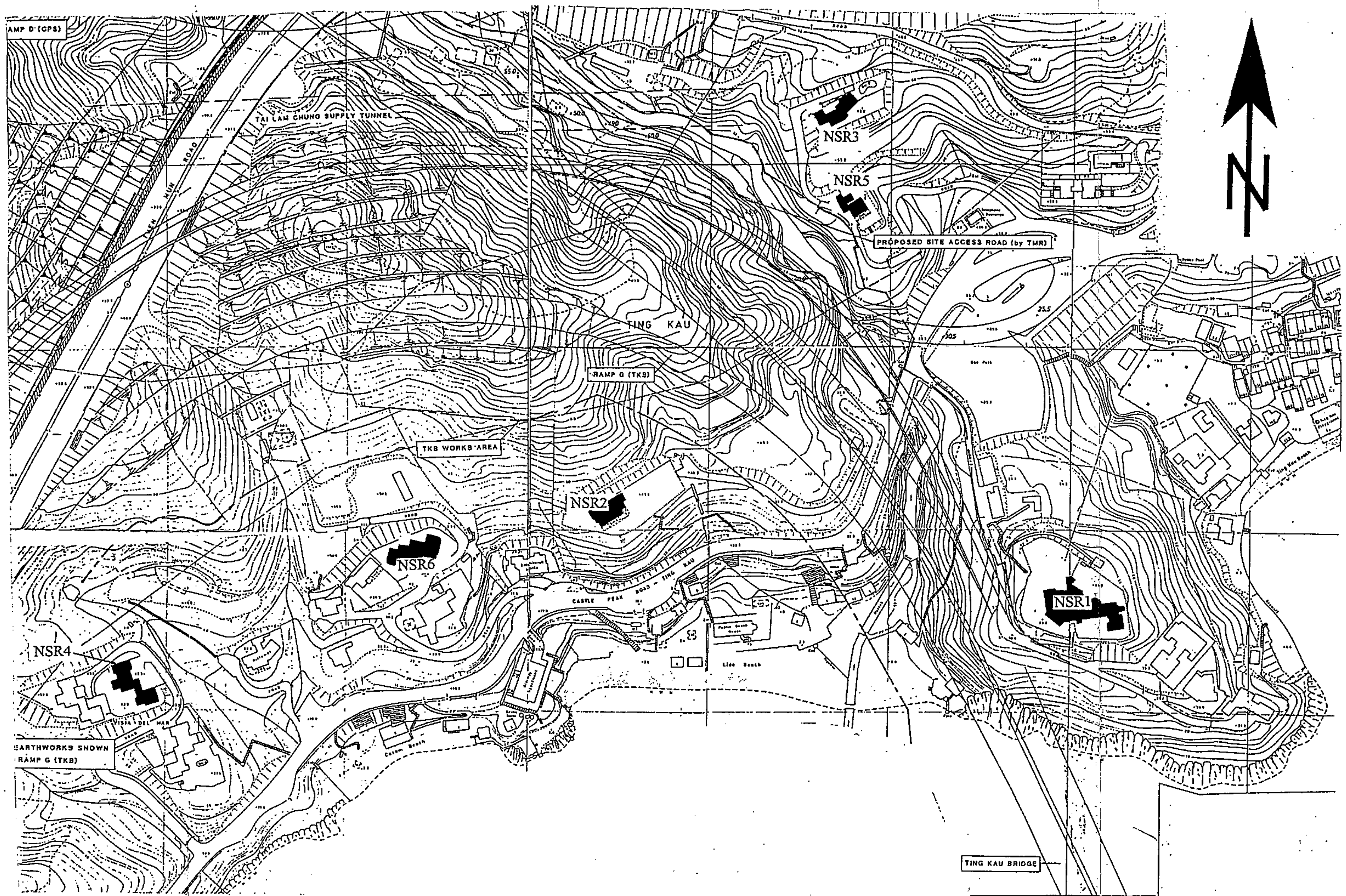
Based upon the detailed noise impact assessment conducted, noise impact during the operational phase will be acceptable subject to provision of pervious friction course road surfacing on each of the new roads, including slip roads, and an indirect technical remedy i.e. provision of noise insulation for one building. A more expensive noise control option would be the erection of a three metre high noise barrier along a 400m length of Ramp D.

Construction noise is however anticipated to be a much bigger problem. It is currently anticipated that all significant construction activities will be limited to the daytime period between 0700 and 1900 hours, excluding Sundays and Public holidays. On this basis the requirements of the Noise Control Ordinance will be satisfied. Predicted levels of construction noise during the daytime, even with all practical noise mitigation incorporated, are however predicted to be above acceptable levels (75 dB(A)) for ten residential buildings (impacting approximately 33 residents). It is suggested that installation of noise insulation for these properties, for the duration of the construction phase, should be considered.

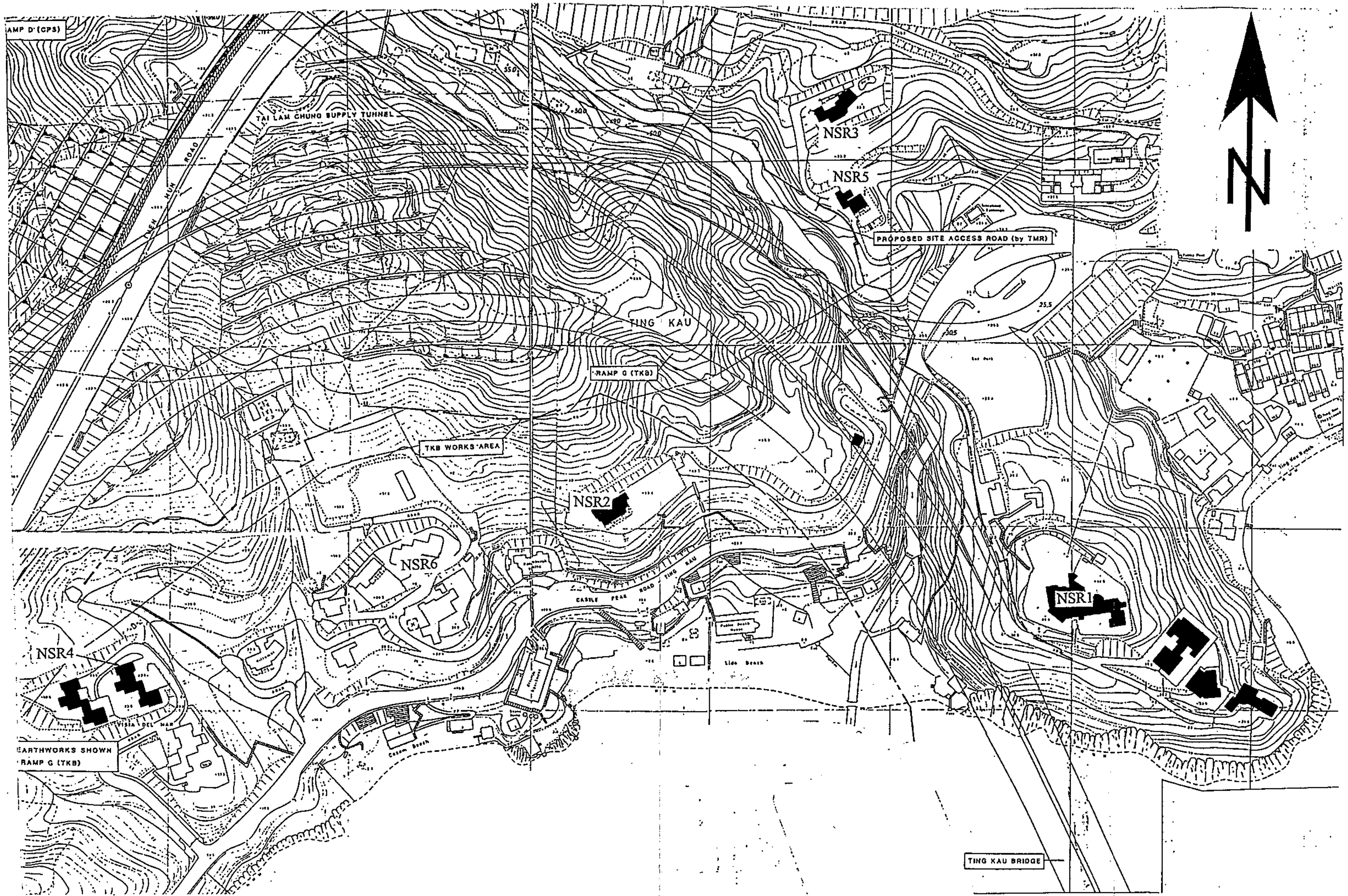


FREEMAN FOX MAUNSELL	Drg. Title · NSRs and ENVIRONMENTAL NOISE SURVEY MEASUREMENT POSITIONS	Job Title : ROUTE 3 TING KAU BRIDGE EIA

Scale :	Job No. 058000	Fig. No. 5.1
Date May 1993		



FREEMAN FOX MAUNSELL	Drg. Title : LOCATION OF NSRs 1 TO 6 - FOR CONSTRUCTION & ROAD TRAFFIC NOISE CALCULATIONS	Job Title : ROUTE 3 - TING KAU BRIDGE EIA	
		Scale : N.T.S	Job No. 058 000	Fig No. 5.2
		Date Nov. 93	



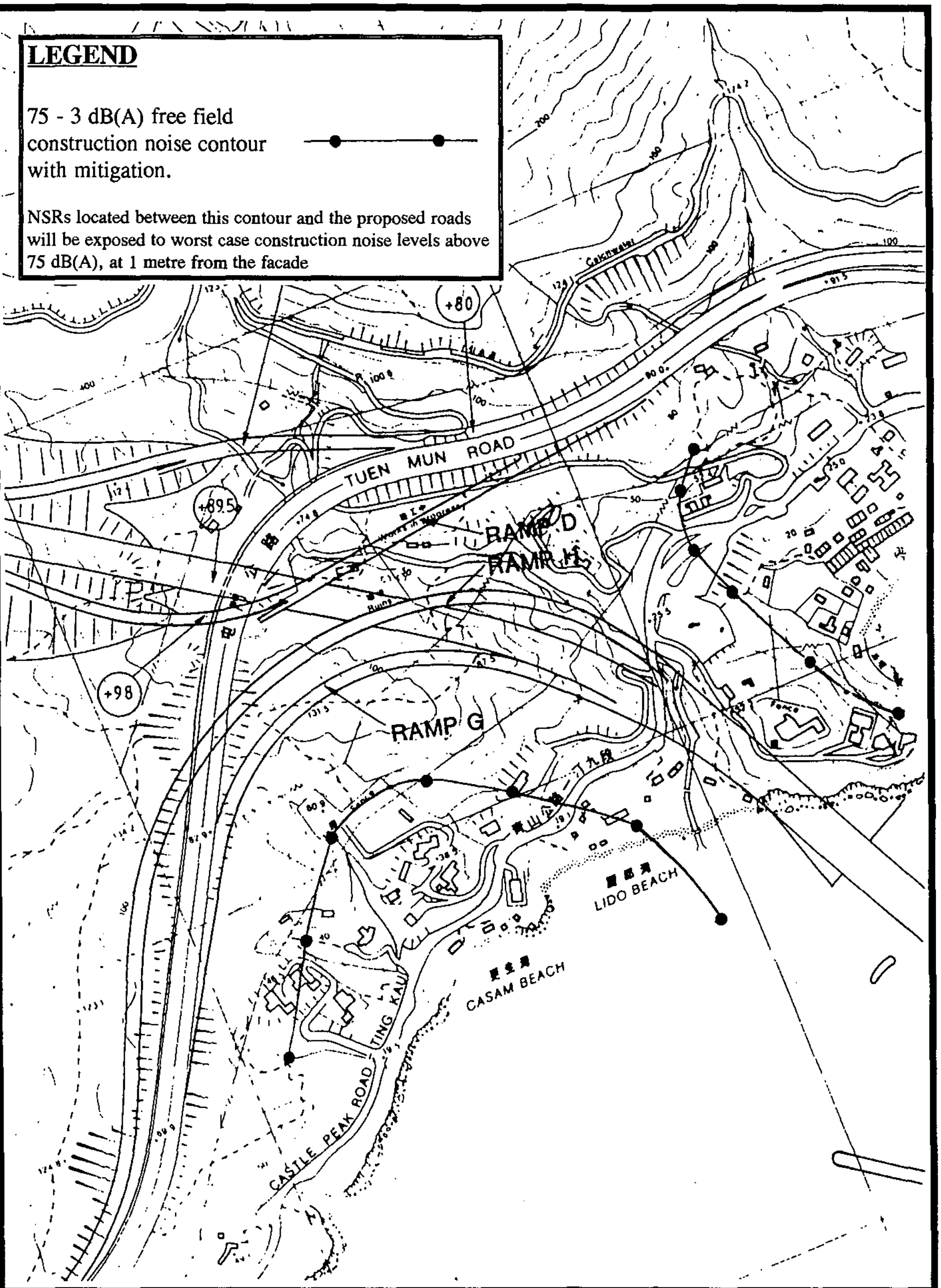
NB : Numbered NSRs were those used in construction and traffic noise calculations.

FREEMAN FOX MAUNSELL	Drg. Title : TEN NSRs AFFECTED BY CONSTRUCTION NOISE (>75 d B(A)) - WITH MITIGATION	Job Title : ROUTE 3 - TING KAU BRIDGE EIA		
		Scale : N.T.S Date Nov. 93	Job No. 058 000	Fig No. 5.3 a

LEGEND

75 - 3 dB(A) free field construction noise contour with mitigation.

NSRs located between this contour and the proposed roads will be exposed to worst case construction noise levels above 75 dB(A), at 1 metre from the facade



FREEMAN FOX MAUNSELL

Job Title : ROUTE 3 TING KAU BRIDGE EIA

Drg Title : Construction noise contour, 75-3 dB(A), free field, with mitigation

Scale : N.T.S.	Job No.	Fig. No.
Date : Nov. 93	058 000	5.3b

FIGURE 5.4
L10 TRAFFIC NOISE
TING KAU INTERCHANGE
PEAK HOUR - YEAR 2011
NO NOISE BARRIERS

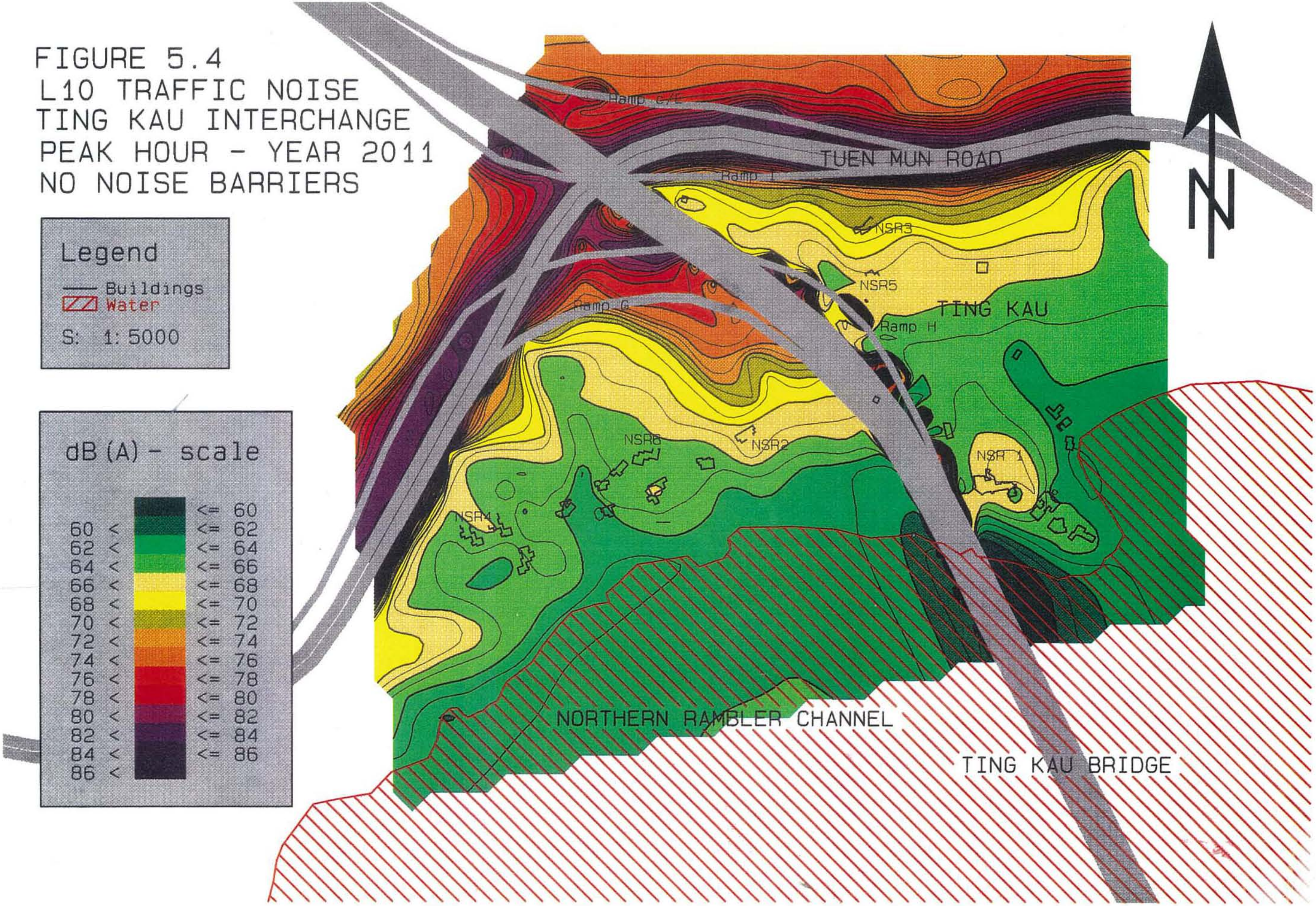
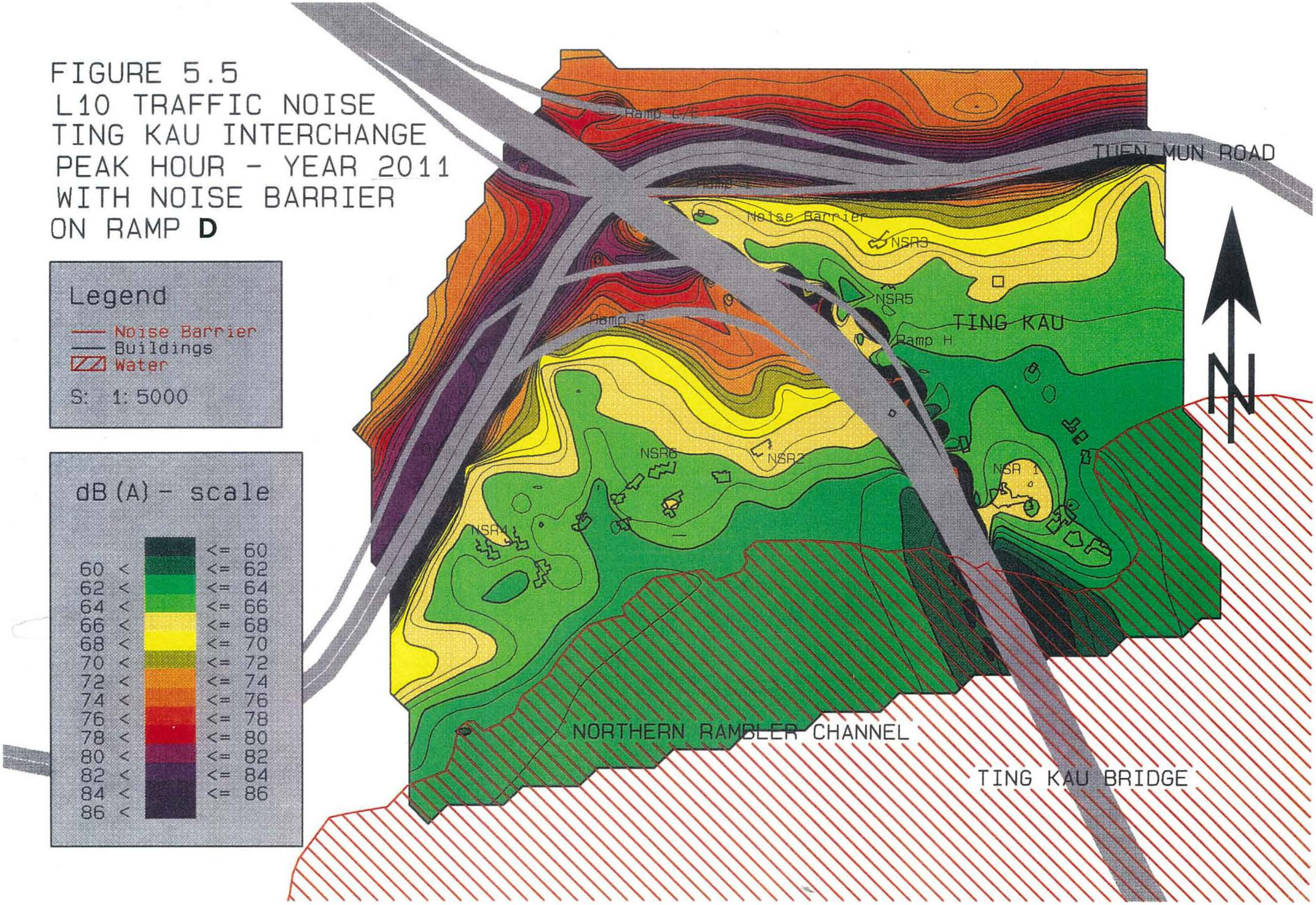


FIGURE 5.5
L10 TRAFFIC NOISE
TING KAU INTERCHANGE
PEAK HOUR - YEAR 2011
WITH NOISE BARRIER
ON RAMP **D**



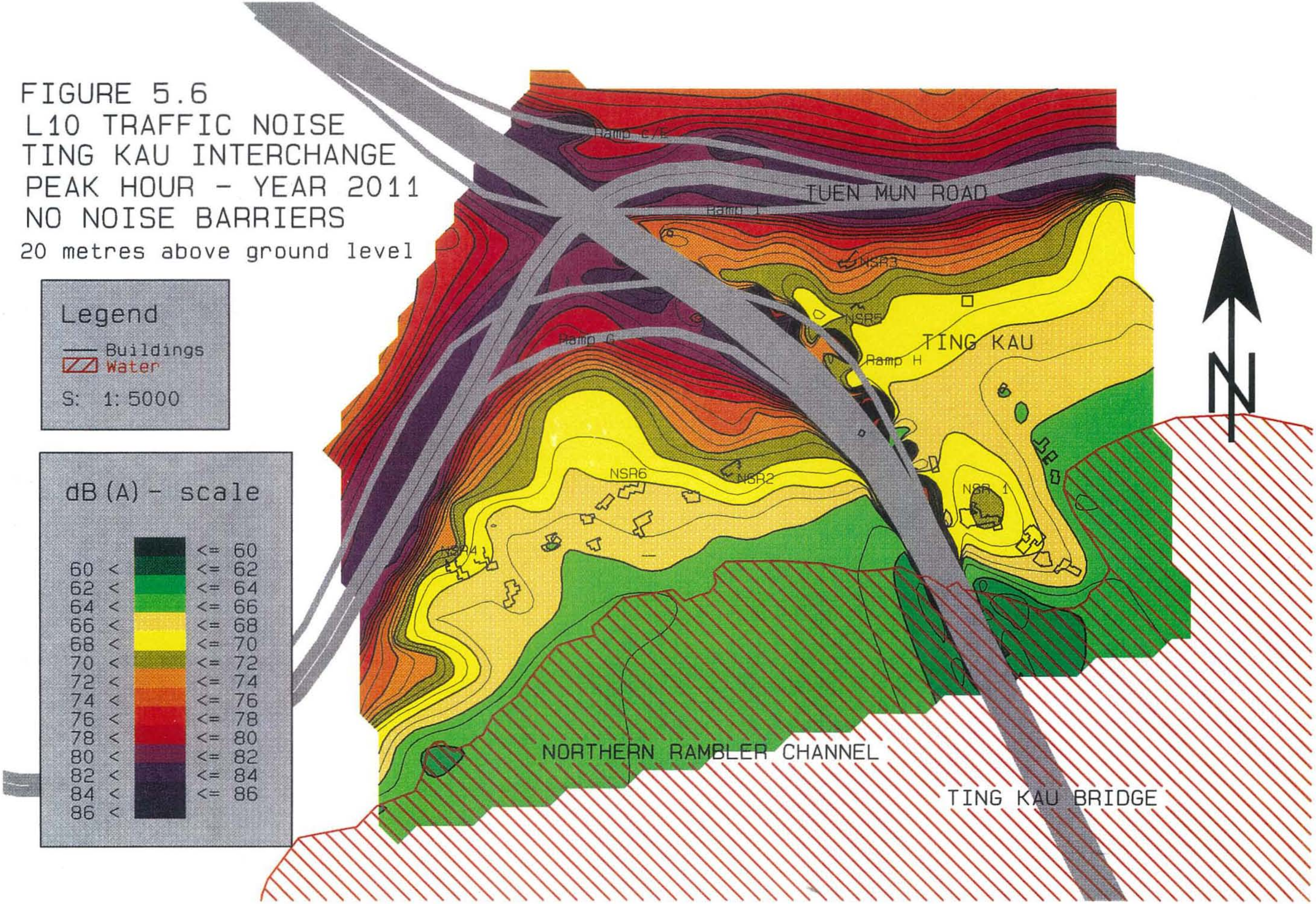
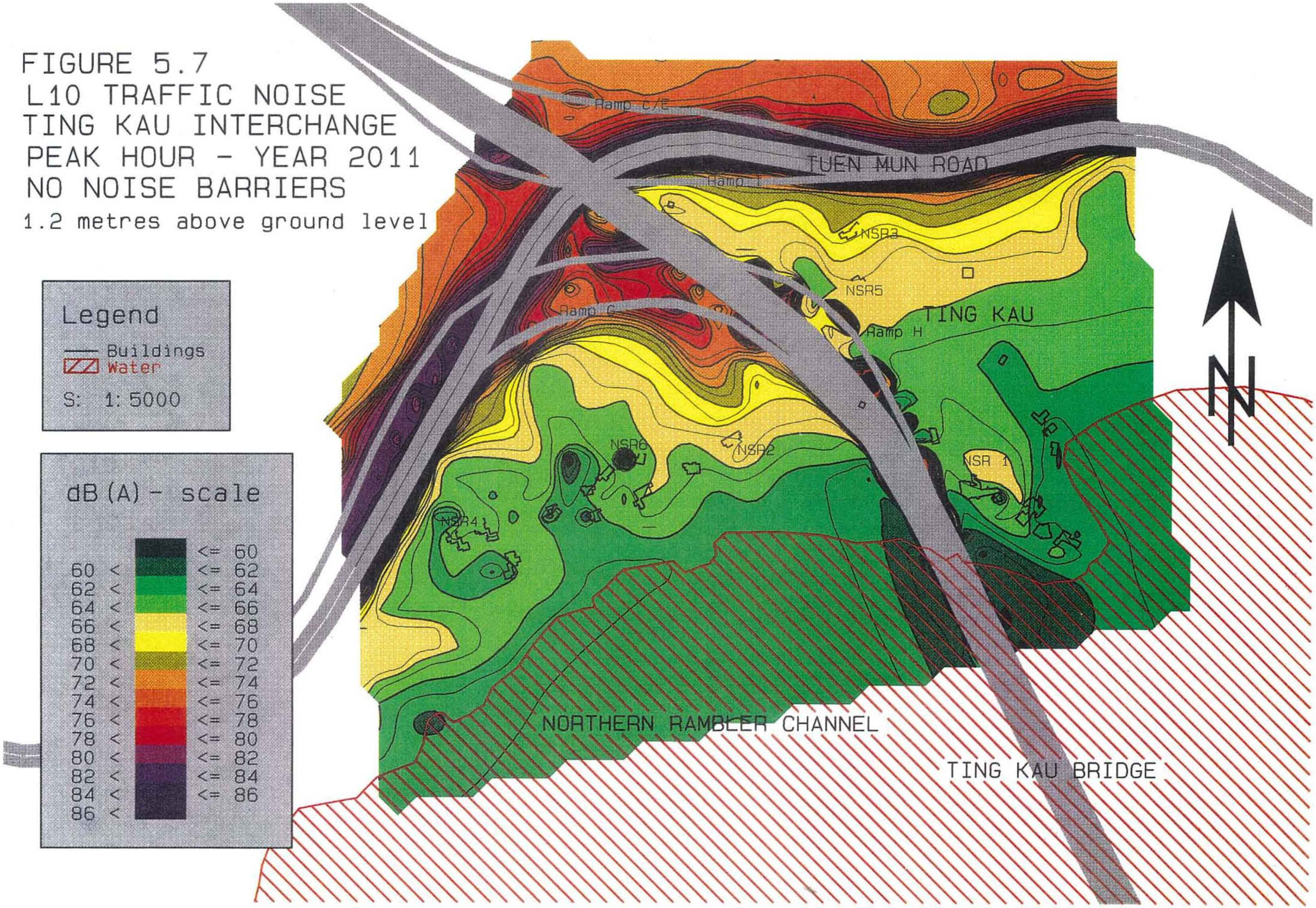


FIGURE 5.6
L10 TRAFFIC NOISE
TING KAU INTERCHANGE
PEAK HOUR - YEAR 2011
NO NOISE BARRIERS
20 metres above ground level

FIGURE 5.7
L10 TRAFFIC NOISE
TING KAU INTERCHANGE
PEAK HOUR - YEAR 2011
NO NOISE BARRIERS
1.2 metres above ground level



WATER QUALITY

CHAPTER 6

6. WATER QUALITY

6.1 INTRODUCTION - MARINE WATER QUALITY

The construction and operation of the proposed Route 3 CPS, TKB has the potential to result in deterioration in the surrounding marine environment. This Chapter identifies and assesses this aspect in detail and mitigation measures are proposed to permit the construction and operation of the TKB with no significant environmental impact to the marine environment.

There will be 10 Water Control Zones (WCZ) in Hong Kong. The TKB is to be located in the newly gazzetted Western Buffer Water Control Zone (WBWCZ), shown in Figure 6.1.

This zone was gazetted on the 1st June 1993 when Water Quality Objectives (WQO) were set and required to be achieved. The WQO are shown in Table 6.1 located at the end of this Chapter. Discharges to the marine environment will be governed by the Technical Memorandum (TM) Standards for Effluent Discharged into Drainage and Sewage System, Inland and Coastal Waters (1991), under the provision of the Water Pollution Control (Amendment) Ordinance 1990.

Any aqueous discharges must be licensed. In deciding whether to grant a license, the Authority's purpose is to meet WQO set out in the Ordinance.

The standards for effluent discharged into the inshore waters of WBWCZ are shown in Table 6.2 and for effluent discharged to WBWCZ marine waters in Table 6.3 these are provided at the end of this Chapter.

6.2 EXISTING MARINE ENVIRONMENT

6.2.1 Water Quality

There are many water quality monitoring stations in WBWCZ (Figure 6.2). The nearest to TKB is Rambler Channel station, for which 1990 water quality data is presented in Table 6.4 at the end of this Chapter. Also presented are Tsing Yi West monitoring station results which, although in a different WCZ, is still close to the proposed bridge location.

The water in the area has relatively high levels of E-coli. This is primarily due to the presence of sewage and storm water outfalls located on the mainland coast between Sham Tseng and Tsuen Wan discharging into the marine environment. The water quality in the area has deteriorated over the last few years. This is believed to be caused by the growth of population in the unsewered areas and the presence of nearby industry located at Sham Tseng, Tsuen Wan and Kwai Chung.

Water quality in the area is expected to improve in the future with the gazetting of WBWCZ and the implementation of the strategic sewage disposal strategy.

6.2.2 Hydraulic Aspects

The coastal water of Hong Kong is affected by fresh water from the Pearl River in the west and oceanic currents from the South China Sea. As a result, the seawater varies between estuarine conditions in the west to oceanic in the east, the effect of the Pearl River being most pronounced during the wet season.

At a more local level, the nature of the sea water is also influenced by local run-off and coastal topography. Existing local flow conditions are examined in more detail in Section 6.4.2.

6.2.3 Sensitive Receivers

The main SRs include:

- eight gazetted beaches in the locality of TKB (Figure 6.3). They have the following bacteriological water quality ranking as designated by "Bacteriological Water Quality of Bathing Beaches in Hong Kong, 1992" and the new ranking system that commenced 1st March 1992.

Beach	Rank 1992	Rank (May 1993)
Tung Wan (Ma Wan)	fair	fair
Anglers	poor	no data
Gemini	poor	poor
Ho Mei Wan	poor	poor/very poor
Casam	fair	poor
Lido	fair	poor
Ting Kau	poor	very poor
Approach	poor	very poor

  There are no non-gazetted beaches in the area.

- Ma Wan Fish Culture Zone, located on the west coast of Ma Wan; and

- aquatic life including fish and the Chinese White Dolphin.

6.2.4 Sea Bed Geology

A geotechnical assessment was undertaken in 1991 of the sea bed strata (Route 3 Design Stage 1, Contract No. HY/90/06, Ground Investigation for Tsing Yi Sector, Final Report Volume 1A, May 1991). The investigation showed that the bedrock is overlain by a mantle of soils varying in thickness between 2 to 50 metres, comprising marine clay, marine sand, alluvium and in-situ decomposed granite and volcanics.

6.2.5 Contaminated Marine Mud

The quality of marine mud in northern Rambler Channel and its vicinity has been investigated at a number of locations in different studies. The results considered in this report are from :

- Contaminated Spoil Management Study (CSMS);
- EPD's Monitoring Station in Rambler Channel (Marine Water Quality in Hong Kong 1990);
- Route 3 Design Stage 1 Investigation (Ground Investigation for Highways in Tsing Yi Sector, Final Report Volumes 1A and 5D); and
- Route 3 Design Stage 2 Investigation (Materialab, Ting Kau Bridge and Approach Viaduct, Sediment Analysis, GEO).

The classification criteria specified in EPD Technical Circular No. (TC) NO 1-1-92 sets contamination threshold levels as follows:

Table 6.5 Classification of Sediments by Metal Content (mg/kg dry weight)

	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
Class A	0.0-0.9	0-49	0-54	0.0-0.7	0-34	0-64	0-140
Class B	1.0-1.4	50-79	55-64	0.8-0.9	35-39	65-74	150-190
Class C	1.5 or more	80 or more	65 or more	1.0 or more	40 or more	75 or more	200 or more

Class A Uncontaminated material, for which no special dredging, transport or disposal methods are required beyond those which would normally be applied for the purpose of ensuring compliance with EPD's Water Quality Objectives, or for protection of sensitive receivers near the dredging or disposal areas.

Class B Moderately contaminated material, which requires special care during dredging and transport, and which must be disposed of in a manner which minimizes the loss of pollutants either into solution or by resuspension.

Class C Seriously contaminated material, which must be dredged and transported with great care, which cannot be dumped in the gazetted marine disposal grounds and which must be effectively isolated from the environment upon final disposal.

Contaminated Spoil Management Study :

In the CSM study sediment samples from different locations in the Hong Kong waters were analyzed for key metal pollutants. The results from the survey together with EPD's routine monitoring programme were used to establish a contamination database. The results from test locations adjacent to the TKB alignment (labelled A-F) are detailed below in Table 6.6 and their locations illustrated in Figure 6.4.

However, at locations E and F, the two closest sampling locations to the proposed bridge alignment, no mud samples were obtained, only rock was found. This suggests that although there is clearly marine mud contamination in the Rambler Channel, this may not be as evident along the proposed bridge alignment because the fast currents encountered in this area prevent silt and mud deposition.

Table 6.6 Analysis of Heavy Metals in Mud Samples (mg/kg), CSMS

	CSMS Reference	Copper Cu	Chromium Cr	Cadmium Cd	Lead Pb	Zinc Zn	Mercury Hg
A.	46	425	53	2.3	66	131	4.4
B.	47	930	117	1.0	90	307	0.47
C.	48	419	65	1.1	62	155	0.4
D.	49	204	81	0.73	93	143	0.56
E.	50	No sample (rock)		-	-	-	-
F.	65	No sample (rock)		-	-	-	-

Key : Class A Class B Class C

EPD Monitoring Station :

The bottom sediments in Hong Kong waters are mainly composed of fine silt and clay. The finest sediments are found in the western waters where influence from the Pearl River is most distinct.

Samples taken at the Rambler Channel Monitoring Station show high negative electro-chemical (Eh) values which indicates that the bottom sediments are anaerobic.

The levels of total organic carbon and nutrients are very high and this manifests the presence of significant organic and nutrient loads in the area.

Heavy metal content in samples from EPD's monitoring station in Rambler Channel (location G on Figure 6.4) gave the following results: (Marine Water Quality in Hong Kong, 1990)

Table 6.7 Analysis of EPD Mud Samples (mg/kg)

Nitrogen	Phosphorus	PCB (μg/kg)	PAH (μg/kg)	Cr	Cu	Zn	Ni	Pb	Hg
800-1000	>2000	>200	>200	25 -50	50 100	<100	20- 30	<50	0.6.9

Key : Class A Class B Class C

Note: (Results in mg/kg unless stated otherwise.)
PCB - Poly Chlorinated Biphenyl PAH - Poly Aromatic Hydrocarbon

Route 3 Design Stage 1 :

A geotechnical assessment for Route 3 CPS, TKB, was undertaken in May 1991. A total of 4 marine samples were taken as part of site investigation. The locations are shown in Figure 6.5. These samples were analyzed for toxic metal content and the results obtained are summarised in Table 6.8

Table 6.8 Heavy Metal Content of Marine Mud, Design Stage 1 (mg/kg)

Sample		Cadmium	Chromium	Mercury	Copper	Zinc
Hole No.	Depth(m)					
5013	0-1	2.0	5.2	0.02	22	26
5013	1.5-2.5	0.8	5.1	0.03	17	43
5014	0-1	0.8	42	0.24	148	131
5014	1.5-2.5	0.9	38	0.26	77	130
5017	0-1	1.0	5.6	0.1	18	38
5017	1.5-2.5	0.9	8.8	0.05	21	43
5021	0-1	1.6	5.5	0.06	70	37
5021	1.5-2.5	1.5	7.5	0.08	13	40

Key :

Class A	Class B	Class C

Route 3 CPS Design Stage 2 :

An additional detailed site investigation is being undertaken at the Design Stage 2 to assess the extent of mud contamination at the areas of the bridge supports and breakwater. Five samples were taken with vibrocore down to 12 metres depth in 3 boreholes and down to 5.6 metres in a fourth borehole. Unfortunately no analysis was undertaken of the samples from the fourth borehole until the 4m depth due to disturbed samples. There was no mud present in the borehole close to the Tsing Yi waterline. The results from the analysis are summarised in Table 6.9 and their locations along the bridge alignment is shown in Figure 6.5

Choosing a worst case scenario approach, the results in Tables 6.6, 6.7, 6.8 and 6.9 compared with EPD standards (given in Table 6.5), indicates that the main part of the samples analysed were Class C, i.e. seriously contaminated material, in particular with Copper and Cadmium. The Route 3 Design Stage 1 indicated contamination down to 2.5 metres depth but no deeper samples were taken to estimate the total depth of contamination.

The Stage 2 investigation samples were taken down to 12m depth and the results showed Class C seriously contaminated material in the upper levels (top 10cm) and Class A uncontaminated material below the 1 metre level. However, one sample indicated moderately contaminated material at 5.5 metres with uncontaminated sediments above. As there is no data for the material between the surface layers and the 1 metre depth it must therefore be assumed that the top 1 metre is contaminated.

On the basis of the available results it is necessary to classify the whole alignment as seriously contaminated material. The results do however show that much of the contamination is limited to the top 2.5 metres layer.

It appears from the EPD monitoring station results that there is also contamination of the mud with trace organic substances in the area.

6.3 CONSTRUCTION IMPACTS AND MITIGATION

6.3.1 Potential Impacts

Impacts can result from dredging and disposal of mud, however the extent of any impact depends greatly on the methods utilised and precautions taken.
No significant impact upon the marine environment is anticipated from piling activities because it will occur after dredging and any remaining mud would only be expected to be disturbed locally, if at all.

Mud Dredging and Disposal

Dredging and dumping of marine muds can result in deterioration of water quality by increasing turbidity, deoxygenating water and releasing heavy metals and organic pollutants into the ecosystem.

Table 6.9 Heavy Metal Content of Marine Mud, Design Stage 2 Investigation (mg/kg)

Sample		Copper	Cadmium	Chromium	Lead	Nickel	Zinc	Mercury
Borehole	Depth (m)							
VC4A	4.0 - 4.1m	10	< 0.2	26	12	18	57	0.05
VC4A	4.9 - 5.0m	12	< 0.2	32	23	22	71	0.04
VC4A	5.5 - 5.6m	12	0.98	24	46	24	73	0.06
VC5	0.0 - 0.1m	170	0.36	62	50	20	120	0.29
VC5	0.9 - 1.0m	20	< 0.2	25	31	8.2	66	0.16
VC5	1.9 - 2.0m	16	0.23	23	38	10	67	0.26
VC5	2.9 - 3.0m	7.8	< 0.2	16	24	8.4	42	0.10
VC5	5.9 - 6.0m	8.5	< 0.2	29	22	17	68	0.06
VC5	8.9 - 9.0m	12	< 0.2	32	29	17	78	0.06
VC5	11.9 - 12.0m	11	< 0.2	30	26	16	69	0.07
VC7	0.0 - 0.1m	127	0.27	45	44	15	94	0.20
VC7	0.9 - 1.0m	11	< 0.2	14	21	7.9	41	0.08
VC7	1.9 - 2.0m	5.8	< 0.2	14	19	8.6	38	0.05
VC7	2.9 - 3.0m	6.1	< 0.2	16	19	9.9	43	0.03
VC7	5.9 - 6.0m	10	< 0.2	27	27	14	63	0.06
VC7	8.9 - 9.0m	10	< 0.2	28	29	14	67	0.05
VC7	11.9 - 12.0m	12	< 0.2	35	29	16	68	0.06
VC9	0.0 - 0.1m	71	< 0.2	36	52	10	72	0.10
VC9	0.9 - 1.0m	6.4	< 0.2	16	18	8.5	38	0.03
VC9	1.9 - 2.0m	6.2	< 0.2	19	17	10	41	0.04
VC9	2.9 - 3.0M	7.1	< 0.2	20	19	11	47	0.04
VC9	5.9 - 6.0m	10	< 0.2	27	26	14	64	0.08
VC9	8.9 - 9.0m	7.9	< 0.2	22	23	10	48	0.05
VC9	11.9 - 12.0m	8.7	< 0.2	23	25	12	54	0.05
VC10	No mud present							

Key : Class A Class B Class C

Remark : 1. The test of copper, cadmium, chromium, lead, nicked and zinc content for sediment is accreditated by HOKLAS.
2. Results are based on mass of dry sample dried at 103-105°C.

Construction of the breakwater will require significant dredging. Previous reports indicate that 2.1Mm^3 is to be dredged but no information is available whether this quantity is based on a design where all mud is removed or only to a certain depth. Rough estimates of the volume of contaminated mud arising are approximately 110,000m^3 (assuming slope of breakwater wall is 2:1, 10m depth of water, 25m contaminated material). Mud analysis indicates that the top 2.5m are seriously contaminated Class C sediments which necessitates restrictions concerning dredging and disposal.

Dredging will also be required for the reclamation seawall located at the Ting Kau headland and the estimated total quantity is 110,000 m^3, of which some is likely to be contaminated.

The bridge supports will be on piles being pushed down through the mud to a solid foundation. This process will not require dredging but it will not be possible to avoid local disturbance to the mud. This impact in not considered to be severe however monitoring during the process is recommended. One of the support pylons is proposed to be placed on the large breakwater.

The Fish Culture Zone (FCZ) at Ma Wan is located in three well sheltered areas on the western coastline of Ma Wan, namely: Tam Shui Wan, Shek Tsai Wan and a small area in Kung Tsai Wan. Impacts on the FCZ at Ma Wan from the marine dredging work will depend on a number of factors such as distance to SR, the water and current directions at the time of the operations and the equipment being used. The FCZ is approximately 3km from the dredging works for the Ting Kau Bridge. For an impact at the FCZ to occur from the works area flood tides would have to be dominant. Inspection of the data obtained from the recently conducted WAHMO modelling indicate that current speeds at the dredging site are low at approximately 0.3 to 0.4m/s and that the flows derived from this area would be forced to the northern side of the Ma Wan Channel by the flows from the Western Harbour, see Figure 6.6.

The current velocity plots show that for the water at Ma Wan FCZ to be impacted by the dredging operations at Ting Kau sediment transport lateral to the main tidal flow would be required, this could be achieved through the generation of a density current. Data from the CSM Study, Figure 6.11, indicates that the surface suspended sediment concentrations fall by an order of upto 10 times within 150m down current of the dredging site and for the near bottom suspended loads, the concentrations fall at a significantly higher rate over the same distance, this latter point is important as density currents travel in the lower layers of the water column. Given the above it is not expected that any impacts on the Ma Wan FCZ will occur from the dredging operations for the Ting Kau Bridge.

It should also be noted that the extensive and detailed monitoring programmes and action plans proposed will further protect the FCZ from impacts due to the Ting Kau Bridge works. Prior to and after any dredging activity baseline water quality will be monitored. During the dredging works it is recommended that 2 monitoring stations and 1 control station be used, the results from these monitoring stations will, in conjunction with the action plans, be used to control the dredging activities, in certain cases the action plans allow for the cessation of works.

6.3.2 Mitigation

Dredging and Dumping

Uncontaminated mud may be disposed of at the gazetted spoil grounds and no special dredging, transport or disposal methods are required beyond those which would normally be applied for the purpose of protecting SRs near the dredging and disposal areas.

Seriously contaminated mud, i.e. Class C, would require dredging and transporting with great care and use of special procedures. It could not be dumped in gazetted spoil disposal grounds but would require disposal at, for example, a site similar to the East Sha Chau Contaminated Mud Disposal Area. A license for dumping the contaminated mud is required.

Construction of the seawall and breakwater, leaving the mud in-situ is a preferred method recommended on environmental grounds. It is however unlikely that this method will be appropriate for the construction of the seawalls, but could be possible for the breakwater.

To minimise potential impacts, the following general pollution avoidance measures would need to be followed during the dredging, transporting and disposal of dredged mud:

- mechanical grabs should be designed, maintained and used to avoid spillage closed grabs which seal tightly should be used. While being lifted, reduced winch speeds would aid in lower sediment loss;

- cutterheads of suction dredgers would be suitable for the material being excavated and should minimise overbreak and sedimentation around the cutter;

- where trailing suction hopper dredgers are used for dredging marine mud, overflowing from the dredger, and the operation of automatic lean mixture overboard systems (ALMOB), should not be permitted;

- all construction plants should be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash;

- all pipe leakages should be repaired promptly and construction plant would not be operated with leaking pipes;

- dredging should cause no visible foam, oil, grease, scum, litter or other objectionable matter to be present on the water;

- all barges and hopper dredgers should be fitted with tight fitting seals to their bottom openings to prevent leakage of material;

- excess material should be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessels are moved;

- loading of barges and hoppers should be controlled to prevent splashing of dredged material to the surrounding water and barges or hoppers should not be filled to a level which would cause overflowing of material or polluted water during loading or transportation;

- adequate freeboard should be maintained on barges to ensure that decks are not washed by wave action;

- care should be taken to ensure that the barges are loaded in such a manner that dredged material does not spill onto decks and exposed fittings; and

- when the dredged material has been unloaded at the disposal area, any material which has accumulated on the deck or other exposed parts of the vessel should be removed and placed in the hold or hopper. Under no circumstance should decks be washed clean in a way that permits material to be released overboard. Hoppers and holds should not be flushed with water to remove any remaining material and should remain tightly closed at all times.

In addition to the above, when dredging within 100m of a beach, the following additional mitigation measures should be employed:

- a floating silt curtain (and/or placement by tremie pipe if water quality monitoring dictates) should be utilised to contain suspended solids;
- dredging should be curtailed when barges move in and out of the silt curtain enclosure; and
- slow hoist speed should be used. (The actual speed will depend on the specific location)

Water quality monitoring during dredging activities and for a period of 4 to 6 weeks after completion of marine works should be undertaken as detailed in Chapter 13.

The above general mitigation measures may provide a basis for specific mitigation measures which should be identified during the EIA of the detailed design when details of dredging locations, quantities and Mud Contamination levels will be known.

6.4 OPERATIONAL IMPACTS AND MITIGATION

6.4.1 Computer Modelling (WAHMO)

The potential water quality impacts arising from the operation of the TKB will be associated with the imposition of bridge piers (supports), in a reclamation on the northern shore and a breakwater in the northern Rambler Channel.

The likely effects are changes in the hydraulic regime (flows, currents, etc.) and associated changes in water quality (dissolved oxygen, BOD, E. coli, SS etc.) A water quality computer modelling study has been carried out and the scope and basic study details were agreed with EPD. The study details and findings will be presented in a Supplementary Report as a separate document but as part of this TKB EIA.

During the Phase I study some WAHMO computer modelling and some physical modelling were carried out and a short review of the findings are provided below:

6.4.2 Review of Previous Hydraulic Modelling

WAHMO Modelling

A hydraulic study using the Port Works Tidal Flow Model and EPD's Water Quality Model was carried out during the Feasibility Study and the results of this modelling were reported in June 1989 in the Hydraulic Study Working Paper:

Three scenarios were modelled, a *Base Case* which modelled existing conditions, a *Basic Scheme* which included reclamation on Tsing Yi Island, Stonecutters Island and Tseun Wan Bay and a long Breakwater at the Ting Kau Bridge and a *Scheme A1*, which included reclamations at Tsing Yi and Stonecutters Island and a short breakwater located at the Ting Kau Bridge.

All scenarios were modelled for flood and ebb tides using both spring and neap tidal condition. Both scenarios of the Port Works model showed a general reduction in flows through the Rambler Channel, but without an increase in the siltation rates. The water quality modelling carried out by EPD showed that in general the water quality improved within the area. Reductions in water quality occurred within the Ting Kau Bay and the waters located inside (eastwards) the breakwater. From the modelling a number of conclusions and recommendations were made and these include:

- a general reduction in the channel flow velocities easing vessel movements, but without an increase in sedimentation rates which is usually associated with flow rate reductions;
- the reclamation in Tseun Wan Bay will improve water quality within the Rambler Channel significantly;
- a reduction in water quality of about 10% will occur within the Ting Kau Bay area on completion of the short breakwater, this reduction was felt to be unacceptable; and it was recommended that;
- a further round of detailed WAHMO modelling, using a model based on a smaller more accurate grid, should be carried out to examine the effect of reshaping the breakwater to provide an optimum design in terms of water quality and ship protection.

Due to limitations in the original WAHMO water quality model used, recommendation was not made to carry out further detailed modelling. Further modelling was executed using a physical model, results of which are reviewed below.

Physical Modelling

The Port Works Physical Model located at Tuen Mun was used for these works. Objectives of this work was to model a breakwater and pier configuration which provided protection from ships without adversely affecting the water flows in the Rambler Channel. From these limitations a breakwater design was devised and subsequently modelled.

The results of the modelling showed that with the breakwater in place, a general increase in Nett Flows through the Rambler Channel will occur for both Spring and Neap tides. The increase in flows would mean that the flushing of the channel would be increased with a consequent reduction in pollution levels.

The results also showed that increased water circulation at Ting Kau Beach would occur, which would reduce pollution levels. Increased lateral flows would occur at the adjacent beaches but this should not have any significant effect as a general reduction in flow velocities was recorded.

Three scenarios were modelled, a *Base Case* which modelled existing conditions, a *Basic Scheme* which included reclamation on Tsing Yi Island, Stonecutters Island and Tseun Wan Bay and a long Breakwater at the Ting Kau Bridge and a *Scheme A1*, which included reclamations at Tsing Yi and Stonecutters Island and a short breakwater located at the Ting Kau Bridge.

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The results also showed that increased water circulation at Ting Kau Beach would occur, which would reduce pollution levels. Increased lateral flows would occur at the adjacent beaches but this should not have any significant effect as a general reduction in flow velocities was recorded.

The previous WAHMO modelling showed that the predominant flow was east to west; this was not the case when using the physical model, when the predominant flow was west to east. One consequence of the change of dominant flows would mean that the main effluent discharge at Tsuen Wan Bay will exit Rambler Channel to the south, thereby improving water quality at Ting Kau Bay.

It should be noted that whilst the pollution levels at the beaches in Ting Kau Area due to pollutants discharged at Tsuen Wan could be reduced with the net flow direction in the Rambler Channel becomes form west to east, pollutants from Sham Tseng (which is closer to the beaches than Tsuen Wan) and all those discharges in the Urmston Road will enter the Rambler Channel. This will somewhat balance the reduction in pollution due to discharges in Tsuen Wan area. Furthermore, the beaches would still be affected by the pollutants discharged at Tsuen Wan during certain period of a tidal cycle.

Also the net flow is not only calibrated against the tidal flow out the residual flow which may be quite sensitive to the calibration parameters. Hence the modelling results should be assessed conservatively.

It should be noted that whilst the pollution levels at the beaches in the Ting Kau area due to pollutants discharged at Tsuen Wan could be reduced with the net flow direction in the Rambler Channel becomes from west to east, pollutants from Sham Tseng (which is closer to the beaches than Tsuen Wan) and all those discharges in the Urmston Road will enter the Rambler Channel.

6.5 SURFACE WATER QUALITY

Tsing Yi

North West Tsing Yi Island has steep slopes and is sparsely vegetated with grasses, disturbed sedges and occasional planted shrubs. The existing water courses that carry the run-off from the land to the Rambler Channel and the sea are generally clean and silt free. Other than during and after exceptional rainfall, there is generally very little flow in any of them.

Ting Kau

The well vegetated southern facing slopes of Ting Kau are drained by a small water course that enters the northern Rambler Channel at the eastern end of Lido Beach. The stream originates to the north above the Tuen Mun Road. The TKB will run across the catchment area and the bridge support pylons will be located in part of the catchment.

The current activities that take place in the catchment are :

- water gathering via the catchwater above Tuen Mun Road which has partially dewatered the stream;
- small scale orchard plots situated along part of the upper catchment;
- residential dwellings have been built in the lower catchment area, below the Tuen Mun Road;
- two roads pass through the catchment area;

- culverts drain storm water to the water course below the catchwater from various cuttings associated with the Catchwater Road and Tuen Mun Road; and

- the stream mouth is trained in its lower reaches and runs through a nullah at Lido Beach.

6.5.1 Legislation

The core environmental legislative provisions for protecting Hong Kong's water courses are represented by the Water Pollution Control Ordinance WPCO (Cap.311), the Waste Disposal (Livestock Waste) Regulations 1988 under the Waste Disposal Ordinance (Cap.354), and the Technical Memorandum (Standards for Effluents Discharged into Drainage and Sewage Systems, Inland and Coastal Waters, 1990).

Under the Water Pollution Control Ordinance the Government is empowered to declare various Water Control Zones (WCZ). In these Water Control Zones polluting discharges are controlled to maintain the desired beneficial uses including direct water supplies, irrigation, aquaculture, preservation of aquatic wildlife, active and passive recreation, transport and stormwater channels.

To date, eight Water Control Zones have been gazetted under the WPCO. Tentatively the Hong Kong Government intends to apply the Water Pollution Control Ordinance to the remaining inland and marine waters before 1995. The study area for the TKB EIA lies in the newly gazetted Western Buffer Water Control Zone.

A summary of the WQO's is presented in Table 6.1 . The area affected by this zone is shown in Figure 6.1

The Relevant Technical Memorandum standards required for discharges into inshore and marine waters for the Western Buffer Water Control Zone are shown in Table 6.2 and 6.3 respectively.

6.5.2 Construction Phase Impacts

Tsing Yi

The key construction activities in this area centres around the North West Tsing Yi Interchange and the southern bridge support. Major earth works will be required here. Potential impacts will relate to surface water run-off resulting in high suspended solids leading to increases in water turbidity. There is potential for contamination to occur through the use of construction chemicals.

Ting Kau

The major construction activities in this area will be associated with the bridge pylons that support the bridge at landfall and the Ting Kau Interchange (ramps H and G). At the Ting Kau Interchange major areas of cutting will be required to facilitate both ramps. Ramp G will be supported on pylons which will vertically shadow the lower stream course which lies close to Lido Beach.

In the course of construction large volumes of concrete will be required for the TKB. A potential source of impact will be the release to surface waters, via run-off or other routes, of liquors containing significant quantities of cement derived materials. Unless precasting is used a batching plant will be required. In-situ casting will create a linear works site with potential impacts occurring both at the construction site and the vertical shadow below it.

Discharge or run-off of lime based materials if uncontrolled would be likely to cause the following primary effects:

- localised increases in turbidity and discoloration;
- localised elevations in pH; and
- accretion of high pH solids.

Detrimental effects to fresh water biota results from contact with elevated levels of pH and sediments in the water.

In addition to concrete and cement derived materials it is possible that quantities of spoil and fill material from construction site run-off could be carried to fresh waters via the drainage system. Such solids have the potential to cause localised problems such as increases in turbidity, discoloration, increases in biochemical oxygen demand (BOD) and nutrient enrichment.

Potential impacts also exist from spillage, leakages and indiscriminate disposal of fuel oils, lubricants and hydraulic fluids used by construction vehicles and plant. These hydrocarbons are potentially toxic to fresh water biota and persist in fresh water sediments.

A further potential impact exists from any uncontrolled discharge of domestic wastes from canteen, washroom and toilet facilities which would be provided at construction sites. The additional BOD, nutrient and faecal bacteria loadings are obviously undesirable in this already impacted area (northern Rambler Channel) and would further prejudice compliance with WQO criteria.

Sensitive receivers

Currently there are various freshwater fauna species associated with the stream near Ting Kau. Fish were recorded at the site on surveys that were carried out during April and May 1993. It can be expected that the freshwater biota in the stream already come under the influence of run-off from small scale fruit plots (pesticides and fertilizers), road run-off, and sewage from the residential dwellings located in the catchment. Further stresses resulting from smothering, exposure to toxins or elevated pH levels would therefore be particularly undesirable.

Compounding effects would result from any impacts on the fresh water system as these would be transferred to the marine environment, via the direct input of the catchment.

Mitigation of impact

With the Western Buffer Water Control Zone declared and the schedule in place covering the area of the proposed TKB any discharges from the site will now be subject to the specific Technical Memorandum schedule (Table 6.2 and 6.3) (Standards for Effluents Discharged into Drainage and Sewage Systems, Inland and Coastal Waters, 1990).

In view of the potential impacts described controls should be applied and site run-off treated wherever practicable. It is considered that clauses should be included in construction contracts requiring these measures to be carried out.

Control and treatment should include the following:

- site compounds should be designed to take account of contaminated surface water. This will involve provision of drainage channels and settlement lagoons to allow interception and controlled release of settled/treated waters;

- discharges from concrete batching should be settled and if necessary pH adjustment made to the supernatant liquor. In the event of settlement alone being insufficient to settle colloidal materials, consideration should be given to further treatment with settling agents prior to discharge;

- oil interceptors should be provided in site compounds and regularly emptied to prevent release of oils and grease into the surface water drainage systems after accidental spillages. The interceptor should have a by-pass to prevent flushing during periods of heavy rain. Oil and fuel bunkers should be bunded to prevent discharges due to accidental spills or breaching of tanks;

- any stockpiles of spoil or fill materials should be treated to reduce erosion of the stockpile and sediment release. In some cases it may be prudent to provide a separate settlement system for larger stockpiles to collect contaminated surface water prior to release to the site drainage system; and

- where possible connection of sewage discharges should be to the existing foul sewage system. Alternatively chemical toilet facilities with appropriate disposal arrangements should be considered and provided where necessary. In any office or site canteen foul water effluent shall be directed to a foul sewer or to water treatment facilities either directly or indirectly by means of pumping.

Monitoring

The detailed Monitoring and Audit requirements are given in Chapter 13 however some general requirements include:

- discharges should be monitored and managed to achieve compliance with the Technical Memorandum in respect to the Western Buffer Water Control Zone.

- inspections should be carried out periodically to ensure that good site practice is being observed and that settlement tanks and lagoon are managed and maintained to ensure optimum performance;

- in the case of wastes containing cement-derived materials, periodic checks should be made on the pH values of the liquor discharged and the receiving waters in the immediate vicinity of the discharge; and

- periodic inspections of oil interceptors should be made to ensure that these are working satisfactorily and that oil derived wastes are collected regularly for appropriate off-site disposal.

6.5.3 Operational Phase

The operational phase impacts should be significantly less than the construction phase impacts.

The main area of potential impact is from runoff from the TKB and its associated sliproads and the transport of material to freshwaters and marine waters.

The main sources of potential contamination are:

- sediment from accumulation on the TKB and the sliproads;
- hydrocarbons and other contaminants resulting from vehicular usage of the TKB;
- hazardous materials (possibly environmentally persistent chemicals or wastes) resulting from spillage, following road traffic accidents.

Sediment burdens in run-off water from elevated sections of the TKB are likely to be small. The most likely sections of the TKB for the incidence of sediment build up would be the slightly depressed and at grade sections where silt and debris could be carried to the area.

The quantities of sediment involved would not be significant and would be similar to those which might be expected for the surrounding area. Impact on freshwater would be decreased as landscape works become more established.

As well as small quantities of oil and petroleum resulting from drippage and spillage from motor vehicles it is also known that urban run-off contains quantities of other contaminants including lead, zinc and cadmium which are present largely as a result of vehicular use. The quantities present in TKB surface run-off would not be expected to be different to those found in any urban run-off derived from large scale vehicular transport infrastructure.

The discharge of this run-off would be unlikely to produce any quantifiable adverse effects and does not justify the incorporation of special mitigation measures.

Significant spillage of hazardous materials as a result of traffic accidents would be anticipated to be an infrequent occurrence. The number of variables involved makes the incidence of such events difficult to predict and assess.

Mitigation of Impact

The transport of the albeit small quantities of sediment to the fresh water environment would be minimised by the installation of appropriate sediment traps within the drainage system.

Reduction or prevention of impact resulting from spillage of hazardous materials could be effected by the installation of " close-off " valves at strategic points within the drainage system. This regime would allow interim storage of a liquid waste or a solid waste carried to the system by wash down procedures. Recovery of materials could be made subsequently and appropriate measures taken for disposal.

The infrequency of such events however makes the additional costs, practicality and complications created by such a system questionable and is not recommended. In the absence of the system described, spillages should, where possible, be contained and recovered.

Monitoring

With the exception of routine inspection and maintenance of the drainage system to ensure that sediment traps within the system are regularly cleared, no other monitoring will be required.

6.5.4 Summary of Key Issues

During the construction phase the key issues will be the prevention of materials, chemicals, sewage etc., from entering the water course and thus the marine waters, suitable clauses should be included in the contract documentation to limit impacts.

During the operational phase the only potential impacts are spillages both routine and accidental.

Table 6.1: WBWCZ Water Quality Objectives

A.	**Aesthetic Appearance**	
(a)	There should be no objectionable odours or discolouration of the water.	Whole Zone
(b)	Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole Zone
(c)	Mineral oil should not be visible on the surface Surfactant should not give rise to a lasting foam.	Whole Zone
(d)	There should be no recognisable sewage-derived debris.	
(e)	Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels,or cause damage to vessels, should be absent.	
(f)	The water should not contain substances which settle to form objectionable deposits.	Whole Zone
B.	**Bacteria**	
(a)	The level of Escherichia coli should not exceed 610 per 100ml, calculated as the geometric mean of all samples collected in a calendar year.	Secondary Contact Recreation Subzones and Fish Culture Subzones
(b)	The level of Escherichia coli should not exceed 180 per 100ml, calculated as the geometric mean of all samples collected from March to October inclusive in 1 calendar year. Samples should be taken at least 3 times in 1 calendar month at intervals of between 3 and 14 days.	
(c)	The level of Escherichia coli should be less than 1 per 100ml, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Water Gathering Ground Subzones
(d)	The level of Escherichia coli should not exceed 1000 per 100ml, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Other inland waters
C.	**Colour**	
(a)	Human activity should not cause the colour of water to exceed 30 Hazen units.	Water Gathering Ground Subzones
(b)	Human activity should not cause the colour of water to exceed 50 Hazen units.	Other inland waters
D.	**Dissolved Oxygen**	
(a)	The level of dissolved oxygen should not fall below 4 mg per litre for 90% of the sampling occasions during the whole year, values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed). In addition, the concentration of dissolved oxygen should not be less than 2mg per litre within 2m of the seabed for 90% of the sampling occasions during the whole year.	Marine waters excepting Fish Culture Subzones
(b)	The level of dissolved oxygen should not be less than 5 mg per litre for 90% of the sampling occasions during the year, values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 m below surface mid-depth and 1 m above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 mg per litre within 2 m of the seabed for 90% of the sampling occasions during the whole year.	
(c)	The level of dissolved oxygen should not be less than 4 mg per litre.	Water Gathering Ground Subzones and other inland waters
E.	**pH**	
(a)	The pH of the water should be within the range of 6.5-8.5 units. In addition, human activity should not cause the natural pH range to be extended by more than 0.2 unit.	
(b)	Human activity should not cause the pH of the water to exceed the range of 6.5-8.5 units.	Water Gathering Ground Subzones
(c)	Human activity should not cause the pH of the water to exceed the range of 6.0-9.0 units.	
F.	**Temperature** Human activity should not cause the natural daily temperature range to change by more than 2.0°C.	Whole zone
G.	**Salinity** Human activity should not cause the natural ambient salinity level to change by more than 10%.	Whole zone

Table 6.1 Cont'd

H.	**Suspended Solids**	
(a)	Human activity should neither cause the natural ambient level to be raised by more than 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters
(b)	Human activity should not cause the annual median of suspended solids to exceed 20 mg per litre.	Water Gathering Ground Subzones
(c)	Human activity should not cause the annual median of suspended solids to exceed 25 mg per litre.	Other inland waters
I.	**Ammonia** The un-ionized ammoniacal nitrogen level should not be more than 0.021 mg per litre, calculated as the annual average (arithmetic mean).	Whole zone
J.	**Nutrients**	
(a)	Nutrients should not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Marine waters
(b)	Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.4 mg per litre expressed as annual water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed).	Marine waters
K.	**5-Day Biochemical Oxygen Demand**	
(a)	The 5-day biochemical oxygen demand should not exceed 3mg per litre.	Water Gathering Ground Subzones
(b)	The 5-day biochemical oxygen demand should not exceed 5mg per litre.	Other inland waters
L.	**Chemical Oxygen Demand**	
(a)	The chemical oxygen demand should not exceed 15 mg per litre.	Water Gathering Ground Subzones
(b)	The chemical oxygen demand should not exceed 30 mg per litre.	Other inland waters
M.	**Toxic substances**	
(a)	Toxic substances in the water should not attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.	Whole zone
(b)	Human activity should not cause a risk to any beneficial use of the aquatic environment.	Whole zone
N.	**Turbidity** Waste discharges should not reduce light transmission substantially from the normal level.	Bathing Beach Subzones

Table 6.2 Standards for Effluent Discharged into the Inshore Waters of Western Buffer Water Control Zone
(All units in mg/L unless otherwise stated; all figures are upper limits unless otherwise indicated)

Determinant / Flow rate (m^3/day)	≤10	>10 and ≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	>800 and ≤1000	>1000 and ≤1500	>1500 and ≤2000	>2000 and ≤3000	>3000 and ≤4000	>4000 and ≤5000	>5000 and ≤6000
pH (pH units)	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9
Temperature (°C)	40	40	40	40	40	40	40	40	40	40	40	40
Colour (lovibond units)(25mm cell length)	1	1	1	1	1	1	1	1	1	1	1	1
Suspended solids	50	30	30	30	30	30	30	30	30	30	30	30
BOD	50	20	20	20	20	20	20	20	20	20	20	20
COD	100	80	80	80	80	80	80	80	80	80	80	80
Oil & Grease	30	20	20	20	20	20	20	20	20	20	20	10
Iron	15	10	10	7	5	4	3	2	1	1	0.8	0.6
Boron	5	4	3	2	2	1.5	1.1	0.8	0.5	0.4	0.3	0.2
Barium	5	4	3	2	2	1.5	1.1	0.8	0.5	0.4	0.3	0.2
Mercury	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Other toxic metals individually	1	1	0.8	0.7	0.5	0.4	0.3	0.2	0.15	0.1	0.1	0.1
Total toxic metals	2	2	1.6	1.4	1	0.8	0.6	0.4	0.3	0.2	0.1	0.1
Cyanide	0.2	0.1	0.1	0.1	0.1	0.1	0.05	0.05	0.03	0.02	0.02	0.01
Phenols	0.5	0.5	0.5	0.3	0.25	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Sulphide	5	5	5	5	5	5	2.5	2.5	1.5	1	1	0.5
Total residual chlorine	1	1	1	1	1	1	1	1	1	1	1	1
Total nitrogen	100	100	80	80	80	80	50	50	50	50	50	30
Total phosphorus	10	10	8	8	8	8	5	5	5	5	5	5
Surfactants (total)	20	15	15	15	15	15	10	10	10	10	10	10
E. coli (count/100 ml)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

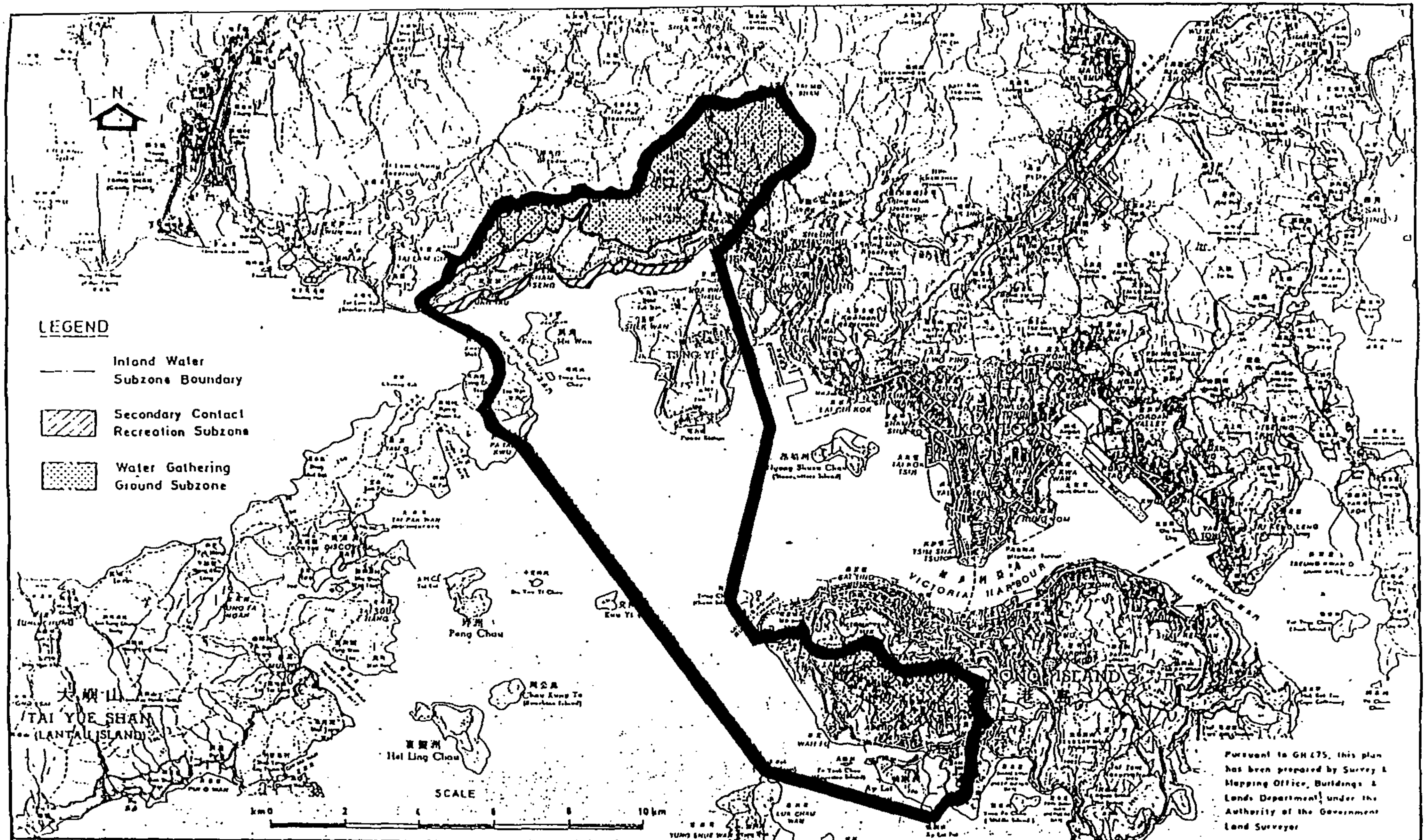
Table 6.3 Standards for Effluent Discharged into the Marine Waters of Western Buffer Water Control Zone
(All units in mg/L unless otherwise stated; all figures are upper limits unless otherwise indicated)

Determinant / Flow rate (m^3/day)	≤10	>10 and ≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	>800 and ≤1000	>1000 and ≤1500	>1500 and ≤2000	>2000 and ≤3000	>3000 and ≤4000	>4000 and ≤5000	>5000 and ≤6000
pH (pH units)	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10
Temperature (°C)	45	45	45	45	45	45	45	45	45	45	45	45
Colour (lovibond units)(25mm cell length)	4	1	1	1	1	1	1	1	1	1	1	1
Suspended solids	500	500	500	300	200	200	100	100	50	50	40	30
BOD	500	500	500	300	200	200	100	100	150	50	40	30
COD	1000	1000	700	700	500	400	300	200	150	100	50	80
Oil & Grease	50	50	50	30	25	20	20	20	20	20	20	20
Iron	20	15	13	10	7	6	4	3	2	1.5	1.2	1
Boron	6	5	4	3.5	2.5	2	1.5	1	0.7	0.5	0.4	0.3
Barium	6	5	4	3.5	2.5	2	1.5	1	0.7	0.5	0.4	0.3
Mercury	0.1	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.1	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Other toxic metals individually	2	1.5	1.2	0.8	0.6	0.5	0.32	0.24	0.16	0.12	0.1	0.1
Total toxic metals	4	3	2.4	1.6	1.2	1	0.64	0.48	0.32	0.24	0.2	0.14
Cyanide	1	0.5	0.5	0.5	0.4	0.3	0.2	0.1	0.1	0.08	0.06	0.04
Phenols	0.5	0.5	0.5	0.3	0.25	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Sulphide	5	5	5	5	5	5	2.5	2.5	1.5	1	1	0.5
Total residual chlorine	1	1	1	1	1	1	1	1	1	1	1	1
Total nitrogen	100	100	80	80	80	80	50	50	50	50	50	50
Total phosphorus	10	10	8	8	8	8	5	5	5	5	5	5
Surfactants (total)	30	20	20	20	15	15	15	15	15	15	15	15
E. coli (count/100 ml)	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000

Table 6.4 **Summary Statistics of 1990 Water Quality of Victoria Harbour**

Determinant		Rambler Channel	Tsing Yi Island West
Temperature (°C)	Surface	23.194 (15.950 - 29.674)	22.791 (16.050 - 28.341)
	Bottom	22.640 (15.890 - 28.503)	22.180 (15.980 - 27.971)
Salinity (ppt)	Surface	29.023 (20.620 - 32.150)	29.352 (16.050 - 32.470)
	Bottom	30.661 (25.637 - 32.270)	31.632 (31.010 - 33.916)
D.O. (% satn.)	Surface	70.192 (37.600 - 132.416)	85.289 (39.880 - 135.309)
	Bottom	59.771 (44.866 - 79.638)	71.371 (41.606 - 108.500)
pH		8.277 (7.860 - 8.813)	8.331 (7.910 - 8.710)
Secchi Disc (m)		1.775 (0.900 - 5.000)	2.183 (1.300 - 3.400)
Turbidity (NTU)		5.872 (1.950 - 27.000)	6.610 (2.300 - 14.733)
S.S. (mg/L)		5.352 (1.500 - 17.333)	5.215 (1.000 - 14.500)
BOD_5 (mg/L)		1.146 (0.170 - 2.745)	0.731 (0.087 - 1.677)
Inorganic N (mg/L)		0.352 (0.102 - 0.982)	0.233 (0.146 - 0.491)
Total N (mg/L)		0.940 (0.515 - 3.123)	0.632 (0.378 - 1.064)
PO4 - P (mg/L)		0.052 (0.002 - 0.136)	0.026 (0.003 - 0.084)
TP (mg/L)		0.097 (0.033 - 0.253)	0.101 (0.040 - 0.497)
Chlorophyll - a (μg/L)		1.759 (0.233 - 9.800)	1.468 (0.533 - 5.133)
E. coli (no./100ml)		978 (67 - 995000)	190 (10 - 1000)

Note :
1. Except as specified, data presented are depth average data.
2. Data presented are annual means except for *E. coli* data which are annual geometric means.
3. Data enclosed in brackets indicate the ranges.



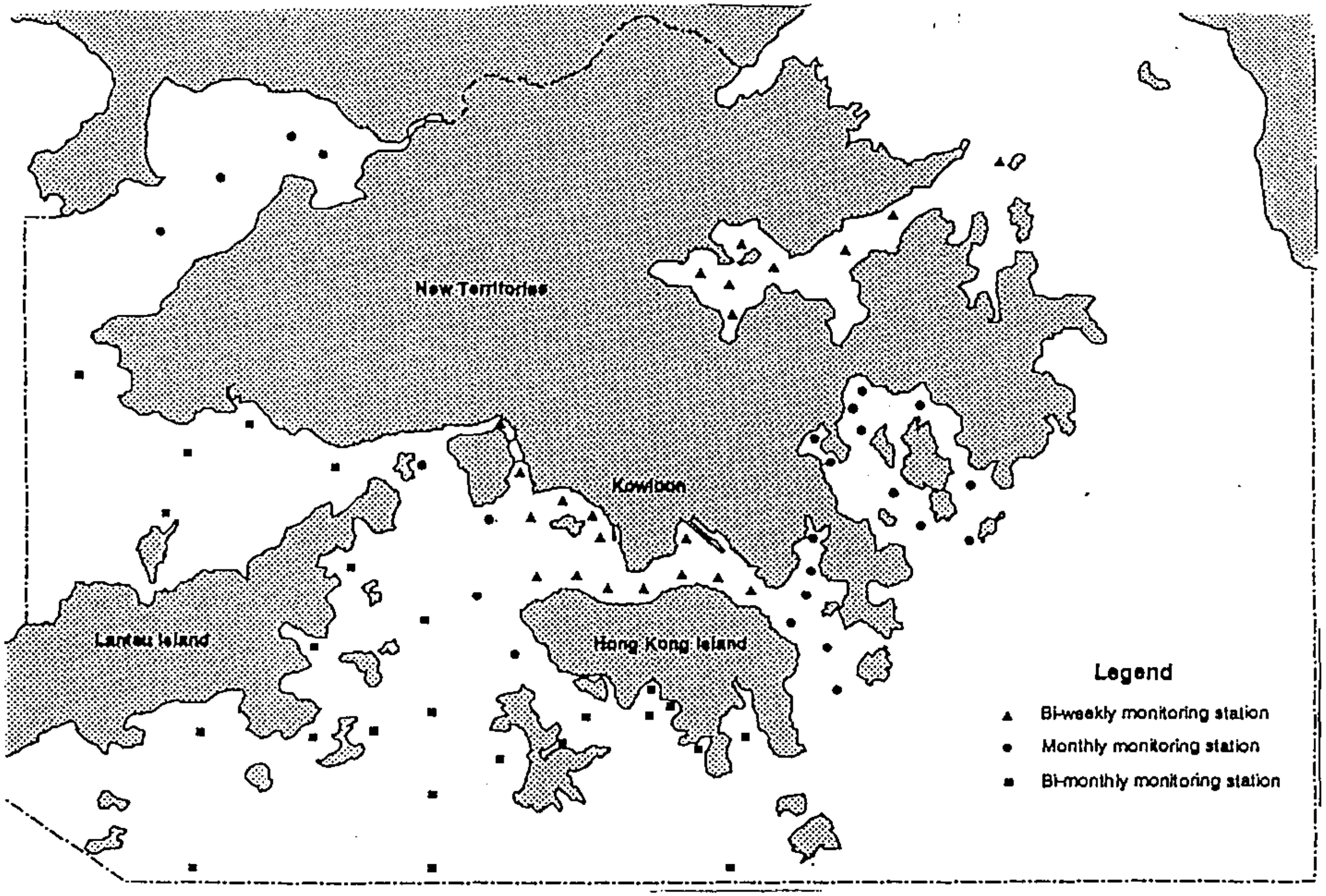
The area edged grey on map is designated as a Water Control Zone under Section 4(1)(a) of the Water Pollution Control Ordinance Cap. 358.

—— Delineation of Inland Water Subzones under Section 5(5) of the above Ordinance

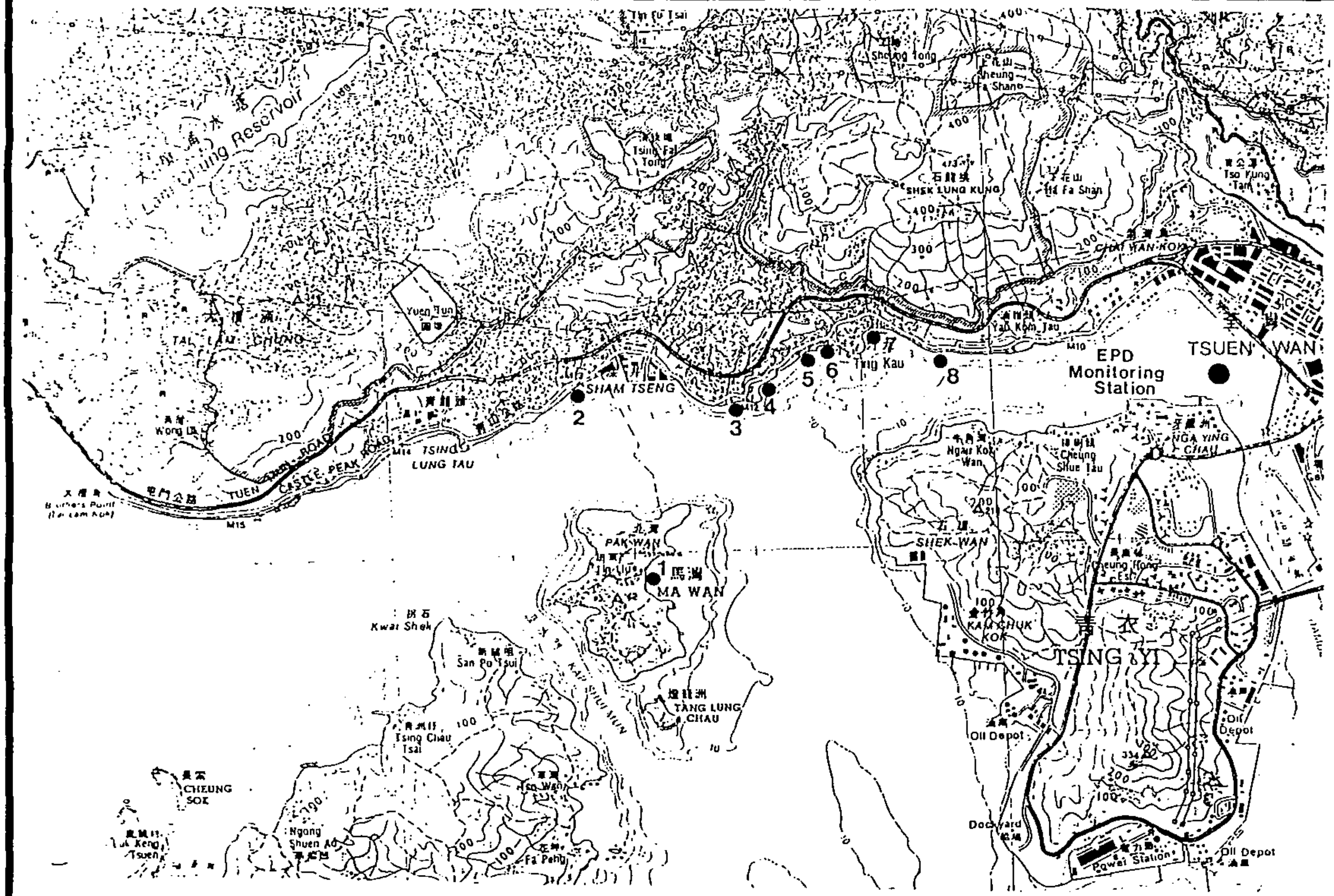
西部緩衝區水質管制區
WESTERN BUFFER WATER CONTROL ZONE
DELINEATION OF ZONE AND SUBZONES

PLANNING, ENVIRONMENT AND LANDS BRANCH
GOVERNMENT SECRETARIAT

Fig. No. 6.1

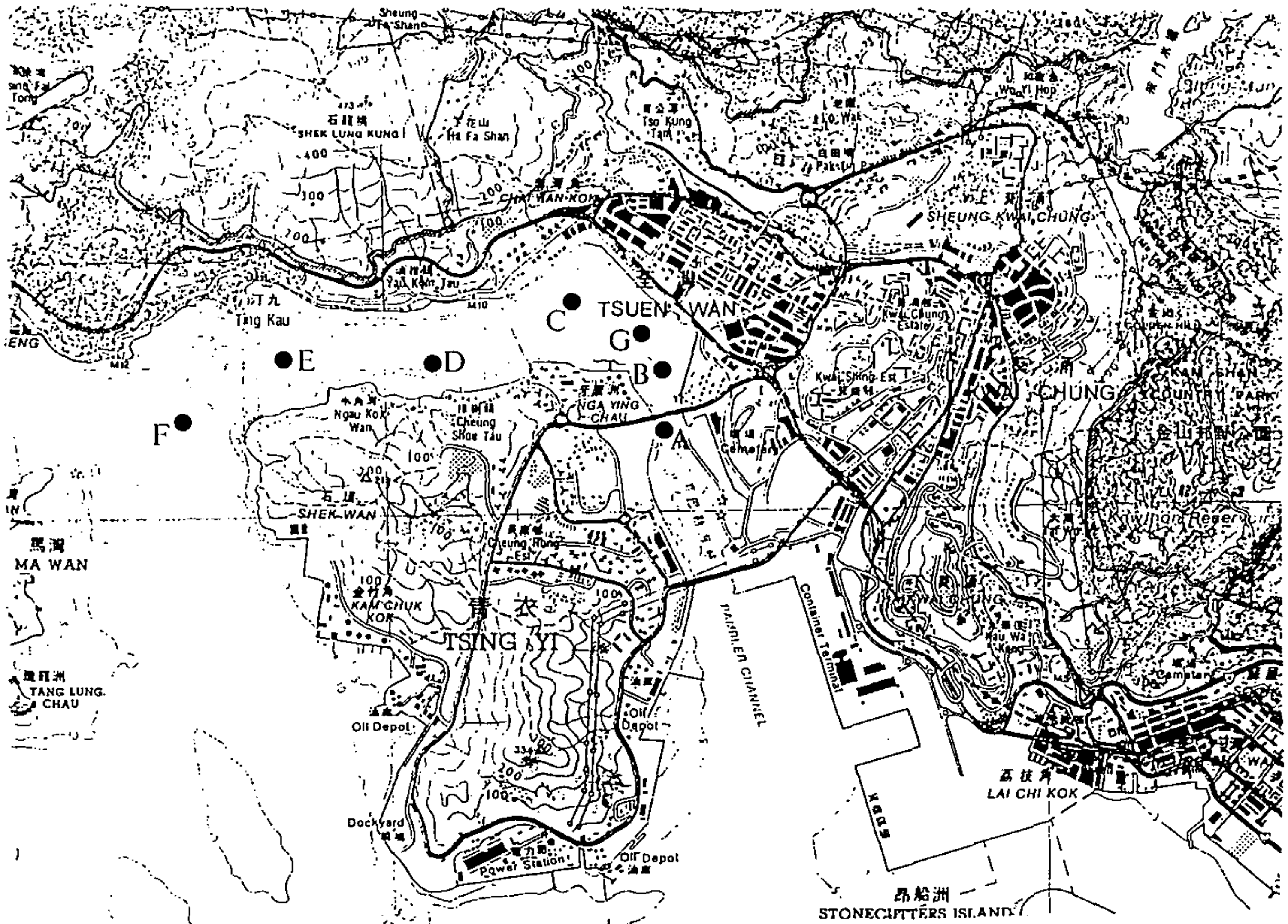


FREEMAN FOX MAUNSELL	Drg. Title : WATER QUALITY SAMPLING LOCATIONS	Job Title : ROUTE 3 TING KAU BRIDGE EIA	
		Scale : / Date July 1993	Job No. 058000	Fig. No. 6.2

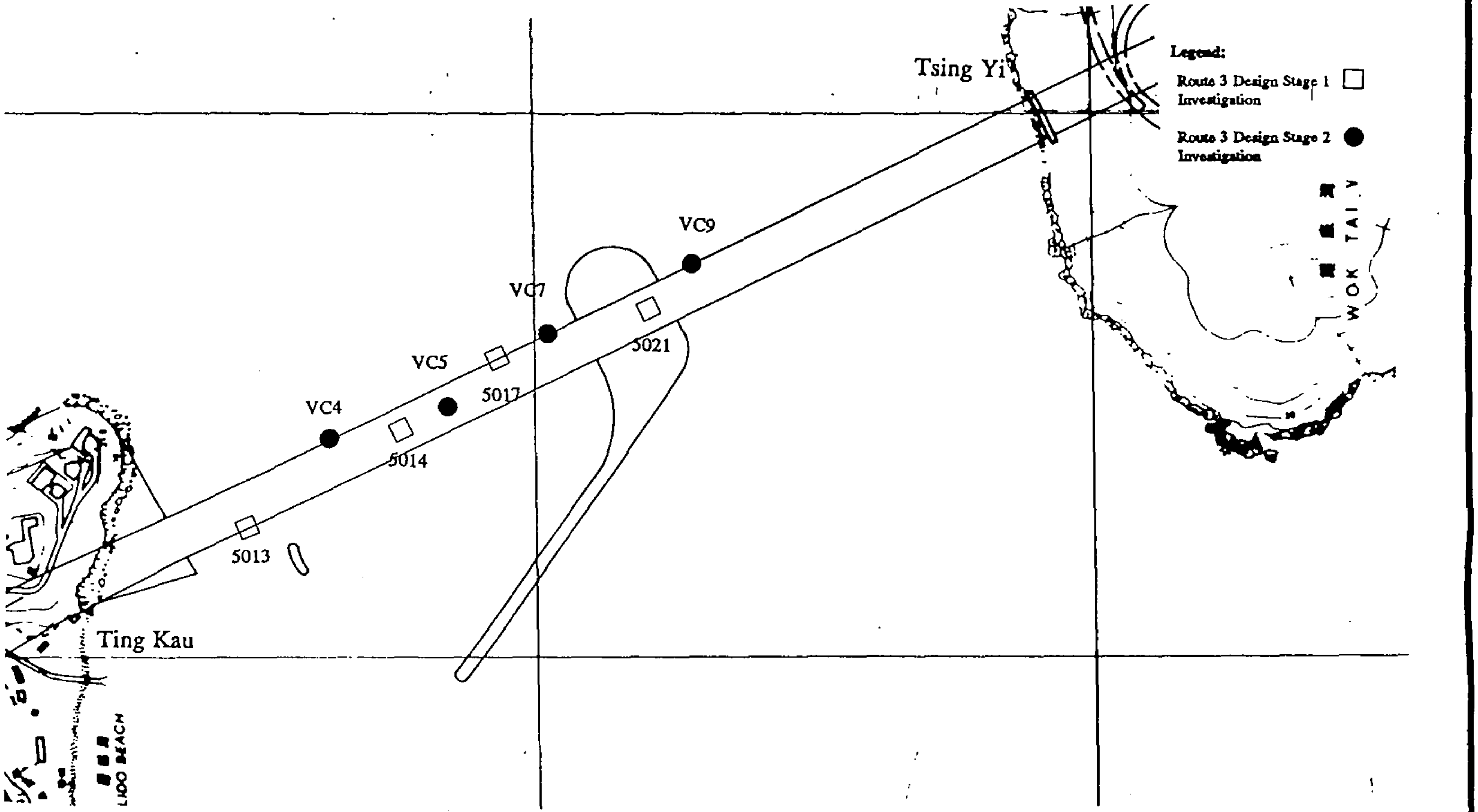


Beach
1 Tung Wan (Ma Wan)
2 Anglers
3 Gemini
4 Ho Mei Wan
5 Casam
6 Lido
7 Ting Kau
8 Approach

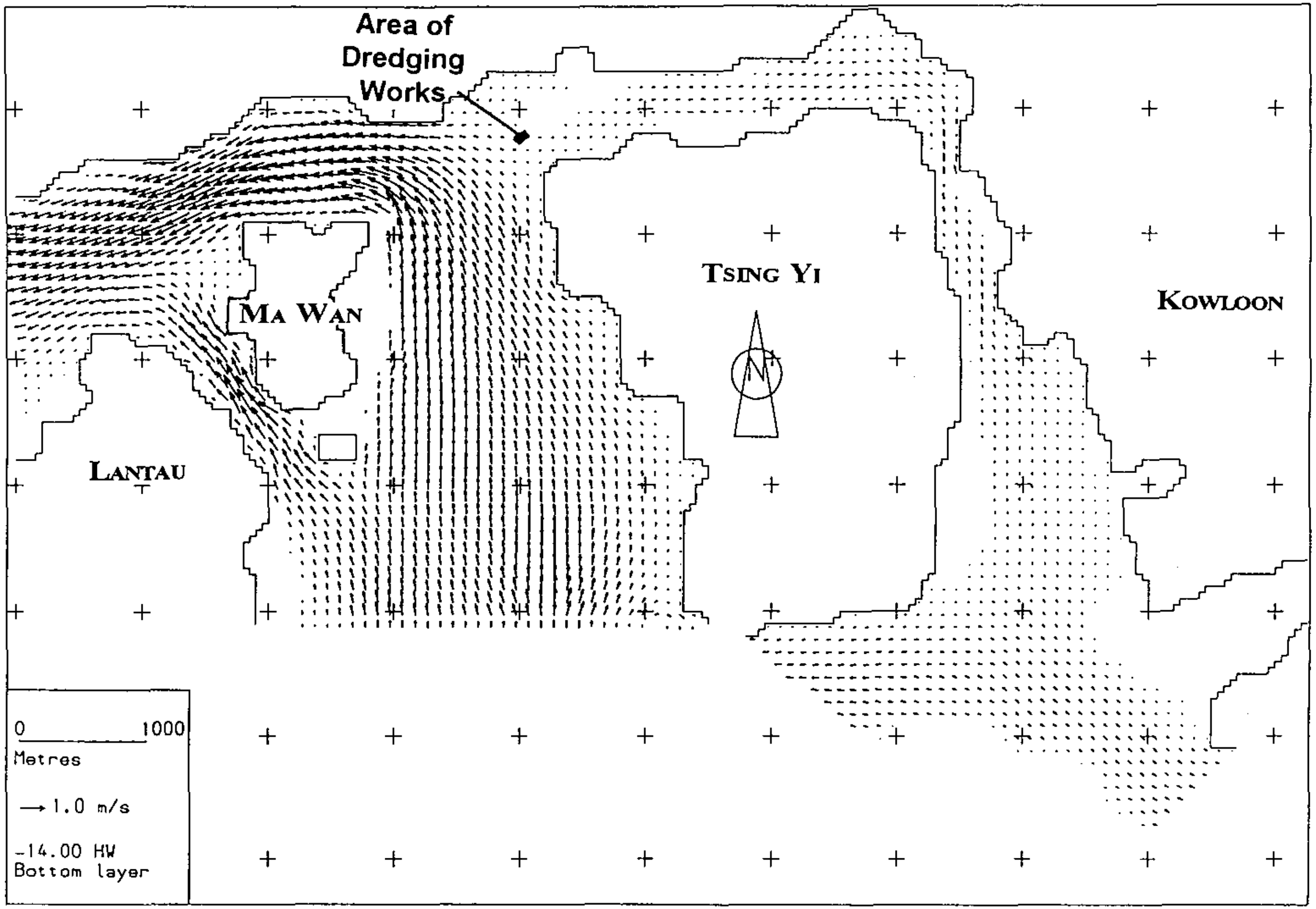
FREEMAN FOX MAUNSELL	Drg. Title : GAZETTED BEACHES, RAMBLER CHANNEL	Job Title : ROUTE 3 TING KAU BRIDGE EIA		
		Scale : 1:50 000	Job No. 058000	Fig. No. 6.3
		Date July 1993		



FREEMAN FOX MAUNSELL	Drg. Title : MUD SAMPLING LOCATIONS	Job Title : ROUTE 3 TING KAU BRIDGE EIA	
		Scale : Date July 1993	Job No. 058000
		Fig. No. 6.4	



FREEMAN FOX MAUNSELL	Drg. Title : LOCATION OF MUD SAMPLES ROUTE 3, DESIGN STAGE 1&2	Job Title : ROUTE 3 TING KAU BRIDGE EIA		
		Scale: 1:5000 / Date July 1993	Job No. 058000	Fig. No. 6.5



Source Route 3 Ting Kau Bridge Sector, Hydraulic Model Studies of the Impacts of Bridge Piers and a Breakwater on Tidal Flows in thre Rambler Channel. Hydraulics & Water Research Report HWR095, November 1993

FREEMAN FOX MAUNSELL

Drg. Title :

Current Velocity Plot;

Dry Neap Flow Patterns in 50m Model - Calibration Conditions

Job Title :

ROUTE 3, TING KAU BRIDGE EIA

Scale:	As Shown	Job No. 058000	Fig. No. 6.6
Date:	Dec' 1993		

WASTE AND SPOIL MANAGEMENT

CHAPTER 7

7. MANAGEMENT OF SPOIL

7.1 INTRODUCTION

The earth works on the Route 3 CPS project fall conveniently into two distinct geographical areas, one to the south of the Tai Lam Tunnel where there is a surplus of excavated material, the other, to the north where in the Stage 1 Design there was an overall deficit in excavated spoil/fill requirements, for the Stage 1 alignment. Current assessment of the adopted alternative alignment in the north, achieves a better balance of cut/fill requirements and has removed the need for borrow areas.

The dividing line between the TKB section and the TLT & YLA section of the route is the abutment position north of Tuen Mun Road and is shown in Figure 1.2. The spoil arising near to the southern portal of the Tai Lam Tunnel is therefore in the TLT & YLA section, however the proposed disposal routes are to the south and within the TKB section study area. It is intended to remove the spoil by conveyor belt and this issue is discussed briefly in this report and is the subject of a Supplementary Study as part of the TLT & YLA road EIA.

Within the TKB section there are major excavations associated with Ramps G and H and indicated in Figure 1.2 which it is understood will generate in the order of $1Mm^3$ of spoil requiring disposal. This requirement along with the need to provide access for construction plant and traffic to the Ting Kau Bridge, TLT & YLA road, and Tuen Mun Road Widening projects has led to a proposal for a haulage and access road to be constructed. This is the subject of a supplementary EIA study which will produce a Supplementary Report - The Ting Kau Haul and Access Road EIA which will be produced as a separate document but will form part of this TKB EIA.

7.2 GENERAL CONSTRUCTION WASTES

7.2.1 Waste Arisings

Wastes will arise from numerous construction activities and sources, of which the main ones include:

- demolition, clearance and site preparation;
- excavation for foundation works;
- residues from construction materials/processes;
- plant and vehicle maintenance and servicing; and
- workforce generated wastes.

In addition, it is possible that some of the demolition and excavation wastes could have been contaminated from previous uses or activities. Therefore a brief study of current and previous land uses of the areas where demolition and excavation are planned will eventually need to be carried out.

If the construction processes produce chemical wastes then the Contractor will be required to register with EPD as a Chemical Waste Producer and provide information including:

- particulars of the waste producer, a nominated contact person and type of business;
- particulars of the waste generation processes and location of waste arising; and

- waste types, quantities and generation rate.

All wastes which fall within the definition of chemical waste as provided in the Waste Disposal (Chemical Waste) (General) Regulation will require disposal by appropriate means (such as to the Chemical Waste Treatment Facility) and may require pre-notification to EPD before disposal.

The contractor's attention is drawn to A Guide to the Chemical Waste Control Scheme, A Guide to the Registration of Chemical Waste Producers and the Code of Practise on the Packaging Labelling and Storage of Chemical Wastes.

As the precise location of the works areas, and the construction methods are unknown and will be determined by the Contractor it is not possible at this stage to estimate the extent and nature of wastes. However these wastes are discussed in general terms.

7.2.2 Demolition, Clearance and Site Preparation

There will be a need for vegetation clearance and demolition of the existing buildings. Wastes will also arise from site preparation activities both at the proposed works sites and the landfall sites and these will consist mainly of concrete, cement and soil.

7.2.3 Excavation for Foundation Works

The excavation required for foundation works could include material from piling operations and other foundation activities.

The information available regarding previous landuse for the likely excavation areas has not given any indication of significant industrial activities or other polluting activities and this would be suitable for reuse as fill material.

There could be a requirement for removal of marine mud at the bridge pier locations. It is known that the mud in the Rambler Channel is very variable in thickness and in many places the upper layers (to a depth of approximately 2.5 metres) is contaminated with heavy metals (See Chapter 6). Therefore any need for excavation/dredging would be significant from a mud disposal aspect particularly given the shortage of suitable marine disposal sites. It is however possible to carry out pier construction while leaving the mud in-situ and this would be environmentally preferred. Marine mud disposal is discussed in Chapter 6.

7.2.4 Residues from Construction Materials/Processes

The residues from construction materials could include:

- cement and grout from on site concrete activities;
- waterproofing and curing materials;
- bitumen; and
- concrete dust from removal of rough edges and general finishing of units.

The residues from these sources should be of limited quantity. It will be very important to monitor and enforce site cleanliness and good housekeeping.

7.2.5 Plant and Vehicle Maintenance

The main items of construction plant and equipment will require regular maintenance and servicing for efficiency reasons as well as to minimise noise and air pollutant emissions. This will generate limited quantities of dirty lubricants, spent air and oil filters and other sundry materials. While relatively inert and solid materials, such as the air filters, are suitable for landfill disposal and can be disposed of via the normal waste stream it is important to prevent oil, grease, gearbox fluids etc., from contaminating the groundwater or land. Thus an acceptable system for collection, storage and proper disposal will be required. It may be possible to identify a recycling contractor for the waste oil and this will be worth consideration at the appropriate time.

Waste oil, grease, gearbox fluids are classified as chemical waste. If they are not recycled, they should be treated at the Chemical Waste Treatment Centre.

7.2.6 Workforce Generated Wastes

Waste from the workforce engaged in construction will comprise of general refuse such as food scraps, paper and empty containers etc., and also sewage. The general refuse will be of only minimal quantities and therefore is insignificant. Temporary toilets and wash facilities (as well as refuse containers) should be provided by the contractor for use by the workforce.

7.3 SPOIL ARISINGS

7.3.1 Main Locations

There are three main areas of construction activity where surplus spoil will be generated:

- North West Tsing Yi - where a major excavation is required to prepare a platform for the construction of the second phase of the North West Tsing Yi Interchange;
- Ting Kau - where a major excavation is required to prepare the formation for the Ting Kau Interchange and connections to Route 2; and
- Rambler Channel - earthworks operations in this area involve the construction of a breakwater and rock island adjacent to the Ting Kau Bridge north tower, and the construction of an area of reclamation on the north side of Rambler Channel. This will enable protection of the adjacent bridge pier and was intended to facilitate the barge loading of material from the Ting Kau earthworks. However for environmental and operational reasons this barge loading facility and the required reclamation is now proposed to be located further West along the coastline near Gemini Beach.

North West Tsing Yi

At the site of the main southern bridge pylon and the interchange located on North West Tsing Yi, there will be large-scale bulk excavation and removal of rock and soft material. The material will be disposed of by lorry transportation along haul roads to an existing barge loading point at Ngau Kok Wan. The small volume of fill which is required to complete the platform for the interchange will be obtained from within the site.

It has been assumed for the purposes of the estimate that the filling material for the breakwater and rock island will be transported from North West Tsing Yi. However, the material could equally well come from Ting Kau.

The balance of the earth works on North West Tsing Yi is a surplus of rock/soft material, currently estimated to be approximately 2.7Mm^3.

Ting Kau

At Ting Kau the surplus of rock/soft material has been estimated and will be approximately 190,000m^3 from Ramp G and 700,000m^3 from Ramp H.

Rambler Channel

Construction of the breakwater and rock island adjacent to TKB north tower and the reclamation on the north side of Rambler Channel will commence with dredging of marine mud to alluvium level, and its subsequent disposal. The quantity of marine mud to be excavated and disposed of was estimated at 2.2Mm^3, in Stage 1.

Following removal of the marine mud, the breakwater and reclamation will be formed by construction of a seawall and general filling using material excavated from North West Tsing Yi and/or Ting Kau, delivered by barge. The volume of rock and filling material required for construction of the breakwater and reclamation is currently estimated at 2.2Mm^3 (Stage 1).

7.4 SPOIL DISPOSAL

7.4.1 Disposal Options

Reuse as Fill within the Route 3 Project

The preferred option for dealing with excavated spoil would be to use it as fill material either within the TKB section or along the rest of the Route 3 CPS alignment. Thus the aim would be to achieve a balance of cut/excavation and fill requirements. However, it is not possible to achieve a balance within the TKB section and the difficulties in transporting spoil over the long distance and the very steep terrain to the sections north of the tunnel make this impracticable.

Reuse as Fill for other Projects

Given the current level of activity and number of major projects in the Territory, including Airport Core Projects this should be a viable option. Obviously from both a cost and environmental view point the less spoil handling and transportation required the better and nearby projects would be favoured. There will be a requirement for physical preparation of the material to ensure its suitability as a fill material.

As a consequence of the traffic impact to local roads, practicalities of haulage of such a large volume by truck and, the difficulty in transporting spoil due to the topography it is proposed that a covered conveyor belt system is used to transport the spoil to a waterfront location on the Rambler Channel. It will then be possible to load the spoil into barges for marine transportation to the utilisation location. The projects which can receive barge-transported material will be the most appropriate recipients of this material.

7.4.2 Discussion

Discussions with the Fill Management Committee (FMC) indicated a desire to ensure that any surplus suitable material is used in other contracts exhibiting a corresponding deficit.

It is presently expected that given the requirement to construct the breakwater early to facilitate construction of Ting Kau Bridge north tower, the majority of material excavated in the early part of the contract period will be utilised in construction of this item. It may, therefore, be assumed that surplus material may become available thereafter, i.e. from 1996/97 onwards. However, it is possible that the breakwater may not be constructed and alternative pier protection could be used.

Reference to the FMC's Database of Fill Requirements and Surpluses (dated March 1992) indicates several projects with a requirement for land source fill during the required time period. Of particular note is the nearby Lantau Port Development with a land source fill requirement in excess of $14Mm^3$/year between 1995 and 2003 inclusive. It is possible that all surplus rock/soft material from the TKB Section could be taken by barge to the Lantau Port Development and used for reclamation purposes. It must be appreciated that this would be dependent on the respective project timings. However current projections for the Lantau Port Development - Container Terminals 10 & 11 appears favourable with scheduled commissioning of berths during 1997 and 1998 and reclamation activities therefore required prior to and during this period. It should also be noted that Civil Engineering Department have advised that any material would require to be crushed and screened to appropriate size prior to loading onto barges.

In addition CED suggest that a fallback disposal option should be identified in parallel. This fallback disposal option would ideally be another major reclamation project. It is not productive to attempt to specify any individual project as a fallback as potentially this would be subject to delays etc. Therefore it is considered that the fallback should be which ever suitable project is available at the appropriate time. This can be identified at a later stage when projects are firmly committed.

7.5 MARINE MUD

7.5.1 Disposal Options

For marine mud which is considered to be uncontaminated the FMC have indicated that although the location of suitable marine dumping sites is difficult to predict for the timescale required (i.e. early 1995), it may be assumed for costing purposes that the marine dumping facility at South Cheung Chau will be used.

However for the marine mud which is considered contaminated according to the criteria as outlined in the *Works Branch Technical Circular No. 22/92 on Marine Disposal of Dredged Mud* then its disposal, in particular the top few metres, will require further detailed consideration. This is discussed in Chapter 6. It may be assumed that material that is deemed to be highly contaminated will require additional measures including:

- the use of sealed grabs in the dredging operation;
- haulage of the material to specially selected dumping grounds;
- tremie pipe disposal of material into the dumping grounds (bottom dumping of contaminated material may not be acceptable but would be subject to monitoring of the dumping ground and associated mitigation measures); and
- permanent isolation of the material from the environment, possibly by the placement of capping sand 1 metre thick.

If the marine mud in considered to be contaminated it would, therefore, considerably increase precautions required and the cost of this operation. As discussed in Chapter 6, Section 6.3.7, it is recommended that if practical, the mud is left in-situ, for the construction of breakwater and reclamation in the Rambler Channel.

7.6 SPOIL DISPOSAL IMPACTS

In terms of the potential for environmental effects spoil disposal activities can be considered to be essentially limited to construction related impacts. Although further consideration needs to be given to end state impacts. These are effects related to the restoration, aftercare and longer-term use of a selected disposal location. This would only be within the Route 3 Country Park Section, Ting Kau Bridge project area, as if spoil is supplied to other projects (such as the LAPH reclamation) or is disposed of to a marine site then any end state restoration etc., will be outside of this project's control.

7.6.1 Construction Related Impacts

These are effects specifically related to construction and disposal activities, most importantly these include:

- production and handling of spoil at construction sites;
- temporary storage or stockpiling of spoil;
- transport of spoil to disposal sites;
- treatment and placement of spoil within a disposal site.

The avoidance or mitigation of environmental effects is a primary objective of this study. In the simplest situations this has involved the choice of the least environmentally damaging disposal option. At the site specific level a range of environmental protection measures are likely to be required including:

- measures aimed at avoiding damage such as ensuring transport and access routes bypass sensitive areas such as residential areas or areas of high ecological interest; and
- the design and programming of site disposal activities to minimise long term impact and maximise environmental gain.

The range of activities involved in spoil disposal, and the potential environmental effects and opportunities to mitigate them, are discussed below:

7.6.2 Production and Handling of Spoil

At the 3 main locations within the TKB Section where spoil will arise and at the barge loading point it will be important to ensure that all spoil handling activities are carried out using techniques which minimise the escape of fugitive dust, particularly during periods of hot, dry weather.

This will require minimal handling, use of dust control equipment such as covered hoppers and mitigation measures such as fine water sprays and dust sheeting of vehicles.

Similarly prevention of run-off and/or leachate carrying high levels of silt from the spoil handling areas will be necessary particularly for large scale operations and during wet weather. This will require covering of handling areas and measures to divert rainwater and surface water and prevent ingress to the handling areas. It is currently proposed to directly tip from trucks into barges. This is a major potential source of spillage and it will be essential to prevent loss of material from the barge loading area to the marine waters of the northern Rambler Channel.

7.6.3 Stockpiling of Spoil

It is expected that stockpiling of spoil will be necessary for operational reasons. This is because it is not realistic to plan for the removal of spoil (from the various locations where it will accumulate) to occur at exactly the same rate as it is deposited.

- Whatever transportation systems are used, they are unlikely to possess sufficient capacity to remove all surplus spoil as it is delivered.

- It is anticipated that some construction activities (such as tunnelling) will operate 24 hours per day but spoil removal and transport is unlikely to be permitted to occur outside of pre-set working hours because of potential disturbance and nuisance. Thus spoil will accumulate at various handling locations awaiting disposal.

It is possible that each construction site and some of the transport rehandling locations will require a spoil stockpile to accommodate disruptions to the spoil transport and disposal system. The size and use of stockpiles will be dependent on a number of factors including size, location and physical layout of each site and the method of spoil transport employed. It would be prudent to allow for sufficient capacity to accommodate several days throughput at each location.

The creation of spoil stockpiles presents a particular set of potential environmental problems. However, it is necessary to know specific details regarding the expected size and location of stockpiles and the nature and physical condition of the spoil to accurately predict the specific impacts at each site. However as the quantities of spoil arising are still uncertain and are currently under review and this issue will be best covered at the detail design stage and acceptable proposals for managing and controlling impacts at stockpiles (and for all spoil handling and transport) should be required as a contract condition.

The key impacts which need to be considered in respect of each stockpile site include:

- Noise from plant used for movement of spoil at the stockpile locations and its potential impact on local residents;
- The handling of dry material and drying out of stockpiled material could result in increases in airborne dust, and deposition within homes and on surrounding vegetation;
- Water run-off and/or leachate from stockpiled spoil material; two key concerns are:
  - contamination of surface water which could affect habitat areas and lead to temporary increases in turbidity in surrounding water bodies;
  - contamination of groundwater.
- Temporary land take: some land chosen for temporary stockpiling may be used for agriculture, recreational use etc; and
- Visual intrusion; if poorly sited, stockpiles are likely to be unacceptable to the local population and Country Park visitors.

7.6.4 Transport of Spoil

The transport of spoil from source to the disposal site(s) consists of two main aspects:

- the movement of material by the primary mode(s) of transport i.e. road, conveyor, marine barge, etc; and
- the handling and subsequent transport at or near the disposal site to achieve access to, and distribution within, the particular site.

Transport costs increase with both the distance travelled and time taken. Similarly, other things being equal, the nuisance due to transport of spoil is reduced for closer sites. Therefore, from both a cost and environmental viewpoint, disposal sites nearer to the point of arisings are preferable, provided the transport infrastructure connecting them is adequate.

The choice of transport method is usually governed to a large extent by the overall quantity of spoil, its rate of production and the location at which it arises.

The types of trucks to be used will depend on the accessibility of the construction sites, and the susceptibility of the surrounding environment to disturbance. Generally, in order to keep the number of lorry loads to a minimum and in the interests of economy, the largest lorries permissable are expected to be used.

In general the advantages of road transport of spoil are:

- suitability for small quantities of spoil;
- high flexibility, allowing for changes in the point of arising and the disposal site; and

- no need for secondary handling as lorries can usually drive up to the disposal point.

The disadvantages of road transport of spoil include:

- uneconomic over large distances;
- relatively small capacity;
- high potential nuisance.

More specifically large quantities of spoil will arise at the Southern Portal of the Tai Lam Tunnel. This is within the TLT & YLA section of the route and the handling aspects are therefore discussed in the TLT & YLA section EIA. However it is proposed that the spoil will be loaded onto a covered conveyor belt. The proposed route for this conveyor system passes through the TKB Section and is shown in Figure 2.1. It has been selected to avoid SRs as far as possible and crosses the Tuen Mun Road on a bridge to a barge loading point near the Gemini Beaches. This transport method is environmentally preferred as it will either completely remove or minimise potential impacts from vehicular transport, traffic disruption, dust and noise emission and should reduce spillage. The Gemini Beach location appears to be the most suitable of the available sites for the barge loading point. However, significant disruption to (and probable closure of) the western Gemini Beach will be inevitable. A further assessment of the proposed conveyor system is presently underway and will be part of the TLT & YLA EIA.

7.6.5 Treatment and Placement at Disposal Site

If the preferred spoil disposal option is realised i.e. reuse of material for reclamation then the treatment will be limited to ensuring that the material is acceptable to the receiving project. This will involve crushing and screening of material.

The placement of material will be under the control of the project manager/engineer. For contaminated material and if the reuse option becomes impracticable and marine dumping is required then standard procedures agreed with EPD will need to be strictly followed including controls to prevent 'short dumping' or any malpractice.

7.7 PROTECTION AND MITIGATION MEASURES

Specific protection and mitigation measures which may be considered where impacts are anticipated are as follows:

- Noise reduction: by selection of quietest plant and working methods and limiting hours of operation, if necessary.
- Attenuation of noise, control of dust spread and reduction in visual intrusion: by carefully locating stockpiles in relation to existing topography, creating new earth bunds and retaining existing tree belts.
- Prevention of surface water pollution: by bunding and directing run-off to settlement ponds.

- Minimising land take, particularly productive land: by limiting the size of the stockpiles and associated working areas.

- Protecting productive agriculture, important habitats and landscape features: fencing all the boundaries to keep the working areas and stockpiles contained.

- Avoiding disruption to public rights of way: provision of temporary footpath diversions if required.

- At the end of the stockpiling activity: restoration of land to its original use and for quality.

LANDSCAPE AND VISUAL IMPACT ASSESSMENT

CHAPTER 8

8. LANDSCAPE AND VISUAL IMPACT ASSESSMENT

8.1 INTRODUCTION

There is no legislation in Hong Kong which specifically relates to the landscape and visual impact of development. However, a degree of control is achieved through the requirement to address visual issues as part of the environmental review and assessment process. The EPD Advice Note (2/90) relating to the 'Application of the EIA Process to Major Private Sector Projects' identifies visual impact as being an issue of concern to be addressed. In addition, HKPSG, Chapter 10 - Landscape and conservation (currently being drafted by EPD) outlines those design criteria which should be considered when planning in a rural environment.

8.2 TERMINOLOGY

For the purposes of the environmental assessment process a clear distinction is drawn between *landscape* and *visual* impacts:

- landscape impact relates to the effect upon the physical characteristics or components, which together form a landscape, e.g. the landform, woodlands, or stream courses; and

- visual impact relates to the changes arising from development to individual 'receiver groups' views of the landscape e.g. local residents or visitors to the Country Parks within the area.

In the assessment, high quality landscape and views are considered to be an environmental resource of equivalent value to, say, clean air or water.

The area of study for the assessment of landscape and visual impacts is defined by the 'Visual Corridor' or zone of visual influence for the whole TKB development i.e. the area within which views of the bridge and its associated road are possible. There may also be off site indirect construction impacts caused, for example, by construction traffic movements or the deposition of tunnel arisings.

The highly visible nature of the TKB Section, and its importance as a future 'Gateway to Hong Kong', places considerable importance upon the assessment of visual impact, to ensure its stature as an important landmark whilst integrating the route corridor with the surrounding landscape character.

8.3 OBJECTIVES

Specific visual impact assessment objectives include:

- assessment of the existing landscape character, and quality;
- identification of the overall visual envelope created by the proposed route corridor;
- identification of the key visual receiver groups within the visual envelope;
- assessment of impact of the proposed route, both during construction and operation, on the existing landscape; and
- identification of residual impacts.

8.4 METHODOLOGY

8.4.1 Introduction

The form of landscape and visual impact assessment adopted for the TKB Section has been formulated in order to address the specific issues typically raised by a development of this scale and nature. The following section outlines the main components of this methodology.

8.4.2 Appraisal of Baseline Conditions and Project Description

In order for the subsequent impact assessment to be evaluated objectively, the existing landscape context must first be established. The baseline conditions are then projected forward to predict a 'no development' alternative to the construction of the TBK Section. Establishment of baseline conditions will include identification and assessment of the following elements:

- Visual Envelope and Existing Views
- Topography, Natural Drainage and Vegetation Cover
- Built Development
- Access and Circulation
- Landscape Character
- Receiver Groups

8.4.3 Identification of Landscape and Visual Impacts

Potential landscape and visual impacts (both positive and negative) will be considered at three points in time:

- during construction;
- on day of opening; and
- in year 15 of operation.

Through the assessment of impacts at these three points in time, distinction will be drawn between temporary, short-term and permanent, (long term) effects. Landscape impacts are predicted primarily on the basis of the order of change to baseline conditions prevalent at the time of assessment (i.e. 1993) and are assessed at two levels:

- firstly in terms of the systematic consideration of impact upon the landscape features; and

- secondly in terms of the overall impacts of development upon the site and its landscape context.

The assessment of visual impacts is then structured by receiver groups in order to present a systematic and structured appraisal. Receivers are identified through the definition of a Visual Envelope, or zone of visual influence, within which views of the structure are possible and the categorisation of individuals into 'user groups' within that envelope area: -

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

The visual assessment will also consider the quality of view, for motorists using the new road in terms of 'serial vision' (i.e. the sequence of visual experiences for motorists travelling in each direction).

8.4.4 Evaluation of Impacts

The degree of severity of landscape and visual impacts are categorised into severe, modernate, low and insignificant impacts.

Impacts on Landscape Resources are predicted by assessing

- character and quality of existing landscape;
- nature of predicted impacts;
- degree of change to key features and existing landscape;
- ability of landscape to accommodate change; and
- significance of change within local, and regional context.

Impacts on Visual Amenity are predicted by identifying changes such as:

- value of existing views;
- degree of change to existing views;
- proximity of receiver;
- sensitivity of receiver;
- number of receivers in group; and
- availability and amenity value of alternative views

Impacts on landscape resources and visual impacts are closely related, since both may result from a single change in baseline conditions. The relative severity may however, differ according to the precise nature and context of the change. For example, a new structure may obstruct existing views from nearby residential properties severely reducing the visual quality of their views. Its position, however, may be predominantly urban and its construction may not involve the loss of any existing features resulting in a minimal impact on the overall character of the area.

8.5 LANDSCAPE CONTEXT

Landscape character developes through the interaction of a number of factors. The basic structure of a landscape is created by its geomorphological features, which, in turn, effect the indigenous vegetation cover. This basic structure is further changed by the actions of man, for example, through the construction of towns or the development of agriculture areas. This interaction of the basic natural resource and human intervention creates areas of discrete landscape character. The broad landscape character of the region is that of steep slopes in the high ground supporting sparse scrub and grassland, and lowlying flat land in the major valleys and along the coastal plain where intensive agriculture, residential, commercial and industrial activities occur.

The Feasibility Study for Route 3 (Landscape Issues, Working Paper) identified 14 character zones within the overall study area. Two of these (zones 13 and 12) are located within the TKB Section: -

- To the north west of Tsing Yi Island a landscape of steephills covered in scrub and grassland with a strong association with the adjacent coastal water (character zone 13).
- In the vicinity of Ting Kau, a coastal strip with diverse vegetation and some influence from surrounding urban fringe developments, strongly associated with the adjacent coastal waters (character zone 12).

Subsequent sections of this report provide a more detailed description of these two landscape types.

8.6 BASELINE CONDITIONS

8.6.1 Character Area 13 - Steep Hill Slope - Tsing Yi Island

This landscape character area encompasses the north west of Tsing Yi Island, to the north and west of the main ridgeline of the Shek Wan hill ranges.

a) Visual Envelope and Existing Views

The zone of visual influence is shown on Figure 8.2. Due to the abrupt nature of the topography, the areas of built development are distinct, limited by the sharp ridgelines of the surrounding hillsides and the height of the built development. The visual envelope may be divided into two distinct areas, North Facing and West Facing slopes:

North Facing Slopes - The existing view of the north facing slopes of the character area across the busy Rambler Channel is that of a steep undeveloped but degraded grassland hillside.

West Facing Slopes - The existing view of the northern section of the western coastline of Tsing Yi Island is that of steep degraded grassland hillside which has been subject to major re-grading, ascending to the ridgeline of the existing slopes immediately south of character area; major earthmoving, borrow activities and marine storage facilities extend along the entire length of the coastal margin, creating an area of severe visual disturbance, and overall low visual amenity value.

The Shek Wan ridgeline forms an important visual barrier to views from the south west into the area. The extensive views from the upper slopes are mirrored by the slopes visibility from a wide area, of predominantly transient visual receivers as described in section (f) below.

b) Topography, Natural Drainage and Vegetation Cover

The natural landscape of this section of Tsing Yi island consists of steep slopes (up to 45°) rising abruptly from the coastline, to a high point of 218m. The broadly flat sided slopes are incised with a number of minor, seasonal watercourses creating a succession of locally prominent spurs. The vegetation cover is typically sparse grassland with occasional scrub species. The establishment of a more diverse range of vegetation cover through natural succession is inhibited by the number of hill fires which occur throughout the area.

c) Built Development

This landscape character area does not contain residential properties. It is, however, visible from a number of significant residential areas (see sections e and f).

Industrial development is limited to docking, storage and reclamation facilities concentrated at the base of the slopes along the coastal margin. Landscape Character Area 13 lies within a wider area which is extensively developed for sea based industrial purposes.

d) Access, Circulation and Views

Access to the area is at present extremely limited. Footpaths run along the main ridgeline from the Fung Shui Wo area to the east and the centre of the island.

The southern and central sections of the western coastline of Tsing Yi Island are served by a road providing access to the many industrial activities within the area. The proposed CRA 1 Route 3, at present under construction, will extend public vehicular access along the western coastline in due course.

e) Landscape Character

The resultant landscape character of Area 13 is one of remote, uninhabited steeply sloping hillsides facing the coastal waters, with an open aspect and extensive views. Human influence on the area is limited to a minor works access road and docking facilities along the water margins on the northern slopes, with more extensive regrading and borrow activities on land and cargo docking and chemical storage facilities along the water margins of the western slopes. Hill fires have a continuing impact on the vegetation cover, creating the denuded grassland slopes, which otherwise will regenerate to scrub and eventually woodland.

f) Receiver Groups

There are no SR groups within the character area itself, the main receivers being concentrated to the north of the area. These would include:

- distant views from properties associated with settlements to the north and east (from Tsing Lung Tau in the west to Tsuen Wan in the east, and Nga Ying Chai on Tsing Yi Island);
- sections of the south facing slopes within the Tai Lam Country Park; and
- south west facing slopes within the Tai Mo Shan Country Park and north west facing slopes in the Shing Mun Country Park. Less sensitive receivers include motorists on the Tuen Mun and Castle Peak roads.

To the south, receivers are generally distant and include:

- scattered properties and footpath users on the island groups to the south;
- waterborne traffic on the coastal waters; and
- workers in the industrial activities along the coastal margin to the south of Tsing Yi Island.

8.6.2 Character Area 12 - Coastal Strip - Ting Kau

This character area encompasses the lower aspects of the hillslopes and coastal areas between the Tuen Mun Road (R2) to the north, Hoi Mei beach to the west and Kan Shui Wan beach to the east on the mainland (see Figure 8.1).

a) Visual envelope and Existing Views

The visual envelope for landscape character 12 is restricted by the landform and vegetation cover that enclose and limit views both within, and to the area.

The main zone of visual influence is southwards, and views experienced are of a well wooded enclave scattered with residential properties set against the steeply sloping grass covered hills to the north. Dominant features within the view are the linear elevated structure, and the shotcrete coated regraded slopes of the Tuen Mun Road and to a lesser extent the alignment and shotcrete regraded slopes associated with the Shek Lunk Kung catch water.

Views within the area are restricted by the topography but more significantly by the mature tree cover and residential properties. More extensive views occur along the coastal margins, across the Rambler Channel to the Island of Tsing Yi, Ma Wan and Lantau in the foreground and smaller islands beyond. The views are heavily influenced by the extensive shipping activities in the surrounding waters, but do not encompass major docking or industrial facilities.

b) Topography, Natural Drainage and Vegetation Cover

The landscape comprises steep southfacing slopes falling from the Tuen Mun Road in the north to a small natural bay comprising a series of small sandy beaches of Hoi Mei, Casam, Lido and Ting Kau, interspersed with rocky headlands. The slopes within the character area form the lower aspects (below 100m AOD) of hills rising to a minor ridge of approx 150m in the north west and 400m to the more significant Shek Lung Kung mountain in the north east. Vegetation cover consists predominantly of scrub and stands of mature trees, creating enclosed woodland cover over much of the study area with limited areas to the north and north west of rough grassland and regenerating scrub.

c) Built Development

The coastal plain comprises a residential enclave, with scattered low rise residential properties and Ting Kau Village. The properties have a strong association with the water margins of the northern Rambler Channel, many having direct access to the sandy beaches and rocky promontories. There are no major industrial developments within the character area.

d) Access and Circulation

Ting Kau Village and the scattered residential properties are served by the Castle Peak Road. Traffic is primarily local, serving the local settlements between Sham Tseng and Tsuen Wan, through traffic utilising the Tuen Mun expressway.

Although no direct access is achievable from the Tuen Mun expressway (the nearest access points being at Sham Tseng and Tsuen Wan), the highway is a major circulation structure within the wider area and its scale, location and volume of traffic exerts a significant influence on the landscape character of the area.

The footpath network within the area is limited, however there are a number of places that enable direct access to the beaches and headlands from the vehicular road network.

Water traffic includes recreational facilities associated with the beaches along the coastal margins and industrial shipping lanes towards the centre of the channel.

e) Landscape Character

The resultant landscape character of the area is one of a pleasant well vegetated south facing coastal land, with a well developed infrastructure and settlement pattern of scattered low rise properties with a quiet introspective disposition set within the natural bay. The area is of good quality and one that would be sensitive to change within the area.

f) Receivers

Potentially the most sensitive receivers, are those of residential properties, together with the less sensitive receivers using the local road and footpath network lie within the character area itself.

In addition, more distant, but major areas of residential receivers occur in Tsuen Wan and Nga Ying Chau. Scattered residential properties and footpath users would create the main receiver groups within the country park to the north and island groups to the south.

The high volume of waterborne traffic in the vicinity create a further transient low sensitivity receiver group.

8.7 ASSESSMENT OF LANDSCAPE AND VISUAL IMPACTS

8.7.1 Introduction

For the purpose of this assessment, the proposed development falls into three distinct components:

- the north west Tsing Yi interchange;
- the TKB crossing; and
- the intersection with the Tuen Mun Road.

8.7.2 Landscape Impacts

Impact on Key Features

Impacts on the landscape are generally of local significance, with the degraded landscape character within Character Area 13 having a greater ability to accomodate the proposed features of the route corridor than the more structured residential area on the mainland (Character Area 12).

a) North West Tsing Yi Interchange

CRA 1 Route 3 enters the proposed interchange and provides a south western connection to Ma Wan Island. In order to maintain engineering requirements, the northern section of the interchange would be positioned within a cutting, resulting in regraded slopes of up to 95m in height to the east, and 10m to the west of the highway boundary respectively.

b) Ting Kau Bridge

The main physical impact of the bridge on the landscape would be the associated abutments, the two main bridge towers and the associated protective breakwaters.

c) Ting Kau Interchange

From the bridge crossing the proposed route would continue as an elevated structure, 70m above ground level as it first crosses the Castle Peak Road and the existing Tuen Mun Road to return to ground level (at approximately 85mPD) to the north of this section.

The physical impact on the landscape will be limited to construction work areas, in the Ting Kau area loss of vegetation cover associated with pier positions; the creation of an area of cutting through the existing ridge (south of Tuen Mun Road) and the increased size and extent of the cuttings and embankments associated with the Tuen Mun Road to the west.

Impact on Landscape Character

a) North West Tsing Yi Island

Regrading would cause the temporary loss of much of the vegetation cover and negatively impact the character of the area. By year 10, however with attention to detailed design the existing landscape may be positively enhanced.

b) Ting Kau Bridge

A bridge structure over the Rambler Channel will influence the character of the waterbody by defining the entrance of the channel as well as influencing the adjacent landmasses.

To the south, the simple uninhabited slopes of Tsing Yi Island could successfully accommodate the bridge alignment without further detrimental effect to the existing low quality landscape character of the area. In comparison the more diverse coastline, with its many settlements, would find the introduction of the bridge structure more difficult to accommodate.

c) *Ting Kau Interchange*

The alignment of the route within the natural bay creates major impact on the landscape character of the immediate surroundings, dominating Ting Kau village, Lido beach and its rocky promontory, in the centre of the bay. The impacts of this grade separated interchange will be compounded when the subsequent part of Route 3 CPS is constructed, adding a further two elevated sliproads to the north of the proposed route.

8.7.2 Visual Impacts

The visual envelope as detailed in Figure 8.2 identifies three broad types of visual intrusion, namely:

- areas in close proximity suffering visual intrusion/obstruction (a);
- areas where only the tops of the two bridge towers may be visible (b); and
- long distance views from the upper reaches of the hills in the Tai Lam, Tai Mo Shan and Shing Mun Country Parks (c)

a) *Immediate Surroundings*

The most significant visual impact would be on SRs within areas with direct views and in close proximity to the proposed route, as detailed in Figure 8.3 and Table 8.1. These areas include:

- The natural bay surrounding Ting Kau Village;
- South facing slopes of the mountain ranges in the Tai Lam Country Park and the coastal plain between Brother Point (Tai Lam Kok) to the west and Chai Wan Kok to the east;
- North and upper northwest coastlines between the coastal margin and the topographical ridge of Tsing Yi Island, between Kam Kok Chuck in the southwest and Nga Ying Chau in the north east;
- The islands of Ma Wan and Tang Lung Chau; and
- North east facing slopes of the northern promontory of Lantau Island between Pa Tau Kwu in the South and San Po Tsui in the north.

Residential properties within the Ting Kau area will be severely affected in terms of visual intrusion, and in some cases, visual obstruction (where the route structures will physically obstruct the view from a property) may occur. At present views from these properties are not affected by major artificial structures; the introduction of the bridge, the elevated section of road between the bridge abutment and the existing Tuen Mun Road will fundamentally change the visual outlook for these properties creating severe visual intrusion in most cases. Mitigation measures within the boundary of properties affected such as screen fencing or planting will mitigate the degree of impact, but will also obstruct their overall view from that point.

Further from the route alignment large residential settlements, villages and individual properties all incur visual intrusion, the severity reducing with the distance from the structures and the intervening topography.

In addition there may be intusion on passive recreation users within the Ting Kau bay and to a lesser extent from the adjacent coastal slopes (Tai Lam Country Park, north and north west sections of Tsing Yi Island and the islands of Ma Wan, Tang Lung Chau and Lantau). Views will also be obtained by users on the local circulation network, in particular the Tuen Mun Road in the vicinity of Ting Kau.

Generally views from these areas, with the exception of the views from the natural bay surrounding Ting Kau Village, already contain intrusive visual elements such as industrial, residential and infrastructure developments. The introduction of a further man made element within the view would not significantly alter the perception of the area, and may with attention to the detailed scale and form of the bridge, in fact become a positive feature within the overall landscape.

b) Views of Upper Sections of the Bridge Structure

Flat lowlying areas immediately beyond this initial area are screened to a greater or lesser degree, by the intervening topography and built development. However the areas identified on the visual envelope may incur views of the mid and upper sections of the two proposed bridge towers, but will not suffer intrusion from the route corridor itself or moving traffic along the proposed highway.

Receivers within these areas include large residential settlements south of Nga Ying Chau, the south west Kwai Chung area and also isolated settlements on the north west coastline of Lantau Island. In addition there are passive recreation users on certain sections of Lantau and Tsing Yi Islands, and the large industrial area to the south of Tsing Yi Island. The overall quality of the view will not be significantly effected.

c) Distant Views

The final broad area of visual intrusion lies further away from the source, from the upper sections of slopes facing the proposed alignment in the Tai Lam, Tai Mo Shan and Shing Mun Country Parks. The main areas effected would be in the vicinity of Tai Mo Shan, up to 7km to the north west; Golden Hill, Smugglers Ridge and the Needle Hill range 6-10km to the west. The lower reaches of these hills are screened by intervening hills, Shek Lung Kung and the built development of Tsuen Wan town.

The largest receiver group visually affected within this area would be the visitors to the Country Parks of Tai Lam, Tai Mo Shan and Shing Mun.

From these distant areas the main impact of the proposed route would be that of the Bridge across the entrance to the Rambler Channel, however it would not form a dominant feature within the views which are more visually effected by the intervening built development at Tsuen Wan and Kwai Chung. In addition, the sheer distance from the bridge and the predominant climatic conditions and resulting poor visibility further reduce these views to render any impact insignificant for much of the year.

8.7.3 Illumination

The proposed illumination of the highway will cause nocturnal visual intrusion throughout the zone of visual influence. Visual receivers in the immediate vicinity of the route, such as the residential properties in the Ting Kau area, may suffer glare from the proximity and orientation to the light source. More distant receivers would suffer intrusion from the linear light aura created by the highway corridor and its associated traffic.

Consideration of the proposed mitigation measures associated with the illumination of the highway at the detailed design stage, may have a significant impact of the reduction of this visual intrusion (see Chapter 9).

8.8 IMPACTS THROUGH TIME

8.8.1 Construction Phase

Source of Impact

The construction of the proposed route will take approximately 4 years, during which time the principle sources of impact would be from:

- site formation, including reclamation;
- construction access and storage areas; and
- construction of the proposed route.

The majority of activity involved with the reclamation and construction will be localised, contained predominantly within the proposed highway corridor. Large scale construction will be required for piling and slope regrading, increasing the initial visual impact on the surrounding area. Additional impacts on local receivers are anticipated as equipment and materials are brought onto site by both sea and road.

Temporary visual intrusion may be suffered by receivers throughout the visual envelope. The severity of the intrusion is dependant on the proximity to the construction works. The residential properties in Ting Kau being subject to severe intrusion from the construction works both in their immediate vicinity and the TKB itself.

Table 8.1 Table of Sensitive Receivers Ting Kau Bridge Sector - Permanent Visual Impact

	Description	Approx distance from centre line of proposed road (slip road) (m)	Impact	Comments
1.	Residential Property Castle Peak Road (west of proposed bridge)	850	S	Direct easterly views.
2.	Residential Property Castle Peak Road (west of proposed bridge)	650	M	Oblique easterly views from front aspect of property.
3.	Residential Property Castle Peak Road (west of proposed bridge)	400	M	Oblique easterly and south easterly views from front aspects of property.
4.	Residential Property Castle Peak Road (west of proposed bridge)	375	M	Oblique easterly and south easterly views from front aspects of property.
5.	Residential Property Castle Peak Road (west of proposed bridge)	390	M	Oblique easterly and south easterly views from front aspects of property.
6.	Residential Property Castle Peak Road (west of proposed bridge)	235	M	Oblique easterly and south easterly views from front aspects of property.
7.	Residential Property Castle Peak Road (west of proposed bridge)	300	SL	Screened by intervening residential properties.
8.	Residential Property Castle Peak Road (west of proposed bridge)	275	SL	Screened by intervening residential properties.
9.	Residential Property Castle Peak Road (west of proposed bridge)	250	SL	Screened by intervening residential properties.
10.	Residential Property Castle Peak Road (west of proposed bridge)	200	SL	Orientated to south west and screened by cutting.
11.	Residential Property Castle Peak Road (west of proposed bridge)	225	M	Director easterly views. Screened by existing vegetation.
12.	Residential Property Castle Peak Road (west of proposed bridge)	200	H(S)	Direct easterly views. Possible visual obstruction.
13.	Residential Property Castle Peak Road (west of proposed bridge)	175	SL	Orientated to south and screened by cutting.
14.	Residential Property Castle Peak Road (west of proposed bridge)	125	S	Direct easterly south easterly views. Possible oblique visual obstruction.
15.	Residential Property Castle Peak Road (east of proposed bridge)	125	S	Direct west and southern views. Possible visual obstruction.
16.	Residential Property Castle Peak Road (east of proposed bridge)	75 (50)	S	Director south westerly/oblique southern views. Possible visual obstruction.
17.	Residential Property Castle Peak Road (east of proposed bridge)	50 (25)	S	Direct west and southern views. Possible visual obstruction.
18.	Residential Property Castle Peak Road (east of proposed bridge)	50	S	Direct west and southern views. Possible visual obstruction.
19.	Residential Property Castle Peak Road (east of proposed bridge)	75	S	Direct south westerly views. Possible visual obstruction.
20.	Residential Property Castle Peak Road (east of proposed bridge)	100	S	Direct south westerly views. Possible visual obstruction.
21.	Residential Property Castle Peak Road (east of proposed bridge)	125	S	Direct south westerly views. Possible visual obstruction.
22.	Residential Property Castle Peak Road (east of proposed bridge)	175 (125)	S	Direct west and southern views. Possible visual obstruction.
23.	Residential Property Castle Peak Road (east of proposed bridge)	175 (125)	S	Direct west and southern views. Possible visual obstruction.
24.	Residential Property Castle Peak Road (east of proposed bridge)	200 (150)	M	Screened by intervening properties.
25.	Residential Property Castle Peak Road (east of proposed bridge)	300 (275)	M	Oblique southerly views.
26.	Residential Property Castle Peak Road (east of proposed bridge)	375 (350)	M	Oblique southerly views.
27.	Residential Property Castle Peak Road (east of proposed bridge)	400(375)	M	Direct southerly views.
28.	Residential Property Castle Peak Road (east of proposed bridge)	175	-	Views screened by landform and vegetation
29.	Residential Property Castle Peak Road (east of proposed bridge)	150	-	Views screened by landform and vegetation
30.	Residential Property Castle Peak Road (east of proposed bridge)	150	-	Views screened by landform and vegetation

Table 8.1 Cont'd

31.	Residential Property Castle Peak Road (east of proposed bridge)	150	-	Views screened by landform and vegetation
	Approximately 30 properties within Ting Kau Village	200-350	15M	Houses on the southern edge of the village would suffer direct views of abutment on Tsing Yi Island. Views from centre of village obstructed by intervening built form.
	Approximately 37 properties to east of Ting Kau Village	350-700	37H	Direct south westerly views.
	6 properties to west of Yau Kom Tau	800-1200	6M	Oblique south westerly views.

Key :
- S - Severe
- M - Moderate
- SL - Slight
- I - Insignificant
- Con - Construction Phase

North West Tsing Yi Island

The north west Tsing Yi interchange would involve extensive regrading of the western slopes of the Shek Wan Range resulting in significant impact on the landscape. (The extent of the regrading would be similar to the CRA 1 Route 3 Section, currently under construction to the south).

The proposed alignment would have a significant impact on the two character areas identified in the baseline conditions, but for two different reasons. In the north west Tsing Yi Island area, the extensive cuttings would involve the physical loss of a large amount of the character area itself. This should however be viewed in context with the extensive regrading along the entire length of the north west coastline which has a significant impact on the quality of the landscape character on the north west section.

Ting Kau

Reclamation and construction works associated with the abutments, towers, and piers of the bridge and elevated section of the route to the Tuen Mun Road expressway will cause only minor localised landscape impact. The most sensitive area lies within the Ting Kau area where inevitable loss of tree cover will occur.

Increased landscape impact will be created in the vicinity of the existing Tuen Mun Road to accommodate the interchange connections involving enlargement of the cuttings and embankments already present along the expressway, and a further area of cutting between the expressway and TKB.

Ting Kau Area the impact on the landscape character area surrounding Ting Kau would be significantly detrimental, introducing permanent visual intrusion and/or obstruction of a major artificial structure, as well as creating temporary intrusion by construction traffic and storage areas.

8.8.2 Operational

Source of Impact

Once constructed and operational the principle sources of the impact would be the physical presence of the road and its associated structures and the movement of traffic along the highway causing no further direct impact on the landscape.

Tsing Yi Island

Due to the low lying alignment of the proposed route in the north west section of Tsing Yi Island, the limited use of elevated structures and the extensive tree planting associated with the landscaping proposals, no significant long term impact on the landscape character of the area will occur. Moving traffic along the highway should in time be screened to incoming views from surrounding areas, and the overall landscape character of the area may be positively improved.

Ting Kau Bridge

The impact of the Bridge itself and associated moving traffic will remain significant throughout its operational life. Its crossing point at the entry of the Rambler Channel will ensure that it is visible from a wide area, to a number of receiver groups, its acceptability as a significant permanent visual element will depend on the detailed design of its scale and proportions, its colour and the materials used for its construction, and the type of illumination adopted and its compatibility with other major road structures within the area.

Ting Kau

The most significant impact of the operational phase of the route will be the introduction of the elevated structure, moving traffic and its associated visual intrusion on the sensitive residential receivers within the Ting Kau area. The route will effectively bisect the natural bay, introducing visual intrusion to an area at present not significantly effected by artificial modern structures.

8.8.3 Residual Impacts (Year 10)

The adoption of mitigation measures recommended in Chapter 9 of this report will do much to reduce the impact of sections of the route from more distant views, especially on the north western slopes of Tsing Yi Island, where, in time the road would become fully integrated with its surroundings and visually screened from sensitive receiver groups. Planting experience on Tsing Yi Island, Tsuen Wan and a wide range of other New Territory sites indicate that tree cover becomes established quickly and would create well established stands in 10 years.

The proposed tree planting associated with the regraded slopes on Tsing Yi Island would become established, and could develop into a well structured, visually attractive wooded slope, thus improving the currently degraded character of the existing landscape.

However the impact of the bridge within the visual envelope will remain a permanent visual element within the character of that area. Its acceptability as a significant permanent visual element will depend on the detailed design of its scale and proportions, colour and materials used for its construction and the extent of illumination adopted. The elevated route corridor in the vicinity of Ting Kau will also remain as a permanent dominant structure within the local landscape; fundamentally changing the quality of the character area it bisects.

8.9 VIEW FROM THE ROAD

There is considerable scope to make this stretch of the Route 3 CPS alignment a pleasant and memorable driving experience. To the south, on the north west section of the Tsing Yi Island, the establishment of woodland stands would create a visually structured enclosure of the route and the toll booth area. The TKB itself has the potential of creating longer views across the surrounding water bodies, eastward towards Tsuen Wan and south westwards across the island groups, passing over the natural Ting Kau bay in the foreground. The northern section would be enclosed by the proposed woodland planting that reflects and extends the influence of the country Park to the north. Revegetating all slopes would avoid the use of tunam or shotcreted surfaces, and the resultant significant visual intrusion of this unsightly artificial surface treatment.

Structures encountered by the motorist will have a significant impact on the quality of view, the ease of driving along the route and consequently the overall perception of the route corridor. A well structured signing system should be adopted and detailed attention given to the visual quality and the comprehensive utilisation of the toll booths. The detailed design of the bridge towers, cables and parapets should be addressed and where possible, views from the bridge to adjacent landmarks maintained to aid orientation.

Table 8.2 Summary Table 4 of Landscape Impacts

LANDSCAPE CHARACTER AREA	VEGETATION			LANDFORM			WATER COURSES			LANDUSE			FEATURES			OVERALL CHARACTER		
	Con	Year 1	Year 15	Con	Year 1	Year 15	Con	Year 1	Year 15	Con	Year 1	Year 15	Con	Year 1	Year 15	Con	Year 1	Year 15
North West Tsing Yi Islands	S	S	P	S	M	SL	I	I	I	S	M	SL	I	I	I	M	SL	P
Ting Kau Bridge (Rambler Channel)	-	-	-	-	-	-	M	SL	SL	M	SL	SL	-	-	-	M	SL	SL
Ting Kau Bay	M	SL	P	M	M	SL	SL	I	I	M	M	M	S	S	S	S	S	S

Key : P = Positive Impact S = Severe Impact I = Insignificant
M = Moderate Impact SL = Slight Impact Con = Construction Phase
- = Not affected

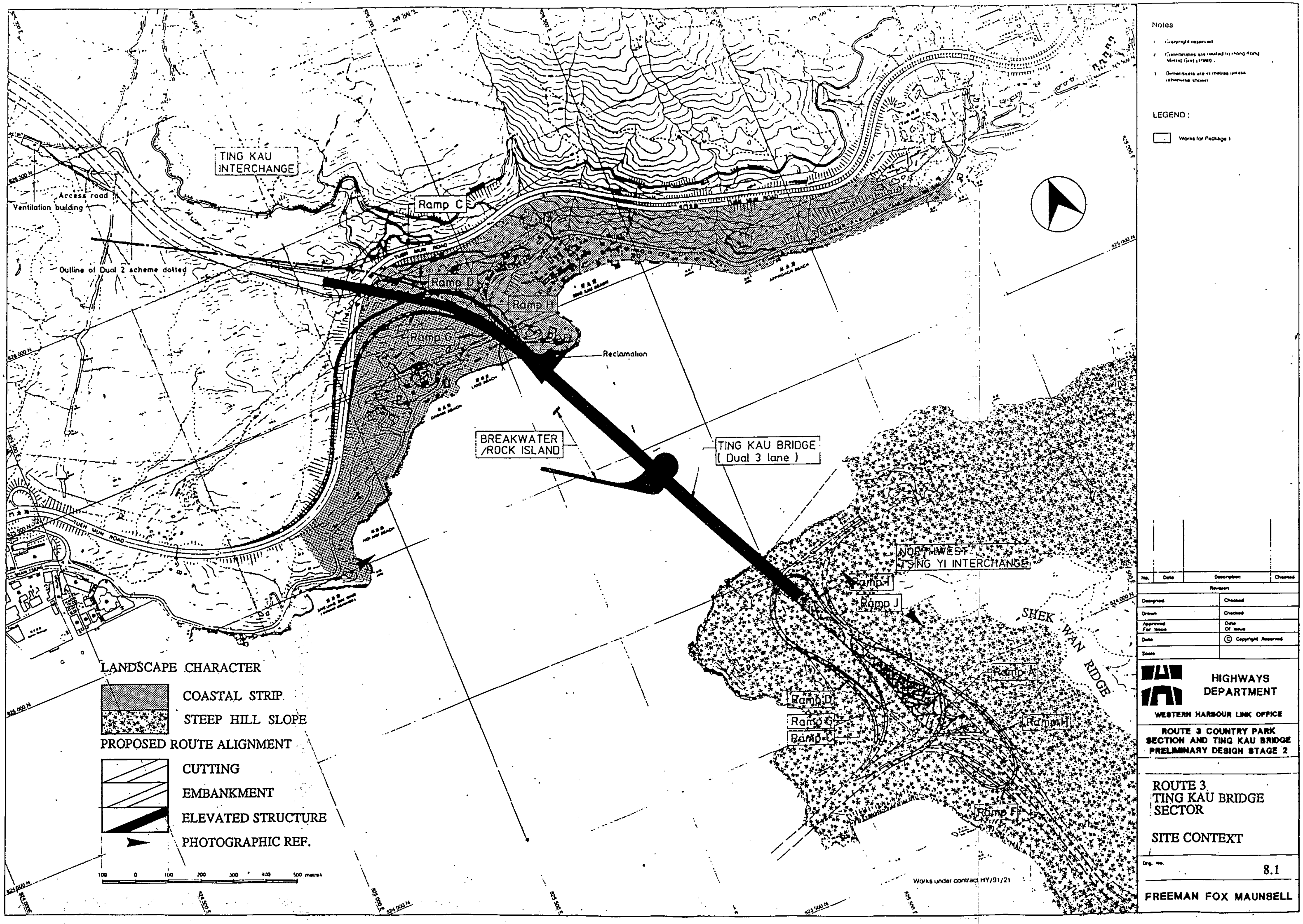
Table 8.3 Summary Table of Visual impacts

Receiver Group	Tsing Yi Interchange			Ting Kau Bridge			Ting Kau Interchange		
	Con	Year 1	Year 15	Con	Year 1	Year 15	Con	Year 1	Year 15
Highly Sensitive Receivers									
Tsing Lung Tau	SL	I	1	M	SL	SL	-	-	-
Sham Tseng	M	SL	1	M	SL	SL	-	-	-
Ting Kau	M	SL	1	S	S	S	S	S	S
Yau Kom Tau	-	-	-	M	SL	SL	-	-	-
Belvedere Garden	-	-	-	SL	SL	SL	-	-	-
Tsuen Wan	-	-	-	SL	SL	SL	-	-	-
Cheung Fat Estate	-	-	-	SL	SL	SL	-	-	-
Ching Tai Court	-	-	-	SL	SL	SL	I	I	1
Cheung On Estate	-	-	-	SL	SL	SL	I	I	1
Country Side Visitors									
Tai Lam Country Park	M	SL	SL	M	SL	SL			
Tai Mo Shan Country Park	-	-	-	I	I	1	-	-	-
Shing Mun Country Park	-	-	-	I	I	1	-	-	-
Lantau Island	S	M	I	S	M	M	I	I	1
Ma Wan Island	S	M	I	S	M	M	I	I	1
Moderately Sensitivity Receivers									
Tuen Mun expressway	I	I	1	M	M	M	M	M	M
Castle Park Road	SL	I	1	S	M	M	S	M	M

Table 8.3 (cont'd)

Receiver Group	Tsing Yi Interchange			Ting Kau Bridge			Ting Kau Interchange		
	Con	Year 1	Year 15	Con	Year 1	Year 15	Con	Year 1	Year 15
Low Sensitivity Receivers									
Marine Transport Routes	M	SL	1	S	S	S	I	I	1
Tsuen Wan	-	-	-	SL	SL	SL	-	-	-
Cheung Shue Tan	-	-	-	M	SL	SL	I	I	1
North West Coastline - Tsing Yi Island	SL	I	1	SL	I	1	I	I	1

Key : P = Positive Impact S = Severe Impact I = Insignificant
M = Moderate Impact SL = Slight Impact Con = Construction Phase
- = Not affected



Notes
LEGEND :
Works for Package 1
TING KAU INTERCHANGE
Access road
Ventilation building
Ramp C
Outline of Dual 2 scheme dotted
Ramp D
Ramp H
Ramp G
Reclamation
BREAKWATER /ROCK ISLAND
TING KAU BRIDGE (Dual 3 lane)
TUEN MUN ROAD
NORTHWEST TSING YI INTERCHANGE
Ramp I
Ramp J
SHEK WAN RIDGE
Ramp A
Ramp D
Ramp G
Ramp C
Ramp H
Ramp F
LANDSCAPE CHARACTER
COASTAL STRIP
STEEP HILL SLOPE
PROPOSED ROUTE ALIGNMENT
CUTTING
EMBANKMENT
ELEVATED STRUCTURE
PHOTOGRAPHIC REF.
100 0 100 200 300 400 500 metres
Works under contract HY/91/21
HIGHWAYS DEPARTMENT
WESTERN HARBOUR LINK OFFICE
ROUTE 3 COUNTRY PARK SECTION AND TING KAU BRIDGE PRELIMINARY DESIGN STAGE 2
ROUTE 3 TING KAU BRIDGE SECTOR
SITE CONTEXT
8.1
FREEMAN FOX MAUNSELL

FREEMAN FOX MAUNSELL

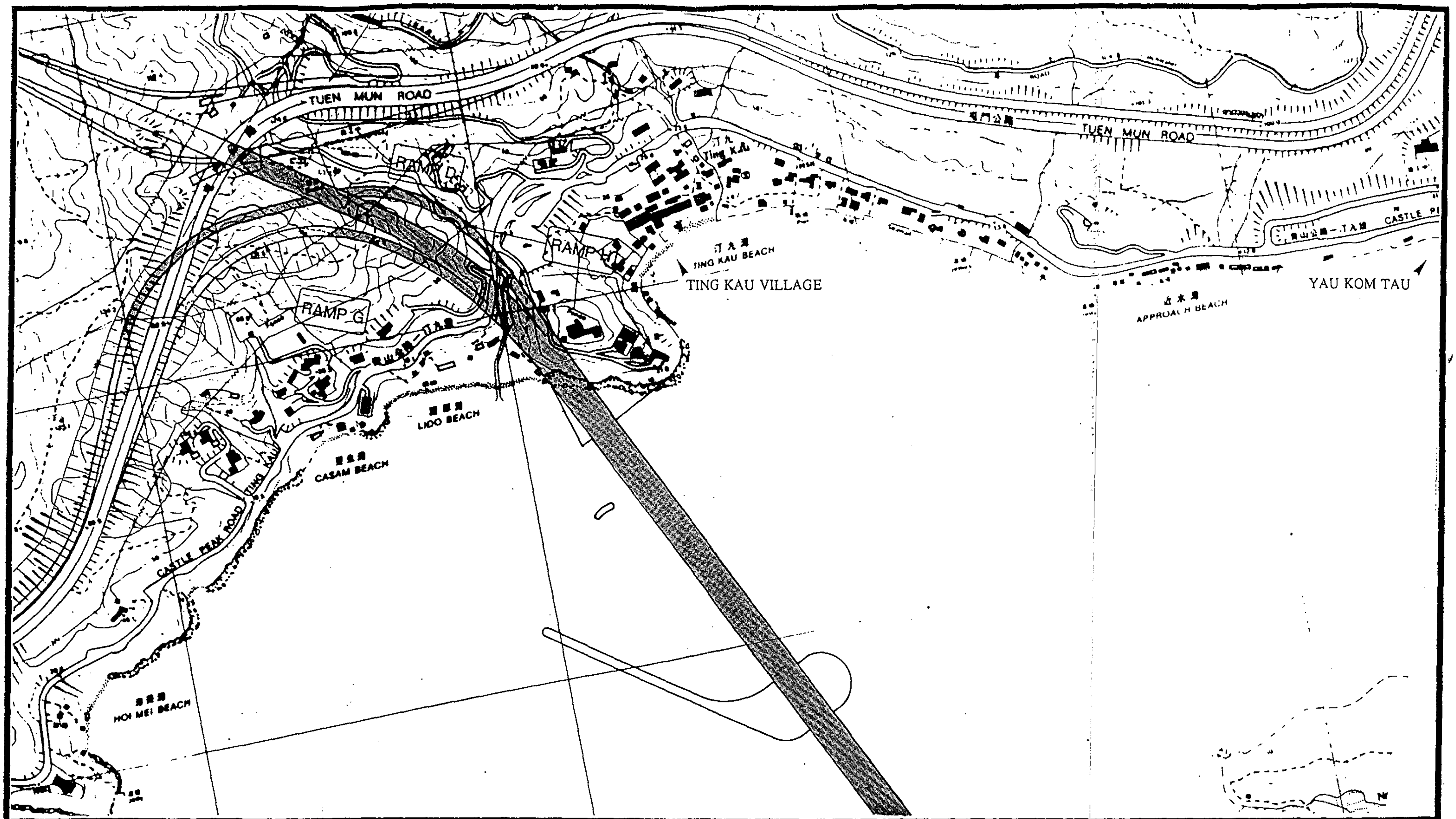
Legend
Immediate surroundings with Direct Views
Views of Upper sections of bridge Tower
Distant Views
Major Ridgelines

Job Title : ROUTE 3 - TING KAU BRIDGE SECTOR. ZONE OF VISUAL INFLUENCE

Scale : 1:50,000

Date : July 1993

Fig. No. 8.2



FREEMAN FOX MAUNSELL

Job Title :
ROUTE 3 - TING KAU BRIDGE SECTOR
LOCATION OF SENSITIVE RECEPTORS

Scale : 1:10,000
Date : July 1993

Fig. No. 8.3

LANDSCAPE MITIGATION

CHAPTER 9

9. LANDSCAPE MITIGATION

9.1 INTRODUCTION

The construction of the TKB section of Route 3 CPS will necessitate substantial disturbance of the existing landscape. Large cut and fill operations will occur at both the Northwest Tsing Yi Interchange and Ting Kau Interchange. Appropriate landscaping and rehabilitation of these areas represents one of the most important environmental challenges facing the project.

Landscape and visual considerations are closely linked. In this regard the landscape mitigation proposals contained in this section are a result of the landscape and visual impact assessment in Section 8. The landscape proposals promoted are also relevant to factors such as erosion control, surface and subsurface slope stability, habitat reinstatement, noise and dust mitigation and pedestrian management.

Substantial information relating to the landscaping of Route 3 CPS has been referenced in previous reports and particularly (Stage 1 Preliminary Design, Technical Report No 19, Draft EIA). Some of this information has been incorporated in this chapter.

The recommendations contained in this section have been designed to be consistent, and integrate with landscape works proposed for the of Route 3 CPS and adjacent areas on Tsing Yi Island. A high priority has been given to maximizing tree establishment on disturbed and adjacent areas along Route 3 CPS. Previous experience at other sites in the New Territories suggests that with appropriate expertise, quality woodland can be readily reinstated.

9.2 OBJECTIVES

Route 3 CPS will connect with the new airport and will provide links to connect to Yuen Long and locations to the north. An important objective will be to create a high standard gateway corridor along the route, particularly over this initial section. To achieve this it will be necessary to reinstate areas of existing high landscape value as well as improve the visual appearance of more degraded areas. The following specific objectives will apply to landscape design:

- minimize the visual impact of the works by blending disturbed areas into the adjoining natural landform;
- maximize the establishment of quality habitat; and
- maximize the advantageous effects of revegetation on slope stability, noise and dust amelioration and pedestrian and traffic management. Landscape works will also be designed to retard the movement of hill fires and improve surface water run off characteristics;

Other more general objectives will include minimizing landscape maintenance, encouraging self propagation, and linking new tree planting areas with existing woodland.

9.3 LANDSCAPE GUIDELINES

There is currently no legislation which specifically relates to landscape impacts that arise from development. However, landscape and revegetation guidelines and specifications have been produced by various government departments and these should be followed when implementing the work. Particular attention has been given to HKPSG Chapter 10. The need to address landscape/rehabilitation issues that arise from development has been identified as part of the environmental assessment process and is now an expectation within all major projects. The most valuable landscape guidelines come from recognition of the basic elements of past successful landscape projects.

9.4 REVIEW OF THE EXISTING LANDSCAPE ENVIRONMENT

The existing landscape environment has been described in Chapter 8. Of particular relevance is the steep and often degraded nature of much of the route. The northwest corner of Tsing Yi Island is devoid of tree cover as a result of frequent hill fires. The hills above Lido and Casam beaches on the northern side of the Channel above Tuen Mun Road have similar poor vegetation cover. Substantial earthworks in the North West Corner of Tsing Yi as a result of other projects, have also contributed to landscape degradation.

Large scale alteration of the landform will occur both at North West Tsing Yi and to a lesser extent the Ting Kau Interchanges. However, the extent and nature of proposed disturbance must be kept in perspective. Considerable disturbance has already occurred in the north west corner of Tsing Yi Island as a result of container port facilities and other works. In addition surrounding hillsides are bare and devoid of trees as a result of the high frequency of hill fires.

On the western side of Tsing Yi Island, disturbance caused by Route 3 CPS will only be one component of a major landform modification programme resulting from an extensive road construction and industrial development programme. It is important that Route 3 CPS impacts neither be seen nor remedied in isolation from other activities. The attractive gateway concept must apply to all disturbed and visible areas in the vicinity.

The Ting Kau area is already characterized by substantial cut and fill operations and elevated road sections associated with the Tuen Mun Road. Many of the hillslopes in the proximity of the interchange are bare and devoid of significant tree cover. The Ting Kau Interchange area is characterized by a diverse range of micro-habitats due to the maturity and diversity of vegetation and a availability of fresh water. Tree destruction should be limited to small pockets of trees associated with the pier positions, immediately above the eastern end of Lido Beach.

Other than visual and ecological impacts, proposed engineering works also have the potential to affect surface erosion and slope instability, increase noise and air pollution as well as alter surface water runoff characteristics. Works in this area also have the potential to affect access to the country park. Landscape and rehabilitation works should address all these potential impacts.

9.5 METHODOLOGY

This chapter provides a practical description of ameliorative landscape measures required to mitigate those landscape and visual impacts previously identified in Chapter 8 and other sections of the EIA Report. Particular attention is given to remedial grading and planting works. The following approach was adopted:

- summarize landscape mitigation requirements identified in other specialist studies within this report;
- for each section of the route, plans were prepared showing the extent of disturbance. Route sections, containing construction activities which will have a serious impact on the existing landscape, received particular attention; and
- use of existing government guidelines, results of vegetation surveys and past experience in similar projects to identify outline landscape proposals.

The outline landscape mitigation proposals considered a number of factors including:

- Roadway and Alignment Design. Sections of the route on both sides of the channel will be characterized by extensive cut and fill operations.
- Linkages and Circulation. The alignment has the potential to present visual and ecological barriers particularly as a result of change in landform and the area of elevated structures at the two interchanges.
- Adjacent Land Use. This includes:
  - industrial facilities and container port facilities on Tsing Yi Island;
  - green belt used for passive recreation;
  - coastal villages and residential areas on northern side of the channel;
  - highways and roads including the Tuen Mun and Castle Peak roads;
  - open space
- Environmental Mitigation Process. A variety of factors and techniques have been manipulated to maximize environmental repair. A strong emphasis has been placed on sensitive grading design and formulating tree planting in landscape recommendations.

9.6 MITIGATION MEASURES

9.6.1 Introduction

The mitigation measures undertaken in association with the route proposals will play an important part in the successful integration of the new road with its surrounding landscape. Landscape mitigation measures fall into two main categories: temporary measures associated with reducing the impact of the roads construction phases; and permanent measures adopted to reduce the impact of the route on surrounding receptors, to aid the integration of the route within the character of the landscape it traverses, as well as being relevant to factors such as erosion control, surface and subsurface slope stability, noise and dust amelioration and pedestrian management. Permanent soft landscape mitigation measures are identified in this Section and detailed in Chapter 8.

9.6.2 Temporary Mitigation Measures (Construction Phase)

The following measures are recommended to reduce the impact during construction:

- Restrict volume of construction traffic on local road network.
- Restrict construction working areas to a minimum (the minimum size will be decided on a site by site basis by the Resident Engineer or equivalent).
- Enclose the working areas with hoardings to define boundary edge and screen low level construction activities (eg car/truck movement) from surrounding receptors.
- Restrict heights of storage materials, stock piles and spoil heaps to low levels.
- Minimise night time working and lighting.

Advanced planting and ground modelling in designated landscape areas should be adopted where damage from construction activity can be avoided to enable the landscape to become established prior to the route becoming operational and making its screening qualities effective in a shorter length of operational time.

9.6.3 Permanent Mitigation Measures

The following measures are recommended to reduce the permanent impacts of the TKB development. Many items do not fall directly into a landscape context, nevertheless they should be carefully considered to enable the successful integration of the route within its surroundings.

- Detailed alignment of the route enabling retention of significant landscape features.

- The treatment of the interface between man made and natural landforms.

- Position of associated operational buildings.

- The use, location and design of retaining walls.

- Specific attention to the visual quality of structures associated with the route.

- Landscape treatment within, and immediately outside the highway boundary.

- Colour and materials used for structures should reflect the colours and materials of the surrounding landscape. As a general principle strong contrast in colour should be avoided and muted colours related to the material environment should be used with darker colour concentrated to the base of the structure to create a sense of stability.

- Detailed attention to the gradients and the profile of regraded slopes, and earth modelling to ensure they reflect the gradients of the natural slopes in the vicinity.

- The use of tunam or shotcrete treatment of regraded slopes should be avoided.

- Screen planting within the curtilage of residential properties to screen the view at source.
- The coastal boundary treatment to areas of reclamation.
- The relationship between the route structures and the shoreline.
- Incorporating areas of redundant land within the highway landscape proposal scheme to aid the integration of the route with its surroundings and avoid the creation of areas of derelict land.
- The extent and form of highway illumination adopted. The size height design and orientation of the light should ensure effective lighting of the highway corridor whilst minimising the potential leakage of light. The use of reflective paints and signing should be fully investigated to determine the need for permanent lighting.

9.6.4 Landform Regrading Works

The visual quality of the regraded slopes with highway corridor will play a major part in the successful integration of the route with its surrounding landscape character.

Geotechnical and engineering requirements dictate the basic form of the slope, there is however scope with the attention to detailed slope profile, to soften its impact. Wherever possible the formed slopes should reflect the angle and alignment of the natural slopes within the area. The slope should not however be greater than 1 (horizontal) : 1.5 (vertical), with a gentler slope of 1:2 preferable.

Attention to the interface between the surrounding topography and the engineered highway slopes should be addressed to reduce the potentially sharp divide and consequent visually intrusive element created between the natural and man made landforms. The long profile of the slope should follow a shallow inverted "S" alignment, include natural landforms profile. Similarly the edges of the regraded slopes should merge into the surrounding landform, rather than appear to be cut out from it. This may involve extra regrading work, outside the geotechnical and engineering requirements, requiring extra land, however the resultant overall landform will be more visually acceptable both from receptors within its immediate vicinity and more distant views (when the new landform will form a component of the overall landscape).

Disturbed areas should be designed to be stable and capable of revegetation wherever possible. It is important that landscape considerations receive high priority and early consideration in the design phase.

A smooth compacted surface is not conducive to vegetation establishment. Wherever consistent with safe geotechnical considerations, the surface of bare earth areas should not be overly compacted and should be left with a textured surface to assist seed and water retention.

Similarly, exposed rock faces are not conducive to revegetation. Rock faces should be either covered with a minimum of 0.5m of soft spoil material and hydroseeded or benched and treated as indicted in Table 9.1.

The collection and reuse of quality topsoil material along the highway corridor is strongly recommended.

9.6.5 Landscape Philosophy

To be successful landscaping and rehabilitation works will require adoption of a basic philosophy.

- Areas of current high landscape value must be reinstated to at least an equivalent standard.
- As a result of the existing degraded nature of much of the route (and particularly north west Tsing Yi Island) an opportunity exists to upgrade visual and ecological values through well designed landscaping incorporating extensive tree planting. This opportunity must be maximized.
- Route 3 CPS works will be only one source of disturbance in the area, and landscape works in this and other projects must be extended to include all adjacent areas and particularly areas south from the Tsing Yi Interchange and north of the Ting Kau Interchange along the TLT & YLA of Route 3 CPS. A total landscape plan is urgently required for the western side of Tsing Yi Island.
- Revegetation works must not be restricted to artificial boundaries delineated by Route 3 CPS earthworks. Tree planting must not highlight cut and fill slopes but rather blend them into the landscape by extending further uphill and into valleys. Tree planting must also extend laterally into adjacent engineering formations.
- Landscape considerations must be prioritized and not sacrificed to expediency in the inevitable cost cutting programme.

9.6.6 Location of Landscape Works

The planting location and specification of planting works are shown in Figures 9.1 and 9.2 (Stage 1 Preliminary Design, Casting and Programme Report, Supporting Information). A total approximate area of 36ha (plan area) will be disturbed. It will be desirable to reinstate approximately 55ha.

Areas which will require reinstatement include:

Area 1. Disturbed areas on the northern side of the bridge associated with ramps G and H (connecting with Tuen Mun Road) and the main northern bridge approach. These works mainly include revegetation of cut and fill slopes. A small area of reclamation at the northern toe of the bridge will also be revegetated. Landscaping works in Area 1 will connect with proposed landscaping works associated with the TLT & YLA of the route to the north.

Area 2. Earthworks on the southern (Tsing Yi Island) side of the bridge associated with the Northwest Tsing Yi Interchange and adjacent reclamation works and access road. Proposed planting within the area will ultimately connect with existing and proposed landscape works further south associated with other highway construction. Landscape works in Area 2 will include hydroseeding, tree planting on slopes and berm planting. Berm planting has been necessitated by the presence of rock in cut batters on the eastern side of the route.

9.6.7 Specific Landscape Details

The extent and nature of proposed landscape works are shown on Figures 9.1 and 9.2. The nature of landscape works follow broad guidelines previously described in Section 5.5.3 of " Stage 1 Preliminary, Design, Costing and Programme Report". These guidelines share a common theme with other landscape works proposed for the area outside of Route 3 CPS.

Both cut and fill slopes should be initially stabilized by hydroseeding and engineering erosion control techniques. The hydroseed mix will incorporate both grass and appropriate tree seeds to simulate the natural woodland composition thereby increasing species diversity through planting. Into this, **Woodland** or **Shrub Mixes** will be planted. The mixes specified vary in the size distribution of plant material and planting density. Specific plant species should be selected at the detailed design stage to respond to local conditions and vegetation types identified along the Route 3 CPS connection.

Selection of suitable species would be assisted by information provided in flora studies conducted for both the TKB and TLT & YLA EIA's for Route 3 CPS. The proposed treatments are described in Table 9.1 and summarised below.

All tree and whip planting should be into appropriately sized pits. Fifty grams of low release fertilizer (minimum release period 8-9 months) should be incorporated into the base of each hole and well mixed with the soil prior to tree planting. Native species tolerant of drought and windy conditions should be selected as far as possible.

Woodland Mix A will be used on Tsing Yi to co-ordinate with the density and size distribution of landscape softworks proposed for adjacent contracts.

Woodland Mix B will be prescribed for the extensive cut and fill areas surrounding the Ting Kau Interchange and later in the TLT & YLA of the Route. This mix would be designed to blend into the country park landscape.

Extended Woodland should be prescribed for planting above and below formed slopes on Tsing Yi Island and the Ting Kau Interchange. This planting mix should have a high component of shrubs and fire resistant species and will provide a transition between taller trees and adjacent grassy hillsides.

Roadside Planting of trees and amenity shrubs would be confined to the more visible sections of the road at the interchanges where traffic speed will be reduced. These areas are more accessible permitting higher levels of maintenance.

Reinstatement Planting of reclaimed areas near both the north and south end of the bridge will be undertaken. Reinstatement would include importing soft fill for ground contouring and as a planting medium. The area should be hydroseeded and trees and whips planted into half the area.

Berm Planting should be undertaken on rocky cut slopes to the north of Tsing Yi Interchange.

Good revegetation results have been observed at these sites for both cut and fill slopes and for a range of substrates. There appears to be no long term unfavourable residual effects.

Table 9.1 Summary of Landscape Treatments

LANDSCAPE TREATMENT	DESCRIPTION
WOODLAND MIX A	Hydroseed with grass and tree seed. Plant trees on 100% of area. Pit plant 80% tree/shrub whips, 20% light standard trees. Density: 1.5m staggered centres.
WOODLAND MIX B	Hydroseed with grass and tree seed. Plant trees on 100% of area. Pit plant 75% tree/shrub whips, 25% light standard trees. Density: 1.5m staggered centres.
EXTENDED WOODLAND	Pit plant 100% of area with tree/shrub whips. Density 1.5m staggered centres.
BERM PLANTING	Construct random stone wall, average one metre high. Drainage layer, filter fabric, topsoil mix, mulch. 3m wide planting area with climbing/trailing plants (2/lin. m). Medium Shrubs/Whips (3/lin. m), light standard trees (1/lin. m).
ROADSIDE PLANTING	Import 450mm topsoil mix, mulch. Plant medium shrubs at 600mm staggered centres and standard trees at average 1 tree/5 lin. m.
REINSTATEMENT PLANTING	Import average 1m depth soft fill. Hydroseed with grass only. Pit plant 75% tree/shrub whips, 25% light standard trees over 50% area.

9.6.8 Fire Control Recommendations

The high frequency of hill fires in this area represents a significant risk to young trees. Protection measures necessary to ensure the early survival of trees include:

- planting a 20m wide buffer strip of fire resistant *Acacia* species around the periphery of planted slopes;

- planting more fire resistant species in the top half of slopes. Exotic, species such as *Pinus elliottii* which are extremely susceptible to fire at all stages of growth, and should not be included within the planting mix;

- with local fire brigades develop a quick response system to hillfires in the vicinity of Route 3 CPS landscape works. Provide relevant fire brigades with landscape location plans and access details; and

- encourage the quick growth of trees above scotch height through optimum initial fertilization, establishment and maintenance techniques.

9.7 LONG TERM RESIDUAL EFFECTS

Experience on Tsing Yi Island, Tsuen Wan and a wide range of other New Territory sites indicates that vigorous and healthy tree cover can be established on cut and fill slopes similar to those in Route 3 CPS. In these areas a range of fire protection measures have been successfully used and 10-12 year old woodland on Tsing Yi Island is showing good resistance to hill fire damage. Within these areas self seeding and establishment of native ground covers are common.

9.8 MONITORING AND MAINTENANCE

While allocation of responsibility for implementation and maintenance is outside the remit of this study several salient points require highlighting.

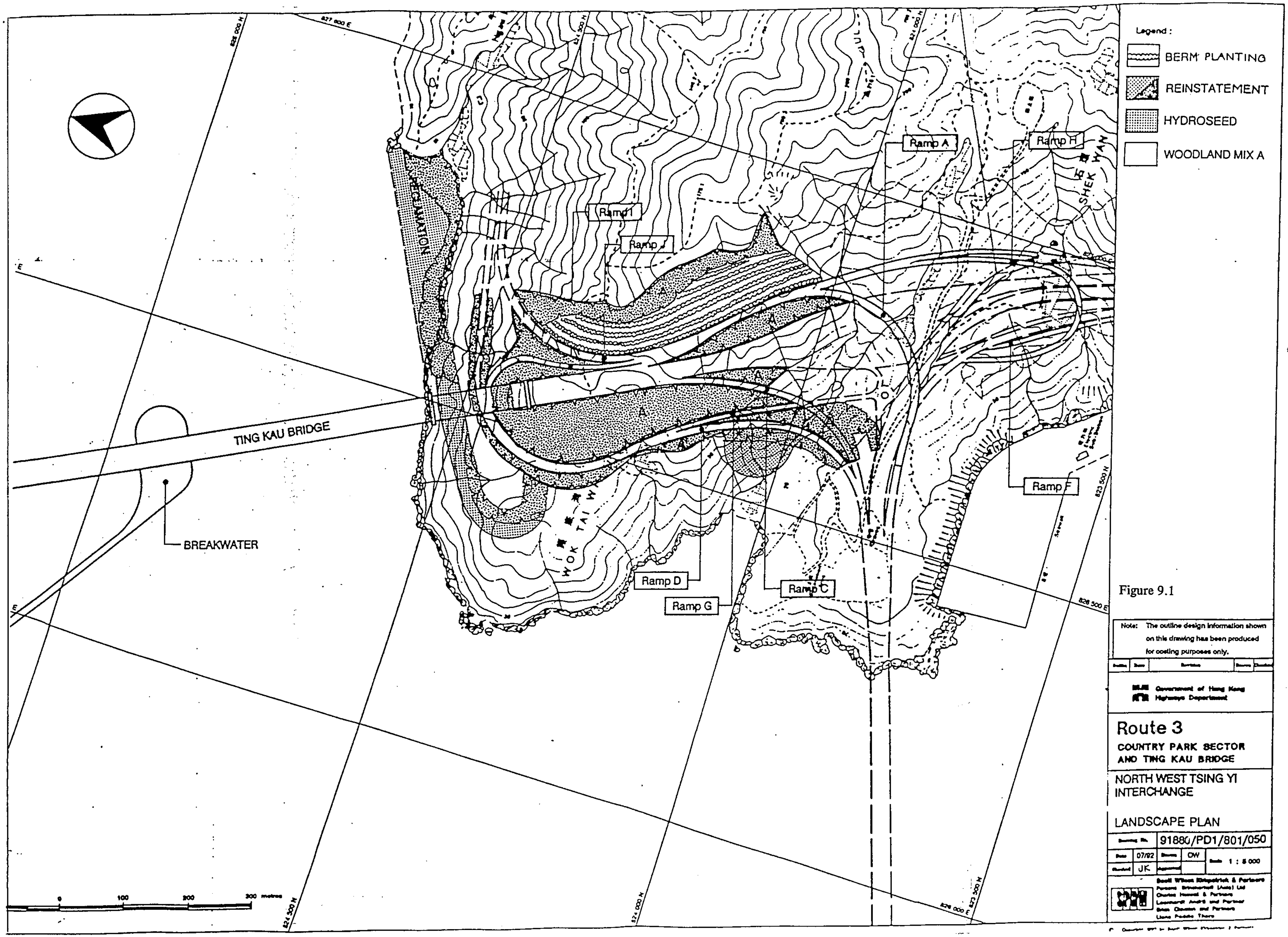
All landscape works should be regularly checked and maintained. Monitoring should not only check the general health of tree stands and grass swards but also ensure that species diversity is maintained and that ground cover remains adequate to prevent erosion. Pure stands of some species such as *Casuarina equisetifolia* can cause ground cover decline. Monitoring will also ensure that surface drainage structures are intact and have not been interfered with by vegetation.

Necessary maintenance works may include fertilizing, thinning tree stands, replanting or resowing, watering and fire protection (in early stages), and all works necessary to ensure beneficial development of landscaped areas.

As previously discussed the need for maintenance should decline with time and will vary with the various categories of landscaping proposed. A minimum maintenance period of two growing seasons is recommended, with fire break maintenance to four years for relevant areas.

Consideration within the design will be given to the storage of surface runoff water from paved areas for the irrigation of landscaped areas after passing through silt and oil traps. Wherever possible landform depressions should be used to maximize water availability to plants.

Proposed landscape works should be discussed with the relevant implementation and maintenance authority at an early stage.


Legend:
BERM PLANTING
REINSTATEMENT
HYDROSEED
WOODLAND MIX A
RECLAMATION
TING KAU BRIDGE
BREAKWATER
Ramp A
Ramp H
Ramp I
Ramp J
Ramp D
Ramp G
Ramp C
Ramp F
SHEK WAN
WOK TAI WAN
0
100
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Note: The outline design information shown on this drawing has been produced for costing purposes only.
Route 3
COUNTRY PARK SECTOR AND TING KAU BRIDGE
NORTH WEST TSING YI INTERCHANGE
LANDSCAPE PLAN
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Figure 9.1

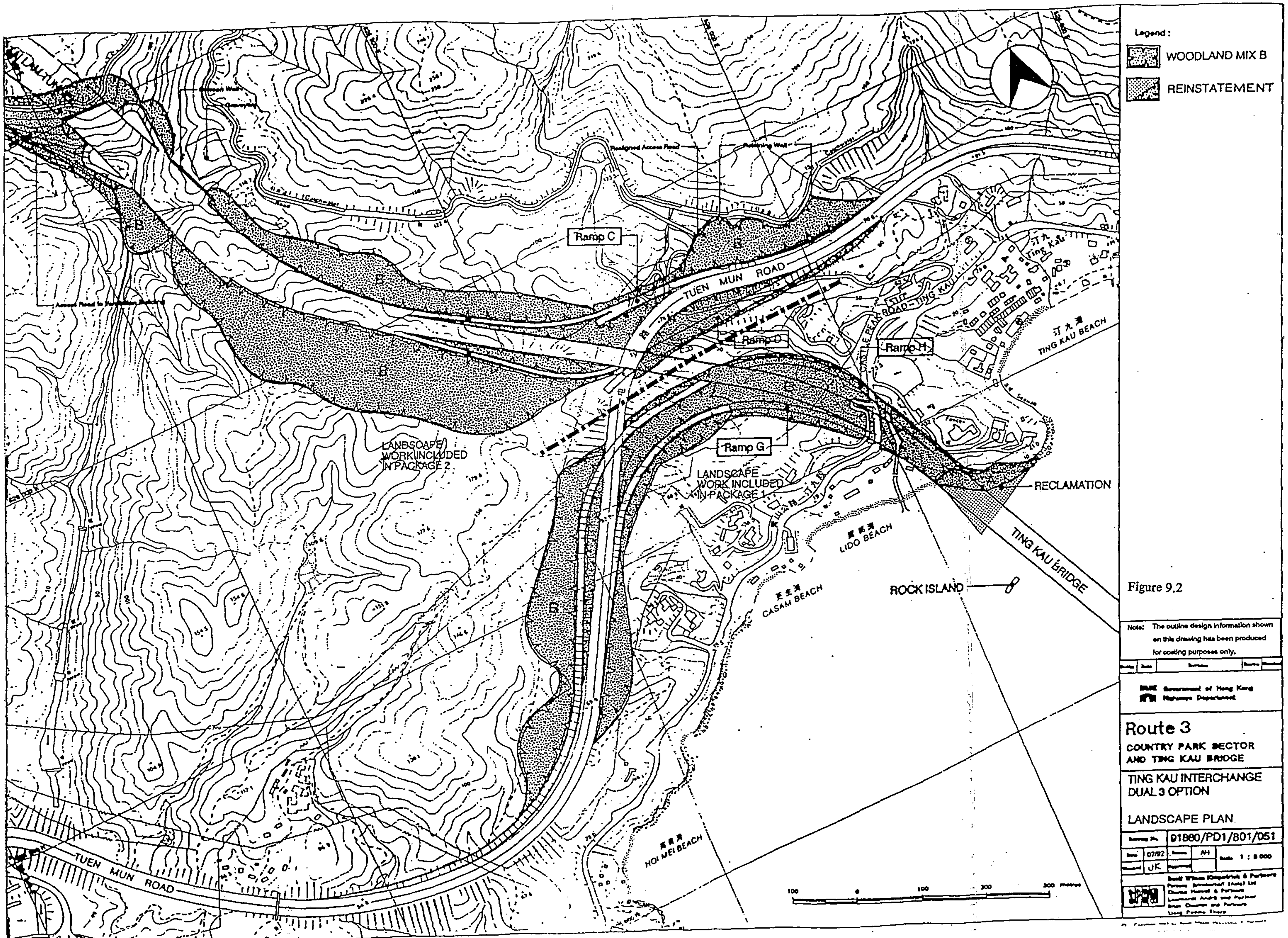
Legend :
WOODLAND MIX B
REINSTATEMENT
Ramp C
Ramp D
Ramp H
Ramp G
TUEN MUN ROAD
CASTLE PEAK ROAD - TING KAU
Ting Kau
汀九灣
TING KAU BEACH
LANDSCAPE WORK INCLUDED IN PACKAGE 2
LANDSCAPE WORK INCLUDED IN PACKAGE 1
RECLAMATION
TING KAU BRIDGE
LIDO BEACH
CASAM BEACH
ROCK ISLAND
HOI MEI BEACH
Retaining Wall
Realigned Access Road
Note: The outline design information shown on this drawing has been produced for costing purposes only.
Government of Hong Kong
Highways Department
Route 3
COUNTRY PARK SECTOR AND TING KAU BRIDGE
TING KAU INTERCHANGE DUAL 3 OPTION
LANDSCAPE PLAN.
91860/PD1/801/051
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Figure 9.2

LAND USE

CHAPTER 10

10. LAND USE

10.1 INTRODUCTION

It is important to identify and assess the impacts and implications of the TKB development in terms of community issues and neighbouring landuses.

The importance of landuse issues is recognised by the Hong Kong Government as demonstrated by the recent approval of several Papers on landscape issues by the Land Development Policy Committee (LDPC), and the incorporation of Chapter 9 on Environment in HKPSG (Hong Kong Government, 1990). A specific Chapter providing guidelines for Landscape and Conservation (Chapter 10) is currently being drafted by EPD for inclusion into HKPSG.

This Chapter considers the nature of neighbouring landuse, and it's significance in terms of potential impacts from TKB on the local community, recreation/resource value of the area, local amenity and development potential.

10.2 OVERVIEW OF LANDUSE ISSUES

10.2.1 General

Construction and operation of Route 3 CPS will inevitably result in landuse impacts along and near to the alignment. These will include not only direct effects such as disruption, loss of amenity/recreation, community severance (perceived and actual) and landtake, but also constraints imposed on future development and urban design due in particular to noise and air quality impacts, and visual intrusion.

As the TKB is an elevated section, potential impacts will tend to be more significant than would be the case for an at grade section in terms of noise and visual intrusion, and by its very nature not as easily integrated into the surrounding environment. However it will be more economical in terms of landtake and is likely to be less significant in terms of effective severance.

10.2.2 Severance

Community severance arises through change in community lifestyle patterns as a result of landuse changes. It may be defined as the separation of residents in a community from facilities, services and friends. With respect to the TKB development this may result from barriers created by the construction of sections of the roadway. Severance may also occur with respect to reduced public access to recreational areas.

Community severance may be assessed in terms of a communities perception, actual separation from areas previously accessible and separation from essential facilities etc. The evaluation of impacts to local communities therefore necessarily involves a subjective element and was undertaken by considering the nature, extent and location of communities in the study area.

10.2.3 Disruption, and Disturbance

Disruption and disturbance can be viewed in terms of increased road traffic, the occurrence of local diversions and obstructions,and physical (measurable) impacts such as noise, dust etc. These effects will generally inconvenience the local community through reducing mobility, interrupting daily activities and creating general nuisance to local residents

10.2.4 Loss of Recreation/Amenity

During the construction and operation of TKB there maybe short and/or long term effects, which by altering the character and nature of the area will affect existing recreational and amenity value. Such impacts are often a result of increasing the background levels of dust, noise and general nuisance.

10.2.5 Landtake

Landtake will inevitably occur as a result of constructing TKB. Initial landtake during construction will necessarily include a number of work sites, the details of which have not been finalized.

10.2.6 Development Potential/Land Value

Changing landuse patterns in terms of increased road traffic, deterioration in air quality and increase in ambient noise will potentially alter the overall character and nature of the area. This in turn is likely to impose constraints on the extent and nature of future development, and may also result in devaluation of existing properties.

10.3 APPROACH

Landuse impacts have been identified in terms of both the construction and operation of the TKB section of Route 3 CPS, and where appropriate the implications of impacts have been considered.

Impacts are assessed in relation to Government landuse zoning and planning policies, the degree and nature of disturbance to both members of the public and visitors to the study area, and the importance of the affected areas in terms of their resource value. Government designated landuses were used to identify where landuse may be a constraining factor on the proposed development.

The significance of potential impacts has been assessed in relation to the nature and extent of sensitive receivers affected.

10.4 EXISTING LANDUSE AND PLANNING CONCEPT OF THE STUDY AREA

Existing landuse in the study area comprises a mix of docking and storage facilities (north west Tsing Yi) on the southern landfall and relatively undeveloped coastline and woodland (with scattered residential premises) rising northwards to Tai Lam Country Park at the northern landfall.

A Review of 1:20 000 scale maps, Outline Zoning Plans (OZP) for Tsuen Wan west, non metropolitan landuse plans and the Territory Development Strategy (TDS) establish that with the exception of north west Tsing Yi the study area generally comprises unprotected woodland. In the non metropolitan areas, little committed development has been identified, consequently landuse impacts associated with these areas is focused on existing landuse.

The main sensitive areas potentially affected by TKB in terms of potential landuse impacts are:

- Communities at Ting Kau

  Existing development in the vicinity of the northern landfall (Ting Kau) comprise low density residential dwellings scattered in the hillside between Tsuen Mun road and Castle Peak roads.

  Ting Kau is a recognised village and care should be taken to minimize potential impacts. The developments are typically low rise (2-3 storeys) and of high quality, situated in a superior position with substantial views across the Rambler Channel. Consequently these communities are extremely sensitive to both the long and short term impacts resulting from the development of TKB.

- Lido Beach

  A 200m stretch of sandy beachland situated close to the reclamation (for the support structure), Lido Beach is heavily used for water based recreation, with approximately 9,600 people visiting the area on a typical weekend (Bacteriological Water Quality of Bathing Beaches in Hong Kong, EPD, 1992), reaching a maximum of 47,000 during peak season.

  Facilities available to the public include food and drink outlets, toilets, life guard etc., in addition to which EPD have expressed an intention for upgrading and improvement.

  At the Eastern end of Lido beach is a small, well used and maintained Temple.

  Although not a prime beach for swimming, water quality was defined as *fair* (1992), (Bacteriological Water Quality of Bathing Beaches in Hong Kong EPD, 1992) this reference has been used for the information on Casam and Ting Kau Beaches below, however it is anticipated that this has deteriorated. In addition a nullah outfall is situated towards the east end of the beach which by discharging directly to the sea is often a deterrent to beach users in the area.

- Casam Beach

  A much smaller beach than Lido, Casam is approximately 40-50m in length. The beach has no facilities for bathers, however it is moderately used for recreation, primarily by members of the local community. Government statistics indicate 1,200 visitors will use the beach on a typical weekend. Maximum recorded in peak season during 1992 was 8,000.

  Water quality is similar to that of Lido Beach and may be downgraded from fair to poor by the annual assessment for 1993.

- Ting Kau Beach

  Ting Kau Beach is situated to the east of the coastline reclamation. Of the order of 100m in length, the beach has a poor water quality rating and is used to a limited extent, such that on a typical weekend, approximately 100 people will visit the area.

- Mainland Wooded Areas

  The wooded hillsides provide a pleasant backdrop to the beaches and are therefore important in terms of their aesthetic appeal. In terms of local amenity and recreation they are of relatively little significance, with a few minor footpaths, mainly used by members of the immediate community.

10.5 CONSTRUCTION PHASE IMPACTS

10.5.1 Introduction

The main construction activities which will potentially result in landuse impacts comprise:

- storage and transport of construction materials;
- general activities such as construction and operation and associated access roads, concrete batching, reclamation construction etc.; and
- proposals to convey spoil to the coastline.

Impacts from the construction phase of the development will primarily affect sensitive receivers in the settlement at Ting Kau, surrounding properties, and users of recreational areas along the coast and in the wooded hillside to the north. Impacts resulting from the construction phase will generally be temporary in nature but significant as they can last for up to 4 years. The restoration of disturbed areas is an important consideration in assessing the longer term potential impacts.

10.5.2 Severance

Severance impacts during the construction phase will generally be limited to perceived severance for communities in the region of Ting Kau as a result of the storage and movement of construction materials in the immediate vicinity of the local villages. There is however likely to be severance and blockage of access roads to properties especially in areas west of Ting Kau, (behind the Lido and Casam Beaches) due to construction of slip roads and ramps in addition to main road/bridge construction.

These difficulties in movement will also be experienced by the properties west of the proposed highway, especially due to their close proximity to major cut and fill works for construction of the slip roads which link to the Tuen Mun Road.

10.5.3 Disruption and Disturbance

The settlement at Ting Kau is likely to be severely disrupted during the construction phase.

Construction traffic will potentially create disruption and disturbance through local traffic diversions, temporary blockage of access roads and general nuisance. Traffic flow on Castle Peak Road is likely to be disrupted due to movements of heavy plant and the volume of construction related traffic. This would adversely affect both residents mobility (disrupting daily activities) and also through traffic on what is an important strategic traffic route serving the area between Tsuen Wan and Sham Tseng.

Deterioration in air quality due to dust and the increase in noise levels are a likely impact of such large scale construction activities. Although major excavation works are required on north west Tsing Yi, it is those required at Ting Kau, the Rambler Channel and coastal areas that will have greatest effect on landuse, due to the location of sensitive receivers.

The levels and effects of dust and noise are detailed in Chapters 4 and 5 respectively, however, associated impacts on landuse in terms of disruption and disturbance are likely to be significant.

10.5.4 Loss of Amenity/Recreation

There are two main types of landuse resource in the study area with recreational /amenity value;

- beaches; and
- the mainland woodland.

Beaches - The recreational and amenity value of Casam and Lido Beaches will be significantly affected by construction activities.

In general terms the reclamation activities and construction of TKB and associated ramps will detract from the currently pleasant environment of the beaches, both visually and through manifestation of physical impacts such as dust and noise. The most significant impact will be to the east end of Lido Beach where the proposed reclamation for the bridge pier and construction area for the bridge pylons are located. Movement of construction materials and vehicles along access roads, noise and dust nuisance, disruption of accessibility would contribute to deterioration of this recreational resource.

Dredging activities associated with the reclamation will potentially cause a visible deterioration of water quality through increased suspended solid loadings, reducing the value of the beaches for bathing and other water related activities. However, given the poor water quality with potential health effects this may not necessarily be viewed as negative.

The proposal to transport excess spoil from the southern tunnel portal (TLT & YLA of Route 3 CPS) to a barging point along the coast via a covered elevated conveyor system will also detract from the local amenity of the beach areas. Current proposals are for the conveyor belt to run to Gemini Beach as opposed to Lido Beach (which was originally proposed) thereby negating the potential impact of a barging point and pier on Lido Beach.

Lido Beach is more significant in terms of it's recreational value than Gemini Beach, which has only limited use by the public. The construction of a barging point and pier to the south west of Gemini Beach (in the vicinity of Hoi Mei) is therefore preferred on environmental grounds.

Although, siting a barge point on Gemini Beach will reduce the already limited amenity value of the beach, this is preferable to transportation of spoil by vehicles with respect to noise, dust and disruption at ground level.

Mainland Woodland - the wooded slopes rising from the coastline are important more in term of their aesthetic appeal and as a backdrop to the beaches rather than for their recreational value. There are only a few footpaths in this area, the land is quite steep and therefore access is limited. However, maintenance or relocation of footpath access should be considered where practicable to maintain existing recreational value.

Detrimental impacts to the woodland area will arise from the construction related landtake including actual construction sites, work areas, storage areas and also if a concrete batching plant and/or precasting yard should be required and located here. The presence of the conveyor belt would be relatively short term and disturbed woodland should be restored on completion of the construction works.

10.5.5 Landtake

Landtake during construction of TKB comprises the temporary and permanent use of areas of land. There is no realistic mitigation of the permanent landtake impacts associated with the roadway foundations, supports, drainage channels etc. For temporary landtake impacts associated with the works sites, storage areas etc., it is essential that careful and sympathetic restoration of the sites is carried out. This will require post construction specialist landscaping and replanting works.

10.6 OPERATIONAL PHASE IMPACTS

10.6.1 Introduction

The main issues associated with TKB post construction include community severance, landtake and noise, air quality and visual impacts which in turn create impacts in relation to development potential and land values.

By the time TKB opens most of the impacts incurred in the construction phase will have ceased. Residual impacts from these activities will largely depend on the effectiveness and efficiency of mitigation measures adopted in earlier stages.

10.6.2 Loss of Amenity/Recreational Value

The permanent loss of amenity will be significant with respect to Lido Beach and to a lesser extent for Casam Beach. Although there will be significant visual impacts and reduced access resulting from the development over the hillside, the importance of this in terms of recreation is less and therefore potential impacts will be limited.

10.6.3 Development Potential/Landvalue

Development potential is affected by the general quality of the surrounding urban environment. It is anticipated that the presence of TKB and Route 3 CPS will change the existing environment such that future non industrial development will be limited in scope. However as indicated in the OZPs there are no specific development plans for the study area.

The most sensitive receivers in the vicinity of the TKB development are the high quality residential premises located on the hillsides. The superior location of the premises contributes significantly to their current value, consequently the inevitable changes to landscape quality, air quality, visual outlook and ambient noise resulting from the development of TKB will potentially result in depreciation in the value of private properties.

10.7 MITIGATION MEASURES

10.7.1 Construction

The scope for mitigation of landuse impacts during construction is often limited. The most effective mitigation is to avoid siting construction activities and particularly work sites in close proximity to sensitive receivers. Care should also be taken in setting out work areas and during daily practices to ensure that associated impacts are minimised.

Timing of works can be important in reducing disruption due to traffic congestion etc., avoiding using roads for heavy plant and equipment during busy traffic periods.

If access to existing properties will be blocked at some stage during construction, alternative access should be provided and maintained.

Where practicable re-instatement should be undertaken on completion of the construction works. Reinstatement of access to existing properties particularly those behind the beaches and for areas with high recreational and amenity value should be required and made a contractual condition.

10.7.2 Operation

Mitigation of landuse impacts will to a certain extent be achieved as a result of noise, air quality and landscape mitigation measures recommended in the preceding sections.

Additional mitigation can be provided through detailed design and management measures. A positive commitment to the management and maintenance of roadside landscape should be undertaken to maintain both the recreational and amenity value of the affected areas development potential and land values.

10.7.3 Benefits

The opportunity to enhance the local environment through the development of mitigation measures should be considered.

Schemes can be utilized to actually improve existing conditions providing opportunities for some positive environmental design, especially along the rear of the beaches, and as a screen to the existing car park.

Footpaths to provide access to remaining recreation areas around the beach front are recommended, and incorporation of both landscaped areas and access routes to them will all serve to improve the general amenity of the community. Access to recreation areas north of Tuen Mun Road must be maintained by providing a route through from the beach area around the slip roads to Route 3 CPS.

ECOLOGY

CHAPTER 11

11 ECOLOGY

11.1 INTRODUCTION

Potential ecological impacts of the proposed section of the Route 3 CPS alignment from Tsing Yi Island northward to Tuen Mun Road were assessed based on existing records and surveys of the site during April and May 1993.

Non-systematic surveys were used to identify plants or animals protected by Hong Kong regulation or international convention, or which are of conservation significance for other reasons such as local rarity.

There are no gazetted or proposed sites of special scientific interest or special areas within this study area. The nearest gazetted conservation area is Tai Lam Country Park, which will be unaffected by development within the current study area.

11.2 TERRESTRIAL FLORA

11.2.1 Tsing Yi Island

Baseline vegetation conditions in the portion of the study area on Tsing Yi Island are affected by wild fire and construction of roads and terminals. Wild fire appeared to have burned the entire area during late 1992 or early 1993, and extensive construction was active at the time of this survey. Slope aspects at the site of the northwest Tsing Yi interchange are northern and western. The topography is steep and soils are thin. Much of the native surface is bare soil or rock.

Vegetation coverage of the site is sparse, due to fires which had recently (autumn or winter 1992) burned over the entire study area. Based on the sparse vegetative cover of the site it is assumed that wild fires frequently occur on this site. Short grass mixed with sedges and bare soil or rock is the predominant habitat type over the entire area except near the shoreline where there are minor stands of small shrubs. Grasses and sedges are generally short (20-30cm), and provides little or no cover for wildlife.

Shrubs had recently (probably 1992) been planted on the eastern portion of the study area in an apparent effort to revegetate the denuded hillsides. However, many of the planted shrubs had died or had been pulled out of the ground shortly after being planted.

The western portion of the Tsing Yi site is disturbed by construction related to the Lantau Fixed Crossing and to local shipping terminals on Tsing Yi. This area was under active construction, and supported no vegetation.

11.2.2 Ting Kau

From the south shore of the mainland at Ting Kau to the Tuen Mun road vegetation cover of the site is predominantly woodland or shrubland. This portion of the study area is defined by a ravine with a permanent fresh water stream, and the small hills immediately surrounding the stream valley.

Vegetation on the site has historically been disturbed by wild fire, construction of buildings and roads, and practice of limited agriculture or horticulture. In addition to numerous private residences, there are public facilities near the beaches for water sports and recreation.

Below Castle Peak Road the level of historic disturbance from building and road construction is higher than in the upper section from Castle Peak Road to Tuen Mun Road. However, wild fire had apparently not affected the area below Castle Peak Road for some time. Vegetative cover of the site consisted generally of a maturing woodland into which some cultivated species were encroaching. Species diversity is relatively high in each ecological layer of this woodland, and individual trees were tall and large in girth. Species recorded in this portion of the study area are listed by ecological layer in Table 11.1.

From Castle Peak Road to Tuen Mun Road the area is vegetated by small patches of woodland interspersed with tall shrubland which is maturing to woodland. In combination with these some what native habitats the area is a mixture of re-vegetation, horticulture, housing, and burned areas, as shown on the habitat map (Figure 11.1).

The area burned by wildfire (apparently also in autumn or winter 1992) is a pine-acacia plantation and low shrubland to the south of the area affected by the proposed alignment. The stream valley and slopes draining into it were unaffected by the fire. Species recorded on the burned area are listed below in Table 11.2.

The northern side of the stream valley in this area is largely cultivated. It consists of orchards of lychee, Prunus spp., wampei, Anona spp., Michelia spp., oranges, Artocarpus, loquat, banana, and others.

The relatively undisturbed tall shrubland on the south side of the valley provides a diversity of habitats. It is maturing toward a woodland climax habitat. Although it provides habitats useful to wildlife, it is surrounded by highways, and is not continuous with less disturbed woodlands or shrublands to the west towards Tai Lam Country Park.

Species encountered in this portion of the study area are listed by ecological layer in Table 11.3. Two unusual species were recorded. These were *Evodia meliaefolia* and *Carallia brachiata*. No protected species were recorded.

Table 11.1 Plant Species Identified Between Lido Beach and Castle Peak Road on the Ting Kau Bridge Section of the Study Area.

Trees and Overstory Vegetation

Aleurites spp.	*Ficus microcarpa*
Bamboo	*Crewia spp.*
Bauninia spp.	*Liquidambar styraciflus*
Bombax malabaricum	*Litsea glutinosa*
Bridella monoica	*Macaranga tenuifolia*
Celtis sinensis	*Melaleuca leucademdron*
Cinnamomum camphora	*Melia azedarach*
Cratoxylum ligustrinum	*Sapium spp.*
Delonix regia	*Schefflera octophylla*
Ficus elastica	*Sterculia lanceolata*
	Tristania conferta

Understory shrubs, small trees, climbers

Brucea javanica	*Ilex rotunda*
Cerbera magghas	*Ligustrum sinensis*
Dalberhia spp.	*Mucuna spp.*
Ficus hirta	*Phoenix hanciana*
Ficus hispida	*Psychotria rubra*
Gardenia jasminoides	*Raphiolepis indica*
Gnetum montanum	*Rhus spp.*
Ilex pubescens	*Vitex negundo*

Herbs

Asparagus cochinchinensis	*Oxalis corymbosa*
Christella parasitica	*Paederia scandens*
Hedyotis acutangula	*Pteris semipinnata*
Ipomoea spp.	*Rubus spp.*
Liriope spicvata	*Sida acutifolia*
Lygodium japonicum	*Youngia japonica*

Table 11.2 Plant Species Recorded in the Burned Area Between Castle Peak Road and Tuen Mun Highway.

<u>**Planted species**</u>

Acacia confusa
Pinus massoniana

<u>**Others**</u>

Dicranopteris linearis
Rhus spp.
Rhodomyrtus tomentosa
Baeckia frutescens
Schefflera octophylla
Pandanus tectorius

Table 11.3 Plant Species Recorded Between Castle Peak Road and Tuen Mun Highway.

Trees	Herbs
Acronychia pedundulata	*Cassytha filiformia*
Litsea rotundifolia	*Dicranopteris linearis*
Pinus massoniana	*Elephantopus spp.*
Sapium spp.	*Miscanthus sinensis*
Schefflera octophylla	*Morinda umbellata*
Sterculia lanceolata	*Neyraudia neyraudiana*
Bamboo	*Smilax china*

<u>**Shrubs & Woody Climbers**</u>

Adina pilulifera
Clerodendrum frutescens
Dalbergia spp.
Embelia laeta
Eurya chinensis
Ficus variolosa
Ilex aspera
Ilex pubescens
Lantana camara
Melastoma spp.
Rhodomyrtus tomentosa
Rhus sinensis
Strophanthus divaricatus
Tetracera asiatica

11.3 TERRESTRIAL FAUNA

11.3.1 Tsing Yi Island

Wildlife use of the Tsing Yi Island portion of the study area is limited by poor habitat quality (Section 11.2.1) and no signs of mammalian use of the area were recorded.

Birds were recorded foraging and feeding on the site, but nesting habitat is limited and available only for ground nesting birds. Black kites and swallows are the most commonly observed species. Other species typical of mixed habitats in upland valleys in Hong Kong were observed on the eastern portion of the study area beyond the proposed areas of disturbance. Species recorded included swallow, house swifts, Chinese and crested bulbuls, crow pheasants, and common kingfishers. No birds of particular conservation significance were recorded.

No reptilian or amphibian species were recorded, and it is doubtful that any use this site due to near absence of vegetative cover.

11.3.2 Ting Kau

Because this portion of the study area is small in extent and has been inhabited for many years, it is unlikely that mammalian species of conservation significance occur. None was recorded during the field surveys. However, evidence of burrowing by rodents was observed in the burned areas, indicating that some small mammals probably occupy the site.

Bird use of the Ting Kau portion of the study area reflected the diversity of habitat types available and the successional nature of the shrubland. Bird species seen are listed below in Table 11.4. Birds were surveyed during the spring of 1993. It is inevitable that additional species occupy the site during other seasons of the year. The Hong Kong Bird Watching Society was consulted regarding the importance of this area for avifauna on a year-round basis with the result that there was no knowledge of occurrence of any species or bird community of special significance.

Table 11.4 Bird Species Recorded from Ting Kau Beach to Tuen Mun Road.

Black kite	Black-naped oriole
Moorhen	Black-necked starling
Spotted dove	Crested myna
Koel	Magpie
Large hawk cuckoo	Crested bulbul
Indian cuckoo	Chinese bulbul
Collared crow	Black-faced laughing thrush
Crow pheasant	Long-tailed tailor bird
Swallow	Magpie robin
Rufous-backed shrike	Great tit
Black drongo	Tree sparrow

Although water levels in the stream in this valley are normally quite low, fish were observed in pools in the middle reaches of the stream near Tuen Mun Road. Reptiles and amphibians were not observed.

Neither butterfly (M. Bascombe, unpub. data) nor dragonfly (K. Wilson, pers. comm.) populations in the area are known to be unusual or noteworthy.

11.4 MARINE ECOLOGY

11.4.1 Methodology

The approach adopted was to review existing biological data and where necessary to supplement this information by means of site visits.

11.4.2 Intertidal Zone

Adjacent to the proposed bridge are six sandy beaches: Approach and Ting Kau Beaches on the east and Lido, Casam, Hoi Mei and Gemini Beaches on the west.

Water quality at these beaches had a grade of from 2 to 4 i.e. fair to very poor for the month of May 1993 (EPD) (see Chapter 6.2.3 for more detailed information). Rambler Channel is fairly heavily polluted from very poor and inadequate sewerage facilities. Sewage is discharged untreated into the sea, either directly or through surface drainage channels.

Particle size analyses of intertidal beach sediments at northwestern Hong Kong were undertaken as undergraduate projects of the Department of Geography and Geology, University of Hong Kong (cited in Morton and Ong Che 1992). The shore habitats studied were Butterfly Beach, Pak Kok and Shek Kok Tsui. They showed an overall mean particle size of 1.19 Ø (i.e. coarse sand) in contrast to the mean particle size of 0.58 Ø (i.e. fine sand) for the southeastern beaches of Hong Kong.

No ecological information is available for these sand beaches. Shin (1987) surveyed the infaunal macrobenthos of eleven swimming beaches in southeastern Hong Kong. Species recorded from this study are presented in Appendix A8. Since the species composition of benthic communities is determined to a great extent by the nature of the sediments, it is likely that the species reported in Shin (1987) may be found also in the study area. However, a lower species richness may probably occur at this site due to low salinity effects from the Pearl Estuary and organic and industrial pollution.

11.4.3 Subtidal Zone

The physical topography of the coast extending from Tsuen Wan to Ma Wan was described by Chiu (1987) as consisting of rocks and boulders lying on bedrock to a depth of around -6m CD, beyond which there is mud and sand.

Hydrological parameters recorded by Chiu (1987) for this site are as follows:

pH	6.5	-	9.0
BOD_5	1.0	-	8.0 mg/l, (frequently 5.0)
Dissolved Oxygen	2.2	-	9.3 mg/l
Salinity	15	-	35 ppt, (low in summer)
Temperature	13.5	-	16.0 °C

The subtidal community within the study area is generally impoverished. The study by Chiu (1987) on the short-spined sea urchin *Anthocidaris crassispina* 1983 - 1984 included a western station at Gemini Beach aside from stations in the east (Lung Ha Wan) and south (Cape D'Aguilar and St. Stephen's Beach). It was found that *A. crassispina*, an economically important urchin which supports a local fishery, was not fished at Gemini beach because of low urchin density and year-round poor under-water visibility. In addition, no juvenile recruitment was observed during the study period, suggesting a stressed environment.

The survey covering 90 sites running from east to west Hong Kong indicated that the urchins were more abundant (0.5 - 16.6 urchin m^{-2}) on the east and south coasts. In the west, only sparse populations were found (0.5 - 3.2 urchins m^{-2}) and extensive areas were devoid of urchins. The sites surveyed in the west included Northwest Tsing Yi Island, Shek Wan, Chun Fa Lok, Rambler Channel, Ting Kok, Gemini Beach, Tai Lam Kok, Pearl Island, Pak Kok, Pillar Point, Northwest Lung Kwu Tang.

Compared to east Hong Kong, the area extending from Tsuen Wan and Ma Wan had poor algal flora. Species recorded by Chiu (1987) included the filamentous *Cladophora delicatula, Gelidium divaricatum* and some *Corallina* spp. The gorgonian *Hicksonella priceps* was commonly found.

The prevailing environmental conditions at the site are such as to preclude the existence of marine life of outstanding diversity, value or interest. The flood tide carries water from Victoria Harbour and the Rambler Channel through the site, resulting in organic and inorganic contamination of the water column and sediments. The ebbing tide brings low salinity water from the Pearl River estuary, (Morton and Morton, 1983). These stressors, especially organic pollution, act on benthic communities in such a way as to reduce species diversity, abundance and biomass, (Pearson and Rosenberg, 1978). EPD water quality figures for 1991 show increased levels of *E.coli*, Total Nitrogen and Total Phosphorous over 1986 figures, indicating increased organic input. EPD figures for May, 1993 graded the water quality of the beaches at and adjacent to the site from 2-4 (fair to very poor).

Chan, Rainbow and Phillips (1990) recorded some of the highest levels of bioavailability of copper, zinc, cadmium, lead, nickel and silver in Hong Kong at Chai Wan Kok. Biomonitoring of barnacles (*Balanus amphitrite amphitrite*) at Chai Wan Kok between 1986-1989 showed higher levels of copper at the site than Kowloon and Queens pier, high levels of cadmium, very high levels of nickel, silver and chromium, with significant increases in the bioavailability of cadmium, lead and chromium between 1986-1989 (Rainbow and Smith, 1992). Metals such as copper, nickel and zinc will affect bivalve larval growth (calabrese *et al*, 1977), copper can affect gonad weight and inhibit or reverse gamete maturation (Gould *et al*, 1988), high levels of copper and cadmium can severely reduce the populations of crustacean isopods (De Nicola Guidici and Guarino, 1989), and cadmium may suppress reproduction in polychaetes such as *Neanthes arenaceodentata* (Reish, 1977). Many other deleterious effects of chronic heavy metal pollution have been recorded.

The proximity of the site to the Rambler Channel and the effects of increased land reclamation (less dilution of contaminants, increased suspended loads of local waters) have resulted in the site having some of the most severe heavy metal contamination in Hong Kong. This, coupled with recent evidence of increased organic pollution, has lead to the view that literature concerning the area from the 1980's will over rather than underestimate the marine ecological value of the area concerned.

The water quality at the Ma Wan FCZ is currently adversely affected by increased sediment loading of the water column due to works connected with the Lantau Expressway and the Lantau Fixed-crossing, offset by the rapid flow of water through the Kap Shui Mun channel. Cumulative effects may occur if the construction of the Ting Kau Bridge coincides with these projects. However, the Ting Kau bridge project itself will not result in a significant impact on the FCZ due to the relative positions of the FCZ and the project area.

The water quality at the Ma Wan FCZ may also be adversely affected by the mariculture activities themselves. Lam, 1990, surveyed the FCZs of Hong Kong with reference to sediment characteristics and water quality relative to that of typhoon shelters and coastal waters. The findings indicated higher organic and nutrient levels in the sediments of FCZs than coastal waters and even higher than in typhoon shelters, common pollution blackspots in Hong Kong. The water quality within FCZs is characterised by lower dissolved oxygen levels and elevated ammoniacal nitrogen content resulting from the accumulation of waste materials.

11.5 POTENTIAL IMPACTS

The proposed project calls for construction of a highway on vertical supports over much of its length on the Ting Kau side. Therefore, it may be feasible to construct the highway without completely destroying vegetation beneath the roadway. However, for the purpose of this assessment it is assumed that the area beneath the proposed route alignment will be completely disturbed during construction, and will require re-vegetation by seeding or transplanting following construction.

11.5.1 Terrestrial Ecology

Tsing Yi

On the Tsing Yi portion of the proposed project area potential impacts to terrestrial flora and fauna are minimal. The site is highly disturbed by existing heavy construction and by historic wild fires. Habitats which would be lost due to highway construction are of little value. It is anticipated that current wildlife use patterns (foraging by birds) would continue after completion of the project.

Ting Kau

No plants listed on the Agriculture and Fisheries Department list of protected plants in Hong Kong were recorded. However, the site does provide a diverse range of micro-habitats due to the maturity and diversity of vegetation and availability of fresh water.

The area between Lido beach and Castle Peak Road supports a mature woodland which is representative of a habitat type which has been dramatically reduced in extent throughout Hong Kong. Although this woodland does not include protected species, it is of conservation significance because it resulted from many years of protection from wild fire and timber harvest, and it is associated with a permanent stream. Although the area is dissected by roads and building sites, it supports a diverse flora and bird fauna.

In addition to providing wildlife habitats, this wooded area stabilises a steep slope and provides an attractive green belt through a low density sub-urban area. Because it occurs along the proposed alignment, it is assumed that the woodland will be destroyed during highway construction.

From Castle Peak Road to Tuen Mun Highway the proposed alignment will again affect the stream and associated woodlands and shrublands. Ramp H in particular will follow the stream channel until it diverges from the stream to merge with Tuen Mun Highway. Roughly at that point the main roadway again joins the stream channel and follows it upstream to Tuen Mun Highway. This suggests that the stream may be affected by the alignment along the entire distance from Tuen Mun Highway to the sea. Thus any aquatic and amphibious wildlife are likely to be adversely impacted by the construction process.

11.5.3 Marine Ecology - Construction Phase

Reclamation for the Ting Kau Bridge would result in loss of intertidal and subtidal habitats and swimming beach area. In view of the impoverished fauna present, the loss may be considered not significant.

Dredging for reclamation would produce higher concentrations of suspended solids (SS), in the water column which would lead to reduced dissolved oxygen levels and light penetration . Increases in SS can reduce photosynthesis by phytoplankton and macroalgae by reducing light penetration. Other animals in the food chain, such as the sea urchins which feed on the macroalgae, would in turn be affected. Increased silt in the water may clog the feeding and respiratory structures of suspension feeders, such as fish, serpulid worms and bivalves, and when settled on the bottom, can smother the other benthos as well as change the nature of the seabed.

Sediments at Rambler Channel which are highly contaminated with heavy metals, may be carried by currents flowing from northwest to southeast. Heavy metals in the sediments may leach and be taken up into the food chain by the fish. Gills of fish may also be clogged leading to fish mortality. As described before in Section 6.3.1 impacts on the water quality of the Ma Wan FCZ due to the dredging works are not expected due to the direction tidal currents and relatively slow velocities at the dredging site, see Figure 6.6.

Cumulative effects in conjunction with dredging in other borrow sites in the vicinity may become significant.

11.5.4 Marine Ecology - Operational Phase

The presence of the bridge and breakwater may cause a change in water movement, reduced tidal flushing and potentially a change in the seabed. The extent of these changes will not be known until the ongoing WAHMO computer modelling has been completed and the results analysed.

No current speed information is available for Rambler Channel itself. The study area on the whole appears to have fast moving currents. According to the Ma Wan Channel Improvement Project, the tidal stream in the Ma Wan Channel goes southeast and south on the upstream and can attain a speed up to 6 knots. Floodstream is weaker and has a rate of 1.25 knots at the centre of the channel.

If fast moving waters carrying a high silt load from the Pearl River reach the breakwater, current speed will slow down since waves lose energy when they meet an obstruction and are refracted. Decrease in current speed may lead to increased siltation in the area, which in turn, may further smother whatever benthic life is still in the area. Decrease in current speed would also mean that effluents move through the area more slowly. With longer residence time and dilution capacity reduced, an oxygen sag may occur, producing anoxic zones. Foul smells from the products of anaerobic oxidation may then be experienced. The likelihood of the latter occurring would be increased if the impact is considered cumulatively together with that of other reclamation narrowing the width of Rambler Channel.

11.6 MITIGATION AND MONITORING

11.6.1 Terrestrial Ecology

Impacts on terrestrial ecology can be mitigated to the extent that the construction process does not destroy all habitats in the vertical shadow of the alignment. Detailed construction plans are not available at this time. Therefore it is not possible to accurately predict the extent of habitat destruction during the construction phase.

However, because the road is on vertical supports above the habitats in question by some 30-40m, it appears possible to construct and certainly to operate much of the roadway without causing complete destruction of the vegetation beneath the alignment. If it is not possible to protect habitats beneath the alignment during road construction, the impacts of habitat loss will be significant in terms of loss of woodland and riparian habitats.

Where vertical support columns must be placed in or very near the stream bed it may also be possible to carry out construction such that stream diversions and associated disturbances are minimally destructive to habitats. Careful restoration and revegetation of the stream channel following construction could result in minimal long-term losses of riparian habitat.

There will be areas where existing landforms will be cut or filled to accommodate Ramp G which will carry traffic from the Ting Kau Bridge westward onto Tuen Mun Road. These are predominantly shrub or shrub/grassland habitats which have been repeatedly burned by wildfire. Loss of habitat in these areas is not as significant as that in riparian forested areas. It is expected to have an insignificant impact on local ecology.

Impacts of cut and fill operations will be reduced by selection of native grass, herb, shrub and tree species for re-vegetation which are useful for wildlife habitation. A list of such revegetation species is given below in Table 11.5.

11.6.2 Marine Ecology

Although the marine flora and fauna of the study area are poor, any measures which reduce limit increases in SS loadings during reclamation and construction works will be needed. Possible mitigation measures are discussed in Chapter 6 and proposed monitoring and audit schedules with appropriate action plans are given in Chapter 13.

Table 11.5 Native plants attractive to frugivorous birds in Hong Kong

SPECIES	HABIT	BIRDS	ATTRACT	PERIOD
Aralia chinensis	small tree	3	x	Dec-Jan
Berchemia racemosa	climber	3	xx	Mar-Apr
Bridelia tomentosa	small tree	4	xxx	Dec-Mar
Cassytha filiformis	parasitse	3	x	Oct-Mar
Celtis sinensis	tree	2	xxx	Jun-Aug
Cinnamomum camphora	large tree	5	xxx	Nov-Jan
Diospyros morrisiana	tree	2	xx	Dec-Jan
Elaeocarpus sylvestris	tree	2	xx	Oct-Nov
Eurya chinensis	shrub	17	xxxx	Oct-Nov
Eurya japonica	shrub	5	xxx	Nov-Jan
Evodia lepta	small tree	14	xxxx	Oct-Nov
Evodia meliaefolia	tree	4	xxx	Nov-Dec
Ficus microcarpa	tree	3	xx	irregular
Ficus superba	tree	3	xx	irregular
Ficus virens	tree	5	xx	irregular
Ilex pubescens	shrub	4	x	Nov-Feb
Litsea rotundifolia	shrub	8	xxx	Oct-Dec
Macaranga tanarius	tree	5	xxx	Jun-Jul
Machilus breviflora	tree	1	x	Oct-Jan
Machilus oreophila	tree	2	xx	April
Machilus thunbergii	tree	2	xx	Jun-Jul
Machilus velutina	tree	1	x	Jan-Feb
Maesa perlarius	shrub	2	xx	Dec-Jan
Mallotus paniculatus	small tree	3	xxx	Dec-Jan
melastoma candidum	shrub	4	xx	Nov-Jan
melastoma sanguineum	shrub	8	xxx	Nov-Jan
Microcos paniculata	small tree	5	x	Oct-Mar
Morinda umbellata	climber	3	xxx	Aug-Sep
paederia scandens	climber	4	xxx	Nov-Mar
psychotria rubra	shrub	8	x	Oct-Jan
Psychotria serpens	climber	7	x	Oct-Mar
Rhaphiolepis indica	shrub	2	xxx	Dec-Jan
Rhodomyrtus tomentosa	shrub	6	xxx	Aug-Nov
Rhus chinensis	small tree	8	x	Nov-Dec
Rhus hypoleuca	small tree	5	x	Nov-Dec
Sapium discolor	tree	12	xxxx	Oct-Dec
Sapium sebiferum	tree	3	xx	Nov-Jan
Schefflera octophylla	tree	7	xxxx	Jan-Mar
Scolopia saeva	tree	2	xx	Dec-Jan
Sterculia lanceolata	Tree	4	xxxx	Jul-Sep

Note : BIRDS = number of bird species known to eat the fruit;
ATTRACT = relative attractiveness to birds;
PERIOD = main fruiting period.

Plant names follow Anon (1978), except *Bridelia tomeniosa* Bl. (= *B. monoica*).

11.7 RESIDUAL IMPACTS

11.7.1 Terrestrial Ecology

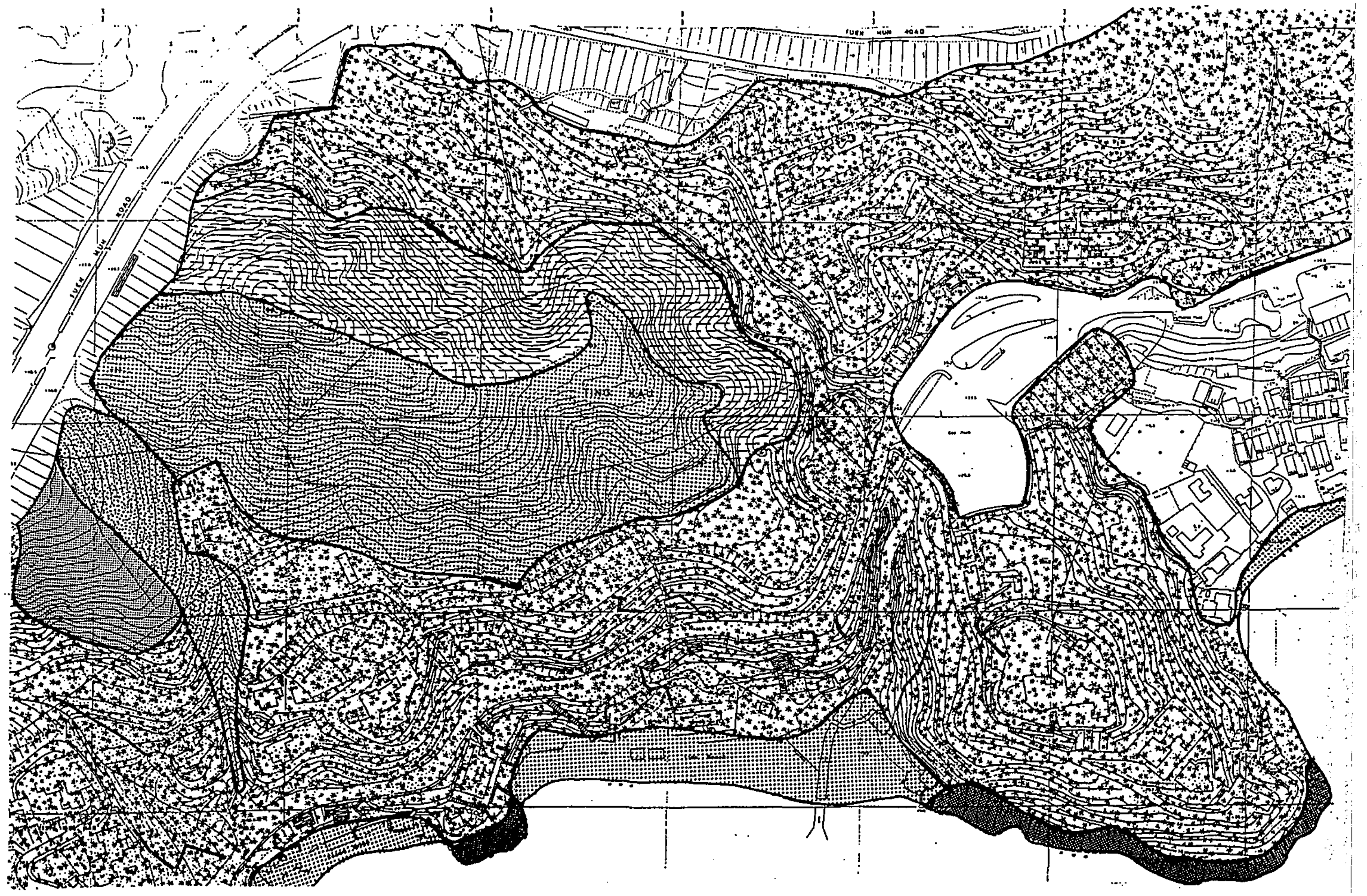
The primary residual impact on terrestrial ecology will be the loss of land area and associated habitat on the Ting Kau side. Although these habitats are mixed with suburban residential and recreational land uses, they are currently somewhat protected due to the general remoteness of the areas involved. As a result, they harbour mature, closed canopy forest cover near a small freshwater stream. In the absence of wild fire, the woodland canopy could progressively extend uphill from the stream valley (above Castle Peak Road) and could provide a productive, stable, and somewhat unusual habitat in this area.

Although it is not certain that all of this woodland and riparian habitat will be destroyed during the construction phase, it is assumed that much of the existing vegetative cover will be lost. It will require several decades for the existing mature woodland areas to be revegetated from bare ground. Restoration of the existing species diversity will also require a number of decades, during which much of the value of the area for birds and invertebrate wildlife will be lost.

11.7.2 Marine Ecology

Mobilization of toxic materials in sediments from the construction and reclamation areas will be a residual impact of the construction phase. The impact will be short-term. Due to the poor baseline condition of the local flora and fauna, the effects are not likely to be severe.

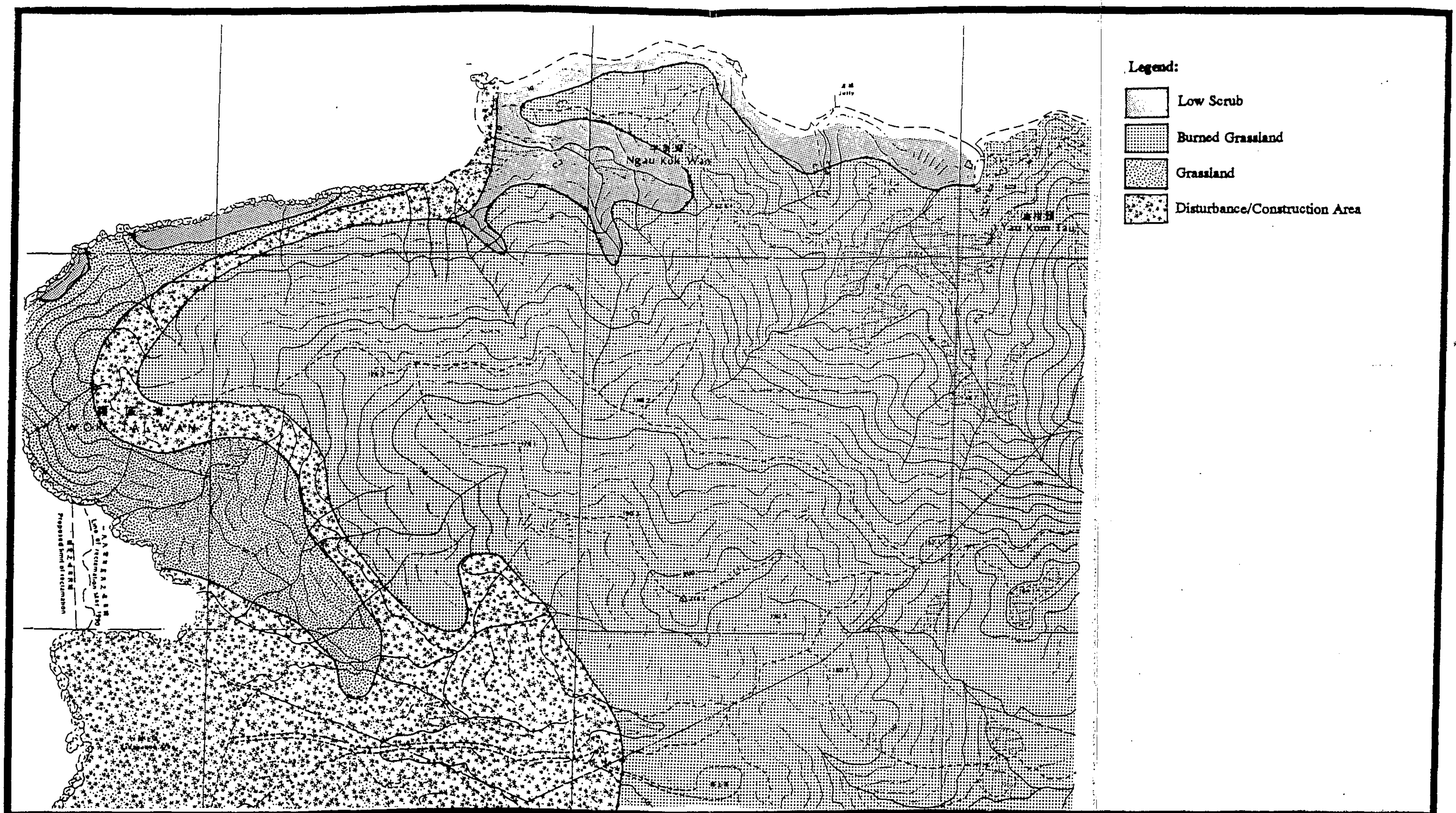
The location of the breakwater may give rise to some residual impacts, due to its effect on current patterns and water flows. The breakwater and other marine structures are currently undergoing WAHMO modelling, the results of this will provide information on any hydraulic changes to the area and any associated impacts will be discussed in the WAHMO modelling study report.



Legend:

- Secondary Woodland/Built-up Development
- Tall Scrub
- Tall Scrub/Woodland
- Low Scrub
- Low Scrub/Burned Grass
- Residential/Transport
- Rock
- Sand

FREEMAN FOX MAUNSELL	Drg. Title : HABITAT MAP TING KAU	Job Title : ROUTE 3 TING KAU BRIDGE EIA
	Scale :	Job No. 058000
	Date July 1993	Fig. No. 11.1



FREEMAN FOX MAUNSELL

Drg. Title :

HABITAT MAP
TSING YI

Job Title :

ROUTE 3 TING KAU BRIDGE EIA

Scale :

Date July 1993

Job No. 058000

Fig. No. 11.2

RISK APPRAISAL

CHAPTER 12

12. RISK APPRAISAL

12.1 INTRODUCTION

12.1.1 Overview

The Ting Kau road bridge connects the north-west corner of Tsing Yi (the Northwest Tsing Yi Interchange) to the mainland to the west of Ting Kau village (the Ting Kau Interchange). The two main support pylons will provide a 420m span across the main part of the northern Rambler Channel[1] (i.e. that closest to Tsing Yi) at an elevation of 65m. The northern part of the bridge will be supported on nine pillars. This Chapter examines the dangers associated with collisions between vessels and the bridge.

12.1.2 Nature of Report

This Chapter is based on a variety of sources including past studies, discussions with Government Departments (notably Marine Department) personnel at the CRC Nga Ying Chau Oil Terminal (hereafter referred to as the CRC-N Terminal) and other parties.

Section 12.2 provides an account of the marine traffic expected in the vicinity of the Ting Kau Bridge. This provides a basis on which to consider the likely incidence of collisions between vessels and the bridge structure as discussed in Section 12.3. Possible measures to reduce the associated dangers are considered in Section 12.4 and the overall conclusions are presented in Section 12.5.

12.2 NATURE OF NEARBY SHIPPING

12.2.1 Overview

In relation to the Ting Kau Bridge, the following vessel routes are of interest:

- the Ma Wan channel which runs (NNW/SSE) between (the eastern side of) Ma Wan and the western side of Tsing Yi;
- the smaller Kap Shui Mun which runs (NW/SE) between the western side of Ma Wan and NE Lantau; and
- the northern Rambler Channel which runs (ENE/WSW) between the northern shores of Tsing Yi and the mainland.

12.2.2 Vessels of Interest

This report is concerned, primarily, with the possibility of physical damage to the Ting Kau Bridge due to vessel collisions. As such, the size (and speed) of the vessel is of more concern than the nature of the cargo (if any). In accord with previous studies and the practice

[1] In dealing with vessel movements, this waterway is generally referred to as the Tsuen Wan Fairway while the Rambler Channel refers to the waterway running north-south alongside the eastern side of Tsing Yi. However, for the sake of consistency, the Tseun Wan Fairway will be referred to as the northern Rambler Channel in this Chapter (as elsewhere in this report).

of Marine Department, consideration will be given to the following vessel sizes:

- Class A: >80,000dwt which are, essentially, bulk carriers delivering coal to Tap Shek Kok (Castle Peak) power station;
- Class B: 30-80,000dwt which comprise a range of bulk carrier, container and general cargo vessels travelling to the power station and cement works as well as into the Pearl River. In the future, the development of Tuen Mun and Pearl River ports and the new airport could lead to a significant increase in the numbers of movements;
- Class C: 15-30,000dwt which are similar in composition to Class B; and
- Class D: 300 - 15,000dwt which represent the smaller "ocean going" vessels including barges and small cargo vessels.

In addition, there are numerous ferries and small vessels (<300dwt) using the waterways in the vicinity of the Ting Kau Bridge.

12.2.3 Numbers of Vessels

Ma Wan and Kap Shui Mun

Marine traffic estimates for current and future usage of these waterways have been an important element for a number of recent studies including:

- Ma Wan Channel Improvement Study (1991) and associated studies;
- Tuen Mun Port Development Study (1992); and
- Lantau Port & Western Harbour Development Studies (1992 - hereafter referred to as LAPH-DS).

Further figures on existing DG (Dangerous Goods) vessel movements are to be found in the *Tsing Yi Risk Reassessment Report* (Technica, 1989 - hereafter referred to as the TY Report). As might be expected, the marine traffic estimates vary from report to report. Nevertheless, the present picture may be summarised as shown in Table 12.1.

Table 12.1: Current Vessel Movements (per annum)

Waterway	Vessels >300dwt	Ferries	Others
Ma Wan Channel	4900	36500	130000
Kap Shui Mun	1000	33700	200000

Notes:

1) Data taken from work by APH Consultants in relation to Working Paper No. 9, *Marine Traffic Requirements*, LAPH-DS.
2) Only the smallest of the Class D vessels (300 - 15,000dwt) can use Kap Shui Mun. In relation to ferries, this smaller waterway tends to be used by southbound ferries while the northbound ferries use the Ma Wan Channel.
3) The TY Report provides an overall estimate of 630 inbound vessels in the Ma Wan Channel for 1992. Unfortunately no indication is given as to the size of vessel being considered to enable a meaningful comparison to be made to the figures above.

For the future, attention has been focused on the increase in the numbers of larger vessels which will use the Ma Wan Channel. The overall number of "ocean going" vessel (i.e. >300 dwt) movements in the area is expected to increase to more than 17,000 per annum by the year 2006. The precise distribution by vessel size and what proportion of the smaller vessels will use the Kap Shui Mun waterway is uncertain, but Table 12.2 provides an indication of the numbers involved.

Table 12.2: Estimated Vessel Movements in 2006 (per annum)

				Size of Vessel		
Waterway	A	B	C	D-1	D-2	All
Ma Wan Channel	200	2500	4000	4000	5000	15700
Kap Shui Mun	0	0	0	0	2000	2000

Notes: D-1 taken as vessels of 5-15,000dwt; and
D-2 taken as vessels of 300 - 5,000dwt.

Table 12.2 is derived from figures presented in LAPH-DS and the Ma Wan studies. The figures include more than 1000 movements of vessels (Classes B, C and D-1) associated with the bulk transport of DGs to proposed hazardous installations (PHIs) and to the new airport. Due to the risks to public safety associated with the bulk transport of DGs through the Ma Wan area, it is increasingly unlikely that such traffic will be permitted in the future. On this basis, the figures presented in Table 12.2 may be taken as an upper estimate of the likely number of vessel movements.

Northern Rambler Channel

The northern Rambler Channel is a relatively minor waterway off the Ma Wan Channel to the north of Tsing Yi. The limited information on annual movements for vessels entering/leaving the northern Rambler Channel (in the vicinity of the proposed Ting Kau Bridge) may be summarised as follows:

- c750 for vessels >300dwt (source: LAPH-DS);
- 129 inward vessels (no specified size) (source: TY Report); and
- c150 inward bulk tankers (Class B) and numerous outward small ships/barges (Class D) associated with the CRC-N Terminal (source: CRC).

It is understood that the most outward movements from the CRC-N Terminal will be via the eastern side of Tsing Yi and will not pass under the Ting Kau Bridge. For the purposes of this analysis, it will be assumed that there will be 300 movements per year of Class B vessels associated with the CRC-N Terminal and a further 400 small vessels (Class D-2) using both the terminal and other facilities in the northern Rambler Channel.

12.2.4 Northern Rambler Channel Activities

Outline

There are various uses for the northern Rambler Channel. Traversing from east to west, these include:

- the Public Cargo Working Area (Area 2 - Tsuen Wan) at the far north-east corner of Tsuen Wan Bay;
- the Tsuen Wan DG Anchorage, to the south-west of the PCWA;
- the CRC-N Terminal on the north-east corner of Tsing Yi;
- boat yards (for small vessels) along the northern shore of Tsing Yi; and
- a large buoyed area covering the northern part of the water at the western end of the Channel is reserved for typhoon sheltering of hydrofoil ferries.

In relation to this study, the two uses of particular concern are the DG Anchorage and the CRC-N Terminal which are discussed in more detail below.

Tsuen Wan DG Anchorage

The DG anchorage is routinely used by barges carrying fuel oil which provide bunkering services to vessels in Hong Kong waters. Typically, there will be up to 10 barges per day using the anchorage. Marine access to the anchorage tends to be from the south (i.e. along the eastern side of Tsing Yi) and, thus, most barges would not be expected to pass under the Ting Kau Bridge.

In typhoon conditions, the DG anchorage could be used by up to 65 vessels and some of these might be expected to access the anchorage via the Ting Kau Bridge.

Partly as a result of the concerns of local residents, the risks associated with the DG anchorage are being studied by consultants under a contract recently awarded by Marine Department. In the longer term (perhaps in 1996/97), it is understood that it is likely that the DG anchorage will be relocated not only to reduce the associated risks but also to permit further reclamation in the area.

One area of possible concern is that it is understood that the preferred relocation area for the DG anchorage is at the western end of the northern Rambler Channel - effectively under the northern part of the Ting Kau Bridge.

CRC-N Terminal

The CRC Nga Ying Chau Terminal handles a variety of flammable liquids. These are imported by bulk carrier (typically 40,000dwt) every two days. These vessels approach the terminal via the northern part of the northern Rambler Channel and would pass under the proposed Ting Kau Bridge.

The imported liquids are transferred to on-site storage tanks and are then dispatched from the terminal via smaller vessels and barges (with a limited amount leaving the terminal by road). These smaller vessels and barges are generally more than 500dwt and number about 6-10 per day and it has been assumed that most of these use the Rambler Channel to the east of Tsing Yi (i.e. they do not pass under the Ting Kau Bridge).

One of the key recommendations of the TY Report was to transfer the operations at the CRC-N Terminal to the "south" CRC Tsing Yi Terminal[2]. CRC are preparing for this move and it is anticipated that it will be completed by April 1997.

12.3 ANALYSIS OF COLLISIONS

12.3.1 Overview

In an ideal world, historical data on actual shipping incidents within the area of interest would provide the basis for analysis. Since the incidence of shipping incidents at a particular location is low, generally there are insufficient data which can be applied directly to the situation under study[3]. For this reason, it is standard practice:

- to obtain generalised incident data; and
- to apply site-specific factors, if possible.

12.3.2 Historical Data

Worldwide data[4] indicate a baseline incident rate (for vessels >500t) of:

1×10^{-4} per movement in restricted waters.

By contrast, the Ma Wan Channel studies present a complex analysis based on consideration

2 This recommendation was a result of concerns over the risks associated with the on-site storage. Interestingly, the TY Report contains no reference to marine traffic associated with the CRC-N Terminal although traffic figures are presented for the other sites.

3 Exceptionally, there are sufficient data to provide a basis for robust analysis - such as for the Straits of Dover for example.

4 Documents consulted include *Hull Casualty Statistics*, published by the Institute of London Underwriters (1992); *The Tanker Register 1992* published by Clarkson Research Studies Limited; and *Casualty Return 1990*, published by Lloyd's Register.

of individual failure causes (grounding, collisions, etc.). However, the overall incident rate (per movement) is comparable with that given above.

Within Hong Kong waters, there are about 35,000 movements per year of ocean-going vessels (>300dwt), 150,000 ferry movements per year and numerous movements of smaller vessels. Against this background, it is perhaps not surprising that it is estimated to be about 200 collisions per year (based upon historical data from the Marine Department) of which several are very serious. In relation to bridges, there has been considerable public concern over three incidents in the past 18 months involving collisions between the superstructures of vessels and the Tsing Yi bridges. However, these incidents are of limited relevance to the Ting Kau Bridge since the clearance is much greater (65m versus 17m) and the issue of concern is a collision causing significant damage to the bridge (i.e. a collision between the hull of a large vessel and the bridge supports).

Although no firm data have been obtained in respect of collisions in the vicinity of the Ma Wan Channel, two losses (a ferry and a cargo vessel) have occurred in the area as a result of typhoons in the past twenty years or so.

12.3.3 Vessels of Interest

In the analysis which follows, consideration is restricted to collisions which could result in significant damage to the Ting Kau Bridge through direct contact with the central support pylon or the associated supporting pillars (and associated foundations).

In broad terms, the damage potential of vessels is a function of mass, velocity and design. Although high speed ferries may have the same kinetic energy as a much heavier but slower vessel, they are fragile craft. For example, in one incident in the Adamasta Channel (between Lantau and Cheung Chau) a high speed ferry was completely wrecked with minimal observable damage to the impacted rocks.

Bridges and their supports can be designed to withstand the impacts of large vessels[5]. Indeed, for the Lantau Fixed Crossing and Kap Shui Mun bridges, the designers are currently working to protect the bridges from impacts of vessels of up to 220,000 dwt. As would be expected, the costs increase in relation to the degree of protection provided.

For the purposes of this analysis, consideration will be given to the risks of collision associated with a range of vessel sizes. To provide a baseline, the initial analysis considers vessels of 5,000dwt or more (i.e. Classes A, B, C and D-1).

12.3.4 Collision Scenarios

There are three scenarios of particular interest in relation to possible collisions with the Ting Kau Bridge:

- a vessel fails to make the turn on the Ma Wan Channel and collides with the bridge;

[5] As would be expected there are many technical papers in this area such as those published by the International Association for Bridge and Structural Engineering (run by the Institution of Structural Engineers in London).

- a vessel passing under the Ting Kau Bridge collides with it; and
- under typhoon conditions, there could be a possibility of a vessel being blown onto the bridge and there would be an enhanced risk of collision from vessels attempting to reach the typhoon shelter beyond the bridge.

These are considered in turn in more detail below.

Ma Wan Channel

The main "bend" on the Ma Wan Channel lies about 1.5km due west of the Ting Kau Bridge. The most likely scenario is:

> *A vessel is proceeding eastward to the north of Ma Wan (i.e. directly towards the bridge) and fails to make the turn and the vessel (with or without power) collides with the bridge.*

Possible reasons for such an incident would include:

- simple human error;
- steering mechanism locked into position;
- ship incident in Channel (collision, explosion, etc.) results in vessel losing control; and
- complete power failure.

Although each of these reasons is unlikely, it would be difficult to argue that any one could be dismissed as incredible. Once the incident has occurred, the vessel will still need to cover 1.5km before reaching the bridge. At a speed of 5 knots (2.6 m/sec), this would take about 10 minutes in which it might be possible to detect the incident and to take some evasive action.

Northern Rambler Channel

Access to the northern Rambler Channel for larger vessels will necessitate passing under the Ting Kau Bridge. The accident scenario of interest is:

> *A vessel is approaching the Ting Kau Bridge (from either direction) and collides with it.*

Possible reasons for collision with the bridge would essentially be the same as those outlined above. However, there would be considerably less room (and time) in which to take evasive action.

Typhoon Conditions

Under (approaching) typhoon conditions, there are two incidents of concern:

> *A vessel loses control in the Ma Wan Channel (or, indeed, in the Western Harbour area) and is blown onto the bridge; and*

> *A vessel attempting to reach the shelter of the DG Anchorage fails to clear the Ting Kau Bridge due to the adverse weather.*

In both cases, the reason for the incident can be classified as "weather".

12.3.5 Collision Probabilities by Scenario

Taking the three scenarios outlined above, the following calculations provide an indication of the chances of a collision between a vessel and the Ting Kau Bridge which may result in significant damage to the bridge. It must be stressed that these calculations are highly speculative and are based on a variety of assumptions many of which are open to question. Nevertheless, the calculations provide both an initial basis on which to estimate the chances of collision and, as importantly, by adopting a consistent approach, an indication of the relative importance of the different causes.

Ma Wan Channel

The calculations for collisions associated with traffic in the Ma Wan Channel are presented below:

Number of vessel movements (per year) (Classes A, B, C, D-1):	*3400 (current)* *10700 (2006)*
Probability of eastward movement: (i.e. 50% of movements)	*0.5*
(Base) incident probability:	*1×10^{-4} per movement*
Given an incident, probability that it occurs in vicinity of Ma Wan "bend"	*0.1 (1 in 10)*
Given an incident at "bend", probability that no corrective action is taken:	*0.5 (1 in 2)*
Given no corrective action, probability that vessel strikes bridge:	*0.25 (1 in 4)*

The chance that a vessel collides with the bridge with the potential to cause significant damage is then:

$3400 \times 0.5 \times 1 \times 10^{-4} \times 0.1 \times 0.5 \times 0.25 = 2.1 \times 10^{-3}$ per year (current)
$10700 \times 0.5 \times 1 \times 10^{-4} \times 0.1 \times 0.5 \times 0.25 = 6.7 \times 10^{-3}$ per year (future)

In other words, on the basis of current marine traffic figures, the chance of a collision between a vessel (>5,000dwt) and the bridge is about 1 in 470 per year. With the projected increase (3-fold by 2006) in traffic in the Ma Wan Channel, this figure is likely to increase to the order of 1 in 150 per year.

Northern Rambler Channel

The calculations for collisions associated with traffic in the Ma Wan Channel are presented below:

Number of vessel movements (per year) (Class B):	*300 (current)* *0 (2006)*
Incident probability:	*1×10^{-4} per movement*
Given an incident, probability that it occurs in vicinity of the bridge:	*0.2 (1 in 5)*
Given an incident at the bridge, probability that no corrective action is taken:	*0.7 (70%)*
Given no corrective action, probability that vessel strikes bridge:	*0.5 (1 in 2)*

The chance that a vessel collides with the bridge with the potential to cause significant damage is then:

$$300 \times 1 \times 10^{-4} \times 0.2 \times 0.7 \times 0.5 = 2.1 \times 10^{-3} \text{ per year (current)}$$

In other words, on the basis of current marine traffic figures, the chance of a collision between a vessel (>5,000dwt) and the bridge is about 1 in 480 per year. With the planned relocation of the CRC-N Terminal to the south of Tsing Yi, this would effectively eliminate the presence of large vessels in the vicinity of the bridge under normal conditions.

Typhoon Conditions

Excluding the ferry loss (mentioned in Section 12.3.2), there has been one cargo vessel loss associated with a typhoon in the Ma Wan area in the past 20 years or so. This provides a first estimate of vessel loss (through typhoons) of about 1 chance in 20 per year. Taking the same proportion of larger vessels (68%) as for the future Ma Wan Channel traffic (Table 12.2) enables the following indicative calculation to be made:

Vessel loss in general area:	*0.05 per year (1 in 20)*
Probability of vessel >5,000dwt:	*0.68*
Given a loss of a large vessel, probability of collision with bridge:	*0.05 (1 in 20)*

The resultant chance of collision with the bridge is then simply:

$$0.05 \times 0.68 \times 0.05 = 1.7 \times 10^{-3} \text{ per year}$$

In other words, the chance of a large vessel being blown onto the bridge is of the order of 1 chance in 590 per year.

With respect to vessels attempting to reach the shelter of the DG anchorage (existing location), the calculation may appear as follows:

Chances of raising a T3 signal:	*6 per year*
(Chances of raising a T8 signal:	*1 per year)*
Number of vessels (>5,000dwt) attempting to pass under Ting Kau Bridge:	*10 per T3 signal*
Increased incident rate (assumed):	*1 in 1000 movements*
Given an incident, probability that it occurs in vicinity of the bridge:	*0.1*
Given an incident at the bridge, probability that no corrective action is taken:	*0.9*
Given no corrective action, probability that vessel strikes bridge:	*0.5*

The chance that a vessel collides with the bridge with the potential to cause significant damage is then:

$$6 \times 10 \times 1 \times 10^{-3} \times 0.1 \times 0.9 \times 0.5 = 2.7 \times 10^{-3} \text{ per year (current)}$$

In other words, the chance of a collision between a vessel (>5,000dwt) attempting to reach the shelter of the DG anchorage (under a T3 signal) and the bridge is of the order of 1 in 370 per year. In the future, the possible relocation of the DG anchorage to the proximity of the bridge could increase this figure.

12.3.6 Collision Probabilities - Summary

The analysis presented above is summarised in Table 12.3 for both the current and future situations.

Table 12.3: Collision Probabilities (per year)

Scenario	Current		Future	
Ma Wan Channel	2.1×10^{-3}	1 in 470/year	6.7×10^{-3}	1 in 150/year
Northern Rambler Channel	2.1×10^{-3}	1 in 480/year	eliminated	
Typhoon				
- vessel loss	1.7×10^{-3}	1 in 590/year	1.7×10^{-3}	1 in 590/year
- DG Anchorage	2.7×10^{-3}	1 in 370/year	$>2.7 \times 10^{-3}$	1 in 370/year
Totals:	**8.6×10^{-3}**	**1 in 115/year**	**1.1×10^{-2}**	**1 in 90/ year**

Overall, it is considered that the chances of a collision between a large vessel (>5,000dwt) and the Ting Kau Bridge will be of the order of 1 in 100 per year for both current and future situations. In the future, although the larger vessel traffic using the northern Rambler Channel will be less (due to the relocation of the CRC-N Terminal), this will be off-set by the risks associated with the greatly increased traffic using the Ma Wan Channel.

The analysis presented in the previous section, for vessels of 5,000 dwt or more, was repeated for different vessel sizes. This provides a basis for comparing the costs of the additional bridge protection with the associated reduction in the chances of a collision causing damage to the bridge. The results of the analysis are summarised in Table 12.4.

Table 12.4: Collision Probabilities by Vessel Size

Vessels with Potential for Damage	Collision Probabilities (per year) Current	Future
> 5,000dwt (Classes A,B,C,D-1)	1 in 115	1 in 90
>15,000dwt (Classes A,B,C)	1 in 210	1 in 180
>30,000dwt (Classes A,B)	1 in 330	1 in 470
>80,000dwt (Class A)	1 in 14100	1 in 6400

12.4 POSSIBLE MITIGATION MEASURES

12.4.1 Overview

Each of the accident scenarios considered above can be broken down into four discrete steps:

- presence of large vessels;
- loss of vessel control;
- vessel approaches bridge; and
- vessel collides with bridge.

Reducing the chances of any of these steps will lead to a proportionate decrease in the chances of collision with the bridge. By inspection, the first three steps can be excluded on the following basis:

- there will be a continuing need for vessels to use the Ma Wan Channel;
- vessel incidents will continue to occur (and, indeed, there is no evidence in Hong Kong or elsewhere to suggest that the incident rate has declined in recent years); and
- given an incident has occurred, it is largely a matter of luck whether or not the vessel will move towards the bridge or elsewhere and there is little which can be done to mitigate against this.

In other words, reducing the chances of significant damage to the bridge as a result of a vessel collision will only result from the provision of physical protection.

12.4.2 Possible Mitigation Measures

In essence, there are three possible measures:

- to provide an artificial "soft" barrier (for example, a sand bank) on the western side of the bridge. In effect, this would prevent a large vessel from reaching the bridge (and would reduce the chances of a cargo loss);

- to provide a "hard" barrier on the western side of the bridge as is envisaged by the proposals for a breakwater; and

- increasing the physical resistance of the bridge foundations.

Such measures are technically feasible[6] and are worthy of further consideration if the chances of a collision appear to be sufficiently high to be of concern.

12.4.3 Possible Criterion for Improvements

In broad terms, the need for improvements (to protect the bridge structures) can be judged against other design principles. For example, it is understood that the bridge will be designed to withstand a 1 in 120 year typhoon and therefore there is little merit in costly improvements to reduce the risks (to the bridge) associated with ship collisions to a level of, say, 1 chance in 1000 per year.

12.5 CONCLUSIONS

12.5.1 An attempt has been made to provide a preliminary estimate of the probability that a ship will collide with the Ting Kau Bridge with sufficient force with the potential to cause significant damage.

12.5.2 The analysis is based on consideration of the following accident scenarios:

- a vessel fails to make the turn on the Ma Wan Channel and collides with the bridge;
- a vessel passing under the Ting Kau Bridge collides with it; and
- under typhoon conditions, there could be a possibility of a vessel being blown onto the bridge and there would be an enhanced risk of collision from vessels attempting

[6] The LFC and Kap Shui Mun bridges will be designed to withstand impacts of vessels of up to 220,000dwt travelling at 16 knots (under power) and at 8 knots (drifting in typhoon conditions) respectively. This will be achieved by surrounding the support piers by, in effect, artificial islands of the order of 100m across.

to reach the sheltered waters beyond the bridge.

12.5.3 The chances of each of these scenarios occurring were estimated using approximate incident data and marine traffic estimates for both the current and future situations. The analysis was restricted to consideration of a range of larger vessels (>5,000dwt) as smaller vessels were considered to be unlikely to cause significant damage to the bridge. It must be emphasised that the numerical analysis is highly speculative and uncertain and, as such, must be regarded as no more than indicative.

12.5.4 For vessels >5,000dwt, the overall chances of a collision were estimated to be of the order of 1 chance in 100 per year for both the current and future situations. If consideration was restricted to vessels >15,000dwt, the chances of a collision would be reduced to about 1 in 200 per year and for vessels >30,000dwt, the chances would be about 1 in 400 per year. If the bridge was designed to withstand the impacts associated with vessels of up to 80,000dwt, the residual chances of a damaging collision (associated with very large vessels >80,000dwt) would, in the longer term, be about 1 in 6400 per year.

12.5.5 The CRC Terminal on the NE corner of Tsing Yi will be relocated to the southern part of the island in due course thus reducing the risks associated with (large) vessels in the northern Rambler Channel. However, this reduction will be offset by the predicted increase in traffic in the Ma Wan Channel.

12.5.6 In essence, the risks of collision (and damage to the bridge) can only be reduced by the provision of further physical protection around the bridge supports. There are a number of possible measures which might be worthy of further examination.

12.5.7 Whether or not such measures should be incorporated depends to some extent on the current design basis. As the bridge will be designed to withstand a 1 in 120 year typhoon, there would be little merit in costly improvements to reduce the risks (to the bridge structure) associated with ship collisions to a level of, say, 1 chance in 1000 per year. However it is possible that other criteria (and, possibly, design principles) might be appropriate where there are direct risks to people (due to an incident involving DGs or an incident resulting in partial collapse of the roadway). On this basis, it is recommended that further consideration should be given to the need for more elaborate technical studies.

MONITORING AND AUDIT

CHAPTER 13

13. ENVIRONMENTAL MONITORING AND AUDIT SCHEDULES

13.1 INTRODUCTION

Environmental monitoring schedules and audit procedures are essential in order to:

- ensure that any environmental impacts resulting from the construction and operation of Route 3 CPS are minimised or kept to 'acceptable' levels at all times;
- establish procedures for checking that mitigation measures have been applied and are effective, and that the appropriate corrective action is undertaken if and when required; and
- provide a means of checking compliance with environmental objectives, recording anomalies and documenting corrective action.

This Section outlines monitoring and audit requirements for the construction and operation of Route 3 CPS in relation to air quality, noise, water quality and waste management, the details of which may be referred to in the appropriate sections. Monitoring and audit activities for both construction and operation should be consistent and complimentary. It should be noted that monitoring during the operation of roadways is not specified by government. However, in order to confirm the findings of the EIA and ensure impacts are maintained at acceptable levels, it is recommended that limited operational monitoring is undertaken, as a single event as detailed in the appropriate sections.

Monitoring schedules have been provided for the necessary environmental parameters (Tables 13.1 to 13.5), however at this stage it is only possible to provide outline schedules as guidance. Detailed monitoring schedule and audit requirements should be incorporated into the construction contract(s) for the Route 3 CPS development in the form of environmental clauses. These clauses should be agreed in consultation with EPD before being finalised and will be prepared during the detailed design stages of the Route 3 CPS development.

It is important to emphasise that monitoring and audit details presented in the schedules such as monitoring frequency location etc. (Tables 13.1 to 13.5) are for reference only. As with the contract clauses such details will need to be finalized during the detailed design, in order that the successful tenderer can, in consultation with EPD, confirm/identify the appropriate monitoring requirements prior to commencing construction.

13.2 TECHNICAL/PERSONNEL REQUIREMENTS

13.2.1 Responsibilities

The TKB Section of Route 3 CPS will be constructed on a Design and Build basis. The successful tenderer will therefore be responsible for construction and will be referred to henceforth as the contractor.

13.2.2 Staff Organisation and Structure

The monitoring and audit work should be carried out by suitably qualified and experienced personnel. It is recommended that the Government employ an independent organisation (the environmental team) to undertake all baseline monitoring and initial (approximately 3 months) compliance monitoring. Such personnel would report directly to the Supervising Officer on site, and there should be sufficient staff to carry out the tasks. After the initial 3 month period all environmental monitoring should be undertaken by the contractor. These later monitoring activities should be checked and audited by the environmental monitoring team.

Whilst required to possess appropriate technical knowledge and training to carry out the tasks, monitoring staff should also have access to a specialist advisor for each main aspect (i.e noise, air quality, water quality and waste management). It would be advisable that details such as qualifications and experience of the environmental staff to be sent to EPD for information/comment.

13.2.3 Equipment

The contractor should be responsible for providing the appropriate and respective monitoring and sampling equipment and other facilities to enable the monitoring to be carried out. The equipment should be approved in advance by EPD.

13.2.4 Monitoring and Audit Manual

The contractor should be required to prepare an environmental monitoring and audit (EM & A) manual, the content of the manual will have to be agreed with EPD prior to the start of the construction works, but it should include the following:

- the construction programme and the required EM & A programmes to assess the environmental impacts due to the development with time;
- the location, frequency and type of environmental monitoring and audit requirements to assess the environmental impacts of the construction;
- the form/content of event/action plans for air, water and noise impacts;
- review of pollution sources and working practices/procedures required in the event of environmental pollution levels being exceeded;
- the content/presentation of monitoring data, their audit and the actions taken with respect to non-compliance with environmental pollution levels;
- appropriate report formats/frequency of submission/special event reports, etc.;
- complaints/consultation procedures ;
- equipment service records and calibration requirements; and
- the locations of sensitive receivers.

13.2.5 Reporting

A monthly monitoring and audit report should be prepared by the monitoring personnel within 7 days of the end of each month and commencing 1 month after the commencement of construction. Copies of the report should be submitted to the senior management representative and simultaneously sent to EPD.

The report should be a relatively brief and concise account of the environmental monitoring during the previous month and should include a summary of:

- ***Project Data*** - A synopsis of the project organisation, project programme, management liaison structure
- ***Monitoring/Audit Requirements*** - Summary of monitoring parameters, Trigger/Action/Target Levels, Action Plans, environmental protection requirements in contract documents, land lease and engineering conditions
- ***Monitoring Methodology*** - Monitoring equipment used, locations, duration/frequency
- ***Monitoring Results*** - Parameter, date, time, environmental conditions, location, etc.
- ***Audit Results*** - Review of pollution sources, working procedures in the event of non-compliance with environmental monitoring levels; action taken in the event of non-compliance; follow-up procedures related to earlier non-compliance actions
- ***Complaints*** - Liaison and consultation undertaken; subsequent action; database of telephone/written complaints, location of complaints; action plan and follow-up procedures etc.
- ***Appendices*** - Appropriate drawings/tables of monitoring locations, sensitive receiver locations, environmental monitoring and audit requirements etc..

The monthly monitoring and audit reports should be supported by submission of a six monthly and annual summary.

13.3 ENVIRONMENTAL MONITORING SCHEDULES

13.3.1 General

Environmental monitoring falls broadly into two categories: firstly baseline monitoring which should be undertaken to establish or update/confirm the existing conditions in the Study Area (this makes it possible to set limits for the construction and operational phases); and secondly compliance monitoring, which should be carried out during both the construction and operational phases of the development to achieve the following 'general' objectives:

- to assess the performance of construction/operation activities in environmental terms;
- to obtain early warning of potential problem areas, permit timely remedial action and identify any environmental impacts;
- to comply with appropriate standards and environmental objectives; and
- to provide reassurance to local communities.

As part of the monitoring schedules three levels have been devised to monitor compliance with environmental objectives and to provide early warning of potential problem areas, thus stimulating the implementation of mitigation before the regulatory standards are reached. The three levels are described below:

- the **Target Level** is the maximum permissible level which will achieve compliance with the appropriate regulatory standards, or other standards such as construction noise criteria outside restricted hours, and is therefore the upper boundary/limit which is acceptable in terms of environmental quality. Consequently, achievement of this level is undesirable and may lead to the cessation of activities. Compliance monitoring schedules are therefore devised such that remedial action is taken to prevent this level being attained, the target level should under no circumstances be considered as the desired level;

- the **Trigger Level** is a reference value to be used as an 'early warning' of a deterioration in environmental quality. Achievement of this level may stimulate increasing the frequency of monitoring and undertaking preliminary investigation (for example to identify any obvious causes) and possibly remedial action if appropriate; and

- the **Action level** indicates that deterioration is significant and that urgent corrective action is required.

As identified in the relevant sections of this Report, monitoring will be required to measure noise levels, particulate levels (for air quality), total suspended solids, dissolved oxygen (marine and fresh water quality) and waste management practices particularly spoil disposal. In addition, monitoring will involve checking on general working practices and compliance with the various control and mitigation measures identified in preceding sections of this Report, results should be reported to the developer/operator and EPD, and reviewed on a regular basis.

The requirements for each of the environmental parameters are different, and therefore it is not possible to propose a single monitoring programme for all aspects. Requirements for the individual parameters are summarized below, and where appropriate outline schedules are presented in Tables 13.1 to 13.5.

13.3.2 Construction

Environmental monitoring during construction will initially be the responsibility of the environmental team and later the contractor. For each construction site a check list should be prepared relating to each of the environmental issues as identified in the EIA. Together with environmental clauses in the contract documents, this check list will form the basis of a proforma for the environmental monitoring programme.

Air Quality Monitoring

A programme of particulate monitoring should be developed to ensure both the effectiveness of dust control measures (see Appendix A4) and to highlight any associated deterioration of air quality during the construction phases. This will necessarily involve simultaneous wind direction and wind speed monitoring. Baseline monitoring will be undertaken at the appropriate SRs prior to commencing construction. Compliance monitoring will subsequently be undertaken during dust generating construction activities to check that appropriate air quality standards are maintained.

An outline air quality monitoring schedule is presented in Table 13.1. The Target Level comprises the accepted TSP limits for construction sites, of 500$\mu g/m^3$ (1hr average) and 260$\mu g/m^3$ (24hr average). Definitions of the Trigger level is given by the exceedence of the sample in relation to the baseline for the Study Area plus 30%, thereby allowing for fluctuating ambient levels. The Action Level is defined by the average of the Trigger and Target values. On breaching the warning levels, action should be taken as described in an outline action plan (Table 13.5).

It is recommended that baseline monitoring should be carried out for at least two consecutive weeks prior to commencing construction activities. Continuous 24-hour monitoring should be undertaken, and 1 hour samples should be obtained at least three times daily at times when the highest dust impact is expected.

It is recommended that compliance monitoring is carried out at 3 locations at the construction site boundary (in the Ting Kau area), with samplers located down wind of active working areas. Potential monitoring locations are given in Figure 13.1a, however, details of construction activities such as sequencing, site layout, size, boundary locations etc. are not available and therefore these locations are presented as examples only.

Location of samplers should be remote from influencing factors such as roads, local obstructions, etc. As a minimum, 24hr samples should be taken at each monitoring location once every six days (at all monitoring stations) and hourly samples should be taken at least three times every six days. The frequency and location of monitoring may alter in accordance with local meteorological conditions and the nature of construction activities.

In the event that unacceptable concentrations of TSP are experienced, more frequent monitoring should be carried out within 24-hours, and should continue until excessive dust emissions are reduced. Details of corrective action are provided in Section 13.3.4 (Table 13.6).

In addition, it will also be necessary to monitor and check the effectiveness of mitigation measures. Depending on the size and nature of the construction site and therefore use of mitigation measures utilized, this will involve monitoring the efficiency, maintenance and use of:

- wheel washers;
- water sprays;
- dust covers;
- plant with filtration equipment; and
- barriers and enclosures.

Regular checks should be made to ensure:

- regular servicing of plant and site vehicles;
- that appropriate construction methods are being utilised and work sites are located away from SRs; and
- site cleanliness and the implementation of good site practice.

Noise Monitoring

Noise monitoring will be required to verify compliance with the guidelines for construction noise and with requirements of any construction noise permits (CNP) and criteria contained in the contract documents. In the absence of statutory controls relevant to unrestricted daytime hours (0700-2300hrs Monday to Saturday inclusive), it is generally accepted that a limit of 75dB(A)$L_{Aeq(30\ min)}$ or 10dB(A) above ambient (whichever is lower) should be used as a guideline. Consequently, for daytime noise, the Target, Trigger and Action Levels have been devised such that the Trigger is 5dB(A) above background noise levels. Action and Target Levels should be 10dB(A) and 15dB(A) respectively above background.

Construction noise during restricted hours i.e. night-time (2300-0700hrs), public holidays and Sundays will be controlled under the provisions of a CNP. However based on current understanding that construction will be scheduled during unrestricted daytime hours only, it is recommended that only daytime compliance monitoring be undertaken.

Day-time compliance monitoring should be undertaken, three times per week and involve measurement of 30 minute time periods during typical activity. Periods of high ambient noise, such as during peak traffic flows should be avoided.

Regular checks will also be required to establish the implementation and effectiveness of mitigation measures. This will require checking and monitoring on a regular basis:

- the use, maintenance and efficiency of construction equipment;
- the appropriate location of noisy plant/equipment;
- the hours of operation;
- the use and effectiveness of noise enclosures and barriers; and
- the implementation of good site practice.

Water Quality Monitoring

The objective of water quality monitoring is to minimise adverse impacts on water quality which may result from construction activities. Monitoring will be required for both marine and fresh water during construction stage.

Marine Water Baseline Monitoring

As identified in Chapter 6, monitoring is required to check the impacts resulting from dredging and other construction works such as access road formation, clearance work for the bridge foundations, etc. The monitoring will involve measurement of dissolved oxygen, suspended solids and turbidity.

In addition to EPD's water quality monitoring programme, ambient levels will be determined by baseline monitoring at two locations close to the areas to be dredged.

Marine Water Compliance Monitoring

Compliance monitoring will be undertaken to establish compliance with the water quality objectives (WQOs). Target, Trigger and Action Levels have been defined according to the WQOs for the Western Buffer Water Control Zone such that the Target Level is the appropriate WQO.

In order to account for the significant seasonal variations in water quality, Trigger and Action Levels have been defined according to background levels as monitored at a number of representative control stations. The Trigger Level is 20% above the running background for suspended solids and 20% below the running background for dissolved oxygen. The running background is derived from the mean of monitored data taken in the previous 2 weeks at the control stations. The Action Level is the average of the Trigger and Target values This definition of Trigger level for DO applies only when ambient DO is lower than the WQO. When ambient DO is higher than the WQO the trigger level is defined as:

ambient DO - $^2/_3$(ambient DO - WQO).

If suitable controls can be found then the ambient level can be taken as the value measured at the control stations, and the running mean would not be necessary.

As a minimum, 2 designated monitoring stations should be established 150m from the active dredging/reclamation areas, a control monitoring station should be established at an appropriate location which will not be influenced by the project or any other development activities. It should be noted that the locations will have to be agreed with EPD and in consultation with AFD. Samples should be taken at both the control and designated monitoring stations at least 4 times per week at mid-flood and mid-ebb tides. Water quality monitoring should be carried out for a further 4 weeks after the completion of the marine works. Examples of potential monitoring stations are presented in Figure 13.1b.

In order to check the effectiveness of mitigation measures it will be necessary to ensure:

- dredging grabs are well maintained and in good working order;
- no lean mixture over board systems are used;
- barge and hopper dredgers have tight fitting hull seals;
- drainage channels, settlement tanks and other where appropriate construction phase water pollution control measures are being used and effectively maintained;
- the effectiveness and maintenance of oil/grease interceptors; and
- the use of equipment for removing floatables.

Fresh Water Quality Compliance Monitoring

Fresh water quality monitoring will be required to measure impacts from construction activities on the Lido Beach streams (see Chapter 6).

The response of sensors and electrodes should be checked with certified standard solutions before each reading. The turbidity meter shall be calibrated to establish the relationship between turbidity readings in "Nephelometric Turbidity Units" NTU and levels of suspended solids (in mg/l). Once this relationship has been established it is expected that only turbidity will be measured, however, this aspect will have to be agreed with EPD.

At monthly intervals, the environmental team/contractor shall provide to the Supervising Officer, EPD and Highway's Department a summary report giving details of all water quality data obtained in that month. This will include a summary report of any repeat baseline or impact monitoring and/or remedial measures taken to maintain the water quality.

Samples will be taken twice per week from each main discharge point and analysed by the contractor. The results should be reported to the Supervising Officer within 24 hours from the completion of analysis.

Should the results exceed the values allowed in the TM " Standards for Effluents discharged into Drainage and Sewage Systems, Inland and Coastal Waters " or EPD's requirements :

- the frequency of readings will be increased to a level to be decided by the Supervising Officer in the circumstances; or
- the contractor shall institute measures so as to comply with the Specification; or
- the polluting operations shall be suspended at the Supervising Officer's direction until the contractor demonstrates that the additional measures are sufficient to ensure compliance with the Specification.

In the event that remedial measures consented to by the Supervising Officer are not being implemented and serious impacts persist, the Supervising Officer may direct the contractor to suspend work until such measures are implemented and impacts are reduced to acceptable levels.

The contractor shall supply to the Supervising Officer each month three copies of a monitoring and audit report in both printed and magnetic media form, to an agreed format, giving the dates, times of each series of measurements and equipment in use. The actual measurements of each recording, together with comments on any discarded measurements, shall also be submitted.

A fresh water quality monitoring schedule is presented in Table 13.4 and an associated action plan in Table 13.8.

13.3.3 Operation

Environmental monitoring during the operation of the development is necessary to verify the findings of the EIA, and is the responsibility of the developer. Post project monitoring requirements for air, and noise are outlined in Table 13.5. It should be stressed that this should be carried out by the contractor.

Air Quality Monitoring

In order to confirm the findings of the EIA it is recommended that operational monitoring be undertaken for vehicle emissions. This could effectively be achieved by a single monitoring program to be undertaken as a single event at a suitable period after opening the road (e.g. approximately 3 months). Parameters to be assessed include NO_2, TSP and RSP.

Noise Monitoring

Operational noise monitoring should be undertaken by the operator to ensure compliance with the relevant HKPSG planning noise standards requirements. It is proposed that a single noise monitoring program is undertaken at potentially significant NSRs a suitable time period after the opening of the road. As with air quality monitoring a period of approximately 3 months is considered to be suitable. Monitoring should also be carried out in response to complaints where appropriate.

Water Quality

It is anticipated that once Route 3 CPS construction is completed and the route is operational impacts from the TKB Section are not expected to arise and consequently monitoring will not be required.

13.3.4 Action Plans

Action Plans should be devised to facilitate the appropriate and immediate response by relevant personnel, in the event that the Target, Action and Trigger Levels are either attained or exceeded. The appropriate action is determined by the frequency of complaints and/or exceedence of the compliance monitoring levels, (Target level).

The requirement for action plans should be contained in the contract conditions and suitable plans should subsequently be submitted by the contractor to EPD (and AFD for Water Quality). An example of an appropriate Action Plan for the development is outlined in Table 13.6 to Table 13.8.

13.4 ENVIRONMENTAL AUDITING

13.4.1 General

The purpose of environmental auditing is to review the effectiveness of the overall environmental protection programme (for both construction and operation) in terms of monitoring, implementation of mitigation and corrective action. The audit process should not be divorced from general management activities, and should promote a pro-active approach to environmental protection.

13.4.2 Construction Phase Auditing

Construction phase auditing should be carried out in conjunction with the construction monitoring programme.

The audits should be conducted monthly during the construction of the development. It is also considered prudent to conduct some audits to coincide with major construction activities.

Records of environmental monitoring should be maintained by the site manager, contractor and operator and the environmental audit should seek to check:

- records of noise monitoring procedures;
- records of environmental monitoring results;
- records of exceedence of any regulatory requirements/target levels;
- details of control and mitigation action taken in response to unacceptable environmental impacts; and
- records of any complaints from residents/SRs in the Study Area and the actions taken once the complaints have been received.

Assessment of monitoring records will ensure that any unanticipated impacts are being addressed and that any improvements required for future monitoring programmes are identified.

A monthly Monitoring and Audit Report should be compiled by the environmental monitoring personnel and submitted to the contractor, Highways Department and EPD (and AFD for Water Quality). These monthly reports should be supported by six monthly and annual summaries.

13.4.3 Operational/Post Project Auditing

A post project audit should be carried out after completion of the construction phase to assess the environmental performance of the road once operational.

The audit should be undertaken after a sufficient time period from Route 3 CPS becoming operational (e.g. 3 months), such that any findings are representative of the road in operation. Post project auditing should verify the findings of the EIA and provide a mechanism for:

- reviewing the effectiveness of, and requirement for on-going monitoring programmes;
- reviewing environmental management practices in terms of achieving environmental objectives;
- reviewing the effectiveness of environmental mitigation; and
- recommending improvements in environmental controls in the event that environmental objectives are not achieved and environmental impacts are unacceptable.

A post project audit report and executive summary should be submitted to EPD and Highways Department within 5 weeks of completing the audit.

In the event of environmental objectives not achieved and impacts unacceptable, the successful tenderer shall implement further improvement as recommended in the post project audit report. This could be a contractual requirement.

TABLE 13.1 AIR QUALITY MONITORING SCHEDULE (CONSTRUCTION)

PARAMETER	OBJECTIVE	TRIGGER LEVEL	ACTION LEVEL	TARGET LEVEL	LOCATION	FREQUENCY/TIMING
Particulates	Baseline assessment	N/A	N/A	N/A	SRs	For a period of at least two consecutive weeks prior to commencing construction activities. 24hr monitoring continuously, and 1-hr sample 3 times daily to coincide with periods when the highest dust impact is expected.
Particulates	Compliance monitoring	1hr TSP, 24hr TSP ≥ **baseline + 30%	Average of Trigger and Target Levels	500$\mu g/m^3$ 1hr average 260$\mu g/m^3$ 24hr average	3 monitoring stations at Site Boundary in line with nearest SRs, locations to be reviewed monthly to take account of dust generating activities	At least one 24hr sample every 6 days, 3 one hour samples every 6 days or more frequently depending on site and wind conditions
**Wind speed	Assessment parameter/ compliance monitoring	N/A	N/A	N/A	Air Quality Monitoring Station and where necessary to account for wind direction with respect to SRs	Continuous
**Wind direction	Assessment parameter/ compliance monitoring	N/A	N/A	N/A	Air Quality Monitoring Station and where necessary to account for wind direction with respect to SRs	Continuous

Note :
** No values recommended, potential impacts are dependant on the nature of the construction activity. High wind speeds during dusty activities and/or wind direction towards an SR should act as a trigger
SRs Sensitive Receivers
N/A Not Applicable

TABLE 13.2 NOISE MONITORING SCHEDULE (CONSTRUCTION)

PARAMETER	OBJECTIVE	TRIGGER LEVEL	ACTION LEVEL	TARGET LEVEL	LOCATION	FREQUENCY/TIMING
L_{10}, L_{50}, L_{90}, $L_{Aeq\ (30\ min)}$	Baseline Assessment	N/A	N/A	N/A	NSRs	24hr monitoring period for one week
L_{10}, L_{50}, L_{90}, $L_{Aeq\ (30\ min)}$	Check Baseline	N/A	N/A	N/A	NSRs	One 24hr period every 3 months or as near as possible for a typical 24hr period. When construction activities are not taking place
$L_{Aeq\ (30\ min)}$	Spot Check	Background + 5dB(A)	Background + 10dB(A)	Background + 15dB(A)	NSRs	Minimum of once per week for each NSR during construction activities
$L_{Aeq\ (30\ min)}$	Compliance monitoring (non-restricted daytime hours)	Background + 5dB(A)	Background + 10dB(A)	Background + 15dB(A)	NSRs	Minimum of 3 times per week between 0700 and 1900hrs, (2300) during general construction work; as appropriate during noisy activities
$L_{Aeq\ (5\ min)}$	Compliance monitoring (restricted hours)	Background + 5dB(A)	Background + 10dB(A)	Background + 15dB(A)	NSRs	Minimum of 3 times per week
$L_{Aeq\ (30\ min)}$	Response to complaints (non-restricted daytime hours)	Background + 5dB(A)	Background + 10dB(A)	Background + 15d B(A)	Complainant	As appropriate
$L_{Aeq\ (5\ min)}$	Response to complaints (restricted hours)	CNP-10dB(A)	CNP-5dB(A)	CNP (ANL)	Complainant	As appropriate

Note : NSRs - Noise Sensitive Receivers
N/A - Not Applicable

TABLE 13.3 MARINE WATER QUALITY MONITORING SCHEDULE (CONSTRUCTION)

PARAMETER	OBJECTIVE	TRIGGER LEVEL	ACTION LEVEL	TARGET LEVEL	LOCATION	FREQUENCY/TIMING
Dissolved oxygen	Baseline assessment	N/A	N/A	N/A	2 monitoring stations close to area to be dredged - 1m below surface - mid level - 1m above sea bed	Prior to commencing construction for a period approximating 2-4 weeks, 2 samples per monitoring station, 4 times per week
Suspended solids/ Turbidity	Baseline assessment	N/A	N/A	N/A	2 monitoring stations close to area to be dredged - 1m below surface - mid level - 1m above sea bed	Prior to commencing construction for a period approximating -2-4 weeks, 2 samples per monitoring station, 4 times per week
Dissolved oxygen	Compliance monitoring	20% below running background levels	Average of Trigger and Target Levels	*WQO	2 Designated monitoring & 1 Control Station - 1m below surface - mid level - 1m above sea bed	During the course of dredging and filling works - 3 times per week, 2 samples per monitoring station
Suspended solids/ Turbidity	Compliance monitoring	20% above running background levels	Average of Trigger and Target Levels	WQO	2 Designated monitoring & 1 Control Station - 1m below surface - mid level - 1m above sea bed	During the course of dredging and filling works - 3 times per week, 2 samples per monitoring station
Dissolved Oxygen	Post construction period compliance monitoring	20% below running background levels	Average of Trigger and Target Levels	*WQO	2 Designated monitoring & 1 Control Station - 1m below surface - mid level - 1m above sea bed	After completion of dredging and filling activities for a period of 4-6 weeks continuously
Suspended solids/ Turbidity	Post construction period compliance monitoring	20% above running background levels	Average of Trigger and Target Levels	WQO	2 Designated monitoring & 1 Control Station - 1m below surface - mid level - 1m above sea bed	After completion of dredging and filling activities for a period of 4-6 weeks continuously

Note : N/A Not applicable
WQO WQO for WB WCZ = dissolved oxygen - 4mg/l (depth average) 2mg/l (bottom); suspended solids - waste dischar e not to raise the natural ambient level by 30%, nor accumulation of suspended solids.
* In the event that the running background level is below the WQO, the Target Level = a level 30% below the running background, or 2mg/l, whichever is greater
Turbidity should also be measured to give an instantaneous indication of the water quality and the frequency and related action should be agreed with EPD
Sampling should be carried out at mid-flood and mid-ebb tides.

TABLE 13.4 FRESH WATER QUALITY MONITORING SCHEDULE

PARAMETER	OBJECTIVE	TRIGGER LEVEL	ACTION LEVEL	TARGET LEVEL	LOCATION	FREQUENCY/TIMING
Dissolved oxygen (mg/l and %) Suspended solids	Baseline assessment Baseline checking	N/A	N/A	N/A	Monitoring Stations - 1m below surface - mid-level - just above stream bed	Prior to commencing construction for a period of 2 months. Check baseline at all the monitoring stations every 3 months.
Dissolved oxygen	Compliance monitoring	20% below running background levels	Average of Trigger and Target Levels	*WQO	Monitoring Stations - 1m below surface - mid level - just above stream bed	During the course of construction daily at each monitoring station
Suspended solids/ Turbidity	Compliance monitoring	20% above running background levels	Average of Trigger and Target Levels	WQO	Monitoring Stations - 1m below surface - mid level - just above stream bed	During the course of construction daily at each monitoring station
Dissolved Oxygen Suspended Solids/ Turbidity	Compliance monitoring	80% Target Level	Average of Target and Trigger Level		Main Discharge Points	During the course of construction, twice per week at each main discharge point.

Note : N/A Not applicable

WQO Water Quality Objective for Western Buffer Water Control Zone = dissolved oxygen - 4mg/l (depth average) 2mg/l (bottom); suspended solids - waste discharge not to raise the natural ambient level by 30%, nor accumulation of suspended solids.

* In the event that the running background level is below the WQO, the Target Level = a level 30% below the running background, or 2mg/l, whichever is greater

TABLE 13.5 POST PROJECT ENVIRONMENTAL MONITORING

PARAMETER	OBJECTIVE	STANDARD	LOCATION	FREQUENCY/TIMING
* AIR QUALITY				
NO_2 TSP RSP	Confirm the findings of the air quality assessment to ensure that air quality impacts are maintained at acceptable levels.	AQOs	Potentially significant sensitive receivers	To be undertaken as a single event over a period, approximately 3 months after opening of the road.
NOISE				
L_{q10}	Check the accuracy of noise modelling and prediction in order to confirm that noise impacts are maintained at acceptable levels.	Appropriate ANLs	Potentially significant NSRs	To be undertaken as a single event, approximately 3 month after opening the road, over a 24hr period **

Note : * NO_2, TSP and RSP should represent the minimum parameters to be sampled.
** Monitoring to be undertaken by the successful tenderer.

TABLE 13.6 AIR QUALITY ACTION PLAN - SUSPENDED PARTICULATES

EVENT	FREQUENCY	ACTION	
		Site Manager	*Contractor*
Breach of Trigger Value	One sample		
	Two consecutive samples	Inform EPD, contractor and Supervising Officer(SO); resample to confirm result	Check working methods/practices to identify any immediate causes; take appropriate remedial action if necessary
Breach of Action Level	One sample	Inform EPD, contractor and SO; resample to confirm result.	Check working methods/practices to identify any immediate causes; take appropriate remedial action if necessary.
	Two consecutive samples	Inform EPD, contractor and SO; resample to confirm result. Increase frequency of monitoring to daily. Propose remedial action to contractor and SO. Continue monitoring after completion of remedial action to confirm action is effective Record events in monitoring report for submission to the contractor and EPD.	Review dust sources: plant, equipment and working procedures, impose necessary mitigation measures Ensure implementation of remedial action. Inform EPD of remedial action. Amend method statement, if appropriate.
Breach of Target Level	One sample	Inform EPD, contractor and SO; Confirm result & increase monitoring frequency to daily. Propose remedial action to contractor and SO. Undertake monitoring at nearest SR. Continue monitoring after completion of remedial action to confirm action is effective. Complete Monitoring Report and submit to contractor and EPD.	Undertake immediate check of activities plant and equipment and employ any appropriate mitigation. In extreme cases cease activities. Ensure corrective action has been undertaken as proposed by (monitoring team) and is effective. Amend method statement, if appropriate. Inform EPD of remedial action

TABLE 13.7 NOISE ACTION PLAN

EVENT	ACTION	
	Site Manager	*contractor*
Breach of: daytime (unrestricted hours) **Trigger value**	Inform contractor, SO	Investigate complaint***
Breach of: daytime (unrestricted hours) **Action Value;** 1 complaint	Inform contractor, EPD, SO; resample at NSR to confirm monitoring result ($L_{Aeq\ (5\ min)}$) within restricted hours, $L_{Aeq\ (30\ min)}$ outside restricted hours) **Submit report to EPD within two weeks of receipt of complaint should the measured noise level exceed the Target, proposals to reduce noise should be recommended in the report	Check working methods, practices, to identify causes, take appropriate remedial action if necessary Inform EPD of remedial action taken
* **2 complaints**	Inform contractor, EPD, SO; resample to confirm monitoring result ($L_{Aeq\ (5\ min)}$ within restricted hours, $L_{Aeq\ (30\ min)}$ outside restricted hours) Increase frequency of monitoring at affected NSRs to at least two measurements per time period or daily as appropriate Propose remedial action Continue monitoring after completion of remedial action to confirm was effective, - **until no further complaint is received within two weeks of the last complaint **Submit report to EPD within two weeks of receipt of complaint should the measured noise level exceed the target, proposal to reduce noise should be recommended in report. Confirm corrective action has been undertaken and is effective in monitoring and audit report	Undertake detailed check of working methods and practices. Investigate complaint and increase impact monitoring*** Undertake appropriate remedial action and provide evidence of having done so Ensure corrective action has been undertaken and is effective Amend method statement if appropriate Inform EPD of remedial Action

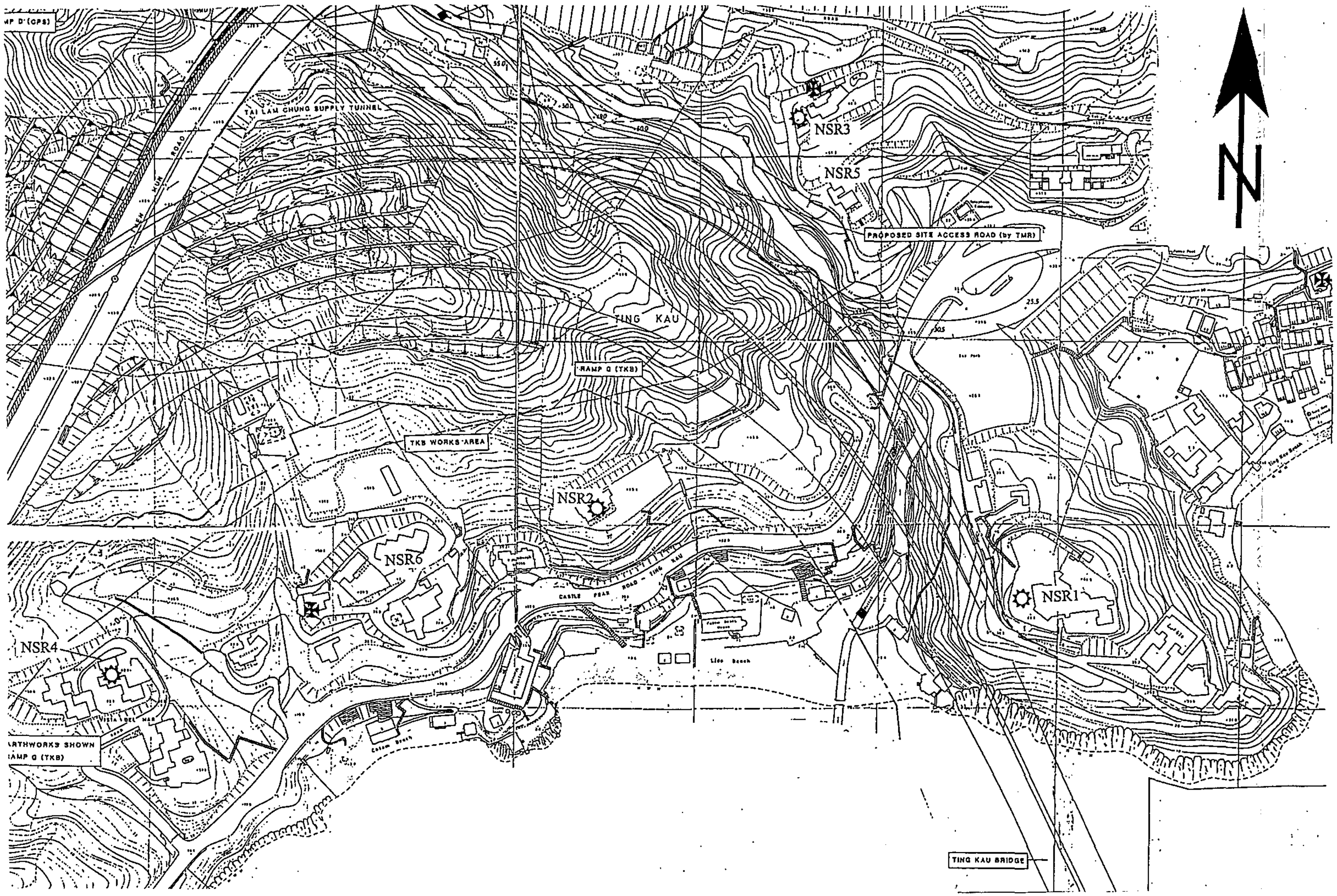
Note:
- * In the event of creeping ambient levels, Trigger Level = 1 complaint, Action Level = 2 complaints
- ** Action associated with response to complaints
- *** The action plan for the target level should be adopted and implemented whenever the noise levels measured during any complaint investigation exceed the appropriate target level.

TABLE 13.8 FRESH AND MARINE WATER QUALITY ACTION PLAN - SUSPENDED SOLIDS AND DISSOLVED OXYGEN

EVENT	FREQUENCY	ACTION		
		Monitoring Team	*SO/Site Manager*	*Contractor*
Breach of Trigger Value	One sample	Inform contractor & SO		
	Two consecutive samples	Inform EPD, contractor and SO; resample to confirm result	Check working methods/practices to identify any immediate causes; take appropriate remedial action if necessary	
Breach of Action Level	One sample	Inform EPD, contractor and SO; resample to confirm result	Check working methods/practices to identify any immediate causes; take appropriate remedial action if necessary	
	Two consecutive samples	Inform EPD, contractor and SO; resample to confirm result	Undertake detailed check of working methods and practices	Review plant, equipment and working procedures
		Increase frequency of monitoring		
		Propose remedial action	Carry out appropriate remedial action as recommended by environmental monitoring team	Ensure implementation of remedial action
		Continue monitoring after completion of remedial action to confirm action is effective	Ensure corrective action has been undertaken and is effective	Inform EPD of remedial action
		Record event in monitoring report for submission to contractor and EPD	Amend method statement, if appropriate	
Breach of Target Level	One sample	Inform EPD, contractor and SO;	Under take immediate check of activities and employ any appropriate mitigation.	Review plant, equipment and working procedures
		Confirm result & increase monitoring frequency	In extreme cases cease activities	Ensure immediate implementation of remedial action
		Propose remedial action	Ensure corrective action has been undertaken as proposed by (monitoring team) and is effective	
		Undertake monitoring at nearest water quality SR		Inform EPD of remedial action
		Continue monitoring after completion of remedial action to confirm action is effective	Amend method statement, if appropriate	
		Complete Monitoring Report and submit to contractor and EPD		

TABLE 13.9 CONSTRUCTION DUST ACTION PLAN

	ACTION	
Event	Site Manager	Contractor
Trigger Level exceeding for one sample	Repeat measurement as soon as possible, and notify contractor.	Identify source of emission.
Trigger Level exceeded for two or more consecutive samples	Repeat measurement as soon as possible. Notify contractor and EPD.	Identify source of emission and impose necessary mitigation measures.
Action Level exceeded for one sample	Repeat measurement as soon as possible. Notify contractor and EPD.	Identify source of emission and impose necessary mitigation measures.
Action Level exceeded for two or more consecutive samples	Start daily monitoring. Notify EPD. Notify contractor and require him to make additional proposals for dust suppression.	Identify source of emission. Review plant, equipment, and working procedures. Submit proposals for reducing dust to the Supervising Officer. Implement remedial action to reduce dust emissions immediately, and notify Supervising Officer of action taken.
Target Level exceeded for one sample	Start daily monitoring. Notify EPD, and provide investigation report as soon as possible. Notify contractor and require him to make additional proposals for dust suppression.	Identify source of emission. Review plant, equipment, and working procedures, and provide investigation report to Supervising Officer. Submit proposals for reducing dust to the Supervising Officer. Implement remedial action to reduce dust emissions immediately, and notify Supervising Officer of action taken.
Target Level exceeded for two or more consecutive samples.	Start daily monitoring. Notify EPD, and provide report on contractor's proposals and actions for dust suppression. Notify contractor and require him to make additional proposals and take immediate steps for dust suppression.	If instructed by Supervising Officer, stop work activities causing excessive dust emissions. Identify source of emission. Review plant, equipment, and working procedures. Submit proposals for reducing dust to the Supervising Officer. Submit investigation report, including measures to prevent further AQO exceedances. Implement remedial action to reduce dust emissions immediately, and notify Supervising Officer of action taken.



PARAMETERS TO BE MONITORED

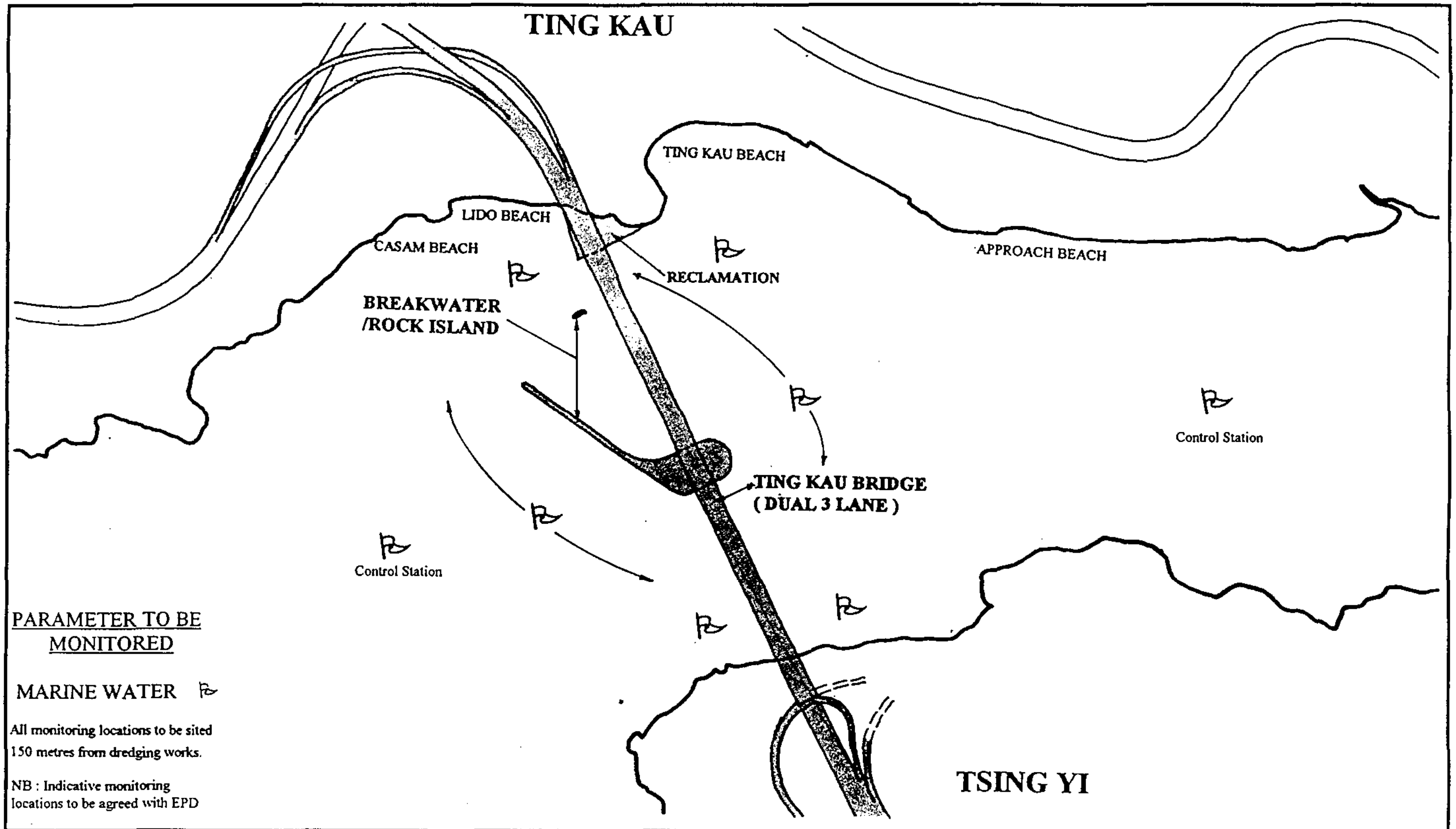
NOISE ☼

AIR ✠

FRESH WATER ◆

NB : Indicative monitoring locations to be agreed with EPD

FREEMAN FOX MAUNSELL	Drg. Title : INDICATIVE BASELINE/COMPLIANCE MONITORING LOCTIONS AT TING KAU BRIDGE	Job Title : ROUTE 3 TING KAU BRIDGE EIA	
		Scale : N.T.S Date Nov. 93	Job No. 058 007
			Fig No. 13.1a



FREEMAN FOX MAUNSELL	Drg. Title : INDICATIVE BASELINE/COMPLIANCE MONITORING LOCTIONS AT TING KAU BRIDGE	Job Title : ROUTE 3 TING KAU BRIDGE EIA		
		Scale : N.T.S Date Nov. 93	Job No. 058 007	Fig No. 13.1b

SUMMARY

CHAPTER 14

14. SUMMARY

14.1 INTRODUCTION

14.1.1 Background

Route 3 Country Park Section (CPS) comprises approximately 15.5 km of roadway connecting north west Tsing Yi in the south to Yuen Long and Route 2 in the North. Ting Kau Bridge (TKB) is the major southern component of Route 3 CPS and together with the Tai Lam Tunnel and Yuen Long Approach Road (TLT & YLA) (which extends from Ting Kau in the south to Au Tau in the north), will become a major element in Hong Kong's land transport infrastructure. Apart from being the first and main approach to the new airport at Chek Lap Kok it will be a vital link to serve the growing traffic demand in the North West New Territories, West Kowloon and the expanding port at Kwai Chung.

A Feasibility Study and Preliminary Design Stage 1 study for the Project were completed in October 1989 and July 1992 respectively. These studies considered the prospective alignments of Route 3 CPS and culminated in the selection of a preferred scheme; in addition certain sections of the scheme have been the subject of further feasibility studies.

In February 1993, Freeman Fox Maunsell were commissioned by the Highway's Department to undertake the Preliminary Design Stage 2 and necessary environmental studies for the Route 3 CPS, TLT & YLA. In addition Freeman Fox Maunsell were commissioned to complete the environmental studies for the Route 3 CPS, TKB. These environmental studies have been consolidated into two respective EIA Reports for the TKB and the TLT & YLA sections of Route 3 CPS.

As the project will be constructed under two separate contracts, both the engineering design and EIA have been divided into two separate studies. The section of Route 3 CPS from the North West Tsing Yi Interchange to the Ting Kau Interchange, henceforth referred to as the Ting Kau Bridge (TKB) Section is the subject of this EIA Report.

This Chapter provides an overview of the TKB section of the route alignment and summarises the key aspects of the environmental studies.

14.1.2 Purpose and Objectives

The EIA has been undertaken to provide both a comprehensive assessment of the potential impacts arising from the construction and operation of the TKB section of Route 3 CPS. In accordance with the Study Brief it has the following specific objectives:

- to provide a comprehensive description of the characteristics of the proposed development;
- to identify and describe the elements of the community, landscape and environment likely to affect/be affected by the proposed development;
- to minimise pollution, environmental disturbance and nuisance arising from the development and related facilities;
- to identify, predict and evaluate the net potential environmental impacts and

cumulative effects resulting from the construction and operation of the development;

- to identify and specify methods, measures and standards for the inclusion into the design which are necessary to effectively mitigate these impacts to an acceptable level;
- to recommend environmental monitoring and audit requirements; and
- to identify additional necessary studies to fulfil the EIA objectives.

14.1.3 Approach

As the TKB Section of Route 3 CPS will be developed on a Design and Build basis, this will provide the Contractor with a high degree of autonomy in terms of the detailed design and construction methods. It is therefore important that the findings of the EIA are translated into the final scheme. Consequently the EIA has been conducted concurrently with the engineering studies, and a major focus has been to contribute positively to the design of the project.

14.2 TING KAU BRIDGE SECTION - PROJECT OVERVIEW

14.2.1 TKB Route Description

The TKB Section extends from North West Tsing Yi across the northern Rambler Channel via Ting Kau Bridge. At its northern landfall the bridge connects to the Ting Kau Interchange as the alignment crosses both Castle Peak and Tuen Mun Roads. From Ting Kau interchange above Tuen Mun Road, the road then proceeds northwards in the TLT & YLA road section towards the southern Tai Lam Tunnel portal.

14.2.2 Structural Components

The main features of the TKB development considered as part of this EIA include:

- Ting Kau Bridge approach from the North West Tsing Yi Interchange which facilitates the link to Ma Wan Island, the North Lantau Expressway and Chek Lap Kok Airport. Northbound sliproads of North West Tsing Yi Interchange will be constructed as part of Route 3 CPS.

- Ting Kau Bridge, a dual three lane cable stayed structure, with a main span of 420m crossing the northern Rambler Channel from Tsing Yi to Ting Kau on the main land.

- A mid channel bridge support which includes a breakwater and rock island to protect the nine pylons supporting the approach section structure of the crossing.

- Ting Kau Interchange, comprising four sliproads named Ramps C, D, G and H. Ramps G and H are considered in the TKB EIA and the rest are considered in the TLT & YLA EIA. The environmental impacts of these ramps have been addressed appropriately according to the timings.

14.2.3 Construction

Construction will take place over approximately four years, schedule to start in January 1995. The construction activities fall into four main categories:

- excavation;
- foundation works;
- superstructure works (cable stayed bridge); and
- road construction - at grade

It is envisaged that the work areas for the two interchanges will be located to either landfall. The route itself will form a linear works site, and there will be major concentrations of activity at intersections where embankments, sliproads and flyovers are to be constructed. In addition the reclamation at Penny's Bay on Lantau Island has been proposed as a works site for the TKB Section.

The reclamation at the Ting Kau landfall will be used as a barge loading facility for spoil arising from the cutting operations.

14.3 STUDY AREA AND ENVIRONMENTAL BASELINE

14.3.1 Definition and General Description of the Study Area

The study area of the EIA comprises the route corridor of the alignment and adjacent areas including Ting Kau, northwest Tsing Yi and the northern Rambler Channel.

The southern component of the study area (north west Tsing Yi Island), comprises steeply sloping sparsely vegetated hillsides rising abruptly from the coastline. The majority of development in this area comprises light industry located along the coastal margin to the west and north of Tsing Yi reclamation.

The mainland at Ting Kau encompasses the hillsides and coastal areas between Tuen Mun Road in the north and the southern coast line. The area between Castle Peak Road and Tuen Mun Road is undeveloped comprising a range of gently rising hills. From Tuen Mun Road the hills and natural countryside rise northwards towards the Tai Lam Country Park reaching a peak at approximately 260m. Vegetation in the areas that are not developed consist primarily of scrub and stands of mature trees which create a green view of the hillside. The settlement pattern in the surrounding areas is disperse, and consists of low-rise development along the coast.

14.3.2 Existing Environmental Conditions

Methodology

In order to determine existing environmental conditions in the study area as a baseline for the assessment, information has been drawn from:

- landuse surveys to determine the location and nature of SRs along the route;
- review of existing environmental data to provide an overview of the prevailing environmental conditions in the study area;

- selected monitoring of ambient noise levels along the route; and
- ecological/vegetation surveys.

Air Quality

The main impact source on existing air quality in the study area comprises traffic on Tuen Mun Road and emissions from industry located on north west Tsing Yi. Baseline air quality monitoring established that pollution levels did not exceed the Hong Kong Air Quality Objectives. However, construction of CRA1, the proposed Lantau Fixed Crossing (LFC) and the Tuen Mun Road widening project may have an adverse effect on the air quality in terms of dust and vehicle emissions.

Noise

Results of baseline monitoring carried out in April/May 1993 and review of existing data established that background levels are low (in the region of 50 -55 dB(A)), reflecting the relatively quiet nature of the Study Area.

Traffic generated noise on Ting Kau is the main noise source in the (mainland) study area. The housing along the coast is mainly affected by the traffic on Castle Peak Road, which serves all residential areas along the coast from Ting Kau to Sham Tseng and the west.

Marine Water Quality

The marine water quality in the northern Rambler Channel is generally poor. A major source of impact on the existing water quality in Hong Kong is the Pearl River, which delivers significant quantities of sediments and industrial effluent to local marine waters. There are a number of outfalls along the coast from Sham Tseng to Tsuen Wan including a nullah outfall at Lido beach. The water in the area has high levels of *E-coli* primarily due to the presence of sewage and storm water outfalls located on the mainland coast between Sham Tseng and Tsuen Wan discharging into the marine environment. The water quality in the area has deteriorated over the last few years, which is believed to be a result of the expanding population in the unsewered areas and the presence of nearby industry located at Sham Tseng, Tsuen Wan and Kwai Chung.

Gazetted beaches in the study area are situated along the Rambler Channel with one on Ma Wan. Ting Kau and Approach beaches have been downgraded *(Bacteriological Water Quality of Bathing Beaches in Hong Kong,* EPD 1992) to *very poor*, Casam, Lido, Gemini, Ho Mei Wan and Anglers beaches have been downgraded to *poor* in 1993 and Tung Wan on Ma Wan is ranked as *"fair"*.

However, it is anticipated that water quality in the area may improve in the future with the gazetting of Western Buffer Water Control Zone and the implementation of the Strategic Sewage Disposal Strategy.

Sediment Quality

Review of existing monitoring data, previous studies and sediment analysis indicate the sediments in the Study Area to be seriously contaminated with heavy metals as well as other pollutants such as nitrogen, phosphorous and hydrocarbons. Four independent mud analysis studies have been carried out in the area and its vicinity and based on this, the mud is considered to be seriously contaminated (Class C) down to 2.5m depth.

14.3.3 Key Existing and Committed Sensitive Receivers

Key existing SRs within and adjacent to the Study Area have been identified in relation to their susceptibility to noise, air quality, industry, cultural, recreational, ecological, visual and livelihood aspects. The SRs are listed below and include:

- Northern Rambler Channel;
- Residential development at Ting Kau;
- The gazetted beaches along Rambler Channel and on Ma Wan;
- Fish culture zone on Ma Wan;
- Temple on Lido Beach; and
- Aquatic life including fish species and the Chinese White Dolphin.

14.4 ENVIRONMENTAL IMPACTS

14.4.1 Air Quality

Construction

Construction dust is predicted to exceed 1-hour and 24-hour desirable maximum concentrations. This is due to the large construction area and the number of assumed concurrent construction activities. Practical mitigation measures have been proposed to reduce these high dust concentrations to an acceptable level. It should be noted that other construction projects operating simultaneously in the area will further degrade local air quality.

Operation

Results of the air quality assessment indicate that TSP will not exceed the assessment criteria for the years 2001 and 2011. Concentrations of NO_2 in close proximity to the alignment however, are likely to approach the AQO standards along Tuen Mun Road in the year 2001, and along the bridge/viaduct in 2011.

Although pollution levels immediately adjacent to both Route 3 CPS and Tuen Mun Road are expected to be significant, pollutants are expected to disperse sufficiently with distance such that sensitive receivers in the study area should not experience pollution levels exceeding the AQO maxima. The need for mitigation is therefore not anticipated.

Future governmental action may bring about mitigation by reducing emission levels from individual vehicles. In 1995, a standard for vehicle diesel fuel will be introduced to limit its pollution (especially particulate) potential. Automotive emission standards will also be tightened in 1995; currently, all newly-imported small vehicles require pollution controls (such as catalytic converters) to comply with the revised standards. A more stringent vehicle inspection and maintenance programme for commercial vehicles is being considered. This is expected reduce pollution levels further in the area.

14.4.2 Noise

Construction

Construction noise will significantly affect receivers in the Ting Kau area. With noise mitigation incorporated in the form of fixed solid barriers around noisy activities, 10 residential dwellings will be subject to noise levels exceeding set noise criteria (NCO). It is recommended that these dwellings should be provided with noise insulation for the duration of the construction period.

Operation

Computer noise modelling indicates that only one dwelling will be subject to noise levels above 70dB(A), subject to provision of pervious friction course road surfacing. It is recommended that this one dwelling should be provided with noise insulation as this is considered to be a more cost effective and practical mitigation measure than erection of a noise barrier along the roadside.

14.4.3 Marine Water Quality

Construction

During the construction phase the key issues will be the prevention of soil, construction materials, chemicals, sewage etc. from entering the water course and thus the marine waters. Impacts on water quality may occur both as a result of surface water run-off and during dredging and dumping (as part of the breakwater and seawall construction), particularly in view of the highly contaminated nature of the marine sediments. To minimise potential impacts, strict mitigation measures should be adopted in relation to controlling run-off through site practice, provision of drainage channels, interceptors etc. The selection of methods and equipment to be used for dredging once decisions are made regarding location and extent of dredging will be important factors in pollution control. Special handling and disposal arrangements need to be made with respect to any contaminated material.

Operation

Potential impacts arising post construction are changes in the hydraulic regime (flows, currents etc.) and associated changes in water quality resulting from the development of the breakwater, reclamation and bridge piers in the northern Rambler Channel. In order to determine the extent and nature of potential effects a WAHMO modelling has been carried out and the details and results of this study are presented in the Ting Kau Bridge WAHMO Modelling Assessment Supplement Paper.

14.4.4 Waste and Spoil Management

The main environmental issues to be addressed with regard to spoil and fill requirements for the TKB are: minimisation of the amount of spoil arising the desire to balance excavation and fill and also the collection, handling and disposal arrangements.

A review of fill and excavation requirements has established three main areas of construction activity where surplus spoil will be generated:

- North West Tsing Yi - major excavation required to facilitate development of the

North West Tsing Yi Interchange resulting in an estimated $2.7Mm^2$ surplus of rock/soft material.

- Ting Kau - major excavation required to facilitate development of the Ting Kau Interchange and connections to Route 2 resulting in approximately $0.9Mm^2$ of surplus material; and

- Rambler Channel - earthworks operations for construction of the breakwater, rock island and seawall for the reclamation on the north side of Rambler Channel resulting in a possible $2.2Mm^2$ of marine mud, requiring disposal.

Viable spoil disposal options comprise use of spoil within the project or reuse for fill in other projects. Potential environmental effects from spoil disposal activities can be considered to be essentially limited to construction related impacts, although further consideration will need to be given to end state impacts.

It is proposed that excess material from the Ting Kau area will be brought by trucks down to the barge loading point at the reclamation. This is further discussed in a Supplementary Study; the Ting Kau Haul and Access Road EIA.

At the site specific level, a range of environmental protection measures are likely to be required including:

- measures ensuring transport and access routes bypass sensitive areas such as residential premises or areas of high ecological interest;

- design and programming of site disposal activities to minimise long term impact and maximise environmental gain.

Prior to disposal, spoil will be stockpiled which will potentially result in environmental problems. However as the quantities of spoil arising are still uncertain and the location of spoil heaps unknown, this issue is best covered at the detailed design stage when acceptable proposals for managing and controlling impacts at stockpiles (and for all spoil handling and transport) should be confirmed and implemented.

14.4.5 Landscape and Visual Impact Assessment

Three elements of the TKB Section of Route 3 CPS have been identified in relation to creating visual and landscape impacts:-

- the North West Tsing Yi Interchange;
- the TKB crossing; and
- the Ting Kau Interchange.

The most severe and permanent impact on landscape character will occur as a result of the Ting Kau Interchange. The potential impacts will additionally be compounded when the subsequent TLT & YLA Route 3 CPS is constructed, adding a further two elevated sliproads to the north of the proposed route.

With regard to visual effects, the impacts of the bridge itself will remain significant throughout its operational life. However the most significant post construction impact will be the introduction of the elevated structure, moving traffic and resulting visual intrusion on receivers within the Ting Kau area.

14.4.6 Landscape Mitigation

Landscape mitigation requirements and proposals are essential in order to:

- minimize the visual impacts of the works by blending disturbed areas back into the terrain;
- maximize the establishment of quality habitat; and
- maximize the advantageous effects of revegetation on slope stability, noise and dust amelioration and pedestrian and traffic management, retard the movement of hill fires and improve water run-off characteristics wherever possible.

Both temporary and permanent landscaping measures have been identified to reduce the impact of the project during and post construction. Measures to be adopted during construction largely consist of good site practices and temporary screening.

In addition to detailed landscape works permanent mitigation measures include attention to the detailed alignment of the route, selection of appropriate colours and materials etc. The nature of landscape works follow broad guidelines previously described in the *Stage 1 Preliminary Design, Costing and Programme Report*, and should be discussed with the relevant implementation and maintenance authority at an early stage. These guidelines share a common theme with other landscape works proposed for the area outside of Route 3 CPS.

14.4.7 Landuse

The main construction activities which will potentially result in landuse impacts comprise:

- storage and transport of construction materials;
- general activities such as construction and operation, associated access roads, concrete batching, reclamation construction etc.; and
- proposals to convey spoil to the coastline.

Impacts from the construction phase of the development will primarily affect sensitive receivers in the settlement at Ting Kau, surrounding properties, and users of recreational areas along the coast and in the wooded hillside to the north. Impacts resulting from the construction phase will generally be temporary in nature (blockage of access roads, severance, disturbance etc.) but are considered to be significant as they can last for up to 4 years. The restoration of disturbed areas is an important consideration in assessing the longer term potential impacts.

With regard to potential impacts on recreational /amenity value, there are two specific areas of concern; the beaches and the mainland woodland. The most significant impact will be to the east end of Lido Beach where the proposed reclamation for the bridge pier and construction area for the bridge pylons are located. Movement of construction materials and vehicles along access roads, noise and dust nuisance and disruption of accessibility would contribute to deterioration of this recreational resource. It may even be necessary to close the beach during the construction.

The main issues associated with TKB post construction include community severance, landtake and noise, air quality and visual impacts which in turn create impacts in relation to development potential and land values. By the time TKB opens most of the impacts incurred in the construction phase will have ceased. Residual impacts from these activities will largely depend on the effectiveness and efficiency of mitigation measures adopted in earlier stages.

The permanent loss of amenity will be significant with respect to Lido Beach and to a lesser extent for Casam Beach. Although there will be significant visual impacts and reduced access resulting from the development over the hillside, the importance of this in terms of recreation is less and therefore potential impacts will be limited.

The most sensitive receivers in the vicinity of the TKB development are the high quality residential premises located on the hillsides. The superior location of the premises contributes significantly to their current value, consequently the inevitable changes to landscape quality, air quality, visual outlook and ambient noise resulting from the development of TKB may affect the value of private properties.

14.4.8 Ecology

Terrestrial Ecology

The primary residual impact on terrestrial ecology will be the loss of land area and associated habitat on the Ting Kau side. Although these habitats are mixed with suburban residential and recreational land uses, they are currently somewhat protected due to the general remoteness of the areas involved. As a result, they harbour mature, closed canopy forest cover near a small freshwater stream. In the absence of wild fire, the woodland canopy could progressively extend uphill from the stream valley (above Castle Peak Road) and could provide a productive, stable, and somewhat unusual habitat in this area.

Although it is not certain that all of this woodland and riparian habitat will be destroyed during the construction phase, it is assumed that much of the existing vegetative cover will be lost. It will require several decades for the existing mature woodland areas to be revegetated from bare ground. Restoration of the existing species diversity will also require a number of decades, during which much of the value of the area for birds and invertebrate wildlife will be lost.

Marine Ecology

Mobilization of toxic materials in sediments from the construction and reclamation areas will be a residual impact of the construction phase. The impact will be short-term. Due to the poor baseline condition of the local flora and fauna, the effects are not likely to be severe.

The location of the breakwater may give rise to some residual impacts, due to its effect on current patterns and water flows. The breakwater and other marine structures are currently undergoing WAHMO modelling, the results of this will provide information on any hydraulic changes to the area and any associated impacts will be discussed in the WAHMO modelling study report.

14.4.9 Environmental Monitoring and Audit

Environmental monitoring and audit requirements for the construction and operation of the TKB Section have been identified and outline monitoring schedules and action plans defined with respect to air quality, water quality and noise. The effective implementation of a comprehensive monitoring and audit programme is essential in order to:

- ensure that any environmental impacts resulting from the construction and operation of the TKB section of Route 3 CPS are minimised or kept to 'acceptable' levels at all times;

- establish procedures for checking that mitigation measures have been applied and are effective, and that the appropriate corrective action is undertaken if and when required; and

- provide a means of checking compliance with environmental objectives, recording anomalies and documenting corrective action.

In order to ensure that these objectives are achieved, monitoring and audit requirements should be incorporated into the contract documents for the project for implementation during both construction and operation of TKB.

RECOMMENDATIONS AND MITIGATION MEASURES

CHAPTER 15

15. RECOMMENDATIONS AND MITIGATION MEASURES

15.1 GENERAL

This section consolidates recommendations and mitigation measures proposed in the previous sections of this report. Mitigation measures recommended should be incorporated wherever possible into the contract documents and specific measures should be agreed with EPD.

It is understood that a further detailed and targeted EIA will be a requirement of the tender process. Each tenderer will need to address any differences between his and this 'reference design' assessed in this EIA. It will also be important to update this assessment in accordance with any new data (such as confirmed traffic flow predictions).

It is recommended that the scope and methodology are agreed with Highways Department and EPD in advance, and the findings are submitted to Highways Department for appropriate consultation and approval.

15.2 AIR QUALITY

- Effective water sprays should be used where and when dust is likely to arise, particularly during the delivery and handling of fill. The effectiveness of wetting can be prolonged by the use of wetting agents that agglomerate dust particles, however, the use of chemical wetting agents may have adverse effects on plants and animals exposed to contaminated run-off.

- During transportation (e.g by dumptruck), materials with the potential to create dust should not be loaded to a level higher than the side and tail boards, and should be dampened and covered before transport.

- A gravel surface or temporary sealed surface on haul roads should be provided.

- A programme of air quality monitoring should be implemented that determines baseline conditions and monitors the period during and after construction. This programme should be developed in accordance with EPDs requirements. Guidelines and outline schedules are presented in Chapter 13.

15.3 NOISE

15.3.1 Construction

It is recommended that mitigation measures be employed to control noise during construction both at source and at the receiver:-

Noise Mitigation at Source

The following measures are recommended:

- **Siting of equipment:** noisy equipment and activities should be sited by the Contractor as far from close-proximity sensitive receivers as is practical. Prolonged operation of noisy equipment close to dwellings should be avoided.

- **Use of Silenced Equipment/Acoustic Enclosures:** noisy plant or processes should be replaced by quieter alternatives where possible. Silenced diesel and gasoline generators and power units, as well as silenced and super-silenced air compressors, can be readily obtained.

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

  Temporary noise barriers or earth embankments may be used to screen specific receivers. The barrier material should have a mass per unit of surface area of at least 7 kg/m^2. The panels should be absorptive with an acoustic lining, and have a noise reduction capability of up to 10 dB(A).

- **Timing of Activities:** noisy activities can be scheduled to minimise exposure of nearby NSRs to high levels of construction noise. For example, noisy activities can be scheduled for midday, or at times coinciding with periods of high background noise (such as during peak traffic hours). As far as possible, noisy operations during teaching hours should be avoided near the existing schools.

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

- **Working Practices:** Idle equipment should be turned off or throttled down. Noisy equipment should be properly maintained and used no more often than is necessary.

  If possible, reduce the numbers of operating items of powered mechanical equipment.

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

Noise Mitigation at the Receiver

- Noise mitigation in the form of acoustic insulation should be employed at all receivers where construction noise levels at one metre from the most exposed facade is predicted to be in excess of 75 dB(A).

- Pervious road surfacing material should be applied to all surfaces where practicable.

15.3.2 Operation

Mitigation in the form of either an acoustic barrier (400m in length and 3 metres in height) or preferably acoustic insulation at the receiver, should be employed to reduce noise to an acceptable level at NSR 3.

15.4 WATER QUALITY

Marine Water Quality

- Construction of marine works such as breakwater, reclamations and bridge piers should be done by leaving mud in-situ where possible.
- Marine sediments shall be categorised by their respective contamination levels and disposed of at gazetted spoil disposal grounds in accordance with EPD and FMC requirements.
- A programme of marine water quality monitoring should be implemented that determines baseline conditions and monitors during construction. This programme should be developed with EPD in accordance with their requirements.

Fresh Water Quality

- Appropriate sediment traps within the drainage system should be installed to minimise the transport of sediment to the fresh water environment.
- Site compounds should be designed to take account of contaminated surface water.
- Treatment of contaminated waters should be undertaken by mechanical or chemical means to ensure that any discharges from the site adhere to the specific Technical Memorandum schedule.
- Procedures for the recovery and containment of spillage during construction of the road should be devised.
- Routine inspection and maintenance of the drainage system should be undertaken to ensure that sediment traps and oil interceptors within the system are regularly cleaned.
- A programme of fresh water quality monitoring should be implemented that determines baseline conditions and monitors during construction. This programme should be developed with EPD in accordance with their requirements.

15.5 MANAGEMENT OF WASTE AND SPOIL

- Construction of TKB whilst leaving marine muds in-situ is a preferred method and is recommended on environmental grounds.
- The aim should be to achieve a balance of all cut excavation and fill operations.
- Noise reduction measures should be implemented to include selection of quietest plant and working methods, and limiting hours of operation if necessary.
- Careful consideration should be given to locating stockpiles in relation to existing topography, creating new earth bunds and retaining existing tree belts as mitigation to noise, dust emissions and visual intrusion.

- Mitigation for the prevention of surface water pollution should include bunding and directing run-off to settlement ponds.
- Land take should be minimised (particularly productive land) through limiting the size of stockpiles and associated working areas.
- All boundary lines should be fenced to keep the working areas and stockpiles contained, and to protect productive agriculture, important habitats and landscape features.
- Temporary footpath diversions should be provided where necessary to avoid disruption to public rights of way.
- At the end of the stockpiling activity, land should be restored to its original use and quality.
- A vegetation survey should be conducted to determine the optimum route for the conveyor belt system (This is part of the TLT & YLA Section).

15.6 LANDSCAPE WORKS

Temporary Mitigation Measures (Construction Phase)

- The volume of construction traffic should be restricted on the local road network.
- Construction working areas should be restricted to a minimum size.
- Working areas should be enclosed with hoardings to define boundary edge and screen low level construction activities (eg. car/truck movement) from surrounding receptors.
- Heights of storage materials, stock piles and spoil heaps should be maintained at low levels.
- Night-time working and lighting should be minimised.
- Advance planting and ground modelling should be undertaken in designated landscape areas where damage from construction activity can be avoided to facilitate establishment of the landscape prior to the route becoming operational.

Permanent Mitigation Measures

Consideration should be given to:

- Detailed alignment of the route enabling retention of significant landscape features.
- The treatment of the interface between man made and natural landforms.
- Position of associated operational buildings.
- The use, location and design of retaining walls.

- Specific attention to the visual quality of structures associated with the route.
- Landscape treatment within, and immediately outside the highway boundary.
- Colour and materials used for structures should reflect the colours and materials of the surrounding landscape. As a general principle strong contrast in colour should be avoided and muted colours related to the material environment should be used with darker colour concentrated to the base of the structure to create a sense of stability.
- Detailed attention to the gradients and the profile of regraded slopes, and earth modelling to ensure they reflect the gradients of the natural slopes in the vicinity.
- The use of tunam or shotcrete treatment of regraded slopes should be avoided.
- Screen planting within the curtilage of residential properties should be undertaken to screen the view at source.
- Areas of redundant land should be incorporated within the highway landscape proposal scheme to aid the integration of the route with its surroundings and avoid the creation of areas of derelict land.
- The size, height, design and orientation of the light should ensure effective lighting of the highway corridor whilst minimising the potential leakage of light. The use of reflective paints and signing should be fully investigated to determine the need for permanent lighting.

Landform Regrading Works

- Wherever possible formed slopes should reflect the angle and alignment of the natural slopes within the area. The slope should not however be greater than 1 (horizontal) : 1.5 (vertical), with a gentler slope of 1:2 preferable.

  Attention should be given to the interface between the surrounding topography and the engineered highway slopes in order to reduce the potentially sharp divide and consequent visually intrusive element created between the natural and man made landforms.
- The long profile of the formed slope should follow a shallow inverted "S" alignment, include natural landforms profile.
- The edges of the regraded slopes should merge into the surrounding landform, rather than appear to be cut out from it which may involve extra regrading work, outside the geotechnical and engineering requirements, requiring extra land.
- Disturbed areas should be designed to be stable and capable of revegetation wherever possible. It is important that landscape considerations receive high priority and early consideration in the design phase.
- Wherever consistent with safe geotechnical considerations, the surface of bare earth areas should not be overly compacted and should be left with a textured surface to assist seed and water retention.

- Rock faces should be either covered with a minimum of 0.5m of soft spoil material and hydroseeded or benched and treated as indicted in Chapter 9 Table 9.1.

- Quality topsoil material along the highway corridor should be collected and reused wherever possible.

Landscape Works

The extent and nature of proposed landscape works are shown in Chapter 9 on Figures 9.1 and 9.2. A total approximate area of 36ha of land (plan area) will be disturbed. It will be desirable to reinstate approximately 55ha.

(i) General

- Re-instatement should be carried out: -

- Revegetation of cut and fill slopes and disturbed areas on the northern side of TKB associated with ramps G and H (connecting with Tuen Mun Road) and the main northern bridge approach.

- Revegetation of a small area of reclamation at the northern toe of TKB.

- Landscaping works in connection with the above areas should connect with proposed landscaping works associated with the TLT & YLA Section of the route to the north.

- Hydroseeding, tree planting on slopes and berm planting as a result of earthworks on the southern (Tsing Yi Island) side of TKB associated with the Northwest Tsing Yi Interchange and adjacent reclamation works and access road.

- Consideration within the design should be given to the storage of surface run-off water from paved areas to be used for the conservation of landscaped areas after passing through silt and oil traps. Wherever possible landform depressions should be used to maximize water availability to plants.

(ii) Specific

- Both cut and fill slopes should be initially stabilized by hydroseeding and engineering erosion control techniques. The hydroseed mix will incorporate both grass and appropriate tree seeds to simulate the natural woodland composition thereby increasing species diversity through planting. Into this, **Woodland** or **Shrub Mixes** should be planted.

- Specific plant species should be selected at the detailed design stage to respond to local conditions and vegetation types identified along the Route 3 connection.

- Suggested planting mixes for revegetation purposes should be adopted as recommended in this report

- Roadside Planting of trees and amenity shrubs would be confined to the more visible sections of the road at the interchanges where traffic speed will be reduced. These areas are more accessible permitting higher levels of maintenance.

- Reinstatement Planting of reclaimed areas near both the north and south end of the bridge will be undertaken. Reinstatement would include importing soft fill for ground contouring and as a planting medium. The area should be hydroseeded and trees and whips planted into half the area.

- Berm Planting should be undertaken on rocky cut slopes to the north of Tsing Yi Interchange.

To be successful landscaping and rehabilitation works will require adoption of a basic philosophy.

- Areas of current high landscape value must be reinstated to at least an equivalent standard.

- As a result of the existing degraded nature of much of the route (and particularly north west Tsing Yi Island) an opportunity exists to upgrade visual and ecological values through well designed landscaping incorporating extensive tree planting. This opportunity must be maximized.

- Route 3 works will be only one source of disturbance in the area, and landscape works in this and other projects must be extended to include all adjacent areas and particularly areas south from the Tsing Yi Interchange and north of the Ting Kau Interchange along the TLT & YLA Section of Route 3.

- Revegetation works must not be restricted to artificial boundaries delineated by Route 3 earthworks. Tree planting must not highlight cut and fill slopes but rather blend them into the landscape by extending further uphill and into valleys. Tree planting must also extend laterally into adjacent engineering formations.

Fire Control Recommendations

The following protection measures should be implemented to ensure the early survival of trees:

- Plant a 20m wide buffer strip of fire resistant *Acacia* species around the periphery of planted slopes

- Planting of the more fire resistant species in the top half of slopes. Exotic, species such as *Pinus elliottii* which are extremely susceptible to fire at all stages of growth, and should not be included within the planting mix

- Liaise with local fire brigades develop a quick response system to hillfires in the vicinity of Route 3 landscape works and provide relevant fire brigades with landscape location plans and access details.

- Encourage the quick growth of trees above scotch height through optimum initial fertilization, establishment and maintenance techniques.

Monitoring

- All landscape works should be regularly checked and maintained. Monitoring will also ensure that surface drainage structures are intact and have not been interfered with by vegetation.

- Necessary maintenance works should include fertilizing, thinning tree stands, replanting or resowing, watering and fire protection (in early stages), and all works necessary to ensure beneficial development of landscaped areas.

15.7 LANDUSE

The scope for mitigation of landuse impacts during construction is often limited. The most effective mitigation is to avoid siting construction activities and particularly work sites in close proximity to sensitive receivers. Mitigation of landuse impacts will to a certain extent be achieved as a result of noise, air quality and landscape mitigation measures recommended in the preceding sections.

- Care should be taken in setting out work areas and during daily practices to ensure that associated impacts are minimised.

- Timing of works should be programmed where possible to minimise traffic congestion etc., e.g. avoiding using roads for heavy plant and equipment during busy traffic periods.

- Where practicable re-instatement should be undertaken on completion of the construction works. Reinstatement of access to existing properties particularly those behind the beaches and for areas with high recreational and amenity value should be required and made a contractual condition.

15.8 ECOLOGY

- Careful restoration and revegetation of the stream channel following construction in order to achieve minimal long-term losses of riparian habitat.

- A qualified ecologist/biologist should be employed during restoration and revegetation works to supervise all planting etc.

- Revegetation of cut and fill areas using native grass, herb, shrub and tree species should be undertaken to facilitate wild life habitation. A list of such revegetation species is given in section 11.

15.9 MONITORING AND AUDIT

- It is recommended that the Government employ a suitably qualified, experienced and independent consultant/organisation (environmental team), prior to commencement of construction works.

- A comprehensive Environmental Monitoring and Audit Manual should be produced by the contractor prior to commencing the works.

- Prior to and during the works, environmental monitoring should be carried out for air quality, (suspended particulates), noise and water quality, and should include baseline monitoring; where specified additional monitoring as a control to determine changes in the baseline not associated with the project; and compliance monitoring to ensure compliance with environmental monitoring Target, Action and Trigger levels.

- All baseline and initial (approximately 3 months) compliance monitoring should be carried out by the environmental team, after which time the contractor will continue compliance monitoring and any specified additional monitoring (control monitoring) using suitably qualified and experienced staff.

- A monthly monitoring report should be prepared by the environmental monitoring team/contractor and submitted to the Supervising Officer, EPD and the Highway's Department.

- Operational monitoring to be undertaken by the contractor is recommended for noise and air quality, to be carried out as a single exercise at a suitable time period after the road becoming operational.

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