



Agreement No. CE 42/96

**Route 16 Investigation Assignment
from West Kowloon to Sha Tin**

**Alternative Alignment
Environmental Impact Assessment
Final Assessment Report**

23 August 1999

Status - Final

Scott Wilson/Parsons Brinckerhoff

in association with
ERM Hong Kong, MVA Asia

TABLE OF CONTENT

1.	INTRODUCTION	1-1
1.1	Preamble	1-1
1.2	Alignment Consideration	1-2
1.3	Alternative Alignment: Key Changes	1-3
1.4	EIA Study Area	1-5
1.5	Objective of the EIA	1-5
1.6	Structure of the Report	1-6
2.	PROJECT DESCRIPTION	2-1
2.1	Alternative Alignment	2-1
2.2	Likely Future Environmental Conditions in the Absence of the Project	2-2
2.3	Construction Activities	2-2
2.4	Traffic Forecasts	2-3
2.5	Operational Phase	2-5
3.	AIR QUALITY	3-1
3.1	Introduction	3-1
3.2	Government Legislation and Standards	3-1
3.3	Baseline Conditions	3-2
3.4	Air Sensitive Receivers	3-3
3.5	Construction Phase	3-4
3.6	Operational Phase	3-6
3.7	Conclusions	3-12
4.	NOISE IMPACT	4-1
4.1	Introduction	4-1
4.2	Governmental Legislation and Standards	4-1
4.3	Baseline Condition	4-5
4.4	Noise Sensitive Receivers	4-6
4.5	Construction Phase	4-7
4.6	Operational Phase	4-25
4.7	Conclusions	4-43
5.	WASTE MANAGEMENT	5-1
5.1	Introduction	5-1
5.2	Environmental Legislation and Standards	5-1
5.3	Assessment Methodology	5-2
5.4	Construction Waste Impact	5-2

5.5	Evaluation of Impacts	5-4
5.6	Mitigation Measures	5-6
5.7	Environmental Monitoring and Audit Requirements	5-10
5.8	Conclusions	5-10
6.	WATER QUALITY	6-1
6.1	Introduction	6-1
6.2	Baseline Conditions	6-1
6.3	Government Legislation and Standards	6-2
6.4	Construction Phase Assessment	6-2
6.5	Operational Phase Assessment	6-7
6.6	Conclusions	6-7
7.	ECOLOGY	7-1
7.1	Introduction	7-1
7.2	Environmental Legislation and Criteria	7-1
7.3	Assessment Methodology	7-2
7.4	Baseline Conditions	7-2
7.5	Ecological importance	7-5
7.6	Impact assessment	7-9
7.7	Mitigation Measures	7-10
7.8	Residual Impacts	7-12
7.9	Conclusions	7-12
8.	HAZARD	8-1
8.1	Introduction	8-1
8.2	Hazard Assessment for Tai Po Road and Shek Lei Pui WTWs	8-1
8.3	Hazard Assessment for LPG Installation	8-29
9.	LANDSCAPE AND VISUAL IMPACT ASSESSMENT	9-1
9.1	Preamble	9-1
9.2	LVIA Study Area	9-1
9.3	Objectives of the LVIA	9-1
9.4	Structure of the LVIA section	9-1
9.5	LVIA Methodology, Glossary and Project Description	9-1
9.6	Baseline Study	9-5
9.7	Review of planning and development control framework	9-8
9.8	Assessment of landscape and visual impacts	9-9
9.9	Residual impacts of the Alternative Alignment	9-15
9.10	Conclusions and Recommendations	9-19

10.	CULTURAL HERITAGE	10-1
10.1	Introduction	10-1
10.2	Environmental Legislation and Guidelines	10-1
10.3	Assessment Methodology	10-2
10.4	Baseline Conditions	10-3
10.5	Source of Impact	10-3
10.6	Evaluation of Impacts	10-4
10.7	Mitigation Measures	10-5
10.8	Conclusions	10-6
11.	ENVIRONMENTAL MONITORING & AUDIT REQUIREMENT	11-1
11.1	Introduction	11-1
11.2	Objectives of Environmental Monitoring & Audit	11-1
11.3	Construction Noise	11-1
11.4	Operational Noise	11-1
11.5	Construction Dust	11-2
11.6	Tunnel Air Quality	11-2
11.7	Waste Management	11-2
11.8	Ecology	11-3
11.9	Cultural Heritage	11-3
12.	Overall Conclusions	12-1

Annex 3A - Sample CALINE4 Output File

Annex 4A - Plant Inventory

Annex 4B - Detailed Calculations of Construction Noise

Annex 4C - Road Traffic Modelling Results

Annex 6A - Water Quality Objectives

Annex 7A - Lists of Flora and Fauna

Annex 8A - Route 16 Tunnel Ventilation Details

Annex 8B - Details of Risk Calculations

Annex 8C - Summary of Modelling Assumptions

LISTS OF TABLE

Table 1.2a	Benefits and Constraints of the Alternative Alignment
Table 2.4a	Prevailing Traffic Flow for the Year 2000 (PM Peak Hour)
Table 2.4b	Projected Traffic Flow for the Year 2019 (PM Peak Hour)
Table 2.4c	Traffic Data Taken from the Route 9 between Tsing Yi and Cheung Sha Wan Detailed Feasibility Study - Final EIA Report
Table 3.2a	Hong Kong Air Quality Objectives (μgm^{-3})
Table 3.2b	Tunnel Air Quality Guidelines (TAQG)
Table 3.3a	Background Air Quality (μgm^{-3})
Table 3.4a	Location of Air Sensitive Receivers (ASRs)
Table 3.6a	NO _x Emission For Route 16 Mainline
Table 3.6b	NO _x and CO Emission from the Mid Ventilation Building
Table 3.6c	Hourly Air Pollutant Levels with Background (μgm^{-3})
Table 3.6d	Predicted Hourly Cumulative NO ₂ , CO ₂ and RSP Levels at All ASRs (μgm^{-3})
Table 3.6e	Predicted Hourly NO ₂ and CO ₂ Levels at All ASRs (μgm^{-3})
Table 4.2a	Permitted Hours of Operation for Percussive Piling
Table 4.2b	EIAO-TM Daytime Construction Noise Standards ($L_{\text{eq}, 30 \text{ min}}$ dB(A))
Table 4.2c	Acceptable Noise Levels (ANL, $L_{\text{eq}, 5 \text{ min}}$ dB(A))
Table 4.2d	EIAO-TM Road Traffic Noise Planning Criteria
Table 4.2e	Acceptable Noise Levels for Fixed Noise Sources
Table 4.3a	Noise Monitoring Results at Bamboo Villa
Table 4.4a	Location of Noise Sensitive Receivers - Construction Phase
Table 4.5a	Cumulative Noise Impacts (No Mitigation Measures)
Table 4.5b	Cumulative Noise Impacts (No Mitigation Measures)
Table 4.5c	Cumulative Noise Impacts (No Mitigation Measures)
Table 4.5d	Sound Power Levels for Specific Silenced PME
Table 4.5e	Cumulative Noise Impacts - With the use of quiet plant (Mitigation 1)
Table 4.5f	Cumulative Noise Impacts - With the use of quiet plant (Mitigation 1)
Table 4.5g	Cumulative Noise Impacts - With the use of quiet plant (Mitigation 1)

Table 4.5h	Cumulative Noise Impacts - With the use of quiet plant & limiting the no. of plant (Mitigation 2)
Table 4.5i	Cumulative Noise Impacts - With the use of quiet plant & limiting the no. of plant (Mitigation 2)
Table 4.5j	Cumulative Noise Impacts - With the use of quiet plant & limiting the no. of plant (Mitigation 2)
Table 4.5k	Cumulative Noise Impacts - With the use of quiet plant, limiting the no. of plant and use of movable barriers (Mitigation 3)
Table 4.5l	Cumulative Noise Impacts - With the use of quiet plant, limiting the no. of plant & use of movable barriers (Mitigation 3)
Table 4.5m	Predicted Construction Noise Levels (Leq, 30 min dB(A))
Table 4.5n	Summary of Proposed Mitigation Measures
Table 4.6a	Noise Sensitive Receivers - Operational Phase
Table 4.6b	Minimum Distance to NSRs
Table 4.6c	Predicted facade noise levels (Leq, 30 min dB(A))
Table 7.5a	Summary of Evaluation on Ecological Importance of Habitat Types within the boundary of Cut Slope and Alignment in Butterfly Valley of the Alternative Alignment
Table 7.5b	Evaluation of Ecological Important Species
Table 7.7a	Summary on Woodland Loss and Compensation for the Entire Route 16 Alignment
Table 8.2a	Plant Operating Data
Table 8.2b	Weather Class - Wind Direction Frequencies at Cheung Sha Wan Weather Station
Table 8.2c	Peak Hour Vehicle Flows on Route 16 for 2019
Table 8.2d	Off Peak Vehicle Flows
Table 8.2e	Vehicle Occupancy (based on Annual Traffic Census, 1996)
Table 8.2f	Base Case Risk Results for Route 16
Table 8.2g	Dominant Contributors to Risk - Tai Po Road WTW
Table 8.2h	Candidate Risk Mitigation Measures (Operation Phase)
Table 8.2i	Risk Results for Mitigation Options
Table 8.2j	Assessment of Risk Mitigation Options (Operation Phase)
Table 8.2k	Dominant Contributors to Risk - Shek Lei Pui WTW
Table 8.2l	Assessment of Risk Mitigation Measures for Shek Lei Pui WTW
Table 8.2m	Assessment of Risk Mitigation Options (Operation Phase) for Shek Lei Pui
Table 8.2n	Candidate Risk Mitigation Measures (Construction Phase)
Table 8.2o	Assessment of Risk Mitigation Options (Construction Phase)

Table 8.3a	LPG Release Scenarios
Table 8.3b	Consequence Analysis - LPG Fireball/BLEVE
Table 8.3c	Consequence Analysis - LPG Flash Fire
Table 8.3d	Estimation of Number of Fatalities - LPG Fireball/BLEVE
Table 8.3e	Estimation of Number of Fatalities - LPG Flash Fire
Table 8.3f	Scenario Frequencies
Table 9.1	Sensitive Visual Receivers
Table 9.2	Summary of Visual Impacts
Table 9.3	Summary of Landscape Loss and Compensation
Table 9.4a	Summary of Landscape Impacts and Recommended Mitigation Measures
Table 9.4b	Summary of Visual Impacts and Recommended Mitigation Measures
Table 10.4a	Known Historical Buildings in Tin Sam Village
Table 10.7a	Summary of Mitigation Measures for LCK Hospital
Table 12.1a	Implementation Schedule of Environmental Mitigation Measures and Key EM&A Requirements

LIST OF FIGURES

Figure 1.1a	General Layout of the Alternative Alignment
Figure 1.3a	Study Area
Figure 2.1a	Landuse Plan
Figure 2.1b	Land Requirement Plan (Sheet 1 of 9)
Figure 2.1c	Land Requirement Plan (Sheet 2 of 9)
Figure 2.1d	Land Requirement Plan (Sheet 3 of 9)
Figure 2.1e	Land Requirement Plan (Sheet 4 of 9)
Figure 2.1f	Land Requirement Plan (Sheet 5 of 9)
Figure 2.1g	Land Requirement Plan (Sheet 6 of 9)
Figure 2.1h	Land Requirement Plan (Sheet 7 of 9)
Figure 2.1i	Land Requirement Plan (Sheet 8 of 9)
Figure 2.1j	Land Requirement Plan (Sheet 9 of 9)
Figure 2.2a	Construction Program
Figure 2.2b	Prevailing Traffic Flow for the Year 2000 (PM peak hour)
Figure 2.2c	Projected Traffic Flow for the Year 2019 (PM peak hour)
Figure 2.2d	Predicted Road Traffic Data for Year 2019 (PM peak hour)
Figure 3.4a	Location of Air Sensitive Receivers
Figure 3.4b	Location of Air Sensitive Receivers
Figure 3.4c	Location of Air Sensitive Receivers
Figure 3.4d	Location of Air Sensitive Receivers
Figure 3.4e	Location of Air Sensitive Receivers
Figure 3.5a	Location of Air Monitoring Station
Figure 3.5b	Location of Air Monitoring Station
Figure 3.6a	Isopleths of Nitrogen Dioxide at Ground Level
Figure 3.6b	Isopleths of Nitrogen Dioxide at Alignment Level
Figure 4.4a	Locations of Noise Sensitive Receivers during Construction Phase
Figure 4.4b	Locations of Noise Sensitive Receivers during Construction Phase
Figure 4.4c	Locations of Noise Sensitive Receivers during Construction Phase
Figure 4.4d	Locations of Noise Sensitive Receivers during Construction Phase

Figure 4.4e	Locations of Noise Sensitive Receivers during Construction Phase
Figure 4.4f	Locations of Noise Sensitive Receivers during Construction Phase
Figure 4.4g	Locations of Noise Sensitive Receivers during Construction Phase
Figure 4.4h	Locations of Noise Sensitive Receivers during Construction Phase
Figure 4.6a	Locations of Noise Sensitive Receivers during Operational Phase
Figure 4.6b	Locations of Site 10
Figure 4.6c	Site 10 - NSRs Location
Figure 4.6d	Locations of Noise Sensitive Receivers during Operational Phase
Figure 4.6e	Locations of Noise Sensitive Receivers during Operational Phase
Figure 4.6f	Locations of Noise Sensitive Receivers during Operational Phase
Figure 4.6g	Locations of Noise Sensitive Receivers during Operational Phase
Figure 4.6h	Locations of Noise Sensitive Receivers during Operational Phase
Figure 4.6i	Site A & B - NSRs Location
Figure 4.6j	Locations of Noise Sensitive Receivers during Operational Phase
Figure 4.6k	Locations of Noise Sensitive Receivers during Operational Phase
Figure 4.6l	Mitigation Option 1
Figure 4.6m	Mitigation Option 1
Figure 4.6n	Mitigation Option 1
Figure 4.6o	Mitigation Option 1
Figure 4.6p	Mitigation Option 2
Figure 4.6q	Mitigation Option 2
Figure 4.6r	Mitigation Option 2
Figure 4.6s	Mitigation Option 2
Figure 4.6t	Mitigation Option 3
Figure 4.6u	Mitigation Option 3
Figure 4.6v	Mitigation Option 3
Figure 4.6w	Mitigation Option 3
Figure 4.6x	Mitigation Option 4
Figure 4.6y	Mitigation Option 4
Figure 4.6z	Mitigation Option 4
Figure 4.6aa	Mitigation Option 4

Figure 4.6ab	Proposed Mitigation Measures
Figure 4.6ab-1	Physical Limitation of Route 16 Slips
Figure 4.6ac	Preliminary Design of Mid Ventilation Building (Part 1)
Figure 4.6ad	Preliminary Design of Mid Ventilation Building (Part 2)
Figure 5.5a	Proposed Haul Road for West Kowloon Section
Figure 7.4a	Habitat Map for Butterfly Valley
Plate 7.4a	Secondary Woodland at Butterfly Valley
Plate 7.4b	Shrubland at Butterfly Valley
Plate 7.4c	Orchard at Butterfly Valley
Plate 7.4d	Plantation Woodland at Butterfly Valley
Plate 7.4e	Wasteland at Butterfly Valley
Plate 7.4f	Main Stream (lower section) at Butterfly Valley
Figure 7.7a	Location of Cut Slope for Compensatory Replanting
Figure 7.7b	Indicative Location of Woodland Loss for the Entire Route 16 Alignment
Figure 7.7c	Indicative Location of Woodland Compensation for the Entire Route 16 Alignment
Figure 7.7d	Location of Re-created Stream at Butterfly Valley
Figure 7.7e	Typical Schematic Cross-section of Re-created Stream
Figure 8.2a	Site Location
Figure 8.2b	Route 16 Operational Phase (Base Case)
Figure 8.2c	Route 16 Operational Phase (Mitigation Options)
Figure 8.2d	Route 16 Operational Phase (Combined Mitigation Options)
Figure 8.2e	Cumulative Risk for Operation Phase of Route 16
Figure 8.2f	Route 16 Construction Phase (Base Case)
Figure 8.2g	Route 16 Construction Phase (Mitigation Options)
Figure 8.2h	Cumulative Risk for Construction Phase of Route 16
Figure 8.2i	Individual Risk Contours for Shek Lei Pui and Tai Po Road WTW Mitigated Cases
Figure 8.2j-1	Plan Showing Chlorine Barrier and Site for New Chlorine Building at Tai Po Road WTW
Figure 8.2j-2	Plan of the Part Enclosure
Figure 8.3a	FN Curve for Risk to Route 16 Due to the Lai Chi Kok Reception Centre LPG Installation

Figure 9.1	General Alignment of Alternative Alignment and Landscape Impact Assessment Study Area
Figure 9.2(a-c)	Typical Cross Sections through Alternative Alignment
Figure 9.3a	Illustrations of Landscape and Visual Impact Definitions, Sheet 1 of 2
Figure 9.3b	Illustrations of Landscape and Visual Impact Definitions, Sheet 2 of 2
Figure 9.4	Visual Analysis of Views from Lion Rock Country Park
Figure 9.4a	Locations of Sensitive Visual Receivers and Visual Catchment
Figure 9.5a	Baseline Studies - Kowloon and Butterfly Valley Sections, Sheet 1 of 3
Figure 9.5b	Baseline Studies - Kowloon and Butterfly Valley Sections, Sheet 2 of 3
Figure 9.5c	Baseline Studies - Kowloon and Butterfly Valley Sections, Sheet 3 of 3
Figure 9.6(a-e)	Baseline Study - Photographs of Landscape Character Areas, Viewpoint 1-5
Figure 9.7a	Impact Assessment Plan, Sheet 1 of 3
Figure 9.7b	Impact Assessment Plan, Sheet 2 of 3
Figure 9.7c	Impact Assessment Plan, Sheet 3 of 3
Figure 9.8	Planning and Development Control Framework
Figure 9.9(a-g)	Typical Landscape Mitigation Measures
Figure 9.10(a-e)	Computer Photomontages and Simulations