SECTION 4

4 AIR QUALITY

4.1 Introduction

4.1.1 The proposed WCR starts from the Tseung Kwan O Area 131 and runs along the coast around Lei Yue Mun and onto South East Kowloon. The Study Area for this air quality assessment is defined as 500 m either side along the proposed WCR alignment. Representative Air Sensitive Receivers (ASRs) within the Study Area have been identified.

4.1.2 Input has been provided on potential air quality impacts for the evaluation of 34 alignment options and the recommendation of 4 options for further investigation in the *Alignment Options Report* submitted in November 1997. Air quality modelling, based on preliminary traffic data was undertaken to evaluate the 4 options identified in the *Selected Options Report* and recommendations were provided for the preferred alignment option to be assessed as part of this EIA Report.

4.1.3 A detailed assessment of the preferred alignment option (Option 2D2) for both construction and operational air quality impacts has been undertaken in this EIA Report to ensure that it complies with relevant Government standards and guidelines and to recommend further mitigation measures to be incorporated into the preliminary design of the alignment.

4.1.4 Dust impact upon the ASRs is considered to be a key issue during the construction phase while vehicle exhausts is considered to be the major sources of pollutant during the operational phase.

4.1.5 Operational air quality impacts of the preferred alignment option has been modelled and suitable mitigation measures have been recommended, where necessary, to ensure compliance of Air Quality Objectives (AQO) and the other environmental criteria. Specific environmental mitigation measures have also been recommended and incorporated into the Environmental Monitoring and Audit (EM&A) Manual.

4.1.6 The potential for air quality impacts associated with relocation of the CED Depot and the Fish Market have also been assessed and are provided in *Annex I* of this report. The results of this assessment show that no air quality impacts would occur as a result of the operation of the CED Depot and the Fish Market at the proposed location.

4.2 Government Legislation and Standards

Construction and Operational Phase

Environmental Impact Assessment Ordinance

4.2.1 The criteria for evaluating air quality impacts are laid out in *Annex 4* of the *Technical Memorandum on Environmental Impact Assessment* (EIAO-TM). The relevant criteria for this Study are given below.

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

Table 4.2a Hong Kong Air Quality Objectives ($\mu g\ m^{-3}$) (i)

Pollutant	Average Time			
	1 Hour (ii)	8 Hour (iii)	24 Hour (iii)	1 Year (iv)
Total Suspended Particulates (TSP)	-	-	260	80
Respirable Suspended Particulates (RSP) (v)	-	-	180	55
Nitrogen Dioxide (NO_2)	300		150	80
Carbon Monoxide (CO)	30,000	10,000	-	-

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

4.2.3 The EIAO-TM also stipulated that the hourly TSP level should not exceed 500 μgm^{-3} TSP (measured at 25°C and one atmosphere) for construction dust impact assessment. Mitigation measures from construction sites have been specified in the *Air Pollution Control (Construction Dust) Regulations*.

4.2.4 In addition to the statutory AQOs limits, the *Tunnel Air Quality Guidelines* (TAQG), specified under the *EPD's Practice Notes on Control of Air Pollution in Vehicle Tunnel*, 1995 should be attained and maintained inside a vehicle tunnel. *Table 4.2b* show these guideline values.

Table 4.2b Tunnel Air Quality Guidelines (TAQG)

Air Pollutant	Averaging Time	Maximum Concentration	
		($\mu g\ m^{-3}$)	ppm
Carbon Monoxide (CO)	5 minutes	115,000	100
Nitrogen Dioxide (NO_2)	5 minutes	1,800	1
Sulphur Dioxide (SO_2)	5 minutes	1,000	0.4
Note: All limits are expressed as at reference conditions of 298K and 101.325 kPa			

4.2.5 In addition, the visibility in tunnel should be controlled to a maximum level equivalent to an extinction coefficient of 0.005 m1 during any 5 minutes interval.

Hong Kong Planning Standards and Guidelines

4.2.6 The *Hong Kong Planning Standards and Guidelines* (HKPSG) recommend buffer distances for roads and highways, to provide adequate buffer for the dilution of vehicle emissions. The HKPSG on usage of open space in the vicinity of roads are presented in *Table 4.2c.*

Table 4.2c HKPSG Guidelines on Usage of Open Space Sites

Type of Road	Buffer Distance	Permitted Uses
Trunk Road and Primary Distributor	>20m 3-20m < 3m	Active and passive recreational uses Passive recreational uses Amenity areas
Active and passive recreational uses	> 10m < 10m	Active and passive recreational uses Passive recreational uses
Local Distributor	> 5m < 5m	Active and passive recreational uses Passive recreational uses
Under Flyover	0	Passive recreational uses

4.3 Baseline Conditions

4.3.1 The WCR runs along the coast of Tseung Kwan O (TKO), Yau Tong and South East Kowloon and the coast along Devil's Peak of TKO, zoned as green belt (TKO OZP Plan No. S/TKO/5, 1998).

4.3.2 The current reclamation and development works of the TKO new town contribute to the high background dust levels at the western TKO area. However, it is expected that the future dust level will diminish with the completion of the current construction works.

4.3.3 There are no existing EPD air quality monitoring stations in the Study Area and, therefore, the nearest EPD air quality monitoring station located in Kwun Tong is referenced. Background air quality at this station is shown in *Table 4.3a.*

Table 4.3a Background Air Quality ($\mu g\ m^{-3}$)

Pollutants	Annual Average [1]
TSP	99
RSP	59
SO_2	19
NO_2	65
CO	1,100 [2]

Note:
(1) The annual averages of Kwun Tong recorded in 1996 were used.
(2) Monitored at Mong Kok Monitoring Station.

4.3.4 Currently, the air quality of Yau Tong area is dominated by industrial and vehicle emissions. A review of the draft Outline Zoning Plan (OZP) for Cha Kwo Ling, Yau Tong, Lei Yue Mun (Plan No. S/K15/9, exhibited on 4.9.1998) show that the marine lots at Yau Tong Bay, together with the adjoining seabed, are zoned "Comprehensive Development Area" (CDA) which would comprise commercial, residential and community uses as part of the ongoing redevelopment of the area. The Yau Tong MTRC station is proposed near Cha Kwo Ling Road and the industrial buildings to the south of the station will be redeveloped into residential/ commercial development with G/IC facilities[5]. It is therefore expected that the future air quality of Yau Tong will improve with the reduction of industrial areas.

4.3.5 For the South East Kowloon (SEK) area, existing industrial and vehicle emissions are the dominant pollutant sources. It is expected that the future air quality would also be affected by the emissions from the proposed SEK Development.

4.4 Air Sensitive Receivers

4.4.1 Representative ASRs have been identified according to the criteria set out in the EIAO-TM and through initial site inspections and review of land use plans of the Study Area. Domestic premises, schools, commercial building, factory and recreation areas are classified as ASRs. ASRs within the Study Area are summarized in *Table 4.4a* and their locations are shown in *Figures 4.4a-k*.

Table 4.4a Air Sensitive Receivers

ASR	Location	Distance from alignment (m)
A1	Ma Shan Tsuen (West)	30
A2	Ma Shan Tsuen (East)	20
A3	Lei Yue Mun Village	30
A4	Sam Ka Tsuen	13
A5	Sam Ka Tsuen Community Centre	15
A6	Yau Tong Centre	30
A7	Proposed Yau Tong Estate Redevelopment (1)	6
A8	Proposed Primary School in Yau Tong CDA Development	115
A9	Proposed Yau Tong CDA Development	195
A10	Sam Ka Tsuen Recreation Ground	20
A11	Proposed Cha Kwo Ling Residential Development	20
A12	Lei Yue Mun Estate Redevelopment	7
A13	Ko Chiu Road Estate Redevelopment	8
A14	Tung Yuen Street Fish Market	40
A15	Yau Tong Industrial Area	120
A16	Bishop of the Roman Catholic Church	60
A17	Eastern Harbour Crossing Housing Site Playground	30
A18	Tsuen Kwan O Village Houses	50

Note:
(1) Yau Tong Estate is scheduled to be redeveloped by 2004.

[5] Detailed EIA Report R7T, Tseung Kwan O Extension, Munsell/REM., October 1996.

4.5 Construction Phase

Potential Sources of Impact

4.5.1 The principal construction air quality impacts will be dust impacts on the adjacent ASRs. Reclamation, excavation work, material handling, bulldozing and vehicle movement on unpaved roads on site are expected to be the major dust generating sources.

4.5.2 The proposed implementation programme of the WCR is shown in *Section 2.3*. Four major sections were identified. They are:

- TKO Section;
- Lei Yue Mun Headland Section (cut and cover tunnel works);
- Lei Yue Mun Slip Roads; and
- Yau Tong Coastal Section.

TKO Section

4.5.3 The construction works of TKO section is expected to last from February 2002 until April 2007, and the associated roadworks will be the major dust sources. However, all the bridge decks and roads will be precasted in the casting yard, located in the TKO reclamation area. All the concrete will be transported from outside and a concrete batching plant is not expected to be required for the WCR worksite. As there are no nearby ASRs, it is expected that any dust emission from a batching plant, if required, would not result in a major adverse impact. Small scale concrete works used for activities such as bridge edge parapets, central dividers, columns, abutment walls, pile caps and piles will be required, however, the dust emission from these activities are considered to be limited.

Cut and Cover Tunnel

4.5.4 A cut and cover tunnel (about 175 m) has been proposed near Lei Yue Mun. Blasting is not expected for the tunnel works. Dusty activities for the tunnel works would include material handling, cut and fill slope works and vehicle movement on haul road.

Lei Yue Mun Slip Road

4.5.5 For the Lei Yue Mun slip roads, cut and fill slope works, material handling and vehicle movement on unpaved road are the major dust source. Precasted road blocks will be used for the slip roads and dust emissions from the associated roadworks will also be limited.

Yau Tong Coastal Section

4.5.6 For the reclamation of the Yau Tong coastal section, marine sand will be used as fill material. As the moisture content of marine sand is high, dust impact arising

from the filling process are expected to be low. Wind erosion over the exposed reclaimed area will be the major dust source during the preloading period.

4.5.7 The material handling rates and construction traffic generated for different activities of the WCR works are shown in *Table 4.5a* below.

Table 4.5a Estimate of Construction Traffic Flow

Activities	Material handling rate (m^3/day)	No of vehicle required [(i)] [(ii)] (veh/day)
Reclamation	2,670	108
Cut and cover section	Fill	
(i) Fill	1,175	
(ii) Cutting	769	

Note:
(i) The working hours are assumed as 12 hour a day, 6 days a week and 26 day a month.
(ii) Capacity of truck is assumed as 7.5m^3 and it is assumed that truck will travel 2 trips for each journey (108 (2 way) and 54 (1 way)).
(iii) All the material from cutting will be used in the filling works and only 406 m^3/day of spoil will be delivered offsite.

4.5.8 Exhaust emissions from construction plant including NO_2, CO and RSP are not expected to result in adverse impacts in the WCR Study Area as the number of plant is expected to be minimal.

Assessment Methodology

4.5.9 Potential dust impacts were predicted using the *Fugitive Dust Model* (FDM). Meterological data for 1994 from Junk Bay weather station, operated by Hong Kong Observatory, was employed for the model run. Emission factors and the associated particle size distributions were obtained from the *Compilation of Air Pollutant Emission Factors, (AP42) 5th Edition* developed by *USEPA*. The emission factors used in the assessment are listed in *Table 4.5b.*

Table 4.5b Emission Factors for Construction Activities

Activities	Emission Factor [(i)]	Remarks
Handling of excavated spoil	0.12 $u^{1.3}$	• moisture content: 4.8% • u: wind speed
Wind erosion	0.188 gs^{-1}	• exposed area: 7ha • working period is 156 days
Bulldozing	0.499 gs^{-1}	• exposed area: 7ha • working period is 156 days
Truck movements on unpaved haul road	2.77 kg/VKT	• silt content of road surface: 10% • vehicle speed: 30kph • vehicle weight: 25 tonnes • vehicle with 10 wheels

Note:
(i) Reference to Compilation of Air Pollutant Emission Factors (AP42), 5th Edition

4.5.10 It is assumed that all the above activities will be operated simultaneously along the whole of the construction site in the model to simulate the worst case scenario.

Evaluation of Construction Impacts

4.5.11 The expected daily and hourly dust impacts generated by the Project on the ASRs at different elevations were modelled and the results are presented in *Table 4.5c.*

Table 4.5c Predicted Hourly and Daily TSP Concentrations ($\mu g/m^3$)

ASD	Hourly TSP Level		Daily TSP Level	
	Ground Level	10m above ground	Ground Level	10m above ground
A1	**832**	**788**	199	196
A2	479	479	169	169
A3	413	449	142	143
A4	339	367	143	143
A5	268	246	146	155
A6	166	166	110	110
A7	153	153	108	108
A8	160	153	109	109
A9	214	204	118	117
A10	344	311	131	128
A11	151	145	105	105
A12	184	184	112	112
A13	155	155	108	108
A14	216	196	118	117
A15	183	170	114	113
A16	210	201	116	115
A17	150	150	105	105
A18	177	177	113	113
AQO Criteria	**500**		**260**	

Note:
(i) **Bold** figure exceeds dust criteria.
(ii) Background TSP concentration included in the results.
(iii) At some locations (A1 to A3), the ground level is lower then the alignment level (10 m above ground), therefore, the TSP concentrations are higher at 10 m above ground.

4.5.12 Due to the close proximity of the ASRs to the site and the extent of construction works, dust levels at some ASRs are predicted to be high. The predicted 1 hour TSP level at ground level and 10 m above ground level are in the range of 150-832 $\mu g/m^{-3}$ and 150-788 $\mu g/m^{-3}$, respectively. The hourly criteria of 500 $\mu g/m^{-3}$ would be exceeded at ASR A1 at both ground level and 10 m above ground. Without implementation of dust control measures, ASR A1 may be affected by dust impacts during construction.

Recommended Mitigation Measures

4.5.13 The construction work may generate high dust impact at some ASRs. The dust control measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* should be incorporated in the Contract Specification and implemented to reduce dust levels to within the acceptable dust criteria of 500 μgm^{-3} arising from the works. Typical control measures are:

- the heights from which excavated materials are dropped should be controlled to a minimum practical height to limit fugitive dust generation from unloading;
- all dusty materials should be sprayed with water immediately prior to any loading, unloading or transfer operation so as to maintain the dusty materials wet;
- the haul road should be located away from sensitive receivers and 20 kph of vehicle speed and water spray of road are recommended for the cut and fill section work;
- every vehicle should be washed to remove any dusty materials from its body and wheels before leaving a construction site;
- the load on the vehicles should be covered entirely by clean impervious sheeting to ensure that the dusty materials do not leak from the vehicle; and
- the working area of any excavation should be sprayed with water before, during and immediately after the operation so as to maintain the entire surface wet.

Residual Impacts

4.5.14 Through the implementation of the above mitigation measures, dust emissions from materials handling and bulldozing will be reduced by 50% and dust from vehicle movement on unpaved haul roads will be reduced by 60%. Moreover, the vehicle speed is limited to 20 kph within the worksite. The dust criteria will be satisfied at all ASRs. The predicted mitigated hourly and daily TSP level at ground level and 10 m above ground level are presented in *Table 4.5d.*

Table 4.5d Mitigated Hourly and Daily TSP concentration (μgm^{-3})

ASD	Hourly TSP Level		Daily TSP Level	
	Ground Level	10m above ground	Ground Level	10m above ground
A1	313	298	126	125
A2	203	203	118	118
A3	184	196	111	111
A4	164	172	111	111
A5	144	139	112	114
A6	117	117	102	102
A7	114	114	102	102
A8	115	114	103	103
A9	130	127	104	104
A10	165	157	113	113
A11	117	116	102	102
A12	122	122	103	103
A13	114	114	102	102
A14	133	128	109	109
A15	123	119	105	105
A16	128	126	104	103
A17	113	113	101	101
A18	120	120	103	103
AQO Criteria	**500**		**260**	

Note:
(i) Background TSP concentration included in the results.

4.5.15 The above prediction have assumed that all activities will be operated simultaneously. However, as depicted in *Section 2.3*, it is expected that all the works will not be operated in parallel. Only the works on Lei Yue Mun slip roads and Yau Tong coastal reclamation section will be constructed at the same time. The above predicted results have therefore taken a worst case conservative estimate and the actual dust impact is expected to be lower.

4.6 Operational Phase

Potential Sources of Impact

4.6.1 Vehicular exhaust emissions including NO_2, CO, and RSP are expected to be the major pollutants sources during the operation of the WCR.

4.6.2 A short tunnel approximately 175 m in length is proposed for WCR near Ma Shan Tsuen (shown in *Figure 4.6a*) and a noise enclosure approximately 130 m in length (shown in *Figure 3.6f*) has been proposed at the slip roads near Sam Ka Tsuen to reduce the noise impact at the NSRs. Semi-enclosures and noise barriers were also proposed in several areas (shown in *Figures 3.6c-f*). Tunnel air quality, emissions from tunnel portal and noise enclosure are potential areas of concern.

Assessment Methodology

Open Road Section

4.6.3 The USEPA approved air dispersion model, CALINE4 was used to predict the pollutant levels of NO_2, RSP and CO from the open section of WCR. The hourly average of pollutants at the worst affected heights, the ground level and the alignment level, including effect of tunnel, noise enclosure and barriers, were modelled in the assessment.

4.6.4 A comparison of the total emission of the critical pollutant, NO_x, from the WCR for years 2006, 2011 and 2021 have been carried out and the results are shown in *Table 4.6a*. A review of the traffic data for the year 2006, 2011 and 2021, has indicated that the year 2021 will be the worst year, assuming the NO_x emission rate maintains at the 2011 level. Traffic data for year 2021 was therefore employed to assess the worst case impact for this Study.

Table 4.6a Comparison of NO_x Emission for Western Coast Road

	Year 2006	**Year 2011**	**Year 2021**
Traffic Flow (veh/hr)	2,500	7,500	8,300
NO_x Emission Rate (g/km/veh)	3.702	3.571	3.571
Total NO_x Emission (g/km/hr)	9,255	26,783	29,639
Note: (1) Fleet emission rate based on EURO II criteria. (2) 2021 NO_x emission rate are not available and 2011 emission rate is used.			

4.6.5 Fleet emission factors based on the EUROII criteria have been used for the model run. As emission factors beyond 2011 are not available for this Study, the 2011 vehicle emission factors were assumed.

4.6.6 Daytime worst case scenario meterological conditions were assumed in the model run. Typical input parameters for the model are listed below:

- wind speed — $1 ms^{-1}$;
- wind direction — worst case for each receivers;
- stability class — D;
- mixing height — 500 m;
- standard deviation of wind direction — 12.5°;
- temperature — 25°C.

4.6.7 The NO_2 level of the Study Area will depend upon the availability of ozone for the NO/NO_2 conversion. It is a function of the ambient concentrations of pollutants including NO, NO_2 and ozone. As the ambient concentration of ozone is not available, the NO_x gas was assumed to be inert gas and levels of NO_2 were taken as 20% of total NO_x emissions.

Portal Emission

4.6.8 The *ISCST3* air dispersion model was used to predict the concentration of NO_2, CO and RSP due to the portal emission from the tunnel and noise enclosure. The portal emissions were assessed based on the procedures stated in *Section III* of *Permanent International Association of Road Congresses* (PIARC), 1991. Portal air jets of 100 m have been assumed along the axis of roads and only the well diluted parts would gradually become sheared off. The portal emission is assumed along the traffic flow. The emission rates of portals for NO_2, CO and RSP have been calculated based on the peak hour traffic flow and a summary of portal emission rates from tunnel and enclosure are shown in *Table 4.6b*.

Table 4.6b Portal Emission of Short Tunnel and Noise Enclosure

	Short Tunnel		Noise Enclosure	
	EB	**WB**	**SB**	**NB**
Length of tunnel box (m)	175	160	130	130
Peak Hourly Traffic Flow (veh/hr)	4,400	6,900	1,000	1,600
% of Private Car (p/pc)	37	55	70	84
% of Heavy Goods Vehicles (HGV)	36	18	30	16
% of taxi	13	20	-	-
% of light Goods Vehicles (LGV)	12	6	-	-
% of Public Bus (PuBus)	2	1	-	-
NO_x Emission Factors for p/pc (g/km/veh)	1.321			
NO_x Emission Factor for HGV (g/km/veh)	7.061			
NO_x Emission Factor for taxi (g/km/veh)	0.779			
NO_x Emission Factor for LGV (g/km/veh)	1.540			
NO_x Emission Factor for PuBus (g/km)	8.578			
Total NO_x Emission Rate (g/km/hr)	15,349	16,087	2,730	3,002
Total NO_2 Emission Rate (g/km/hr) [ii]	3,070	3,217	546	600
Total Average Emission of NO_x (g/km)	3.49	2.33	2.73	1.88
Total Average Emission of NO_2 (g/km)[ii]	0.70	0.47	0.55	0.38

Note:
(i) The Emission Rate is calculated from fleet emission factors based on the year 2011 of EURO II.
(ii) NO_2 emission rate is 20% of total NO_x emission.
(iii) EB - Eastbound, WB - Westbound, SB - Southbound, NB - Northbound

Evaluation of Operational Impacts

4.6.9 Exhaust vehicle emissions from vehicles using the WCR and from the tunnel and enclosure portals are the major pollutant sources during the operational phase. Cumulative hourly pollutant levels of open road with noise barrier and portal emission of tunnel and enclosure at both the ground level and alignment level, have been modelled and the results are presented in *Table 4.6c*.

Table 4.6c Cumulative Predicted Hourly Air Quality Impacts ($\mu g/m^3$)

ASR	Cumulative predicted hourly concentration (i)					
	Ground Level			Alignment Level		
	NO_2	CO	RSP	NO_2	CO	RSP
A1	279	3,763	147	271	3,648	142
A2	250	3,281	129	246	3,280	126
A3	262	3,497	143	251	3,382	137
A4	199	2,856	117	203	2,856	118
A5	184	3,020	113	214	3,368	128
A6	204	2,631	104	215	2,756	111
A7	151	2,490	89	218	3,069	12
A8	118	1,722	81	118	1,722	81
A9	145	2,000	86	145	1,999	86
A10	206	2,913	108	243	3,492	130
A11	175	2,327	102	175	2,327	102
A12	223	2,848	110	249	3,194	123
A13	177	2,847	92	248	3,772	129
A14	292	2,355	153	288	2,355	150
A15	154	1,846	93	154	1,846	91
A16	194	2,762	107	254	3,687	142
A17	146	2,251	82	210	3,171	121
A18	262	3,377	120	277	3,607	127
AQO Criteria	**300**	**30,000**	**180 (ii)**	**300**	**30,000**	**180 (ii)**

Note:
(i) Cumulative concentration includes portal emissions from tunnel and enclosures, open road emission, emission from open road with barriers and background pollutant concentrations.
(ii) Based on 24 hours averaging time.

4.6.10 The predicted results show that the air quality at all ASRs will satisfy the AQO requirements and further mitigation measures are therefore not required.

4.6.11 6.8 m and 8 m high semi-enclosures (*Figures 3.6g-h*) and horizontal noise barriers (shown in *Figure 3.6 c-f* and *3.6j*) have been recommended in *Section 3.6* to reduce the noise impact along the WCR main alignment in the Yau Tong Area. With the barriers in place, pollutants will tend to accumulate at alignment level and disperse at a higher level (immediately above the barrier). ASRs located in the proximity of the noise barriers will be subjected to higher pollutant concentration. However, modelling results show that the AQO will still be satisfied at these ASRs along the WCR alignment.

4.6.12 The results in *Table 4.6c* and *Figure 4.6 a* and *b* have been incorporated with the effects on open road and enclosure and short tunnel only. Isopleths of the NO_2 maximum concentration for the operational phase of the WCR at ground level and alignment level, including open road emission, emission from open road with noise barrier and emissions from enclosure and tunnel portals, were plotted and are shown in *Figures 4.6a-f*.

Tunnel & Enclosure Air Quality

4.6.13 For the short tunnel of 175 m proposed near Ma Shan Tsuen, ventilation fans are expected to be installed to facilitate the air movement within the tunnel. It is assumed that with the piston effect of vehicles travelling through the tunnel combined with mechanical ventilation fans installed along the tunnel, the minimum air exchange of 8 will be achieved and will meet the EPD's tunnel air quality requirements, presented in *Table 4.6d*.

4.6.14 A 130 m noise enclosure is recommended in *Section 3* along Lei Yue Mun Slip Roads. To maintain the air quality inside the enclosure structure, a minimum air exchange of 4 should be rachieved with the piston effect of vehicles travelling. The air quality inside the enclosure will thus satisfy the TAQG and detailed calculations are presented in *Table 4.6d*.

4.6.15 The preliminary ventilation design of the short tunnel and noise enclosure will be confirmed and refined in the detailed design stage. It is assumed that the air quality inside the tunnel and enclosure will satisfy the TAQO, provided that the recommended ventilation rate can be achieved. This should be demonstrated during the detailed design of the Project and the ventilation engineer should confirm recommended ventilation rates in the design of tunnel.

Table 4.6d Short Tunnel and Noise Enclosure Ventilation Calculations

	Short Tunnel		Noise Enclosure	
	EB	**WB**	**SB**	**NB**
Length of Tunnel/Enclosure Box (m)	175	160	130	130
Cross-sectional Area (m^2)	114.4	114.4	60	60
Tunnel Volume (m^3)	20,020	18,304	7,440	7,440
Peak Hourly Traffic Flow (veh/hr)	4,400	6,900	1,000	1,600
Total NO_x Emission Rate (g/km/hr)	15,349	16,087	2,730	3,002
Total NO_x Emission Rate (g/hr) within Tunnel/Enclosure	2,687	2,572	355	390
Total NO_2 Emission Rate (g/hr) within Tunnel/Enclosure (ii)	286.7	257.2	35.5	39
Ventilation Rate (m^3/hr) (iii)	160,160	160,160	29,760	29,760
NO_2 Concentration attributed to the fleet (μgm^{-3})	1,678	1,606	1,193	1,311
Total NO_2 Concentration (Fleet emission + Background) (μgm^{-3})	1,743	1,671	1,258	1,376
TAQG NO_2 Criteria (μgm^{-3})	**1,800**			

Notes:
(i) The fleet emission calculation is based on *Table 4.6b*.
(ii) The percentage conversion of NO_x to NO_2 is 10% inside the tunnel/enclosure box and 20% outside the tunnel.
(iii) An air exchange of 8 for tunnel box and 4 for enclosure box are assumed.

Mitigation Measures

4.6.16 The cumulative predicted results show that the air quality at the ASRs will satisfy the AQO and further mitigation measures are therefore not required.

4.6.17 To ensure compliance with the TAQG, the following measures are recommended: an air exchange of 8 for the tunnel section near Ma Shan Tsuen and air exchange of 4 for the noise enclosure at the slip road near Sam Ka Tsuen to satisfy the TAQG requirement.

Residual Impacts

4.6.18 As cumulative predicted results show that the air quality at all ASRs will satisfy the AQO, no adverse residual impacts are expected.

4.7 Conclusions

Construction Phase

4.7.1 Dust will be the major pollutant during the construction of the WCR. Reclamation, site clearance, ground excavation, bulldozing and materials handling and vehicle movements on unpaved site roads are expected to be the major dust sources. A worst case conservative scenario has been undertaken with high dust impacts predicted at Ma Shan Tsuen west, in the absence of any mitigation measures. Mitigation measures in accordance with the *APCO (Construction Dust) Regulation* have been recommended to reduce the dust impacts and are to be checked by EM&A procedures to ensure that the air quality meets the dust criteria at all ASRs. It is not expected that all the activities will be operated simultaneously, thus actual dust level will likely be lower than reported.

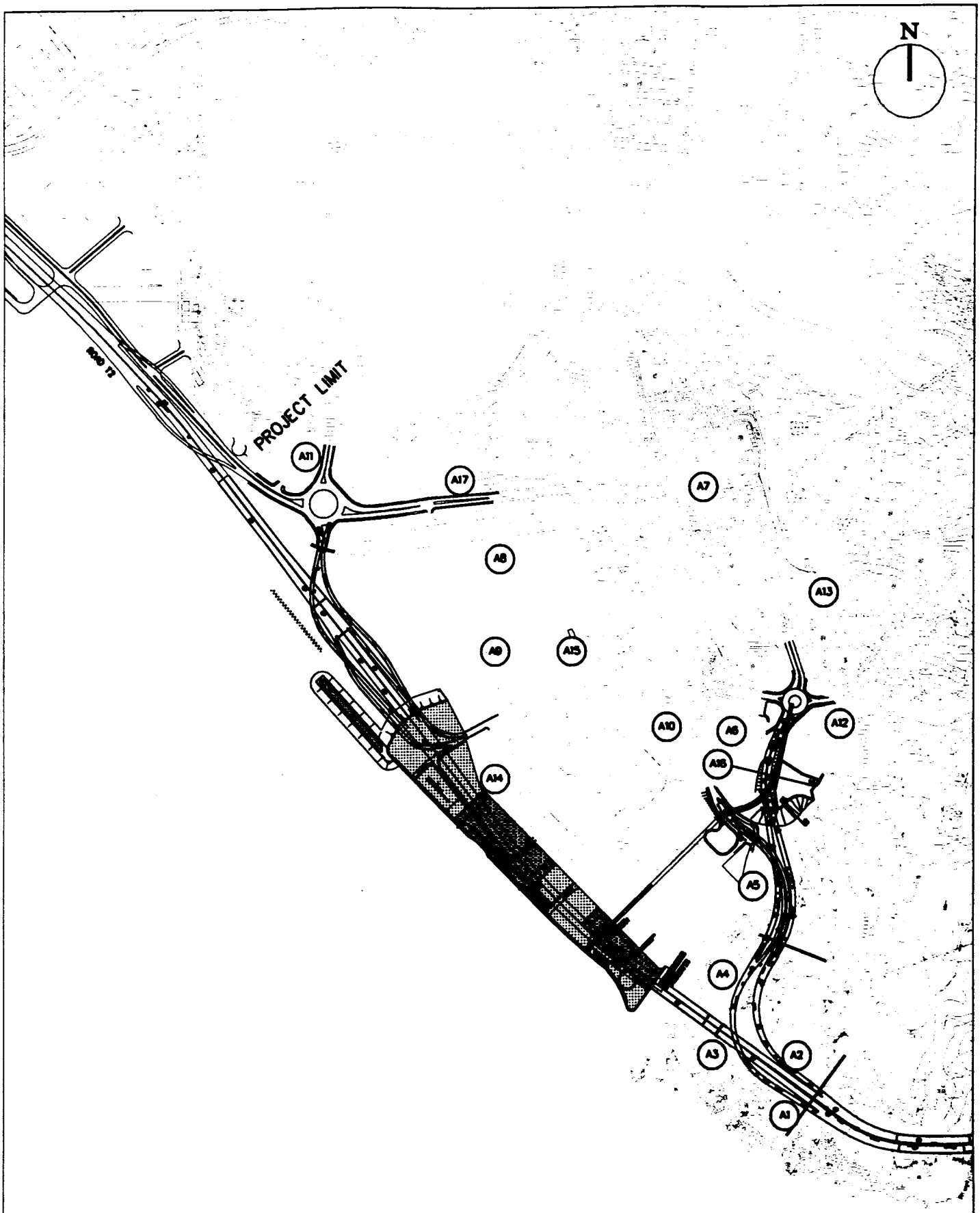
Operational Phase

4.7.2 Vehicle exhaust is expected to be the major pollutant source during the operation of the WCR. Air quality modelling has been carried out for the cumulative impacts from the alignment, short tunnel, noise enclosure and barriers. The results indicate that air quality at all ASRs will satisfy the AQO requirements and adverse air quality impact is not expected.

4.7.3 It is recommended that the ventilation design of tunnel/enclosure should achieve an air exchange of 8 for the short tunnel near Ma Shan Tsuen, and air exchange of 4 for the noise enclosure near Sam Ka Tsuen, to satisfy the TAQG requirement. As the TAQG will be met with the provision of the mechanical ventilation, air quality monitoring during the operational phase will not be required for the short tunnel and enclosure.

4.8 EM&A Requirements

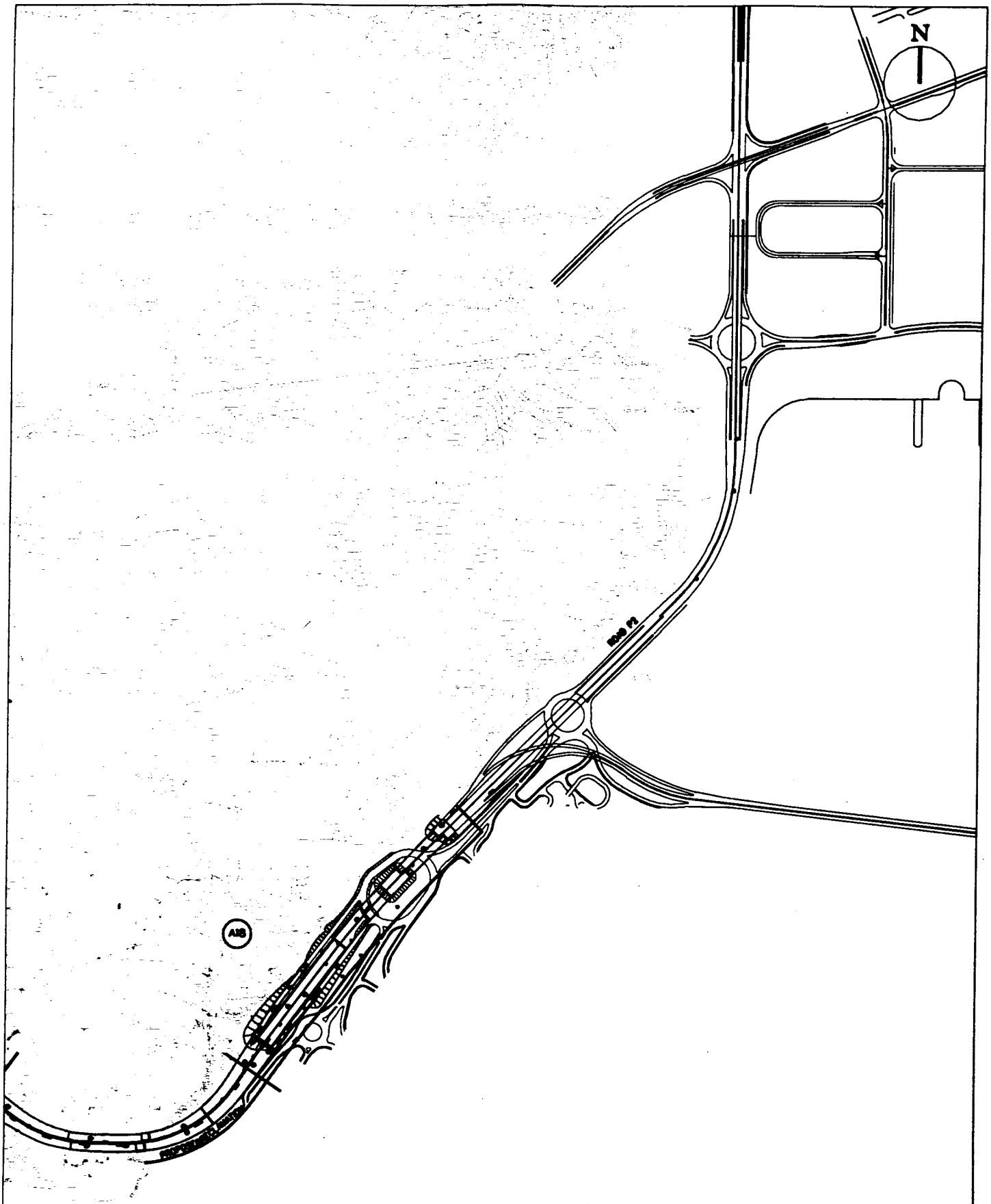
4.8.1 Environmental monitoring and audit (EM&A) for dust generated during the construction phase will be undertaken to ensure that the dust criteria will not be exceeded. The EM&A programme has been developed separately in the EM&A Manual and is summarised in *Section 10.4.*



KEY
A10 - Air Sensitive Receiver

WCR, TKO YAU TONG – AIR SENSITIVE RECEIVERS
(sheet 1 of 2)

MAUNSELL CONSULTANTS ASIA LTD
DATE: FEB 99
SCALE: 1 : 11000
FIGURE No. 4.4a



KEY
A10 - Air Sensitive Receiver

WCR, TKO – AIR SENSITIVE RECEIVERS
(sheet 2 of 2)

MAUNSELL CONSULTANTS ASIA LTD

DATE: FEB 99

SCALE: 1 : 11000

FIGURE No. 4.4b

ASRs A1 - A4

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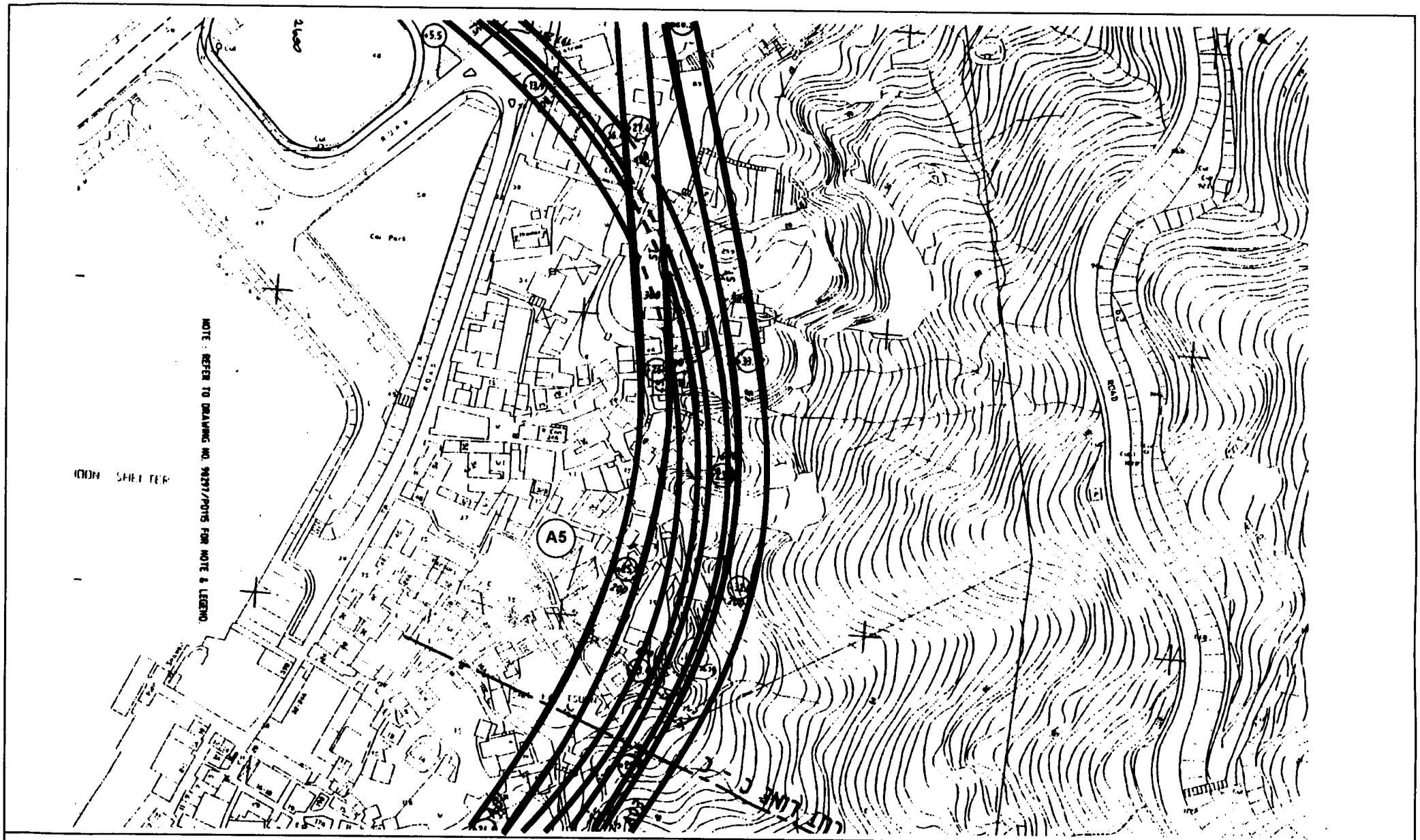
DATE: MAR 99

SCALE: NTS

FIGURE No. 4.4c

Maunsell

FILE: C1609u3
DATE: 04/03/99



ASR A5

MAUNSELL CONSULTANTS ASIA LTD

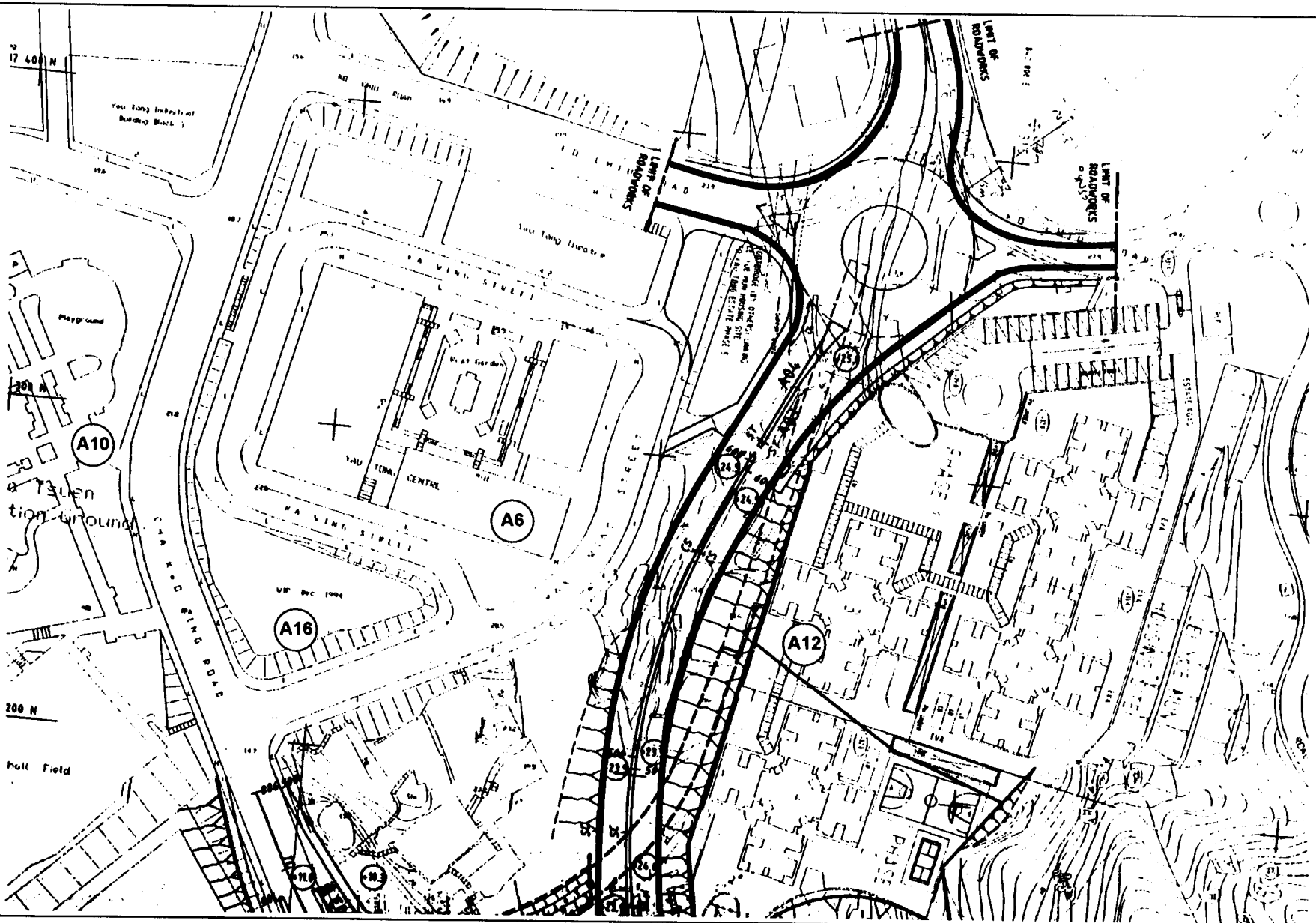
DATE: MAR 99

FIGURE No. 4.4d

SCALE: NTS

Maunsell

FILE: C1609u2
DATE: 04/03/99



ASRs A6, A10, A12, & A16

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

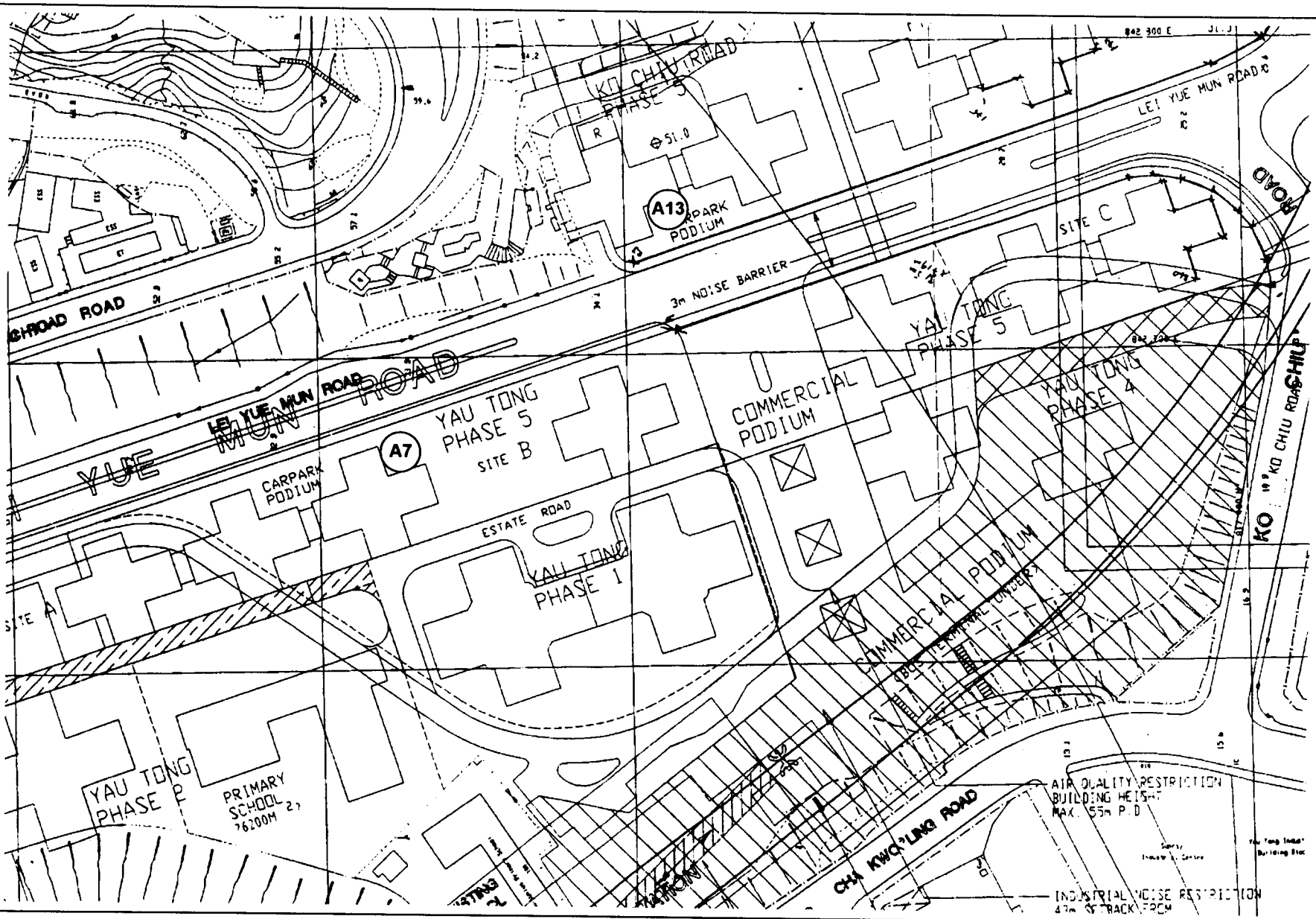
DATE: MAR 99

SCALE: NTS

FIGURE No. 4.4e

Maunsell

FILE: C1609u4
DATE: 04/03/99



ASRs 7 & 13

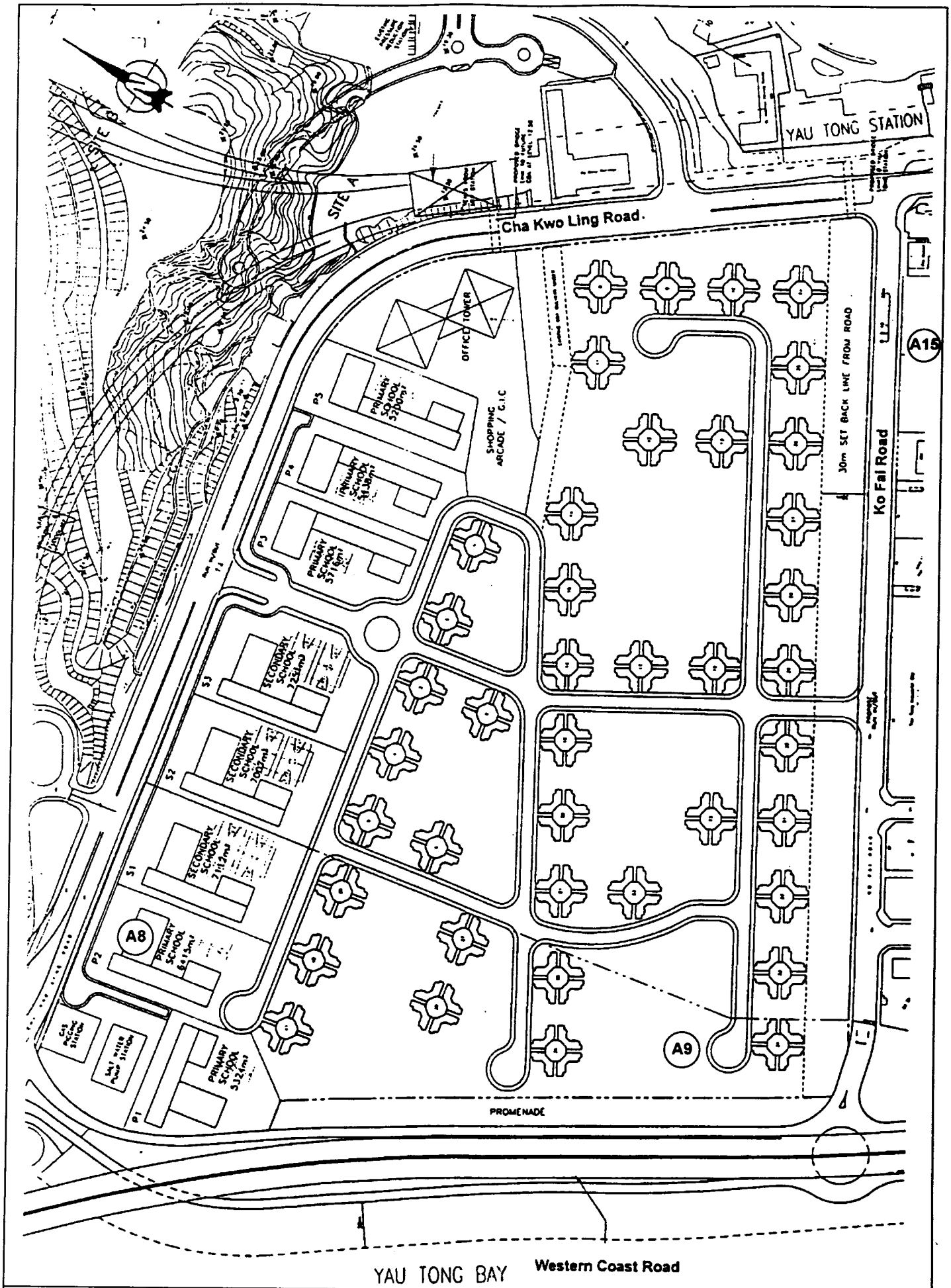
MAUNSELL CONSULTANTS ASIA LTD
茂盛工程顧問有限公司

DATE: MAR 99

SCALE: NTS

FIGURE No. 4.4f

FILE: C1609N1
DATE: 04/03/99



YAU TONG BAY CDA SITE - ASRs A8, A9 & A15

MAUNSELL CONSULTANTS ASIA LTD 茂盛工程顧問有限公司

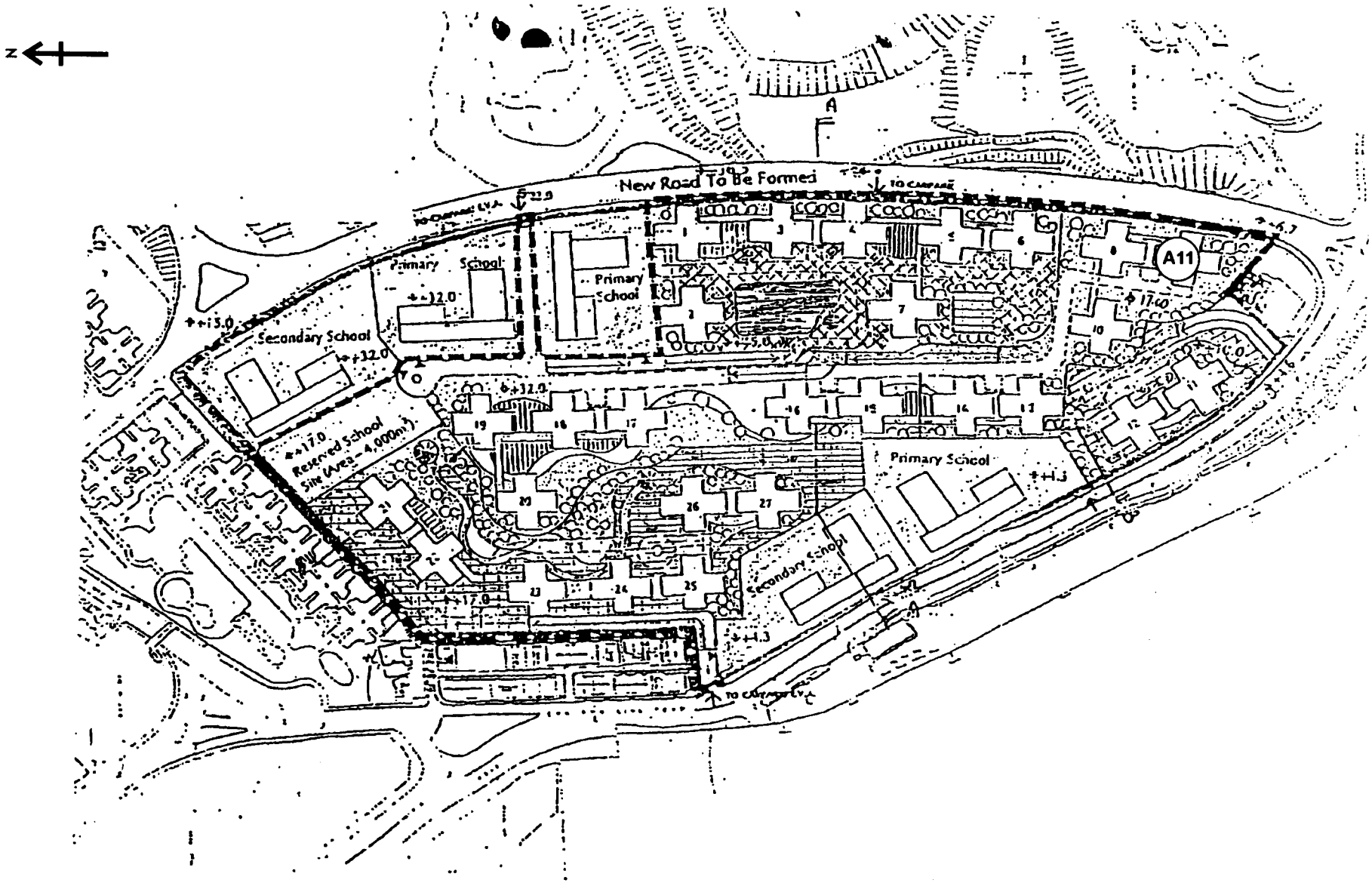
DATE: MARCH 99

FIGURE No. 4.4g

SCALE: NTS

FILE: C1609/C1609N2

DATE: 03/08/98

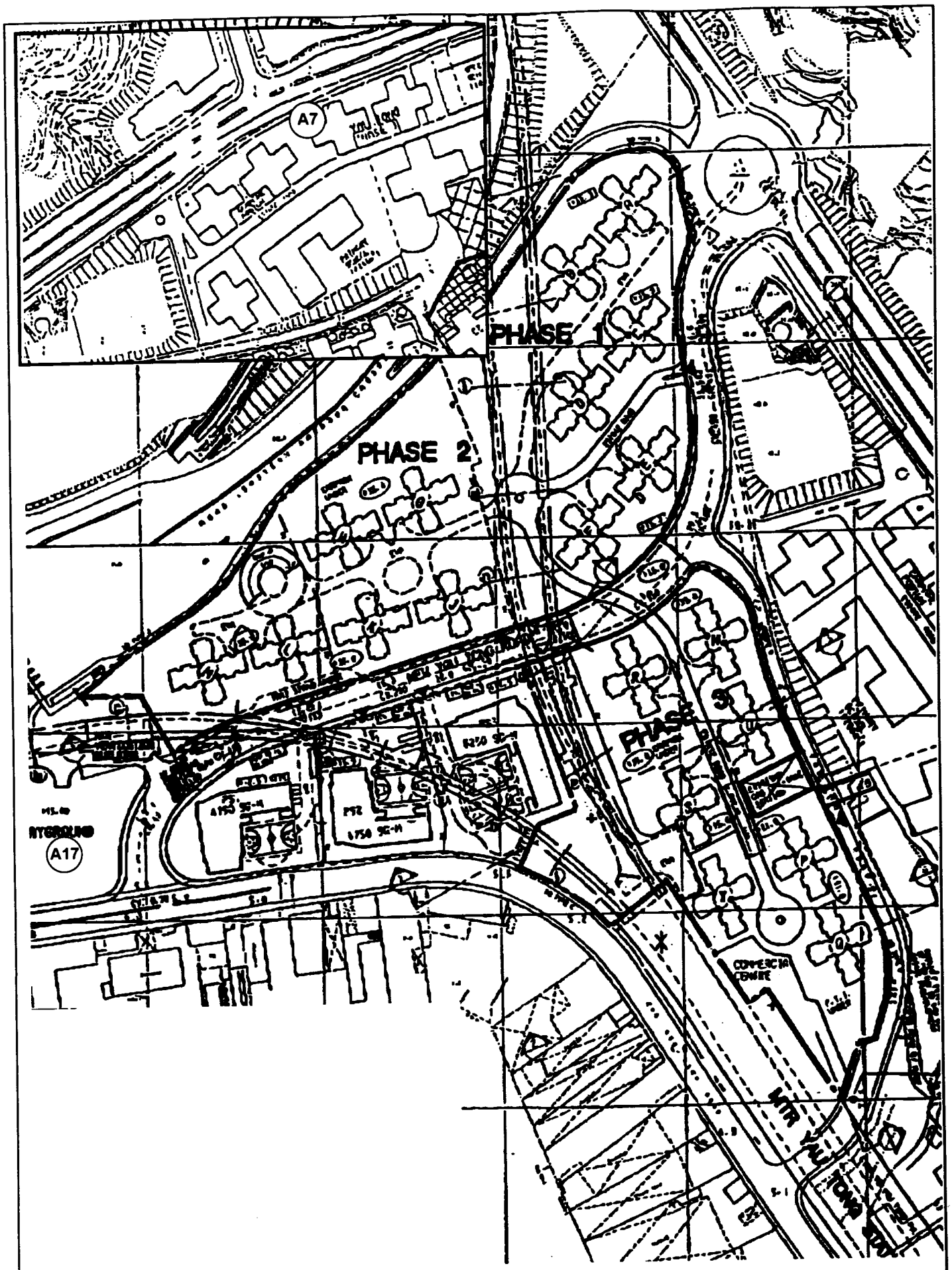


CHA KWO LING SITE - ASRs 11

FIGURE No.	4.4h
SCALE: NTS	DATE: MARCH 99

Maunsell

FILE: C1609/C1609n3



YAU TONG HKHA ASR'S 7 & 17

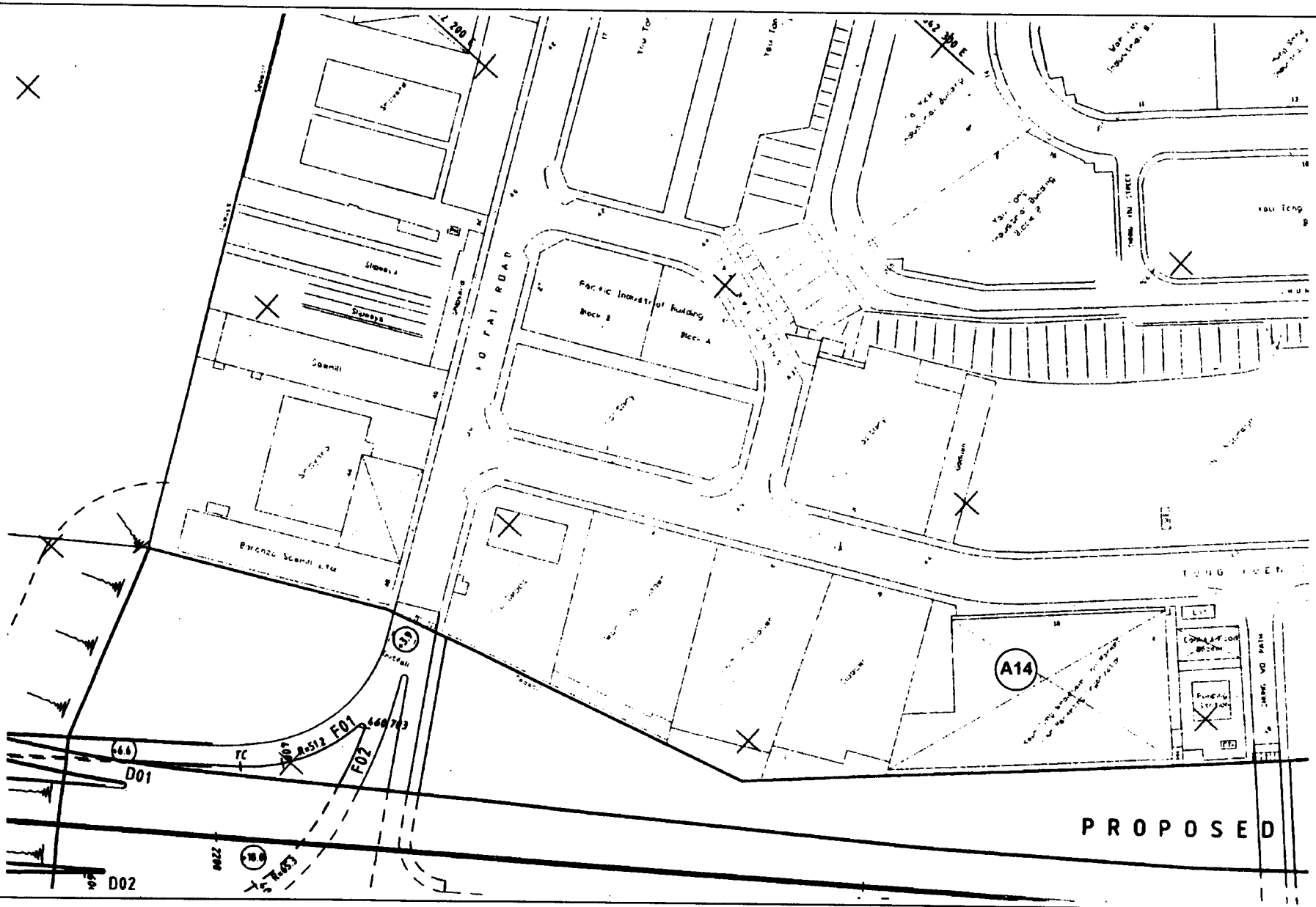
FIGURE No. 4.4i

SCALE: NTS

DATE: MAY 99

Maunsell

FILE: C1609m2



ASR A14

MAUNSELL CONSULTANTS ASIA LTD
茂盛工程顧問有限公司

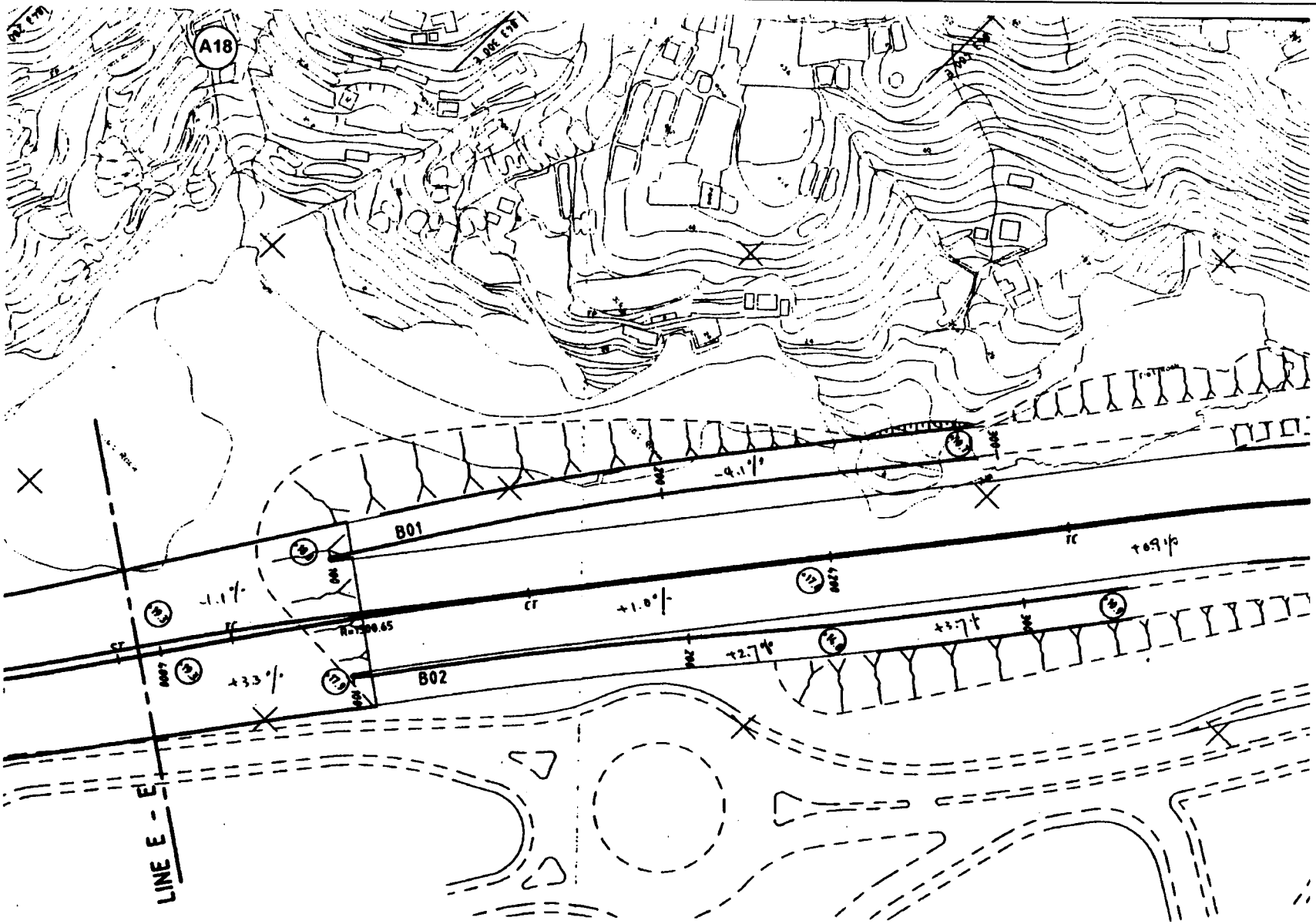
DATE : MAR 99

SCALE : NTS

FIGURE No. 4.4j

Maunsell

FILE: C1609u5
DATE: 04/03/99



ASR A18

MAUNSELL CONSULTANTS ASIA LTD
汎盛工程顧問有限公司

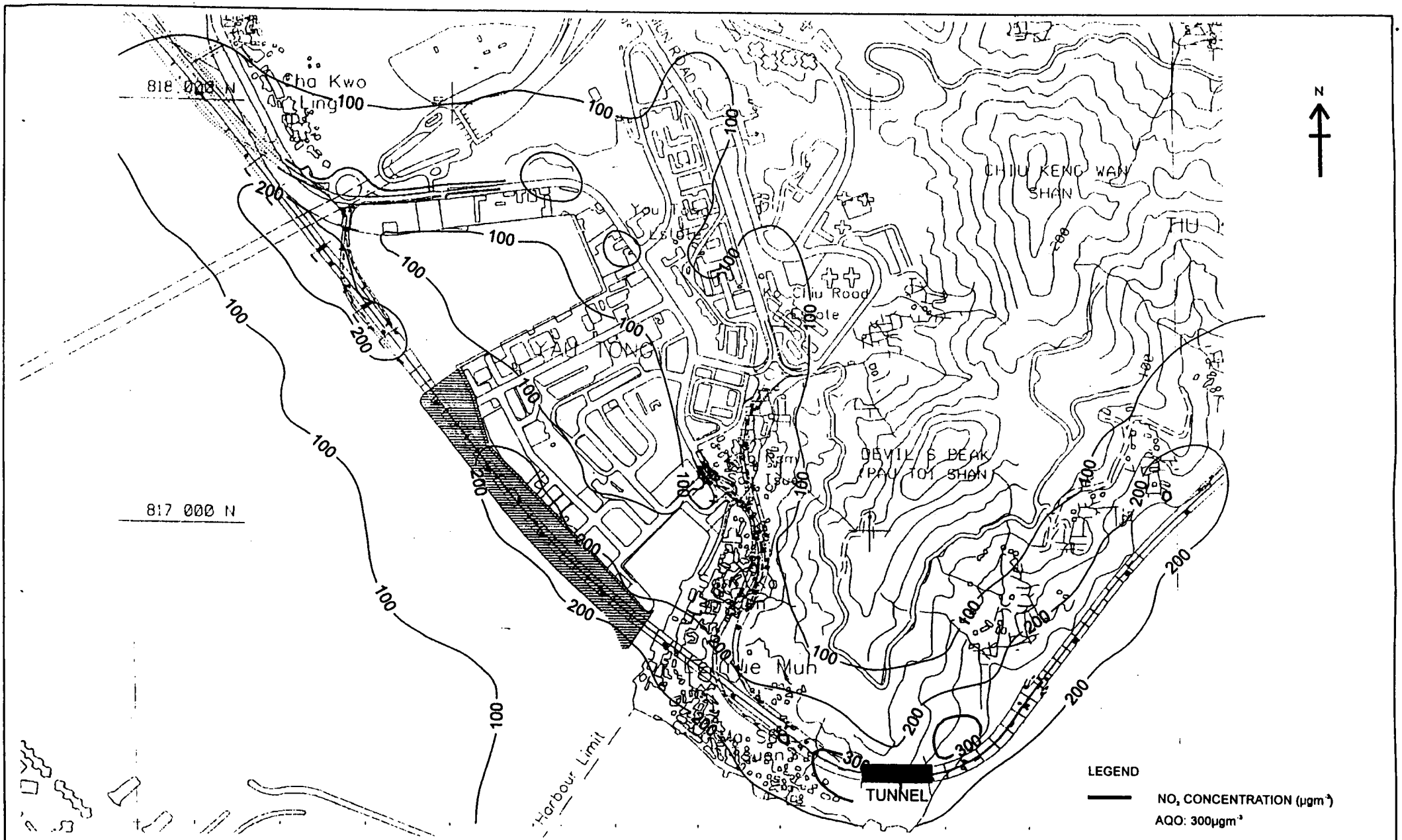
DATE: MAR 99

FIGURE No. 4.4k

SCALE: NTS

Maunsell

FILE: C1609u1
DATE: 04/03/99

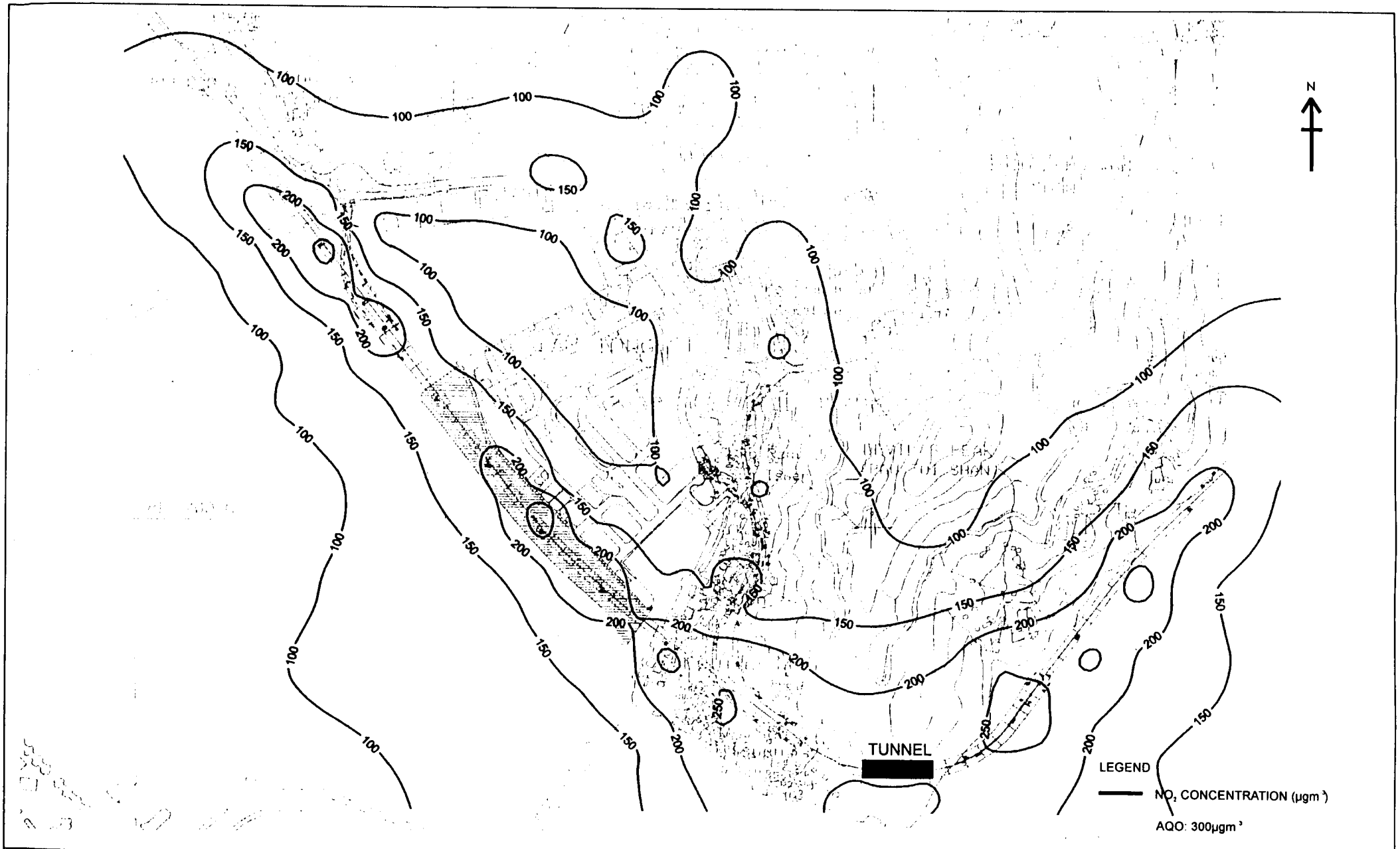


CUMULATIVE PREDICTED MAXIMUM HOURLY NO_2 CONCENTRATION AT GROUND LEVEL

FIGURE No.	
4.6a	
SCALE: NTS	DATE: 11/06/98

Maunsell

FILE: C1609/C1609L



CUMULATIVE PREDICTED MAXIMUM HOURLY NO_2 CONCENTRATION AT ALIGNMENT LEVEL

FILE: C1609/C1609L1

FIGURE No.	
4.6b	
SCALE: NTS	DATE: 11/06/98

Maunsell

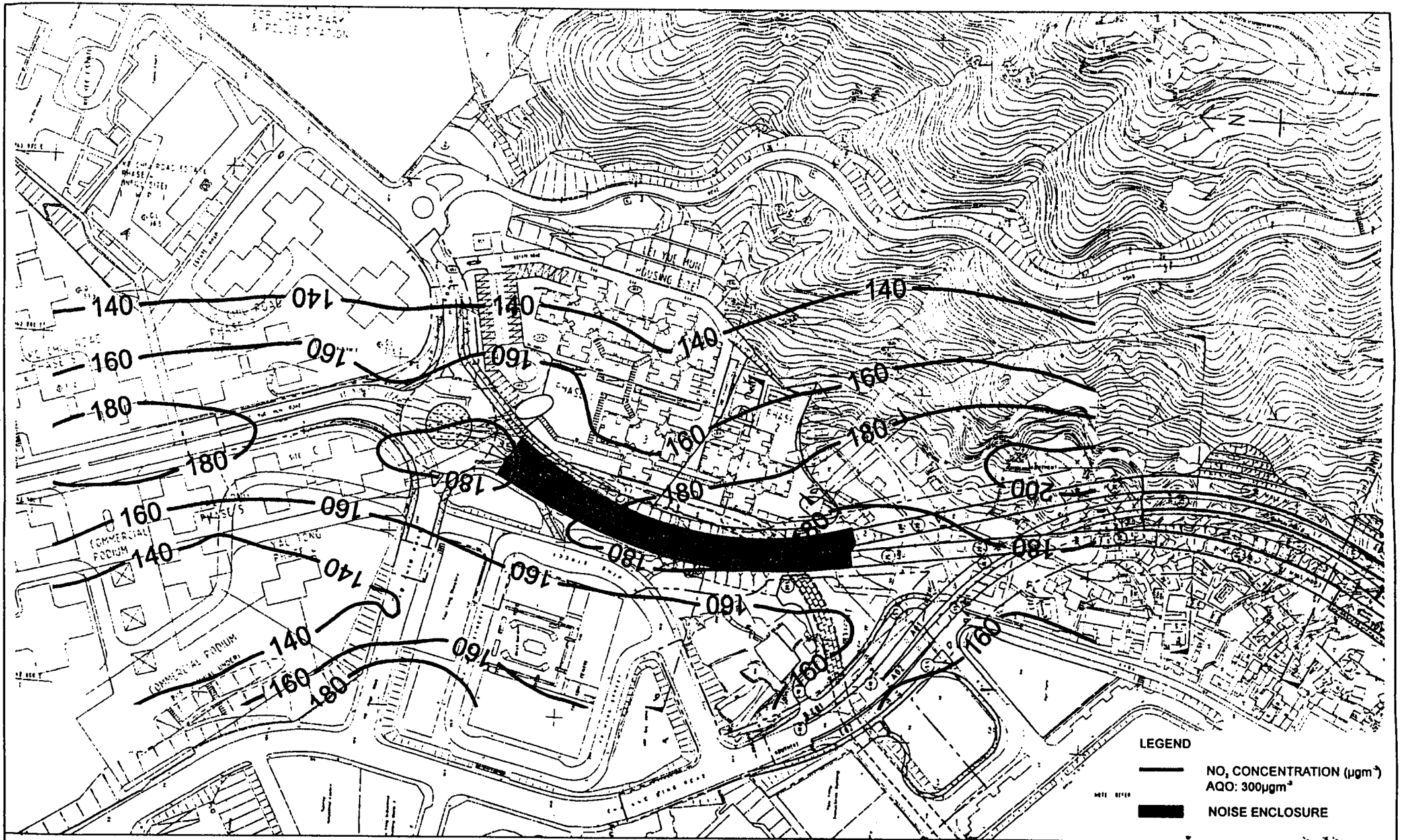


FIGURE 4.6c

CONTOUR OF HOURLY NO_2 CONCENTRATION NEAR NOISE ENCLOSURE AT GROUND LEVEL

FILE: C1609/C1609o
DATE: 11/08/98

Environmental Resources Management

ERM

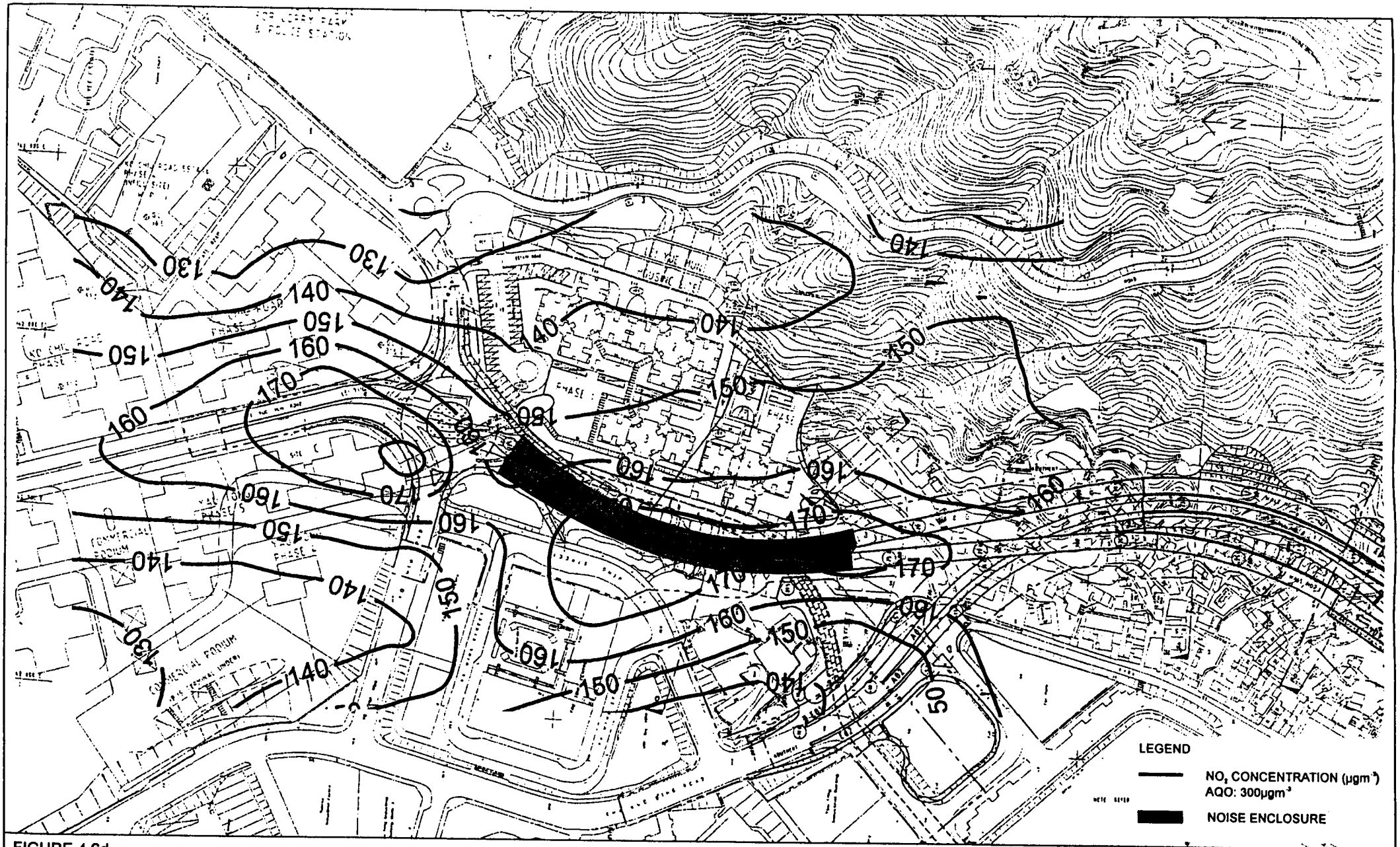


FIGURE 4.6d

CONTOUR OF HOURLY NO_2 CONCENTRATION NEAR NOISE ENCLOSURE AT ALIGNMENT LEVEL

FILE: C1609/C1609o1
DATE: 11/08/98

Environmental Resources Management

ERM

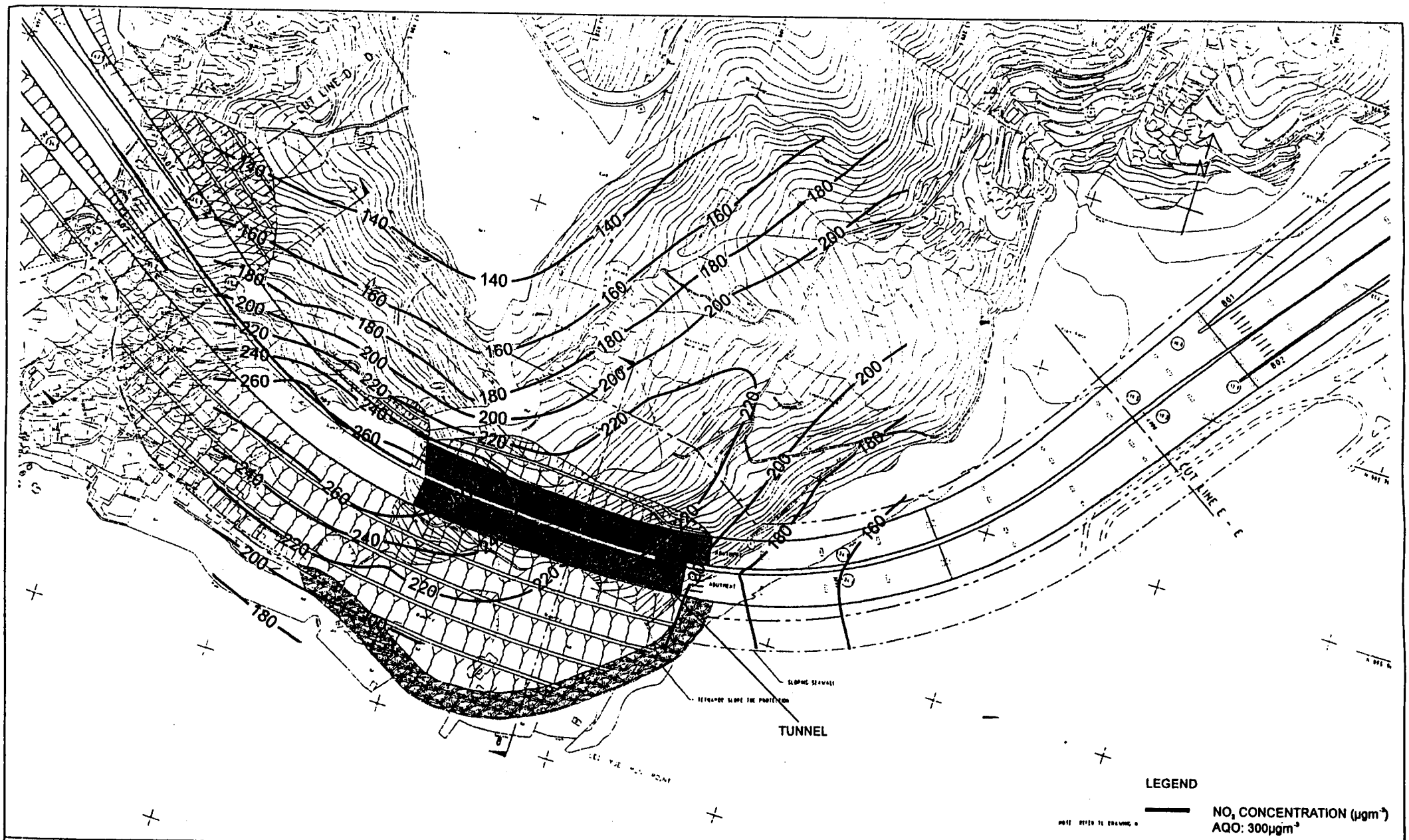


FIGURE 4.6e

CONTOUR OF HOURLY NO_2 CONCENTRATION NEAR TUNNEL AT ALIGNMENT LEVEL

FILE: C1609/C1609P
DATE: 11/06/96

Environmental Resources Management

ERM

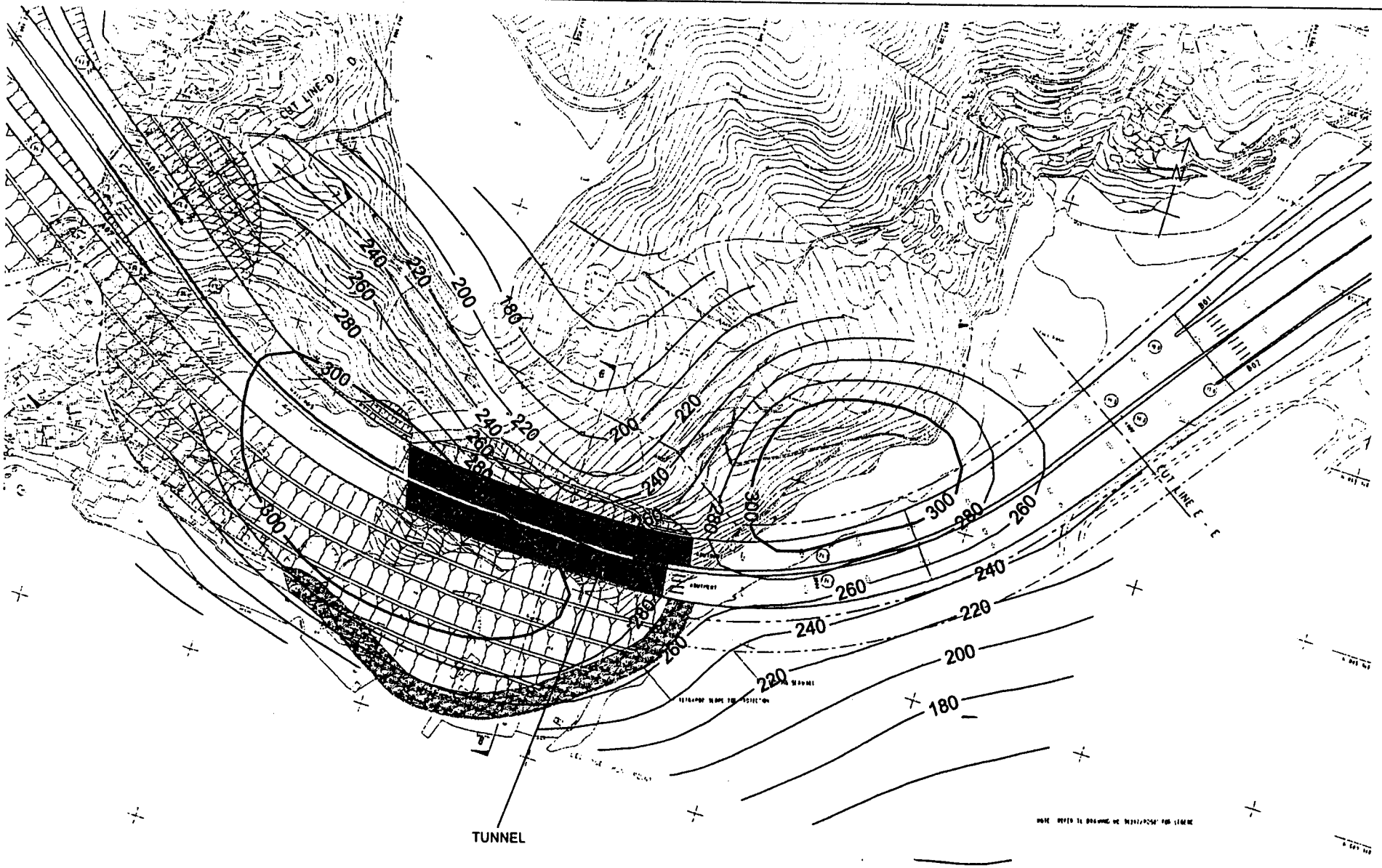


FIGURE 4.6f

CONTOUR OF HOURLY NO2 CONCENTRATION AT GROUND LEVEL FOR PORTAL EMISSION

FILE: C1609u
DATE: 04/03/99

Environmental Resources Management

ERM