Appendix 4.4f   **Detailed Calculations of In-Tunnel Air Quality**
along Tuen Mun Road Town Centre Section near Chi Lok Fa Yuen

Normal Condition

Tunnel Parameter

Tunnel length (m), L	=	78
Tunnel height (m), H	=	8
Tunnel width (m), W	=	28
Tunnel size (m2), At	=	H * W
		224
Equivalent diameter (m), dt	=	$(4*At/\pi)^{0.5}$
		16.88804
Effective length of the tunnel (m), Le	=	L + 2*3*dt
		179.3282

Emission Data

Traffic Breakdown (%)

Tunnel traffic (Link no.)	Traffic flow (veh/hr)	Motor Cycles	Petrol PC &LGV	Taxi	Non-franchised Buses <6.4t	Non-franchised Buses 6.4-15t	Non-franchised Buses >15t	Private Light Buses <3.5t	Private Light Buses >3.5t	Diesel PC&LGV <2.5t	Diesel LGV 2.5-3.5t	Diesel LGV >3.5t	HGV<15t	HGV>15t	Single Deck Franchised Buses	Double Deck Franchised Buses	Public Light Buses
132	5333	0.02	0.40	0.09	0.00	0.02	0.00	0.00	0.01	0.01	0.08	0.06	0.25	0.01	0.00	0.02	0.03
133	4017	0.01	0.38	0.09	0.00	0.02	0.00	0.00	0.01	0.01	0.06	0.04	0.33	0.02	0.00	0.01	0.02
Total	9350	0.02	0.39	0.09	0.00	0.02	0.00	0.00	0.01	0.01	0.07	0.05	0.28	0.01	0.00	0.02	0.03
NOx Emission Factor (g/mile)		1.14	0.28	0.28	0.00	7.07	0.00	0.00	0.82	1.07	0.59	3.76	7.89	10.01	5.44	5.81	0.77

Weighted NOX E.F. (g/km/veh)	=	1.8929
NO2 emission factor per unit length (g/m/s), w	=	12.5% * Weight NOX E.F. * Traffic flow
	=	6.15E-04

Vehicle Data

Nominal dimensions of vehicles are given in Transport Planning and Design Manual, Vol. 2 as:

	W	H	L
Motor Cycles	1.7	1.5	4.6
Petrol PC &LGV	1.7	1.5	4.6
Taxi	1.7	1.5	4.6
Non-franchised Buses <6.4t	2.5	3.5	12
Non-franchised Buses 6.4-15t	2.5	3.5	12
Non-franchised Buses >15t	2.5	3.5	12
Private Light Buses <3.5t	2	3	6.5
Private Light Buses >3.5t	2	3	6.5
Diesel PC&LGV <2.5t	2.1	1.6	5.2
Diesel LGV 2.5-3.5t	2.1	1.6	5.2
Diesel LGV >3.5t	2.1	1.6	5.2
HGV<15t	2.5	4.6	16
HGV>15t	2.5	4.6	16
Single Deck Franchised Buses	2.5	3.5	12
Double Deck Franchised Buses	2.5	4.6	12
Public Light Buses	2	3	6.5

* No dimensions for motor cycles and non-franchised buses are provided.
* For the purpose of this study, the dimensions of motor cycles and taxi are assumed to be the same as private car
and the dimension of non-franchised buses are assumed to be the same as single deck franchised buses.

Appendix 4.4f   **Detailed Calculations of In-Tunnel Air Quality**
along Tuen Mun Road Town Centre Section near Chi Lok Fa Yuen

Normal Condition

Nominal cross-sectional area (m2)	=	(1.7*1.5*0.02)+(1.7*1.5*0.39)+(1.7*1.5*0.09)+(2.5*3.5*0.02)+(2*3*0.01)+(2.1*1.6*0.01)+(2.1*1.6*0.07)+(2.1*1.6*0.05)+(2.5*4.6*0.28)+(2.5*4.6*0.01)+(2.5*4.6*0.02)+(2*3*0.03)	
	=	5.71837	
Number of lanes per direction, nl	=	4	
Equivalent cross-sectional area for each direction (m2), Av	=	22.87348	
Equivalent diameter of vehicle (m), dv	=	(4*Av/π)^0.5	
	=	5.396614	

Traffic density (traffic flow /s), N	=	2.597222	
Average vehicle speed (m/s), v	=	50 km/hr	
	=	13.88889	
Head to head distance on a lane (m), l	=	2*nl*v/N	
	=	42.78075	

Diffusion Parameters

Reynolds number, Re	=	(v*dv)/σ	where σ = 15.6*10^-6
	=	4804678	
According to Figure 16 (Ohashi and Koso)			
Since l / dt	=	2.533198	
D / (N * dt^2 * Re^0.13)	=	0.29	
Longitudinal			
diffusion coefficient (m2/s) , D	=	0.29 * (N * dt^2 * Re^0.13)	
	=	1587.384	

Maximum Concentration of NO2

Cmax (μg/m3)	=	w * Le^2 / (8 * D * At)	
(without background)	=	7	

Appendix 4.4f   **Detailed Calculations of In-Tunnel Air Quality
along Tuen Mun Road Town Centre Section near Chi Lok Fa Yuen**

Worse Condition

Tunnel Parameter

Tunnel length (m), L	=	78
Tunnel height (m), H	=	8
Tunnel width (m), W	=	28
Tunnel size (m2), At	=	H * W
		224
Equivalent diameter (m), dt	=	$(4 \cdot At/\pi)^{0.5}$
		16.88804
Effective length of the tunnel (m), Le	=	L + 2*3*dt
		179.3282

Emission Data

Traffic Breakdown (%)

Tunnel traffic (Link no.)	Traffic flow (veh/hr)	Motor Cycles	Petrol PC &LGV	Taxi	Non-franchised Buses <6.4t	Non-franchised Buses 6.4-15t	Non-franchised Buses >15t	Private Light Buses <3.5t	Private Light Buses >3.5t	Diesel PC&LGV <2.5t	Diesel LGV 2.5-3.5t	Diesel LGV >3.5t	HGV<15t	HGV>15t	Single Deck Franchised Buses	Double Deck Franchised Buses	Public Light Buses
132	5333	0.02	0.40	0.09	0.00	0.02	0.00	0.00	0.01	0.01	0.08	0.06	0.25	0.01	0.00	0.02	0.03
133	4017	0.01	0.38	0.09	0.00	0.02	0.00	0.00	0.01	0.01	0.06	0.04	0.33	0.02	0.00	0.01	0.02
Total	9350	0.02	0.39	0.09	0.00	0.02	0.00	0.00	0.01	0.01	0.07	0.05	0.28	0.01	0.00	0.02	0.03
NOx Emission Factor (g/mile)		1.02	0.38	0.38	0.00	10.41	0.00	0.00	1.21	1.55	0.86	5.57	11.82	15.06	9.45	10.26	1.14

Weighted NOX E.F. (g/km/veh)	=	2.8272
NO2 emission factor per unit length (g/m/s), w	=	12.5% * Weight NOX E.F. * Traffic flow
	=	9.18E-04

Vehicle Data

Nominal dimensions of vehicles are given in Transport Planning and Design Manual, Vol. 2 as:

	W	H	L
Motor Cycles	1.7	1.5	4.6
Petrol PC &LGV	1.7	1.5	4.6
Taxi	1.7	1.5	4.6
Non-franchised Buses <6.4t	2.5	3.5	12
Non-franchised Buses 6.4-15t	2.5	3.5	12
Non-franchised Buses >15t	2.5	3.5	12
Private Light Buses <3.5t	2	3	6.5
Private Light Buses >3.5t	2	3	6.5
Diesel PC&LGV <2.5t	2.1	1.6	5.2
Diesel LGV 2.5-3.5t	2.1	1.6	5.2
Diesel LGV >3.5t	2.1	1.6	5.2
HGV<15t	2.5	4.6	16
HGV>15t	2.5	4.6	16
Single Deck Franchised Buses	2.5	3.5	12
Double Deck Franchised Buses	2.5	4.6	12
Public Light Buses	2	3	6.5

* No dimensions for motor cycles and non-franchised buses are provided.
* For the purpose of this study, the dimensions of motor cycles and taxi are assumed to be the same as private car
and the dimension of non-franchised buses are assumed to be the same as single deck franchised buses.

Appendix 4.4f   **Detailed Calculations of In-Tunnel Air Quality**
                     along Tuen Mun Road Town Centre Section near Chi Lok Fa Yuen

Worse Condition

Nominal cross-sectional area (m2)   = (1.7*1.5*0.02)+(1.7*1.5*0.39)+(1.7*1.5*0.09)+(2.5*3.5*0.02)+(2*3*0.01)+(2.1*1.6*0.01)+(2.1*1.6*0.07)+(2.1*1.6*0.05)+(2.5*4.6*0.28)+(2.5*4.6*0.01)+(2.5*4.6*0.02)+(2*3*0.03)
                                                     = 5.71837
Number of lanes per direction, nl   = 4
Equivalent cross-sectional area for each direction (m2), Av   =   22.87348
Equivalent diameter of vehicle (m), dv   = (4*Av/π)^0.5
                                                     = 5.396614

Equivalent length of each vehicle (m)   = (4.6*0.02)+(4.6*0.39)+(4.6*0.09)+(12*0.02)+(6.5*0.01)+(5.2*0.01)+(5.2*0.07)+(5.2*0.05)+(16*0.28)+(16*0.01)+(12*0.02)+(6.5*0.03)
                                                     = 8.41653
Distance between vehicle (m)   = 1   (worst case)
Head to head distance on a lane (m), l   = 9.41653
Traffic density (traffic flow /s), N   = 2.597222
Average vehicle speed (m/s), v   = l*N/(2*nl)
                                                     = 3.057103

Diffusion Parameters
Reynolds number, Re   = (v*dv)/σ   where σ = 15.6*10^-6
                                                     = 1057564
According to Figure 16 (Ohashi and Koso)
Since   l / dt   = 0.557586
D / (N * dt^2 * Re^0.13)   = 0.14
Longitudinal
diffusion coefficient (m2/s) , D   = 0.14 * (N * dt^2 * Re^0.13)
                                                     = 629.4417

Maximum Concentration of NO2
Cmax (µg/m3)   = w * Le^2 / (8 * D * At)
(without background)   = 26

Appendix 4.4f   **Detailed Calculations of In-Tunnel Air Quality
along Tuen Mun Road Town Centre Section near Chi Lok Fa Yuen**

Overall Concentrations

Six assessment points (ASRs H1-H6) at the boundary of the enclosure are chosen.
Using CALINE4 and ISCST3 model, the air pollutants concentrations at the 6 assessment points at different levels are calculated.
The highest concentration among the six assessment points is assumed to be the background
concentration inside the proposed enclosure section.

Elevation	NO2 Concentrations (ug/m3) at Various Levels	
	(mAG)	NO_2
H1	0.0	309
	4.0	389
	8.0	511
H2	0.0	274
	4.0	286
	8.0	285
H3	0.0	246
	4.0	246
	8.0	245
H4	0.0	268
	4.0	296
	8.0	317
H5	0.0	272
	4.0	311
	8.0	382
H6	0.0	281
	4.0	304
	8.0	319

Therefore, the NO2 background concentration inside the enclosure is   511 ug/m^3

**Total Maximum NO2 concentration inside enclosure of
Tuen Mun Road near Chi Lok Fa Yuen (Normal Speed)**   =   7 + 511
                                                           =   518   ug/m3

**Total Maximum NO2 concentration inside enclosure of
Tuen Mun Road near Chi Lok Fa Yuen (Worse Case)**   =   26 + 511
                                                           =   537   ug/m3