3 AIR QUALITY IMPACT

3.1 Introduction

3.1.1 This section presents an assessment of potential air quality impacts arising from the construction and operation of the Project. Appropriate mitigation measures have been recommended to minimize the identified air quality impacts to an acceptable level. The air quality impact assessment was conducted in accordance with the requirement in Annexes 4 and 12 of the EIAO-TM and the requirements in Section 3.4.4 and Appendix B and B-1 of the EIA Study Brief (ESB-323/2019).

3.2 Environmental Legislation, Standards and Guidelines

Air Quality Objectives & Technical Memorandum on EIA Process

3.2.1 The *Air Pollution Control Ordinance* provides the statutory authority for controlling air pollutants from a variety of sources. The *Hong Kong Air Quality Objectives* (AQOs), which stipulate the maximum allowable concentrations over specific periods for typical pollutants, should be met. The prevailing AQOs has been enforced on 1 January 2022 and is adopted for this EIA study. The prevailing AQOs are listed in **Table 3.1**.

Table 3.1 Hong Kong Air Quality Objectives (Effective on 1 January 2022)

Pollutants	Averaging Time	Concentration Limit (μg/m^3) [1]	Number of Exceedance Allowed per Year
Respirable Suspended Particulates (RSP or PM_{10})[2]	24-hour	100	9
	Annual [4]	50	N/A
Fine Suspended Particulates (FSP or $PM_{2.5}$)[3]	24-hour	50	18 [5]
	Annual [4]	25	N/A
Nitrogen Dioxide (NO_2)	1-hour	200	18
	Annual [4]	40	N/A
Sulphur Dioxide (SO_2)	10-min	500	3
	24-hour	50	3
Ozone (O_3)	8-hour	160	9
Carbon Monoxide (CO)	1-hour	30,000	0
	8-hour	10,000	0
Lead (Pb)	Annual	0.5	N/A

Note:
[1] Gaseous air pollutant is measured at 293K and 101.325kPa
[2] Suspended particulates in air with a nominal aerodynamic diameter of 10µm or smaller.
[3] Suspended particulates in air with a nominal aerodynamic diameter of 2.5µm or smaller.
[4] Arithmetic mean
[5] The new AQO allows 35 days of exceedance per calendar year for daily FSP. Instead, government and related projects shall adopt a more stringent standard with the number of allowable exceedance of 18 days per calendar year.

3.2.2 Apart from AQOs, the limit of hourly Total Suspended Particulates (TSP) concentration should not exceed 500 µg/m^3 (measured at 25°C and one atmosphere) for construction dust impact assessment according to Annex 4 of EIAO-TM.

Air Pollution Control (Construction Dust) Regulation

3.2.3 Notifiable and regulatory works are under the control of *Air Pollution Control (Construction Dust) Regulation*. This Project is expected to include notifiable works (work inside tunnel, superstructure construction and demolition, road construction work) and regulatory works (dusty material handling and excavation). Contractors and site agents are required to inform Environmental Protection Department (EPD) and adopt dust reduction measures to minimize dust emission, while carrying out construction works, to the acceptable level.

Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation

3.2.4 The *Air Pollution Control (Non-road Mobile Machinery) (Emission) Regulation* comes into effect on 1 June 2015. Under the Regulation, Non-road mobile machinery (NRMMs), except those exempted, are required to comply with the prescribed emission standards. From 1 September 2015, all regulated machines sold or leased for use in Hong Kong must be approved or exempted with a proper label in a prescribed format issued by EPD. Starting from 1 December 2015, only approved or exempted NRMMs with a proper label are allowed to be used in specified activities and locations including construction sites. The Contractor is required to ensure the adopted machines or non-road vehicle under the Project could meet the prescribed emission standards and requirement.

Air Pollution Control (Fuel Restriction) Regulation

3.2.5 The *Air Pollution Control (Fuel Restriction) Regulation* prohibits the use of liquid fuel or solid fuel for any relevant plants in Sha Tin fuel restriction area. In Shatin, only gaseous fuel is allowed in general but liquid fuel with sulphur content not exceeding 0.005% by weight may be used or operated only on a construction site.

Practice Note on Control of Air Pollutant in Vehicle Tunnels

3.2.6 The *Practice Note on Control of Air Pollution in Vehicle Tunnels* prepared by EPD provides guidelines on control of air pollution in vehicle tunnels. Guideline values on tunnel air quality are presented in **Table 3.2**.

Table 3.2 Tunnel Air Quality Guidelines (TAQG)

Pollutants	Averaging Time	Maximum Concentration in μg/m³ [1]	Maximum Concentration in ppm
Carbon Monoxide (CO)	5-minute	115,000	100
Nitrogen Dioxide (NO_2)	5-minute	1,800	1
Sulphur Dioxide (SO_2)	5-minute	1,000	0.4

Note:
[1] Measured at 298K and 101.325kPa

Development Bureau Technical Circular (Works)

3.2.7 The *Development Bureau Technical Circular (Works) No. 13/2020* is one of the environmental guidelines on timely application of temporary electricity and wider use of electric vehicles in public works contract. *Development Bureau Technical Circular (Works) No. 1/2015* also requires that no exempted generators, air compressors, excavators and crawler cranes shall be allowed in the new capital works contracts of public works (including design and build contracts) with an estimated contract value exceeding $200 million, unless is at the discretion of the Architect/Engineer considering no feasible alternative.

3.3 Description of Environment

3.3.1 The nearest EPD fixed air quality monitoring station is located at Sham Shui Po and Sha Tin respectively for Kowloon side and Shatin side. The annual average monitoring data recorded at EPD's Sham Shui Po and Sha Tin air quality monitoring station have shown declining trend of pollutant concentrations in the past five years. The recent five years (2016 - 2020) annual average concentrations of the key air pollutants relevant to the Project are summarized in **Table 3.3** and **Table 3.4**. The discussion on the key air pollutant relevant to the Project refers to **Section 3.5.12, 3.5.17 – 3.5.36**.

Table 3.3 Average Concentrations of Pollutants in the Recent Five Years (Year 2016 – 2020) at Sham Shui Po EPD Air Quality Monitoring Station

Pollutant	Averaging Time	Observed Concentration (μg/m³)				
		2020	2019	2018	2017	2016
Respirable Suspended Particulates (RSP) (μg/m³)	10th Highest 24-hour	59	65	59	72	77
	Annual	28	33	33	33	35
Fine Suspended Particulates (FSP) (μg/m³)	19th Highest 24-hour	27	33	37	40	46
	Annual	14	18	21	21	23
Nitrogen Dioxide (NO_2)	19th Highest 1-hour	151	176	152	194	161
	Annual	**45**	**48**	**49**	**54**	**58**

Remarks:
[1] Bolded value indicates exceedance of the AQO.

Table 3.4 Average Concentrations of Pollutants in the Recent Five Years (Year 2016 – 2020) at Sha Tin EPD Air Quality Monitoring Station

Pollutant	Averaging Time	Observed Concentration (μg/m³)				
		2020	2019	2018	2017	2016
Respirable Suspended Particulates (RSP) (μg/m³)	10th Highest 24-hour	54	60	65	72	66
	Annual	25	28	32	31	29
Fine Suspended Particulates (FSP) (μg/m³)	19th Highest 24-hour	28	31	35	46	40
	Annual	15	17	19	21	20
Nitrogen Dioxide (NO_2)	19th Highest 1-hour	136	150	149	144	137
	Annual	28	32	35	34	38

Remarks:
[1] Bolded value indicates exceedance of the AQO.

3.3.2 Apart from the air quality monitoring data, EPD has released a set of background levels from "Pollutants in the Atmosphere and their Transport over Hong Kong", PATH model (PATHv2.1). The air pollutant concentrations in the Study Area, in reference to the PATH data in Year 2025, are summarized in **Table 3.5**.

Table 3.5 Background Air Pollutants in Year 2025 Extracted from the PATHv2.1 Model

Pollutant	Avg. Time	AQO [1]	Data Summary	PATHv2.1 Grid in Year 2025 [2]					
				41,35	41,36	40,38	41,38	41,39	42,39
Fine Suspended Particulates (FSP) [3][4]	24-hr	50 (18)[6]	Max.	**70**	**67**	**69**	**67**	**67**	**67**
			19th Max.	30	30	33	33	32	33
			No. of Exceedance(s)	6	6	6	6	6	6

Pollutant	Avg. Time	AQO [1]	Data Summary	PATHv2.1 Grid in Year 2025 [2]					
				41,35	41,36	40,38	41,38	41,39	42,39
	Annual	25	-	14	14	14	15	14	15
Respirable Suspended Particulates (RSP) [4]	24-hr	100 (9)	Max.	87	83	85	83	83	83
			10th Max.	61	62	62	63	62	64
			No. of Exceedance(s)	0	0	0	0	0	0
	Annual	50	-	27	26	26	27	26	27
Nitrogen Dioxide (NO_2)	1-hr	200 (18)	Max	178	140	140	138	144	145
			19th Max.	107	95	95	91	93	87
			No. of Exceedance(s)	0	0	0	0	0	0
	Annual	40	-	18	16	17	15	17	15

Remarks:
[1] Values in () mean the number of exceedances allowed per year.
[2] Bolded value indicates exceedance of the AQO.
[3] Annual FSP concentration is adjusted by adding 3.5 µg/m^3 with reference to "Guidelines on Choice of Models and Model Parameters".
[4] 10th highest daily and annual RSP concentration is adjusted by adding 10.3 µg/m^3 and 11 µg/m^3 respectively with reference to "Guidelines on Choice of Models and Model Parameters".
[5] All concentrations are in microgram per cubic metre (µg/m^3)
[6] The new AQO allows 35 days of exceedance per calendar year for daily FSP. Instead, government and related projects shall adopt a more stringent standard with the number of allowable exceedance of 18 days per calendar year

3.4 Identification of Air Sensitive Receivers

3.4.1 In accordance with Annex 12 of the EIAO-TM, any domestic premises, hotel, hostel, hospital, clinic, nursery, temporary housing accommodation, school, educational institution, office, factory, shop, shopping centre, place of public worship, library, court of law, sports stadium or performing arts centre are considered as ASRs.

3.4.2 In accordance with Clause 3.4.4.2 of the EIA Study Brief, the assessment area for air quality impact assessment should be defined by a distance of 500m from the boundary of the Project Area and the works of the Project. Illustration of the proposed assessment area is presented in **60604728/R42b/Figure 3.1.1 – 3.1.3**. For identification of the representative ASRs within the assessment area that would likely be affected by the potential impacts from the construction and operation of the Project, a review has been conducted based on the relevant available information including topographic maps, Outline Zoning Plans (OZPs), such as OZP Plan No. S/K18/21 – Kowloon Tong and S/K/23 – Wang Tau Hom & Tung Tau, and other published plans in the vicinity of the Project Site. The representative ASRs within the assessment area are identified and given in **Table 3.6** and **Table 3.7** below. Their locations on Kowloon and Shatin sides are illustrated in **60604728/R42b/Figure 3.1.1** and **60604728/R42b/Figure 3.1.2 – 3.1.3** respectively.

Table 3.6 Representative Air Sensitive Receivers at Kowloon Portal

ASR ID	Description	Land Use	Shortest Distance from Site Boundary (m)	Assessment Height (mAG)
A01	Eastland Heights	Residential	20	1.5, 5, 10, 20, 30
A02	Westland Heights	Residential	30	1.5, 5, 10, 20, 30
A03	Jumbo Court	Residential	25	1.5, 5, 10, 20, 30
A04	Block B, Alice Court	Residential	10	1.5, 5, 10, 20, 30

ASR ID	Description	Land Use	Shortest Distance from Site Boundary (m)	Assessment Height (mAG)
A05	Marple Court	Residential	10	1.5, 5, 10, 20, 30
A06	Block 2, Welcome Gardens	Residential	10	1.5, 5, 10, 20, 30
A07	Block 4, Lung Cheung Court	Residential	15	1.5, 5, 10, 20, 30
A08	Block 3, Lung Cheung Court	Residential	35	1.5, 5, 10, 20, 30
A09	Block 2, Lung Cheung Court	Residential	60	1.5, 5, 10, 20, 30
A10	Block A, Peninsula Heights	Residential	35	1.5, 5, 10, 20, 30, 40, 50
A11	Block 1, Meridian Hill	Residential	25	1.5, 5, 10, 20, 30
A12	Broadcast Drive Garden	Recreational	10	1.5
A13	Lung Cheung Road Park	Recreational	10	1.5
A14	Lion Rock Park	Recreational	90	1.5
A15	Lion Rock Archery Range	Recreational	45	1.5
A16	Lion Rock Baseball Field 1	Recreational	55	1.5
A17	Lion Rock Baseball Field 2	Recreational	10	1.5
A18	Planned Residential Development (NKIL 6579)	Residential	35	1.5, 5, 10, 20, 30, 40, 50, 60
A19	Vista Panorama	Residential	145	1.5, 5, 10, 20, 30, 40, 50
A20	Pearl Court	Residential	185	1.5, 5, 10, 20, 30, 40, 50
A21	Beverly Height	Residential	320	1.5, 5, 10, 20, 30, 40
A22	Le Chateau	Residential	215	1.5, 5, 10, 20, 30
A23	Lung Cheung Court Block 5	Residential	180	1.5, 5, 10, 20, 30
A24	Moonbeam Terrance Block B	Residential	220	1.5, 5, 10, 20, 30
A25	Block 6, Lung Cheung Court	Residential	165	1.5, 5, 10, 20
A26	Block 10, Lung Cheung Court	Residential	95	1.5, 5, 10, 20, 30
A27	Jumbo Court	Residential	50	1.5, 5, 10, 20, 30
A28	Beacon Hill School	Educational	245	1.5, 5, 10, 20, 30
A29	Orion Court	Residential	230	1.5, 5, 10, 20
A30	Arcadia Gardens	Residential	240	1.5, 5, 10, 20, 30, 40
A31	Hong Kong Baptist University	Educational	220	10, 20, 30[1]
A32	Verdun Villa	Residential	270	1.5, 5, 10, 20, 30, 40
A33	Pine Tree Gardens	Residential	325	5, 10, 20, 30, 40[2]
A34	Pine Tree Gardens	Residential	335	5, 10, 20, 30, 40, 50[2]

ASR ID	Description	Land Use	Shortest Distance from Site Boundary (m)	Assessment Height (mAG)
A35	Delite Court	Residential	460	1.5, 5, 10, 20, 30
A36	The Church of Jesus Christ of Latter-Day Saints	Community	455	1.5, 5, 10, 20, 30
A37	Cornwall Street Children's Playground	Recreational	415	1.5
A38	163 Waterloo Road	Residential	385	1.5, 5, 10
A39	Sir Run Run Shaw Building, HKBU	Educational	295	1.5, 5, 10, 20, 30
A40	Baptist Hospital Block A	Hospital	350	1.5, 5, 10, 20, 30
A41	Telephone Exchange	Commercial	390	1.5,5,10, 20
A42	155 Waterloo Road	Residential	430	1.5, 5, 10
A43	Yew Chung International Children's House	Educational	480	1.5, 5, 10
A44	149 Waterloo Road	Residential	525	1.5, 5
A45	Hong Kong Baptist Hospital Block D	Hospital	410	1.5, 5, 10, 20, 30, 40
A46	People's Liberation Army Kowloon East Barracks	Military	450	1.5, 5
A47	School of Continuing Education HKBU	Educational	410	1.5, 5, 10, 20
A48	Kowloon International Baptist Church	Community	420	1.5, 5, 10
A49	Shaw Tower, Hong Kong Baptist University	Educational	460	1.5, 5, 10, 20, 30, 40
A50	Broadcast Drive Playground	Recreational	415	1.5
A51	Chun Sing House, Tin Ma Court	Residential	100	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120
A52	Podium on Tin Ma Court Carpark	Recreational	155	10
A53	Wang Yiu House, Wang Tau Hom Estate	Residential	230	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80
A54	Tin Ma Court Commercial Centre	Commercial	305	5, 10, 20[2]
A55	Wang Tau Home Estate Wang Lai House	Residential	305	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80
A56	Ka Keung Court Block B	Residential	175	5, 10, 20, 30, 40, 50, 60, 70, 80, 90 100, 110, 120, 130, 140[3]
A57	Lok Sin Tong Yu Kan Hing Secondary School	Educational	175	1.5, 5, 10, 20
A58	Fook Tak Monastery	Community	420	1.5, 5
A59	CCC Rotary Secondary School	Educational	440	1.5, 5, 10, 20

Remark:
[1] ASR is located on artificial slope. No air-sensitive uses below 10 mAG.
[2] ASR is located on artificial slope. No air-sensitive uses below 5 mAG.
[3] Carpark at ground floor. No air-sensitive uses below 5 mAG.

Table 3.7 Representative Air Sensitive Receivers at Shatin Portal

ASR ID	Description	Land Use	Shortest Distance from Site Boundary (m)	Assessment Height (mAG)
A61	Hin Yau House, Hin Keng Estate	Residential	385	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100
A62	Hin Keng Shopping Centre	Recreational	445	1.5, 5, 10, 20
A63	64 Hin Tin	Village	410	1.5, 5, 10
A64	Hin Fu House, Hin Keng Estate	Residential	210	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100
A65	138 Hin Tin	Village	250	1.5, 5, 10
A66	Ka Wing House, Ka Tin Court	Residential	145	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100
A67	Helen Liang Memorial Secondary School (Sha Tin)	Educational	165	1.5, 5, 10, 20, 30
A68	Union Hospital	Hospital	30	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80
A69	House 1, Hill Paramount	Residential	20	10, 20[1]
A70	Parc Royale Tower 1	Residential	130	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80
A71	Block 2, Julimount Garden	Residential	40	1.5, 5, 10, 20, 30, 40, 50, 60, 70
A72	Block 4, Julimount Garden	Residential	30	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80
A73	Wai Sum House, Lung Hang Estate	Residential	220	1.5, 5, 10, 20, 30, 40, 50, 60
A74	Cypress Court, Worldwide Gardens	Residential	65	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80
A75	Laurel Court, WorldWide Gardens	Residential	5	10, 20, 30, 40, 50, 60, 70[2]
A76	Hung Mui Kuk Barbecue Area	Recreational	5	1.5
A77	King Sam House, King Tin Court	Residential	215	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90
A78	Golden Fortune Court, Golden Lion Garden	Residential	255	10, 20, 30, 40, 50, 60, 70, 80, 90[2]
A79	Village House at Hung Mui Kuk	Village	30	1.5, 5, 10
A80	Kak Tin Village	Village	10	1.5, 5, 10
A81	Koon Yam Kok, Kak Tin Village	Village	50	1.5, 5, 10
A82	Sha Tin Government Primary School	Educational	65	1.5, 5, 10, 20, 30
A83	Yu Wai House, Sun Tin Wai Estate	Residential	45	1.5, 5, 10, 20, 30, 40, 50, 60
A84	Foo Wai House, Sun Tin Wai Estate	Residential	40	1.5, 5, 10, 20, 30, 40, 50, 60, 70

ASR ID	Description	Land Use	Shortest Distance from Site Boundary (m)	Assessment Height (mAG)
A85	Wing Wai House, Sun Tin Wai	Residential	215	1.5, 5, 10, 20, 30, 40, 50, 60
A86	Yan Wai House, Sun Tin Wai	Residential	260	1.5, 5, 10, 20, 30, 40, 50, 60, 70
A87	Shatin Methodist College	Educational	210	1.5, 5, 10, 20, 30
A88	Fung Wai House, Sun Tin Wai	Residential	150	1.5, 5, 10, 20, 30, 40, 50, 60
A89	Shing Wai House, Sun Tin Wai	Residential	95	1.5, 5, 10, 20, 30, 40, 50, 60, 70
A90	Sha Tin Tau New Village	Village	10	1.5, 5, 10
A91	Wing Shing House, Fung Shing Court	Residential	35	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100
A92	Che Kung Temple Sports Centre	Recreational	305	1.5, 5, 10, 20
A93	Shek Jing House, Chun Shek Estate	Residential	310	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80
A94	Kwok Tak Seng Catholic Secondary School	Educational	220	1.5, 5, 10, 20
A95	Chun Shek Shopping Centre	Residential	285	1.5, 5, 10, 20
A96	104A Sha Tin Tau	Village	245	1.5, 5, 10
A97	Sha Tin Tau Village	Village	25	1.5, 5, 10
A98	Tsang Tai Uk	Village	215	1.5, 5, 10
A99	L Louey	Residential	455	1.5, 5, 10
A100	Hin Wan House, Hin Keng Estate	Residential	250	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120
A101	Hin Kwai House, Hin Keng Estate	Residential	200	1.5, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120

Remark:
[1] ASR is located on podium. No air-sensitive uses below 10 mAG.
[2] Carpark at ground floor. No air-sensitive uses below 10 mAG.

3.5 Identification of Environmental Impacts

<u>Construction Phase</u>

3.5.1 The Project comprises the construction of a new tunnel and upgrade of associated roads, rehabilitation/reconstruction of the two existing tunnel tubes, Kowloon-bound and Shatin-bound, and the widening of LRT Road. The constructions work would involve site clearance, site formation, excavation, slope works, tunneling works by Tunnel Boring Machine (TBM) for new tunnel tube, drill and break on existing tunnel tubes, superstructure construction such as administration buildings, ventilation building and road widening. Among these works, the dominant dust source would be associated with excavation, spoil handling and wind erosion of exposed works areas, while the dust emission associated with superstructure construction is considered minor. The tentative working hours would be 07:00 to 19:00 from Monday to Saturday for general works sites, 24-hour a day for tunneling works by TBM. The TBM launching shaft is proposed at Shatin portal which is further away from any ASRs such that its direct impact on ASR is minimized.

3.5.2 A 60-meter TBM launching shaft at Shatin Portal will be mined by drill and break while a 100-meter tunnel at Kowloon Portal will be mined for TBM break out. These drill and break works will involve wet drilling, handling of excavated material and unpaved haul road. Similarly, the existing Kowloon-bound tunnel tube will be enlarged by drill and break as well which also involves wet drilling, handling of excavated material and haul road inside the tunnels. Unlike the unpaved nature of new tunnel, the paved surface of existing tunnels can be maintained as paved haul roads for dump trucks. These dust emission sources due to drill and break operations was considered in modelling assessment. For the existing Shatin-bound tunnel, there will be no enlargement works. Only possible repairing works concerning internal structures are to be conducted, which are subject to the detailed structural inspection to be carried after the full closure of the tube. Possible repairing works are not likely to occur for the whole Shatin-bound tunnel and might include removal and replacement of overhead ventilation duct slab, tunnel road slab, injection of grout at defect location and spray membrane. These dust emission sources due to repairing works was considered in the modelling assessment.

3.5.3 The new tunnel tube will be excavated and constructed by TBM 24-hour a day. For a Mixshield slurry type TBM, excavated boulders will be crushed inside TBM, mixed with the slurry and then hydraulicly removed through a closed slurry circuit. The excavated material will be wet in nature and conveyed by conveyor system to the stockpiling area for loading to dump trucks and transport to Lam Tei Quarry. Given the closed system of TBM and wet nature of the slurry generated, the dust emission associated with the tunneling works by TBM and the subsequent conveying and handling of excavated material is expected minimum. Therefore, the tunneling works by TBM was not considered in the modelling assessment.

3.5.4 Based on the tentative construction programme, the whole construction period is from Year 2025 to Year 2034. The construction of associated utilities and superstructures, e.g. administrative buildings and ventilation buildings at portals, will be carried out between Year 2025 to Year 2028. The tunneling of the new middle tunnel by TBM is envisaged to commence in 2027. Upon the commissioning of the new tunnel tube in Year 2029 for 2-lane Kowloon bound, the original Kowloon-bound tunnel will be closed down for the enlargement work and rehabilitation, and commission 3-lane tunnel in Year 2034. The new middle tunnel will be temporarily closed off for minor modification works to 3 lanes and be commissioning in Year 2034 for Shatin bound, together with the closure of Shatin-bound tunnel. The original Shatin-bound tunnel will be closed off for refurbishment, expected to be completed by Year 2034 and reserved for emergency use. Alongside with these tunnel works, the road widening of Lion Rock Tunnel Road at Shatin side (except toll plaza area) will commence in December 2028 and complete by Year 2033. Details of the tentative construction programme is presented in **Appendix 3.1**.

3.5.5 The abovementioned construction programme will maintain the trans-regional traffic between Kowloon and Sha Tin uninterrupted during the construction phase and the 4-lanes will be maintained during the interim period. Given heavy traffic between the regions, the portal emission, exhaust from ventilation buildings and the open road emission, from both project and existing roads, would also contribute significant particulates to the ambient, cumulative with the construction dust impact brought by the construction activities.

Concurrent Projects

3.5.6 *Revised Trunk Road T4 and associated Improvement Works in Sha Tin* Project (hereafter “T4”) is the concurrent project nearby, which has major improvement work to Sha Tin Road near Pok Hong Estate. The location of T4 is illustrated in **60604728/R42b/Figure 2.16**. The construction will commence in Year 2023 for completion in September 2028. Given the far distance from LRT Shatin portal, i.e. more than 2km away, construction works of T4 would not be a cumulative issue to the tunneling work and associated works taken place at the toll plaza. Furthermore, the road widening works for LRT Road will commence in December 2028, where its major dusty works start in June 2029 after the completion of T4 in September 2028. There would be no concurrent works of T4 expected during the construction phase of the Project. Construction works of T4 were therefore not considered in the modelling assessment.

3.5.7 *In-situ Reprovisioning of Sha Tin Water Treatment Works – South Works* (STWTW) by WSD is another concurrent project in Shatin, near the Shatin portal of LRT. The location of STWTW is illustrated in **60604728/R42b/Figure 2.16**. The main works commenced in August 2020 for completion in January 2025 and landscaping works will be completed by 2027 tentatively. With the confirmation by WSD, there should be no project interfacing between STWTW and the Project, i.e. no concurrent construction works is expected. Therefore, it was not considered in the modelling assessment.

3.5.8 *The Proposed Drainage Improvement Works at Chui Tin Street and Chui Tin Street Soccer Pitch* by DSD is the project to upgrade the stormwater drainage systems at Chui tin Street. The location of the Proposed Drainage Improvement Works at Chui Tin Street and Chui Tin Street Soccer Pitch is illustrated in **60604728/R42b/Figure 2.16**. The construction works is tentatively scheduled to commence in Year 2023 for phased completion in Year 2031. The proposed 900-metre box culvert will be completed section by section where the workfront is restricted to 20 – 30 metres each. Given the small scale of construction works, the cumulative dust impact is expected to be minor. It is therefore not considered in the modelling assessment.

3.5.9 *Relocation of Diamond Hill Fresh Water and Salt Water Service Reservoirs to Cavern* (DHSRs) by WSD is the other concurrent project in Kowloon, which constructs and relocates the DHSRs into the cavern. The location of DHSRs is illustrated in **60604728/R42b/Figure 2.16**. The tunnel portal of relocated DHSRs is proposed next to Lion Rock Park Transit Nursery. The construction is tentatively scheduled to commence in 2022 and the major dusty construction works will be completed by 2026. The major dust source of DHSRs within 500m study area of the Project would be the portal emission close to Lion Rock Park Transit Nursery, which is due to the cavern construction scheduled to complete by Year 2026. Based on the tentative construction programme of the Project, the construction activities to be undertaken before 2026 would be the site formation works for the new ventilation building at Kowloon portal and mined tunnel for TBM break out, which are 400 metres away from the tunnel portal of relocated DHSRs. In order to address the cumulative dust impact at the late stage of DHSRs, the remaining works, including the portal emission close to Lion Rock Park Transit Nursery and its mains laying works, were considered in the modelling assessment.

Existing Emission Sources

3.5.10 Abundant land uses in the vicinity are residential, schools, villages and country park. Existing chimneys are identified at Hong Kong Baptist University Campus, Hong Kong Baptist University Hospital and Union Hospital within 500m study area. Locations of identified chimney are illustrated in **Appendix 3.8**. Referring to the feedback from Union Hospital, the chimney is for the generator set which is in standby for any emergency, such as power failure. Thus, it was not considered in the modelling assessment. Only existing chimneys near Kowloon Portal were considered in the modelling assessment.

3.5.11 There are also major stack sources within 4 km from the project boundary, which may contribute to the ambient air quality in the study area. The identified 4-km stack sources include Fu Shan Crematorium on Shatin side, and Diamond Hill Crematorium and Ma Tau Kok Town Gas Plant on Kowloon side. However, these 4-km sources are all sheltered by hills, which have no direct line of sight to the study area. No direct impact from these sources on the study area is anticipated. Thus, they were not considered in the modelling assessment.

Identification of Key Air Pollutants of Emission from Construction Activities

3.5.12 Major construction activities such as excavation, spoiling handling and wind erosion cause potential fugitive emission in particulates. On-site use of diesel-powered engines is also the potential source for other gaseous pollutants, such as NO_2, SO_2, CO and smoke. The emission in NO_2, CO and particulates are regulated under the Air Pollution Control (Non-road

Mobile Machinery) (Emission) Regulation. Fuel with sulphur content not exceeding 0.005% by weight will be used to minimize SO_2 emission in accordance with the *Air Pollution Control (Fuel Restriction) Regulation*. Thus, particulates from construction activities would be the major air pollutant during construction phase. According to Annex 4 of the EIAO-TM, Total Suspended Particulates (TSP) is the criteria pollutant for construction dust impacts, in addition to the AQOs. Quantitative assessments of TSP, as well as the other particulates fraction, Respirable Suspended Particulates (RSP) and Fine Suspended Particulates (FSP) stipulated in AQOs, are to be conducted for assessing construction dust impact due to the Project.

Operation Phase

3.5.13 Vehicular emission is the dominant source of air pollutants within 500m study area from the Project boundary. Open road emission associated with the Project includes LRT Road on both Kowloon and Shatin side, toll plaza, new or modified slip roads. The widening of tunnels and connecting roads would enhance the traffic flow, in particular an increase of traffic at peak hours, which results in higher emission in short term. Other open road emission sources are the existing major roads, including Lung Cheung Road and Waterloo Road on Kowloon side, and Hung Mui Kuk Road and Sha Tin Road on Shatin side.

3.5.14 Vehicular emission inside the tunnel are the same emission as the one on open roads but released in manner via portals and ventilation buildings. The ventilation exhaust on Kowloon side is designed to be released towards the Lion Rock in 45 degrees upward, facing away nearby ASRs such that its direct impact on ASR is minimized. The ventilation exhaust on Shatin side is designed to be released vertically, given sufficient distance from any ASRs nearby. The emission strengths of these sources are subject to the split of exhaust between portals and ventilation buildings on both Kowloon and Shatin sides according to engineering design.

Concurrent Projects

3.5.15 T4 would have completed and commissioned by the time of Project completion. The vehicular emission associated with T4 was considered in the modelling assessment.

3.5.16 It is anticipated that there is no air pollutant emission due to the operation of STWTW, the Proposed Drainage Improvement Works at Chui Tin Street and Chui Tin Street Soccer Pitch and DHSRs. Vehicle access is expected for the purpose of operation and maintenance, however, only minor traffic is anticipated. This traffic was incorporated in the traffic forecast and was considered in the modelling assessment.

Identification of Key Air Pollutants *of Vehicular Emission*

3.5.17 Vehicular emission comprises several pollutants, including Nitrogen Oxides (NO_X), RSP, FSP, Sulphur Dioxides (SO_2), Carbon Monoxide (CO), Lead (Pb), Toxic Air Pollutants (TAPs), etc. According to "An Overview on Air Quality and Air Pollution Control in Hong Kong" published by EPD [1], one of the major air pollution issues is the local street-level pollution. Motor vehicles, especially diesel vehicles, are the main sources of these pollutants at street level in Hong Kong. For other pollutants such as Diesel Particulate Matters (DPM), Polycyclic Aromatic Hydrocarbons (PAHs) and Volatile Organic Compounds (VOCs), due to the low concentration in vehicular emission, they are not considered as key pollutants for the purpose of this study.

3.5.18 **Nitrogen oxides (NO_X)** is a major pollutant from fossil fuel combustion. According to the 2019 Hong Kong Emission Inventory Report published by EPD[2], marine vessels and public electricity generation are the largest NOx emission sources and accounted for 35% and 30%

[1] https://www.epd.gov.hk/epd/english/environmentinhk/air/air_maincontent.html
[2] https://www.epd.gov.hk/epd/english/environmentinhk/air/data/emission_inve.html

of the total emission in 2019, respectively. Vehicles were also a major NOx emission source, accounting for 16% of the total.

3.5.19 In the presence of O_3 and VOC, NOx would be converted to NO_2. Increasing traffic flow would inevitably increase the NOx emission and subsequently the roadside NO_2 concentration. Hence, NO_2 is one of the key pollutants for the operational air quality assessment of the Project. 1-hour and annual average NO_2 concentrations at each identified ASRs would be assessed and compared with the relevant prevailing AQOs to determine the compliance.

3.5.20 **Respirable Suspended Particulates (RSP)** refers to suspended particulates with a nominal aerodynamic diameter of 10µm or less. According to the 2019 Hong Kong Emission Inventory Report published by EPD, marine vessels was the largest RSP emission source and accounted for 28% of the total emissions in 2019. Non-combustion sectors replaced public electricity generation as the 2nd major RSP emission sources, accounting for 26% of the total emission in 2019. Road transport is also a major RSP emission source, accounting for 9% of the total emission in 2019.

3.5.21 Increase in traffic flow would inevitably increase the roadside RSP concentrations. Hence, RSP is a key pollutant for the operational air quality assessment of the Project. The 24-hour and annual average RSP concentrations at each identified ASR would be assessed and compared with the relevant prevailing AQO to determine the compliance.

3.5.22 **Fine Suspended Particulates (FSP)** refers to suspended particulates with a nominal aerodynamic diameter of 2.5µm or less. According to the 2019 Hong Kong Emission Inventory Report published by EPD, navigation was the largest FSP emission source and accounted for 35% of the total emissions in 2019. Road transport is also a major FSP emission source, accounting for 11% of the total emission in 2019.

3.5.23 Similar to the RSP, increasing traffic flow would increase the roadside FSP. Hence, FSP is also a key pollutant for the operational air quality assessment of the Project. The 24-hour and annual averaged FSP concentrations at each identified ASR would be assessed and compared with the relevant prevailing AQO to determine the compliance.

3.5.24 **Sulphur dioxide (SO_2)** is formed primarily from the combustion of sulphur-containing fossil fuels. In Hong Kong, power stations and marine vessels are the major sources of SO_2, followed by aviation and other combustion. SO_2 emission from vehicular exhaust is due to the sulphur content in diesel oil. According to the 2019 Hong Kong Emission Inventory Report released by EPD, SO_2 emissions from vehicles had been substantially reduced by 80% between 2001 and 2019, due to substantial efforts in capping sulphur content in liquid fuel and launching of emission capping programme on power plants. Electricity generation and marine vessels are currently the largest SO_2 emission sources accounting for 63% and 28% of total emission in 2019.

3.5.25 As of 1 July 2010, EPD has tightened the statutory motor vehicle diesel and unleaded petrol specification to EURO V level, which further tightens the cap on sulphur content from 0.005% to 0.001 %. In view that road transport only contributes a very small amount of SO_2 emission, less than 0.5% of total emission in 2018, relatively low measured concentrations and the adoption of low-sulphur and ultra-low-sulphur fuel under the existing government policy, SO_2 would not be a critical air pollutant of concern.

3.5.26 **Carbon Monoxide (CO)** is a typical pollutant emitted from fossil fuel combustion and comes mainly from vehicular emissions. With reference to the “Air Quality in Hong Kong 2020”, the highest 1-hour average (2,850 µg/m^3) and the highest 8-hour average (1,685 µg/m^3) CO concentrations were recorded at Causeway Bay monitoring station; these values were around one tenth and one fifth of the respective AQO limits. In view that there is still a large margin to the AQOs, CO would not be a critical air pollutant of concern.

3.5.27 **Ozone (O_3)** is produced from photochemical reaction between NOx and VOCs in the presence of sunlight, which will not be generated by this Project. Concentration of O_3 is governed by both precursors and atmospheric transport from other areas. When precursors transport under favorable meteorological conditions and sunlight, ozone will be produced. This explains why higher ozone levels are generally not produced in the urban core or industrial area but rather at some distance downwind after photochemical reactions have taken place. In the presence of large amounts of NOx in the roadside environment, O_3 reacts with NO to give NO_2 and thus results in O_3 removal. O_3 is therefore not considered as a key air pollutant for the operational air quality assessment of a road project.

3.5.28 **Lead (Pb)** is not considered as a critical air pollutant of concern. The sale of leaded petrol has been banned in Hong Kong since April 1999. According to the "Air Quality in Hong Kong 2019", the annual averages were ranging from 10 ng/m^3 (in Central/Western) to 11 ng/m^3 (in Tsuen Wan). The measured concentrations were well below the AQO limits of 500 ng/m^3.

3.5.29 **Toxic Air Pollutants (TAPs)** is a type of the pollutants found in vehicular exhaust, which are known or suspected to cause cancer or other serious health and environmental effects. With reference to EPD's Assessment of Toxic Air Pollutant Measurements in Hong Kong Final Report, 2003[3], monitored TAPs in Hong Kong include diesel particulate matters (DPM), toxic elemental species, dioxins, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), carbonyls, and volatile organic compounds (VOCs). According to the results of Assessment of Toxic Air Pollutant Measurements in Hong Kong Final Report and Sources of PCB emissions[4], vehicular emission is not considered as primary source of dioxins, PCBs, carbonyls and most toxic elemental species in Hong Kong. Therefore, these pollutants are not considered as key pollutants for quantitative assessment for the operation phase of a road project.

3.5.30 **Diesel Particulate Matters (DPM)**, as part of the overall Respirable Suspended Particulates (RSP), is one of the most important parameters contributing to the overall health risk of the population. Local vehicular emission is one of the major sources of DPM.

3.5.31 As recommended by EPD's Assessment of Toxic Air Pollutant Measurements in Hong Kong Final Report, 2003, elemental carbon (EC) is used as a surrogate for DPM, and with reference to Measurements and Validation for the Twelve-month Particulate Matter Study in Hong Kong, 2017, EC was high in the past but reached a steady level in 2008 and showed a declining trend from 2011 to 2017. With the continual efforts by EPD to reduce particulate emission from the vehicular fleet, a discernible decreasing trend is noted in the level of particulate matter. Therefore, DPM is not selected as representative pollutant for quantitative assessment for this project.

3.5.32 **Polycyclic Aromatic Hydrocarbons (PAHs)** are organic compounds of two or more fused benzene rings, in linear, angular or cluster conformations. Local vehicular traffic is also an important source of PAHs. For this group, the most important PAH is Benzo[a]pyrene, and it is often selected as a marker for the PAHs in EPD's Assessment of Toxic Air Pollutant Measurements in Hong Kong Final Report, 2003. The EU Air Quality Standards for PAHs (expressed as concentration of Benzo[a]pyrene) is 1 ng/m^3 for annual average[5]. With reference to "Air Quality in Hong Kong 2019", annual average concentrations of PAHs (Benzo[a]pyrene) measured at EPD's TAP monitoring stations (Tsuen Wan and Central/Western) were 0.02 ng/m^3 and 0.03 ng/m^3, which is far below the EU Standards. Thus, PAHs are not considered as key pollutants for quantitative assessment for this project.

3.5.33 **Volatile Organic Compounds (VOCs)** are of great concern due to the important role played by them in a range of health and environmental problems. The US EPA has designated many

[3] https://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentinhk/air/studyrpts/files/tapfr1.pdf
[4] http://www.eea.europa.eu/publications/EMEPCORINAIR5/Sources_of_PCB_emissions.pdf/view
[5] https://ec.europa.eu/environment/air/quality/standards.htm

VOC, including those typically found in vehicular emission, as air toxics. According to Assessment of Toxic Air Pollutant Measurements in Hong Kong Final Report, 2003, among the VOC compounds, benzene and 1,3-butadiene are the most significant ones for Hong Kong. The UK Air Quality Standards for benzene and 1,3-butadiene are 5.0 $\mu g/m^3$ and 2.25 $\mu g/m^3$ respectively [6]. According to "Air Quality in Hong Kong 2019", annual average concentrations of benzene at EPD's TAP monitoring stations (Tsuen Wan and Central/Western) were 1.03 $\mu g/m^3$ and 1.08 $\mu g/m^3$. The levels of 1,3-butadiene were 0.04 $\mu g/m^3$ and 0.06 $\mu g/m^3$ for Central/Western and Tsuen Wan districts respectively. They are far below the UK Standards. Thus, VOCs are not considered as key pollutants for quantitative assessment for this project.

Key Pollutants in Tunnel and Full Enclosure

3.5.34 NO_X as a major pollutant from tailpipe, release in a semi-confined space, such as tunnel and full enclosure would inevitably increase the concentration inside. Therefore, NO_2 is one of the key pollutants for in-tunnel air quality assessment and compared against the TAQG.

3.5.35 With more stringent control on the sulphur content in fuel, tailpipe SO_2 emission has been further reduced as of 1 July 2010. Referring to *Practice Note on Control Air Pollution in Vehicle Tunnels* issued by EPD, continuous monitoring of SO_2 is normally not required considering the traffic mix in Hong Kong as SO_2 emission in tunnel is expected to be limited. Therefore, SO_2 is not considered as key pollutant for in-tunnel air quality assessment in this study.

3.5.36 CO is a typical pollutant from tailpipe due to fossil fuel combustion. In view of the ratio CO (5-minute) concentration to NO_2 (5-minute) concentration in TAQG is 64, while the emission rate of CO is only on average 4 times of emission rate of NO_X according to the EMFAC v4.3. Therefore, CO would comply with TAQG if NO_2 concentration complies with the criterion. Hence, CO is not considered as key pollutant for in-tunnel air quality assessment in this study. Moreover, continuous measurement of CO would be conducted inside the tunnel according to the monitoring requirements of *Practice Note on Control of Air Pollutant in Vehicle Tunnels* issued by EPD to ensure the compliance of TAQG.

3.6 Assessment Methodology

<u>Construction Phase</u>

Construction Dust

3.6.1 Construction activities with significant particulate emission are to be identified from the construction method according to engineering design. Construction dust impact will be predicted based on emission factors from US Environmental Protection Agency (USEPA) Compilation of Air Pollution Emission Factors (AP-42), 5th edition and activity information from the engineer design. The major construction activities of concern include site clearance, site formation, excavation, slope works and construction vehicle movement, and were considered in the assessment as heavy construction activities during working hours. Wind erosion of open construction work site was considered during non-working hours. The drill and break works involve wet drilling, handling of excavated material and unpaved / paved haul roads. The relevant emission factors identified from AP-42 are summarized in **Table 3.8**. Detailed calculation of dust emission sources are presented in **<u>Appendix 3.3</u>**.

[6] https://uk-air.defra.gov.uk/assets/documents/Air_Quality_Objectives_Update.pdf

Table 3.8 Emission Factor for Dusty Construction Activities

Emission Source	Activity	Emission Factor	Remarks
Site clearance, site formation, excavation, slope works	Heavy Construction Activities	E(TSP) = 2.69 Mg/hectare/month of activity	Ref. from AP-42, Section 13.2.3, 1/95 ed.
	Wind Erosion	E(TSP) = 0.85 Mg/hectare/year	Ref. from AP-42, Section 11.9, 11/06 ed.
Drill and break on TBM launching shaft, break-out shaft and enlargement of existing Kowloon-bound tunnel	Wet Drilling	E(TSP) = 3.99 x 10^{-4} kg/Mg	Ref. from Table B-5, Emissions from the Crushed Granite Industry: State of the Art.
	Spoil Handling	E(TSP) = 9.26 x 10^{-5} kg/Mg	By formula ref. from AP-42, Section 13.2.4, 11/06 ed.
	Unpaved Haul Road	E(TSP) = 3.30 g/vehicle-meter-travelled	By formula ref. from AP-42, Section 13.2.2, 11/06 ed.
	Paved Haul Road	E(TSP) = 0.645 g/vehicle-meter-travelled	By formula ref. from AP-42, Section 13.2.1, 1/11 ed.
Repairing Works of existing Shatin-bound tunnel	Heavy Construction Activities	E(TSP) = 2.69 Mg/hectare/month of activity	Ref. from AP-42, Section 13.2.3, 1/95 ed. Scale of work subject to detailed structural inspection. Assume repairing work at 20% area of the tunnel

3.6.2 Construction dust emission factors in United States Environmental Protection Agency (USEPA) AP-42 are expressed in terms of TSP. Fractions of finer particulates are to be estimated from the TSP emission factor with the size distribution of the concerned process, in order to compare against the AQOs. Construction activity generally involves aggregate handling, therefore the particle size distribution of aggregate handling, which is available in AP-42 by USEPA, is adopted for heavy construction activities. Particle size distribution of construction dust is listed in **Table 3.9**.

Table 3.9 Particle Size Distribution for Construction Dust

Process	Cumulative % of TSP		
	RSP	FSP	Reference
Aggregate Handling (equivalent to Heavy Construction Activities)	47.3%	7.2%	Page 13.2.4-4, Section 13.2.4, AP-42, USEPA (Version 11/06)

3.6.3 Based on the tentative construction programme, the construction activities would peak in Year 2027, in particular the demand on dump truck, which causes the significant emission during the construction period. Thus, Year 2027 is selected as the assessment year of the construction phase.

3.6.4 All construction works areas were assumed to be working in full capacity and to be conducting simultaneously for the assessment purpose. 12 hours (07:00-19:00) a day, 7 days a week was assumed for the construction period in the modelling assessment. Wind erosion is assumed for the other non-working hours (19:00 to 07:00 of the following day).

Concurrent Projects

3.6.5 The emission inventory of DHSRs, including dust sources due to cavern construction and mains laying works, was adopted directly from its EIA report (Register No. EIA-271/2021) and is presented in **Appendix 3.4**.

Vehicular Emission

3.6.6 As discussed in **Section 3.6.3**, the demand on dump truck will peak in Year 2027 to transport the excavated material from the tunneling works by TBM to Lam Tei Quarry. Additional traffic will be generated by these dump trucks. According to the Project design, all dump trucks will be travelling from Shatin to Lam Tei Quarry via Lion Rock Tunnel Road, Eagle Nest Tunnel and Shing Mun Tunnel, which is the shortest and practical construction traffic route requiring no detouring and also away from travelling within a densely populated Kowloon Area (i.e. Lung Cheung Road) before arriving at Lam Tei Quarry. Traffic forecast for Year 2027 incorporated with these induced traffic was adopted for the assessment. The traffic data is presented in **Appendix 3.2**. As a worst-case assumption during the construction period (Year 2025 – Year 2034), the vehicular emission factor of Year 2025 was coupled with the traffic data of Year 2027 for the estimation of emission rates.

3.6.7 Vehicular emission from open roads, existing portals and ventilation buildings and start emission, was estimated with the same approach adopted for Operation Phase. Detailed methodology refers to **Section 3.6.16 – 3.6.33**. The detailed calculation of vehicular emission source is presented in **Appendix 3.5** and **Appendix 3.7**.

Chimney Emission

3.6.8 Chimneys identified within 500m study area in Kowloon include Hong Kong Baptist University Campus, Hong Kong Baptist Hospital and their locations are illustrated in **Appendix 3.8**. Their stack parameters were obtained from their owners / operators. These sources were considered as point sources in the modelling assessment. Referring to the feedback from Union Hospital, the chimney is for the generator set which is in standby for any emergency, such as power failure. Thus, it was not considered in the modelling assessment. In addition, there is no boiler or Towngas / diesel boiler installed in the hospital.

Dispersion Modelling and Modelling Approach for Construction Dust

3.6.9 According to Guidelines on Assessing the 'TOTAL' Air Quality Impacts by EPD, an integrated modelling system PATHv2.1 which is developed and maintained by EPD was applied to provide background pollutant concentrations in assessing the total impact in the study area. In addition, Weather Research and Forecast (WRF) meteorological data were adopted for modelling.

3.6.10 American Meteorological Society (AMS) and U.S. Environmental Protection Agency (EPA) Regulatory Model (AERMOD), the HKEPD approved air dispersion model, was applied to predict the air quality impacts at the representative ASRs due to the Project. Hourly average of TSP, daily and annual averages of RSP and FSP concentrations were predicted at each identified ASRs at various assessment height, ranging from 1.5 metres to 30 metres above ground.

3.6.11 Hourly meteorological conditions including wind data, temperature, relative humidity, pressure, cloud cover and mixing height of Year 2015 were extracted from the WRF meteorological data adopted in the PATHv2.1 system. The dataset by WRF should be intact and consistent among parameters. In order to avoid any hours misidentified as missing data by AERMOD and its associated components, the WRF met data were handled manually to set wind direction between 0° – 0.1° to be 360°. The height of the input data was assumed to be 9 metres above ground for the first layer of the WRF data as input.

3.6.12 The wind speed and mixing heights in the WRF data were further adjusted before meteorological pre-processing by AERMET. The minimum wind speed was capped at 1 metre per second. The mixing height was capped between 131 metres and 1941 metres according to the observation in Year 2015 by HKO. After pre-processed by AERMET, the mixing height was verified once again and adjusted to the capped range if necessary.

3.6.13 Surface characteristic parameters such as albedo, Bowen ratio and surface roughness are required in the AERMET. The parameters are determined according to land use classified for the surrounding and the latest AERMOD Implementation Guide. The determination of the surface characteristics Parament is presented in **Appendix 3.9**. Terrain option was applied in AERMOD, to where the base elevation of receptors and sources were input.

3.6.14 As particulates are concerned, dry deposition was applied in the model run. Particle size distribution is assigned for particles with aerodynamic diameters smaller than 10 µm to each type of source in the AERMOD in order to account for the particle deposition. The particle size distributions for construction dust are summarized in **Table 3.10**.

Table 3.10 Particle Size Distribution of Aggregate Handling (equivalent to Heavy Construction Activities and Wind Erosion)

Average Particle Diameter (µm)	Normalized Distribution
1.25	7%
3.75	20%
7.5	20%
12.5	18%
22.5	35%

Remarks:
[1] Reference from Table of Aerodynamic Particle Size Multiplier (k) for Equation 1, Section 13.2.4-4, AP-42, USEPA

Cumulative impact of Criteria Air Pollutants

3.6.15 Cumulative air pollutant concentration at ASRs is to be derived by the sum of contributions by construction works, vehicular emission, concurrent projects, nearby chimneys, and background contribution from PATHv2.1 system on hour-by-hour basis. Averaging results, namely daily and annual, are derived from the cumulative hour-by-hour results in accordance with Title 40, Code of Federal Regulations, US Environmental Protection Agency (USEPA 40 CFR) Part 51 “Revision to the Guideline on Air Quality Models, January 2017”. If the total number of valid hours is less than 18 for 24-hour average, the total concentration should be divided by 18 for the 24-hour average. For annual average, the sum of all valid hourly concentrations is divided by the number of valid hours during the year. For daily average, cumulative results at each ASR amongst 365 days are ranked by highest concentration and compared with the maximum allowable concentration to determine the number of exceedance throughout a year. The air quality impact on ASRs is evaluated by number of exceedance per annum against the AQO criteria.

Operation Phase

Vehicular Emission from Open Roads

3.6.16 The key air pollutant associated with vehicular emission are NO_2, RSP and FSP. Major road emission sources within 500m study area include LRT Road, toll plaza, Lung Cheung Road and Waterloo Road on Kowloon side, and Hung Mui Kuk Road and Sha Tin Road on Shatin side.

3.6.17 EMFAC-HK v4.3 was adopted to estimate the vehicular emission factors in NO_X, NO_2, RSP and FSP in various travelling speeds, and the worst ambient conditions, i.e. the lowest temperature and relative humidity for each season with reference to the observation in Year 2019 by HKO meteorological stations, namely King's Park Station and Sha Tin Station. The emission factor in NO was then derived by assuming NO_X consists of NO and NO_2 only.

3.6.18 The traffic data for each road in 500m study area comprises 24-hour traffic flow with vehicle percentage, travelling speed in 18 vehicle classes and is presented in **Appendix 3.2**. Transport Department (TD) agreement on the adopted traffic data is also presented in the appendix. With reference to the traffic data, hourly emission factor of each open road was determined by summation of emission by each vehicle class which is product of traffic flow and emission factor at specific speed and ambient condition. The hourly emissions factors of NO, NO_2, RSP and FSP were further divided by the hourly flow to obtain a composite emission rate in gram per miles per vehicle, ready for input to the dispersion model. The detailed calculation of vehicular emission source is presented in **Appendix 3.14**.

Start Emission

3.6.19 Start emission refers to the air pollutants generated due to the ignition of the vehicle engines which is released at vehicle tailpipes. Franchised bus is generally higher in start emission among all 18 vehicle classes. The start emission is of concern particularly at locations where engine start frequently takes place, for example termini of franchised buses. No PTI exists in the 500m study area but small bus termini including Hin Keng Bus Terminus (5 routes), Sun Tin Wai Bus Terminus (3 routes), Chun Shek Bus Terminus (3 routes) and Sun Chui Bus Terminus(1 route) on Shatin side, and Broadcast Drive Bus Terminus (1 route) on Kowloon side. Apart from bus terminus, there are also minibus termini, namely Hin Tin Village Minibus Terminus (3 routes), Julimount Garden Minibus Terminus (2 routes), Worldwide Garden Minibus Terminus (1 route) on Shatin Side and Broadcast Drive (2 routes) on Kowloon side. Given the limited number of bus / minibus routes serviced, the start emission in these termini are considered minor. The locations of these bus termini are illustrated in **Appendix 3.23**.

3.6.20 Start emission generally occurs on the local road where there is a potential trip start, while no start emission along district distributor or expressway is anticipated. For the assessment purpose, start emission was assumed at all local roads irrelevant to the actual location of engine start. Also, all vehicle classes were assumed to have potential trip start on local road, including public transport which usually starts its engine at its termini throughout its service route.

3.6.21 Start emission factors of 18 vehicle classes at various soak times were extracted from EMFAC-HK v4.3, among which the highest factor is adopted for a vehicle class. Frequency of start emission of a vehicle type on a road is estimated by its forecasted VKT and Trips/VKT ratio extracted from Traffic Census. Detailed estimation of start emission is presented in **Appendix 3.14**.

Emission from Proposed Portals and Ventilation Buildings

3.6.22 The estimation of vehicular emission rates from portals and ventilation buildings followed the same approach for the open road. Instead, the total emission along a tunnel was determined by the product of composite emission rate, traffic flow and the length of the tunnel tube. The emission factors of winter was adopted as a conservative assumption. Subject to the performance of ventilation system by design, the total emission is split by proportion among portals and ventilation buildings. According to the latest engineering design, the split ratio of portal to ventilation building is 3:7 and 2:8 for northbound and southbound tunnels respectively. The detailed calculation of portal and ventilation emission sources, and design of ventilation buildings by engineers, e.g. exhaust velocity and height, are presented in **Appendix 3.16**.

The parameter of the ventilation buildings at Kowloon and Shatin portals are summarized in **Table 3.11**.

Table 3.11 Design Parameters of Ventilation Buildings at Both Portals

Design Parameters	Ventilation Building At Sha Tin Portal for Shatin Bound Tunnel	Ventilation Building At Kowloon Portal for Kowloon Bound Tunnel
Building Height (mPD)	127	121
Base Elevation (mPD)	98	94
Release Height (mAG)	29	27
Exhaust Split Ratio (portal to vent bldg.)	3:7	2:8
Angle of Release	Vertical	45 degrees upward (towards Lion Rock)
Temperature of Release	Ambient	Ambient

Chimney Emission

3.6.23 Details in chimney emission refer to **Section 3.6.8**.

Determination of Assessment Year

3.6.24 The Project is expected to fully commission with 6 lanes in Year 2034. The assessment year will be determined by the year with the highest vehicular emission burden in the study area in 15 years after commissioning, i.e. Year 2034 – Year 2049. With reference to the TIA, the traffic forecast showed that the traffic in the study area would peak in Year 2041, owing to the peak of Hong Kong population in Year 2041 and decreasing trend afterwards, referring to *Hong Kong Population Projections* by Census and Statistics Department. Therefore, the vehicular emission burdens of NO_X, RSP and FSP for Year 2034, Year 2038 and Year 2041 were estimated with EMFAC-HK v4.3 and are presented in **Table 3.12**. The traffic data is presented in **Appendix 3.2** and the assumption adopted in EMFAC-HK is presented in **Appendix 3.14**. Year 2034 was selected as the assessment year, which had the highest vehicular emission burden in NOx, RSP and FSP in 15 years after commencement.

Table 3.12 Vehicular Emission Burden in the Study Area

Year	Vehicular Emission Burden (kg per day)		
	NOx	RSP	FSP
2034	176.4	5.8	5.3
2038	150.2	4.3	3.9
2041	154.1	4.4	4.0

Dispersion Modelling and Modelling Approach for Open Road

3.6.25 CALINE4, the HKEPD approved air dispersion model for road source developed by the California Department of Transport, was used to assess the contribution due to vehicular emission from road networks within 500m study area.

3.6.26 The surface roughness is dependent on the land use characteristics, which is estimated to be 10% of average height of physical structure within 1 km radius of the Subject Site. Typically, the value is assumed to be 370 cm and 100 cm for urban and new development respectively. Given that the abundant low-rise industrial buildings and structures, surface roughness of 100 cm was assumed in the assessment.

3.6.27 Under the current EPD guideline, the hourly meteorological data including wind speed, wind direction, and air temperature from the relevant grids from the WRF Meteorological data (same basis for PATHv2.1 model), were employed for the model run. PCRAMMET was applied to generate Pasquill-Gifford stability class for the meteorological input to CALINE4 model based on the WRF meteorological data.

3.6.28 There is a height limitation for line sources in CALINE4, i.e. road height higher than 10 metres above ground is considered as 10 metres high above ground for assessment purpose. As rule of thumb, the vertical height difference between road source and receptor in model shall not larger than their actual vertical difference in order to avoid underestimation. Such approach was applicable to the Kowloon side. However, on the Shatin side, the LRT Road locates on the hill side, higher than the general area of Tai Wai and Sha Tin, thus LRT road was considered as a 10-metre elevated road. However, some receptors, such as Worldwide Garden and Sun Tin Wai Estate, locate closer to the highway roads. The heights of receptors were therefore adjusted according to the height of nearest section of Lion Rock Tunnel Road in model, i.e. Actual height of ASR (mPD) – (Actual road elevation (mPD) – 10m). Should a receptor be 10 metres below the elevated road, its modelling height was adjusted to 0 metre as a conservative approach. The detailed configuration of road sources in model is presented in **Appendix 3.14**.

3.6.29 Proposed noise mitigation measure, e.g. barrier and semi-enclosure which alters the emission characteristics was also considered in the assessment, as well as the existing noise barrier if any. The potential air quality impact with and without these measures were also predicted to investigate the implication associated with the proposed noise mitigation measures.

3.6.30 Ozone Limiting Method (OLM) has been adopted for the conversion of NO_X to NO_2 based on the ozone background concentration from PATHv2.1. Regarding vehicular emission, NO_2 and NO were predicted separately in CALINE4. Following the principle of OLM, the total predicted vehicular NO_2 is estimated as below:

$$[NO_2]_{vehicular} = [NO_2]_{predicted} + \text{MIN}\ \{[NO]_{predicted}, \text{ or } (46/48) \times [O_3]_{PATH}\}$$

where

$[NO_2]_{vehicular}$ is the total predicted vehicular NO_2 concentration
$[NO_2]_{predicted}$ is the predicted NO_2 concentration
$[NO]_{predicted}$ is the predicted NO concentration
MIN means the minimum of the two values within the bracket
$[O_3]_{PATH}$ is the representative O_3 PATH concentration (from other contribution)
(46/48) is the molecular weight of NO_2 divided by the molecular weight of O_3

Dispersion Modelling and Modelling Approach for Portals and Ventilation Buildings

3.6.31 AERMOD was applied for the prediction of air pollutant contributions due to portal emissions and ventilation buildings. Details of model parameters refer to **Section 3.6.10 - 3.6.13**.

3.6.32 The portal emission, such as the new tunnel and refurbished tunnels, was modelled as a train volume sources in accordance with the recommendations in the Permanent International Association of Road Congress Report (PIARC, 1991). The pollutants were assumed to eject from the portal as a portal jet such that 2/3 of the total emissions is dispersed within the first 50m of the portal and the other 1/3 of the total emissions within the second 50m. The emission inventory of portals and ventilation buildings is presented in **Appendix 3.16**.

3.6.33 The emission from ventilation building was modelled as a point source subject to the louver design, either horizontal, vertical or both to simulate a titled release. The particle size distribution was determined by emission factors extracted from EMFAC-HK results.

Cumulative impact of Criteria Air Pollutants

3.6.34 Cumulative air pollutant concentration at ASRs was derived by the sum of contributions by open roads, portal and ventilation buildings, nearby chimneys and background contribution from PATHv2.1 system on hour-by-hour basis. Details in deriving averaging results and evaluation against AQOs are discussed in **Section 3.6.15**. The air quality impact on ASRs was evaluated by number of exceedance per annum against the AQO criteria.

3.7 Prediction and Evaluation of Environmental Impacts

Construction Phase

Kowloon Side

3.7.1 The cumulative air quality impact due to construction activities, open roads, existing portals and ventilation buildings, nearby chimneys and construction works of DHSRs within 500m assessment area at representative ASRs in Year 2027 have been predicted. The predicted unmitigated cumulative air quality impact were 135 – **1165** µg/m^3 in maximum hourly TSP, 62 – **128** /m^3 in 10th highest daily RSP, 26 – **53** µg/m^3 in annual RSP, 30 – 44 µg/m^3 in 19th highest daily FSP and 14 – 19 µg/m^3 in annual FSP. It is noted that exceedance of hourly TSP, daily and annual RSP would be expected at the representative ASRs, thus mitigation measures are deemed necessary. The detailed predictions of unmitigated results are presented in **Appendix 3.10**.

Shatin Side

3.7.2 The cumulative air quality impact due to construction activities, open roads, existing portals and ventilation buildings within 500m assessment area at representative ASRs in Year 2027 have been predicted. The predicted unmitigated cumulative air quality impact would be 141 – **980** µg/m^3 in maximum hourly TSP, 62 – 100 µg/m^3 in 10th highest daily RSP, 27 – 51 µg/m^3 in annual RSP, 32 – 41 µg/m^3 in 19th highest daily FSP and 15 – 19 µg/m^3 in annual FSP. It is noted that the exceedance in hourly TSP would be expected at the representative ASRs, thus mitigation measures are deemed necessary. The detailed predictions of unmitigated results are presented in **Appendix 3.11**.

Operation Phase

Kowloon Side

3.7.3 The cumulative air quality impact due to open roads, portals and ventilation buildings and nearby chimneys within 500m assessment area at representative ASRs in Year 2034 have been evaluated. No noise mitigation measures is proposed, as shown in **60604728/R42b/Figure 4.4.1**, thus the assessment has considered existing noise barriers only. The predicted cumulative air quality impact on the ASRs are summarized in **Table 3.13**. The detailed predictions with breakdown of contribution by sources are presented in **Appendix 3.17**. The predictions showed that daily and annual averages of RSP and FSP, hourly and annual averages of NO_2 at representative ASRs would comply with the AQOs. The highest annual NO_2 concentration was predicted to be 34 µg/m^3 at A13 where is influenced by traffic at Waterloo Road and Lung Cheung Road and the connecting slip road.

Table 3.13 Worst Predicted Cumulative Air Quality Impact at Representative ASRs in Year 2034 in Kowloon

ASRID	10th Highest Daily Average RSP Conc. (µg/m^3) (AQO: 100 µg/m^3)	Annual RSP Conc. (µg/m^3) (AQO: 50 µg/m^3)	19th Highest Daily Average FSP Conc. (µg/m^3) (AQO: 50 µg/m^3)	Annual FSP Conc. (µg/m^3) (AQO: 25 µg/m^3)	19th Highest Hourly Average NO_2 Conc. (µg/m^3) (AQO: 200 µg/m^3)	Annual NO_2 Conc. (µg/m^3) (AQO: 40 µg/m^3)
A01	62.6	26.7	30.5	14.7	122.5	26.0
A02	62.5	26.6	30.5	14.7	120.3	24.3
A03	62.6	26.6	30.5	14.7	121.7	24.2

ASRID	10th Highest Daily Average RSP Conc. (µg/m^3) (AQO: 100 µg/m^3)	Annual RSP Conc. (µg/m^3) (AQO: 50 µg/m^3)	19th Highest Daily Average FSP Conc. (µg/m^3) (AQO: 50 µg/m^3)	Annual FSP Conc. (µg/m^3) (AQO: 25 µg/m^3)	19th Highest Hourly Average NO_2 Conc. (µg/m^3) (AQO: 200 µg/m^3)	Annual NO_2 Conc. (µg/m^3) (AQO: 40 µg/m^3)
A04	62.9	26.7	30.6	14.7	126.6	25.5
A05	63.0	26.7	30.6	14.7	125.4	25.9
A06	63.0	26.7	30.7	14.8	124.9	26.7
A07	63.0	26.8	30.8	14.8	125.2	27.5
A08	62.9	26.7	30.7	14.7	115.1	26.2
A09	63.0	26.9	30.9	14.9	131.0	30.3
A10	62.8	26.9	30.9	14.9	127.3	30.9
A11	63.0	26.9	31.0	14.9	128.4	31.4
A12	62.7	26.8	30.7	14.9	123.4	29.0
A13	62.8	27.0	30.8	15.0	124.2	33.8
A14	62.2	26.5	30.3	14.6	106.1	20.4
A15	62.2	26.5	30.3	14.6	104.3	20.9
A16	62.2	26.5	30.2	14.5	108.5	19.8
A17	62.4	26.6	30.4	14.6	109.2	22.8
A18	62.4	26.6	30.4	14.7	112.0	23.4
A19	62.8	26.9	30.9	14.9	118.5	30.4
A20	63.2	26.9	30.9	14.8	120.1	27.9
A21	63.1	26.8	30.9	14.7	117.0	26.9
A22	63.1	26.9	31.1	14.8	127.3	31.2
A23	62.7	26.9	30.6	14.9	123.1	29.8
A24	63.3	26.9	31.0	14.8	121.4	29.6
A25	62.6	26.7	30.5	14.8	116.5	26.3
A26	62.7	26.6	30.5	14.7	109.6	24.7
A27	62.5	26.6	30.5	14.7	114.9	24.1
A28	63.2	26.8	30.9	14.7	115.1	26.2
A29	62.9	26.8	30.8	14.8	124.7	29.9
A30	62.7	26.8	30.6	14.8	119.6	26.6
A31	62.4	26.6	30.4	14.6	107.1	21.6
A32	62.7	26.7	30.6	14.7	115.6	25.4
A33	61.9	27.1	30.4	14.8	126.4	29.0
A34	61.9	27.1	30.4	14.8	125.8	29.2
A35	61.4	26.9	30.2	14.7	124.0	28.6
A36	61.8	26.9	30.4	14.6	135.2	27.5
A37	61.8	26.9	30.4	14.6	134.8	27.7
A38	62.1	27.1	30.6	14.8	130.5	30.0
A39	61.6	27.0	30.2	14.7	124.2	25.8
A40	61.6	27.0	30.2	14.7	126.4	26.8
A41	61.6	27.0	30.2	14.7	126.6	26.1

ASRID	10th Highest Daily Average RSP Conc. (μg/m³) (AQO: 100 μg/m³)	Annual RSP Conc. (μg/m³) (AQO: 50 μg/m³)	19th Highest Daily Average FSP Conc. (μg/m³) (AQO: 50 μg/m³)	Annual FSP Conc. (μg/m³) (AQO: 25 μg/m³)	19th Highest Hourly Average NO_2 Conc. (μg/m³) (AQO: 200 μg/m³)	Annual NO_2 Conc. (μg/m³) (AQO: 40 μg/m³)
A42	62.0	27.2	30.6	14.9	129.1	31.3
A43	62.0	27.1	30.5	14.7	126.4	27.8
A44	61.9	27.0	30.4	14.7	125.3	26.5
A45	61.5	27.0	30.2	14.7	124.2	25.8
A46	61.6	26.8	30.2	14.6	121.7	22.3
A47	61.6	26.9	30.2	14.6	122.2	25.3
A48	61.7	27.0	30.3	14.7	125.4	27.7
A49	61.8	26.9	30.3	14.6	124.3	24.0
A50	61.7	27.1	30.4	14.8	126.2	28.6
A51	62.2	26.8	30.4	14.8	119.8	28.2
A52	62.2	26.6	30.4	14.6	114.8	22.8
A53	62.6	26.5	30.4	14.6	110.1	21.8
A54	62.3	26.9	30.6	14.9	121.8	29.0
A55	62.6	26.5	30.4	14.6	111.3	21.4
A56	62.4	26.5	30.4	14.6	108.1	21.1
A57	62.5	26.5	30.4	14.6	108.3	21.4
A58	62.8	26.6	30.6	14.7	117.8	23.1
A59	62.5	26.8	30.3	14.5	117.3	24.3

3.7.4 According to the discrete results, the worst affected level would be 1.5 metres above ground (mAG), and 5mAG for those locations as their first level of air sensitive use. The contour plots of RPS, FSP and NO_2 at 1.5mG and 5mAG on Kowloon side are illustrated in **60604728/R42b/Figure 3.26 – 3.37**. Higher particulates and NO_2 concentrations would generally be predicted outside Kowloon portal and along Lung Cheung Road. No exceedance in daily and annual averages of RSP and FSP, and hourly NO_2 was predicted in the study area. However, exceedance in annual NO_2 at 1.5mAG was predicted along Lung Cheung Road and the interchange among Lung Cheung Road, Waterloo Road and Lion Rock Tunnel Road, a slope north of Broadcast Drive Garden and northern part of Lung Cheung Road Park. No air sensitive use exists on the roads and the slope north of Broadcast Drive Garden. There are footpaths and stairs in the northern part of Lung Cheung Road Park, which are in transient nature, i.e. long-term NO_2 impact is not applicable. Also, exceedance in annual NO_2 at 5mAG was predicted on Lung Cheung Road between Vista Panorama and Lung Cheung Road Park, where there is no sensitive use. It is anticipated that there would be no adverse air quality impact on the Kowloon side due to the operation of the improved LRT.

Incremental Air Quality Impact arising from the Project

3.7.5 In order to evaluate the air quality impact arising from the Project, the cumulative air quality impact without the presence of the Project has also been predicted. The incremental change is summarized in **Table 3.14**. The detailed prediction is presented in **Appendix 3.18**. With the presence of the Project, the increment in cumulative air quality impact at representative ASRs is minor, e.g. generally less than 1 μg/m³ in annual NO_2, less than 0.1 μg/m³ in annual RSP and FSP. High increments in cumulative annual NO_2 concentrations were observed at 30mAG of Planned Residential Development (NKIL 6579) (A18) for 0.60 μg/m³ and 20mAG of A18 for 0.58 μg/m³.

Table 3.14 Incremental Air Quality arising from the Project in Kowloon

ASRID	Change in 10th Highest Daily Average RSP Conc. (μg/m³)	Change in Annual RSP Conc. (μg/m³)	Change in 19th Highest Daily Average FSP Conc. (μg/m³)	Change in Annual FSP Conc. (μg/m³)	Change in 19th Highest Hourly Average NO_2 Conc. (μg/m³)	Change in Annual NO_2 Conc. (μg/m³)
A01	-0.02 – 0.00	-0.02 – 0.00	-0.01 – 0.00	-0.02 – 0.00	-7.89 – -1.27	-0.64 – -0.06
A02	-0.02 – -0.01	-0.02 – 0.00	-0.01 – 0.00	-0.01 – 0.00	-7.98 – -2.75	-0.45 – -0.11
A03	-0.04 – -0.01	-0.02 – 0.00	-0.01 – 0.00	-0.02 – 0.00	-7.20 – 0.10	-0.52 – -0.07
A04	-0.08 – -0.01	-0.02 – 0.00	-0.01 – -0.01	-0.02 – 0.00	-11.29 – 0.28	-0.71 – -0.02
A05	-0.08 – -0.03	-0.02 – 0.00	-0.01 – -0.01	-0.02 – 0.00	-7.48 – 0.09	-0.60 – -0.07
A06	-0.08 – -0.03	-0.02 – 0.00	-0.03 – -0.01	-0.02 – 0.00	-1.53 – 2.36	-0.53 – -0.10
A07	-0.09 – -0.03	-0.01 – 0.00	-0.04 – -0.01	-0.01 – 0.00	-3.43 – 0.23	-0.46 – -0.10
A08	-0.08 – -0.03	-0.01 – 0.00	-0.04 – -0.01	-0.01 – 0.00	-1.61 – 1.08	-0.42 – -0.14
A09	-0.07 – -0.01	-0.01 – 0.00	-0.02 – -0.01	-0.01 – 0.00	-1.88 – 0.71	-0.34 – -0.03
A10	~ 0.00	-0.02 – 0.00	-0.01 – 0.00	-0.02 – 0.00	-3.04 – 0.52	-0.35 – 0.02
A11	~ 0.00	-0.01 – 0.00	~ 0.00	-0.01 – 0.00	-1.17 – -0.28	-0.17 – 0.02
A12	~ 0.00	-0.02	~ 0.00	-0.02	-6.62	-0.64
A13	-0.12	-0.04	-0.05	-0.03	-11.00	-1.77
A14	-0.01	-0.02	-0.01	-0.02	-3.33	-0.51
A15	-0.03	-0.06	-0.03	-0.05	-17.03	-1.56
A16	-0.01	-0.04	-0.01	-0.03	-3.94	-1.01
A17	-0.10	-0.06	-0.17	-0.06	-7.58	-1.76
A18	-0.29 – 0.06	-0.07 – 0.02	-0.17 – 0.02	-0.06 – 0.02	-7.00 – 7.49	-1.92 – 0.60
A19	-0.02 – 0.02	-0.01 – 0.01	-0.03 – 0.04	-0.01 – 0.01	-3.62 – 0.02	-0.34 – 0.14
A20	-0.01 – 0.02	-0.01 – 0.01	-0.03 – 0.03	-0.01 – 0.01	-1.05 – 0.29	-0.34 – 0.24
A21	-0.02 – 0.01	-0.01 – 0.01	-0.02 – 0.02	-0.01 – 0.01	-1.40 – 0.41	-0.27 – 0.17
A22	-0.01 – 0.00	0.00 – 0.01	-0.01 – 0.00	0.00 – 0.01	-0.87 – 2.30	-0.12 – 0.37
A23	-0.01 – 0.00	~ 0.00	-0.02 – -0.01	~ 0.00	-1.07 – 1.61	-0.15 – 0.25
A24	-0.01 – 0.00	~ 0.00	-0.01 – -0.01	~ 0.00	-0.68 – 0.99	-0.08 – 0.26
A25	-0.03 – 0.00	-0.01 – 0.00	-0.03 – -0.02	~ 0.00	-0.71 – -0.33	-0.13 – 0.03
A26	-0.06 – -0.03	-0.01 – 0.00	-0.01 – 0.00	-0.01 – 0.00	-2.25 – -0.36	-0.31 – -0.11
A27	-0.02 – -0.01	-0.01 – 0.00	-0.01 – 0.00	-0.01 – 0.00	-7.69 – -0.68	-0.36 – -0.12
A28	-0.02 – 0.00	~ 0.00	-0.01 – -0.01	~ 0.00	-1.57 – -0.20	-0.06 – 0.04
A29	-0.02 – 0.00	~ 0.00	-0.01 – -0.01	~ 0.00	-0.47 – -0.07	-0.05 – 0.07
A30	-0.03 – 0.00	~ 0.00	-0.01 – 0.00	~ 0.00	-0.51 – 0.98	-0.11 – 0.08
A31	-0.03 – -0.01	~ 0.00	-0.01 – -0.01	~ 0.00	-0.20 – -0.06	-0.11 – -0.08
A32	-0.03 – -0.01	0.00 – 0.00	-0.01 – 0.00	~ 0.00	-0.54 – 1.21	-0.10 – 0.08
A33	0.00 – 0.01	0.00 – 0.01	0.00 – 0.01	0.00 – 0.01	-0.50 – 0.23	-0.07 – 0.24
A34	0.00 – 0.01	0.00 – 0.01	0.00 – 0.01	0.00 – 0.01	-0.49 – 0.21	-0.08 – 0.25
A35	~ 0.01	~ 0.00	0.00 – 0.01	~ 0.00	-0.53 – -0.03	0.00 – 0.18
A36	0.01 – 0.02	~ 0.00	0.00 – 0.01	~ 0.00	-0.38 – 1.20	0.00 – 0.15
A37	0.01	~ 0.00	0.01	~ 0.00	0.88	0.16
A38	0.01 – 0.02	0.00 – 0.01	0.00 – 0.01	~ 0.00	-0.10 – 1.17	0.12 – 0.20

ASRID	Change in 10th Highest Daily Average RSP Conc. (μg/m^3)	Change in Annual RSP Conc. (μg/m^3)	Change in 19th Highest Daily Average FSP Conc. (μg/m^3)	Change in Annual FSP Conc. (μg/m^3)	Change in 19th Highest Hourly Average NO_2 Conc. (μg/m^3)	Change in Annual NO_2 Conc. (μg/m^3)
A39	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.53 – -0.21	-0.08 – 0.07
A40	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.52 – 0.25	-0.07 – 0.08
A41	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.37 – 0.26	-0.04 – 0.06
A42	~ 0.01	~ 0.00	~ 0.00	~ 0.00	0.21 – 1.34	0.13 – 0.18
A43	~ 0.01	~ 0.00	0.00 – 0.01	~ 0.00	-0.03 – 0.73	0.15 – 0.18
A44	~ 0.01	~ 0.01	~ 0.01	0.00 – 0.01	0.16 – 0.73	0.23 – 0.24
A45	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.46 – 0.08	-0.07 – 0.00
A46	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.54 – 0.21	-0.02 – -0.02
A47	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.36 – -0.02	-0.06 – -0.04
A48	~ 0.00	~ 0.00	~ 0.00	~ 0.00	0.22 – 0.62	-0.06 – -0.06
A49	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.55 – 0.22	-0.08 – -0.06
A50	~ 0.00	~ 0.00	~ 0.00	~ 0.00	0.37	-0.07
A51	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.79 – 0.07	-0.11 – 0.13
A52	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.02	0.04
A53	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.37 – -0.03	-0.07 – 0.02
A54	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.66 – -0.14	-0.03 – 0.24
A55	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.62 – -0.01	-0.06 – 0.03
A56	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.58 – 0.01	-0.08 – 0.00
A57	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-1.31 – -0.23	-0.05 – -0.03
A58	~ 0.01	~ 0.00	~ 0.00	~ 0.00	0.29 – 0.81	0.06 – 0.09
A59	0.00 – 0.01	~ 0.00	~ 0.00	~ 0.00	-0.45 – 1.08	-0.05 – 0.14

Shatin Side

3.7.6 The cumulative air quality impact due to open roads, portals and ventilation buildings within 500m assessment area at representative ASRs in Year 2034 have been evaluated. Noise mitigation measures are proposed for Shatin side, which are along the Lion Rock Tunnel Road, and the assessment has incorporated such measures. The details of proposed noise mitigation measures refer to **60604728/R42b/Figure 4.4.2 – 4.4.4**. Details of noise mitigation measures in Shatin refers to **Section 4.7.27**. The predicted cumulative air quality impact at the ASRs are summarized in **Table 3.15** and the detailed results with breakdown of contribution by sources are presented in **Appendix 3.19**. The predictions showed that daily and annual averages of RSP and FSP, hourly and annual averages of NO_2 at representative ASRs would comply with the AQOs. The predicted highest annual NO_2 concentration would be 34 μg/m^3 at Che Kung Temple Sports Centre (A92).

Table 3.15 Worst Predicted Cumulative Air Quality Impact at Representative ASRs in Year 2034 in Shatin (With Proposed Noise Mitigation Measures)

ASRID	10th Highest Daily Average RSP Conc. (μg/m^3) (AQO: 100 μg/m^3)	Annual RSP Conc. (μg/m^3) (AQO: 50 μg/m^3)	19th Highest Daily Average FSP Conc. (μg/m^3) (AQO: 50 μg/m^3)	Annual FSP Conc. (μg/m^3) (AQO: 25 μg/m^3)	19th Highest Hourly Average NO_2 Conc. (μg/m^3) (AQO: 200 μg/m^3)	Annual NO_2 Conc. (μg/m^3) (AQO: 40 μg/m^3)
A61	62.3	26.6	32.9	14.6	104.9	22.9
A62	62.4	26.6	33.0	14.7	116.2	26.8
A63	62.4	26.6	32.9	14.6	116.3	24.1
A64	62.3	26.5	32.8	14.6	100.6	19.6
A65	62.3	26.6	32.9	14.6	101.9	21.8
A66	62.3	26.6	32.9	14.6	99.8	20.1
A67	62.3	26.6	32.9	14.6	100.7	20.2
A68	62.4	26.7	33.0	14.7	102.2	22.3
A69	62.4	26.7	33.0	14.7	102.9	23.1
A70	62.3	26.6	33.0	14.7	102.0	22.9
A71	62.3	26.6	32.9	14.7	102.5	22.2
A72	62.4	26.7	33.0	14.7	105.2	23.9
A73	62.3	26.6	32.9	14.6	101.7	21.2
A74	63.3	26.8	33.0	14.7	100.8	22.2
A75	63.3	26.8	33.0	14.7	99.8	20.8
A76	63.2	26.8	32.9	14.7	106.2	20.7
A77	63.2	26.7	32.9	14.6	99.1	19.6
A78	63.1	26.7	32.8	14.6	97.5	19.2
A79	63.2	26.7	32.8	14.6	98.4	19.2
A80	63.2	26.7	32.9	14.7	102.4	19.6
A81	63.2	26.7	32.8	14.6	97.8	19.2
A82	61.9	26.7	32.5	14.7	118.6	28.0
A83	61.8	26.7	32.5	14.6	107.9	24.9
A84	61.8	26.7	32.5	14.6	108.4	24.0
A85	61.8	26.7	32.5	14.6	118.9	27.5
A86	61.8	26.6	32.4	14.6	106.3	23.9
A87	61.7	26.6	32.4	14.6	110.1	24.2
A88	61.8	26.6	32.4	14.6	104.6	23.1
A89	61.9	26.7	32.5	14.6	109.7	25.1
A90	64.0	27.0	33.1	14.7	120.5	21.7
A91	61.8	26.7	32.4	14.6	105.3	22.7
A92	62.0	26.8	32.6	14.7	125.0	33.6
A93	61.8	26.7	32.4	14.6	120.0	27.2
A94	61.9	26.7	32.4	14.6	110.5	25.3
A95	61.8	26.7	32.4	14.6	112.3	24.5
A96	61.8	26.6	32.4	14.6	113.4	23.5

ASRID	10th Highest Daily Average RSP Conc. (μg/m³) (AQO: 100 μg/m³)	Annual RSP Conc. (μg/m³) (AQO: 50 μg/m³)	19th Highest Daily Average FSP Conc. (μg/m³) (AQO: 50 μg/m³)	Annual FSP Conc. (μg/m³) (AQO: 25 μg/m³)	19th Highest Hourly Average NO_2 Conc. (μg/m³) (AQO: 200 μg/m³)	Annual NO_2 Conc. (μg/m³) (AQO: 40 μg/m³)
A97	63.9	27.0	33.1	14.7	98.5	20.8
A98	63.7	26.9	32.9	14.6	97.8	19.5
A99	62.2	26.5	32.8	14.6	101.3	20.9
A100	62.3	26.5	32.8	14.6	100.5	20.0
A101	62.3	26.5	32.8	14.6	100.0	19.7

3.7.7 According to the discrete results, the worst affected level would be 1.5 metres above ground (mAG). The contour plots of RPS, FSP and NO_2 at 1.5mAG on Shatin side are illustrated in **60604728/R42b/Figure 3.38 – 3.43** respectively. Higher particulates and NO_2 concentrations would generally be predicted along local roads and Lion Rock Tunnel Road. No exceedance in daily and annual averages of RSP and FSP, and hourly NO_2 would be predicted in the study area. However, exceedance in annual NO_2 would appear at Hin Keng Street where local traffic is the dominant contributor in cumulative NO_2. There is no air sensitive use on the road. Also, exceedance in annual NO_2 would appear at southeast corner of Tin Sum Fire Station where the open ground is generally used for parking, i.e. long-term NO_2 impact is not applicable. Thus, it is anticipated that there is no adverse air quality impact on Shatin side due to the operation of the improved LRT.

Implication of Proposed Noise Mitigation Measures

3.7.8 In order to evaluate the implication of proposed noise mitigation measures, a scenario without the proposed noise mitigation measures has been predicted. The change due to proposed noise mitigation measures is summarized in **Table 3.16**. The detailed predictions with breakdown of contribution by sources are presented in **Appendix 3.20**. With reference to the predictions, the cumulative air quality impact would still comply with the AQOs with the absence of the noise mitigation measures. With the implementation of proposed noise mitigation measures, the difference in cumulative air quality impact at representative ASRs is generally minor, e.g. generally ranging from -0.32 to 0.91 μg/m³ in annual NO_2, -0.01 to 0.16 μg/m³ in annual RSP and -0.01 to 0.15 μg/m³ in annual FSP. High increment in cumulative annual NO_2 was observed at 1.5mAG of Sha Tin Tau New Village (A90) for 3.50 μg/m³ and 1.5mAG of Hung Mui Kuk Barbecue Area (A76) for 2.07 μg/m³.

Table 3.16 Implication of Proposed Noise Mitigation Measures in Shatin

ASRID	Change in 10th Highest Daily Avg RSP Conc. (μg/m³)	Change in Annual RSP Conc. (μg/m³)	Change in 19th Highest Daily Avg FSP Conc. (μg/m³)	Change in Annual FSP Conc. (μg/m³)	Change in 19th Highest Hourly Avg NO_2 Conc. (μg/m³)	Change in Annual NO_2 Conc. (μg/m³)
A61	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.07 – 0.00	-0.03 – -0.02
A62	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.65 – 0.03	-0.04 – -0.03
A63	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.13 – -0.01	-0.04 – -0.04
A64	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.01 – 0.00	-0.05 – -0.01
A65	~ 0.00	~ 0.00	~ 0.00	~ 0.00	0.00 – 0.00	-0.08 – -0.08
A66	-0.01 – 0.00	~ 0.00	-0.01 – 0.00	~ 0.00	-0.01 – 0.02	-0.08 – 0.00
A67	-0.01 – -0.01	~ 0.00	-0.01 – -0.01	~ 0.00	-0.01 – 0.00	-0.09 – -0.09
A68	-0.03 – 0.01	0.00 – 0.03	0.00 – 0.04	0.00 – 0.03	-0.09 – 0.52	0.06 – 0.76

ASRID	Change in 10th Highest Daily Avg RSP Conc. (µg/m3)	Change in Annual RSP Conc. (µg/m3)	Change in 19th Highest Daily Avg FSP Conc. (µg/m3)	Change in Annual FSP Conc. (µg/m3)	Change in 19th Highest Hourly Avg NO_2 Conc. (µg/m3)	Change in Annual NO_2 Conc. (µg/m3)
A69	-0.05 – -0.04	0.02 – 0.02	0.03 – 0.04	0.02 – 0.02	-1.07 – -0.15	0.43 – 0.53
A70	-0.01 – 0.00	-0.01 – 0.01	-0.01 – 0.01	-0.01 – 0.01	-0.02 – 0.95	-0.14 – 0.24
A71	-0.02 – 0.00	0.00 – 0.02	-0.02 – 0.02	0.00 – 0.02	0.00 – 1.44	-0.09 – 0.46
A72	-0.02 – 0.00	-0.01 – 0.02	0.00 – 0.02	0.00 – 0.02	0.00 – 0.39	-0.10 – 0.42
A73	~ 0.00	-0.01 – 0.01	0.00 – 0.02	-0.01 – 0.01	-0.47 – 0.52	-0.14 – 0.18
A74	-0.02 – 0.04	-0.01 – 0.03	-0.01 – 0.04	-0.01 – 0.03	-1.36 – 1.35	-0.23 – 0.61
A75	-0.03 – 0.06	-0.01 – 0.04	-0.02 – 0.06	-0.01 – 0.04	0.15 – 1.44	-0.32 – 0.91
A76	0.07	0.10	0.10	0.09	9.93	2.07
A77	~ 0.00	0.00 – 0.01	0.00 – 0.01	0.00 – 0.01	-0.12 – 1.87	-0.06 – 0.09
A78	~ 0.00	0.00 – 0.01	0.00 – 0.01	0.00 – 0.01	-0.08 – 0.16	-0.06 – 0.08
A79	0.00 – 0.01	~ 0.00	-0.01 – -0.01	~ 0.00	0.01 – 0.17	-0.11 – -0.05
A80	-0.01 – 0.03	-0.01 – 0.03	-0.01 – 0.04	-0.01 – 0.02	0.05 – 5.39	-0.22 – 0.52
A81	0.01 – 0.01	~ 0.00	~ 0.00	~ 0.00	-0.71 – -0.64	-0.05 – -0.05
A82	-0.04 – 0.00	-0.01 – 0.02	-0.01 – 0.02	-0.01 – 0.01	-1.27 – 2.06	-0.28 – 0.36
A83	-0.04 – 0.01	-0.01 – 0.03	-0.01 – 0.04	-0.01 – 0.03	0.54 – 2.50	-0.28 – 0.66
A84	-0.03 – 0.00	-0.01 – 0.02	0.00 – 0.03	0.00 – 0.02	-0.55 – 1.87	-0.20 – 0.50
A85	~ 0.00	0.00 – 0.01	0.00 – 0.01	0.00 – 0.01	-0.54 – 1.23	-0.12 – 0.13
A86	~ 0.00	~ 0.00	0.00 – 0.01	~ 0.00	-0.32 – 0.56	-0.09 – 0.10
A87	~ 0.00	~ 0.00	0.00 – 0.01	~ 0.00	-0.26 – 0.50	-0.10 – 0.04
A88	~ 0.00	0.00 – 0.01	0.00 – 0.01	~ 0.00	-0.16 – 0.27	-0.08 – 0.12
A89	-0.02 – 0.00	-0.01 – 0.01	0.00 – 0.02	-0.01 – 0.01	-1.30 – 2.70	-0.25 – 0.32
A90	0.02 – 0.19	0.02 – 0.16	0.02 – 0.16	0.02 – 0.15	2.96 – 20.33	0.41 – 3.50
A91	-0.01 – 0.00	-0.01 – 0.01	0.00 – 0.01	-0.01 – 0.01	-1.13 – 0.61	-0.25 – 0.18
A92	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.32 – 0.00	-0.05 – -0.04
A93	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.79 – 0.41	-0.04 – 0.03
A94	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.61 – 0.00	-0.05 – -0.03
A95	~ 0.00	~ 0.00	-0.01 – 0.00	~ 0.00	-1.23 – 0.08	-0.04 – -0.03
A96	~ 0.00	~ 0.00	~ 0.00	~ 0.00	0.00 – 0.04	-0.04 – -0.04
A97	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.19 – 0.08	-0.12 – 0.05
A98	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-1.26 – -0.19	-0.04 – -0.04
A99	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-1.04 – 0.00	-0.03 – -0.03
A100	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.01 – 0.00	-0.03 – 0.00
A101	~ 0.00	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.04 – 0.00

Incremental Air Quality Impact arising from the Project

3.7.9 In order to evaluate the air quality impact arising from the Project, the cumulative air quality impact without the presence of the Project has also been predicted. The incremental change is summarized in **Table 3.17**. The detailed prediction is presented in **Appendix 3.21**. With the presence of the Project, the increment in cumulative air quality impact at representative ASRs is minor, i.e. generally less than 0.81 µg/m^3 in annual NO_2, less than 0.10 µg/m^3 in annual RSP and less than 0.09 µg/m^3 in annual FSP. High increment in cumulative annual

NO_2 concentrations was observed at 1.5 mAG of Sha Tin Tau New Village (A90) for 3.51 µg/m^3 and at 1.5 mAG of Hung Mui Kuk Barbecue Area (A76) for 1.94 µg/m^3.

Table 3.17 Incremental Air Quality Impact arising from the Project in Shatin

ASRID	Change in 10th Highest Daily Average RSP Conc. (µg/m^3)	Change in Annual RSP Conc. (µg/m^3)	Change in 10th Highest Daily Average FSP Conc. (µg/m^3)	Change in Annual FSP Conc. (µg/m^3)	Change in 19th Highest Hourly Average NO_2 Conc. (µg/m^3)	Change in Annual NO_2 Conc. (µg/m^3)
A61	~ 0.00	~ 0.00	-0.01 – 0.00	~ 0.00	-0.72 – 0.36	-0.14 – -0.06
A62	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.78 – -0.22	-0.13 – -0.10
A63	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.58 – -0.26	-0.14 – -0.13
A64	-0.01 – 0.00	-0.01 – 0.00	-0.02 – 0.00	-0.01 – 0.00	-1.51 – 0.05	-0.27 – 0.02
A65	-0.01 – -0.01	-0.01 – -0.01	~ 0.00	~ 0.00	-0.45 – -0.01	-0.21 – -0.20
A66	-0.01 – 0.00	-0.01 – 0.00	-0.01 – 0.01	-0.01 – 0.00	-2.07 – -0.08	-0.33 – 0.01
A67	-0.01 – -0.01	-0.01 – 0.00	~ 0.00	-0.01 – 0.00	-0.56 – 0.05	-0.29 – -0.20
A68	-0.02 – 0.01	0.00 – 0.03	0.01 – 0.04	0.00 – 0.03	-0.69 – 1.49	-0.12 – 0.57
A69	-0.02 – -0.01	0.03 – 0.04	0.04 – 0.05	0.03 – 0.04	-0.35 – -0.29	0.34 – 0.61
A70	-0.01 – 0.00	-0.01 – 0.01	-0.01 – 0.01	0.00 – 0.01	-0.23 – 1.12	-0.24 – 0.12
A71	-0.01 – 0.01	0.00 – 0.02	-0.01 – 0.02	0.00 – 0.02	-0.53 – 0.81	-0.11 – 0.28
A72	-0.02 – 0.01	0.00 – 0.02	0.01 – 0.03	0.01 – 0.02	-0.33 – 0.21	-0.08 – 0.30
A73	0.00 – 0.00	0.00 – 0.01	0.00 – 0.02	0.00 – 0.01	-0.68 – 0.52	-0.19 – 0.12
A74	-0.02 – 0.04	-0.01 – 0.03	-0.01 – 0.04	0.00 – 0.03	-1.30 – 0.96	-0.31 – 0.53
A75	-0.05 – 0.06	-0.02 – 0.04	-0.04 – 0.05	-0.02 – 0.04	-0.64 – 0.87	-0.80 – 0.81
A76	0.06	0.10	0.09	0.09	9.52	1.94
A77	~ 0.00	0.00 – 0.01	0.00 – 0.01	0.00 – 0.01	-0.29 – 2.04	-0.07 – 0.06
A78	~ 0.00	0.00 – 0.01	~ 0.00	0.00 – 0.01	-0.28 – 0.13	-0.06 – 0.05
A79	~ 0.01	~ 0.01	~ 0.00	0.00 – 0.01	0.50 – 0.87	-0.03 – 0.03
A80	~ 0.02	~ 0.02	0.02 – 0.04	~ 0.02	1.18 – 4.90	0.16 – 0.33
A81	~ 0.02	~ 0.01	0.01 – 0.01	~ 0.01	-0.55 – -0.09	0.04 – 0.04
A82	-0.02 – 0.00	0.00 – 0.02	0.01 – 0.02	0.00 – 0.01	-0.64 – 2.21	-0.11 – 0.30
A83	-0.03 – 0.02	0.00 – 0.03	0.00 – 0.04	0.00 – 0.03	0.52 – 2.65	-0.20 – 0.60
A84	-0.02 – 0.01	0.00 – 0.02	0.00 – 0.03	0.00 – 0.02	-1.96 – 2.04	-0.08 – 0.45
A85	~ 0.00	0.00 – 0.01	0.00 – 0.01	0.00 – 0.01	-0.12 – 1.48	-0.07 – 0.12
A86	~ 0.00	~ 0.00	0.00 – 0.01	~ 0.00	-0.15 – 0.40	-0.05 – 0.09
A87	~ 0.00	~ 0.00	0.00 – 0.01	~ 0.00	-0.21 – 0.80	-0.06 – 0.05
A88	~ 0.00	0.00 – 0.01	0.00 – 0.01	0.00 – 0.01	-0.31 – 0.61	-0.03 – 0.12
A89	-0.01 – 0.01	0.00 – 0.01	0.00 – 0.03	0.00 – 0.01	-1.96 – 2.46	-0.12 – 0.31
A90	0.02 – 0.19	0.02 – 0.16	0.02 – 0.16	0.02 – 0.15	3.41 – 20.89	0.42 – 3.51
A91	~ 0.00	0.00 – 0.01	0.00 – 0.01	0.00 – 0.01	-1.22 – 0.53	-0.16 – 0.17
A92	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.23 – 0.09	-0.02 – -0.01
A93	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.47 – 0.41	-0.01 – 0.03
A94	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.49 – 0.07	0.00 – 0.01
A95	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-0.77 – 0.49	0.00 – 0.01
A96	~ 0.00	~ 0.00	~ 0.01	~ 0.00	0.13 – 0.28	0.00 – 0.01

ASRID	Change in 10th Highest Daily Average RSP Conc. (μg/m^3)	Change in Annual RSP Conc. (μg/m^3)	Change in 10th Highest Daily Average FSP Conc. (μg/m^3)	Change in Annual FSP Conc. (μg/m^3)	Change in 19th Highest Hourly Average NO_2 Conc. (μg/m^3)	Change in Annual NO_2 Conc. (μg/m^3)
A97	~ 0.01	~ 0.01	~ 0.01	0.00 – 0.01	-1.45 – 0.29	0.08 – 0.18
A98	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-1.86 – -0.19	0.05 – 0.08
A99	~ 0.00	~ 0.00	~ 0.00	~ 0.00	-1.53 – -0.67	-0.11 – -0.11
A100	-0.01 – 0.00	-0.01 – 0.00	-0.01 – 0.00	-0.01 – 0.00	-1.02 – 1.16	-0.21 – 0.02
A101	-0.01 – 0.00	-0.01 – 0.00	-0.02 – 0.00	-0.01 – 0.00	-1.39 – 1.27	-0.25 – 0.03

Sensitivity Test on Air Quality Impact from Bus Termini in Kowloon and Shatin

3.7.10 As discussed in **Section 3.6.19 – 3.6.21**, start emission of vehicles was assessed in a broad-brush approach, which assumed potential trip start occurring on local road for all vehicle classes and adopted highest start emission factor disregard the engine soak time. However, there is no engine start/stop for a franchised bus along its service route in real life situation, instead it would only happen at its terminus. To better understand the air quality impact arising from a bus terminus, a sensitivity test on bus termini on Kowloon and Shatin sides was conducted with precise approach which considered start emission with soak time and emission to be released along 700m of travel upon engine start at a bus terminus. The precise method concerns those ASRs close to a bus terminus, including A61 – 63 near Hin Keng Bus Terminus, A77 – A78 near Sun Chui Bus Terminus, A85 – A88 near Sun Tin Wai Bus Terminus, A93 – A96 near Chun Shek Bus Terminus, while on Kowloon side A04 – A08, A26 near Broadcast Drive Bus Terminus. For simplicity, the vehicular emission with precise approach, including start, idling and running emissions, was evaluated as additional sources to these locations, and see if the broad-brush approach would significantly underestimate the air quality impact.

3.7.11 The frequency of start emission was determined based on the bus schedules at each terminus. Long soak time was assumed for the first hour of route service (i.e. 720 minutes) to address the cold-start emission. Soak time of 10 min or 20 min was assumed in later hours, subject to the bus schedule. The detailed results and calculation of the start emission at subject termini on Kowloon and Shatin sides are presented in **Appendix 3.23**. The results showed that the cumulative air quality impact on the concerned locations would continue to comply with the AQOs taking account of impacts due to bus termini on and Kowloon and Shatin sides.

3.7.12 The sensitivity test can also serve as a worst-case for start emission from minibus terminus because of relatively lower emission of minibus and small terminus with no internal route. The cumulative air quality impact on A65 near Hin Tin Village Minibus Terminus, A70 and A71 near Julimount Garden Minibus Terminus, A74 and A75 near Worldwide Garden Minibus Terminus, A01 – A03 and A27 near Broadcast Drive Minibus Terminus was estimated based on the results from Hin Keng Bus Terminus. The maximum hourly NO_2/maximum daily average RSP/maximum daily average FSP concentrations contribution from Hin Keng Bus Terminus was added to the 19th highest hourly average NO_2/10th highest daily average RSP/19th highest daily average FSP of the respective ASRs. Adjustment factors taking into account the frequency of buses and minibus was applied to the short-term contributions from Hin Keung Bus Terminus. For long-term results, the annual contribution in NO_2/RSP/FSP from Hing Keng Bus Terminus was added directly to the respective results of those ASRs. The cumulative NO_2, RSP and FSP concentrations at these concerned ASRs would continue comply with the AQOs taking account of impacts due to nearby minibus termini. Detailed calculation and results are presented in **Appendix 3.23**.

3.7.13 Considering the air quality impact due to bus / minibus termini, the cumulative NO_2, RSP and FSP concentrations at these ASRs close to the concerned facilities would continue to comply with AQOs. The findings concluded on Kowloon and Shatin sides still hold, i.e. no adverse air quality impact due to the operation of the improved LRT is anticipated.

In-tunnel Air Quality

3.7.14 The proposed new tunnel tube and the refurbished tunnel tubes are to be equipped with mechanical ventilation system in 24-hour operation for the detection of any exceedance within the tunnel. The ventilation fans will be operated on demand control, i.e. the fan will be switched on if there is any exceedance detected, which diverts the vehicular exhaust inside tunnel to ventilation building for release. According to the *Practice Note on Control of Air Pollution in Vehicle Tunnels* by EPD, the ventilation system will be designed to have sufficient capacity to cope with the air pollution emission under the worst foreseeable traffic condition and meet the concentration limits stipulated in the guidelines. Monitoring of traffic flow and air pollutant concentrations inside the tunnel will be carried out. With implementation of the active ventilation, the air pollutants are not likely to accumulate inside tunnel tube. It is expected that there is no adverse in-tunnel air quality inside the new tunnel tube and refurbished ones.

3.8 Mitigation of Adverse Environmental Impacts

Construction Phase

3.8.1 In order to minimise the construction dust impact, the following dust mitigation measures shall be implemented:

- Watering once every 2 hours on heavy construction work areas to reduce dust emission by 91.7%. Any potential dust impact and watering mitigation would be subject to the actual site condition. For example, a construction activity that produces inherently wet conditions or in cases under rainy weather, the above water application intensity may not be unreservedly applied. While the above watering frequency is to be followed, the extent of watering may vary depending on actual site conditions but should be sufficient to achieve the removal efficiency. The dust levels would be monitored and managed under an EM&A programme as specified in the EM&A Manual.
- For the tunnelling works by drill and break, in addition to the regular watering at spoiling handing and unpaved / paved haul roads, a sealed door should be installed at the opening to avoid the escape of fugitive dust from the excavation, i.e. at both Kowloon and Shatin portals. A dust collector with dust removal efficiency of at least 80% should be installed at the ventilation exhaust to treat dust-laden exhaust before release to the ambient. The exhaust vents for construction of TBM launch shaft, enlargement works of existing Kowloon-bound tunnel and repairing works of existing Shatin-bound tunnel will locate at Shatin portal, while the one for TBM break out will locate at Kowloon portal.

3.8.2 With the implementation of the above measures, the predicted cumulative TSP, RSP and FSP concentrations at the representative ASRs are summarized in **Table 3.18** and **Table 3.19**. The predictions showed that the hourly average of TSP, daily and annual average of RSP and FSP at representative ASRs would comply with the criteria as stipulated in the TM-EIAO and the AQOs. The detailed prediction results are presented in **Appendix 3.12 – 3.13**.

3.8.3 According to the discrete results, the worst affected level would be 1.5 metres above ground (mAG), and 5mAG for those locations as their first level of air sensitive use. The contour plots of TSP, RPS and FSP at 1.5mAG and 5mAG on Kowloon side and 1.5mAG on Shatin side are illustrated in **60604728/R42b/Figure 3.2 – 3.11** and **60604728/R42b/Figure 3.12 – 3.16** respectively. High particulates concentrations would generally be predicted at the proposed works area, such as outside Kowloon Portal and along Lion Rock Tunnel Road. However, no exceedance in hourly TSP, daily and annual averages of RSP and FSP would be predicted in the study area. With the implementation of the proposed dust mitigation measures, i.e. watering once every 2 hours on construction works area, sealed door and dust collector at tunnel opening, no adverse dust impact would be anticipated.

Table 3.18 Worst Predicted Cumulative Air Quality Impact at Representative ASRs in Year 2027 in Kowloon (With Dust Mitigation Measures)

ASRID	Maximum Hourly Average TSP Conc. (μg/m^3) (EIAO-TM: 500 μg/m^3)	10th Highest Daily Average RSP Conc. (μg/m^3) (AQO: 100 μg/m^3)	Annual RSP Conc. (μg/m^3) (AQO: 50 μg/m^3)	19th Highest Daily Average FSP Conc. (μg/m^3) (AQO: 50 μg/m^3)	Annual FSP Conc. (μg/m^3) (AQO: 25 μg/m^3)
A01	138.1	63.8	27.7	31.0	15.2
A02	138.0	63.8	27.4	30.9	15.1
A03	146.7	64.2	27.4	31.0	15.0
A04	159.3	64.5	27.8	31.5	15.2
A05	141.8	64.7	27.8	31.8	15.2
A06	141.5	65.2	27.8	32.0	15.3
A07	141.7	65.1	27.8	32.2	15.3
A08	141.5	64.4	27.7	32.0	15.2
A09	141.5	65.1	28.0	32.4	15.5
A10	139.1	65.0	28.6	32.0	15.7
A11	144.1	66.1	28.6	32.4	15.7
A12	138.3	64.0	28.2	31.4	15.5
A13	158.7	67.0	29.8	32.1	16.0
A14	137.6	62.3	27.5	30.4	14.9
A15	137.6	62.4	27.5	30.4	15.0
A16	137.5	62.2	27.4	30.3	14.9
A17	158.8	69.2	30.1	32.3	15.6
A18	155.0	66.6	29.3	31.8	15.5
A19	138.9	64.7	28.1	32.1	15.6
A20	140.6	64.6	28.0	32.0	15.4
A21	139.6	64.3	27.7	31.9	15.3
A22	141.1	64.6	27.8	32.1	15.4
A23	139.9	64.3	27.7	31.4	15.4
A24	142.1	64.6	27.6	32.0	15.3
A25	140.1	64.1	27.4	31.2	15.2
A26	140.2	64.0	27.3	31.1	15.0
A27	138.0	63.7	27.3	30.8	15.0
A28	141.6	64.2	27.3	31.7	15.0
A29	140.4	64.6	27.5	31.5	15.3
A30	140.3	64.4	27.4	31.3	15.2
A31	139.5	63.7	27.0	30.6	14.8
A32	140.1	64.2	27.3	31.1	15.1
A33	152.6	62.8	27.6	30.9	15.2
A34	152.6	62.8	27.6	30.9	15.2
A35	141.9	62.1	27.3	30.6	15.0
A36	142.5	62.7	27.2	30.9	14.9
A37	143.9	62.7	27.3	30.9	14.9

ASRID	Maximum Hourly Average TSP Conc. (μg/m³) (EIAO-TM: 500 μg/m³)	10th Highest Daily Average RSP Conc. (μg/m³) (AQO: 100 μg/m³)	Annual RSP Conc. (μg/m³) (AQO: 50 μg/m³)	19th Highest Daily Average FSP Conc. (μg/m³) (AQO: 50 μg/m³)	Annual FSP Conc. (μg/m³) (AQO: 25 μg/m³)
A38	152.8	63.2	27.7	31.2	15.2
A39	151.1	62.2	27.4	30.4	15.0
A40	151.0	62.1	27.5	30.4	15.1
A41	151.0	62.1	27.4	30.4	15.0
A42	153.1	62.9	27.8	31.3	15.4
A43	152.8	63.0	27.5	31.1	15.1
A44	153.2	62.8	27.4	30.9	15.0
A45	151.5	62.0	27.3	30.4	14.9
A46	152.1	62.1	27.1	30.4	14.7
A47	152.7	62.0	27.3	30.5	14.9
A48	150.7	62.2	27.4	30.7	15.0
A49	151.6	62.6	27.2	30.5	14.8
A50	150.8	62.3	27.5	30.8	15.1
A51	138.9	63.4	27.9	30.8	15.5
A52	138.1	62.8	27.2	30.7	15.0
A53	138.5	63.4	26.9	30.9	14.8
A54	138.1	62.7	27.6	31.1	15.5
A55	138.6	63.4	26.9	31.0	14.8
A56	139.4	63.5	26.9	30.6	14.7
A57	138.5	63.3	26.9	30.7	14.8
A58	138.7	63.8	27.0	31.4	15.0
A59	135.9	63.8	27.4	30.9	15.0

Table 3.19 Worst Predicted Cumulative Air Quality Impact at Representative ASRs in Year 2027 in Shatin (With Dust Mitigation Measures)

ASRID	Maximum Hourly Average TSP Conc. (μg/m³) (EIAO-TM: 500 μg/m³)	10th Highest Daily Average RSP Conc. (μg/m³) (AQO: 100 μg/m³)	Annual RSP Conc. (μg/m³) (AQO: 50 μg/m³)	19th Highest Daily Average FSP Conc. (μg/m³) (AQO: 50 μg/m³)	Annual FSP Conc. (μg/m³) (AQO: 25 μg/m³)
A61	148.1	62.6	26.9	33.1	14.8
A62	148.8	62.7	27.1	33.3	14.9
A63	148.1	62.7	27.0	33.2	14.8
A64	148.2	62.7	27.1	33.1	14.8
A65	148.6	62.8	27.2	33.2	14.8
A66	148.5	62.9	27.4	33.3	14.9
A67	148.5	62.9	27.3	33.3	14.8
A68	150.0	64.7	29.1	33.8	15.3
A69	149.4	65.4	29.1	33.9	15.3

ASRID	Maximum Hourly Average TSP Conc. (μg/m^3) (EIAO-TM: 500 μg/m^3)	10th Highest Daily Average RSP Conc. (μg/m^3) (AQO: 100 μg/m^3)	Annual RSP Conc. (μg/m^3) (AQO: 50 μg/m^3)	19th Highest Daily Average FSP Conc. (μg/m^3) (AQO: 50 μg/m^3)	Annual FSP Conc. (μg/m^3) (AQO: 25 μg/m^3)
A70	149.2	63.1	27.6	33.4	15.0
A71	150.5	63.9	28.5	33.6	15.2
A72	150.4	63.8	28.7	33.7	15.3
A73	149.4	62.7	27.3	33.2	14.9
A74	145.1	64.5	28.2	33.7	15.2
A75	149.1	66.1	29.1	34.0	15.4
A76	148.5	63.9	28.0	33.4	15.0
A77	141.1	64.0	27.3	33.2	14.9
A78	140.9	63.7	27.2	33.0	14.8
A79	142.4	65.2	29.6	33.7	15.3
A80	165.6	67.2	29.5	34.0	15.3
A81	143.1	64.9	28.6	33.5	15.1
A82	153.2	63.2	28.3	33.3	15.2
A83	153.0	63.0	28.0	33.2	15.1
A84	152.7	62.7	27.7	33.1	15.0
A85	152.2	62.2	27.2	32.9	14.9
A86	152.0	62.0	27.0	32.7	14.8
A87	151.9	62.0	27.1	32.8	14.8
A88	152.1	62.1	27.1	32.8	14.8
A89	153.2	62.6	27.9	33.1	15.1
A90	148.3	64.0	27.4	33.1	14.8
A91	151.9	62.3	27.3	32.8	14.9
A92	152.2	62.5	27.3	33.1	15.1
A93	152.0	62.0	27.1	32.8	14.9
A94	151.9	62.2	27.0	32.6	14.8
A95	152.0	62.0	27.0	32.7	14.8
A96	151.9	62.0	26.9	32.6	14.7
A97	148.5	64.1	27.4	33.3	14.9
A98	148.5	63.7	27.2	33.0	14.8
A99	148.6	62.4	26.8	33.0	14.7
A100	148.1	62.6	26.9	32.9	14.7
A101	148.1	62.7	27.0	33.0	14.7

3.8.4 Dust suppression measures stipulated in the Air Pollution Control (Construction Dust) Regulation and good site practices listed below should be carried out to further minimize construction dust impact.

- Use of regular watering to reduce dust emissions from exposed site surfaces and unpaved roads, particularly during dry weather.
- Use of frequent watering for particularly dusty construction areas and areas close to ASRs.

- Side enclosure and covering of any aggregate or dusty material storage piles to reduce emissions. Where this is not practicable owing to frequent usage, watering shall be applied to aggregate fines.
- Open stockpiles shall be avoided or covered. Where possible, prevent placing dusty material storage piles near ASRs.
- Tarpaulin covering of all dusty vehicle loads transported to, from and between site locations.
- Establishment and use of vehicle wheel and body washing facilities at the exit points of the site.
- Provision of not less than 2.4m high hoarding from ground level along site boundary where adjoins a road, streets or other accessible to the public except for a site entrance or exit.
- Imposition of speed controls for vehicles on site haul roads.
- Where possible, routing of vehicles and positioning of construction plant should be at the maximum possible distance from ASRs.
- Instigation of an environmental monitoring and auditing program to monitor the construction process in order to enforce controls and modify method of work if dusty conditions arise.

3.8.5 To minimize the exhaust emission from NRMMs during the construction phase, below measures shall be applied as far as practicable:

- Connect construction plant and equipment to main electricity supply and avoid use of diesel generators and diesel-powered equipment;
- Exempted NRMMs shall be avoided;
- Deploy electrified NRMMS as far as practicable.

Operation Phase

3.8.6 No adverse air quality impact is anticipated during the operational phase of the Project, thus mitigation measure is deemed not necessary.

3.9 Evaluation of Residual Impacts

Construction Phase

3.9.1 With the implementation measures specified in the Air Pollution Control (Construction Dust) Regulation together with the recommended water frequency (dust removal efficiency of 91.7%) on the works areas, exposed surface and unpaved road, i.e. once every 2 hours a sealed door to be installed at the opening of tunnel, a dust collector with dust removal efficiency of at least 80% to be installed at the ventilation exhaust, no adverse residual impact would be expected from the construction of the Project.

Operation Phase

3.9.2 No adverse residual impact is expected during the operation phase of the Project.

3.10 Environmental Monitoring and Audit

Construction Phase

3.10.1 EM&A for potential dust impacts are recommended during the construction phase of the Project so as to check compliance with legislative requirements. Details of the monitoring and audit programme are presented in a stand-alone EM&A Manual.

Operation Phase

3.10.2 No adverse impact would be generated during the operation phase of the Project. No EM&A would be required during the operation of the Project.

3.11 Conclusion

3.11.1 Potential construction dust impact would arise from the construction of the proposed new tunnel tube, refurbishment of existing tunnels and road widening works. Cumulative dust impact from construction activities, vehicular emission from open road, existing portals and ventilation buildings, emission from chimneys and concurrent projects has been evaluated. The prediction results concluded that cumulative TSP, RSP and FSP concentrations at all ASRs would comply with the criteria stipulated in EIAO-TM and AQOs and no adverse construction dust impact is anticipated with the implementation dust control measures, i.e. watering once every 2 hours, installation of sealed door at both Kowloon and Shatin portals, and dust collector with at least 80% dust removal efficiency for the tunnel mined by drill and break at Shatin portal for construction of TBM launch shaft, enlargement works of existing Kowloon-bound tunnel and repairing works of existing Shatin-bound tunnel, and at Kowloon portal for the construction of TBM break out.

3.11.2 Vehicular emission is the dominant source of air pollutants in the study area. Cumulative air quality impact arising from the operation of new tunnel tube, refurbished existing tunnels, associated portal and ventilation building and widened roads, and other existing sources such as vehicular emission from open roads and chimneys within 500m study area has been evaluated. The prediction results concluded that the cumulative NO_2, RSP and FSP concentration at all ASRs would comply with AQOs and no adverse air quality impact is anticipated arising from the operation of LRT.