4 Air Quality

4.1 Legislation, Standards and Guidelines

4.1.1 General

4.1.1.1 All the legislation and guidelines that are relevant to the air quality impact assessment are identified, including, but not limited to, the following:

- Criteria and guidelines for evaluating and assessing air quality impact as specified in Section 1 of Annexes 4 and 12 of the Technical Memorandum on Environmental Impact Assessment Ordinance (TM-EIAO);
- Air Pollution Control Ordinance (APCO) (Cap. 311);
- Air Pollution Control (Construction Dust) Regulation; and
- Hong Kong Air Quality Objectives (AQOs).

4.1.2 Air Quality Objectives

4.1.2.1 The principal legislation for controlling air pollutants is the Air Pollution Control Ordinance (APCO) (Cap 311) which provides a statutory framework for establishing the AQOs and stipulating the anti-pollution requirements for air pollution sources. The AQOs stipulate limits on concentrations for 7 pollutants including Sulphur Dioxide (SO_2), Respirable Suspended Particulates (RSP), Fine Suspended Particulate (FSP), Nitrogen Dioxide (NO_2), Carbon Monoxide (CO), Photochemical Oxidants (as Ozone (O_3)), and Lead (Pb). The AQOs are listed in **Table 4.1**.

Table 4.1 Hong Kong Air Quality Objectives (HKAQO)

Pollutant	Limits on Concentration, μg/m³ [1] (The Number of Exceedance per calendar year allowed is shown in brackets)				
	10-min	1-hour	8-hour	24-hour	Annual
SO_2	500 (3)			125 (3)	
RSP [2]				100 (9)	50
FSP [3]				75 (9)	35
CO		30,000 (0)	10,000 (0)		

Pollutant	**Limits on Concentration, μg/m³ [1]** (The Number of Exceedance per calendar year allowed is shown in brackets)				
	10-min	**1-hour**	**8-hour**	**24-hour**	**Annual**
NO_2		200 (18)			40
O_3			160 (9)		
Pb					0.5

Notes:
[1] All measurements of the concentration of gaseous air pollutants, i.e., sulphur dioxide, nitrogen dioxide, ozone and carbon monoxide, are to be adjusted to a reference temperature of 293Kelvin and a reference pressure of 101.325 kilopascal.
[2] Respirable suspended particulates (RSP) means suspended particles in air with a nominal aerodynamic diameter of 10 μm or less.
[3] Fine suspended particulates (FSP) means suspended particles in air with a nominal aerodynamic diameter of 2.5 μm or less.

4.1.3 Air Pollution Control (Construction Dust) Regulation

4.1.3.1 The Air Pollution Control (Construction Dust) Regulation specifies processes that require special dust control. The Contractors are required to inform the Environmental Protection Department (EPD) and adopt proper dust suppression measures while carrying out "Notifiable Works" (which requires prior notification by the regulation) and "Regulatory Works" to meet the requirements as defined under the regulation.

4.1.4 Total Suspended Particulate Criteria

4.1.4.1 There is no criterion on Total Suspended Particulate (TSP) under the AQO. In accordance with Annex 4 of TM-EIAO, a limit of 500μg/m^3 for 1-hour TSP concentration at any sensitive receivers should be adopted for evaluating air quality impacts.

4.1.5 Odour Criteria

4.1.5.1 In accordance with the Annex 4 of the TM-EIAO, odour level at an air sensitive receiver shall meet 5 odour units based on an averaging time of 5 seconds.

4.2 Description of the Environment

4.2.1 Existing Ambient Air Quality Conditions

<u>Tai Po Air Quality Monitoring station</u>

4.2.1.1 The latest 5 years air quality monitoring data (available up to 2014) of the various air pollutants monitored at the nearest Tai Po air quality monitoring stations operated by EPD are shown in **Table 4.2** and have been compared with the AQOs for information.

Table 4.2 Air quality monitoring data (Tai Po Station, 2010 – 2014)

Pollutant	Year	Highest 1-hour Conc. beyond the allowed exceedance (µg/m^3)	Highest 24-hour Conc. beyond the allowed exceedance (µg/m^3)	Highest 8-hour Conc. beyond the allowed exceedance (µg/m^3)	Annual Conc. (µg/m^3)
SO_2 [5] [6]	2010	68	24	N/M	8
	2011	46	23	N/M	8
	2012	46	17	N/M	7
	2013	55	24	N/M	9
	2014	65	15	N/M	4
	5-year mean	56	21 [16%]	N/M	7
	New AQO	N/A	125 (3)	N/A	N/A
NO_2 [6]	2010	143	101	N/M	<u>46</u>
	2011	146	99	N/M	<u>45</u>
	2012	145	108	N/M	<u>51</u>
	2013	159	125	N/M	<u>53</u>
	2014	145	124	N/M	<u>45</u>
	5-year mean	148 [74%]	111	N/M	<u>48 [120%]</u>
	New AQO	200 (18)	N/A	N/A	40
CO	2010	N/M	N/M	N/M	N/M
	2011	N/M	N/M	N/M	N/M
	2012	N/M	N/M	N/M	N/M
	2013	N/M	N/M	N/M	N/M
	2014	N/M	N/M	N/M	N/M
	5-year mean	N/M	N/M	N/M	N/M
	New AQO	30,000 (0)	N/A	10,000 (0)	N/A
O_3 [6]	2010	238	96	119	38
	2011	260	153	144	48
	2012	360	112	143	34

Pollutant	Year	Highest 1-hour Conc. beyond the allowed exceedance (µg/m^3)	Highest 24-hour Conc. beyond the allowed exceedance (µg/m^3)	Highest 8-hour Conc. beyond the allowed exceedance (µg/m^3)	Annual Conc. (µg/m^3)
	2013	213	119	156	47
	2014	286	140	144	52
	5-year mean	271	124	141 [88%]	44
	New AQO	N/A	N/A	160 (9)	N/A
TSP	2010	N/M	216	N/M	64
	2011	N/M	139	N/M	69
	2012	N/M	N/M	N/M	N/M
	2013	N/M	N/M	N/M	N/M
	2014	N/M	N/M	N/M	N/M
	5-year mean	N/M	178	N/M	67
	New AQO	N/A	N/A	N/A	N/A
RSP [6]	2010 [4]	732	94	N/M	45
	2011	197	93	N/M	46
	2012	196	91	N/M	41
	2013	205	102	N/M	N/M [7]
	2014	242	92	N/M	41
	5-year mean	210	95 [95%]	N/M	43 [86%]
	New AQO	N/A	100 (9)	N/A	50
FSP [6]	2010	N/M	N/M	N/M	N/M
	2011	N/M	N/M	N/M	N/M
	2012	135	69	N/M	28
	2013	178	80	N/M	N/M [7]
	2014	162	63	N/M	27
	5-year mean	158	71 [95%]	N/M	28 [80%]
	New AQO	N/A	75 (9)	N/A	35

Note:

[1] N/M - Not Measured; N/A - Not applicable since there is no AQO for this parameter.

[2] Number of exceedance allowed under the AQO is shown in ( ), % of the AQO is shown in [ ]. The 5-year mean is the average of the yearly maximum.

[3] Monitoring results exceeding the AQO are underlined.

[4] The value was recorded during a dust plume originated from the northern part of China in March 2010, which was an abnormal event, and hence has not been used in the calculation of the 5-year mean.

[5] Monitoring data based on the AQO of 10-min SO_2 is currently not publicly available.

[6] In consideration of the number of exceedance allowance of the AQO, the values presented indicate the concentration levels beyond the AQO allowance limit, details as below:

- 4th highest concentration for 24-hour SO_2;

- 19th highest concentration for 1-hour NO_2; and
- 10th highest concentration for 8-hour O_3, 24-hour RSP and FSP.

[7] Annual average is not presented for noncompliance with the representative requirement of no less than 2/3 representative period in a quarter.

4.2.1.2 It can be seen from **Table 4.2** that the 19th highest 1-hour NO_2 concentrations were relatively steady from Year 2010 to Year 2014 with a range of 143μg/m^3 in Year 2010 to 159μg/m^3 in Year 2013, all complying with the AQO of 200μg/m^3. The highest daily NO_2 concentration was between 99μg/m^3 and 125μg/m^3 during the 5 years. No obvious trend for annual NO_2 was also observed, but it rose to 53 μg/m^3 in Year 2013. The concentration exceeded the AQO of 40μg/m^3 for all 5 years.

4.2.1.3 The 10th highest daily RSP concentration records generally complied with the AQO in recent years except for Year 2013. In particular, the dust plume from northern Mainland China in March 2010 has resulted in an abnormal hourly RSP concentration. The annual RSP concentration showed a general decreasing trend, from 46μg/m^3 in Year 2011 to 41μg/m^3 in Year 2014 and all complied with the AQO.

4.2.1.4 The FSP monitoring programme was commenced in Year 2011 and therefore no data was available from Year 2009 to 2010. The 10th highest daily FSP concentrations ranged from 63μg/m^3 to 80μg/m^3, which exceeded the AQO in Year 2013. Only two annual FSP concentration was presented, 28μg/m^3 in Year 2012 and 27μg/m^3 in Year 2014, for Year 2013, EPD stated that, the amount of recorded data is not enough for calculating the annual average.

4.2.1.5 The 10th highest 8-hour averaged O_3 concentrations ranged from 119μg/m^3 to 156μg/m^3, all complying with the AQO of 160μg/m^3.

4.2.1.1 Monitoring records of SO_2 indicated that the concentrations were in relatively low level and were well within the AQO in all 5 years. There was no CO monitoring data in Tai Po Station.

Tuen Mun Air Quality Monitoring station

4.2.1.2 Tuen Mun air quality monitoring station has been operating by EPD since Year 2014. Hence, only one-year data is available. Air quality monitoring data in Year 2014 of the various air pollutants monitored at the nearest Tuen Mun air quality monitoring stations are shown in **Table 4.3** and have been compared with the AQOs for information.

Table 4.3 Air quality monitoring data (Tuen Mun Station, 2014)

Pollutant	Year	Highest 1-hour Conc. beyond the allowed exceedance (µg/m³)	Highest 24-hour Conc. beyond the allowed exceedance (µg/m³)	Highest 8-hour Conc. beyond the allowed exceedance (µg/m³)	Annual Conc. (µg/m³)
SO_2 [4] [5]	2014	89	33 [26%]	N/M	15
	New AQO	N/A	125 (3)	N/A	N/A
NO_2 [5]	2014	184 [92%]	149	N/M	53 [133%]
	New AQO	200 (18)	N/A	N/A	40
CO	2014	N/M	N/M	N/M	N/M
	New AQO	30,000 (0)	N/A	10,000 (0)	N/A
O_3 [5]	2014	328	136	168 [105%]	41
	New AQO	N/A	N/A	160 (9)	N/A
TSP	2014	N/M	N/M	N/M	N/M
	New AQO	N/A	N/A	N/A	N/A
RSP [5]	2014	386	125 [125%]	N/M	47 [94%]
	New AQO	N/A	100 (9)	N/A	50
FSP [5]	2014	235	83 [111%]	N/M	30 [86%]
	New AQO	N/A	75 (9)	N/A	35

Note:
[1] N/M - Not Measured; N/A - Not applicable since there is no AQO for this parameter.
[2] Number of exceedance allowed under the AQO is shown in ( ), % of the AQO is shown in [ ].
[3] Monitoring results exceeding the AQO are underlined.
[4] Monitoring data based on the AQO of 10-min SO_2 is currently not publicly available.
[5] In consideration of the number of exceedance allowance of the AQO, the values presented indicate the concentration levels beyond the AQO allowance limit, details as below:

- 4th highest concentration for 24-hour SO_2;
- 19th highest concentration for 1-hour NO_2; and
- 10th highest concentration for 8-hour O_3, 24-hour RSP and FSP.

4.2.1.3 It can be seen from **Table 4.3** that the 19th highest 1-hour NO_2 concentration was 184µg/m³ in Year 2014, which complying with the AQO of 200µg/m³. The highest daily NO_2 concentration was 149µg/m³. The annual concentration in Year 2014 was 53µg/m³, which exceeded the AQO of 40µg/m³.

4.2.1.4 The 10th highest daily RSP concentration record exceeded the AQO of 100µg/m³ in Year 2014, the concentration was 125µg/m³. The annual RSP concentration in Year 2014 was 47µg/m³ which complied with the AQO.

4.2.1.5 The 10th highest daily FSP concentrations was 83µg/m³, which exceeded the AQO in Year 2014. The annual concentration in Year 2014 was 30µg/m³, which exceeded the AQO of 35µg/m³.

4.2.1.6 The 10th highest 8-hour averaged O_3 was 168µg/m³, which exceeded the AQO of 160µg/m³.

4.2.1.7 Monitoring record of SO_2 indicated that the concentrations were in relatively low level and within the AQO in Year 2014. There was no CO monitoring data in Tuen Mun Station.

4.2.2 Future Air Quality

4.2.2.1 It should be noted that the ambient air quality conditions described in above sections are the historical data and background concentrations in Tai Po which are not truly representative to the Project site. During the 12th Hong Kong-Guangdong Joint Working Group Meeting on Sustainable Development and Environmental Protection (Nov 2012), the Hong Kong and Guangdong Governments jointly endorsed a Major Air Pollutant Emission Reduction Plan for the Pearl River Delta (PRD) Region up to year 2020. Key emission reduction measures to be implemented in Hong Kong and Pearl River Delta Economic Zone (PRDEZ) include:

Hong Kong Government

- tightening of vehicle emission standards;
- phasing out highly polluting commercial diesel vehicles;
- retrofitting Euro II and Euro III franchised buses with selective catalytic reduction devices;
- strengthening inspection and maintenance of petrol and liquefied petroleum gas vehicles;
- requiring ocean-going vessels to switch to using low sulphur fuel while at berth;
- tightening the permissible sulphur content level of locally supplied marine diesel;
- controlling emissions from off-road vehicles/equipment;
- further tightening of emission caps on power plants and increasing use of clean energy for electricity generation; and
- controlling VOC contents of solvents used in printing and construction industry.

Pearl River Delta Economic Zone

- installing desulphurization and denitrification systems at large-scale coal-fired power generating units;
- closing down small-scale power generating units;
- phasing out heavily polluting cement plants as well as iron and steel plants;
- installing vapour recovery systems at petrol filling stations, oil depots and on tanker trucks;

- implementing new pollutant emission standards for boilers as well as specific industries such as cement, furniture manufacturing, printing, shoe-making and surface coating (automobile manufacturing) industries;
- installing denitrification systems at new dry-type cement kilns;
- tightening the emission standards for newly registered petrol vehicles to Guangdong IV standard; and
- progressively supplying diesel at National IV standard and petrol at Guangdong IV standard.

4.2.2.2 In order to predict the future ambient air quality, PATH (Pollutants in the Atmosphere and their Transport over Hong Kong), a regional air quality model, has been developed by EPD to simulate air quality over Hong Kong against the PRD as background, taking into account the measures to improve air quality.

4.2.2.3 The project involves 6 grids in the PATH, including 24_44, 24_45, 25_43, 25_44, 25_45 and 26_45. The hourly pollutant concentration data predicted by PATH for year 2020 are provided by EPD and are summarised in the following **Table 4.4**. **Figure 4.2.1** illustrates the locations of concerned PATH grids.

Table 4.4 Future ambient air quality for concerned PATH grids (Year 2020)

Pollutant	PATH Grids	Highest 1-hour Conc. beyond the allowed exceedance (µg/m^3)	Highest 24-hour Conc. beyond the allowed exceedance (µg/m^3)	Highest 8-hour Conc. beyond the allowed exceedance (µg/m^3)	Annual Conc. (µg/m^3)
SO_2 [3]	24_44	133 [1]	23	-	-
	24_45	150 [1]	23	-	-
	25_43	115 [1]	22	-	-
	25_44	142 [1]	22	-	-
	25_45	151 [1]	23	-	-
	26_45	152 [1]	22	-	-
	AQO	500 (3)	125 (3)	N/A	N/A
NO_2 [3]	24_44	123	-	-	20
	24_45	128	-	-	20
	25_43	117	-	-	19
	25_44	118	-	-	18
	25_45	121	-	-	19
	26_45	113	-	-	17
	AQO	200 (18)	N/A	N/A	40
CO	24_44	2477	-	1447	-
	24_45	2441	-	1525	-

Pollutant	PATH Grids	Highest 1-hour Conc. beyond the allowed exceedance (µg/m^3)	Highest 24-hour Conc. beyond the allowed exceedance (µg/m^3)	Highest 8-hour Conc. beyond the allowed exceedance (µg/m^3)	Annual Conc. (µg/m^3)
	25_43	2129	-	1288	-
	25_44	2273	-	1340	-
	25_45	2242	-	1392	-
	26_45	2016	-	1256	-
	AQO	30,000 (0)	N/A	10,000 (0)	N/A
O_3 [3]	24_44	-	-	144	-
	24_45	-	-	145	-
	25_43	-	-	148	-
	25_44	-	-	144	-
	25_45	-	-	144	-
	26_45	-	-	146	-
	AQO	N/A	N/A	160 (9)	N/A
RSP [3]	24_44	-	86	-	43
	24_45	-	88	-	43
	25_43	-	86	-	43
	25_44	-	84	-	43
	25_45	-	86	-	42
	26_45	-	86	-	42
	AQO	N/A	100 (9)	N/A	50
FSP [3] [4]	24_44	-	65	-	31
	24_45	-	66	-	31
	25_43	-	65	-	31
	25_44	-	63	-	30
	25_45	-	64	-	30
	26_45	-	64	-	30
	AQO	N/A	75 (9)	N/A	35

Note:

[1] Values are given as highest 10-minute SO_2 concentrations, which are estimated based on EPD's "Guidelines on the Estimation of 10-minute Average SO_2 Concentration for Air Quality Assessment in Hong Kong".

[2] Values in ( ) indicate number of exceedance allowed under the AQO.

[3] In consideration of the number of exceedance allowance of the AQO, the values presented indicate the concentration levels beyond the AQO allowance limit, details as below:

- 4th highest concentration for 24-hour SO_2;
- 19th highest concentration for 1-hour NO_2; and
- 10th highest concentration for 8-hour O_3, 24-hour RSP and FSP.

[4] FSP concentrations are estimated in accordance with EPD's "Guidelines on the Estimation of FSP for Air Quality Assessment in Hong Kong".

4.2.2.4 It can be seen from the above table that, with the implementation of the emission reduction measures by both the Hong Kong and Guangdong Governments, future background air quality in Year 2020 would be significantly improved from recent existing conditions and would fully comply with the AQO. In particular, the annual background NO_2 concentration on the project site would be significantly reduced to 20µg/m^3 in Year 2020.

4.3 Air Sensitive Receivers

4.3.1.1 In accordance with Annex 12 of the TM-EIAO, Air Sensitive Receivers (ASRs) include 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. Any other premises or places which, in terms of duration or number of people affected, has a similar sensitivity to the air pollutants as the abovementioned premises and places are also considered as a sensitive receiver.

4.3.1.2 Representative ASRs within 500m from the boundary of the Project site have been identified. These ASRs include both the existing and planned developments. Existing ASRs are identified by means of reviewing topographic maps, aerial photos, land status plans, supplemented by site inspections. They mainly include residential buildings with different storey heights, educational institution etc.

4.3.1.3 Planned/committed ASRs have been identified by making reference to relevant Outline Zoning Plans (OZP), Outline Development Plans, Layout Plans and other published plans in the vicinity of the alignment, including:

- Fu Tei Au and Sha Ling Outline Zoning Plan (No. S/NE-FTA/14); and
- Man Kam To Outline Zoning Plan (No. S/NE-MKT/2).

4.3.2 Construction Phase

4.3.2.1 Construction activities associated with the Project will include heavy construction works for road widening, hiking trail and construction of utilities. With reference to the EIA Study Brief for this Project (ESB-271/2014), the study area for air quality impact assessment should generally be defined by a distance of 500m from the boundary of the construction site, and representative ASRs that would be potentially affected by the construction activities have been identified in **Table 4.5**. **Figure 4.3.1** illustrates the extent of the study area for construction dust assessment and the identified representative ASRs.

4.3.3 Operational Phase

4.3.3.1 Similar to construction phase, representative ASRs for operational phase within of 500m from the Project boundary and road widening works have been identified. These ASRs include both the existing and planned developments. The locations of the representative ASRs for operational air quality assessment have been identified in **Table 4.5.** The locations of the representative ASRs are illustrated in **Figure 4.3.2**.

Table 4.5 Representative ASRs for air quality impact assessment

ASR ID	Description	Land use [1]	No. of Storey	Approx. Separation Distance from Project Boundary (m)	Affected During Construction Phase	Affected During Operational Phase
Existing ASRs						
A1	Lo Wu Control Point	GIC	4	650	✓	✓
A2	Village House along Lo Wu Road	R	3	470	✓	✓
A3	Lo Wu Public School	E	1	440	✓	✓
A4	Lo Wu Document Storage Building	GIC	2	770	✓	✓
A5	Village House along Lo Wu Station Road	R	3	730	✓	✓
A6	Food and Environmental Hygiene Department	GIC	1	580	✓	✓
A7	Village House along Man Kam To Road	R	2	500	✓	✓
A8	Border District Police Headquarter	GIC	4	380	✓	✓
A9	Village House along Man Kam To Road	R	3	280	✓	✓
A10	Village House along Man Kam To Road	R	1	290	✓	✓
A11	Village House along Man Kam To Road	R	1	20	✓	✓

ASR ID	Description	Land use [1]	No. of Storey	Approx. Separation Distance from Project Boundary (m)	Affected During Construction Phase	Affected During Operational Phase
A13	Temple	W	1	10	✓	✓
A14	Village House along Man Kam To Road	R	3	10	✓	✓
A15	Village House along Man Kam To Road	R	1	110	✓	✓
A16	Village House along Man Kam To Road	R	2	240	✓	✓
A17	Village House along Man Kam To Road	R	1	350	✓	✓
A18	Ta Kwu Ling Division Border Enforcement Unit Block	OU	1	410	✓	✓
A19	Village House near Man Kam To Operation Base	R	3	160	✓	✓
A20	Man Kam To Boundary Control Point	OU	1	410	✓	✓
A21	Village House to the south of Man Kam To Boundary Control Point	R	3	200	✓	✓
A22	Hung Kiu San Tsuen	R	3	200	✓	× [2]
A23	Village House at San Uk Ling	R	3	10	✓	✓
A24	Village House along Lin Ma Hang Road	R	3	<10	✓	✓

ASR ID	Description	Land use [1]	No. of Storey	Approx. Separation Distance from Project Boundary (m)	Affected During Construction Phase	Affected During Operational Phase
A25	Village House along Muk Wu	R	3	210	✓	✓
A26	Village House along Lin Ma Hang Road	R	3	40	✓	✓
A28	Village House along Lin Ma Hang Road	R	3	<10	✓	✓
A29	Village House at Muk Wu Nga Yiu	R	3	110	✓	✓
A30	Village House at Muk Wu Chuen Yiu (Planned)	R	3	<10	✓	✓
A31	Village House at Muk Wu Chuen Yiu	R	3	30	✓	✓
A32	Recreational use – Planned development	REC	N/A	210	✓	✓
A33	Recreational use – Planned development	REC	N/A	190	✓	✓
A34	Recreational use – Planned development	REC	N/A	300	✓	✓
A35	Recreational use – Planned development	REC	N/A	460	✓	✓
A36	Recreational use – Planned development	REC	N/A	380	✓	✓
A37	House No. 28 Ta Kwu Ling Village	R	3	500	✓	✓

ASR ID	Description	Land use [1]	No. of Storey	Approx. Separation Distance from Project Boundary (m)	Affected During Construction Phase	Affected During Operational Phase
Planned ASRs						
P1	OWTF Phase 2	GIC	N/A	200	× [3]	✓

Note:

[1] R – Residential; E – Education; GIC – Government, institution and community; W – Worship; OU – Other Specified Uses; REC - Recreation.

[2] ASR A22 is not located within 500m assessment area during operational phase.

[3] As the ASR A13 is nearer to the worksite and subsequently worse impact than the planned ASR P1, it is not identified in the assessment during construction phase. However, in the operational phase, the OWTF is identified for conservative purpose.

4.4 Construction Dust Assessment

4.4.1 Identification of Pollution Sources and Emission Inventory

4.4.1.1 The key air pollution sources within the assessment area that may bear upon the air quality during construction phase include dust emission associated with the construction activities due to the Project, the vehicular emission from the neighbouring roads such as Man Kam To Road and idling vehicles at Man Kam To Boundary Control Point (MKTBCP), the barging facilities at Siu Lam and due to the concurrent projects (i.e. OWTF Phase 2 and Widening of Western Section of Lin Ma Hang Road).

4.4.1.2 Other far-field emission sources outside the assessment area which would also have certain influence on the background air quality level include territory wide vehicular emission, power plants, marine emission, as well as regional emission from PRD.

4.4.1.3 Specifically, the existing and potential near-field sources are described in the following sections:

<u>Dust Emission associated with the Project</u>

4.4.1.4 A review on the construction methodology and tentative implementation programme has been conducted. In general, construction dust will be generated mainly from the at-grade construction work sites (as presented in **Appendix 4.1**) including the following:

- Site clearance;
- Soil excavation;
- Stockpile;
- Backfilling;
- Site formation; and
- Wind erosion of open site.

4.4.1.5 There is a barging point located off-site in Siu Lam which is currently being operated with the Express Rail Link (XRL) project. The barging facilities will operate for a working period of 22 days a month and 6 hours a day from 10:00am to 4:00pm, except Sundays and public holidays. **Figure 1.3** illustrates the locations of Siu Lam Barging Point.

4.4.1.6 The spoil materials would be directly transported to the tipping halls of the barging point by trucks and then unloaded to the barges. In order to reduce the impact on road traffic, surplus inert construction and demolition (C&D) materials from the construction of the C&C facilities at Sandy Ridge Cemetery and Lin Ma Hang Road will be stored at a temporary stockpile area on-site. Therefore, the construction activities within this works area would be limited to the unloading of spoils. Other dust activities, such as site clearance and site formation, would not be undertaken concurrently with the barging point.

4.4.1.7 Haul roads within the barging point would be all paved and water spraying would be provided to keep wet condition. All vehicles transferring materials to the barging point will be washed at exit points on-site and dusty materials will be covered with tarpaulin. After unloading, vehicles would be required to pass through vehicle washing facilities with high pressure water jet at every discernible or designated vehicle exit point at the barging point.

4.4.1.8 The tipping halls would be 3-sided enclosure with a top cover, water spraying and dust curtain would be provided at the unloading points (from barging point to the barges).

4.4.1.9 With implementation of measures as mentioned, no adverse dust impact arising from the operation of the barging point is anticipated.

4.4.1.10 Fugitive dust impact assessments have been carried out based on conservative assumptions of general construction activities which include the following:

- Heavy construction activities including site clearance, ground excavation, construction of the associated facilities, haul road etc;
- Wind erosion of all active open sites;
- Loading/ Unloading from trucks at stockpiles;
- All construction activities at all work sites to be undertaken concurrently in order to assess the worst-case situation;
- Construction working periods of 26 days a month and 12 hours a day from 7:00am to 7:00pm, except Sundays and public holidays.

Dust Emission associated with Concurrent Projects

4.4.1.11 The tentative commencement year for the construction of this Project is Year 2017 with target completion in Year 2022. **Section 1.9** has identified a number of key potential concurrent projects within 500m from this Project and it is concluded that the projects “Development of Organic Waste Treatment Facilities, Phase 2” (OWTF Phase 2) and “Widening of Western Section of Lin Ma Hang Road” would have cumulative air quality impacts during the construction phase of this Project and hence these have been included in the assessment. Dust emission sources and strengths presented in the approved EIA Study “*Development of Organic Waste Treatment Facilities, Phase 2*” (AEIAR-180/2013), as the best available information, are adopted in this construction dust assessment. However, no information is available for project "Widening of Western Section of Lin Ma Hang Road". Hence, emission strengths for the construction of this Project have therefore been adopted (refer to **Section 4.4.3.1**) as the best available information. **Appendix 4.1** presents the locations of dust sources for OWTF Phase 2 and the Project "Widening of Western Section of Lin Ma Hang Road".

Dust Emission from Existing Cement Plant

4.4.1.12 A cement plant located near Muk Wu Nga Yiu within 500m assessment area was identified during the site visit conducted in June 2014. No operation and activities within the cement plant were observed. Liaison with EPD has also been made to obtain the Specified Process (SP) licence for this plant. However, EPD advised that this plant is no longer in operation and there is no SP licence for this plant. Hence, it is not included in the assessment.

Dust Emission from Proposed Temporary Asphalt Plant

4.4.1.13 According to the approved Section 16 planning application for *"A Proposed Temporary Asphalt Plant at Man Kam To Road, Sheung Shui"* (A/NE-FTA/148), a planned asphalt plant will commence its operation in the future for a 5-year period. Information will be detailed in **Section 4.5.1**.

Dust Emission from Road Traffic (i.e. Open Roads and Man Kam To Boundary Control Point)

4.4.1.14 Particulate emissions, which are generally RSP and FSP with aerodynamic diameters less than 10μm and 2.5μm, are also generated from road traffic. Emission sources within 500m assessment area include vehicles on roads and idling vehicles at the MKTBCP (such as kiosks, loading/unloading bays). They have also been considered in the cumulative dust impact assessment during construction phase of the Project.

4.4.2 Key Representative Pollutants

4.4.2.1 According to Section 13.2.4.3 of USEPA AP-42, among all aerodynamic particle sizes (i.e. TSP), there are 47% of particles with an aerodynamic diameter of <10 μm (i.e. RSP). Hence, TSP and RSP are the most representative pollutants for construction phase assessment. However, upon the effect of the AQO from 1 January 2014, a new criteria pollutant, FSP, has been included in the AQO. As a conservative approach, FSP has also been assessed, notwithstanding that it only constitutes 7% of the total particles in fugitive dust. Hence, the 1-hour TSP, 24-hour RSP/ FSP, and annual RSP/ FSP concentrations at each identified ASR have been assessed and compared with the AQO or the requirements of TM-EIAO to determine their compliance.

4.4.2.2 Fuel combustion from the use of Powered Mechanical Equipment (PME) during construction works could be a source of NO_2, SO_2 and CO. However, the emissions from PMEs are considered negligible as compared with the tailpipe emissions from vehicles. In addition, there is no source of Pb and O_3 emission during the construction phase. Hence, NO_2, SO_2, CO, Pb and O_3 are not considered as the key pollutants for quantitative dust assessment.

4.4.3 Assessment Methodology

Dust Emission associated with the Project

4.4.3.1 The prediction of dust emissions is based on typical values and emission factors from United States Environmental Protection Agency (USEPA) Compilation of Air Pollution Emission Factors (AP-42), 5th Edition. References of the dust emission factors for different dust generating activities are listed in **Table 4.6** below. Details are discussed in the following sections. **Appendix 4.2** presents the calculation of dust emission factors.

Table 4.6 References of dust emission factors (TSP) for different activities

Operating Sites	Activities	Equations and Assumptions	Reference
All construction and excavation sites	Heavy construction activities including land clearance, ground excavation, cut and fill operations, construction of the facilities, haul road, etc.	E = 1.2 tons/acre/month of activity or = 2.69Mg/hectare/month of activity	USEPA AP42, S.13.2.3.3
Stockpiles	Loading/ Unloading at stockpile	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$ $(kg/megagram)$ k is particle size multiplier U is average wind speed M is material moisture content	USEPA AP42, S13.2.4
All construction sites	Wind Erosion	E = 0.85 Mg/hectare/yr (24 hour emission)	USEPA AP42, S.11.9, Table 11.9.4

4.4.3.2 Dust emission from construction vehicle movement will generally be limited within the confined worksites and the emission factor given in AP-42 S.13.2.3.3 has taken this factor into account. Watering facilities will be provided at every designated vehicular exit point. Since all vehicles will be washed at exit points and vehicle loaded with the dusty materials will be covered entirely by clean impervious sheeting before leaving the construction site, dust nuisance from construction vehicle movement outside the worksites is unlikely to be significant.

Determination of Worst Assessment Year

4.4.3.3 Quantities of dust generation associated with the Project for each year have been estimated to identify the worst assessment year and results are tabulated as in **Table 4.7** below. It can be seen that the highest dust generation would occur in Year 2020 and hence it is selected as the worst assessment year. **Appendix 4.2** presents the calculations of estimated dust emission.

Table 4.7 Estimated dust emission during construction period

Year	Estimated Dust Emission due to Heavy Construction (ton per year)
2017	163
2018	397
2019	541
2020	**608**
2021	287
2022	86

Note:
[1] Value in bold is the maximum among all years.

Dust Dispersion Modelling Approach

4.4.3.4 Dust impact assessment is undertaken using the EPD approved Fugitive Dust Model (FDM). It is a well-known Gaussian Plume model designed for computing air dispersion for fugitive dust sources. Modelling parameters including dust emission factors, particles size distributions, surface roughness, etc are referred to EPD's "*Guidelines on Choice of Models and Model Parameters*" and USEPA AP-42. The density of dust is assumed to be 2.5g/m^3. A surface roughness of 50cm is assumed in the model to represent the local terrain. Owing to the limitation of the FDM model, worksites located higher than 20m above ground level are set to the maximum height of 20m in the model as the worst-case assumption.

4.4.3.5 Particle size distribution is estimated based on S13.2.4.3 of USEPA AP-42. **Table 4.8** presents the particle size distribution of TSP, RSP and FSP adopted in the assessment.

Table 4.8 Particle size distribution in FDM

Particle Size (μm)	Average Particle Size(μm)	Particle Size Distribution		
		TSP	RSP	FSP
0 – 2.5	1.25	7%	15%	100%
2.5 – 5	3.75	20%	42%	-
5 – 10	7.5	20%	43%	-
10 – 15	12.5	18%	-	-
15 - 30	22.5	35%	-	-
	Total:	**100%**	**100%**	**100%**

4.4.3.6 With reference to EPD's "Guidelines on Assessing the 'Total' Air Quality Impacts", the chemical transport modeling system-based approach is adopted. Hourly air quality data from the PATH model for Year 2020 is used as the background concentrations for conservative assessment. Hourly meteorological data (including wind direction, wind speed, temperature and mixing height) for Year 2010 extracted from the PATH model are used. Since there is no stability data available from PATH, PCRAMMET model has been used to predict the stability classes. In addition, the mixing heights from the PATH which are lower than the minimum mixing height recorded by the Hong Kong Observatory (HKO) in Year 2010 (i.e. 121m) are capped at 121m. For the treatment of calm hours, the approach recommended in the "Guideline on Air Quality Models Version 05" (US EPA) is followed.

4.4.3.7 During daytime working hours (7am to 7pm), it is assumed that dust emissions would be generated from all dust generating activities and wind erosion. During night-time non-working hours (7pm to 7am of the next day), Sunday and public holidays, dust emission source would include wind erosion only as construction activities during these hours are ceased.

4.4.3.8 Fugitive dust impacts are modelled for ASR heights at 1.5m, 5m, 10m, 15m and 20m above ground. Since some of the dust generating sources associated with the Project are located on hilly terrain and source heights are capped at 20m in FDM, these assessment levels would therefore cover the worst-case scenario. Both the unmitigated and mitigated scenarios are presented. A 100x100m grid is used to generate the pollution contours in order to investigate the pollutant dispersion.

4.4.3.9 A summary of FDM modelling parameters that has been adopted in the construction dust assessment are given in **Table 4.9** below:

Table 4.9 Modelling parameters in FDM

Parameters	**Input**	**Remark**
Background Concentration	Hourly results from PATH model for Year 2020	Provided by EPD
Modelling mode	Flatted terrain	-
Meteorological data	Hourly meteorological data adopted in PATH	Provided by EPD
Anemometer Height	10m	-
Surface Roughness	50cm	-

Parameters	Input	Remark
Emission period	General construction activities during daytime working hours (7 am to 7 pm) Stockpile during daytime working hours (7 am to 7 pm) Wind erosion during both day-time (7am to 7pm) and night-time (7pm to 7am of the next day) OWTF Phase 2 construction activates during daytime working hours (7 am to 7 pm) "Widening of Western Section of Lin Ma Hang Road" construction activates during daytime working hours (7 am to 7 pm)	-
Assessment height	1.5m, 5m,10m, 15m and 20m	-

4.4.3.10 It is understood that construction activities will not be taken place on the entire work sites at the same time, but to be undertaken at moving multiple work fronts spread across the work sites. The active areas on each work sites could be best estimated based on the construction method, construction programme and number of operating plants. However, as a conservative assessment, it is assumed that the hourly and annual percentage active areas are both 100%.

4.4.3.11 In addition, as mentioned in **Section 4.4.1.11**, dust emission sources and strengths presented in the approved EIA Study "*Development of Organic Waste Treatment Facilities, Phase 2*" (AEIAR-180/2013) are adopted in this assessment.

Dust Emission from Concurrent Sources (i.e. Open Roads and Man Kam To Boundary Control Point)

4.4.3.12 Approach for prediction of vehicular emissions from open road and idling vehicles at Man Kam To Boundary Control Point (MKTBCP) are the same as operational phase assessment as described in **Section 4.5.3**, in which the dispersion model, CALINE4 is used to assess the vehicular emission impact. Vehicular emissions from open road are determined using the latest EMFAC-HK based on the Year 2020 projected traffic data. **Appendix 4.3** presents the hourly RSP and FSP emission factors for each road link for Year 2020.

4.4.3.13 Idling emission at MKTBCP are estimated in accordance with Permanent International Association of Road Congresses (PIARC) at assessment year 2020 and the methodology is described in **Section 4.4.3**. **Appendix 4.4** presents the detailed calculations of idling emissions for Year 2020.

Dust Emission from Concurrent Sources (i.e. Planned Asphalt Plant)

4.4.3.14 Dust emission from the planned asphalt plant are reference form the approved Section 16 planning application for "A Proposed Temporary Asphalt Plant at Man Kam To Road, Sheung Shui" (A/NE-FTA/148) is also assessed in accordance with the methodology described in **Section 4.5.3**, whereas the dispersion model ISCST3 is used to simulate the emission impact.

Far-field Source Contribution (i.e. Future Background Air Quality)

4.4.3.15 Details are given in **Section 4.5.3**. The hourly pollutant concentration data predicted by PATH for Year 2020 are directly adopted.

4.4.3.16 Only RSP concentrations are available from PATH model. According to EPD's "Guidelines on the Estimation of PM2.5 for Air Quality Assessment in Hong Kong", the conservative correction as shown in **Table 4.10** are adopted to determine the background FSP concentrations. For hourly background TSP concentrations, it is considered reasonable to assume the hourly RSP concentrations from PATH as the ambient TSP background concentrations, since the particulates of sizes larger than 10μm generated from far-field dust sources would have been largely settled before reaching the ASRs, and hence most of the particulates contributed from far-field sources affecting the ASRs will likely be of less than or equal to 10μm in size (i.e. RSP).

Table 4.10 Conversion factors for RSP/FSP

Annual (µg/m^3)	Daily (µg/m^3)
FSP = 0.71 x RSP	FSP = 0.75 x RSP

Prediction of the Cumulative Construction Dust Impact

4.4.3.17 The cumulative construction dust impact is a combination of the emission impacts contributed from the near field and far field sources (i.e. at local scale and background air quality impact from other concurrent and regional sources) on hourly basis.

4.4.3.18 In consideration of the number of exceedance allowance of the daily AQO (refer to **Table 4.1**), the pollutant concentrations beyond the AQO's allowance limits (i.e. the 10th highest 24-hour RSP/ FSP concentrations) are presented. The annual predicted RSP/ FSP concentrations are also assessed and all predicted levels are then compared with the AQOs. Besides, the 1-hour TSP concentration as stipulated under Annex 4 of TM-EIAO is also determined at each ASR.

4.4.4 Prediction and Evaluation of Environmental Impacts

4.4.4.1 The predicted maximum unmitigated 1-hour TSP concentrations, and 10th highest 24-hour and annual RSP / FSP concentrations are presented in the **Table 4.11** below and detailed in **Appendix 4.5**. Exceedances of the TSP, RSP and/or FSP criteria are predicted at almost all ASRs. Mitigation measures are therefore required to reduce the potential air quality impact during construction phase. **Figures 4.4.1 – 4.4.5** illustrate the contours for the cumulative unmitigated 1-

hour TSP concentrations, and 10th highest 24-hour and annual RSP / FSP concentrations at 1.5m above ground, which is the worst hit level.

Table 4.11 Unmitigated cumulative TSP, RSP and FSP concentrations

ASR ID [2]	Location	TSP Concentration (μg/m^3) [1]	RSP Concentration (μg/m^3) [1]		FSP Concentration (μg/m^3) [1]	
		Max. 1-hour	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A1	Lo Wu Control Point	**1590**	**103**	50	65	32
A2	Village House along Lo Wu Road	**1934**	**113**	**54**	65	32
A3	Lo Wu Public School	**1908**	**117**	**55**	65	32
A4	Lo Wu Document Storage Building	**1473**	**102**	49	65	32
A5	Village House along Lo Wu Station Road	**1159**	**119**	**51**	68	32
A6	Food and Environmental Hygiene Department	**1362**	**135**	**53**	67	32
A7	Village House along Man Kam To Road	**1047**	**127**	**53**	67	32
A8	Border District Police Headquarter	**1047**	**122**	50	66	31
A9	Village House along Man Kam To Road	**1256**	**130**	**53**	67	32
A10	Village House along Man Kam To Road	**1703**	**160**	**59**	71	32
A11	Village House along Man Kam To Road	**1435**	**206**	**88**	67	32
A13	Temple	**1418**	**196**	**64**	71	33
A14	Village House along Man Kam To Road	**1518**	**135**	**60**	65	32

ASR ID [2]	Location	TSP Concentration (μg/m^3) [1]	RSP Concentration (μg/m^3) [1]		FSP Concentration (μg/m^3) [1]	
		Max. 1-hour	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A15	Village House along Man Kam To Road	**1911**	**113**	**55**	64	31
A16	Village House along Man Kam To Road	**1556**	**102**	**51**	63	31
A17	Village House along Man Kam To Road	**1422**	**103**	50	64	31
A18	Ta Kwu Ling Division Border Enforcement Unit Block	**1332**	97	**52**	65	31
A19	Village House near Man Kam To Operation Base	**1788**	**111**	**59**	65	32
A20	Man Kam To Boundary Control Point	**1497**	99	**52**	65	31
A21	Village House to the south of Man Kam To Boundary Control Point	**964**	**107**	**54**	65	31
A22	Hung Kiu San Tsuen	**579**	**101**	46	66	31
A23	Village House at San Uk Ling	**839**	**168**	**65**	65	31
A24	Village House along Lin Ma Hang Road	**816**	**170**	**92**	64	31
A25	Village House along Muk Wu	**686**	92	**52**	64	31
A26	Village House along Lin Ma Hang Road	467	**128**	**54**	65	31
A28	Village House along Lin Ma Hang Road	**787**	**210**	**107**	67	33

ASR ID [2]	Location	TSP Concentration (µg/m³) [1]	RSP Concentration (µg/m³) [1]		FSP Concentration (µg/m³) [1]	
		Max. 1-hour	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A29	Village House at Muk Wu Nga Yiu	**1174**	**102**	**55**	66	32
A30	Village House at Muk Wu Chuen Yiu (Planned)	**2753**	**202**	**100**	**77**	**39**
A31	Village House at Muk Wu Chuen Yiu	**2461**	**149**	**74**	70	35
A32	Recreational use – Planned development	**3554**	99	49	74	**36**
A33	Recreational use – Planned development	**2415**	**107**	50	**83**	**37**
A34	Recreational use – Planned development	**2780**	97	47	**77**	34
A35	Recreational use – Planned development	**2076**	97	46	**77**	34
A36	Recreational use – Planned development	**1562**	93	48	68	**37**
A37	Recreational use – Planned development	**1153**	93	45	72	32

Note:
[1] Bolded values mean exceedance over the respective criteria.
[2] As the ASR A13 is nearer to the worksite and subsequently worse impact than the planned ASR P1, it is not identified in the assessment during construction phase. However, in the operational phase, the OWTF is identified for conservative purpose.
[3] Maximum concentrations across the assessment heights of 1.5m, 5m, 10m, 15m and 20m at each ASRs are presented in this table.

4.4.5 Mitigation Measures

4.4.5.1 In order to reduce the dust emission from the Project and achieve compliances of relevant criteria at ASRs, the following specific mitigation measures are recommended:

- Regular watering under a good site practice should be adopted. In accordance with the “Control of Open Fugitive Dust Sources” (USEPA AP-42) as given in Appendix 4.6, watering once per hour on exposed worksites and haul road is proposed to achieve dust removal efficiency of 91.7%. These dust suppression efficiencies are derived based on the average haul road traffic of

45 per hour, average evaporation, etc. (see Appendix 4.6). Any potential dust impact and watering mitigation would be subject to the actual site conditions. For example, for 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 frequencies are to be followed, the extent of watering may vary depending on actual site conditions. The dust levels would be monitored and managed under an Environmental Monitoring and Audit (EM&A) programme as specified in the EM&A Manual.

4.4.5.2 In addition, the Contractor is also obliged to follow the procedures and requirements given in the Air Pollution Control (Construction Dust) Regulation. It stipulates the construction dust control requirements for both Notifiable (e.g. site formation) and Regulatory (e.g. road opening) Works to be carried out by the Contractor. The following dust suppression measures should be incorporated by the Contractor to control the dust nuisance throughout the construction phase:

- Any excavated or stockpile of dusty material should be covered entirely by impervious sheeting or sprayed with water to maintain the entire surface wet and then removed or backfilled or reinstated where practicable within 24 hours of the excavation or unloading;
- Any dusty materials remaining after a stockpile is removed should be wetted with water and cleared from the surface of roads;
- A stockpile of dusty material should not be extended beyond the pedestrian barriers, fencing or traffic cones;
- The load of dusty materials on a vehicle leaving a construction site should be covered entirely by impervious sheeting to ensure that the dusty materials do not leak from the vehicle;
- Where practicable, vehicle washing facilities with high pressure water jet should be provided at every discernible or designated vehicle exit point. The area where vehicle washing takes place and the road section between the washing facilities and the exit point should be paved with concrete, bituminous materials or hardcores;
- When there are open excavation and reinstatement works, hoarding of not less than 2.4m high should be provided as far as practicable along the site boundary with provision for public crossing. Good site practice shall also be adopted by the Contractor to ensure the conditions of the hoardings are properly maintained throughout the construction period;
- The portion of any road leading only to construction site that is within 30m of a vehicle entrance or exit should be kept clear of dusty materials;

- Surfaces where any pneumatic or power-driven drilling, cutting, polishing or other mechanical breaking operation takes place should be sprayed with water or a dust suppression chemical continuously;
- Any area that involves demolition activities should be sprayed with water or a dust suppression chemical immediately prior to, during and immediately after the activities so as to maintain the entire surface wet;
- Where a scaffolding is erected around the perimeter of a building under construction, effective dust screens, sheeting or netting should be provided to enclose the scaffolding from the ground floor level of the building, or a canopy should be provided from the first floor level up to the highest level of the scaffolding;
- Any skip hoist for material transport should be totally enclosed by impervious sheeting;
- Every stock of more than 20 bags of cement or dry pulverised fuel ash (PFA) should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides;
- Cement or dry PFA delivered in bulk should be stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line and no overfilling is allowed;
- Loading, unloading, transfer, handling or storage of bulk cement or dry PFA should be carried out in a totally enclosed system or facility, and any vent or exhaust should be fitted with an effective fabric filter or equivalent air pollution control system; and
- Exposed earth should be properly treated by compaction, turfing, hydroseeding, vegetation planting or sealing with latex, vinyl, bitumen, shortcrete or other suitable surface stabiliser within six months after the last construction activity on the construction site or part of the construction site where the exposed earth lies.

4.4.5.3 For the Siu Lam Barging Point, the following good site practices are required:

- All road surface within the barging facilities will be paved;
- Dust enclosures will be provided for the loading ramp, installation of 3-sided screen with top cover and the provision of water sprays at the discharge point would be provided;
- Vehicles will be required to pass through designated wheel wash facilities; and
- Continuous water spray at the loading point.

4.4.5.4 With implementation of the abovementioned mitigation measures, the maximum mitigated 1-hour TSP concentrations, and 10th highest 24-hour and annual RSP / FSP concentrations are calculated and presented in **Table 4.12** below. Results indicate that there are no exceedances of respective criteria predicted at all ASRs. Detailed results are given in **Appendix 4.7**.

4.4.5.5 In addition, contours of mitigated 1-hour TSP concentrations, and 10th highest and annual RSP / FSP concentrations at 1.5m above ground are shown in the **Figures 4.4.6 – 4.4.10**. Contours also indicate that there are no exceedances at all air sensitive uses.

Table 4.12 Mitigated cumulative TSP, RSP and FSP concentrations

ASR ID [2]	Location	TSP Concentration (μg/m^3) [1]	RSP Concentration (μg/m^3) [1]		FSP Concentration (μg/m^3) [1]	
		Max. 1-hour	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A1	Lo Wu Control Point	195	86	44	65	31
A2	Village House along Lo Wu Road	218	86	45	65	31
A3	Lo Wu Public School	202	86	45	65	31
A4	Lo Wu Document Storage Building	203	86	44	65	31
A5	Village House along Lo Wu Station Road	179	88	45	65	31
A6	Food and Environmental Hygiene Department	178	88	44	63	31
A7	Village House along Man Kam To Road	188	88	45	64	31
A8	Border District Police Headquarter	191	87	44	63	31
A9	Village House along Man Kam To Road	208	88	45	63	31
A10	Village House along Man Kam To Road	204	89	45	63	31
A11	Village House along Man Kam To Road	196	95	49	63	31

ASR ID [2]	Location	TSP Concentration ($\mu g/m^3$) [1]	RSP Concentration ($\mu g/m^3$) [1]		FSP Concentration ($\mu g/m^3$) [1]	
		Max. 1-hour	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A13	Temple	211	97	46	64	31
A14	Village House along Man Kam To Road	191	88	45	63	31
A15	Village House along Man Kam To Road	197	86	44	63	31
A16	Village House along Man Kam To Road	167	85	44	63	31
A17	Village House along Man Kam To Road	161	85	44	64	31
A18	Ta Kwu Ling Division Border Enforcement Unit Block	171	86	44	65	31
A19	Village House near Man Kam To Operation Base	205	86	44	64	30
A20	Man Kam To Boundary Control Point	182	87	44	65	31
A21	Village House to the south of Man Kam To Boundary Control Point	170	87	44	64	30
A22	Hung Kiu San Tseun	226	91	45	65	31
A23	Village House at San Uk Ling	164	93	45	65	30
A24	Village House along Lin Ma Hang Road	163	89	48	64	30
A25	Village House along Muk Wu	163	86	44	64	30
A26	Village House along Lin Ma Hang Road	166	91	44	65	30

ASR ID [2]	Location	TSP Concentration ($\mu g/m^3$) [1]	RSP Concentration ($\mu g/m^3$) [1]		FSP Concentration ($\mu g/m^3$) [1]	
		Max. 1-hour	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A28	Village House along Lin Ma Hang Road	166	90	50	65	31
A29	Village House at Muk Wu Nga Yiu	166	87	44	65	30
A30	Village House at Muk Wu Chuen Yiu (Planned)	309	94	49	65	31
A31	Village House at Muk Wu Chuen Yiu	265	90	46	65	31
A32	Recreational use – Planned development	384	91	47	65	31
A33	Recreational use – Planned development	294	98	48	67	31
A34	Recreational use – Planned development	320	94	45	66	31
A35	Recreational use – Planned development	243	95	45	66	31
A36	Recreational use – Planned development	192	89	47	65	31
A37	House No 28 Ta Kwu Ling Village	174	91	44	65	30

Note:
[1] Bolded values mean exceedance over the respective criteria.
[2] As the ASR A13 is nearer to the worksite and subsequently worse impact than the planned ASR P1, it is not identified in the assessment during construction phase. However, in the operational phase, the OWTF is identified for conservative purpose.
[3] Maximum concentrations across the assessment heights of 1.5m, 5m, 10m, 15m and 20m at each ASRs are presented in this table.

4.4.6 Residual Environmental Impacts

4.4.6.1 With the implementation of the mitigation measures as stipulated in the Air Pollution Control (Construction Dust) Regulation, dust control measures, including watering once per hour on exposed worksites and haul road, and good site practices, the predicted 1-hour TSP, 24-hour and annual RSP / FSP concentrations on area in the vicinity of the construction sites would comply with the respective criteria. With the implementation of measures as mentioned in this section, no adverse dust impact arising from the operation of Siu Lam barging point is expected. Hence, no adverse residual air quality impact during construction phase is anticipated.

4.5 Operational Air Quality Assessment

4.5.1 Identification of Pollution Sources

4.5.1.1 The key existing air pollution sources within the assessment area that may bear upon the air quality during operational phase include the vehicular emission from the neighbouring roads such as Man Kam To Road and idling vehicles at MKTBCP.

4.5.1.2 Other far-field emission sources outside the assessment area which would also have certain influence on the background air quality level include territory wide vehicular emission, power plants, marine emission, as well as regional emission from PRD.

4.5.1.3 Other than the existing air pollution sources, it is anticipated that the future infrastructure developments in the vicinity of the Project would also induce additional traffic and hence incur additional emission burden which may also cause potential air quality impacts on the ASRs.

4.5.1.4 Specifically, the existing and potential near-field sources are described in the following sections below:

Vehicular Emission from Open Road

4.5.1.5 Major air pollution source in the vicinity of the Project during operational phase would be tailpipe emission generated from traffic on open road. Vehicular emissions from the existing road networks, and those induced by the concurrent projects, including the Development of Lok Ma Chau Loop (LMC Loop), North East New Territories New Development Area (NENT NDA), Liantang / Heung Yuen Wai Boundary Control Point (LT-HYW BCP) etc. that would have cumulative air quality impact on nearby ASRs have also been addressed. **Figure 4.5.1** illustrates the road networks within 500m assessment area which is considered as near-field vehicular emission sources in the operational air quality assessment.

4.5.1.6 Liaisons with the respective project proponents of the aforesaid concurrent projects have been made to obtain the latest available project information and details. Where information is not available, references will be made to the approved EIA reports or best available information from public domain.

Vehicular Emission from Idling Vehicles

4.5.1.7 MKTBCP are located within 500m assessment area and hence the emission from idling vehicles at kiosks and loading/unloading bays has been included in the assessment. **Figure 4.5.1** illustrates the locations of MKTBCP.

Industrial Emission

4.5.1.8 Chimney survey and desktop study have been conducted to identify existing chimneys within 500m from the boundary of the Project and no chimney was found. According to the latest programme of the planned OWTF Phase 2, it would come into operation in Year 2019. Cumulative air quality impact during the operational phase of the Project is therefore anticipated and has been considered in this assessment. Locations of stack and flare of OWTF Phase 2 are shown in **Figure 4.5.2**.

4.5.1.9 According to the approved Section 16 planning application for "A Proposed Temporary Asphalt Plant at Man Kam To Road, Sheung Shui" (A/NE-FTA/148), a planned asphalt plant will commence its operation in the future for a 5-year period, however, implementation programme is not available. **Figure 4.5.2** illustrates the location of the planned asphalt plant. It is understand that the planned asphalt plant is located outside 500m assessment area, however, as a conservative assessment, industrial emission from the planned asphalt plant is included in the near-field dispersion model for the cumulative air quality assessment.

Helicopter Emission

4.5.1.10 According to the Strategic Environmental Assessment (SEA) Report for the Land Use Planning for the Closed Area (CE 60/2005), there are 2 helipads in the vicinity and these helipads are primarily for emergency purpose and are not frequently used. Locations of helipads are shown in **Figure 4.5.2**. Hence, any air quality impacts from those helipads are not considered significant.

Potential Crematorium

4.5.1.11 Any crematorium to be planned at the Sandy Ridge Cemetery are considered as a Designated Project as per Schedule 2, Part I, Category N.4 of the TM-EIAO. A separate EIA study will be conducted to fulfil all the statutory requirements and procedures under the EIAO and thus the potential cumulative operational air quality impact associated with any crematorium will be excluded from this EIA study.

4.5.2 Key Representative Pollutants

4.5.2.1 As discussed in **Section 4.1**, the Air Pollution Control Ordinance (APCO) (Cap 311) and its subsidiary regulations define statutory AQOs for 7 common air pollutants including NO_2, SO_2, RSP, FSP, CO, O_3 and Pb. According to Appendix B, Clause 5 (ii) of the EIA Study Brief, the key / representative air pollutant parameters for the project shall be identified, including the types of pollutants and the averaging time concentration.

4.5.2.2 The air quality pollutant source during the operational phase of the project would be the emission from the vehicles travelling on the new and existing roads. The tailpipe emission would comprise a number of pollutants, including Nitrogen Oxides (NO_X), RSP, FSP, SO_2, Toxic Air Pollutants (TAP), Pb etc. Determination of representative air pollutants for this Project is discussed in the following:

Nitrogen Dioxide (NO_2)

4.5.2.3 NOx is known to be one of the pollutants emitted by vehicles. Together with Volatile Organic Compound (VOC) and in the presence of O_3 under sunlight, NOx would be transformed to NO_2. According to the 2013 Hong Kong Emission Inventory Report published by EPD [4-1] which is the latest available information at the time of preparing this report, the dominant source of NOx generated in HK is the navigation which constitutes about 31% of the total in 2013. Road transport is the third largest NOx emission group, accounting for about 23% of the total. **Table 4.13** presents the 2013 emission percentage and the amount of NOx in Hong Kong.

Table 4.13 The emission percentage and the amount of NOx in Hong Kong (2013)

Pollutant Source Categories	NO_x Emission %[1]	NO_x Emission (tons) [1]
Public Electricity Generation	31%	34,580
Road Transport	23%	25,740
Navigation	31%	35,630
Civil Aviation	6%	6,240
Other Fuel Combustion	10%	11,040
Total	**100%**	**113,220**

Note:
[1] Figures extracted from 2013 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/sites/default/files/epd/2013EIReport_eng_1b.pdf)

4.5.2.4 Upon operation of the Project, there would be an increase in the traffic flow and hence the NOx emission and subsequently the NO_2 concentrations. Hence, NO_2 is one of the key representative pollutants for the operational air quality assessment of the Project.

4.5.2.5 The 1-hour and annual average NO_2 concentrations at each identified ASR are assessed and compared with the AQO to determine their compliance.

Respirable Suspended Particulates (RSP) and Fine Suspended Particulates (FSP)

4.5.2.6 RSP refers to suspended particulates with a nominal aerodynamic diameter of 10µm or less. According to the EPD's data [4-1], and other research studies (Tian *et al.*, 2012 & Wie-Zhen *et al.*, 2008), road vehicles, particularly diesel vehicles, are one of the sources of RSP in Hong Kong.

4.5.2.7 According to the latest statistics of 2013 Hong Kong Emission Inventory Report [4-1], road transport is the second largest source of RSP accounting for 18% of the total emissions while other fuel combustion including for industrial uses accounted for 14% of the total. **Table 4.14** presents the 2013 emission percentage and the amount of RSP in Hong Kong.

Table 4.14 The emission percentage and the amount of RSP in Hong Kong (2013)

Pollutant Source Categories	RSP		FSP	
	Emission % [1]	Emission (tons) [1]	Emission % [1]	Emission (tons) [1]
Public Electricity Generation	16%	940	9%	430
Road Transport	18%	1,090	21%	1,000
Navigation	36%	2,160	42%	2,000
Civil Aviation	<1%	60	1%	60
Other Fuel Combustion	14%	850	16%	780
Non-combustion	16%	950	10%	480
Total	[2]	**6,040**	100%	**4,740**

Note:
[1] Figures extracted from 2013 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/sites/default/files/epd/2013EIReport_eng_1b.pdf)
[2] Figures are directly extracted from the report and may not be added to 100% or the total sum of the emission from all source categories.

4.5.2.8 Upon the operation of the Project, there would be an increase in the traffic flow and hence the RSP concentrations. Hence, RSP is also one of the key representative pollutants for the operational air quality assessment of the Project.

4.5.2.9 FSP refers to suspended particulates with a nominal aerodynamic diameter of 2.5μm or less. Similar to RSP, FSP is sourced from fuel combustion, road vehicles, etc, and is also considered as one of the key representative pollutants for the operational air quality assessment of the Project.

4.5.2.10 The 24-hour and annual average RSP/ FSP concentrations at each identified ASR are assessed and compared with the AQO to determine their compliance.

Sulphur Dioxide (SO_2)

4.5.2.11 According to the latest statistics of 2013, Hong Kong Emission Inventory Report [3-1], the dominant source of SO_2 in Hong Kong is from navigation and electricity generation, which constitutes about 50% and 47% of the total emissions respectively. Road transport and other fuel combustions from industrial sources both contribute only to less than 1% of the total SO_2 emissions. The introduction of ultra low sulphur diesel for vehicle fleet has reduced the SO_2 emission from road transport in Hong Kong significantly. **Table 4.15** presents the 2013 emission percentage and the amount of SO_2 in Hong Kong.

Table 4.15 The emission percentage and the amount of SO_2 in Hong Kong (2013)

Pollutant Source Categories	**SO_2 Emission %[1]**	**SO_2 Emission (tons) [1]**
Public Electricity Generation	47%	14,680
Road Transport	<1%	50
Navigation	50%	15,740
Civil Aviation	2%	540
Other Fuel Combustion	<1%	280
Total	[2]	**31,280**

Note:
[1] Figures extracted from 2013 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/sites/default/files/epd/2013EIReport_eng_1b.pdf)
[2] Figures are directly extracted from the report and may not be added to 100% or the total sum of the emission from all source categories.

4.5.2.12 As discussed in **Section 4.2**, the latest 5-year average of 4th highest 24-hour SO_2 concentration in Tai Po is only 16% of the AQO. This clearly indicates that the AQOs for SO_2 could be well achieved with great margin in the study area. Given that road transport only contributes a very small amount of SO_2 and there is still a large margin to the AQO compared to the other pollutants such as RSP and NO_2, it is appropriate to consider that SO_2 is not the key pollutant for quantitative assessment for the operational phase of the Project.

Ozone (O_3)

4.5.2.13 Unlike other pollutants such as NOx, O_3 is not a primary pollutant emitted from man-made sources but is formed by a set of complex chain reactions between various chemical species, including NOx and VOC, in the presence of sunlight. According to Sun *et al.* [4-2] & [4-3] the rate of formation of O_3, also known as Ozone Production Efficiency, depends not only on NOx and VOC levels, but atmospheric oxidation, temperature, radiation, and other meteorological factors in the atmosphere of different regions. The formation of O_3 generally takes several hours to proceed (EPD, 2012) [4-4] and therefore O_3 recorded locally could be attributed to emissions generated from places afar.

4.5.2.14 According to "A Study to Review Hong Kong's Air Quality Objectives" [4-5], due to the abundance of its precursors (VOC and NOx) from a great variety of sources such as motor vehicles, industries, power plants and consumer products, etc., ozone can be widely formed in the region and can be transported over long distance. The general rising trend of ozone levels in Hong Kong over the past years reflects an aggravation in the photochemical smog problem on a regional scale. All these indicate that local traffic emission is not a dominant controlling factor in O_3 formation.

4.5.2.15 In addition, the EPD's "Air Quality in Hong Kong 2013" report [4-4] stated that NOx emissions from motor vehicles and chimneys have the potential to react with and remove O_3 in the air, and regions with heavy traffic normally have lower ozone levels than areas with light traffic. It is therefore possible that the Project may contribute to a decrease in O_3 in the immediate area along main roads. O_3 is therefore not considered as a key parameter in this assessment.

Lead (Pb)

4.5.2.16 As leaded petrol has been banned in Hong Kong since in 1999, it is no longer considered as a primary source in Hong Kong. According to the latest EPD study report in 2013 - "Annual Air Quality Monitoring Results - Air Quality in Hong Kong 2013" (http://www.aqhi.gov.hk/api_history/english/report/files/AQR2012e_final.pdf), the measured 3-month averaged lead level was ranging from 4 ng/m^3 (Tung Chung) to 100 ng/m^3 (Yuen Long). The measured concentration is much lower than annual AQO limit of 500ng/m^3. Therefore, lead is not considered as a key / representative air pollutant for the operational air quality assessment.

Carbon Monoxide (CO)

4.5.2.17 CO is one of the primary pollutants emitted by road transport. According to the latest statistics of 2013 Hong Kong Emission Inventory Report [4-1] CO emissions from road transport contributed about 59% of total CO emission in 2013. **Table 4.16** presents the 2013 emission percentage and the amount of CO in Hong Kong.

Table 4.16 The emission percentage and the amount of CO in Hong Kong (2013)

Pollutant Source Categories	CO Emission % [1]	CO Emission (tonnes)[1]
Public Electricity Generation	6%	3,930
Road Transport	59%	35,840
Navigation	19%	11,670
Civil Aviation	5%	3,320
Other Fuel Combustion	10%	6,040
Total	[2]	**60,790**

Note:
[1] Figures extracted from 2013 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/sites/default/files/epd/2013EIReport_eng_1b.pdf)
[2] Figures are directly extracted from the report and may not be added to 100% or the total sum of the emission from all source categories.

4.5.2.18 Despite road transportation being the dominant source of CO emission, however, the air quality impact from CO is relatively minor. According to the records in EPD's monitoring stations, the highest 1-hour concentration was 4,070 μg/m^3 and the highest 8-hour concentration is 2,860 μg/m^3 in Causeway Bay [4-4] in Year 2013, both were well below the AQO standard of 30,000 (1-hour) and 10,000 (8-hour), respectively. CO is therefore not a key parameter for assessment.

Conclusion

4.5.2.19 As discussed in the above sections, only the NO_2, RSP and FSP are considered the key air quality pollutant for this project and the concentrations of the other pollutants are very low and hence are not considered as the key pollutants for the purposes of this air quality assessment.

4.5.3 Assessment Methodology

General

4.5.3.1 The area for air quality impact assessment should be defined by a distance of 500m from the boundary of the Project site or other project locations.

4.5.3.2 The assessment has evaluated the impacts arising from three classes of emission sources depending on their distance from the project site, including:

(1) Project induced contribution;

(2) Pollutant-emitting activities in the immediate neighbourhood; and

(3) Other contributions from pollution not accounted for by (1) and (2).

4.5.3.3 All sources within 500m assessment area (i.e. (1) and (2)) are considered as near-field source impacts and are predicted using local-scale models. These sources include vehicular emission from existing road network and proposed roads within the Project site. Although the planned asphalt plant is located outside 500m assessment area, it has been included in the near-field assessment in this EIA as conservative assessment.

4.5.3.4 Other far-field pollution source impacts (3) which are beyond 500m from the Project (i.e. background concentration), are predicted using regional scale model – Pollutant in the Atmosphere and the Transport over Hong Kong, PATH. In PATH model, all major emission sources including public electricity generation, road transport, navigation, civil aviation, industries, other fuel combustion and non-combustion sources covering both HKSAR and PRDEZ are considered.

4.5.3.5 The cumulative operational air quality impact is then a combination of the contributions from the near-field and far-field sources.

Determination of Assessment Year

4.5.3.6 During operational phase of the Project, as advised by the Traffic Engineer, the project induced traffic would be peak during "*Festival Days*" which include the following days :

- Ching Ming Festival;
- Chung Yeung Festival;

- Last two weekends including the Saturday and Sunday before Ching Ming and Chung Yeung Festival; and
- First two weekends including the Saturday and Sunday following Ching Ming and Chung Yeung Festival.

4.5.3.7 During the "*Normal Days*" other than Festival Days, it is anticipated that the traffic pattern would be similar to that of the existing condition.

4.5.3.8 Since the grid-specific meteorological data extracted from EPD's PATH model which is based on Year 2010 is adopted in this operational air quality assessment, the festival days have been identified from the 2010's calendar. A total of 19 festival days have been identified in Year 2010 and they are presented in **Table 4.17** below.

Table 4.17 Festival days in Year 2010

Date	Description
27-March-2010 (Sat)	2nd last Saturday before Ching Ming Festival
28-March-2010 (Sun)	2nd last Sunday before Ching Ming Festival
3-April-2010 (Sat)	Last Saturday before Ching Ming Festival
4-April-2010 (Sun)	Last Sunday before Ching Ming Festival
6-April-2010 (Tue)	Ching Ming Festival
10-April-2010 (Sat)	First Saturday following Ching Ming Festival
11-April-2010 (Sun)	First Sunday following Ching Ming Festival
17-April-2010 (Sat)	Second Saturday following Ching Ming Festival
18-April-2010 (Sun)	Second Sunday following Ching Ming Festival
2-October-2010 (Sat)	2nd last Saturday before Chung Yeung Festival
3-October-2010 (Sun)	2nd last Sunday before Chung Yeung Festival
9-October-2010 (Sat)	Last Saturday before Chung Yeung Festival
10-October-2010 (Sun)	Last Sunday before Chung Yeung Festival
16-October-2010 (Sat)	Chung Yeung Festival
17-October-2010 (Sun)	Day after Chung Yeung Festival
23-October-2010 (Sat)	First Saturday following Chung Yeung Festival
24-October-2010 (Sun)	First Sunday following Chung Yeung Festival
30-October-2010 (Sat)	Second Saturday following Chung Yeung Festival
31-October-2010 (Sun)	Second Sunday following Chung Yeung Festival

4.5.3.9 In order to determine the worst air quality impact arising from the operation of the Project, the highest road emissions within the next 15 years upon commissioning of the proposed road have been taken into account. Based on the current tentative programme and advices from Traffic Engineer, the commissioning year of road is in Year 2022, and the project induced traffic will reach its maximum in Year 2032. Therefore, EmFAC-HK models have been carried out for Year 2022 (first commissioning), 2027, 2029 (Interim Year), 2030, 2031, 2032, and 2037 (15 years after commissioning) to determine the highest emission scenario and the worst assessment year.

4.5.3.10 Vehicular tailpipe emissions from open roads during normal days and festival days are calculated based on the latest EMFAC-HK model to identify the emissions for different years. The traffic forecast data is given in **Appendix 4.8**. The methodology, key model assumptions and results (including emission factors) are presented in **Appendix 4.9**.

4.5.3.11 According to the existing air quality conditions as presented in **Section 4.2**, NO_2 is considered as the most critical air pollutant during the operational stage of this Project given its continuous non-compliance of annual AQOs criteria from Year 2010 to 2014. The total NOx emissions within the assessment areas for all years are summarised in **Table 4.18** below. Results indicate that the highest daily NOx emission scenario would occur in Year 2030, while the highest annual NOx emission scenario would be in Year 2022.

Table 4.18 Summary of NOx emissions

Year	Daily NOx Emission [1] (ton /day)		Annual NOx Emission [1, 2] (ton /year)
	Normal Day	Festival Day	
2022	0.040	0.022	**14.19**
2027	0.032	0.078	12.61
2029	0.027	0.104	11.59
2030	0.024	**0.112**	10.04
2031	0.020	0.095	8.48
2032	0.019	0.081	8.11
2037	0.018	0.047	6.97

Note:

[1] Value in bold is the maximum among all years.

[2] Annual NOx emission is calculated based on 19 Festival Days and 346 Normal Days in each year.

4.5.3.12 The project would have its highest air quality impact on nearby ASRs during the 19 festival days only since its project induced traffic would be peak during these days. Hence, the operation of the project would likely cause the highest short-term contribution on ASRs during the festival days in Year 2030, while the highest long-term air quality impact would occur in Year 2022. As such, the cumulative 1-hour, 24-hour and annual NO_2 / RSP / FSP concentrations for both Years 2022 and 2030 are calculated in this operational air quality assessment.

<u>Vehicular Emission from Open Road</u>

4.5.3.13 The EMFAC-HK calculates the hourly vehicular emission (in tonne) for each road category. The hourly emission rates for each vehicle class (in gram per mile per vehicle) are obtained by dividing the hourly emissions calculated in the EMFAC-HK by the VMT for the respective hour. The calculation of the NOx, RSP and FSP emission factors for different road groups are given in **Appendix 4.9**. The composite vehicle emission factors for each road link for Year 2022 and Year 2030 are given in **Appendix 4.10**.

4.5.3.14 The USEPA approved near field air dispersion model, CALINE4 developed by the California Department of Transport is used to assess vehicular emissions impact from all existing and planned open road network.

4.5.3.15 Grid-specific meteorological data extracted from EPD's PATH model is adopted in CALINE4 model, including relevant temperature, wind speed, direction and mixing height. The stability classes are estimated using PCRAMMET model. The mixing height is capped to 121m as per the real meteorological data recorded at King's Park in Year 2010. For the treatment of calm hours, the approach recommended in the "*Guideline on Air Quality on Air Quality Models Version 05 (USEPA)*" is adopted.

4.5.3.16 The surface roughness height is closely related to the land use characteristics, and the surface roughness is estimated as 10% of the average height of physical structures within 1km study area. A surface roughness of 50cm is assumed for study area to represent the rural setting and low-rise buildings in the vicinity of the Project. The wind standard deviation is estimated in accordance with the "*Guideline on Air Quality Models (Revised), 1986 (USEPA)*", as summarised in **Table 4.19**.

Table 4.19 Summary of wind standard deviation

Stability Class	Wind Standard Deviation (roughness = 50cm)
A	28.6
B	28.6
C	22.3
D	15.9
E	9.5
F	4.8

4.5.3.17 Owing to the limitation of the CALINE4 model, elevated road higher than 10m above local ground or water surface are set to the maximum height of 10m in the model as the worst-case assumption. For barriers along roads or any proposed noise barriers as a noise mitigation measures, the line source is modelled at the tip of the barrier and the mixing width is limited to the actual uncovered road width in order to address the associated secondary environmental impact.

4.5.3.18 Ozone Limiting Method (OLM) is adopted for conversion of NOx to NO_2, using the predicted O_3 and NO_2 levels from PATH model. According to EPD's "Guidelines on Choice of Models and Model Parameters", the vehicular tailpipe NO_2 emission is assumed to be 7.5% of NOx.

4.5.3.19 Since the vehicular emission sources are at local ground level, the impact at ASRs are assessed at 1.5m, 5m, 10m, 15m and 20m above ground.

Vehicular Emission from Idling Vehicles

4.5.3.20 Emission rates of idling vehicles in MKTBCP have been determined based on the number of vehicles, the processing time at the kiosks and the loading / unloading bays. The idling emission estimation has been based on the emission factors for different Euro engine types in accordance with the latest report on "*Road Tunnels: Vehicle Emissions and Air Demand for Ventilation*" published by the Permanent International Association of Road Congresses (PIARC, 2012), taking into account the mass factor for HGVs and air-conditioning loading factor. Traffic pattern, volume and idling duration at kiosks / loading bays / unloading bays are estimated by the Traffic Engineer. Detailed calculations of idling emissions are given in **Appendix 4.11**.

4.5.3.21 Similar to the assessment methodology for the vehicular emission from open roads, the potential air quality impact due to idling emission at MKTBCP is assessed by the EPD's approved model CALINE4. Emission from kiosks, loading / unloading bays are modelled as "Parking Lot".

Industrial Emission

4.5.3.22 Chimneys associated with the planned OWTF Phase 2 would cause cumulative air quality impact during operational phase of the Project. Reference has been made to the approved EIA Report "*Development of Organic Waste Treatment Facilities, Phase 2*" (AEIAR-180/2013) for the pollutant emission rates, stack height, temperature etc. Although the planned asphalt plant is located outside 500m assessment area, it has been included in the near-field assessment in this EIA as conservative assessment. Reference has been made to the approved Section 16 planning application for *"A Proposed Temporary Asphalt Plant at Man Kam To Road, Sheung Shui"* (A/NE-FTA/148) for the emission parameters. **Appendix 4.12** presents the details of industrial emission.

4.5.3.23 The potential air quality impact associated with the industrial emissions is assessed by the EPD approved dispersion model, ISCST3. All these emissions have been modelled as "Point" sources in the model. OLM is adopted for conversion of NO_x to NO_2, using the predicted O_3 levels from PATH model. The in-stack NO_2:NO_x ratio for the industrial chimneys is assumed to be 10%.

Far-field Source Contribution (i.e. Future Background Air Quality)

4.5.3.24 PATH is a regional air quality model developed by EPD to simulate air quality over Hong Kong against the PRD as background. It simulates wind field, pollutant emissions, transportation and chemical transformation and outputs pollutant concentrations over Hong Kong and the PRD region at a fine grid size of 1.5km.

4.5.3.25 During the 12th Hong Kong-Guangdong Joint Working Group Meeting on Sustainable Development and Environmental Protection

(Nov 2012), the Hong Kong and Guangdong Governments jointly endorsed a Major Air Pollutant Emission Reduction Plan for the Pearl River Delta Region up to year 2020.

4.5.3.26 A comprehensive emission inventory for Hong Kong and PRD was compiled for year 2010 based on current best estimates and projected to 2020 in accordance with the emission reduction measures proposed in the plan. The emission inventories for year 2020 was modelled in PATH to predict air quality for future years. The Hong Kong emission inventories are summarised in the **Table 4.20** below.

Table 4.20 Summary of Hong Kong Emission Inventory (Year 2020) for the PATH Model

Year	Emission Group	Annual Emission (Tonnes per year)			
		SO_2	NO_x	RSP	VOC
2020	Public Electricity Generation	6,180	20,900	560	360
	Road Transport	322	11,000	540	1,640
	Navigation	15,695	37,010	2,440	3,867
	Civil Aviation	650	8,770	120	570
	Other Fuel Combustion	228	8,100	697	720
	Non-combustion	N/A	N/A	1,032	21,488
	Total	**23,075**	**87,200**	**5,389**	**28,645**

4.5.3.27 PATH model is used to quantify the future background air quality. Far-field emission sources (i.e. all those outside 500m assessment area) including roads, marine, airports, power plants and industries within the PRDEZ and Hong Kong were considered in the PATH model. Details of the PATH Model and related emission inventory can be found in EPD's web site.

4.5.3.28 Considering that the emission control technology will be progressively improving in future years, use of the territory wide emission inventory for Year 2020 for assessing the future background concentrations for Years 2022 and 2030 is considered to be conservative. Therefore, the hourly concentrations of NO_2, RSP and O_3 predicted by the PATH model for Year 2020 has been directly adopted in the calculation of cumulative air quality impact for Years 2022 and 2030 in this EIA. FSP concentrations, as mentioned in **Section 4.4.3**, are determined based on EPD's "*Guidelines on the Estimation of FSP for Air Quality Assessment in Hong Kong*".

Prediction of the Cumulative Operational Air Quality Impact

4.5.3.29 The cumulative operational air quality is a combination of the emission impacts contributed from the near field and far field sources (i.e. at local scale and background air quality impact from other concurrent and regional sources) on hourly basis.

4.5.3.30 In consideration of the number of exceedance allowance of the hourly and daily AQO (refer to **Table 4.1**), the pollutant concentrations after the AQO's allowance limits (i.e. the 19th highest 1-hour NO_2 concentrations and 10th highest 24-hour RSP/ FSP concentrations) are determined at each ASR. The annual predicted concentrations are also assessed and all predicted levels are then compared with the AQOs.

4.5.3.31 For prediction of the annual pollutant concentrations, the emission factors for the festival day are adopted for the identified 19 festival days while the emission factors for normal day are adopted for the rest of the year of 2010.

4.5.4 Prediction and Evaluation of Environmental Impacts

4.5.4.1 The 19th highest 1-hour and annual NO_2 concentrations, and 10th highest 24-hour and annual RSP/ FSP concentrations in Years 2022 and 2030 are presented in the **Tables 4.21** and **4.22** below respectively. Detailed results are presented in **Appendix 4.13**. It can be seen that all the predicted NO_2 / RSP / FSP concentrations are within the respective criteria.

4.5.4.2 Contours of the 19th highest 1-hour and annual NO_2 concentrations, 10th highest 24-hour and annual RSP / FSP concentrations at the worst affected level (i.e. 1.5m above ground) for Years 2022 and 2030 are plotted in **Figures 4.5.3 – 4.5.14**. It is also found that there are no exceedances at all air sensitive uses. Hence, no adverse cumulative air quality impact during operational phase of the project is anticipated.

Table 4.21 Cumulative NO_2, RSP and FSP concentrations (Year 2022)

ASR ID	Location	NO_2 Concentration (µg/m^3)		RSP Concentration (µg/m^3)		FSP Concentration (µg/m^3)	
		1-hour (19th highest)	Annual	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A1	Lo Wu Control Point	125	22	86	43	65	31
A2	Village House along Lo Wu Road	125	22	86	43	65	31
A3	Lo Wu Public School	125	22	86	43	65	31
A4	Lo Wu Document Storage Building	125	22	86	43	65	31
A5	Village House along Lo Wu Station Road	126	23	86	44	65	31
A6	Food and Environmental Hygiene Department	122	22	84	43	63	30

ASR ID	Location	NO_2 Concentration ($\mu g/m^3$)		RSP Concentration ($\mu g/m^3$)		FSP Concentration ($\mu g/m^3$)	
		1-hour (19th highest)	Annual	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A7	Village House along Man Kam To Road	130	25	84	44	63	31
A8	Border District Police Headquarter	125	22	84	43	63	31
A9	Village House along Man Kam To Road	127	23	84	43	63	31
A10	Village House along Man Kam To Road	122	21	84	43	63	30
A11	Village House along Man Kam To Road	124	24	84	43	63	31
A13	Temple	126	24	84	43	63	31
A14	Village House along Man Kam To Road	124	22	84	43	63	31
A15	Village House along Man Kam To Road	122	22	84	43	63	30
A16	Village House along Man Kam To Road	127	24	84	43	63	31
A17	Village House along Man Kam To Road	134	26	85	43	64	31
A18	Ta Kwu Ling Division Border Enforcement Unit Block	131	31	86	43	65	30
A19	Village House near Man Kam To Operation Base	123	21	86	42	64	30
A20	Man Kam To Boundary Control Point	133	32	86	43	65	30

ASR ID	Location	NO_2 Concentration ($\mu g/m^3$)		RSP Concentration ($\mu g/m^3$)		FSP Concentration ($\mu g/m^3$)	
		1-hour (19th highest)	Annual	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A21	Village House to the south of Man Kam To Boundary Control Point	123	22	86	42	64	30
A23	Village House at San Uk Ling	125	22	86	42	65	30
A24	Village House along Lin Ma Hang Road	127	24	86	43	64	30
A25	Village House along Muk Wu	124	20	86	42	64	30
A26	Village House along Lin Ma Hang Road	116	19	86	42	65	30
A28	Village House along Lin Ma Hang Road	117	21	86	43	65	30
A29	Village House at Muk Wu Nga Yiu	114	19	86	42	65	30
A30	Village House at Muk Wu Chuen Yiu (Planned)	115	20	86	43	65	30
A31	Village House at Muk Wu Chuen Yiu	115	19	86	42	65	30
A32	Recreational use – Planned development	115	19	86	42	65	30
A33	Recreational use – Planned development	116	19	86	42	65	30
A34	Recreational use – Planned development	116	19	86	42	65	30
A35	Recreational use – Planned development	115	19	86	42	65	30
A36	Recreational use – Planned development	115	19	86	42	65	30
A37	House No. 28 Ta Kwu Ling Village	115	18	86	42	65	30

ASR ID	Location	NO_2 Concentration (µg/m^3)		RSP Concentration (µg/m^3)		FSP Concentration (µg/m^3)	
		1-hour (19th highest)	Annual	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
P1	OWTF Phase 2	125	21	84	43	63	30

Note:
[1] Maximum concentrations across the assessment heights of 1.5m, 5m, 10m, 15m and 20m at each ASRs are presented in this table.

Table 4.22 Cumulative NO_2, RSP and FSP concentrations (Year 2030)

ASR ID	Location	NO_2 Concentration (µg/m^3)		RSP Concentration (µg/m^3)		FSP Concentration (µg/m^3)	
		1-hour (19th highest)	Annual	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A1	Lo Wu Control Point	125	21	86	43	65	31
A2	Village House along Lo Wu Road	125	21	86	43	65	31
A3	Lo Wu Public School	125	21	86	43	65	31
A4	Lo Wu Document Storage Building	125	22	86	43	65	31
A5	Village House along Lo Wu Station Road	125	22	86	44	65	31
A6	Food and Environmental Hygiene Department	122	21	84	43	63	30
A7	Village House along Man Kam To Road	127	23	84	44	63	31
A8	Border District Police Headquarter	123	22	84	43	63	31
A9	Village House along Man Kam To Road	123	22	84	43	63	31
A10	Village House along Man Kam To Road	122	21	84	43	63	30

ASR ID	Location	NO_2 Concentration ($\mu g/m^3$)		RSP Concentration ($\mu g/m^3$)		FSP Concentration ($\mu g/m^3$)	
		1-hour (19th highest)	Annual	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A11	Village House along Man Kam To Road	122	22	84	43	63	31
A13	Temple	123	22	84	43	63	31
A14	Village House along Man Kam To Road	122	21	84	43	63	31
A15	Village House along Man Kam To Road	122	21	84	43	63	30
A16	Village House along Man Kam To Road	124	22	84	43	63	31
A17	Village House along Man Kam To Road	128	24	85	43	64	31
A18	Ta Kwu Ling Division Border Enforcement Unit Block	129	28	86	43	65	30
A19	Village House near Man Kam To Operation Base	123	21	86	42	64	30
A20	Man Kam To Boundary Control Point	129	28	86	43	64	30
A21	Village House to the south of Man Kam To Boundary Control Point	123	21	86	42	64	30
A23	Village House at San Uk Ling	124	21	86	42	64	30
A24	Village House along Lin Ma Hang Road	124	22	86	43	64	30
A25	Village House along Muk Wu	124	20	86	42	64	30
A26	Village House along Lin Ma Hang Road	116	19	86	42	65	30

ASR ID	Location	NO_2 Concentration (μg/m^3)		RSP Concentration (μg/m^3)		FSP Concentration (μg/m^3)	
		1-hour (19th highest)	Annual	24-hour (10th highest)	Annual	24-hour (10th highest)	Annual
A28	Village House along Lin Ma Hang Road	115	20	86	43	65	30
A29	Village House at Muk Wu Nga Yiu	114	19	86	42	65	30
A30	Village House at Muk Wu Chuen Yiu (Planned)	115	19	86	43	65	30
A31	Village House at Muk Wu Chuen Yiu	114	19	86	42	65	30
A32	Recreational use – Planned development	115	18	86	42	65	30
A33	Recreational use – Planned development	116	18	86	42	65	30
A34	Recreational use – Planned development	115	18	86	42	65	30
A35	Recreational use – Planned development	114	18	86	42	65	30
A36	Recreational use – Planned development	115	19	86	42	65	30
A37	House No 28 Ta Kwu Ling Village	114	18	86	42	65	30
P1	OWTF Phase 2	124	20	84	43	63	30

Note:
[1] Maximum concentrations across the assessment heights of 1.5m, 5m, 10m, 15m and 20m at each ASRs are presented in this table.

4.5.5 Mitigation Measures

4.5.5.1 All the predicted pollutant concentrations are in compliance with the AQO. Hence, no mitigation measures are required.

4.5.6 Residual Environmental Impacts

4.5.6.1 Based on the operational air quality assessment results, there is no adverse residual air quality impact during the operational phase of the Project.

4.6 Conclusion

4.6.1.1 Air quality impact assessment has been conducted for both construction and operational phases of the Project. Potential dust impact would be generated from the site formation, slope works, road works etc. during construction phase. Quantitative construction dust assessment has been conducted. Results have concluded that there will not be any adverse residual air quality impact during construction phase given frequent watering on all worksites once per hour during working hours (7am – 7pm). For the Siu Lam Barging Point which is currently used by the XRL project, with the implementation of mitigation measures in the Air Pollution Control (Construction Dust) Regulation, good site practices and dust control measures, no adverse dust impact is anticipated.

4.6.1.2 Operational air quality assessment has concluded that the predicted air quality impact on all air sensitive receivers would comply with AQO, and hence no adverse residual air quality impact during operational phase is anticipated.

4.7 References

[4-1] Environmental Protection Department (2013), 2013 Hong Kong Emission Inventory Report (http://www.epd.gov.hk/epd/sites/default/files/epd/2013EIReport_eng_1b.pdf)

[4-2] Sun Y.,Wang L.L.,Wang Y.S. (2010) “In situ measurements of SO_2, NOx, NOy, and O_3 in Beijing, China during August 2008” Science of the Total Environment 409 (2011), P933-940

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[4-4] Environmental Protection Department (2013), Air Quality in Hong Kong 2013 (http://www.aqhi.gov.hk/api_history/english/report/files/AQR2013e_final.pdf)

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