3. Air Quality Impact

3.1 Introduction

This section presents the assessment of potential air quality impacts associated with the construction and operational phase of the proposed Core Arts and Cultural Facilities (CACFs), other Arts and Cultural Facilities (OACFs) and Infrastructure and Support Facilities. Dust generated from various construction activities is the primary concern during the construction phase. During the operation phase the major sources of air pollution include, but are not limited to, vehicular emissions in the vicinity of and within the project area including from open roads, ventilation shafts, tunnel portals and from the nearby Western Harbour Crossing (WHC) portal; marine emissions relating to the nearby China Ferry Terminal, Ocean Terminal and New Yau Ma Tei Public Cargo Working Area (NYPCWA), and; odours from the adjacent New Yau Ma Tei Typhoon Shelter (NYMTTS). Representative Air Sensitive Receivers (ASRs) within 500 m of the subject site have been identified and the worst case impacts on these receivers will be assessed. Suitable mitigation measures, where necessary, have been recommended to protect the nearby sensitive receivers and to achieve the legislative criteria and guidelines.

3.2 Air Quality Legislations, Standards and Guidelines

The following legislation and regulations provide the standards and guidelines for evaluation of air quality impacts and the type of works that are subject to air pollution control:

- Environmental Impact Assessment Ordinance (EIAO) (Cap. 499.S16), EIAO-TM, Annexes 4 and 12;
- Air Pollution Control Ordinance (APCO) (Cap. 311) and the Air Quality Objectives (AQO);
- Air Pollution Control (Construction Dust) Regulation;
- Control of Air Pollution in Car Parks (ProPECC PN 2/96);
- Practice Note on Control of Air Pollution in Vehicle Tunnels, and;
- Guidance Note on the Best Practicable Means for Cement Works (Concrete Batching Plant) BPM 3/2

3.2.1 Technical Memorandum on Environmental Impact Assessment Process

The criteria and guidelines for evaluation of air quality impacts are laid out in Annex 4 and Annex 12 of the *Technical Memorandum on Environmental Impact Assessment Process* (EIAO-TM). Annex 4 stipulates the criteria for evaluating air quality impacts. This includes meeting the Air Quality Objectives and other standards established under the *Air Pollution Control Ordinance*, as well as meeting the hourly Total Suspended Particulate concentration of 500 µg/m^3 and the 5-second average odour concentration of 5 odour units (ou). Annex 12 provides the guidelines for conducting air quality assessments under the EIA process, including determination of air sensitive receivers, assessment methodology and impact prediction and assessment.

3.2.2 Air Pollution Control Ordinance

The principal legislation for the management of air quality is the *Air Pollution Control Ordinance (APCO) (Cap 311)*. The APCO specific Air Quality Objectives (AQOs) which stipulate the statutory limits of air pollutants and the maximum allowable numbers of exceedance over specific periods. The AQOs are summarised in **Table 3.1**.

Table 3.1: Hong Kong Air Quality Objectives

Pollutant	Averaging Time	AQO concentration (µg/m³)	Allowable exceedances
Sulfur Dioxide (SO_2)	1 hour	800	3
	24 hours	350	1
	Annual	80	0
Total Suspended Particulates (TSP)	1 hour(1)	500(1)	
	24 hours	260	1
	Annual	80	0
Respirable Suspended Particulates (RSP)	24 hours	180	1
	Annual	55	0
Nitrogen Dioxide (NO_2)	1 hour	300	3
	24 hours	150	1
	Annual	80	0
Carbon Monoxide (CO)	1 hour	30,000	3
	8 hours	10,000	1
Ozone (O_3)	1 hour	240	3
Lead	3 months	1.5	0

Note (1) The criterion under EIAO-TM not an AQO

3.2.3 Air Pollution Control (Construction Dust) Regulation

The *Air Pollution Control (Construction Dust) Regulation* enacted under the APCO defines notifiable and regulatory works activities that are subject to construction dust control, as listed below:

Notifiable Works:

1. Site formation
2. Reclamation
3. Demolition of a building
4. Work carried out in any part of a tunnel that is within 100 m of any exit to the open air
5. Construction of the foundation of a building
6. Construction of the superstructure of a building
7. Road construction work

Regulatory Works:

1. Renovation carried out on the outer surface of the external wall or the upper surface of the roof of a building
2. Road opening or resurfacing work
3. Slope stabilisation work
4. Any work involving any of the following activities:
    a. Stockpiling of dusty materials
    b. Loading, unloading or transfer of dusty materials
    c. Transfer of dusty materials using a belt conveyor system
    d. Use of vehicles
    e. Pneumatic or power-driven drilling, cutting and polishing
    f. Debris handling
    g. Excavation or earth moving
    h. Concrete production
    i. Site clearance
    j. Blasting

Notifiable works require that advance notice of activities shall be given to EPD. The Regulation also requires the works contractor to ensure that both notifiable works and regulatory works are conducted in accordance with the Schedule of the Regulation, which provides dust control and suppression measures.

3.2.4 Practice Note on Control of Air Pollution in Car Parks and in Vehicle Tunnels

The practice note for professional persons *ProPECC PN 2/96* and the *Practice Note on Control of Air Pollution in Vehicle Tunnels* prepared by EPD provide guidance on the control of air pollution in car parks and vehicle tunnels, respectively. These two practice notes include air quality guidelines required for the protection of public health and factors that should be considered in the design and operation of car parks and vehicle tunnels in order to achieve the required air quality. The limits for air pollutants as recommended by the two practice notes are summarised in **Table 3.2**. As there will be fully enclosed vehicle roads and car parks inside the proposed WKCD basement, the air quality within the basement will need to comply with the relevant air pollutant limits as given in the Table.

Table 3.2: Limits of air pollutant concentrations inside car parks and vehicle tunnels

Air Pollutant	Averaging Time	Maximum Concentration (µg/m^3)*	Parts Per Million (ppm)	Remark
Carbon Monoxide (CO)	5 minutes	115,000	100	Applicable to both car parks and vehicle tunnels
Nitrogen Dioxide (NO_2)	5 minutes	1,800	1	Ditto
Sulfur Dioxide (SO_2)	5 minutes	1,000	0.4	Applicable to vehicle tunnels only

* Concentrations at reference conditions of 298K and 101.325kPa.

3.2.5 Guidance Note on the Best Practicable Means for Cement Works (Concrete Batching Plant) BPM 3/2

This note lists the minimum requirement for meeting the best practicable means for *Cement Works (Concrete Batching Plant)*. The guidance note includes: emission limits; fugitive emission control recommendations; monitoring requirements; commissioning details, and; operation and maintenance provisions. This guidance note is relevant because concrete batching plant currently used by the adjacent XRL project would be handed over to and used by the WKCD Project during the construction phase.

3.3 Baseline Conditions

3.3.1 Site Description

The project lies on the south-western tip of the Kowloon Peninsula with Victoria Harbour to the west and south of the site and the existing urbanised areas to the north and east. The New Yau Ma Tei Typhoon Shelter (NYMTTS) is adjacent to the site to the north.

Land uses surrounding the project are mainly comprised of residential, commercial and government/institution/community (GIC) use. The WKCD boundary is flanked by primary distributor roads: Austin Road West, running immediately adjacent to the northern edge of the WKCD boundary; Canton Road, running adjacent to the eastern boundary; Lin Cheung Road, perpendicular to the mid-northern boundary, and; the Western Harbour Crossing on the northwest boundary. The Ocean Terminal and China Ferry Terminal are to the south-east of the site.

The site for the proposed development is flat to undulating with a ground level of 5 to 23 mPD, the surrounding terrain is flat.

3.3.2 Meteorology

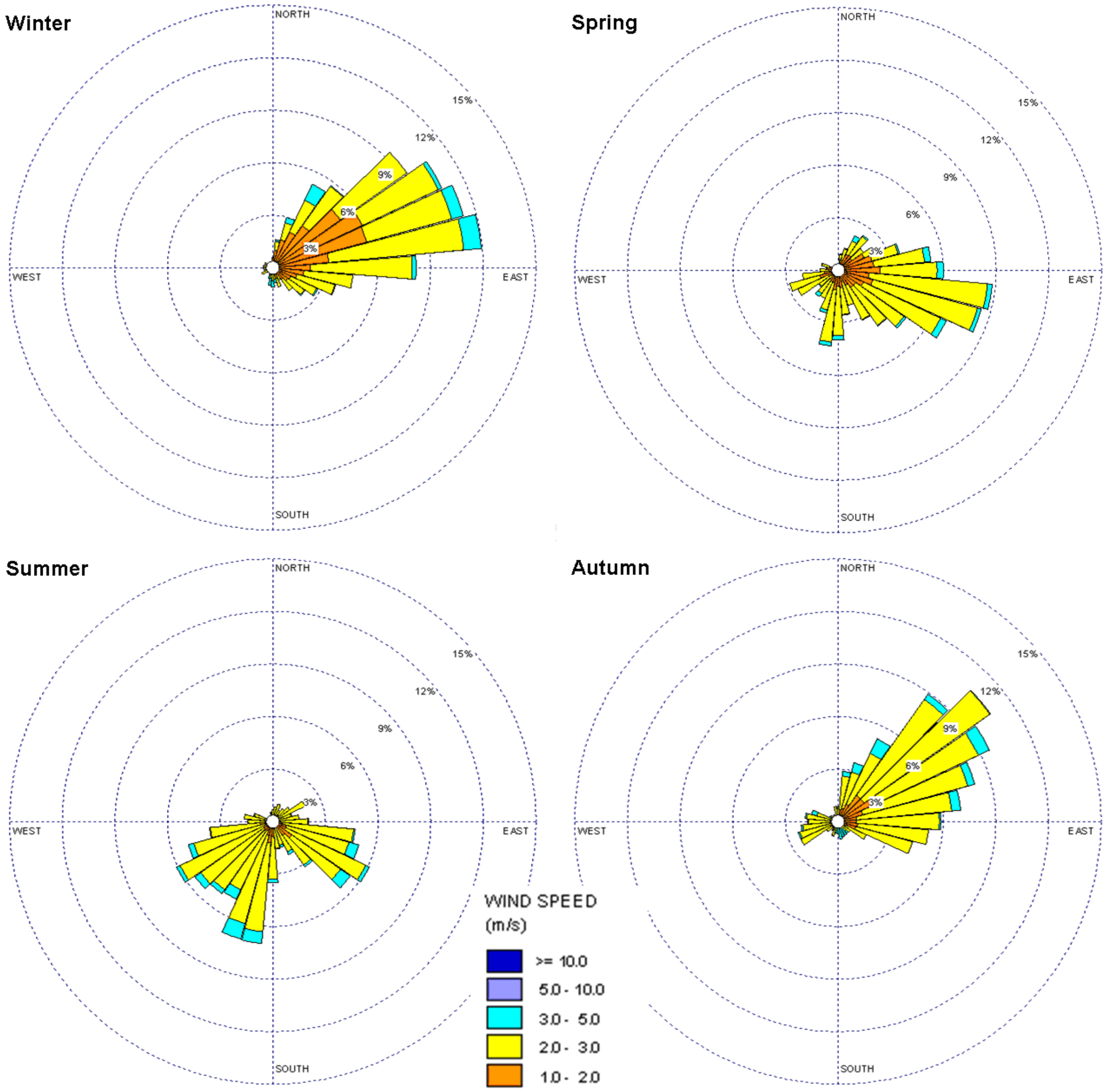
The PATH (Pollutants in the Atmosphere and their Transport over Hong Kong) model, a regional air quality prediction model developed by EPD, is used to predict the meteorology at WKCD. The PATH model is also used to predict background air quality as a result of various sources in Hong Kong and the surrounding regions including the Pearl River Delta Economic Zone (PRDEZ).

Features of the wind profile that are significant for WKCD are both the wind speed and wind direction. Low wind speeds are significant for dispersion of non buoyant area sources, such as odours, as low wind speeds can allow for accumulation of odour which may be swept off site when the wind speed increases. At high wind speeds, dust emissions can become significant.

At the WKCD site, winds from the northeast are frequent in the autumn and winter. Significant sources that lay to the northeast of the site include Austin Road West and Lin Cheung Road. Easterly winds are dominant in spring. Kowloon Peninsula lays to the east of the site. During summer the winds are predominately from the southeast to the southwest. The major source from the southwest is marine emissions in transit to and from the China Ferry; the China Ferry and Ocean Terminals, the southern tip of the Kowloon Peninsula and Victoria Harbour to the southeast of WKCD.

Graph 3.1 shows seasonal windroses for WKCD from PATH data at grid (28, 27). PATH uses wind data based on meteorology information from 2010.

Graph 3.1: Seasonal windroses for WKCD from 2010 PATH data at grid (28, 27)



3.3.3 Air Sensitive Receivers

The existing and planned representative Air Sensitive Receivers (ASRs) that could be effected by the WKCD Project within 500 m from its site boundary have been identified and are summarised in **Table 3.3**. The final use of each of the parcels may change in the future; therefore, ASRs have been assessed at a variety of intervals up to the proposed maximum height of the buildings that are currently planned. Receptors are located every four metres from 4 m to 20 m above ground and every 10 metres from 20 m to the maximum height of the proposed building. A bias is generated towards the lower levels as this is where the maximum pollutant concentrations are expected to occur.

A field study of the selected existing ASRs external to WKCD was undertaken and the fresh air intake and residential levels were estimated based on a visual survey. Fresh air intakes for low level commercial property were assumed to be at podium level or where ventilation ducts were identified. Residential receptors were assessed every four metres from the lowest residential level up to 20 metres and then every 10 metres above that.

All the ASRs as listed in **Table 3.3** are subject to air quality impact during the operation phase of WKCD. Construction of the WKCD Project is scheduled to complete in phases from 2013 to 2020 when the majority of the site works and superstructures are expected to be completed. The planned ASRs representing facilities/buildings within the WKCD site that will be completed at the early stage of the Project will be subject to air quality impact due to construction of the facilities/buildings at a later stage. Hence, the years in which the planned ASRs will be subject to the construction phase air quality impacts are detailed in **Table 3.3** and shown in **Figures 3.1a** and **3.1b**. Shaded cells in **Table 3.3** are indicative of residential ASRs.

Table 3.3: Representative ASRs Identified for the Assessment

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
1	SRT-1	Sorrento – Tower 1 Residential (Existing ASR)	404	24	19	65	2013 – 2020	4m above podium
2	SRT-2			28	23			8m above podium
3	SRT-3			32	27			12m above podium
4	SRT-4			36	31			16m above podium
5	SRT-5			40	35			20m above podium
6	SRT-6			50	45			30 m above podium
7	SRT-7			60	55			40 m above podium
8	SRT-8			70	65			50 m above podium
9	SRT-9			80	75			60 m above podium
10	SRT-10			90	85			70 m above podium
11	SRT-11			100	95			80 m above podium
12	SRT-12			110	105			90 m above podium
13	SRT-13			120	115			100 m above podium
14	SRT-14			130	125			110 m above podium
15	SRT-15			140	135			120 m above podium
16	SRT-16			150	145			130 m above podium
17	SRT-17			160	155			140 m above podium
18	SRT-18			170	165			150 m above podium
19	SRT-19			180	175			160 m above podium
20	SRT-20			190	185			170 m above podium
21	SRT-21			200	195			180 m above podium
22	SRT-22			210	205			190 m above podium
23	SRT-23			220	215			200 m above podium

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
24	SRT-24			230	225			210 m above podium
25	SRT-25			240	235			220 m above podium
26	SRT-26			250	245			230 m above podium
27	SRT-27			260	255			240 m above podium
28	CLS-1	The Cullinan – Lunar Sky Serviced Apartment (Existing ASR)	194	59.8	54.8	33	2013 – 2020	lowest possible fresh air intake (1st floor above podium)
29	CLS-2			62.6	57.6			2nd lowest possible fresh air intake (2nd floor above podium)
30	CLS-3			127.0	122			24th floor inlet
31	CLS-4			129.8	124.8			25th floor inlet
32	CLS-5			163.4	158.4			37th floor inlet
33	CLS-6			166.2	161.2			38th floor inlet
34	WF3-1	The Waterfront – Tower 3 Residential (Existing ASR)	158	36.2	31.2		2013 – 2020	4m above podium
35	WF3-2			40.2	35.2			8m above podium
36	WF3-3			44.2	39.2			12m above podium
37	WF3-4			48.2	43.2			16m above podium
38	WF3-5			58.2	53.2			20m above podium
39	WF3-6			68.2	63.2			30 m above podium
40	WF3-7			78.2	73.2			40 m above podium
41	WF3-8			88.2	83.2			50 m above podium
42	WF3-9			98.2	93.2			60 m above podium
43	WF3-10			108.2	103.2			70 m above podium
44	WF3-11			118.2	113.2			80 m above podium
45	WF3-12			128.2	123.2			90 m above podium
46	WF3-13			138.2	133.2			100 m above podium
47	WF6-1	The Waterfront – Tower 6 Residential (Existing ASR)	309	36.1	31.1		2013 – 2020	4m above podium
48	WF6-2			40.1	35.1			8m above podium
49	WF6-3			44.1	39.1			12m above podium
50	WF6-4			48.1	43.1			16m above podium
51	WF6-5			58.1	53.1			20m above podium
52	WF6-6			68.1	63.1			30 m above podium
53	WF6-7			78.1	73.1			40 m above podium
54	WF6-8			88.1	83.1			50 m above podium
55	WF6-9			98.1	93.1			60 m above podium
56	WF6-10			108.1	103.1			70 m above podium
57	WF6-11			118.1	113.1			80 m above podium
58	WF6-12			128.1	123.1			90 m above podium

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
59	WF6-13			138.1	133.1			100 m above podium
60	ICC-1	International Commerce Centre(i) Office (Existing ASR)	142	61.3	56.3	>100	2013 – 2020	5th floor inlet
61	ICC-2			64.1	59.1			6th floor inlet
62	ICC-3			66.9	61.9			7th floor inlet
63	ICC-4			69.7	64.7			8th floor inlet
64	ICC-5			72.5	67.5			9th floor inlet
65	ICC-6			75.3	70.3			10th floor inlet
66	ICC-7			145.3	140.3			35th floor inlet
67	ICC-8			148.1	143.1			36th floor inlet
68	ICC-9			150.9	145.9			37th floor inlet
69	ICC-10			153.7	148.7			38th floor inlet
70	ICC-11			156.5	151.5			39th floor inlet
71	ICC-12			159.3	154.3			40th floor inlet
72	ICC-13			220.9	215.9			62nd floor inlet
73	ICC-14			223.7	218.7			63rd floor inlet
74	ICC-15			226.5	221.5			64th floor inlet
75	ICC-16			229.3	224.3			65th floor inlet
76	ICC-17			285.3	280.3			85th floor inlet
77	ICC-18			288.1	283.1			86th floor inlet
78	ICC-19			290.9	285.9			87th floor inlet
79	ICC-20			293.7	288.7			88th floor inlet
80	ICC-21			302.1	297.1			91st floor inlet
81	ICC-22			335.7	330.7			103rd floor inlet
82	HT2-1	The HarbourSide – Tower 2 Residential (Existing ASR)	47	30.8	25.8	63	2013 – 2020	4m above podium
83	HT2-2			34.8	29.8			8m above podium
84	HT2-3			38.8	33.8			12m above podium
85	HT2-4			42.8	37.8			16m above podium
86	HT2-5			46.8	41.8			20m above podium
87	HT2-6			56.8	51.8			30 m above podium
88	HT2-7			66.8	61.8			40 m above podium
89	HT2-8			76.8	71.8			50 m above podium
90	HT2-9			86.8	81.8			60 m above podium
91	HT2-10			96.8	91.8			70 m above podium
92	HT2-11			106.8	101.8			80 m above podium
93	HT2-12			116.8	111.8			90 m above podium
94	HT2-13			126.8	121.8			100 m above podium
95	HT2-14			136.8	131.8			110 m above podium
96	HT2-15			146.8	141.8			120 m above podium

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
97	HT2-16			156.8	151.8			130 m above podium
98	HT2-17			166.8	161.8			140 m above podium
99	HT2-18			176.8	171.8			150 m above podium
100	HT2-19			186.8	181.8			160 m above podium
101	HT2-20			196.8	191.8			170 m above podium
102	HT2-21			206.8	201.8			180 m above podium
103	HT2-22			216.8	211.8			190 m above podium
104	HT2-23			226.8	221.8			200 m above podium
105	HT2-24			236.8	231.8			210 m above podium
106	HT2-25			246.8	241.8			220 m above podium
107	HT2-26			256.8	251.8			230 m above podium
108	HT2-27			266.8	261.8			240 m above podium
109	WKTA1-1	Topside Developments at West Kowloon Terminus Site A(ii) (iii) Commercial (Planned ASR from 2015 onwards)	31	28.0	23	15	2015 – 2020	4m above podium
110	WKTA1-2			32.0	27			8m above podium
111	WKTA1-3			36.0	31			12m above podium
112	WKTA1-4			40.0	35			16m above podium
113	WKTA1-5			44.0	39			20m above podium
114	WKTA1-6			54.0	49			30 m above podium
115	WKTA1-7			64.0	59			40 m above podium
116	WKTA1-8			74.0	69			50 m above podium
117	WKTA1-9			84.0	79			60 m above podium
118	WKTA2-1	Topside Developments at West Kowloon Terminus Site A(ii) (iii) Commercial (Planned ASR from 2015 onwards)	198	28.0	23	21	2015 – 2020	4m above podium
119	WKTA2-2			32.0	27			8m above podium
120	WKTA2-3			36.0	31			12m above podium
121	WKTA2-4			40.0	35			16m above podium
122	WKTA2-5			44.0	39			20m above podium
123	WKTA2-6			54.0	49			30 m above podium
124	WKTA2-7			64.0	59			40 m above podium
125	WKTA2-8			74.0	69			50 m above podium
126	WKTA2-9			84.0	79			60 m above podium
127	WKTA2-10			94.0	89			70 m above podium
128	WKTA2-11			104.0	99			80 m above podium
129	WKTA3-1	Topside Developments at West Kowloon Terminus Site A(ii) (iii) Commercial	404	28.0	23	15	2015 – 2020	4m above podium
130	WKTA3-2			32.0	27			8m above podium
131	WKTA3-3			36.0	31			12m above podium
132	WKTA3-4			40.0	35			16m above podium
133	WKTA3-5			44.0	39			20m above podium
134	WKTA3-6			54.0	49			30 m above podium

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
135	WKTA3-7	(Planned ASR from 2015 onwards)		64.0	59			40 m above podium
136	WKTA3-8			74.0	69			50 m above podium
137	WKTA3-9			84.0	79			60 m above podium
138	WKTA4-1	Topside Developments at West Kowloon Terminus Site A(ii) (iii) Commercial (Planned ASR from 2015 onwards)	182	28.0	23	25	2015 – 2020	4m above podium
139	WKTA4-2			32.0	27			8m above podium
140	WKTA4-3			36.0	31			12m above podium
141	WKTA4-4			40.0	35			16m above podium
142	WKTA4-5			44.0	39			20m above podium
143	WKTA4-6			54.0	49			30 m above podium
144	WKTA4-7			64.0	59			40 m above podium
145	WKTA4-8			74.0	69			50 m above podium
146	WKTA4-9			84.0	79			60 m above podium
147	WKTA4-10			94.0	89			70 m above podium
148	WKTA4-11			104.0	99			80 m above podium
149	WKTA4-12			114.0	109			90 m above podium
150	WKTA4-13			124.0	119			100 m above podium
151	AMT-1	The Arch – Moon Tower Residential (Existing ASR)	95	42.0	37	52	2013 – 2020	4m above podium
152	AMT-2			46.0	41			8m above podium
153	AMT-3			50.0	45			12m above podium
154	AMT-4			54.0	49			16m above podium
155	AMT-5			58.0	53			20m above podium
156	AMT-6			68.0	63			30 m above podium
157	AMT-7			78.0	73			40 m above podium
158	AMT-8			88.0	83			50 m above podium
159	AMT-9			98.0	93			60 m above podium
160	AMT-10			108.0	103			70 m above podium
161	AMT-11			118.0	113			80 m above podium
162	AMT-12			128.0	123			90 m above podium
163	AMT-13			138.0	133			100 m above podium
164	AMT-14			148.0	143			110 m above podium
165	AMT-15			158.0	153			120 m above podium
166	AMT-16			168.0	163			130 m above podium
167	AMT-17			178.0	173			140 m above podium
168	AMT-18			188.0	183			150 m above podium
169	AMT-19			198.0	193			160 m above podium
170	AMT-20			208.0	203			170 m above podium
171	AMT-21			218.0	213			180 m above podium
172	AMT-22			228.0	223			190 m above podium

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
173	PB1-1	Residential Developments at Austin Station(iii) Residential (Planned ASR from 2015 onwards)	326	15.8	10.8	23	2015 – 2020	4m above podium
174	PB1-2			30.1	25.1			8m above podium
175	PB1-3			34.1	29.1			12m above podium
176	PB1-4			38.1	33.1			16m above podium
177	PB1-5			42.1	37.1			20m above podium
178	PB1-6			46.1	41.1			30 m above podium
179	PB1-7			56.1	51.1			40 m above podium
180	PB1-8			66.1	61.1			50 m above podium
181	PB1-9			76.1	71.1			60 m above podium
182	PB1-10			86.1	81.1			70 m above podium
183	PB1-11			96.1	91.1			80 m above podium
184	PB2-1	Residential Developments at Austin Station(iii) Residential (Planned ASR from 2015 onwards)	222	15.8	10.8	21	2015 – 2020	4m above podium
185	PB2-2			30.1	25.1			8m above podium
186	PB2-3			34.1	29.1			12m above podium
187	PB2-4			38.1	33.1			16m above podium
188	PB2-5			42.1	37.1			20m above podium
189	PB2-6			46.1	41.1			30 m above podium
190	PB2-7			56.1	51.1			40 m above podium
191	PB2-8			66.1	61.1			50 m above podium
192	PB2-9			76.1	71.1			60 m above podium
193	PB2-10			86.1	81.1			70 m above podium
194	PB3-1	Residential Developments at Austin Station(iii) Residential (Planned ASR from 2015 onwards)	182	30.6	25.6	26	2015 – 2020	4m above podium
195	PB3-2			34.6	29.6			8m above podium
196	PB3-3			38.6	33.6			12m above podium
197	PB3-4			42.6	37.6			16m above podium
198	PB3-5			46.6	41.6			20m above podium
199	PB3-6			56.6	51.6			30 m above podium
200	PB3-7			66.6	61.6			40 m above podium
201	PB3-8			76.6	71.6			50 m above podium
202	PB3-9			86.6	81.6			60 m above podium
203	PB3-10			96.6	91.6			70 m above podium
204	PB4-1	Residential Developments at Austin Station(iii) Residential (Planned ASR from 2015 onwards)	39	49.5	44.5	20	2015 – 2020	4m above podium
205	PB4-2			53.5	48.5			8m above podium
206	PB4-3			57.5	52.5			12m above podium
207	PB4-4			61.5	56.5			16m above podium
208	PB4-5			65.5	60.5			20m above podium
209	PB4-6			75.5	70.5			30 m above podium
210	PB4-7			85.5	80.5			40 m above podium

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
211	PB4-8			95.5	90.5			50 m above podium
212	PB4-9			105.5	100.5			60 m above podium
213	PB4-10			115.5	110.5			70 m above podium
214	WOB-1	Wai On Building – Block A Residential (Existing ASR)	47	11.8	6.8	16	2013 – 2020	4m above podium
215	WOB-2			15.8	10.8			8m above podium
216	WOB-3			19.8	14.8			12m above podium
217	WOB-4			23.8	18.8			16m above podium
218	WOB-5			27.8	22.8			20m above podium
219	WOB-6			37.8	32.8			30 m above podium
220	WOB-7			47.8	42.8			40 m above podium
221	WOB-8			57.8	52.8			50 m above podium
222	VT1-1	The Victoria Towers – Tower 1 Residential (Existing ASR)	31	49.3	44.3	52	2013 – 2020	4m above podium
223	VT1-2			53.3	48.3			8m above podium
224	VT1-3			57.3	52.3			12m above podium
225	VT1-4			61.3	56.3			16m above podium
226	VT1-5			65.3	60.3			20m above podium
227	VT1-6			75.3	70.3			30 m above podium
228	VT1-7			85.3	80.3			40 m above podium
229	VT1-8			95.3	90.3			50 m above podium
230	VT1-9			105.3	100.3			60 m above podium
231	VT1-10			115.3	110.3			70 m above podium
232	VT1-11			125.3	120.3			80 m above podium
233	VT1-12			135.3	130.3			90 m above podium
234	VT1-13			145.3	140.3			100 m above podium
235	VT1-14			155.3	150.3			110 m above podium
236	VT1-15			165.3	160.3			120 m above podium
237	VT1-16			175.3	170.3			130 m above podium
238	VT1-17			185.3	180.3			140 m above podium
239	VT1-18			195.3	190.3			150 m above podium
240	VT1-19			205.3	200.3			160 m above podium
241	VT1-20			215.3	210.3			170 m above podium
242	VT1-21			225.3	220.3			180 m above podium
243	VT1-22			235.3	230.3			190 m above podium
244	VT1-23			13.0	8			Fresh Air Intake
245	LCS-1	Lai Chak Middle School Educational (Existing ASR)	31	11.2	6.2	7	2013 – 2020	4m above podium
246	LCS-2			15.2	10.2			8m above podium

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
247	CHC1-1	China HK City – Tower 3(i) Commercial (Existing ASR)	15	23.1	18.1	11	2013 – 2020	4m above podium
248	CHC1-2			27.1	22.1			8m above podium
249	CHC1-3			31.1	26.1			12m above podium
250	CHC1-4			35.1	30.1			16m above podium
251	CHC1-5			39.1	34.1			20m above podium
252	CHC1-6			49.1	44.1			30 m above podium
253	CHC2-1	China HK City – Tower 5(i) Commercial (Existing ASR)	7	23.1	18.1	11	2013 – 2020	4m above podium
254	CHC2-2			27.1	22.1			8m above podium
255	CHC2-3			31.1	26.1			12m above podium
256	CHC2-4			35.1	30.1			16m above podium
257	CHC2-5			39.1	34.1			20m above podium
258	CHC2-6			49.1	44.1			30 m above podium
259	RPH-1	The Royal Pacific Hotel(i) Hotel (Existing ASR)	119	23.1	18.1	15	2013 – 2020	4m above podium
260	RPH-2			27.1	22.1			8m above podium
261	RPH-3			31.1	26.1			12m above podium
262	RPH-4			35.1	30.1			16m above podium
263	RPH-5			39.1	34.1			20m above podium
264	RPH-6			49.1	44.1			30 m above podium
265	PCK-1	Pacific Club Kowloon Recreational (Existing ASR)	317	24.0	19	4	2013 – 2020	4m above podium
266	P01a-1	Parcel 01 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2015 onwards)	N/A	13.4	4.0	7	2015 – 2020	See Note (vi)
267	P01a-2			17.4	8.0			
268	P01a-3			21.4	12.0			
269	P01a-4			25.4	16.0			
270	P01a-5			29.4	20.0			
271	P01a-6			39.4	30.0			
272	P01a-7			49.4	40.0			
273	P01b-1	Parcel 01 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2015 onwards)	N/A	13.4	4.0	7	2015 – 2020	See Note (vi)
274	P01b-2			17.4	8.0			
275	P01b-3			21.4	12.0			
276	P01b-4			25.4	16.0			
277	P01b-5			29.4	20.0			
278	P01b-6			39.4	30.0			
279	P01b-7			49.4	40.0			
280	P01c-1	Parcel 01		13.4	4.0	7	2015 – 2020	See Note (vi)

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
281	P01c-2	Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2015 onwards)		17.4	8.0			
282	P01c-3			21.4	12.0			
283	P01c-4			25.4	16.0			
284	P01c-5			29.4	20.0			
285	P01c-6			39.4	30.0			
286	P01c-7			49.4	40.0			
287	P01d-1	Parcel 01 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2015 onwards)		13.4	4.0	7	2015 – 2020	See Note (vi)
288	P01d-2			17.4	8.0			
289	P01d-3			21.4	12.0			
290	P01d-4			25.4	16.0			
291	P01d-5			29.4	20.0			
292	P01d-6			39.4	30.0			
293	P01d-7			49.4	40.0			
294	P01e-1	Parcel 01 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2015 onwards)		49.4	40.0	7	2015 – 2020	
295	P02-1	Parcel 02 Retail/ Dining/ Entertainment /Residential (Planned ASR from 2030 onwards)	N/A	13.4	4.0	15	Phase 2 construction, not complete until 2030	See Note (vi)
296	P02-2			17.4	8.0			
297	P02-3			21.4	12.0			Lowest residential floor
298	P02-4			25.4	16.0			
299	P02-5			29.4	20.0			
300	P02-6			39.4	30.0			
301	P02-7			49.4	40.0			
302	P02-8			59.4	50.0			
303	P03-1	Parcel 03 Retail/ Dining/ Entertainment /Residential (Planned ASR from 2030 onwards)	N/A	11.2	4.0	8	Phase 2 construction, not complete until 2030	
304	P03-2			15.2	8.0			
305	P03-3			19.2	12.0			Lowest residential floor
306	P03-4			23.2	16.0			
307	P03-5			27.2	20.0			
308	P04-1	Parcel 04	N/A	9.0	4.0	5	Phase 2	See Note (vi)

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
309	P04-2	Retail/ Dining/ Entertainment (Planned ASR from 2030 onwards)		13.0	8.0		construction, not complete until 2030	
310	P04-3			17.0	12.0			
311	P04-4			21.0	16.0			
312	P04-5			25.0	20.0			
313	P04-6			35.0	30.0			
314	P05-1	Parcel 05 Office/ Residential (Planned ASR from 2017 onwards)	N/A	13.4	4.0	15	2017 – 2020	See Note (vi)
315	P05-2			17.4	8.0			
316	P05-3			21.4	12.0			
317	P05-4			25.4	16.0			
318	P05-5			29.4	20.0			
319	P05-6			39.4	30.0			Lowest residential floor
320	P05-7			49.4	40.0			
321	P06-1	Parcel 06 Office(v) Residential (Planned ASR from 2017 onwards)	N/A	13.4	4.0	14	2017 – 2020	See Note (vi)
322	P06-2			17.4	8.0			
323	P06-3			21.4	12.0			
324	P06-4			25.4	16.0			
325	P06-5			29.4	20.0			
326	P06-6			39.4	30.0			Lowest residential floor
327	P06-7			49.4	40.0			
328	P07-1	Parcel 07 Office(v) Residential (Planned ASR from 2017 onwards)	N/A	13.4	4.0	14	2017 – 2020	See Note (vi)
329	P07-2			17.4	8.0			
330	P07-3			21.4	12.0			
331	P07-4			25.4	16.0			
332	P07-5			29.4	20.0			
333	P07-6			39.4	30.0			Lowest residential floor
334	P07-7			49.4	40.0			
335	P08-1	Parcel 08 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2018 onwards)	N/A	13.4	4.0	5	2018 – 2020	See Note (vi)
336	P08-2			17.4	8.0			
337	P08-3			21.4	12.0			
338	P08-4			25.4	16.0			
339	P08-5			29.4	20.0			
340	P09-1	Parcel 09	N/A	13.4	4.0	15	2017 – 2020	See Note (vi)
341	P09-2			17.4	8.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
342	P09-3	Office(v)/ Residential (vi) (Planned ASR from 2017 onwards)		21.4	12.0			
343	P09-4			25.4	16.0			
344	P09-5			29.4	20.0			
345	P09-6			39.4	30.0			Lowest residential floor
346	P09-7			49.4	40.0			
347	P10-1	Parcel 10 Office+ Retail/ Dining/ Entertainment (v) Residential (Planned ASR from 2017 onwards)	N/A	13.4	4.0	15	2017 – 2020	See Note (vi)
348	P10-2			17.4	8.0			
349	P10-3			21.4	12.0			
350	P10-4			25.4	16.0			
351	P10-5			29.4	20.0			
352	P10-6			39.4	30.0			Lowest residential floor
353	P10-7			49.4	40.0			
354	P10-8			59.4	50.0			
355	P11-1	Parcel 11 Retail/ Dining/ Entertainment (v) Residential (Planned ASR from 2017 onwards)	N/A	13.4	4.0	15	2017 – 2020	See Note (vi)
356	P11-2			17.4	8.0			
357	P11-3			21.4	12.0			Lowest residential floor
358	P11-4			25.4	16.0			
359	P11-5			29.4	20.0			
360	P11-6			39.4	30.0			
361	P11-7			49.4	40.0			
362	P11-8			59.4	50.0			
363	P12-1	Parcel 12 Planned Performance Art Venues within WKCD (iv) (Planned ASR from beyond 2020)	N/A	13.4	4.0	15	Beyond 2020	See Note (vi)
364	P12-2			17.4	8.0			
365	P12-3			21.4	12.0			
366	P12-4			25.4	16.0			
367	P12-5			29.4	20.0			
368	P13-1	Parcel 13 Office+ Retail/ Dining/ Entertainment (v) Residential (Planned ASR	N/A	13.4	4.0	15	2017 – 2020	See Note (vi)
369	P13-2			17.4	8.0			
370	P13-3			21.4	12.0			
371	P13-4			25.4	16.0			
372	P13-5			29.4	20.0			
373	P13-6			39.4	30.0			Lowest residential floor

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
374	P13-7	from 2017 onwards)		49.4	40.0			
375	P13-8			59.4	50.0			
376	P14-1	Parcel 14 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2017 onwards)	N/A	13.4	4.0	12	2017 – 2020	See Note (vi)
377	P14-2			17.4	8.0			
378	P14-3			21.4	12.0			
379	P14-4			25.4	16.0			
380	P14-5			29.4	20.0			
381	P14-6			39.4	30.0			
382	P14-7			49.4	40.0			
383	P15-1	Parcel 15 Planned Performance Art Venues within WKCD + Retail/ Dining/ Entertainment (iv) Office(iv) (Planned ASR from 2017 onwards)	N/A	13.4	4.0	12	2017 – 2020	See Note (vi)
384	P15-2			17.4	8.0			
385	P15-3			21.4	12.0			
386	P15-4			25.4	16.0			
387	P15-5			29.4	20.0			
388	P15-6			39.4	30.0			
389	P15-7			49.4	40.0			
390	P16-1	Parcel 16 Retail/ Dining/ Entertainment (v) Residential (Planned ASR from 2018 onwards)	N/A	13.4	4.0	8	2018 – 2020	See Note (vi)
391	P16-2			17.4	8.0			
392	P16-3			21.4	12.0			
393	P16-4			25.4	16.0			
394	P16-5			29.4	20.0			
395	P16-6			39.4	30.0			Lowest residential floor
396	P16-7			49.4	40.0			
397	P16-8			59.4	50.0			
398	P17-1	Parcel 17 Retail/ Dining/ Entertainment + Residential (Planned ASR from 2018 onwards)	N/A	13.4	4.0	15	2018 – 2020	See Note (vi)
399	P17-2			17.4	8.0			
400	P17-3			21.4	12.0			
401	P17-4			25.4	16.0			
402	P17-5			29.4	20.0			
403	P17-6			39.4	30.0			Lowest residential floor
404	P17-7			49.4	40.0			
405	P18a-1	Parcel 18	N/A	13.4	4.0	8	2020	See Note (vi)
406	P18a-2			17.4	8.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
407	P18a-3	Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)		21.4	12.0			
408	P18a-4			25.4	16.0			
409	P18a-5			29.4	20.0			
410	P18a-6			39.4	30.0			
411	P18a-7			49.4	40.0			
412	P18b-1	Parcel 18 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)	N/A	13.4	4.0	8	2020	See Note (vi)
413	P18b-2			17.4	8.0			
414	P18b-3			21.4	12.0			
415	P18b-4			25.4	16.0			
416	P18b-5			29.4	20.0			
417	P18b-6			39.4	30.0			
418	P18b-7			49.4	40.0			
419	P18c-1	Parcel 18 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)	N/A	13.4	4.0	8	2020	See Note (vi)
420	P18c-2			17.4	8.0			
421	P18c-3			21.4	12.0			
422	P18c-4			25.4	16.0			
423	P18c-5			29.4	20.0			
424	P18c-6			39.4	30.0			
425	P18c-7			49.4	40.0			
426	P18d-1	Parcel 18 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)	N/A	13.4	4.0	8	2020	See Note (vi)
427	P18d-2			17.4	8.0			
428	P18d-3			21.4	12.0			
429	P18d-4			25.4	16.0			
430	P18d-5			29.4	20.0			
431	P18d-6			39.4	30.0			
432	P18d-7			49.4	40.0			
433	P18e	Parcel 18 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2030 onwards)	N/A	49.4	40.0	8	Phase 2 construction, not complete until 2030	
434	P19-1	Parcel 19	N/A	13.4	4.0	14	2018 – 2020	See Note (vi)

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
435	P19-2	Hotel + Retail/ Dining/ Entertainment (v) Residential (Planned ASR from 2018 onwards)		17.4	8.0			
436	P19-3			21.4	12.0			
437	P19-4			25.4	16.0			
438	P19-5			29.4	20.0			
439	P19-6			39.4	30.0			Lowest residential floor
440	P19-7			49.4	40.0			
441	P19-8			59.4	50.0			
442	P20-1	Parcel 20 Planned Performance Art Venues within WKCD + Retail/ Dining/ Entertainment (iv) (Planned ASR from 2017 onwards)	N/A	13.4	4.0	13	2017 – 2020	See Note (vi)
443	P20-2			17.4	8.0			
444	P20-3			21.4	12.0			
445	P20-4			25.4	16.0			
446	P20-5			29.4	20.0			
447	P20-6			39.4	30.0			
448	P20-7			49.4	40.0			
449	P20-8			59.4	50.0			
450	P21-1	Parcel 21 Office + Retail/ Dining/ Entertainment (v) Residential (Planned ASR from 2017 onwards)	N/A	13.4	4.0	13	2017 – 2020	See Note (vi)
451	P21-2			17.4	8.0			
452	P21-3			21.4	12.0			
453	P21-4			25.4	16.0			
454	P21-5			29.4	20.0			
455	P21-6			39.4	30.0			Lowest residential floor
456	P21-7			49.4	40.0			
457	P22-1	Parcel 22 GIC + Retail/ Dining/ Entertainment (v) Residential (Planned ASR from 2018 onwards)	N/A	13.4	4.0	13	2018 – 2020	See Note (vi)
458	P22-2			17.4	8.0			
459	P22-3			21.4	12.0			
460	P22-4			25.4	16.0			
461	P22-5			29.4	20.0			Lowest residential floor
462	P22-6			39.4	30.0			
463	P22-7			49.4	40.0			
464	P22-8			59.4	50.0			
465	P23a-1	Parcel 23 Planned Performance	N/A	13.4	4.0	8	2020	See Note (vi)
466	P23a-2			17.4	8.0			
467	P23a-3			21.4	12.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
468	P23a-4	Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)		25.4	16.0			
469	P23a-5			29.4	20.0			
470	P23a-6			39.4	30.0			
471	P23a-7			49.4	40.0			
472	P23b-1	Parcel 23 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)		13.4	4.0	8	2020	See Note (vi)
473	P23b-2			17.4	8.0			
474	P23b-3			21.4	12.0			
475	P23b-4			25.4	16.0			
476	P23b-5			29.4	20.0			
477	P23b-6			39.4	30.0			
478	P23b-7			49.4	40.0			
479	P23c-1	Parcel 23 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)		13.4	4.0	8	2020	See Note (vi)
480	P23c-2			17.4	8.0			
481	P23c-3			21.4	12.0			
482	P23c-4			25.4	16.0			
483	P23c-5			29.4	20.0			
484	P23c-6			39.4	30.0			
485	P23c-7			49.4	40.0			
486	P23d-1	Parcel 23 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)		13.4	4.0	8	2020	See Note (vi)
487	P23d-2			17.4	8.0			
488	P23d-3			21.4	12.0			
489	P23d-4			25.4	16.0			
490	P23d-5			29.4	20.0			
491	P23d-6			39.4	30.0			
492	P23d-7			49.4	40.0			
493	P23e	Parcel 23 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)		49.4	40.0	8	2020	
494	P24-1	Parcel 24 Office + Retail/ Dining/	N/A	13.4	4.0	14	2018 – 2020	See Note (vi)
495	P24-2			17.4	8.0			
496	P24-3			21.4	12.0			
497	P24-4			25.4	16.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
498	P24-5	Entertainment (v) Residential (Planned ASR from 2018 onwards)		29.4	20.0			
499	P24-6			39.4	30.0			Lowest residential floor
500	P24-7			49.4	40.0			
501	P24-8			59.4	50.0			
502	P25-1	Parcel 25 Pavilion (iv) (Planned ASR from 2017 onwards)	N/A	13.4	4.0	1	2017 – 2020	See Note (vi)
503	P25-2			17.4	8.0			
504	P25-3			21.4	12.0			
505	P25-4			25.4	16.0			
506	P25-5			29.4	20.0			
507	P26-1	Parcel 26 Office + Retail/ Dining/ Entertainment (v) Residential (Planned ASR from 2018 onwards)	N/A	13.4	4.0	15	2018 – 2020	See Note (vi)
508	P26-2			17.4	8.0			
509	P26-3			21.4	12.0			
510	P26-4			25.4	16.0			
511	P26-5			29.4	20.0			
512	P26-6			39.4	30.0			Lowest residential floor
513	P26-7			49.4	40.0			
514	P26-8			59.4	50.0			
515	P27-1	Parcel 27 Office + Retail/ Dining/ Entertainment (v) Residential (Planned ASR from 2018 onwards)	N/A	13.4	4.0	15	2018 – 2020	See Note (vi)
516	P27-2			17.4	8.0			
517	P27-3			21.4	12.0			
518	P27-4			25.4	16.0			
519	P27-5			29.4	20.0			
520	P27-6			39.4	30.0			
521	P27-7			49.4	40.0			Lowest residential floor
522	P27-8			59.4	50.0			
523	P28-1	Parcel 28 Office + Retail/ Dining/ Entertainment (v) Residential (Planned ASR from 2018 onwards)	N/A	13.4	4.0	21	2018 – 2020	See Note (vi)
524	P28-2			17.4	8.0			
525	P28-3			21.4	12.0			
526	P28-4			25.4	16.0			
527	P28-5			29.4	20.0			
528	P28-6			39.4	30.0			Lowest residential floor
529	P28-7			49.4	40.0			
530	P28-8			59.4	50.0			
531	P28-9			69.4	60.0			
532	P28-10			79.4	70.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
533	P29-1	Parcel 29 Office + Retail/ Dining/ Entertainment (v) Residential (Planned ASR from 2018 onwards)	N/A	13.4	4.0	23	2018 – 2020	See Note (vi)
534	P29-2			17.4	8.0			
535	P29-3			21.4	12.0			
536	P29-4			25.4	16.0			
537	P29-5			29.4	20.0			
538	P29-6			39.4	30.0			Lowest residential floor
539	P29-7			49.4	40.0			
540	P29-8			59.4	50.0			
541	P29-9			69.4	60.0			
542	P29-10			79.4	70.0			
543	P30a-1	Parcel 30 Planned Performance Art Venues within WKCD (iv) (Planned ASR from beyond 2020)	N/A	13.4	4.0	6	Beyond 2020	See Note (vi)
544	P30a-2			17.4	8.0			
545	P30a-3			21.4	12.0			
546	P30a-4			25.4	16.0			
547	P30a-5			29.4	20.0			
548	P30b-1	Parcel 30 Planned Performance Art Venues within WKCD (iv) (Planned ASR from beyond 2020)		13.4	4.0	6	Beyond 2020	See Note (vi)
549	P30b-2			17.4	8.0			
550	P30b-3			21.4	12.0			
551	P30b-4			25.4	16.0			
552	P30b-5			29.4	20.0			
553	P30c-1	Parcel 30 Planned Performance Art Venues within WKCD (iv) (Planned ASR from beyond 2020)		13.4	4.0	6	Beyond 2020	See Note (vi)
554	P30c-2			17.4	8.0			
555	P30c-3			21.4	12.0			
556	P30c-4			25.4	16.0			
557	P30c-5			29.4	20.0			
558	P30d-1	Parcel 30 Planned Performance Art Venues within WKCD (iv)		13.4	4.0	6	Beyond 2020	See Note (vi)
559	P30d-2			17.4	8.0			
560	P30d-3			21.4	12.0			
561	P30d-4			25.4	16.0			
562	P30d-5			29.4	20.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
		(Planned ASR from beyond 2020)						
563	P30e	Parcel 30 Planned Performance Art Venues within WKCD (iv) (Planned ASR from beyond 2020)		29.4	20.0	6	Beyond 2020	
564	P31-1	Parcel 31 Retail/ Dining/ Entertainment (iv) Office(iv) (Planned ASR from 2018 onwards)	N/A	13.4	4.0	22	2018 – 2020	See Note (vi)
565	P31-2			17.4	8.0			
566	P31-3			21.4	12.0			
567	P31-4			25.4	16.0			
568	P31-5			29.4	20.0			
569	P31-6			39.4	30.0			
570	P31-7			49.4	40.0			
571	P31-8			59.4	50.0			
572	P31-9			69.4	60.0			
573	P31-10			79.4	70.0			
574	P31-11			89.4	80.0			
575	P32-1	Parcel 32 Retail/ Dining/ Entertainment + Residential (Planned ASR from 2018 onwards)	N/A	13.4	4.0	15	2018 – 2020	See Note (vi)
576	P32-2			17.4	8.0			
577	P32-3			21.4	12.0			Lowest residential floor
578	P32-4			25.4	16.0			
579	P32-5			29.4	20.0			
580	P32-6			39.4	30.0			
581	P32-7			49.4	40.0			
582	P34-1	Parcel 34 Office + Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2018	N/A	13.4	4.0	21	2018 – 2020	See Note (vi)
583	P34-2			17.4	8.0			
584	P34-3			21.4	12.0			
585	P34-4			25.4	16.0			
586	P34-5			29.4	20.0			
587	P34-6			39.4	30.0			
588	P34-7			49.4	40.0			
589	P34-8			59.4	50.0			
590	P34-9			69.4	60.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
591	P34-10	onwards)		79.4	70.0			
592	P35a-1	Parcel 35 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2017 onwards)	N/A	13.4	4.0	7	2017 – 2020	See Note (vi)
593	P35a-2			17.4	8.0			
594	P35a-3			21.4	12.0			
595	P35a-4			25.4	16.0			
596	P35a-5			29.4	20.0			
597	P35b-1	Parcel 35 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2017 onwards)		13.4	4.0	7	2017 – 2020	See Note (vi)
598	P35b-2			17.4	8.0			
599	P35b-3			21.4	12.0			
600	P35b-4			25.4	16.0			
601	P35b-5			29.4	20.0			
602	P35c-1	Parcel 35 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2017 onwards)		13.4	4.0	7	2017 – 2020	See Note (vi)
603	P35c-2			17.4	8.0			
604	P35c-3			21.4	12.0			
605	P35c-4			25.4	16.0			
606	P35c-5			29.4	20.0			
607	P35d-1	Parcel 35 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2017 onwards)		13.4	4.0	7	2017 – 2020	See Note (vi)
608	P35d-2			17.4	8.0			
609	P35d-3			21.4	12.0			
610	P35d-4			25.4	16.0			
611	P35d-5			29.4	20.0			
612	P35e-1	Parcel 35 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2017 onwards)		29.4	20.0	7	2017 – 2020	

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
613	P36-1	Parcel 36 Retail/ Dining/ Entertainment (iv) (Planned ASR from 2018 onwards)	N/A	11.4	4.0	15	2018 – 2020	See Note (vi)
614	P36-2			15.4	8.0			
615	P36-3			19.4	12.0			
616	P36-4			23.4	16.0			
617	P36-5			27.4	20.0			
618	P36-6			37.4	30.0			
619	P36-7			47.4	40.0			
620	P36-8			57.4	50.0			
621	P36-9			67.4	60.0			
622	P36-10			77.4	70.0			
623	P37-1	Parcel 37 Retail/ Dining/ Entertainment (iv) (Planned ASR from 2017 onwards)	N/A	11.4	4.0	15	2017 – 2020	See Note (vi)
624	P37-2			15.4	8.0			
625	P37-3			19.4	12.0			
626	P37-4			23.4	16.0			
627	P37-5			27.4	20.0			
628	P37-6			37.4	30.0			
629	P37-7			47.4	40.0			
630	P37-8			57.4	50.0			
631	P37-9			67.4	60.0			
632	P37-10			77.4	70.0			
633	P38-1	Parcel 38 Office + Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2017 onwards)	N/A	13.4	4.0	21	2017 – 2020	See Note (vi)
634	P38-2			17.4	8.0			
635	P38-3			21.4	12.0			
636	P38-4			25.4	16.0			
637	P38-5			29.4	20.0			
638	P38-6			39.4	30.0			
639	P38-7			49.4	40.0			
640	P38-8			59.4	50.0			
641	P38-9			69.4	60.0			
642	P38-10			79.4	70.0			
643	P39-1	Parcel 39 Office + Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020	N/A	13.4	4.0	11	2020	See Note (vi)
644	P39-2			17.4	8.0			
645	P39-3			21.4	12.0			
646	P39-4			25.4	16.0			
647	P39-5			29.4	20.0			
648	P39-6			39.4	30.0			
649	P39-7			49.4	40.0			
650	P39-8			59.4	50.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
651	P39-9	onwards)		69.4	60.0			
652	P39-10			79.4	70.0			
653	P40a-1	Parcel 40 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2018 onwards)	N/A	13.4	4.0	6	2018 – 2020	See Note (vi)
654	P40a-2			17.4	8.0			
655	P40a-3			21.4	12.0			
656	P40a-4			25.4	16.0			
657	P40a-5			29.4	20.0			
658	P40a-6			39.4	30.0			
659	P40a-7			49.4	40.0			
660	P40b-1	Parcel 40 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2018 onwards)		13.4	4.0	6	2018 – 2020	See Note (vi)
661	P40b-2			17.4	8.0			
662	P40b-3			21.4	12.0			
663	P40b-4			25.4	16.0			
664	P40b-5			29.4	20.0			
665	P40b-6			39.4	30.0			
666	P40b-7			49.4	40.0			
667	P40c-1	Parcel 40 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2018 onwards)		13.4	4.0	6	2018 – 2020	See Note (vi)
668	P40c-2			17.4	8.0			
669	P40c-3			21.4	12.0			
670	P40c-4			25.4	16.0			
671	P40c-5			29.4	20.0			
672	P40c-6			39.4	30.0			
673	P40c-7			49.4	40.0			
674	P40d-1	Parcel 40 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2018 onwards)		13.4	4.0	6	2018 – 2020	See Note (vi)
675	P40d-2			17.4	8.0			
676	P40d-3			21.4	12.0			
677	P40d-4			25.4	16.0			
678	P40d-5			29.4	20.0			
679	P40d-6			39.4	30.0			
680	P40d-7			49.4	40.0			
681	P40e	Parcel 40 Planned Performance Art Venues within WKCD (iv) (Planned ASR		49.4	40.0	6	2018 – 2020	

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
		from 2018 onwards)						
682	P41-1	Parcel 41 Pavilion (iv) (Planned ASR from 2030 onwards)	N/A	13.4	4.0	1	Phase 2 construction, not complete until 2030	See Note (vi)
683	P41-2			17.4	8.0			
684	P41-3			21.4	12.0			
685	P41-4			25.4	16.0			
686	P41-5			29.4	20.0			
687	P43a-1	Parcel 43 Hotel + Retail/ Dining/ Entertainment (iv) (Planned ASR from 2020 onwards)	N/A	16.5	4.0	13	2020	See Note (vi)
688	P43a-2			20.5	8.0			
689	P43a-3			24.5	12.0			
690	P43a-4			28.5	16.0			
691	P43b-1	Parcel 43 Hotel + Retail/ Dining/ Entertainment (iv) (Planned ASR from 2020 onwards)		16.5	4.0	13	2020	See Note (vi)
692	P43b-2			20.5	8.0			
693	P43b-3			24.5	12.0			
694	P43b-4			28.5	16.0			
695	P43b-5			32.5	20.0			
696	P43c-1	Parcel 43 Hotel + Retail/ Dining/ Entertainment (iv) (Planned ASR from 2020 onwards)		16.5	4.0	13	2020	See Note (vi)
697	P43c-2			20.5	8.0			
698	P43c-3			24.5	12.0			
699	P43c-4			28.5	16.0			
700	P43c-5			32.5	20.0			
701	P43d-1	Parcel 43 Hotel + Retail/ Dining/ Entertainment (iv) (Planned ASR from 2020 onwards)		16.5	4.0	13	2020	See Note (vi)
702	P43d-2			20.5	8.0			
703	P43d-3			24.5	12.0			
704	P43d-4			28.5	16.0			
705	P43d-5			32.5	20.0			
706	P43d-6			42.5	30.0			
707	P43d-7			52.5	40.0			
708	P43e-1	Parcel 43 Hotel + Retail/ Dining/ Entertainment		16.5	4.0	13	2020	See Note (vi)
709	P43e-2			20.5	8.0			
710	P43e-3			24.5	12.0			
711	P43e-4			28.5	16.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
712	P43e-5	(iv) (Planned ASR from 2020 onwards)		32.5	20.0			
713	P43e-6			42.5	30.0			
714	P43e-7			52.5	40.0			
715	P43e-8			62.5	50.0			
716	P43f-1	Parcel 43 Hotel + Retail/ Dining/ Entertainment (iv) (Planned ASR from 2020 onwards)		16.5	4.0	13	2020	See Note (vi)
717	P43f-2			20.5	8.0			
718	P43f-3			24.5	12.0			
719	P43f-4			28.5	16.0			
720	P43f-5			32.5	20.0			
721	P43f-6			42.5	30.0			
722	P43f-7			52.5	40.0			
723	P43f-8			62.5	50.0			
724	P43g-1	Parcel 43 Hotel + Retail/ Dining/ Entertainment (iv) (Planned ASR from 2020 onwards)		16.5	4.0	13	2020	See Note (vi)
725	P43g-2			20.5	8.0			
726	P43g-3			24.5	12.0			
727	P43g-4			28.5	16.0			
728	P43g-5			32.5	20.0			
729	P43g-6			42.5	30.0			
730	P43g-7			52.5	40.0			
731	P43h-1	Parcel 43 Hotel + Retail/ Dining/ Entertainment (iv) (Planned ASR from 2020 onwards)		16.5	4.0	13	2020	See Note (vi)
732	P43h-2			20.5	8.0			
733	P43h-3			24.5	12.0			
734	P43h-4			28.5	16.0			
735	P43h-5			32.5	20.0			
736	P43h-6			42.5	30.0			
737	P43h-7			52.5	40.0			
738	P43i-1	Parcel 43 Hotel + Retail/ Dining/ Entertainment (iv) (Planned ASR from 2020 onwards)		16.5	4.0	13	2020	See Note (vi)
739	P43i-2			20.5	8.0			
740	P43i-3			24.5	12.0			
741	P43i-4			28.5	16.0			
742	P43i-5			32.5	20.0			
743	P43i-6			42.5	30.0			
744	P43j-1	Parcel 43 Hotel + Retail/ Dining/ Entertainment (iv) (Planned ASR		16.5	4.0	13	2020	See Note (vi)
745	P43j-2			20.5	8.0			
746	P43j-3			24.5	12.0			
747	P43j-4			28.5	16.0			
748	P43j-5			32.5	20.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
		from 2020 onwards)						
749	P43k-1	Parcel 43 Hotel + Retail/ Dining/ Entertainment (iv) (Planned ASR from 2020 onwards)		16.5	4.0	13	2020	See Note (vi)
750	P43k-2			20.5	8.0			
751	P43k-3			24.5	12.0			
752	P43k-4			28.5	16.0			
753	P46a-1	Parcel 46 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)	N/A	16.4	4.0	5	2020	See Note (vi)
754	P46a-2			20.4	8.0			
755	P46a-3			24.4	12.0			
755	P46a-4			28.4	16.0			
756	P46a-5			32.4	20.0			
757	P46a-6			42.4	30.0			
758	P46b-1	Parcel 46 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)		16.4	4.0	5	2020	See Note (vi)
759	P46b-2			20.4	8.0			
760	P46b-3			24.4	12.0			
761	P46b-4			28.4	16.0			
762	P46b-5			32.4	20.0			
763	P46b-6			42.4	30.0			
764	P46c-1	Parcel 46 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)		16.4	4.0	5	2020	See Note (vi)
765	P46c-2			20.4	8.0			
766	P46c-3			24.4	12.0			
767	P46c-4			28.4	16.0			
768	P46c-5			32.4	20.0			
769	P46c-6			42.4	30.0			
770	P46d-1	Parcel 46 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)		16.4	4.0	5	2020	See Note (vi)
771	P46d-2			20.4	8.0			
772	P46d-3			24.4	12.0			
773	P46d-4			28.4	16.0			
774	P46d-5			32.4	20.0			
775	P46d-6			42.4	30.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
776	P46e-1	Parcel 46 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)		42.4	30.0	5	2020	
777	P50-1	Parcel 50 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2020 onwards)	N/A	9.0	4.0	NA	2020	See Note (vi)
778	P50-2			13.0	8.0			
779	P50-3			17.0	12.0			
780	P50-4			21.0	16.0			
781	P50-5			25.0	20.0			
782	P51-1	Parcel 51 Freespace (Planned ASR from 2016 onwards)	N/A	9.0	4.0	NA	2016 – 2020	See Note (vi)
783	P51-2			13.0	8.0			
784	P51-3			17.0	12.0			
785	P51-4			21.0	16.0			
786	P51-5			25.0	20.0			
787	P52-1	Parcel 52 Pavilion (iv) (Planned ASR from 2016 onwards)	N/A	9.0	4.0	2	2016 – 2020	See Note (vi)
788	P52-2			13.0	8.0			
789	P52-3			17.0	12.0			
790	P52-4			21.0	16.0			
791	P52-5			25.0	20.0			
792	P53-1	Parcel 53 Pavilion (iv) (Planned ASR from 2014 onwards)	N/A	9.0	4.0	2	2014 – 2020	See Note (vi)
793	P53-2			13.0	8.0			
794	P53-3			17.0	12.0			
795	P53-4			21.0	16.0			
796	P53-5			25.0	20.0			
797	P54-1	Parcel 54 Planned Performance Art Venues within WKCD (iv) (Planned ASR from 2017 onwards)	N/A	9.0	4.0	1	2017 – 2020	See Note (vi)
798	P54-2			13.0	8.0			
799	P54-3			17.0	12.0			
800	P54-4			21.0	16.0			
801	P54-5			25.0	20.0			

No.	ASR	Description	Horizontal distance from WKCD site boundary (m)	Height (mPD)	Height above ground (m)	No. of storeys	Year subject to construction phase impact	Notes
802	OP	Open space (Planned ASR from 2017 onwards)	N/A	6.5	1.5	0	2017-2020	

Notes (i) Estimated locations of the fresh air takes of these developments are taken as the ASRs.

(ii) The locations and no. of storeys of the planned ASRs representing the topside development at West Kowloon Terminus (WKT) Site A are based on the approved EIA for Hong Kong Section of the Guangzhou – Shenzhen – Hong Kong Express Rail Link (XRL).

(iii) According to the approved EIA for Road Works at West Kowloon, these planned ASRs will be occupied upon completion of construction of the Road Works at West Kowloon project in 2014.

(iv) The planned ASRs represent the indicative fresh air intake locations of these planned developments.

(v) Selected assessment height is the indicative location of fresh air intake at podium level.

(vi) The planned ASRs at 4m above ground level are assessment points for reference only, but are not fresh air intake or openable window locations.

3.4 Identification of Pollution Sources

3.4.1 Background Air Quality

The WKCD is located on the Kowloon Peninsula and is surrounded by the sea on two of its four sides. In accordance with the *Guidelines in Assessing the 'TOTAL' Air Quality Impacts*, WKCD is categorised as an urban area. There is no EPD general air quality monitoring station located in this area, the recent five years (2007 –2011) annual average monitoring data recorded at five of EPD's general air quality monitoring stations in urban areas is used to estimate the background TSP concentration. Using this average allows for the harbour setting of the site to be considered and provides more representative estimation of the background concentrations than by using any one station only.

With reference to EPD's *Air Quality Annual Report*, the EPD's general air quality monitoring stations in urban areas that can be considered as an indication of the background concentration include Central/Western, Kwun Tong, Sham Shui Po, Tsuen Wan and Kwai Chung. The average TSP concentration of all these five monitoring stations is detailed in **Table 3.4**

Table 3.4: Average Background TSP Concentrations from EPD's Urban Air Monitoring Stations (Year 2007-2011)

Urban Stations	Distance from WKCD Boundary (km)	Annual Average TSP Concentration (µg/m^3)					5-year Average Concentration (µg/m^3)
		2007	2008	2009	2010	2011	
Tsuen Wan	8.65	79	67	63	63	69	68.2
Kwai Chung	6.46	**85**	79	70	71	71	75.2
Sham Shui Po	2.83	79	**81**	77	76	79	78.4
Kwun Tong	6.10	**82**	72	70	67	74	73.0
Central	1.91	77	78	73	76	78	76.4

/Western		
	Average	74.2

Note: Monitoring results that exceeded AQO are shown in bold characters.

Dust monitoring has been undertaken in the vicinity of the proposed West Kowloon Terminus (WKT) from March 2010 to December 2012 inclusive as part of the environmental monitoring and audit (EM&A) works for XRL project. The air monitoring stations considered to be most relevant to WKCD are AM16 and AM17, as both stations are in close proximity to the WKCD site (see **Figure 3.2**). The annual average TSP concentration during that construction period of WKT has been calculated, as shown in **Table 3.5** (see **Appendix 3.27** for details).

Table 3.5: Air Quality Monitoring Results for Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link relevant to WKCD (March 2010 – December 2012)

Monitoring Station	Location	Annual Average TSP Concentration (μg/m^3)			3-year Average Concentration (μg/m^3)
		2010$^{(1)}$	2011	2012	
AM16	Tower 3, The Waterfront	74.2	73.4	54.3	67.1
AM17	The Victoria Towers	74.7	79.3	55.5	69.7
				Average	68.4

Note: (1) Monitoring results from March 2010 to December 2010.

As the air quality monitoring stations AM16 and AM17 border the XRL site boundary, it is reasonable to assume that the average TSP concentration of these two stations can represent XRL generated dust concentrations plus prevailing background dust concentrations at the WKCD area. While the 5-year average TSP concentration in urban areas as obtained from EPD's urban air quality monitoring stations (74.2 μg/m^3 from **Table 3.4**) is comparable to that from the XRL data (68.4 μg/m^3 from **Table 3.5**), it is considered that using the XRL monitoring data is a more reasonable estimate for the WKCD TSP assessment. This is because there is a sufficient amount of XRL data (about 3 years' data) and the XRL monitoring stations are in close proximity to the WKCD site whereas the EPD's monitoring stations are at much larger distances (1.91 km to 8.65 km) from the site.

Operational air quality contaminants of significance to the Project area include: SO_2, from marine; NO_2, from vehicles and marine; and RSP, from vehicles and marine. The 5-year average concentrations for these pollutants are detailed in **Table 3.6**.

Table 3.6: Average Background Air Pollutant Concentrations from EPD's Urban Air Monitoring Stations (Year 2007-2011)

Pollutant	Urban Stations and 5-year Average Concentration (μg/m^3)					AQO criteria (μg/m^3)	5-year Average Concentration (μg/m^3)
	Tsuen Wan	Kwai Chung	Sham Shui Po	Kwun Tong	Central/ Western		
Sulfur Dioxide (SO_2)	19.8	24.4	17.4	13.8	17.6	80	18.6
Nitrogen Dioxide (NO_2)	63.2	64.6	68.4	60.4	52.8	80	61.9
Respirable Suspended Particulate (RSP/PM_{10})	51.2	50.4	51.2	48.8	49.6	55	50.2

In addition to the urban air quality monitoring stations, EPD had operated a local air quality monitoring station at the WKCD site to record background air pollutant concentrations from September 2011 to August 2012. Although the monitoring data is only for a single year, the recorded information is useful as a direct indication of the onsite air quality. **Table 3.7** shows the background air quality data for the WKCD site for 2011-2012 (see details in **Appendix 3.20)**.

Table 3.7: Average Background Air Pollutant Concentrations from EPD's Local Monitoring Station at WKCD Site (September 2011 – August 2012)

Pollutant	Annual Average Concentration (µg/m^3)	AQO criteria (µg/m^3)
Sulfur Dioxide (SO_2)	11.4	80
Nitrogen Dioxide (NO_2)	46.7	80
Respirable Suspended Particulate (RSP/PM_{10})	45.0	55

By comparing the EPD's onsite monitoring results at WKCD with the 5-year average from the urban monitoring stations, it can be seen that the onsite monitoring results are significantly lower – approximately 39% lower for SO_2, 25% lower for NO_2, and 10% lower for RSP.

The future background air pollutant concentrations to be used for predicting the total air quality impact due to operational phase for NO_2, RSP and SO_2 are as extracted from the PATH model (for year 2015) released by EPD in December 2012.

The New Yau Ma Tei Typhoon Shelter (NYMTTS) is located adjacent to the north of the WKCD site. Due to its proximity, any odour emissions from NYMTTS could potentially affect the future development of WKCD. Based on the information provided by EPD, the number of odour complaints against NYMTTS received by EPD from 2006 to 2013 are as summarised in **Table 3.8**.

Table 3.8: Number of Odour Complaints against NYMTTS Received by EPD (2006-2013)

Year	No. of Odour Complaints against NYMTTS
2006	1
2007	3
2008	Nil
2009	Nil
2010	2 (not including a complaint against suspected malodour from ships)
2011	Nil
2012	Nil
2013 (till 28 April 2013)	Nil

The locations where the above complaints were lodged are as shown in Figure 1 in **Appendix 3.26a**. It can be seen from the above that:

- There were only one to three odour complaints against NYMTTS per year in 2006, 2007 and 2010, and none in 2008, 2009, 2011, 2012 and 2013 (up to April 2013).

- The few complaints were lodged from residents located on the north end of NYMTTS; these locations are over 1,500 m from the WKCD site boundary. In other words, no complaints were received from occupants within the 500 m assessment area of the WKCD site in the past seven years.

An odour patrol along the watercourse boundary of the NYMTTS was carried out in March 2011 to identify any malodour. The odour patrol route and the patrol results are documented in **Appendix 3.26a**. According to the odour patrol, malodour was only detected surrounding the northern portion of the boundary of NYMTTS, i.e., along the route from P2 to P3 in Figure 1 in **Appendix 3.26a** whereas no malodour was detected along the patrol route from P1 to P2.

3.4.2 Construction Phase

Construction of the WKCD facilities will be carried out in phases, with construction of Phase 1 aimed at commencement in 2013 for completion in 2020 (see **Appendix 2.4** for the tentative construction programme). During construction, the major activities that would generate construction dust emissions include the following:

- Excavation activities;
- Foundation works;
- Concrete batching plant and barging points (assumed to be handed over from the XRL project to WKCD);
- Site Formation, and;
- Movement of mobile plant and vehicles on haul roads.

Based on a review of the construction methods adopted for the WKCD Project, construction dust will be potentially generated from the aforementioned land-based construction activities and is therefore identified as the representative pollutants. Therefore, it is considered appropriate to adopt total suspended particulate (TSP) as the key pollutant during the construction phase. According to the *"2011 Hong Kong Emission Inventory Report"* published by EPD[1] in March 2013, which is the latest available information at the time of preparing this Report, the top 3 major sources of RSP include navigation, road transport and public electricity generation, which collectively accounted for about 72% of the total RSP emission in 2011 whereas non-combustion sources only constituted about 15% of the total emission. Since construction dust is only one of the various non-combustion sources, it is considered that RSP would not be a representative pollutant of construction dust.

Construction of the critical elements of WKCD is scheduled to begin in 2013. Due to construction of concurrent projects in the vicinity, cumulative impacts are expected. **Table 3.9** summarises the concurrent projects that may contribute to cumulative construction dust impacts.

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[1] http://www.epd.gov.hk/epd/english/environmentinhk/air/data/files/2011HKEIReport.pdf

Table 3.9: Summary of concurrent projects during construction phase

Project	Construction Period	Possible Cumulative Impact	Included in Cumulative Impact Assessment
Hong Kong Section of the Guangzhou – Shenzhen – Hong Kong Express Rail Link (XRL)	Jan 2010 – 2015	Dust emissions from construction of the West Kowloon Terminus and operation of the concrete batching plant and barging points	Yes
Road Works at West Kowloon	2011 – 2014	According to the EIA, major dusty construction activities and excavation works are to be completed by March 2012. Minor dust emissions may arise from the remaining road works and movement of mobile plant and vehicles	No
Road Improvement Works in West Kowloon Reclamation Development – Phase I	Late 2013 / early 2014 – end 2015	Dust emissions from the roadworks construction and movement of mobile plant and vehicles	Yes
Central Kowloon Route	2015 – end 2020	Dust emissions from construction works.	Yes

As an updated schedule of construction works for the WKT of the XRL project is not available for 2013-2015, it is not possible to incorporate realistic dust emission sources of WKT into the FDM model for assessment of cumulative impacts. As such, relevant EM&A monitoring data of the XRL project is used to assess the potential cumulative impacts as described **Section 3.4.1**.

With reference to the dust monitoring results from the two air quality monitoring stations (AM16 and AM17) in the vicinity of the WKCD site from March 2010 to December 2012 inclusive, the average TSP concentration during that construction period of WKT has been calculated, as shown in **Appendix 3.27**. It is reasonable to assume that the average TSP concentration from these two dust monitoring stations can represent XRL generated dust concentrations plus prevailing background dust concentrations at the WKCD area. The background concentration used for the TSP assessment for WKCD is therefore taken as 68.4 µg/m^3 (**Table 3.5**).

For the Central Kowloon Route (CKR) project, its construction dust impact assessment area overlaps part of the corresponding assessment area for WKCD. Therefore, the relevant TSP modelling results from the published EIA of CKR project have been added to those of the WKCD for ASRs that are within the overlapped portion of both assessment areas in order to assess the cumulative effects.

3.4.3 Operation Phase – Vehicular Emissions

During the operation phase, there will be cumulative air quality impacts on the ASRs due to vehicular emissions from:

- Existing and proposed open roads outside the WKCD area but within the 500 m assessment area;
- Proposed underpasses/landscape decks along the Austin Road West and Lin Cheung Road and the associated top openings under the Road Works at West Kowloon project, which is within the 500 m assessment area;
- Portal of the existing Western Harbour Crossing (WHC) which is in the vicinity of the WKCD site, and;

- Ventilation exhausts and portals serving the planned underground roads within the WKCD area.

It should be noted that all of the above vehicular emission sources, except the planned underground roads within WKCD, are due to the current and planned road networks serving the West Kowloon area. Therefore, it is anticipated that the WKCD development itself would only have a relatively small contribution to the total vehicular emissions in the area. On the contrary, the WKCD development would be subject to potential air quality impacts that are largely generated by the existing/planned road traffic in the area.

The air quality inside the WKCD basement where the underground vehicle roads are located should meet the air pollutant standards as recommended by the EPD's *Practice Note on Control of Air Pollution in Vehicle Tunnels* (see **Table 3.2**). Therefore, the basement ventilation system should be properly designed by WKCDA's consultant/engineer to adequately remove or dilute vehicle emissions and the basement air quality should be monitored to ensure compliance with the relevant air quality standards.

3.4.4 Operation Phase – Marine Traffic Emissions

There are existing marine activities within the 500 m assessment area, which include:

- Fast ferry traffic movements, based on scheduled sailings of up to 170 daily movements (ferry going to is one movement, ferry leaving is a second movement) at the China Ferry Terminal;
- Tugs associated with Derrick lighter barge movements in the NYMTTS;
- Derrick lighter barges operating at the New Yau Ma Tei Public Cargo Working Area (NYPCWA), and;
- Ocean Cruise Ship berthing at the Ocean Terminal.

Although emissions from all the above current marine activities are not attributable to the WKCD development, the development itself would be subject to potential air quality impacts caused by such marine emissions.

Under the current development of marine traffic planning at the WKCD site, it is intended that marine services at WKCD will primarily be provided for visitor or leisure activities. In terms of traffic volume, the support on the need of the possible piers has been a key outcome from the public consultation in view of general public's opinions and needs. No precedence case or similar scale of development as the WKCD has been developed in the Victoria Harbour and therefore no realistic marine traffic forecast can be developed at this stage of the Project. However, as the possible piers would only be used by visitors or for leisure purposes without any planning for routine uses, it is anticipated that the marine traffic to be generated at the two possible piers would be insignificant when compared to the aforementioned existing marine activities. No vessel landing will be included at the optional viewing platform and for the proposed landing steps of WKCD, and therefore they are being designed as features of the development and will not serve any marine traffic.

3.4.5 Operation Phase – Odour Emissions

3.4.5.1 New Yau Ma Tei Typhoon Shelter

The NYMTTS is located adjacent to the north of the WKCD site. Due to its proximity, any odour emissions from NYMTTS could potentially affect the future development of WKCD. It should be noted that similar to the emissions from surrounding marine activities the WKCD development does not contribute to any odour emissions from NYMTTS. As the first step to identify such potential odour issues, the historical complaints against the odour from NYMTTS received by EPD have been reviewed (see **Section 3.4.1**). In addition, odour patrols and odour source monitoring were also conducted for NYMTTS, the results of which are presented in **Section 3.6.3**.

3.4.5.2 Optional Waste and Wastewater Facilities

The air quality impacts due to potential odour emissions from the optional automatic waste collection facility has been reviewed and assessed in a qualitative manner.

3.4.6 Operation Phase – Industrial Emissions

Chimney survey and desktop study have been conducted to identify any existing or planned chimneys of industrial operations within the 500m assessment area. Based on the survey and desktop study findings, no existing or planned chimneys were identified within the assessment area.

3.4.7 Operation Phase – Identification of Key Air Pollutants of Concern

As presented in **Section 3.2.2**, under the APCO, AQOs are stipulated for seven criteria air pollutants, namely, nitrogen dioxide (NO_2), sulphur dioxide (SO_2), total suspended particulates (TSP), respirable suspended particulates (RSP), carbon monoxide (CO), ozone and lead. As identified in **Sections 3.4.3** and **3.4.4**, during the operation phase, the WKCD development would be subject to potential air quality impacts due to emissions from the road traffic within and in the vicinity of WKCD as well as the surrounding marine traffic/vessels. Each of the seven criteria pollutants has been reviewed for its relevance to such major air pollution sources of the Project as follows.

Nitrogen Dioxide (NO_2)

According to the *"2011 Hong Kong Emission Inventory Report"* published by EPD in March 2013, navigation and road transport are the top two major sources of nitrogen oxides (NO_x) generated in Hong Kong, constituting respectively about 33% and 29% of the total NO_x emission in 2011. NO_x would be transformed to NO_2 in the presence of O_3 under sunlight. As summarised in **Table 3.6**, the latest 5-year average of the annual NO_2 concentration in the urban areas (i.e., Tsuen Wan, Kwai Chung, Sham Shui Po, Kwun Tung and Central/Western) is about 77% of the corresponding AQO. Therefore, NO_2 has been identified as a key air pollutant of the emissions from both road traffic and marine traffic/vessels, and has been assessed against the relevant AQOs for this Project.

Respirable Suspended Particulates (RSP)

According to the latest statistics of *"2011 Hong Kong Emission Inventory Report"*, navigation and road transport are the top two major sources of RSP in Hong Kong, accounting for respectively about 37% and 19% of the total RSP emissions in 2011. As summarised in **Table 3.6**, the latest 5-year average of the annual RSP concentration in the urban area is about 91% of the corresponding AQO. Therefore, RSP has been identified as a key air pollutant of the emissions from both road traffic and marine traffic/ vessels, and has been assessed against the relevant AQOs for this Project.

Sulphur Dioxide (SO_2)

According to the latest statistics of *"2011 Hong Kong Emission Inventory Report"*, 54% of total SO_2 emission in Hong Kong is attributed to navigation whereas only below 1% of the total emission is due to road transport. The introduction of ultra low sulphur diesel for vehicle fleet in 2000 has also helped reducing the SO_2 emission from road transport in Hong Kong. As summarised in **Table 3.6**, the latest 5-year average of the annual SO_2 concentration in the urban area is about 23% of the corresponding AQO. While the 5-year average SO_2 level appears to be well below the relevant AQO with a large margin, a number of the future ASRs within WKCD (such as those at Parcels 02, 03, 10, 11, 13, 15, etc.) are close to the potential marine traffic emission sources from the ferry/cruise ship terminals. Therefore, SO_2 has been identified as a key air pollutant of the emissions from marine traffic/vessels (but not from road transport), and has been assessed against the relevant AQOs for this Project.

Ozone

According to the *"Air Quality in Hong Kong 2011"* published by EPD[2], ozone is a major constituent of photochemical smog. It is not a pollutant directly emitted from man-made sources but formed by photochemical reactions of primary pollutants such as NO_x and volatile organic compounds (VOCs) under sunlight. As it takes several hours for these photochemical reactions to take place, ozone recorded in one place could be attributed to VOC and NO_x emissions from places afar. Hence, ozone is a regional air pollution problem. In other words, unlike such air pollutants as NO_x, RSP and SO_2, ozone is not a pollutant directly attributable to emissions from nearby marine or road traffic. As a result, ozone is not identified as a key air pollutant for air quality impact assessment for this Project, though it is one of the criteria pollutants under the AQO.

Carbon Monoxide (CO)

According to the latest statistics of *"2011 Hong Kong Emission Inventory Report"*, road transport and navigation are the top two major sources of CO emissions in Hong Kong, contributing to respectively about 67% and 18% of the total CO emission in 2011. However, based on the *"Air Quality in Hong Kong 2012 Preliminary Report"* published by EPD[3], the highest 1-hour CO level and the highest 8-hour CO concentration in Mong Kok are respectively 3,590 µg/m^3 and 2,755 µg/m^3, which are only 12% and 28% of the corresponding AQO respectively. Given that the ambient CO levels are well below the relevant AQO with large margins as opposed to the other pollutants such as RSP and NO_2, it is considered appropriate to select RSP and NO_2, but not CO, as the key pollutants for air quality impact assessment against the AQO for this Project.

Lead

Since leaded petrol was banned in Hong Kong on 1 April 1999, it is no longer considered as a primary source in Hong Kong. According to the *"Air Quality in Hong Kong 2011"* published by EPD, the ambient lead concentrations continued to linger at very low levels during 2011 as in previous years, and the overall 3-month averages, ranging from 0.02 µg/m^3 (in Kwun Tong and Tung Chung) to 0.104 µg/m^3 (in Yuen

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[2] http://www.epd-asg.gov.hk/english/report/files/AQR2011e_final.pdf

[3] http://www.epd-asg.gov.hk/english/report/files/AQR2012_prelim_en.pdf

Long), were well below the AQO limit of 1.5 µg/m^3. Therefore, it is not considered as a key air pollutant for the operation phase air quality impact assessment.

Identified Key Air Pollutants

Based on the above review results, the following key air pollutants of concerns are identified for the purpose of air quality impact assessment during the operation phase of WKCD:

- For road traffic emissions – NO_2 and RSP; and
- For marine traffic/vessel emissions – SO_2, NO_2 and RSP.

3.5 Air Quality Modelling Methodology

3.5.1 Construction Phase

3.5.1.1 Introduction

To assess the construction phase through air quality modelling, use of the air quality model Fugitive Dust Model (FDM) was required. In accordance with the EPD's *Guidelines on Choice of Models and Model Parameters*, FDM was used to predict the air pollutant concentrations due to fugitive and open dust source impacts, which are shown in **Figures 3.3a to k** and **3.4a to f**. Details of the emission rates from the activities are given in **Appendices 3.1** to **3.3**.

3.5.1.2 Model Description – FDM

FDM is a computerised air quality model specifically designed for computing the concentration and deposition impacts from fugitive dust sources. The model is generally based on the well-known Gaussian Plume formulation for computing concentrations, but the model has been specifically adapted to incorporate an improved gradient transfer deposition algorithm. FDM is one of the air quality models listed as commonly used for EIA studies by EPD in *Guidelines on Choice of Models and Model Parameters.*

It should be noted that FDM and all Gaussian based dispersion models have limited ability to predict dispersion in the following situations[4]:

- Causality effects

  Gaussian plume models assume pollutant material is transported in a straight line instantly (like a beam of light) to receptors that may be several hours or more in transport time away from the source. The model takes no account for the fact that the wind may only be blowing at 1 m/s and will have only travelled 3.6 km in the first hour. This means that Gaussian models cannot account for causality effects, where the plume may meander across the terrain as the wind speed or direction changes. This effect is not considered to be significant for the WKCD site as the site is small.

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[4] *Good Practice Guide for Atmospheric Dispersion Modelling.* Ministry for the Environment, New Zealand (June 2004)

- Low wind speeds

  Gaussian-plume models 'break down' during low wind speed or calm conditions due to the inverse speed dependence of the steady state plume equation. These models usually set a minimum wind speed of 0.5 m/s or 1.0 m/s and ignore or overwrite data below this limit.

- Straight-line trajectories

  Gaussian models will typically overestimate terrain impingement effects during stable conditions because they do not account for turning or rising wind caused by the terrain itself. This effect is not considered to be important for WKCD as the site and surrounding terrain is flat.

- Spatially uniform meteorological conditions

  Gaussian models assume that the atmosphere is uniform across the entire modelling domain, and that transport and dispersion conditions exist unchanged long enough for the material to reach the receptor even if this is several kilometres away. In the atmosphere, truly uniform conditions rarely occur. As the WKCD site and surrounding assessment area is sufficiently small with no significant terrain features, uniform meteorological conditions are considered appropriate.

- No memory of previous hour's emissions

  In calculating each hour's ground-level concentrations, Gaussian models have no memory of the contaminants released during the previous hours. This limitation is especially important for the proper simulation of morning inversion break-up, fumigation and diurnal recycling of pollutants.

3.5.1.3 Assumptions and Inputs – FDM

During the construction stage, the study area will not have many tall buildings. As such, the *"Guideline on Air Quality model (revised), EPA - 450/2-78-027R, July 1986"* is used to calculate the roughness length for use in FDM.

The EPD guideline on *"Choice of Models and Model Parameters"* states: the selection of rural or urban dispersion coefficients in a specific application should follow a land use classification procedure. If the land use types including industrial, commercial and residential uses account for 50% or more of an area within a 3 km radius from the source, the site is classified as urban; otherwise it is classified as rural. The surface roughness height is closely related to the land use characteristics of a study area and associated with the roughness element height. As a first approximation, the surface roughness can be estimated as 3 to 10 percent of the average height of physical structures. Typical values used for urban and new development areas are 370 cm and 100 cm, respectively.

Within a three kilometre radius of the site 55% is classified as urban and the remaining 45% is sea. As the sea roughness is typically given a value of 0.01 cm and urban is assumed to be 370 cm, an area averaged roughness height of 205 cm is used. This is to take account of the low turbulence over the sea water, and also the very large turbulence generated due to nearby large structures.

Hourly meteorological data for a full year as extracted from the PATH model released by EPD in December 2012 (meteorological data year 2010, grid 28, 27) has been adopted for use in the FDM. The data is considered to be the most up to date data available. PATH data has been observed to have a lower mixing height for some hours, when compared to the measured mixing height. The minimum mixing height recorded by HKO in 2010 is 121.3 m, whereas the PATH minimum mixing height is 40 m. The HKO minimum mixing height of 121.3 m is used to replace any PATH mixing height below this value. This approach is considered appropriate as it will minimise over-estimation due to lower mixing heights and also will minimise under-estimation due to high stacks being excluded in the mixing volume. The PATH data with the above modification is considered to be representative of the site wind data at WKCD.

Prediction of dust emissions is based on emissions factors from the *Compilation of Air Pollution Emission Factors (AP-42), 5th Edition* published by the US Environmental Protection Agency (USEPA). The emission factor for a typical heavy construction activity is 2.69 megagrams (Mg)/hectare/month according to *Section 13.2.3.3* of *AP-42*. The number of working days for a month and number of working hours per day of the project are anticipated to be 26 days and 12 hours respectively. No construction work is anticipated to be carried out on Sundays. Based on *Table 11.9-4* of *AP-42*, the emission factor of wind erosion is 0.85 megagrams (Mg)/hectare/year. The locations of assumed dust sources are given in **Figures 3.3a** to **3.3k**. The key dust emission factors adopted in FDM are summarised in **Table** 3.10**.**

Table 3.10: Key Dust Emission Factors Adopted in the Assessment

Activities	Emission Factors	Reference
Heavy construction activities including all above ground and open construction works, excavation and slope cutting works	2.69 Mg/hectare/month	Section 13.2.3.3 AP-42, 5th Edition
Wind erosion from heavy construction	0.85 Mg/hectare/year	Table 11.9-4 AP-42, 5th Edition
Paved haul road within concrete batching plant	Emission Factor = $k \times (sL)^{0.91} \times (W)^{1.02}$ g/VKT where k is particle size multiplier ***** sL is road surface silt loading W is average truck weight	Section 13.2.1 AP-42, 5th Edition (Jan 2011 edition)

* The particle size distribution was made reference to Section 13.2.1(Table 13.2.1-1) of the USEPA Compilation of Air Pollution Emission Factors (AP-42), 5th Edition (Jan 2011 edition).

For the mitigated scenario, the active construction areas have ground watering applied once per hour or 12 times per day. This gives rise to dust suppression of 91.7%, as estimated in **Appendix 3.8***.* The unmitigated scenario does not employ any watering for dust suppression.

For the concrete batching plant, it is assumed that the plant will be handed over from the XRL project to the WKCD Project, and therefore the emissions from the plant will be the same as those given in the approved EIA for XRL. All assumptions and calculations are extracted from the Specified Process (SP) License issued to the XRL for the concrete batching plant. The concrete batching plant and haul roads within the site are modelled as having operation hours of 12 hours per day, that is, from 7:00 am to 7:00 pm.

No stockpile is modelled as excavated material is anticipated to be transported out of the site immediately after generation. Barging points are assumed to be handed over from the XRL project to the WKCD

Project, and therefore the emissions from the plant will be the same as those given in the approved EIA for XRL.

The emission inventory and calculation of emission factors for the construction activities are detailed in **Appendices 3.1 to 3.3.**

With addition of the average background TSP concentration of two monitoring stations as described in **Section 3.4.1**, i.e., 68.4 µg/m^3, the hourly, daily and annual TSP concentrations at the identified ASRs have been predicted and compared with the hourly, daily and annual average TSP criteria of 500 µg/m^3, 260 µg/m^3 and 80 µg/m^3 respectively.

3.5.1.4 Methodology – FDM

Construction on the WKCD site is to be completed in stages; as such the FDM assessment has been completed for each construction year from 2013 to 2020, when the majority of the site works and superstructures are expected to be completed.

For hourly and daily TSP, a tiered modelling approach has been adopted. Tier 1 assumes 100% active area for a given year is emitting TSP. This Tier 1 scenario (i.e. assuming 100% active area for the WKCD Project and the concurrent project) is hypothetical and for screening purposes to identify which ASRs may be subject to TSP concentrations above the relevant standards. For the purpose of the Tier 1 screening, the dust mitigation measures, including frequent water spraying, as detailed in **Section 3.5.1.3**, are taken into account when estimating the dust emission rates from the construction activities. Details of the Tier 1 dust sources including their coordinates, dimensions and estimated emission rates are detailed in **Appendix 3.4**. Locations of the assumed dust sources for the Tier 1 assessment are shown in **Figures 3.3a** to **3.3k**. The Tier 1 hourly and daily TSP levels at all the ASRs are then predicted for both scenarios of with and without the dust mitigation measures in place.

The ASRs identified with hourly or daily TSP non-compliance under Tier 1 screening, where mitigation measures are in place, are selected for the subsequent Tier 2 assessment.

The entire works area is broken into a number of zones for construction timetabling purposes. Based on the assumed construction plant inventory of individual zones and planned construction activities for each year, the percentage active areas for different zones are calculated, as summarised in **Table 3.11**. The maximum percentage active area for each year is taken from all zones and applied to the entire site.

It is assumed in the Tier 2 assessment that the maximum percentage active area of the WKCD site for each zone, and the corresponding active areas of the relevant concurrent project, would be located closest to the ASR being assessed. The Tier 2 hourly or daily TSP levels at each of these ASRs are predicted with the dust mitigation measures in place.

Under normal circumstances, construction activities for the proposed Project and the concurrent projects would likely spread over the whole work sites and zones. As such, the maximum percentage active area calculated from all zones, applied to the entire WKCD site, and the corresponding active areas of the relevant concurrent project to be located closest to a particular ASR at any one time during the Tier 2 assessment is a conservative approach. Details of the Tier 2 dust sources including their coordinates, dimensions and estimated emission rates are given in **Appendix 3.5**. Locations of the assumed dust sources for Tier 2 assessment are shown in **Figures 3.4a** to **3.4f**.

For the assessment of annual TSP concentrations, the active work area over the entire year would be less than that for a typical working hour or a typical working day. The percentage active area averaged over each construction year has been estimated for each zone as summarised in **Table 3.11**. The annual TSP assessment is based on the percentage active areas for individual zones. The annual TSP levels are predicted at all the ASRs for both scenarios of with and without the dust mitigation measures in place. Details of the dust sources for annual TSP assessment including their coordinates, dimensions and estimated emission rates are given in **Appendix 3.6**. Locations of assumed dust sources for annual assessment are shown in **Figures 3.3a** to **3.3k**.

Based on project-specific information, the percentages of active work areas for heavy construction activities for hourly, daily and annual TSP assessment have been estimated and are summarised in **Table 3.11**. Detailed estimation of the percentages of active work areas are provided in **Appendix 3.7**.

Table 3.11: Summary of tentative active area calculations for Tier 2 and Annual TSP assessment

Construction Year	Zone	Percentage Active Area		
		Hourly	Daily	Annually
2013	1	47.1%	47.1%	18.4%
	2a	0.0%	0.0%	0.0%
	2b	17.8%	17.8%	6.1%
	3	21.1%	21.1%	3.5%
	4	0.0%	0.0%	0.0%
	5	0.0%	0.0%	0.0%
	The Park (A, B, C)	1.4%	1.4%	0.8%
	Maximum	**47.1%**	**47.1%**	**18.4%**
2014	1	3.7%	3.7%	1.3%
	2a	66.1%	66.1%	44.6%
	2b	13.4%	13.4%	9.0%
	3	16.1%	16.1%	9.6%
	4	0.0%	0.0%	0.0%
	5	0.0%	0.0%	0.0%
	The Park (A, B, C)	9.9%	9.9%	9.9%
	Maximum	**66.1%**	**66.1%**	**44.6%**
2015	1	0.9%	0.9%	0.8%
	2a	6.5%	6.5%	5.7%
	2b	4.5%	4.5%	3.9%
	3	5.1%	5.1%	2.2%
	4	0.0%	0.0%	0.0%
	5	0.0%	0.0%	0.0%
	The Park (A, B, C)	0.3%	0.3%	0.3%

Construction Year	Zone	Percentage Active Area		
		Hourly	Daily	Annually
	Maximum	**6.5%**	**6.5%**	**5.7%**
2016	1	0.6%	0.6%	0.6%
	2a	1.3%	1.3%	0.7%
	2b	0.6%	0.6%	0.3%
	3	0.2%	0.2%	0.2%
	4	22.9%	22.9%	16.7%
	5	0.0%	0.0%	0.0%
	The Park (A, B, C)	0.5%	0.5%	0.5%
	Maximum	**22.9%**	**22.9%**	**16.7%**
2017	1	0.0%	0.0%	0.0%
	2a	3.2%	3.2%	3.2%
	2b	0.7%	0.7%	0.7%
	3	0.2%	0.2%	0.2%
	4	13.0%	13.0%	3.7%
	5	3.1%	3.1%	1.8%
	The Park (A, B, C)	2.4%	2.4%	1.6%
	Maximum	**13.0%**	**13.0%**	**3.7%**
2018	1	0.0%	0.0%	0.0%
	2a	6.2%	6.2%	6.2%
	2b	1.4%	1.4%	1.4%
	3	0.2%	0.2%	0.2%
	4	1.9%	1.9%	1.9%
	5	1.8%	1.8%	1.1%
	The Park (A, B, C)	1.5%	1.5%	1.5%
	Maximum	**6.2%**	**6.2%**	**6.2%**
2019	1	0.0%	0.0%	0.0%
	2a	0.0%	0.0%	0.0%
	2b	1.4%	1.4%	1.4%
	3	0.0%	0.0%	0.0%
	4	1.9%	1.9%	1.9%
	5	0.4%	0.4%	0.4%
	The Park (A, B, C)	1.5%	1.5%	0.6%
	Maximum	**1.9%**	**1.9%**	**1.9%**
2020	1	0.0%	0.0%	0.0%
	2a	0.0%	0.0%	0.0%
	2b	1.4%	1.4%	1.2%
	3	0.0%	0.0%	0.0%
	4	0.8%	0.8%	0.3%
	5	0.4%	0.4%	0.2%

Construction Year	Zone	Percentage Active Area		
		Hourly	Daily	Annually
	The Park (A, B, C)	0.0%	0.0%	0.0%
	Maximum	**1.4%**	**1.4%**	**1.2%**

Note: (a) The Tier 2 assessment for hourly and daily TSP uses the maximum percentage active area for all zones.
(b) The assessment of annual TSP uses zone specific percentage active area.

3.5.2 Operation Phase – Vehicular Emissions

3.5.2.1 Introduction

To assess the operational air quality, a variety of models were required. In accordance with the EPD's *Guidelines on Choice of Models and Model Parameters*, the following air dispersion models have been employed to predict the cumulative NO_2 and RSP levels at the identified ASRs:

- EMFAC-HK V2.5.1 (I and M) model has been used to determine the fleet average emission factors, for all the planned and existing roads within the 500 m assessment area, including planned underpass roads within WKCD site, and the proposed Central Kowloon Route (CKR). The model has included the effect of Inspection and Maintenance (I/M) program and is applicable for calendar years between 2013 and 2040.
- CALINE4 has been used to predict the air pollutant concentrations due to vehicular emissions from all open road links within the 500 m assessment area, which are as shown in **Figures 3.5.1a** to **3.5.1y**.
- ISCST3 has been used to predict the air pollutant concentrations due to vehicular emissions from the Western Harbour Crossing (WHC) portal (modelled as volume sources); the proposed underpasses/landscape deck portals (modelled as volume sources) and the associated top openings (modelled as area source) under the Road Works at West Kowloon project; as well as from the assumed ventilation serving the planned underground roads within the WKCD site (modelled as volume or point sources). The locations of all such pollution sources are as shown in **Figure 3.6**.
- Pollutants in the Atmosphere and the Transport over Hong Kong (PATH) has been used to predict the current background air pollution due to sources outside the project boundary. Sources include, but are not limited to: the Pearl River Deltas Economic Zone (PRDEZ); the Hong Kong International Airport; power plants in HKSAR; roads beyond the WKCD, and; marine emissions. Background data predicted by PATH for year 2015 represents the worst case year relevant to the assessment of the Project.

The localised impacts due to the vehicle emissions within the 500 m assessment area of WKCD have been separately modelled by the near-field models (CALINE4 and ISCST3) in which the vehicular emission factors have been calculated from the EMFAC-HKV2.5.1 model.

The cumulative hourly maximum NO_x and RSP concentrations are predicted by the above models by using the corresponding MM5 hourly meteorological data in 2010 as extracted from the PATH model released by EPD in December 2012.

3.5.2.2 Model Description – EMFAC-HKV2.5.1

EMFAC-HKV2.5.1 is an emissions inventory model that calculates emissions inventories for motor vehicles operating on roads in Hong Kong. The model is used for estimating vehicular tailpipe emissions including RSP and NO_x. The model can take into account both vehicle technologies and driving conditions. The model follows that of the California Air Resources Boards' EMFAC model but with modifications to cater for local factors, including the substantial reduction of the smoky vehicle problem in recent years.

3.5.2.3 Assumptions and Inputs – EMFAC-HK

For all the planned and existing roads within the 500 m assessment area including those planned underpass roads within WKCD site and the proposed CKR, the EMFAC-HK V2.5.1 model (I and M), which is the latest version at the time of preparing this report, has been used to determine the fleet average emission factors.

The Burden mode, used for calculating area-specific emission factors, has been selected in the model. Under this mode, the total emissions of pollutants such as RSP and NO_x were computed for each type of vehicle class based on temperature, relative humidity, speed corrected emission factors and vehicle activity. Hourly output was selected.

The assumptions and input parameters on modelling of vehicle emission factors are presented in the following sections. The traffic data used for the assessment includes the hourly traffic flows of 16 vehicle classes at various road links and the speed fractions of various vehicle classes in four model years. The model years are: 2015 (the year when operation of the Project was originally planned to commence); intermediate years 2020 and 2025, and 2030 (15 years after commencement of operation of the Project). According to the recently updated Project programme (see **Appendix 2.4**), the planned commencement of operation of the Project has been changed to 2017. Despite the change, the EMFAC results as presented in **Graph 3.2** show that year 2015 represents the worst case scenario where the total traffic emission is the highest among all model years of 2015, 2020, 2025 and 2030. In other words, the total traffic emission in year 2017 when the Project is planned to commence operation is anticipated to be lower than that in year 2015. Therefore, use of the emission estimates in 2015 for air quality impact assessment is a conservative approach.

Traffic data is provided by the Traffic Consultant, and are presented in the following sections. The traffic forecast data has been submitted to the Transport Department (TD) for review. TD has no objection in principle to the traffic data. The correspondence from TD is provided in **Appendix 3.9** for reference. The 24-hour traffic patterns are given in **Appendix 3.10**.

Vehicle Emission Standards

The emission standards, according to the latest implementation programme (as of November 2012) have been adopted in EMFAC-HK V2.5.1 model for vehicles registered in Hong Kong. In this model, the latest European Union (EU) emission standard, Euro VI, for all vehicle classes can be applied, with the exception of motorcycles which do not have applicable new EU emission standards.

Road Grouping

The road links for assessment have been grouped into five types. Emission factors for the following five road types have been calculated:

Road Type 1 - Expressway (Design speed limit: 100kph);

Road Type 2 - Trunk Road (Design speed limit: 80kph);

Road Type 3 - Trunk Road (Design speed limit: 50kph);

Road Type 4 - Local Roads (Design speed limit: 50kph), and;

Road Type 5 - Trunk Road (Design speed limit: 70kph).

The five road types are characterised by continuous and interrupted flow with different design speed limits. It is assumed that there is continuous traffic flow in Expressway and Trunk Roads (Road Types 1, 2, 3 & 5), whereas there is interrupted flow in Local Roads (Road Type 4). The road type classification of individual road links in the assessment area are as shown in **Figures 3.5.1a** to **3.5.1y.** Road Type 5 is associated with the CKR and will not be present in 2015 or 2020, but will be present in 2025 and 2030, as CKR is anticipated to be in operation in 2021.

Vehicle Classes

Vehicles operating on open roads have been categorised into 16 vehicle classes according to the *Guideline on Modelling Vehicle Emission – Appendix I* for EMFAC-HK V2.5.1, and is presented in **Table 3.12**.

Table 3.12: Vehicle Classification in the EMFAC-HK Model

Index	Description	Notation in EMFAC-HK Model	Fuel Type	Gross Vehicle Weight
1	Private Cars (PC)	PC	ALL	ALL
3	Taxi	taxi	ALL	ALL
4	Light Goods Vehicles (<=2.5t)	LGV3	ALL	<=2.5ton
5	Light Goods Vehicles (2.5-3.5t)	LGV4	ALL	>2.5-3.5ton
6	Light Goods Vehicles (3.5-5.5t)	LGV6	ALL	>3.5ton
7	Medium & Heavy Goods Vehicles (5.5-15t)	HGV7	ALL	>5.5ton-15ton
8	Medium & Heavy Goods Vehicles (>=15t)	HGV8	ALL	>15ton
11	Public Light Buses	PLB	ALL	ALL
12	Private Light Buses (<=3.5t)	PV4	ALL	<=3.5ton
13	Private Light Buses (>3.5t)	PV5	ALL	>3.5ton
14	Non-franchised Buses (<6.4t)	NFB6	ALL	<=6.4ton
15	Non-franchised Buses (6.4-15t)	NFB7	ALL	>6.4ton – 15ton
16	Non-franchised Buses (>15t)	NFB8	ALL	<=15ton
17	Single Deck Franchised Buses	FBSD	ALL	ALL
18	Double Deck Franchised Buses	FBDD	ALL	ALL
19	Motor Cycles	MC	ALL	ALL

Exhaust / Evaporation Technology Fraction

Vehicle classes are grouped with different exhaust technology indexes and technology fractions. Each technology group represent a distinct emission control technologies. The EMFAC-HK V2.5.1 model has a set of default exhaust technology fractions which best represents the scheduled implementation of new vehicle emission standards as of November 2012. As there is no update to the planned emission control measures since the release of the guideline in November 2012, the default exhaust technology fractions are considered to be applicable in this assessment.

Vehicle Population

According to the *Guideline on Modelling Vehicle Emissions,* the vehicle population forecast function in EMFAC-HKV2.5.1 used 2010 as the base year. Natural replacement of vehicles and a set of annual growth rates and survival rates for different vehicles are assumed for 2011 to 2040. In particular, vehicles including private cars, motorcycles, and goods vehicles are assumed to grow by a varying percentage (from 0% - 2.5% annual) during the period whereas the number of franchised buses, public light buses and taxis are assumed to have no growth.

There have been some minor policy change from April 2012 to November 2012. The changes include moving two diesel taxis (TAXI) to the private car (PC) category and moving 4 LPG Private light buses (PV4) to the PV5 category. These changes, however, are considered to be insignificant and therefore have been excluded from the assessment. The default populations from the April 2012 population information have been adopted for the model years (2015, 2020, 2025, and 2030). The vehicle age distributions, in the base year 2010, are presented in **Appendix 3.11** for reference.

The use of electric vehicles (EVs), which do not have tailpipe emissions, has been promoted by the government in the recent years. By April 2012, there were more than 310 EVs in Hong Kong. The introduction of EVs will have an impact on the future vehicle fleet composition, although the effect is still unknown. Impacts will vary with policy in the future and the successful application of EVs as an alternative to the traditional vehicles. As a conservative approach, this assessment does not take into account the presence of EVs and any programme on the promotion of EVs.

Accrual Rate

Default values and compositions have been adopted with reference to in the EMFAC-HKV2.5.1 Guideline.

Diurnal Variation of Daily Vehicle Kilometres Travelled (VKT)

For each vehicle class, the Vehicle Kilometres Travelled (VKT) of individual hours is calculated by multiplying the hourly number of vehicles with the length of the corresponding road link (in kilometres). Diurnal (24-hour) traffic pattern has been provided by Traffic Consultant. The lengths of individual road links of the connecting road are given in **Appendix 3.12**. The 24-hour VKT values for all vehicle classes in each of the model years 2015, 2020, 2025 and 2030 together with a graphical plot, are provided in **Appendix 3.13**.

Daily Trips

The daily trips were used to estimate the cold start emissions of the petrol and LPG vehicles only, as is prescribed by the model. Therefore, trips for vehicles other than petrol or LPG type vehicles would be assumed to be zero. Different road types have different number of trips as follows.

Expressway and Trunk Road (Road Types 1, 2 & 3)

Zero trips are assumed in Expressway and Trunk Roads since there will be no cold start under normal circumstances.

Local Road (Road Type 4)

For Local Roads, the number of trips in the assessment area, $\text{Trip}_{\text{within assessment area}}$, has been estimated as:

$$\text{Trip}_{\text{within assessment area}} = (\text{Trip}_{\text{within HK}}/\text{VKT}_{\text{within HK}}) \times \text{VKT}_{\text{within assessment area}}$$

$\text{Trip}_{\text{within HK}}$ is the default data of EMFAC-HKV2.5.1 model. $\text{VKT}_{\text{within HK}}$ is the VKT of local roads in Hong Kong, which is estimated based on the default VKT data of EMFAC-HKV2.5.1 model and the relevant data as published in the *Annual Traffic Census 2010* by TD. Details of the trip estimation are as shown in **Appendix 3.14**. According to the Mobile Source Group of EPD, the default VKT and trips in the model are based on EPD's estimated data for Hong Kong. $\text{VKT}_{\text{within assessment area}}$ is calculated as mentioned above. The trips in each year are provided in **Appendix 3.13**.

While the number of trips is dependent on vehicle population, no project-specific vehicle population data can be identified for the assessment area according to the Traffic Consultants. However, project-specific VKT has been estimated based on the traffic forecast in the assessment area. Moreover, it can be argued that VKT is related to vehicle population in such a way that a higher vehicle population would generally result in a higher VKT. As a result, it has been proposed to estimate the number of trips in the assessment area on the basis of the project-specific VKT and the assumption that the number of trips per VKT in the assessment area would be similar to the number of trips per VKT in Hong Kong. It is considered that this proposed approach is based on best available data and reasonable assumption. This approach for estimating the number of trips together with the results of estimation has been submitted to TD for review. TD has no objection in principle to the method and the correspondence from TD is provided in **Appendix 3.9** for reference.

Hourly Temperature and Relative Humidity Profile

Annual and monthly hourly average ambient temperature and relative humidity obtained from the meteorological data as extracted from the 2010 HKO's King's Park meteorology station (with at least 90% valid data) have been adopted. The 24-hour variations of the annual averages of temperature and relative humidity are presented graphically in **Appendix 3.15**.

Speed Fractions

The 24-hour speed fractions for different road types and individual vehicle classes are provided by the Traffic Consultant, and are calculated based on the 24-hour traffic flow in each model year and the volume/capacity ratio of different road types. For each vehicle class, the VKT of each road link was grouped into sub-groups with speed bins of 8 km/h (0 - 8 km/h, 8 - 16 km/h, 16 - 24 km/h, etc.). The speed fraction of each sub-group was derived by the summation of the total VKT of road link within this sub-group divided by the total VKT of all road links. The estimated speed fractions provided by the Traffic Consultant are given in **Appendix 3.16**.

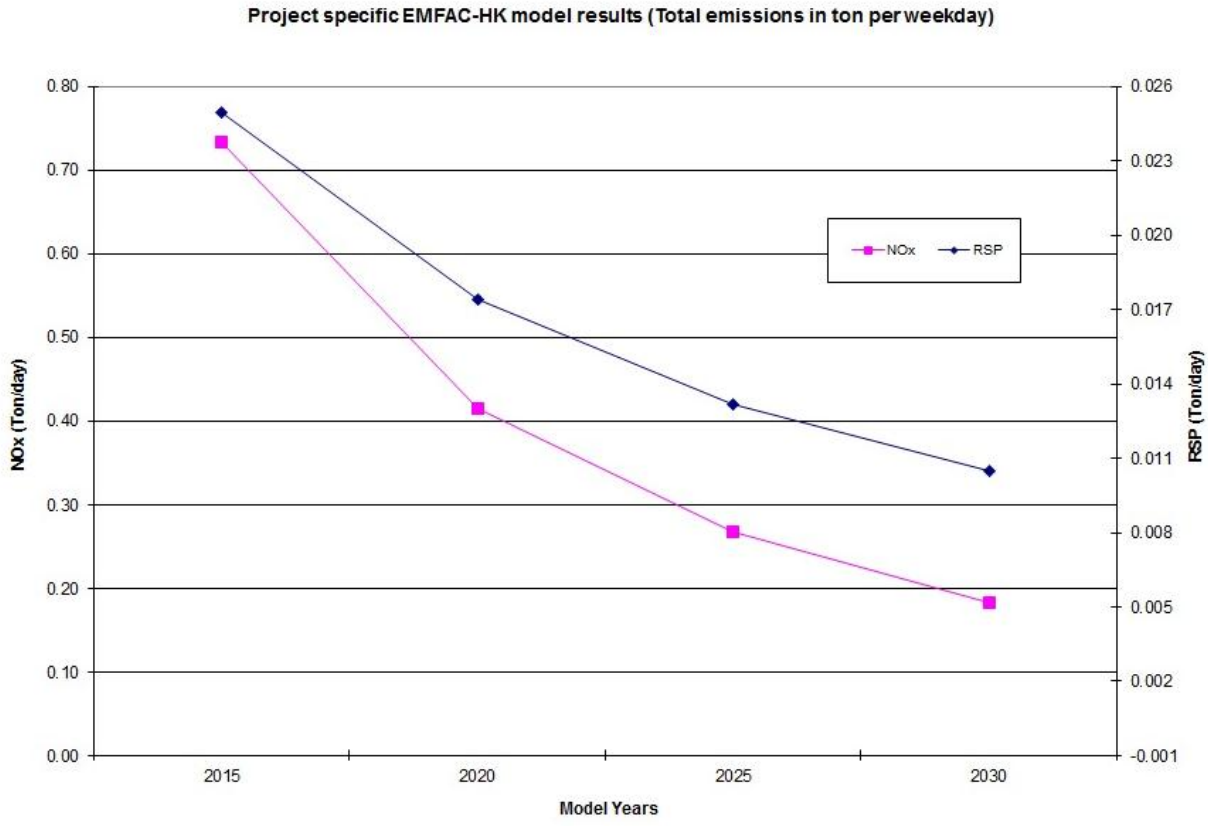
The maximum speed for Heavy Goods Vehicles, Franchised Buses and Non-franchised Buses has been restricted to 70 km/h and for Public Light Buses to 80 km/h.

Predicted Emission Factors by EMFAC-HKV2.5.1 model

To determine the emissions with 15 years after commencement of the Project, emission rates were modelled for years 2015, 2020, 2025 and 2030. Upon modelling with EMFAC-HKV2.5.1, the emissions for each vehicle class at different hours are then divided by the corresponding VKT to obtain 24-hr emission factors in grams/vehicle-kilometre (g/veh-km). The calculations of emission factors for each model year are shown in **Appendix 3.17**. By comparing the total emissions in different model years as shown in **Graph 3.2**, year 2015 represents the worst case scenario where the total emission is the highest among all model years. Even with addition of the traffic due to the CKR project after 2020, the worst-case year is still predicted to be 2015. This is because despite the increased traffic volume, the total emissions are expected to decrease as a result of the retirement of older and more polluting vehicles in the fleet, which would be replaced with newer vehicles with lower emissions. Therefore, it is proposed to use the emission factors of this worst case year 2015 for the prediction of air quality impacts due to vehicular emissions in order to arrive at conservative impact assessment results.

Although the planned commencement year of operation of the Project has been updated from 2015 to 2017, use of the emission factors in 2015 represents conservative emissions for the assessment. This is because the total traffic emission in year 2017 is anticipated to be lower than that in year 2015 as illustrated in **Graph 3.2**.

Graph 3.2: Comparison of RSP and NO_x EMFAC results for 2015, 2020, 2025 and 2030



3.5.2.4 Model Description – ISCST3

The Industrial Source Complex – Short Term version 3 (ISCST3) dispersion model was used to model the air pollutant concentrations due to vehicular emissions from the Western Harbour Crossing (WHC) portal (modelled as volume sources); the proposed underpasses/landscape deck portals (modelled as volume sources) and the associated top openings (modelled as area source) under the Road Works at West Kowloon project; as well as from the assumed ventilation serving the planned underground roads within the WKCD site (modelled as point or volume sources).

ISCST3 is a steady state Gaussian plume model which can be used to assess pollutant concentrations from sources associated with an industrial source complex. ISCST3 is one of the models prescribed by the EPD *Guidelines on Choice of Models and Model Parameters*. ISCST3 is considered an appropriate model to use for this situation as meteorological conditions will not vary greatly over the site, as the site is relatively flat and small and no significant effects are expected due to terrain variations.

It should be noted that ISCST3 and all Gaussian based dispersion models have limited ability to predict dispersion in the situations as described previously in **Section 3.5.1.2**.

3.5.2.5 Assumptions and Inputs – ISCST3

The operational sources for ISCST3 modelling (shown in **Figure 3.6**) include:

- Proposed underpasses/landscape decks along the Austin Road West and Lin Cheung Road and the associated top openings under the Road Works at West Kowloon project, which is within the 500 m assessment area;
- Portal of the existing WHC which is in the vicinity of the WKCD site; and
- Ventilation exhausts and portals serving the planned underground roads within the WKCD area.

EMFAC-HKV2.5.1 and the traffic modelling data from the Traffic Consultants were used to generate the inputs for use in ISCST3.

Hourly meteorological data for a full year as extracted from the PATH model released by EPD in December 2012 (meteorological data year 2010, grid 28, 27) has been adopted for use in ISCST3. The data is considered to be the most up to date data available. PATH data has been observed to have a lower mixing height for some hours, when compared to the measured mixing height. The minimum mixing height recorded by HKO in 2010 is 121.3 m, whereas the PATH minimum mixing height is 40 m. The HKO minimum mixing height of 121.3 m is used to replace any PATH mixing height below this value. This approach is considered appropriate as it will minimise over-estimation due to lower mixing heights and also will minimise under-estimation due to high stacks being excluded in the mixing volume. The PATH data with the above modification is considered to be representative of the site wind data at WKCD.

<u>Ventilation Exhausts/Portals Serving WKCD Basement</u>

The basement will be ventilated through stacks; however the proportion released through stacks and through the portals cannot be determined until a comprehensive ventilation study is carried out during the detailed design phase. Two scenarios were therefore considered for the ventilation of the WKCD basement:

<u>Scenario I – 100% of the vehicle emissions generated within the basement is ventilated through a series of stack exhausts and 0% through the basement entry and exit points</u>

Under this Scenario, the exhausts are assumed to be attached to buildings within the WKCD and were modelled as 6 m tall point sources with an exit air velocity of 2.0 m/s. The stack diameter was dependant on the ventilation area. The basement is broken into three areas, namely B1 Road, B1 Loading and B2 Carpark, for the purpose of the ventilation calculations. The areas are shown in **Figures 3.5.1n**, **3.5.1r**, **3.5.1s** and **3.5.1t**;

Standard practice is to model ventilation shafts as point sources. As the final dimensions of the exhaust louvres are yet to be known at this stage, it is considered appropriate to model the basement ventilation louvres as stacks. A single stack is used at approximately the horizontal centre of the proposed louvre area to allow the greatest flexibility in the final stack location.

The Practice Note ADM-2 recommends MTR ventilation exhausts should be located not closer than 5 m to any opening such as an openable or fixed window, doorway, building ventilation system intake or exhaust and the like in any building irrespective of whether such ventilation shaft is freestanding or is accommodated in a building. Although there is no such practice note for underground roads and tunnels, this basis has been used to adopt a minimum stack height of 6 m. This is considered to give worst case results at the ground level and allows for flexibility of the final design and the ventilation to be located at this level.

There are several ventilation exhausts for the XRL/WKT basement carpark, however this basement does not include an underground road and therefore does not need to be considered as a concurrent source.

Scenario II – 100% of the vehicle emissions generated within the basement is ventilated through the basement entry and exit points and 0% through a series of stack exhausts

Under this Scenario, the basement emissions were considered as a total of the three roads (basements roads A, B and C) as shown in **Figures 3.5.1n**, **3.5.1r**, **3.5.1s** and **3.5.1t**. The detailed design of the basement and its ventilation system is not yet complete; therefore it has been broadly assumed that the emissions would be evenly distributed among the three entry/exit points to approximate the scenario. Therefore, one third of the total basement emissions were assumed to be emitted from the western portal near the western tunnel, one third through the eastern portal onto Austin Road West and one third through the northern portal onto Austin Road West.

The basement entry and exit point are not treated as a standard portal as the traffic does not exit directly from the portal, that is the vehicles come to a T-intersection at the entry and exit point for Location A and C as shown in **Figure 3.6**. The entry and exit points are modelled as volume sources based on the dimensions of the opening.

Underpasses/landscape decks along the Austin Road West and Lin Cheung Road and the associated top openings

The portal emissions are the worst case emissions from portals and other openings of Austin Road West and Lin Cheung Road. EPD's *Guidelines on Choice of Models and Model Parameters* recommends portals and similar openings are modelled as volume sources according to the Permanent International of Road Congresses (PIARC) *XIXth World Road Congress Report*. To obtain worst case emissions from each top opening and portal, using the recommended guideline the following situations were considered:

Scenario 1 - 10% of tunnel emissions released through short top openings, the remainder released through the tunnel portal;

Scenario 2 - 20% of tunnel emissions released through short top openings, the remainder released through the tunnel portal;

Scenario 3 - 30% of tunnel emissions released through short top openings, the remainder released through the tunnel portal, and;

Scenario 4 - Maximum emissions according to PIARC recommendations (which are dependant on top opening lengths – 66% of emissions through top opening if the length is 50m and 100% through top opening if the length is 100m), the remainder of emissions which are not released through the top opening are released through the tunnel portal.

By adopting the traffic forecast in the worst case year of 2015, the emission rates for Scenarios 1 to 4, with 100% of the WKCD basement emission through its portals (Scenario II) are given in **Appendix 3.18a – Appendix 3.18d** whereas the emission rates for Scenarios 1 to 4, with 100% of the WKCD basement emissions through its stack exhausts (Scenario I) are given in **Appendix 3.18e – Appendix 3.18h**. All scenarios were modelled to determine the worst case effects.

By adopting the traffic forecast in 2020, the emission rates for the combination of Scenario I and Scenario 1 are also estimated, as presented in **Appendix 3.19**. Based on the comparison of the modeling results for all eight combinations of Scenarios I & II with Scenarios 1-4 for the worst case year of 2015, the results for different combinations differ by a small amount (less than 2%) and yet the combination of Scenario I with Scenario 1 tends to give relatively more conservative results. Therefore, this combination has been used to estimate the emission rates for year 2020, which are then used to refine the NO_2 modelling results for those planned ASRs that will be in operation from 2020 onwards (see **Section 3.6.2**).

EMFAC-HKV2.5.1 model results and the traffic modelling data from the Traffic Consultants were used to generate the inputs for use in ISCST3.

Existing WHC Portal

The portal emissions are modelled according to EPD's *Guidelines on Choice of Models and Model Parameters*, which recommends portals and similar openings are modelled as volume sources according to the PIARC *XIXth World Road Congress Report*. Details of the assumptions are in **Appendix 3.18a – Appendix 3.18h** and **Appendix 3.19**.

3.5.2.6 Model Description – CALINE4

CALINE4 is a line source air quality model developed by the California Department of Transportation and is one of the models prescribed by the EPD *Guidelines on Choice of Models and Model Parameters*. It is based on the Gaussian diffusion equation and employs a mixing zone concept to characterise pollutant dispersion over the roadway.

The purpose of the model is to assess air quality impacts near transportation facilities. Given source strength, meteorology and site geometry, CALINE4 can predict pollutant concentrations for receptors located within 500 m of a given roadway. As with all Gaussian models, CALINE4 has some limitations, as described in **Section 3.5.1.2**.

3.5.2.7 Assumptions and Inputs – CALINE4

The predicted traffic flows have taken into account the development of the four concurrent projects, namely: Road Works at West Kowloon; Road Improvement Works in West Kowloon Reclamation; the Hong Kong Section of the XRL, and; Central Kowloon Route (CKR). **Appendix 3.10** presents details of the 24-hour traffic forecast for different vehicles and individual road links within the 500 m assessment area (see **Figures 3.5.1a** to **3.5.1y**) as provided by the Traffic Consultants.

Hourly meteorological data for a full year as extracted from the PATH model released by EPD in December 2012 (meteorological data year 2010, grid 28, 27) has been adopted for use in CALINE4. The data is considered to be the most up to date data available. PATH data has been observed to have a lower mixing height for some hours, when compared to the measured mixing height. The minimum mixing height recorded by HKO in 2010 is 121.3 m, whereas the PATH minimum mixing height is 40 m. The HKO minimum mixing height of 121.3 m is used to replace any PATH mixing height below this value. This approach is considered appropriate as it will minimise over-estimation due to lower mixing heights and also will minimise under-estimation due to high stacks being excluded in the mixing volume. The PATH data with the above modification is considered to be representative of the site wind data at WKCD. A roughness coefficient of 370cm is used, as the area is considered to be urban.

Based on the worst case emission factors and the 24-hour traffic flow in 2015, the composite fleet emission factors have been calculated for the road links, as detailed in **Appendix 3.23**.

By adopting the traffic forecast in 2020, the composite fleet emission factors have also been calculated for the road links, as detailed in **Appendix 3.24**. These emission factors have been used to refine the NO_2 modelling results for those planned ASRs that will be in operation from 2020 onwards (see **Section 3.6.2**).

3.5.3 Operation Phase – Marine Emissions

3.5.3.1 Introduction

To assess the operational air quality from marine sources ISCST3 was used to predict the cumulative NO_x, RSP and SO_2 levels at the identified ASRs in accordance with the EPD's *Guidelines on Choice of Models and Model Parameters*,

Under the current development of marine traffic planning at the WKCD site, it is intended that marine services at WKCD will primarily be provided for visitor or leisure activities. In terms of traffic volume, the support on the need of the possible piers has been a key outcome from the public consultation in view of general public's opinions and needs. No precedence case or similar scale of development as the WKCD has been developed in the Victoria Harbour and therefore no realistic marine traffic forecast can be developed at this stage of the Project. However, as the possible piers would only be used by visitors or for leisure purposes without any planning for routine uses, it is anticipated that the marine traffic to be generated at the two possible piers would be insignificant when compared to the existing marine activities. No vessel landing will be included at the optional viewing platform and for the proposed landing steps of WKCD, and therefore they are being designed as features of the development and will not serve any marine traffic.

Marine emissions considered to be important for the assessment are: fast ferry traffic movements, based on scheduled sailings at the China Ferry Terminal; cargo-handling vessel traffic movements along the Yau Ma Tei Fairway at the western edge waterfront of the WKCD site; derrick lighter barges operating at the New Yau Ma Tei Public Cargo Working Area (NYPCWA), and; ocean cruise ship emissions at berth at the Ocean Terminal. As the marine emissions are all from existing marine activities within the surrounding waters and the WKCD development itself does not contribute to any marine traffic emissions, the cumulative SO_2 levels due to the various surrounding sources are assessed for the proposed ASRs within the WKCD site only. ISCST3 has been used to predict the air pollutant concentrations due to marine sources. The locations of all such pollution sources are as shown in **Figure 3.7**. Details of the emissions rates for individual sources are given in **Appendix 3.25**.

The cumulative hourly maximum NO_x, RSP and SO_2 concentrations are predicted by the above models by using the corresponding MM5 hourly meteorological data in 2010 as extracted from the PATH model released by EPD in December 2012.

3.5.3.2 Model Description – ISCST3

Gaussian model ISCST3 has been used for modelling potential impacts from the above-mentioned nearby marine emission sources. Refer to **Section 3.5.2.4** for model description and limitations.

3.5.3.3 Assumptions and Inputs – ISCST3

Given the lack of realistic marine traffic forecast for the two possible piers and the insignificant contribution to the existing marine traffic in the surrounding waters of WKCD (see **Section 3.4.4**), it is anticipated that the air quality impact due to potential marine traffic emissions from future operation of the two possible piers of WKCD would not be significant as compared to that due to the existing marine traffic level. Hence, the marine traffic emissions due to the two possible piers of WKCD are not included in the modelling exercise.

The operational sources for the ISCST3 modelling (shown in **Figure 3.7**) include:

- Fast ferry traffic movements, based on scheduled sailings, of up to 170 daily movements (ferry going to is one movement, ferry leaving is a second movement) at the China Ferry Terminal;
- Tugs associated with derrick lighter barge movements in the NYMTTS;
- Derrick lighter barges operating at the New Yau Ma Tei Public Cargo Working Area (NYPCWA), and;
- Ocean cruise ship movements at the Ocean Terminal.

Hourly meteorological data for a full year as extracted from the PATH model released by EPD in December 2012 (meteorological data year 2010, grid 28, 27) has been adopted for use in CALINE4. The data is considered to be the most up to date data available. PATH data has been observed to have a lower mixing height for some hours, when compared to the measured mixing height. The minimum mixing height recorded by HKO in 2010 is 121.3 m, whereas the PATH minimum mixing height is 40 m. The HKO minimum mixing height of 121.3 m is used to replace any PATH mixing height below this value. This approach is considered appropriate as it will minimise over-estimation due to lower mixing heights and also will minimise under-estimation due to high stacks being excluded in the mixing volume. The PATH data with the above modification is considered to be representative of the site wind data at WKCD.

New Yau Ma Tei Public Cargo Working Area (NYPCWA)

The NYPCWA is located on the north-south shoreline of the NYMTTS to the north of WKCD. The area is mainly used for loading and unloading cargo using derrick lighter barges. The shoreline is approximately 1,250 metres long. According to the *Merchant Shipping (Local Vessels) (Typhoon Shelters) Regulation – Chapter 548E* the maximum permitted length for local vessels in the typhoon shelter is 50 metres. For manoeuvring purposes it was assumed that each vessel would need 5 metres at bow and stern. The maximum number of vessels operating at any one time was therefore assumed to be the shoreline length divided by vessel and manoeuvring length, which gives 20 vessels. Although this does not take into account a larger possible vessel density should smaller barges being used, it is still considered realistic estimate, as a visual survey identified a similar number of vessels along the shore front.

The emission rates were estimated with reference to the *USEPA Non-Road Diesel Standards* and *USEPA Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories (April 2009)*, hereafter referred to as "*USEPA Methodology*". The barges were assumed to have an engine size of 314.6 kW, which is based on average engine size information from 250 ton cranes. Based on the maximum theoretical loading factor of 43% for gantry cranes[5], a loading factor of 50%, which is considered to be conservative, is assumed for the barges. A visual survey showed the derrick lighters operate approximately 5 minutes out of every 20 minutes, with an on-off sequence of: rigging – 10 minutes; crane operation – 5 minutes; unrigging – 5 minutes. Therefore all engines are assumed to be operating at 50% load and for 25% of the operation hours.

Marine diesel engines are assumed to have an average operating lifetime of 10,000 hours. Derrick lighter barges are assumed to operate during the same period as the NYPCWA, i.e., 7:00 am to 9:00 pm daily or 14 hours per day (Monday to Saturday), with a time-in mode of 25%. Based on these assumptions, it can be estimated that the average life span of the marine engine on a derrick lighter barge is approximately 10 years, which is used to determine the emission rate for the engines by making reference to the emission standards for non-road diesel engines. This estimated engine life span is considered to give a conservative emission rate as the average age of engines is likely to be less than 10 years. Based on a visual survey, the exhaust height of the derrick lighter engine is assumed to be 8.7m (approximately the height of three shipping containers). Details of estimating the engine emission can be found in **Appendix 3.25**.

Information provided by the marine sub-consultant estimates 130 small craft movements per day in the NYMTTS (both entering and leaving). It is assumed that all small craft are tugs and are restricted to the same operation period as the NYPCWA, that is, 7:00 am to 9:00 pm daily.

The NO_x emission rates for tugs were estimated by using actual engine data sourced from maritime sales information. RSP emission rates are based on Harbour Craft Emission Factors as published in the "*USEPA Methodology*". SO_2 emission rates were estimated from the *Starcrest Consulting Group, LLC Puget Sound Maritime Air Emission Inventory (April 2007).* The tugs were assumed to have two 696 kW engines (average engine size from maritime sales information). The RSP emission rates were adjusted according to the *Starcrest Consulting Group, LLC Puget Sound Maritime Air Emission Inventory (April 2007)* whereas the SO_2 emission rates were adjusted based on the fuel sulfur content as given in the reference material, and the actual fuel sulfur content as used in Hong Kong marine vessels. Detailed information can be found in **Appendix 3.25**.

Engine loading factor for tugs was assumed to be 31% as described in the *"USEPA Methodology"*. The tug movements were divided evenly among the operating hours and so for modelling purposes there are nine tug movements per operating hour of NYPCWA.

As the tugs are moving, the emissions are modelled as a series of area sources. To allow for variation in the actual vessel route, a width of 30 m is applied. The average hourly area emission rate was calculated by the instantaneous emission rate (g/s) multiplied by the time that it takes for the vessel to move over the

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[5] Starcrest Consulting Group, LLC, 2009. *Rubber Tired Gantry (RTG) Crane Load Factor Study.* Poulsbo: Starcrest Consulting Group, LLC.

length of the route (based on the reported average speed), and then divided by the total route area and 3600 seconds (one hour).

The estimated emission rates are summarised in **Table 3.13** and details of the estimation are given in **Appendix 3.25**.

Table 3.13: Estimated Emission Rates of Barges at NYPCWA

Pollutant	Vessel type	Estimated Emission Rates
NOx	Barge	0.0799 g/s for each barge
	Tug	2.30 x 10^{-6} g/m^2.s for each tug
RSP	Barge	0.0022 g/s for each barge
	Tug	8.81 x 10^{-8} g/m^2.s for each tug
SO_2	Barge	0.0136 g/s for each barge
	Tug	6.07 x 10^{-7} g/m^2.s for each tug

China Ferry Terminal

The China Ferry Terminal is located to the south-east of WKCD. Three main companies operate at the Terminal, which are: CotaiJet, TurboJet and Chu Kong Passenger Transport Limited. Sailing timetables were reviewed for each of the companies and total vessel unloading/loading to the terminal calculated. The total unloading/loading was from one to 14 vessels per hour, between the hours of 7:00am and 11:00pm. Outside of these hours there are no scheduled ferry services and therefore no emissions modelled.

The emission rates were calculated based on the "*Institute for the Environment, The Hong Kong University of Science & Technology: Study on Marine Vessels Emission Inventory*", hereafter referred to as the *"HK Inventory"*. During berthing, it is assumed that only auxiliary engines are operational. An overall average emission rate for all ferries was calculated for berthing based on the average auxiliary engine information available. The auxiliary engines are assumed to have a loading factor of 45% during cruise and berthing, as stated in the *"HK Inventory".* It is also assumed that each unloading/loading takes 30 minutes to complete, including manoeuvring and berthing.

From information available from ferry operators, the exhausts were assumed to emit at water level, as no stack was visible for majority of the ferries surveyed, and stacks for fast ferries are horizontal. To account for this exhaust position, the stacks were modelled with an efflux velocity of 0.001 m/s and an equivalent stack diameter. This approach is as described in Section 6.1 of the *USEPA AERMOD Implementation Guide, 2009* and is considered conservative.

Emissions for the movement of fast ferries to and from the terminal were also modelled. Separate emission factors were calculated for Macau ferries (i.e., fast ferries travelling to/from Macau) and China ferries (i.e., fast ferries travelling to/from cities in Mainland China). Emissions are estimated based on the *"HK Inventory".* Slow cruise is defined as 8 – 12 knots, but the marine speed limit within Victoria Harbour is 10 knots. Therefore, all fast ferries are assumed to travel at 10 knots within the study area for the purpose of estimating the engine emission rates.

For Macau ferries, the largest engine power as stated in the "*HK Inventory"* is 9,280kW and the maximum design cruise speed is 45 knots. For China ferries, the largest engine power as stated in the "*HK Inventory"* is 5,490kW and the maximum design cruise speed is 32 knots. In order to estimate the ferry engine power at the cruise speed of 10 knots, it is assumed that the engine power, which can be estimated as hydrodynamic drag force multiplied by cruise speed, is directly proportional to the cruise speed. In other words, the hydrodynamic drag force is assumed to be at a constant level that equals to the highest hydrodynamic drag force at maximum engine power. This is a conservative assumption for estimating the engine power at reduced cruise speed conditions where the hydrodynamic drag force would be lower. With such a conservative assumption, it can be estimated that the engine power levels for Macau ferries and China ferries travelling at 10 knots are respectively 0.22 (i.e., 10knots / 45knots) x 9,280kW and 0.31 (i.e., 10knots / 32knots) x 5,490kW. Each scheduled travel of a fast ferry is considered to have two vessel trips along the ferry route (one to and one from). The estimated emission rates are summarised in **Table 3.14** and details of the estimation are given in **Appendix 3.25**.

As the marine traffic emissions are included as part of the emission inventory of the PATH model, there is a certain amount of double counting. The modelling results for the fast ferries are therefore considered to be conservative.

Table 3.14: Estimated Emission Rates of Fast Ferries at China Ferry Terminal

Pollutant	Mode	Estimated Emission Rates
NOx	Berth	0.12 g/s for each ferry*
	China Ferry - Transit	8.84 x 10^{-6} g/m^2.s for each ferry
	Macau Ferry - Transit	1.01 x 10^{-5} g/m^2.s for each ferry
RSP	Berth	0.004 g/s for each ferry*
	China Ferry - Transit	2.79 x 10^{-7} g/m^2.s for each ferry
	Macau Ferry - Transit	3.21 x 10^{-7} g/m^2.s for each ferry
SO_2	Berth	0.026 g/s for each ferry*
	China Ferry - Transit	1.88 x 10^{-6} g/m^2.s for each ferry
	Macau Ferry - Transit	2.15 x 10^{-6} g/m^2.s for each ferry

*Assumed to last for 30 minutes during each hour of operation

Ocean Terminal

The Ocean Terminal is located to the south-east of WKCD. A 40,000-ton ship is berthed at the Ocean Terminal during day-time but leaves for the sea during night-time. This 40,000-ship is hereafter referred to as the day-time ship. Other cruise ships are also periodically berthed at the Ocean Terminal. There are totally two berths available at the Ocean Terminal. Therefore, it is assumed for the worst-case scenario that both the day-time ship and another 70,000-ton ship are berthed at the Terminal simultaneously, with the 70,000-ton ship berthing for 24 hours of a day (hereafter referred to as the 24-hour ship). The day-time ship is generally berthed between about 8:00am and 8:00pm, and has been modelled as such. The 24-hour ship is assumed to be berthed for 24 hours at the Terminal, as when visiting it can be berthed at the Terminal for more than a day. This modelling approach is considered to have captured the worst-case scenario when both cruise ships are at the berths.

Emission rates of the ships berthing at the Ocean Terminal were estimated by using the *"USEPA Methodology"*, MARPOL regulations, as stated in *Merchant Shipping (Prevention of Air Pollution) Regulation – Chapter 413M, Section 27 (3) (b)* and engine information for the auxiliary engines. No information was available as to whether the ship is to cold iron during berth, so it is assumed all auxiliary engines are running for the entire time the cruise ships are berthed at the Ocean Terminal. During berthing, the cruise ships would also be running auxiliary boilers to provide hot water, heating and other services. These services would be provided by exhaust heat exchangers on the main and auxiliary engines during cruising, however during berth the main engines are off and therefore auxiliary boilers are needed. Boiler emissions were estimated based on the *"HK Inventory"*. The fuel used during berthing is assumed to be residual oil, with a sulfur content of 2.8%. This is conservative as some ocean going vessels use distillate fuel, which has a lower sulfur content and leads to lower RSP and SO_2 emissions. The future projected average fuel sulfur content is 1.98% for auxiliary engines and 2.07% for auxiliary boilers, both of which are lower than the assumed 2.8% sulfur content. Moreover, the MARPOL regulations will reduce the sulfur content to 0.5% from 2020 onwards.

To prevent over-estimation of the SO_2 emissions from the ships berthing at the Ocean Terminal, a calibration exercise was performed with reference to the on-site SO_2 data recorded at the EPD's WKCD monitoring station (see **Section 3.4.1**). Historic berthing timetable at the Ocean Terminal during the monitoring period of the WKCD monitoring station (i.e., from Sep 2011 to Aug 2012) was identified. As there are many day-time marine traffic emission sources (e.g., Star Ferries, China ferries, Macau ferries, recreational and cargo vessels) during day-time, the calibration exercise was carried out only for night-tme periods between 9pm and 8am when the 24-hour ship alone is berthed at the Ocean Terminal (the day-time ship is at cruise during night-time) and the emissions from fast ferries and other marine traffic are minimal. The calibration results were then used to adjust the SO_2 emission rate for the 24-hour ship to provide more realistic estimates of the maximum SO_2 concentrations at the ASRs. The SO_2 emission rate for the day-time ship, which is smaller in tonnage than the 24-hour ship, is conservatively assumed to be the same as the adjusted emission rate for the 24-hour ship. Details of the calibration results for estimation of SO_2 emission rates are given in **Appendix 3.25**.

Based on a visual survey and information on the day-time ship, the height of the stacks was assumed to be 50 metres. Based on engine information, there are four auxiliary engines for day-time ship, and it is therefore assumed there are four stacks. The estimated emission rates of the ships are summarised in **Table 3.15** and details of the estimation are given in **Appendix 3.25**. No emissions for vessels sailing to and from the terminal were estimated or modelled as this is considered to be adequately covered by the PATH model and is outside the 500 m assessment area.

Table 3.15: Estimated Emission Rates of Cruise Ships at Ocean Terminal

Pollutant	Vessel	Estimated Emission Rates (g/s)
NOx	Day-time ship	12.97
	24-hour ship	14.55
RSP	Day-time ship	1.88
	24-hour ship	1.97
SO_2	Day-time ship	7.62
	24-hour ship	7.62

3.5.4 Operation Phase – General Emissions

To assess the operational air quality, a variety of models were required. In accordance with the EPD's *Guidelines on Choice of Models and Model Parameters*.

3.5.4.1 Model Description - PATH

The PATH model is a numerical air quality modelling system developed specifically for use in Hong Kong. The model comprises of three modules: an emission model; a prognostic meteorological model and an Eulerian transport and chemistry model. These modules are interfaced together and set up on a series of nested domains to account for influences outside of Hong Kong.

3.5.4.2 Assumptions and Inputs – PATH

An updated version of PATH was released by the EPD for general use in December 2012. As there is no significant policy change or inventory update since the release of the latest PATH and the submission of this report, use of the 2012 PATH model in its current state is considered appropriate.

For EIA applications, PATH simulates wind field, pollutant emissions, transportation and chemical transformation and outputs pollutant concentrations over Hong Kong and the Pearl River Delta (PRD) region at a fine grid size of 1.5km.

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. A comprehensive emission inventory for Hong Kong and PRD was compiled for year 2010 based on current best estimates and projected to 2015 and 2020 in accordance with the emission reduction measures proposed in the plan. The emission inventory for year 2010 was used in PATH and produced reasonable agreement with air quality measurements. The projected emission inventories for years 2015 and 2020 were also used in PATH to predict air qualities for future years. The emission inventories include the total emissions from six key groups, namely, public electricity generation, road transport (emissions estimated based on VKT forecast provided by TD and EMFAC-HK model version 2.1), navigation, civil aviation (emissions estimated based on forecasted air traffic movements), other fuel combustion (covering emissions from such major facilities as HK & China Gas, Green Island Cement and Integrated Waste Management Facilities) and non-combustion. The Hong Kong emission inventories of the key air pollutants of concerns for the Project are summarized in **Table 3.16**.

Table 3.16: Summary of 2015 and 2020 Hong Kong Emission Inventory for the PATH Model

Pollutant	Total Emission in 2015 (ton/year)	Total Emission in 2020 (ton/year)
SO_2	26,625	23,075
NO_x	98,100	87,200
RSP	5,706	5,389

PATH model was used to quantify the background air quality during the operational phase of the Project. Emission sources including roads, marine, airports, power plants and industries within the Pearl River Delta Economic Zone 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.

The hourly SO_2, NO_x and RSP concentrations as extracted from the PATH for year 2015 are adopted as the background air pollutant concentrations in the estimation of cumulative impact for the Project during the worst case year of 2015. The hourly pollutant concentrations as extracted from the PATH for year 2020 have also been used to refine the NO_2 modelling results for those planned ASRs that will be in operation from 2020 onwards (see **Section 3.6.2**).

Since the vehicular and marine traffic emissions at local scale (i.e. within the 500m assessment area) have been modeled by near-field dispersion models, namely, CALINE4 and ISCST (see **Sections 3.5.2** and **3.5.3**), adding the PATH background concentrations to the near-field modeling results would lead to certain amount of double counting, and hence conservative cumulative modeling results.

3.5.4.3 Other Assumptions

According to *Entec UK Limited: Defra UK Ship Emissions Inventory, 2010* the NO_x:NO_2 ratio can vary between 0.05 and 0.10. The NO_x formed during combustion comprise predominantly of NO, with a small percentage of primary NO_2. In the atmosphere the NO oxidises to NO_2 which is considered as secondary NO_2. For conservative results a conversion factor of 0.10 has been used for NO_x to NO_2.

The Ozone Limiting Method (OLM) as described in *EPD's Guidelines on Choice of Models and Model Parameters* has been adopted to estimate the conversion of NO_x to NO_2 from both marine and vehicular emissions. The ozone concentrations are based on the future hourly background ozone concentrations for year 2015 or 2020, which were extracted from grid (28, 27) of the most up to date PATH. Grid (28, 27) of the PATH model is used because the majority of the WKCD area falls within this grid (see **Figure 3.8**).

The NO_x/NO_2 conversion for vehicular and marine emissions is therefore estimated as follows:

$$[NO_2] = 0.075 \text{ x } [NO_x]_{vehicle} + \text{minimum of } \{0.925 \text{ x } [NO_x]_{vehicle} \text{ or } (46/48) \text{ x } [O_3]_{PATH}\} + 0.10 \text{ x } [NO_x]_{marine} + \text{minimum of } \{0.90 \text{ x } [NO_x]_{marine} \text{ or } (46/48) \text{ x } [O_3]_{PATH}\}$$

where

$[NO_2]$	is the estimated hourly vehicular NO_2 concentration (predicted by CALINE4 and ISCST);
$[NO_x]_{vehicle}$	is the hourly NO_x concentration as predicted by CALINE4 and ISCST3 for vehicular emissions at the receptor;
$[O_3]_{PATH}$	is the hourly ozone concentrations as extracted from the aforementioned grid of the PATH model for year 2015 or 2020; and
$[NO_x]_{marine}$	is the hourly NO_x concentration as predicted by ISCST3 for marine emissions at the receptor.

To estimate the total hourly concentrations, the hourly pollutant concentrations as predicted by CALINE4 and ISCST3 (vehicular and marine) are added together with the future hourly background pollutant concentrations as extracted from the relevant grid of the PATH model. Therefore, the total hourly concentrations of NO_2 are calculated as follows:

$$[NO_2]_{total} = [NO_2] + [NO_2]_{PATH}$$

where

$[NO_2]_{total}$	is the total hourly NO_2 concentration;
$[NO_2]$	is the hourly vehicular and marine NO_2 concentration which is first predicted by CALINE4 and ISCST3 as NO_x and then converted to NO_2 by using OLM; and
$[NO_2]_{PATH}$	is the hourly NO_2 concentrations as extracted from the aforementioned grid of the PATH model for year 2015 or 2020.

Similarly, the total hourly RSP (vehicular and marine) and SO_2 (marine emissions only) concentrations are also calculated by adding together the hourly results predicted by CALINE4, ISCST3 and PATH.

With the total hourly NO_2, RSP and SO_2 estimated, the daily results are obtained by taking the arithmetic mean of the 24 hourly results. Similarly, the annual concentrations are calculated as the arithmetic mean of the whole year of hourly results.

3.5.5 Operation Phase – Odour Emissions

3.5.5.1 Odour Source Monitoring

In order to assess the potential odour impacts on WKCD, odour source monitoring was undertaken to identify the key odour emission sources from NYMTTS, and to perform field investigation and laboratory tests to quantify the odour emission rates (OER) of NYMTTS on typical hot days when the air temperature is over 30^{o}C. According to the weather data recorded at the Hong Kong Observatory station in 2010, the mean daily maximum air temperatures in July, August and September were respectively 32.1^{o}C, 31.9^{o}C and 30.5^{o}C, representing the top three hottest months in the year. Therefore, typical hot days are taken as the summer days when the daytime air temperature is over 30^{o}C.

Odour source monitoring was carried on 21 and 22 August 2012. On both monitoring days, the weather was sunny and the air temperatures were in the range of 30^{o}C to 32^{o}C. On-site measurements and samplings were performed during the ebb tide periods, with reference to the Hong Kong Observatory's tidal chart in order to capture the worst case odour emissions when the sea water depth was the shallowest. It is therefore considered that the odour source monitoring results obtained could be used to represent the worst case odour emission scenario for NYMTTS during typical hot days when the air temperature is over 30^{o}C.

All the field sampling and measurement works as well as the laboratory testing works were carried by a laboratory that has been accredited by the Hong Kong Laboratory Accreditation Scheme (HOKLAS).

<u>Sampling Grids</u>

For the purpose of evaluating odour emission rates, NYMTTS was divided into 30 sampling grids for the odour source monitoring as illustrated in **Figure 3.9**. The arrangement and sizes of the grids were determined based on the following site-specific information into account:

- Results of the odour patrol in March 2011. During the odour patrol conducted in March 2011 malodour was only detected surrounding the watercourse boundary of northern portion of NYMTTS, i.e., along the route from P2 to P3 in Figure 1 in **Appendix 3.26a** whereas no malodour was detected along the patrol route from P1 to P2. The report documenting the results of odour patrol in March 2011 is attached in **Appendix 3.26a**. Moreover, such odour patrol results are consistent with the records of odour complaint against NYMTTS received by EPD in the past seven years from 2006 to 2013 (see **Table 3.8**). In view of these findings, more grids are placed on the northern portion (i.e., north of P2) of NYMTTS than in its southern portion.

- Review of the drainage discharges into NYMTTS. According to drainage records from the Drainage Services Department (DSD), there are two box culvert outfalls (i.e., Cherry Street Box Culvert and Jordan Road Box Culvert) and one drainage pipe discharging into NYMTTS, and their locations are as shown in **Figure 3.9**. All such outfalls and pipe discharges were observed during the odour patrol and odour sampling works. The two box culvert locations are very close to the locations where elevated odour concentrations (with sewage/rotten-egg odour) were found during the odour patrol in March 2011 (i.e., locations C and F as shown in Figure 1 in **Appendix 3.26a**). Therefore, it is considered that the malodour should be mainly due to the effluent discharge from the box culverts. Hence, more grids of finer sizes (i.e., grids 5-10, 20-23 and 28-30) were placed in vicinity of the two outfalls in order to capture the emission strength.

As control stations, two locations outside of NYMTTS have also been included in the sampling and testing exercises. Their locations are as shown in **Figure 3.9**.

On-site Testing and Sampling

At each of the 30 grids, an air sample was collected through a floating ventilated sampling hood located at the water surface of the grid. The design of the floating ventilated sampling hood is based on the specification in the VDI 3880 standard in Germany. The volumetric flow rate of the sampler measured at the sampling days was 5.2 m^3/h, which is near the low end of allowable range of the hood and is equivalent to an air flow speed inside the hood of about 0.019 m/s (calculated by dividing the flow rate with the cross-sectional area of the hood, i.e., 0.075 m^2). Air drawn into the hood was first passed through an activated carbon filter. This filter was changed at the beginning of each sampling day to prevent saturation.

On the day of sampling it was observed at the grids in the vicinity of Cherry Street Box Culvert (approximately grids 29 and 30) there were fine bubbles coming from the water surface. A low air flow speed was used to allow the odour concentration inside the sampling hood to build up to a high level, which is suitable for the subsequent olfactometry analysis to obtain reliable and conservative results. A higher velocity would increase the dilution volume and therefore lead to lower concentrations. Moreover, wind speed at such a low value is equivalent to a calm wind condition, which is a worst case scenario for atmospheric dispersion of air pollutants. Therefore, it is considered that the odour emission rates determined based on the odour samples collected at this low air flow speed would represent conservative and worst case emission source data for the subsequent modelling exercise.

During the field sampling, the following on-site tests were also carried out:

(a) Hydrogen sulfide (H_2S)

During the odour patrol in March 2011, rotten egg and sewage smell was detected at the locations where malodour was perceived (see Tables 11 and 13 of **Appendix 3.26a**), and elevated hydrogen sulfide (H_2S)

concentrations were measured at the locations where the odour concentrations were found to be higher (see Tables 14 and 15 of **Appendix 3.26a**). Therefore, H_2S would likely be one of the key odorous chemicals, and hence H_2S was measured to provide initial idea about the strength of odour emission.

(b) Odour intensity and hedonic tone

These parameters were measured to characterise any malodour and to serve as supplementary data for the subsequent laboratory testing odour concentrations.

(c) Water depth

Water depth was measured to check against the tidal conditions and was also required for the purpose of collecting water samples at various water depths.

(d) Water temperature, salinity, pH and dissolved oxygen (DO)

These water parameters were measured to collect the necessary marine water quality of NYMTTS on the sampling days so as to identify if and how odour emission would be affected by the water quality, particularly the DO levels.

(e) Weather data

Ambient air temperature, relative humidity, wind direction and wind speed were measured to capture the weather conditions on the sampling days.

Laboratory Testing of Air Samples

The collected air samples were delivered to the accredited laboratory within 24 hours from sample collection. The odour concentrations were determined by using dynamic olfactometry, according to the European Standard Method BS EN13725:2003, and samples were tested for hydrogen sulfide using UV fluorescence analyzer. For each air sample, 3 rounds of laboratory testing of hydrogen sulfide were conducted to obtain the average testing result.

3.5.5.2 Odour Review

To review the odour monitoring results obtained in August 2012, odour sampling and testing works were carried out on 18 and 20 February 2013 as well as on 18, 20 and 22 March 2013 by a HOKLAS accredited laboratory. The main purposes of the review are to repeat the odour sampling and testing works at the selected grids 5, 7-11, 14, 17 and 20-30 for comparison with the corresponding odour monitoring results in August 2012; and to determine the key contributors of odour emissions from NYMTTS (i.e., air-bound, water-bound or sediment-bound odour). The grids selected for the odour review exercise include mainly those grids that were identified with high odour emissions and sewage/rotten egg odour during the monitoring in August 2012.

At each of the selected grids for the odour review, an air sample was collected by placing the dynamic flux chamber at the water surface of the grid. Nitrogen is supplied to the chamber as the carrier gas for collecting the sample because nitrogen is odour-free and is expected to provide more realistic odour testing results of the odour generated from the water surface. The volumetric flow rate of nitrogen gas inside the chamber is 3.5 L/min (or 0.21 m^3/h) and is equivalent to an air flow speed inside the chamber of about 0.00044 m/s (calculated by dividing the flow rate with the covered surface area of 0.132 m^2). Such a low air flow speed would allow the odour concentration inside the chamber to build up to a high level and is also equivalent to a calm wind condition, which would give conservative odour testing results.

All collected air samples were delivered to the accredited laboratory for testing of odour concentrations by using dynamic olfactometry, according to the European Standard Method BS EN13725:2003. In addition, water and marine sediment samples were also collected for laboratory testing of odour concentrations in order to identify the water-bound and sediment-bound odour levels.

Based on the odour monitoring results in August 2012 as well as the odour review results in February and March 2013, the OERs at each of the 30 grids were estimated. The odour review results together with the odour monitoring results are presented in **Appendix 3.26b** while details of the estimated OERs are given in **Appendix 3.26c**.

3.5.5.3 Model Description – ISCST3

Gaussian model ISCST3 has been used for modelling potential effects from odour due to NYMTTS. Refer to **Section 3.5.1.2** for model description and limitations.

3.5.5.4 Inputs and Assumptions – ISCST3

The odour identified for a number of grids during the odour monitoring was perceived as sea water odour with a hedonic tone of zero (i.e., neutral or no odour), which is of the same odour quality at the two control stations (see **Table 3.26**). An odour with a hedonic tone of zero is considered to be neutral and neither pleasant nor offensive.

Odours from different sources can undergo various phenomena, one of which is masking, whereby the presence of one odour can disguise, or mask, the presence of a second. Different odorants may also interact. This can cause interactive or 'synergistic' effects, such that the sum of the odorants may be either greater than or less than the intensity of the odour components. In practice, odours from significantly different sources and with different characters are usually neither additive nor synergistic, but instead one source tends to dominate, or mask, the presence of the other.[6]

Dispersion models assume a conservation of mass of contaminants, that is the odour intensity of a mixture of two different odorous sources are considered to be additive. Odour modelling is not able to predict synergistic or masking effects, and to that effect, modelling a pleasant and offensive odour source in parallel would produce one overall 'odour' intensity, which would not be representative of, the different hedonic tones of the individual odours, the relative decrease in intensity of the individual odours or the potential for one odour to mask the other.

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[6] Ministry for the Environment, 2003. *Good Practice Guide for Assessing and Managing Odour in New Zealand*. Wellington: Ministry for the Environment.

Sea-water has a neutral tone and is generally considered to be non-offensive, and is assumed to be masked by the presence of offensive odour. However, as Annex 4 of the EIAO-TM does not allow for a differentiation between different types of odours, the emissions for all grids of the NYMTTS together with the surrounding sea water within the 500 m assessment area have been modelled in parallel.

The OER values are calculated from low tide, typical hot day emission rates and have been assumed to occur for the entire hour, for every hour for the whole modelling period, i.e., 24 hours a day, 365 days per year.

With the OER determined, the odour emissions have been modelled as area sources by using ISCST3 to predict the odour impact on the proposed WKCD development, i.e., the ASRs identified within WKCD (see **Table 3.3** and **Figure 3.1b**), according to the EPD's *Guidelines on Choice of Models and Model Parameters*. Meteorological data as extracted from grid (28, 27) of the PATH model released by EPD in December 2012 has been used for the assessment.

In the approved EIA for Kai Tak Development (EIA-157/2008), a factor of 2.3 or 2.5 was used to convert the hourly average odour concentration as predicted by ISCST3 into 5-second average concentrations depending on the atmospheric stability class. In this modelling exercise, the factor of 2.5 was adopted for the conversion under all stability classes for conservative estimation. The 5-second average odour concentrations estimated were then compared with the odour criterion of 5 ou in accordance with the EIAO-TM. As odour emissions are existing, only new ASRs within the WKCD boundary are assessed as the WKCD project does not contribute odour emissions to the surrounding 500 m study area.

3.5.5.5 Methodology – ISCST3

The odour impacts on WKCD from the NYMTTS and the surrounding sea water within the 500 m assessment area are modelled and assessed under the following three scenarios:

- Background odour scenario
- Current odour scenario
- Mitigated odour scenarios A and B

Background Odour Scenario

Under this scenario, all the grids of NYMTTS are assumed to be generating sea water odour. This is considered as the background sea water odour levels even if there were no malodour emissions from the entire NYMTTS, representing the lowest possible odour levels at WKCD.

Current Odour Scenario

Under this scenario, all the grid cells of NYMTTS were modelled using the OER estimated based on the odour source monitoring and review results (see **Table 3.26**). This represents the potential current odour impacts on WKCD due to both odour emissions from NYMTTS and sea water odour emissions from the surrounding marine environment.

Mitigated Odour Scenarios A and B

As detailed in **Section 3.7.3.1**, measures have been planned to improve the Dry Weather Flow Interceptors (DWFI) upstream of both Cherry Street and Jordon Road Box Culverts, which will help mitigate the water-bound odour emission from NYMTTS by reducing the amount of effluent discharges or organic matters entering the NYMTTS. The tender to construct a new DWFI upstream of the Cherry Street Box Culvert has already been launched whereas the improvement works for DWFI upstream of the Jordon Road Box Culvert are yet to be started. In light of the different status of the improvement measures for the two Box Culverts, two mitigated scenarios have been adopted:

Mitigated Scenario A: Under this scenario, the recommended improvement measures for both Cherry Street and Jordon Road Box Culverts are implemented, and therefore the amount of effluent discharges or organic matters entering the NYMTTS via both Box Culverts would be reduced as explained in the **Section 3.7.3.1**. As there is no sufficient available data to quantify the reduction in water-bound odour emissions that would result from reduction in organic matters, a sensitivity test approach in evaluating the potential reduction in odour impacts due to the DWFI improvement works has been adopted. Under the sensitivity test, four assumed ratios of reduction in organic matters to reduction in water-bound odour emissions, i.e., 1:1, 1:0.75, 1:0.5 and 1:0.25, have been modelled. For example, the ratio of 1:0.75 refers to the situation where the reduction of water-bound odour emissions is 75% of the reduction in organic matters entering NYMTTS. The OER for grid cells identified with high odour emissions in the vicinity of both Cherry Street and Jordon Road Box Culverts would be reduced according to each of the four assumed ratios. The OER for all other grid cells of NYMTTS are the same as those adopted in the current odour scenario. This represents the potential residual odour impacts on WKCD after implementation of the recommended improvement measures for both Cherry Street and Jordon Road Box Culverts.

Mitigated Scenario B: Under this scenario, the recommended improvement measures for only the Cherry Street Box Culvert are implemented, and therefore the amount of effluent discharges or organic matters entering the NYMTTS via the Box Culvert would be reduced as explained in the **Section 3.7.3.1**. Similar to the Mitigated Scenario A, the sensitivity test approach has been adopted by using the four assumed ratios of reduction in organic matters to reduction in water-bound odour emissions, i.e., 1:1, 1:0.75, 1:0.5 and 1:0.25. The OER for grid cells identified with high odour emissions in the vicinity of only the Cherry Street Box Culvert would be reduced according to each of the four assumed ratios. The OER for all other grid cells of NYMTTS are the same as those adopted in the current odour scenario. This represents the potential residual odour impacts on WKCD after implementation of the recommended mitigation measures for only the Cherry Street Box Culvert (but not for the Jordon Road Box Culvert).

In all the above ten scenarios, the surrounding 500 metres sea water odour emissions have been included in the modelling exercise.

3.6 Evaluation and Assessment of the Air Quality Impacts

3.6.1 Construction Phase

3.6.1.1 Construction Phase Tier 1 Results

The Tier 1 screening results for unmitigated and mitigated scenarios including the background contribution are tabulated in **Appendix 3.28**. The unmitigated and mitigated results are summarised as follows.

Hourly

The Tier 1 hourly TSP results under both unmitigated and mitigated scenarios are summarized in **Table 3.17**. There would be exceedances of the hourly TSP limit of 500 µg/m^3 under the Tier 1 unmitigated scenario from 2014 to 2020. However, under the Tier 1 mitigated scenario, exceedances of the hourly TSP limit would only occur from 2015 to 2018, but no exceedances in 2013, 2014, 2019 and 2020.

The locations of the dust sources are shown in **Figures 3.3a** to **3.3k**. **Figures 3.11a** to **3.11h** and **3.12a** to **3.12h** show the Tier 1 hourly TSP concentration contours for unmitigated and mitigated scenarios, respectively.

Table 3.17: Summary of Predicted Cumulative Hourly Average TSP Concentrations for All ASRs (Tier 1 Unmitigated & Mitigated)

Year	Tier 1 Unmitigated Scenario Range of Maximum Hourly TSP (µg/m^3) [Criterion - 500 µg/m^3]	Tier 1 Mitigated Scenario Range of Maximum Hourly TSP (µg/m^3) [Criterion - 500 µg/m^3]
2013	120 – 422	74 – 147
2014	97 – 1992	75 – 420
2015	150 – 4731	79 – 580
2016	175 – 5296	79 – 623
2017	203 – 5108	81 – 543
2018	207 – 4465	82 – 503
2019	148 – 3760	76 – 429
2020	113 – 3161	73 – 479

Table 3.18 shows the receptors that would breach the hourly TSP limit of 500 µg/m^3 under the Tier 1 mitigated scenario for years 2015 to 2018. ASRs that were predicted to exceed the hourly TSP limit of 500 µg/m^3 for the Tier 1 mitigated scenario were modelled further under Tier 2 conditions, as described in **Section 3.5.1.4**.

Table 3.18: Predicted Cumulative Hourly Average TSP Concentrations for ASRs with Exceedance (Tier 1 Mitigated)

ASR	Height above ground (m)	Maximum Hourly TSP (µg/m³) [Criterion - 500 µg/m³]	Remark
2015			
P01d-1	4	580	Planned Performance Art Venues within WKCD. It is a possible fresh air intake. Exceedance subject to Tier 2 assessment.
P53-1	4	575	Planned Performance Art Venues within WKCD. It is a possible open area. Exceedance subject to Tier 2 assessment.
2016			
P01a-1	4	534	Planned Performance Art Venues within WKCD. It is a possible fresh air intake. Exceedance subject to Tier 2 assessment.
P01b-1	4	550	Planned Performance Art Venues within WKCD. It is a possible fresh air intake. Exceedance subject to Tier 2 assessment.
P01c-1	4	616	Planned Performance Art Venues within WKCD. It is a possible fresh air intake. Exceedance subject to Tier 2 assessment.
P53-1	4	623	Planned Performance Art Venues within WKCD. It is a possible open area. Exceedance subject to Tier 2 assessment.
2017			
P52-1	4	543	Planned Performance Art Venues within WKCD. It is a possible open area. Exceedance subject to Tier 2 assessment
2018			
P52-1	4	503	Planned Performance Art Venues within WKCD. It is a possible open area. Exceedance subject to Tier 2 assessment

Daily

The daily TSP results for Tier 1 unmitigated and mitigated scenario including the background contribution are tabulated in **Appendix 3.28.** **Table 3.19** summarises the Tier 1 results for daily TSP under both unmitigated and mitigated scenarios. There would be exceedances of the daily TSP limit of 260 µg/m^3 under the Tier 1 unmitigated scenario from 2014 to 2020. However, under the Tier 1 mitigated scenario, no ASR are predicted to exceed the daily TSP limit for any of the assessment years.

The locations of the dust sources are shown in **Figures 3.3a** to **3.3k**. **Figures 3.13a** to **3.13h** and **Figures 3.14a** to **3.14h** show the daily TSP concentration contours for unmitigated and mitigated scenarios, respectively.

Table 3.19: Summary of Predicted Cumulative Daily Average TSP Concentrations for All ASRs (Tier 1 Unmitigated & Mitigated)

Year	Tier 1 Unmitigated Scenario Range of Maximum Daily TSP ($\mu g/m^3$) [Criterion - 260 $\mu g/m^3$]	Tier 1 Mitigated Scenario Range of Maximum Daily TSP ($\mu g/m^3$) [Criterion - 260 $\mu g/m^3$]
2013	73 - 149	69 – 90
2014	74 – 433	69 –132
2015	80 – 1110	70 – 223
2016	86 –1844	70 – 257
2017	84 –1278	70 – 204
2018	91 –1266	71 – 200
2019	82 –1187	70 – 190
2020	75 –1050	69 – 173

3.6.1.2 Construction Phase Tier 2 Results

The Tier 2 results including the background contribution, as described in **Section 3.5.1.4** are tabulated in **Appendix 3.29**, and are discussed below.

Hourly

Tier 2 scenario was performed for those ASR subject to exceedance of the hourly TSP limit under the Tier 1 mitigated scenario. Under the Tier 2 mitigated scenario no ASRs were subject to exceedance of the hourly TSP limit of 500 µg/m³, as summarised in **Table 3.20**. Detailed results can be found in **Appendix 3.29**. The locations of the dust sources are shown in **Figures 3.3a** to **3.3k**. **Figures 3.15a** to **3.15f** show the hourly TSP concentration contours under the Tier 2 mitigated scenario.

Table 3.20: Summary of Predicted Cumulative Hourly Average TSP Concentrations (Tier 2 Mitigated)

ASR	Height above ground (m)	Maximum Hourly TSP ($\mu g/m^3$) [Criterion - 500 $\mu g/m^3$]
2015		
P01d-1	4	406
P53-1	4	265
2016		
P01a-1	4	343
P01b-1	4	374
P01c-1	4	438
P53-1	4	413
2017		
P52-1	4	247
2018		
P52-1	4	162

Daily

There are no ASRs that would be subject to exceedance of the daily TSP limit under the Tier 1 mitigated scenario. Therefore, it is not necessary to run the Tier 2 mitigated scenario for daily TSP.

3.6.1.3 Construction Phase Annual Results

The annual results for mitigated and unmitigated scenarios including the background contribution are tabulated in **Appendix 3.30** and are also summarised in **Table 3.21**. There would be exceedances of the annual TSP limit of 80 µg/m^3 under the unmitigated scenario for years 2014 and 2016 only. However, under the mitigated scenario, no ASRs would exceed the annual TSP limit for any of the assessment years.

The locations of the dust sources are shown in **Figures 3.3a** to **3.3k**. **Figures 3.17a** to **3.17h** and **Figures 3.18a** to **3.18h** show the annual TSP concentration contours for unmitigated and mitigated scenarios, respectively.

Table 3.21: Summary of Predicted Cumulative Annual Average TSP Concentrations for All ASRs (Unmitigated & Mitigated)

Year	**Unmitigated Scenario Range of Maximum Annual TSP (µg/m^3) [Criterion - 80 µg/m^3]**	**Mitigated Scenario Range of Maximum Annual TSP (µg/m^3) [Criterion - 80 µg/m^3]**
2013	68 - 76	68 - 70
2014	69 - 81	68 - 75
2015	68 - 79	68 - 79
2016	69 - 84	68 - 78
2017	68 - 79	68 - 71
2018	68 - 78	68 - 72
2019	68 - 75	68 - 71
2020	68 - 75	68 - 74

3.6.2 Operation Phase – Vehicular and Marine Emissions

The predicted air quality results have included the background pollutant levels as extracted from the PATH model for year 2015 based on the latest released model and the cumulative impacts of the following emissions:

- Existing and proposed open roads within the 500 m assessment area;
- Proposed underpasses/landscape decks along the Austin Road West and Lin Cheung Road and the associated top openings under the Road Works at West Kowloon project;
- Existing WHC portal in the vicinity of the WKCD site;

- Ventilation exhausts/portals serving the planned underground roads within the WKCD area;
- Emissions from stationary marine sources at NYPCWA, China Ferry Terminal and Ocean Terminal, and;
- Fast ferry and tug movements within the 500 m assessment area.

Comparison of the predicted cumulative NO_2, RSP and SO_2 concentrations and any exceedances for individual ASRs under all modelled scenarios during the worst case year of 2015 (see **Sections 3.5.2.3** and **3.5.2.5**) can be found in **Appendix 3.31**. For the planned ASRs that will only be in operation in or after 2020, however, the modelling results that are based on the worst case year of 2015 with the highest total road traffic emissions would be overly conservative because those planned ASRs are yet to exist in 2015. As a result, the relevant modelling works for road traffic emissions have been refined for such planned ASRs by adopting the traffic forecast in 2020 and the background concentrations as extracted from the PATH for year 2020 in order to obtain more realistic estimates of the predicted maximum cumulative NO_2 levels. Details of the modelling results using the traffic forecast and background concentrations in 2020 are given in **Appendix 3.32**. The contours for cumulative NO_2, SO_2 and RSP at 1.5m, 12m, 40m, 50m and 60m above ground are shown in **Figure 3.19** to **Figure 3.93**.

According to the modelling results as summarised in **Table 3.22**, all the ASRs would be in compliance with the corresponding AQOs for daily and annual RSP; for hourly, daily and annual SO_2; as well as for hourly, daily and annual NO_2. However, the predicted maximum hourly or daily NO_2 concentrations at some of the ASRs would exceed the corresponding AQO for up to once per year, which is within the allowable numbers of exceedance for hourly NO_2 (3 times per year) and for daily NO_2 (once per year). Details of such hourly and daily NO_2 exceedances, together with the breakdown of NO_2 contributions due to different sources, are summarised in **Table 3.23**.

Table 3.22: Summary of Predicted Cumulative RSP, SO_2 and NO_2 Concentrations for All ASRs

Air Pollutant	Averaging Time	AQO (µg/m^3)	Allowable Exceedances in a Year	Range of Maximum Concentrations (µg/m^3)	Maximum No. of Exceedance in a Year
RSP Note (1)	24 hours	180	1	114.5 – 117.7	0
	1 year	55	0	42.8 – 51.7	0
SO_2 Note (1)	1 hour	800	3	84.7 – 619.1	0
	24 hours	350	1	31.5 – 89.0	0
	1 year	80	0	7.9 – 16.2	0
NO_2 Note (2)	1 hour	300	3	259.7 – 314.9	0 – 1
	24 hours	150	1	108.0 – 150.3	0 – 1
	1 year	80	0	45.0 – 79.7	0

Notes:
(1) The predicted SO_2 and RSP concentrations for all existing and planned ASRs are based on the traffic forecast during the worst-case year of 2015 and the background concentrations as extracted from the PATH for year 2015.
(2) The predicted NO_2 concentrations for existing ASRs and planned ASRs that will be in operation before 2020 are based on the traffic forecast during the worst-case year of 2015 and the background concentrations as extracted from the PATH for year 2015 whereas the predicted NO_2 concentrations for planned ASRs that will be in operation in/after 2020 have been refined based on the traffic forecast in 2020 and the background concentrations as extracted from the PATH for year 2020.

From **Table 3.23**, four existing ASRs, namely, WOB-1, VT1-23, SRT-1 and SRT-2, would be subject to exceedance of the AQO for hourly NO_2 for once a year, which is, however, below the allowable number of exceedances (3 times per year). At two planned ASRs, namely, P09-1 and P37-1, the cumulative maximum daily NO_2 concentrations would marginally exceed the AQO for daily NO_2 by only 0.2 to 0.3 µg/m^3 (about 0.1% to 0.2% of the AQO for daily NO_2) for once per year, which is still within the allowable number of exceedance under the AQO for daily NO_2 (once per year). Therefore, these four existing ASRs and two planned ASRs would still be in compliance with the AQO for hourly NO_2 and daily NO_2 respectively. As noted in **Table 3.3**, ASRs P09-1 and P37-1 are at 4m above ground level, and are therefore assessment points for reference only but not fresh air intake or openable window locations.

It can also be seen from **Table 3.23** that majority (some 78%-81%) of the hourly/daily NO_2 concentrations would be from the background concentration and the remaining 19%-22% would be due to nearby marine traffic/vessel plus road traffic emissions. Of these 19%-22% contributions, the percentage contributions from nearby road traffic emissions for the four existing ASRs would be around 6%-12%, which are lower than the corresponding percentages (some 18%-19%) for the two planned ASRs. As the WKCD Project would only contribute to some road traffic emissions (from the underpass road within WKCD and the flyover across WHC portal), the Project is not the key contributor to the exceedance of hourly or daily NO_2 limits (only once in a year) at the six ASRs.

Table 3.23: Breakdown of Predicted Cumulative NO_2 Concentrations by Sources for ASRs with Potential Exceedance

ASR	Height above ground (m)	Description	Maximum Cumulative Hourly/Daily NO_2 Concentrations (µg/m^3)*						
			Background Contribution		Marine Traffic Contribution		Road Traffic Contribution		Total Concentration$^{\#}$
Hourly NO_2 (AQO: 300 µg/m^3, not to be exceeded for more than 3 times per year)									
WOB-1	6.8	Wing On Building – Block A Residential (Existing ASR)	246.2	80.6%	39.6	13.0%	19.6	6.4%	305.4 [1]
VT1-23	8	The Victoria Towers – Tower 1 Residential (Existing ASR)	246.2	80.3%	41.6	13.6%	18.7	6.1%	306.5 [1]
SRT-1	19	Sorrento – Tower 1 Residential (Existing ASR)	246.2	78.2%	30.0	9.5%	38.7	12.3%	314.9 [1]
SRT-2	23		246.2	81.1%	29.9	9.8%	27.6	9.1%	303.7 [1]
Daily NO_2 (AQO: 150 µg/m^3, not to be exceeded for more than once per year)									
P09-1	4	Office/ Residential (Planned from 2017 onwards)	118.9	79.1%	2.2	1.5%	29.2	19.4%	150.3 [1]
P37-1	4	Retail/ Dining/ Entertainment (Planned from 2017 onwards)	118.9	79.2%	3.7	2.5%	27.6	18.4%	150.2 [1]

*Percentages in shaded cells represent the percentage share of the total concentrations.
$^{\#}$Numbers in bracket refer to the numbers of exceedance per year.

As explained in **Sections 3.4.3** and **3.4.4**, majority of the vehicular emission sources and all marine emission sources are due to respectively the nearby current/planned road networks serving the West Kowloon area and the existing marine activities in the surrounding waters, but not due to the WKCD development itself. To illustrate this, breakdown of the predicted maximum hourly NO_2 contributions due to different sources has been identified at a number of selected ASRs during the worst case year of 2015, as presented in **Table 3.24**. These selected ASRs cover existing ASRs close to but outside the WKCD boundary and planned ASRs representing the various types of future developments (to be operated before 2020) scattering within the entire WKCD area. It can be seen from the Table that 88%-100% of NO_2 contributions would be due to the background concentration plus the surrounding marine traffic emissions, with 12% or less from the nearby road traffic emissions. As the WKCD Project would only result in some road traffic emissions (from the underpass road within WKCD and the flyover across WHC portal), WKCD itself would have very minor contribution to the predicted air quality impacts at the ASRs.

Table 3.24: Breakdown of Predicted Cumulative Hourly NO_2 Concentrations by Sources for Selected ASRs (for the Worst Case Year of 2015)

ASR	Height above ground (m)	Description	Maximum Cumulative Hourly NO_2 Concentrations (µg/m^3)* (AQO: 300 µg/m^3, not to be exceeded for more than 3 times per year)						
			Background Contribution		Marine Traffic Contribution		Road Traffic Contribution		Total Concentration$^{\#}$
WOB-1	6.8	Wing On Building – Block A Residential (Existing ASR)	246.2	80.6%	39.6	13.0%	19.6	6.4%	305.4 [1]
VT1-23	8	The Victoria Towers – Tower 1 Residential (Existing ASR)	246.2	80.3%	41.6	13.6%	18.7	6.1%	306.5 [1]
SRT-1	19	Sorrento – Tower 1 Residential (Existing ASR)	246.2	78.2%	30.0	9.5%	38.7	12.3%	314.9 [1]
SRT-2	23		246.2	81.1%	29.9	9.8%	27.6	9.1%	303.7 [1]
P01a-1	4	Planned performance art venue (Planned ASR from 2015 onwards)	246.2	86.0%	40.0	14.0%	0.1	0.0%	286.3
P01a-3	12		246.2	86.1%	39.9	13.9%	0.0	0.0%	286.1
P01a-5	20		246.2	86.1%	39.7	13.9%	0.0	0.0%	285.9
P01a-7	40		246.2	87.5%	35.2	12.5%	0.0	0.0%	281.4
P09-1	4	Office/ Residential (Planned ASR from 2017 onwards)	246.2	87.3%	35.9	12.7%	0.0	0.0%	282.1
P09-3	12		246.2	87.5%	35.2	12.5%	0.0	0.0%	281.4
P09-5	20		246.2	87.9%	33.8	12.1%	0.0	0.0%	280.0
P09-7	40		277.2	99.2%	2.2	0.8%	0.0	0.0%	279.4
P10-1	4	Office + Retail/ Dining/ Entertainment Residential (Planned ASR from 2017 onwards)	246.2	85.8%	40.9	14.2%	0.0	0.0%	287.1
P10-3	12		246.2	85.8%	40.8	14.2%	0.0	0.0%	287.0
P10-5	20		246.2	85.9%	40.5	14.1%	0.0	0.0%	286.7
P10-8	50		246.2	88.1%	33.4	11.9%	0.0	0.0%	279.6
P16-1	4	Retail/ Dining/ Entertainment Residential (Planned ASR from 2018 onwards)	277.2	99.4%	1.8	0.6%	0.0	0.0%	279.0
P16-3	12		277.2	99.4%	1.7	0.6%	0.0	0.0%	278.9
P16-5	20		277.2	99.4%	1.7	0.6%	0.0	0.0%	278.9
P16-8	50		277.2	99.5%	1.3	0.5%	0.0	0.0%	278.5
P29-1	4	Office + Retail/ Dining/ Entertainment Residential	277.2	99.8%	0.5	0.2%	0.1	0.0%	277.8
P29-3	12		277.2	99.8%	0.5	0.2%	0.0	0.0%	277.7
P29-5	20		277.2	99.8%	0.5	0.2%	0.0	0.0%	277.7

ASR	Height above ground (m)	Description	Maximum Cumulative Hourly NO_2 Concentrations (µg/m^3)* (AQO: 300 µg/m^3, not to be exceeded for more than 3 times per year)						
			Background Contribution		Marine Traffic Contribution		Road Traffic Contribution		Total Concentration#
P29-10	70	(Planned ASR from 2018 onwards)	277.2	99.9%	0.4	0.1%	0.0	0.0%	277.6
P35c-1	4	Planned performance art venue (Planned ASR from 2017 onwards)	277.2	99.6%	1.1	0.4%	0.0	0.0%	278.3
P35c-3	12		277.2	99.6%	1.1	0.4%	0.0	0.0%	278.3
P35c-5	20		277.2	99.6%	1.1	0.4%	0.0	0.0%	278.3
P37-1	4	Retail/ Dining/ Entertainment (Planned ASR from 2017 onwards)	246.2	88.1%	6.7	2.4%	26.6	9.5%	279.5
P37-3	12		277.2	99.6%	0.1	0.0%	1.0	0.4%	278.3
P37-5	20		277.2	99.7%	0.1	0.0%	0.8	0.3%	278.1
P37-10	70		277.2	100.0%	0.0	0.0%	0.0	0.0%	277.2
P51-1	4	Freespace (Planned ASR from 2016 onwards)	277.2	99.9%	0.2	0.1%	0.0	0.0%	277.4
P51-3	12		277.2	99.9%	0.2	0.1%	0.0	0.0%	277.4
P51-5	20		277.2	99.9%	0.2	0.1%	0.0	0.0%	277.4
P52-1	4	Pavilion (Planned ASR from 2016 onwards)	277.2	100.0%	0.0	0.0%	0.0	0.0%	277.2
P52-3	12		277.2	100.0%	0.0	0.0%	0.0	0.0%	277.2
P52-5	20		277.2	100.0%	0.0	0.0%	0.0	0.0%	277.2
OP	1.5	Open Space (Planned ASR from 2017 onwards)	277.2	100.0%	0.0	0.0%	0.0	0.0%	277.2

*Percentages in shaded cells represent the percentage share of the total concentrations.
#Numbers in bracket refer to the numbers of exceedance per year.

To illustrate the predicted air quality impacts in 2020, breakdown of the predicted maximum hourly NO_2 contributions due to different sources has also been identified by adopting the traffic forecast and background concentrations for the year of 2020 at selected ASRs, as presented in **Table 3.25**. The selected ASRs cover existing ASRs close to but outside the WKCD boundary and planned ASRs representing the future developments within WKCD, particularly those in the vicinity of the WHC portal. It can be seen from the Table that 73%-100% of NO_2 contributions would be due to the background concentration plus the surrounding marine traffic emissions, with 27% or less from the nearby road traffic emissions. The NO_2 contributions from nearby road traffic for P43d and P43e at not more than 12m above ground (21%-27%) are much higher than those for other ASRs (0.0%-8.9%), chiefly because of their proximity to the WHC portal. Another observation is that the cumulative maximum hourly NO_2 concentrations of the existing ASRs in 2020 would be considerably lower than those in 2015 (i.e., **Table 3.24**), indicating an appreciable extent of improvement in air quality from 2015 to 2020.

Table 3.25: Breakdown of Predicted Cumulative Hourly NO_2 Concentrations by Sources for Selected ASRs (for Year 2020)

ASR	Height above ground (m)	Description	Maximum Cumulative Hourly NO_2 Concentrations (µg/m^3)* (AQO: 300 µg/m^3, not to be exceeded for more than 3 times per year)						
			Background Contribution		Marine Traffic Contribution		Road Traffic Contribution		Total Concentration
WOB-1	6.8	Wing On Building – Block A Residential	259.7	97.1%	4.9	1.8%	2.9	1.1%	267.5

ASR	Height above ground (m)	Description	Maximum Cumulative Hourly NO_2 Concentrations ($\mu g/m^3$)* (AQO: 300 $\mu g/m^3$, not to be exceeded for more than 3 times per year)						
			Background Contribution		Marine Traffic Contribution		Road Traffic Contribution		Total Concentration
		(Existing ASR)							
VT1-23	8	The Victoria Towers – Tower 1 Residential (Existing ASR)	214.5	74.5%	61.7	21.4%	11.7	4.1%	287.9
SRT-1	19	Sorrento – Tower 1 Residential (Existing ASR)	214.5	79.9%	30.0	11.2%	23.8	8.9%	268.3
SRT-2	23		259.7	98.8%	0.0	0.0%	3.1	1.2%	262.8
P37-1	4	Retail/ Dining/ Entertainment (Planned ASR from 2017 onwards)	259.7	98.8%	0.1	0.0%	3.0	1.1%	262.8
P37-3	12		259.7	98.9%	0.1	0.0%	2.7	1.0%	262.5
P37-5	20		259.7	99.0%	0.1	0.0%	2.4	0.9%	262.2
P37-10	70		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P39-1	4	Office + Planned performance art venues (Planned ASR from 2020 onwards)	259.7	99.0%	0.1	0.0%	2.6	1.0%	262.4
P39-3	12		259.7	99.4%	0.1	0.0%	1.5	0.6%	261.3
P39-5	20		259.7	99.7%	0.1	0.0%	0.7	0.3%	260.5
P39-10	70		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43a-1	4	Hotel + Retail/ Dining/ Entertainment (Planned ASR from 2020 onwards)	259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43a-3	12		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43a-4	16		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43b-1	4	Ditto	259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43b-3	12		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43b-5	20		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43c-1	4	Ditto	259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43c-3	12		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43c-5	20		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43d-1	4	Ditto	202.8	72.6%	2.7	1.0%	73.9	26.4%	279.4
P43d-3	12		202.8	77.3%	2.7	1.0%	56.7	21.6%	262.2
P43d-5	20		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43d-7	40		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43e-1	4	Ditto	202.8	72.2%	3.2	1.1%	74.9	26.7%	280.9
P43e-3	12		202.8	77.5%	3.2	1.2%	55.8	21.3%	261.8
P43e-5	20		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43e-8	50		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43f-1	4	Ditto	259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43f-3	12		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43f-5	20		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43f-8	50		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43g-1	4	Ditto	259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43g-3	12		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7

ASR	Height above ground (m)	Description	Maximum Cumulative Hourly NO_2 Concentrations (µg/m^3)* (AQO: 300 µg/m^3, not to be exceeded for more than 3 times per year)						
			Background Contribution		Marine Traffic Contribution		Road Traffic Contribution		Total Concentration
P43g-5	20		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43g-7	40		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43h-1	4	Ditto	259.7	100.0%	0.0	0.0%	0.1	0.0%	259.8
P43h-3	12		259.7	100.0%	0.0	0.0%	0.1	0.0%	259.8
P43h-5	20		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43h-7	40		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43i-1	4	Ditto	259.7	99.9%	0.0	0.0%	0.2	0.1%	259.9
P43i-3	12		259.7	100.0%	0.0	0.0%	0.1	0.0%	259.8
P43i-5	20		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43i-6	30		259.7	100.0%	0.0	0.0%	0.0	0.0%	259.7
P43j-1	4	Ditto	259.7	99.9%	0.0	0.0%	0.3	0.1%	260.0
P43j-3	12		259.7	99.9%	0.0	0.0%	0.2	0.1%	259.9
P43j-5	20		259.7	100.0%	0.0	0.0%	0.1	0.0%	259.8
P43k-1	4	Ditto	259.7	99.9%	0.0	0.0%	0.3	0.1%	260.0
P43k-3	12		259.7	99.9%	0.0	0.0%	0.2	0.1%	259.9
P43k-4	16		259.7	100.0%	0.0	0.0%	0.1	0.0%	259.8

*Percentages in shaded cells represent the percentage share of the total concentrations.

3.6.3 Operation Phase – Odour Emissions

3.6.3.1 Odour Patrol Results

The odour patrol was carried out in March 2011 by the HOKLAS accredited laboratory. According to the odour patrol results (as detailed in **Appendix 3.26a**), malodour was only detected surrounding the watercourse boundary of northern portion of NYMTTS, i.e., along the route from P2 to P3 in Figure 1 in **Appendix 3.26a**, whereas no malodour was found along the patrol route from P1 to P2 including the adjoining boundary between NYMTTS and WKCD site. During the on-site measurement and odour sampling, calm wind conditions were recorded, which is generally an unfavourable condition for atmospheric dispersion or dilution of air pollutants including odour. Therefore, the malodour detected at various locations along NYMTTS boundary, particularly locations C and F as shown in Figure 1 in **Appendix 3.26a**, during the odour patrol would likely be due to odour episode from their immediate vicinity, i.e., the two box culvert outfalls as shown in **Figure 3.9**.

The odour patrol result is consistent with the records of odour complaint against NYMTTS received by EPD from 2006 to 2013 (up to April 2013), during which a total of six odour complaints were received. All the complainants were located around the northern portion of NYMTTS.

3.6.3.2 Odour Source Monitoring Results

Odour Emission Rates

The Odour Emission Rate (OER) estimated for individual grids of NYMTTS based on the odour source monitoring results in August 2012 as well as the odour review results in February and March 2013 are summarised in **Table 3.26**. The odour source monitoring and review results are given in **Appendix 3.26b**, while details of the estimated OERs are documented in **Appendix 3.26c**. It can be seen from the **Table 3.26** that relatively higher OERs and sewage/rotten egg odour are found in the grids in vicinity of the two box culvert outfalls as shown in **Figures 3.9**, which are identified as the major source of odour from NYMTTS. Inflammable material odour was detected at some of the grids. Elevated OERs associated with sewage odour are consistently associated with high H_2S level indicating that the odour would mainly be from anaerobic decomposition of organic matters discharged into NYMTTS.

The odour identified for grids 1-4, 6, 11-12, 17-18 and 26 was perceived as sea water odour with a hedonic tone of zero (i.e., neutral or no odour), which is of the same odour quality at the two control stations. An odour with a hedonic tone of zero is considered to be neutral and neither pleasant nor offensive.

The aforementioned OER values are calculated from low tide, typical hot day emission rates and have been assumed to occur for the entire hour, for every hour for the whole modelling period, i.e., 24 hours a day, 365 days per year.

Odours from different sources can undergo various phenomena, one of which is masking, whereby the presence of one odour can disguise, or mask, the presence of a second. Different odorants may also interact. This can cause interactive or ‘synergistic’ effects, such that the sum of the odorants may be either greater than or less than the intensity of the odour components. In practice, odours from significantly different sources and with different characters are usually neither additive nor synergistic, but instead one source tends to dominate, or mask, the presence of the other.

Dispersion models assume a conservation of mass of contaminants, that is the odour intensity of a mixture of two different odorous sources are considered to be additive. Odour modelling is not able to predict synergistic or masking effects, and to that effect, modelling a pleasant and offensive odour source in parallel would produce one overall ‘odour’ intensity, which would not be representative of, the different hedonic tones of the individual odours, the relative decrease in intensity of the individual odours or the potential for one odour to mask the other.

Sea-water has a neutral tone and is generally considered to be non-offensive, and is assumed to be masked by the offensive odour (e.g., sewage/rotten egg odour), however as Annex 4 of the EIAO-TM does not allow for a differentiation between the types of odours, the emissions for all grids have been modelled in parallel.

Table 3.26 Estimated Odour Emission Rates for NYMTTS

Grid No.	Estimated OER ($ou/m^2/s$)	On-site Ambient H_2S Concentration (ppm)	Odour Quality [Median Hedonic Tone]
1	0.032	<0.003	Sea water [0]
2	0.032	<0.003	Sea water [0]

Grid No.	Estimated OER (ou/m^2/s)	On-site Ambient H_2S Concentration (ppm)	Odour Quality [Median Hedonic Tone]
3	0.032	<0.003	Sea water [0]
4	0.032	<0.003	Sea water [0]
5	0.997	0.153	Sewage/Sewage odour - Rotten egg [-2]
6	0.032	<0.003	Sea water [0]
7	1.322	1.367	Sewage/Sewage odour - Rotten egg [-4]
8	0.130	0.022	Sewage/Sewage odour - Rotten egg, Seawater [-1]
9	0.205	0.563	Sewage/Sewage odour - Rotten egg [-3]
10	0.093	0.117	Sewage/Sewage odour - Rotten egg [-1]
11	0.032	<0.003	Sea water [0]
12	0.032	<0.003	Sea water [0]
13	0.520	0.004	Inflammable materials odour [-1]
14	0.033	0.018	Sewage/Sewage odour - Rotten egg, Seawater [-1]
15	0.032	<0.003	Inflammable materials odour [-1]
16	0.032	<0.003	Inflammable materials odour [-1]
17	0.032	<0.003	Sea water [0]
18	0.032	<0.003	Sea water [0]
19	0.032	<0.003	Inflammable materials odour [-1]
20	0.175	0.063	Sewage/Sewage odour - Rotten egg, Seawater [-1]
21	0.148	0.040	Sewage/Sewage odour - Rotten egg, Seawater [-1]
22	0.228	0.433	Sewage/Sewage odour - Rotten egg, Seawater [-2]
23	0.830	0.397	Sewage/Sewage odour - Rotten egg [-2]
24	0.071	0.038	Sewage/Sewage odour - Rotten egg, Seawater [-1]
25	0.032	0.004	Sewage/Sewage odour - Rotten egg, Seawater [-1]
26	0.160	<0.003	Sea water [0]
27	0.052	0.006	Sewage/Sewage odour - Rotten egg, Seawater [-1]
28	0.113	0.403	Sewage/Sewage odour - Rotten egg [-2]
29	1.129	0.983	Sewage/Sewage odour - Rotten egg [-3]
30	2.702	1.267	Sewage/Sewage odour - Rotten egg [-4]
Control 1	0.032	<0.003	Sea water [0]
Control 2	0.032	<0.003	Sea water [0]

Note: Shaded cells indicate the grids with relatively higher OER values and hydrogen sulfide levels.

Major Odour Source

A multi-dimensional analysis of the odour profile from the NYMTTS was performed to determine the major source of odour. As such, the odour concentrations were determined from air-bound, water-bound and sediment-bound sources. The various contributions were normalised against the air-bound odour concentrations. It was found that majority of the odour would be contributed from water and minority from sediment. Unlike other locations that were found to have odour problems such as Kai Tak Nullah and Shing Mun River, the major odour source for NYMTTS is not from its sediment. In other words, the malodour emissions from NYMTTS would mainly be water-bound odour. More information can be found in **Appendix 3.26b**.

3.6.3.3 Odour Modelling Results

Based on the OERs as presented in **Appendix 3.34**, the ten scenarios as detailed in **Section 3.5.5.5** have been modelled to predict the odour impacts on the planned ASRs within WKCD (see **Figure 3.1b**). The predicted maximum odour concentrations and numbers of exceedance over the odour criterion (5 ou/m^3) for the various scenarios are summarised in **Table 3.27**. In the Table, the ASRs are grouped as residential ASRs and non-residential ASRs. The former refer to those that have been planned for residential use whereas the latter refer to those that have been planned for such non-residential uses as offices, retails, hotels, performance venues, open space, etc. In other words, most of the non-residential ASRs represent potential fresh air intake locations for such developments, with some representing open space. Full tabular odour modelling results can be found in **Appendix 3.35.**

The contours of 5-second odour concentrations within the WKCD site under the ten scenarios are shown in **Figures 3.94** to **3.103**.

Table 3.27 Summary of Odour modelling Results

		Current Scenario	Mitigated Scenario A for Different Ratios*				Mitigated Scenario B for Different Ratios*				Back-ground Scenario
			1:1	1:0.75	1:0.5	1:0.25	1:1	1:0.75	1:0.5	1:0.25	
Residential	No. of ASR exceeding 5 ou/m^3	22	2	7	12	17	20	20	21	21	0
	Total no. of ASR assessed	65	65	65	65	65	65	65	65	65	65
	Range of predicted maximum odour concentration (ou/m^3)	2.6 – 9.1	1.5 – 5.1	1.9 – 6.3	2.1 – 7.3	2.4 – 8.2	2.2 – 8.1	2.4 – 8.5	2.4 – 8.7	2.5 – 8.9	0.6 – 2.0
	Predicted maximum no. of exceedance in a year#	33 [0.4%]	6 [0.1%]	18 [0.2%]	27 [0.3%]	32 [0.4%]	28 [0.3%]	28 [0.3%]	29 [0.3%]	33 [0.4%]	0 [0%]
Non-Residential	ASR exceeding 5 ou/m^3	355	60	190	260	310	330	338	343	351	0
	Total no. of ASR assessed	473	473	473	473	473	473	473	473	473	473
	Range of predicted maximum odour concentration (ou/m^3)	2.2 – 13.7	1.2 – 8.5	1.5 – 9.8	1.7 – 11.1	1.9 – 12.4	1.7 – 13.7	1.8 – 13.7	1.9 – 13.7	2.1 – 13.7	0.6 – 4.0
	Predicted maximum no. of exceedance in a year#	218 [2.5%]	76 [0.9%]	99 [1.1%]	136 [1.6%]	187 [2.1%]	190 [2.2%]	199 [2.3%]	205 [2.3%]	213 [2.4%]	0 [0%]

*Ratios of reduction in effluent discharges or organic matters entering NYMTTS to reduction in water-bound odour emissions.
#Percentages inside bracket represent the % of hours with exceedance in a year.

The background model represents the odour emitted from NYMTTS and the surrounding 500 m of seawater should foul water not enter from the box culverts. The background values are considered to be the lowest possible odour level achievable at the receivers. The background odour scenario modelling results shows a range of 0.6 to 2.0 ou/m^3 for residential ASRs and 0.6 to 4.0 ou/m^3 for non-residential ASRs. The receivers modelled show that no residential or non-residential ASRs are expected to exceed the 5 ou/m^3 criterion.

During the current odour scenario, the predicted maximum results indicate exceedance of the odour criterion of 5 ou/m^3 at 22 of the 65 residential receivers and 355 of the 473 non-residential receivers. The range of odour concentrations is from 2.6 to 9.1 ou/m^3 for residential receivers and from 2.2 to 13.7 ou/m^3 for non-residential receivers. Residential ASRs are expected to exceed the criterion for up to 33 hours per year (or up to 0.4% of the time in a year) and non-residential ASRs for up to 218 hours per year (or up to 2.5% of the time in a year). The values represent a hypothetical worst case scenario where odour from NYMTTS was assumed to be continuously released throughout every day at the same rates as the OERs that were obtained during the sampling on hot summer days.

The odour patrol results and odour monitoring results have identified that odour emission from NYMTTS is mainly due to discharge from the two box culverts. If the amount of such effluent discharge entering the stormwater system decreases, which ultimately is released into NYMTTS, the water-bound malodour is expected to decrease, and therefore the OER from the NYMTTS would be expected to reduce (**Section 3.7.3.1**).

The modelling results of mitigated scenario A (reduction of effluent discharge from both Cherry Street and Jordon Road Box Culverts) show that 2 to 17 of the 65 planned residential ASRs are expected to exceed the 5 ou/m^3 criterion, and their odour concentrations range from 1.5 to 8.2 ou/m^3. For non-residential ASRs, 60 to 310 of the 473 planned receivers are expected to exceed the odour criterion, and their odour concentrations range from 1.2 to 12.4 ou/m^3. Residential ASRs are expected to exceed the criterion for up to 32 hours per year (or up to 0.4% of the time in a year) and non-residential ASRs for up to 187 hours per year (or up to 2.1% of the time in a year).

For the mitigated scenario B (reduction of effluent discharge from only the Cherry Street Box Culvert), the modelling results show that 20 to 21 of the 65 planned residential ASRs are expected to exceed the 5 ou/m^3 criterion, and their odour concentrations range from 2.2 to 8.9 ou/m^3. For non-residential ASRs, 330 to 351 of the 473 planned receivers are expected to exceed the odour criterion, and their concentrations range from 1.7 to 13.7 ou/m^3. Residential ASRs are expected to exceed the criterion for up to 33 hours per year (or up to 0.4% of the time in a year) and non-residential ASRs for up to 213 hours per year (or up to 2.4% of the time in a year).

The mitigated odour results show decreases in the predicted odour impacts when the Dry Weather Flow Interceptors (DWFI) upstream of NYMTTS are improved to achieve an interception efficiency of 80%, as discussed in **Section 3.7.3.1** and **Appendix 3.34**. As expected, the mitigated scenario A would generally result in lower odour impacts that the mitigated scenario B. However, the extent of odour impact reduction would depend on the level of reduction in water-bound odour emission that could be achieved by reducing the organic matters entering the NYMTTS.

It should be noted that the odour modelling results are considered conservative for a number of reasons as follows:

- It is expected odour emissions from NYMTTS in night time or non-summer months would be smaller due to lower sea temperatures and hence slower rate of odour release from anaerobic digestion and fermentation of organic matters and therefore the actual rate of exceedance during the current or mitigated scenarios would be lower than the model results. According to the "*Baseline Odour Sampling Report – Executive Summary*" completed for the Kai Tak Development project, odour monitoring was carried out to determine the baseline odour emissions from the water surface of the Kai Tak Approach Channel (KTAC) in March 2010 , August 2010 and February 2011 before any implementation of the improvement works. The OERs obtained in the three months showed substantial seasonal variations. In particular, the OERs obtained at two sampling locations at northern KTAC in March 2010 and February 2011 (non-summer months) were roughly 7% to 20% of the OERs measured in August 2010 (a summer month);
- The odour complaints in the previous 7 years as shown in **Table 3.8** are low, which also suggests a considerable amount of conservatism within the modelling results, therefore the actual rate of exceedance during the current scenario is expected to be lower than the model results; and
- Variation in the odour emission rate could be expected due to tidal variation, that is, at high tide the water available for dilution of the stormwater is increased, which would be expected to dilute the odour emission rate. A variation in the OER would also be expected during rainfall periods, due to the dilution and mixing of the stormwater, therefore the actual rate of exceedance during the current scenario would be lower than the model results.

To facilitate further analysis of the modelling results, **Table 3.28** to **Table 3.30** show the predicted maximum odour concentrations and numbers of exceedance during day-time and night-time of individual months under the current scenario, mitigated scenario A and mitigated scenario B. It can be seen from the Tables that exceedance of the odour criterion would not occur at any residential ASRs during day-time throughout a year, but would only occasionally happen during night-time (not more than 0.7% of the time in a month). It should be noted that the OERs at night-time would be lower than those at day-time due to the generally cooler water at night, and hence the odour exceedance at night-time is expected to be even lower than the predicted values in the Tables.

For non-residential ASRs, there would only be occasional exceedance of the odour criterion at day-time in January, October and December only (not more than 0.8% of the time in a month). While the predicted maximum odour exceedance percentages for non-residential ASRs during the night-time in February, March, April, October, November and December appear to be relatively higher than those in other months, these months are not in summer with generally lower water temperatures. Therefore, it is anticipated that the odour concentrations or exceedance percentages for the non-residential ASRs in these non-summer months would be lower than the predicted values in **Table 3.28** to **Table 3.30**.

While the mitigated odour modelling results show a number of ASRs to be in exceedance of the 5 ou/m^3 criterion, it is important to note that WKCD does not contribute to the odour emitted from NYMTTS.

Table 3.28 Breakdown of Odour modelling Results under Current Scenario

Month	Predicted maximum odour concentration (ou/m^3)				Predicted maximum no. of exceedance in a month(3)			
	Residential ASRs		Non-residential ASRs		Residential ASRs		Non-residential ASRs	
	Day-time(1)	Night-time(2)	Day-time	Night-time	Day-time	Night-time	Day-time	Night-time
Jan	1.9	7.2	5.7	9.3	0 [0.0%]	1 [0.1%]	1 [0.1%]	8 [1.1%]
Feb	2.3	8.6	4.1	13.7	0 [0.0%]	3 [0.4%]	0 [0.0%]	16 [2.4%]
Mar	1.5	7.6	3.2	13.7	0 [0.0%]	2 [0.3%]	0 [0.0%]	19 [2.6%]
Apr	0.7	9.0	3.9	13.2	0 [0.0%]	2 [0.3%]	0 [0.0%]	21 [2.9%]
May	1.3	9.1	3.2	11.9	0 [0.0%]	4 [0.5%]	0 [0.0%]	9 [1.2%]
Jun	2.7	9.0	2.8	10.6	0 [0.0%]	3 [0.4%]	0 [0.0%]	5 [0.7%]
Jul	0.6	9.1	1.3	11.3	0 [0.0%]	5 [0.7%]	0 [0.0%]	6 [0.8%]
Aug	2.6	8.5	4.2	11.6	0 [0.0%]	3 [0.4%]	0 [0.0%]	15 [2.0%]
Sep	2.3	9.1	3.4	13.7	0 [0.0%]	1 [0.1%]	0 [0.0%]	18 [2.5%]
Oct	1.7	5.9	5.8	12.3	0 [0.0%]	1 [0.1%]	3 [0.4%]	31 [4.2%]
Nov	2.7	9.1	3.8	13.6	0 [0.0%]	3 [0.4%]	0 [0.0%]	17 [2.4%]
Dec	2.8	8.7	11.9	13.7	0 [0.0%]	5 [0.7%]	6 [0.8%]	43 [5.8%]

Notes: (1) Day-time means 7am to 7pm.
- (2) Night-time means 7pm to 7am.
(3) Percentages inside bracket represent the % of hours with exceedance in a month.
- (4) Shaded cells represent results during summer months.

Table 3.29 Breakdown of Odour modelling Results under Mitigated Scenario A

Month	Predicted maximum odour concentration (ou/m^3)				Predicted maximum no. of exceedance in a month(3)			
	Residential ASRs		Non-residential ASRs		Residential ASRs		Non-residential ASRs	
	Day-time(1)	Night-time(2)	Day-time	Night-time	Day-time	Night-time	Day-time	Night-time
Jan	1.7	6.5	5.2	8.4	0 [0.0%]	1 [0.1%]	1 [0.1%]	8 [1.1%]
Feb	2.1	7.7	3.7	12.4	0 [0.0%]	3 [0.4%]	0 [0.0%]	16 [2.4%]
Mar	1.3	6.8	2.9	12.4	0 [0.0%]	1 [0.1%]	0 [0.0%]	17 [2.3%]
Apr	0.6	8.1	3.6	12.0	0 [0.0%]	2 [0.3%]	0 [0.0%]	18 [2.5%]
May	1.2	8.1	2.9	10.9	0 [0.0%]	4 [0.5%]	0 [0.0%]	8 [1.1%]
Jun	2.4	8.1	2.6	9.5	0 [0.0%]	3 [0.4%]	0 [0.0%]	5 [0.7%]
Jul	0.6	8.2	1.3	10.1	0 [0.0%]	5 [0.7%]	0 [0.0%]	5 [0.7%]
Aug	2.4	7.7	3.8	10.7	0 [0.0%]	3 [0.4%]	0 [0.0%]	12 [1.6%]
Sep	2.1	8.2	3.1	12.4	0 [0.0%]	1 [0.1%]	0 [0.0%]	14 [1.9%]
Oct	1.6	5.3	5.3	11.2	0 [0.0%]	1 [0.1%]	2 [0.3%]	20 [2.7%]
Nov	2.4	8.2	3.5	12.3	0 [0.0%]	3 [0.4%]	0 [0.0%]	15 [2.1%]
Dec	2.5	7.8	10.8	12.4	0 [0.0%]	5 [0.7%]	6 [0.8%]	40 [5.4%]

Notes: (1) Day-time means 7am to 7pm.
- (2) Night-time means 7pm to 7am.
(3) Percentages inside bracket represent the % of hours with exceedance in a month.
- (4) Shaded cells represent results during summer months.

Table 3.30 Breakdown of Odour modelling Results under Mitigated Scenario B

Month	Predicted maximum odour concentration (ou/m^3)				Predicted maximum no. of exceedance in a month(3)			
	Residential ASRs		Non-residential ASRs		Residential ASRs		Non-residential ASRs	
	Day-time(1)	Night-time(2)	Day-time	Night-time	Day-time	Night-time	Day-time	Night-time
Jan	1.8	7.1	5.7	9.2	0 [0.0%]	1 [0.1%]	1 [0.1%]	8 [1.1%]
Feb	2.3	8.4	4.0	13.7	0 [0.0%]	3 [0.4%]	0 [0.0%]	16 [2.4%]
Mar	1.4	7.4	3.2	13.7	0 [0.0%]	2 [0.3%]	0 [0.0%]	19 [2.6%]
Apr	0.7	8.7	3.8	13.1	0 [0.0%]	2 [0.3%]	0 [0.0%]	20 [2.8%]
May	1.3	8.8	3.1	11.7	0 [0.0%]	4 [0.5%]	0 [0.0%]	9 [1.2%]
Jun	2.6	8.8	2.7	10.3	0 [0.0%]	3 [0.4%]	0 [0.0%]	5 [0.7%]
Jul	0.6	8.9	1.3	11.0	0 [0.0%]	5 [0.7%]	0 [0.0%]	6 [0.8%]
Aug	2.6	8.4	4.1	11.2	0 [0.0%]	3 [0.4%]	0 [0.0%]	15 [2.0%]
Sep	2.2	8.9	3.4	13.7	0 [0.0%]	1 [0.1%]	0 [0.0%]	17 [2.4%]
Oct	1.7	5.8	5.7	12.2	0 [0.0%]	1 [0.1%]	3 [0.4%]	30 [4.0%]
Nov	2.6	8.9	3.8	13.6	0 [0.0%]	3 [0.4%]	0 [0.0%]	16 [2.2%]
Dec	2.7	8.6	11.6	13.7	0 [0.0%]	5 [0.7%]	6 [0.8%]	42 [5.6%]

Notes: (1) Day-time means 7am to 7pm.
(2) Night-time means 7pm to 7am.
(3) Percentages inside bracket represent the % of hours with exceedance in a month.
(4) Shaded cells represent results during summer months.

3.6.3.4 Optional Waste Facilities

Should the optional automatic waste collection facility be adopted for the WKCD Project, such facility will be located at basement levels to avoid any potential odour issues. In addition, the following odour containment and control measures, where necessary, will be provided:

- The waste facilities will be totally enclosed. Negative pressure ventilation will be provided within the enclosures to avoid any fugitive odorous emission from the facilities. In addition, any waste storage tanks will be connected to deodorisation facilities directly to eliminate the odour problem.
- Air inside the enclosures will be collected by air handling equipment for containing and directing odorous gases to deodorisation facilities.
- Deodorisation facilities by chemical, biological or physical methods (e.g. adsorption by activated carbon) with a minimum odour removal efficiency of 95% will be provided to treat potential odorous emissions from the facilities so as to minimise any potential odour impact to the nearby ASRs.

With the proper locations of the optional waste facility and the above odour containment and control measures in place to substantially confine and reduce the potential odour emissions at sources, it is anticipated that there would not be significant odour impact on the nearby ASRs.

3.7 Mitigation Measures

3.7.1 Construction Phase

3.7.1.1 General Dust Control Measures

To ensure compliance with the TSP criteria during the construction phase, the relevant requirements stipulated in the *Air Pollution Control (Construction Dust) Regulation* and EPD's *Guidance Note on the Best Practicable Means for Cement Works (Concrete Batching Plant) BPM 3/2(93)* as well as the good practices for dust control should be implemented to reduce the dust impact. The dust control measures are detailed as follows:

Dust emissions could be suppressed by regular water spraying on site. In general, water spraying twice a day could reduce dust emission from active construction area by 50%. However, for this WKCD Project, more frequent water spraying, i.e., 12 times a day or once every hour, is required for heavy construction activities at all active works area in order to achieve a higher dust suppression efficiency of 91.7% to reduce the dust impacts to acceptable levels. A watering intensity of 3.75 L/m^2, 12 times a day or once every hour, is predicted to achieve 91.7% dust suppression efficiency. Detailed calculations can be found in **Appendix 3.8**. Heavy construction activities include construction of roads, drilling, ground excavation, cut and fill operations (i.e., earth moving), etc.

3.7.1.2 Best Practices for Dust Control

In addition to implementing the recommended dust control measures mentioned above, it is recommended that the relevant best practices for dust control as stipulated in the *Air Pollution Control (Construction Dust) Regulation* should also be adopted to further reduce the construction dust impacts of the Project. These best practices include:

Good Site Management

- Good site management is important to help reducing potential air quality impact down to an acceptable level. As a general guide, the Contractor should maintain high standard of housekeeping to prevent emission of fugitive dust. Loading, unloading, handling and storage of raw materials, wastes or by-products should be carried out in a manner so as to minimise the release of visible dust emission. Any piles of materials accumulated on or around the work areas should be cleaned up regularly. Cleaning, repair and maintenance of all plant facilities within the work areas should be carried out in a manner minimising generation of fugitive dust emissions. The material should be handled properly to prevent fugitive dust emission before cleaning.

Disturbed Parts of the Roads

- Each and every main temporary access should be paved with concrete, bituminous hardcore materials or metal plates and kept clear of dusty materials; or
- Unpaved parts of the road should be sprayed with water or a dust suppression chemical so as to keep the entire road surface wet.

Exposed Earth

- Exposed earth should be properly treated by compaction, hydroseeding, vegetation planting or seating with latex, vinyl, bitumen within six months after the last construction activity on the site or part of the site where the exposed earth lies.

Loading, Unloading or Transfer of Dusty Materials

- All dusty materials should be sprayed with water immediately prior to any loading or transfer operation so as to keep the dusty material wet.

Debris Handling

- Any debris should be covered entirely by impervious sheeting or stored in a debris collection area sheltered on the top and the three sides.
- Before debris is dumped into a chute, water should be sprayed so that it remains wet when it is dumped.

Transport of Dusty Materials

- Vehicle used for transporting dusty materials/spoils should be covered with tarpaulin or similar material. The cover should extend over the edges of the sides and tailboards.

Wheel washing

- Vehicle wheel washing facilities should be provided at each construction site exit. Immediately before leaving the construction site, every vehicle should be washed to remove any dusty materials from its body and wheels.

Use of vehicles

- The speed of the trucks within the site should be controlled to about 10km/hour in order to reduce adverse dust impacts and secure the safe movement around the site.
- Immediately before leaving the construction site, every vehicle should be washed to remove any dusty materials from its body and wheels.
- Where a vehicle leaving the construction site is carrying a load of dusty materials, the load should be covered entirely by clean impervious sheeting to ensure that the dusty materials do not leak from the vehicle.

Site hoarding

- Where a site boundary adjoins a road, street, service lane or other area accessible to the public, hoarding of not less than 2.4m high from ground level should be provided along the entire length of that portion of the site boundary except for a site entrance or exit.

3.7.1.3 Best Practices for Concrete Batching Plant

It is recommended that the relevant best practices for dust control as stipulated in the *Guidance Note on the Best Practicable Means for Cement Works (Concrete Batching Plant) BPM 3/2* should also be adopted to further reduce the construction dust impacts of the Project. These include:

Exhaust from Dust Arrestment Plant

- Wherever possible the final discharge point from particulate matter arrestment plant, where is not necessary to achieve dispersion from residual pollutants, should be at low level to minimise the effect on the local community in the case of abnormal emissions and to facilitate maintenance and inspection

Emission Limits

- All emissions to air, other than steam or water vapour, shall be colourless and free from persistent mist or smoke

Engineering Design/Technical Requirements

- As a general guidance, the loading, unloading, handling and storage of fuel, raw materials, products, wastes or by-products should be carried out in a manner so as to prevent the release of visible dust and/or other noxious or offensive emissions

Detailed mitigation methods and guidance can be found in the stand-alone EM&A Manual.

3.7.2 Operation Phase – Vehicular and Marine Emissions

Since it has been assessed that all the ASRs would be in compliance with all the relevant AQOs for SO_2, NO_2 and RSP, no mitigation measures for vehicular or marine traffic emissions are required during the operation phase.

3.7.3 Operation Phase – Odour Emissions

3.7.3.1 New Yau Ma Tei Typhoon Shelter

Based on the odour source monitoring and review results, it has been ascertained that malodour emissions from NYMTTS are localised at the areas in the vicinity of outfalls from the Cherry Street and Jordon Road Box Culverts and are mainly due to effluent discharges from these two Box Culverts. As a result, the most effective way to mitigate the malodour emissions is to stop or prevent the effluent discharges from entering the NYMTTS via the two Box Culverts. For this, a review of the government’s existing and planned measures to improve the water quality of NYMTTS was carried out and the review results are presented in **Appendix 3.36**.

According to the review, the following current measures relevant to NYMTTS have been implemented:

- Installation of dry weather flow interceptors (DWFI) in the stormwater drainage system along the upstream area of NYMTTS;
- Regular inspection by EPD to identify and rectify any misconnections of private building sewers to stormwater drains to avoid discharge of foul water into the NYMTTS, and;

- Regular monitoring of silt levels and desilting for the box culverts that discharge into the NYMTTS by DSD.

In addition, the measures to improve the interception of effluent discharge into the NYMTTS via the two Box Culverts are at the planning stage. It is recommended to implement these improvement measures in order to mitigate the odour emissions from NYMTTS as detailed below.

Installation of New DWFI for Cherry Street Box Culvert

As detailed in **Appendix 3.33**, there are three existing DWFIs upstream of the Cherry Street Box Culvert, and their interception efficiencies were found to be in the range of 0.9% to 48.6%.

It has been recommended as one of the short term measures in the *EPD Feasibility Study, 2010*[7] to improve the existing DWFIs. According to the information provided by DSD, the upgrading works for the three existing DWFIs upstream of the Cherry Street Box Culvert are included in the project titled "Upgrading of West Kowloon and Tsuen Wan Sewerage". Subject to successful bid for funding, the construction works of the project are scheduled for commencement in 2016 and completion in end 2023.

DSD has engaged consultants to conduct an assignment entitled "Agreement No. CE 1/2012 (DS) Construction of Dry Weather Flow Interceptor at Cherry Street Box Culvert and Other Works – Investigation, Design and Construction", which involves, among other things, the investigation and design of a new DWFI at the outlet of the Cherry Street Box Culvert (see **Figure 1** in **Appendix 3.36**). Based on the information provided by DSD, the consultancy commenced in end August 2012 and subject to successful bid for funding in 2013, the construction work is scheduled to start in early 2014 for completion in second half of 2018.

With the existing DWFIs upgraded and the new DWFI installed, it is anticipated that the efficiency of intercepting effluent discharge into NYMTTS via the Cherry Street Box Culvert can be improved to 80%. As a result, the amount of effluent discharge entering NYMTTS would be reduced by 80%, which would result in reducing the water-bound odour emissions (see **Appendix 3.34**) from areas in the vicinity of the Box Culvert. Details of the assumptions and estimation are given in **Appendix 3.33**.

Upgrading/Improvement of Existing DWFIs Upstream of Jordan Road Box Culvert

As detailed in **Appendix 3.33**, there are two existing DWFIs upstream of the Jordan Road Box Culvert that have been recommended for improvement works under the *EPD Feasibility Study, 2010*. While no interception efficiencies were measured for these two DWFIs, using the best available information for geographically similar DWFI locations from the *Feasibility Study* it is reasonable to assume that the current interception efficiencies of the DWFIs upstream of Jordan Rd Box Culvert would be similar to the average values of all other existing DWFI, i.e., 32.4%. According to the information provided by DSD, the upgrading works for the existing two DWFIs upstream of the Jordan Road Box Culvert are included in the project titled "Upgrading of West Kowloon and Tsuen Wan Sewerage". Subject to successful bid for funding, the construction works of the project are scheduled for commencement in 2016 and completion in end 2023.

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[7] EPD, 2010. Review of West Kowloon and Tsuen Wan Sewerage Master Plans – Feasibility Study
http://www.epd.gov.hk/epd/english/environmentinhk/water/studyrpts/twwk_final_rpt.html

With the existing DWFIs upgraded, it is anticipated that the interception efficiency of the two existing DWFI upstream of the Jordon Road Box Culvert can be increased to 80% (**Appendix 3.34**). As a result, the amount of effluent discharge entering NYMTTS in the vicinity of the Jordan Road Box Culvert would be reduced by about 60.7%, which would result in reducing the water-bound odour emissions from areas in the vicinity of the Box Culvert (**Appendix 3.34**). More details of the assumptions and estimation are given in **Appendix 3.33**.

<u>Other potential mitigation measures</u>

Other potential odour mitigation measures include dredging at the seabed; in-situ bioremediation of marine sediments at the seabed; improvement in aeration or water circulation within NYMTTS. As marine sediments would only contribute to a small proportion of the odour emission from NYMTTS (see **Appendix 3.26b**), it is anticipated that dredging or bioremediation which is intended to remove or treat any odorous marine deposit at the seabed, would not be effective measures for reducing odour emission from NYMTTS. For the potential measures of aerating water or improving water circulation inside a typhoon shelter, the former measure will lead to decrease in water buoyancy while the latter measure will result in increasing water current flow. The New Yau Ma Tei Public Cargo Working Area is located on the north-south shoreline of the NYMTTS, which is mainly used by barges for loading and unloading of cargo. Therefore, both of these measures would impose potential safety concerns on the loading/unloading operations of barges using the Cargo Working Area. As a result, all these potential measures are not effective or feasible for NYMTTS.

Summary of Recommended Measures

After review of the government's existing and planned mitigation measures as well as the potential measures, it is recommended to implement the mitigation measures as summarised in **Table 3.31.**

Table 3.31 Summary of Recommended Odour Mitigation Measures for NYMTTS

Mitigation Measures	Timeframe	Proposed Implementation Agent
Construct a new DWFI at the Cherry Street Box Culvert	Early 2014 to 2nd half of 2018 (subject to successful bid for funding)	DSD
Improve the 3 existing DWFIs upstream of the Cherry Street Box Culvert as part of the project titled "Upgrading of West Kowloon and Tsuen Wan Sewerage"	2016 to end 2023 (subject to successful bid for funding)	DSD
Improve the 2 existing DWFIs upstream of the Jordan Road Box Culvert as part of the project titled "Upgrading of West Kowloon and Tsuen Wan Sewerage"	2016 to end 2023 (subject to successful bid for funding)	DSD

Based on the indicative completion time of the various facilities within WKCD, only a small portion of the facilities in WKCD (17% of the total gross floor area) including Xiqu Phase 1, hotel, office and retail, dining and entertainment (RDE) facilities in the Park area would tentatively be completed by 2016 whereas majority of the facilities in WKCD (58% of the total gross floor area), including residential, offices, hotels and RDE facilities would tentatively be completed in 2018 and beyond. Therefore, the mitigation measure of constructing the new DWFI at Cherry Street Box Culvert would be near completion when majority of the WKCD facilities are in place.

3.7.3.2 Optional Waste Facility

Should the optional automatic waste collection facility be adopted for the WKCD Project, such facility will be located at basement levels to avoid any potential odour issues. In addition, the odour containment and control measures as detailed in **Section 3.6.3.4**, where necessary, will be provided.

With the proper location of the optional waste facility and the odour containment and control measures in place to substantially confine and reduce the potential odour emissions at sources, it is anticipated that there would not be significant odour impact on the nearby ASRs.

3.8 Evaluation of Residual Impacts

3.8.1 Construction Phase

It has been assessed that there would neither be exceedance of the hourly TSP limit under the Tier 2 mitigated scenario nor exceedance of the AQO for daily TSP under the Tier 1 mitigated scenario at any of the ASRs throughout the entire construction period. Similarly, no exceedance of the AQO for annual TSP was predicted at any of the ASRs for the entire construction period under the mitigated scenario. Hence, no residual impacts are anticipated during the construction phase.

3.8.2 Operation Phase – Vehicular and Marine Emissions

According to the modelling results, all the identified ASRs would be in compliance with the corresponding AQO for hourly, daily and annual SO_2; for hourly, daily and annual NO_2 as well as for daily and annual RSP. However, during the worst case year of 2015, four existing ASRs, namely, WOB-1, VT1-23, SRT-1 and SRT-2, would be subject to exceedance of the AQO for hourly NO_2 (i.e., 300 $\mu g/m^3$) by about 3.7-14.9 $\mu g/m^3$ (or about 1.2%-5.0% of the relevant AQO) for once a year, and two planned ASRs, namely, P09-1 and P37-1, would be subject to marginal exceedance of the AQO for daily NO_2 (i.e., 150 $\mu g/m^3$) by about 0.2-0.3 $\mu g/m^3$ (or about 0.1%-0.2% of the relevant AQO) for once a year. Since the numbers of such hourly and daily NO_2 exceedances are within the respective allowable numbers of exceedances (3 times per year for hourly NO_2 and once per year for daily NO_2), the AQO for hourly and daily NO_2 would still be complied with at the six ASRs. Hence, no residual impacts are anticipated during the operation phase due to vehicular and marine emissions.

3.8.3 Operation Phase – Odour Emissions

3.8.3.1 New Yau Ma Tei Typhoon Shelter

With implementation of the proposed odour mitigation measures, it has been assessed that the current odour impacts on WKCD would be reduced by a considerable extent. Nevertheless, the predicted mitigated odour impacts at some of the ASRs within WKCD would still exceed the odour criterion of 5 ou/m^3 ASRs under worst case scenario. Therefore, in accordance with EIAO-TM Clause 4.4.3 the predicted residual odour impacts at such WKCD ASRs are assessed as follows:

(i) Effects on public health and health of biota or risk to life

In terms of human health effects of hydrogen sulphide (a key substance contributing to the malodour emission from NYMTTS), respiratory, neurological, and ocular effects are the most sensitive end-points in humans following inhalation exposures[8]. There are no adequate data on carcinogenicity. Exposure of H_2S at 2.0 ppm would cause bronchial constriction in asthmatic individuals; while exposure of 3.6 ppm H_2S would cause increase eye complaints for general population; and exposure of 20 ppm H_2S would cause fatigue, loss of appetite, headache, irritability, poor memory, and dizziness.

Besides, with reference to the *Integrated Risk Information System (IRIS)* of USEPA, the reference concentration of H_2S for chronic inhalation exposure to human population without an appreciable risk of deleterious effects during a lifetime is 2×10^{-3} mg/m^3 (or 0.00142 ppm).

With reference to the measured ambient H_2S concentrations (**Table 3.26**), the maximum ambient H_2S concentration within the entire NYMTTS area is 1.367ppm, whereas the ambient concentrations in the grids bordering the WKCD are below the detection limit of 0.003ppm. With air dispersion effects, it is anticipated that the H_2S concentrations within the WKCD site would be even lower than such levels measured within NYMTTS. The anticipated ambient H_2S levels within the WKCD site would therefore be well below the threshold concentration for H_2S of 2.0 ppm which has adverse health symptom on asthmatic individuals.

Subject to the extent of air dispersion which largely depends on wind directions, the ambient H_2S concentrations within WKCD may be above the reference chronic inhalation exposure concentration (RfC) of 0.00142 ppm as stipulated in the USEPA IRIS. If people are consistently exposed to H_2S concentrations over the RfC on a daily basis for the course of their life, some detrimental effects may occur. Although the ambient H_2S levels within WKCD may exceed the RfC, the exceedance, if any, would only be expected to occur when wind is blowing from high emission grids in NYMTTS to WKCD, i.e., roughly from the directions between north-west and north-east. According to the windroses for WKCD in 2010 as extracted from the PATH (see **Graph 3.1**), wind blowing from such directions would occur for approximately 20% of the year. Therefore, it is expected that the planned ASRs within WKCD would not be subject to adverse human health impact from potential exposure to H_2S.

(ii) The magnitude of adverse environmental impacts

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[8] World Health Organization, 2003. *Concise International Chemical Document 53, Hydrogen Sulfide: Human Health Aspects.*

The predicted worst-case odour concentrations at the ASRs under all assessed scenarios are summarized in **Table 3.27** and are also tabulated in **Appendix 3.35**. The predicted maximum residual odour impacts under mitigated scenarios A or B range from 1.5 to 8.9 ou/m^3 for residential ASRs and from 1.2 to 13.7 ou/m^3 for non-residential ASRs (i.e., potential fresh air intake locations). Residential ASRs are expected to exceed the odour criterion for up to 33 hours per year (or up to 0.4% of the time in a year) and non-residential ASRs for up to 213 hours per year (or up to 2.4% of the time in a year).

(iii) Geographic extent of the adverse environmental impacts

The modelling results for mitigated scenarios A or B show that 2 to 21 of the 65 planned residential ASRs within WKCD (see **Figure 3.1b**) are expected to exceed the 5 ou/m^3 criterion. For non-residential ASRs (i.e., potential fresh air intake locations), 60 to 351 of the 473 planned receivers within WKCD are expected to exceed the odour criterion.

(iv) Duration and frequency of the adverse environmental impacts

The duration and frequency of exceedance of odour criterion at the ASRs under the assessed scenarios are tabulated in **Appendix 3.35**. Under the mitigated scenario A or B, exceedances of the odour criterion are predicted to occur for up to 33 hours per year for residential ASRs (or up to 0.4% of the time in a year), and up to 213 hours per year (or up to 2.4% of the time in a year) for non-residential ASRs (i.e., potential fresh air intake locations).

(v) Likely size of the community or the environment that may be affected by the adverse impacts

As indicated in **Section 3.6.3.3**, with the implementation of proposed odour mitigation measures, the odour concentrations in the WKCD would be reduced as compared with the current scenario. However, exceedances of the odour criterion are still predicted at a number of ASRs under the mitigated scenarios. Yet the modelling results indicate that the worst-case odour impacts would more likely occur at ASRs near the ground level.

(vi) Degree to which the adverse environmental impacts are reversible or irreversible

The existing odour nuisance from the NYMTTS will be alleviated with the implementation of the odour mitigation measures proposed.

(vii) Ecological context

The predicted exceedance would not involve any ecological context.

(viii) Degree of disruption to sites of cultural heritage

The predicted exceedance would not involve any cultural heritage context.

(ix) International and regional importance

The predicted exceedance would not involve any international and regional importance.

(x) Likelihood and degree of uncertainty of adverse environmental impacts

Odour Sampling

The degree of certainty of the predicted odour impacts depends on the accuracy of the estimated odour emission rates and the air dispersion modelling. The number of air samples collected as well as the intrinsic limitations of the air sampling technique and the olfactometry analysis would also affect the accuracy of odour emission rate estimation.

Given that the odour monitoring and review were carried out in a limited number of days, the measured odour concentrations were obtained under worst case conditions with the monitoring exercise carried out on typical hot days in the summer season of 2012 with low tide and high air temperatures (over 30°C). It is believed that the estimated odour emission rates are reasonable worst case conditions.

Odour Concentration

It is expected odour emissions from NYMTTS in winter time would be smaller due to lower sea temperatures. Therefore the actual rate of exceedance during the current or mitigated scenarios would be lower than the predicted values. Variation in the odour emission rate could be expected due to tidal variation, that is, at high tide the relative dilution of the water entering from the box culverts would increase. A variation in the OER would also be expected during rainfall periods, due to the dilution and mixing of the stormwater.

In the odour modelling, however, the same set of OER obtained, based on the odour monitoring results on typical hot days was adopted for 24 hours a day and 365 days a year. Therefore, it is considered that the actual extent and frequency of odour exceedance during both the current and mitigated scenarios would be lower than those predicted by the modelling exercise.

Laboratory Methods

Air sampling is an important step in the process of measuring the odour concentrations of the sources; it would affect the quality and reliability of the results. All the odour sampling was carried out by the HOKLAS accredited laboratories. The potential error associated with odour sampling process is considered to be on the low side.

It should be noted that all the odour concentrations (in ou/m^3) and hence area source emission rates (in ou/m^2/s) were measured by olfactometry analysis carried out at HOKLAS accredited laboratories. The odour concentrations were determined by using dynamic olfactometry, according to the European Standard Method BS EN13725:2003.

The European Standard Method specifies a method for the objective determination of the odour concentration of a gaseous sample using dynamic olfactometry with human assessors. The detection limit for this European Standard Method is 10 ou/m^3. Yet the detection limit of this European Standard Method could vary between laboratories. Therefore, in reviewing the odour concentration results (in ou/m^3), it should be noted that a measured low odour concentration value would normally has a higher degree of error due to the inherent properties of the olfactometry analysis method.

Odour Chemistry/Interaction

Odours from different sources can undergo various phenomena, one of which is masking, whereby the presence of one odour can disguise, or mask, the presence of a second. Different odorants may also interact. This can cause interactive or 'synergistic' effects, such that the sum of the odorants may be either greater than or less than the intensity of the odour components. In practice, odours from significantly different sources and with different characters are usually neither additive nor synergistic, but instead one source tends to dominate, or mask, the presence of the other. Sea-water has a neutral tone and is generally considered to be non-offensive, and is assumed to be masked by the presence of odorous substances such as H_2S.

Model Restrictions

Dispersion models assume a conservation of mass of contaminants, that is the odour intensity of a mixture of two different odorous sources are considered to be additive. Odour modelling is not able to predict synergistic or masking effects, and to that effect, modelling a pleasant, neutral and/or offensive odour source in parallel would produce one overall 'odour' intensity, which would not be representative of, the different hedonic tones of the individual odours, the relative decrease in intensity of the individual odours or the potential for one odour to mask the other.

Conservative Model Results

It should be noted that the odour modelling results are considered conservative for a number of reasons as follows:

- It is expected odour emissions from NYMTTS in night time or non-summer months would be smaller due to lower sea temperatures and hence slower rate of odour release from anaerobic digestion and fermentation of organic matters and therefore the actual rate of exceedance during the current or mitigated scenarios would be lower than the model results. According to the "*Baseline Odour Sampling Report – Executive Summary*" completed for the Kai Tak Development project, odour monitoring was carried out to determine the baseline odour emissions from the water surface of the Kai Tak Approach Channel (KTAC) in March 2010 , August 2010 and February 2011 before any implementation of the improvement works. The OERs obtained in the three months showed substantial seasonal variations. In particular, the OERs obtained at two sampling locations at northern KTAC in March 2010 and February 2011 (non-summer months) were roughly 7% to 20% of the OERs measured in August 2010 (a summer month);;
- The odour complaints in the previous 7 years as shown in **Table 3.8** are low, which also suggests a considerable amount of conservatism within the modelling results, therefore the actual rate of exceedance during the current scenario is expected to be lower than the model results; and
- Variation in the odour emission rate could be expected due to tidal variation, that is, at high tide the water available for dilution of the stormwater is increased, which would be expected to dilute the odour emission rate. A variation in the OER would also be expected during rainfall periods, due to the dilution and mixing of the stormwater, therefore the actual rate of exceedance during the current scenario would be lower than the model results.

As shown in **Table 3.28** to **Table 3.30**, the exceedance of the odour criterion would not occur at any residential ASRs during day-time throughout a year, but would only occasionally happen during night-time (not more than 0.7% of the time in a month). It should be noted that the OERs at night-time would be lower than those at day-time due to the generally cooler water at night, and hence the odour exceedance at night-time is expected to be even lower than the predicted values in the Tables.

For non-residential ASRs, there would only be occasional exceedance of the odour criterion at day-time in January, October and December only (not more than 0.8% of the time in a month). While the predicted maximum odour exceedance percentages for non-residential ASRs during the night-time in February, March, April, October, November and December appear to be relatively higher than those in other months, these months are not in summer with generally lower water temperatures. Therefore, it is anticipated that the odour concentrations or exceedance percentages for the non-residential ASRs in these non-summer months would be lower than the predicted values in **Table 3.28** to **Table 3.30**.

While the mitigated odour modelling results show a number of ASRs to be in exceedance of the 5 ou/m^3 criterion, it is important to note that WKCD does not contribute to the odour emitted from NYMTTS.

Considering all the aforementioned information, the predicted residual effects from odour under the mitigated scenarios can be considered to be very conservative and hence the actual residual odour impacts would likely be much lower than the predicted results.

3.8.3.2 Optional Waste Facilities

With the proper locations of the optional waste facility (i.e., automatic waste collection facility) and the odour containment and control measures in place to substantially confine and reduce the potential odour emissions at sources, it is anticipated that there would not be significant odour impact on the nearby ASRs.

3.9 Environmental Monitoring and Audit

3.9.1 Construction Phase

Regular dust monitoring is considered necessary during the construction phase of the Project and regular site audits are also required to ensure the dust control measures are properly implemented. Details of the environmental monitoring and audit (EM&A) programme will be presented in the stand-alone EM&A Manual.

3.9.2 Operation Phase

Since it has been assessed that all the ASRs would be in compliance with all the relevant AQOs for SO_2, NO_2 and RSP, no residual air quality impacts due to vehicular or marine traffic emissions are anticipated. Therefore, no monitoring is considered necessary for vehicular or marine traffic emissions.

For the monitoring of odour emission, it is proposed to carry out monthly odour patrol during summer seasons (from July to September) for at least two years. The key purposes of the odour monitoring are to ascertain the effectiveness of the proposed improvement measures for NYMTTS over time, and to monitor any on-going odour impacts at the ASRs within WKCD. If residual odour impact is still found at the end of the odour monitoring programme, further investigation would be carried out to review the odour problem and to identify the parties responsible for further remedial action.

3.10 Conclusion

3.10.1 Construction Phase

With implementation of the recommended mitigation measures as well as the relevant control requirements as stipulated in the *Air Pollution Control (Construction Dust) Regulation* and EPD's *Guidance Note on the Best Practicable Means for Cement Works (Concrete Batching Plant) BPM 3/2(93)*, it has been assessed that there would neither be exceedance of the hourly TSP limit under the Tier 2 mitigated scenario nor exceedance of the AQO for daily TSP under the Tier 1 mitigated scenario at any of the ASRs throughout the entire construction period. For annual TSP results, no exceedance of the corresponding AQO was predicted at any of the ASRs during the construction phase provided the recommended mitigation measures are in place.

3.10.2 Operation Phase

Vehicle and Marine Emissions

Majority of the vehicular emission sources and all marine emission sources are due to respectively the nearby current/planned road networks serving the West Kowloon area and the existing marine activities in the surrounding waters, but not due to the WKCD development itself. Therefore, the WKCD Project alone would only have very minor contribution to the predicted air quality impacts at the ASRs.

According to the modelling results, all the identified ASRs would be in compliance with the corresponding AQO for hourly, daily and annual SO_2; for hourly, daily and annual NO_2 as well as for daily and annual RSP. However, during the worst case year of 2015, four existing ASRs, namely, WOB-1, VT1-23, SRT-1 and SRT-2, would be subject to exceedance of the AQO for hourly NO_2 (i.e., 300 $\mu g/m^3$) by about 3.7-14.9 $\mu g/m^3$ (or about 1.2%-5.0% of the relevant AQO) for once a year, and two planned ASRs, namely, P09-1 and P37-1, would be subject to marginal exceedance of the AQO for daily NO_2 (i.e., 150 $\mu g/m^3$) by about 0.2-0.3 $\mu g/m^3$ (or about 0.1%-0.2% of the relevant AQO) for once a year. Since the numbers of such hourly and daily NO_2 exceedances are within the respective allowable numbers of exceedances (3 times per year for hourly NO_2 and once per year for daily NO_2), the AQO for hourly and daily NO_2 would still be complied with at the six ASRs.

In conclusion, no adverse air quality impacts due to vehicular or marine traffic emissions are anticipated during the operation phase of the WKCD Project.

Odour Emissions from NYMTTS

With the recommended improvement measures for NYMTTS in place, it is predicted that the potential odour impacts on all the ASRs within WKCD would be reduced to 1.5 - 8.9 ou/m^3 for residential ASRs and to 1.2 -13.7 ou/m^3 for non-residential ASRs. Residential ASRs refer to those ASRs that have been planned for residential uses whereas non-residential ASRs refer to those that have been planned for such non-residential uses as offices, retails, hotels, performance venues, open space, etc. Under the mitigated scenarios, the predicted numbers of times of exceeding the odour criterion in a year would be up to 33 hours per year (or up to 0.4% of the time in a year) and 213 hours per year (or up to 2.4% of the time in a year) for residential ASRs and non-residential ASRs respectively.

Potential residual odour impacts are predicted at 2 to 21 of the 65 residential ASRs as well as at 60 to 351 of the 473 non-residential ASRs under the mitigated scenarios. Nevertheless, the potential residual impacts have been assessed to be acceptable in view of the nature, magnitude, duration and frequency of the impacts as well as the conservative odour modelling results. It is particularly important to note that WKCD does not contribute to the odour emitted from NYMTTS.

Odour Emissions from Optional Waste Facilities

With the proper locations of the optional waste facility (i.e., automatic waste collection facility) and the odour containment and control measures in place to substantially confine and reduce the potential odour emissions at sources, it is anticipated that there would not be significant odour impact on the nearby ASRs.