3 AIR QUALITY

3.1 INTRODUCTION

3.1.1 This Section presents an assessment of the potential air quality impact from the construction and operation of the Theme Park and associated developments. Air Sensitive Receivers (ASRs) have been identified and worst case impacts on these receivers have been modelled.

3.1.2 Dust generation from the construction activities is a key concern during the construction phase. While vehicular emission from the adjacent roads and vehicle parking areas; off-site and territory-wide impacts caused by internal traffic and Theme Park-bound tourists; air emissions from GTP, fireworks displays, fuel combustion equipment including boilers; and odour emissions from sewage pumping station are the concerns during the operation of the Theme Park and associated developments. Mitigation measures are recommended, where necessary, to ensure that the legislative criteria and guidelines will be satisfied. Cumulative air quality impacts with other concurrent projects are also discussed. Additional information used in this assessment of air quality is provided in *Annex B*.

3.2 EVALUATION CRITERIA

STATUTORY REQUIREMENTS

3.2.1 The principal legislation for the management of air quality is the *Air Pollution Control Ordinance, Cap 311* (APCO). The whole of the HK SAR is covered by the *Hong Kong Air Quality Objectives* (AQOs) which stipulates the statutory limits of typical air pollutants and the maximum allowable exceedance values over specific periods. The AQOs are shown in *Table 3.2a*.

Table 3.2a - Hong Kong Air Quality Objectives (μgm^{-3}) (a)

Pollutant	Averaging Time				
	1 Hours (b)	8 Hours (c)	24 Hours (c)	3 Months (d)	1 Year (d)
Total Suspended Particulates (TSP)	-	-	260	-	80
Respirable Suspended Particulates (e) (RSP)	-	-	180	-	55
Sulphur Dioxide (SO_2)	800	-	350	-	80
Nitrogen Dioxide (NO_2)	300	-	150	-	80
Carbon Monoxide (CO)	30,000	10,000	-	-	-
Lead	-	-	-	1.5	-
Ozone (O_3) (f)	240	-	-	-	-

Note:
(a) Measured at 298K (25°C) and 101.325 kPa (one atmosphere)
(b) Not to be exceeded more than three times per year
(c) Not to be exceeded more than once per year
(d) Arithmetic means
(e) Respirable suspended particulates are defined as particles suspended in the air with a nominal aerodynamic diameter of 10 µm and smaller.
(f) Photochemical oxidants are determined by measurement of ozone only.

3.2.2 In addition, the EIAO-TM stipulates that one hour average TSP concentration of 500 μgm^{-3} measured at 298 K (25°C) and 101.325 kPa (1 atm) should not be breached for construction dust impacts. Mitigation measures for construction sites specified in the *Air Pollution Control (Construction Dust) Regulation* should be followed.

3.2.3 Under the *Air Pollution Control (Furnaces, Ovens and Chimneys)(Installation and Alteration) Regulations*, boiler with total fuel consumption rate more than 25 litres of liquid fuel per hour, 35 kg of solid fuel per hour or 1,150 MJ of gaseous fuel per hour are required to obtain approval from EPD before the installation/alteration of such facilities.

NON-AQO POLLUTANTS

3.2.4 In the absence of the above statutory guidelines for specific pollutants, the assessment will be based on international guidelines such as those promulgated by the *World Health Organization* (WHO) or based upon a health risk assessment approach which rely on the combination of toxicity data promulgated by the USEPA (from a database such as IRIS or occupation exposure limit) with estimated levels of human exposure and appropriate safety factor. The result is an estimate of safe air pollution concentration which can be compared with the criteria stipulated in Annex 4 of EIAO-TM for the assessment.

3.2.5 The order of preference in selecting the guideline values to be used in the assessment was as follows:

- WHO guidelines;
- USEPA guidelines;
- California Air Resources Board (CARB) guidelines; and
- Occupational Exposure Limit (OEL).

3.2.6 The Study Brief calls for an assessment of possible air quality impacts due to the fireworks displays and specifically cites, the following groups of non-AQO pollutant, as being worthy of further consideration:

- VOCs;
- dioxins and furans; and
- heavy metals.

3.2.7 With the exception of lead for which there is an AQO, all three groups of pollutant will be addressed using the approach described above.

ODOUR

3.2.8 In accordance with EIAO-TM, it also stipulates that 5 odour units should be met based on an averaging time of 5 seconds for odour prediction assessment.

3.3 BASELINE CONDITIONS AND SENSITIVE RECEIVERS

EXISTING ENVIRONMENT AND BACKGROUND AIR QUALITY

3.3.1 The air quality within the Study Area is currently rural affected by emissions from the North Lantau Highway (NLH) and to a lesser extent the GTP. The GTP is a 300 MW oil-fired standby gas turbine plant which provides electricity at times of peak load normally during the summer months and under emergency situations in the unlikely event of a disruption elsewhere in the system. Vehicular emissions from the NLH are more confined within the vicinity of the carriageway though the increase in vehicular emissions has contributed to background pollution levels of the Study Area. The potential impacts from the GTP will be discussed in more detail in *Section 3.5*.

3.3.2 The Environmental Protection Department (EPD) operates a network of Air Quality Monitoring Stations in Hong Kong but none of these stations is located within the Study Area. The nearest EPD's monitoring stations are located in Tsuen Wan, Central/Western and the recently commissioned Tung Chung stations. The latter is located along the north Lantau coast and resembles the newly developed areas to the west of the urban areas. Data collected from the Tung Chung monitoring station can therefore be used to provide information on background pollution levels. However only four months of monitoring data (July - October 1999) is available at the time of report preparation and the average pollution levels are summarised in the *Table 3.3a*.

Table 3.3a - Average Pollution Concentrations Recorded in Tung Chung (μgm^{-3})

Pollutants	Average Pollution Concentrations
SO_2	14
NO_2	36
CO	64
O_3	42
RSP	39
TSP	67

Note: Data measured from Tung Chung Air Monitoring Station, July-October 1999

3.3.3 Besides the data collected from EPD's Tung Chung monitoring station, China Light and Power (CLP) has operated an air quality monitoring station in Penny's Bay for a number of years. Monitoring results of sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) over the past three years are summarised in *Annex B1 and B2*. The annual average SO_2 and NO_2 concentrations are 6 and 33 μgm^{-3} respectively which are comparable to the monitoring results collected from Tung Chung over a shorter period of time. However, data collected from Penny's Bay should be referenced where available as the station has been in operation for a longer time period and takes seasonal variations into account and located within the Study Area. Data collected from the Tung Chung station will be used for the background pollution concentrations of carbon monoxide (CO), ozone (O_3), Respirable Suspended Particulates (RSP) and Total Suspended Particulates (TSP).

Ozone

3.3.4 O_3 is the tri-atomic form of molecular oxygen and is one of the strongest oxidising agents, which makes it highly reactive. Most of the O_3 in the troposphere (lower atmosphere) is formed indirectly by a series of complex photochemical reaction of oxygen, nitrogen oxides and reactive hydrocarbons in the presence of sunlight and warm temperature. However, it should be noted that O_3 is also transported from the stratosphere (upper atmosphere),where it is formed by the action of UV radiation on O_2, to the ground level under certain meteorological conditions.

3.3.5 Data collected from EPD's monitoring stations in 1997 identified O_3 episodes in Hong Kong with a maximum concentration of 270 and 243 μgm^{-3} monitored in Sha Tin and Central/Western respectively exceeding the one-hour Air Quality Objective (AQO).

Maximum O_3 concentration of 239 μgm^{-3}, marginally below the one hour criterion of 240 μgm^{-3}, was recorded at Tap Mun in 1998.

3.3.6 High O_3 concentrations were recorded in Tung Chung exceeding the one-hour AQO level twice over the reported period in 1999. The first episode of high O_3 concentrations was recorded on 20 August 1999 when a tropical cyclone Sam swept across the Philippines and entered the South China Sea. The weather in Hong Kong was fine and the temperature reached a maximum of 33.2 ^{0}C. The weather was influenced by a high pressure with a mean wind speed of 3.5 ms^{-1} blowing from the south west. High O_3 concentrations developed in the early afternoon in Tung Chung, Shatin and Tap Mun monitoring stations exceeding the AQO (*Figure 3.3a*). O_3 concentration reached 335 μgm^{-3} at 3:00pm in Tung Chung possibly due to recirculation of air pollutants and the associated photochemistry within the Tung Chung valley causing the O_3 concentration to rise and maintain at a high levels throughout the afternoon. The high O_3 concentrations recorded in Shatin (295 μgm^{-3}) and Tap Mun (294 μgm^{-3}) are probably due to the photochemical reaction downwind of the urban plume. Around 200 μgm^{-3} of O_3 concentrations were recorded for the other stations suggesting this is a territory-wide O_3 episode.

3.3.7 On 12 September 1999, typhoon York developed as a tropical depression about 430 km Northeast of Manila tracking westwards for 4 days before hitting Hong Kong with a Number 10 tropical cyclone warning signal hoisted on 16 September 1999. The weather on 12 September 1999 was fine with a maximum temperature of 32.5 ^{0}C though trace amount of rainfall was recorded. The wind was relatively calm (around 2 ms^{-1}) blowing from west, north-west direction. High O_3 concentrations were observed on that day in Tung Chung (278 μgm^{-3}) and Tap Mun (284 μgm^{-3}) exceeding the AQO (*Figure 3.3b*). O_3 concentrations recorded from Shatin and Tai Po were above 150 μgm^{-3} whereas the stations at Tsuen Wan and Yuen Long recorded a much lower concentration. This was probably due to the lower pollutant emissions, in particular NO_x emission from vehicles, in Tung Chung and Tap Mun than in the more urbanised areas where the high NO_x emission would reduce the formation of O_3 under a series of photochemical reactions.

3.3.8 The formation of O_3 is a complex and regional phenomena. The high concentrations recorded in Tung Chung may not fully represent Penny's Bay due to potential recirculation within the steep Tung Chung valley and the photochemical reactions in a regional context. The topography of the Penny's Bay is surrounded by hills of less than 300 m to the east and west and a much lower ridge to the north. A wide opening to the south of the bay provides good ventilation and reduces the potential for recirculation to occur within the bay area. It is expected that the future O_3 concentrations will follow the general pattern established within the HKSAR though the projected increase in NO emission from vehicles in the Northshore Lantau could reduce the O_3 formation in the Penny's Bay area through photochemical reactions.

FUTURE CONDITION

3.3.9 In future, in order to serve the Northshore Lantau Development and the Theme Park and associated developments, new roads and a railway will be established. Penny's Bay Rail Link (PBRL) detailed in *Annex M*, Route 10-NLYLH, CKWLR and the planned distributor roads will contribute to the air quality in the Study Area. It is understood that electric trains will be used and no local air emissions will be produced from PBRL operation.

AIR SENSITIVE RECEIVERS

3.3.10 Representative ASRs have been identified according to the criteria set out in the EIAO-TM and through site inspections and review of land use plans of the Study Area.

3.3.11 Domestic premises, hotel, hostel, hospital, clinic, nursery, temporary housing accommodation, school, educational institution, office, factory, shop, shopping centre, place of public worship, library, court of law, sports stadium or performing arts centre, home for the aged and active recreational activity areas are classified as ASRs. ASRs in the Study Area have been identified and are summarised in *Table 3.3b*. Locations of the ASRs/Assessment Points are shown in *Figure 3.3c*.

Table 3.3b - Air Sensitive Receivers/Assessment Points

ASR	Location	Construction Phase	Operational Phase
A1	Penny's Bay GTP	✔	✔
A2	Possible Country Park Extension Area	✔	✔
A3	Possible Country Park Extension Area	✔	✔
A4	Possible Country Park Extension Area	✔	✔
A5	Luk Keng Tsuen	✔	✔
A6	Discovery Bay	✔	✔
A7	Peng Chau	✔	✔
A8	Theme Park	✗	✔
A9	Resort in Theme Park (Phase I and II)	✗	✔
A10	Theme Park (Phase III) Extension	✗	✔
A11	Divisional Fire Station (West of the Penny's Bay Rail Station)	✗	✔
A12	Divisional Police Station	✗	✔
A13	Divisional Fire Station (East of the Penny's Bay Rail Station)	✗	✔
A14	Water Recreational Centre	✗	✔
A15	Eco Park	✗	✔
A16	Theme Park Gateway	✗	✔
A17	Tourist and Convention Village	✗	✔
A18	Technodrome	✗	✔

3.4 CONSTRUCTION PHASE

IDENTIFICATION OF ENVIRONMENTAL IMPACT

3.4.1 Impacts arising from the construction of Theme Park and associated developments primarily relate to dust nuisance and gaseous emissions from the construction plant and vehicles, with dust generation being the major concern. The construction activities include, site formation, construction of the Theme Park and associated developments including hotels and Water Recreation Centre; road construction of Road P2, a section of CKWLR between Yam O Interchange to Penny's Bay Roundabout, Resort Road (D1 and D2); and PBRL including tunnelling works, track construction and Yam O and Penny's Bay Rail Stations works.

Theme Park and Water Recreation Centre

3.4.2 The Theme Park will be formed by reclaiming an area of land at Penny's Bay. The Theme Park will comprise 2 construction phases. The construction works of Penny's Bay Reclamation Stage 1 will be started tentatively from second quarter of 2000 to third quarter of 2002. Stage 2 of the reclamation works will be started tentatively from third quarter of 2001 to fourth quarter of 2008 (refer to *Section 2.6*).

3.4.3 Dredging, placement of seawall and filling of marine sand and rocks are the major construction works during reclamation. Public filling will be also carried out for the filling works, described in *Section 2.6.4*. Half of the public fill materials will be transported by barge and the remaining portion will be transported by trucks. Materials handling, wind erosion, truck haulage on unpaved roads are the major sources of the dust impact. The dredged marine mud will contain high moisture content and dust emission from dredging will be limited. All the dredged and fill materials are transported by barge and the fill materials will be directly dumped into sea, thus no fugitive emissions are expected. 50% of the public fill materials will be transported by barge and the remaining portion will be transported by trucks. Surcharge, mainly sand, is required for the site formation. The quantity of mud dredged or sand filled and surcharge and its material handling rates and number of trucks are presented in *Table 3.4a*. The construction period will be 24 days a month and 24 hours a day.

Table 3.4a - Material Handling Rate and Number of Vehicles used for Penny's Bay Reclamation Works

	Construction Activities	**Duration of Construction Works (months)**	**Quantity of Materials in m^3/No. of Trucks**	**Material Handling Rate (m^3/day) (a)**
Stage 1	Dredging	9	40M	185,185
	Public Fill + Surcharge	15	2M	5,556
	Truck Movement	-	10 trucks/hr (b)	-
Stage 2	Dredging	45	5M	4,556
	Public Fill + Surcharge	33	6.75M	8,523
	Truck Movement	-	5 trucks/hr (b)	-

Note:
(a) Working periods are assumed as 24 days a month and 24 hours a day
(b) The materials are mainly transported by barge with limited portion of materials handled by trucks.

3.4.4 Water Recreation Centre, including a lake for irrigation and water sport recreation activities together with desilting and pumping facilities, will be constructed at the north-west of the Theme Park and associated developments area. Materials handling, wind erosion and truck haulage on the unpaved road during excavation works comprise dust generating activities. The quantity of excavated spoils and its materials handling rates, and number of trucks are presented in *Table 3.4b*.

Table 3.4b - Material Handling Rate and Number of Vehicles used for Water Recreation Centre Construction Works

Construction Activities	Duration of Construction Works (months)	Quantity of Materials in $m^{3\wedge}$/No. of Trucks	Material Handling Rate (m^3/day) [(a)]
Excavation	21	1M	1,984
Truck Movement	-	10 trucks/hr [(b)]	-

Note:
(a) Working periods are assumed as 24 days a month and 16 hours a day
(b) The materials are mainly transported by barge with limited portion of materials handled by trucks.

3.4.5 A concrete batching plant is proposed north-west of the Water Recreation Centre. A Specified Process Licence for the Cement Works under the APCO should be required for the approval of the works.

Road Construction of Road P2, CKWLR Section, Resort Road (D1 and D2)

3.4.6 General road construction works will be carried out for the construction of CKWLR Section, Road P2, Resort Road (D1 and D2). For a section of CKWLR at Yam O, drill and blast method required for road excavation of 340 m length will be last for 24 months with total 0.25 Mm^3 of soft material and 0.34 Mm^3 of rock generated. One blast will be performed per day. It is assumed that blasting will not be conducted in parallel with other construction activities. The quantity of rock and soft materials excavated and materials handling rates, and number of trucks are presented in *Table 3.4c*.

Table 3.4c - Material Handling Rate and Number of Vehicles used for CKWLR at Yam O

Construction Activities	Duration of construction works (months)	Quantity of Materials in m^3/No. of trucks	Material Handling Rate (m^3/day) [(a)]
Excavation			
Sand	24	0.14M	242
Rock	24	0.34M	590
Truck Movement	-	10 trucks/hr [(b)]	-

Note:
(a) Working periods are assumed as 24 days a month and 16 hours a day
(b) The materials are mainly transported by barge with limited portion of materials handled by trucks.
(c) Reference to *Annex M* (PBRL EIA)

Penny's Bay Rail Link

3.4.7 The Penny's Bay Rail Link (PBRL) comprises a new 3.6 km link from the existing Tung Chung Line at Yam O to the Theme Park and associated developments. Tunnel works, Yam O and Penny's Bay Rail Station works and at-grade track construction are the major construction works of the PBRL. A 850 m tunnel at Yam O will be excavated by drill and blast method for total 250 tunnel blasts and 10 surface blasts with 27,000 m^3 of spoil generated. It is expected that blasting will not be conducted in parallel with other construction activities. Two blasts will be performed per day. A cut and cover section is proposed for the rail works between Yam O Station and the north portal of Yam O rail tunnel. The excavated spoil and material handling rates are summarised in *Table 3.4d* below. The details of the construction of PBRL are provided in *Annex M*.

Table 3.4d - Volume of PBRL Spoil Generated and Materials Handling Rates

Construction Activities	Duration of Construction Works (months)	Quantity of Materials in m^3/No. of Trucks	Material Handling Rate (m^3/day) [(b)]
Excavation (Cut and Cover Tunnel)	18	16,500	38
Excavation (Yam O Tunnel)	18	27,000	63
Other Excavation [(a)]	18	25,000	58
Truck Movement	-	20 trucks/day	-

Note:
(a) Other excavation including station works and alignment works.
(b) Working periods are assumed as 24 days a month and 16 hours a day

Yam O Reclamation

3.4.8 The Yam O reclamation will be started from the fourth quarter of year 2002 to the third quarter of year 2003. The major activities are seawall construction, dredging and filling. The dredged marine mud will contain high moisture content and dust emission from the site will be limited. The materials for filling is mainly marine sand. Barges will be employed for the transportation of mud and sand for disposal or filling, respectively. Public filling is required for the filling works. 50% of the public fill will be directly dumped into the sea and 50% of public fill together with surcharge will be used for the site formation. The 50% public fill and surcharge comprises fugitive dust sources. The total volume of dredged and filled materials are maximum of 0.3 Mm^3 and 0.9 Mm^3 respectively, see *Section 2.6.1*.

Construction Plant Operation

3.4.9 Gaseous emissions from the construction plants comprises another source of air pollution. SO_2, NO_2 and RSP will be the major pollutants emitted from the diesel-powered equipment. Equipment such as concrete trucks, dump trucks, excavators and backholes are expected to contribute most of the emissions. The total number of plant operated during site formation for the construction of Theme Park and associated developments will be around 74. The emission factors for tracked loader, recommended in AP-42, are used to estimate the gaseous emissions from the construction plants. The emission factors and the total emission rates are summarised in *Table 3.4e* below. Owing to the long distances from the ASRs to the emission sources, it provides longer reaction time for the conversion of NO_x to NO_2 at the ASRs. Thus 30% of NO_x will be assumed to convert to NO_2 in the assessment.

Table 3.4e - Emission Factors and Emission Rates For Construction Plants

	Parameter
Total Worksite Area (m^2)	3.8×10^6
Total No. of Plant	74
Emission Factors of NO_x from AP-42 (g/hr)	375.22
Total Emission Rate of NO_x (g/s)	7.71
Total Emission Rate of NO_x per Area ($g/m^2/s$)	2.03×10^{-6}
Total Emission Rate of NO_2 per Area ($g/m^2/s$) [(a)]	6.9×10^{-7}
Emission Factors of SO_2 from AP-42 (g/hr)	34.4
Total Emission Rate of SO_2 (g/s)	0.71
Total Emission Rate of SO_2 per Area ($g/m^2/s$)	1.86×10^{-7}
Emission Factors of RSP from AP-42 (g/hr)	26.4
Total Emission Rate of RSP (g/s)	0.54
Total Emission Rate of RSP per Area ($g/m^2/s$)	1.43×10^{-7}

Note:
(a) 30% of NO_x is assumed to be converted to NO_2.

3.4.10 Due to the large construction area involved, the calculated emission rates per unit area is very small. Pollutant emitted will be diluted very rapidly over this large construction area.

It is therefore, expected that air pollution impact due to construction plant operation is unlikely.

Cumulative Impacts

3.4.11 As discussed in *Section 2.13,* there are other concurrent projects especially for the Northshore Lantau Development such as CKWLR, Special Duties Unit (SDU) Base located beside Refuse Transfer Station, Yam O Tuk Services Reservoir being constructed in parallel with the Theme Park and associated developments. However, SDU Base and Yam O Tuk Service Reservoirs are located at more than 2km away Penny's Bay, the dust impacts to the identified ASRs is not expected. Thus only CKWLR will be considered in the cumulative impact. The cumulative impacts are discussed below:

Chok Ko Wan Link Road (Section between Penny's Bay Roundabout to R10 Toll Plaza)

3.4.12 A section of CKWLR from Penny's Bay Roundabout to Route 10 Toll Plaza located at Fa Peng will be constructed between January 2001 and March 2004. Blast and drill method is required for the road construction at the section between Penny's Bay Roundabout and Pa Tau Kwu with 1.8 Mm^3 of rock and 0.8 Mm^3 of soft materials generated. One blast will be performed per day.

3.4.13 17 ha reclamation is required from the east of Tsing Chau Tsai up to Fa Peng. The major dust generated activities for the section of CKWLR construction includes blasting at Tsing Chau Tsai for road opening, reclamation, materials handling, wind erosion, truck movements on the unpaved road and road construction. The dredged marine mud will contain high moisture content and dust emission from the site will be limited. The materials for filling is mainly sand which is a potential fugitive dust source. The volume of dredged and filled materials are 0.4 Mm^3 and 1.9 Mm^3 respectively.

Route 10 - North Lantau to Yuen Long Highway

3.4.14 Route 10 - North Lantau to Yuen Long Highway (R10-NLYLH) at North Lantau section will be constructed tentatively from second quarter of year 2002 to fourth quarter of year 2006. Reclamation including dredging of mud, seawall construction and filling, site formation and road constructions are the major construction works. It is expected that less than 0.5 Mm^3 of mud will be dredged. Materials handling, wind erosion and road construction are the dust generating activities during construction.

3.4.15 However, the R10-NLYLH is located along the coastal line of Fa Peng and Pa Tau Kwu Headland will be acted as a barrier, the dust impacts from R10-NLYLH on the Penny's Bay is limited.

ASSESSMENT METHODOLOGY

3.4.16 Dust emissions from the construction activities are the main pollutants during construction phase. Total Suspended Particulates (TSP) concentration levels were predicted by the *Fugitive Dust Model* (FDM). Meteorological data for 1997 from Cheung Chau weather station, operated by the Hong Kong Observatory, was employed for the construction dust modelling. Dust emission rates and associated particle size distributions for the assessment were determined based on the *Compilation of Air Pollutant Emission Factors, 5th Edition, USEPA* (AP-42). Mitigation measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* were also adopted in the assessment. The construction works except reclamation work at Theme Park Phase I are expected to be conducted 24 days a month and 16 hours a day. The construction at Theme Park Phase I will be conducted 24 days a month and 24 hours a day. The mitigated emission rates are summarised in *Table 3.4f* below. The emission rate calculations are shown in *Annex B3*.

Table 3.4f - Mitigated Emission Factors for Construction Activities

Construction Activities	Mitigated Emission Factors [(a) (b)]	Remarks
Penny's Bay Stage 1 Reclamation		
Materials Handling	0.52 g/Mg	• 5,556 m^3 per day • moisture content: 4.8% • particle size multiplier: 0.75 • u: 5.1 m/s (average wind speed from Cheung Chau Weather Station 1997 • density of spoil: 1.94 Mg/m^3 • 50% reduction by water suppression
Wind Erosion	2.69×10^{-6} $g/m^2/s$	-
Concrete Batching Plant	0.0164 kg/Mg	• capacity: 1,500 m^3/day • 90% reduction by mitigation measures • density: 2.4
Truck Movements on Unpaved Haul Road	0.25 kg/VKT	• no. of truck: 10 trucks per hour • silt content: 10% • speed: 10 kph • weight: 12.5 Mg • 85% reduction by paved road
Penny's Bay Stage 2 Reclamation		
Materials Handling	0.52 g/Mg	• 8,523 m^3 per day • moisture content: 4.8% • particle size multiplier: 0.75 • u: 5.1 m/s (average wind speed from Cheung Chau Weather Station 1997 • density of spoil: 1.94 Mg/m^3 • 50% reduction by water suppression
Wind Erosion	2.69×10^{-6} $g/m^2/s$	-
Concrete Batching Plant	0.0164 kg/Mg	• capacity: 1,500 m^3/day • 90% reduction by mitigation measures • density: 2.4
Truck Movements on Unpaved Haul Road	0.25 kg/VKT	• no. of truck: 5 trucks per hour • silt content: 10% • speed: 10 kph • weight: 12.5 Mg • 85% reduction by paved road
Water Recreational Centre		
Materials Handling	0.52 g/Mg	• 1,984 m^3 per day • moisture content: 4.8% • particle size multiplier: 0.74 • u: 5.1 m/s (average wind speed from Cheung Chau Weather Station 1997 • density of spoil: 1.94 Mg/m^3 • 50% reduction by water suppression
Wind Erosion	2.69×10^{-6} $g/m^2/s$	-
Truck Movements on Unpaved Haul Road	0.25 kg/VKT	• no. of truck: 10 trucks per hour • silt content: 10% • speed: 10 kph • weight: 12.5 Mg • 85% reduction for paved road

Construction Activities	Mitigated Emission Factors [(a) (b)]	Remarks
Road Construction at CKWLR Yam O Section		
Materials Handling	0.52 g/Mg	• 242 m^3 per day • moisture content: 4.8% • particle size multiplier: 0.74 • u: 5.1 m/s (average wind speed from Cheung Chau Weather Station 1997 • density of spoil: 1.94 Mg/m^3 • 50% reduction by water suppression
Wind Erosion	2.69x10^{-6} g/m^2/s	-
Truck Movements on Unpaved Haul Road	0.25 kg/VKT	• no. of truck: 10 trucks per hour • silt content: 10% • speed: 10 kph • weight: 12.5 Mg • 85% reduction for paved road
Blasting	0.00022A$^{1.5}$ kg/blast	• A = horizontal area • 1 blast per day
Road Construction	9.73x10-6 g/m^2/s	assume 30% of the site is active
Road Construction of Road P2 and Theme Park Resort Roads (D1 and D2)		
Road Construction	9.73x10^{-6} g/m^2/s	assume 30% of the site is active
Penny's Bay Rail Link		
Materials Handling	0.52 g/Mg	• 159 m^3 per day • moisture content: 4.8% • particle size multiplier: 0.74 • u: 5.1 m/s (average wind speed from Cheung Chau Weather Station 1997 • density of spoil: 1.94 Mg/m^3 • 50% reduction by water suppression
Wind Erosion	2.69x10^{-6} g/m^2/s	-
Truck Movements on Unpaved Haul Road	0.25 kg/VKT	• no. of truck: 20 trucks per day • silt content: 10% • speed: 10 kph • weight: 12.5 Mg • 85% reduction for paved road
Blasting	0.00022A$^{1.5}$ kg/blast	• A = horizontal area • 2 blasts per day
Yam O Reclamation		
Materials Handling	0.52 g/Mg	• 4,167 m^3 per day • moisture content: 4.8% • particle size multiplier: 0.74 • u: 5.1 m/s (average wind speed from Cheung Chau Weather Station 1997 • density of spoil: 1.94 Mg/m^3 • 50% reduction by water suppression
Wind Erosion	2.69x10^{-6} g/m^2/s	-
Truck Movements on Unpaved Haul Road	0.25 kg/VKT	• no. of truck: 3 trucks per hour • silt content: 10% • speed: 10 kph • weight: 12.5 Mg • 85% reduction for paved road

Note:
(a) Reference to Compilation of Air Pollutant Emission Factors, USEPA (AP-42), 5th Edition
(b) Mitigation measures stipulated in the Air Pollution Control (Construction Dust) Regulation has been adopted

EVALUATION OF IMPACT

3.4.17 The dust impacts of the construction of Theme Park and associated developments with the concurrent projects have been modelled. The mitigation measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* have been adopted in the prediction. The predicted hourly and daily dust impacts on the ASRs at the ground level and 10 m above ground are summarised in *Table 3.4g* below.

Table 3.4g - Predicted Hourly and Daily Dust Level from Construction Activities (μgm^{-3}) [(a) (b)]

ASRs [(c)]	Location	Predicted Concentrations			
		Ground Level		10m above Ground	
		Hourly TSP	Daily TSP	Hourly TSP	Daily TSP
A1	Penny's Bay GTP	180	106	164	102
A2	Possible Country Park Extension Area	135	95	135	95
A3	Possible Country Park Extension Area	151	98	151	98
A4	Possible Country Park Extension Area	147	85	147	85
A5	Luk Keng Tsuen	182	89	168	87
A6	Discovery Bay	134	82	131	81
A7	Peng Chau	153	81	150	81
Dust Criteria		500	260	500	260

Note:
(a) Background TSP concentration of 67 μgm^{-3} has been included in the results
(b) Mitigation measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* has been adopted in the predicted
(c) ASRs A8 - A18 are planned receivers and no construction impacts are expected

3.4.18 The hourly and daily dust levels for blasting activities of CKWLR and PBRL have been modelled and are presented in *Table 3.4h*.

Table 3.4h - Predicted Cumulative Hourly and Daily Dust Level from Blasting (μgm^{-3}) [(a)]

ASRs [(b)]	Location	Predicted Concentrations			
		Ground Level		10m above Ground	
		Hourly TSP	Daily TSP	Hourly TSP	Daily TSP
A1	Penny's Bay GTP	61	0.19	61	0.19
A2	Possible Country Park Extension Area	18	0.07	18	0.07
A3	Possible Country Park Extension Area	39	0.17	39	0.17
A4	Possible Country Park Extension Area	80	0.35	78	0.35
A5	Luk Keng Tsuen	32	0.16	32	0.16
A6	Discovery Bay	15	0.05	15	0.05
A7	Peng Chau	7	0.02	7	0.02
Dust Criteria		500	260	500	260

Note:
(a) Mitigation measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* has been adopted in the predicted
(b) ASRs A8 - A18 are planned receivers and no construction impacts are expected

3.4.19 The cumulative dust impacts of construction activities of Theme Park and associated developments together with blasting are summarised in *Table 3.4i*.

Table 3.4I - Predicted Cumulative Hourly and Daily Dust Level (μgm^{-3}) [(a) (b)]

ASRs [(c)]	Location	Predicted Concentrations			
		Ground Level		10m above Ground	
		Hourly TSP	Daily TSP	Hourly TSP	Daily TSP
A1	Penny's Bay GTP	242	106	225	102
A2	Possible Country Park Extension Area	153	95	153	95
A3	Possible Country Park Extension Area	190	98	190	98
A4	Possible Country Park Extension Area	226	85	225	85
A5	Luk Keng Tsuen	214	89	200	87
A6	Discovery Bay	149	82	146	81
A7	Peng Chau	160	81	157	81
Dust Criteria		500	260	500	260

Note:
(a) Background TSP concentration of 67 μgm^{-3} has been included in the results
(b) Mitigation measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* has been adopted in the predicted
(c) ASRs A8 - A18 are planned receivers and no construction impacts are expected

3.4.20 The above results indicate that the predicted cumulative hourly and daily TSP levels at 1.5 m above ground are in the range of 149 - 242 μgm^{-3} and 81 - 106 μgm^{-3}, respectively, while hourly and daily dust impact at 10 m above ground were predicted in a range of 146 - 225 μgm^{-3} and 81 - 102 μgm^{-3}, respectively. Highest both hourly and daily TSP levels at both ground level and 10 m above ground were predicted at A1 (Penny's Bay GTP). The predicted TSP levels at all ASRs were within both hourly and daily dust criteria with the adoption of the recommended mitigation measures in the *Air Pollution Control (Construction Dust) Regulation*.

3.4.21 The sample output file for the dust model run is presented in *Annex B4*.

MITIGATION MEASURES

3.4.22 The following control measures are stipulated in the *Air Pollution Control (Construction Dust) Regulation* and should be implemented to limit the dust emissions from the site:

- the stockpile should be properly treated and sealed with latex, vinyl, bitumen or other suitable surface stabiliser if a stockpile of dusty materials is more than 1.2 m high and lies within 50 m from any site boundary that adjoins a road, street, or other area accessible to the public;
- effective dust screens, sheeting or netting should be provided to enclose the scaffolding from the ground floor level of the building or if a canopy is provided at the first floor level, from the first floor level, up to the highest level of the scaffolding where a scaffolding is erected around the perimeter of a building under construction;
- skip hoist for material transport should be totally enclosed by impervious sheeting;
- any excavated dusty materials or stockpile of dusty materials should be covered entirely by impervious sheeting or sprayed with water so as to maintain the entire surface wet, and recovered or backfilled or reinstated within 24 hours of the excavation or unloading;
- stockpile of dusty materials should not extend beyond the pedestrian barriers, fencing or traffic cones;
- dusty materials remaining after a stockpile is removed should be wetted with water and cleared from the surface of roads;
- vehicle washing facilities should be provided at every vehicle exit point;

- the area where vehicle washing takes place and the section of the road between the washing facilities and the exit point should be paved with concrete, bituminous materials or hardcores;
- where a site boundary adjoins a road, streets or other area accessible to the public, hoarding of not less than 2.4 m high from ground level should be provided along the entire length except for a site entrance or exit;
- every main haul road should be scaled with concrete and kept clear of dusty materials or sprayed with water so as to maintain the entire road surface wet;
- the portion of road leading only to a construction site that is within 30m of a designated vehicle entrance or exit should be kept clear of dusty materials;
- every stock of more than 20 bags of cement should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides;
- cement delivered in bulk should be stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line such that, in the event of the silo approaching an overfilling condition, an audible alarm is triggered and the material filling stops within one minutes;
- silos used for the storage of cement should not be overfilled;
- loading, unloading, transfer, handling or storage of bulk cement or any cement during or after the de-bagging process should be carried out in a totally enclosed system or facility, and any vent or exhaust should be fitted with an effective fabric filter or equivalent air pollution control system or equipment;
- Cement, or any other dusty materials collected by fabric filters or other air pollution control system or equipment should be disposed of in totally enclosed containers;
- stockpile of dusty materials should be either covered entirely by impervious sheeting, placed in an area sheltered on the top and the 3 sides; or sprayed with water so as to maintain the entire surface wet;
- all dusty materials should be sprayed with water prior to any loading, unloading or transfer operation so as to maintain the dusty material wet;
- vehicle speed should be limited to 10 kph except on completed access roads;
- every vehicle should be washed to remove any dusty materials from its body and wheels before leaving the construction sites;
- the load of dusty materials carried by vehicle leaving a construction site should be covered entirely by clean impervious sheeting to ensure that the dusty materials do not leak from the vehicle;
- the working area of excavation should be sprayed with water immediately before, during and immediately after the operation so as to maintain the entire surface wet;
- the area within 30 m from the blasting area should be wetted with water prior to blasting; and
- blasting should not be carried out when the strong wind signal or tropical cyclone warning signal No.3 or higher is hoisted unless prior permission of the Commissioner of Mines is obtained.

3.4.23 In addition, according to the *EPD's Best Practicable Means Requirements for Cement Works (Concrete Batching Plant)*, the following mitigation measures should be adopted to prevent fugitive dust emissions:

- loading, unloading, handling, transfer or storage of any dusty materials should be carried out in totally enclosed system;
- all dust-laden air or waste gas generated by the process operations should be properly extracted and vented to fabric filtering system to meet the emission limits for TSP;
- vents for all silos and cement/pulverised fuel ash (PFA) weighing scale should be fitted with fabric filtering system;

- the materials which may generate airborne dusty emissions should be wetted by water spray system;
- all receiving hoppers should be enclosed on three sides up to 3m above unloading point;
- all conveyor transfer points should be totally enclosed;
- all access and route roads within the premises should be paved and wetted; and
- vehicle cleaning facilities should be provided and used by all concrete trucks before leaving the premises to wash off any dust on the wheels and/or body.

3.5 OPERATIONAL PHASE

IDENTIFICATION OF ENVIRONMENTAL IMPACTS

3.5.1 Vehicular emissions from the adjacent road networks including CKWLR, Route 10 and the distributor road P2, and the emissions from the GTP comprise operational air quality issues associated with the Theme Park and associated developments.

3.5.2 Additionally vehicle emissions from the vehicle parking areas and air emissions from fireworks displays, fuel combustion equipment and the sewage pumping station comprise other sources of air pollutant that will need to be addressed.

3.5.3 Potential air quality impacts during the operation of PBRL will be limited since the electric passenger trains will be used, no local air emissions will be produced.

Vehicular Emissions from Road Networks and Territory-wide Air Emissions caused by Theme Park Traffic

3.5.4 Vehicle emissions from the road networks in Northshore Lantau including the CKWLR, Route 10, NLH, Road P1 and P2, and Resort Road (D1 and D2) will be the major air pollutant sources during the operation of Theme Park and associated developments. In addition, emissions from Theme Park related traffic caused by internal traffic within the HK SAR and cross-boundary traffic will also affect air quality in the Study Area.

Vehicle Emissions from Vehicle Parking Areas and Theme Park Internal Traffic

3.5.5 Vehicle emissions from two vehicle parking areas (see *Section 2.12*) within the Theme Park may affect ASRs nearby. For internal traffic within the Theme Park, it is expected that traffic flow on local roads will be small and gaseous fuel will be used as fuel for vehicles (plus some electric vehicles), adverse air quality impact due to internal traffic is not anticipated.

Emissions from Combustion Equipment

3.5.6 Boilers for heating and domestic heating uses are the major sources of industrial emissions from the Theme Park and the associated development. There are totally 254 small size boilers with capacity in a range of 240 and 330 kW proposed associated with the Theme Park operation. The total fuel consumption rates are 105.72×10^6 kWh per year. NO_2, SO_2, CO and RSP are the major pollutant sources if diesel fuel is used. However, HKITP intends to use gaseous fuel and hence the associated SO_2 and RSP will be much reduced. NO_2 will be the main pollutant contributing to the cumulative air quality impact within the Study Area when gaseous fuel is used. The comparative emissions from boilers using gaseous fuel or diesel fuel are shown in *Tables 3.5a & b* below. Owing to the long distances from the ASRs to the emission sources, it provides longer reaction time for the conversion of NO_x to NO_2 at the ASRs. Thus 30% of NO_x will be assumed to convert to NO_2 in the assessment.

Table 3.5a - Emission Rates of Pollutants using Gaseous Fuel

	Gaseous Fuel		
	NO_x	**SO_2**	**RSP**
Total Fuel Consumption Rate (kWh/yr)	105.72×10^6		
Hourly Fuel Consumption Rate	1256 m^3		
Emission Factors (kg/10^6 m^3) [(a)]	1600	9.6	72
Emission Rate (g/s)	0.56	0.0033	0.025
Total annual production (kg/yr)	17604	1042	7813
Note: (a) Reference to AP-42 (b) 30% of NO_x convert to NO_2			

Table 3.5b - Emission Rates of Pollutants using Diesel Fuel

	Diesel Fuel		
	NO_x	**SO_2**	**RSP**
Total Fuel Consumption Rate (kWh/yr)	105.72×10^6		
Hourly Fuel Consumption Rate	1110 L		
Emission Factors (kg/10^3 L) [(a)]	2.4	8.5	0.24
Emission Rate (g/s)	0.74	2.62	0.074
Total annual production (kg/yr)	23336	82650	23017
Note: (a) Reference to AP-42 (b) 30% of NO_x convert to NO_2			

3.5.7 It can be seen that 80,000 kg of SO_2 will be reduced when gaseous fuel is used which represents only 1.3% of SO_2 emission when compared with diesel fuel. There will be an advantage of using gaseous fuel over diesel fuel.

3.5.8 In order to assess the potential air quality impact from the boiler emissions, a relative low stack height of 6 m is assumed for the worst case modelling purpose. It should, however, be noted that the final stack height will be controlled under *Air Pollution Control (Furnaces, ovens and Chimneys) (Installation and Alteration) Regulations*.

Emissions from Penny's Bay Gas Turbine Plant

3.5.9 The China Light and Power Company Limited (CLP) commissioned a 300 MW open cycle gas turbine plant at Penny's Bay in 1992 with an expected operational lifetime of 25 years. The plant comprises of 3 x 100 MW open cycle units with three separate 50 m stacks. The plant is fired by distillate fuel oil (diesel) with scope for possible future expansion to 600 MW. Air quality impact from this GTP has been identified as a key issue and wind tunnel modelling and numerical modelling were commissioned to assess the impact on local air quality arising from operation of the GTP.

Emissions from Fireworks Displays

3.5.10 The Study Brief issued for the Theme Park EIA (*Annex L*) includes a requirement for the assessment of air quality impacts associated with the operational phase of the Project. A range of operational activities are required to be addressed and these include the assessment of impacts associated with the proposed fireworks/pyrotechnics displays. Pyrotechnics usually consist of a mixture of two ingredients: a fuel and an oxidiser. They differ from explosives in that the reaction rates are very low and produce relatively little gas when compared with propellants.

3.5.11 The typical composition of pyrotechnics is black powder which is largely potassium nitrate, carbon and sulphur, plus substances added to produce effects and colours, typically various metals or metallic compounds and other chemicals. The scientific literature on the effect of fireworks on air quality is extremely limited. An on-line search of approximately four million scientific papers has only produced three papers related to dioxins emissions.

3.5.12 Researches focusing on the effects of particulates and metals from fireworks or detonation of black powder are more readily available.

3.5.13 Effects of pyrotechnic displays on indoor and regional air quality have been studied by (Dutcher *et al*, 1999)(1) and (Perry, 1999)(2) respectively and their findings published in the *Journal of the Air & Waste Management Association*. Both papers concluded that fine particulate matter dominated by K and S and other common pyrotechnic device constituents such as selected heavy metals were identified (Dutcher *et al*, 1999). The paper by Perry reported elevation of the fine particulates ($PM_{2.5}$) concentration in the western Washington State area. The maximum 24-hour averaged $PM_{2.5}$ mass concentration apportioned to the pyrotechnic displays was 18.5 μgm^{-3}. The majority of this mass (54%) was composed of K and S, which originated from the combustion of black powder. Other reference(3) suggested the solid products comprise mainly of K_2CO_3, K_2SO_4 and K_2S. Based on these papers it appears that particulates emissions warrant further assessment. It is also noted that some heavy metals will be emitted and hence will be the subject of further consideration.

3.5.14 During the combustion of black powder, gaseous emissions (about 31% by weight) including approximately 30% CO_2, 4-5% CO, and 40% N_2 and small amount of H_2O and H_2S. In view of the small amount of black powder being used and the relative small portion of associated CO emission from fireworks displays, the impact from CO is not expected. However, H_2S may pose some impact to the environment as this odourous compound can be detected at low concentrations. The potential odour impact will need to be addressed in the following section as part of the Study Brief requirements.

3.5.15 Four principal groups of pollutants are identified in the Study Brief, as being of potential concern:

- dioxins (which for the purposes of this assessment will be taken to include both polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans);

(1) Dabrina D. Dutcher, Kevin D. Perry, and Thomas A. Cahill, Effects of Indoor Pyrotechnic Displays on the Air Quality in the Houston Astrodome, J. Air & Waste Manage. Assoc. 49:156-160, 1999

(2) Kevin D. Perry, Effects of Outdoor Pyrotechnic Displays on the Regional Air Quality of Western Washington State, J. Air & Waste Mange. Assoc. 49:146-155, 1999

(3) Hussain G and Rees G J, Combustion of Black Powder Part 1: Thermo-Analytical Studies 1990

- volatile organic compounds (VOCs), which are of concern both with regard to their potential for direct impacts on human health and for their potential to promote the formation of photochemical smog;
- RSP and the associated heavy metals; and
- odour.

3.5.16 These substances will be further considered in following sections. With the exception of RSP, none of the papers identified in the on-line database researches have identified impact to the ambient levels of other AQO pollutants. Furthermore, the composition of fireworks is such that emissions of the remaining AQO pollutants are not anticipated to be of concern. On this basis AQO pollutants, other than RSP and possibly lead, will not be considered further.

Odour Emissions From Sewage Pumping Station

3.5.17 A sewage pumping station proposed at the north-west of the Theme Park beside the proposed Water Recreational Centre. The capacity of the station is 112,320 m^3/day. Odour, originating mainly from hydrogen sulphide in the sewage, could be released from the pumping station and is a potential source of nuisance to the vicinity. In addition, pumping chambers with maximum capacity of 0.2 m^3/s are proposed underground along the Resort Road (D1 and D2) of Theme Park. As the chambers are proposed underground, the odour will not be emitted to the air and it would not cause any adverse odour impact.

ASSESSMENT METHODOLOGY

Vehicle Emissions from Road Networks

3.5.18 The USEPA approved air dispersion model, *CALINE4* was used to predict the pollutant levels of NO_2, RSP and CO from the road networks within the Study Area including:

- North Lantau Highway;
- Chok Ko Wan Link Road;
- Road P2; and
- Roads D1 and D2.

3.5.19 The hourly average of pollutants at two affected heights, the ground level and 10 m above ground, were modelled in the assessment.

3.5.20 Fleet emission factors based on the EURO III criteria have been used for this assessment. As emission factors beyond 2011 are not available for this Study, 2011 vehicle emission factors were therefore assumed for traffic beyond 2011. It is however believed that emission rates beyond 2011 will be lower than 2011 as more stringent controls will be put in place and more vehicles will be fitted with advanced emission control systems. The predicted results will therefore be conservative.

3.5.21 Traffic flow based on design capacity of the above road networks provided by the Traffic Consultant were employed for the analysis of vehicle emissions. It was assumed that peak hour traffic will occur during daytime and worst case scenario of neutral meteorological conditions were used in the model runs. Typical input parameters for the model are listed below:

- wind speed 1 ms^{-1};
- wind direction worst case for each receivers;
- stability class D;
- mixing height 500 m;
- standard deviation of wind direction 12 degree;
- surface roughness 80 cm; and
- temperature 25^0C.

3.5.22 The NO_x gas is assumed to be inert and levels of NO_2 were taken as 20% of total NO_x emissions since the worst affected sensitive receivers are located close to the road alignment.

Vehicle Emissions from Vehicle Parking Areas

3.5.23 Emissions from public parking areas within the Theme Park were estimated based on person trips data of year 2024 provided by the HKITP as shown in *Table 3.5c* below. Hotel guests have not been included as they will be dropping off close to the hotel developments. Average occupancy of vehicles from the *Annual Traffic Census 1998* was used in the evaluation of the public carpark emissions during peak hours (9-10 am and 9-10 pm) where most people are arriving and leaving the Theme Park and the associated developments.

Table 3.5c - Daily Person Trips Travelled by Private Vehicle in Year 2024

Market Segment	Number of Trips by Private Vehicles	Number of Trips by Tour Coaches
Resident Workforce	750	0
HK Resident Visitors	1,013	0
Tourists	2,108	28,109
Day Visitors	0	1,924

3.5.24 Greater volumes of pollutants may be emitted due to idling operations of tour coaches during peak hours. The *ISCST3* air dispersion model was used to predict the potential impact on the nearby ASRs. Idling of private vehicles is normally of a very short duration hence is not included in this assessment. For this assessment, it has been assumed that an area of 1500 m^2 for each of the 2 public parking areas will be allocated for the parking of tour coaches. Meteorological data for 1997 from Cheung Chau weather station, operated by Hong Kong Observatory, were employed for the model run. Vehicle idling emission factors of 2.0 g/min-veh for NO_x and CO for bus provided by EPD were used as emission factors for the vehicle idling operations. Each tour coach is assumed idling at the carpark for a maximum of 10 minutes within the 1-hour assessment period. The levels of NO_2 were taken as 20% of total NO_x emissions. RSP emission is considered negligible as reference to MOBILE6 Emission Factor Model for heavy-duty diesel engines (RSP emission rate = 0.043 g/min-veh) developed by the USEPA and was therefore not included in the assessment.

Territory-wide Air Emissions Caused by Theme Park Traffic

3.5.25 Vehicle emissions from Theme Park related traffic caused by internal traffic within HK SAR and cross-boundary traffic were estimated based on person trips data provided by the HKITP shown in *Table 3.5d* below. In order to compare with the total Vehicle-kilometre-travelled (vkt) value obtained from CTS-3 Study for the assessment year in 2016, year 2014 person trips data were used. Average occupancy of vehicles were obtained from the *Annual*

Traffic Census 1998 to estimate the number of vehicles generated by the operation of the Theme Park. Vkt value was calculated by the total number of traffic generated and average distance travelled from town centre to the Theme Park. The vkt value was then compared with the total vkt obtained from the CTS-3 Study to evaluate the impact from additional traffic generated by the Theme Park and associated developments.

Table 3.5d - Daily Person Trips Travelled in Year 2014

Market Segment	Private Vehicle	Taxi	Bus	Tour Coach	Rail (PBRL)	Ferry
Resident Workforce	379	95	2,655	0	5,878	474
HK Resident Visitors	648	432	5,833	0	13,611	1,080
Tourists	1,214	809	7,283	16,184	14,161	809
Day Visitors (Transboundary)	0	0	4,006	821	0	0
Hotel Guests	2,079	1,578	860	717	1,004	932

Emissions from Combustion Equipment

3.5.26 As discussed earlier in this Section, NO_2 emission comprises the critical pollutant attributed to the Theme Park combustion equipment, and the NO_2 impacts on receivers located at different heights were assessed. Impacts of the combustion equipment were modelled with the air dispersion model, *ISCST3*. Meteorological data of Cheung Chau Weather Station for the year 1997 were used for the model run. Combustion data of the boilers are provided by HKITP and are shown in *Annex B5*. Types of the fuel, fuel consumption rates, physical dimension for stacks, exit gas temperature are included. Emission rates of pollutants are calculated based on *Compilation of Air Pollutant Emission Factors, 5th Edition* (AP-42).

Emissions from Penny's Bay Gas Turbine Plant

3.5.27 A review of the air quality impact from the GTP has been carried out to identify the potential air quality constraints to the proposed Theme Park and associated developments based on the findings from EIA of Gas Turbine Plant at Penny's Bay[(1)]. The report identified potential constraints on high-rise developments within the Penny's Bay Area.

3.5.28 The proposed development layout will be reviewed to confirm the proposed height restriction in the vicinity of the GTP is adequate to avoid any potential air quality impact. Any proposed development exceeding the specified limit will need to be addressed in terms of potential impact and or obstruction to the dispersion of the GTP plume. Special reference will be made to air quality at elevated ASRs to the south of the Bay based on the previous wind tunnel modelling velocity measurements over the site and test results.

Emissions from Fireworks Displays

3.5.29 Emissions from fireworks displays will be estimated based on the data provided by HKITP and information from on-line database searches. The assessment will include the following pollutants: RSP, heavy metals, VOC, dioxins and odour. Detailed consideration will be given to those pollutant identified as being of concern in the Study Brief, and others, such as RSP, which have been identified from the on-line database researches. Quantitative model-based assessment will, where appropriate, be utilised to predict impacts. Dispersion

(1) EIA of Gas Turbine Plant at Penny's Bay, Final Key Issue Report No. 1, Air Quality Impact (ERL, November 1990)

modelling will be carried out using meteorology data from the year 1997 from the Hong Kong Observatory's Cheung Chau Weather Station.

Heavy Metals

3.5.30 Disney committed to minimise any potential exposure to harmful air contaminants by prohibiting the use of heavy metals such as chromium, lead, mercury, arsenic, manganese, nickel or zinc in the purchase and use of pyrotechnics products (please refer to a letter from International Theme Park in *Annex B7*). Based on the data provided by HKITP, 42% of the total mass of fireworks is emitted to the atmosphere. If it is assumed that the total mass is turned to RSP the worst-case particulates emission will be around 2.6 kg and 14.7 kg for low-level and mid-level shows, respectively. Typically the composition of the particulates emission consists largely of Potassium Sulphate and a trace amount of metals in the form of, Potassium, Sodium, Magnesium, Aluminium, Antimony, Barium, Strontium, Titanium and Copper compounds. According to the USEPA's Integrated Risk Information System, there are no human carcinogenic data for the above metals, and they are therefore considered to be non-carcinogenic. Potential impacts from these metal compounds can be estimated using the percentage composition of these metal compounds within the mass of the particulates emission.

3.5.31 The *ISCST3* dispersion model will be used to simulate the potential RSP concentrations at ASRs. Estimated emissions are based on two mid-level and three low-level shows happening at the same hour (i.e. 2100 hours) every night. Based on the discussion with the fireworks specialist, the shows are modelled as separate volume sources, 27000 m^3 and 8000 m^3 respectively. The modelling results will then be compared with the respective daily and annual RSP criteria. The impacts of the metal compounds are estimated by comparison with the relevant non-AQO criteria.

Dioxins and VOCs

3.5.32 Impacts from dioxins and VOCs will be addressed with reference to the available literature.

Odours

3.5.33 The *ISCST3* air dispersion model has been used to predict an output which is described by the model as a maximum 1 hour mean concentration. In actual fact, this output corresponds more closely to a maximum 3 minute average. To provide a margin of error it has been conservatively assumed that concentration calculated by *ISCST3* can be equated to a 15 minute mean. In order to convert the model outputs to maximum 5 second mean concentrations, a two-step conversion process has been defined by EPD. The first step is the conversion of the model output to a maximum three minute mean using the power low formula proposed by Duffee *et al* (1) . The second step is the conversion of 3 minute means to 5 second means using the approach suggested by the Warren Spring Laboratory (WSL) (2) . The resulting factors for converting the model outputs to 5 second means, are presented in *Table 3.5e*.

(1) RA Duffee, MA O'Brien & N Ostojic, Odour Modelling - Why and How, in recent Developments and Current Practices in Odour, Regulations, Control and Technology, Transaction of the Air & Waste Management Association, ED. DR Derenzon & A Gnyp

(2) A W C Keddie, Dispersion of Odours, in Odour Control - A Concise Guide, Warren Spring Laboratory, 1980

Table 3.5e - Factors for Converting Model Outputs to Maximum 5 second Mean Odour Concentrations

Pasquill Stability Class	Conversion 15 minute to 3 minute mean	Conversion 3 minute to 5 second mean	Overall Conversion Factor
A	2.23	10	22.3
B	2.23	10	22.3
C	1.70	5	8.50
D	1.38	5	6.90
E	1.31	5	6.55
F	1.31	5	6.55

EVALUATION OF IMPACTS

Vehicular Emissions from Road Networks

3.5.34 Vehicular emissions from the road network are one of the major sources of pollutants and affect air quality at lower levels. Pollutant levels at the two worst affected heights, ground level and at 10 m above ground, have been modelled and the results are presented in *Table 3.5f*. Both the existing and planned road networks, described in *Section 3.5.4*, plus background pollutant concentrations have been included in the model. A 24-hour NO_2 and RSP criteria were used in the assessment. A factor of 0.4 was, therefore, used in for the conversion of hourly NO_2 and RSP concentration to daily NO_2 and RSP concentration.

Table 3.5f - Predicted Hourly Air Quality Impacts from Open Road (μgm^{-3})

ASRs	Predicted Concentration [(a)]							
	Ground Level				10m Above Ground			
	Hourly NO_2	Daily NO_2	Hourly CO	Daily RSP	Hourly NO_2	Daily NO_2	Hourly CO	Daily RSP
A1	135	74	984	58	131	72	984	58
A2	48	39	179	42	48	39	179	42
A3	44	37	179	41	44	37	179	41
A4	63	45	294	45	63	45	294	45
A5	135	74	984	58	135	74	984	58
A6	56	42	294	44	56	42	294	44
A7	56	42	294	43	56	42	294	43
A8	93	57	639	50	93	57	639	50
A9	82	53	524	48	78	51	409	47
A10	135	74	984	59	131	72	869	58
A11	116	66	869	54	112	65	754	54
A12	119	67	869	55	116	66	869	54
A13	97	59	639	51	97	59	639	51
A14	104	61	754	52	101	60	639	51
A15	138	75	984	60	138	75	984	60
A16	157	83	1,214	63	153	81	1,214	62
A17	142	77	1,099	59	135	74	984	58
A18	146	78	1,099	61	142	77	1,099	61
AQO Criteria	300	150	30,000	180	300	150	30,000	180

Notes:
(a) Background pollutants concentration included in the results

3.5.35 Full compliance with the AQO's is expected at all the ASRs was predicted. Maximum hourly NO_2 and CO and daily RSP concentrations of 157 μgm^{-3}, 1214 μgm^{-3} and 63 μgm^{-3}, respectively, were predicted at the ground level of Theme Park Gateway (A16). Interpretation of the model results indicates that there will be no adverse cumulative air quality impacts associated with the road networks.

3.5.36 Sample CALINE4 output files are shown in *Annex B6*.

Vehicle Emissions from Public Vehicle Parking Areas

3.5.37 Emissions from the public vehicle parking area within the Theme Park were evaluated based on the daily person trips data provided by the HKITP for the year 2024. About 3,871 person trips would be travelling by private vehicles and 30,033 person trips by tour coaches. About 15% of which will arrive or depart the Theme Park during peak hours (9-10 am and 9-10 pm) according to the Arrivals and Departures data for the year 2024 provided by the HKITP. Based on an average occupancy of 1.5 for private vehicles and 40 for tour coaches, it was estimated that about 400 private vehicles and 100 tour coaches will be arriving or departing the parking area during peak hours. Provided the small number of vehicles will be distributed over two large vehicle parking areas of about 90,000 m^2, air quality impact due to vehicle emissions from parking areas is expected to be insignificant.

3.5.38 Emissions from tour coaches waiting for the boarding passengers were estimated at the ground level and 10m above ground using *ISCST3* model. Assuming 100 tour coaches are idling over an area of 1,500 m^2 for each of the two parking areas for maximum of 10 minutes, the predicted pollutant concentrations at the nearest ASRs are shown in *Table 3.5g* below

Table 3.5g - Predicted Pollutant Concentrations from Idling Emission of Tour Coaches (μgm^{-3})

ASRs	Locations	Predicted Hourly NO_2 Concentration		Predicted Hourly CO Concentration	
		Ground Level	10m Above Ground	Ground Level	10m Above Ground
A11	Divisional Fire Station (West of the Penny's Bay Rail Station)	74	51	217	131
A12	Divisional Police Station	86	53	261	139
A13	Divisional Fire Station (East of the Penny's Bay Rail Station)	65	50	185	128

Notes:
(a) Background concentration included in the results

Territory-wide Air Emissions Caused by Theme Park Traffic

3.5.39 Air quality impact from additional traffic generated by the operation of Theme Park and associated developments was evaluated using daily person trip data of year 2014 in order to compared with the projected CTS-3 traffic figures in 2016 as shown in *Table 3.5c* .

3.5.40 Number of additional vehicles generated within the HKSAR and transboundary traffic and their vehicle-kilometre-travelled (vkt) were estimated and are shown in *Tables 3.5h* and *3.5i* below:

Table 3.5h - Additional Daily Traffic Generated by the Operation of Theme Park

Additional Traffic Generated	Private Vehicles	Taxi	Bus	Tour Coach
Trips by Local Traffic	4321	2914	16631	16901
Trips by transboundary traffic	0	0	4006	821
Average Occupancy of Vehicles	1.5	2	50	40
No. of Additional Local Vehicles	2880	1457	333	423
No. of Additional transboundary Vehicles	0	0	80	20

Table 3.5I - Additional VKT Generated by the Operation of Theme Park

	Local Traffic	Transboundary Traffic
Total Number of Vehicles Per Day	5,093	100
Average Distance Traveled Per Returned Trip (km)	34	44
vkt (Daily)	173,162	4,400
vkt (Yearly)	63,204,130	160,600
Percentage vkt of total vkt obtained from CTS-3 Study (23,815,904,689) of year 2016	0.26 %	6.7×10^{-4} %

3.5.41 As compared with the total vkt obtained from *CTS-3 Study* for the assessment year in 2016, additional traffic generated will only contribute to 0.26 % and 6.7×10^{-4} % of the total vkt. Air quality impact due to Theme Park related traffic is therefore not significant.

3.5.42 Alternative access modes, described in *Section 14*, using railway (PBRL) and ferry have been taken into account in the evaluation. *Table 3.5d* shows that, about 34,654 and 3,295 person trips would be taking the PBRL and ferry respectively. These two transport modes contribute to about 43 to 44% of the total person trips generated to the Theme Park. Significantly more road traffic would be generated should these alternative access modes not be provided. The consequence would be an increase in traffic related emissions.

Emissions from Boilers at Low Receiver Levels

3.5.43 The predicted hourly NO_2 concentration at ground level and 10 m above ground are listed in *Table 3.5j* below.

Table 3.5j - Predicted Hourly NO_2 Concentration at Low Elevations

ASRs	Predicted Hourly NO_2 Concentration [(a)]	
	Ground Level	10m Above Ground
A1	35	35
A2	37	36
A3	36	35
A4	35	35
A5	36	36
A6	35	35
A7	34	35
A8	35	36
A9	36	37
A10	35	35
A11	35	35
A12	35	35
A13	35	35
A14	35	35
A15	37	37
A16	34	34
A17	34	34
A18	35	35
AQO Criteria	300	300

Note:
(a) Background of NO_2 (33 μgm^{-3}) from Penny's Bay Gas Turbine Plant Monitoring Station has been included in the prediction.

Cumulative Impacts of GTP, Vehicle and Boiler Emissions at Low Level Receivers

3.5.44 NO_2, CO and RSP are the major pollutants in vehicle exhaust emissions. ASRs at lower levels, i.e., at ground level and 10 m above ground, will receive higher impacts. The cumulative air pollutant levels at low level receivers, taking into account contributions from vehicle emissions from the road networks, public parking area, GTP and boiler emissions, are shown *in Table 3.5k* below.

Table 3.5k - Cumulative Pollutants Concentration at Low Level Receivers (μgm^{-3})

ASR	Cumulative Concentration							
	Ground Level				10m Above Ground			
	Hourly NO_2	Daily NO_2	Hourly CO	Daily RSP	Hourly NO_2	Daily NO_2	Hourly CO	Daily RSP
A1	137	74	984	58	133	72	984	58
A2	52	40	179	42	51	40	179	42
A3	47	37	179	41	47	37	179	41
A4	65	45	294	45	65	45	294	45
A5	137	74	984	58	137	74	984	58
A6	58	42	294	44	58	42	294	44
A7	57	42	294	43	57	42	294	43
A8	95	58	639	50	96	58	639	50
A9	85	54	524	48	82	52	409	47
A10	136	74	984	59	133	72	869	58
A11	118	66	869	54	114	65	1,025	54
A12	121	68	869	55	118	66	754	54
A13	99	60	639	51	99	60	869	51
A14	107	61	754	52	103	60	639	51
A15	142	75	984	60	142	75	984	60
A16	158	83	1,214	63	155	81	1,214	62
A17	143	77	1,099	59	136	74	984	58
A18	148	78	1,099	61	144	77	1,099	61
AQO Criteria	300	150	30,000	180	300	150	30,000	180

Notes:
(a) Vehicle exhaust, boiler emissions and background levels are included in the results
(b) Since emissions of CO and RSP from boilers are negligible, only results from vehicle emissions are presented

3.5.45 The cumulative hourly and daily NO_2, CO and RSP concentrations from vehicle and boiler emissions show full compliance of the AQOs at all ASRs. The predicted cumulative hourly NO_2 and CO and daily RSP concentrations at ground level and 10 m above ground are in the range of 47 - 158 μgm^{-3}, 179-1,214 μgm^{-3} and 41-63 μgm^{-3} respectively. It is also indicated that NO_2 is the critical pollutant and maximum hourly NO_2 concentration of 158 μgm^{-3} was predicted at A16 (Theme Park Gateway) at ground level which comprises 53% of AQO for the worst case scenario. It is stated in the *EIA of Gas Turbine Plant at Penny's Bay*[1] that about 60 μgm^{-3} of NO_2 should be added to predicted level under high wind speed conditions, and the maximum hourly NO_2 levels at A16 will become 218 μgm^{-3} which is still within the AQO criteria.

3.5.46 Isopleths of the critical pollutant (NO_2) at both ground level and 10 m above ground are shown in *Figures 3.5a-b*. The plots show that pollutants levels in the area are within the AQO criteria.

Emissions from Boilers at High Receiver Levels

3.5.47 The high level of ASRs are affected mainly by the boiler emissions. The predicted hourly NO_2 concentration at 20 m, 30 m and 40 m above ground are listed in *Table 3.5l* below.

[1] EIA of Gas Turbine Plant at Penny's Bay, Final Key Issue Report No. 1, Air Quality Impact (ERL, November 1990)

Table 3.5l - Predicted Hourly NO_2 Concentration at High Elevations

ASRs	Predicted Hourly NO_2 Concentration [(a)]		
	20m Above Ground	30m Above Ground	40m Above Ground
A1	36	37	37
A2	35	35	35
A3	35	35	34
A4	35	34	34
A5	36	35	35
A6	36	36	36
A7	35	35	35
A8	37	38	37
A9	38	42	41
A10	36	36	36
A11	36	37	37
A12	36	38	37
A13	36	37	36
A14	36	36	36
A15	36	36	35
A16	34	34	34
A17	34	34	34
A18	35	35	35
AQO Criteria	300	300	300

Note:
(a) Background of NO_2 (33 μgm^{-3}) from Penny's Bay Gas Turbine Plant Monitoring Station has been included in the prediction.

3.5.48 The above results indicated that the NO_2 criteria will be satisfied at all elevations. It also indicated that the worst affected level is 30 m above ground. The highest hourly NO_2 was predicted at A9 (Resorts in Theme Park) which is 42 μgm^{-3}.

Emissions from Penny's Bay Gas Turbine Plant

3.5.49 The EIA of Gas Turbine Plant at Penny's Bay[(1)] concluded that the GTP will not cause any unacceptable air quality impact to ground level receptors. The predicted SO_2 concentration was in excess of the AQO under a high wind speed (15 ms^{-1}) situation at elevated receptor, 100 m above ground and 500 m away from the GTP, causing constraints on the proposed high-rise developments to the west of the GTP under the worst case operating scenario with 6 units running at 50% load.

3.5.50 Further mathematical modelling was carried out under a more probable wind speed of 10 ms^{-1} and wind directions ranging from 47^o to 109^o to assess the air quality impact to the proposed high-rise development within the Penny's Bay area. The predicted SO_2 concentration 500 m away from the GTP reaches 400 μgm^{-3} at about 60 m above ground and the 400 μgm^{-3} contour remains relatively flat until it approaches the elevated ground. This forms the basis for the recommended height restriction of 60 m above ground to the high-rise development under a conservative assumption of 6 units operating at 50% load. A more realistic operating scenario of 3 units running at 100% load instead of 6 units at 50% gives higher plume rise and reduces predicted concentrations at both ground-level and elevated receptors. Previous mathematical modelling results as shown in *Figure 3.5c* suggest that the 400 μgm^{-3} SO_2 contour is about 110 m above ground at 500 m from source under a north-easterly wind. The GTP plume should clear the proposed high-rise development to the west of the GTP and no constraint should be applied under this modelling scenario.

3.5.51 To estimate the air quality impact on elevated receptors located to the south of the GTP, it is necessary to examine the plume behaviour under a northerly wind. Results from previous wind tunnel measurements for this wind direction indicated that the plume would be pulled down towards the ground due to the terrain to the north. The GTP is effectively located in the wake of a group of hills and ridges with a peak height of about 150 to 200 m. Furthermore, the measured vertical profile at the power station site under northerly wind (358^o) also indicates that both the mean wind velocity (at and above the stack discharge height) and the turbulence intensity (for the lower 200 m) are significantly enhanced after crossing the hills to the north of the GTP. This suggests that the pollutant is discharged into a highly turbulent wake generated by the hill and ridges upstream of the plant and the effluents would be rapidly transported to the ground by turbulent mixing.

3.5.52 Wind tunnel measurements confirm the suggestion of this turbulent mixing zone within 500 m from the GTP. Dispersion of the GTP plume in this well mixed zone up to 100 m above ground would tend to be given a relative uniform pollution concentration. This suggests pollutant concentrations within this shallow boundary layer should be similar to the recorded maximum ground level SO_2 concentrations of less than 400 μgm^{-3} under the worst case modelling scenario.

3.5.53 Review of the wind tunnel modelling results suggests height restriction up to 50 m within the first 500 m distance should be applied to protect elevated receptors in the immediate vicinity and reduce obstruction to the dispersion of the GTP plume. Building within 500 m to 1 km from the GTP should not be taller than 100 m to avoid any physical obstruction to plume dispersion.

3.5.54 Buildings within the Water Recreation Centre should be low-density and low-rise in character and should not exceed 6 m in height and the building within the Theme Park will be limited to 100 m in height to avoid potential air quality impact from the GTP. Although the Theme Park is subject to a maximum building height of 100 m, the majority of structures for individual themed areas are low rise development within some broad height band except for some visual icons consist of tall and slim structure. The location of these structures will be more than 500 m from the GTP and not affecting the wind flow pattern or plume dispersion at the GTP. Hotel development along the south side of the development will be limited to a maximum building height of 40 m provide further safeguard to any potential obstruction to the approach flow.

3.5.55 It is therefore expected that the dispersion of the chimney emissions from the GTP will not be affected by the proposed low-rise development in the immediate vicinity and the land use planning of the area would avoid constraints imposed by the GTP. The recommended height restriction should be adequate to protect the air quality within the Penny's Bay area.

Emissions from Fireworks Displays

Dioxins

Overview

3.5.56 The term "dioxin" is often used to denote a family of compounds known chemically as polychlorinated dibenzo-para-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Each compound comprises two benzene rings interconnected by oxygen atoms. In the case of PCDDs, the benzene rings are joined by two oxygen bridges, whereas in the PCDFs, the benzene rings are connected by a carbon bond and an oxygen bridge.

3.5.57 There are 75 PCDDs and 135 PCDFs, each differing in the number and position of the chlorine atoms. Each individual PCDD or PCDF is termed a *congener* (giving 210 in total), while groups of congeners with the same number of chlorine atoms are called *homologues*. The homologue groups are often abbreviated for convenience; for example, tetrachloro CDDs and CDFs (PCDD/Fs with four substituted chlorine atoms) are abbreviated to TCDDs and TCDFs respectively, while the fully chlorinated octachloro congeners (eight substituted chlorine atoms) are abbreviated to OCDD and OCDF respectively.

3.5.58 PCDD and PCDF congeners with chlorine atoms in the 2, 3, 7 and 8 positions are of particular environmental concern, especially the tetrachloro-CDD congener 2,3,7,8-TCDD, which achieved notoriety following its release from the ICSEMA plant at Seveso, Italy in 1977.

3.5.59 Of the 17 PCDD and PCDF congeners with chlorine in the 2, 3, 7 and 8 positions, 2,3,7,8-TCDD is the most toxic, and by convention is assigned a toxicity rating of 1.0 (called a Toxic Equivalent Factor or TEF). The remaining 2,3,7,8-positional congeners are then assigned lower TEFs comparable to their toxicity, relative to that of 2,3,7,8-TCDD. The toxicity of any mixture of PCDDs and PCDFs, relative to 2,3,7,8-TCDD, can then be expressed by multiplying the concentrations of the 2,3,7,8-positional congeners present in the mixture by their respective TEFs. The resulting products for each congener are called Toxic Equivalents (TEQs), with units identical to that in which the concentrations of the individual congeners are expressed. The TEQ of the mixture is obtained by summing the individual TEQs.

3.5.60 While a number of toxicity rating schemes have been developed, the scheme that has been internationally adopted is that of NATO/CCMS (1988), under which the TEFs are termed International TEFs, or I-TEFs. The summation of individual TEQs for a mixture of PCDDs and PCDFs is termed the International Toxic Equivalent or I-TEQ of the mixture.

3.5.61 These compounds arise from a diverse range of both natural and man made sources. However, there is general agreement that man-made sources and activities are far greater contributors to the environmental burden of PCDD/Fs than natural processes, especially since the 1930s, from which time there has been a steady increase in environmental levels coinciding with the large scale production and use of chlorinated chemicals (Fortin and Caldbick, 1997; Alcock *et al*, 1998). Man-made sources of PCDD/Fs can be divided into three main categories, broadly defined as follows (Fiedler, 1993):

- chemical processes;

- combustion processes;
- secondary sources.

3.5.62 To date, we are not aware of any studies undertaken and reported in the open literature that quantify the contribution of fireworks to the national or local inventory of PCDD/Fs.

Ambient Levels of Dioxins in the Hong Kong Environment

3.5.63 To date, the most comprehensive set of data on ambient levels of PCDD/Fs in the Hong Kong SAR has been developed by the Environmental Protection Department. The EPD currently operates two Air Quality Monitoring Stations (AQMS) at which, the levels of PCDD/Fs are measured on a regular basis. The AQMS are located at Central/Western and Tsuen Wan. Over the period July 1997 to July 1999, the median concentrations reported were 0.093 pg I-TEQ m^{-3} at Central/Western and 0.1 pg I-TEQ m^{-3} at Tsuen Wan.

3.5.64 To place these values in context, the reported concentrations fall within the range of typical values reported in other large cities and metropolitan areas of the world. The following are examples of concentrations reported in other areas:

- urban areas of Japan - 0.08 to 0.28 pg I-TEQ m^{-3}
- urban areas of Germany - 0.07 to 0.35 pg I-TEQ m^{-3}
- 4 urban sites in the UK - 0.1 pg I-TEQ m^{-3} (median)
- urban sites in the United States - 0.016 to 0.45 pg I-TEQ m^{-3}
- urban sites in Korea - 0.029 to 0.69 pg I-TEQ m^{-3}

Fireworks as a Source of Dioxin Emissions to the Atmosphere

3.5.65 As stated above, we have been unable to identify any published sources of information that document the contribution of emissions from fireworks to the total inventory of atmospheric emissions of PCDD/Fs.

3.5.66 A paper published in the UK in 1997 (Dyke and Coleman, 1997) in the journal *Chemosphere*, reported that there was a fourfold increase in the ambient concentration of PCDD/Fs in the atmosphere during the 5 November celebrations. These celebrations traditionally include not only the use of fireworks but also the open burning of large quantities of material (principally wood) in bonfires. These findings stimulated further work to determine the principal source of these increases in ambient concentrations and led to the recent publication of a paper by Fleischer *et al* (1999).

3.5.67 The principal conclusions of the paper are as follows:

- The majority of the fireworks tested in the experiments were harmless and the 2,3,7,8-TCDD congener, which is the principal source of concern, was not detected in any of the samples.

- Levels of impurities, such as pentachloropheonol (PCP), in fireworks should be minimised as far as is practicable. This will be achieved via controls on the procurement process.

- "No indications were found that emissions from fireworks may cause air pollution."

- Any PCDD/Fs detected in the samples had tended to be transferred from the raw materials (eg paper) into the solid residues (ie ash).

- The presence of copper in some products catalysed the formation of some PCDD/Fs in solid residues but not in gaseous emissions. As a consequence measures are proposed in *Section 6* to ensure that the solid residues are managed in the same manner as chemical wastes.

3.5.68 The conclusion was therefore that the observations made by Dyke and Coleman were as a result of emissions of PCDD/Fs from open burning of waste wood in bonfires, rather than fireworks.

3.5.69 From this assessment we conclude that the proposed fireworks displays will not be a significant source of atmospheric emissions of PCDD/Fs and hence should not be considered further.

Volatile Organic Compounds

3.5.70 An on-line search of approximately four million scientific papers did not identify any published sources of information that document the contribution of emissions from fireworks to the national or local inventory of Volatile Organic Compounds (VOC) emissions. The *Compilation of Air Pollutant Emission Factors, US EPA (AP-42)* document does not report any VOC emissions from the detonation of black powder which is the main component of fireworks. No emission factors for VOCs were identified in the on-line search of scientific abstracts.

3.5.71 A recent publication by Fleischer *et al* (1999) suggested VOC emissions from fireworks and pyrotechnics are unlikely due to high temperatures of up to 2,500 ^{0}C accompanying the deflagration of pyrotechnic compositions. We therefore conclude that the proposed fireworks displays will not be a significant source of atmospheric emissions of VOC and hence should not be considered further.

RSP and Heavy Metals

3.5.72 During the launch of the fireworks, an explosive charge will be used to fire the shell to the air before detonation. The detonation of the fireworks will generate respirable suspended particulates (RSP) emissions (Dutcher 1999), which predominantly comprise potassium and sulphate (Perry, 1999) and trace amounts of some other elements used for the generation of the required pyrotechnic effects. Such emissions will largely be dispersed and diluted at the burst height during the fireworks displays and very shortly thereafter. Estimated potential RSP emissions based on the information provided by HKITP will be around 2.6 kg and 14.7 kg for typical low-level and mid-level shows respectively, assuming that, as a worst case, 42% of the total weight of the fireworks will be released as RSP into the atmosphere. Daily and annual RSP concentrations predicted at the ASRs at ground level due to these worst case fireworks emissions are shown in *Table 3.5m*.

Table 3.5m - Predicted Worst Case RSP Concentrations at Ground Level (μgm^{-3})

ASRs	Locations	Daily RSP Concentration	Annual RSP Concentration
A1	Penny's Bay GTP	39.50	39.03
A2	Possible Country Park Extension Area	47.83	39.58
A3	Possible Country Park Extension Area	45.27	39.21
A4	Possible Country Park Extension Area	47.88	39.14
A5	Luk Keng Tsuen	39.67	39.03
A6	Discovery Bay	40.07	39.04
A7	Peng Chau	41.24	39.04
A8	Theme Park (Phase I and II)	40.40	39.08
A9	Resort in Theme Park (Phase I and II)	42.23	39.06
A10	Theme Park (Phase III) Extension	40.63	39.02
A11	Divisional Fire Station (West of the Penny's Bay Rail Station)	40.15	39.07
A12	Divisional Police Station	40.85	39.10
A13	Divisional Fire Station (East of the Penny's Bay Rail Station)	40.17	39.06
A14	Water Recreational Centre	41.75	39.06
A15	Eco Park	41.31	39.04
A16	Theme Park Gateway	39.54	39.02
A17	Tourist and Convention Village	39.43	39.01
A18	Technodrome	39.41	39.01

Note:
(a) Background level of 39 μgm^{-3} included in the results

3.5.73 The predicted maximum daily and annual average RSP concentrations were 47.88 and 39.58 μgm^{-3}, respectively, at the proposed country park extension area (A4 and A2). It should be noted that the predicted RSP concentrations include a background concentration of 39 μgm^{-3}. Maximum daily and annual average RSP contributions from the fireworks displays are 8.88 and 0.58 μgm^{-3} respectively. The potential RSP impacts from the fireworks displays will therefore be very low when compared with the AQOs of 180 and 55 μgm^{-3} for daily and annual averages.

3.5.74 Isopleths of daily maximum RSP concentration at ground level and 30m above ground level are shown in *Figures 3.5d* and *3.5e*, respectively. The isopleths indicate that daily RSP levels at both elevations are very low within the bay area. Background level has not been added to the predicted concentrations to highlight the small incremental increase of RSP levels from fireworks emissions. Sensitive receptors located at Peng Chau and Discovery Bay are further away from the Theme Park and hence not be affected.

3.5.75 Typically the composition of the particulates emission consists largely of potassium and sulphate and a trace amount of trace elements such as Sodium, Magnesium, Aluminium, Antimony, Barium, Strontium, Copper and Titanium compounds. HKITP has committed to exclude the purchase of any pyrotechnics that contain Chromium, Lead, Mercury, Arsenic, Manganese, Nickel or Zinc in their formulation. This minimises the use of potentially harmful heavy metals and reduces possible impacts to the surrounding environment. Of those elements included in the pyrotechnic product, the following is a list of their percentage compositions:

- Aluminium (Al) 2.93%
- Antimony (Sb) 1.28%
- Barium (Ba) 3.06%
- Strontium (Sr) 1.64%

- Copper (Cu) 0.92%
- Titanium (Ti) 0.40%

3.5.76 It has been assumed that RSP has the same elemental composition. *Table 3.5n* shows the predicted maximum annual average ground level concentrations at ASRs and the corresponding assessment criteria. It is evident that the predicted concentrations are well below the assessment criteria.

Table 3.5n - Predicted Worst Case Annual Average Pollutant Concentrations at Ground Level (μgm^{-3})[(a)(b)]

ASRs	Locations	Predicted Annual Pollutant Concentration					
		Al	**Sb**	**Ba**	**Sr**	**Cu**	**Ti**
A1	Penny's Bay GTP	0.0009	0.0004	0.0009	0.0005	0.0003	0.0001
A2	Possible Country Park Extension Area	0.0171	0.0075	0.0178	0.0096	0.0053	0.0023
A3	Possible Country Park Extension Area	0.0061	0.0027	0.0064	0.0034	0.0019	0.0008
A4	Possible Country Park Extension Area	0.0042	0.0018	0.0044	0.0024	0.0013	0.0006
A5	Luk Keng Tsuen	0.0009	0.0004	0.0010	0.0005	0.0003	0.0001
A6	Discovery Bay	0.0011	0.0005	0.0011	0.0006	0.0003	0.0001
A7	Peng Chau	0.0011	0.0005	0.0011	0.0006	0.0003	0.0001
A8	Theme Park (Phase I and II)	0.0023	0.0010	0.0024	0.0013	0.0007	0.0003
A9	Resort in Theme Park (Phase I and II)	0.0017	0.0007	0.0018	0.0009	0.0005	0.0002
A10	Theme Park (Phase III) Extension	0.0007	0.0003	0.0007	0.0004	0.0002	0.0001
A11	Divisional Fire Station (West of the Penny's Bay Rail Station)	0.0021	0.0009	0.0022	0.0012	0.0007	0.0003
A12	Divisional Police Station	0.0029	0.0012	0.0030	0.0016	0.0009	0.0004
A13	Divisional Fire Station (East of the Penny's Bay Rail Station)	0.0016	0.0007	0.0017	0.0009	0.0005	0.0002
A14	Water Recreational Centre	0.0019	0.0008	0.0020	0.0011	0.0006	0.0003
A15	Eco Park	0.0012	0.0005	0.0012	0.0007	0.0004	0.00016
A16	Theme Park Gateway	0.0005	0.0002	0.0005	0.0003	0.0002	0.00007
A17	Tourist and Convention Village	0.0004	0.0002	0.0004	0.0002	0.0001	0.00005
A18	Technodrome	0.0003	0.0001	0.0003	0.0001	0.0001	0.00004
Criteria [(b)]		100 [(e)]	5[(c)]	5[(c)]	-	2.4 [(d)]	100 [(e)]

Note:

(a) Background concentrations are not included in the prediction.

(b) Annual average criteria, short term exposure limits are not available for these pollutants.

(c) A *Reference Note on Occupational Exposure Limits for Chemical Substances in the Work Environment, 1995, Labour Department HK.* A safety factor of 100 has been applied for conversion of Time-weight-average value to long term exposure limit and to allow for variability in human response to chemicals.

(d) *California Air Resources Board(CARB)*

(e) *Occupational Exposure Limits, 1991, Health & Safety Executive, UK.* A safety factor of 100 has been applied for conversion of Time-weight-average value to long term exposure limit and to allow for variability in human response to chemicals.

3.5.77 Based on the above analysis, the planned fireworks displays will not create a significant increase in the ambient RSP or heavy metal concentrations. Provided that there are controls on the composition of these products they procure through a strict procurement process to prohibit the use of certain metals specified by HKITP, this matter is not of concern. Consideration should also be given to reducing the extent to which fireworks containing copper are used whilst maintaining the integrity and speciality of the fireworks displays. It should be noted that whilst some forms of titanium are banned from consumer fireworks products in the United States (i.e. American Pyrotechnics Association Standard 87-1, 1998), no such ban applies to display fireworks, such as those that would be used at the Theme Park. Furthermore, the assessment shows that as a worst case there is a margin of approximately five orders of magnitude between the assessment criteria and the maximum predicted concentration.

Odour

3.5.78 Hydrogen Sulphide (H_2S) is an odourous compound that would be emitted into the atmosphere from the detonation of black powder, which is one of the major components of fireworks (around 41%). This gaseous pollutant has a distinct bad egg smell and can be detected even at a very low ambient concentration (Odour Threshold Value of 0.66 μgm^{-3}). The emission factor reported by Disney[1] is 0.225 g of H_2S per kg of black powder consumed. The highest predicted odour level on and averaging time of 5 seconds is 1.46 Odour Unit (OU) at the ASR A2 (Proposed Country Park Extension). Odour levels predicted at the ASRs at ground level on an averaging time of 5 seconds are shown in *Table 3.5o*.

Table 3.5o - Predicted Odour Level at Ground Level (Odour Unit)

ASRs	Locations	Odour Units
A1	Penny's Bay GTP	0.09
A2	Possible Country Park Extension Area	1.46
A3	Possible Country Park Extension Area	0.23
A4	Possible Country Park Extension Area	0.40
A5	Luk Keng Tsuen	0.03
A6	Discovery Bay	0.05
A7	Peng Chau	0.05
A8	Theme Park (Phase I and II)	0.22
A9	Resort in Theme Park (Phase I and II)	0.13
A10	Theme Park (Phase III) Extension	0.15
A11	Divisional Fire Station (West of the Penny's Bay Rail Station)	0.13
A12	Divisional Police Station	0.20
A13	Divisional Fire Station (East of the Penny's Bay Rail Station)	0.11
A14	Water Recreational Centre	0.10
A15	Eco Park	0.03
A16	Theme Park Gateway	0.03
A17	Tourist and Convention Village	0.03
A18	Technodrome	0.02
Notes: (a) Odour levels predicted on an averaging time of 5 seconds.		

3.5.79 The predicted results show that the EIAO-TM criteria of 5 odour units on an averaging time of 5 seconds will be met at all ASRs and hence that any odour emissions from the fireworks displays would not cause a nuisance.

3.5.80 Walt Disney has been staging frequent fireworks displays for many years and has confirmed that there have never been any complaints received about noxious odours being generated by fireworks in the four different Disney theme parks around the world. All of these four sites, the closest residential neighbourhood to Disneyland is approximately 400 metres from the theme park and the fireworks launch site. Considering Disney's past operational history and the planned distance between the Hong Kong Theme Park site and the nearest sensitive

(1) Hussain, G and G J Rees, Combustion of Black Powder, Part 1. Thermo-Analytical Studies. Propellants, Explosives, Pyrotechnics (1990), in agreement with the South California Air Quality Management District.

receptor (Police Station, A12) located some 800 m away from the fireworks launch site, there should not be any adverse odour impact generated by fireworks displays.

Odour from Sewage Pumping Station

3.5.81 Hydrogen sulphide is the major source of odour from the proposed sewage pumping station in Theme Park. As the flow of sewage is small and it is anticipated that odour suppression measures such as enclosing the odour sources and providing odour scrubbing systems would be incorporated in the design of the facility, odour nuisance from sewage would be sufficiently mitigated and the odour criteria would likely be satisfied.

MITIGATION MEASURES

3.5.82 Although the predicted results show no exceedance of the established criteria, some recommendations are required for ensuring good air quality at the development.

3.5.83 Building height restrictions of up to 50 m within the first 500 m from GTP and 100 m within 500 m to 1 km from GTP were recommended in the Penny's Bay. For example, buildings within the Water Recreation Centre should be low-density and low-rise in character and should not exceed 6m in height. Hotel development along the south side of the development should be limited to a maximum building height of 40 m provide further safeguard to any potential obstruction to the approach flow.

3.5.84 In order to minimise any potential exposure to harmful air contaminant, HKTPL agreed that any pyrotechnics that specifically use chromium, lead, mercury, arsenic, manganese, nickel or zinc would not be purchased for the fireworks displays.

3.5.85 Since the detail design of the sewage pumping stations is not available at this stage, detailed mitigation measures cannot be prescribed. However, odour suppression measures such as enclosing the odour sources and providing scrubbing system should be incorporated in the design of the facilities so as to minimise the odour nuisance to the adjacent ASRs.

3.6 RESIDUAL IMPACTS

CONSTRUCTION PHASE

3.6.1 There are no residual impacts predicted associated with the construction of the Theme Park Phase 1 & 2 with the concurrent projects after the implementation of the recommended mitigation measures described in *Section 3.4.22 and 3.4.23* above.

OPERATIONAL PHASE

3.6.2 There are no residual impacts predicted associated with the vehicular emissions from the open road networks at low level receivers and boiler emissions at high level receivers in the vicinity.

3.6.3 With the incorporation of the building height restriction recommended in *Section 3.5.84* into the design of the structures in the Theme Park and Water Recreation Centre, no residual impacts are expected.

3.6.4 Without the use of the specifically pyrotechnics substances recommended in *Section 3.5.85* in the fireworks displays, residual impacts are not expected.

3.6.5 Although the detail design of the proposed sewage pumping station is not available at this stage, however, with odour suppression measures stated in *Section 3.5.86* to be incorporated with the design, no residual impact is expected.

3.7 ENVIRONMENTAL MONITORING AND AUDIT

3.7.1 Monitoring and auditing of air quality has been recommended for the construction and operational phase. The specific monitoring requirements are detailed in *Annex N* of this EIA Report which comprises the stand-alone Project EM&A Manual.

3.8 CONCLUSIONS

BASELINE CONDITIONS

3.8.1 The air quality within the Study Area is currently rural affected by emissions from the North Lantau Highway and to a lesser extent the GTP. The existing air quality for the Study Area is comparable with the monitoring results collected from Tung Chung. In future, vehicular emissions are expected to contribute more significantly to the air quality in the Study Area.

CONSTRUCTION PHASE

3.8.2 Impacts arising from the construction of the Project primarily relate to dust nuisance and gaseous emissions from the construction plant and vehicles, with dust generation being the major concern. The construction activities include, site formation, construction of the theme park and associated facilities including hotels and water recreation area; road construction of road P2, a section of CKWLR between Yam O Interchange to Penny's Bay Roundabout, theme park internal road D1 and D2; and PBRL including track construction and Yam O and Penny' Bay Rail stations works.

3.8.3 With the incorporation of the mitigation measures recommended in *Section 3.4.22*, the prediction of the cumulative hourly and daily TSP levels indicates that there is no exceedance found in the identified ASRs taking into account the construction of the concurrent projects.

3.8.4 To ensure no exceedance of the TSP level at the receivers, EM&A is recommended.

OPERATIONAL PHASE

3.8.5 Vehicular emissions from the adjacent road networks including CKWLR, Route 10 and the distributor road P2, and the emissions from the GTP are the major air quality concerns to the Theme Park. In addition, the vehicle emissions from the public parking areas and emissions from fireworks displays, fuel combustion equipment and sewage pumping station are another air quality concerns to the adjacent ASRs. Potential air quality impacts during the operation of Penny's Bay Rail Link will be limited since electric passenger trains will be used, no air emissions will be produced.

3.8.6 All statutory AQOs will be satisfied at all ASRs at both low level (ground level and 10 m above ground) and high level (20-40 m above ground) due to the vehicular emission from road networks to and boiler emissions from the Theme Park. Height restrictions will be incorporated into the Theme Park plans to avoid any potential air quality impact from the Penny's Bay GTP and it has been assessed that the dispersion of the chimney emissions will not be affected by the Theme Park and associated developments.

3.8.7 Impact from fireworks displays has been assessed through literature review and dispersion modelling. Based on the available literature, fireworks displays will not be a significant source of atmospheric emissions of PCDD/Fs and VOC. The modelling results indicated emissions from fireworks would increase the predicted daily and annual RSP concentrations by 8.88 and 0.58 μgm^{-3} respectively at the worst affected ASR. Based on the RSP modelling results and the low percentage of heavy metal compositions, impacts from heavy metals are not expected. Potential odour impact from H_2S has also been modelled and the results at the ASRs are within the acceptable criteria.

3.8.8 Fireworks displays emissions impact on air quality would only contribute to marginal increase in the air pollutant levels in the atmosphere; operational monitoring is proposed for verification proposes, due to the paucity of published scientific data on this subject.

3.8.9 Potential odour impacts from the proposed sewage pumping station would not affect the adjacent ASRs with the adoption of recommended odour control measures in the detailed design stage such as enclosing the odour sources and provision of odour scrubbing systems.

3.8.10 The air quality impacts during construction and operational phases of Theme Park are summarised in *Table 3.8a*.

Table3.8a Summary of Air Quality Impact for Theme Park

Issue	Construction Impact	Operational Impact
Assessment Points	• Penny's Bay Gas Turbine Plant (A1) • Possible Country Park Extension Area (A2) • Possible Country Park Extension Area (A3) • Possible Country Park Extension Area (A4) • Luk Keng Tsuen (A5) • Discovery Bay (A6) • Peng Chau (A7)	• Penny's Bay Gas Turbine Plant (A1) • Possible Country Park Extension Area (A2) • Possible Country Park Extension Area (A3) • Possible Country Park Extension Area (A4) • Luk Keng Tsuen (A5) • Discovery Bay (A6) • Peng Chau (A7) • Theme Park (A8) • Resort in Theme Park (A9) • Theme Park (Phase III) Extension (A10) • Divisional Fire Station (West of the Penny's Bay Rail Station) (A11) • Divisional Police Station (A12) • Divisional Fire Station (East of the Penny's Bay Rail Station) (A13) • Water Recreation Centre (A14) • Eco Park (A15) • Theme Park Gateway (A16) • Tourist and Convention Village (A17) • Proposed Tourism Development at Tsing Chau Tsai East (A18)
Relevant Criteria	Hourly dust criteria recommended in EIAO-TM is 500 μgm^{-3} and daily dust criteria stipulated in the Hong Kong Air Quality Objective (AQOs) is 260 μgm^{-3}.	Hourly NO_2, CO and daily RSP stipulated in HKAQOs are 300 μgm^{-3}, 10000 μgm^{-3} and 180 μgm^{-3} respectively.
Potential Impacts	Background dust level of 67 μgm^{-3} has been included in the prediction.	Background of NO_2 (33 μgm^{-3}), CO (64 μgm^{-3}) and RSP (39 μgm^{-3}) have been included in the prediction.
	Dust nuisance and the construction plant emissions are the major impacts during construction.	1. Vehicular emissions from open road networks such as CKWLR, NLH, distributor road P2 and Roads D1 and D2 are the major concern during operational phase.
	1. Theme Park Phase I and II reclamation, Water Recreation Centre construction works, Yam O reclamation, road construction of CKWLR section between Yam O to Pa Tau Kwu, distribution road P2 and Theme Park Resort Road (D1 and D2) and construction works of PBRL are the major construction works. Construction works of CKLWR section between Penny's Bay Roundabout to R10 Toll Plaza would be the cumulative impact with Theme Park construction.	The prediction indicated that NO_2 is the critical pollutants. Highest hourly NO_2 at ground level and at alignment level were both predicted at A16 (Theme Park Gateway) which the predicted hourly NO_2 concentrations at ground level and at 10m above ground are 158 μgm^{-3} and 155 μgm^{-3} respectively.
	2. The major dust generating activities are drill and blast, materials handling, wind erosion, trucks movement on unpaved road, concrete batching and road construction.	2. Cumulative impacts of open road networks, Penny's Bay Gas Turbine Plant and combustion equipment in Theme Park are another concern at low level receivers. The prediction indicated that NO_2 is the critical pollutants. Highest hourly NO_2 at ground level and at alignment level

Issue	Construction Impact	Operational Impact
		were both predicted at A16 (Theme Park Gateway) which the predicted hourly NO_2 concentrations at ground level and at alignment level are 158 μgm^{-3} and 155 μgm^{-3} respectively.
	3. The predictions indicated that the dust levels predicted at all ASRs with 1.5 m above ground and 10m above ground are within dust criteria. Highest hourly and daily dust levels were predicted at A1 (Penny's Bay Gas Turbine Plant) at both ground level and 10m above ground. The predicted hourly and daily dust level at 1.5 m above ground is 242 μgm^{-3} and 106 μgm^{-3} respectively, while 225 μgm^{-3} and 102 μgm^{-3} at 10m above ground for hourly and daily dust level prediction respectively.	3. Emissions from combustion equipment in Theme Park are the major concerns at the high level receivers. The prediction indicated that the worst affected level was 30m above ground and NO_2 is the critical pollutant. Highest NO_2 was predicted at A9 (Resort in Theme Park) which was 42μgm^{-3}.
		4. The air quality impact due to vehicle emissions from parking areas is expected to be significant.
		5. Air Quality due to Theme Park related traffic is not significant due to small number of VKT and use of alternative mode transports.
		6. Exceedance of SO_2 concentration was predicted under high wind speed at 100m above ground and 500m away from the GTP. The predicted SO_2 concentration 500m away from the GTP reaches 400 μgm^{-3} at about 60m above ground. Building height is recommended to be restricted to 50m above ground within the first 500m distance and 100m within 1km from the GTP. In addition, building within Water Recreation Centre should be low-density and low-rise in character and should not exceed 6m in height.
		7. VOCs, dioxins and furans, RSP and associated heavy metal and odour are potential sources of impacts during fireworks displays. The prediction and literature reviews indicated that the impacts from the fireworks displays to the vicinity are low and not significant.
		8. Potential odour impacts from proposed sewage pumping stations would not affect the adjacent ASRs with the adoption of control measures such as enclosing the odour sources and providing scrubbing system.
Mitigation Measures	Control measures stipulated in *Air Pollution Control (Construction Dust) Regulation* as follows:	Mitigation measures as follows:
	• the stockpile should be properly treated and sealed with latex, vinyl, bitumen or other suitable surface stabiliser if a stockpile of dusty materials is more than 1.2m high and lies within 50m from any site boundary that adjoins a road, street, or other area accessible to the public; • effective dust screens, sheeting or netting should be provided to enclose the scaffolding from the ground floor level of the building or if canopy is provided at the first floor level, from the first floor level, up to the highest level of the scaffolding where a scaffolding is erected around the perimeter of a building under construction;	• Building height restriction are recommended as 50m above ground within the first 500m from GTP and 100m above ground within 1 km from GTP • HKTPL agreed that any pyrotechnics that specifically use chromium, lead, mercury, arsenic, manganese, nickel or zinc would not be purchased for the fireworks displays use. • Odour suppression measures such as enclosing and scrubbing system should be incorporated in the design of the proposed sewage pumping station.

Issue	Construction Impact	Operational Impact
	• skip hoist for material transport should be totally enclosed by impervious sheeting; • any excavated dusty materials or stockpile of dusty materials should be covered entirely by impervious sheeting or sprayed with water so as to maintain the entire surface wet, and recovered or backfilled or reinstated within 24 hours of the excavation or unloading; • stockpile of dusty materials should not extend beyond the pedestrian barriers, fencing or traffic cones; • dusty materials remaining after a stockpile is removed should be wetted with water and cleared from the surface of roads; • vehicle washing facilities should be provided at every vehicle exit point; • the area where vehicle washing takes place and the section of the road between the washing facilities and the exit point should be paved with concrete, bituminous materials or hardcores; • where a site boundary adjoins a road, streets or other area accessible to the entire length except for a site entrance or exit; • every main haul road should be scaled with concrete and kept clear of dusty materials or sprayed with water so as to maintain the entire road surface wet; • the portion of road leading only to a construction site that is within 30m of a designated vehicle entrance or exit should be kept clear of dusty materials; • every stock of more than 20 bags of cement should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides; • cement delivered in bulk should be stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line such that, in the event of the silo approaching an overfilling condition, an audible alarm is triggered and the material filling stops within one minutes; • silos used for the storage of cement should not be overfilled; • loading, unloading, transfer, handling or storage of bulk cement or any cement during or after the de-bagging process should be carried out in a totally enclosed system or facility, and any vent or exhaust should be fitted with effective fabric filter or equivalent air pollution control system or equipment; • cement, or any other dusty materials collected by fabric filters or other air pollution control system or equipment should be disposed of in totally enclosed containers; • stockpile of dusty materials should be either covered entirely by	

Issue	Construction Impact	Operational Impact
	impervious sheeting, placed in an area sheltered on the tope and the 3 sides; or sprayed with water so as to maintain the entire surface wet; • all dusty materials should be sprayed with water prior to any loading. Unloading or transfer operation so as to maintain the dusty material wet; • vehicle speed should be limited to 10kph except on completed access roads; • every vehicle should be washed to remove any dusty materials from its body and wheels before leaving the construction sites; • the load of dusty materials carried by vehicle leaving a construction site should be covered entirely by clean impervious sheeting to ensure that the dusty materials do not leak from the vehicle; • the working area of excavation should be sprayed with water immediately before, during and immediately after the operation so as to maintain the entire surface wet; • the area within 30m from the blasting area should be wetted with water prior to blasting; and • blasting should not be carried out when the strong wind signal or tropical cyclone warning signal No.3 or higher is hoisted unless prior permission of the Commissioner of Mine is obtained.	
	Control measures stipulated in the *EPD's Best Practicable Means Requirements for Cement Works (Concrete Batching Plant)* as follow:	
	• loading, unloading, handling, transfer or storage of any dusty materials should be carried out in totally enclosed system; • all dust-laden air or waste gas generated by the process operations should be properly extracted and vented to fabric filtering system to meet the emission limits for TSP; • vents for all silos and cement/pulverised fuel ash (PFA) weighing scale should be fitted with fabric filtering system; • the materials which may generate airborne dusty emissions should be wetted by water spray system; • all receiving hoppers should be enclosed on three sides up to 3m above unloading point; • all conveyor transfer points should be totally enclosed; • all access and route roads within the premises should be paved and wetted; and • vehicle cleaning facilities should be provided and used by all concrete trucks before leaving the premises to wash off any dust on the wheels and/or body.	
Residual Impacts	No residual impacts identified.	No residual impacts identified.

Issue	Construction Impact	Operational Impact
Environmental Acceptability	Acceptable	Acceptable