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Traffic from Paved Road

$E = k(sL)^{0.91}(W)^{1.02}$

Where	E :	particulate emission factor, g/veh-km
	k :	particulate size multiplier for particle size range and units of interest
	sL :	road surface silt loading, g/m^2
	W :	average weight, ton

In this study,

k :	3.23	g/veh-km	(AP-42, Table 13.2.1-1)
sL :	14	g/m^2	Excavation, loading and unloading of spoils are conducted at construction sites and quarries, and the nature of these activities are similar. The sL for a quarry is estimated between 2.4 g/m^2 and 14 g/m^2 according to Section 13.2.1 of AP-42. The maximum sL value is assumed for the construction sites.
W:	5	ton	(Assumed the materials will be transported by the village vehicles; the weight of village vehicles(5 tonnes) was assumed to be lower than light goods vehicles)

Therefore,

E : 184.132 g/veh-km

A traffic density of 10 veh/hr

The removal effeciency is estimated based on USEPA Control of Open Fugitive dust Sources (EPA-450/3-88-008)
By C = 100 - (0.8*p*d*t)/i

where	C	average control efficiency, in percent
	p	potential average hourly daytime evaporation rate, in mm/h
	d	average hourly daytime traffic rate in vehicles per hour
	i	application intensity in $litre/m^2$
	t	time between applications in hour

"The Year's Weather -2011" issued by Hong Kong Observatory, the total annual evaporation recorded in Hong Kong is 1476.7mm (58.14 inches)
Therefore,

p	0.37791	mm/h	(0.0065*annual evaporation in inches)
d	10	per hour	peak hourly daytime traffic is used for conservative approach
i	0.5	$liter/m^2$	

Time Between Application (hour)	Average Control Efficiency (%)
6	63.7
3	81.9
1.5	90.9

For a traffic density of 10 veh/hr, the emission rate due to traffic from paved road is

Mitigation efficiency:	90.9	(Watering appicated every 1.5 hours)
With Mitigartion		
Emission rate (g/m/s):	2.78341E-05	
Without Mitigartion		
Emission rate (g/m/s):	0.000306886	

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Heavy Construction

Accoording to Section 13.2.3 of AP-42

Emission rate	=	1.2	tons arcs/acce/month of activities	(ref : AP-42 S13.2.3.3)
	=	2.69	Mg/hectare/month of activities	(ref : AP-42 S13.2.3.3)

In this study,

Percentage active operating area(%) :	100	(usual practice for typical construction site)
Mitigation efficiency:	90.9	(The removal effeciency is estimated based on USEPA Control of Open Fugitive dust Sources (EPA-450/3-88-008) and Watering every 1.5 hours)

With Mitigartion

Emission rate (g/sq.m/day):	0.9383796	(1Mg= 1,000,000g; 1 hectare = 10 000 square meters; Assume 26 woking days per month)
Emission rate (g/sq.m/s):	2.607E-05	(Assume 10 working hours a day; From 0800 to 1900 exclude 1200 to 1300)

Without Mitigartion

Emission rate (g/sq.m/day):	10.34615385	(1Mg= 1,000,000g; 1 hectare = 10 000 square meters; Assume 26 woking days per month)
Emission rate (g/sq.m/s):	2.874E-04	(Assume 10 working hours a day; From 0800 to 1900 exclude 1200 to 1300)

Wind Erosion

For the dust calculations, the emission factor as suggested by the USEPA's Compilation of Air Pollutant Emission Factors, 5th edition, 1995 (AP-42),
Section 11.9 Table 11.9-4, for wind erosion is 0.85 Mg/ha/yr.

Emission rate (g/sq.m/s):	=([0.85Mg/ha/yr] x [1000000g/Mg])/([10000sq.m/ha] x [(365 x 24 x 3600)s/yr])
Emission rate (g/sq.m/s):	2.69533E-06

The removal effeciency is estimated based on USEPA Control of Open Fugitive dust Sources (EPA-450/3-88-008), Equation (3-3) and Figure 3-3
By : C = 75 x (M - 1) [for 1 ≤ M ≤ 2] ; C = 62+6.7M [for 2 ≤ M ≤ 5]
where C Instantaneous control efficiency, percent
M ratio of controlled to uncontrolled surface moisture contents

According to the Equation (3-3), by increase the surface moisture content by a ratio of 4.18 would achieve 90% dust suppression efficiency:
Dust suppression efficiency = 62 + 6.7 x (4.18) = 90%

Area of wind erosion:	2144	m2
Soil Density:	2000	kg/m^3 (from engineer)

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Material moisture content; The moisture content for a quarry is estimated between 0.3% and 1.1% according to Section 13.2.4 of AP-42.

If Moisture content is 0.3%:

Uncontrolled Surface Moisture Content:	0.3	%	
Controlled Surface Moisture Content:	1.3	%	
Assume			
Depth of Water Penetrated:	0.02	m	Referenced from the Dennis R.Fitz & Kurt Bumiller(2000) " Evaluation of Watering to Control Dust in High Winds", Journal of the Air & Waste Management Association.

Therefore,

Weight of Uncontrolled Wet Surface:	=2144 x 2000 x 0.02/(1-0.3%) =	86018 kg
Weight of Controlled Wet Surface:	=2144 x 2000 x 0.02/(1-1.3%) =	86890 kg
Water Intensity:	(86890- 86018)/2144 =	0.4 L/m^2/hour

If Moisture content is 1.1%:

Uncontrolled Surface Moisture Content:	1.1	%	
Controlled Surface Moisture Content:	4.6	%	
Assume			
Depth of Water Penetrated:	0.02	m	Referenced from the Dennis R.Fitz & Kurt Bumiller(2000) " Evaluation of Watering to Control Dust in High Winds", Journal of the Air & Waste Management Association.

Therefore,

Weight of Uncontrolled Wet Surface:	=2144 x 2000 x 0.02/(1-1.1%) =	86714 kg
Weight of Controlled Wet Surface:	=2144 x 2000 x 0.02/(1-4.6%) =	89895 kg
Water Intensity:	(89895- 86714)/2144 =	1.5 L/m^2/hour

Therefore, the conservative scenario (moisture content = 1.1%) is adopted in the assessment.

With Mitigartion
Emission rate (g/sq.m/s): = 2.69533E-07

Without Mitigartion
Emission rate (g/sq.m/s): = 2.69533E-06

Water loss of evaporation for each hour

The Year's Weather -2011 issued by Hong Kong Observatory, the the range of mean daily evaporation recorded in Monthly Values is 2.4 to 5.4mm (Table 13 of SUMMARY OF METEOROLOGICAL AND TIDAL OBSERVATIONS IN HONG KONG 2011)

For worst case scenario, the mean daily evaporation values of 5.4mm is adopted in assessment:

Evaporation rate: 0.225 mm/h

The evaporation rate per m^2 : 0.2 L/m^2/hour

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Material Handling

Accoording to Section 13.2.4 of AP-42

E = k (0.0016) x (U/2.2)^1.3 / (M/2)^1.4 (kg/Mg)

Where
- E : Emission factor, g/megagram
- k : Particulate size multiplier, k=0.74 as defined according to Table 2 of Section 13.2.4
- U : Average wind speed at Cheung Chau from 2006 to 2010 (i.e. ~ 4.93m/s)
- M : Material moisture content; Material handling at construction sites and stone quarrying, and the nature of these activities are similar. The moisture content for a quarry is estimated between 0.3% and 1.1% according to Section 13.2.4 of AP-42. For conservative scenario, the minimum moisture content value (0.3%) is assumed for the construction sites.

E = 0.04813 kg/megagram

Volume of C&D material, m^3:	15352		
Soil Density, kg/m^3:	2000		(from engineer)
Duration of excavation:	444	days	(excluding holidays)
=	4440	hours	(10 working hours per day - 07:00 to 12:00 and 13:00 to 18:00)

Average amount of material to be removed per hour (R), kg/hr
= Volume of soil X Density / Number of operation hours
6915.315315 (from engineer)

Maximum No of trucks loading/unloading at stoclpile per hour =	10	(from engineer)
Maximum carrying capacity for each truck(kg) =	960	(from engineer)
Maximum of materials loading at stockpile per hour (R), kg/hr=	9600	

Material Handling Area(stockpile), m^2 = 1103

Without Mitigartion

Emission rate (g/sq.m/s): = E x R / Area
= 1.16351E-07

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Concrete Batching Plant

Unloading of raw material

TSP emsiion factor (kg/Mg):		0.0035	(AP-42, Section 11.12, Table 11.12-1- Aggregate transfer)
Maximum Loading Rate(kg/hr)		9600	
Area of unloading material(m^2)		20	
Without Mitigartion			
Emission rate (g/sq.m/s):	=	E x R / Area	
	=	0.000467	
Emission Height :		0.5	

Cement/PFA Silos

Small Cement Silos

Maximum TSP emsiion factor (mg/m^3):		50	(According to the Guidance Note on the Best Practicable Means for Cement Works (Concrete Batching Plant) BPM 3/2(93), the design emission concentrations of the dust collectors for cement/ Pulverised Fuel Ash (PFA) silos and mixer of the concrete batching plant should not exceed 50 mg/m^3 .)
Dust extraction flow rate for each mixer (m^3/hr)		1700	
Number of operation hours:		12	
Number of small cement silos:		1	
Emission height (m)		20	
Maximum Emission rate (g/s):	=	=[Maximum TSP emsiion factor (mg/m^3)] x [Dust extraction flow rate for each mixer (m^3/hr)] / (3600 x 1000)	
	=	0.0236	

PFA Silos

Maximum TSP emsiion factor (mg/m^3):		50	(According to the Guidance Note on the Best Practicable Means for Cement Works (Concrete Batching Plant) BPM 3/2(93), the design emission concentrations of the dust collectors for cement/ Pulverised Fuel Ash (PFA) silos and mixer of the concrete batching plant should not exceed 50 mg/m^3 .)
Dust extraction flow rate for each mixer (m^3/hr)		1700	
Number of operation hours:		12	
Number of PFA silos:		2	
Emission height (m)		20	
Maximum Emission rate (g/s):	=	=[Maximum TSP emsiion factor (mg/m^3)] x [Dust extraction flow rate for each mixer (m^3/hr)] / (3600 x 1000)	
	=	0.02361111	

Large Capacity Cement Silos

Maximum TSP emsiion factor (mg/m^3):		50	(According to the Guidance Note on the Best Practicable Means for Cement Works (Concrete Batching Plant) BPM 3/2(93), the design emission concentrations of the dust collectors for cement/ Pulverised Fuel Ash (PFA) silos and mixer of the concrete batching plant should not exceed 50 mg/m^3.)
Dust extraction flow rate for each mixer (m^3/hr)		2200	
Number of operation hours:		12	
Number of cement silos:		1	
Emission height (m)		20	
Maximum Emission rate (g/s):	=	=[Maximum TSP emsiion factor (mg/m^3)] x [Dust extraction flow rate for each mixer (m^3/hr)] / (3600 x 1000)	
	=	0.030556	

Mixing Tower

Mixer

Maximum TSP emsiion factor (mg/m^3):		50	(According to the Guidance Note on the Best Practicable Means for Cement Works (Concrete Batching Plant) BPM 3/2(93), the design emission concentrations of the dust collectors for cement/ Pulverised Fuel Ash (PFA) silos and mixer of the concrete batching plant should not exceed 50 mg/m^3 .)
Dust extraction flow rate for each mixer (m^3/hr)		1700	
Number of operation hours:		12	
Number of mixing tower:		1	
Emission height (m)		20	
Maximum Emission rate (g/s):	=	=[Maximum TSP emsiion factor (mg/m^3)] x [Dust extraction flow rate for each mixer (m^3/hr)] / (3600 x 1000)	
Emission rate (g/s):	=	0.0236	

Infomration of TSP emission sources

Point Sources

ID	Description	X-Coordinate	Y-Coordinate	Elevation (meters)	Emission Rate (Unmitigated)	Emission Point Hight(m)	Temperature (K)	Exit Velocity (m/s)
SRC1	Small Cement Silo 1	820391.9	808322.9	3.9	0.0236	20	298	12
SRC4	PFA Silo 1	820403.9	808316.8	3.9	0.0236	20	298	12
SRC8	PFA Silo 2	820410.2	808313.7	3.9	0.0236	20	298	12
SRC19	Large Capacity Cement Silo 1	820402.2	808312.1	3.9	0.030556	20	298	12
SRC21	Mixer 1	820386.6	808315.7	3.9	0.0236	20	298	12

Area sources

ID	Description	X-Coordinate	Y-Coordinate	Elevation (meters)	Working Hour		Non-working Hour	Release Height (m)	X-Length (m)	Y-Length (m)	Angle
					Emission Rate (Unmitigated)	Emission Rate (Mitigated)	Emission Rate-Wind Erosion (Unmitigated)				
SRC5	Paved road 1	820389.8	808331.7	4.5	3.07E-04	2.78E-05	---	0	2.5	105	114.8
SRC6	Paved road 2	820480.8	808285.9	4.5	3.07E-04	2.78E-05	---	0	48.5	2.5	114.8
SRC7	Paved road 3	820422.1	808312.9	4.5	3.07E-04	2.78E-05	---	0	28	2.5	115.0
SRC12	Storage Area 1	820322.4	808308.4	4	1.16E-07	1.16E-07	2.70E-06	0	19	26	116.3
SRC14	Storage Area 2	820635.7	808174.7	4.6	1.16E-07	1.16E-07	2.70E-06	0	20.1	30	80.5
SRC15	Demolish Sludge Digester	820377.2	808315.3	4.4	2.87E-04	2.61E-05	2.70E-06	0	20	36	115.6
SRC16	Demolish Primary Sedimentation Tank	820453.8	808294.3	4.4	2.87E-04	2.61E-05	2.70E-06	0	9	24	112.9
SRC3	sewage work	820864.6	808706.2	18	2.70E-06	2.70E-07	2.70E-06	0.5	1.3	20	-171.3
SRC9	sewage work 1	820841.1	808621	34	2.70E-06	2.70E-07	2.70E-06	0.5	2.2	20	-140.0
SRC10	sewage work 2	820713.8	808397.2	37	2.70E-06	2.70E-07	2.70E-06	0.5	2	20	141.0
SRC11	sewage work 3	820815.5	808380	42	2.70E-06	2.70E-07	2.70E-06	0.5	2	20	159.4
SRC13	sewage work 4	820872.9	808280	15.1	2.70E-06	2.70E-07	2.70E-06	0.5	1.5	20	174.0
SRC17	Construction Area	820448.9	808339.2	4.4	2.87E-04	2.61E-05	2.70E-06	0	28	55	115.4
SRC18	Unpaved Area	820398.2	808350.1	4.4	2.70E-06	2.70E-06	2.70E-06	0	18	23	114.9
SRC22	Unloading area 1	820340.8	808285.8	4	1.16E-07	1.16E-07	2.70E-06	0.5	1.5	2	117.8
SRC25	Unoading area 2	820635.2	808164.6	4	1.16E-07	1.16E-07	2.70E-06	0.5	1.5	2	-2.9
SRC26	Storage area (CBP)	820406.4	808307.4	4	0.000467	0.000467	2.70E-06	0.5	4	5	111.8