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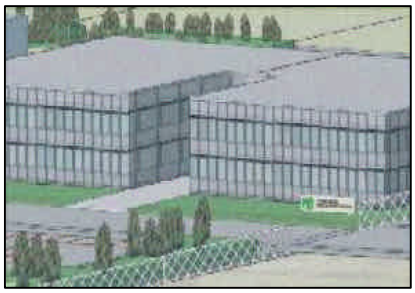
in association with

BMT

Environmental Impact Assessment for Development of an EcoPark in Tuen Mun Area 38

Final EIA Report

Volume 2 – Appendix D (AQIA Modelling)




環境保護署

Environmental Protection Department

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Appendix D.1

Recovery Processes Remaining After Initial Screening

Material Type	Process	Potential Emissions	Available Control Equipment/ Measures	Level of impact	Included in Assessment ?
Batteries					
Lead-acid	Mechanical / Physical separation of battery into separate components	Fugitive dust from the dust attached on the battery surface (not from the components)	• Good site practice to minimise fugitive dust emission • Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • Enclosed system with active air extraction system with dust control system	Negligible	No
Zinc-carbon / Alkaline	Shredding, Electromagnetic separation & neutralization (of electrolyte) – will be within the enclosed machine	Fugitive dust from discharge point of shredded material	• Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • Enclosed system with active air extraction system with dust control system	Negligible	No
Lithium	Shredding and Electromagnetic/ Physical separation/ Hydrosaline deactivation – will be within the enclosed machine	Fugitive dust from discharge point of shredded material	• Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • Enclosed system with active air extraction system with dust control system	Negligible	No
NiCd/ NiMH/ Li ion	Cadmium (13-22%); Cobalt (0.5-2%); Lithium Hydroxide (0-4%); Nickel (20-32%); Potassium Hydroxide (0-4%) and Sodium Hydroxide (0-4%)[6]; Others (assume polymers, metals; 32%)	Fugitive dust from discharge point of shredded material	• Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • Enclosed system with active air extraction system with dust control system	Negligible	No
Electronics					
CRT Recovery	Separation and Testing	Nil	N/A	Nil	N/A
	Shredding, electromagnetic and electrostatic sorting – will be within the enclosed machine	Fugitive dust from discharge point of shredded material	• Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • Enclosed system with active air extraction system with dust control system	Negligible	No
Computer/ Electronics Recovery	Separation and Testing	Nil	N/A	Nil	N/A
	Shredding and Separation (Electromagnetic and electrostatic) – will be within the enclosed machine	Fugitive dust from discharge point of shredded material	• Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • Enclosed system with active air extraction system with dust control system	Negligible	No

Material Type	Process	Potential Emissions	Available Control Equipment/ Measures	Level of impact	Included in Assessment ?
White Goods Dismantling	Separation and Testing	Nil	N/A	Nil	N/A
	Manual Dismantling and Separation	CFC emitted from old type air conditioner and refrigerator	• Good site practice to remove residual CFC before dismantling. As the use of CFC for refrigerant is fading out, the white good with CFC will become less in the future.	Negligible	No
Fluorescent Lamp Recovery	Crush-and-Sieve/ Volatization/ Cyclone / magnetic separation in the enclosed mercury recovery machine for fluorescent lamp	Fugitive dust from any opening of the recovery machine	• Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency)	Negligible	No
		Hg from the mercury recovery machine for fluorescent lamp	• Cyclones, dust filter and carbon filter package as specified in the technical information of the mercury recovery machine for fluorescent lamp.	TBD	Yes
Glass					
	Manual/ Automated Sorting	Nil	N/A	Nil	N/A
	Crusher – to reduce the glass to smaller size to improve the melting efficiency of glass will be within the enclosed machine	Fugitive dust from discharge of glass particles to the melting furnace	• Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • Enclosed system with active air extraction system with dust control system	Negligible	No
	Melting furnace/ Moulding/ Forming and Finishing	Fugitive dust and VOC	• Baghouse with 99% PM control efficiency • VOC control equipment such as condensation and/or activated carbon adsorption with 90% control efficiency	TBD	Yes
	Fuel Combustion	PM, SO_2, NO_2, CO & VOC	• Ultra-low sulphur diesel (ULSD) with 0.005% by weight of sulphur	TBD	Yes
Organic Food Waste					
In-vessel Composting	Handling/ delivery of organic food waste	Odour	• All the containers should be covered • The handling and delivery area should be enclosed and equipped with odour control device such as bio filter or activated carbon filter to remove odour before discharge to the atmosphere. • Negative pressure should be provided for the enclosed space to avoid any un-controlled odour emit to the atmosphere	Negligible	No

Material Type	Process	Potential Emissions	Available Control Equipment/ Measures	Level of impact	Included in Assessment ?
	Curing : Organic waste will be placed in a sealed container with heat and moisture controlled. Air is circulated through out the material to maintain the necessary porosity for even maturing. When the air temperature rises above the optimal operating range, air is drawn off through the exhaust passes through bio-filter to remove odour.	Odour	• Bio filter or activated carbon filter to remove odour before discharge to the atmosphere	Negligible	No
	Fuel combustion	PM, SO_2, NO_2, CO & VOC	• Ultra-low sulphur diesel (ULSD) with 0.005% by weight of sulphur	TBD	Yes
Ferrous Metals					
	Sorting	Nil	N/A	Nil	N/A
	Baling	Nil	N/A	Nil	N/A
	Mechanical shearing and shredding	Nil	N/A	Nil	N/A
Non-ferrous Metals					
	Sorting – materials are sorted by visual inspection into various grades according to industry specifications	Nil	N/A	Nil	N/A
	Baling	Nil	N/A	Nil	N/A
	Processing (sweating, smelting, refining)	PM, SO_2, heavy metals, halogens, TAP, Dioxin	• Baghouse or ECP with 99.9% dust control efficiency, wet-scrubber with 80% SO_2 removal efficiency	TBD	Yes
	Fuel combustion	PM, SO_2, NO_2, CO & VOC	• Ultra-low sulphur diesel (ULSD) with 0.005% by weight of sulphur	TBD	Yes
Paper					
	Automated sorting via conveyors, optical sensors and chutes	Nil	N/A	Nil	N/A
	Baling	Nil	N/A	Nil	N/A
	Pulping (e.g. boiler and dryer) / Cleaning/ De-inking/ Flotation – based on the reference document on Best Available Technique in the Pulp and Paper Industry published by European Commission in December 2001, VOC emission from pulping process are very small	VOC	Nil	Negligible	No
	Bleaching – generally oxygen, ozone, peroxide and peracetic acid will be used in the bleaching process. (ref: *Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques in the Pulp and Paper Industry*, EU Directive, Dec 2001)	NIL	• Non-chlorine bleaching agents include oxygen, ozone, peroxide and peracetic aicd.	NIL	No

Material Type	Process	Potential Emissions	Available Control Equipment/ Measures	Level of impact	Included in Assessment ?
	Fuel combustion	PM, SO_2, NO_2, CO & VOC	• Ultra-low sulphur diesel (ULSD) with 0.005% by weight of sulphur	TBD	Yes
Plastics					
	Sorting	Nil	N/A	Nil	N/A
	Crushing and Baling	Nil	N/A	Nil	N/A
	Clean plastic flakes	Nil	N/A	Nil	N/A
	Blending – dried flakes and pellets (virgin material)	Nil	N/A	Nil	N/A
	Moulding/ Extrusion by electric moulding machine and extruder	Fugitive dust and VOC from moulding machine and extruder	• Localised collection hood at point of moulding and extrusion in the moulding machine and extruder with control devices • Baghouse with 99% PM control efficiency • VOC control equipment such as condensation and/or activated carbon adsorption with 90% control efficiency	TBD	Yes
		odour from moulding machine and extruder	• Bio filter or activated carbon filter to remove odour before discharge to the atmosphere with 90% control efficiency	Negligible	No
Textiles					
	Sorting	Nil	N/A	Nil	N/A
	Baling	Nil	N/A	Nil	N/A
Rubber Tyres					
	De-beading	Fugitive dust from the dust attached on the tyre surface	• Good site practice to minimise fugitive dust emission • Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • enclosed facility with active air extraction system with dust control system	Negligible	No
	Shredding – enclosed mechanical shredding	Fugitive dust from discharge of shredded rubber	• Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • Enclosed system with active air extraction system with dust control system	Negligible	No

Material Type	Process	Potential Emissions	Available Control Equipment/ Measures	Level of impact	Included in Assessment ?
	Mechanical Crumbing / Cryogenic Processing within the enclosed system	Fugitive dust from grinded fine rubber particles	• Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • Enclosed system with active air extraction system with dust control system	TBD	Yes
	Magnetic separation and air separator within the enclosed system/ Sieving	Fugitive dust attached on the tyre surface from sieving	• Good site practice to minimise fugitive dust emission • Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • Enclosed system with active air extraction system with dust control system	Negligible	No
	Re-treading – within the enclosed system and electric heating will be used for vulcanisation/ autoclave	Fugitive dust, VOC and odour emissions are localised at the re-treading machine	• To connect a collection system venting the fugitive dust and VOC from the enclosed re-treading machine to the control equipment before removing the re-treaded tyres out from the machine. • Localised collection hood with control devices (e.g. baghouse, with 99% dust control efficiency and activated carbon filter or bio-filter with 90% control efficiency to control odour and VOC or wet scrubber to control both the fugitive dust and VOC emissions) • VOC control equipment such as condensation and/or activated carbon adsorption with 90% control efficiency • Enclosed system with active air extraction system with control system	Negligible	No

Material Type	Process	Potential Emissions	Available Control Equipment/ Measures	Level of impact	Included in Assessment ?
Wood					
	Dismantling / Sorting	Nil	N/A	Nil	N/A
	Hydraulic compaction/ Mechanical shearing	Nil	N/A	Nil	N/A
	Pallet refurbishment	Nil	N/A	Nil	N/A
	Process – chipping within the enclosed machine	Fugitive dust from the discharge of wood chips	• Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • Enclosed system with active air extraction system with control system	Negligible	No
	Bleaching – generally oxygen, ozone, peroxide and peracetic acid will be used in the bleaching process. (ref: *Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques in the Pulp and Paper Industry*, EU Directive, Dec 2001)	NIL	• Non-chlorine bleaching agents include oxygen, ozone, peroxide and peracetic aicd.	NIL	No
	Process – magnetic separation	Nil	N/A	Nil	N/A
	Plastic Wood Composite (PWC) Manufacturing – plastic and wood chips will mix together and heat up by electric power. PWC will then form by extrusion	Fugitive dust and VOC from the point of PWC extrusion from the extruder odour from the point of PWC extrusion from the extruder	• Localised dust/ particles collection hood with dust control device (e.g. baghouse, with 99% control efficiency) • VOC control equipment such as condensation and/or activated carbon adsorption with 90% control efficiency • Bio filter or activated carbon filter with 90% control efficiency to remove odour before discharge to the atmosphere	TBD Negligible	Yes No
	Fuel combustion	PM, SO_2, NO_2, CO & VOC	• Ultra-low sulphur diesel (ULSD) with 0.005% by weight of sulphur	TBD	Yes
Spent Copper Etchant					
	Electrolytic Process	Nil	N/A	Nil	N/A
	Chemical Treatment Process	Nil	N/A	Nil	N/A

Appendix D.2

Detailed Emission Rate Calculations for AQIA (Unmitigated)

D.2.1 Electronics – Fluorescent Lamp Recovery

Total throughput of fluorescent lamp : 25,100 tpa x 25% = 6,275 tpa
Recovery efficiency : 100%
Total material produced from the process : 6,275 tpa

Emission rate calculation

Weight of fluorescent lamp: 120g (extract from http://www.elcfed.org/lighting_material.html)

Total buffered throughput of fluorescent lamp : 6,275 ton/year

= 6,275 x 10^6 g/year
= 6,275 x 10^6 / 120 tube / year
= 6,275 x 10^6 / 120 / (300 x 12) tube / hour (assuming 1 year = 300 days and 12 hours /day)
= 14,525 tube / hour

According to the technical data of the fluorescent lamp recovery machine, up to 5,000 tubes per hour can be processes. Therefore, 3 machines are required to cater the total throughput of 6,275 ton/year assuming the industry operating 300 days a year and 12 hours a day.

The Hg stack emission from the process is 0.001 mg/m^3 and the flow rate of stack is 2000 m^3/h. Therefore, the emission rate for one machine is:

0.001 mg/m^3 x 2000 m^3/h
= 0.001 x 10^{-3} g/m^3 x 2000 / (60 x 60) m^3/s
= 5.5556e-7 g/s per machine

Total emission rate for 3 machines are = 5.5556e-7 g/s x 3 = **1.6667e-6 g/s**

The fugitive Hg emission from the process : 0.003 mg/m^3 (average of 0.001-0.005 mg/m^3)
Volume of plant-room : 300 m^3 (100 m^2 x 3m)
Flow : 3 air changes per hour

Therefore, the emission rate for one machine is:

0.003 mg/m^3 x 300 m^3 x 3 /hour
= 0.003 x 10^{-3} g/m^3 x 300 x 3 / (60 x 60) m^3/s
= 2.5e-7 g/s per machine
Total emission rate for 3 machines are = 2.5e-7 g/s x 3 = **7.5e-7 g/s**

Total Emission from the process = **2.4167e-6 g/s**
Assumed Stack Height = **6m above ground**
Stack Diameter = **250mm**
Stack Temperature = **23.5°C**
Efflux Velocity = **16.41m/s**

Reference

1. *MRT System AB, Technical Performance Data*

D.2.2 Glass

Total throughput of glass : 42,680 tpa
Recovery efficiency : 88%
Total material produced from the process : 37,387 tpa

a. from fuel combustion (for Scenario 1 only)

Energy consumption of glass : 16 GJ/ton = 15.1651 MMBtu/ton (refer to Annex 7 for detailed calculations)

Unit	PM	SO_2	NO_x	CO	VOC
lb/ 1000 gal	2	0.785^	24	5	0.252
lb/ MMBtu*	0.0143	0.0056	0.1714	0.0357	0.0018
kg/ MMBtu	0.0065	0.0025	0.0778	0.0162	0.0008
kg/ Mg	0.0983	0.0386	1.1792	0.2457	0.0124
g/s	**0.2835**	**0.1113**	**3.4018**	**0.7087**	**0.0357**

b. from process (electric melting furnace)

Unit	PM	VOC
kg/ Mg	0.007[@]	0.1
g/s	**0.0202[@]**	**0.0288[#]**

c. from process (forming and finishing)

Unit	PM	VOC
kg/ Mg	(negligible)	4.4
g/s	-	**1.2693[#]**

^ 157 x 0.005% by weight of sulphur = 0.785 lb / 1000 gal
** lb/ 1000 gal / 140 = lb/ MMBtu*
[@] controlled emission by baghouse with 99% control efficiency
[#] assumed all VOC are odorous and controlled emission by activated carbon filter with 90% control efficiency

References

1. *Fuel consumption 16 GJ/ton from EP Indicator & Benchmark Shortlist Document - Glass (Container), remas (http://remas.ewindows.eu.org)*

2. *USEPA - AP-42 Chapter 1.3 Fuel Oil Combustion - 0.005% by weight of sulphur, no.2 oil fired (SCC1-01-005-01, 1-02-005-01, SCC1-03-005-01)*

3. *USEPA - AP-42 Chapter 11.15 Glass Manufacturing*

D.2.3 Organic Food Waste

Total throughput of food : 19,750 tpa
Recovery efficiency : 100%
Total material produced from the process : 19,750 tpa

Emission rate calculation

from fuel combustion (for Scenario 1 only)

Energy consumption of organic food waste : 3.1353 MMBtu/ton (refer to Annex 7 for detailed calculations)

Unit	PM	SO_2	NO_x	CO	VOC
lb/ 1000 gal	2	0.785^	24	5	0.252
lb/ MMBtu*	0.0143	0.0056	0.1714	0.0357	0.0018
kg/ MMBtu	0.0065	0.0025	0.0778	0.0162	0.0008
kg/ Mg	**0.0203**	0.0080	0.2438	0.0508	0.0026
g/s	**0.0310**	**0.0122**	**0.3715**	**0.0774**	**0.0039**

^ 157 x 0.005% by weight of sulphur = 0.785 lb / 1000 gal
** lb/ 1000 gal / 140 = lb/ MMBtu*

References

1. *USEPA - AP-42 Chapter 1.3 Fuel Oil Combustion - 0.005% by weight of sulphur, no.2 oil fired (SCC1-01-005-01, 1-02-005-01, SCC1-03-005-01)*

D.2.4 Non-Ferrous Metals

Assumed Material Throughput

Assessment Scenario	Scenario 1	Scenario 2	Scenario 3
Total throughput (tpa)	10,000	2,500	Nil
Recovery efficiency	100%	100%	Nil
Total material produced from the process (tpa)	10,000	2,500	Nil

Energy Consumptions

Non-Ferrous Metal	Energy Consumption (MMBtu/ton)
Al	11.3738
Pb	0.7483
Cu	7.0842
Zn	2.8999

Detailed calculations of energy consumptions for non-ferrous metal recovery are attached in Annex 7 of this Appendix.

Emission Factors from AP-42 (Non-Ferrous Metal)

Description of Secondary Non-Ferrous Metals Manufacturing Process	Emission Factor (kg/ Mg material produced)				
	PM	SO_2	NO_x	CO	VOC
Lead					
Fuel Combustion (for Scenario 1 only)	0.0048	0.0019	0.0582	0.0121	0.0006
Sweating	35	ND	-	-	-
Reverberatory Smelting/ Blast Smelting-Cupola	1.12[a]	40[a]	-	-	-
Reverberatory Smelting	0.5[a]	40[a]	-	-	-
Blast Smelting-Cupola	1.12[a]	27[a]	-	-	-
Fugitive Emission (Sweating)	1.8	-	-	-	-
Fugitive Emission (Smelting)	12.1	-	-	-	-
Aluminium					
Fuel Combustion (for Scenario 1 only)	0.0737	0.0289	0.8844	0.1843	0.0093
Sweating Furnace w/ baghouse	1.65	-	-	-	-
Smelting (Reverberatory Furnace) w/ baghouse	0.65	-	-	-	-
Demagging w/ baghouse	25	-	-	-	-
Copper					
Fuel Combustion (for Scenario 1 only)	0.0459	0.0180	0.5509	0.1148	0.0058
Cupola Furnace (scrap copper and brass)	35	-	-	-	-
- Fugitive Emission	1.1	-	-	-	-
Rotary Furnace (brass and bronze)	150	-	-	-	-
- Fugitive Emission	1.3	-	-	-	-
Zinc					
Fuel Combustion (for Scenario 1 only)	0.0188	0.0074	0.2255	0.0470	0.0024
Reverberatory Sweating (residual scrap)	16	-	-	-	-
- Fugitive Emission	0.63	-	-	-	-
Sodium Carbonate Leaching Calcining	44.5	-	-	-	-
Kettle pot	0.05	-	-	-	-
- Fugitive Emission	0.0025	-	-	-	-
Muffle distillation	22.5	-	-	-	-
- Fugitive Emission	1.18	-	-	-	-
Retort Reduction	23.5	-	-	-	-

[a] *maximum emission factors (controlled) of reverberatory smelting and blast smelting cupola were adopted.*

For conservative approach, the maximum emission rates (g/s) of different air pollutants were adopted in the assessment. The following tables detail the selection of emission rates.

References

1. *USEPA - AP-42 Chapter 12.11 Secondary Lead Processing*
2. *USEPA - AP-42 Chapter 12.8 Secondary Aluminium Operations*
3. *USEPA - AP-42 Chapter 12.9 Secondary Copper Smelting*
4. *USEPA - AP-42 Chapter 12.14 Secondary Zinc Processing*

Calculated Emission Rates for Scenario 1 (Non-Ferrous Metal)

Description of Secondary Non-Ferrous Metals Manufacturing Process	Emission Rate (g/s)				
	PM	SO_2	NO_x	CO	VOC
Lead	1.2453	**30.8657**	0.0449	0.0094	0.0005
Fuel Combustion	0.0037	0.0015	0.0449	0.0094	0.0005
Sweating	0.2701[c]	-	-	-	
Reverberatory Smelting/ Blast Smelting-Cupola	0.8642 [a]	30.8642 [a]	-	-	-
Reverberatory Smelting	0.3858 [ab]	30.8642 [a]	-	-	-
Blast Smelting-Cupola	0.8642 [ab]	20.8333 [a]	-	-	-
Fugitive Emission (Sweating)	0.0139[c]	-	-	-	-
Fugitive Emission (Smelting)	0.0934[c]	-	-	-	-
Aluminium	**21.1217**	0.0223	**0.6824**	**0.1422**	**0.0072**
Fuel Combustion	0.0569	0.0223	0.6824	0.1422	0.0072
Sweating Furnace w/ baghouse	1.2731[b]	-	-	-	-
Smelting (Reverberatory Furnace) w/ baghouse	0.5015[b]	-	-	-	-
Demagging w/ baghouse	19.2901[b]	-	-	-	-
Copper	1.4814	0.0139	0.4250	0.0886	0.0045
Fuel Combustion	0.0354	0.0139	0.4250	0.0886	0.0045
Cupola Furnace (scrap copper and brass)	0.2701[c]	-	-	-	-
- Fugitive Emission	0.0085[c]	-	-	-	-
Rotary Furnace (brass and bronze)	1.1574[c]	-	-	-	-
- Fugitive Emission	0.0100[c]	-	-	-	-
Zinc	0.8506	0.0057	0.1740	0.0362	0.0018
Fuel Combustion	0.0145	0.0057	0.1740	0.0362	0.0018
Reverberatory Sweating (residual scrap)	0.1235[c]	-	-	-	-
- Fugitive Emission	4.9E-03[c]	-	-	-	-
Sodium Carbonate Leaching Calcining	0.3434[c]	-	-	-	-
Kettle pot	0.0004[c]	-	-	-	-
- Fugitive Emission	1.9E-05[c]	-	-	-	-
Muffle distillation	0.1736[c]	-	-	-	-
- Fugitive Emission	0.0091[c]	-	-	-	-
Retort Reduction	0.1813[c]	-	-	-	-
Non-Ferrous Metal Emission Rate (Max)	**21.1217**	**30.8657**	**0.6824**	**0.1422**	**0.0072**

[a] *maximum emission rates of reverberatory smelting and blast smelting cupola were adopted.*

[b] *emission rates were calculated based on the controlled emission factors in USEPA's AP-42*

[c] *controlled emission by baghouse with 99% control efficiency*

Total emission rates in bold and underlined are the maximum emission rates for each pollutant

Calculated Emission Rates for Scenario 2 (Non-Ferrous Metal)

Description of Secondary Non-Ferrous Metals Manufacturing Process	Emission Rate (g/s)				
	PM	SO_2	NO_x	CO	VOC
Lead	0.3104	**7.7160**	-	-	-
Sweating	0.0675[c]		-	-	
Reverberatory Smelting/ Blast Smelting-Cupola	0.2160[a]	7.7160	-	-	-
Reverberatory Smelting	0.0965 [ab]	7.7160 [a]	-	-	-
Blast Smelting-Cupola	0.2160 [ab]	5.2083 [a]	-	-	-
Fugitive Emission (Sweating)	0.0035[c]	-	-	-	-
Fugitive Emission (Smelting)	0.0233[c]	-	-	-	-
Aluminium	**5.2662**	-	-	-	-
Sweating Furnace w/ baghouse	0.3183[b]	-	-	-	-
Smelting (Reverberatory Furnace) w/ baghouse	0.1254[b]	-	-	-	-
Demagging w/ baghouse	4.8225[b]	-	-	-	-
Copper	0.3615	-	-	-	-
Cupola Furnace (scrap copper and brass)	0.0675[c]	-	-	-	-
- Fugitive Emission	0.0021[c]	-	-	-	-
Rotary Furnace (brass and bronze)	0.2894[cb]	-	-	-	-
- Fugitive Emission	0.0025[c]	-	-	-	-
Zinc	0.2090	-	-	-	-
Reverberatory Sweating (residual scrap)	0.0309[c]	-	-	-	-
- Fugitive Emission	0.0012[c]	-	-	-	-
Sodium Carbonate Leaching Calcining	0.0858[c]	-	-	-	-
Kettle pot	0.0001[c]	-	-	-	-
- Fugitive Emission	4.8E-06[c]	-	-	-	-
Muffle distillation	0.0434[c]	-	-	-	-
- Fugitive Emission	0.0023[c]	-	-	-	-
Retort Reduction	0.0453[c]	-	-	-	-
Non-Ferrous Metal Emission Rate (Max)	**5.2662**	**7.7160**	**-**	**-**	**-**

[a] *maximum emission rates of reverberatory smelting and blast smelting cupola were adopted.*

[b] *emission rates were calculated based on the controlled emission factors in USEPA's AP-42*

[c] *controlled emission by baghouse with 99% control efficiency*

Total emission rates in bold and underlined are the maximum emission rates for each pollutant

For scenario 2, because total fuel consumption rate was proposed for the whole Eco-Park, emission rates of non-ferrous metals due to fuel combustion are not presented in this section.

References

1. *USEPA - AP-42 Chapter 12.11 Secondary Lead Processing*
2. *USEPA - AP-42 Chapter 12.8 Secondary Aluminium Operations*
3. *USEPA - AP-42 Chapter 12.9 Secondary Copper Smelting*
4. *USEPA - AP-42 Chapter 12.14 Secondary Zinc Processing*

Heavy Metals in PM (Non-Ferrous Metal)

For those emission factors for heavy metals and Non-Criteria Pollutants not available in AP-42, the emission rates will be determined based on the Particulate Matter (PM) to pollutant ratios as stated in the Best Practicable Measures (BPMs) for different related Specified Processes (SP) issued by EPD. Moreover, the emission factors/rates for lead and tin are based on USEPA's AP-42 on secondary lead processing industry. Furthermore, in accordance with *USEPA 1990b*, 2.2% of total chromium emission would be chromium VI (Cr^{6+}). Detailed calculations can be referred to the attached tables in Annexes 8 to 12.

Dioxin Emission (Non-Ferrous Metal)

Process	Potential Release Route (µg I-TEQ/t)	Max. Emission Factor (µg I-TEQ/t)	Max. Emission Rate (g I-TEQ/s) (Worst-Impact)	Max. Emission Rate (g I-TEQ/s) (Clean)
2nd Cu (controlled)[1]	50	**100**	(Throughput = 10,000 tpa) 7.716e-8	(Throughput = 2,500 tpa) 1.929e-8
2nd Al (controlled)[2]	35			
2nd Pb (controlled)[3]	8			
2nd Zn (controlled)[4]	**100**			

The dioxin emission factors were based on "*Standardized Toolkit for Identification and Quantification of Dioxin and Furan Releases*", UNEP Chemicals Geneva, Switzerland, May 2003. For conservative approach, the maximum emission factor of the four processes was adopted in the assessment, i.e., emission factor of secondary zinc of 100 µg I-TEQ/t was adopted.

Remarks
1. thermal processing of scrap copper materials is carried out in furnaces which are well controlled and fitted with afterburners and fabric filters; the scrap should undergo some sorting and classification prior to processing to minimize contaminants
2. controlled systems adopted using afterburners, scrap pre-treatment and gas cleaning with filters and lime injection
3. furnaces fitted with fabric filters where PVC is excluded from battery separators.
4. hot briquetting rotary furnaces are used with basic dust control such as fabric filter or electrostatic precipitator.

D.2.5 Paper

Total throughput of paper : 200,000 tpa
Recovery efficiency : 100%
Total material produced from the process : 200,000 tpa

Emission rate calculation

a. from fuel combustion (for Scenario 1 only)

Energy consumption of paper : 6.5 GJ/ton = 6.1608 MMBtu/ton (refer to Annex 7 for detailed calculations)

Unit	PM	SO_2	NO_x	CO	VOC
lb/ 1000 gal	2	0.785^	24	5	0.252
lb/ MMBtu*	0.0143	0.0056	0.1714	0.0357	0.0018
kg/ MMBtu	0.0065	0.0025	0.0778	0.0162	0.0008
kg/ Mg	0.0399	0.0157	0.4791	0.0998	0.0050
g/s	**0.6161**	**0.2418**	**7.3928**	**1.5402**	**0.0776**

^ 157 x 0.005% by weight of sulphur = 0.785 lb / 1000 gal
** lb/ 1000 gal / 140 = lb/ MMBtu*

References

1. *Fuel consumption 6.5 GJ/ton from EP Indicator & Benchmark Shortlist Document - Paper (Only), remas (http://remas.ewindows.eu.org)*

2. *USEPA - AP-42 Chapter 1.3 Fuel Oil Combustion - 0.005% by weight of sulphur, no.2 oil fired (SCC1-01-005-01, 1-02-005-01, SCC1-03-005-01)*

D.2.6 Plastics

Total throughput of plastics : 102,740 tpa
Recovery efficiency : 100%
Total material produced from the process : 102,740 tpa

Emission rate calculation

a. from extrusion

Unit	PM	VOC
kg/ Mg	0.0479	0.0353
g/s	3.7973e-3[@]	0.0280[#]

b. from moulding

Unit	PM	VOC
kg/ Mg	0.0651	0.0307
g/s	5.1608e-3[@]	0.0243[#]

Total emission rate

Process	PM	VOC
Extrusion	3.7973e-3	0.0280[#]
Moulding	5.1608e-3	0.0243[#]
Total	**8.9580e-3**	**0.0523**

[@] *controlled emission by baghouse with 99% control efficiency*
[#] *assumed all VOC are odorous and controlled emission by activated carbon filter with 90% control efficiency*

Reference

1. *Emission Calculation Fact Sheet - Plastic Production and Products Manufacturing, Environmental Science and Services Division of Michigan Department of Environmental Quality*

D.2.7 Rubber Tyres

Grinding (cryogenic grinding)

Total throughput of rubber tyre for grinding : 16,558 tpa
Recovery efficiency : 100%
Total material produced from the process : 16,558 tpa

Emission rate calculation

PM Emission Rate : 0.4 kg/hr = 1.1111e-3 g/s (with 2000 tpa)
PM Emission Rate : 1.1111e-3 g/s x 2000 / 16558 = **9.1986e-3 g/s** (with 16,558 tpa)

Reference

1. *Technical Guidelines on the Identification and Management of Used Tyres, Technical Working Group of Basel Convention*

D.2.8 Wood

Total throughput of wood : 41,260 tpa
Recovery efficiency : 100%
Total material produced from the process : 41,260 tpa

a. from fuel combustion (Scenario 1)

Energy consumption of wood : 3.1353 MMBtu/ton (refer to Annex 7 for detailed calculations)

Unit	PM	SO_2	NO_x	CO	VOC
lb/ 1000 gal	2	0.785^	24	5	0.252
lb/ MMBtu*	0.0143	0.0056	0.1714	0.0357	0.0018
kg/ MMBtu	0.0065	0.0025	0.0778	0.0162	0.0008
kg/ Mg	0.0203	0.0080	0.2438	0.0508	0.0026
g/s	**0.0647**	**0.0254**	**0.7762**	**0.1617**	**0.0081**

b. from extrusion

Unit	PM	VOC
kg/ Mg	0.0479	0.0353
g/s	**0.0015**	**0.0112[#]**

[@] *controlled emission by baghouse with 99% control efficiency*

[#] *assumed all VOC are odorous and controlled emission by activated carbon filter with 90% control efficiency*

References

1. *USEPA - AP-42 Chapter 1.3 Fuel Oil Combustion - 0.005% by weight of sulphur, no.2 oil fired (SCC1-01-005-01, 1-02-005-01, SCC1-03-005-01)*

2. Emission Calculation Fact Sheet - Plastic Production and Products Manufacturing, Environmental Science and Services Division of Michigan Department of Environmental Quality

D.2.9 Fuel Combustion Emissions for Scenarios 2 and 3

Sulphur content of Ultra-Low Sulphur Diesel (ULSD): 0.005%

Total fuel (ULSD) consumption : 7,500 L/hour (Scenario 2)
Total fuel (ULSD) consumption : 3,500 L/hour (Scenario 3)

Emission rates calculation

Unit	PM	SO_2	NO_x	CO	VOC
lb/10^3gal	2	0.785^	24	5	0.252
kg/10^3L or g/L*	0.24	0.0942	2.88	0.6	0.0302
g/s (Scenario 2)	**0.5000**	**0.1963**	**6.0000**	**1.2500**	**0.0630**
g/s (Scenario 3)	**0.2333**	**0.0916**	**2.8000**	**0.5833**	**0.0294**

^ 157 x 0.005% by weight of sulphur = 0.785 lb / 1000 gal
** kg/10^3L or g/L = 0.12 x lb/10^3gal*

Reference

1. *USEPA - AP-42 Chapter 1.3 Fuel Oil Combustion - 0.005% by weight of sulphur, no.2 oil fired (SCC1-01-005-01, 1-02-005-01, SCC1-03-005-01)*

D.2.10 Emission Rate Calculations for Other Sources

Temporary Mixed Construction Waste Sorting Facility (TMCWSF)

Particular matter (PM) emissions from the Temporary Mixed Construction Waste Sorting Facility (TMCWSF) (formerly referred as C&D material sorting facility or C&DMSF) based on the emission inventory extracted from the *Attachment 1 Environmental Protection Measures Incorporated into the Design of the Fill Bank Project of the Project Profile entitled "Expansion and Extension of Fill Bank at Tuen Mun Area 38"* (Application No. DIR-113/2005).

a. Emission from TMCWSF

Descriptions of TMCWSF	**PM Emission Rate, g/s**
Oversized material crushing	0.0012
Screening	0.0531
Material Handling – loading/unloading	0.0088
Total	**0.0631**

The emission area was assumed to be 1m x 1m and so the total PM emission rate = **0.0631 g/s/m^2**.

b. Emission from the access roads to TMCWSF (Road width = 2m)

ID	**From**		**To**		**Length, m**	**Emission Rate, g/s/m**	**Area, m^2**	**Emission Rate, g/s/m^2**
	x	**y**	**x**	**y**				
R1	811371	825618	811349	825592	34.06	0.000202	68.12	0.000101
R11	811349	825592	811476	825539	137.62	0.000202	275.24	0.000101
R12	811476	825539	811230	824959	630.01	0.000202	1260.02	0.000101

Owing to the restriction of ISCST3, the access roads were broken into several segments so that the length/width ratio was less than 10.

Annex 1 Emission Factors from USEPA AP-42 and Other International References (Scenario 1)

	Total Throughput (tonnes/yr)	Recovery Efficiency[b]	Material Produced (tonnes/yr)	Emission Factor (kg/ Mg material produced)[a] PM	SO_2	NO_x	CO	VOC	Ref.
Electronics	25100	100%	25100						
Fluorescent Lamp Recovery (Stack)	6275	100%	6275	Emission Rate calculated directly based on the technical info					1
Fluorescent Lamp Recovery (Fugitive)									1
Glass	42680	88%	37387						
Fuel Combustion				0.0983	0.0386	1.1792	0.2457	0.0124	2, 3
Container w/ baghouse				0.007				0.1	4
Forming & Finishing - Container				Negligible				4.4	4
Organic Food Waste									
- In-vessel Composting	19750	100%	19750						
Fuel Combustion				0.0203	0.0080	0.2438	0.0508	0.0026	
Non-Ferrous Metals	10000	100%	10000						
Lead	10000	100%	10000						
Fuel Combustion				0.0048	0.0019	0.0582	0.0121	0.0006	2, 5
Sweating				35	ND				6
Reverberatory Smelting/ Blast Smelting-Cupola				1.12	40				6
Reverberatory Smelting				0.5	40				6
Blast Smelting-Cupola				1.12	27				6
Fugitive Emission (Sweating)				1.8					6
Fugitive Emission (Smelting)				12.1					6
Aluminium	10000	100%	10000						
Fuel Combustion				0.0737	0.0289	0.8844	0.1843	0.0093	2, 5, 7
Sweating Furnace w/ baghouse				1.65					8
Smelting (Reverberatory Furnace) w/ baghouse				0.65					8
Demagging w/ baghouse				25					8
Copper	10000	100%	10000						
Fuel Combustion				0.0459	0.0180	0.5509	0.1148	0.0058	2, 5
Cupola Furnace (scrap copper and brass)				35					9
- Fugitive Emission				1.1					9
Rotary Furnace (brass and bronze)				150					9
- Fugitive Emission				1.3					9
Zinc	10000	100%	10000						
Fuel Combustion				0.0188	0.0074	0.2255	0.0470	0.0024	2, 5
Reverberatory Sweating (residual scrap)				16					10
- Fugitive Emission				0.63					10
Sodium Carbonate Leaching Calcining				44.5					10
Kettle pot				0.05					10
- Fugitive Emission				0.0025					10
Muffle distillation				22.5					10
- Fugitive Emission				1.18					10
Retort Reduction				23.5					10
Paper	200000	100%	200000						
Fuel Combustion				0.0399	0.0157	0.4791	0.0998	0.0050	2, 5, 11
Plastics	102740	100%	102740						
Extruder				0.0479				0.0353	13
Moulding Machine				0.0651				0.0307	13
Rubber Tyres	20020	100%	20020						
Grinding of rubber tyres	16558	100%	16558	Emission Rate calculated directly based on the technical info					14
Wood	41260	100%	41260						
Plastic Wood Composite Manufacturing									
Fuel Combustion				0.0203	0.0080	0.2438	0.0508	0.0026	2, 5
Extrusion Process				0.0479				0.0353	13
Total Fuel Combustion (considered in the process)									

Annex 2 Calculated Emission Rates (Scenario 1)

	Total Throughput (tonnes/yr)	Recovery Efficiency[b]	Material Produced (tonnes/yr)	Emission Rate (g/s)[a] PM[a] (w/ baghouse)	SO_2	NO_x	CO	VOC
Electronics	25100	100%	25100					
Fluorescent Lamp Recovery (Stack)	6275	100%	6275					
Fluorescent Lamp Recovery (Fugitive)								
Glass	42680	88%	37387	0.3037	0.1113	3.4018	0.7087	1.3339
Fuel Combustion				0.2835	0.1113	3.4018	0.7087	0.0357
Container w/ baghouse				0.0202				0.0288
Forming & Finishing - Container								1.2693
Organic Food Waste								
- In-vessel Composting	19750	100%	19750	0.0310	0.0122	0.3715	0.0774	0.0039
Fuel Combustion				0.0310	0.0122	0.3715	0.0774	0.0039
Non-Ferrous Metals	10000	100%	10000	21.1217	30.8657	0.6824	0.1422	0.0072
Lead	10000	100%	10000	1.2453	30.8657	0.0449	0.0094	0.0005
Fuel Combustion				0.0037	0.0015	0.0449	0.0094	0.0005
Sweating				0.2701				
Reverberatory Smelting/ Blast Smelting-Cupola				0.8642	30.8642			
Reverberatory Smelting				0.3858	30.8642			
Blast Smelting-Cupola				0.8642	20.8333			
Fugitive Emission (Sweating)				0.0139				
Fugitive Emission (Smelting)				0.0934				
Aluminium	10000	100%	10000	21.1217	0.0223	0.6824	0.1422	0.0072
Fuel Combustion				0.0569	0.0223	0.6824	0.1422	0.0072
Sweating Furnace w/ baghouse				1.2731				
Smelting (Reverberatory Furnace) w/ baghouse				0.5015				
Demagging w/ baghouse				19.2901				
Copper	10000	100%	10000	1.4814	0.0139	0.4250	0.0886	0.0045
Fuel Combustion				0.0354	0.0139	0.4250	0.0886	0.0045
Cupola Furnace (scrap copper and brass)				0.2701				
- Fugitive Emission				0.0085				
Rotary Furnace (brass and bronze)				1.1574				
- Fugitive Emission				0.0100				
Zinc	10000	100%	10000	0.8506	0.0057	0.1740	0.0362	0.0018
Fuel Combustion				0.0145	0.0057	0.1740	0.0362	0.0018
Reverberatory Sweating (residual scrap)				0.1235				
- Fugitive Emission				4.9E-03				
Sodium Carbonate Leaching Calcining				0.3434				
Kettle pot				0.0004				
- Fugitive Emission				1.9E-05				
Muffle distillation				0.1736				
- Fugitive Emission				0.0091				
Retort Reduction				0.1813				
Paper	200000	100%	200000	0.6161	0.2418	7.3928	1.5402	0.0776
Fuel Combustion				0.6161	0.2418	7.3928	1.5402	0.0776
Plastics	102740	100%	102740	8.9580E-03				0.0523
Extruder				3.7973E-03				0.0280
Moulding Machine				5.1608E-03				0.0243
Rubber Tyres	20020	100%	20020	9.1986E-03				
Grinding of rubber tyres	16558	100%	16558	9.1986E-03				
Wood	41260	100%	41260	0.0662	0.0254	0.7762	0.1617	0.0194
Plastic Wood Composite Manufacturing								
Fuel Combustion				0.0647	0.0254	0.7762	0.1617	0.0081
Extrusion Process				0.0015				0.0112
Total Fuel Combustion (considered in the process)								

	Total Emission Rate (g/s)				
	PM[c] (w/ baghouse)	**SO_2**	**NO_x**	**CO**	**VOC**
from Eco Park (High Temperature)	**22.1371**	**31.2563**	**12.6247**	**2.6302**	**0.1614**
from Eco Park (Ambient Temperature)	**0.0197**				**1.3329**

Annex 3 Emission Factors from USEPA AP-42 and Other International References (Scenario 2)

	Total Throughput (tonnes/yr)	Recovery Efficiency[b]	Material Produced (tonnes/yr)	Emission Factor (kg/ Mg material produced)[a] PM	SO_2	NO_x	CO	VOC	Ref.
Electronics	25100	100%	25100						
Fluorescent Lamp Recovery (Stack)	6275	100%	6275	Emission Rate calculated directly based on the technical info					1
Fluorescent Lamp Recovery (Fugitive)									1
Glass	42680	88%	37387						
Container w/ baghouse				0.007				0.1	4
Forming & Finishing - Container				Negligible				4.4	4
Organic Food Waste									
- In-vessel Composting	19750	100%	19750						
Non-Ferrous Metals	2500	100%	2500						
Lead	2500	100%	2500						
Sweating				35	ND				
Reverberatory Smelting/ Blast Smelting-Cupola				1.12	40				
Reverberatory Smelting				0.5	40				6
Blast Smelting-Cupola				1.12	27				6
Fugitive Emission (Sweating)				1.8					6
Fugitive Emission (Smelting)				12.1					6
Aluminium	2500	100%	2500						
Sweating Furnace w/ baghouse				1.65					8
Smelting (Reverberatory Furnace) w/ baghouse				0.65					8
Demagging w/ baghouse				25					8
Copper	2500	100%	2500						
Cupola Furnace (scrap copper and brass)				35					9
- Fugitive Emission				1.1					9
Rotary Furnace (brass and bronze)				150					9
- Fugitive Emission				1.3					9
Zinc	2500	100%	2500						
Reverberatory Sweating (residual scrap)				16					10
- Fugitive Emission				0.63					10
Sodium Carbonate Leaching Calcining				44.5					10
Kettle pot				0.05					10
- Fugitive Emission				0.0025					10
Muffle distillation				22.5					10
- Fugitive Emission				1.18					10
Retort Reduction				23.5					10
Paper	200000	100%	200000						
Plastics	102740	100%	102740						
Extruder				0.0479				0.0353	13
Moulding Machine				0.0651				0.0307	13
Rubber Tyres	20020	100%	20020						
Grinding of rubber tyres	16558	100%	16558	Emission Rate calculated directly based on the technical info					14
Wood	41260	100%	41260						
Plastic Wood Composite Manufacturing									
Extrusion Process				0.0479				0.0353	13
Total Fuel Combustion (7500 L/hr)									

Annex 4 Calculated Emission Rates (Scenario 2)

	Total Throughput (tonnes/yr)	Recovery Efficiency[b]	Material Produced (tonnes/yr)	Emission Rate (g/s)[a] PM[a] (w/ baghouse)	SO_2	NO_x	CO	VOC
Electronics	25100	100%	25100					
Fluorescent Lamp Recovery (Stack)	6275	100%	6275					
Fluorescent Lamp Recovery (Fugitive)								
Glass	42680	88%	37387	0.0202				1.2982
Container w/ baghouse				0.0202				0.0288
Forming & Finishing - Container								1.2693
Organic Food Waste								
- In-vessel Composting	19750	100%	19750					
Non-Ferrous Metals	2500	100%	2500	5.2662	7.7160			
Lead	2500	100%	2500	0.3104	7.7160			
Sweating				0.0675				
Reverberatory Smelting/ Blast Smelting-Cupola				0.2160	7.7160			
Reverberatory Smelting				0.0965	7.7160			
Blast Smelting-Cupola				0.2160	5.2083			
Fugitive Emission (Sweating)				0.0035				
Fugitive Emission (Smelting)				0.0233				
Aluminium	2500	100%	2500	5.2662				
Sweating Furnace w/ baghouse				0.3183				
Smelting (Reverberatory Furnace) w/ baghouse				0.1254				
Demagging w/ baghouse				4.8225				
Copper	2500	100%	2500	0.3615				
Cupola Furnace (scrap copper and brass)				0.0675				
- Fugitive Emission				0.0021				
Rotary Furnace (brass and bronze)				0.2894				
- Fugitive Emission				0.0025				
Zinc	2500	100%	2500	0.2090				
Reverberatory Sweating (residual scrap)				0.0309				
- Fugitive Emission				0.0012				
Sodium Carbonate Leaching Calcining				0.0858				
Kettle pot				0.0001				
- Fugitive Emission				4.8E-06				
Muffle distillation				0.0434				
- Fugitive Emission				0.0023				
Retort Reduction				0.0453				
Paper	200000	100%	200000					
Plastics	102740	100%	102740	8.9580E-03				0.0523
Extruder				3.7973E-03				0.0280
Moulding Machine				5.1608E-03				0.0243
Rubber Tyres	20020	100%	20020	9.1986E-03				
Grinding of rubber tyres	16558	100%	16558	9.1986E-03				
Wood	41260	100%	41260	0.0015				0.0112
Plastic Wood Composite Manufacturing								
Extrusion Process				0.0015				0.0112
Total Fuel Combustion (7500 L/hr)				0.5000	0.1963	6.0000	1.2500	0.0630

Total Emission Rate (g/s)

	PM[c] (w/ baghouse)	**SO_2**	**NO_x**	**CO**	**VOC**
from Eco Park (High Temperature)	**5.7864**	**7.9123**	**6.0000**	**1.2500**	**0.0918**
from Eco Park (Ambient Temperature)	**0.0197**				**1.3329**

Annex 5 Emission Factor from USEPA AP-42 and other References – Scenario 3

	Total Throughput (tonnes/yr)	Recovery Efficiency[b]	Material Produced (tonnes/yr)	Emission Factor (kg/ Mg material produced)[a]						Ref.
				PM	SO_2	NO_x	CO	Hg	VOC	
Electronics	25100	100%	25100							
Fluorescent Lamp Recovery (Stack)	6275	100%	6275	Emission Rate calculated directly based on the technical info						1
Fluorescent Lamp Recovery (Fugitive)										1
Glass	42680	88%	37387							
Container w/ baghouse				0.007					0.1	4
Forming & Finishing - Container				Negligible					4.4	4
Organic Food Waste										
- In-vessel Composting	19750	100%	19750							
Paper	200000	100%	200000							
Plastics	102740	100%	102740							
Extruder				0.0479					0.0353	13
Moulding Machine				0.0651					0.0307	13
Rubber Tyres	20020	100%	20020							
Grinding of rubber tyres	16558	100%	16558	Emission Rate calculated directly based on the technical info						14
Wood	41260	100%	41260							
Plastic Wood Composite Manufacturing										
Extrusion Process				0.0479					0.0353	13
Total Fuel Combustion (3500 L/hr)										

Annex 6 Calculated Emission Rate – Scenario 3

	Total Throughput (tonnes/yr)	Recovery Efficiency[b]	Material Produced (tonnes/yr)	Emission Rate (g/s)[a]					
				PM[a] (w/ baghouse)	SO_2	NO_x	CO	Hg	VOC
Electronics	25100	100%	25100					2.42E-06	
Fluorescent Lamp Recovery (Stack)	6275	100%	6275					1.67E-06	
Fluorescent Lamp Recovery (Fugitive)								7.50E-07	
								1.0390E-06	
Glass	42680	88%	37387	0.0202					1.2982
Container w/ baghouse				0.0202					0.0288
Forming & Finishing - Container									1.2693
Organic Food Waste									
- In-vessel Composting	19750	100%	19750						
Paper	200000	100%	200000						
Plastics	102740	100%	102740	8.9580E-03					0.0523
Extruder				3.7973E-03					0.0280
Moulding Machine				5.1608E-03					0.0243
Rubber Tyres	20020	100%	20020	9.1986E-03					
Grinding of rubber tyres	16558	100%	16558	9.1986E-03					
Wood	41260	100%	41260	0.0015					0.0112
Plastic Wood Composite Manufacturing									
Extrusion Process				0.0015					0.0112
Total Fuel Combustion (3500 L/hr)				0.2333	0.0916	2.8000	0.5833		0.0294

Total Emission Rate (g/s)

	PM[c] (w/ baghouse)	**SO_2**	**NO_x**	**CO**	**Hg**	**VOC**
from Eco Park (High Temperature)	**0.2535**	**0.0916**	**2.8000**	**0.5833**		**0.0582**
from Eco Park (Ambient Temperature)	**0.0197**				**2.42E-06**	**1.3329**

Annex 7 Total Energy Consumption Calculations

Material	Latent Heat of fusion (Btu/lb)[1]	Specific Heat Capacity (Btu/lb F)[2]	Melting Point (F)[2]	Room Temperature (F)[3]	Heat transfer per unit mass (Btu/lb)	Total Energy required to melt metal from solid at room temperature to liquid at melting temperature (Btu/lb)	Ratio to Al	Total Energy Consumption (MMBtu/ton)[4]	Total Material to be Produced (tpa)	Total Energy Consumption in Eco Park (MMBtu/ yr)	Total Fuel Consumption (L/ hr)
	q(lhf)	Cp	T1	T2	q(shc) = Cp (T1 - T2)	q(total) = q(lhf) + q(shc)	f = q (total) metal / q (total) al	E = 7.58 x f			
Al	169	0.22	1220	74.3	252.054	421.054	1.0000	11.3738	10000	113738	
Pb	11.3	0.03	621	74.3	16.401	27.701	0.0658	0.7483	10000	7483	
Cu	91.1	0.09	1976	74.3	171.153	262.253	0.6228	7.0842	10000	70842	
Zn	43.3	0.09	786	74.3	64.053	107.353	0.2550	2.8999	10000	28999	
						Highest Energy Consumption from Non-ferrous Metal Recovery				113738	
Glass	-	-	-	-	-	-	-	15.1651	37387	566973	
Paper	-	-	-	-	-	-	-	6.1608	200000	1232162	
								Total	**247387**	**1912873**	MMBtu/ yr
								10% of Total Energy Consumption		**191287**	MMBtu/ yr
							Organic Food Waste	3.1353	19750	61923	
							Wood	3.1353	41260	129364	
							Total of Organic Food Waste and Wood		61010	191287	

Total Energy Consumption (Scenario 1) **2104160** MMBtu/ yr
Total Fuel Consumption (Scenario 1) **15781** L/ hr

Note:
1 Specific latent heat of fusion for different metals are extracted from the Engineers Edge website (http://www.engineersedge.com/properties_of_metals.htm)
2 Specific heat capacity and melting point for different metals are extracted from the Engineering Tool Box website (http://www.engineeringtoolbox.com/24_152.html)
3 Room temperature is determined based on the average temperature of year 2002 meterological data of Tuen Mun Station
4 Total energy consumptions of 12000 MJ/tonne for secondary aluminium process, 16 GJ/tonne glass manufacturing and 6.5 GJ/tonne for paper are extracted from EP Indicator & Benchmark Shortlisy Document, REMAS Website

Annex 8 Comparison Table of Relevant BPMs and PM to Pollutant Ratio Calculations

	Particulates	Hydrogen Chloride	Chlorine	Fluorine	Phosphorus	Lead	Beryllium	Cadmium	Mercury	Nickel	Arsenic	Tin	Molybdenum	Copper	Antimony	Chromium	Platinum	Selenium	Rhodium
BPM Emission Limit (mg/m^3)																			
Metal Recovery (BPM 10)	50	50	30	10		2	0.002	0.2	0.2	1	1								
Aluminium (Secondary) Works (BPM 2/1)	50	50		10	10	5	0.002	1	1		2	10	10	5	5	2	2	2	1
Copper Works (BPM 6)	50			5		2				10		10		20					
Max Pollutant Emission Limit	**50**	**50**	**30**	**10**	**10**	**5**	**0.002**	**1**	**1**	**10**	**2**	**10**	**10**	**20**	**5**	**2**	**2**	**2**	**1**
Max PM to Pollutant Ratio	100%	100%	60%	20%	20%	42% *	0.004%	2%	2%	20%	4%	30% *	20%	40%	10%	4%	4%	4%	2%

Emission Rate Calculations

	PM	HCl	Cl	HF	P	Pb	Be	Cd	Hg	Ni	As	Sn	Mo	Cu	Sb	Cr	Pt	Se	Rh
	Emission Rate - Scenario 1 (g/s)																		
Al	21.0648	21.0648	12.6389	4.2130	4.2130	8.8472	8.43E-04	0.4213	0.4213	4.2130	0.8426	6.3194	4.2130	8.4259	2.1065	0.8426	0.8426	0.8426	0.4213
Pb	1.2415	1.2415	0.7449	0.2483	0.2483	0.5214	4.97E-05	0.0248	0.0248	0.2483	0.0497	0.3725	0.2483	0.4966	0.1242	0.0497	0.0497	0.0497	0.0248
Cu	1.4460	1.4460	0.8676	0.2892	0.2892	0.6073	5.78E-05	0.0289	0.0289	0.2892	0.0578	0.4338	0.2892	0.5784	0.1446	0.0578	0.0578	0.0578	0.0289
Zn	0.8361	0.8361	0.5017	0.1672	0.1672	0.3512	3.34E-05	0.0167	0.0167	0.1672	0.0334	0.2508	0.1672	0.3345	0.0836	0.0334	0.0334	0.0334	0.0167
	Emission Rate - Scenario 2 (g/s)																		
Al	5.2662	5.2662	3.1597	1.0532	1.0532	2.2118	2.11E-04	0.1053	0.1053	1.0532	0.2106	1.5799	1.0532	2.1065	0.5266	0.2106	0.2106	0.2106	0.1053
Pb	0.3104	0.3104	0.1862	0.0621	0.0621	0.1304	1.24E-05	0.0062	0.0062	0.0621	0.0124	0.0931	0.0621	0.1242	0.0310	0.0124	0.0124	0.0124	0.0062
Cu	0.3615	0.3615	0.2169	0.0723	0.0723	0.1518	1.45E-05	0.0072	0.0072	0.0723	0.0145	0.1084	0.0723	0.1446	0.0361	0.0145	0.0145	0.0145	0.0072
Zn	0.2090	0.2090	0.1254	0.0418	0.0418	0.0878	8.36E-06	0.0042	0.0042	0.0418	0.0084	0.0627	0.0418	0.0836	0.0209	0.0084	0.0084	0.0084	0.0042
Worst	**5.2662**	**5.2662**	**3.1597**	**1.0532**	**1.0532**	**2.2118**	**2.11E-04**	**0.1053**	**0.1053**	**1.0532**	**0.2106**	**1.5799**	**1.0532**	**2.1065**	**0.5266**	**0.2106**	**0.2106**	**0.2106**	**0.1053**

** Percentage Composition of lead and tin were extracted from USEPA AP-42 Chapter 12.11 Secondary Lead Processing*

Annex 9 Emission Factor from USEPA AP-42 and other References – Scenario 1

	Material Produced (tonnes/yr)	Emission Factor (kg/ Mg material produced)[a]																			Ref.
		PM	Cl	HCl	F	P	Pb	Be	Cd	Hg	Ni	As	Sn	Mo	Cu	Sb	Cr	Pt	Se	Rh	
Electronics	25100																				
Fluorescent Lamp Recovery (Stack)	6275	Emission Rate calculated directly based on the technical info																			1
Fluorescent Lamp Recovery (Fugitive)																					1
Non-Ferrous Metals	10000																				
Lead	10000																				
Sweating		35					8														
Reverberatory Smelting/ Blast Smelting-Cupola		1.12					0.15														
Reverberatory Smelting		0.5					ND														6
Blast Smelting-Cupola		1.12					0.15														6
Fugitive Emission (Sweating)		1.8					0.9														6
Fugitive Emission (Smelting)		12.1					0.3														6
Aluminium	10000																				
Sweating Furnace w/ baghouse		1.65																			8
Smelting (Reverberatory Furnace) w/ baghouse		0.65																			8
Demagging w/ baghouse		25																			8
Copper	10000																				
Cupola Furnace (scrap copper and brass)		35																			9
- Fugitive Emission		1.1																			9
Rotary Furnace (brass and bronze)		150																			9
- Fugitive Emission		1.3																			9
Zinc	10000																				
Reverberatory Sweating (residual scrap)		16																			10
- Fugitive Emission		0.63																			10
Sodium Carbonate Leaching Calcining		44.5																			10
Kettle pot		0.05																			10
- Fugitive Emission		0.003																			10
Muffle distillation		22.5																			10
- Fugitive Emission		1.18																			10
Retort Reduction		23.5																			10

Annex 10 Calculated Emission Rate (Heavy Metals and Non-Criteria Pollutants) – Scenario 1

	Material Produced (tonnes/yr)	Emission Rate (g/s)[a]																		
		PM[a] (w/ baghouse)	Cl	HCl	F	P	Pb	Be	Cd	Hg	Ni	As	Sn	Mo	Cu	Sb	Cr	Pt	Se	Rh
Electronics	25100									2.42E-06										
Fluorescent Lamp Recovery (Stack)	6275									1.67E-06										
Fluorescent Lamp Recovery (Fugitive)										7.50E-07										
Non-Ferrous Metals	10000	21.0648	12.6389	21.0648	4.2130	4.2130	8.8472	8.43E-04	0.4213	0.4213	4.2130	0.8426	6.3194	4.2130	8.4259	2.1065	0.8426	0.8426	0.8426	0.4213
Lead	10000	1.2415	0.7449	1.2415	0.2483	0.2483	0.8239	4.97E-05	0.0248	0.0248	0.2483	0.0497	0.3725	0.2483	0.4966	0.1242	0.0497	0.0497	0.0497	0.0248
Sweating		0.2701					0.0617													
Reverberatory Smelting/ Blast Smelting-Cupola		0.8642					0.1157													
Reverberatory Smelting		0.3858																		
Blast Smelting-Cupola		0.8642					0.1157													
Fugitive Emission (Sweating)		0.0139					0.0069													
Fugitive Emission (Smelting)		0.0934					0.0023													
Aluminium	10000	21.0648	12.6389	21.0648	4.2130	4.2130	8.8472	8.43E-04	0.4213	0.4213	4.2130	0.8426	6.3194	4.2130	8.4259	2.1065	0.8426	0.8426	0.8426	0.4213
Sweating Furnace w/ baghouse		1.2731																		
Smelting (Reverberatory Furnace) w/ baghouse		0.5015																		
Demagging w/ baghouse		19.2901																		
Copper	10000	1.4460	0.8676	1.4460	0.2892	0.2892	0.6073	5.78E-05	0.0289	0.0289	0.2892	0.0578	0.4338	0.2892	0.5784	0.1446	0.0578	0.0578	0.0578	0.0289
Cupola Furnace (scrap copper and brass)		0.2701																		
- Fugitive Emission		0.0085																		
Rotary Furnace (brass and bronze)		1.1574																		
- Fugitive Emission		0.0100																		
Zinc	10000	0.8361	0.5017	0.8361	0.1672	0.1672	0.3512	3.34E-05	0.0167	0.0167	0.1672	0.0334	0.2508	0.1672	0.3345	0.0836	0.0334	0.0334	0.0334	0.0167
Reverberatory Sweating (residual scrap)		0.1235																		
- Fugitive Emission		4.9E-03																		
Sodium Carbonate Leaching Calcining		0.3434																		
Kettle pot		0.0004																		
- Fugitive Emission		1.9E-05																		
Muffle distillation		0.1736																		
- Fugitive Emission		0.0091																		
Retort Reduction		0.1813																		
		Total Emission Rate (g/s)																		
		PM	**Cl**	**HCl**	**F**	**P**	**Pb**	**Be**	**Cd**	**Hg**	**Ni**	**As**	**Sn**	**Mo**	**Cu**	**Sb**	**Cr**	**Pt**	**Se**	**Rh**
from Eco Park (High Temperature)		**21.0648**	**12.6389**	**21.0648**	**4.2130**	**4.2130**	**8.8472**	**8.43E-04**	**0.4213**	**0.4213**	**4.2130**	**0.8426**	**6.3194**	**4.2130**	**8.4259**	**2.1065**	**0.8426**	**0.8426**	**0.8426**	**0.4213**
from Eco Park (Ambient Temperature)										**2.42E-06**										

Annex 11 Emission Factor from USEPA AP-42 and other References –Scenario 2

	Material Produced (tonnes/yr)	Emission Factor (kg/ Mg material produced)[a]																			Ref.
		PM	Cl	HCl	F	P	Pb	Be	Cd	Hg	Ni	As	Sn	Mo	Cu	Sb	Cr	Pt	Se	Rh	
Electronics	25100																				
Fluorescent Lamp Recovery (Stack)	6275	Emission Rate calculated directly based on the technical info																			1
Fluorescent Lamp Recovery (Fugitive)																					1
Non-Ferrous Metals	2500																				
Lead	2500																				
Sweating		35					8														
Reverberatory Smelting/ Blast Smelting-Cupola		1.12					0.15														
Reverberatory Smelting		0.5					ND														6
Blast Smelting-Cupola		1.12					0.15														6
Fugitive Emission (Sweating)		1.8					0.9														6
Fugitive Emission (Smelting)		12.1					0.3														6
Aluminium	2500																				
Sweating Furnace w/ baghouse		1.65																			8
Smelting (Reverberatory Furnace) w/ baghouse		0.65																			8
Demagging w/ baghouse		25																			8
Copper	2500																				
Cupola Furnace (scrap copper and brass)		35																			9
- Fugitive Emission		1.1																			9
Rotary Furnace (brass and bronze)		150																			9
- Fugitive Emission		1.3																			9
Zinc	2500																				
Reverberatory Sweating (residual scrap)		16																			10
- Fugitive Emission		0.63																			10
Sodium Carbonate Leaching Calcining		44.5																			10
Kettle pot		0.05																			10
- Fugitive Emission		0.003																			10
Muffle distillation		22.5																			10
- Fugitive Emission		1.18																			10
Retort Reduction		23.5																			10

Annex 12 Calculated Emission Rate (Heavy Metals and Non-Criteria Pollutants) – Scenario 2

	Material Produced (tonnes/yr)	Emission Rate (g/s)[a]																		
		PM[a] (w/ baghouse)	Cl	HCl	F	P	Pb	Be	Cd	Hg	Ni	As	Sn	Mo	Cu	Sb	Cr	Pt	Se	Rh
Electronics	25100									2.42E-06										
Fluorescent Lamp Recovery (Stack)	6275									1.67E-06										
Fluorescent Lamp Recovery (Fugitive)										7.50E-07										
Non-Ferrous Metals	2500	5.2662	3.1597	5.2662	1.0532	1.0532	2.2118	2.11E-04	0.1053	0.1053	1.0532	0.2106	1.5799	1.0532	2.1065	0.5266	0.2106	0.2106	0.2106	0.1053
Lead	2500	0.3104	0.1862	0.3104	0.0621	0.0621	0.2060	1.24E-05	0.0062	0.0062	0.0621	0.0124	0.0931	0.0621	0.1242	0.0310	0.0124	0.0124	0.0124	0.0062
Sweating		0.0675					0.0154													
Reverberatory Smelting/ Blast Smelting-Cupola		0.2160					0.0289													
Reverberatory Smelting		0.0965																		
Blast Smelting-Cupola		0.2160					0.0289													
Fugitive Emission (Sweating)		0.0035					0.0017													
Fugitive Emission (Smelting)		0.0233					0.0006													
Aluminium	2500	5.2662	3.1597	5.2662	1.0532	1.0532	2.2118	2.11E-04	0.1053	0.1053	1.0532	0.2106	1.5799	1.0532	2.1065	0.5266	0.2106	0.2106	0.2106	0.1053
Sweating Furnace w/ baghouse		0.3183																		
Smelting (Reverberatory Furnace) w/ baghouse		0.1254																		
Demagging w/ baghouse		4.8225																		
Copper	2500	0.3615	0.2169	0.3615	0.0723	0.0723	0.1518	1.45E-05	0.0072	0.0072	0.0723	0.0145	0.1084	0.0723	0.1446	0.0361	0.0145	0.0145	0.0145	0.0072
Cupola Furnace (scrap copper and brass)		0.0675																		
- Fugitive Emission		0.0021																		
Rotary Furnace (brass and bronze)		0.2894																		
- Fugitive Emission		0.0025																		
Zinc	2500	0.2090	0.1254	0.2090	0.0418	0.0418	0.0878	8.36E-06	0.0042	0.0042	0.0418	0.0084	0.0627	0.0418	0.0836	0.0209	0.0084	0.0084	0.0084	0.0042
Reverberatory Sweating (residual scrap)		0.0309																		
- Fugitive Emission		1.2E-03																		
Sodium Carbonate Leaching Calcining		0.0858																		
Kettle pot		0.0001																		
- Fugitive Emission		4.8E-06																		
Muffle distillation		0.0434																		
- Fugitive Emission		0.0023																		
Retort Reduction		0.0453																		

	Total Emission Rate (g/s)																	
	PM	**Cl**	**HCl**	**F**	**P**	**Pb**	**Be**	**Cd**	**Hg**	**Ni**	**As**	**Sn**	**Mo**	**Cu**	**Sb**	**Cr**	**Pt**	**Se**	**Rh**
from Eco Park (High Temperature)	**5.2662**	**3.1597**	**5.2662**	**1.0532**	**1.0532**	**2.2118**	**2.11E-04**	**0.1053**	**0.1053**	**1.0532**	**0.2106**	**1.5799**	**1.0532**	**2.1065**	**0.5266**	**0.2106**	**0.2106**	**0.2106**	**0.1053**
from Eco Park (Ambient Temperature)									**2.42E-06**										

Annex 13 References

1. MRT System AB, Technical Performance Data
2. USEPA - AP-42 Chapter 1.3 Fuel Oil Combustion - 0.005% by weight of sulphur, no.2 oil fired (SCC1-01-005-01, 1-02-005-01, SCC1-03-005-01)
3. Fuel consumption 16 GJ/ton from EP Indicator & Benchmark Shortlist Document - Glass (Container), remas (http://remas.ewindows.eu.org)
4. USEPA - AP-42 Chapter 11.15 Glass Manufacturing
5. Energy Consumption Calculations in Annex B of Appendix D
6. USEPA - AP-42 Chapter 12.11 Secondary Lead Processing
7. Fuel consumption 12,000 MJ/ton from EP Indicator & Benchmark Shortlist Document - Aluminium (Secondary), remas (http://remas.ewindows.eu.org)
8. USEPA - AP-42 Chapter 12.8 Secondary Aluminium Operations
9. USEPA - AP-42 Chapter 12.9 Secondary Copper Smelting
10. USEPA - AP-42 Chapter 12.14 Secondary Zinc Processing
11. Fuel consumption 6.5 GJ/ton from EP Indicator & Benchmark Shortlist Document - Paper (Only), remas (http://remas.ewindows.eu.org)
12. Davis, W.T., 2000, "Air Pollution Engineering Manual", Air and Waste Management Associations, John Wiley & Sons, Inc. New York, N.Y.
13. Emission Calculation Fact Sheet - Plastic Production and Products Manufacturing, Environmental Science and Services Division of Michigan Department of Environmental Quality
14. Technical Guidelines on the Identification and Management of Used Tyres, Technical Working Group of Basel Convention
15. Locating and Estimating Air Emissions from Sources of Dioxins and Furans, USEPA

a. Particulate Matter (PM) will be collected and pass through a baghouse. It is a normal practice for a baghouse with control efficiency of 99% to be installed to control PM emission.
b. Details of Recovery Efficiency of the Material refer to Annex A

Annex A Recovery Efficiency of Assessed Processes

Material Type & Estimated Throughput	Composition of Process Feedstock	Type and Qty of Material Diverted	Remarks	Throughput (tonnes/yr)	Recovery Efficiency	Material Produced				
						tonnes/yr	tonnes/day (300 days)	Operation Hour	tonnes/hour	tonnes/sec
Electronics (Estimated total throughput = 25,100tpa (15% of overall estimated arisings in 2021[1])				25100	100%	25100	83.67	12	6.9722	0.001936728
CRT Recovery				6275	100%	6275	20.92	12	1.7431	0.000484182
Computer/Electronics Recovery				6275	100%	6275	20.92	12	1.7431	0.000484182
White Goods Dismantling				6275	100%	6275	20.92	12	1.7431	0.000484182
Fluorescent Lamp Recovery				6275	100%	6275	20.92	12	1.7431	0.000484182
Glass (Estimated total throughput in vertically integrated system = 42,680 tpa (15.1% of overall estimated arisings in 2021 [1])										
Sorting	Glass, Others (dyes, paper, plastics)	5-15% residual waste (by automated sorting)	Process rate: 10 tph for coloured glass through automated sorting technology	42680	88%	37387	124.62	12	10.3852	0.002884779
Processing	Sorted glass	Typical residual waste factor ~2% (paper, plastics from labels)	Selection of process will be dependent on the output required							
Re-manufacturing	Crushed glass (to 20mm)	Typical residual waste factor of 3% (paper, plastics from labels)	Production capabilities - 50 to 300 tpd glass							
	Molten Glass	Typical residual waste factor of 3% (ceramics and other contaminants)								
Organic Food Waste (Estimated total throughput = 82,180tpa (4.2% of overall estimated arisings in 2021 [1]); 19,748tpa for in-				19750						
In-vessel composting	Organic material (from agriculture premises; markets)			19750	100%	19750	65.83	12	5.4861	0.00152392
Non-ferrous Metals (Estimated Total Throughput in vertically integrated system = 57,100tpa (25% of overall estimated arisings in				57100						
Processing (Lead)			from non-ferrous	14275	100%	14275	47.58	12	3.9653	0.001101466
Processing (Aluminum)		Loss in drosses (Reverberatory (2-3%) [11])		14275	100%	14275	47.58	12	3.9653	0.001101466
Processing (Copper)				14275	100%	14275	47.58	12	3.9653	0.001101466
Processing (Zinc)				14275	100%	14275	47.58	12	3.9653	0.001101466
Paper (Estimated Total Throughput in vertically integrated system = 507,590 tpa (15.8% of overall estimated arisings in 2021 [1]))										
				200000	100%	200000	666.67	12	55.5556	0.015432099
Plastics (Estimated Total Throughput in vertically integrated system = 102,740tpa (7.1% of overall estimated arisings in 2021 [1]))										
				102740	100%	102740	342.47	12	28.5389	0.007927469
Rubber Tyres (Estimated Total Throughput = 20,020 tpa (52.3% of overall estimated arisings in 2021 [1]); assumes 3,462tpa diverted										
				20020	100%	20020	66.73	12	5.5611	0.001544753
Retreading	Used Tyre casings	buffed rubber tyre; 0.325kg per tyre (or 5% of total feedstock) [3]		3462	100%	3462	11.54	12	0.9618	0.000267165
Grinding				16558	100%	16558	55.19	12	4.5993	0.001277588
Wood (Estimated Total Throughput in vertically integrated system = 41,260 tpa (12.6% of overall estimated arisings in 2021 [1]))										
Plastic Wood Composite Manufacturing				41260	100%	41260	137.53	12	11.4611	0.003183642

Appendix D.3

Detailed Emission Rate Calculations for AQIA Scenario 2 (Mitigated)

D.3.1 Emission Factors from AP-42 (Non-Ferrous Metal) (without Demagging of Aluminium)

Description of Secondary Non-Ferrous Metals Manufacturing Process	Emission Factor (kg/ Mg material produced)
	PM
Lead	
Fuel Combustion (for Scenario 1 only)	0.0048
Sweating	35
Reverberatory Smelting/ Blast Smelting-Cupola	1.12[a]
Reverberatory Smelting	0.5[a]
Blast Smelting-Cupola	1.12[a]
Fugitive Emission (Sweating)	1.8
Fugitive Emission (Smelting)	12.1
Aluminium	
Fuel Combustion (for Scenario 1 only)	0.0737
Sweating Furnace w/ baghouse	1.65
Smelting (Reverberatory Furnace) w/ baghouse	0.65
Demagging w/ baghouse	25
Copper	
Fuel Combustion (for Scenario 1 only)	0.0459
Cupola Furnace (scrap copper and brass)	35
- Fugitive Emission	1.1
Rotary Furnace (brass and bronze)	150
- Fugitive Emission	1.3
Zinc	
Fuel Combustion (for Scenario 1 only)	0.0188
Reverberatory Sweating (residual scrap)	16
- Fugitive Emission	0.63
Sodium Carbonate Leaching Calcining	44.5
Kettle pot	0.05
- Fugitive Emission	0.0025
Muffle distillation	22.5
- Fugitive Emission	1.18
Retort Reduction	23.5

[a] *maximum emission factors (controlled) of reverberatory smelting and blast smelting cupola were adopted.*

For conservative approach, the maximum emission rates (g/s) of different air pollutants were adopted in the assessment. The following tables detail the selection of emission rates.

References

1. *USEPA - AP-42 Chapter 12.11 Secondary Lead Processing*
2. *USEPA - AP-42 Chapter 12.8 Secondary Aluminium Operations*
3. *USEPA - AP-42 Chapter 12.9 Secondary Copper Smelting*
4. *USEPA - AP-42 Chapter 12.14 Secondary Zinc Processing*

D.3.2 Calculated Emission Rates for Scenario 2 (Non-Ferrous Metal) (without Demagging of Aluminium)

Description of Secondary Non-Ferrous Metals Manufacturing Process	Emission Rate (g/s)
	PM
Lead	0.3104
Sweating	0.0675[c]
Reverberatory Smelting/ Blast Smelting-Cupola	0.2160[a]
Reverberatory Smelting	0.0965 [ab]
Blast Smelting-Cupola	0.2160 [ab]
Fugitive Emission (Sweating)	0.0035[c]
Fugitive Emission (Smelting)	0.0233[c]
Aluminium	**0.4437**
Sweating Furnace w/ baghouse	0.3183[b]
Smelting (Reverberatory Furnace) w/ baghouse	0.1254[b]
Copper	0.3615
Cupola Furnace (scrap copper and brass)	0.0675[c]
- Fugitive Emission	0.0021[c]
Rotary Furnace (brass and bronze)	0.2894[cb]
- Fugitive Emission	0.0025[c]
Zinc	0.2090
Reverberatory Sweating (residual scrap)	0.0309[c]
- Fugitive Emission	0.0012[c]
Sodium Carbonate Leaching Calcining	0.0858[c]
Kettle pot	0.0001[c]
- Fugitive Emission	4.8E-06[c]
Muffle distillation	0.0434[c]
- Fugitive Emission	0.0023[c]
Retort Reduction	0.0453[c]
Non-Ferrous Metal Emission Rate (Max)	**0.4437**

[a] *maximum emission rates of reverberatory smelting and blast smelting cupola were adopted.*

[b] *emission rates were calculated based on the controlled emission factors in USEPA's AP-42*
[c] *controlled emission by baghouse with 99% control efficiency*

Total emission rates in bold and underlined are the maximum emission rates for each pollutant

For scenario 2, because total fuel consumption rate was proposed for the whole Eco-Park, emission rates of non-ferrous metals due to fuel combustion are not presented in this section.

References

1. *USEPA - AP-42 Chapter 12.11 Secondary Lead Processing*
2. *USEPA - AP-42 Chapter 12.8 Secondary Aluminium Operations*
3. *USEPA - AP-42 Chapter 12.9 Secondary Copper Smelting*
4. *USEPA - AP-42 Chapter 12.14 Secondary Zinc Processing*

D.3.3 Controlled Emission Rates of the Gaseous Heavy Metal and Toxic Air Pollutants for Scenario 2 (Mitigated)

Chlorine (Cl_2), hydrogen chloride (HCl), Fluorine/Fluoride (F) and Mercury are gaseous pollutants arising from non-ferrous metal manufacturing. According to the 1996 EU Directive on *Integrated Pollution Prevention and Control (IPPC) – Reference Document on Best Available Techniques in the Non Ferrous Metals Industries, December 2001*, chlorine, hydrogen chloride and fluorine/fluoride emissions can be controlled by wet or semi-dry alkaline scrubber. Mercury emission can be abated by several control devices as listed below.

Pollutant	Controlled Emission Rates by IPPC*	Controlled Devices suggested by IPPC	Adopted Controlled Emission Rates
Chlorine	2 mg/m^3	Wet or Semi-dry alkaline scrubber	**2 mg/m^3**
Hydrogen chloride	0.1 – 40 mg/m^3		**40 mg/m^3**
Fluorine/ Fluoride	0.1 – 5 mg/m^3		**5 mg/m^3**
Mercury	0.02 – 0.1 mg/m^3	Boliden/Norzink process[a] Bolchem process[b] Outokumpu process[c] Sodium thiocyanate process[d] Activated Carbon Filter[e] Superlig Ion Exchange Process[f] Added with Potassium Iodide[g] Selenium Scrubber[h] Selenium Filter[i] Lead Sulphide Process[j]	**0.1 mg/m^3**

Remarks:

a. This based on a wet scrubber using the reaction between mercuric chloride and mercury to form mercurous chloride (calomel), which precipitates from the liquor.
b. Mercury is oxidised by 99% sulphuric acid and the mercury containing acid is diluted to 80%. The mercury is then precipitated as sulphide with thiosulphate and filtered off.
c. The gas at, about 350 °C, is led through a packed bed tower where it is washed counter currently with an about 90% sulphuric acid at about 190 °C. The acid is formed in situ from the SO3 in the gas. The mercury is precipitated as a selenium-chloride compound. The mercury sludge is removed from the cooled acid, filtered and washed.
d. This process is used at a zinc roaster. The SO2 gas is washed with a solution of sodium thiocyanate and the Hg is removed as sulphide.
e. An adsorption filter using activated carbon is used to remove mercury vapour from the gas stream.
f. This process uses ion exchange to remove mercury from the product acid and achieves a concentration of mercury < 0.5 ppm (~0.1 mg/m^3).
g. Potassium iodide is added to the acid, which has to be at least 93% strength, at temperature of about 0 °C. Mercury iodide, HgI2, is then precipitated.
h. This is based on a wet scrubber and uses the reaction between amorphous selenium in sulphuric acid and mercury to remove high concentrations of mercury vapour.
i. A dry scrubbing process which uses amorphous selenium to react with mercury vapour to form mercury selenide
j. A dry scrubbing process using lead sulphide nodules as the media removes mercury from the gas stream.

Controlled Emission rate (g/s) = max. PM emission rate of non-ferrous metal (g/s) × {average controlled emission rates (in mg/m^3) / PM emission limit of BPM (i.e., 50mg/m^3)}

Controlled Cl_2 emission rate	=	0.4437 × (2 / 50)	=	0.0177 g/s
Controlled HCl emission rate	=	0.4437 × (40 / 50)	=	0.3550 g/s
Controlled F emission rate	=	0.4437 × (5 / 50)	=	0.0444 g/s
Controlled Hg emission rate	=	0.4437 × (0.1 / 50)	=	8.9×10^{-4} g/s

The calculation of the controlled emission rates for PM, SO_2 and other heavy metals are presented in the following pages of this appendix.

D.3.4 Emission Factors from AP-42 (Non-Ferrous Metal) for Mitigated Scenario 2 (Uncontrolled Dust Emission Factors for Secondary Lead and Aluminium Recovery)

Description of Secondary Non-Ferrous Metals Manufacturing Process	Emission Factor (kg/ Mg material produced)	
	PM	SO_2
Lead		
Sweating	35	ND
Reverberatory Smelting/ Blast Smelting-Cupola	162[a]	40[a]
Reverberatory Smelting	162[a]	40[a]
Blast Smelting-Cupola	153[a]	27[a]
Fugitive Emission (Sweating)	1.8	-
Fugitive Emission (Smelting)	12.1	-
Aluminium		
Sweating Furnace	7.25	-
Smelting (Reverberatory Furnace)	2.15	-
Copper		
Cupola Furnace (scrap copper and brass)	35	-
- Fugitive Emission	1.1	-
Rotary Furnace (brass and bronze)	150	-
- Fugitive Emission	1.3	-
Zinc		
Reverberatory Sweating (residual scrap)	16	-
- Fugitive Emission	0.63	-
Sodium Carbonate Leaching Calcining	44.5	-
Kettle pot	0.05	-
- Fugitive Emission	0.0025	-
Muffle distillation	22.5	-
- Fugitive Emission	1.18	-
Retort Reduction	23.5	-

[a] *maximum emission factors of reverberatory smelting and blast smelting cupola were adopted.*

D.3.5 Calculated Emission Rates for Mitigated Scenario 2 (Non-Ferrous Metal) (Without Demagging Process, with SO_2 Control Emission and Provided With up to 99.9% Dust Control Efficiency)

Description of Secondary Non-Ferrous Metals Manufacturing Process	Emission Rate (g/s)	
	PM	SO_2
Lead	**0.0407**	**1.5432**
Sweating	0.0068[b]	
Reverberatory Smelting/ Blast Smelting-Cupola	0.0313[ab]	1.5432
Reverberatory Smelting	0.0313 [ab]	1.5432 [a]
Blast Smelting-Cupola	0.0295 [ab]	1.0417 [a]
Fugitive Emission (Sweating)	0.0003[b]	-
Fugitive Emission (Smelting)	0.0023[b]	-
Aluminium	0.0018	-
Sweating Furnace	0.0014[b]	-
Smelting (Reverberatory Furnace)	0.0004[b]	-
Copper	0.0361	-
Cupola Furnace (scrap copper and brass)	0.0068[b]	-
- Fugitive Emission	0.0002[b]	-
Rotary Furnace (brass and bronze)	0.0289[b]	-
- Fugitive Emission	0.0003[b]	-
Zinc	0.0209	-
Reverberatory Sweating (residual scrap)	0.0031[b]	-
- Fugitive Emission	0.0001[b]	-
Sodium Carbonate Leaching Calcining	0.0086[b]	-
Kettle pot	0.00001[b]	-
- Fugitive Emission	4.8E-07[b]	-
Muffle distillation	0.0043[b]	-
- Fugitive Emission	0.0002[b]	-
Retort Reduction	0.0045[b]	-
Non-Ferrous Metal Emission Rate (Max)	**0.0407**	**1.5432**

[a] *maximum controlled emission rates (with 80% SO_2 removal) of reverberatory smelting and blast smelting cupola were adopted*
[b] *controlled emission by baghouse or ECP with 99.9% control efficiency*

References

1. *USEPA - AP-42 Chapter 12.11 Secondary Lead Processing*
2. *USEPA - AP-42 Chapter 12.8 Secondary Aluminium Operations*
3. *USEPA - AP-42 Chapter 12.9 Secondary Copper Smelting*
4. *USEPA - AP-42 Chapter 12.14 Secondary Zinc Processing*
5. *Pollution Prevention and Abatement Handbook, World Bank Group, July 1998*

Annex 1 Uncontrolled Emission Factor from USEPA AP-42 and other References – Scenario 2 (Mitigated)

	Material Produced (tonnes/yr)	Emission Factor (kg/ Mg material produced)[a]															Ref.
		PM	P	Pb	Be	Cd	Ni	As	Sn	Mo	Cu	Sb	Cr	Pt	Se	Rh	
Electronics	25100																
Fluorescent Lamp Recovery (Stack)	6275	Emission Rate calculated directly based on the technical info															1
Fluorescent Lamp Recovery (Fugitive)																	1
Non-Ferrous Metals	2500																
Lead	2500																
Sweating		35		8													
Reverberatory Smelting/ Blast Smelting-Cupola		162		52													
Reverberatory Smelting		162		32													6
Blast Smelting-Cupola		153		52													6
Fugitive Emission (Sweating)		1.8		0.9													6
Fugitive Emission (Smelting)		12.1		0.3													6
Aluminium	2500																
Sweating Furnace		7.25															
Reverberatory Furnace		2.15															
Copper	2500																
Cupola Furnace (scrap copper and brass)		35															9
- Fugitive Emission		1.1															9
Rotary Furnace (brass and bronze)		150															9
- Fugitive Emission		1.3															9
Zinc	2500																
Reverberatory Sweating (residual scrap)		16															10
- Fugitive Emission		0.63															10
Sodium Carbonate Leaching Calcining		44.5															10
Kettle pot		0.05															10
- Fugitive Emission		0.003															10
Muffle distillation		22.5															10
- Fugitive Emission		1.18															10
Retort Reduction		23.5															10

Annex 2 Calculated Emission Rate (Heavy Metals and Non-Criteria Pollutants) – Scenario 2 with 99.9% Dust Control Efficiency

	Material Produced (tonnes/yr)	Emission Rate (g/s)[a]														
		PM[a] (w/ baghouse)	P	Pb	Be	Cd	Ni	As	Sn	Mo	Cu	Sb	Cr	Pt	Se	Rh
Electronics	25100															
Fluorescent Lamp Recovery (Stack)	6275															
Fluorescent Lamp Recovery (Fugitive)																
Non-Ferrous Metals	2500	0.0407	0.0081	0.0389	1.63E-06	0.0008	0.0081	0.0016	0.0122	0.0081	0.0163	0.0041	0.0016	0.0016	0.0016	0.0008
Lead	2500	0.0407	0.0081	0.0389	1.63E-06	0.0008	0.0081	0.0016	0.0122	0.0081	0.0163	0.0041	0.0016	0.0016	0.0016	0.0008
Sweating		0.0068		0.0015												
Reverberatory Smelting/ Blast Smelting-Cupola		0.0313		0.0100												
Reverberatory Smelting		0.0313		0.0062												
Blast Smelting-Cupola		0.0295		0.0100												
Fugitive Emission (Sweating)		0.0003		0.0002												
Fugitive Emission (Smelting)		0.0023		0.0001												
Aluminium	2500	0.0018	0.0004	0.0008	7.25E-08	0.0000	0.0004	0.0001	0.0005	0.0004	0.0007	0.0002	0.0001	0.0001	0.0001	0.0000
Sweating Furnace		0.0014														
Reverberatory Furnace		0.0004														
Copper	2500	0.0361	0.0072	0.0152	1.45E-06	0.0007	0.0072	0.0014	0.0108	0.0072	0.0145	0.0036	0.0014	0.0014	0.0014	0.0007
Cupola Furnace (scrap copper and brass)		0.0068														
- Fugitive Emission		0.0002														
Rotary Furnace (brass and bronze)		0.0289														
- Fugitive Emission		0.0003														
Zinc	2500	0.0209	0.0042	0.0088	8.36E-07	0.0004	0.0042	0.0008	0.0063	0.0042	0.0084	0.0021	0.0008	0.0008	0.0008	0.0004
Reverberatory Sweating (residual scrap)		0.0031														
- Fugitive Emission		1.2E-04														
Sodium Carbonate Leaching Calcining		0.0086														
Kettle pot		0.0000														
- Fugitive Emission		4.8E-07														
Muffle distillation		0.0043														
- Fugitive Emission		0.0002														
Retort Reduction		0.0045														

	Total Emission Rate (g/s)														
	PM	**P**	**Pb**	**Be**	**Cd**	**Ni**	**As**	**Sn**	**Mo**	**Cu**	**Sb**	**Cr**	**Pt**	**Se**	**Rh**
from EcoPark (High Temperature)	**0.0407**	**0.0081**	**0.0389**	**1.63E-06**	**0.0008**	**0.0081**	**0.0016**	**0.0122**	**0.0081**	**0.0163**	**0.0041**	**0.0016**	**0.0016**	**0.0016**	**0.0008**
from EcoPark (Ambient Temperature)															

Appendix D.4

AQIA Results (Unmitigated)

Appendix D.5

AQIA Results for Scenario 2 (Mitigated)

Appendix D.6

Dust Impact From EcoPark for Scenarios 2 and 3

Appendix D.7

Contour Plots of the Major Pollutants for Scenario 2

Appendix D.8

Contour Plots of the Major Pollutants for Scenario 3