EcOz Environmental Services

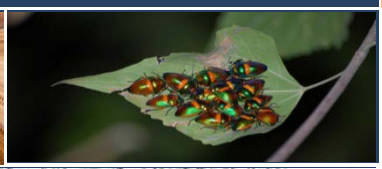
Appendix R Greenhouse Gas Emissions Report

Sherwin Iron (NT) Pty Ltd

Sherwin Creek Iron Ore Project

Environmental Impact Statement





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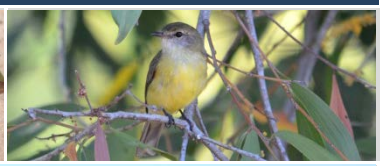
Greenhouse Gas Emissions Report

Prepared for: Sherwin Iron (NT) Pty Ltd

Prepared by: EcOz Environmental Services





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1 Emissions

1.1 Overburden mining

Daily fuel usage and mining plant used for orverburden mining at Deposit C is displayed in the table below.

Table 1-1. Vehicles and fuel usage per day

Vehicle	Number of vehicles	Fuel Usage (Litres/day)
Excavator	2	623.03
Dump truck	4	335.48
Dozer 1	1	287.67
Dozer 2	1	205.48
Grader	1	164.38
Water cart	1	239.73
Water cart (road train)	1	410.96
Drill rig	1	406.85

For combustion engines, emission factors relate to the quantity of substance emitted from an engine to its power or fuel consumption. Methods for estimating emissions from combustion engines are provided in the *National Pollutant Inventory (NPI) Emissions Estimate Techniques Manual for Combustion Engines* (DEWHA 2008). The manual provides the following equation to calculate emissions from mobile mining equipment such as graders, excavators and dozers.

Ei = Qf x LF x EFi

Where:

Ei = Emission of substance i for a specific engine type (kg/day)

Qf = Quantity of fuel combusted during the reporting year (kg/day)

LF = Load factor utilised in facility operations for equipment type

EFi = Emission factor of substance i, for given engine and fuel type (kg/L)

i = substance i

The following table displays emissions from each mining plant type used in overburden mining.

Table 1-2. Emissions from mining plant

Pollutant	Ei (kg/day)					
	Excavator	Dump truck	Dozer	Grader	Water Cart	Drill Rig
CO	6.18	9.78	2.16	0.39	4.74	0.69
Formaldehyde	0.27	0.62	0.21	1.41×10^{-3}	0.30	0
NO_X	24.71	22.88	8.95	1.03	11.09	2.34
PM 2.5 µm	1.67	1.88	0.76	6.40×10^{-2}	0.91	0.17
PM 10 µm	1.81	1.29	0.83	6.87×10^{-2}	0.63	0.18
PAHs	1.19×10^{-3}	3.95×10^{-4}	3.49×10^{-4}	6.56×10^{-3}	1.91×10^{-4}	7.22×10^{-5}
SO_2	1.54×10^{-2}	1.61×10^{-2}	6.50×10^{-3}	5.39 x 10-5	7.79×10^{-3}	1.73×10^{-3}
Total VOCs	3.09	1.04	0.89	1.33	0.50	0.18

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

The following table displays the total emissions to air of pollutants from overburden mining.

Table 1-3. Pollutants kg/day

Pollutant	Ei (kg/day)
CO	23.94
Formaldehyde	1.40
NO_X	71
PM 2.5 µm	5.46
PM 10 µm	4.81
PAHs	8.76×10^{-3}
SO_2	4.76×10^{-2}
Total VOCs	7.04

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

1.2 Ore mining

Daily fuel usage and mining plant to be used for ore mining at Deposit C is displayed in the table below.

Table 1-4. Fuel usage L/day

Vehicle	Number of vehicles	Fuel Usage (Litres/day)
Excavator	2	243.75
Dump truck	4	131.25
Dozer 1	1	172.60
Dozer 2	1	123.29
Grader	1	65.75
Water cart	1	86.30
Water cart (road train)	1	147.95

The following table displays emissions from each mining plant type used in ore mining.

Table 1-5. Emissions from mining plant

Pollutant	Ei (kg/day)				
	Excavator	Dump truck	Dozer	Grader	Water Cart
CO	2.41	3.82	1.56	0.16	1.71
Formaldehyde	0.10	0.24	0.12	2.44×10^{-2}	0.11
NO_X	9.65	8.95	5.37	0.41	3.99
PM 2.5 µm	0.65	0.74	0.46	2.56×10^{-2}	0.33
PM 10 µm	0.71	0.50	0.50	2.75×10^{-2}	0.23
PAHs	4.67×10^{-4}	2.59×10^{-2}	2.09×10^{-4}	2.62×10^{-7}	6.70×10^{-5}
SO_2	6.02×10^{-3}	6.29×10^{-3}	3.9×10^{-3}	2.16 x 10-5	2.81×10^{-3}
Total VOCs	1.21	0.41	0.54	0.53	0.18

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

The following table displays the total emissions to air of pollutants from ore mining.

Table 1-6. Total Pollutants from mining

Pollutant	Ei (kg/day)
CO	9.66
Formaldehyde	0.61
NO_X	28.38
PM 2.5 µm	2.20
PM 10 µm	1.96
PAHs	2.67×10^{-2}
SO_2	1.90×10^{-2}
Total VOCs	2.86

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

1.3 Crushing and stockpile management

Daily fuel usage and mining plant to be used for crushing and stockpile management is displayed in the table below.

Table 1-7. Daily fuel usage for crushing and stockpile management

Plant	Number of plant	Fuel Usage (Litres/day)
Excavator	1	271.85
Crusher	2	699.04
Screener	1	349.52
Stacker	2	124.27
Loader	2	407.77

The *National Pollutant Inventory (NPI) Emission estimate technique manual for Combustion Engines* (DEWHA 2008) provides techniques to estimate emissions from stationary combustions engines, such as crushers and screen plant. The following equation uses emission factors, engine power and operating hours to calculate emissions:

$E_i = P \times OpHrs \times EF_i \times ((100\text{-}ER_i)/100)$

Where:

E_i = Total emission of substance i from a stationary combustion engine (kg/day)

P = Engine power capacity rating (kW)

OpHrs = Operating hours of engine (h/d)

EF_i = Emission factor of substance i (kg/L)

ER_i = Emission reduction efficiency for substance i

i = substance i

Assuming that no reduction efficiency measures are implemented the equation is reduced to:

$E_i = P \times OpHrs \times EF_i$

The following table shows emissions from mining equipment from crushing and stockpile management.

Table 1-8. Emissions from mining equipment used for crushing and stockpile management

Pollutant	Ei (kg/day)				
	Excavator	Crusher	Screen	Stacker	Loader
CO	1.48	22.64	5.37	1.74	2.42
Formaldehyde	6.41×10^{-2}	0	0	1.62×10^{-4}	0.17
NO_X	0.64	104.93	24.90	10.44	8.07
PM 2.5 µm	0.40	7.18	1.70	0.20	0.67
PM 10 µm	0.43	7.18	1.70	0.20	0.74
PAHs	2.86×10^{-4}	3.31×10^{-7}	7.86×10^{-8}	2.36×10^{-7}	4.17×10^{-4}
SO_2	3.70×10^{-3}	2.36×10^{-2}	5.61×10^{-3}	2.11×10^{-3}	5.04×10^{-3}
Total VOCs	0.74	7.73	1.83	0.16	1.07

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

Total emissions from crushing and stockpile management are displayed in the table below.

Table 1-9. Total crushing and stockpile management emissions

Pollutant	Ei (kg/day)
CO	33.66
Formaldehyde	0.24
NO_X	148.98
PM 2.5 µm	10.15

Pollutant	Ei (kg/day)
PM 10 µm	10.26
PAHs	7.04×10^{-4}
SO_2	4.01×10^{-2}
Total VOCs	11.53

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

1.4 Ore Transport

Daily fuel usage and vehicles to be used to transport iron ore from Deposit C to Mataranka is displayed in the table below. The distance from Deposit C to Mataranka is approximately 150km.

Table 1-10. Vehicle fuel usage from Sherwin to Mataranka

Vehicle	Number of vehicles	Fuel usage (Litres/day)
Road train	13	8899.83
Loader	1	135.92
Escort vehicle	2	207.12

For road trains and loaders the following equation is used to calculate emissions:

Ei = Qf x LF x EFi

Where:

Ei = Emission of substance i for a specific engine type (kg/day)

Qf = Quantity of fuel combusted during the reporting year (kg/day)

LF = Load factor utilised in facility operations for equipment type

EFi = Emission factor of substance i, for given engine and fuel type (kg/L)

i = substance

The *National Pollutant Inventory (NPI) Emission estimate technique manual for Combustion Engines* (DEWHA 2008) provides techniques to estimate emissions from road transport vehicles, such as cars operating as an escort for road train convoys. The following equation uses emission factors and distances travelled to calculate emissions:

$E_i = L_y \times EF_i$

Where:

E_i = Total emission of substance i from a road transport vehicle (kg/day)

L_Y = Distance travelled per day (km/day)

EF_i = Emission factor of substance i (kg/km)

i = substance i

The table below shows the total emissions from delivery of ore from Sherwin Mine (deposit C) to Mataranka.

Table 1-11. Total emissions from delivery of ore between Sherwin and Mataranka

Pollutant	Ei (kg/day)			
	Road Train	Loader	Escort car	Total
CO	18.91	0.81	2.07	**21.79**
Formaldehyde	0	5.83×10^{-2}	0	**5.83×10^{-2}**
NO_X	48.95	2.69	1.39	**53.03**
PM 2.5 µm	2.45	0.22	0.41	**3.96**
PM 10 µm	2.67	0.25	0.43	**4.30**
PAHs	8.90×10^{-4}	1.39×10^{-4}	6.63×10^{-5}	**1.10×10^{-3}**
SO_2	3.78×10^{-2}	0.001679825 1.68×10^{-3}	3.52×10^{-3}	**5.83×10^{-2}**
VOCs	2.22	0.36	0.17	**7.75**

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

Daily fuel usage and vehicles to be used to transport iron ore from Mataranka to Darwin Port at East Arm is displayed in the table below. The distance travelled is approximately 422km.

Table 1-12. Vehicle fuel usage from Mataranka to Darwin Port

Plant	Number of plant	Fuel usage (Litres/day)
Road train	25	32637.61
Loader	2	135.92
Genset	1	79.40

A single genset is operated at Mataranka. The *National Pollutant Inventory Emissions Estimation Technique Manual for Fossil Fuel Electric Power Generation* (SEWPaC 2012) provides techniques to estimate emissions from electricity generation. The equation used to calculate emissions from diesel generators is described further in section 1.6.

The table below shows the total emissions from delivery of ore from Mataranka to Darwin Port at East Arm.

Table 1-13. Total emissions from delivery of ore Mataranka to Darwin Port

Pollutant	Ei (kg/day)			
	Road Train	Loader	Genset	Total
CO	69.35	2.97	1.27	**73.59**
Formaldehyde	0	0.21	1.51×10^{-3}	**0.21**
NO_X	179.51	9.90	5.72	**195.12**
PM 2.5 µm	8.975	0.82	0.40	**10.19**
PM 10 µm	9.79	0.91	0.40	**11.10**
PAHs	3.26×10^{-3}	5.12×10^{-4}	1.92×10^{-08}	**3.78×10^{-3}**
SO_2	0.14	6.18×10^{-3}	1.35×10^{-3}	**0.15**
VOCs	8.16	1.31	0.42	**9.89**

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

The following table displays the total emissions to air of pollutants from transport of ore from Sherwin Mine (deposit C) to Darwin Port.

Table 1-14. Total air emissions from transport of ore between Sherwin and Darwin Port

Pollutant	Ei (kg/day)
CO	95.39
Formaldehyde	0.27
NO_X	248.15
PM 2.5 µm	14.15
PM 10 µm	15.40
PAHs	4.87×10^{-3}
SO_2	0.20
Total VOCs	12.64

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

1.5 Mining vehicles

Daily fuel consumption for a service cart, four-wheel drive (4WD) vehicles and a bus operating at Deposit C is displayed in the table below.

Table 1-15. Fuel consumption for service cart, light vehicles and bus

Vehicle	Number of vehicles	Fuel Usage (Litres/day)
Service cart	1	60
Light vehicle (4WD)	5	200
Bus	1	56

The *National Pollutant Inventory (NPI) Emission estimate technique manual for Combustion Engines* (DEWHA 2008) provides techniques to estimate emissions from industrial vehicles used on mine sites. Emissions from industrial vehicles can be calculated from the quantity of fuel used and emission factors for the particular fuel substance, in this instance diesel. The manual provides specific emissions factors for light goods vehicles (LGVs) diesel exhaust emissions and bus diesel exhaust emissions.

$E_i = Q_f \times EF$

Where:

Q_f = Fuel used (Litres/day)

EF = Emissions factor

E_i = Emissions of substance i (kg/day)

The table below displays emissions from a service cart, 4WD vehicles and a bus.

Table 1-16. Daily emissions for service cart, light vehicles and bus

Pollutant	Ei (kg/day)		
	Service cart	4WD	Bus
CO	0.41	3.8	0.81
NO_X	0	1.8	1.68
PM 2.5 µm	1.38	0.46	0.12
PM 10 µm	0.10	0.48	0.12
PAHs	0.11	3.2×10^{-4}	2.58×10^{-5}
SO_2	4.26×10^{-5}	3.4×10^{-3}	9.52×10^{-4}
Total VOCs	1.02×10^{-3}	8.4×10^{-2}	6.72×10^{-2}

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

The following table displays the total emissions to air of pollutants from industrial vehicles.

Table 1-17. Total air emissions from industrial vehicles

Pollutant	Ei (kg/day)
CO	5.02
NOX	4.86
PM 2.5 µm	0.68
PM 10 µm	0.71
PAHs	3.88×10^{-4}
SO2	5.37×10^{-3}
Total VOCs	0.26

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

1.6 Electricity generation

Daily fuel consumption for electricity generation at Deposit C is displayed in the table below.

Table 1-18. Fuel consumption from electricity generation

Plant	Number of plant	Fuel usage (Litres/day)
Genset site office	1	144
Genset camp	1	240
Lighting towers	6	288

The *National Pollutant Inventory Emissions Estimation Technique Manual for Fossil Fuel Electric Power Generation* (SEWPaC 2012) provides techniques to estimate emissions from electricity generation. The following equation uses the emission factors technique and is based on fuel consumption:

$EKPY,I = AR \times EFI \times (1-(CEi / 100)$

Where:

EKPY, i = emission rate of pollutant i, kg/day

AR = activity rate (fuel use), tonnes/day

EFi = uncontrolled emission factor of pollutant i, kg/tonne

CEi = overall control efficiency for pollutant i, %

Assuming there are no control measures for pollutants the equation becomes:

EKPY, i = AR x EFi

Table 1-19. Daily emissions from electricity generation

Pollutant	Ei (kg/day)		
	Site office genset	Camp genset	Lighting towers
NO_X	10.37	20.74	17.28
CO	2.30	4.61	3.84
Total VOCs	0.76	1.53	1.27
PM 10 µm	0.73	1.47	1.22
PM 2.5 µm	0.72	1.44	1.20
SO_2	2.45×10^{-3}	4.90×10^{-3}	4.08×10^{-3}
Acetaldehyde	1.87×10^{-3}	3.74×10^{-3}	3.12×10^{-3}
Benzene	2.16×10^{-3}	4.32×10^{-3}	3.6×10^{-3}
Formaldehyde	2.74×10^{-3}	5.47×10^{-3}	4.56×10^{-3}
Toluene	9.65×10^{-4}	1.93×10^{-3}	1.61×10^{-3}
Xylenes	6.77×10^{-4}	1.35×10^{-3}	1.13×10^{-3}

NO_X = Oxides of Nitrogen, CO = Carbon monoxide, VOC = Volatile organic compounds, PM = Particulate matter, SO_2 = Sulfur dioxide

The following table displays the total emissions to air of pollutants from electricity generation.

Table 1-20. Total air emissions from electricity generation

Pollutant	Ei (kg/day)
NO_X	48.38
CO	10.75
Total VOCs	3.56
PM 10 µm	3.43
PM 2.5 µm	3.36
SO_2	1.14×10^{-2}
Acetaldehyde	8.74×10^{-3}
Benzene	1.01×10^{-2}
Formaldehyde	1.28×10^{-2}

Toluene	4.50×10^{-3}
Xylenes	3.16×10^{-3}

CO = Carbon monoxide, Formaldehyde = methyl aldehyde, NO_X = Oxides of Nitrogen, PM = Particulate matter, PAHs = Polycyclic aromatic hydrocarbons, SO_2 = Sulfur dioxide, VOCs = volatile organic compounds

References

DEWHA, 2008, *National Pollutant Inventory- Emission Estimation Technique Manual for Combustion Engines Version 3.0*, Department of the Environment, Water, Heritage and the Arts, Commonwealth Government of Australia, Canberra, ACT.

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