Client: Copperwood Resources, Inc. Project ID.: 17C050
Project: Air Permit Application Emissions Calculations - Version 2
Prepared by: CED1 Date: 06/25/18
Checked by: AKM Date: 07/02/18

Process Plant Building Space Heaters (F010)
Fugitive Emissions Source (Characterized as Volume Source for Air Dispersion Modeling)
Emissions Calculations:

All space heaters will be located in the process plant, including the grinding/flotation plant, concentrate area, and reagent area. It will be assumed that propane combustion emissions will be exhausted throughout the process plant building and will be considered a volume source from an air dispersion modeling standpoint.

Emission Factors

AP-42 Table 1.5-1 Emission Factors for LPG Combustion (Updated 07/08)

Pollutant	Emission Factor - lb/1000 gal	
NOx	13	
CO	7.5	
TOC	1.0	
PM	0.7	(Assume all PM10)
SO2	0.10S	S=sulfur content expressed in gr/100 ft3 gas vapor (see calc at bottom)
SO2	0.0812	at S=10 ppm

Potential to Emit - Traditional Approach, uncontrolled running all year round

Required Heat Input Rate:	1.452	mmBtu/hr	This is net load load required based on heat load calculations prepared by Gmining. The heat load was determined after taking into account the heat gain from electric motors in the building.
Operating time:	8760	hr/yr	
1000 gal LPG=	91.5	mmBtu	AP-42 Chapter 1.5
Total burner fuel usage=	0.016	- 1000 gal/hr	

Uncontrolled	NOx	SOx	PM10	CO	VOC
Emissions (lb/hr)	0.21	1.3E-03	0.01	0.12	0.02
Emissions (lb/yr)	1807	11	97	1043	139
Emissions (tpy)	0.9	5.6E-03	0.05	0.5	0.1

Normal/Actual Emissions

Days/year requiring mine heat:	182.5	day/yr	Based on data from National Weather Service Forecast Office, there are 148 days/year with average temperature under 32 F.
Operating time:	4380	hr/yr	

Uncontrolled	NOx	SOx	PM10	CO	VOC
Emissions (lb/hr)	0.21	1.3E-03	0.01	0.12	0.02
Emissions (lb/yr)	904	6	49	521	70
Emissions (tpy)	0.5	2.8E-03	0.02	0.26	0.03

Calculation of S

S= gr S/100 ft3 vapor		7000	gr=1 lb
sulfur content	10	ppm	Platt's Petrochemicals Guide to Specifications - LPG
ɔor density at 1 atm, 70F	0.116	lb/ft3	
ntent of vapor at 10 ppm	0.00000116	lb/ft3	
convert to gr/100ft3:			
S=	0.812	gr S/100 ft3 vapor	

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Ore handling and processing emissions are comprised from the following fugitive emissions that are characterized as Volume Sources:
1. Ore Transfer from Portal to First Transfer Point (fugitive)
2. Surplus Ore Transfer at Ore Stockpile for Temporary Storage (fugitive)
3 Transfer Points at Ore Bins/Reclaim Area (fugitive)
4 Transfer Points at SAG Mill (fugitive)
5 Concentrate Handling Operations (fugitive)

Surface Ore Handling and Processing

EUFUGITIVES

	Process thru-put ton/hr [1]	E factor PM lb/ton	E factor PM-10 lb/ton	E-Factor PM-2.5 [4] lb/ton	Capture Efficiency % note 3a	Control Efficiency % note 3b PC equip	Control Efficiency % note 3a Enclosure	Emissions PM lb/hr	Emissions PM-10 lb/hr	Emissions PM-2.5 (lb/hr)	Efactor Reference	
1. Ore Transfer from Portal to First Transfer Point (fugitive)												
Process F001												
Feed Ore Transfer Conveyor (No. 1) to Ore Transfer Conveyor (No. 2)	363	0.003	0.0011	0.000165			95%	0.054	0.020	0.0030	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Feed Ore Transfer Conveyor (No. 1) to Surplus Ore Feed Conveyor (No. 4) (to Ore Stockpile)	182	0.003	0.0011	0.000165			95%	0.027	0.010	0.0015	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Surplus Ore Feed Transfer (using FE) to Feed Ore Conveyor (No.1) (Return from Ore Stockpile)	182	0.0013	0.0006	0.0001			95%	0.012	0.005	0.0008	13.2.4 Equation (1), see Calc 1	
						Fugitive Emissions from F001		0.093	0.035	0.005	lb/hr maximum	
						maximum hours based on:		7300	7300	7300	hr/yr maximum	(see Note No. 5)
								680	258	39	lb/yr maximum	
								0.34	0.13	0.02	ton/yr maximum	
2. Surplus Ore Transfer at Ore Stockpile for Temporary Storage (fugitive)								0.30	0.11	0.02	ton/yr actual	
Process F002												
Ore Transfer Conveyor (No. 4) Transfer to Drop Point (within Ore Stockpile)	182	0.003	0.0011	0.000165			95%	0.027	0.010	0.001	11.19-2 Conveyor Transfer Point (Uncontrolled)	
FEL removes material from Conveyor No. 4 drop point for transfer to staging area within Ore Stockpile footprint. (handling/maintaining piles) (See Note 2)	182	0.0013	0.0006	0.0001				0.230	0.109	0.016	13.2.4 Equation (1), see Calc 1	
						Fugitive Emissions from F002		0.258	0.119	0.018	lb/hr maximum	
						maximum hours based on:		7300	7300	7300	hr/yr maximum	(see Note No. 5)
								1880	868	131	lb/yr maximum	
								0.94	0.43	0.07	ton/yr maximum	
3 Transfer Points at Ore Bins/Reclaim Area (fugitive)								0.82	0.38	0.06	ton/yr actual	
Process F003												
Ore Transfer Conveyor No. 2 to Ore Bin Conveyor	363	0.003	0.0011	0.000165			95%	0.054	0.0200	0.0030	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Ore Bin Conveyor Transfer to Ore Bins No. 1 to No. 4	363	0.003	0.0011	0.000165			95%	0.054	0.0200	0.0030	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Ore Bins No. 1 to No. 4 Transfer to Ore Bin Feeders No. 1 to No. 4	363	0.003	0.0011	0.000165			95%	0.054	0.020	0.0030	11.19-2 Conveyor Transfer Point (Uncontrolled)	
Ore Bin Feeders No. 1 to No. 4 Transfer to SAG Mill Feed Conveyor No. 3	363	0.003	0.0011	0.000165			95%	0.054	0.020	0.0030	11.19-2 Conveyor Transfer Point (Uncontrolled)	
						Fugitive Emissions from F003		0.218	0.080	0.012	lb/hr maximum	
						maximum hours based on:		7300	7300	7300	hr/yr maximum	(see Note No. 5)
								1590	583	87	lb/yr maximum	
								0.79	0.29	0.04	ton/yr maximum	
4 Transfer Points at SAG Mill (fugitive)								0.69	0.25	0.04	ton/yr actual	
Process F005												
SAG Mill Feed Conveyor No. 3 Transfer to SAG Mill Hopper	363	0.003	0.0011	0.000165	90.0%	95%		0.0054	0.00200	0.00030	11.19-2 Conveyor Transfer Point (Uncontrolled)	
SAG Mill Hopper to SAG Mill	363	0.003	0.0011	0.000165	90.0%	95%		0.0054	0.00200	0.00030	11.19-2 Conveyor Transfer Point (Uncontrolled)	
						Fugitive Emissions from F005		0.011	0.004	0.001	lb/hr maximum	
						maximum hours based on:		8760	8760	8760	hr/yr maximum	(see Note No. 5)
								95	35	5	lb/yr maximum	
								0.048	0.017	0.003	ton/yr maximum	
								0.042	0.015	0.002	ton/yr actual	

Client: Copperwood Resources, Inc. Project ID.: 17C050
Project: Air Permit Application Emissions Calculations - Version 2
Prepared by: CED1 Date: 06/25/18
Checked by: AKM Date: 07/02/18

Reagent Emission Summary (exempt sources)

1 Hazardous air polutant emissions
2 Particulate emissions from handling dry materials
3 VOC emissions from material handling

1. Hazardous Air Pollutant Emissions

SDS Name Common name - form	Hazardous Component & CAS Number	Compoistion % weight	HAP Emissions		
Flomin C-3430 (SIBX) - supersac dry	Sodium isobutyl xanthate 25306-75-6	90%	0.1	lb/year	
MIBC - liquid	Methyl isobutyl carbinol 108-11-2	100%	6	lb/year	See section 3 below
Carboxymethyl Cellulose Sodium - granular	Carboxymethyl Cellulose Sodium 9004-32-4	100%	2.7E-02	lb/year	

Note : Balance of material composition is non-hazardous.
*MIBC and sodium sulfite are listed toxic air contaminants under Michigan's air pollution regulations.
+MIBC emissions calculations are provided in Section 3 on this sheet.

Reagent	Consumption		Form	Packaging	Reagent Function
Sodium Hydrosulfinde (NaHS)	1,132	ton/yr	liquid	drum or IBC	Conditioner
Sodium Isobutyl Xantante (C-3430)	560	ton/yr	granular	sack	Collector
Methyl Isobutyl Carbinol (MIBC)	90	ton/yr	liquid	drum or IBC	Frother
Dowfroth 250 (D-250)	90	ton/yr	liquid	drum or IBC	Frother
Alkylaryl Dithiophosphate (A249)	421	ton/yr	liquid	drum or IBC	Conditioner
n-Dodecyl Mercaptan (NDM)	85	ton/yr	liquid	drum or IBC	Conditioner
Sodium Silicates	542	ton/yr	liquid	drum or IBC	Conditioner
Carboxymethyl Cellulose Sodium	180	ton/yr	granular	sack	Conditioner
Hydrated Lime	7,227	ton/yr	granular	bulk	Conditioner
Flocculant (To be determined)	1.1	ton/yr	liquid	drum or IBC	Particle Attraction
Anti-Scalant (To be determined)	11,700	gal/yr	liquid	drum or IBC	Scale inhibitor

2 PM Emissions for Handling Dry Materials

Emissions are calculated for granular material handling, which will generate PM. There will be one transfer point accounted to address the material being added to the receiving tank. Once the dry material is mixed in the tank, no further PM will be generated.
(activity inside mill building, contributes to fugitive volume source)

	Max. Annual thruput ton/yr [1]	E factor PM lb/ton	E factor PM-10 lb/ton	E factor PM-2.5 lb/ton	Control Efficiency [2] %	Emissions PM lb/yr	Emissions PM-10 lb/yr	Emissions PM-2.5 lb/yr	E factor reference
SIBX	559.9	0.003	0.0011	0.0011	95%	0.1	0.03	0.03	11.19-2 Conveyor Transfer Point (Uncontrolled)
Carboxymethyl Cellulose Sodium	180.4	0.003	0.0011	0.0011	95%	0.03	0.01	0.010	11.19-2 Conveyor Transfer Point (Uncontrolled)
Hydrated Lime (received in bulk)	7227.0	0.003	0.0011	0.0011	95%	1.08	0.40	0.40	11.19-2 Conveyor Transfer Point (Uncontrolled)
				Totals =		Emissions PM	Emissions PM-10	Emissions PM-2.5	
						1.36E-04	5.00E-05	5.00E-05	lb/hr [3]
						1	0.4	0.4	lb/yr
						0.0006	0.0002	0.0002	tons/yr

1. Maximum annual throughputs were provided by Copperwood for reagent use in the process plant.
2. This emission source is indoors or enclosed. Efficiency applied is: 95%
3. The maximum operating hours for the mill in hours per year is: 8,760

3 MIBC Emissions from Volatilization from MIBC reagent storage tank

(activity inside reagent building) (exempt source)
Working Loss Equation from Section 7.1 of AP-42 for Liquid Storage Tanks:

$L_W = 0.0010 \times M_V \times P_{VA} \times Q \times K_N \times K_P$

Where:
M_V = Vapor Molecular Weight, lb/lb-mole = 102.2
P_{VA} = Vapor pressure at daily average liquid surface temperature, psia[1] = 9.67E-02
Q = Annual net throughput, bbl/year (1 bbl = 31.5 gal) = 641
K_N = Turnover factor, dimensionless = 1
K_P = Working loss product factor for most organic liquids, dimensionless = 1

S.G. = 0.802 @ 25 °C, density of H_2O = 1000 kg/m^3, thus, density of MIBC = 802 kg/m3 (6.7 lb/gal)

Annual Usage 90 tons/year
26925 gal/year
Q= 641 bbl/year

$L_W = 0.0010 \times M_V \times P_{VA} \times Q \times K_N \times K_P$

L_W = **6** lb/year MIBC Emissions
0.00072 lb/hr MIBC emissions in 7300 hr/yr

4 n-Dodecyl Mercaptan (NDM) Emissions from Volatilization from NDM reagent storage tank

(activity inside reagent building) (exempt source)
Working Loss Equation from Section 7.1 of AP-42 for Liquid Storage Tanks:

$L_W = 0.0010 \times M_V \times P_{VA} \times Q \times K_N \times K_P$

Where:
M_V = Vapor Molecular Weight, lb/lb-mole = 202.41
P_{VA} = Vapor pressure at daily average liquid surface temperature, psia[2] = 0.1
Q = Annual net throughput, bbl/year (1 bbl = 31.5 gal) = 568
K_N = Turnover factor, dimensionless = 1
K_P = Working loss product factor for most organic liquids, dimensionless = 1

S.G. = 0.845 @ 20 °C, density of H_2O = 1000 kg/m^3, thus, density of MIBC = 845 kg/m3 (7.1 lb/gal)

Annual Usage 85 tons/year
23859 gal/year
Q= 568 bbl/year

$L_W = 0.0010 \times M_V \times P_{VA} \times Q \times K_N \times K_P$

L_W = **11** lb/year NDM Emissions
0.00131 lb/hr NDM emissions in 7300 hr/yr

Notes:
1. This is the vapor pressure for MIBC at 20 °C as reported by the manufacturer. The vapor pressure is listed as 5 mmHg, the conversion is 5 X 0.019336 psia/mmHg = 0.0716 = 7.16E-02 psia.
2. The vapor pressure for NDM at 20 °C as reported by the manufacturer is < 0.1 psia.

Total Reagent VOC Emission Summary
18 lb/year VOC Emissions
0.0020 lb/hr VOC Emissions in 7300 hr/yr

Client: Copperwood Resources, Inc. Project ID.: 17C050
Project: Air Permit Application Emissions Calculations - Version 2
Prepared by: CED1 Date: 06/25/18
Checked by: AKM Date: 07/02/18

Emergency Generators EUGENERATORS - SV-004, SV-005, & SV-006
Version e-GGRT RY2013.R.01
Date: 3/19/2018

Equation C-1:

$$CO_2 = 1x10^{-3} * Fuel * HHV * EF$$

$$CH_4 \text{ or } N_2O = 1 \times 10^{-3} * Fuel * HHV * EF$$

Facility Name:	Copperwood Resources, Inc.
Reporter Name:	
Unit or Group Name/ ID:	EUGENERATORS - SV-004, SV-005, & SV-006
Configuration Type:	
Fuel/ Fuel Type:	Distillate Fuel Oil No. 2 (Diesel)
Reporting Period:	NA - PTE Calculations
Comments:	Source data should be consistent with Emergency Generators sheet.
Unit Type:	General Stationary Fuel Combustion

Fuel Input Data

[Fuel] = Mass or volume of fuel combusted per year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel)	70,800.
[HHV] = Default High heat value of the fuel, from Table C-1 (mmBtu/mass or mmBtu/volume)	0.138

Gallons Distillate Fuel Oil No. 2 (Diesel) based on 3 emergency generators at a combined 141.6 gallons/hour fuel usage at peak capacity and 500 hours/year maximum operation.

Constants

[1 x 10^{-3}] = Conversion Factor from kg to metric tons (constant)	0.001

Annual CO_2 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-1

[EF] = Fuel-Specific Default CO_2 Emission Factor, from Table C-1 (kg CO_2/mmBtu)	73.96
[CO_2] = Annual CO_2 emissions from combustion of the specified fuel (metric tons)	**723**

Enter this value in e-GGRT

Annual CH_4 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for CH_4, from Table C-2 (kg CH_4/mmBtu)	0.003
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons)	**0.03**

Enter this value in e-GGRT

VMT conct truck =

Annual N_2O Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for N_2O, from Table C-2 (kg N_2O/mmBtu)	0.0006
[N_2O] = Annual N_2O emissions from combustion of the specified fuel (metric tons)	**0.006**

Enter this value in e-GGRT

INFORMATION ONLY: Annual CH_4 Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{CH4}] = Global Warming Potential for CH_4	25
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons CO_2e)	0.73

INFORMATION ONLY: Annual N_2O Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{N2O}] = Global Warming Potential for N_2O	298
[N_2O] = Annual N_2O emissions from combustion of the specified fuel (metric tons CO_2e)	1.75

Total CO2e emissions EUGENERATORS 725 metric tons CO2e
798 short tons CO2e

Client: Copperwood Resources, Inc. Project ID.: 17C050
Project: Air Permit Application Emissions Calculations - Version 2
Prepared by: CED1 Date: 06/25/18
Checked by: AKM Date: 07/02/18

1. Thruput and Production Rates for Mine Excavation/Ore Production

Actual thruput / process rates:

EUFUGITIVES-blast
Version e-GGRT RY2013.R.01
Today's date 8/23/2018

Pounds ANFO used per year: 4,239,840

Equation C-1: $CO_2 = 1x10^{-3} * Fuel * HHV * EF$

CH_4 or $N_2O = 1 \times 10^{-3} * Fuel * HHV * EF$

Facility Name:	Copperwood Resources, Inc.
Reporter Name:	
Unit or Group Name/ ID:	EUFUGITIVES-blast
Configuration Type:	
Fuel/ Fuel Type:	Distillate Fuel Oil No. 2 (Diesel) - 6% of ANFO/emulsion
Reporting Period:	NA - PTE Calculations
Comments:	Source data should be consistent with Underground sheet.
Unit Type:	General Stationary Fuel Combustion

Fuel Input Data

[Fuel] = Mass or volume of fuel combusted per year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel)	36,341
[HHV] = Default High heat value of the fuel, from Table C-1 (mmBtu/mass or mmBtu/volume)	0.138

Gallons Distillate Fuel Oil No. 2 (Diesel) based on 4,239,840 pounds ANFO potential usage at 6% Distillate Fuel Oil No. 2 and 7 pounds/gallon

Constants

[1 x 10^{-3}] = Conversion Factor from kg to metric tons (constant)	0.001

Annual CO_2 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-1

[EF] = Fuel-Specific Default CO_2 Emission Factor, from Table C-1 (kg CO_2/mmBtu)	73.96
[CO_2] = Annual CO_2 emissions from combustion of the specified fuel (metric tons)	**371**

Enter this value in e-GGRT

Annual CH_4 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for CH_4, from Table C-2 (kg CH_4/mmBtu)	0.003
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons)	**0.015**

VMT conct truck =

Enter this value in e-GGRT

Annual N_2O Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for N_2O, from Table C-2 (kg N_2O/mmBtu)	0.0006
[N_2O] = Annual N_2O emissions from combustion of the specified fuel (metric tons)	**0.003**

Enter this value in e-GGRT

INFORMATION ONLY: Annual CH_4 Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{CH4}] = Global Warming Potential for CH_4	25
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons CO_2e)	0.38

INFORMATION ONLY: Annual N_2O Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{N2O}] = Global Warming Potential for N_2O	298

Client: Copperwood Resources, Inc. Project ID.: 17C050
Project: Air Permit Application Emissions Calculations - Version 2
Prepared by: CED1 Date: 06/25/18
Checked by: AKM Date: 07/02/18

Space Heaters - F010
Version e-GGRT RY2013.R.01
Date: 7/2/2018

Equation C-1:

$$CO_2 = 1x10^{-3} * Fuel * HHV * EF$$

$$CH_4 \text{ or } N_2O = 1 \times 10^{-3} * Fuel * HHV * EF$$

Facility Name:	Copperwood Resources, Inc.
Reporter Name:	
Unit or Group Name/ ID:	Space Heaters - F010
Configuration Type:	
Fuel/ Fuel Type:	LPG Combustion
Reporting Period:	NA - PTE Calculations
Comments:	Source data should be consistent with Space Heaters sheet.
Unit Type:	General Stationary Fuel Combustion

Fuel Input Data

[Fuel] = Mass or volume of fuel combusted per year, from company records as defined in §98.6 (express mass in short tons for solid fuel, volume in standard cubic feet for gaseous fuel, and volume in gallons for liquid fuel)	140,160.
[HHV] = Default High heat value of the fuel, from Table C-1 (mmBtu/mass or mmBtu/volume)	0.091

Gallons Liquid Petroleum Gas (LPG) based on 16 gallons/hour fuel usage at peak capacity and 8760 hours/year maximum operation.

Constants

[1 x 10^{-3}] = Conversion Factor from kg to metric tons (constant)	0.001

Annual CO_2 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-1

[EF] = Fuel-Specific Default CO_2 Emission Factor, from Table C-1 (kg CO_2/mmBtu)	62.87
[CO_2] = Annual CO_2 emissions from combustion of the specified fuel (metric tons)	**802**

Enter this value in e-GGRT

Annual CH_4 Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for CH_4, from Table C-2 (kg CH_4/mmBtu)	0.003
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons)	**0.04**

Enter this value in e-GGRT

VMT conct truck =

Annual N_2O Mass Emissions For the Specific Fuel Type (metric tons) from Equation C-8

[EF] = Fuel-Specific Default Emission Factor for N_2O, from Table C-2 (kg N_2O/mmBtu)	0.0006
[N_2O] = Annual N_2O emissions from combustion of the specified fuel (metric tons)	**0.008**

Enter this value in e-GGRT

INFORMATION ONLY: Annual CH_4 Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{CH4}] = Global Warming Potential for CH_4	25
[CH_4] = Annual CH_4 emissions from combustion of the specified fuel (metric tons CO_2e)	0.96

INFORMATION ONLY: Annual N_2O Mass Emissions For the Specific Fuel Type Converted to Carbon Dioxide Equivalent (metric tons CO_2e)

[GWP_{N2O}] = Global Warming Potential for N_2O	298
[N_2O] = Annual N_2O emissions from combustion of the specified fuel (metric tons CO_2e)	2.28

Total CO2e emissions Space Heaters 805 metric tons CO2e
886 short tons CO2e

Client: Copperwood Resources, Inc. Project ID.: 17C050
Project: Air Permit Application Emissions Calculations - Version 2
Prepared by: CED1 Date: 06/25/18
Checked by: AKM Date: 07/02/18

Facility Stacks

Michigan Rule 336.1331 PM Limits Evaluation

	SV-001	SV-002	SV-003	SV-004	SV-005	SV-006
Limit in lb PM per 1000 lb exhaust gas	0.10	0.10	0.10	0.10	0.10	0.10
Stack exhaust rate - cfm	330000	340000	180000	7540	3625	3625
scfm	330006	340007	179817	2943	1407	1407
Calculate pounds gas:						
	60	60	61	872	880	880
pressure - atm	1	1	1	1	1	1
density - lb/cf	0.075	0.075	0.075	0.075	0.075	0.075
Venitlation exhaust rate - lb/min	24750	25500	13500	566	272	272
lb/hr	1485000	1530000	810000	33930	16313	16313
Hourly rate - 1000 lb exhaust gas	1485.0	1530.0	810.0	33.9	16.3	16.3
PM Emission Sources:						
Stack Emissions[1]- lb PM/hr	2.45	2.52	1.336	0.36	0.16	0.16
PM rate (lb PM per 1000 lb gas)=	0.00165	0.00165	0.00165	0.011	0.010	0.010
Does stack meet Table 31 Limit?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
New Source Performance Standards:						
40 CFR 60.382 Standard for Particulate Matter						
Limits listed in (a)(1) - gram/dry std cubic meter	0.05	0.05	0.05	0.05	0.05	0.05
Stack Emissions (see summary)- lb PM/hr	2.45	2.52	1.336	0.359	0.161	0.161
convert to g/hr	0.0054	0.0056	0.00294	0.00079	0.00036	0.00036
Stack exhaust rate - scfm	330006	340007	179817	2943	1407	1407
convert to m3/hr	561011	578011	305688	5003	2392	2392
PM concentration - g PM/m3	9.62E-09	9.62E-09	9.63E-09	1.58E-07	1.48E-07	1.48E-07
Does stack meet the NSPS limit?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**

1 m3/second =	2119	cfm (conversion factor from m3/sec to cfm)
1 cfm =	1.70	m3/hour (conversion factor from cfm to m3/hour)
1 cfm =	0.00047	m3/second (conversion factor from cfm to m3/second)

Emergency Generators

Michigan Rule 336.1402 Emissions of sulfur dioxide from fuel-burning sources other than power plants

Limit	1.7	lb SO2 per mm BTU fuel input	
			molecular weight
Fuel usage at 100% load=	141.6	gal/hr	S = 32
Fuel density=	7.1	lb/gal	SO2 = 64
Fuel heat rating=	19300	Btu/lb for diesel	
Heat Input=	19403448	Btu/hr	
Unit conversion =	1000000	Btu/mm Btu	
Heat Input=	19.40	mm Btu/hr	
Ultra Low Sulfur Diesel Fuel	15	ppm sulfur	
Sulfur emissions			
Fuel usage at 100% load=	141.6	gal/hr	
Fuel density=	7.1	lb/gal	
Fuel usage at 100% load=	1005.4	lb/hr	
Emission rate of S at 15 ppm=	0.01508	lb/hr S	
	0.5	lb S per lb SO2	
Emission rate of SO2 =	0.0302	lb SO2/hr	
Comparative Value =	0.0016	lb SO2/mm Btu fuel input	
Does generator meet SO2 limit?	**Yes**		

Note: Although the hourly SO2 emissions for this generator are presented on page 17 per AP-42, Ch. 3.3 Gasoline and Diesel Industrial Engines, a mass balance approach is taken here to calculate emissions to compare to Michigan limits. Since that chapter of AP-42 was published in 1996, diesel fuel is now mandated as ultra-low sulfur diesel, formulated to contain a maximum of 15 ppm sulfur.

Facility Name:	Copperwood Resources, Inc.	Contact Name:	
Facility Address:		Contact Phone Number:	
Geocoordinates (if known):		Contact Email Address:	

Chemical Name	CAS No.	Screening Level			AQD Screening Level?	AQD Footnote	Allowable Emission Rate (AER)				Proposed Emission Rate (ER)			Is Proposed Emission Rate less than AER?	
							ITSL		IRSL or SRSL						
		ITSL µg/m³	ITSL Avg Time	IRSL or SRSL µg/m³			lbs per month, 24-hr, 8-hr or 1-hr	Max lbs per hour	lbs per month	Max lbs per hour	Rate	Rate Units	Max Hourly ER lbs/hour	Screening Level Specific ER	Max Hourly Rate
Antimony	7440-36-0	0.2	annual		Y		8	0.108			1.99E-04	lbs/24-hr	8.28E-06	yes	yes
Arsenic	7440-38-2			0.002	Y				0.08	0.00108	3.79E-02	lbs/month	5.27E-05	yes	yes
Barium	7440-39-3	5	8-hr		Y	35	0.1	0.1			9.47E-02	lbs/8-hr	1.18E-02	yes	yes
Beryllium	7440-41-7	0.02	24-hr		Y		0.0024	0.001			1.05E-03	lbs/24-hr	4.40E-05	yes	yes
Beryllium	7440-41-7			0.004	Y				0.16	0.00216	3.16E-02	lbs/month	4.40E-05	yes	yes
Cadmium	7440-43-9			0.006	Y				0.24	0.00324	1.97E-02	lbs/month	2.73E-05	yes	yes
Chromium, Trivalent	16065-83-1	5	8-hr		Y	17	0.1	0.1			1.55E-02	lbs/8-hr	1.93E-03	yes	yes
Cobalt	7440-48-4	0.2	8-hr		Y		0.004	0.004			0.00068	lbs/8-hr	5.88E-04	yes	yes
Copper	7440-50-8	2	8-hr		Y		0.04	0.04			1.60E+00	lbs/8-hr	2.00E-01	no	no
Magnesium	7439-95-4	100	8-hr		Y	38	2	2			2.73E-01	lbs/8-hr	3.41E-02	yes	yes
Manganese	7439-96-5	0.3	annual		Y	29	12	0.162			9.06E+00	lbs/month	1.26E-02	yes	yes
Mercury	7439-97-6	0.3	annual		Y	7	12	0.162			1.49E-03	lbs/month	2.07E-06	yes	yes
Mercury	7439-97-6	1	24-hr		Y		0.12	0.05			4.96E-05	lbs/24-hr	2.07E-06	yes	yes
Molybdenum	7439-98-7	30	8-hr		Y		0.6	0.6			2.77E-04	lbs/8-hr	3.46E-05	yes	yes
Nickel	7440-02-0			0.058	Y				2.32	0.03132	8.58E-01	lbs/month	1.19E-03	yes	yes
Selenium	7782-49-2	2	8-hr		Y	34	0.04	0.04			2.22E-04	lbs/8-hr	2.78E-05	yes	yes
Silver - soluble	7440-22-4	0.1	8-hr		Y		0.002	0.002			4.92E-04	lbs/8-hr	6.15E-05	yes	yes
Tin	7440-31-5	20	8-hr		Y		0.4	0.4			3.92E-04	lbs/8-hr	4.90E-05	yes	yes
Phosphorus (total)	7723-14-0	1	8-hr		Y	32	0.02	0.02			4.51E-02	lbs/8-hr	5.64E-03	no	yes
Phosphorus (total)	7723-14-0	0.2	annual		Y	32	8	0.108			4.06E+00	lbs/month	5.64E-03	yes	yes
MIBC	108-11-2	1000	8-hr		Y		20	20			5.79E-03	lbs/8-hr	7.23E-04	yes	yes
n-Dodecyl Mecaptan	112-55-0	8	8-hr		Y		0.16	0.16			1.05E-02	lbs/8-hr	1.31E-03	yes	yes

29 - The ITSL for manganese is most appropriately applied to PM10-Mn data rather than TSP-Mn data.

Facility Name:	**Copperwood Resources, Inc.**	**Contact Name:**	
Facility Address:		**Contact Phone Number:**	
		Contact Email Address:	

Chemical Name	CAS No.	Screening Level: ITSL µg/m³	Screening Level: ITSL Avg Time	Screening Level: IRSL or SRSL µg/m³	AQD Screening Level?	AQD Footnote	Allowable Emission Rate (AER): ITSL: lbs per month, 24-hr, 8-hr or 1-hr	Allowable Emission Rate (AER): ITSL: Max lbs per hour	Allowable Emission Rate (AER): IRSL or SRSL: lbs per month	Allowable Emission Rate (AER): IRSL or SRSL: Max lbs per hour	Proposed Emission Rate (ER): Rate	Proposed Emission Rate (ER): Rate Units	Proposed Emission Rate (ER): Max Hourly ER lbs/hour	Is Proposed Emission Rate less than AER?: Screening Level Specific ER	Is Proposed Emission Rate less than AER?: Max Hourly Rate
			annual												
Benzene	71-43-2	30	annual		Y		1200	16.2			1.08E+01	lbs/month	1.51E-02	yes	yes
Benzene	71-43-2	30	24-hr		Y		3.6	1.5			3.61E-01	lbs/24-hr	1.51E-02	yes	yes
Benzene	71-43-2			1	Y				40	0.54	10.84	lbs/month	1.51E-02	yes	yes
Toluene	108-88-3	5000	24-hr		Y		600	250			0.13	lbs/24-hr	5.45E-03	yes	yes
Xylene	1330-20-7	390	annual		Y	2	15600	210.6			2.70	lbs/month	3.74E-03	yes	yes
Propylene	115-07-1	8600	8-hr		Y		172	172			1.30	lbs/24-hr	5.41E-02	yes	yes
Formaldehyde	50-00-0	30	24-hr		Y		3.6	1.5			0.04	lbs/24-hr	1.53E-03	yes	yes
Formaldehyde	50-00-0			0.8	Y				32	0.432	1.10E+00	lbs/month	1.53E-03	yes	yes
1,3-Butadiene	106-99-0	33	annual		Y		1320	17.82			5.46E-01	lbs/month	7.59E-04	yes	yes
1,3-Butadiene	106-99-0			0.3	Y				12	0.162	5.46E-01	lbs/month	7.59E-04	yes	yes
Acetaldehyde	75-07-0	9.00	24-hr		Y		1.08	0.45			0.01	lbs/24-hr	4.89E-04	yes	yes
Acetaldehyde	75-07-0			5	Y				200	2.7	3.52E-01	lbs/month	4.89E-04	yes	yes
Acrolein*	107-02-8	5	1-hr		Y	13	0.005	0.005			1.53E-04	lbs/hr	1.53E-04	yes	yes
Acrolein*	107-02-8	0.16	annual		Y	13	6.4	0.0864			1.10E-01	lbs/month	1.53E-04	yes	yes
Naphthalene	91-20-3	3	annual		Y		120	1.62			0.061	lbs/24-hr	2.52E-03	yes	yes
Naphthalene	91-20-3	520	8-hr		Y		10.4	10.4			0.020	lbs/8-hr	2.52E-03	yes	yes
Naphthalene	91-20-3			0.8	Y				32	0.432	1.816	lbs/month	2.52E-03	yes	yes
Acenaphthylene	208-96-8	35	24-hr		Y		4.2	1.75			0.004	lbs/24-hr	1.79E-04	yes	yes
Acenaphthene	83-32-9	210	24-hr		Y		25.2	10.5			2.18E-03	lbs/24-hr	9.08E-05	yes	yes
Fluorene	86-73-7	140	24-hr		Y		16.8	7			5.96E-03	lbs/24-hr	2.48E-04	yes	yes
Phenanthrene*	85-01-8	0.1	annual		Y		4	0.054			5.70E-01	lbs/month	7.91E-04	yes	yes
Anthracene	120-12-7	1000	24-hr		Y		120	50			5.73E-04	lbs/24-hr	2.39E-05	yes	yes
Fluoranthene	206-44-0	140	24-hr		Y		16.8	7			0.0019	lbs/24-hr	7.82E-05	yes	yes
Pyrene	129-00-0	100	24-hr		Y		12	5			1.7E-03	lbs/24-hr	7.20E-05	yes	yes
PAHs **				0.006	Y	5			0.24	0.00324	1.24E-02	lbs/month	1.73E-05	yes	yes
Benzo(g,h,l)perylene	191-24-2	13	annual		Y		520	7.02			7.77E-03	lbs/month	1.08E-05	yes	yes

* Acrolein and phenanthrene have annual ITSL screening thresholds, however, the allowable emission rate (AER) is expressed in lb/month with no annual rate available in this pre-programmed spreadsheet. To compare values, the Proposed Emission Rate (ER) has been expressed in a lb/month basis (lb/month = lb/hr * 720 hr/month)

** Per Note 5 in the Screening Level Footnotes, the seven carcinogenic polycyclic aromatic hydrocarbons (PAHs) identified from AP-42 for diesel emissions from the emergency generators and fire pump should be evaluated additively, utilizing the relative potency factors (RPF) approved by the AQD in its document *Screening Levels for PAHs* dated November 4, 2015. Table 3 of the Screening Level document provides an example of how this could be done. For screening purposes in this worksheet, the facility-wide maximum hourly emission rate for the seven carcinogenic PAHs were added together, adjusted using the appropriate RPF to develop a Relative Maximum Hourly Emission Rate for each compound. The facility-wide Relative Maximum Hourly Emission Rate was compared against the Secondary Risk Screening Level (SRSL) for benzo(a)pyrene of 0.006 µg/m³.

Client: Copperwood Resources, Inc. Project ID.: 17C050
Project: Air Permit Application Emissions Calculations - Version 2
Prepared by: CED1 Date: 06/25/18
Checked by: AKM Date: 07/02/18

Copperwood Air Dispersion Model Input Data - Emission Rates of Criteria Pollutants

Point Sources [1]

Emission Source		Stack Height (Above Ground) (m) [1]	Stack Diameter (m) [1]	Stack Exit Velocity (m/s)	Stack Gas Temp (°K)	PM10 (lb/hr)	PM10 (g/sec)	PM2.5 (lb/hr)	PM2.5 (g/sec)	NO2 (lb/hr)	NO2 (g/sec)	SO2 (lb/hr)	SO2 (g/sec)	CO (lb/hr)	CO (g/sec)
SV-001	West Mine Exhaust Vent	9	2	49.4	289	1.261	**0.159**	0.248	**0.0313**	4.90	**0.617**	2.27	**0.286**	77.26	**9.734**
SV-002	East Mine Exhaust Vent	9	2	50.9	289	1.30	**0.164**	0.256	**0.0322**	5.04	**0.635**	2.34	**0.295**	79.60	**10.029**
SV-003	Portal Mine Exhaust Vent	1	4.8	17.9	289	0.69	**0.087**	0.135	**0.0171**	2.67	**0.336**	1.24	**0.156**	42.14	**5.310**
SV-004	Emergency Generator No. 1	4.5	0.2	112.8	740	0.359	**0.0452**	0.359	**0.0452**	0.74	**0.093**	0.018	**0.0023**	2.15	**0.271**
SV-005	Emergency Generator No. 2	4.5	0.2	54.2	744	0.081	**0.0102**	0.081	**0.0102**	0.45	**0.056**	0.009	**0.0011**	0.50	**0.063**
SV-006	Emergency Generator No. 3	4.5	0.2	54.2	744	0.081	**0.0102**	0.081	**0.0102**	0.45	**0.056**	0.009	**0.0011**	0.50	**0.063**

Volume Sources [3]

Emission Source		Volume Height (m)	Volume Width (m)	Release Height (m)	Adjusted Road Width	Initial Horizontal Dimension (m)	Initial Vertical Dimension (m)	PM10 Emissions (lb/hr)	PM10 Emissions (g/sec)	No. of Volume Source Segments	PM10 Rate per Volume (g/sec)	PM2.5 Emissions (lb/hr)	PM2.5 Emissions (g/sec)	PM2.5 Rate per Volume (g/sec)	NO2 Emissions (lb/hr)	NO2 Emissions (g/sec)	NO2 Emissions per Volume (g/sec)	SO2 Emissions (lb/hr)	SO2 Emissions (g/sec)	SO2 Emissions per Volume (g/sec)	CO Emissions (lb/hr)	CO Emissions (g/sec)	CO Emissions per Volume (g/sec)
F001	Ore Transfer from Portal to First Transfer Point (Transfer Tower) [4]	N/A	N/A	0.75		0.21	0.21	0.035	**0.0045**	1		**0.0053**	**0.0007**										
F002	Surplus Ore Transfer to Ore Stockpile [5]	N/A	N/A	5		0.21	0.21	0.119	**0.0150**	1		**0.0180**	**0.0023**										
F003A/B	Transfer Points at Ore Bins/Reclaim Area [6]	N/A	N/A	11.0		7.27	10.2	0.080	**0.010**	2	**5.03E-03**	**0.0120**	**0.0015**	**7.55E-04**									
F004	Management of Ore within Ore Stockpile Area [7]	NA	N/A	16.2		0.81	3.8	0.272	**0.034**	1		**0.0412**	**0.0052**										
F005	Transfer Points at SAG Mill [8]	N/A	N/A	13		7.90	12.00	0.004	**0.0005**	1		0.001	**7.55E-05**										
F006A/B	Concentrate Handling Operations [9]	N/A	N/A	6		8.72	5.60	0.004	**0.0005**	2	**2.72E-04**	0.0006	**8.15E-05**	**4.07E-05**									
F009A/B	Reagent Mixing and Management [10]	N/A	N/A	6.5		7.27	6.10	5.00E-05	**6.30E-06**	2	**3.15E-06**	5.00E-05	**6.30E-06**	**3.15E-06**									
F010	Space Heaters - Process Plant Building [17]	N/A	N/A	13		36.1	12.10	1.11E-02	**1.40E-03**	3	**4.67E-04**	1.11E-02	**1.40E-03**	**4.67E-04**	0.21	0.026	**0.0087**	0.001	0.00016	**5.41E-05**	0.12	0.015	**0.005**
HR-01	Vehicle Travel on Ore Stockpile [11]	10.2	10.1	5.1	10.1	4.7	4.7	0.990	0.1247	13	**9.60E-03**	0.099	0.012	**9.60E-04**									
HR-02	Conct Truck Travel on Access Road [12]	10	8.5	5.0	8.5	7.9	4.7	0.37	0.0469	239	**1.96E-04**	0.037	0.005	**1.96E-05**									
HR-03	Water Transport Truck on Access Road [13]	8.6	8.4	4.3	8.4	7.8	4.0	0.48	0.0605	167	**3.62E-04**	0.048	0.006	**3.62E-05**									
HR-04	[14]	10	8.5	5.0	8.5	7.9	4.7	0.38	0.0480	240	**2.00E-04**	0.038	0.005	**2.00E-05**									
HR-05	Explosives Truck Travel on Access Road [15]	10	8.5	5.0	8.5	7.9	4.7	0.38	0.0476	207	**2.30E-04**	0.038	0.005	**2.30E-05**									

Area Sources

Emission Source	X-Axis Length (m)	Y-Axis Length (m)	Release Height (m)	Initial Vertical (m)	Area (m2)	PM10 Emissions (lb/hr)	PM10 Emissions (g/sec)	PM10 Emissions (g/m^2-sec)	PM2.5 Emissions (lb/hr)	PM2.5 Emissions (g/sec)	PM2.5 Emissions (g/m^2-sec)
F007 - Wind Erosion at Ore Stockpile			15	7.0	51,790	0.23	0.03	**5.56E-07**	0.057	0.007	**1.39E-07**
F008 - Wind Erosion at TDF			30	14.0	38,079	0.4	0.05	**1.33E-06**	0.205	0.026	**6.79E-07**

Building Dimensions [16]

Building Name	X-Axis Bldg/Structure Length (m)	Y-Axis Bldg/Structure Width (m)	Bldg/ Structure Height (m)	Area (m2)	UTM Coordinates Easting (m)	UTM Coordinates Northing (m)
Process Plant and Support Facility	108.4	37.8	26	4,098	270405	5172284
Concentrate Processing Area	43	34	12	1,462	270366	5172261
Reagent Building	31.6	14	4.8	442	270397	5172325
Ore Bins/Reclaim Area	32	18.8	22	602	270564	5172416
Warehouse	37.7	37.5	6	1,414	270446	5172436
Truck Shop/Mine Services Area	18.6	46.3	6	861	270472	5172467
Dry	37.5	25	3	938	270423	5172467

Client: Copperwood Resources, Inc. Project ID.: 17C050
Project: Air Permit Application Emissions Calculations - Version 2
Prepared by: CED1 Date: 06/25/18
Checked by: AKM Date: 07/02/18

Notes:

(1) Stack heights and diameters were calculated based on outlet information provided by Copperwood. All listed heights are measured from the base of the area where they are located. The dimensions for the portal exhaust is based on information provided by Copperwood.

(2) The emergency generators will operate as needed a maximum of 500 hours per year. The three emergency generators will be located as shown on Figure 2.

(3) All volume sources were calculated based on the MDEQ guidance document entitled *Air Dispersion Modeling Guidance Document* dated September 2009.

(4) This represents particulate emissions vented from conveyor No. 1 transfer tower at F001. The transfer conveyor is assumed to be 1.5 meters above ground, with the release height being 1.5 / 2 = 0.75. The initial horizontal dimension is the width of the conveyor = 3 feet = 0.91 meters / 4.3 = 0.21 meters. The initial vertical dimension is the drop distance = 3 feet = 0.91 meters / 4.3 = 0.21 meters.

(5) To estimate this volume source at F002, the release height was the height of the drop point at the ore stockpile = 10 / 2 = 5 meters. The initial horizontal dimension is the width of the conveyor = 3 feet = 0.91 meters / 4.3 = 0.21 meters. The initial vertical dimension is the drop distance = 3 feet = 0.91 meters / 4.3 = 0.21 meters.

(6) To estimate emissions from the ore bins/reclaim area (F003), it will be assumed the emissions will be released within the footprint of the structure. Therefore, the release height for the structure is the height of the bins = 22 meters / 2 = 11 meters. There will be two volume sources. The initial horizontal dimension for each volume source = 31.25 / 4.3 = 7.27 meters (which is half the length of one side of the structure), while the initial vertical dimension = 22 / 2.15 = 10.2 meters.

(7) For F004, to estimate emissions from a FE loader at a pile, it was assumed the release height for the FE loader bucket will be at about 4 feet in height or 1.2 meters. Given the height of the Ore Stockpile will be 15 meters above ground level, the adjusted loader height will be 1.2 + 15 = 16.2 meters. The initial horizontal dimension is the width of the bucket = 3.5 meters / 4.3 = 0.81 meters. The initial vertical dimension is the height of the drop = 16.2 / 4.3 = 3.8 meters.

(8) F005 will be a drop point just inside the process plant building. To estimate emissions from inside the process plant, the release height will be the height of the building = 26 meters / 2 = 13 meters. The initial horizontal dimension will be the width of the building = 34 / 4.3 = 7.9 meters. The initial vertical dimension will be 26 / 2.15 = 12 meters.

(9) Emissions from the concentrate load-out area at F006 include management of concentrate inside the building. This emission source is minimal due to enclosure of the drop point and the fact the material is 9% moisture. It is nonetheless included in air dispersion modeling to be conservative. For purposes of modeling, it is assumed it would be a volume source that includes just the southwest end of the building. The volume is one source that includes release of the emissions from the roof of the building. The release height is the midpoint of the building height = 12 / 2 = 6 meters. There will be two volume sources. The initital horizontal dimension is one-half of the building width = 37.5 / 4.3 = 8.72 meters. The initial vertical dimension is the building height = 12 / 2.15 = 5.6 meters.

(10) Emissions from the reagent building include particulate emissions from mixing of reagents. While these sources are exempt sources, they are being included in air dispersion modeling to be conservative. Modeling for TACs associated with reagent mixing was not required. For purposes of modeling, it is assumed emissions would come from the entire building. Therefore, the building was divided into two volume sources using MDEQ guidance for setting up volume sources associated with release of emissions from building roofs/vents. The release height is the midpoint of the building height = 13 / 2 = 6.5 meters. The initial horizontal dimension of each volume source is 31.25 / 4.3 = 7.27 meters. The initial vertical dimension of each volume source is 13 / 2.15 = 6.1 meters.

(11) For HR-01, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of a CAT 990H FE loader, the height is 5.1 meters, the width is 4.1 meters and length 12.8 meters. Given this information, the volume height is 5.1 * 2 = 10.2 meters, with the volume width being the loader width + 6 meters = 4.1 + 6 = 10.1 meters. The release height = volume height / 2 = 10.2 / 2 = 5.1 meters. The initial horizontal dimension = the volume width / 2.15 = / 2.15 = 4.7 meters, with the initial vertical dimension = height of the volume / 2.15 or 10.2 / 2.15 = 4.7 meters.

(12) For HR-02, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product haul truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15 = 4.7 meters.

(13) For HR-03, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of water transport truck, the height is 14 feet (including trailer + distance from ground) or 4.3 meters. The width is 8 feet or 2.4 meters. The overall length (including trailer and cab) is 65 feet or 19.8 meters. Given this information, the volume height is 4.3 * 2 = 8.6 meters, with the volume width being the truck width + 6 meters = 8.4 meters. The release height = volume height / 2 = 8.6 / 2 = 4.3 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 16.8 / 2.15 = 7.8 meters, with the initial vertical dimension = height of the volume / 2.15 or 8.6 / 2.15 = 4 meters.

(14) For HR-04, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product delivery truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15 = 4.7 meters.

(15) For HR-05, this included estimation of vehicle height, volume width, release height, initial lateral dimension and initial vertical dimension. Based on use of bulk product delivery truck, the height is 16 feet (including trailer + distance from ground) or 5 meters. The width is 8.3 feet or 2.5 meters. The overall length (including trailer and cab) is 53 feet or 16 meters. Given this information, the volume height is 5 * 2 = 10 meters, with the volume width being the truck width + 6 meters = 8.5 meters. The release height = volume height / 2 = 10 / 2 = 5 meters. For alternating volume sources, the initial horizontal dimension = 2 X the adjusted road width / 2.15 = 17 / 2.15 = 7.9 meters, with the initial vertical dimension = height of the volume / 2.15 or 10 / 2.15 = 4.7 meters.

(16) Dimensions are provided for buildings on-site that are adjacent identified emission sources. These additional buildings are included in the dispersion model even though these structures do not release emissions. This is because these structures could have some impact on downwash and/or cavity effects at the site. Dimensions for buildings were provided by Lycopodium.

(17) Space heaters will be located throughout the process plant building to provide additional heating, particularly during winter months. For purposes of air dispersion modeling, it is assumed emission would come from the entire building. Therefore, the building was dividd into three volume sources using MDEQ guidance for setting up volume sources associated with release of emissions from buildings. The release height is the midpoint of the building height = 26/2 = 13 meters. The initial horizontal dimension of each volume source is 108.4/3 = 36.1 meters. The initial vertical dimension of each volume source is 26/2.15 = 12.1 meters.

Foth

Client: Copperwood Resources, Inc. Project ID.: 17C050
Project: Air Permit Application Emissions Calculations - Version 2
Prepared by: CED1 Date: 06/25/18
Checked by: AKM Date: 07/02/18

Copperwood Air Dispersion Model Input Data - Emission Rates of Toxic Air Contaminants

	% Copper [2]	% Lead [2]	% Phosphorus [2]
Ore	1.460	1.10E-03	0.00
Concentrate	29.170	1.00E-03	2.48
Native Soils	0.00197	1.54E-03	0.07
Tailings	0.4675	1.27E-03	0.00

Point Sources

Emission Source		Copper	Lead	Phosphorus	Units
SV-001 West Mine Exhaust Vent		4.51E-03	3.39E-06	0.00	g/sec
SV-002 East Mine Exhaust Vent		4.64E-03	3.49E-06	0.00	g/sec
SV-003 Portal Mine Exhaust Vent		2.46E-03	1.85E-06	0.00	g/sec
SV-004 - Emergency Generator No. 1					g/sec
SV-005 - Emergency Generator No. 2					g/sec
SV-006 - Emergency Generator No. 3					g/sec

Volume Sources

Emission Source	Number of Volume Source Segments	Copper	Lead	Phosphorus	Units
F001 - Ore Transfer at Transfer Tower	1	1.71E-04	1.29E-07	0.00	g/sec
F002 - Surplus Ore Transfer to Ore Stockpile	1	4.74E-04	3.56E-07	0.00	g/sec
F003A&B - Transfer Points at Ore Bins/Reclaim Area [1]	2	2.00E-04	1.51E-07	0.00	g/sec
F004 - Management of Ore at Ore Stockpile	1	1.06E-03	7.97E-07	0.00	g/sec
F005 - Transfer Points at SAG Mill	1	2.00E-05	1.51E-08	0.00	g/sec
F006A&B - Concentrate Handling Operations [1]	2	2.16E-04	7.41E-09	1.84E-05	g/sec
HR-01 - Vehicle Travel on Ore Stockpile [1]	13	6.55E-04	4.93E-07	0.00	g/sec
HR-02 - Concentrate Truck Travel on Access Road [1, 3]	239	1.81E-08	1.41E-08	6.5E-07	g/sec
HR-03 - Water Truck Travel on Access Road [1, 3]	167	3.34E-08	2.60E-08	1.20E-06	g/sec
HR-04 - Reagent/Grinding Media Truck on Access Road [1,3]	240	1.84E-08	1.44E-08	6.64E-07	g/sec
HR-05 - Explosives Truck Travel on Access Road [1,3]	207	3.48E-05	2.71E-05	7.63E-07	g/sec

Area Sources

Emission Source	Area	Copper	Lead	Phosphorus	Units
F007 - Wind Erosion at Ore Stockpile	51,790	4.06E-08	3.05E-11	0.00	g/m2-sec
F008 - Wind Erosion at TDF	38,079	1.20E-08	3.26E-11	0.00	g/m2-sec

Notes:

1. Each copper, lead, and phosphorus concentration is for each volume source segment. Lead is included here although it is regulated as a federal criteria pollutant
2. Lead and TAC emission rates for ore materials are based on PM emission composition.
3. For vehicle travel on the access road (HR-02, HR-03, HR-04, and HR-05), all emission calculations were calculated based on the percentage of TACs in native soils. Note that the access road will be dressed with clean aggregate material, such that trucks are not in direct contact with native

Table C-1 to Subpart C - Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel

Fuel Type	Default High Heat Value	Default CO_2 Emission Factor
Coal and Coke	**mmBtu/short ton**	**kg CO_2 /mmBtu**
Anthracite	25.09	103.69
Bituminous	24.93	93.28
Subbituminous	17.25	97.17
Lignite	14.21	97.72
Coal Coke	24.80	113.67
Mixed (Commercial sector)	21.39	94.27
Mixed (Industrial coking)	26.28	93.90
Mixed (Industrial sector)	22.35	94.67
Mixed (Electric Power sector)	19.73	95.52
Natural Gas	**mmBtu/scf**	**kg CO_2 /mmBtu**
(Weighted U.S. Average)	1.026E-03	53.06
Petroleum Products	**mmBtu/gallon**	**kg CO_2 /mmBtu**
Distillate Fuel Oil No. 1	0.139	73.25
Distillate Fuel Oil No. 2	0.138	73.96
Distillate Fuel Oil No. 4	0.146	75.04
Residual Fuel Oil No. 5	0.140	72.93
Residual Fuel Oil No. 6	0.150	75.10
Used Oil	0.138	74.00
Kerosene	0.135	75.20
Liquefied petroleum gases (LPG)[1]	0.092	61.71
Propane[1]	0.091	62.87
Propylene[1]	0.091	67.77
Ethane[1]	0.068	59.60
Ethanol	0.084	68.44
Ethylene[2]	0.058	65.96
Isobutane[1]	0.099	64.94
Isobutylene[1]	0.103	68.86
Butane[1]	0.103	64.77
Butylene[1]	0.105	68.72
Naphtha (<401 deg F)	0.125	68.02
Natural Gasoline	0.110	66.88
Other Oil (>401 deg F)	0.139	76.22
Pentanes Plus	0.110	70.02
Petrochemical Feedstocks	0.125	71.02
Petroleum Coke	0.143	102.41
Special Naphtha	0.125	72.34
Unfinished Oils	0.139	74.54
Heavy Gas Oils	0.148	74.92
Lubricants	0.144	74.27

Table C-1 to Subpart C - Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel

Fuel Type	Default High Heat Value	Default CO_2 Emission Factor
Motor Gasoline	0.125	70.22
Aviation Gasoline	0.120	69.25
Kerosene-Type Jet Fuel	0.135	72.22
Asphalt and Road Oil	0.158	75.36
Crude Oil	0.138	74.54
Other Fuels (Solid)	**mmBtu/short ton**	**kg CO_2 /mmBtu**
Municipal Solid Waste	9.95 [3]	90.70
Tires	28.00	85.97
Plastics	38.00	75.00
Petroleum Coke	30.00	102.41
Other Fuels (Gaseous)	**mmBtu/scf**	**kg CO_2 /mmBtu**
Blast Furnace Gas	9.20E-05	274.32
Coke Oven Gas	5.99E-04	46.85
Propane Gas	2.52E-03	61.46
Fuel Gas [4]	1.39E-03	59.00
Biomass Fuels - Solid	**mmBtu/short ton**	**kg CO_2 /mmBtu**
Wood and Wood Residuals (dry basis)[5]	17.48	93.80
Agricultural Byproducts	8.25	118.17
Peat	8.00	111.84
Solid Byproducts	10.39	105.51
Biomass Fuels - Gaseous	**mmBtu/scf**	**kg CO_2 /mmBtu**
Landfill Gas	4.85E-04	52.07
Other Biomass Gases	6.55E-04	52.07
Biomass Fuels - Liquid	**mmBtu/gallon**	**kg CO_2 /mmBtu**
Ethanol	0.084	68.44
Biodiesel	0.128	73.84
Rendered Animal Fat	0.125	71.06
Vegetable Oil	0.120	81.55

[1] The HHV for components of LPG determined at 60°F and saturation pressure with the exception of ethylene.

[2] Ethylene HHV determined at 41°F (5°C) and saturation pressure.

[3] Use of this default HHV is allowed only for: (a) units that combust MSW, do not generate steam, and are allowed to use Tier 1; (b) units that derive no more than 10 percent of their annual heat input from

Table C-1 to Subpart C - Default CO_2 Emission Factors and High Heat Values for Various Types of Fuel

Fuel Type	Default High Heat Value	Default CO_2 Emission Factor

MSW and/or tires; and (c) small batch incinerators that combust no more than 1,000 tons of MSW per year.

[4] Reporters subject to subpart X of this part that are complying with §98.243(d) or subpart Y of this part may only use the default HHV and the default CO_2 emission factor for fuel gas combustion under the conditions prescribed in §98.243(d)(2)(i) and (d)(2)(ii) and §98.252(a)(1) and (a)(2), respectively. Otherwise, reporters subject to subpart X or subpart Y shall use either Tier 3 (Equation C–5) or Tier 4.

[5] Use the following formula to calculate a wet basis HHV for use in Equation C-1: HHVw=((100-M)/100)*HHVd where HHVw = wet basis HHV, M = moisture content(percent) and HHVd=dry basis HHV from Table C-1.

Table C-2 to Subpart C - Default CH_4 and N_2O Emission Factors for Various Types of Fuel

Fuel Type	Default CH_4 Emission Factor (kg CH_4/mmBtu)	Default N_2O Emission Factor (kg N_2O/mmBtu)
Coal and Coke (All fuel types in Table C-1	1.1E-02	1.6E-03
Natural Gas	1.0E-03	1.0E-04
Petroleum (All fuel types in Table C-1)	3.0E-03	6.0E-04
Fuel Gas	3.0E-03	6.0E-04
Municipal Solid Waste	3.2E-02	4.2E-03
Tires	3.2E-02	4.2E-03
Blast Furnace Gas	2.2E-05	1.0E-04
Coke Oven Gas	4.8E-04	1.0E-04
Biomass Fuels - Solid (All fuel types in Table C-1, except wood and wood residuals)	3.2E-02	4.2E-03
Wood and wood residuals	7.2E-03	3.6E-03
Biomass Fuels - Gaseous (All fuel types in Table C-1)	3.2E-03	6.3E-04
Biomass Fuels – Liquid (All fuel types in Table C-1)	1.1E-03	1.1E-04

Note: Those employing this table are assumed to fall under the IPCC definitions of the "Energy Industry" or "Manufacturing Industries and Construction". In all fuels except for coal the values for these two categories are identical. For coal combustion, those who fall within the IPCC "Energy Industry" category may employ a value of 1 g of CH4/mmBtu.

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