APPENDIX I

UPDATED PROJECT EMISSIONS

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I.1 INTRODUCTION

This appendix provides information on the proposed Gahcho Kué Project (Project) emissions in the updated Application Case and the updated Construction Case. The objective of this appendix is to identify and describe any changes to the Project emission estimates in the updated air quality assessment from the original air quality assessment presented in the 2010 Environmental Impact Statement (EIS; De Beers 2010).

I.2 CHANGES IN THE UPDATED AIR QUALITY ASSESSMENT

A list of changes in the assessment approach, assumptions and data made in the updated air quality assessment are presented in Section 2 of the Updated Air Quality Assessment. Changes that directly affect the estimates of the Project emissions are outlined in Table I.2-1. The table also references the section of the appendix where a detailed discussion of each of the changes can be found.

Table I.2-1 A Summary of Changes Affecting Project Emissions in the Updated Air Quality Assessment

Changes	Section in the Appendix I
The updated Application Case is based on the assessment of three years of operation (Years 1, 5, and 8) compared to the original Application Case in the EIS which was based on two years (Years 1 and 5 of the project operation)	I.3.2
A portion of the particulate matter (PM) emissions from sources within the mine pits were assumed to be retained within the pit due to the depth of the pits rather than be released into the atmosphere beyond the pit boundary	I.3.2.4.1
Dioxin/furan emissions from the Project's waste incinerator were assessed based on a waste incinerator operation of 12 hours per day instead of the 24 hours per day in the 2010 EIS	I.3.2.2.3
Revised the Project's and the Snap Lake's waste incinerator dioxin/furan emissions based on Snap Lake waste incinerator stack sampling data.	I.3.2.2.3
Production and deposition schedules of the overburden, mine rock and coarse processed kimberlite (PK) were updated based on the information presented in the 2012 EIS Supplement (De Beers 2012)	I.3.1.1
Revised mitigation of the Fine Processed Kimberlite Containment (PKC) Facility	I.3.2.1
More precise haul road locations and distances	I.3.2.1 and I. 3.2.4.10
Mine rock and haul road surface silt content value	I.3.1.3
Revised road dust mitigation efficiencies for both the summer and winter seasons	I.3.2.4.10
Revised drained lake bed areas	I.3.2.6

I.3 PROJECT EMISSIONS IN THE UPDATED APPLICATION CASE

The Golder Associates Ltd. (Golder) air quality team worked closely with the team at De Beers and the engineering consulting firm designing the Project, namely, JDS Engineering and Mining Inc. (JDS), to define the air emission parameters for the Project. For the purpose of this assessment, the Project emission sources were grouped into the following categories:

- Stack sources: these include power generator, auxiliary boiler, waste incinerator and roller crusher scrubber stacks.
- Mobile diesel combustion equipment: this includes all of the mobile and portable diesel combustion equipment at the Project.
- Mining and material handling activities: these are activities at the Project that will result in fugitive dust emissions.
- Winter access roads.
- Drained Kennady lakebed.

The following subsections describe the supporting data used in the updated Project emission calculations as well as any changes to the emissions of each source during both the operations phase and construction phase.

I.3.1 SUPPORTING DATA USED IN PROJECT EMISSION CALCULATIONS

I.3.1.1 Material Balance

Prior to calculating the Project emissions, the quantity and distribution of the overburden, mine rock, kimberlite and coarse PK were reviewed to determine the most appropriate basis for each emission calculation. Tables I.3-1 to I.3-3 outline the quantity and distribution of the overburden, mine rock and coarse PK during the construction phase and operations phase of the Project based on the latest information presented in the 2012 EIS Supplement (De Beers 2012). Kimberlite annual production rates will reach a maximum of 3.0 million tonnes per year (Mt/y) after lower production rates in the first two years.

Table I.3-1 Overburden Removal from Year -2 to Year 7

Mine Year	Overburden Removal (m³)			
	5034	Hearne	Tuzo	Total
-2[(a)]	204,000	—	—	204,000
-1[(a)]	117,000	—	—	117,000
1	984,000	—	—	984,000
2	—	—	—	—
3	—	—	—	—
4	—	552,000	—	552,000
5	—	328,000	827,000	1,155,000
6	—	—	159,000	159,000
7	—	—	92,000	92,000
Total	**1,305,000**	**880,000**	**1,078,000**	**3,263,000**

Source: De Beers 2012.

(a) Construction years.

m³ = cubic metres.

Table I.3-2 Mine Rock Removal from Year -2 to Year 7

Mine Year	5034 Mine Rock (Mt)			Hearne Mine Rock (Mt)	Tuzo Mine Rock (Mt)			Total
	To South Mine Rock Pile	To West Mine Rock Pile	Total	To West Mine Rock Pile	To 5034 Pit	To West Mine Rock Pile	Total	
-2	1.6	—	1.6	—	—	—	—	1.6
-1	16.0	—	16.0	—	—	—	—	16.0
1	27.2	—	27.2	—	—	—	—	27.2
2	24.7	—	24.7	—	—	—	—	24.7
3	3.6	14.1	17.7	—	—	—	—	17.7
4	—	10.5	10.5	1.9	—	—	—	12.4
5	—	2.9	2.9	10.0	—	11.6	11.6	24.5
6	—	—	—	11.8	7.1	6.2	13.3	25.1
7	—	—	—	3.6	27.2	—	27.2	30.8
8	—	—	—	—	31.5	—	31.5	31.5
9	—	—	—	—	9.9	—	9.9	9.9
10	—	—	—	—	4.0	—	4.0	4.0
11	—	—	—	—	0.3	0.7	1.0	1.0
Total	**73.1**	**27.5**	**100.6**	**27.3**	**80.0**	**18.5**	**98.5**	**226.4**

Source: De Beers 2012.

Mt = million tonnes.

Table I.3-3 Coarse Processed Kimberlite Deposition

Mine Year	Coarse and Grits (Mt)			
	Coarse PK Pile	Construction and Reclamation	West Pile	Total
1	1.89	—	—	1.89
2	2.25	—	—	2.25
3	2.25	—	—	2.25
4	2.05	0.20	—	2.25
5	0.92	0.92	0.41	2.25
6	—	0.72	1.53	2.25
7	—	—	2.25	2.25
8	—	—	2.25	2.25
9	—	—	2.25	2.25
10	—	—	2.25	2.25
11	—	—	1.35	1.35
Total	**9.36**	**1.84**	**12.29**	**23.49**

Source: De Beers 2012.

PK = processed kimberlite; Mt = million tonnes.

I.3.1.2 Moisture Content

None of the moisture content information used in the updated assessment has changed from that in the 2010 EIS. Table I.3-4 provides a summary of the moisture content assumed for various types of material.

Table I.3-4 Moisture Content of Material

Material	Moisture Content (%)
Overburden	24.0
Mine rock	7.5
Kimberlite	6.0
Coarse Processed Kimberlite	12.0

Source: De Beers 2010.

% = percent.

I.3.1.3 Silt Content

Silt content is the fraction of silt, particles smaller than 75 microns (µm) in diameter, in a specific type of material. The silt content of the overburden was obtained from Table I.3-5 in the United States Environmental Protection Agency (U.S. EPA) Compilation of Air Pollutant Emission Factors: AP-42 (U.S. EPA 2006a) due to a lack of site-specific silt data. Table 13.2.4-1 in U.S. EPA (2006a) contains a list of various types of material (e.g., coal, sand, clay and etc.) and their respective silt contents. In the 2010 EIS, the silt content for the mine rock, kimberlite and coarse PK were assumed to be similar to the silt content of crushed limestone. However, recent haul road surface samples collected at the De Beers Snap Lake Mine indicated that silt content of the road surface would be closer to 7.3% (Golder 2012) instead of the 1.6% assumed in the 2010 EIS. Therefore, the silt content of road surface has been revised to 7.3% in this updated air quality assessment. Table I.3-5 summarizes the silt content for each type of material.

Table I.3-5 Silt Content of Material

Material	Silt Content (%)
Overburden	7.5
Mine rock (road surface)	7.3
Kimberlite	1.6
Coarse Processed Kimberlite	1.6

% = percent.

I.3.1.4 Metal Composition of Mine Rock, Kimberlite and Coarse Processed Kimberlite

The majority of the metal emissions from the Project originate from mine rock, kimberlite and coarse processed kimberlite dust released during mining and transport operations. Metal emissions from the combustion sources are negligible in comparison to metal fractions in the fugitive particulate emissions. None of the metal compositions for mine rock, kimberlite and coarse PK has changed from that presented in the 2010 EIS.

I.3.2 OPERATIONS PHASE EMISSIONS

The operations phase of the Project was assessed in the Application Case in the 2010 EIS. As noted in Section I.2, there have been several changes to both the approach and the assumptions used in the updated Application Case in this assessment. The largest change in the assessment approach in the updated Application Case is the number of years of the Project's operation that were modelled. Details of this change are provided in the next section.

I.3.2.1 Operational Years Assessed

Two main factors that influence the predicted ground-level concentrations at a receptor from the dispersion model are the emission rates and the locations of the emission sources relative to the receptor. A large portion of the emissions from the Project are from mobile sources. The emissions and location of these mobile sources will change from year to year depending on the activities that will be undertaken in any particular year. In the 2010 EIS, the Application Case was primarily based on two modelled scenarios:

- a maximum emission scenario (primarily based on Year 8 emissions) with emissions allocated based on the Year 1 mine configuration; and
- a maximum emission scenario (primarily based on Year 8 emissions) with emissions allocated based on the Year 5 mine configuration.

The configuration for Year 1 and Year 5 instead of Year 8 was chosen in the 2010 EIS because the majority of the mining activities in Year 1 and Year 5 will be undertaken near the boundary of the project footprint; in Year 8, the majority of the mining activities will be taken place in the centre of the footprint. These two scenarios provided a conservative representation of the Application Case in the 2010 EIS. Because of the changes in the material balance information and the fine PK disposal location, the two scenarios in the original Application Case in the 2010 EIS were further reviewed to determine their appropriateness for the updated air quality assessment. Instead of assessing two synthetic scenarios that may be overly conservative compared to any particular year of operation, it was recommended that actual Year 1, Year 5, and Year 8 emissions with their respective mine configurations in these years should be modelled in this updated air quality assessment.

The updated Project operation emissions in Year 1, Year 5 and Year 8 are presented in Tables I.3-6 to I.3-11. The location of emission sources in each of these years are shown in Figures I.3-1 to I.3-3. The updated emission scenarios incorporated any change to haul roads and PK disposal piles associated with the revised design of the Fine Processed Kimberlite Containment (PKC) Facility.

Table I.3-6 Year 1 Operations Phase Annual Criteria Air Contaminant Emissions

Source	Emission Rate (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Diesel Generators	0.48	982.68	261.02	17.07	17.60	21.40
Auxiliary Boiler	0.03	2.62	0.66	0.05	0.22	0.43
Waste Incinerator	1.41	1.38	4.38	3.07	3.07	3.07
Crushers	—	—	—	3.24	4.29	9.61
Drilling and Blasting	11.69	93.55	447.35	1.08	9.93	14.55
Loading/Unloading	—	—	—	2.39	15.41	28.24
Bulldozing	—	—	—	4.53	7.81	29.77
Grading	—	—	—	3.53	32.59	97.81
Storage Pile Erosion	—	—	—	4.40	29.34	58.69
Conveyors	—	—	—	5.50	5.50	15.00
Minefleet Exhaust	1.25	597.77	194.17	28.30	28.16	28.16
Road Dust	—	—	—	29.71	290.31	920.10
Winter Access Road	0.00	0.35	0.16	0.01	0.01	0.01
Aggregate Plant	—	—	—	6.41	8.61	22.78
Dry Lakebed	—	—	—	8.49	56.58	110.98
Total	**14.86**	**1,678.36**	**907.74**	**114.24**	**476.84**	**1,262.78**

SO_2 = sulphur dioxide; NO_X = nitrogen oxides; CO = carbon dioxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm; t/y = tonnes per year.

Table I.3-7 Year 5 Operations Phase Annual Criteria Air Contaminant Emissions

Source	Emission Rate (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Diesel Generators	0.48	982.68	261.02	17.07	17.60	21.40
Auxiliary Boiler	0.03	2.62	0.66	0.05	0.22	0.43
Waste Incinerator	1.41	1.38	4.38	3.07	3.07	3.07
Crushers	—	—	—	3.84	4.89	10.96
Drilling and Blasting	11.69	93.55	447.35	1.05	9.39	13.78
Loading/Unloading	—	—	—	4.25	27.38	50.17
Bulldozing	—	—	—	4.32	7.43	28.40
Grading	—	—	—	3.53	33.04	107.19
Storage Pile Erosion	—	—	—	8.90	59.35	118.70
Conveyors	—	—	—	6.60	6.60	18.00
Minefleet Exhaust	1.25	597.82	194.19	28.30	28.39	28.39
Road Dust	—	—	—	22.93	227.71	791.23
Winter Access Road	0.00	0.35	0.16	0.01	0.01	0.01
Aggregate Plant	—	—	—	6.41	8.61	22.78
Dry Lakebed	—	—	—	10.16	67.73	135.46
Total	**14.86**	**1,678.42**	**907.76**	**116.96**	**468.35**	**1,242.78**

SO_2 = sulphur dioxide; NO_X = nitrogen oxides; CO = carbon dioxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 microns; t/y = tonnes per year.

Table I.3-8 Year 8 Operations Phase Annual Criteria Air Contaminant Emissions

Source	Emission Rate (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Diesel Generators	0.48	982.68	261.02	17.07	17.60	21.40
Auxiliary Boiler	0.03	2.62	0.66	0.05	0.22	0.43
Waste Incinerator	1.41	1.38	4.38	3.07	3.07	3.07
Crushers	—	—	—	3.84	4.89	10.96
Drilling and Blasting	11.69	93.55	447.35	1.16	11.22	16.34
Loading/Unloading	—	—	—	5.17	33.32	61.05
Bulldozing	—	—	—	4.74	8.19	31.17
Grading	—	—	—	3.53	32.22	89.79
Storage Pile Erosion	—	—	—	6.27	41.82	83.65
Conveyors	—	—	—	6.60	6.60	18.00
Minefleet Exhaust	1.25	597.82	194.19	28.30	27.98	27.98
Road Dust	—	—	—	47.97	462.69	1,350.05
Winter Access Road	0.00	0.35	0.16	0.01	0.01	0.01
Aggregate Plant	—	—	—	6.41	8.61	22.78
Dry Lakebed	—	—	—	7.26	48.37	96.75
Total	**14.86**	**1,678.42**	**907.76**	**137.92**	**674.58**	**1,743.64**

SO_2 = sulphur dioxide; NO_x = nitrogen oxides; CO = carbon dioxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm; t/y = tonnes per year.

Table I.3-9 Year 1 Operations Phase Annual VOC, PAH, Trace Metals and Dioxin/Furan Emissions

Source	Emission Rate [t/y]			
	VOC	PAH	Trace Metals	Dioxins and Furans[(a)]
Diesel Generators	25.15	0.07	0.183	—
Auxiliary Boiler	0.03	0.00	0.001	1.22×10^{-13}
Waste Incinerator	1.31	0.00	0.004	2.59×10^{-10}
Crushers	—	—	2.279	—
Drilling and Blasting	—	—	0.819	—
Loading/Unloading	—	—	3.629	—
Bulldozing	—	—	1.676	—
Grading	—	—	—	—
Storage Pile Erosion	—	—	3.534	—
Conveyors	—	—	1.968	—
Minefleet Exhaust	29.75	0.22	0.632	—
Road Dust	—	—	60.344	—
Winter Access Road	0.03	—	0.000	—
Aggregate Plant	—	—	1.282	—
Dry Lakebed	—	—	—	—
Total	**56.27**	**0.29**	**76.351**	**2.59×10^{-10}**

(a) dioxin/furan emission rates are in tonnes per year based on World Health Organization's (WHO) toxic equivalent factors (Van den Berg, M., Birnbaum, L.S., el at, 2006).

t/y = tonnes per year; VOC = volatile organic compounds; PAH = polycyclic aromatic hydrocarbons.

Table I.3-10 Year 5 Operations Phase Annual VOC, PAH, Trace Metals and Dioxin/Furan Emissions

Source	Emission Rate [t/y]			
	VOC	PAH	Trace Metals	Dioxins and Furans[(a)]
Diesel Generators	25.15	0.07	0.183	—
Auxiliary Boiler	0.03	0.00	0.001	1.22×10^{-13}
Waste Incinerator	1.31	0.00	0.004	2.59×10^{-10}
Crushers	—	—	2.279	—
Drilling and Blasting	—	—	0.776	—
Loading/Unloading	—	—	3.544	—
Bulldozing	—	—	1.599	—
Grading	—	—	—	—
Storage Pile Erosion	—	—	11.407	—
Conveyors	—	—	3.743	—
Minefleet Exhaust	29.75	0.22	0.639	—
Road Dust	—	—	46.578	—
Winter Access Road	0.03	—	0.000	—
Aggregate Plant	—	—	1.282	—
Dry Lakebed	—	—	—	—
Total	**56.28**	**0.29**	**72.035**	**2.59×10^{-10}**

(a) dioxin/furan emission rates are in tonnes per year based on WHO's toxic equivalent factors (Van den Berg, M., Birnbaum, L.S., el at, 2006).

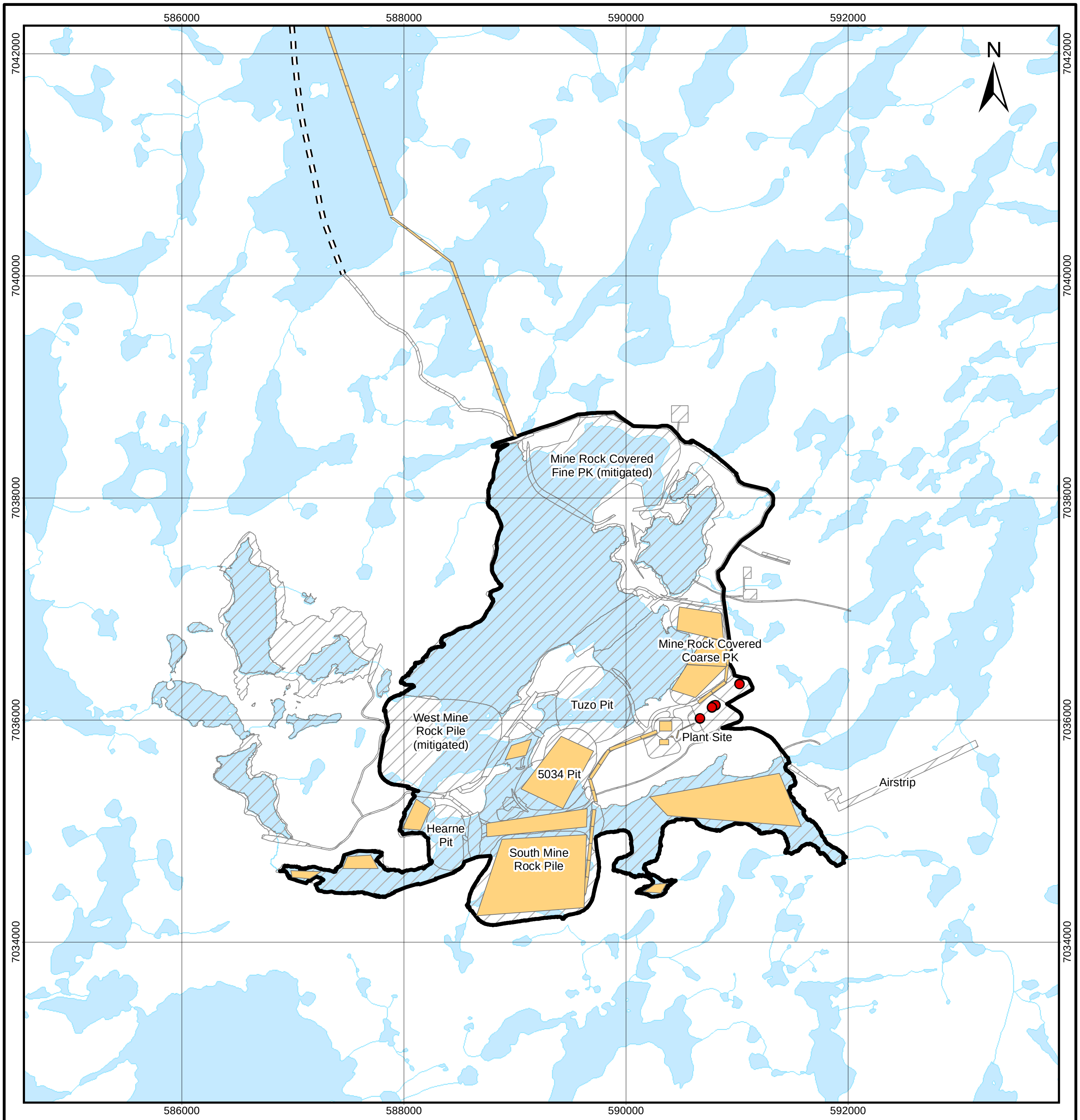
t/y = tonnes per year; VOC = volatile organic compounds; PAH = polycyclic aromatic hydrocarbons.

Table I.3-11 Year 8 Operations Phase Annual VOC, PAH, Trace Metals and Dioxin/Furan Emissions

Source	Emission Rate [t/y]			
	VOC	PAH	Trace Metals	Dioxins and Furans[(a)]
Diesel Generators	25.15	0.07	0.183	—
Auxiliary Boiler	0.03	0.00	0.001	1.22×10^{-13}
Waste Incinerator	1.31	0.00	0.004	2.59×10^{-10}
Crushers	—	—	2.279	—
Drilling and Blasting	—	—	0.920	—
Loading/Unloading	—	—	3.666	—
Bulldozing	—	—	1.755	—
Grading	—	—	—	—
Storage Pile Erosion	—	—	7.981	—
Conveyors	—	—	3.743	—
Minefleet Exhaust	29.75	0.22	0.462	—
Road Dust	—	—	97.434	—
Winter Access Road	0.03	—	0.000	—
Aggregate Plant	—	—	1.282	—
Dry Lakebed	—	—	—	—
Total	**56.28**	**0.29**	**119.711**	**2.59×10^{-10}**

(a) dioxin/furan emission rates are in tonnes per year based on WHO's toxic equivalent factors (Van den Berg, M., Birnbaum, L.S., el at, 2006).

t/y = tonnes per year; VOC = volatile organic compounds; PAH = polycyclic aromatic hydrocarbons.



LEGEND

= = Proposed Winter Access Road
Watercourse
Waterbody
Point Source
Area Source
Development Area Boundary
Project Footprint

NOTES

Base data source: National Topographic Base Data (NTDB) 1:50,000

GAHCHO KUÉ PROJECT

Emission Sources in the Updated Application Case Year 1 Operations

PROJECTION: UTM Zone 12	DATUM: NAD83		DE BEERS CANADA
Scale: 1:50,000 (500 250 0 500 Metres)			
FILE No: E2012-Air-022-GIS			DATE: June 11, 2012
JOB NO: 11-1365-0001	REVISION NO: 1		Figure I.3-1
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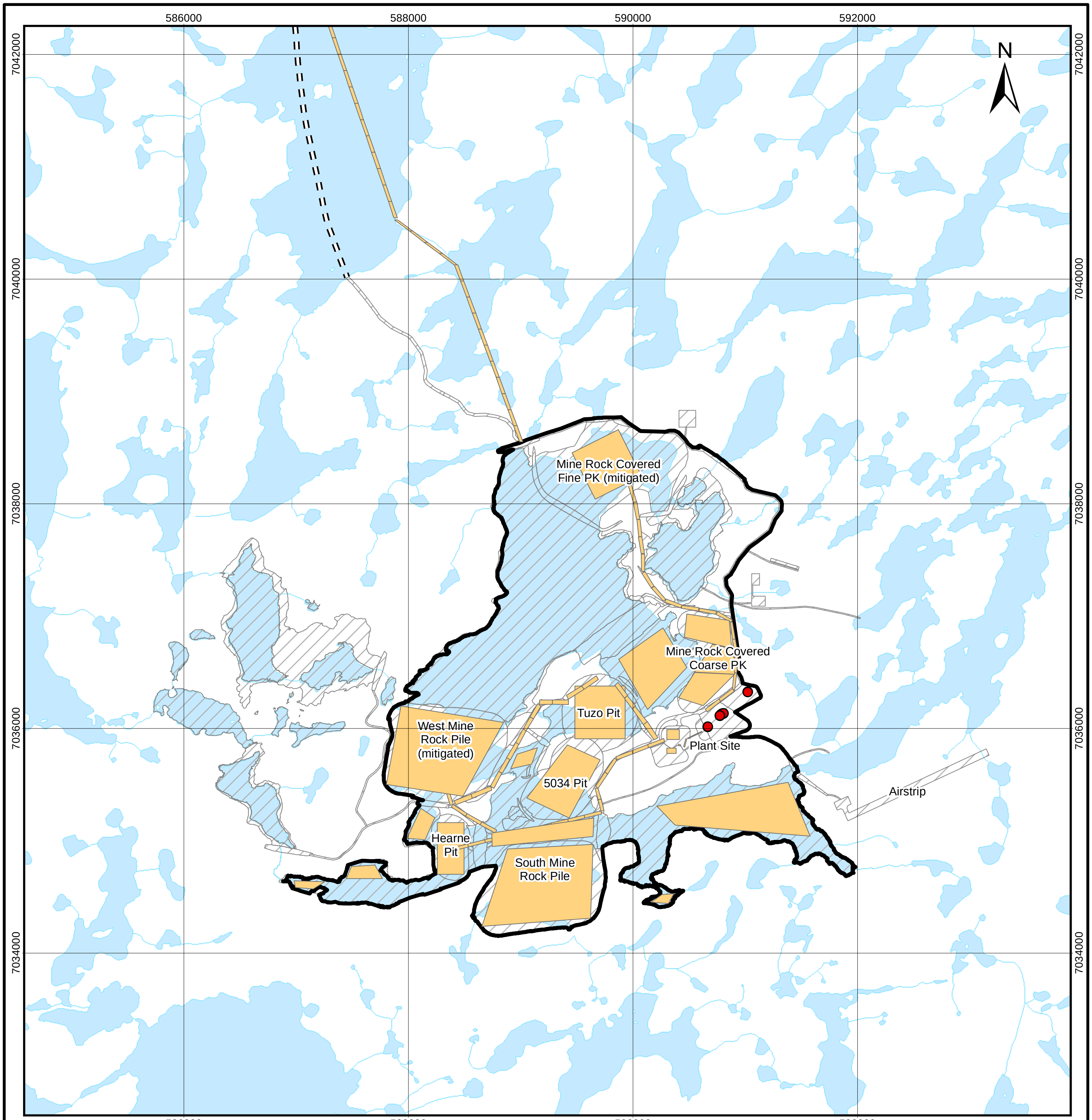

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LEGEND

= = Proposed Winter Access Road
Watercourse
Waterbody
Point Source
Area Source
Development Area Boundary
Project Footprint

NOTES

Base data source: National Topographic Base Data (NTDB) 1:50,000

GAHCHO KUÉ PROJECT

Emission Sources in the Updated Application Case Year 5 Operations

PROJECTION: UTM Zone 12	DATUM: NAD83		DE BEERS CANADA
Scale: 1:50,000 (500 250 0 500 Metres)			
FILE No: E2012-Air-023-GIS			DATE: June 11, 2012
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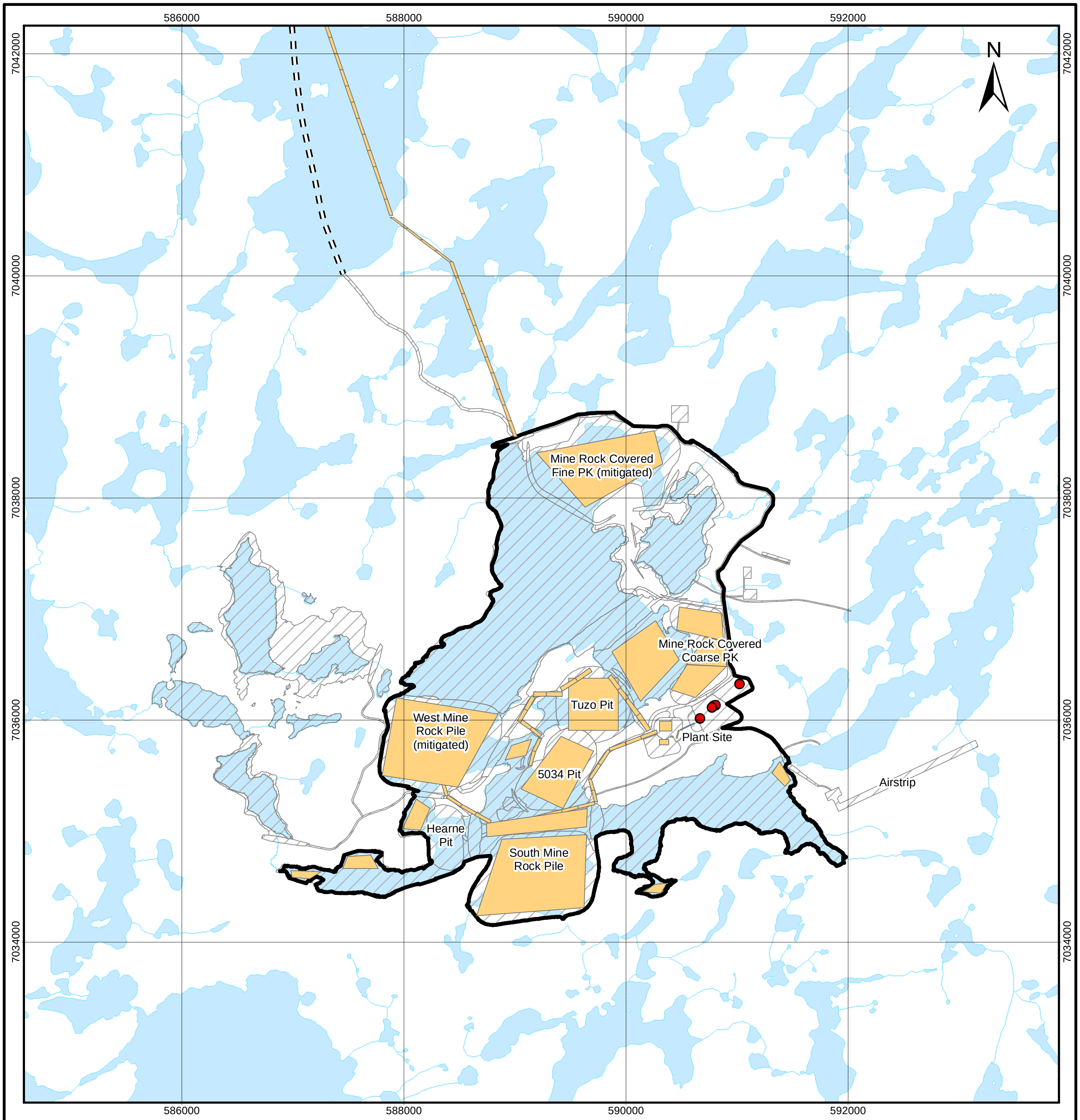

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LEGEND

- = = Proposed Winter Access Road
- Watercourse
- Waterbody
- Point Source
- Area Source
- Development Area Boundary
- Project Footprint

NOTES

Base data source: National Topographic Base Data (NTDB) 1:50,000

GAHCHO KUÉ PROJECT

Emission Sources in the Updated Application Case Year 8 Operations

PROJECTION: UTM Zone 12	DATUM: NAD83	DE BEERS CANADA
Scale: 1:50,000 (500 250 0 500 Metres)		
FILE No: E2012-Air-024-GIS		DATE: June 11, 2012
JOB NO: 11-1365-0001	REVISION NO: 1	**Figure I.3-3**
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I.3.2.2 Stack Emissions

I.3.2.2.1 Generators

A total of five 2,825 kilowatts electrical (kW[e]) prime-rated diesel-fired power generators will be installed to meet the Projects electricity requirements. Three of the five generators will be running during the operations phase of the Project. There was no change to the generator emissions in the updated Application Case. The generator emissions are identical in Years 1, 5, and 8 of operation. The criteria air contaminant (CAC) emissions from the power generators are summarized in Table I.3-12. The VOC, PAH and trace metal emissions from the generators are summarized in Table I.3-13.

Table I.3-12 Power Generator Criteria Air Contaminant Emissions

Source	Emission Rate [t/y]					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Generator 1	0.16	327.56	87.01	5.69	5.87	7.13
Generator 2	0.16	327.56	87.01	5.69	5.87	7.13
Generator 3	0.16	327.56	87.01	5.69	5.87	7.13
Total	**0.48**	**982.68**	**261.02**	**17.07**	**17.60**	**21.40**

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_x = nitrogen oxides; CO = carbon dioxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-13 Generator VOC, PAH and Trace Metal Emissions

Source	Emission Rate (t/y)		
	VOC	PAH	Metals
Generator 1	8.38	0.02	0.061
Generator 2	8.38	0.02	0.061
Generator 3	8.38	0.02	0.061
Total	**25.15**	**0.07**	**0.183**

t/y = tonnes per year; VOC = volatile organic compound; PAH = polycyclic aromatic hydrocarbon.

I.3.2.2.2 Auxiliary Boiler

There is no change to the auxiliary boiler emissions in the updated Application Case. The auxiliary boiler emissions are identical in Years 1, 5, and 8 of operation. A summary of the CAC emissions from the auxiliary boiler is provided in Table I.3-14. The VOC, PAH, and trace metal emissions associated with the boiler are summarized in Table I.3-15.

Table I.3-14 Auxiliary Boiler Criteria Air Contaminant Emissions

Source	Emission Rate (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Auxiliary boiler	0.03	2.62	0.66	0.05	0.22	0.43

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_x = nitrogen oxides; CO = carbon dioxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm; t/d = tonnes per day.

Table I.3-15 Auxiliary Boiler VOC, PAH and Trace Metal Emissions

Source	Emission Rate (t/y)			
	VOC	PAH	Metal	Dioxins/Furans[a]
Auxiliary boiler	0.03	0.00	0.001	1.22×10^{-13}

[a] dioxin/furan emission rate is in tonnes per year based on WHO's toxic equivalent factors (Van den Berg, M., Birnbaum, L.S., el at, 2006).

t/yr = tonnes per year; VOC = volatile organic compound; PAH = polycyclic aromatic hydrocarbon.

I.3.2.2.3 Waste Incinerator

As noted in Section I.2, two changes have been made in the Project's waste incinerator emissions. The 1-hour, 24-hour and annual predictions in the 2010 EIS were assessed based on an assumption that the waste incinerator would be in continuous operation. However, based on information provided by De Beers Snap Lake Mine, the waste incinerator at the Project will be a batch operation with the incinerator firing up to a maximum of 12 hours per day. The waste incinerator typically goes through a loading, pre-heating, incineration, cool-down and unloading cycle. This operational cycle involves about 6 hours of actual incineration time (i.e., firing), twice daily. Based on the new information, the previous assumption would have over-predicted the 24-hour and annual concentrations, especially for compounds such as dioxins and furans. In the updated Application Case, the 1-hour dioxin and furan predictions were still based on the maximum hourly waste incinerator emission rates. However, the 24-hour and annual dioxin and furan predictions were based on the average daily waste incinerator emission rates, which are 50% less than the maximum hourly emission rates.

The second change that was made was in how the waste incinerator's dioxin and furan emissions were estimated. In the 2010 EIS, the dioxin and furan emissions were estimated based on U.S. EPA AP-42 emission factors for modular starved-air waste combustor (1996). The AP-42 emission factors were developed by U.S. EPA based on stack surveys conducted between 1970s and 1990s. These emission factors are typically conservative in nature and do not reflect the advancement in the waste incinerator technology over time. The revised waste incinerator emission rates were derived from actual dioxin/furan emission rates recorded during a stack sampling survey of the waste incinerator at De Beers' Snap Lake Mine in 2007 (Maxxam Analytics Inc., 2007). The revised dioxin and furan emission rate for the Project's waste incinerator was pro-rated from the Snap Lake waste incinerator emissions based on the amount of waste to be incinerated and the assumption that the Project's waste incinerator will meet Canada Wide Standards for dioxin and furan emissions for municipal waste incineration (CCME 2001). The incinerator emissions were assumed to remain identical in Years 1, 5, and 8 of operation. The incinerator CAC emissions are presented in Table I.3-16. The VOC, PAH, trace metal, and dioxin and furan emissions are summarized in Table I.3-17.

Table I.3-16 Waste Incinerator Criteria Air Contaminant Emissions

Source	Emission Rate (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Incinerator	1.41	1.38	4.38	3.07	3.07	3.07

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_x = nitrogen oxides; CO = carbon dioxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-17 Waste Incinerator VOC, PAH, Trace Metal and Dioxin/Furan Emissions

Source	Emission Rate (t/y)			
	VOC	PAH	Metal	Dioxins/Furans[(a)]
Incinerator Annual	1.31	0.00	0.004	5.17×10^{-10} (peak) 2.59×10^{-10} (average)[(a)]

(a) Peak emissions based on 24 hour per day operation were used to predict 1-hour concentrations. Average emissions based on 12 hours per day operation were used to predict 24-hour and annual concentrations. Both emission rates are expressed in tonnes per year based on WHO's toxic equivalency factors (Van den Berg, M., Birnbaum, L.S., el at, 2006).

t/y = tonnes per year; VOC = volatile organic compound; PAH = polycyclic aromatic hydrocarbon.

I.3.2.2.4 High Pressure Roller Crusher Scrubber Stack

The high pressure roller crusher scrubber stack emissions remain unchanged from the 2010 EIS. Table I.3-18 summarizes the emissions from the high pressure roller crusher scrubber stack.

Table I.3-18 High Pressure Roller Crusher Scrubber Stack Emissions

Source	Emission Rate (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
Scrubber stack	0.24	1.29	2.86

t/yr = tonnes per year; VOC = volatile organic compound; PAH = polycyclic aromatic hydrocarbon.

I.3.2.3 Exhaust Emissions from Mining Equipment

All mine equipment exhaust emissions remained unchanged in the updated Application Case. However, the allocation of these emissions has changed based on the Years 1, 5, and 8 mine configurations used in the updated Application Case. The particulate emissions have changed due to a proportion of the particulates emitted being retained within the mine pits. A more detailed discussion on the pit retention of the particulate emissions is provided in the next section (Section I.3.2.4.1). The CAC emissions associated with the mine vehicle exhaust are presented in Table I.3-19. The VOC, PAH, and trace metal emission rates from the mine vehicle exhaust are summarized in Table I.3-20. Metal emissions are varied year to year because they are associated with the particulate emissions.

Table I.3-19 Mine Equipment Exhaust Criteria Air Contaminant Emissions

Year	Emission Rates (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP[a]
Year 1	1.25	597.82	194.19	28.30	28.16	28.16
Year 5	1.25	597.82	194.19	28.30	28.39	28.39
Year 8	1.25	597.82	194.19	28.30	27.98	27.98

[a] The NONROAD model does not provide TSP emission factors. TSP emissions were assumed to be equal to PM_{10} emissions.

t/yr = tonnes per year; SO_2 = sulphur dioxide; NO_x = nitrogen oxides; CO = carbon dioxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-20 Mine Equipment Exhaust VOC, PAH and Trace Metal Emissions

Year	Emission Rates (t/yr)		
	VOC	PAH	Metal
Year 1	29.75	0.22	0.632
Year 5	29.75	0.22	0.639
Year 8	29.75	0.22	0.462

t/yr = tonnes per year; VOC = volatile organic compound; PAH = polycyclic aromatic hydrocarbon.

I.3.2.4 Fugitive Particulate Emissions from Mine and Plant Operations

I.3.2.4.1 Escape Fraction of Particulate Emissions from Open Pits

All particulate emissions from the mine pits are limited by the phenomenon of pit wall retention. Particulates released within a mine pit have the potential to physically impact the mine pit walls. The impact causes deposition within the mine pit, effectively scrubbing particulates and reducing the amount emitted beyond the pits. The remaining portion that is emitted from the pits is referred to as the escape fraction.

As discussed in Section I.2, the concept of pit retention on particulate emissions was not incorporated in the 2010 EIS. It was one of the changes incorporated in the updated assessment. The escape fraction is calculated using the U.S. EPA open-pit algorithm contained within the ISC3 model (Lakes Environmental 2011). The escape fraction is dependent upon the settling velocity of a particle which depends largely upon the effective diameter of the particle. The following equation demonstrates this:

$$E_i = \frac{1}{\left(1 + \frac{v_g}{\alpha U_r}\right)}$$

Where:
E_i = escape fraction;
v_g = gravitational settling velocity (metres per second [m/s]);
α = proportionality constant; and
U_r = wind speed at 10 m/s.

To obtain the value of v_g, the following additional formula was used:

$$v_g = \frac{(\rho - \rho_{air}) g d_p^2 c_2 S_{cf}}{18\mu}$$

Where:

ρ = particle density (grams per cubic centimetre [g/cm^3]);
ρ_{air} = density of air (g/cm^3);
g = gravitational constant (metres per square second [m/s^2]);
d_p = particle diameter (µm);
c_2 = conversion constant (square centimetre per square micron [cm^2/µm^2]);
S_{cf} = the slip correction factor; and
µ = absolute viscosity of the air (gram per centimetre per second [g/cm/s]).

Table I.3-21 presents the escape fraction calculated for TSP, PM_{10} and $PM_{2.5}$.

Table I.3-21 Escape Fractions for Particulates Emitted within the Mine Pits

Particulate Type	Mean Diameter (µm)	Escape Fraction
TSP	30	0.69
PM_{10}	10	0.95
$PM_{2.5}$	2.5	1.00

PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm; µm = micron.

I.3.2.4.2 Drilling and Blasting Operations

Drilling and blasting occur primarily within the mine pits. Given this, the pit retention of particulate emissions described in the previous section would apply to the drilling and blasting emissions. The overall drilling and blasting emissions have changed from those presented in the EIS. Mine rock tonnages have been updated and therefore particulate emissions estimates have been revised accordingly. Escape fractions presented in Table I.3-21 were applied to all blasting and drilling particulate emissions. Tables I.3-22 to I.3-24 presents a summary of the emissions associated with the drilling and blasting in Years 1, 5, and 8 of operation.

Table I.3-22 Year 1 Drilling and Blasting Emissions

Source	Emission Rates (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Drilling	—	—	—	0.77	4.84	7.43
Explosive detonation	11.69	93.55	447.35	—	—	—
Fugitive dust	—	—	—	0.31	5.10	7.12
Total	**11.69**	**93.55**	**447.35**	**1.08**	**9.93**	**14.55**

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_x = nitrogen oxides; CO = carbon dioxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-23 Year 5 Drilling and Blasting Emissions

Source	Emission Rates (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Drilling	—	—	—	0.77	4.84	7.43
Explosive detonation	11.69	93.55	447.35	—	—	—
Fugitive dust	—	—	—	0.28	4.55	6.36
Total	**11.69**	**93.55**	**447.35**	**1.05**	**9.39**	**13.78**

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_x = nitrogen oxides; CO = carbon dioxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-24 Year 8 Drilling and Blasting Emissions

Source	Emission Rates (t/y)					
	SO_2	NO_X	CO	TSP	PM_{10}	$PM_{2.5}$
Drilling	—	—	—	0.77	4.84	7.43
Explosive detonation	11.69	93.55	447.35	—	—	—
Fugitive dust	—	—	—	0.39	6.38	8.91
Total	**11.69**	**93.55**	**447.35**	**1.16**	**11.22**	**16.34**

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_x = nitrogen oxides; CO = carbon dioxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.3.2.4.3 Loading and Unloading Operations

Particulate emissions can be generated by loading and unloading the overburden, mine rock, kimberlite, and PK. In the updated Application Case, loading and unloading emissions for coarse PK were assumed to be zero because coarse PK from the plant is expected to posses a high moisture content. Observations of coarse PK at De Beers Snap Lake and Victor mines have shown that it has the consistency of damp sand. As such, it is reasonable to assume that coarse PK handling generates no fugitive particulate emissions.

With the exception to the change in the coarse PK handling emissions, all other loading and unloading emissions in the updated Application Case remained unchanged. Some of the loading and unloading activities, however, will be conducted within the mine pits. Escape fractions for particulate emissions due to pit retention were applied to the loading emissions released in the pits. Tables I.3-25 to I.3-27 summarizes the loading and unloading emissions in the updated assessment.

Table I.3-25 Year 1 Loading and Unloading Emissions

Material	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
Overburden	0.17	1.07	1.96
Mine rock	2.04	13.13	24.07
Kimberlite	0.19	1.21	2.21
Total	**2.39**	**15.41**	**28.24**

t/y= tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-26 Year 5 Loading and Unloading Emissions

Material	Emission Rates (t/y)		
	TSP	PM_{10}	$PM_{2.5}$
Overburden	0.39	2.51	4.60
Mine rock	3.67	23.66	43.36
Kimberlite	0.19	1.21	2.21
Total	**4.25**	**27.38**	**50.17**

t/y= tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-27 Year 8 Loading and Unloading Emissions

Material	Emission Rates (t/y)		
	TSP	PM_{10}	$PM_{2.5}$
Overburden	0.00	0.00	0.00
Mine rock	4.72	30.42	55.74
Kimberlite	0.45	2.90	5.31
Total	**5.17**	**33.32**	**61.05**

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.3.2.4.4 Bulldozing Operations

The particulate emissions associated with bulldozing of the overburden, mine rock, kimberlite, and coarse PK were estimated based on methodology described in AP-42, Section 11.9 (U.S. EPA 1998). The bulldozing emission factors are expressed as kilograms of particulate emissions per hour of dozer operation based on the following formulae:

$$TSP\ EF = 0.0034(S)^{2.5}$$

$$PM_{15}\ EF = 0.0056(S)^{2.0}$$

$$PM_{10}\ EF = 0.60 \times PM_{10}\ EF$$

$$PM_{2.5}\ EF = 0.031 \times TSP\ EF$$

Where:

EF = emission factor (kilogram per hour [kg/h])
s = material silt content (%)
M = material moisture content (%)

As discussed previously, the silt content of the mine rock has been revised in the updated assessment based on samples collected at the Snap Lake Mine. The bulldozing emissions associated overburden, kimberlite, and coarse PK otherwise remained unchanged from those in the 2010 EIS. However, some of the bulldozing activities will be conducted within the mine pits. Therefore, escape fractions for particulate emissions due to mine retention were applied to these emissions. Tables I.3-28 to I.3-30 present summaries of the updated bulldozing emissions for each of the modelled years.

Table I.3-28 Year 1 Bulldozing Emissions

Material	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
Overburden	0.08	0.13	0.53
Mine rock	4.34	7.56	28.50
Kimberlite	0.09	0.10	0.57
Coarse PK	0.03	0.03	0.17
Total	**4.53**	**7.81**	**29.77**

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-29 Year 5 Bulldozing Emissions

Material	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
Overburden	0.10	0.15	0.65
Mine rock	4.08	7.11	26.82
Kimberlite	0.11	0.12	0.71
Coarse PK	0.03	0.03	0.22
Total	**4.32**	**7.43**	**28.40**

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-30 Year 8 Bulldozing Emissions

Material	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
Overburden	0.00	0.00	0.00
Mine rock	4.62	8.05	30.36
Kimberlite	0.10	0.11	0.63
Coarse PK	0.03	0.03	0.19
Total	**4.74**	**8.19**	**31.17**

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.3.2.4.5 Crushing Operations

The crusher emissions have changed from those presented in the 2010 EIS. Crusher emissions were brought into line with the tonnage production rates for each of the three years modelled. Table I.3-31 summarizes the primary crusher emissions. The emissions are lower for Year 1 and then increase and level off for the remaining years.

Table I.3-31 Primary Crusher Emissions

Year	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
1	3.00	3.00	6.75
5	3.60	3.60	8.10
8	3.60	3.60	8.10

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.3.2.4.6 Conveyor Operation

There will be four conveyors used to transfer crushed kimberlite from the primary crusher to the main process plant. Two conveyors will be used to discharge the coarse PK from the process plant to an adjacent temporary outdoor storage pile. In the updated Application Case, emissions were only expected from the kimberlite conveyors and not from the coarse PK conveyors because coarse PK has high moisture content. Table I.3-32 presents the conveyor emissions for all three years modelled.

Table I.3-32 Conveyor Emissions

Year	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
1	5.5	5.5	15.0
5	6.6	6.6	18.0
8	6.6	6.6	18.0

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.3.2.4.7 Aggregate Plant Operations

An aggregate plant will be built to provide aggregates required for Project construction. After the construction of the Project is completed, the aggregate plant will operate intermittently for approximately one month each year to provide the granular material for haul road maintenance. Although the aggregate plant will operate for approximately one month per year during the operating phase of the Project, it was conservatively assumed that the plant will be in continuous operation. The preliminary design of the aggregate plant indicated that the plant will consist of:

- one screen;
- three crushers; and
- five conveyors.

The aggregate plant emissions remained unchanged from the 2010 EIS. Table I.3-33 provides a summary of the aggregate plant emissions.

Table I.3-33 Aggregate Plant Emissions

Material	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
Crushers	0.33	1.77	3.94
Screen	0.05	0.81	2.41
Conveyors	6.02	6.02	16.43
Total	**6.41**	**8.61**	**22.78**

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.3.2.4.8 Wind Erosion

Fugitive dust emissions may be generated by wind erosion of outdoor stockpiles or exposed surfaces of loose materials present at the South Mine Rock Pile, West Mine Rock Pile, run-of-mine (ROM) stockpile, coarse PK stockpiles and dried lake bed. Emissions associated with wind erosion of the dried lake bed are discussed separately in Section I.3.2.6. Surfaces subjected to wind erosion can be separated into two categories: an active area and an inactive area. The emissions for the active area of a surface were calculated assuming that the area will be disturbed on an hourly basis. An erosion potential for every hour of the year was calculated and summed to provide an annual emission factor. Conversely, the emissions for the inactive area of a surface were estimated assuming the area will be disturbed once a year.

The methodology used to estimate the fugitive dust emissions from these sources remained unchanged from the 2010 EIS. However, the emissions were revised in the updated Application Case to reflect the storage piles in operation in each of the three years assessed. Table I.3-34 presents the active, inactive and total area for the surfaces with wind erosion emissions.

Table I.3-34 Active and Inactive Areas for Wind Erosion Emission Sources

Material	Area (m²)		
	Active	Inactive	Total
South Mine Rock Pile	18,000	760,453	778,453
West Mine Rock Pile	18,000	770,719	788,719
ROM	3,000	11,000	14,000
Coarse PK Area 4	n/a	1,296	1,296
Coarse PK Area 2 (Year 5)	n/a	213,370	213,370
Coarse PK Area 2 (Year 8)	n/a	422,605	422,605
Total	**39,000**	**2,179,443**	**2,218,443**

ROM = run of mine; m^2 = square metres; n/a = not applicable.

Per the 2010 EIS, the updated air quality assessment conservatively assumed that the conditions favourable for wind-blown emissions from the inactive areas of the exposed surfaces can only occur between May and September. Because these areas will be disturbed infrequently, these areas will be covered by snow during the rest of the year. Therefore, no wind-blown emissions from the inactive areas of the exposed surfaces are expected. Tables I.3-35 to I.3-37 summarizes the wind-erosion emission rates for each of the three years modelled.

Table I.3-35 Year 1 Wind Erosion Emissions

Material	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
Active Areas			
ROM	0.36	2.39	4.78
South Mine Rock Pile	3.01	20.03	40.07
Inactive Areas			
ROM	0.01	0.09	0.18
South Mine Rock Pile	1.02	6.82	13.63
Coarse PK Area 4	0.00	0.01	0.03
Total	**4.40**	**29.34**	**58.69**

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-36 Year 5 Wind Erosion Emissions

Material	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
Active Areas			
ROM	0.36	2.39	4.78
West Mine Rock Pile	3.24	21.59	43.19
Inactive Areas			
ROM	0.01	0.09	0.18
South Mine Rock Pile	2.13	14.22	28.44
West Mine Rock Pile	2.13	14.22	28.44
Coarse PK Area 4	0.00	0.01	0.02
Coarse PK Area 2	1.02	6.82	13.64
Total	**8.90**	**59.35**	**118.70**

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-37 Year 8 Wind Erosion Emissions

Material	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
Active Areas			
ROM	0.36	2.39	4.78
Inactive Areas			
ROM	0.01	0.09	0.18
South Mine Rock Pile	1.94	12.91	25.82
West Mine Rock Pile	1.94	12.91	25.82
Coarse PK Area 4	0.00	0.01	0.03
Coarse PK Area 2	2.03	13.51	27.02
Total	**6.27**	**41.82**	**83.65**

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.3.2.4.9 Grading Operations

Grading emissions changed from the grading emissions used in the 2010 EIS. Portions of the grading for each year modelled were conducted within the mine pits and therefore the pit retention algorithm was applied to reduce the total emissions of PM_{10} and $PM_{2.5}$. Table I.3-38 presents the grading emission factors and the grading emissions.

Table I.3-38 Grading Emissions

Year	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
1	3.53	32.59	97.81
5	3.53	33.04	107.19
8	3.53	32.22	89.79

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.3.2.4.10 Road Dust Emissions

Particulate emissions are expected to be generated when mine vehicles travel on the unpaved haul roads at the Project. The road dust emissions were estimated based on Section 13.2.2 of AP-42 (U.S. EPA 2006b). The emission factor from AP-42 can be expressed by the following formula:

$$EF = k\left(\frac{s}{12}\right)^a\left(\frac{W}{3}\right)^b$$

where:

EF = emission factor in pounds per vehicle mile travelled (lb/VMT)
s = silt content of the unpaved road surface (%)
k, a, b = particulate matter size-specific constants from Section 13.2.2 of AP-42 (U.S. EPA 2006b)
W = mean vehicle weight (ton)

In the updated air quality assessment, the silt content of the haul roads was changed from 1.6% based on silt content of crushed limestone provided in Table 13.2.4-1 in the United States Environmental Protection Agency (U.S. EPA) Compilation of Air Pollutant Emission Factors: AP-42 (U.S. EPA 2006a) to 7.3% based on samples collected at the Snap Lake Mine.

Changes were also made to the haul road distances in the updated assessment. Based on inputs from the team at JDS, more accurate haul road distance and location information was made available. The new information was reflected in the updated road dust emissions.

During the summer months of May to September, road dust emissions can be mitigated by intermittent watering of the haul roads. The quantity of road dust emitted into the atmosphere depends primarily on the amount of water applied to the roads, the frequency of application and the water evaporation rate from the road surface. Data from field tests conducted in North Dakota, New Mexico, Ohio and Missouri (U.S. EPA 1987) indicated that frequent water applications every 1.8 to 4.5 hours can achieve dust control efficiencies between 59% and 88%. The Environment Canada guidance document for National Pollution Release Inventory (Environment Canada 2010) reporting recommends a 55% control efficiency when roads are watered twice a day and 70% control efficiency when roads are watered more than twice a day. In the 2010 EIS, the original Application Case was conservatively assessed based on a 55% control efficiency due to lack of site specific data. Based on further discussions with De Beers, the roads are typically watered more than twice a day during the summer season and therefore a higher control efficiency of 70% was assumed in updated Application Case.

Watering of the haul roads will not be possible in the winter due to freezing conditions. However, a large degree of natural mitigation of the road dust emissions can be expected from the freeze-drying of the road material and from snow and ice accumulation on the road surface. A study conducted at De Beers Snap Lake and Victor mines (Golder 2012) determined the natural mitigation on the road dust emissions brought about by the winter conditions. It was concluded that the natural winter mitigation efficiency on road dust emissions at these mines is approximately 95%. The 2010 EIS was based on an assumption of 0% mitigation of road dust emissions in the winter; the updated assessment assumed that 95% of the winter road emissions will be mitigated by the natural winter conditions and prevented from being released into the atmosphere.

The largest contributor of particulate emissions from the Project are the road dust emissions generated from haul roads, both within the pits and outside the mine pits. Other than the seasonal mitigation (i.e., 70% in summer and 95% in winter) discussed earlier, escape fractions due to pit retention were also applied to the road dust emissions from haul roads located within the mine pits. The annual road dust emissions in Years 1, 5, and 8 are summarized in Table I.3-39. The seasonal road dust emission rates are summarized in Table I.3-40

Table I.3-39 Road Dust Annual Emission Rates

Material	Haul Road Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
Year 1	29.71	290.31	920.10
Year 5	22.93	227.71	791.23
Year 8	47.97	462.69	1,350.05

t/y= tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

Table I.3-40 Winter and Summer Road Dust Emission Rates in Annual Emission Rates

Material	Haul Road Summer Emission Rates (t/y)			Haul Road Winter Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP	$PM_{2.5}$	PM_{10}	TSP
Year 1	24.09	235.39	746.02	5.62	54.92	174.07
Year 5	18.59	184.63	641.54	4.34	43.08	149.69
Year 8	38.90	375.16	1,094.63	9.08	87.54	255.41

t/y= tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.3.2.5 Winter Access Road Emissions

The emissions associated with the winter access road are unchanged from those presented in the EIS. Per the approach used in the 2010 EIS, the winter access road emissions were only modelled as active emission sources from January to April to reflect the seasonal nature of winter road traffic. A summary of the winter access road emission are presented in Table I.3-41.

Table I.3-41 Emissions from 15 Kilometre Stretch of the Winter Access Road

Emission Parameter	Emission Rates (t/d)
SO_2	5.32×10^{-6}
NO_X	2.92×10^{-3}
CO	1.34×10^{-3}
TSP	6.41×10^{-5}(a)
PM_{10}	6.41×10^{-5}
$PM_{2.5}$	5.90×10^{-5}
VOC	2.73×10^{-4}

(a) MOBILE does not provide an emission factor for TSP. PM_{10} is a subset of TSP. Therefore, it was assumed that the TSP emission rate is equal to the PM_{10} emission rate.

t/d = tonnes per day.

I.3.2.6 Wind Blown Dust Emissions from Drained Kennady Lakebed

The development of the Gahcho Kué mine will require the partial draining of Kennady Lake and the exposure of substantial portions of the lakebed to the atmosphere. Concern has been expressed that the sediment at the bottom of the lake would dry and contribute to windblown dust. In the 2010 EIS, it was conservatively assumed that conditions favourable for wind-blown emissions from the dried lake bed could occur from May to September. It was assumed that the lake bed will be covered by snow during the rest of the year; no wind-blown emissions can be expected during that time. The same assumption was used in the updated air quality assessment.

Over the project life-cycle, different areas of Kennady Lake will be drained. In the updated assessment, the area of exposed lakebed for each of the three modelled years was considered. Each of the years modelled has a different area of exposed lakebed. Exposed lakebeds during the summer months will be subject to wind erosion. However, the lakebeds will be frozen during the winter months and covered in snow; therefore, the wind-blown dust emissions from the exposed lakebed will be zero during the winter months. The estimated wind-blown dust emissions from the exposed lakebed for Years 1, 5, and 8 are summarized in Table I.3-42.

Table I.3-42 Wind-blown Dust Emissions from Exposed Kennady Lakebed

Year	Emission Rates (t/y)		
	$PM_{2.5}$	PM_{10}	TSP
Year 1	8.49	56.58	110.98
Year 5	10.16	67.73	135.46
Year 8	7.26	48.37	96.75

t/y = tonnes per year; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.3.2.7 Greenhouse Gas Emissions

Greenhouse Gases (GHG) emitted from the Project will be unaffected by the changes outlined in the updated air quality assessment. Therefore, the maximum annual GHG emissions that were presented in the 2010 EIS remain valid.

I.4 PROJECT EMISSIONS IN THE UPDATED CONSTRUCTION CASE

The construction of the Project will occur over a period of two years. The construction period will include Project construction and dewatering part of Kennady Lake before mining can begin. After the water above the ore bodies has been drained, pre-stripping of the open pits and initial mining will begin.

Sources of emissions present during the construction phase of the Project will be similar to emission sources present during the operations phase of the Project, with the exception of the sources associated with the kimberlite ore processing and coarse PK disposal activities. Changes in the assessment approach, assumptions and data that were incorporated in the updated Application Case were also incorporated in the updated Construction Case. Table I.4-1 summarizes the maximum CAC emissions associated with the construction activities at the Project.

Table I.4-1 Updated Construction Phase Criteria Air Contaminant Emissions

Source	Emission Rate (t/y)					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Diesel Generators	3.14	657.89	182.78	17.51	17.86	20.40
Waste Incinerator	1.41	1.38	4.38	3.07	3.07	3.07
Drilling & Blasting	7.10	56.80	268.42	0.89	6.84	10.23
Loading/Unloading	—	—	—	2.44	15.71	28.78
Bulldozing	—	—	—	4.21	7.33	27.66
Grading	—	—	—	1.77	16.32	49.39
Storage Pile Erosion	—	—	—	3.68	24.51	49.01
Mine fleet Exhaust	0.61	309.25	101.91	15.17	15.00	15.00
Road Dust	—	—	—	5.86	58.31	205.93
Aggregate Plant	—	—	—	6.41	8.61	22.78
Winter Access Road	0.00	0.59	0.27	0.01	0.01	0.01
Dry Lake Bed Fugitives	—	—	—	9.48	63.22	126.45
Totals	**12.26**	**1,025.91**	**557.76**	**68.73**	**220.48**	**509.32**

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_X = nitrogen oxides; CO = carbon monoxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.5 SUMMARY OF PROJECT AND REGIONAL EMISSIONS

Based on the changes to the Project emissions described in the previous sections, a summary of the cumulative emissions assessed in the Baseline Case, updated Application Case and updated Construction Case is provided in Table I.5-1.

Table I.5-1 Summary of Project and Regional Emissions in Each Assessment Case

Source	Emission Rate [t/y]					
	SO_2	NO_X	CO	$PM_{2.5}$	PM_{10}	TSP
Baseline Case						
Snap Lake Mine	110.96	3,165.65	1,100.11	60.59	91.62	183.23
Updated Application Case						
Gahcho Kué Project	14.86	1,678.42	907.76	137.92	674.58	1743.64
Snap Lake Mine	110.96	3,165.65	1,100.11	60.59	91.615	183.23
Total	**125.82**	**4844.06**	**2,007.87**	**198.51**	**766.20**	**1,926.87**
Updated Construction Case						
Gahcho Kué Project	12.26	1,025.91	557.76	68.73	220.48	509.32
Snap Lake Mine	110.96	3,165.65	1,100.11	60.59	91.62	183.23
Total	**123.22**	**4,191.55**	**1,657.87**	**129.32**	**312.09**	**692.55**

t/y = tonnes per year; SO_2 = sulphur dioxide; NO_x = nitrogen oxides; CO = carbon dioxide; TSP = total suspended particulates; PM_{10} = particulate matter with particle diameter less than 10 µm; $PM_{2.5}$ = particulate matter with particle diameter less than 2.5 µm.

I.6 REFERENCES

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I.7 ACRONYMS

I.7.1 ACRONYMS

ANFO	ammonium nitrate fuel oil
CAC	criteria air contaminant
CO	carbon monoxide
De Beers	De Beers Canada Inc.
EIS	environmental impact statement
GHG	greenhouse gas
Golder	Golder Associates Ltd.
JDS	JDS Engineering and Mining Inc.
N	nitrogen
NO	nitric oxide
NO_2	nitrogen dioxide gas
NO_X	nitrogen oxides
NWT	Northwest Territories
PAH	polycyclic aromatic hydrocarbon
PAI	potential acid input
PETN	pentaerythritol tetranitrate
PM	particulate matter, generally
PK	processed kimberlite
PKC	processed kimberlite containment
PM_{10}	particulate matter with particle diameter less than 10 μm
$PM_{2.5}$	particulate matter with particle diameter less than 2.5 μm
Project	Gahcho Kué Project
ROM	run-of-mine
SO_2	sulphur dioxide gas
TNT	trinitrotoluene
TSP	total suspended particulates
U.S. EPA	Unites States Environmental Protection Agency
VOC	volatile organic compound

I.7.2 UNITS OF MEASURE

%	percent
μ	micro - 10^{-6}
μm	micron or micrometre = 10^{-6} m
5.21E^{-02}	Scientific notation: 0.0521 = 5.21E-02 = 5.21×10-2
g	gram
kg	kilogram
kg/h	kilograms per hour
km	kilometre
km/h	kilometres per hour
km^2	square kilometres
kW(e)	kilowatt (electric)
L	litre
lb	pound
lb/VMT	pound per vehicle miles travelled
m	metre
m/s	metres per second
m^2	square metres
m^3	cubic metres
mm	millimetres
Mt	million tonne
Mt/y	million tonnes per year
t	tonne = 1,000 kg
t/d	tonnes per day
t/y	tonne per year